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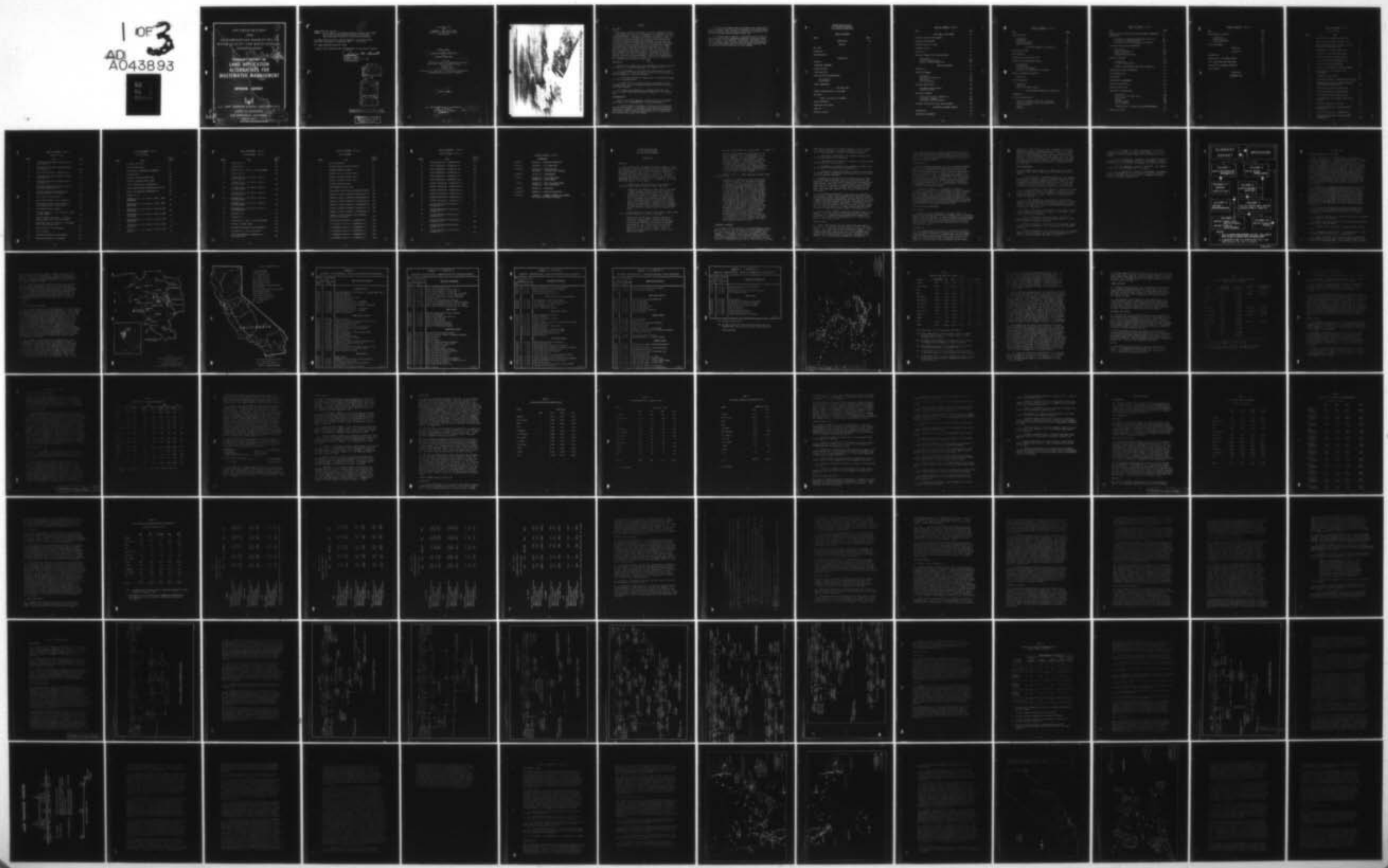

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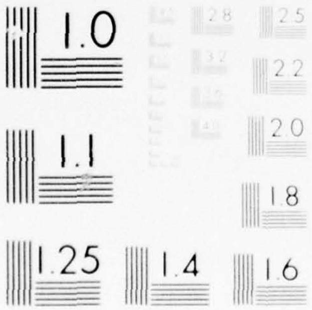

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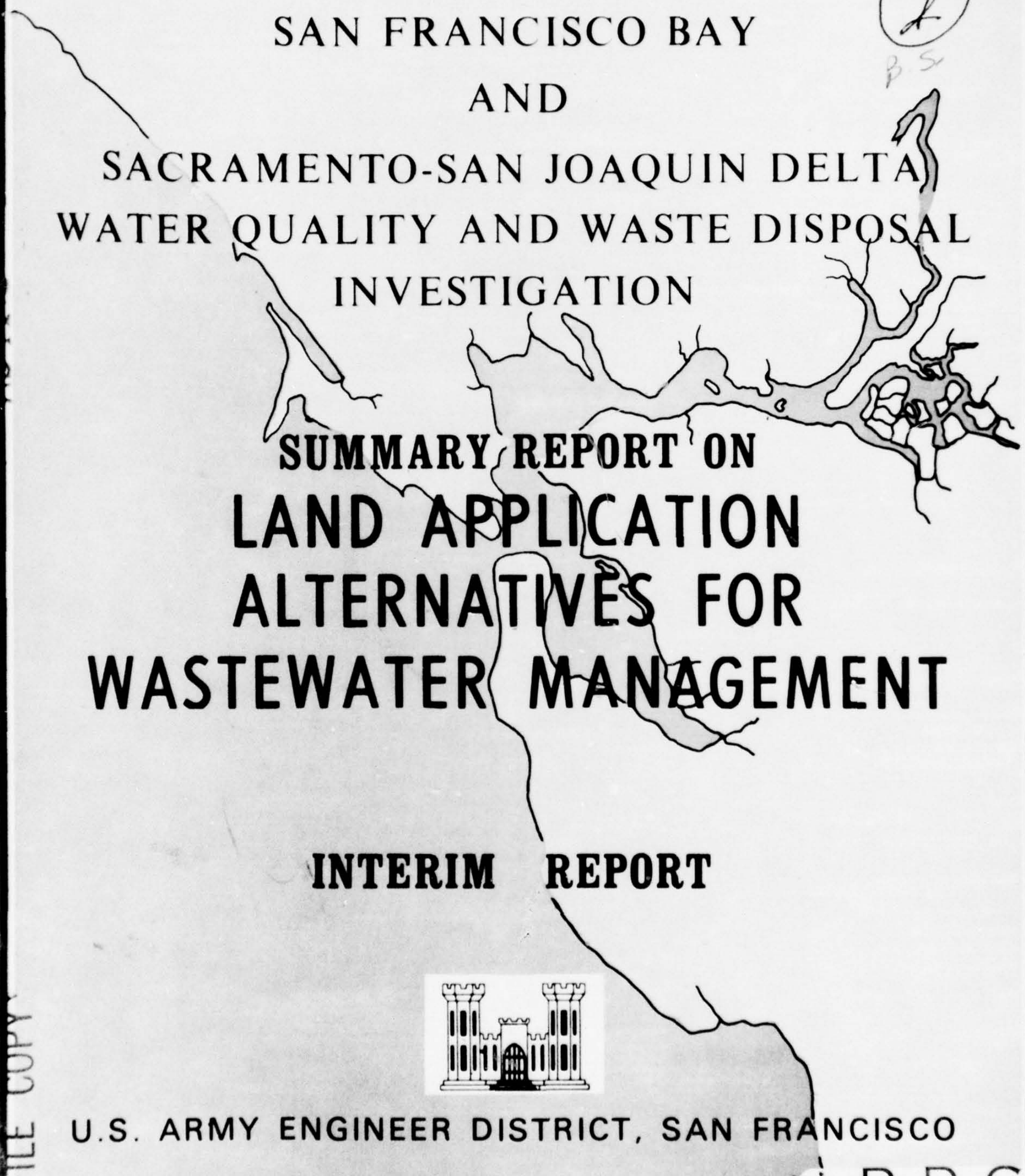

SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN DELTA WATER QUALITY AND WASTE DISPOSAL INVESTIGATION

SUMMARY REPORT ON LAND APPLICATION ALTERNATIVES FOR WASTEWATER MANAGEMENT

INTERIM REPORT

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA
MARCH 1975

SPDPD-U [Mar 75] 1st Ind
SUBJECT: Interim Report - San Francisco Bay and Sacramento-San Joaquin
Delta, Water Quality and Waste Disposal Investigation -
Land Application Alternatives for Wastewater Management

DA, South Pacific Division, Corps of Engineers, 630 Sansome Street,
Room 1216, San Francisco, California 94111 17 July 1975

TO: HQDA (DAEN-CWP-W) WASH DC 20314

I concur in the conclusions and recommendations of the District Engineer.

Richard M. Connell
RICHARD M. CONNELL
Brigadier General, U. S. Army
Division Engineer

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SAN FRANCISCO BAY
AND
SACRAMENTO - SAN JOAQUIN DELTA
WATER QUALITY AND WASTE DISPOSAL
INVESTIGATION

SUMMARY REPORT
ON
(6) LAND APPLICATION ALTERNATIVES
FOR
WASTEWATER MANAGEMENT

for the
San Francisco Bay and Sacramento-San Joaquin
Delta Water Quality and Waste Disposal
Investigation.
Summary Report.

Alternatives for the State of California's Consideration
in Comprehensive Water Quality Planning

(9) INTERIM REPORT,

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA
(11) MARCH 1975

(12) 340 P.

391 022

SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN DELTA REGION

ABSTRACT

THE STUDY

This report presents the results of a Corps of Engineers' effort in developing alternatives for the management of wastewater and sludge including wastewater reclamation alternatives, as related to the land treatment of wastes. Two regional wastewater management concepts incorporating land application, each including three separate alternatives for municipal and industrial discharges, are described and evaluated in terms of the objectives of national economic development, environmental quality, social well-being, and regional development. Land application techniques for treating wastewater offer a viable alternative means of meeting Federal and State water quality objectives and goals for many areas of the 12-county San Francisco Bay and Sacramento-San Joaquin Delta Region. Information presented will provide input to the State of California's water quality planning program, especially in the development of the State's "Comprehensive Water Quality Control Plans" for basins within the San Francisco Bay and Sacramento-San Joaquin Delta Region.

CONCLUSIONS

Concerning the feasibility of the development of land application alternatives for wastewater management on a regional basis:

a. The development of land application alternatives for wastewater management on a regional basis is feasible and could produce an effluent comparable to tertiary treatment.

b. The ultimate disposal of sludge could be accomplished through the use of land application.

c. Through the use of land application, a valuable resource, reclaimed water, could be recovered and beneficially used for various enhancement purposes.

d. No major socio-ecological or economic factors have been identified which would negate wastewater management by land application.

RECOMMENDATIONS

Based on the work accomplished in this study and its resultant conclusions, it is recommended that the Corps of Engineers:

a. Provide technical assistance to the State of California on land treatment systems for the disposal of municipal and industrial effluents, as requested, in completing and/or updating Comprehensive Water Quality Control Plans for basins within the San Francisco Bay and Sacramento-San Joaquin Delta Region;

b. Continue and expand, under the original study authorization and in cooperation with the State of California and the Environmental Protection Agency, data collection and analysis of non-point sources pollution including urban stormwater runoff; and,

c. Be authorized to prepare, in cooperation with the State of California and its local governmental agencies, subregional feasibility reports on land treatment of municipal, industrial, and non-point discharges in the 12-county San Francisco Bay and Sacramento-San Joaquin Delta Region with the objectives being consistent with comprehensive policies and plans for water quality.

SUMMARY REPORT ON LAND APPLICATION ALTERNATIVES FOR WASTEWATER MANAGEMENT

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SUMMARY REPORT ON LAND
APPLICATION ALTERNATIVES
FOR WASTEWATER MANAGEMENT

INTRODUCTION

AUTHORITY

1. This study has been undertaken in partial response to various Congressional actions which directed the Corps of Engineer's involvement in water quality control, measures for waste disposal and wastewater management alternatives in the San Francisco Bay and Sacramento-San Joaquin Delta Region of California. The Corps' efforts in developing regional alternatives for the management of wastewater and sludge are summarized in this document. Numerous appendices support this summary report. Following are the specific authorities for this interim report:

a. Sacramento, San Joaquin and Kern Rivers, California, Resolution, House Committee on Public Works, 8 May 1964:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports on Sacramento, San Joaquin and Kern Rivers, California, published as House Document 191, 73rd Congress, Second Session, and other reports with a view to determining the feasibility of remedial measures for water quality control and other purposes, included in comprehensive development of the Sacramento-San Joaquin Delta, including verification of conclusions by model analysis as deemed necessary," adopted 8 May 1964.

b. San Francisco Bay, California, Water Quality Control Study, Section 216 Flood Control Act of 1965 - PL 89-298:

> "The Secretary of the Army is hereby authorized and directed to cause to be made, under the direction of the Chief of Engineers, an investigation and study of San Francisco Bay California, including San Pablo Bay, Suisun Bay, and other adjacent bays and tributaries thereto, with a view toward determining the feasibility of, and extent of Federal interest in, measures for waste disposal and water quality control and allied purposes."

c. Resolution, House Committee on Public Works, [illegible] November 1971:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is requested to determine the advisability of improvements in the interest of wastewater management and alternatives thereto, in the San Francisco Bay, California area, including San Pablo Bay, Suisun Bay, and other adjacent bays and tributaries thereto, in connection with investigations authorized for study of San Francisco Bay, California, by Section 216 of the Flood Control Act of 1965."

d. Committee Resolution, Senate Committee on Public Works, 23 November 1971:

> "Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors is requested to determine the advisability of improvements in the interest of wastewater management and alternatives thereto, in the San Francisco Bay, California area, including San Pablo Bay, Suisun Bay, and other adjacent bays and tributaries thereto, in connection with investigations authorized for a study of San Francisco Bay, California, by Section 216 of the Flood Control Act of 1965: and for Sacramento, San Joaquin and Kern Rivers, California by Resolution dated 8 May 1964 by the Committee on Public Works of the House of Representatives, United States. In carrying out the aforesaid investigation, the Board shall evaluate general alternatives for the management of wastewater on a regional basis, including the elimination of pollutant discharges and shall conduct such investigation with the participation, consultation and cooperation of the Environmental Protection Agency and State and local water pollution control agencies and, where appropriate, State and local agencies with environmental planning responsibilities."

INTERAGENCY AGREEMENT

2. On 8 March 1972 the California State Water Resources Control Board, Region IX of the Environmental Protection Agency and the U.S. Army Engineer District, San Francisco, executed a joint agreement for interagency water quality management planning assistance. As specified by the agreement, the Corps is to provide planning assistance to the State of California in the preparation of "Comprehensive Water Quality Control Plans" for basins

within the San Francisco Bay and Delta Region. In order to provide this planning assistance, four specific objectives were outlined in the "Joint Agreement" for study by the Corps of Engineers:

a. Development of alternatives for treatment processes incorporating land application of wastewater;

b. Development of alternatives for disposal of treatment system sludge by means of land application;

c. Development of alternatives for wastewater reclamation and use as related to land application procedures; and,

d. Evaluation of above alternatives in terms of the objectives of national economic development, environmental quality, social well-being, and regional development.

3. In addition, it was agreed that the Corps of Engineers would not directly address non-point sources of pollution such as urban storm water runoff and agricultural drainage in this wastewater management report. Also, the cities of San Francisco and Sacramento constitute the only sources of combined sanitary sewage and stormwater flow in the study area and since these excessive flows are under local study these combined flows were not included in the investigation.

4. Final alternatives developed in this report are comprised of combinations of land application components and conventional wastewater treatment plants. Conventional treatment components have been included since previous investigations have shown that the most viable systems of wastewater management involving land application would be a combination of both types of improvements. Consideration of conventional treatment components was also necessary to develop general data on sources and amounts of treatment system sludge which might be applied to land and to develop a range of full-system costs.

5. An all tertiary treatment system also is presented only for the purpose of providing a basis for cost comparison and to depict how the sludge from a complete water-oriented disposal scheme could ultimately be disposed of by land application if a tertiary treatment alternative were selected.

SOURCES OF DATA

6. Several investigations have been conducted by other agencies and organizations concerning various topics pertinent to this study. Subject topics ranged from land use and population growth to regional wastewater management plans as well as the future programs of the local municipalities, sanitary districts, and the Regional Water Quality Control Boards within the study area. Assistance on the technical aspects of wastewater management was obtained from

numerous published sources of Federal, State, and local agencies, and from various articles or papers available in the literature. Most of these data sources are on file at the San Francisco District Office, U.S. Army Corps of Engineers, 100 McAllister Street, San Francisco, California, 94102.

STUDY OBJECTIVES

7. When the Congress authorized the Corps of Engineers wastewater study, it did so with the understanding that the study would be conducted in the context of the State's requirements as well as those of other Federal agencies involved in water quality management. The Corps' role, then, is primarily one of assistance to the State, and not to conduct an independent investigation. The two objectives of this study, therefore, were: (a) to assist the State of California in the development of its Comprehensive Water Quality Control Plans for the San Francisco Bay and Sacramento-San Joaquin Delta Region; and, (b) to determine the feasibility of wastewater disposal oriented primarily to the use of land application as a renovation technique.

8. No specific alternative is recommended for adoption by the State. The function of the study has been to develop data and to analyze alternatives oriented toward land application of wastewater and sludge in order to assist the State in judging which method, or combination of methods, for the disposition, reuse or reclamation of wastewater is most suitable for adoption in the basins and subbasins of the 12-county Bay-Delta Region. The information generated from this study has been furnished to the State of California and the Environmental Protection Agency.

PARTICIPATION AND COORDINATION

Participation

9. Information and data presented in this report reflect the maximum use of previous study efforts by Federal, State of California, regional, and local agencies. In order to provide for the specialized expertise and local experience in engineering and environmental areas, several consulting firms provided technical input for this study under contract. A listing of these consulting firms is shown on the inside back cover.

Coordination

10. This study has been coordinated on a continuing basis with and has had active participation of Region IX of the Environmental Protection Agency, the State of California Water Resources Control Board, and the California Regional Water Quality Control Boards. During the conduct of this study, informational presentations were made to the San Francisco Bay Conservation and Development

Commission, the Association of Bay Area Governments, the Bay Area Sewage Services Agency, the San Francisco Bay Water Quality Group, the California Regional Water Control Boards. Several monitoring sessions on report development and progress were held with representatives of the Environmental Protection Agency and various State agencies. In addition, the public was informed of the Corps' study and assisted in its conduct by means of public meetings, workshops and through visits made by Corps personnel to individuals within the study area.

REPORT ARRANGEMENT

11. This interim report consists of a summary report and eleven appendices, bound in nine volumes, which are summarized below (see Figure 1):

a. Vol. I, Appendix A - Background Information. This appendix has as its basis an earlier report on wastewater management entitled "Alternatives for Managing Wastewater in the San Francisco Bay and Sacramento-San Joaquin Delta Area" prepared by the U.S. Army Corps of Engineers, San Francisco District in July 1971. This appendix contains all pertinent background information regarding the study.

b. Vol. II, Appendix B - Plan Formulation. This appendix summarizes the engineering, economic, environmental, social, and institutional information used for the development of wastewater management alternatives and their evaluation. Numerous secondary appendices support this appendix.

c. Vol. III, Appendix B1 - Design and Cost. This appendix presents the detailed engineering design data and concepts utilized to formulate the various wastewater and sludge management alternatives and their associated costs. Detailed cost estimates are presented in Attachment A to this appendix.

d. Vol. IV, Appendix B2 - Environmental. This appendix presents the environmental considerations in regard to the land application concept of wastewater management.

e. Vol. V, Appendix B3 - Social Well-Being. This appendix relates the social adjustments anticipated with regard to the wastewater management alternatives presented.

f. Vol. V, Appendix B4 - Public Health. This appendix presents the public health implications of the land applicaton of wastewater and sludge.

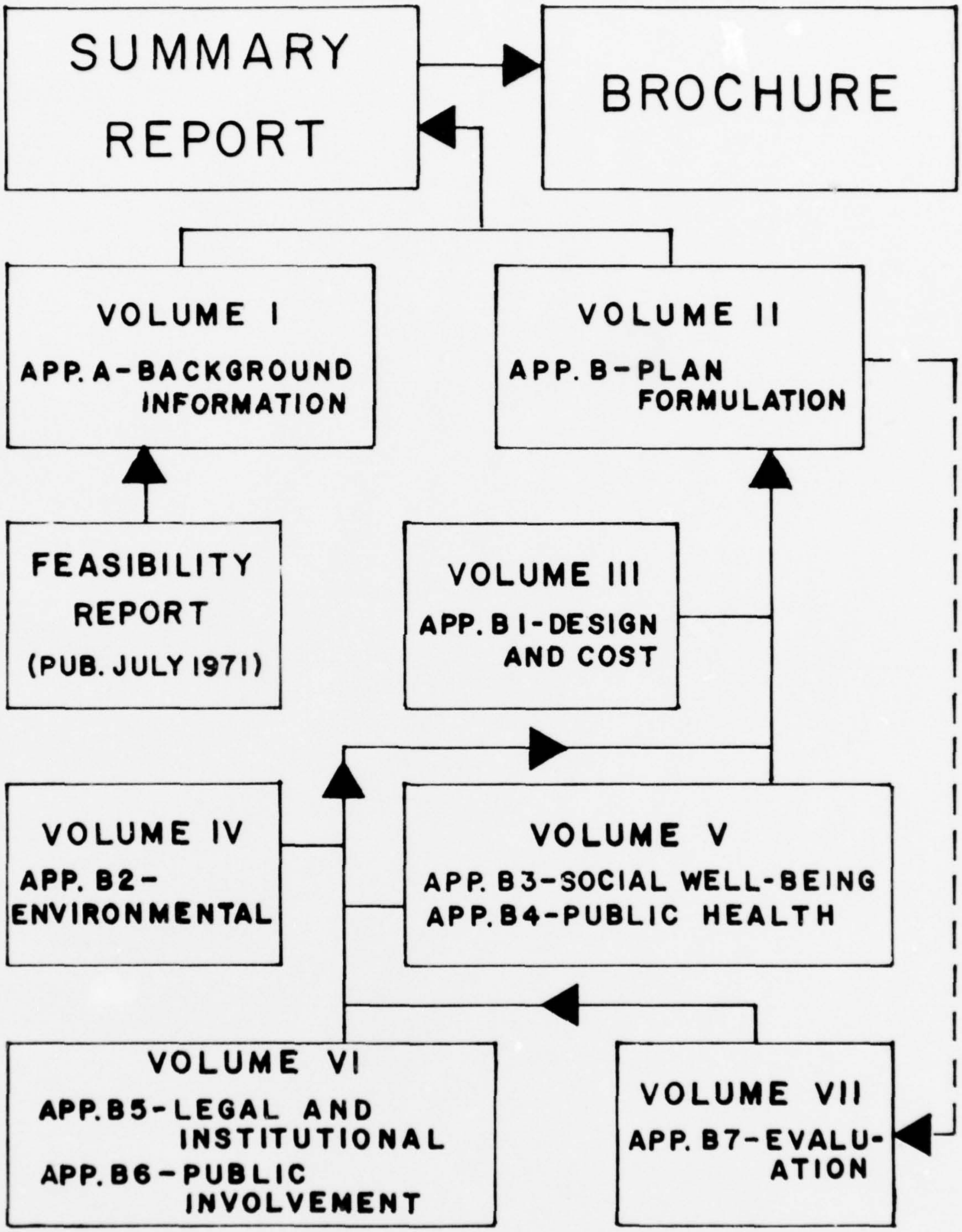
g. Vol. VI, Appendix B5 - Legal and Institutional. This appendix summarizes the legal concerns and institutional arrangements with respect to various wastewater management alternatives.

h. Vol. VI, Appendix B6 - Public Involvement. This appendix summarizes the activities of the San Francisco District in involving the public and special interest groups in the wastewater management program.

i. Vol. VII, Appendix B7 - Evaluation. This appendix presents the environmental, social, economic and special considerations evaluation concepts for each of the wastewater management alternatives developed.

j. Vol. VIII, Appendix C - Plates for Appendices. This appendix furnishes all the plates developed for the study.

k. Vol. IX, Appendix D - Comments on the Brochure. This appendix reflects all comments received as a result of the public information brochure, "Land Application Alternatives for Wastewater Management" which was released in December 1973.



NOTE:

1. ALL PLATES ARE SHOWN IN VOL. VIII, APP. C ENTITLED "PLATES FOR APPENDICES"
2. COMMENTS ON THE BROCHURE WILL BE REFLECTED IN VOL. IX, APP. D

FIGURE 1

THE STUDY AREA

GENERAL CHARACTERISTICS OF THE AREA

12. The study area in this report is located in west-central California and consists of the San Francisco Bay and Delta estuarine system and adjacent land areas covering 12 counties (Plate 1) with a total area of about 10,000 square miles. About 80 percent of the 12-county land area is tributary to the Bay and Delta estuarine system. The remaining 20 percent is comprised of portions of Marin, Sonoma, San Francisco, San Mateo and Santa Clara Counties which drain to the Pacific Ocean either directly or by way of streams not tributary to the Bay. The study area includes significant areas designated by the California State Water Resources Control Board as Basin Planning Areas. It includes the San Francisco Bay Basin, portions of planning basins in the Central Valley (Sacramento River, Sacramento - San Joaquin Delta, and San Joaquin) and areas within the North Coastal and Central Coastal Basins. The Basin Planning Areas designated by the State Water Resources Control Board are shown on Plate 2.

13. The San Francisco Bay system, consisting of San Francisco Bay proper, San Pablo Bay, Carquinez Strait and Suisun Bay, extends from the Golden Gate north about 30 miles and then east for about 20 miles to Pittsburg, and south about 40 miles to the vicinity of San Jose. The Bay's only connection with the ocean is through the Golden Gate. The San Francisco Bay drainage basin, as distinguished from the overall tributary area to the Bay, totals some 4,000 square miles, of which about 425 square miles are the Bay's water surface at mean high water. The Bay's shoreline is about 275 miles long at mean high water and contains substantial marshland areas.

14. The San Francisco Bay and Delta estuarine system and Pacific Ocean were divided into five water quality zones to permit differentiation of water quality in different parts of the system. These zones are:

a. South San Francisco Bay - southerly from San Francisco-Oakland Bridge to southern tip of the Bay.

b. Central Bay - the area north of San Francisco-Oakland Bridge, San Pablo Bay to Carquinez Bridge.

c. Carquinez Strait - Suisun Bay - Carquinez Bridge to Chipps Island.

d. Sacramento-San Joaquin Delta - a triangular region of about 1,100 square miles lying to the east of Chipps Island.

e. Pacific Ocean Area - The continental shelf extending about 30 miles westerly from the Golden Gate has a slope of about 23 feet per mile to the 100-fathom contour. The Farallon Islands are located near the seaward limits of the shelf. Located on the shelf about eight miles west of the Golden Gate is a semi-circular bar whose elevation is 36 feet or less below mean sea level. The bar has been improved for deep-draft navigation by means of a channel dredged to an authorized depth of 55 feet.

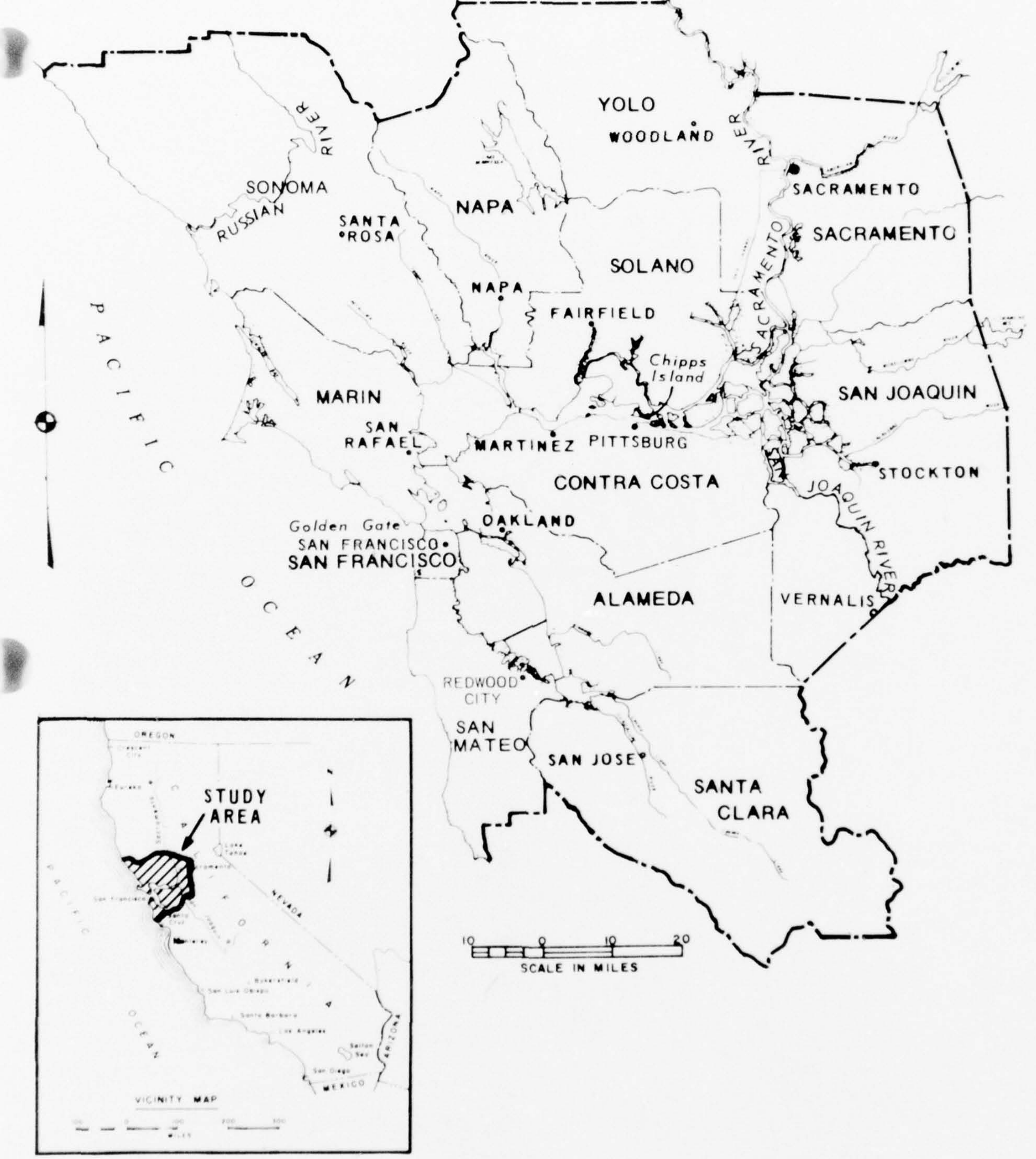
15. Major municipal wastewater dischargers in the study area are listed in Table 1 and shown on Plate 3. These dischargers were designated as major municipal dischargers because of the population they serve, wastewater flows treated, and their relative geographic locations. Present municipal and industrial waste load data for the study area prior to treatment, as shown on Table 2, were compiled from various consulting engineer reports to the California Regional Water Quality Control Boards and to the U.S. Army Corps of Engineers.

GEOGRAPHY

Climate, Geology and Topography

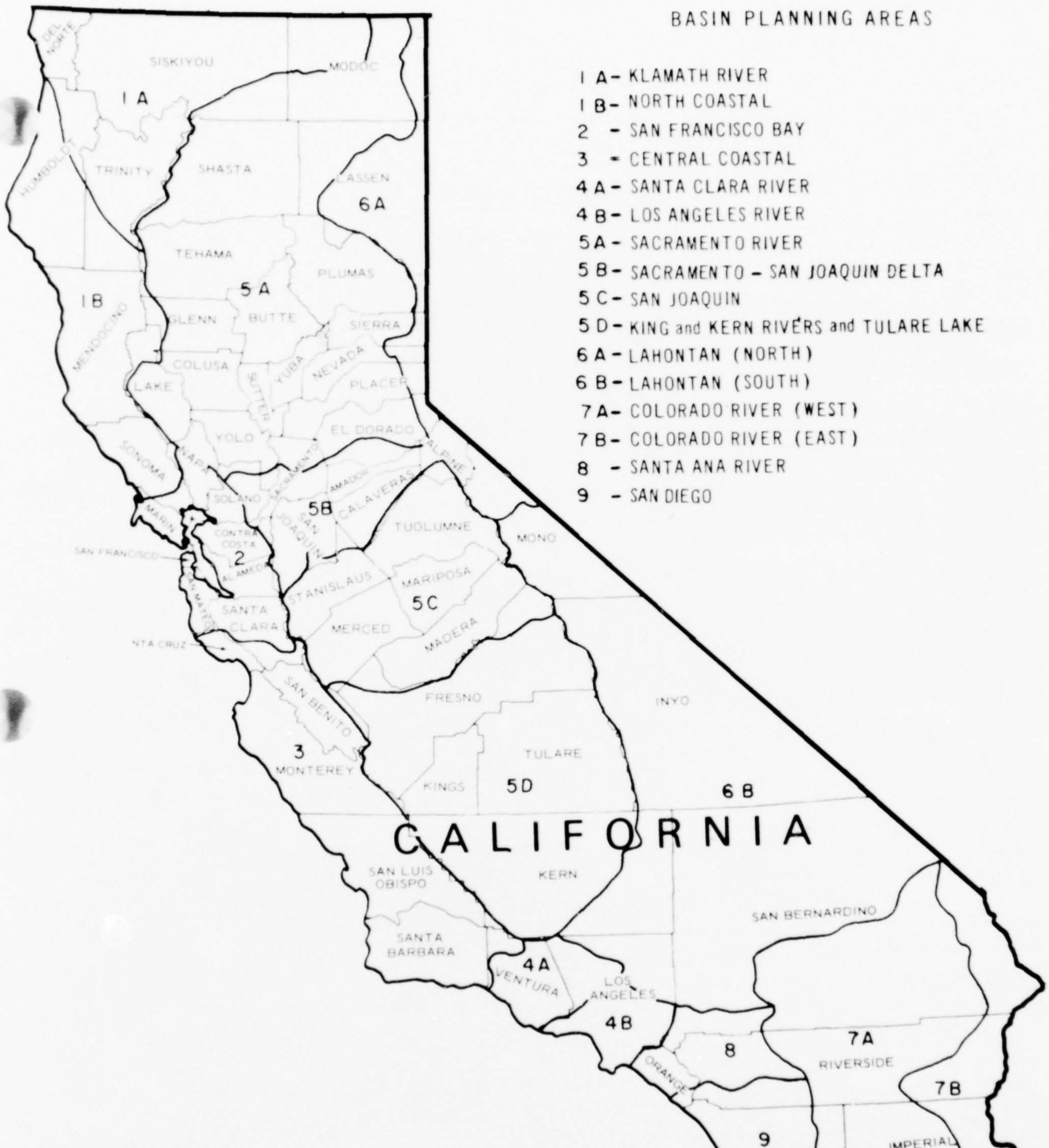
16. There are wide contrasts in climate within short distances around San Francisco Bay. In San Francisco, sea fogs and low stratus cloudiness associated with them are characteristic of the climate. In the summer the temperature of the San Francisco Bay area is usually low near the coast and atmospheric pressure relatively high while the interior of California is characterized by the opposite in both elements. This tends to intensify the landward movement of air and to make the prevailing westerly winds brisk and persistent, especially from May to August. As a result of the steady sweep of air from the Pacific, there are few extremes of heat or cold. Pronounced wet and dry seasons are another characteristic of the climate. On the average, almost 85 percent of the total annual rainfall occurs between November and April. The climate of Oakland and other East Bay cities is similar to that of San Francisco, but daily mean temperatures are about four degrees higher at maximum and four degrees lower at minimum. Annual precipitation at Oakland Airport is about three inches less than San Francisco's 20.5 inches.

17. The Sacramento-San Joaquin Valley is characterized by warm dry summers and mild winters except for the highest altitudes. In the mountains the summers are warm and dry but winter temperatures fall below freezing frequently. The summer droughts are the result of a subtropical high pressure belt located off the coast which prevents summer rainfall. In winter, the high pressure area moves to the south and allows Pacific storms to move inland and deposit their moisture over the watershed. The centers of these storms usually pass over the basin area. The mild winter climate is due to the moderating effects of the Pacific Ocean on the one side and



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO–
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
12 COUNTY STUDY AREA
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 1



BASIN PLANNING AREAS

1 A - KLAMATH RIVER
1 B - NORTH COASTAL
2 - SAN FRANCISCO BAY
3 - CENTRAL COASTAL
4 A - SANTA CLARA RIVER
4 B - LOS ANGELES RIVER
5 A - SACRAMENTO RIVER
5 B - SACRAMENTO - SAN JOAQUIN DELTA
5 C - SAN JOAQUIN
5 D - KING and KERN RIVERS and TULARE LAKE
6 A - LAHONTAN (NORTH)
6 B - LAHONTAN (SOUTH)
7 A - COLORADO RIVER (WEST)
7 B - COLORADO RIVER (EAST)
8 - SANTA ANA RIVER
9 - SAN DIEGO

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO -
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
BASIN PLANNING AREAS

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

TABLE 1
MAJOR MUNICIPAL WASTEWATER DISCHARGERS

IDENTIFICATION NUMBER		DISCHARGER
(1)	(2)	
		ALAMEDA COUNTY
AL01	2 03 025	East Bay Municipal Utility Dist. - Special Dist. No. 1
AL02	2 03 037	City of Hayward
AL03	2 LL 043	City of Livermore
AL04	2 03 070	Ora Loma Sanitary District
AL05	2 03 100	City of San Leandro
AL06	2 02 119a	Union Sanitary District - Alvarado
AL07	2 LL 129	Valley Community Services District
AL08	2 LL 130a	Veterans Administration Hospital - Livermore
AL09	2 LL 016	Castlewood Corporation
AL10	2 01 119b	Union Sanitary District - Irvington
AL11	2 01 119c	Union Sanitary District - Newark
AL12	2 LL 078	City of Pleasanton
		CONTRA COSTA COUNTY
CC01	2 08 004	City of Antioch
CC02	2 08 019d	Contra Costa County Sanitary District No. 15
CC03	2 08 010	Brentwood Sanitary District
CC04	2 08 012	Byron Sanitary District
CC05	2 07 017	Central Contra Costa Sanitary District
CC06	2 05 021	Crockett - Valona Sanitary District
CC07	2 05 076	City of Pinole
CC08	2 08 077b	City of Pittsburg - Camp Stoneman Plant
CC09	2 94 082	City of Richmond
CC10	2 05 086	Rodeo Sanitary District
CC11	2 05 103	San Pablo Sanitary District
CC13	2 05 038	Town of Hercules
CC14	2 06 019b	Contra Costa County Sanitary District No. 5
CC15	2 07 063	Mountain View Sanitary District
CC16	2 07 018	City of Concord
CC17	2 05 019a	Contra Costa County Sanitary District No. 7A
CC18	2 08 077a	City of Pittsburg - Montezuma Plant
CC19	2 08 069	Oakley Sanitary District
		MARIN COUNTY
MR01	-	Angel Island
MR02	2 10 164	Bolinas Community Public Utility District
MR03	2 05 036	Hamilton Air Force Base
MR04	2 05 040	Las Gallinas Valley Sanitary District
MR05	2 04 057	City of Mill Valley
MR06	2 04 081	Richardson Bay Sanitary District

1 of 5

TABLE 1 (CONT'D)

MAJOR MUNICIPAL WASTEWATER DISCHARGERS

IDENTIFICATION NUMBER (1)	IDENTIFICATION NUMBER (2)	DISCHARGER
MR07	2 LL 160	Mill Valley Air Force Base
MR08	2 04 050	Marin County Sanitary District No. 1
MR09	2 04 051	Marin County Sanitary District No. 5
MR10	2 05 052b	Marin County Sanitary District No. 6 - Novato
MR11	2 05 104a	San Rafael Sanitary District - Main Plant
MR12	2 04 106	Sausalito - Marin City Sanitary District
MR13	-	Stinson Beach
MR14	2 10 115	Tomales Sewer Maintenance District
MR15	2 05 104b	San Rafael Sanitary District - Marin Bay Plant
MR16	2 05 052c	Marin County Sanitary District No. 6 - Bahia
MR17	2 05 057a	Marin County Sanitary District No. 6 - Ignacio
		NAPA COUNTY
NP01	2 05 003	American Canyon County Water District
NP02	2 05 015	City of Callistoga
NP03	2 05 064	Napa County Sanitation District
NP04	2 LL 071	Pacific Union College
NP05	2 05 091	City of Saint Helena
NP06	2 05 131	Veterans Home of Yountville
NP07	2 LL 065	Napa Valley Mobile Home Park
NP08	2 05 054	Meadowood Development Company
		SACRAMENTO COUNTY
ST01	5A 34 008	Sacramento Metropolitan Airport
ST02	5A 34 048	Sacramento County Central Sanitation District
ST03	5A 34 018	City of Folsom
ST04	5A 34 007	City of Galt
ST05	5A 34 011	City of Isleton
ST06	5A 34 009	Natomas County Sanitation District
ST08	5A 34 047	City of Sacramento - Main Plant
ST09	5A 34 042	Sacramento Signal Depot
ST10	5A 34 008	City of Walnut Grove
ST11	5A 34 007	Rio Linda County Water District
ST12	5A 34 003	Linwood Sewer Maintenance District
ST13	5A 34 002	Highlands Sanitary District
ST14	5A 34 033	Arden Sanitation District
ST15	5A 34 049	McClellan Air Force Base
ST16	5A 34 028	Northeast County Sanitation District
ST17	5A 34 010	Sacramento County Sanitation District No. 6
ST18	5A 34 023	Cordova Sanitary District
ST19	5A 34 017	Arden Gold Sanitary District
ST21	5A 34 014	Folsom Prison

2 of 5

TABLE 1(CONT'D)

MAJOR MUNICIPAL WASTEWATER DISCHARGERS

IDENTIFICATION NUMBER (1)	IDENTIFICATION NUMBER (2)	DISCHARGER
ST22	3A 34 051	City of Sacramento - Meadowview Plant
ST23	5A 34 011	Manlove Sewer Maintenance District
ST24	5A 34 031	Mather Air Force Base
ST25	5A 34 050	Elk Grove Sanitary District
		CITY AND COUNTY OF SAN FRANCISCO
SF02	2 04 140a	San Francisco - North Point Plant
SF03	2 10 140b	San Francisco - Richmond Sunset Plant
SF04	2 04 140c	San Francisco - Southeast Plant
SF05	2 04 125a	U.S.N. Treasure Island
SF06	2 03 125b	U.S.N. Yerba Buena Island
		SAN JOAQUIN COUNTY
SJ01	5B 39 055	Deuel Vocational Institute
SJ02	5C 39 011	City of Escalon
SJ03	5B 39 017	Lockeford Sanitary District
SJ04	5B 39 025	City of Lodi
SJ05	5C 39 048	City of Manteca & Lathrop County Water District
SJ07	5C 39 001	Sharpe Army Depot
SJ08	5B 39 040	City of Stockton - Main Plant
SJ09	5B 39 050	City of Tracy
SJ10	5B 39 033	City of Stockton - Northwest Plant
SJ11	5B 39 030	Lincoln Village Sanitary District
SJ12	5B 39 007	Woodbridge Sanitary District
SJ13	5C 39 003	Raymus Village
		SAN MATEO COUNTY
SM01	2 02 094	Cities of San Carlos and Belmont
SM02	2 03 011	City of Burlingame
SM03	2 03 028	Estero Municipal Improvement District
SM04	2 03 035	Guadalupe Valley Municipal Improvement District
SM05	2 10 177	Half Moon Bay Sanitary District
SM06	2 02 056	Menlo Park Sanitary District
SM07	2 03 058	City of Millbrae
SM08	2 10 067	North San Mateo County Sanitation District
SM09	2 10 072b	City of Pacifica - Linda Mar Plant
SM10	2 02 080	City of Redwood City (including Redwood Shores)
SM11	2 10 072a	City of Pacifica - Sharp Park Plant
SM12	2 03 102	City of San Mateo
SM13	2 03 110	Cities of South San Francisco and San Bruno
SM14	2 10 060	Montara Sanitary District

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TABLE 1 (CONT'D)

MAJOR MUNICIPAL WASTEWATER DISCHARGERS

IDENTIFICATION NUMBER (1)	IDENTIFICATION NUMBER (2)	DISCHARGER
SM15	2 03 096a	San Francisco International Airport
SM16	2 10 034	Granada Sanitary District
		SANTA CLARA COUNTY
SC01	3 43 011	Cities of Gilroy and Morgan Hill
SC02	2 01 099	City of San Jose
SC03	2 01 113	City of Sunnyvale
SC04	2 01 074	City of Palo Alto
SC05	2 01 062	City of Mountain View
SC06	2 01 046	City of Los Altos
SC07	2 01 059	Milpitas Sanitary District
SC08	2 01 002	City of Alviso
		SOLANO COUNTY
SL01	2 06 009	City of Benecia
SL02	5A 48 024	City of Dixon
SL03	2 07 029	Fairfield - Suisun Sewer District
SL04	2 05 124	U.S.N. Mare Island
SL05	5B 48 009	City of Rio Vista
SL06	2 48 005	City of Vacaville - Elmira Plant
SL07	2 05 128	Vallejo Sanitation and Flood Control District
SL08	5B 07 117	Travis Air Force Base
SL10	5B 48 006	Vacaville Medical Facility
SL11	5B 48 004	City of Vacaville - Brown St. Plant
		SONOMA COUNTY
SN02	1B 49 067	Russian River County Sanitation District
SN03	1B 49 055	City of Cloverdale
SN04	1B 49 057	Forestville County Sanitation District
SN05	1B 49 068	Sonoma County Airport
SN06	1B 49 063	Stewards Training and Recreation Inc.
SN07	1B 49 058	City of Healdsburg
SN08	1B 49 069	Los Guilicos School
SN09	1B 49 064	Windsor County Water District
SN10	1B 49 060	City of Santa Rosa - Oakmont Plant
SN11	1B 49 056	City of Santa Rosa - College Avenue Plant
SN12	1B 49 059	City of Santa Rosa - Laguna Plant
SN13	1B 49 071	City of Sebastopal
SN15	1B 49 066	Bodega Bay Public Utility District
SN16	1B 49 061	Occidental County Sanitation District

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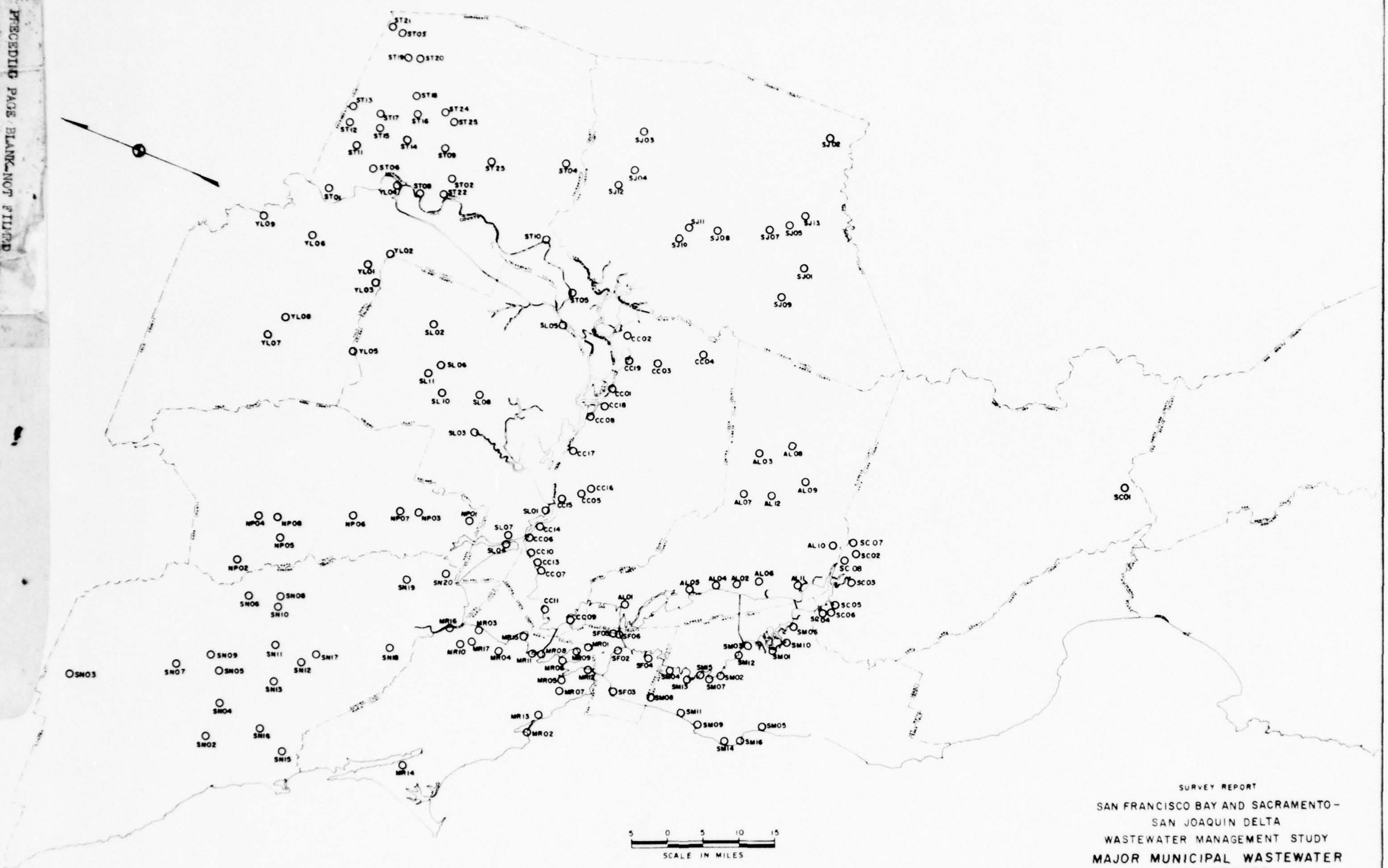
TABLE 1 (CONT'D)
MAJOR MUNICIPAL WASTEWATER DISCHARGERS

IDENTIFICATION NUMBER		DISCHARGER
(1)	(2)	
SN17	1B 49 062	Cities of Rohnert Park and Cotati
SN18	2 05 025	City of Petaluma
SN19	2 05 109	Sonoma Valley County Sanitation District
SN20	2 05 123	U.S.N. Skaggs Island
		YOLO COUNTY
YL01	5A 57 020	City of Davis
YL02	5A 57 024	El Macero Sewer Maintenance District
YL03	5A 57 019	University of California at Davis
YL04	5B 57 003	West Sacramento Sanitary District
YL05	5A 57 017	City of Winters
YL06	5A 57 013	City of Woodland
YL07	5A 57 008	Esparto Sanitary District
YL08	5A 57 009	Madison Service District
YL09	5A 57 002	Knights Landing Service District
		5 of 5

(1) As used in this report.

(2) As used by the State Water Resources Control Board in "Interim Water Quality Control Plans," dated June 1971.

\- Not identified.



SURVEY REPORT

SAN FRANCISCO BAY AND SACRAMENTO–
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY

MAJOR MUNICIPAL WASTEWATER DISCHARGERS

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 3

TABLE 2

MUNICIPAL AND INDUSTRIAL LOADINGS - 1972

County	FLOW (MGD)	BOD	TDS	TN	TP	GHM-T
Alameda	162.4	307.8	929.8	44.7	17.5	12.8
Contra Costa	198.0	317.3	1,210.8	64.2	12.7	5.9
Marin	22.0	42.7	126.5	5.3	2.5	2.3
Napa	19.4	29.4	139.7	5.9	3.7	5.1
Sacramento	111.4	294.5	647.4	32.0	12.0	8.1
San Francisco	107.6	232.7	631.3	31.6	12.3	5.8
San Joaquin	74.2	188.7	410.8	18.6	6.8	12.7
San Mateo	66.9	143.1	386.1	17.2	7.0	4.5
Santa Clara	149.2	377.7	861.5	43.7	16.3	20.4
Solano	30.2	76.2	167.8	8.7	3.1	3.4
Sonoma	21.5	59.4	117.5	6.1	2.1	3.0
Yolo	23.9	59.9	114.1	5.2	1.8	7.9
TOTALS	986.7	2,129.4	5,743.3	283.2	97.8	91.9

All values except flow are reported as 1,000 lbs/day.

GHM-T (Gross Heavy Metals - Total) includes: Arsenic, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Molybdenum, Nickel and Zinc.

BOD (Biochemical Oxygen Demand) is the amount of oxygen required to decompose organic compounds to stable substances.

TDS (Total Dissolved Solids) is that quantity of mineral matter contained in wastewater in a dissolved state.

TN (Total Nitrogen) is the total quantity of nitrogen present in the form of ammonia, organic, nitrite, and nitrate-nitrogen.

TP (Total Phosphorus) is the total quantity of phosphorus present in the form of orthophosphates, condensed phosphates, and organic phosphates.

of the high barrier of the Sierra Nevada range which protects the basin from the cold air masses of the interior on the other side. The valley floor is free of frost during the growing season with the average frost-free period being more than seven and one-half months. The valley floor has an average of 15 days when the minimum temperatures fall below 32 degrees F. Maximum temperatures in the summer, however, will exceed 100 degrees F. on an average of 15 days each year and exceed 90 degrees F. about 45 days of each year. Relative humidities in summer vary from about 36 percent to 89 percent.

18. The 12-county area encompasses parts of two geomorphic provinces of California, the Coast Ranges and the Great Valley. Each province is characterized by distinctive natural topographical and geological features. The Coast Ranges comprise a series of nearly parallel mountain ranges and valleys that trend in a northwesterly direction and rise to elevations of over 4,000 feet. This trend is largely controlled by the geologic structure in the underlying rocks which is dominated by the active San Andreas Fault system running nearly the full length of the Coast Ranges. In contrast, the Great Valley consists of a central, comparatively flat alluvial plain, about 400 miles long and 50 miles wide, lying between the Coast Ranges and the Sierra Nevada range to the east. Elevations in the Great Valley, with few exceptions, range from sea level to 100 feet. The valley is drained by the Sacramento and San Joaquin Rivers, which join in the Delta area before entering San Francisco Bay. The southernmost part of the Great Valley, the Tulare Lake Basin, is an interior drainage basin with no direct drainage to the sea. It is separated from other portions of the San Joaquin Valley by a very low divide.

19. The Sacramento and San Joaquin River sub-basins (including Tulare Lake Basin) drain about one-third of the area of California. The two rivers are the principal source of fresh water and are the primary means by which agricultural wastewaters are carried from the Central Valley. Prior to any development by man in the Central Valley, the natural outflow through the Delta, in a normal water year, was about 30 million acre-feet. Because of water use within the Central Valley and net exports from its basin, the present average Delta outflow is about 18 million acre-feet per year. As water use in the Central Valley increases and exports from the basin grow, it has been estimated that the net Delta outflow may be as low as seven million acre-feet in year 2020. The greater part of municipal and industrial wastewaters analyzed in this report derive from fresh waters that are introduced into the 12-county area as water supply diversions from the headwaters of the two river basins.

20. Local streams draining into San Francisco Bay have a combined mean annual discharge of about 450,000 acre-feet. The mean normal annual precipitation over the Bay's local drainage area is 19 inches. The mean annual evaporation over the entire Bay system is about 48 inches.

21. The mean range of tide at the Golden Gate is about five feet, with a mean tidal prism in the Bay of about 1.2 million acre-feet. The total water volume at mean high tide in the Bay system is about 5.5 million acre-feet. Thus, the mean tidal prism is about 21 percent of the total volume of water in the Bay.

NATURAL RESOURCES

22. The major natural resource of the San Francisco Bay-Delta Region is its continuous waterways which serve a major role in the areas commercial and manufacturing growth. Petroleum, natural gas, sand, and gravel are the items most economically significant of the mineral resources of the area. Other valuable resources include mercury, salt, sulphur and peat.

23. Other important natural resources in the study area are: the fertile productive lands, sustaining an agricultural output valued at 500 million dollars per year: important fish and wildlife areas in which sport fishing is a major recreational use of San Francisco Bay-Delta waters; and the marshlands of the Bay and Delta which are important to the migratory birds using the Pacific Flyway.

DEMOGRAPHY AND CULTURE

24. The population of the 12-county study area has tripled over the past 40 years, with approximately 60 percent of the increase occurring in the last 20 years. The growth rate of the 12-county study area over the last 20 years has lagged slightly behind that for the entire State. However, several counties within the study area have experienced over 100 percent growth in the last 20 years (Table 3). The principal cities shown on Table 3 represent those cities which had a population in excess of 100,000 during the year 1970.

25. The professional, technical, and managerial fields were the largest occupation group in the study area in 1970; over 614,000 people or 28 percent of all people employed worked in this group. Clerical and kindred workers were the second largest occupational grouping: 21.5 percent were employed. People in farming occupations were the smallest grouping, only 1.4 percent were employed in this group.

LAND USE

26. The present land use character of the study area indicates a diversity of elements hardly matched by any other region of the country. Such an evolution to its present status can be seen in terms of these distinct development periods:

TABLE 3

1970 POPULATION OF THE 12 COUNTIES IN STUDY AREA AND THE PRINCIPAL CITIES 1/

County	Growth Rate 1950-1970 2/	County Population	Principal City	Principal City Population
Alameda	1.45	1,073,000	Oakland	362,000
Contra Costa	1.86	558,000		
Marin	2.40	206,000		
Napa	1.70	79,000		
Sacramento	2.25	631,000	Sacramento	254,000
San Francisco	.90	716,000	San Francisco	716,000
San Joaquin	1.45	290,000	Stockton	108,000
San Mateo	2.35	556,000		
Santa Clara	3.65	1,065,000	San Jose	444,000
Solano	1.60	170,000		
Sonoma	1.95	205,000		
Yolo	2.20	92,000		
Total		5,641,000		

1/ Bureau of Census figures to nearest thousand.

2/ California growth rate, 1950-1970 = 1.85 (Bureau of Census). Growth rate defined as 1970 population ÷ 1950 population.

a. The Gold Rush of the mid-1800's,

b. The introduction of rail transportation in the late 1800's, and

c. The events of national and international importance, such as the wars and space exploration from early 1900's to today.

As a result, petroleum, communications, shipping and transportation, finance and commerce, aerospace, military, research, electronics, government, manufacturing, and agribusiness, among other economic factions, have all helped to create the current "dynamism" of the study area.

27. In the study area growth and development of the urbanized areas generally followed the bay shoreline, directed largely by the constraints of the terrain, provision of transportation facilities, and the location of important economic and service activities. Sacramento grew outward from the core, generally in a southerly direction at first, but more recently to the northeast. By and large, the pattern of urban land consumption was predictable and evolved in a natural and logical manner. Growth was forced along clearly delineated flat areas and transportation systems. The most urbanized counties in terms of area are: San Francisco (70 percent), San Mateo (20 percent), Contra Costa (20 percent) and Alameda (20 percent). The least urbanized in area are: Sonoma and Napa (both slightly over 2 percent), Yolo (3 percent) and Solano (3.5 percent).

ECONOMIC ACTIVITY

28. Total employment for the study area was about 2,363,000 for 1970. Government and service employment are the largest and fastest growing employment groups in the study region with employment of 500,000 and 498,000, respectively. The financial industry centered in San Francisco also has experienced rapid growth.

29. Employment in agriculture has declined in the last five years. Increased efficiency in farm technology has outpaced the growth in demand of agricultural products leading to the long-term decline in agricultural employment. Despite employment declines, agriculture is a very important industry for the area. For example, the Sacramento Valley is a leading producer of fruits, nuts, and field crops and Napa Valley produces some of the best premium California table wines.

30. During 1970, manufacturing employment averaged 388,000. One of the largest industries in manufacturing is the electric machinery industry with 66,000 in employment. Wholesale and retail trade constituted about 484,000 in employment in 1970. San Francisco County had the largest trade employment.

STUDY AREA IN THE FUTURE

FACTORS AFFECTING FUTURE GROWTH

31. The area's economic growth will continue to depend upon a combination of internal and external factors. The region has an expansive, diversified and wealthy market. To the extent that the region maintains a desirable living environment, a well educated and productive labor force, and continues to be a favorable location for investment, it can be expected to grow at a fast pace.

POPULATION PROJECTIONS

32. Two population projections were considered in this study. The first was the Series D-150 developed by the California Department of Finance. These values are the population levels generally utilized by the State of California for basin planning. Therefore, this study was also based on the same population data. The second projection was the E-0 series, also developed by the California Department of Finance. The E-0 series is of interest to many agencies and segments of the public as a frame of reference for future planning. Grant regulations of the State Water Resources Control Board for wastewater treatment facilities make use of these projections in critical air basins. Also, the E-0 series is used for planning in critical air basins as discussed later in this report. Table 4 shows the Series D-150 and Series E-0 population projections for the counties within the study area. With the Series D-150 projections, the population of the study area can be expected to increase from a 1975 population of about 6.1 million people to 9.2 million in 2000, an approximate increase of 51 percent, and with the Series E-0 projections, the population of the study area can be expected to increase from about 6.0 million people in 1975 to 7.6 million in 2000.

PROJECTED LAND USE - 2000

33. While for the purpose of this report other projections are carried to the year 2020, land use, relying on independent projections are carried only to the year 2000. The shorter time span is due to the interdependence and complexities associated with land use projections.

34. The 12 counties of the study area are projected to have a total population of over 9.2 million people by 2000 - 7.5 plus million in the Bay region (9 counties) and 1.7 million in the Delta (3 counties). Distribution and characteristics of future development will depend on location of employment, accessibility of jobs to residential areas, large-scale planned housing schemes, environmental concerns, and planning controls, regarding both location and intensity of land uses. Most industries will grow faster outside the more densely developed and stabilized core areas. As this fanning out process continues, a substantial decentralization of the study area economy will occur. Except for occasional instances, real dispersal or recentralization is unlikely. Much

TABLE 4

COMPARISON OF POPULATION PROJECTIONS 1/

County	1975		1980		1990		2000	
	Series D-150	Series E-0	Series D-150	Series E-0	Series D-150	Series E-0	Series D-150	Series E-0
Alameda	1,140	1,100	1,200	1,150	1,380	1,220	1,510	1,275
Contra Costa	615	605	690	650	850	735	990	790
Marin	230	222	262	242	336	285	403	322
Napa	88	88	103	96	147	114	193	127
Sacramento	683	683	741	728	865	818	972	883
San Francisco	710	710	720	710	730	705	725	690
San Joaquin	315	313	340	332	394	368	446	400
San Mateo	580	560	615	570	675	580	720	575
Santa Clara	1,220	1,185	1,385	1,305	1,760	1,560	2,105	1,765
Solano	188	188	214	212	303	262	421	305
Sonoma	235	232	275	257	371	308	481	356
Yolo	104	102	119	113	156	137	194	160
Total	6,108	5,988	6,684	6,365	7,967	7,092	9,160	7,648

1/ Data from California Department of Finance with values reported as thousands of persons.

of the available "skipped over" land within urban metropolitan areas will be filled in. Densities will probably increase in urban centers and along transportation corridors; e.g., BART (Bay Area Rapid Transit System). By and large, future development will be characterized by more compact groupings and intense land utilization.

35. The majority of new employment and industrial opportunities (urbanization) is expected to occur as an expansion of already existing centers. It appears that areas particularly favored by absolute expansion potential are: South Bay (San Jose area), Central Contra Costa County, Southeast Bay (Fremont area), Central Alameda County, and Sacramento metropolitan area. Likewise, areas forecast for greater proportion of growth increase are the smaller (in population) counties: Sonoma, Napa, Marin and Yolo. Particular expansion is also projected for the Pittsburg-Antioch area (Contra Costa County) and areas adjacent to the San Francisco and Oakland Airports. San Francisco City and County will continue to retain its position as the center for finance and commerce. Sacramento County will increase its role as a governmental and service center. San Jose metropolitan area will show the greatest growth in economic diversity and as an area of increased importance as an urban center. It appears that the density in terms of population per overall urban metropolitan areas will be stabilized in the immediate future and start to increase again within a decade or so.

36. Based on Series D-150 projections, the population density is forecasted to reach about 1.4 persons per acre, or over 890 persons per square mile by 2000. This represents an increase of about 0.5 persons per acre, or over 350 persons per square mile. The projected basic land use absorption is as follows:

Urban/Developed		1,065,800 acres
Residential	(600,400 acres)	
Streets/Highways	(221,700 acres)	
Commerce/Industry/Other Urban	(243,700 acres)	
Undeveloped and Agriculture		5,597,700 acres
Total Acres		6,663,500 acres

The total proportion of urbanized land of the study area is projected to increase by almost 7 percent, from 9.2 percent to 15.9 percent by the year 2000. This amounts to a net conversion increase of almost 450,000 acres. During this period, the proportion of residential usage to remaining developed land is expected to increase from almost 50 percent to 56 percent.

ECONOMIC ACTIVITY

37. Based on California Framework Study assumptions on economic growth in the area, it is estimated that industrial employment in the study area will increase from 2,362,800 to 5,059,000 by 2020. Manufacturing employment is expected to double by 2020. Wholesale and retail trade employment can be expected to increase 600,000 people by 2020. The following manufacturing groups require large quantities of water in their operation and have large waste loads:

a. Oil Refineries - Based on a predicted increase in per capita consumption of refined petroleum products from the present 31 barrels per year to about 75 barrels per year in 2020 and assuming an available supply, the total annual production of refineries located in the study area will probably increase from 170 million barrels per year to some 1 billion barrels per year in 2020, an annual growth rate of about 3-1/2 percent.

b. Paper and Allied Products - This industrial group manufactures about 2,000 tons per day of paper products. In the next 50 years, production is projected to increase to about 12,000 tons per day. Employment in this industry is expected to more than double by 2020.

c. Canning - Canning production is expected to increase at a rate of about three percent annually. Employment within the food and kindred products industry is expected to decrease slightly by 2020. There will be about 59,600 people employed in this industry by 2020 in the study area.

d. Chemicals - Production of chemicals in the study area is expected to grow 11-fold in the period of 1970-2020. The expected increase in petroleum refining in the study area would contribute to an expansion of petro-chemical production. Employment in the chemical industry is expected to double by 2020.

e. Steel - Within the study area, industrial steel products are anticipated to increase in annual consumption from 2.2 million tons to 11 million tons and product manufacturing is expected to increase from 600,000 tons to 12 million tons per year. The Primary Metals industry employment is expected to increase by 50 percent.

f. Agriculture - It is estimated that by the year 2020, the amount of land used for irrigated agriculture in the nine Bay Area counties will be 416,000 acres, a reduction of some 15 percent from 1967. By 2020, irrigated land in the Delta (Yolo, Sacramento and San Joaquin Counties) is expected to increase by some 15 to 20 percent to 1.55 million acres. In the Central Valley tributary to the 12-county area, including Tulare Lake Basin, it is estimated that about seven million acres will be under irrigation by 2020.

WASTE LOADS

38. Using the established population projections, future wastewater flows and constituents were estimated. Municipal wastewater flows were projected for dry weather flows only and include those flows generated by sanitary systems in residential dwellings and commercial establishments. It represents wastewater flows generated in connection with people rather than products. Existing dry weather wastewater flows for each municipal discharger or service area were obtained from data of the California Regional Water Quality Control Boards and from local and subregional reports. Dry weather flows were selected since it was assumed that infiltration would be removed from collection systems by local corrective action over the study period. Based on population estimates and industrial development in the service areas, wastewater flows were modified to exclude those flows which should more properly be included in industrial wastewaters. The municipal flows were corrected to the year 1970, which was used as a population projection base year for the design data.

39. The 1970 flow for each discharger was multiplied by a growth factor which is the ratio of the county population in any desired year to the 1970 county population to obtain flows in future years. Growth factors are shown in Table 5 and the resultant initial municipal flows are presented, by county, in Table 6.

40. The wastewater constituents developed were based on data presented in the various subregional reports to the California Regional Water Quality Control Boards. Data were developed on a milligram per liter (mg/l) basis for each county and flow-weighted to obtain a county average. The initial municipal county constituent loadings assumed a BOD of 200 mg/l, TN of 27 mg/l, TP of 11 mg/l, GHM of 3.5 mg/l, and TDS of 550 mg/l. These values were assumed to be constant over time because they were the best data initially available.

41. Each discrete industry with a known existing process wastewater discharge was identified from the various subregional reports, Regional Water Quality Control Board reports, and the U.S. Army Corps of Engineers' Form 4345-1 (Application for Permit to Discharge or Work in Navigable Waters and their Tributaries). For all industries, data were utilized to obtain a process flow increase factor. This factor was then applied to the existing flows to obtain the 1975 and 2000 process flows. The existing flows were obtained from the same sources as were used to identify the existing discrete industries. Only those industries which discharge 0.01 MGD or greater effluents were considered. Table 7 presents the initial industrial wastewater flows.

REGIONAL PLANNING GOALS AND OBJECTIVES

Introduction

42. Regional planning goals are essential in establishing a planning framework since such goals guide the thrust of an entire planning effort. They are ends toward which individual policies, programs

TABLE 5

POPULATION PROJECTION GROWTH FACTORS

COUNTY	STUDY YEAR			
	1970	1975	2000	2020
Alameda	-	1.053	1.397	1.678
Contra Costa	-	1.093	1.792	2.330
Marin	-	1.116	1.941	2.670
Napa	-	1.139	2.331	3.797
Sacramento	-	1.061	1.584	1.902
San Francisco	-	1.068	1.047	1.117
San Joaquin	-	1.068	1.724	2.069
San Mateo	-	1.043	1.258	1.439
Santa Clara	-	1.145	1.971	2.723
Solano	-	1.117	2.352	4.706
Sonoma	-	1.170	2.439	3.415
Yolo	-	1.195	2.173	3.261

TABLE 6

PROJECTED MUNICIPAL WASTEWATER FLOWS 1/

COUNTY	FLOW/YEAR (MGD)			
	1970	1975	2000	2020
Alameda	132	140	185	222
Contra Costa	59	65	109	141
Marin	20	22	38	53
Napa	8	9	20	30
Sacramento	94	100	149	179
San Francisco	102	103	107	115
San Joaquin	52	56	90	108
San Mateo	52	54	65	75
Santa Clara	122	140	241	332
Solano	21	24	51	102
Sonoma	16	18	39	54
Yolo	12	15	27	41
Total	690	746	1,121	1,452

1/ Initial Data.

TABLE 7

PROJECTED INDUSTRIAL WASTEWATER FLOWS 1/

COUNTY	FLOW/YEAR (MGD)	
	1975	2000
Alameda	14.0	31.4
Contra Costa	143.2	294.3
Marin	1.0	2.3
Napa	0.7	1.5
Sacramento	0.6	1.3
San Francisco	0.04	0.09
San Joaquin	12.6	27.9
San Mateo	3.9	9.4
Santa Clara	2.4	2.6
Solano	4.4	10.3
Sonoma	0	0
Yolo	3.2	2.6
Total	186.04	383.69

1/ Initial Data.

and efforts may be directed. They include a large measure of idealism, for they present in a broad manner and in words that which the region considers to be ultimately desirable.

43. Most regional goals can be defined by sets of regional objectives which serve as the basis for the actual formulation, design and evaluation of a plan or project. Regional objectives differ from regional goals in that they are more tangible and usually reflect a condition which is immediately attainable by controlling real parameters such as chemical and/or physical factors, ecological associations and recreation in the case of environmental considerations; public attitudes and public health in the case of social considerations; and costs and benefits in the case of economic aspects. By meeting regional objectives, the planning goals of a region may be achieved wholly or in part.

Regional Planning Goals

44. Regional planning goals have been established by nearly every planning agency in the San Francisco Bay-Delta Region. From the plans and policies of State, regional and local planning agencies, the following regional planning goals have been identified by the Corps of Engineers for this study of wastewater management in the San Francisco Bay and Sacramento-San Joaquin Delta Region:

a. Protect and enhance the major physical features and environmental qualities of the area.

b. Provide the opportunity for all persons in the area to obtain adequate shelter convenient to other activities and facilities, in neighborhoods that are satisfying to them.

c. Provide ample land and facilities, and develop a strong, diversified economic base, for the economic distribution and growth of the area in order to allow opportunities for all citizens and communities to improve their economic well-being.

d. Create a sense of regional identity, responsibility, and cooperation among citizens, organizations, and governments in the area.

e. Promote the distinctive character and identity of the area and of its parts.

f. Provide all residents with opportunities for a wide range of cultural, social, educational, health and commercial activities and facilities.

Regional Planning Objectives

45. Using the identified regional planning goals, objectives have been formulated for the San Francisco Bay-Delta Region. Certain of these objectives are included in published reports of other agencies. Others have been developed by the Corps.

a. Maintain and enhance to the highest possible levels the quality of all waters in the region.

b. Protect all waters in the region from adverse water quality factors.

c. Protect and enhance aquatic life and associated wildlife in streams, rivers, estuaries, oceans, freshwater marshes, salt water marshes, lakes, ponds and riparian vegetation.

d. Preserve and enhance overall diversity of life and carrying capacities in terrestrial associations, such as forests and grasslands, and their associated wildlife, with special emphasis upon rare and endangered animals and plants.

e. Minimize disturbance of the region's natural processes and life cycles.

f. Protect and enhance the distinctive character, identity, and community values of affected areas.

g. Maintain air quality at levels necessary to protect public health.

h. Maintain air quality at levels necessary to prevent damage to plant life, animal life and aesthetics.

i. Prevent degradation of air quality where it is presently of a higher quality than required by Federal-State standards.

j. Reduce to acceptance levels those noises which have a deleterious effect on the life cycles of wildlife and humans or have a negative effect on aesthetics of the environment.

k. Protect and enhance public health through the reduction of disease transmission and nuisance factors (water pollutants, disease vectors, toxic elements, plant and animal pests and noise).

l. Protect valuable natural and manmade amenities, and increase aesthetic beauty of water bodies, land areas, and the landwater interface.

m. Promote creation of visually and aesthetically pleasing facilities as an integrated physical element within constituent areas.

n. Enhance opportunities and increase range of aquatic and terrestrial recreation activities for enjovment of both local and visitor populations.

o. Provide increased capability and convenience of access to recreation and amenity facilities.

p. Protect and enhance contemporary cultural values, historical sites and archaeological sites.

q. Promote an optimum utilization of land, water, energy, air, chemical and human resources, with specific emphasis upon both short-term use and long-term productivity.

r. Maximize reclamation and reuse of municipal, industrial and agricultural wastewaters and residual solids.

s. Help maintain, or help the orderly transition of the agricultural environment, where deemed appropriate.

t. Minimize hardships and disruptions, insofar as possible, to affected residents, business, agriculture, services, access linkages and community cohesion, caused by relocation, displacement, dispersion, or barriers.

u. Prevent and deter, to the extent possible, disruption to the local economy, jobs, stability, life style and development pattern of affected areas.

v. Enhance and preserve insofar as possible, employment opportunities in terms of job availability, diversity, stability and mobility.

w. Enhance opportunities for human betterment through greater and more equitable distribution of wages, goods and public and private services.

x. Through well-balanced local participation and involvement programs and efforts, help create a legitimate sense of participation, identity, responsibility and cooperation among citizens, organizations, leaders and governments.

NEEDS AND PROBLEMS

INTRODUCTION

46. This section deals with the present and projected demands for water and the sources of water supply to meet these demands through the year 2020. The section also discusses surface and groundwater quality conditions, highlights anticipated water quality problems and presents water quality guidelines used by the Corps in the development of wastewater management alternatives.

WATER REQUIREMENTS

Agriculture

47. Agricultural water requirements are based on projected irrigation needs for each county. Projections assume that water use per irrigated acre will not change over time from that information shown in the latest census of agriculture for each county. Future irrigated acreage requirements for each county have been developed by the various counties and the District offices of the California State Department of Water Resources. Agricultural water requirements for 1970, 1975, 2000 and 2020 are presented in Table 8.

Municipal and Industrial

48. Industrial water requirements are derived from data generated in a study by Lawrence Berkeley Laboratory made for the U.S. Corps of Engineers. Industrial water requirements are projected to year 2020. Cooling water is included in the industrial water projections. Most industrial cooling water used in the study area is brackish water. Since the county water supplies projected by the Department of Water Resources are for fresh water supplies, it was necessary to remove cooling water figures in order to make the county industrial water use data comparable to Department of Water Resources projections of water supply. Industrial water requirements were adjusted for Alameda, Contra Costa, San Francisco, San Mateo and Santa Clara Counties.

49. Municipal water requirements are based on per capita use data from the Department of Water Resources. An increase in per capita use was projected: a five percent increase between 1970 and 1975, a 10 percent increase between 1970 and 2000 and 10 percent between 1970 and 2020. Per capita use data include industrial water uses, therefore, the industrial water requirements were removed to determine projected municipal water use before municipal and industrial water requirements were projected. County projections are presented in Table 9.

Recreation

50. Outdoor recreation is inseparably tied to the land and its waters. The California Outdoor Recreation Plan (1960) indicates

TABLE 8

AGRICULTURAL WATER REQUIREMENTS

(1,000 of Acre-Feet)

	1970	1975	2000	2020
Alameda	36.6	28.9	17.4	17.1
Contra Costa	124.4	124.4	148.5	150.7
Marin	2.6	2.6	1.6	.8
Napa	16.4	19.0	50.8	58.8
San Francisco	-	-	-	-
San Mateo	13.8	14.5	15.7	11.9
Santa Clara	133.0	120.5	70.7	43.7
Solano	382.5	400.9	440.0	437.0
Sonoma	49.6	52.6	70.9	86.3
Sacramento	461.8	474.4	500.0	514.0
San Joaquin	1,402	1,436	1,508	1,503
Yolo	832	848	920	956
TOTAL	3,455	3,522	3,744	3,779

TABLE 9

MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS

(1,000 of Acre-Feet)

	1970	1975	2000	2020
Alameda				
Municipal	194.0	214.5	298.3	358.0
Industrial	12.8	12.7	15.8	23.2
Contra Costa				
Municipal	96.3	110.5	189.8	246.7
Industrial	72.6	132.9	140.8	190.4
Marin				
Municipal	38.5	44.9	81.8	112.5
Industrial	1.5	1.6	4.3	11.3
Napa				
Municipal	9.8	11.7	27.3	40.9
Industrial	7.9	19.4	30.8	54.5
San Francisco				
Municipal	136.4	140.1	160.6	174.9
Industrial	2.2	2.3	2.9	4.3
San Mateo				
Municipal	87.7	96.0	121.4	138.8
Industrial	6.6	7.3	12.2	18.6
Santa Clara				
Municipal	198.1	238.3	429.7	593.3
Industrial	8.9	9.9	13.9	19.3
Solano				
Municipal	24.6	28.9	63.7	127.3
Industrial	9.2	9.6	9.8	13.0
Sonoma				
Municipal	32.6	40.1	87.5	122.4
Industrial	5.7	6.4	9.3	13.1
Sacramento				
Municipal	187.5	208.9	326.7	392.0
Industrial	17.5	18.8	23.9	38.0
San Joaquin				
Municipal	53.9	60.5	102.2	122.7
Industrial	23.1	24.5	27.6	42.5
Yolo				
Municipal	13.5	16.9	32.3	48.4
Industrial	11.5	12.1	11.5	14.9

that 60 percent of all outdoor recreation involves water-associated activities. Table 10 gives the present and projected water requirements for fish, wildlife and recreation in each of the counties in the 12-county study area. The requirements shown in Table 10 are for water used in fish and wildlife management areas and refuges.

Fish and Wildlife

51. The water requirements for fish and wildlife areas make up the greatest percentage of the demands indicated in Table 10. The consumptive use of water by recreationists at outdoor camping and picnic facilities is minute. However, the domestic water needs of the hundreds of thousands of annual visitors to the Bay Area is substantial and has been included as part of the municipal water requirement.

52. In addition to the water demands shown in Table 10 for fish and wildlife management areas, various governmental, public and private water and utility agencies have entered into agreements with the California Department of Fish and Game to insure adequate streamflows and reservoir water levels to protect and improve fishery, wildlife and recreational values. The annual water requirements for streamflow maintenance agreements range from 3,000 acre-feet per year to about 240,000 acre-feet per year. This latter agreement relates to releases from Folsom Reservoir in Sacramento County for fishery management.

53. Fish and wildlife resources in the San Francisco Bay-Delta Region are suffering from the results of urbanization and industrialization. Land reclamation, water development projects and water pollution have impaired ecological associations causing loss and deterioration of fish and wildlife habitat. Degradation of the natural environment, including its dependent fish and wildlife resources, has aroused deep and sincere public concern. Local, regional, State and Federal agencies have responded by implementing new standards for environmental protection, including those for wastewater discharge. Many programs and proposed standards outlining improvements in wastewater treatment have been promoted and in some cases implemented. Coupled with the demand for higher quality wastewater discharges there is a growing concern for the conversion, reclamation and reuse of all natural resources. Increasing demands by growing communities for higher quality urban water supplies will continue to deplete existing surface and subsurface water sources which now supply fish and wildlife, aesthetic, and other needs. Unless treated wastewaters are eventually returned to the hydrologic system, extensive local and regional areas will be adversely affected by increasing and conflicting water demands and water shortages.

AVAILABLE WATER SUPPLY

54. In general, most counties have or will have water projects under construction to satisfy water needs for the next 20 years. Table 11 presents information on "dependable" water supplies to

TABLE 10

FISH, WILDLIFE AND RECREATION WATER REQUIREMENTS[1/]

(1,000 Acre-Feet per year)

	1970	1975	1990-1995	2000	2020
Alameda	0	0	0	0	0
Contra Costa	37.0	37.0	37.0	38.0	38.0
Marin	1.0	1.0	2.0	2.0	2.0
Napa	0	0	0	0	0
San Francisco	0	0	0	0	0
San Mateo	1.1	1.3	1.0	2.0	3.0
Santa Clara	0	0	0	0	0
Solano	46.3	48.6	56.0	61.8	65.0
Sonoma	1.0	1.0	1.0	1.3	2.0
Sacramento	65.7	66.7	70.0	70.3	71.0
San Joaquin	67.1	69.0	75.0	75.7	76.0
Yolo	2.0	2.0	2.0	2.0	2.0
TOTAL	221.2	226.6	244.0	253.1	259.0

Source: Documentation of Bulletin 160-70, California Department of Water Resources, August 27, 1971.

[1/] Requirements are for limited outdoor camping and picnicking only. Most consumptive use for recreation is included with municipal requirements.

TABLE 11

DEPENDABLE WATER SUPPLIES 1/

(1,000 Acre-Feet/year)

	1970	1975	1990-1995	2000	2020
ALAMEDA					
Water Supplies					
Local Surface and Ground Water	98.0	98.0	98.0	98.0	98.0
Imports, Local Agencies	113.2	134.7	227.0	228.0	230.0
Federal Projects	-	-	22.0	22.0	22.0
State Water Project	21.1	27.5	61.0	77.9	88.0
Wastewater Reclamation	3.0	3.0	3.0	3.0	3.0
Total Water Supplies	235.3	263.2	411.0	428.9	441.0
CONTRA COSTA					
Water Supplies					
Local Surface and Ground Water	154.6	159.0	173.0	125.7	212.0
Imports, Local Agencies	90.4	100.4	137.0	149.8	179.0
Federal Projects	87.9	107.3	195.0	230.7	323.0
State Water Project	-	-	-	-	-
Wastewater Reclamation	-	16.8	18.8	18.8	18.8
Total Water Supplies	332.9	383.5	523.8	525.0	732.8
MARIN					
Water Supplies					
Local Surface and Ground Water	33.0	33.0	33.0	33.0	33.0
Imports, Local Agencies	-	-	-	-	-
Federal Projects	10.0	10.0	57.0*	57.0*	57.0*
State Water Project	-	-	-	-	-
Wastewater Reclamation	-	-	-	-	-
Total Water Supplies	43.0	43.0	90.0	90.0	90.0

* Conveyance facilities from Warm Springs Reservoir to southern Marin County were not approved in a recent bond election.

TABLE 11 (Cont'd)

DEPENDABLE WATER SUPPLIES 1/

(1,000 Acre-feet/year)

	1970	1975	1990-1995	2000	2020
NAPA					
Water Supplies					
Local Surface and Ground Water	25.0	25.0	25.0	25.0	25.0
Imports, Local Agencies	-	-	-	-	-
Federal Projects	7.0	7.0	7.0	7.0	7.0
State Water Project	-	-	25.0	25.0	25.0
Wastewater Reclamation	-	-	-	-	-
Total Water Supplies	32.0	32.0	57.0	57.0	57.0
SAN FRANCISCO					
Water Supplies					
Local Surface and Ground Water	3.0	3.0	3.0	3.0	3.0
Imports, Local Agencies	134.6	138.4	159.5	159.5	175.2
Federal Projects	-	-	-	-	-
State Water Project	-	-	-	-	-
Wastewater Reclamation	1.0	1.0	1.0	1.0	1.0
Total Water Supplies	138.6	142.4	163.5	163.5	179.2
SAN MATEO					
Water Supplies					
Local Surface and Ground Water	34.0	34.0	34.0	34.0	34.0
Imports, Local Agencies	71.0	80.1	115.0	121.3	135.0
Federal Projects	-	-	-	-	-
State Water Project	-	-	-	-	-
Wastewater Reclamation			1.0	1.0	1.0
Total Water Supplies	105.0	114.1	150.0	156.3	170.0

TABLE 11 (Cont'd)

DEPENDABLE WATER SUPPLIES 1/

(1,000 Acre-Feet/year)

	1970	1975	1990-1995	2000	2020
SANTA CLARA					
Water Supplies					
Local Surface and Ground Water	185.0	185.0	185.0	185.0	185.0
Imports, Local Agencies	24.9	33.0	77.0	92.2	132.0
Federal Projects	-	-	55.0	79.6	167.0
State Water Project	44.1	54.1	100.0	100.0	100.0
Wastewater Reclamation	-	-	3.0	3.0	3.0
Total Water Supplies	254.0	272.1	420.0	459.8	587.0
SOLANO					
Water Supplies					
Local Surface and Ground Water	187.5	188.4	191.0	191.0	191.0
Imports, Local Agencies	22.0	22.0	22.0	22.0	22.0
Federal Projects	178.1	178.3	179.0	179.0	179.0
State Water Project	-	-	-	42.0	42.0
Wastewater Reclamation	-	-	-	-	-
Total Water Supplies	387.6	388.7	434.0	434.0	434.0
SONOMA					
Water Supplies					
Local Surface and Ground Water	47.0	47.0	47.0	47.0	47.0
Imports, Local Agencies	-	-	-	-	-
Federal Projects	42.0	42.0	109.0	109.0	109.0
State Water Project	-	-	-	-	-
Wastewater Reclamation	-	-	-	-	-
Total Water Supplies	89.0	89.0	156.0	156.0	156.0

TABLE 11 (Cont'd)

DEPENDABLE WATER SUPPLIES 1/

(1,000 Acre-Feet/year)

	1970	1975	1990-1995	2000	2020
SAN JOAQUIN					
Water Supplies					
Local Surface and Ground Water	1,085.6	1,060.3	988.0	964.4	919.0
Imports, Local Agencies	-	-	-	-	-
Federal Projects	85.4	111.1	244.0	273.9	345.0
State Water Project	-	-	-	-	-
Wastewater Reclamation	-	-	-	-	-
Total Water Supplies	1,171.0	1,171.4	1,232.0	1,238.3	1,264.0
SACRAMENTO					
Water Supplies					
Local Surface and Ground Water	640.3	656.1	706.0	735.7	799.0
Imports, Local Agencies	-	-	-	-	-
Federal Projects	30.3	51.4	253.0	250.3	245.0
State Water Project	-	-	-	-	-
Wastewater Reclamation	-	-	-	-	-
Total Water Supplies	670.6	707.5	959.0	986.0	1,044.0
YOLO					
Water Supplies					
Local Surface and Ground Water	729.1	729.1	789.1	797.8	797.8
Imports, Local Agencies	-	-	-	-	-
Federal Projects	-	-	-	-	-
State Water Project	-	-	-	-	-
Wastewater Reclamation	-	-	-	-	-
Total Water Supplies	729.1	729.1	789.1	797.8	797.8

1/ Source: Memorandum and Documentation of DWR Bulletin 160-170; DWR Bulletin 184, Ten Counties Investigation.

the year 2020 by county. Dependable supplies are defined as firm commitments by water suppliers for their planning purposes. However, based only on these dependable supplies there still may be future shortages and certain counties may have to look to the use of reclaimed wastewaters as an adjunct to multiple purpose reservoir projects presently in the planning phase. Dependable water supplies and potential sources of additional water in the study area to the year 2020 are discussed in the following sections. Assumptions regarding the dependable water supplies are shown on Table 12.

Dependable Water Supplies

55. The Federal Central Valley Project will provide water to some of the counties in the study area. It is anticipated that 55,000 acre-feet per year in 1990 and 167,000 acre-feet per year in 2020 will be available from the San Felipe Division of this project for Santa Clara County. Contra Costa County will have 268,000 acre-feet by 2020 from the Central Valley Projects' Contra Costa Canal and Folsom North Canal. The Folsom South Canal Unit will provide Alameda County with 22,000 acre-feet by 1990. Water supplies for San Joaquin County are projected to increase from 53,000 acre-feet per year from Delta Mendota Canal to 317,000 acre-feet in 2020 as a result of additional supplies made available by the Folsom South Canal. Sacramento County will have 140,000 acre-feet by 2020 from the Auburn and Folsom Reservoirs of the Central Valley Project.

56. In San Joaquin County, the water use from the Corps of Engineers' New Hogan Reservoir is projected to increase from 20,000 acre-feet per year to 42,000 acre-feet by 1990 and then decline to 28,000 acre-feet by 2020. Warm Springs Reservoir is under construction by the Corps of Engineers and will supply Sonoma County 67,000 acre-feet by 1990. Sonoma County also will obtain 42,000 acre-feet per year from Lake Mendocino Reservoir. Marin County could be supplied with 47,000 acre-feet by 1990 from Warm Springs Reservoir.

57. The Bureau of Reclamation's project for Solano County will supply 179,000 acre-feet per year by 2020.

58. The California State Water Project is currently nearing completion by the Department of Water Resources. The North Bay Aqueduct of the State Water Project will provide Solano County with 42,000 acre-feet per year and Napa County will receive 25,000 acre-feet per year. Water via the South Bay Aqueduct of the Project will provide Santa Clara County with 100,000 acre-feet by 2020 and Alameda County with 88,000 acre-feet by 2020.

TABLE 12

ASSUMPTIONS REGARDING DEPENDABLE WATER SUPPLIES
SAN FRANCISCO BAY & DELTA REGION [1/]

The availability of water supplies for the San Francisco Bay and Delta Region is based upon the following assumptions in source data regarding existing and proposed projects and arrangements:

(a) ALAMEDA. Imports - East Bay MUD, 102 AF in 1967 to 230 AF in 2020. Central Valley Project - Folsom South Canal, 22 AF in 1990. State Water Project - South Bay Aqueduct, 18 AF in 1967 to 88 AF in 2020.

(b) CONTRA COSTA. Imports - East Bay MUD, 85 AF in 1967 to 179 AF in 2020. Central Valley Project - Contra Costa Canal and Folsom South Canal, from 54 AF in 1967 to 268 AF in 2020. Wastewater reclamation reflects agreement between Contra Cost County Water District and Central Contra Costa County Sanitary District.

(c) MARIN. Federal Projects - Sonoma/Marin Aqueduct[2/] fed by Warm Springs Reservoir[3/] and Lake Mendocino, 10 AF in 1967 to 57 AF in 1990.

(d) NAPA. State Water Project - North Bay Aqueduct, 25 AF by 1990.

(e) SACRAMENTO. Central Valley Project - Increase in water supply largely from Auburn and Folsom South Units, 22 AF in 1967 building up to 253 AF by 1990 then declining to 245 AF by 2020.

(f) SAN FRANCISCO. Increase in Hetch Hetchy Aqueduct supply, 180 AF in 1967 to 448 AF in 2020. Surplus will be sold.

(g) SAN JOAQUIN.[4/] Central Valley Project - Delta Mendota Canal and Folsom South Canal, 53 AF in 1967 to 317 AF in 2020. Other Federal Projects - Increase in water supply from New Hogan Reservoir, 20 AF in 1967 to 42 AF in 1990, then declines to 28 AF by 2020.

(h) SAN MATEO. Imports - Purchase of surplus Hetch Hetchy Aqueduct water from SFWD, 66 AF in 1967 to 135 AF in 2020.

(i) SANTA CLARA. Imports - Purchase of surplus Hetch Hetchy Aqueduct water from SFWD. Central Valley Project - San Felipe Division, 55 AF in 1990 to 167 AF in 2020. State Water Project - South Bay Aqueduct, 39 AF in 1967 to 100 AF in 2020.

(j) SOLANO. State Water Project - North Bay Aqueduct, 42 AF by 1990.

(k) SONOMA. Federal Projects - Warm Springs Reservoir will supply 67 AF by 1990.

(l) YOLO. Indian Valley Reservoir will supply 60 AF by 1990.

[1/] 1000 acre-feet.

[2/] Marin County would have to approve a bond issue for construction of the aqueduct.

[3/] Assumed to be on line in 1990.

[4/] 285,000 A.F. in New Melones Reservoir expected to be available to the Central Valley Project by 1980 has not been included because much of the water may be used in other counties outside the 12-county S.F. Bay-Delta Region.

59. Following is a brief discussion of local sources of water for the study area. The principal source of water supply for Alameda County is the East Bay Municipal Utility District's Mokelumne River imports which will be 230,000 acre-feet by 2020. For Contra Costa County, East Bay Municipal Utility District's imports from the Mokelumne River will be 179,000 acre-feet by 2020. San Joaquin County receives its local surface water supplies largely from Delta Channels, and also from the Mokelumne and Calaveras Rivers.

60. In San Francisco, the principal source of water supply is the San Francisco Water Department's Hetch-Hetchy Aqueduct imports from the Tuolumne River, Alameda Creek, and San Mateo County Reservoirs. Santa Clara County plans to purchase 132,000 acre-feet by 2020 from the San Francisco Water Department supply. The principal source of water supply for San Mateo County is also the San Francisco Water Department's Hetch Hetchy Aqueduct which is projected to increase to 135,000 acre-feet by 2020.

61. Local surplus water supplies diverted from the Sacramento and American Rivers under water-rights agreements with the Bureau of Reclamation will supply Sacramento County with upwards of 380,000 acre-feet by 2020. The city of Vallejo in Solano County also imports 22,000 acre-feet from the Sacramento River Basin.

62. Yolo County receives part of its water supply from Clear Lake and Cache Creek, 102,000 acre-feet per year. From the Sacramento River, Yolo County will receive an additional 402,000 acre-feet by 2020. The Tehama-Colusa Canal, now under construction, will deliver to the Dunnigan Water District 19,000 acre-feet per year. The Indian Valley Reservoir, recently authorized for construction by the Yolo County Flood Control and Water Conservation District will supply 60,000 acre-feet per year.

Potential Sources

63. In the event of shortages in Contra Costa County the logical sources of supply would be the proposed Kellogg Division of the Central Valley Project for the eastern part of the county and a transfer of water from Alameda County via East Bay Municipal Utility District facilities for the western part of the county.

64. Marin County may be short 36,000 acre-feet by 2020. The proposed Sonoma-Marin Conduit could convey water diverted from the Russian River to eastern Marin County.

65. The proposed Knights Valley Aqueduct could convey water diverted from the authorized (but inactive) Knights Valley Reservoir in Lower Russian River basin to existing Lake Hennessey in Napa. Napa Valley would be able to get 25,000 acre-feet per year. The proposed Spring

Valley Pump Storage Project to develop water from the Napa River is an alternate way to meet water shortages in Napa County. In San Joaquin the most likely additional source to meet water shortages would be the New Melones Reservoir.

66. Potential sources to meet anticipated shortages in San Mateo County are possible State Water Project imports, Bean Hollow Reservoir and wastewater reclamation. Wastewater reclamation is also being considered by Santa Clara County to meet its projected shortages. It already plans on using 3,000 acre-feet of reclaimed wastewater by 1990. This amount can be increased considerably by the use of reclaimed sewage to irrigate parks and recreation facilities, industrial process water, and groundwater recharge.

67. A likely source of supply to meet shortages in Solano County would be increased imports of water from the Sacramento Basin. Also shortages could be met by the proposed West Sacramento Canal Unit of the Central Valley Project. The most likely sources to meet demands in Sonoma County are enlargement of Lake Mendocino and additional imports from South Fork Eel River subsequent to the completion of Warm Springs Reservoir. Shortages in Yolo County may be met by enlargement of the proposed West Sacramento Canal Division of the Central Valley Project.

ASSOCIATED PROBLEMS

Surface Water Quality Degradation

68. The water quality of the Bay-Delta Estuary, as defined in traditional pollution terms, has improved on the whole over 1950 conditions. Biochemical oxygen demand, the amount of oxygen required for bacterial decomposition of organic wastes over a specified period of time, generally has decreased. Dissolved oxygen concentrations have increased to the point where most aquatic organisms have sufficient amounts to survive in most parts of the Bay-Delta Estuary. Coliform counts have been reduced significantly by chlorination of waste effluents. However, dissolved oxygen depletions still occur in the South Bay, south of Dumbarton Bridge, and in the San Joaquin River downstream of Stockton. Recent studies indicate that the biochemical oxygen demand assimilative capacity of the Sacramento River below the city of Sacramento is rapidly being approached. Studies from the State San Francisco Bay-Delta Water Quality Control Program reveal that biostimulatory materials (mostly nitrogen and phophorus which are necessary for algae growth) and toxicity may be more applicable indicators of pollution and eutrophication than biochemical oxygen demand and dissolved oxygen concentrations.

69. Studies indicate that the discharge of municipal and industrial wastewaters have a toxic effect on benthic organisms, causing a decrease in species diversity which is a common criterion for measuring

the degree of pollution of a body of water. More significantly, these benthic organisms are important as a vital link in the food chain of higher aquatic organisms such as fish. Toxicity has also been documented as a cause of several recent fish kills in the Bay-Delta Estuary. Moreover, the effects of toxicity in non-lethal concentrations, while not killing fish outright, impair fish so that they die from other causes or cannot continue normal activities such as feeding, migration and reproduction.

70. State Bay-Delta Program studies also indicate that municipal and industrial waste discharges contribute significantly to the reservoir of biostimulatory nutrients in the Bay-Delta Estuary. These discharges have been cited as a possible cause for annual summer algal blooms in the Delta and lower reaches of the Sacramento and San Joaquin Rivers. Discharge of agricultural drainage water from the San Joaquin Valley into the estuary via agricultural drains, programmed to be completed in the late 1970's and 1980's, would also contribute to increased levels of nutrients in the estuary. Studies also indicate that algal growth in the Bay is not now limited by nutrient levels but by some unknown factors, possibly turbidity. Algal blooms have the following effects on water quality: Impair the aesthetics of the water and are an indicator of eutrophication or aging of the estuary: reduce the beneficial uses of water; and while producing excess oxygen during the day, algae can depress oxygen levels during the night to anaerobic conditions, thereby seriously impairing the aquatic environment's ability to sustain itself.

71. It has been estimated that 10,000 to 20,000 pounds of pesticides in the form of non-degradable chlorinated hydrocarbons entered surface waters of the Bay-Delta system in 1965. Concentrations in parts of the estuary exceed the maximum concentration (50 parts per trillion) recommended by the National Technical Advisory Committee on Water Quality Criteria. While this concentration seems very low, it must be noted that concentrations have been found in tissues of aquatic life up to 20,000 times that of their environment and in excess of the considered safe level for human consumption.

Groundwater Problems

72. The extensive groundwater basins of California provide natural regulation for runoff from tributary drainage areas and for precipitation directly on overlying lands. About one-half of the water presently used on irrigated lands and for domestic, municipal and industrial purposes in the State is regulated in groundwater basins. Additional natural regulation could be provided if the presently unused groundwater storage capacity were utilized to the full extent of the possible safe yield of the underground basins. Furthermore, as additional surplus water supplies are developed and made available for storage in groundwater basins, the safe yield of the underground reservoirs can be increased.

73. The estimated mean seasonal requirements for water in California, in 1967, were approximately 28,600,000 acre-feet, of which about 11,500,000 acre-feet were supplied from underground sources. In 1967 about 580,000 acre-feet were withdrawn from the San Joaquin Valley and one million acre-feet from the Sacramento Valley.

74. The draft on groundwater in the San Francisco Bay Area amounts to about 300,000 acre-feet seasonally. The net extraction of groundwater in the area surrounding San Francisco Bay exceeds the safe yield of the underground basins by a large amount. Sea-water intrusion exists, or is threatening, in many of the coastal basins. Facilities for artificial recharge of underground storage are presently being operated in Santa Clara and Alameda Counties.

75. A large part of the domestic, industrial, and irrigation development of the Central Coastal Area is dependent upon development of groundwater storage, due to the generally small runoff available in the streams of the area. Draft on several of the major groundwater basins of the area has been so great that serious problems have arisen with respect to their adequacy, not only for future development, but also for maintaining the existing economy. Water levels in many of the coastal basins have fallen below sea level and progressive lowering is occurring in the San Ynez, Santa Maria, San Benito, and South Santa Clara Valley Basins. The 1967 gross pumpage in the Central Coastal Area approximated 750,000 acre-feet, of which about 60 percent occurs in the Salinas Valley.

76. Utilization of groundwater for irrigation in the Central Valley did not become significant until after 1900. However, the more or less complete diversion of available surface water supplies during the irrigation season in the south San Joaquin Valley prior to 1910, gave impetus to the development of supplemental supplies from groundwater storage. The 1967 pumpage of groundwater in the Sacramento Valley has been estimated to be about 1.0 million acre-feet, and in the San Joaquin Valley to be about 580,000 acre-feet per season. Quality problems have been evidenced in some valley basins. High groundwater tables existing over large areas of the Sacramento Valley present a problem of drainage for the improvement of agriculture.

Other Water Quality Problems

77. Naval and merchant ships still discharge raw sewage into Bay-Delta waters. This poses a pollution problem in the receiving waters in the vicinity of Alameda Naval Air Station when aircraft carriers are in port. Discharge of raw sewage from house boats causes limited pollution, particularly in Richardson Bay. Wastewater from the three largest dischargers to the estuary, the cities of Sacramento and San Francisco (North Point and Southeast Treatment Plants) and the East Bay Municipal Utility District (serving the cities of Oakland, Berkeley, Emeryville, etc.) presently receives only primary treatment with chlorination. As previously mentioned,

the cities of Sacramento and San Francisco have combined sanitary and storm sewage systems which necessitate discharge of raw wastewater to the receiving waters during rainy periods. The Navy and involved local agencies are making considerable progress in solving these problems. The Navy is providing its ships with storage tanks and is constructing shoreside waste disposal facilities. East Bay Municipal Utility District is upgrading its treatment facilities and the cities of San Francisco and Sacramento are evaluating various solutions to their combined sewage problem.

REGIONAL WATER QUALITY GOALS AND GUIDELINES

78. The State of California has established water quality objectives based on beneficial uses of water and has initiated the planning, implementation and enforcement actions necessary to maintain these objectives. To satisfy the requirements of the State's Porter-Cologne Act, as well as Federal planning requirements, the State developed in 1971 interim basin plans to serve as water quality planning and enforcement guidelines pending the adoption of comprehensive water quality control plans which currently are under preparation. The water quality objectives and waste discharge prohibitions from those State interim basin plans which interface with the San Francisco Bay - Delta Region are presented in Attachment B to Appendix A.

79. The Corps' wastewater management study was directed toward the needs anticipated in the year 1975-2000 timeframe. Since the State's comprehensive water quality control plans were still to be completed, planning criteria for this period regarding water quality objectives, waste discharge prohibitions and allowable discharge levels of critical pollutants were not available. The magnitude of the wastewater treatment and residual solids disposal problems, the public's increasing demand for high water quality standards consistent with environmental objectives, and the growing concern of all levels of government for improved wastewater management lead to the conclusion that planning criteria will be much more stringent as time progresses. Such a trend was evidenced in late 1972 when the water quality objectives and waste discharge prohibitions for the San Francisco Bay Basin were amended as tentative preliminary input to the comprehensive water quality control plans. This more stringent thinking is presented in Attachment C to Appendix A. These water quality objectives and waste discharge prohibitions establish a lower bound of water quality goals and guidelines for the Corps' planning efforts in wastewater management.

80. Realizing that future water quality objectives and water discharge prohibitions could not be predicted at this time, the Corps' effort was directed rather toward defining broad treatment technologies which could be expected to be compatible with future stringent wastewater mangement discharge conditions. Three such broad technological

approaches are available; physical-chemical treatment systems, advanced biological treatment systems and land treatment systems. None of these systems is new in concept and the unit processes involved currently are in use. It was felt that the unit processes from these systems could be combined to achieve comparable high levels of wastewater treatment and used, to the scale needed, in wastewater management alternatives for the San Francisco Bay and Delta Region. These and other treatment methodologies are discussed in the next major section of this report.

81. The State of California furnished the Corps with several items of general and specific guidance regarding water quality objectives and waste discharge prohibitions, non-degradation and land application systems. The following items of guidance from the State were used by the Corps in the development of wastewater management alternatives.

a. Statewide standards for the safe direct use of reclaimed wastewater for irrigation and recreational impoundments of the California State Department of Public Health from Title 17, California Administrative Code, Sections 8025 through 8050.

b. Resolution No. 68-16 of the California State Water Resources Control Board commonly called the Board's "non-degradation" policy. The key provision of this resolution is as follows:

> "Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies."

c. Letter dated 26 December 1972 from the State of California indicating that:

(1) "There should be no surface runoff from the land application sites of either wastewater or storm water at any time when wastewater is present on the site."

(2) "No controllable water quality factor shall degrade the quality of any groundwater. Exceptions will be considered where the controllable factor is reclaimed wastewater and where existing and potential beneficial uses will be protected."

WASTEWATER TREATMENT METHODS

INTRODUCTION

82. A wide variety of processes can be used to treat wastewater prior to final disposal. The choice of the method of treatment is determined by wastewater management goals and objectives. As these goals and objectives become more stringent, based on State and Federal requirements, the degree of wastewater treatment must be increased.

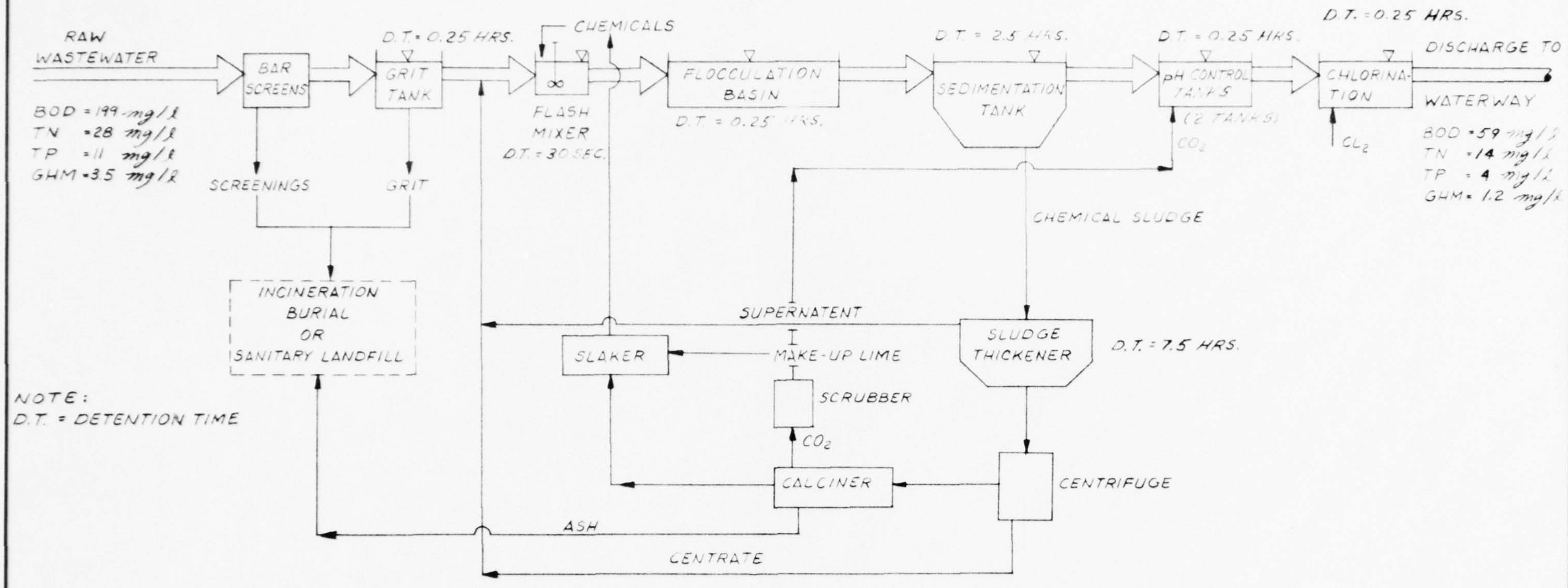
83. As stated previously, water quality objectives and waste discharge prohibitions for the year 1975-2000 timeframe could not be predicted. Consequently, it was concluded that the formulation of wastewater mangement improvements would be based on high removal waste treatment technologies.

84. Two general waste treatment methodologies have been addressed in this study for the development of wastewater management improvements. One treatment method combines various conventional treatment units together forming an advanced treatment process and discharges treated effluent to receiving surface water bodies. The second method involves the application of treated wastewater on designated land areas.

CONVENTIONAL TREATMENT

85. In order to provide for the maximum possible reduction of pollutants in facilities discharging to surface waters, maximum consideration was given to developing a full tertiary treatment process. Rationale for such a treatment process was to achieve as close to 99 percent removal as possible of critical pollutants (short of demineralization) and to provide a process comparable to land treatment. Since this process would provide an extremely high level of treatment and might not be fully required to achieve future water quality objectives, a series of advanced treatment processes providing lower degrees of treatment was considered. These advanced treatment processes, however, would provide removals higher than those required to meet current water quality objectives. Conventional treatment processes considered are discussed in the following sections.

86. When physical-chemical treatment is used (see Figure 2), the incoming wastewater passes through screening devices to remove the large solid matter and grit. Chemicals, lime or alum, are added to the wastewater in a flash mixing basin which provides for a rapid high intensity mixing of the chemical coagulant with the wastewater. Flocculation, or the development of large particles as a result of the chemical addition, occurs next and prior to the removal of the suspended solids in the sedimentation tank. The treated wastewater is then disinfected with chlorine and discharged to the receiving surface water body. The sludge collected at the bottom of the sedimentation tank is pumped to a sludge thickener. This sludge is high



PHYSICAL - CHEMICAL TREATMENT PROCESS

FIGURE 2

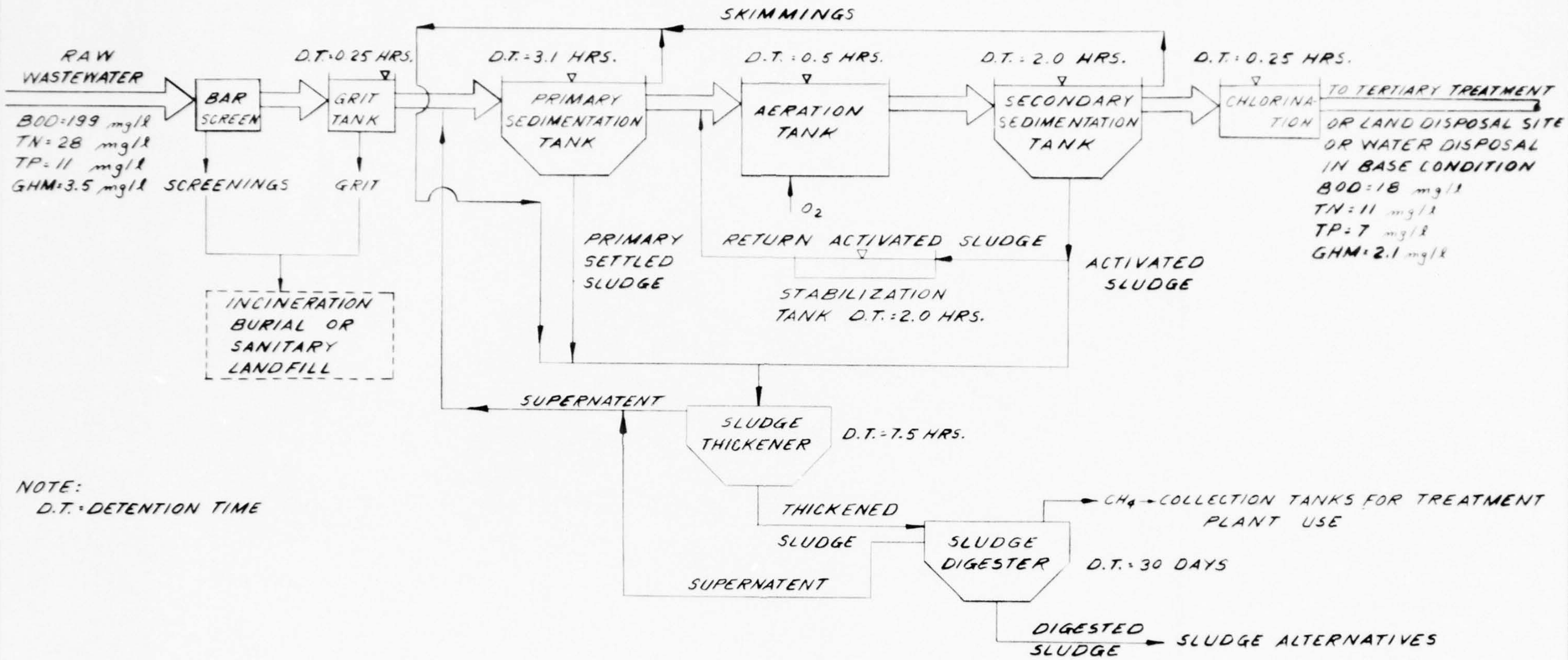
in chemical composition (lime) which can be recovered by recalcination methods for later reuse. This treatment process will result in removal of approximately 70 percent of the available BOD, 50-65 percent of the nutrients (60 to 80 percent removal of phosphorus and 20 to 50 percent removal of nitrogen), and 65 percent of the heavy metals present but there is no removal of total dissolved solids. This type of treatment was not used in the development of wastewater management alternatives because the trend in the San Francisco Bay-Delta Region is toward biological treatment. However, the better aspects of the physical-chemical process, such as lime utilization for phosphorus removal, were used in developing the full tertiary and advanced treatment processes.

87. The basic biological treatment process (see Figure 3) consists of screening devices and primary sedimentation for the removal of settleable organics, floating oils, and grease. The wastewater then enters aeration tanks where it is mixed with activated sludge and agitated by compressed air. After aeration and mixing, the wastewater flows to final settling tanks where the sludge is separated by sedimentation. A portion of the settled sludge is returned to the inlet end of the aeration tank to innoculate the incoming sewage. The treated wastewater is chlorinated prior to disposal. This basic biological treatment process can have several variations. Those used in this study include:

a. Addition of a nitrification/denitrification process (see Figure 4) in which ammonia nitrogen is biologically converted to nitrogen gas;

b. Addition of dual medial filter (see Figure 5) for the purpose of polishing the treated wastewater. The filter is employed for the removal of finely divided suspended material. These treatment processes can be combined with the basic biological treatment process so that partial or full tertiary treatment (see Figures 6 and 7) is applied to wastewater. Tertiary treatment provides for the removal of pollutants not completely removed by secondary treatment process, such as suspended solids, refractory organics, and nutrients.

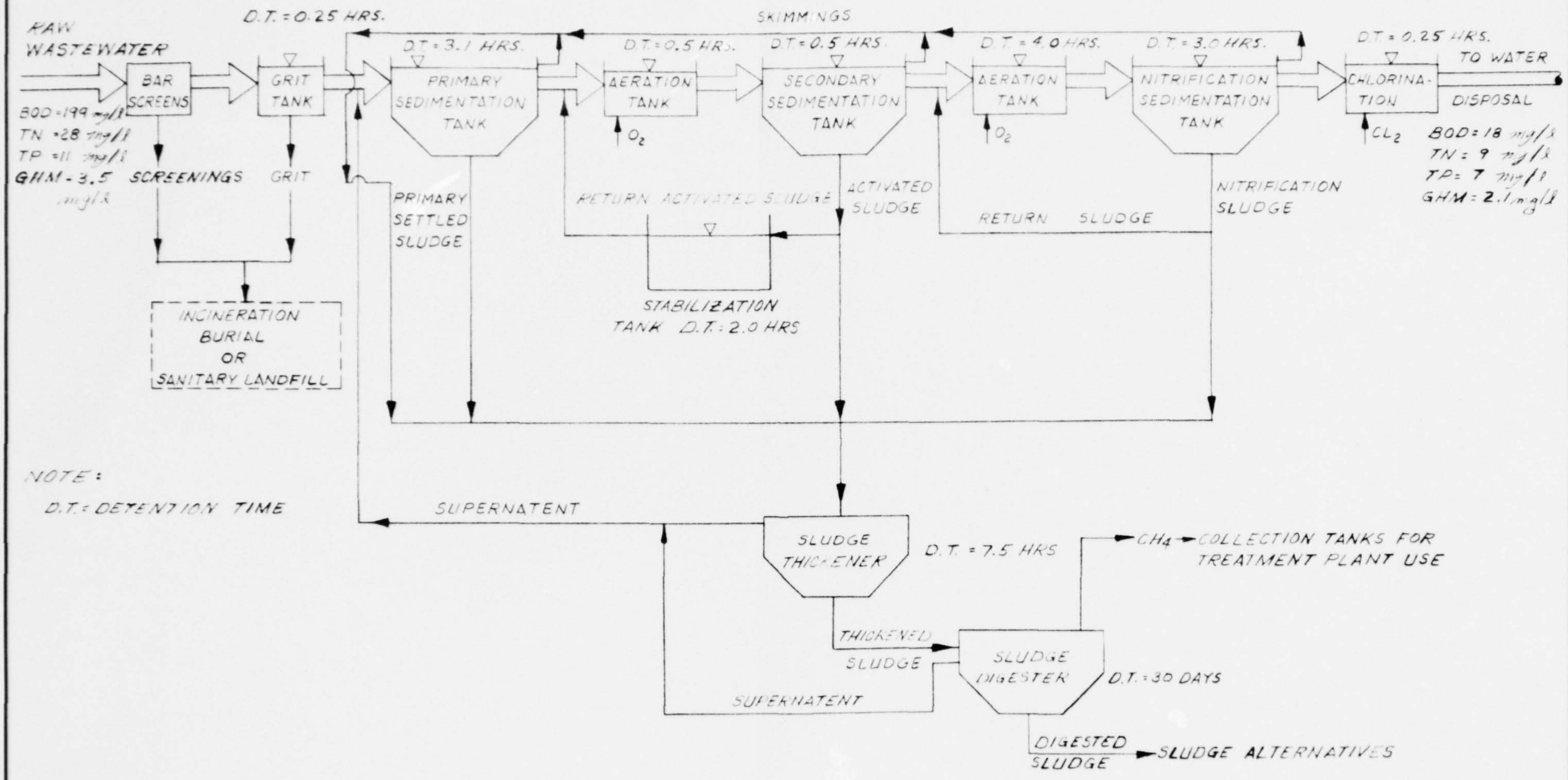
88. A full tertiary treatment as used in this report consists of conventional biological treatment, 98 percent phosphorus removal, nitrification and denitrification, dual media filtration, and carbon adsorption. Sludge is collected from the sedimentation tanks and pumped to an anaerobic digester for stabilization. For those unit processes which use chemicals: i.e., phosphorus removal and carbon adsorption, the chemicals will be recovered by thermal regeneration for later use



NOTE:
D.T.=DETENTION TIME

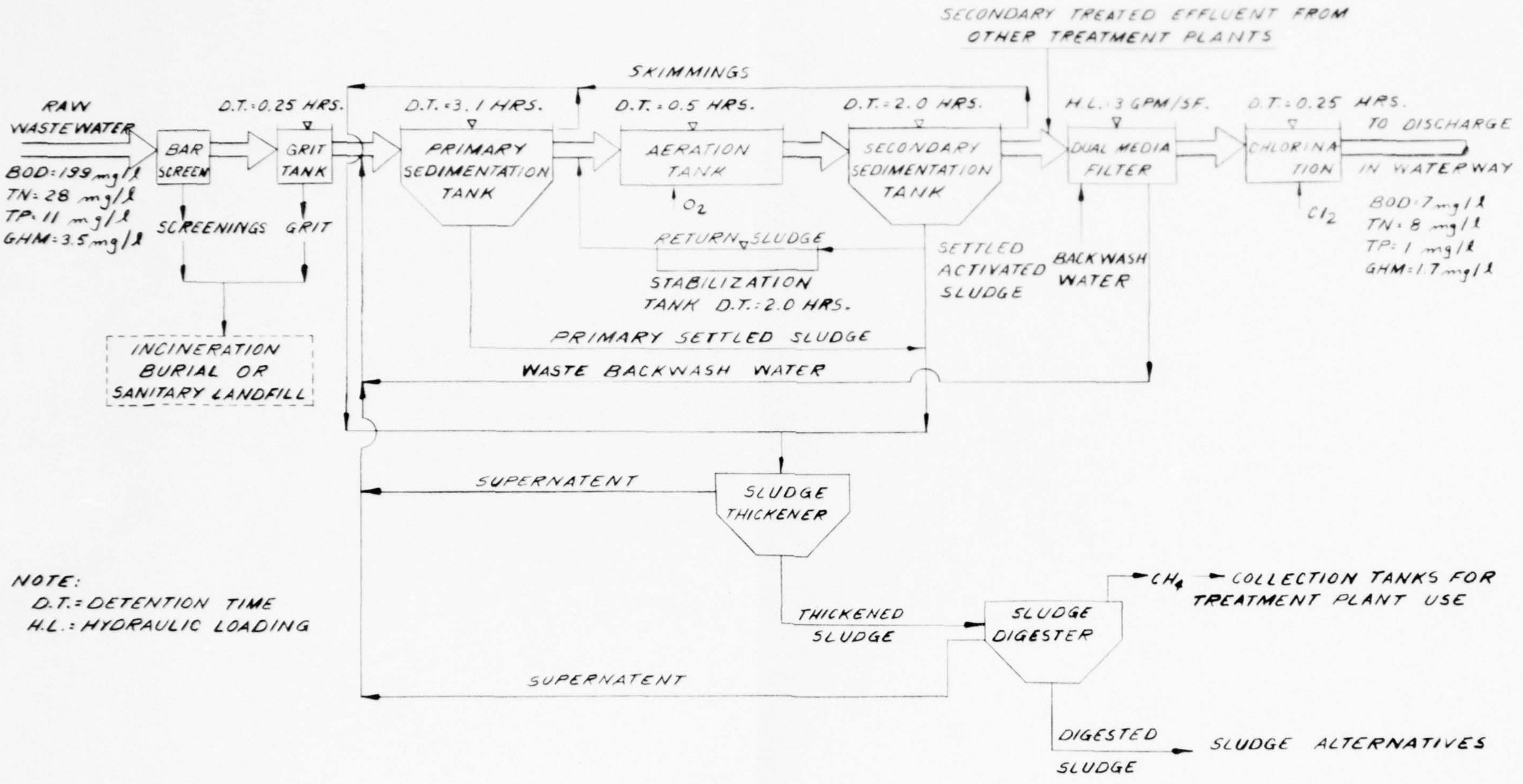
SECONDARY TREATMENT PROCESS

FIGURE 3



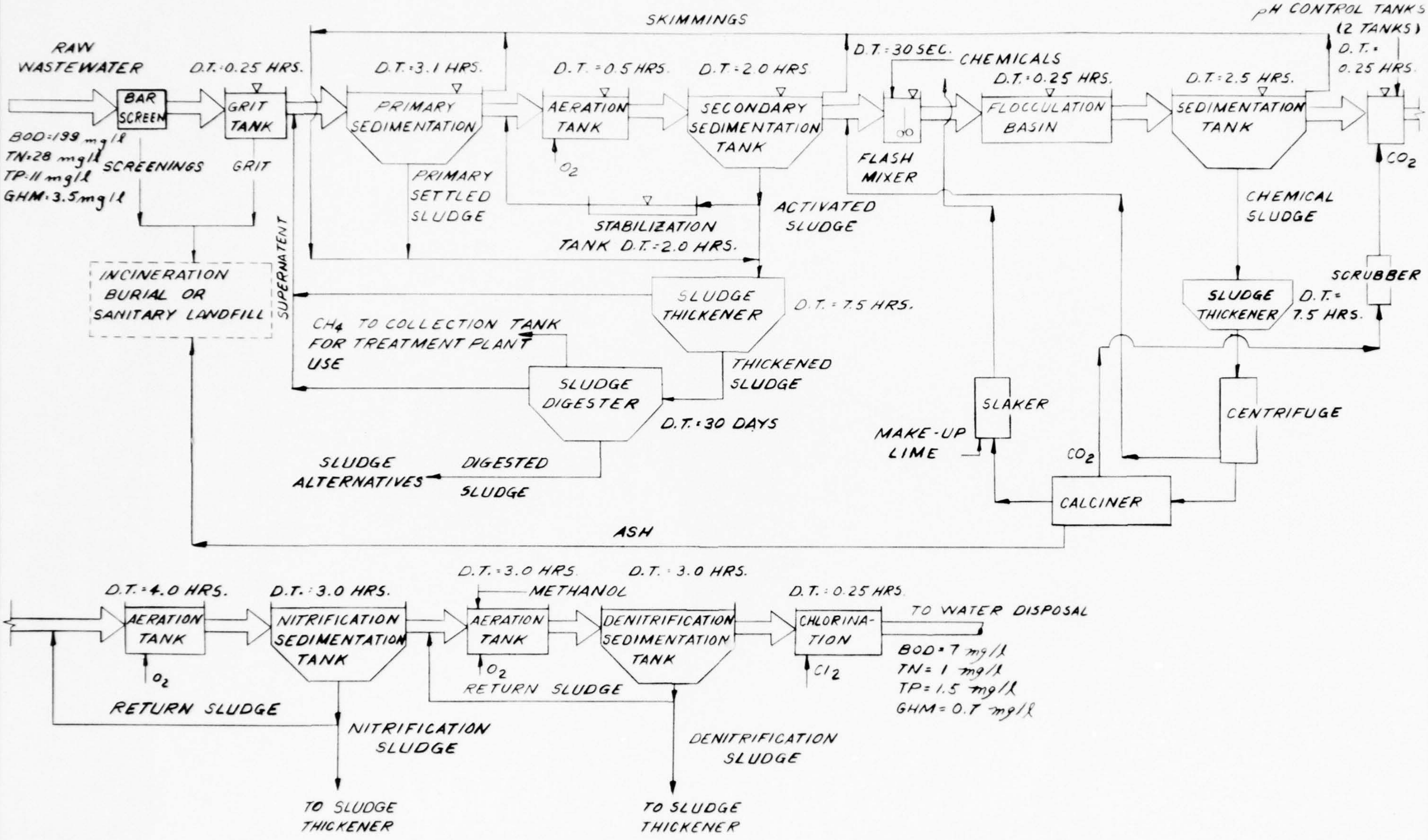
ADVANCED TREATMENT PROCESS TYPE A

FIGURE 4



ADVANCED TREATMENT PROCESS TYPE B

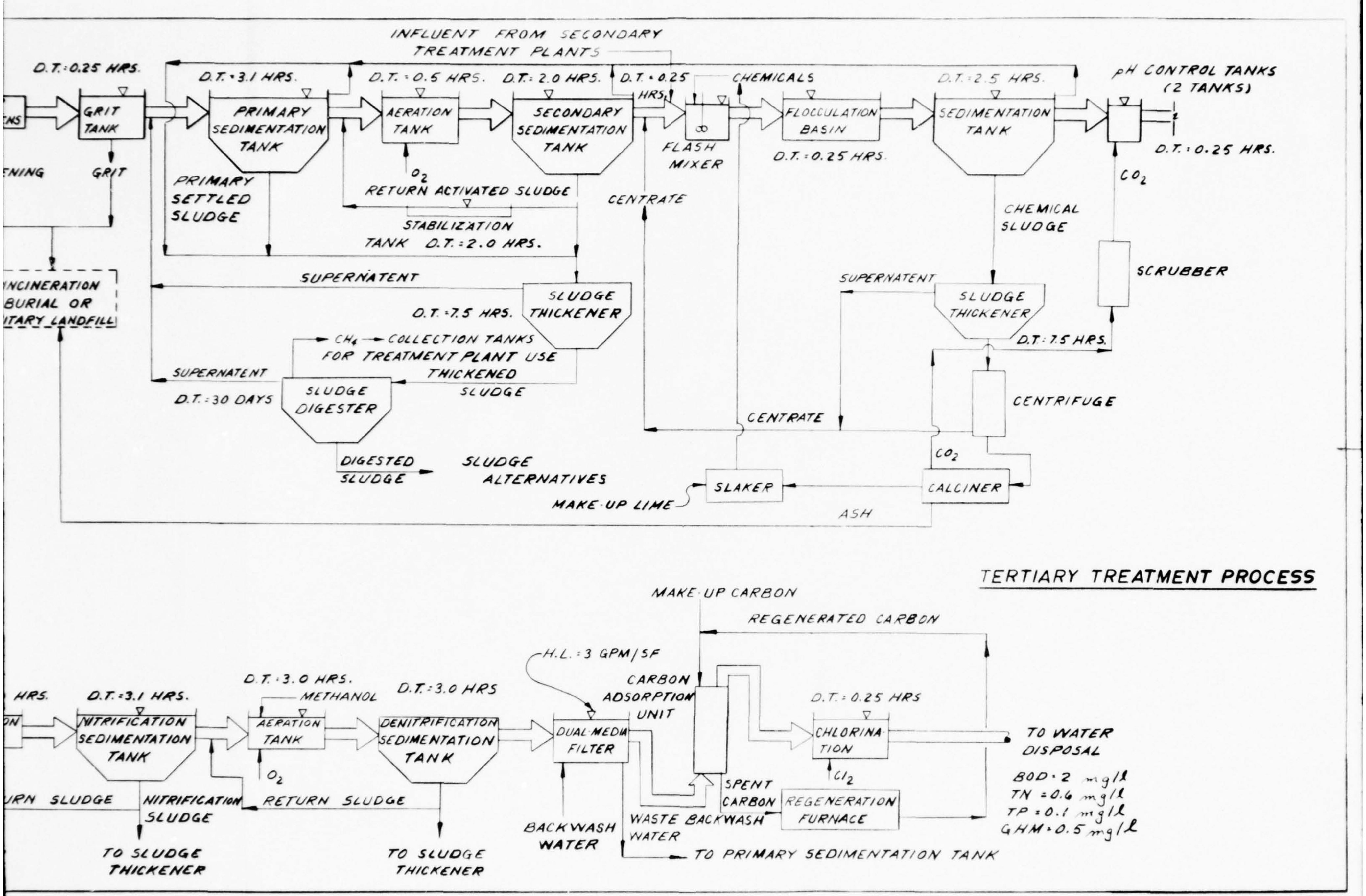
FIGURE 5



NOTE:
D.T.=DETENTION TIME

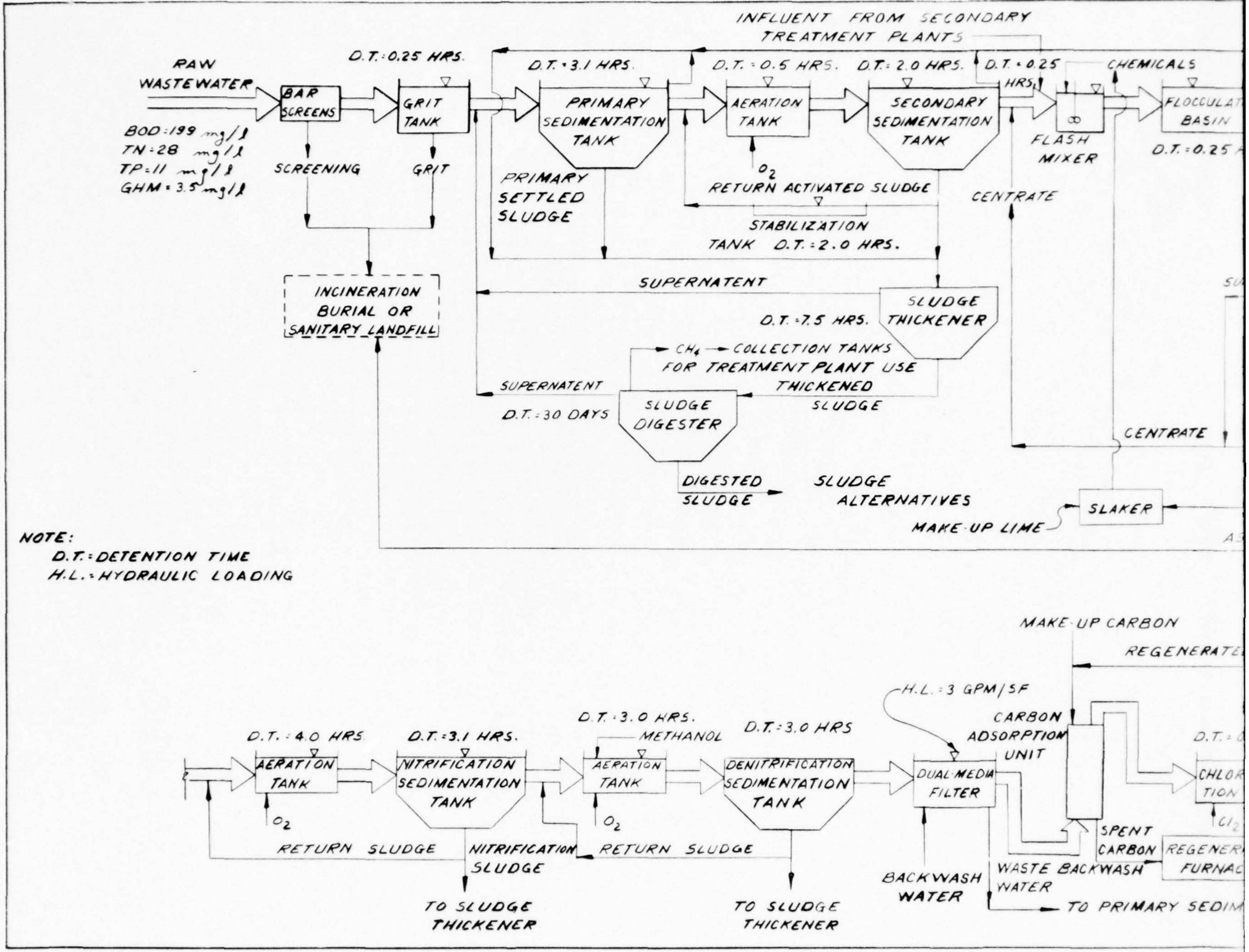
ADVANCED TREATMENT PROCESS TYPE C

FIGURE 6



TERTIARY TREATMENT PROCESS

FIGURE 7



NOTE:
D.T.:DETENTION TIME
H.L.:HYDRAULIC LOADING

2

89. Treatment processes discussed in this report result in the removal efficiencies shown in Table 13. Removal efficiencies shown were obtained from various published engineering documents, textbooks and professional articles. They represent average values for the individual processes shown.

LAND APPLICATION

Introduction

90. Of the general types of treatment considered in this study, land application or the "living filter" is the most unique. Instead of relying on individual tertiary or advanced treatment units in the treatment sequence as is done for the more conventional physical chemical and advanced biological systems, land application relies on the natural in-place soils and associated ground cover (the living filter) to accomplish tertiary treatment. The process is truly unique among unit treatment processes in that while the applied wastewater is being renovated and impurities removed, it is also being reused as irrigation water for the ground cover. Not only does land application allow an initial reuse of wastewater as irrigation water but it also provides additional quantities of high quality water which have been renovated in the plant-soil system.

Background

91. The land-soil system acts as a filter, removing impurities from the wastewater and at the same time supplying the soil-plant system with nutrients and water for growth of plant life. The name "living filter" has been used to describe the process since the ground cover is an integral part of the system. The concept of applying waste products to land areas has been practiced for centuries. Application of treated wastewaters to land areas is a proven concept in many areas. A sewage farm for Melbourne, Australia, has been successfully operating since the previous century. Cattle and sheep, raised for human consumption, have been fed forage grown with wastewaters on the farm.

92. About 40 percent of the total sewage produced at inland facilities in England and Wales is applied to agricultural land. In California such large cities as Fresno and Bakersfield practice land application of wastewaters. Nearly all of the communities in the Southern San Joaquin Valley and Tulare Basin practice some form of land application, principally through irrigation of crops and pasture.

TABLE 13

CONVENTIONAL WASTEWATER TREATMENT PROCESSES - AVERAGE REMOVAL EFFICIENCIES

Treatment Process	AVERAGE REMOVAL EFFICIENCY %				
	Biochemical Oxygen Demand	Total Nitrogen	Total Phosphorus	Gross Heavy Metals	Total Dissolved Solids
Secondary 1/	91	60	32	40	<1
Aerated Lagoons	85	10	10	25	<1
Advanced Secondary Type A 2/	91	68	32	40	<1
Advanced Secondary Type B 3/	96	72	86	52	10
Advanced Secondary Type C 4/	96	96	86	79	<1
Full Tertiary 5/	99	98	99	85	10

1/ Includes primary sedimentation, aeration, secondary sedimentation, and chlorination.

2/ Includes secondary treatment plus nitrification.

3/ Includes secondary treatment plus dual media filtration.

4/ Includes secondary treatment plus 80% phosphorus removal and nitrification/denitrification.

5/ Includes secondary treatment plus 98% phosphorus removal, nitrification/denitrification, dual media filtration, and carbon adsorption.

93. In the San Francisco Bay-Delta Region about 5 to 10 percent of all wastewater flows are disposed of by some form of land application. Although golf course irrigation and hillside spraying are the two most common methods, the city of Pleasanton intensely irrigates about 100 acres of pasture lands on which cattle are grazed. In California, as a whole, over 200 municipalities, communities and industries practice some form of land application with treated wastewaters.

94. The "living filter" concept has the following unique features which make it an attractive alternative to conventional advanced wastewater treatment when considering total water resource management:

a. Irrigation with treated wastewaters on crop and pasture lands could replace or release higher quality water supplies normally used for irrigation.

b. Nutrients are returned to the land where they are beneficially used by plants.

c. Discharges to water bodies would be lessened; this will insure that less pollutants, such as BOD, nitrogen, and phosphorus, will be directly entering the surface waterways.

d. The fate of waste materials can be more easily monitored and controlled on land areas.

e. It becomes possible to avoid the constant upgrading of treatment plants in order to meet higher standards.

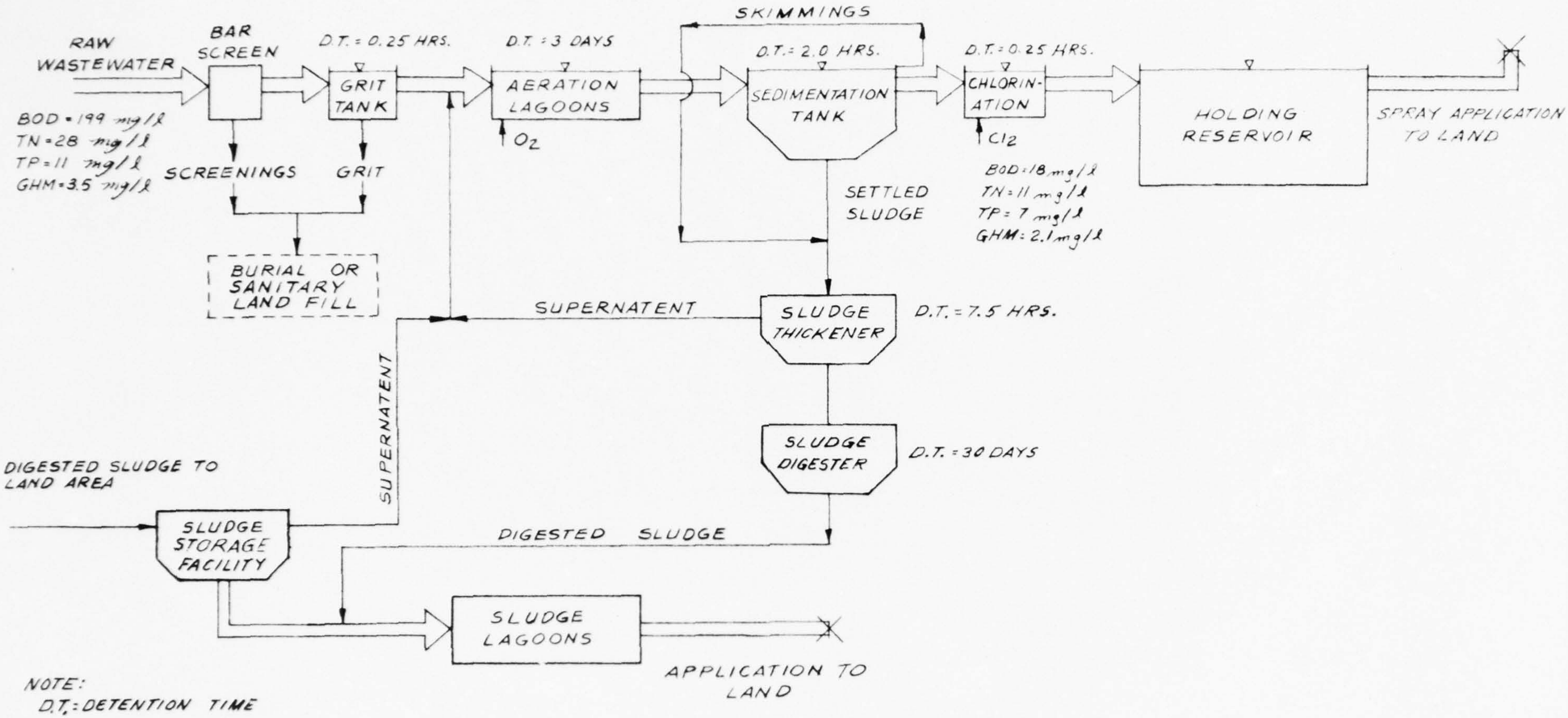
f. Crops and pasture grasses grown on land application sites provide additional benefits.

g. Water renovated by the "living filter" can be recollected and reused for additional beneficial purposes.

95. Prior to land application, wastewater will be given secondary-level pretreatment followed by chlorination to destroy bacterial pathogens. Pretreatment methods considered in this study include the activated sludge process, Figure 3 (Land Treatment - Type X), and treatment in aerated lagoons, Figure 8 (Land Treatment - Type Y). Either of these systems will pretreat wastewater to an acceptable and comparable degree amenable to further treatment by the "Living filter."

Application Methods

96. The three most common methods of applying wastewater in land application systems are by spray irrigation, overland runoff (sheet flow) and rapid infiltration. Spray irrigation can be accomplished with in-place or travelling spray rigs. Overland runoff utilizes ditches, usually about 100 feet apart per one percent of slope. General ground slopes are usually in the range of 2-6 percent. Water released from the ditches flows over the soil cover and top soil



NOTE:
D.T.: DETENTION TIME

LAND TREATMENT PROCESS TYPE Y

FIGURE 8

surface layer. Rapid infiltration applies water on a landsite for 10-14 days with resting periods of a few days between applications. A fourth method, ridge and furrow irrigation, could be used for crops that are sensitive to spray on their foliage. After preliminary evaluation of these methods, spray irrigation was considered to have the widest application to the study area and was the only method evaluated in this report.

Removal Mechanisms

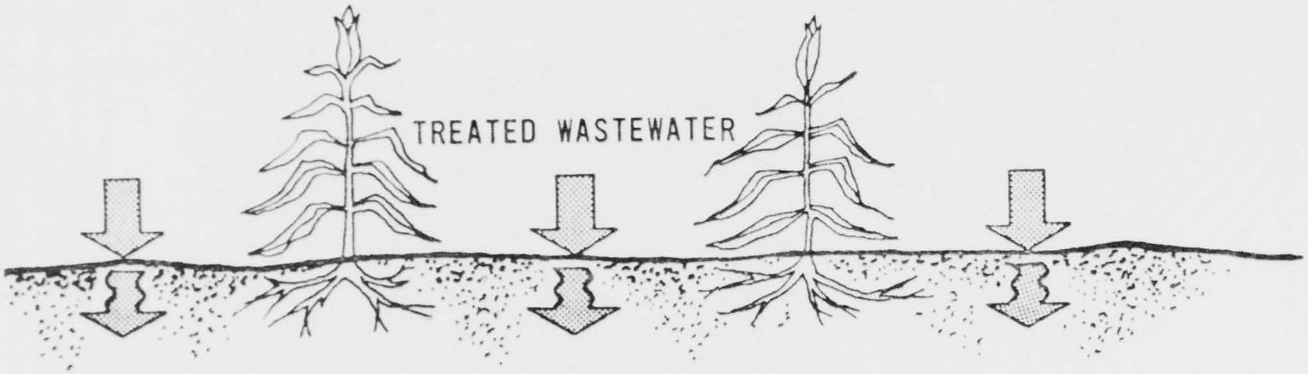
97. The land treatment process utilizes the entire bio-system, including the soil and its vegetative cover, to purify the wastewater. Wastewater is renovated by three basic internal mechanisms operating within the soil, namely plant uptake; filtration, ion exchange and fixation; and reactions with soil micro-organisms. These mechanisms are active to some degree in all types of soil and control the effectiveness of the land to sustain wastewater renovation and optimum crop production. The sketch on page 60 illustrates the removal mechanisms. They are discussed in more detail in the following sections.

98. Of primary concern are the amounts of the various nutrients removed from the applied wastewater by crop and pasture lands. The amounts of major nutrients such as nitrogen and phosphorus lost through plant uptake represent quantities lost through harvesting all or portions of the growing vegetation. Quantities removed per acre depend not only on the content of the element in the part of the crop that is harvested but on the total weight of dry material removed. Since both plant composition and yield vary widely, different amounts of the nutrients are removed by different plant species. For this study, it was assumed that crops such as cotton, sugar beets or corn (crops which use about 150 pounds of nitrogen per acre per year) would be harvested and that pasture grasses such as ryes, bromes and fescues would be grown. These pasture grasses remove about 200 pounds of nitrogen per acre per year. In general, phosphorus is removed by most crops at rates comparable with about one-fifth of the nitrogen removal rate.

99. Physical and chemical phenomena are important among removal mechanisms not only as they relate to the accumulation of pollutants in the upper path of the soil horizon, but also with respect to the indirect role of soil chemistry in relation to biological renovation and to the influence of chemical interactions on soil physical properties.

a. Filtration is the straining or mechanical removal of suspended particles which are larger than the openings between the soil grains. This, for the most part, takes place near the surface and initially removes the very large particles. As filtrtion proceeds, the openings become smaller because of accumulating material and smaller particles are removed. The process is essentially the same as that occurring in mechanical treatment plants. However, treatment plant filtration rates are many times the rates contemplated for land application. This allows the organic fraction of

LAND TREATMENT PROCESS



ROOT SYSTEMS	- TAKE UP SOLUBLE NUTRIENTS
SOIL PARTICLES	- MECHANICALLY STRAIN SUSPENDED SOLIDS - ADSORB BACTERIA, VIRUSES, PHOSPHORUS, AND HEAVY METALS
SOIL MICROORGANISMS	- CONSUME DISSOLVED ORGANIC, NITROGENOUS AND PHOSPHORUS MATERIALS

the solids to degrade and become part of the soil system. Because of the relatively low application rates and subsequent organic decomposition, the living filter should be able to perform indefinitely, without clogging or chemical buildup problems.

b. Ion exchange, perhaps the most commonly recognized chemical process which occurs in soils, is related to characteristics of both the clay fraction and organic matter. Although ion exchange is more important where considering dissolved chemicals which are positively charged (cations), soils under certain conditions also have a limited capacity to retain negatively charged chemicals (anions). Cation exchange capacity increases both with the organic content of soils and soil acidity (pH). Heavy metal cations in wastewater applied to soils must compete with common cations in normal exchange phenomena. Since heavy metal cations are normally present in wastewater at much lower levels than common cations, this exchange phenomena, while significant, is not the most effective process in the removal of heavy metals from solution.

c. Adsorption is the most important process by which pollutants are removed from wastewaters applied to soils and is defined as the capacity of soils to retain certain dissolved chemicals so tightly that they can only be removed from the solid fraction with great difficulty. It differs from ion exchange in that, by definition, exchangeable ions are freely replaceable. Several processes may be involved in adsorption. Initially, it involves an ion exchange phase but eventually the surface adsorbed ions become incorporated within the soil structure as an impurity unavailable to the soil solution. The process is particularly significant in the removal of heavy metals and phosphate and is aided by organic matter present in the soil.

d. So far the removal mechanisms described have depended upon physical and chemical interactions of constituents in the soil solution with some component of the soil structure. However, if the concentrations of cations and anions in the soil solution become sufficiently high, mutual association between specific types of constituents in solution will occur to form solid chemical compounds with limited solubility. Although the concentration levels at which precipitation will begin to occur depend upon the individual compounds in question, many of the cations and anions found in wastewater can potentially precipitable in the soil.

100. Biochemical reactions which occur in the soil are those directly or indirectly related to processes by which micro-organisms degrade the applied wastewater organics. Primary micro-organisms of the soil are bacteria, fungi, algae and soil animals such as protozoa, earthworms and nematodes. These organisms are the ecological units that may likely have the largest effect upon wastewater applied to land. They are important in that they can transform wastewater

components extensively from gases, liquids or solids. Transformation processes involving micro-organisms have significant effects upon carbon, nitrogen, sulfur, and phosphorus and include mineralization and immobilization, nitrification, denitrification, and oxidation-reduction.

101. The following summary briefly describes the effects of the foregoing removal mechanisms on certain critical constituents:

a. Suspended Solids - Suspended solids removal by the "living filter" can be quite efficient. Most authorities credit a percolation type system such as rapid infiltration or spray irrigation with essentially complete (99%+) removal. Overland runoff is somewhat less efficient, less predictable and much more difficult to control. Even with these drawbacks, it is estimated that 80 percent of suspended solids could be removed from secondary effluent by overland runoff. The main mechanism involved in spray irrigation and rapid infiltration is filtration by the soil mantle. That of overland runoff is filtration through the organic litter on the soil surface and may include some filtration horizontally in the first few inches of soil.

b. Oxygen Demanding Compounds - These materials are generally considered to be the relatively easily degraded organic compounds. The Biochemical Oxygen Demand (BOD) is accepted as an index of their presence. Organic decomposition in the soil is essentially the same as that occurring in biological secondary treatment processes. The same groups of microorganisms operate in both systems. Biological secondary treatment merely increases the concentration of active microorganisms and provides an ideal environment in order to speed up the decomposition process, which occurs naturally in soil systems.

c. Dissolved Solids - Total dissolved solids, also expressed as TDS, consist mostly of sodium, potassium, magnesium and calcium sulfates and chlorides in solution. Most of these materials are not removed in any significant degree from wastewaters by soils. Although significant ion exchange can occur in the soil matrix, this is only an exchange of ions rather than a net removal of dissolved solids. Neither is there a significant removal of dissolved solids by plant uptake, especially in relation to the total quantities in the applied wastewater. In arid or semi-arid areas where evaporation is significant, there can be a net salt accumulation in soils as a result of irrigation or water spreading operations if provisions for adequate leaching are not provided. Salt buildup in the soil horizon due to the removal of carriage water by evapotranspiration historically has been prevented or corrected by applying excess amounts of irrigation water which percolate the applied or previously built-up salts beyond the plant root zone where they no longer are harmful to plants. In steady state conditions, all dissolved solids applied by the wastewater percolates below the plant root zone. Although total quantities of salt do not increase, the percolate may exhibit increased concentrations of TDS because of the removal of carriage water by evapotranspiration. As the quantities of percolate decrease in relation to total annual applications of wastewater, these TDS concentrations will increase. Under like conditions of evapotranspiration it must be stressed that similar increases in the mineralization of percolating water occurs in normal irrigation practice. While it is possible to protect the "living filter" from salt accumulation, the fate of the percolated salts must be carefully monitored and controlled to prevent an undesirable deterioration of ground and surface waters.

d. Nutrients - The two basic nutrients, phosphorus and nitrogen, are removed by various combinations of plant uptake and binding to the soil particles. Generally, nitrogen will be the limiting element on a short-term basis (yearly) whereas phosphorus will be the limiting element over a long period of time (50 or 100 years). Phosephates from applied wastewater ultimately end up either utilized by plants, or bound to soil particles as insoluable phosphates. Phosphate removal is generally accepted as complete in a well-managed soil system, especially at low application rates. Phosphate percolation usually occurs only when the soil capacity for assimilating the phosphates is reached. Reactions involving nitrogen in the soil are both very complex and very important, especially since nitrogen (in the nitrate form) seems to be the limiting element in land application systems. All of the major site components (plants, soil and micro-organisms) can provide active responses to nitrogen, depending on its form. Nitrogen can be applied to the soil in several forms, organic, ammonium or nitrate. About 90 percent of the total nitrogen in secondary effluent is in the inorganic form, as either ammonium or nitrate. The major opportunity for nitrate removal is by plant uptake. The amount removed is largely a function of the particular crop used. If more nitrogen is applied than can be used by the plants (or volatilized to nitrogen gas), the excess will percolate. Essentially all nitrogen percolating below the root zone is in the nitrate form. Some nitrate may be immobilized in the upper layers of the soil by incorporation into microbial cells and thus retained above the root zone as organic nitrogen. Ammonium nitrogen reaching the site has potential for two initial pathways. Some can be temporarily adsorbed by the soil particles. Fixation in less soluable forms by clay minerals is possible. The fraction temporarily held is available to micro-organisms. This microbial activity is also the second potential direct pathway. These aerobic organisms oxidize the ammonium nitrogen. The end product is still nitrate but the time lag inherent in the process is a definite benefit for overall removal efficiency. In effect the soils and organisms provide temporary storage for some of the nitrogen which is then gradually released for plant uptake during the non-spray rest periods.

e. Heavy Metals - The heavy metals considered are cadmium, cobalt, chromium, copper, iron, mercury, manganese, molybdenum, nickel, lead, and zinc. These heavy metals are considered by some to be a cause of possible concern in land application practices. There are two basic concerns in dealing with heavy metals. First, that excessive amounts will percolate into underground water supplies or into recollected water thereby impairing their uses. Secondly, that the soluable fraction of these metals in the soil will be so great as to create excessive concentrations in plants which would either kill the plant or prevent its further use as harvested crop due to high toxicity. Several different mechanisms have been postulated for binding the metals in insoluable forms. Heavy metal cations are strongly adsorbed by organic matter which reduces their mobility. In addition, clay materials are often credited with having high cation exchange capability for holding onto heavy metals. These mechanisms are believed to be quite effective in permanently binding metals to the soil matrix.

INITIAL DEVELOPMENT OF ALTERNATIVES

WATER QUALITY ZONES

102. The San Francisco Bay system extends from the eastern end of Chipps Island at the city of Pittsburg, where the Sacramento and San Joaquin Rivers join, westward and southward to the mouth of Coyote Creek near the city of San Jose. The Golden Gate is about halfway between San Jose and Antioch and is the Bay's only direct connection with the Pacific Ocean. The Sacramento-San Joaquin Delta is roughly triangular in shape and extends from Chipps Island on the west, to the city of Sacramento on the north, and on the south to Vernalis on the San Joaquin River about 10 miles southeast of the city of Tracy.

103. Water quality zones were established in the San Francisco Bay-Delta system and its adjacent offshore ocean waters to permit differentiation and evaluation of water quality within different portions of the estuarine system. Five zones were established by the Corps of Engineers based on physical configuration factors and physical, chemical and biological water quality conditions. In all cases, the zones either correspond with, or were aggregations of, water quality zones developed for the State's Bay-Delta Program in the mid-60's. These five water quality zones are described in the following sections. In all cases, it was assumed that streams or rivers tributary to a zone become in fact part of that zone.

a. Pacific Ocean - Pacific Ocean waters offshore from and adjacent to the study area.

b. South San Francisco Bay - That portion of San Francisco Bay which lies south of the Oakland-San Francisco Bay Bridge.

c. Central Bay - Central Bay, as defined for this study, lies between the Oakland-San Francisco Bay Bridge and the Carquinez Strait Bridge and includes San Pablo Bay.

d. Carquinez Strait - Suisun Bay - This zone includes Suisun Bay east of Carquinez Strait Bridge to the junction of the Sacramento and San Joaquin Rivers near Pittsburg.

e. Sacramento - San Joaquin Delta - (as described in Paragraph 102).

BASE CONDITION

104. An existing or base condition was defined and used as a starting point for the development of the various wastewater management alternatives. The year 1975 rather than the current year was chosen as the Base Condition. Both the State Water Resources Control Board and the California Regional Water Quality Control Boards have directed certain dischargers to coordinate planning on a local subregional

basis. As a result, interim water quality control plans have been developed for all basins in the study area and in some instances more definitive subregional plans have been developed. These plans specify short-term improvements for local dischargers and have been incorporated into present EPA project grant lists.

105. The year 1975 was chosen since it was a logical breakpoint in local planning activities. By 1975, nearly all of the short-term improvements which have been recommended by local subregional planning studies or required by the interim water quality control plans of the California Regional Water Quality Control Boards and the State Water Resources Control Board would either be in operation or under construction. The Base Condition is not a proposed wastewater management alternative. It is, rather, the expected progress which will be made by local effort in the next few years. Plate 4 shows the municipal wastewater facilities expected to be in operation or under construction by 1975.

POTENTIAL LAND APPLICATION SITES

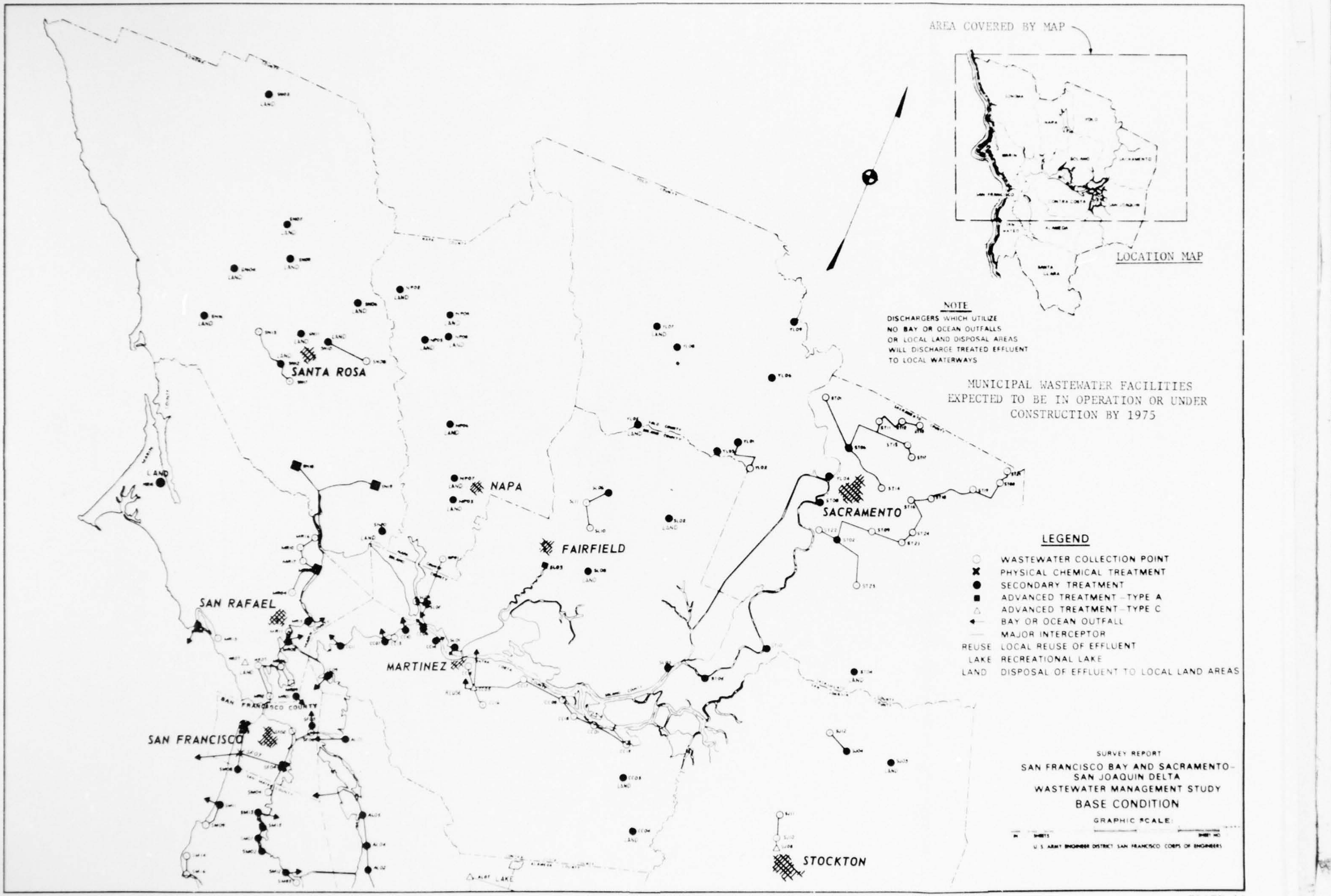
106. Potential land sites were identified within and surrounding the study area for the application of treated wastewater. The entire area lying within the following boundaries was systematically reviewed to determine general areas containing potential wastewater application sites: the northern boundary being the Shasta-Siskiyou County border: the southern boundary being the Tehachapi Mountain range: the eastern boundary being the Sierra Nevada Mountain range; and, the western boundary being the Pacific Ocean. The following exclusionary criteria were used to initially exclude lands from consideration for wastewater application:

a. All land areas having elevations greater than 1,500 feet were to be eliminated because any pumping head greater than 1,500 feet would not be economically feasible.

b. In order to eliminate certain major legal and institutional problems and to insure that present natural open space was not reduced, essentially all land areas situated in national and state parks and national wildlife refuges were excluded.

c. All land areas projected to become urban by the year 2020 were excluded. This was done to insure that any potential site would not be located within an urbanized area.

d. To insure proper vegetative growth and percolation of applied wastewater, all land areas having an identifiable hardpan layer or bedrock at a depth of less than four feet were excluded.



NOTE

DISCHARGERS WHICH UTILIZE
NO BAY OR OCEAN OUTFALLS
OR LOCAL LAND DISPOSAL AREAS
WILL DISCHARGE TREATED EFFLUENT
TO LOCAL WATERWAYS

MUNICIPAL WASTEWATER FACILITIES
EXPECTED TO BE IN OPERATION OR UNDER
CONSTRUCTION BY 1975

LEGEND

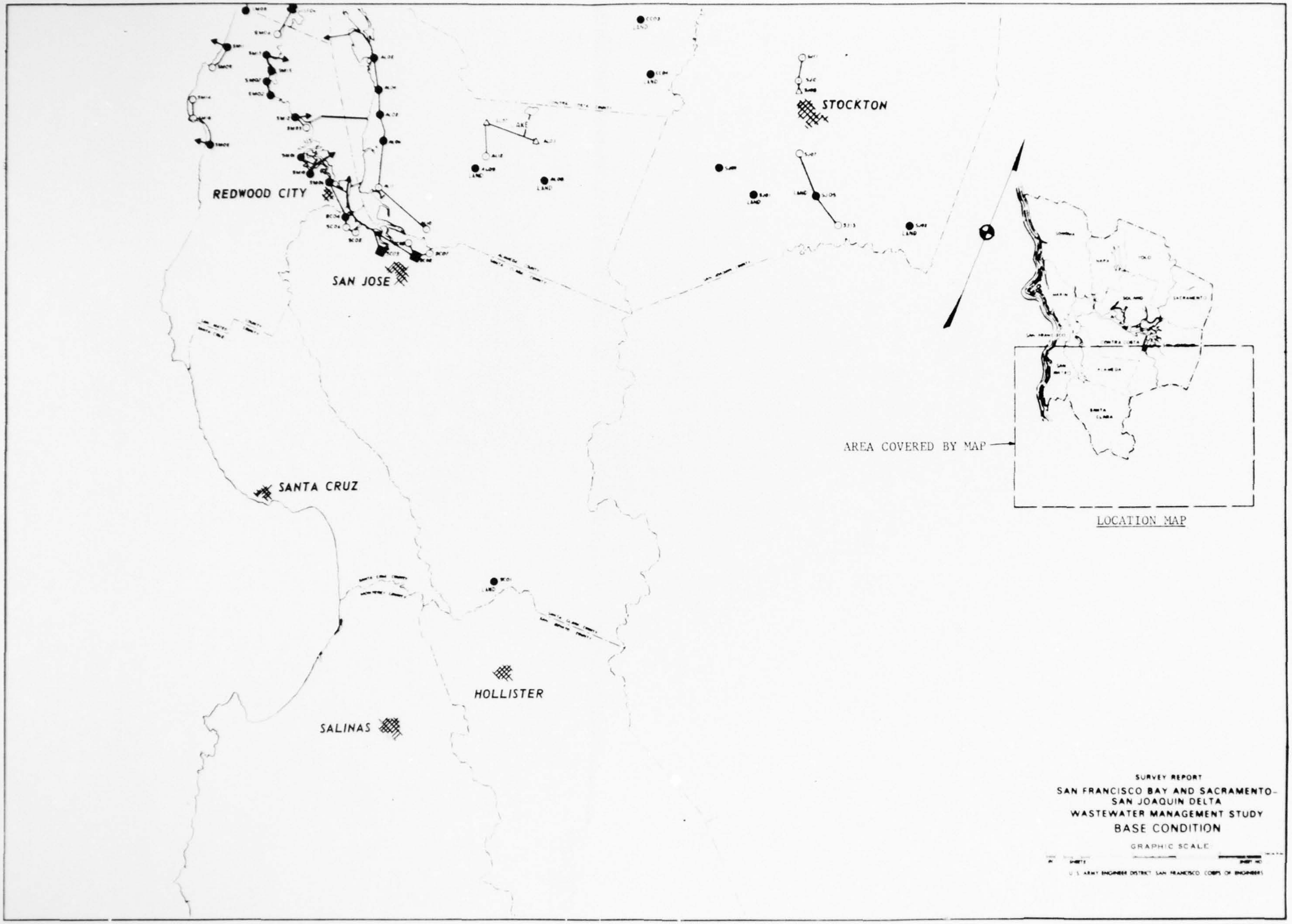
○	WASTEWATER COLLECTION POINT
✖	PHYSICAL CHEMICAL TREATMENT
●	SECONDARY TREATMENT
■	ADVANCED TREATMENT – TYPE A
△	ADVANCED TREATMENT – TYPE C
←	BAY OR OCEAN OUTFALL
—	MAJOR INTERCEPTOR
REUSE	LOCAL REUSE OF EFFLUENT
LAKE	RECREATIONAL LAKE
LAND	DISPOSAL OF EFFLUENT TO LOCAL LAND AREAS

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO–
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
BASE CONDITION
GRAPHIC SCALE:

IN SHEETS SHEET NO.

U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 4A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
BASE CONDITION

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 4B

e. To insure that possible flooding would not become an economic or environmental hazard, all lands in major flood plains were excluded.

f. Small isolated landsites which were considerable distance from the nearest wastewater sources were also eliminated. It was assumed that land areas of 5,000 acres or less or of insufficient capacity to accept a total wastewater application rate of at least five million gallons per day per mile from the source would be uneconomical to develop.

107. As a result of using these initial screening criteria, 53 potential land application sites were identified. These 53 potential sites are shown on Plate 5. Based on location, preliminary environmental considerations, and engineering feasibility, 17 sites were chosen for additional study. These 17 potentially suitable sites were representative of most of the features such as elevation, soil conditions, native vegetation and irrigated agriculture found in the original 53. Also, the 17 sites represented a mix of interior valley and coastal areas. Further review of characteristics appropriate to accommodating a regional wastewater management solution resulted in the selection, for more detailed evaluation, of eight of these potentially suitable sites located within and immediately south of the San Francisco Bay and Delta Region. These eight sites, together with all other potentially suitable sites within the 12-County study area, are shown on Plate 6.

108. The eight selected sites are considered to be representative of the planning, design and cost factors which must be considered in developing systems for the large-scale land application of wastewater. These sites cover a gross area of about one million acres and assuming an average application rate of 6.5 acre-feet/acre/year would have the total capacity for the application of about 4.8 billion gallons per day of wastewater. A general description of each of the eight sites, including the rationale for site selection, follows:

109. Site No. 4[1] - This site, adjacent to Suisun Bay, was selected to represent the opportunity for enhancing an existing wildlife habitat. The site has little or no potential for agricultural purposes because the existing soils have poor drainage characteristics. However, growth of plant foods for waterfowl could be achieved. The site includes the Grizzly Island Wildlife Management Area which is currently managed essentially as a waterfowl habitat. This site is an integral part of the San Francisco Bay system and does not appear to have an alternate location. The nearest major source of wastewater is the Fairfield-Travis Air Force Base complex in Solano County.

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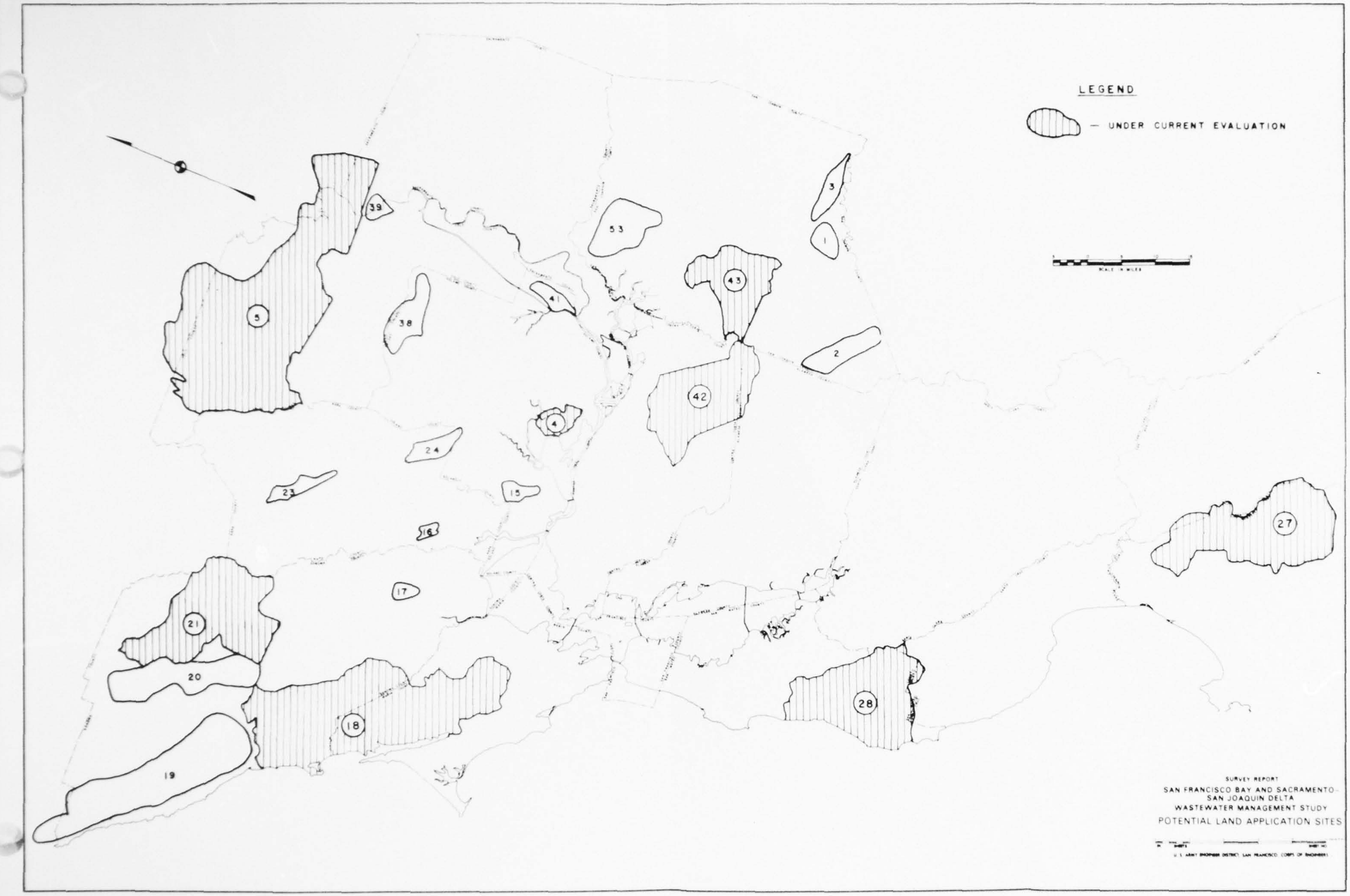
[1] The U.S. Bureau of Reclamation currently is conducting studies in this general area relative to the reuse of wastewater for marshland enhancement.

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
POTENTIAL LAND APPLICATION SITES

PLATE 5



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
POTENTIAL LAND APPLICATION SITES

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 6

110. Site No. 5 - This site, in Yolo and Colusa Counties, is the largest of the eight sites and includes a variety of land types. This site was selected because of the potential opportunities for the development of irrigated pastures, orchard enhancement, streamflow and groundwater augmentation, and general crop irrigation. The major features within this site are the Dunnigan Hills, the Cache Creek Valley and Sacramento Valley lands. Most of the area is under intensive farming, including general irrigated cropping and rice production. There are many similar sites in the Central Valley area. The nearest major source of wastewater to this site is Sacramento, 20 miles to the southeast.

111. Site No. 18 - This site, in Marin County north of Mt. Tamalpais and in Sonoma County south of the Russian River, was selected because it represents a typical north coast range location with adjacent dispersed major metropolitan areas. Land application of wastewater at this site offers the potential for the development of forests, the possibility of streamflow augmentation and, along with Site No. 28, would support the concept of preserving open space. The site includes the basins of Nicasio Creek, Walker Creek, Estero Americano and Salmon Creeks. The basin of San Antonio Creek is excluded because of poor soil conditions. The nearest major wastewater sources are Petaluma and the Santa Rosa Complex.

112. Site No. 21 - This site includes three valleys in the vicinity of Healdsburg in Sonoma County: Alexander Valley, Knights Valley, and the Russian River Valley in the vicinity of Windsor. These valley areas are considered representative of a number of interior valleys in the north coast range. Land application at this site offers the potential for irrigation of existing crops, irrigation of forest areas, streamflow and groundwater augmentation and recreational enhancement. The nearest wastewater sources to this site are those in the vicinity of Santa Rosa and Healdsburg.

113. Site No. 27 - This site, in Monterey and San Benito Counties, includes the Gabilan Creek Basin and easterly side of the Salinas Valley south from Salinas to near Soledad, including Quail and McCoy Creeks. The source of wastewaters for this site would be from the southern portion of the Study Area. Capacity in the site would be reserved for wastewaters generated in the Monterey Bay-Salinas Valley area. Land application in this area offers the potential for managed forests, particularly of Monterey pine, and also for irrigation of crops on a valley floor. Application of wastewater for irrigation could enhance agricultural activity and at the same time diminish or reverse the salt water intrusion into the area caused by excessive irrigation pumping.

114. Site No. 28 - This site includes most of the southwest part of San Mateo County surrounding the Pescadero Creek area. It represents an area close to substantial urban development with potential for developing or improving redwood forests for commercial use and open space - recreation needs. In addition, recreational use may be

further enhanced by streamflow augmentation. The potential sources of wastewater for this area would be from oceanside San Mateo County and South San Francisco Bay communities.

115. Site No. 42 - This site lies in Contra Costa County east of Mt. Diablo and includes the Marsh and Kellogg Creek Valleys, Deer Valley, and the forebays of the Delta-Mendota Canal and the California Aqueduct. It offers potential development for recreation and open space areas, forest lands and wildlife habitats. Site No. 42 is typical of a mix of irrigated agriculture and rolling foothills immediately adjacent to an expanding urban complex. The nearest major sources of wastewater for this area would be from Antioch and Stockton.

116. Site No. 43 - This site includes Union and Roberts Islands southwest of Stockton. Although the area has a high water table it appears possible that wastewater could be applied to the lands and recovered by means of drains and pumping in a manner consistent with present irrigation and drainage practices. The site is typical of the Delta Islands with large flat areas being currently farmed. The use of wastewater in this area could provide an excellent source of irrigation water as an alternative to riverflow and pumping from wells. The nearest major sources of wastewater for Site 43 are Antioch and Stockton.

COMPUTER COST OPTIMIZATION PROGRAM

Introduction

117. A methodology was necessary for determining possible least-financial cost plans involving land application for the collection and treatment of wastewater in the 12-County San Francisco Bay and Sacramento-San Joaquin Delta Region. Because of the complexity associated with the financial cost analysis of large wastewater systems, the use of advanced computational procedures involving computer technology was found desirable.

Program Theory

118. In structuring a network to represent the wastewater disposal system for a municipal area, a line or "arc" is assigned for each function or activity. An arc would be used to represent a treatment process or a group of processes, conveyance routes between source points, and outfall lines for final effluent discharge. By connecting all the arc nodes of a complete system, such that treatment processes and conveyance routes are in a technically feasible sequence, a network is formed. The basic objective in analyzing a network is to determine the flow in each arc, zero or otherwise, which will minimize the total system costs and at the same time satisfy all the established supply and demand constraints.

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LAND APPLICATION ALTERNATIVES FOR WASTEWATER MANAGEMENT FOR THE--ETC(U)
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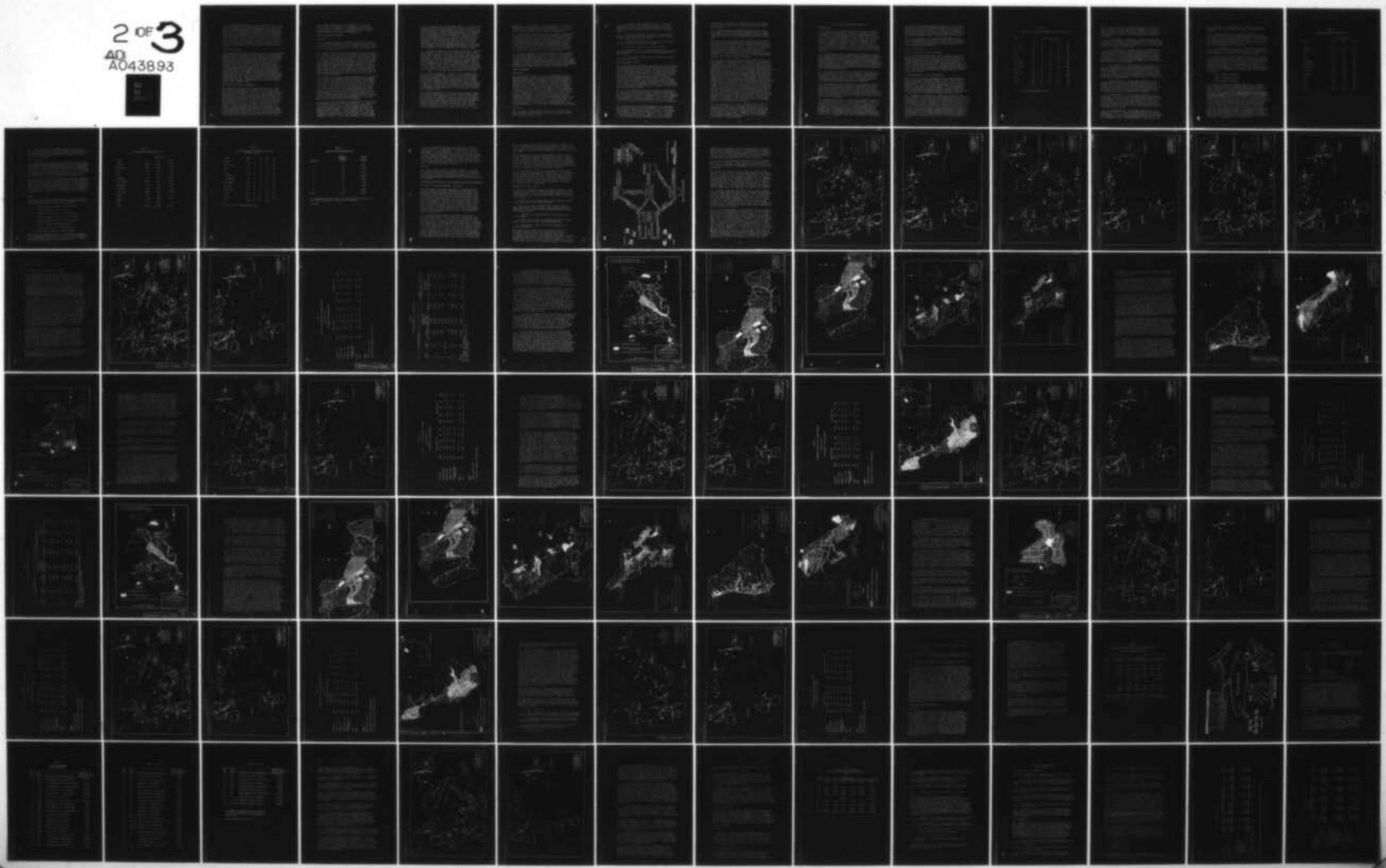

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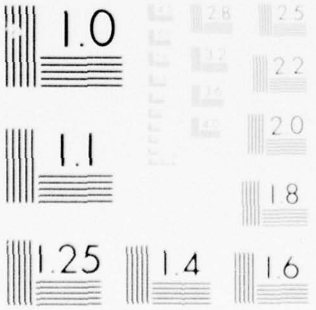


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

119. Flows are assigned to each arc in the network and thus, a flow pattern is generated. Beginning with the source node, costs of collection, treatment, and disposal of wastewater in the direction of flow are computed at each node on the flow pattern from established cost curves. The program checks the feasibility of the solution by determining if all demands are met and all constraints are satisfied. The network program determines if optimal conditions are satisfied in each arc and if the total solution is optimized. The relative values of the node prices on the two extremities of the arc, the arc cost, and the flow define an optimal condition. When the solution is feasible and optimal conditions in any arc are satisfied, the flow in the arc is considered as a possible solution in further network analysis.

Cost Curve Development

120. The primary purpose of the cost curves is to serve as preliminary screening criteria with which the model could test numerous possible wastewater network alternatives and select the least costly for more detailed study. The cost curves developed and utilized in the model were based primarily on data from other water quality studies. The basic data were updated to reflect January 1972 cost levels (an appropriate date during the period of model development) and were modified to insure that various treatment methods and conveyance modes were being compared on a equal basis. All curves are in terms of total annual unit cost, including capital and operation and maintenance costs, with treatment costs expressed in cents/1,000 gallons, conveyance costs expressed in cents/1,000 gallons/mile, and pumping costs expressed in cents/1,000 gallons/foot of pumping head. At the beginning of the study, it was decided to develop costs based on three interest rates. These were 5-3/8 percent and two higher rates (7 and 10 percent). These higher rates were selected based on possible future economic trends.

Procedures for Alternative Development

121. There are two phases of data preparation which must be completed prior to utilization by the model. The first phase encompasses the engineering aspect. Source points must be established with actual locations, projected wastewater flows, and treatment systems. Additionally, all the source points must be interconnected with conveyance lines and the engineering data developed; i.e., length of conveyances through either rural or urban areas. Once these data have been developed, the second phase of preparation can be accomplshed, that of placing data in a format which is acceptable to the model. A standard 80-card column computer worksheet can be used for this purpose. In developing model networks for testing, almost any possible wastewater management regionalization is possible as long as the input network is less than 1,000 arcs. First, various system subregionalizations could be considered. The model can then indicate which conveyance routings would be of greater expense and thus, they could be immediately eliminated from further consideration. The

total system can then be tested as a single entity with any desired constraint included; i.e., limiting the total quantity of nutrients to be discharged in a specified discharge outfall or water quality zone, or placing a requirement on the system that a certain minimum level of treatment be established.

RANGE OF ALTERNATIVES EXAMINED

Wastewater

122. As previously discussed, a conceptual configuration of facilities for 1975 was developed to provide a common base for evaluating wastewater management alternatives. By agreement, this Base Condition configuration was used as a starting point for the development and testing of various alternatives.

123. Numerous alternative configurations consisting of combinations of land application and surface water disposal for wastewater generated in the San Francisco Bay and Delta Region were investigated by using a least-cost optimization mathematical model. The 1975 Base Condition was used as a starting point from which all the alternative networks were developed. The Base Condition provided information on treatment plant consolidations, conveyance routings, and outfall locations. Alternatives were developed with the assumption that each would use some proportional amount of land treatment. Land application components ranged from an economical minimal use of land treatment to large-scale conceptual use. This last concept would insure that all wastewater generated would be treated by the land with no direct discharge to surface waterways.

124. Within each of the eight basic land application areas potential entrance points were established. With these data, the wastewater source points, land application sites, and discharge outfalls were interconnected with conveyance lines and various treatment schemes were placed at those source points where treatment plants could be constructed. These factors allowed the establishment of networks which could be refined into least-cost alternatives considering various constraints. Constraints considered included such items as water quality objectives (quantities of BOD, nutrients and heavy metals discharged to each water quality zone), minimum levels of treatment, maximum regionalization, and minimum or maximum quantities which could be treated at the land application sites. By these methods, five initial alternatives were developed.

125. The five initial alternatives were developed for further study and refinement. They were least-cost solutions for the amounts of land involved formulated with readily available information concerning environmental, social, and public health considerations dealing with land treatment. It was anticipated that as more information became available, it would be used to revise these five alternatives. Also, because of the initial lack of data on sludge transportation methods and costs and the effects of various sludge components on the soil system, sludge components were not included.

126. Two different types of pretreatment systems for wastewater were considered in developing the alternatives. Both systems used a comparable biological secondary treatment process for use with the land application concept. In the first two alternatives, the wastewater is to be treated at existing or expanded Base Condition facilities by activated sludge units prior to conveyance to the land sites. Only treated wastewater is to be conveyed. In the second pretreatment system, which pertains to the last three alternatives, raw wastewater is conveyed to the land sites and treated in aeration lagoons prior to the storage and spray application on the land. It was assumed that either pretreatment system would provide comparable constituent removal for subsequent land treatment. These five initial alternatives are described in the following paragraphs.

127. Technical Alternative A - This alternative attempts to maximize the incorporation of 1975 facilities thereby minimizing the incremental capital investment required for the future. Under this alternative about 50 percent of the region's preliminary year 2000 wastewater flow is conveyed to land application sites following secondary treatment in existing or expanded Base Condition treatment plants. Land requirements for this alternative were approximately 130,000 acres. Reservoirs, with capacity for about 50 percent of the total yearly incoming effluent, are provided at the land application sites to provide storage during the four-month period when spray application to the land cannot be accomplished. Seven facilities provide tertiary treatment for wastewaters being discharged to surface waters.

128. Technical Alternative B - Alternative B also emphasizes the retention of the planned 1975 facilities. This alternative makes greater use of land treatment and less use of tertiary treatment than does Alternative A. Under this alternative over 60 percent of the region's preliminary year 2000 wastewater flow is conveyed to land areas following secondary treatment for storage and subsequent treatment by land application. Approximately 145,000 acres of land are required for spray application. The remainder of the wastewater is discharged to surface waters after tertiary treatment in five regional treatment plants.

129. Technical Alternative C - This alternative presents a regional configuration which tends to place greater reliance on land treatment than does either Alternative A or B. Many of the 1975 treatment facilities are converted to pumping stations and all wastewater destined for land application receives secondary-level treatment in aeration lagoons at the land application sites. This secondary effluent is conveyed to storage reservoirs and finally receives advanced treatment by land application. More than 65 percent of the region's preliminary year 2000 waste flow is applied to land for

treatment under this alternative. About 175,000 acres of land are required for spray application. In this alternative about 35 percent of the region's year 2000 wastewater flows receives tertiary treatment at seven facilities prior to discharge to surface waters.

130. Technical Alternative D - Alternative D is similar to Alternative C except that fewer of the Base Condition treatment facilities are retained and more land application is proposed. Secondary treatment before spray application to the land would be accomplished in aeration lagoons at the land sites. Under this alternative, over 80 percent of the region's preliminary year 2000 wastewater flow is conveyed to land areas for secondary treatment, storage, and spray application to land. About 205,000 acres of land are required for spray application. Less than 20 percent of the region's wastewater flows discharge to surface waters after tertiary treatment.

131. Technical Alternative E - This alternative presents a conceptual regional land treatment configuration. It allows for no direct discharge of treated wastewater to the Pacific Ocean or San Francisco Bay and Delta Estuary. Raw sewage is conveyed to the land areas where secondary treatment is accomplished by aeration lagoons. The secondary effluent is conveyed to storage reservoirs and finally receives advanced treatment by spray application to the land. Approximately 255,000 acres are necessary to manage the region's year 2000 wastewater flow.

PUBLIC INVOLVEMENT

Introduction

132. With broadening public interest in the development of water resources, planners recognize that social and political feasibility are as essential a part of the planning process as environmental, engineering, and economic considerations. The planner considers the limits of social and political feasibility throughout the entire planning process. Agreement between the planner and the community upon the existence of a problem which demands a study of feasible solutions is extremely important. The purpose of public involvement in planning is to achieve mutual understanding and a reasonable consensus of agreement with the community by means of constant communication with individuals and organizations who in the end are the determining influences. Effective public participation in water resources development is based on the recognition that those affected by planning should have the opportunity to influence and shape the plans. The operational realization of this is accomplished by involving the public in planning through communication processes including information, evaluation, feedback, and subsequent plan revisions.

Objectives

133. As a basis for development and organization of public involvement in planning, specific program objectives are required. These objectives are set out as follows:

a. To present information which will assist the public in defining their water resources needs and to provide the public an opportunity to influence and shape the formulation of planning alternatives and to express preferences in choosing a course of action.

b. To provide the planners with definite channels through which to obtain information on public goals, priorities and preferences regarding planning alternatives.

c. To coordinate related land and water resources planning with other Federal, State, and local agencies.

d. To explain planning processes and procedures.

e. To minimize conflicts in determining and meeting the needs and preferences of the various communities and groups within the public interest.

f. To use information obtained in developing plans to meet the desires of the public.

Public Involvement Program

134. The initial public involvement program for this study consisted of joint public meetings with the State Water Resources Control Board and the Environmental Protection Agency, and workshop sessions with special groups representing environmental and agricultural interests. Prior to each public meeting, notices of the meeting, brochures for background information, and copies of the joint agreement for interagency water quality management planning between the State of California, the Environmental Protection Agency, and the Corps of Engineers were distributed. Such information also was distributed to Congressional representatives, Federal agencies, State representatives, county and local government, industries, utilities, organized local interest groups, the news media, and individuals interested in wastewater management planning.

135. The first public meeting was held in Martinez, California, on 17 April 1972 at the Contra Costa County Administration Building. The second meeting was actually a series of three successive sessions. The first session was held on 21 September 1972 at the State Resources Agency Building in Sacramento, California. The second was held on 25 September 1972 at the Marin County Civic Center in San Rafael. The third meeting was held at the San Jose City Hall on 28 September 1972.

136. Meetings were jointly chaired by the Corps, the State Water Resources Control Board, and the Environmental Protection Agency. An introductory presentation was made at the start of each meeting which expanded on information previously distributed. Statements from interested parties were then requested. A complete record of the hearings was made including names of those in attendance for future review and further consideration in planning efforts.

These records are available for review in the Corps' San Francisco District Office. Also, they are to be furnished higher echelons for information.

137. The basic purpose of a workshop is to generate an input of local needs, desires, and goals for the planning study. An additional objective is to lay the ground work for continuing feedback from local interests in developing and assessing planning alternatives.

138. Three environmental workshop sessions were held with various San Francisco Bay environmental groups. Advance information for discussion was mailed to the interested organizations and individuals and included an environmental summary. Workshop sessions were held on 11 October and 15 November 1972 and 17 April 1973. In addition, a workshop session with agricultural interests was held on 21 November 1972 at the University of California in Berkeley for representatives of the University of California's Agricultural Extension Service. The structure of the meeting and materials furnished were the same as for the environmental workshops.

139. The initial public involvement program produced testimony that indicated general concern regarding the large-scale land application of wastewater and sludge and the Corps' initial alternatives. The major concerns and observations resulting from the public involvement program are as follows: There was general concern regarding environmental preservation. Also, the massive disruption of community structure and the loss of tax base was of concern to many residents living in some of the identified land application site areas. Many participants desired additional information on groundwater effects from the land application of effluent. There was concern regarding the quality of effluent prior to land application, the potential for public health problems, and the fate of heavy metals and nutrients in the soil mantle. Monterey and Yolo Counties interests voiced strong opposition to the use of land areas in their counties for the application of wastewater and sludge. In addition, Monterey County interests felt that wastewaters should not be transported into their area from the San Francisco Bay and Delta Region. Favorable comments regarding agricultural benefits came from individuals and agencies in San Joaquin, Marin and Napa Counties. Marin County expressed some concern regarding high application rates and indicated that reduced application rates would allow additional agricultural acreage to be benefited. There were several suggestions, including one from Napa County, that a demonstration project or "pilot plant" should precede any decision for the implementation of the land application concept.

140. The final phase of the public involvement program consisted of the wide distribution of a public information brochure in December 1973. The brochure highlighted the results of the Corps' study and presented information on land application concepts for the consideration of the State of California in its comprehensive water quality planning program. Comments on the public information brochure have been provided to the State of California and are included in a separate appendix.

FINAL WASTEWATER MANAGEMENT ALTERNATIVES

INTRODUCTION

141. The objective of the public involvement program was to provide a framework by which the public could actively participate in the study effort. The public meetings not only provided the opportunity to keep the area's residents informed of the study's scope and status but also to obtain their reaction to various alternatives being developed. As a result of the public meetings and workshop sessions, valuable information was obtained by the Corps of Engineers to develop final wastewater management alternatives which reflected, as much as possible, the desires of the public. Also, as comments from the public were being evaluated, the data used to develop the initial technical alternatives were finalized and updated based on more recent information.

142. Several important areas of consideration developed as a result of the September 1972 public meetings. Various comments and suggestions from interested agencies and the public-at-large were used in revising the alternatives. For instance, it was recommended that additional emphasis be placed on the first phases of the various subregional plans being completed within the San Francisco Bay Area by various engineering consulting firms working for the cities in the study area and that the Corps' wastewater management alternatives be more closely aligned with the State's Interim Basin Plans.

143. Two important considerations also presented at the public meetings involved Sites 27 and 28. The U.S. Geological Survey noted that Site 28 was located in an area of San Mateo County considered to be susceptible to landslide deposits. This information was used in refining the usable land acreage in Site 28. As a result, Site 28 was reduced from an initial 114,600 acres to 14,000 acres.

144. Local interests in the Monterey County area objected to the use of Site 27 for the treatment of wastewater originating from outside their area. Due to their insistence that Site 27 not be used as a primary land application area, the site was used only as a possible add-on site to the basic alternatives. The site was retained to provide flexibility and additional options for dischargers in the southern portion of the study area and to permit evaluation of the concept of interbasin transfer of wastewater.

145. Another important aspect of alternative development presented at the public meetings was that of possible staging effects. Generally, it was suggested that such a high tertiary level of treatment for the wastewater being directly discharged to surface waterways might not be required. If this were the case, it would then be possible to reduce the level of treatment required for the year 2000 with the ultimate goal of providing the full tertiary level of treatment for the year 2020. It was suggested that an intermediate-level alternative be developed to accommodate a lower degree of treatment. This concept

was utilized as final alternatives were developed. With such systems, lower degrees of treatment were proposed and receiving water quality conditions were held to projected 1975 levels. These treatment systems would be used prior to the use of a full tertiary treatment system such that a staging of the levels of treatment would be developed from the Base Condition through a conceptual year 2020 Master Plan.

146. As a final comment, it was noted that the wastewater being collected by underdrains in each land site would be of a high quality and could have numerous reuse potentials. Various reuse opportunities were investigated for the utilization of this reclaimed water as the final alternatives were developed.

REVISION OF DESIGN DATA

Municipal Wastewater Flows and Constituents

147. The final municipal wastewater flow data did not significantly change from the initial data used. After an analysis was made of projected municipal flows from the completed local subregional reports, it was ascertained that the initial data would be satisfactory. The wastewater constituent data used initially was, however, changed. The basis for changing these data was the completed subregional reports. These reports furnished current data on municipal flows and constituents. Table 6 presented earlier summarizes the finalized municipal wastewater flows. Final municipal wastewater constituent loadings by county are presented in Table 14.

Industrial Wastewater Flows and Constituents

148. The initial industrial wastewater data were based primarily on the U.S. Army Corps of Engineers' Permit Program. From an overall conceptual viewpoint, the initial projection of data did not take into consideration such items as economic and production projections or industrial output. In most regional studies, projections are based on population, employment, and income estimates. The final industrial flow and constituent data were based on these essential items. The Corps contracted with the Lawrence Berkeley Laboratory for the development of such data based on established industrial statistical averages.

149. The emphasis on regional water planning has resulted in various planning regions being designated and data developed for these areas which present population projections along with estimates of earnings for various major industrial sectors. The method used was to relate water and wastes to industrial output once employment and earnings data had been furnished. The U.S. Bureau of Census provided data on water use by manufacturing industries for the nation and for various national industrial water-use regions. These data were used to develop a base year (1967) growth rate situation. From this base year, employment projections by county were developed and related to wastewater flows through projected productivity for each industry. Factors were developed to account for advances in future process technologies and recycling of both cooling and process water.

TABLE 14

PROJECTED FINAL MUNICIPAL WASTEWATER CONSTITUENT LOADINGS 1/

COUNTY	CONSTITUENTS (mg/1)				
	BOD	TN	TP	GHM	TDS
Alameda	209	35	14	2.2	700
Contra Costa	230	40	11	2.2	700
Marin	240	30	14	1.6	700
Napa	270	35	15	2.0	700
Sacramento	275	35	14	1.9	700
San Francisco	245	35	14	2.5	700
San Joaquin	280	35	14	1.1	700
San Mateo	275	35	14	2.2	700
Santa Clara	272	35	14	2.5	700
Solano	274	35	15	1.9	700
Sonoma	280	35	14	1.9	700
Yolo	270	35	14	2.0	700

1/ Based on year 2000 wastewater flows.

150. A total of eight industrial water-use strategies were then developed to account for various years when the advances in technology and recycling would occur. From an anaylsis of these data, a selected situation could be formulated which would represent the most probable condition expected to occur. The following strategies were developed and analyzed.

a. Strategy Number 1 - To obtain the maximum projected water use values, it was assumed that future water intake and wastewater flows would be based on current data and information. It was further assumed that there would be no additional recycling of water or general improvements in the technology of water reuse.

b. Strategy Number 2 - (Process Water) It was assumed that by 1975 a 50 percent improvement toward the maximum possible level of recycling of process water would be achieved in all industries and by 1985 the maximum possible recycling of process water would be reached in all industries. It also was assumed that by 1985 a new improved technology for process water would be implemented in all industries. The cooling water systems were assumed to remain unaffected by improvements in recycling or new technology.

c. Strategy Number 3 - (Cooling Water) It was assumed that by 1975 a 50 percent improvement toward the maximum possible level of recycling of cooling water would be achieved in all industries and by 1985 the maximum possible recycling of cooling water would be reached in all industries. It was assumed that by 1985 a new improved technology for cooling waters would be implemented in all industries. The process water streams were assumed to remain unaffected by improvements in recycling or new technology.

d. Strategy Number 4 - (Process and Cooling Water) It was assumed that by 1975 a 50 percent improvement toward the maximum possible level of recycling of process and cooling water would be achieved in all industries and by 1985 the maximum possible recycling of process and cooling water would be reached in all industries. It also was assumed that by 1985 a new improved technology for process and cooling water would be implemented in all industries.

e. Strategy Number 4A - (Process and Cooling Water) It was assumed that by 1975 a 25 percent improvement toward the maximum possible level of recycling of process and cooling water would be achieved in all industries. This value would gradually be increased to 38 percent by 1980, 50 percent improvement by 1985, and a maximum level of recycling would be achieved in 1990. It was also assumed that by 1985 a new improved technology for process and cooling water would be implemented in all industries.

f. Strategy Number 4B - (Process and Cooling Water) It was assumed that by 1985 a 50 percent improvement toward the maximum possible level of recycling of process and cooling water would be achieved in all industries. This value would gradually be increased to 75 percent improvement by 2000 and the maximum level of recycling would be achieved in 2010. It was also assumed that by 2000 a new improved technology for process and cooling water would be implemented in all industries.

g. Strategy Number 4C - (Process and Cooling Water) It was assumed that by 1985 a 50 percent improvement toward the maximum possible level of recycling of process and cooling water would be achieved in all industries and by 2000 the maximum possible recycling of process and cooling water would be achieved in all industries. It was also assumed that by 2020 a new improved technology for process and cooling water would be implemented in all industries.

h. Strategy Number 5 - To provide a lower bound to the possible level of water use in the more immediate future, it was assumed that the maximum level of recycling and new technology for both process and cooling water would be instituted in all industries by 1975.

151. To provide for a probable situation which may occur due to recent technological advancements and environmental legislation, a combination encompassing industrial water use strategies 4, 4A and 4B was selected for projection purposes. Also, due to the low concentration of anticipated waste constituents in cooling water and the probability of maximum reuse, cooling water from Contra Costa County industries was removed from the discharge flow. As a result, Table 15 summarizes the projected industrial wastewater discharge flows based on the following strategies:

a. 1975 - Based on Strategy 4A

b. 2000 - Based on Strategy 4B

c. 2020 - Based on Strategy 4

152. Estimates of the gross industrial waste loads for the period 1970 to 2020 were based on the assumption that the amount of waste now generated (1970) per constant dollar would remain reasonably constant in the future. Projections for the period 1970 to 2020 for each county were developed. It is important that the results reported be interpreted and applied with the understanding that they represent gross waste loadings. Based on trends evidenced in recent environmental legislation, these gross waste loadings must be reduced prior to discharge into any regionalized system. It has been assumed that industries would be required to reduce waste constituent loadings by 65 percent in 1975 and 90 percent by 2000 through various industrial treatment methods. These assumed reductions represent projected lower limits of treatment which industry, as a whole, may have to attain prior to discharge. Lower limits were assumed for the purpose of providing an unfavorable situation which a combined municipal-industrial system must care for in assuring proper treatment of all wastewater. In this manner, each final alternative to be developed would provide acceptable treatment for the total municipal-industrial flow under conditions less than optimal. This provides a built-in safety factor.

TABLE 15

PROJECTED INDUSTRIAL WASTEWATER FLOWS

COUNTY	FLOW/YEAR (MGD) 1975	2000	2020
Alameda	26.5	34.3	50.6
Contra Costa	134.1	174.5	258.0
Marin	1.4	3.8	8.9
Napa	16.3	28.4	44.6
Sacramento	15.5	20.5	29.3
San Francisco	4.8	6.6	9.8
San Joaquin	21.0	24.5	33.6
San Mateo	14.8	25.7	39.6
Santa Clara	21.0	30.1	41.7
Solano	7.4	8.2	11.0
Sonoma	5.0	7.6	10.7
Yolo	9.9	10.4	13.5
Total	277.7	374.6	551.3

153. With both municipal and industrial flows formulated, it is then possible to develop the total flows not only by counties but also for each major wastewater source. The finalized municipal and industrial flows and constituent loadings used are reported in Table 16 and Table 17, respectively.

Land Availability

154. The initial data used for each potential land application site were preliminary in nature and were being refined by a consulting engineering firm. Based on a detailed analysis, including environmental concerns and physical conditions, the eight selected land application sites were refined not only in configuration but also in usable acreage for wastewater and sludge application. The initial data for each land site were based on a preliminary engineering and environmental scan. The finalized data were based on detailed land site evaluations.

155. As a result of the revised data, certain preliminary wastewater conveyance routings had to be changed as well as land area treatment facilities relocated. Also, detailed wastewater application rates for each of the land application sites were determined. These application rates, based on soil structure, vegetative cover and water quality conditions were then used to determine maximum quantities of wastewater each site would effectively treat. A summarization of the finalized land application data (usable acreage and maximum capacity) are shown in Table 18.

Energy

156. Data were obtained from the literature to determine electrical requirements (total kilowatt hours) for the various treatment process configurations used in this study. These data follow:

a. Physical-chemical treatment - 795 kw-hr/day/MG

b. Secondary treatment - 671 kw-hr/day/MG

c. Advanced treatment (Type A) - 917 kw-hr/day/MG

d. Advanced treatment (Type B) - 1,383 kw-hr/day/MG

e. Advanced treatment (Type C) - 1,247 kw-hr/day/MG

f. Tertiary treatment - 3,041 kw-hr/day/MG

g. Land treatment (Type X) - 836 kw-hr/day/MG

h. Land treatment (Type Y) - 2,329 kw-hr/day/MG

These values would approximate the total requirements for operation of the wastewater treatment facility. Included in these values are accessory equipment required at any treatment plant; i.e., pumps, instrumentation facilities, and chemical feed systems.

TABLE 16

FINAL MUNICIPAL AND INDUSTRIAL FLOWS

	FLOW (MGD)		
COUNTY	1975	2000	2020
Alameda	166.1	219.4	273.0
Contra Costa	199.1	283.2	399.2
Marin	23.5	42.2	61.7
Napa	25.4	48.7	75.0
Sacramento	115.2	169.3	208.0
San Francisco	107.9	114.0	124.4
San Joaquin	76.6	114.2	141.3
San Mateo	69.0	91.0	114.2
Santa Clara	160.7	270.7	374.0
Solano	31.6	59.0	112.5
Sonoma	23.3	46.1	64.7
Yolo	25.0	37.7	54.5
Total	1,023.3	1,495.5	2,002.5

TABLE 17

FINAL MUNICIPAL AND INDUSTRIAL CONSTITUENT LOADINGS (mg/l) 1/

County	BOD	TN	TP	GHM	TDS
Alameda	182	30	12	3.2	600
Contra Costa	102	18	5	1.3	330
Marin	219	27	13	5.1	645
Napa	120	17	9	9.9	382
Sacramento	249	31	12	3.1	625
San Francisco	234	33	13	3.3	664
San Joaquin	229	27	11	3.8	567
San Mateo	202	26	11	3.6	524
Santa Clara	248	31	12	4.2	630
Solano	244	31	13	3.1	615
Sonoma	244	30	12	3.9	596
Yolo	209	26	10	8.6	526

1/ Based on year 2000 wastewater flows.

TABLE 18

FINALIZED LAND APPLICATION DATA

Land Area	Maximum Capacity 1/ (MGD)	Total 2/ Usable Acreage
28	64	14,000
27	275	58,000
42	228	38,000
43	236	54,000
05	952	192,000
04	15	3,700
21	175	45,000
18	240	54,000
TOTAL	2,185	459,000

1/ Assuming an application rate of 4.5 acre-feet per acre per year for crops and 9.0 acre-feet per acre per year for pastures.

2/ Round.

157. It was assumed that methane, a gas produced during sludge digestion, could be recovered and used in place of most natural gas requirements at the treatment plants. Proper anaerobic digestion will produce a gas by-product with 65 to 70 percent methane, 25 to 30 percent carbon dioxide, and approximately 1 to 50 percent hydrogen sulfide, nitrogen, and hydrogen. Once the impure gases have been removed, methane can be collected and used as fuel for engines which drive blowers, compressors and pumps; and to provide heating of the digester sludge and plant facilities. Natural gas would be necessary only for start-up and emergency conditions.

Chemicals

158. Various chemicals would be required to support the treatment plant operations and to insure that proper removal of constituents is maintained. Recovery of certain chemicals (lime and carbon) would be economically feasible on large capacity treatment plants. Criteria for determination of the chemical requirements were obtained from the literature.

DEVELOPMENT AND DESCRIPTION OF FINAL WASTEWATER MANAGEMENT ALTERNATIVES

Development of Wastewater Management Alternatives

159. As a result of the public input and the revised design data, six final wastewater management alternatives were developed incorporating two regional wastewater management concepts (B-Series and D-Series) for the land application of wastewater and sludge. Under the B-Series concept of alternatives, wastewater would be treated by a biological secondary process (activated sludge) prior to transmission to a designated land area. No raw wastewater would be conveyed to the landsites. Once the treated wastewater enters a land area, it would undergo channel aeration to remove any septic odors prior to storage in reservoirs and land application. Under the D-Series concept of alternatives, raw wastewater would be conveyed to designated land areas. Upon entrance into the site, the wastewater would be treated in aeration lagoons prior to storage and spray application (see Figure 8).

160. The basic B-Series concept of alternatives retains most of the current investment in conventional sewage treatment plants and provides an initial level of treatment prior to conveyance to land application areas. The D-Series concept of alternatives, on the other hand, converts most of the Base Condition treatment plants to pumping stations and transports raw wastewater to the land areas for treatment. Within each series concept, there are three separate alternatives which stress various aspects of treatment and conceptual planning. In Alternatives B-1 and D-1, full tertiary treatment is provided for water-oriented discharges prior to disposal. The B-2 and D-2 alternatives provide a lower level of treatment for wastewater being discharged to surface water bodies, as was suggested at the public meetings. These two alternatives, however, allow more pollutants to reach surface

waters than were allowed by the 1975 Base Condition facilities. The B-3 and D-3 alternatives are variations of the basic B-1 and D-1 alternatives. These two systems propose and explore the interbasin transfer of wastewater by using an additional land site in the Monterey-San Benito County area.

161. All alternatives provide a complete regional system for the disposal of the Region's sludge by land application methods. In the B-Series concept of alternatives, digested sludge from all treatment plants enters land-site lagoons where sludge is air dried for two years before application to land. In the D-Series concept of alternatives (Figure 8), sludge from the sedimentation basins is digested and added to storage. The sketch on page 89 conceptually shows these two different approaches in applying wastewater and sludge to the land.

162. Also developed was a full tertiary treatment system which discharges treated effluent directly to surface waters. In developing this system, the Corps of Engineers made no studies relative to the need for any specific level of treatment. This is the responsibility of the State of California. The levels of treatment shown were assumed by the Corps of Engineers, as discussed previously. With such a configuration, sludge could be handled as previously discussed for the B-Series concept of alternatives.

Development of Sludge Systems

163. Most of the wastewater treatment processes used produce a solids concentration as a result of chemical or biological reaction in the treatment of sewage. This solids concentration, termed sludge, refers to the settleable waste solids removed in the treatment of wastewater. These include:

a. Screenings - the largest solids found in wastewater such as rags, wood, rocks and large organic materials.

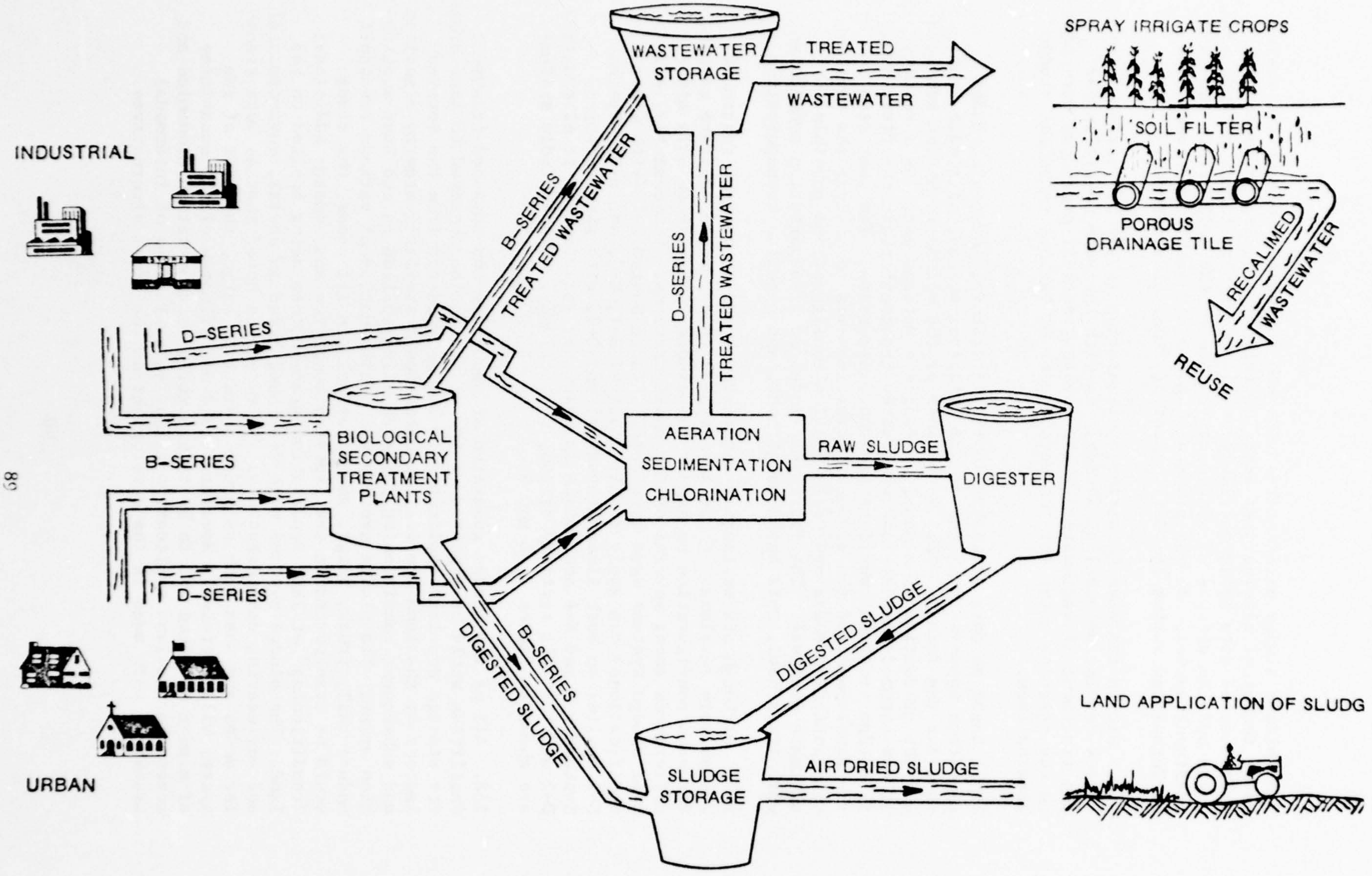
b. Grit - the small, coarse particles of sand, gravel, and other minute pieces of mineral matter: also includes a variety of items such as coffee grounds, seeds, and similar materials which are not of mineral origin.

c. Skimmings - the floatable portion of the sludge such as oils and grease.

d. Organic solid sludges - the suspended and larger colloidal organic waste solids from the biological treatment units.

e. Lime sludges - produced by high-lime treatment for the removal of phosphates.

164. Sludge must be rendered into a form which is suitable for the method of transportation being utilized for its transport to a final disposal location. Such processes could consist of thickening, anaerobic or aerobic digestion, air-drying on sand beds, dewatering by centrifuges or vacuum filters, or incineration. Each process will produce a sludge with a different composition: i.e., total solids content, percent organic matter and inorganic characteristics.



LAND APPLICATION SYSTEMS

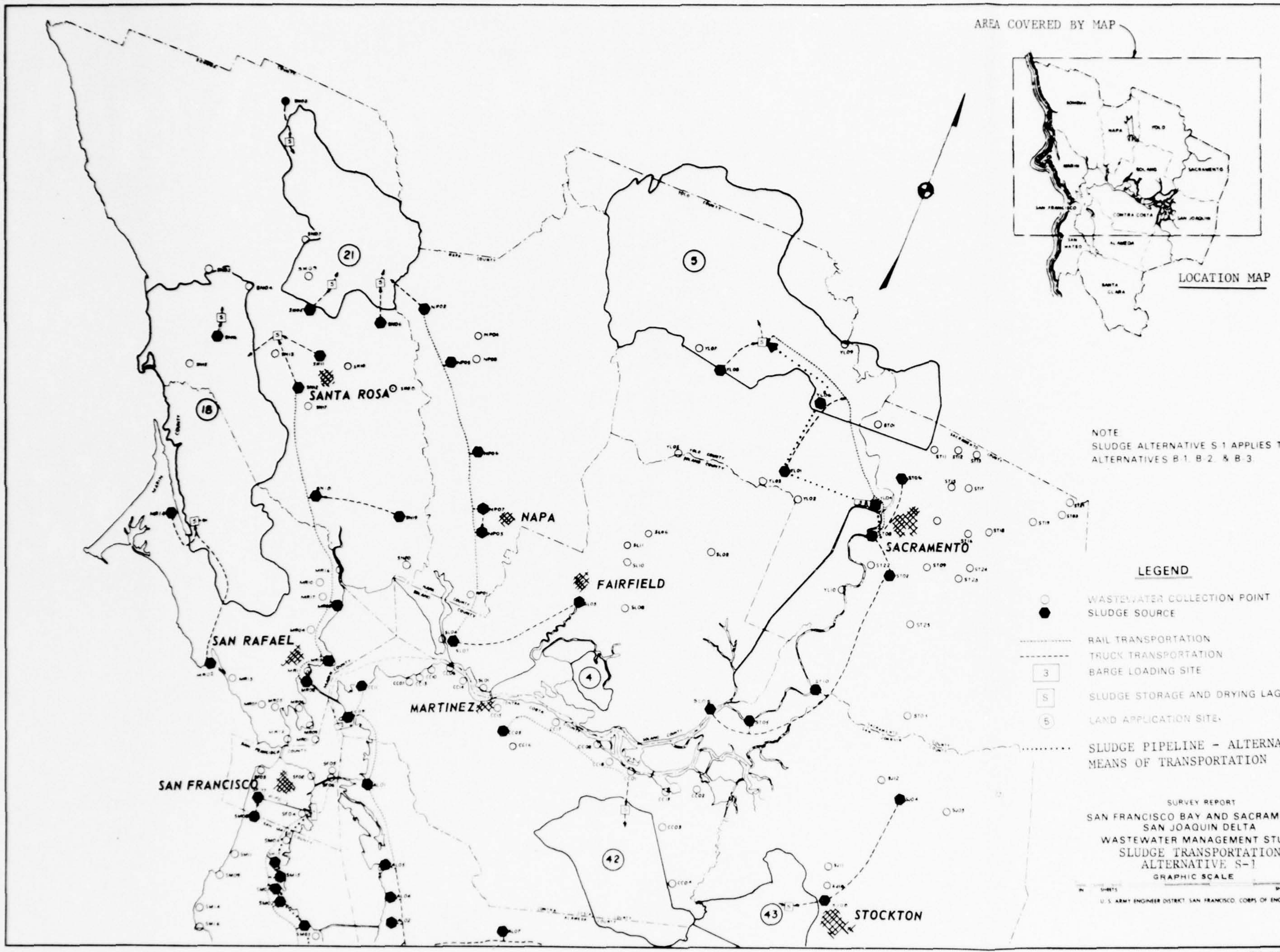
Preliminary sludge alternatives were not formulated because the wastewater technical alternatives were for initial planning purposes with only limited data being available on sludge transportation methods and costs and the effects of sludge components on the soil within the land treatment system. It was planned that the sludge alternatives would be formulated during the development of final alternatives.

165. Within the Base Condition configuration (1975) are various processes for the disposal of sludge. As with the Base Condition for the treatment of wastewater, these sludge treatment processes were used as the starting point for the development of various technical sludge alternatives.

166. Based on data presented in the literature, anaerobic sludge digestion appears to be one of the principal methods of sludge treatment for the future. This is because of the volume reduction achieved and the production of a usable resource - methane gas. As a result, it was assumed that at each wastewater treatment plant the first stage in sludge treatment would be anaerobic digestion. The next step in the development of the sludge alternatives was to analyze the various transportation modes and consolidation configurations possible for ultimate disposal. The four basic modes of transportation considered were truck haul, rail haul, barge haul, and pipeline transportation.

167. Although six wastewater alternatives and a tertiary treatment system were developed, there was no need to develop a separate system for each configuration to handle the sludge. There were only minor differences among several of the configurations. Consequently, only four sludge systems were developed. Sludge System S-1 (with minor modifications) can apply to Alternatives B-1, B-2, and B-3. System S-2 applies to both Alternatives D-1 and D-2, with minor changes. Systems S-3 and S-4 are unique in that they apply solely to Alternative D-3 and the full tertiary system, respectively. These sludge systems are shown on Plates 7, 8 and 9.

168. All of the sludge generated at secondary and advanced treatment facilities would be digested at the plants and be conveyed to land areas for storage and land application. Sludge produced from the aerated lagoons at the land application areas would similarly undergo digestion and subsequent conditioning prior to being applied in the land application areas. The sludge systems use a combination of various transport modes; rail, truck, barge, and pipeline. In all cases, the sludge would be transported in the digested condition and undergo additional "conditioning" at land application areas before being applied to the land. The sludge systems were developed based on social, environmental and engineering considerations. It should be noted that as more transfer modes are used such as truck to rail to barge, the cost of the system will increase. However, based on estimates of the quantities of sludge produced and to be transported, transportation economics and access to the land application areas, several forms of intermodal transfers were used in the development of the final alternatives.



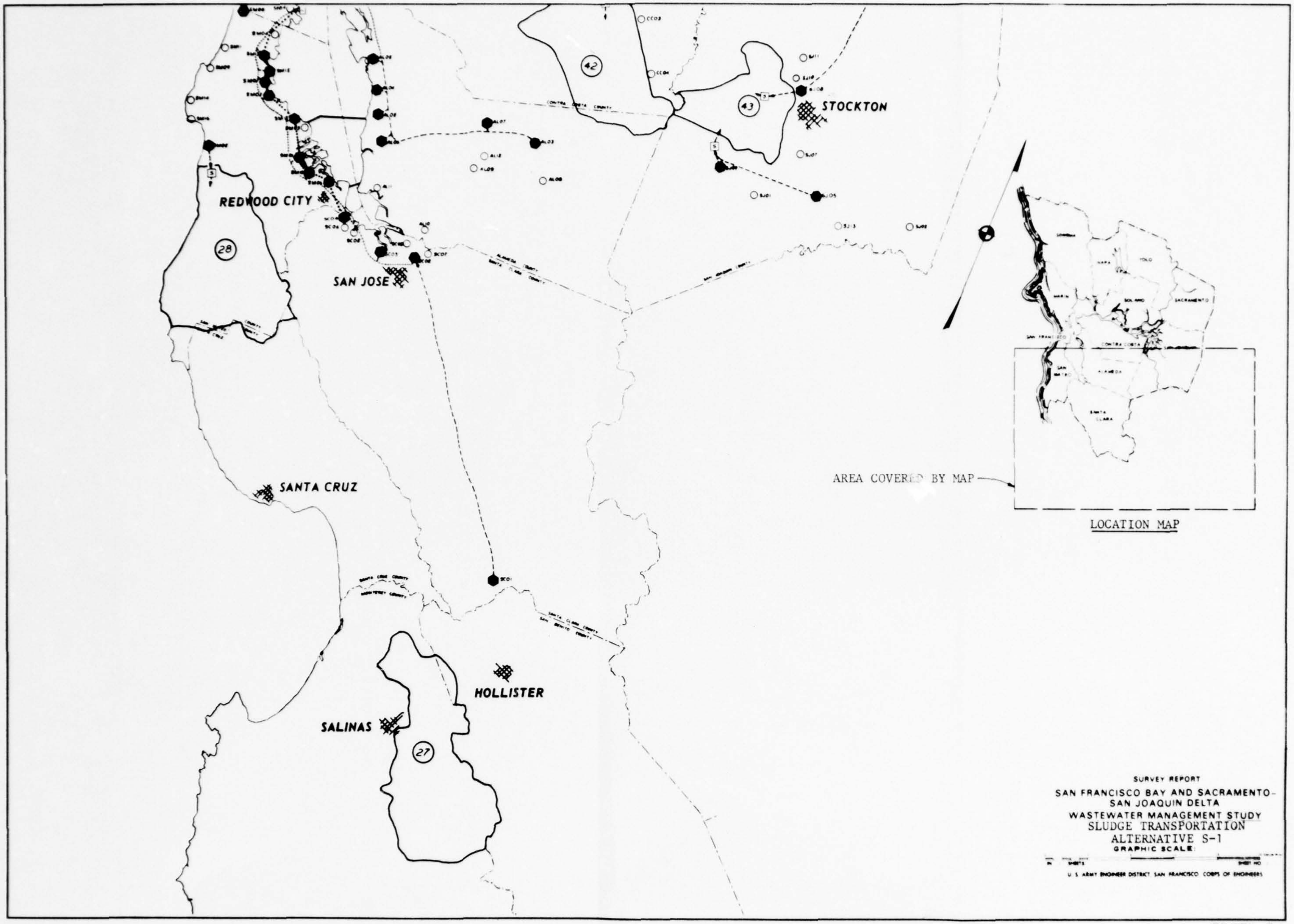
NOTE
SLUDGE ALTERNATIVE S-1 APPLIES TO
ALTERNATIVES B-1, B-2, & B-3

LEGEND

○ WASTEWATER COLLECTION POINT
⬢ SLUDGE SOURCE
RAIL TRANSPORTATION
TRUCK TRANSPORTATION
3 BARGE LOADING SITE
S SLUDGE STORAGE AND DRYING LAGOONS
5 LAND APPLICATION SITE
SLUDGE PIPELINE - ALTERNATE MEANS OF TRANSPORTATION

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
SLUDGE TRANSPORTATION
ALTERNATIVE S-1
GRAPHIC SCALE
IN SHEETS SHEET NO
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 7A



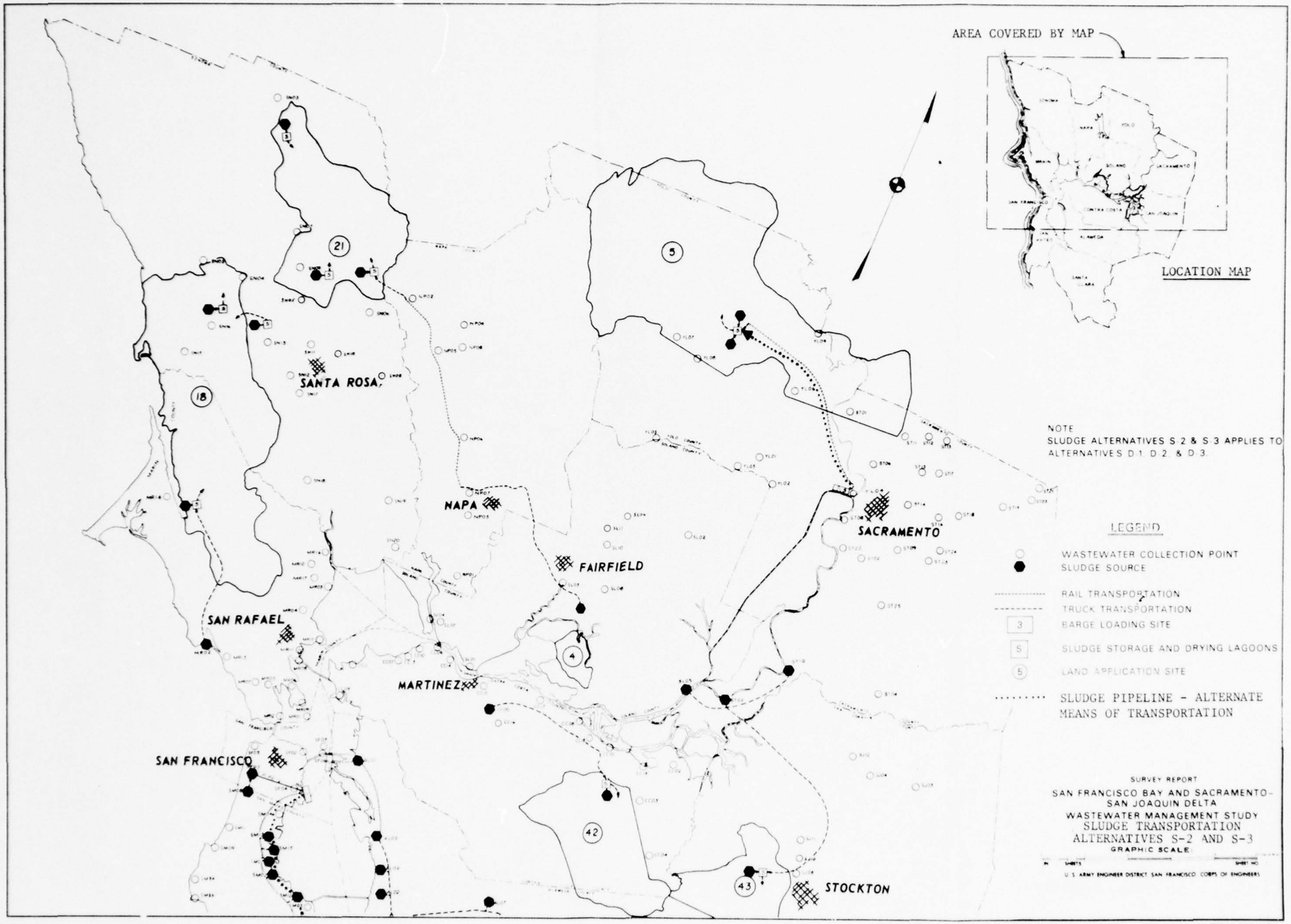
SURVEY REPORT

SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
SLUDGE TRANSPORTATION
ALTERNATIVE S-1
GRAPHIC SCALE

IN SHEETS SHEET NO

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 7B

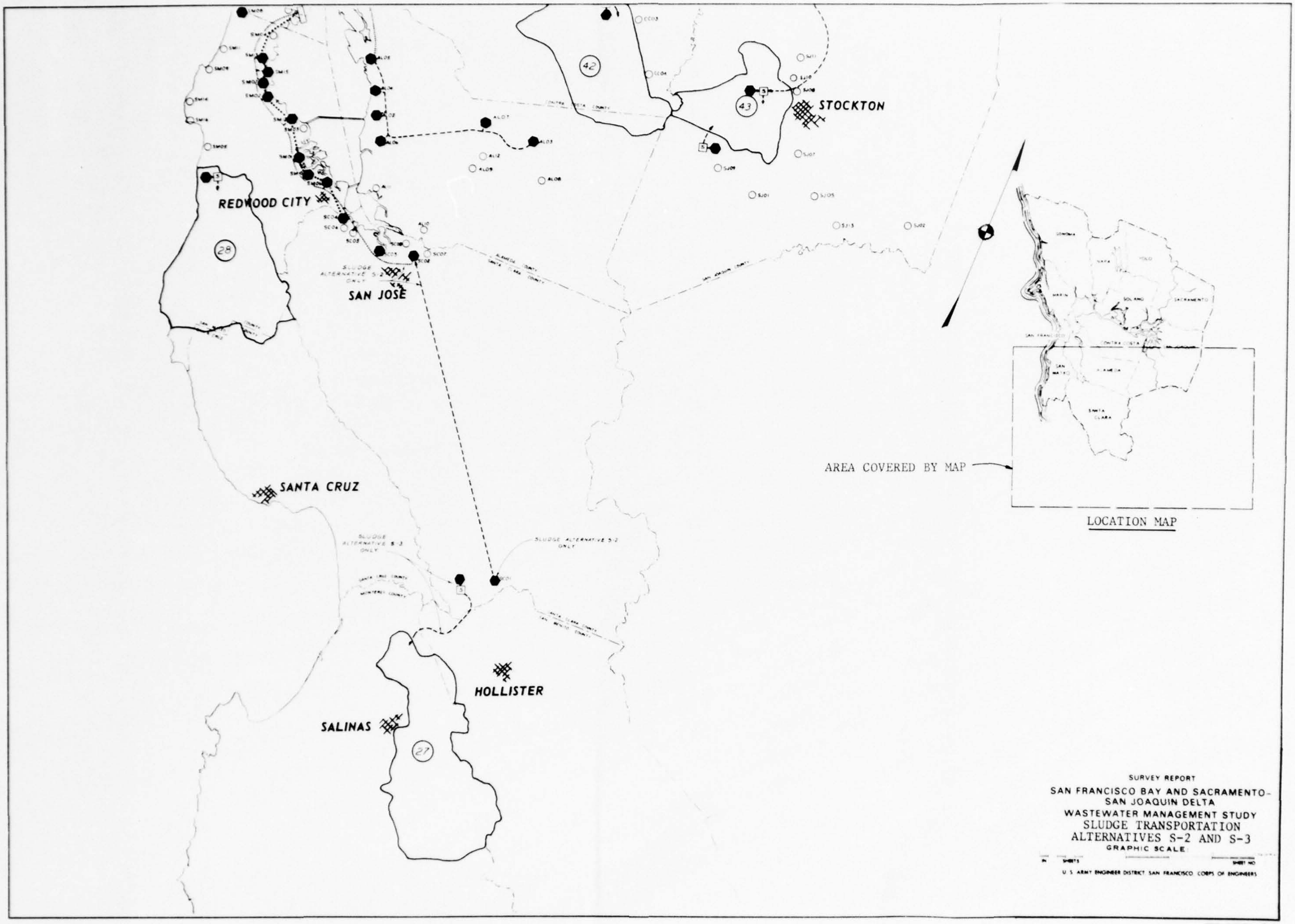


NOTE
SLUDGE ALTERNATIVES S-2 & S-3 APPLIES TO ALTERNATIVES D-1, D-2, & D-3.

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
SLUDGE TRANSPORTATION
ALTERNATIVES S-2 AND S-3

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

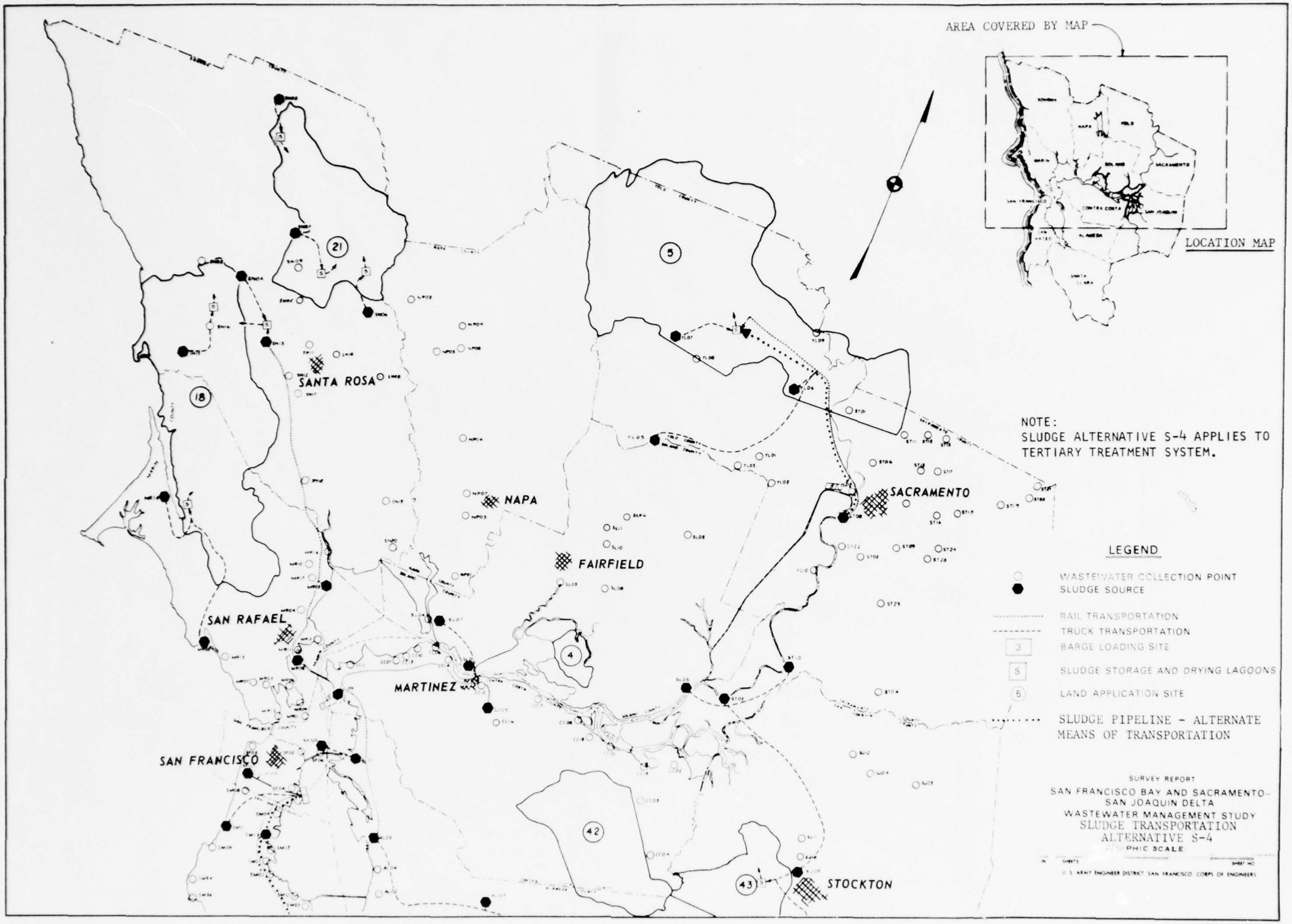
PLATE 8A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
SLUDGE TRANSPORTATION
ALTERNATIVES S-2 AND S-3
GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 8B

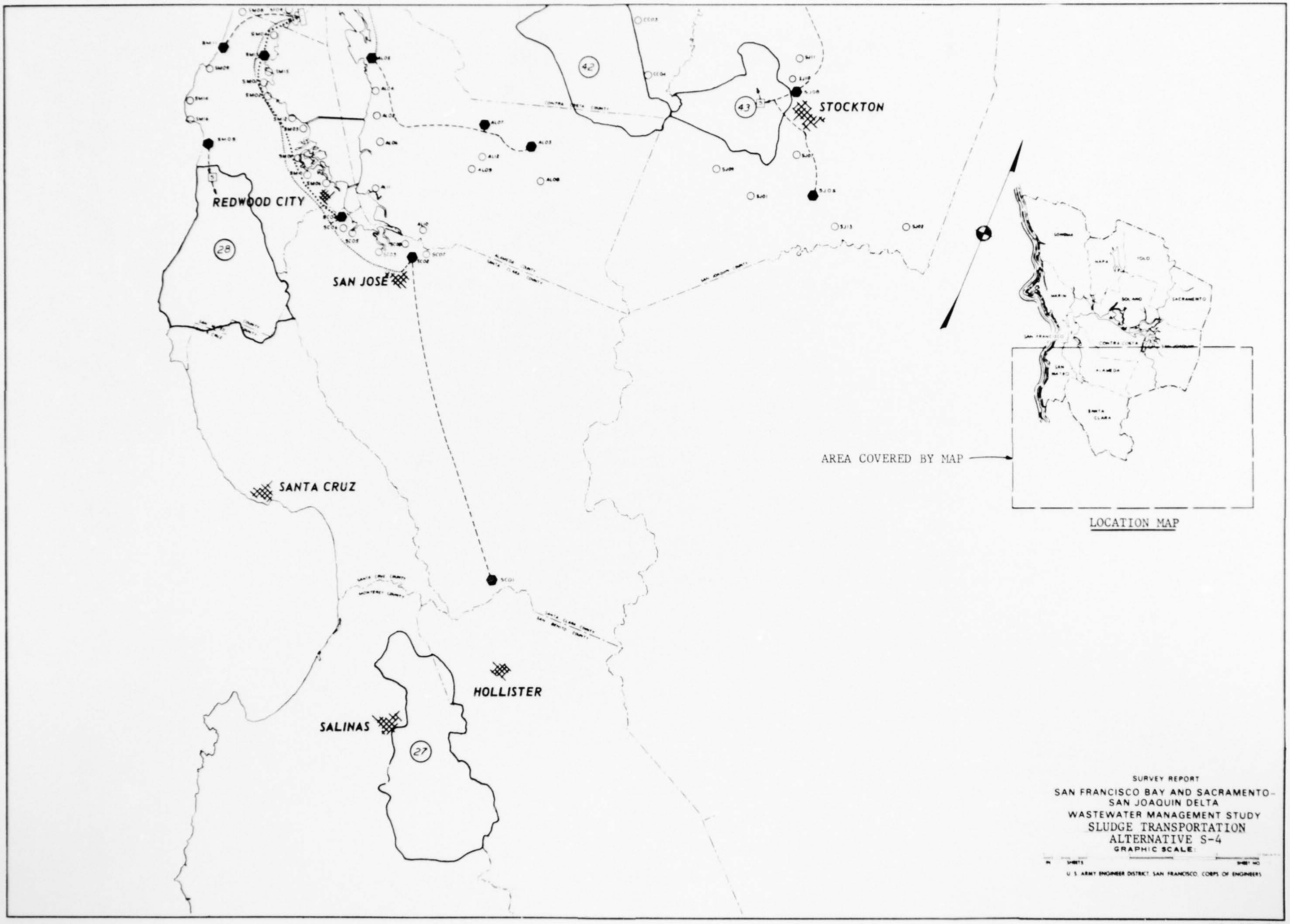


NOTE:
SLUDGE ALTERNATIVE S-4 APPLIES TO TERTIARY TREATMENT SYSTEM.

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
SLUDGE TRANSPORTATION
ALTERNATIVE S-4

IN SHEETS SHEET NO
U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 9A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
SLUDGE TRANSPORTATION
ALTERNATIVE S-4
GRAPHIC SCALE
IN SHEETS SHEET NO.
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 9B

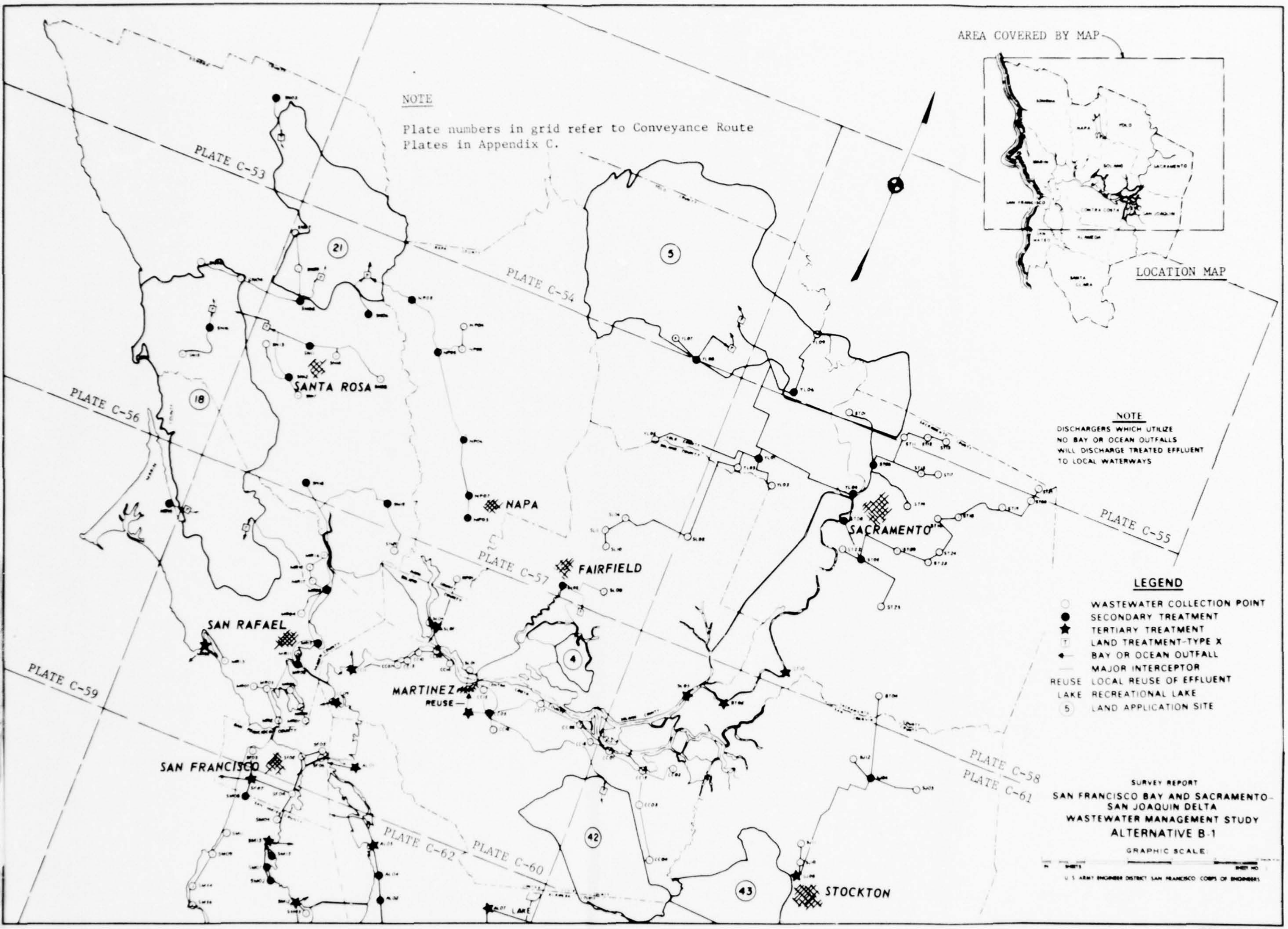
Alternative and Site Development Descriptions

169. Alternative B-1 - Wastewaters would either undergo local tertiary treatment and discharge to surface waterways or would receive biological secondary treatment and be conveyed to seven land areas for storage and subsequent land application. A total of 945 MGD (65 percent of the year 2000 flow) would receive tertiary treatment and 510 MGD (35 percent of the year 2000 flow) would be applied to the land areas. Plate 10 depicts the configuration of conveyance lines and wastewater management facilities for Alternative B-1. It should be noted that plates depicting the alternative wastewater management configurations and sludge systems do not show the revised acreages at land application sites. Only the gross outline of the initial land application sites are shown. Areas suitable for wastewater and sludge application are shown on the site development plates.

170. Wastewaters from all sources in the South San Francisco Bay area (550 MGD) would be combined for treatment in five tertiary plants and discharged between Dumbarton Bridge and the San Francisco-Oakland Bay Bridge. There would be two ocean discharges totalling 120 MGD: less than 1 MGD in the Bolinas-Stinson Beach area and the remainder from the San Francisco complex. In addition, 9 MGD from the Gilroy-Morgan Hill area would be conveyed to the Pacific Ocean via local streams. In Central San Francisco Bay between the Bay Bridge and the Carquinez Strait Bridge, 167 MGD would be discharged at three tertiary facilities. There would be no discharge between the Carquinez Strait Bridge and Chipps Island. Approximately 99 MGD of tertiary effluent would be discharged in the Delta east of Chipps Island. Wastewaters from the Livermore Valley area would receive tertiary treatment and be discharged to a local manmade lake in Doolan Canyon. Wastewater constituents discharged to the various waster quality zones under this alternative are shown in Table 19.

171. Wastewaters from northern Sonoma and most of Napa Counties would be treated in local biological secondary treatment plants prior to conveyance to Site 21 for land application. Wastewaters from southern and central Sonoma County and all of Marin County, less the Bolinas-Stinson Beach area, would be conveyed to Site 18. Land Site 4 would receive treated wastewater from the Fairfield-Travis AFB area. The flow from northern Solano, Yolo, and northern Sacramento Counties would be conveyed to Site 5. Southern San Joaquin County would utilize Site 43 while eastern Contra Costa County and the city of Benicia would use Site 42. The western portion of San Mateo County would convey its treated wastewater to Site 28.

172. Site development details are discussed below for the land treatment of wastewater at the seven application sites. Land application data, including waste quantities and major acreage requirements by site, are shown in Table 20. Total land requirements in the vicinity of the landsites are about 156,500 acres.



NOTE

Plate numbers in grid refer to Conveyance Route Plates in Appendix C.

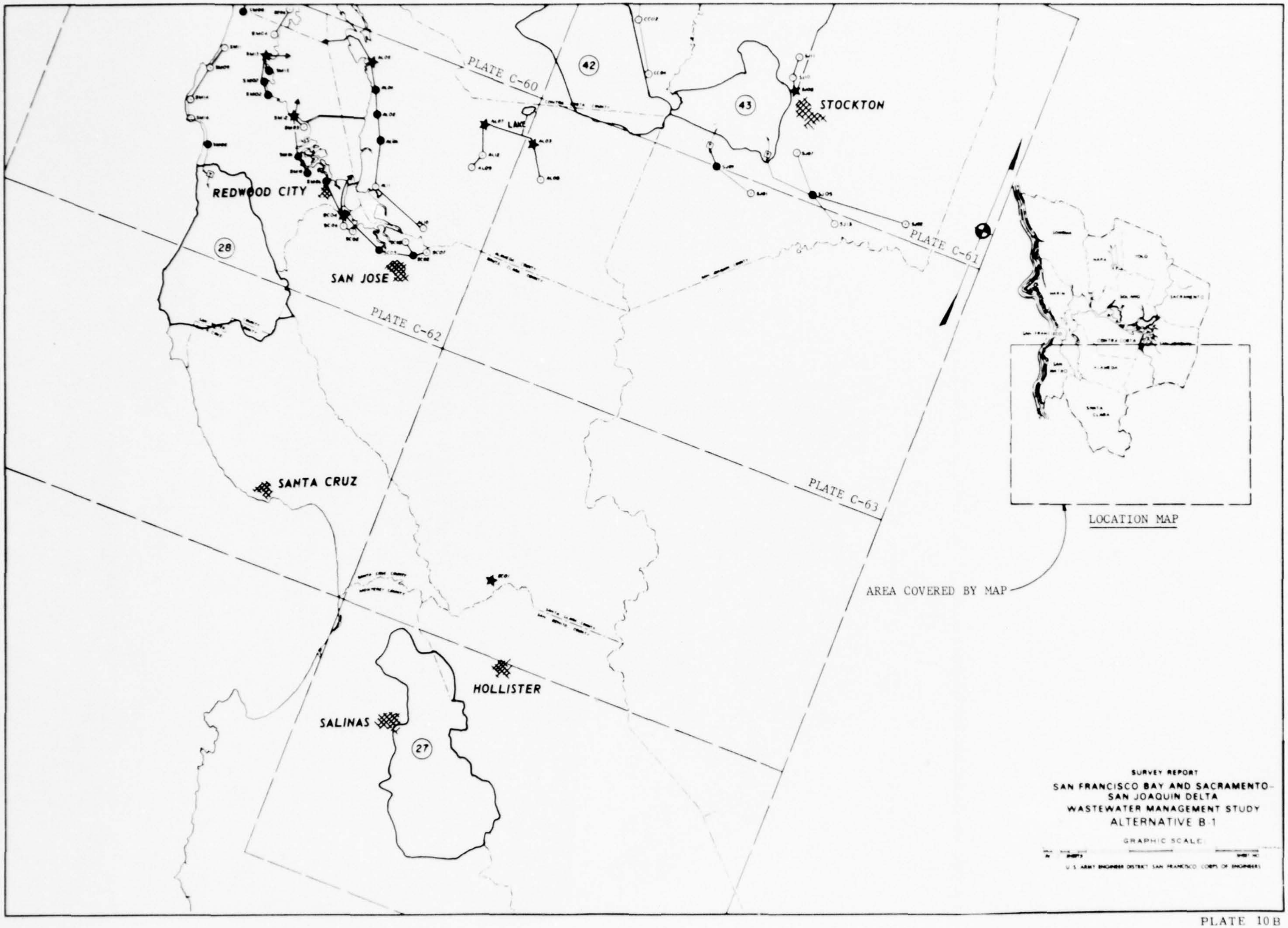
NOTE

DISCHARGERS WHICH UTILIZE NO BAY OR OCEAN OUTFALLS WILL DISCHARGE TREATED EFFLUENT TO LOCAL WATERWAYS

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE B-1

U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 10A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO–
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE B-1

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 10B

TABLE 19

WASTEWATER CONSTITUENT DISCHARGE SUMMARY

Alternative B-1

(Discharge to Surface Waters)

	Base Condition					Alternative B-1				
LOCATION	FLOW	BOD	TN	TP	GHM	FLOW	BOD	TN	TP	GHM
PACIFIC OCEAN	115	57.6	13.8	3.8	1.9	129	2.1	0.6	0.1	0.6
SOUTH SF BAY	372	58.6	31.1	22.7	9.9	550	5.1	2.1	0.4	2.4
CENTRAL SF BAY	130	24.9	12.5	7.5	3.3	167	2.8	0.8	0.2	0.7
CARQUINEZ STRAIT - SUISUN BAY	107	16.9	10.1	6.5	2.9	0	0	0	0	0
DELTA	207	27.0	14.7	9.7	4.3	99	1.5	0.5	0.1	0.4
TOTAL	931	185.0	82.2	50.2	22.3	945	11.5	4.0	0.8	4.1

<u>NOTES</u>:

Flow reported in MGD.

Constituents reported in 1,000 lbs/day.

TABLE 20

LAND APPLICATION DATA - ALTERNATIVE B-1

	WASTE QUANTITIES		ACRES				
				Proposed for Use			
Land Site	Wastewater (MGD)	Sludge (dry tons/yr)	Suitable for Wastewater and Sludge Application	Wastewater	Sludge	Wastewater 1/ and Sludge Storage 2/	Total
4	15	0	3,700	3,700	0	470	4,170
5	218	170,800	192,000	40,940	34,160	6,320	81,420
18	81	12,800	53,900	16,500	2,523	1,040	20,063
21	55	15,000	45,300	11,320	3,020	1,177	15,517
27	Not Used	-	57,900	-	-	-	-
28	5	400	14,000	890	150	477	1,517
42	118	23,400	37,700	19,000	4,660	1,310	24,970
43	18	18,600	53,700	4,650	3,740	615	9,005
TOTAL 3/	510	241,000	458,200	97,000	48,000	11,500	156,500

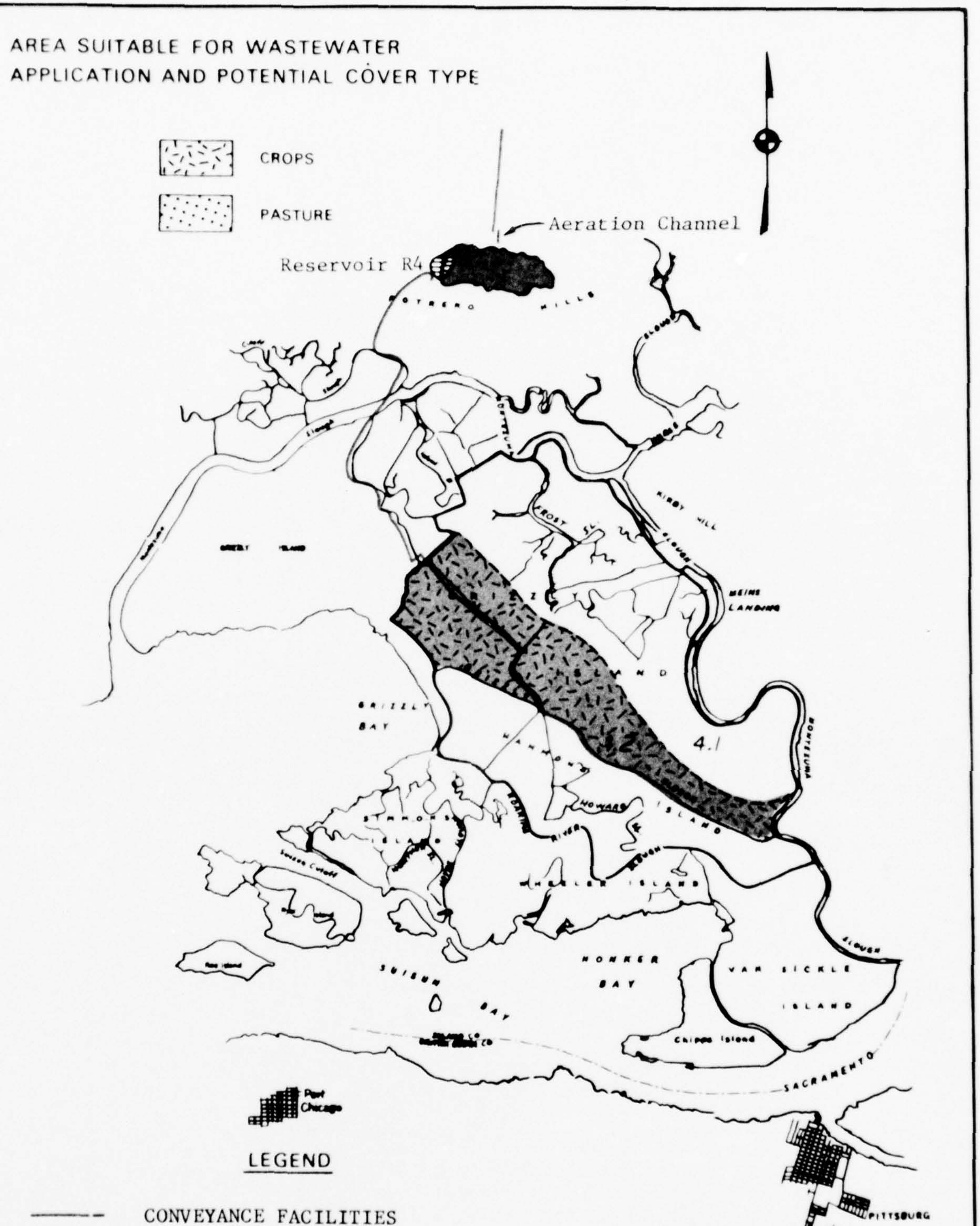
1/ Excludes reuse reservoirs.
2/ Includes storage at offsite facilities.
3/ Some totals rounded.

a. Wastewater discharged to Site 4 would receive secondary treatment at the Fairfield facility and then would be pumped to an offsite storage reservoir in the Potrero Hills. Plate 11 shows the wastewater reservoir location, the main distribution pipeline, and the area to be irrigated. The only area suitable for crops within this site is north of Grizzly Slough and the wastewater, approximately 15 MGD, would be applied there. Sludge would not be applied at this site due to the limited dry land available for application. A total of 3,700 acres would be used at this landsite for wastewater application.

b. Site 5 is located in the northeastern portion of Yolo County (including the southern tip of Colusa County) and would receive approximately 218 MGD of secondary effluent from treatment facilities in Sacramento, Yolo, and part of Solano Counties. Plate 12 shows the three onsite wastewater storage reservoirs, the one sludge lagooning area, the main distribution pipelines, and the actual areas to be irrigated. The land application areas were selected as close to the reservoirs as economically practical. The crop area north and east of the reservoirs was used since a minimum of pumping would be required for the distribution system. The pastureland north and west of the reservoirs was used since it provided the most economical distribution system and minimum land cost. A total of 75,100 acres (39 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

c. Site 18 in southwestern Sonoma and northwestern Marin Counties, would receive about 81 MGD of secondary effluent. Plate 13 shows the four proposed wastewater reservoirs, the three sludge lagoons, the main distribution pipelines, and the actual areas to be irrigated. Two of the wastewater reservoirs would be small in size because they receive the flow from small isolated communities. One reservoir and one sludge lagoon are situated east of the site. A total of 19,000 acres (35 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

d. Site 21, see Plate 14, is located in northeastern Sonoma County and would receive approximately 55 MGD of treated effluent from several locations. A total of three wastewater and three sludge lagoons would be required. One sludge lagoon is located east of the site. The wastewater disposal areas were selected as close to each reservoir as possible. For Reservoir R21B the cropland adjacent to the reservoir would be used since this would provide the most economical distribution system. The pastureland immediately north of Reservoir R21C would not have sufficient capacity for all the wastewater from that reservoir. Additional area would be required and the pasture area further north was selected. The most economical land application area for the wastewater from Reservoir R21D would be the cropland adjacent



LEGEND

— - — CONVEYANCE FACILITIES

■ AREA PROPOSED FOR WASTEWATER APPLICATION

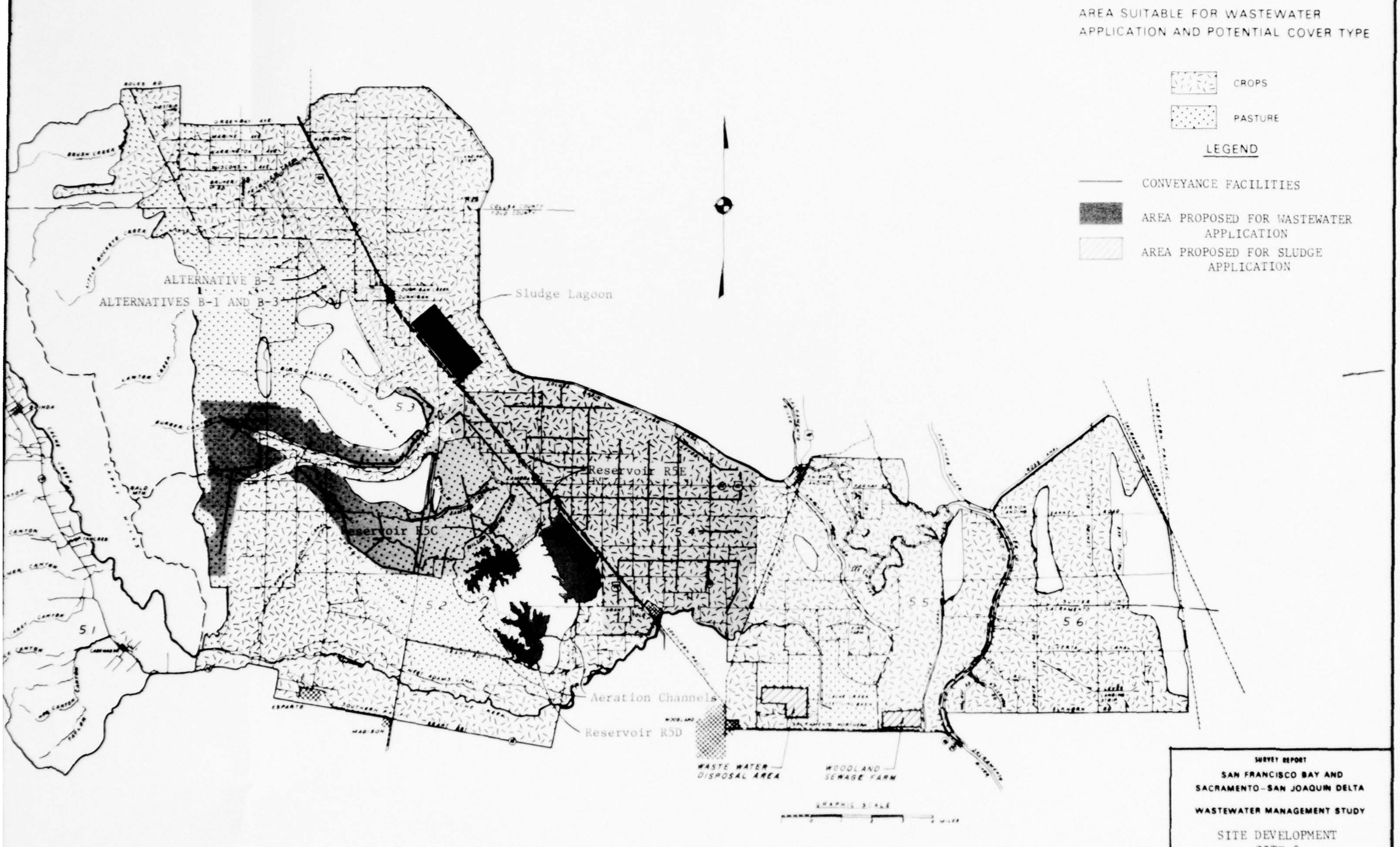
▨ AREA PROPOSED FOR SLUDGE APPLICATION

GRAPHIC SCALE:

SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO–SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 4
ALTERNATIVES B-1, B-2 and B-3

PLATE 11



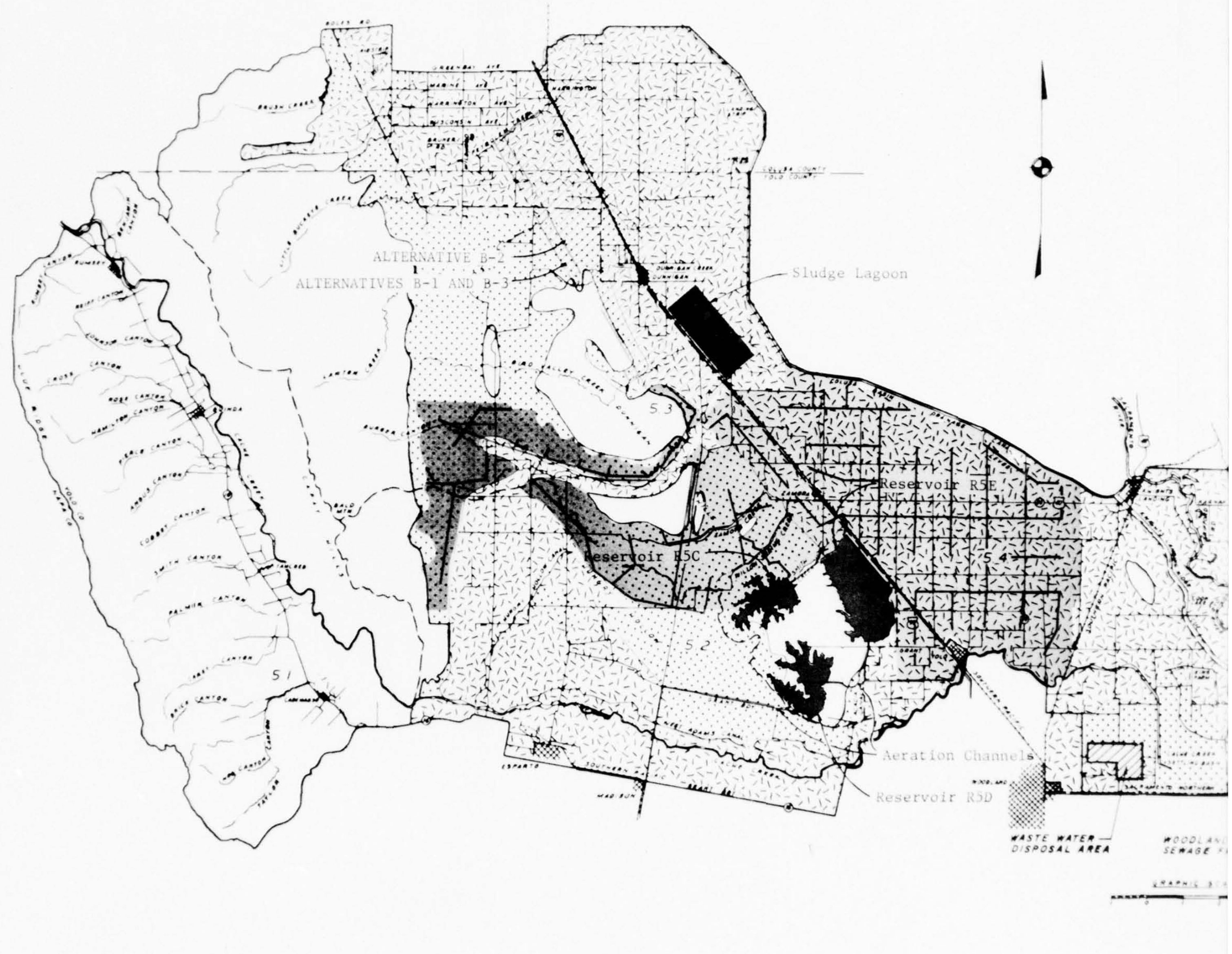
SURVEY REPORT

SAN FRANCISCO BAY AND SACRAMENTO–SAN JOAQUIN DELTA

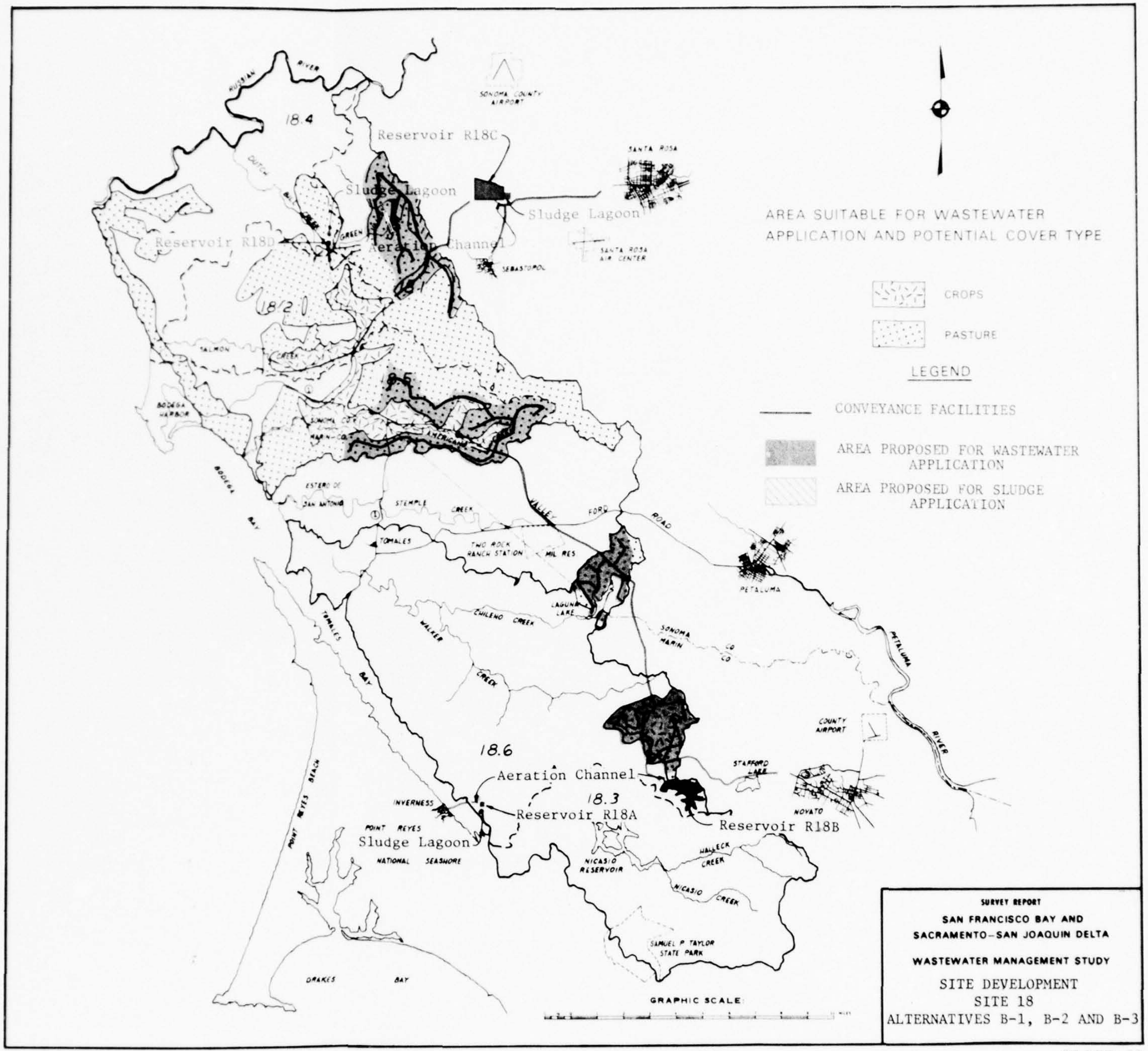
WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 5
ALTERNATIVES B-1, B-2 AND B-3

PLATE 12

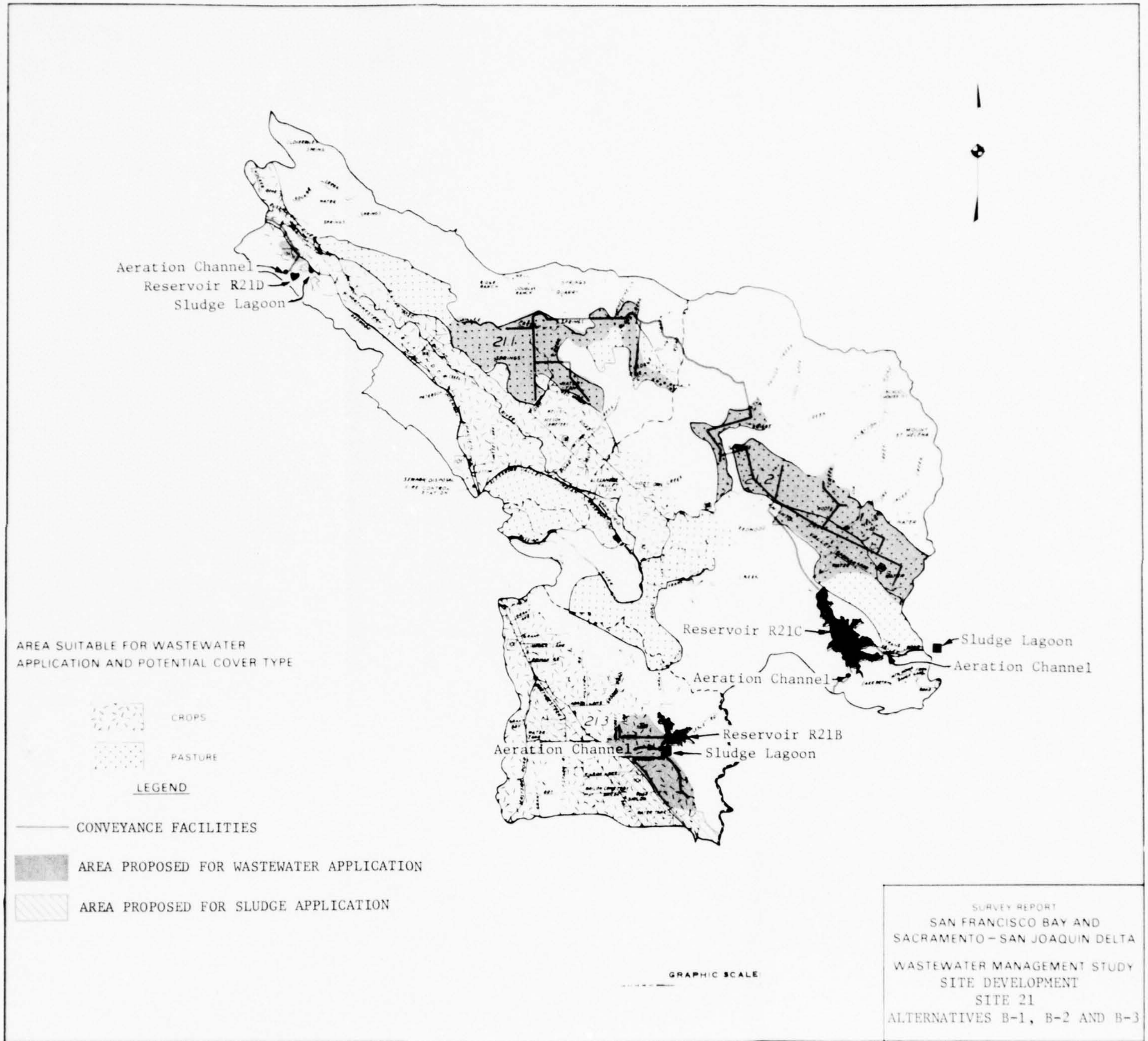

ALTERNATIVE B-2
ALTERNATIVES B-1 AND B-3
Sludge Lagoon
5 3
Reservoir R5E
Reservoir R5C
5 4
5 2
5 1
Aeration Channels
Reservoir R5D
WASTE WATER DISPOSAL AREA
WOODLAND SEWAGE
GRAPHIC SCALE

2



SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO–SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
SITE DEVELOPMENT
SITE 18
ALTERNATIVES B-1, B-2 AND B-3

PLATE 13



SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY
SITE DEVELOPMENT
SITE 21
ALTERNATIVES B-1, B-2 AND B-3

PLATE 14

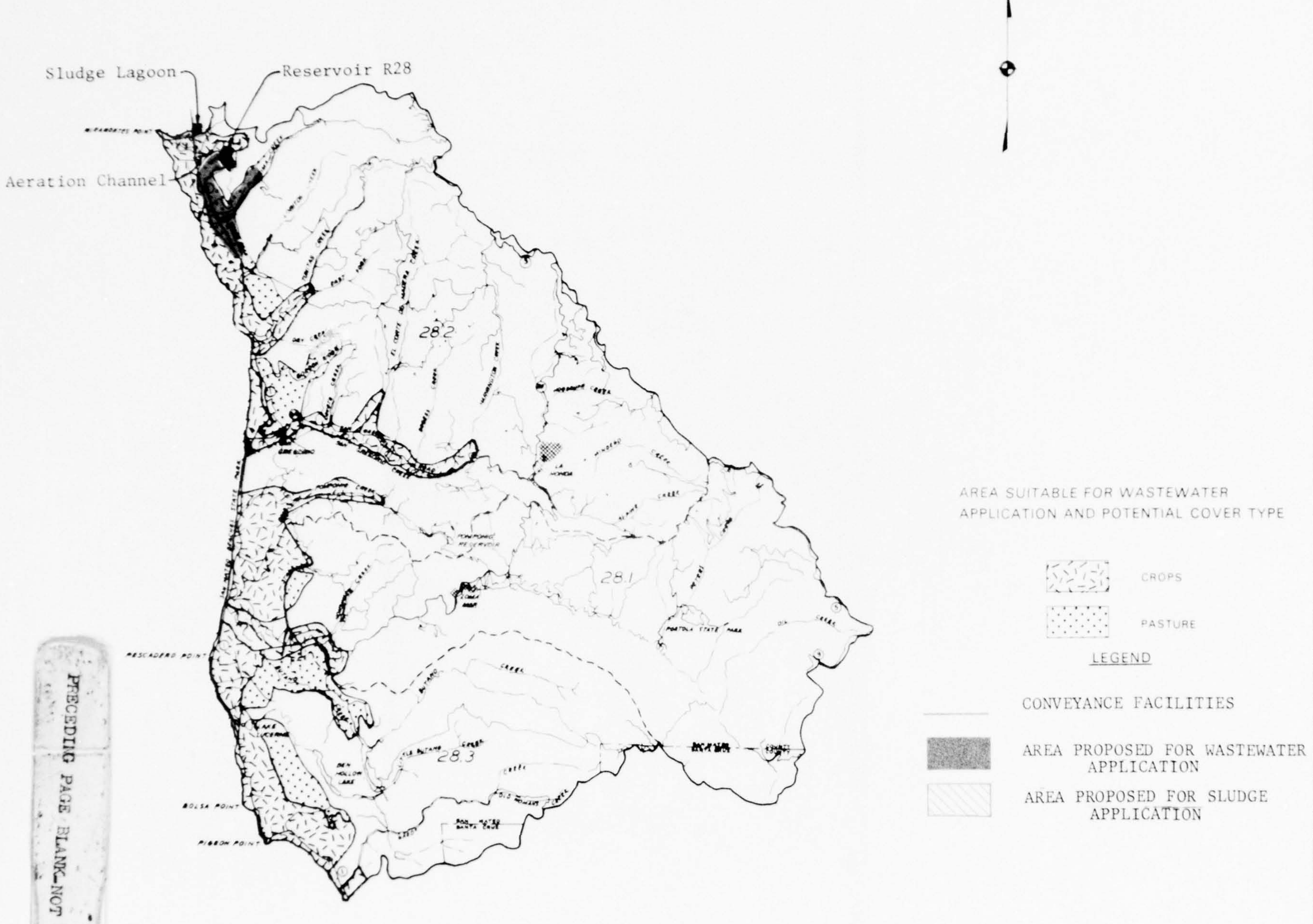
to Highway 101. A total of 14,300 acres (32 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

e. The secondary treatment plant at Half Moon Bay in San Mateo County would discharge its effluent to Site 28. The effluent, about five MGD, would be pumped to one onsite reservoir (see Plate 15) in the northwestern portion of the area. The pasture adjacent to the reservoir and east of Highway 1 was selected for wastewater disposal because it was closest to the reservoir. A total of 1,040 acres (7.5 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

f. Wastewater from the Central Contra Costa County facility would be pumped to one onsite reservoir at Site 42. Plate 16 shows site development features. The sludge lagoon lies north of the site. Since the land adjacent to the reservoir would provide for the most economical distribution system, it was the first to be selected for wastewater disposal. This area was not sufficient to dispose of the total effluent. Therefore, the pastureland south and west of Byron was selected. This land was used because it would be more economical to irrigate than the narrow valleys that extend into the hills. Also, since pastureland has a higher application rate and lower cost than does cropland, less acreage would be required. A total of 23,660 acres (63 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

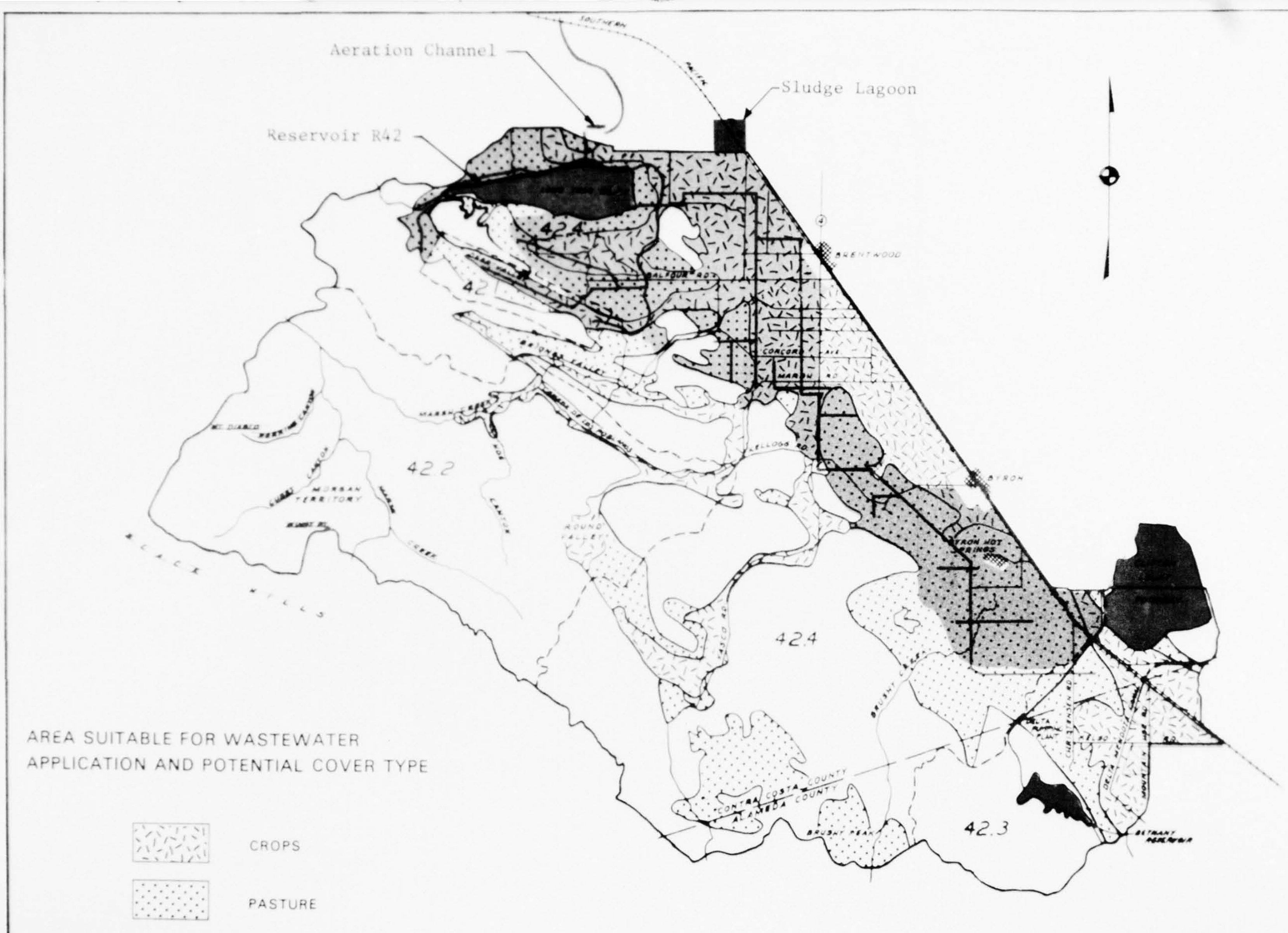
g. The secondary treatment plants at Manteca and Tracy would discharge to two reservoirs located at Site 43 in San Joaquin County. Because natural reservoir areas within the site are limited, one of the wastewater reservoirs and one sludge lagoon would be located out of the site location. Plate 17 shows the reservoir locations for wastewater and sludge, disposal areas, and the main distribution pipelines for the 18 MGD of wastewater to be applied. The cropland adjacent to each of the reservoirs would be used for wastewater application. A total of 8,390 acres (16 percent of the suitable acreage) would be used at this site for the land application of wastewater and sludge.

173. Sludge lagoons would be located near the wastewater storage reservoirs in order to minimize maintenance crew travel time. The sludge application sites would be located in relatively flat areas that could be easily disc harrowed. In developing the site layout, the wastewater application area was located nearest the wastewater reservoir to minimize pipe and pumping costs. Since there can be no wastewater applied to an area that will receive sludge, the sludge application area was located outside the wastewater application area. This would provide a satisfactory economical arrangement since sludge application requires no fixed distribution system. Plates 11 through 17 show the sludge application areas within each land site.



SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY
SITE DEVELOPMENT
SITE 28



LEGEND

CONVEYANCE FACILITIES

▨ AREA PROPOSED FOR WASTEWATER APPLICATION

▨ AREA PROPOSED FOR SLUDGE APPLICATION

GRAPHIC SCALE

SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 42
ALTERNATIVES B-1, B-2 AND B-3

AREA SUITABLE FOR WASTEWATER APPLICATION AND POTENTIAL COVER TYPE

▨	CROPS
░	PASTURE

LEGEND

——— CONVEYANCE FACILITIES

▓ AREA PROPOSED FOR WASTEWATER APPLICATION

▨ AREA PROPOSED FOR SLUDGE APPLICATION

GRAPHIC SCALE

SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 43
ALTERNATIVES B-1, B-2 AND B-3

PLATE 17

174. Sludge System S-1 (see Plate 7) would be applicable for wastewater Alternatives B-1, B-2 and B-3. Sludge from the San Mateo coastal secondary plant (SM05) would be trucked to Site 28. Sludge from Gilroy-Morgan Hill would be trucked to San Jose. A rail line terminating at the San Francisco Southeast Plant would pick up all of the sludge produced at the facilities north of San Jose. Additionally, sludge from the North San Mateo County plant would be trucked to the Lake Merced facility and the total sludge would be piped to the Southeast facility. Sludge produced along the East Bay (including Livermore Valley) would be transported by truck to San Leandro and then by rail to the Richmond facility to be joined by a rail line from San Pablo. A barge would then collect the sludge from both the Southeast and Richmond facilities and transport it to an unloading facility near Sacramento. Here the sludge would be unloaded and transported by rail line to Site 5.

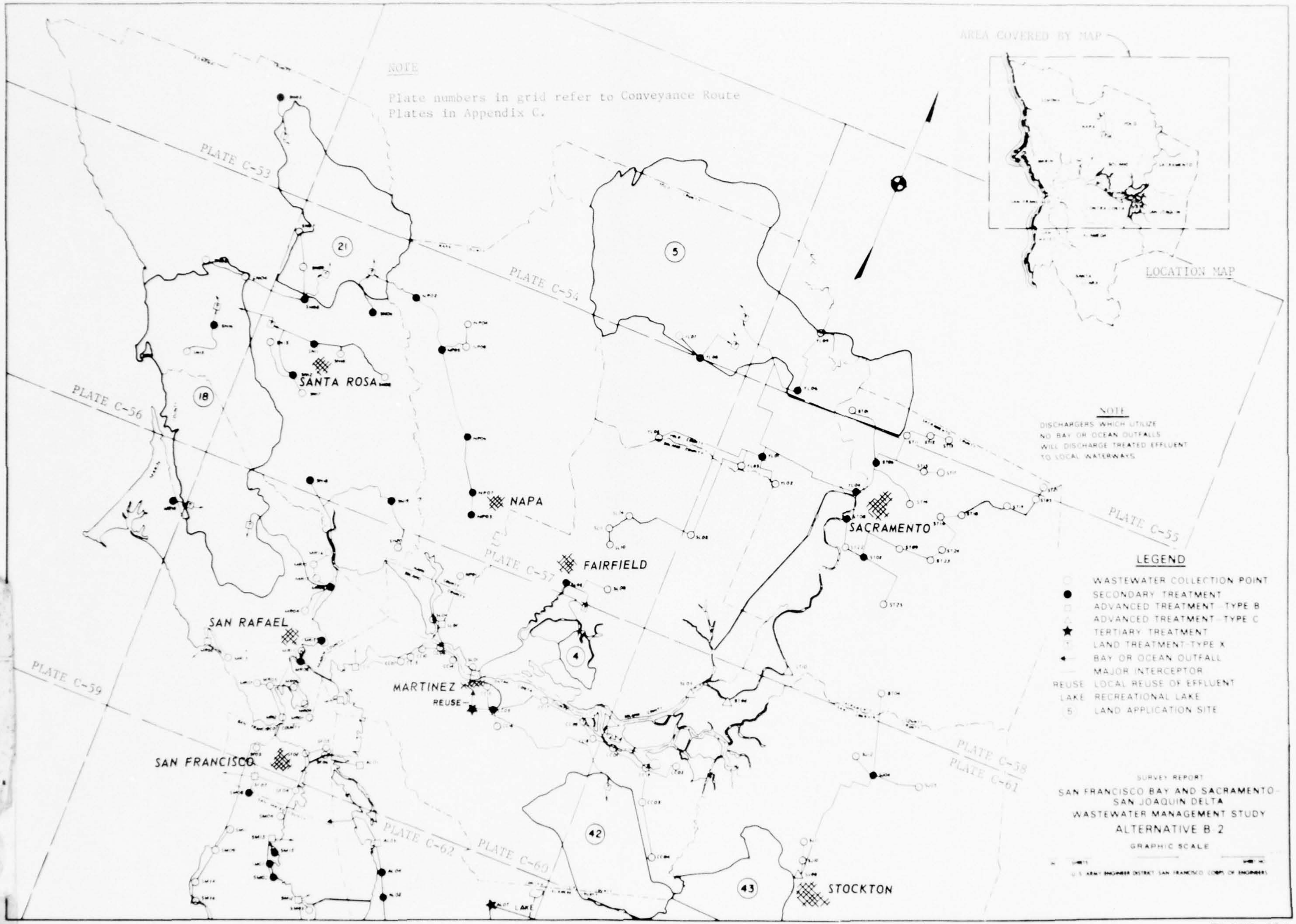
175. A rail line would originate in Central Marin and would pick up sludge along the way, transporting it to Site 18. Sludge from small communities in Sonoma and Marin Counties would be trucked to Site 18.

176. Sludge from the Napa Valley would be transported by rail to Calistoga and trucked to Site 21. Smaller communities near Site 21 would truck sludge directly to the land area. Sludge from the Fairfield area would be trucked to the Napa Valley rail line originating at Vallejo.

177. Sludge from Central Contra Costa County would be railed and trucked to Site 42. Sludge from the facilities in San Joaquin County would be trucked to Site 43.

178. A rail line would transport sludge from the Sacramento area and from the barge unloading facility to Site 5. Communities in Solano, Sacramento, and Yolo Counties would truck sludge to the rail line or truck directly to Site 5.

179. Alternative B-2 - Except for the degree of treatment that would be required for discharges to waterways, Alternative B-2 (Plate 18) is identical to Alternative B-1 (see Plate 10). Wastewater quantities are the same. A total of 945 MGD (65 percent of the year 2000 flow) would receive advanced treatment and 510 MGD (35 percent of the year 2000 flow) would be applied to the land. The criteria for the degree of treatment in this alternative was applied to all unit processes after secondary treatment so that the total emissions of individual constituents discharged to each water quality zone would not exceed the quantity discharged under the Base Condition. All discharges in each zone would be required to have identical treatment levels. Using this criteria, discharges to the Pacific Ocean, South Bay, and Central Bay would receive secondary treatment followed by dual media filtration. In the Delta, secondary treatment plus 80 percent phosphorus removal and nitrification and denitrification would be required. Wastewater constituents discharged to the various water quality zones under this alternative are summarized in Table 21.



NOTE

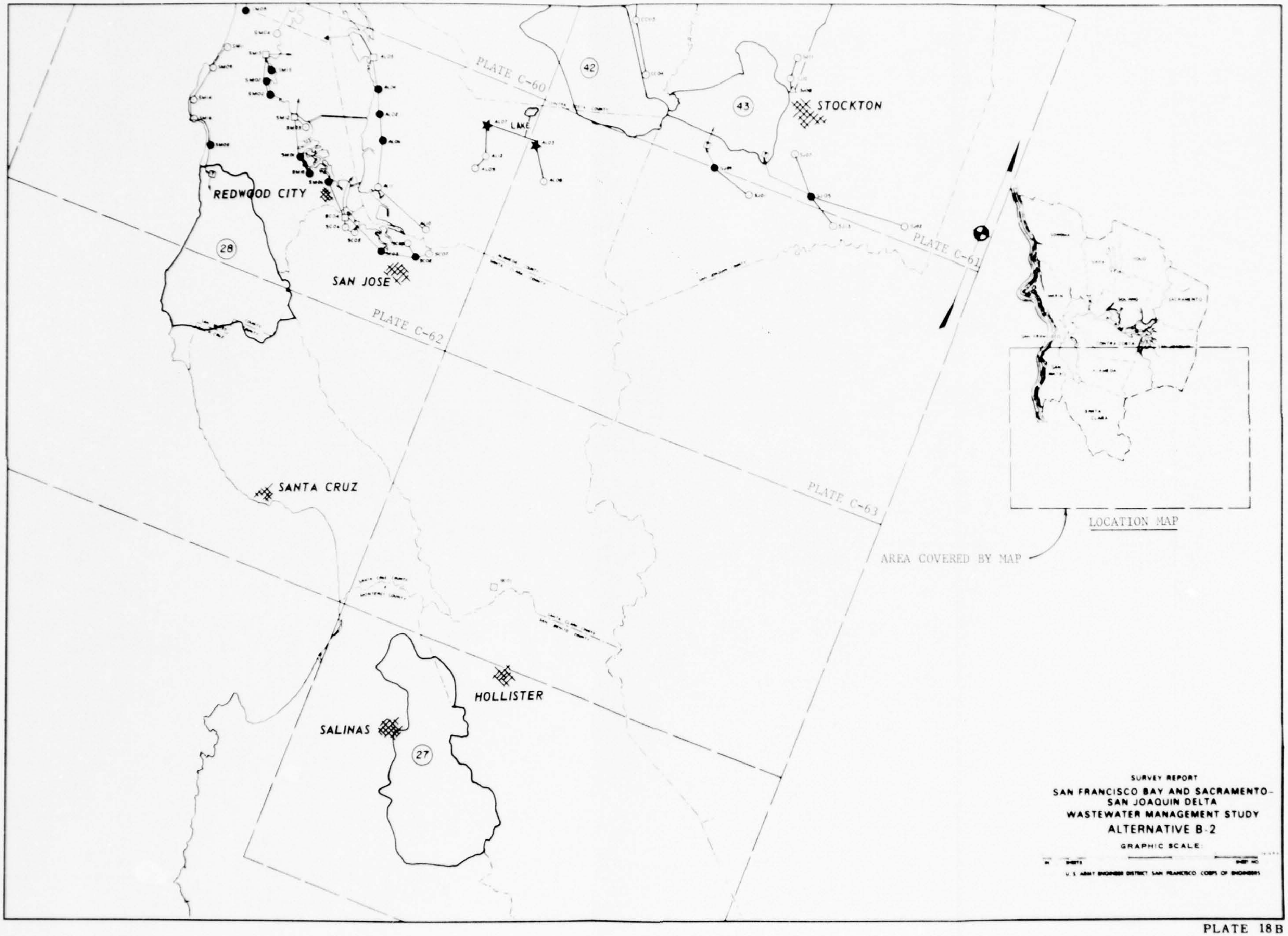
Plate numbers in grid refer to Conveyance Route Plates in Appendix C.

NOTE

DISCHARGERS WHICH UTILIZE NO BAY OR OCEAN OUTFALLS WILL DISCHARGE TREATED EFFLUENT TO LOCAL WATERWAYS

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE B-2

PLATE 18A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE B-2
GRAPHIC SCALE:
U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 18B

TABLE 21

WASTEWATER CONSTITUENT DISCHARGE SUMMARY

Alternative B-2

(Discharge to Surface Waters)

	Base Condition					Alternative B-2				
LOCATION	FLOW	BOD	TN	TP	GHM	FLOW	BOD	TN	TP	GHM
PACIFIC OCEAN	115	57.6	13.8	3.8	1.9	129	7.7	8.1	1.3	0.8
SOUTH SF BAY	372	58.6	31.1	22.7	9.9	550	30.0	27.9	6.1	3.2
CENTRAL SF BAY	130	24.9	12.5	7.5	3.3	167	10.0	10.6	1.7	0.9
CARQUINEZ STRAIT - SUISUN BAY	107	16.9	10.1	6.5	2.9	0	0	0	0	0
DELTA	207	27.0	14.7	9.7	4.3	99	5.8	0.9	1.2	0.2
TOTAL	931	185.0	82.2	50.2	22.3	945	53.5	47.5	10.2	5.1

<u>NOTES</u>:

Flow reported in MGD.

Constituents reported in 1,000 lbs/day.

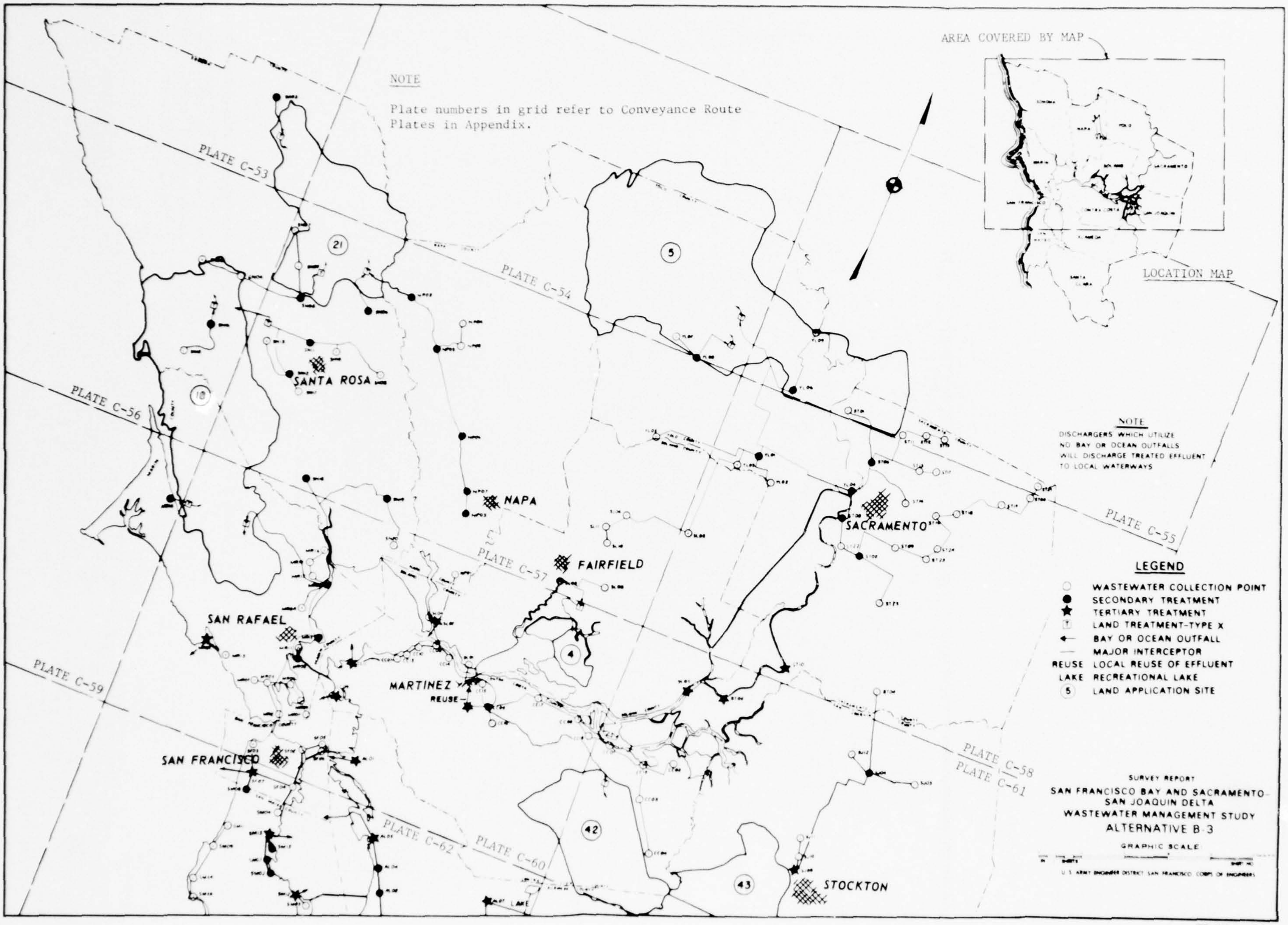
180. The sludge lagoons for this alternative would be in the same location and have the same operation and maintenance considerations as those in Alternative B-1. Also, the sludge application sites would remain the same as in Alternative B-1. The land area required for sludge lagoons and application would be reduced slightly since, because of the lower degree of treatment, smaller quantities of sludge will be produced. Plates 11 through 17 also show site development features for this alternative. Total land requirements in the vicinity of the landsites are about 155,400 acres.

181. Alternative B-3 - This alternative (see Plate 19) is another variation of Alternative B-1. Wastewater from San Jose, Milpitas, and Alviso would receive secondary treatment at the San Jose Plant prior to conveyance to Site 27. Secondary effluent from the Gilroy-Morgan Hill facility would also be conveyed to Site 27. Year 2000 flows for these discharges are 187 MGD. A total of 758 MGD (51 percent of the year 2000 flow) would receive tertiary treatment and 697 MGD (49 percent of the year 2000 flow) would be applied to land. Wastewater constituents discharged to the various water quality zones are summarized in Table 22.

182. Except for the addition of Site 27, land application areas would remain the same as in Alternative B-1. Two reservoirs would be used to store the additional 187 MGD. Capacity in Site 27 would also accommodate all of the projected flows in the Monterey, Salinas, Santa Cruz complex for the year 2000. Plate 20 shows the location of the two reservoirs (one of which is offsite), the area to be irrigated, and the main distribution pipelines. As with the other sites, the land nearest the reservoirs would be most economical to irrigate. The pastureland in the northwestern portion of the site would be used for wastewater from Reservoir R27C. The pastureland in the southeastern portion of the area would be utilized for wastewater from Reservoir R27D. However, this area would not have sufficient capacity for the total volume of effluent. Therefore, the cropland adjacent to the pasture area would be used. A total of 37,970 acres (65 percent of the total suitable acreage) would be used in Site 27 for wastewater application. Total land requirements for this alternative in the vicinity of the eight landsites are about 195,000 acres.

183. The sludge transportation, treatment, and application systems for this alternative would be identical to those of Alternative B-1. Even though the wastewater from San Jose and Morgan Hill-Gilroy facilities would go to Site 27, the sludge produced at these plants would still go to Site 5 as in Alternative B-1.

184. Alternative D-1 - In this alternative (see Plate 21) wastewaters would either receive tertiary treatment and be discharged to local waterways or be conveyed from local sources to land areas where they would receive the equivalent of secondary treatment in onsite aeration lagoons prior to storage and application on the land. Base Condition treatment facilities not used in connection with disposal to water bodies would be converted to pump stations.



NOTE

Plate numbers in grid refer to Conveyance Route Plates in Appendix.

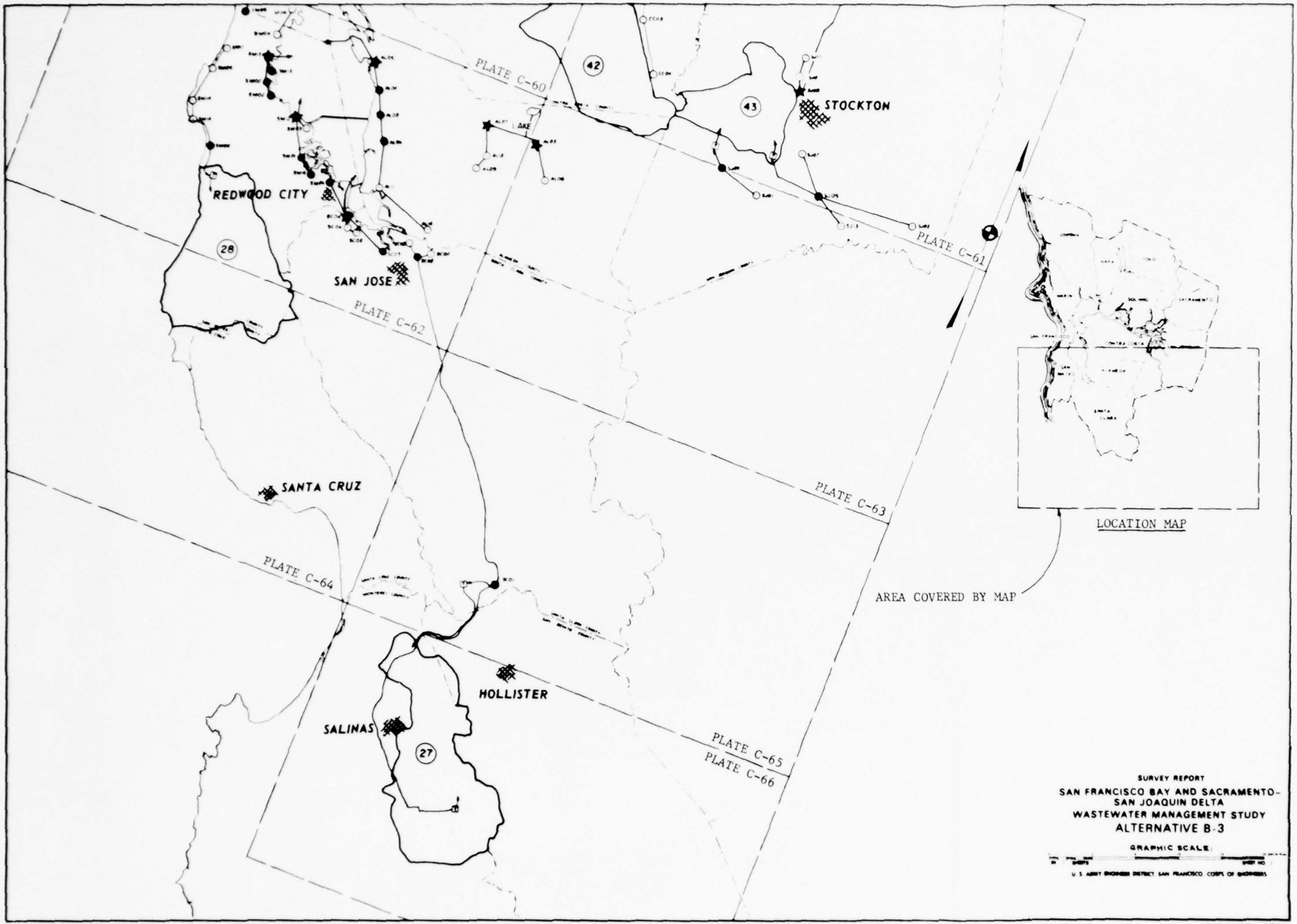
NOTE

DISCHARGERS WHICH UTILIZE NO BAY OR OCEAN OUTFALLS WILL DISCHARGE TREATED EFFLUENT TO LOCAL WATERWAYS

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE B-3

U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 19A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE B-3

GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 19B

TABLE 22

WASTEWATER CONSTITUENT DISCHARGE SUMMARY

Alternative B-3

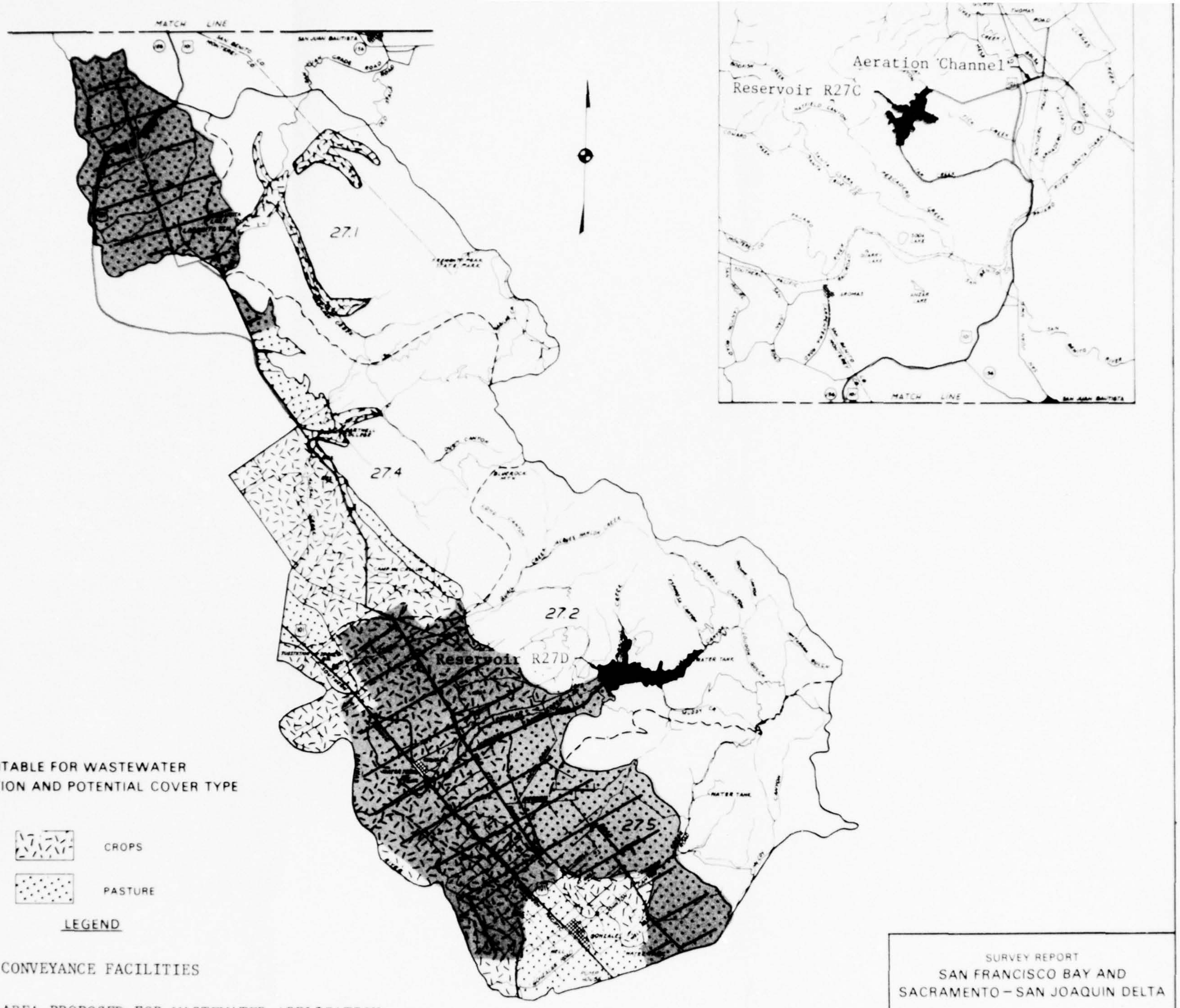
(Discharge to Surface Waters)

	Base Condition					Alternative B-3				
LOCATION	FLOW	BOD	TN	TP	GHM	FLOW	BOD	TN	TP	GHM
PACIFIC OCEAN	115	57.6	13.8	3.8	1.9	120	1.9	0.6	0.1	0.5
SOUTH SF BAY	372	58.6	31.1	22.7	9.9	372	4.5	1.6	0.3	1.6
CENTRAL SF BAY	130	24.0	12.5	7.5	3.3	167	2.8	0.8	0.2	0.7
CARQUINEZ STRAIT - SUISUN BAY	107	16.9	10.1	6.5	2.9	0	0	0	0	0
DELTA	207	27.0	14.7	9.7	4.3	99	1.5	0.5	0.1	0.4
TOTAL	931	185.0	82.2	50.2	22.3	758	10.7	3.5	0.7	3.2

NOTES:

Flow reported in MGD.

Constituents reported in 1,000 lbs/day.



AREA SUITABLE FOR WASTEWATER
APPLICATION AND POTENTIAL COVER TYPE

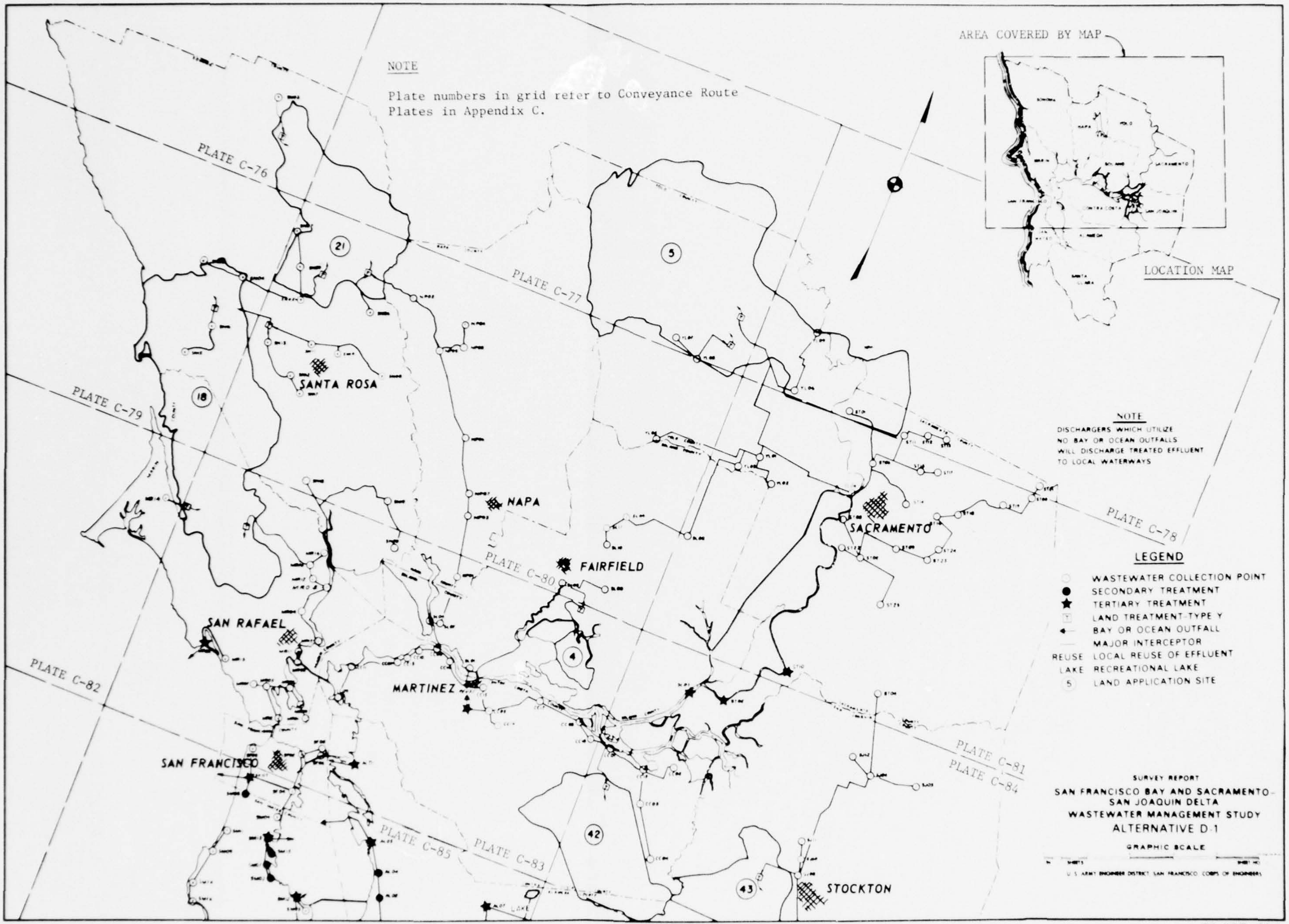
▨	CROPS
⁘	PASTURE

LEGEND

—	CONVEYANCE FACILITIES
■	AREA PROPOSED FOR WASTEWATER APPLICATION
▨	AREA PROPOSED FOR SLUDGE APPLICATION

SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY
SITE DEVELOPMENT
SITE 27
ALTERNATIVE B-3



NOTE

Plate numbers in grid refer to Conveyance Route Plates in Appendix C.

NOTE

DISCHARGERS WHICH UTILIZE NO BAY OR OCEAN OUTFALLS WILL DISCHARGE TREATED EFFLUENT TO LOCAL WATERWAYS

LEGEND

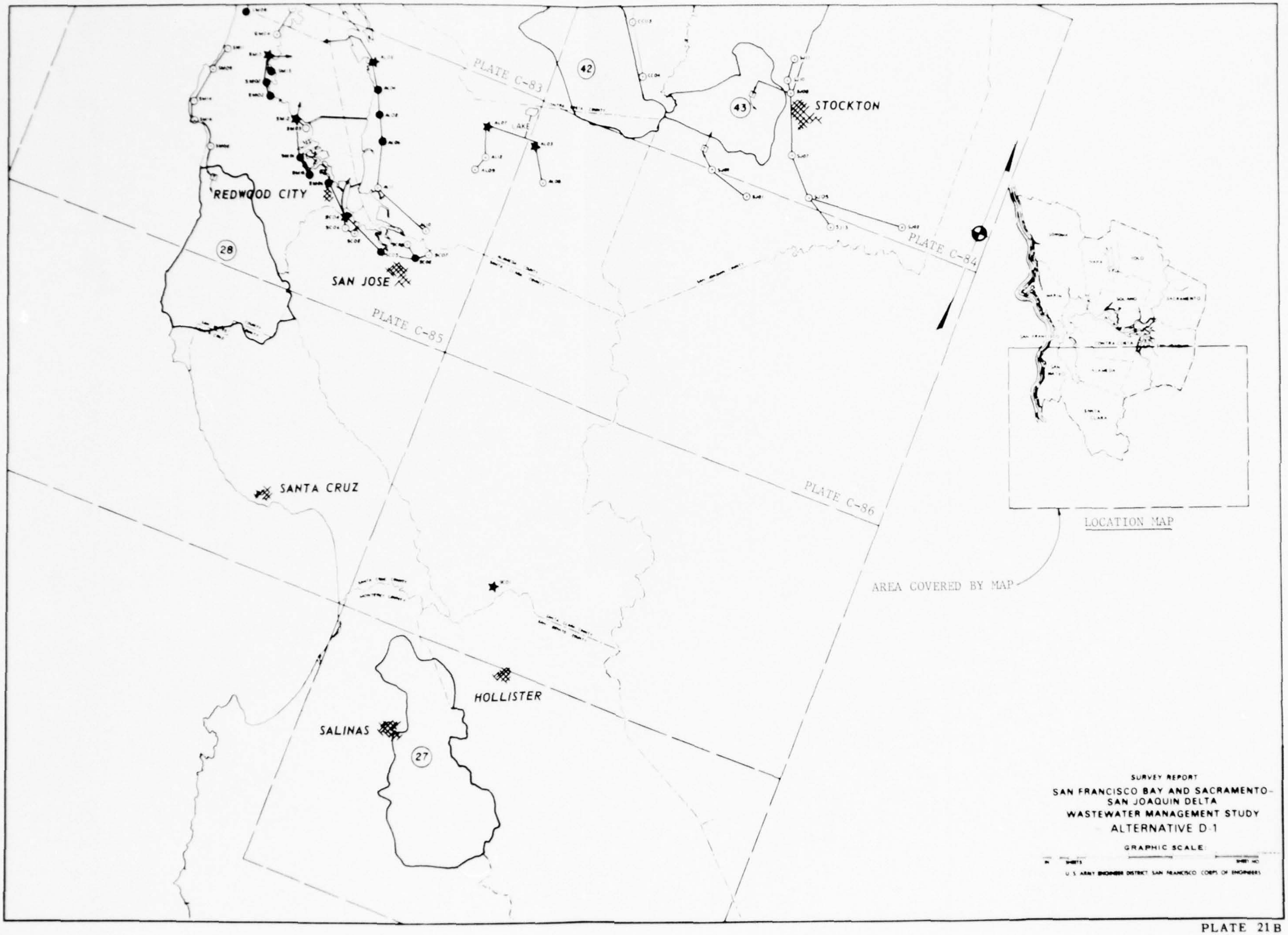
○	WASTEWATER COLLECTION POINT
●	SECONDARY TREATMENT
★	TERTIARY TREATMENT
T	LAND TREATMENT-TYPE Y
←	BAY OR OCEAN OUTFALL
—	MAJOR INTERCEPTOR
REUSE	LOCAL REUSE OF EFFLUENT
LAKE	RECREATIONAL LAKE
⑤	LAND APPLICATION SITE

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE D-1

GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 21 A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE D-1

GRAPHIC SCALE:

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 21B

185. As in the B-1 alternative, all wastewaters in the South Bay (550 MGD) would receive tertiary treatment at five facilities and be discharged between Dumbarton Bridge and the San Francisco-Oakland Bay Bridge. Approximately 129 MGD would be discharged to the Pacific Ocean after tertiary treatment, 120 MGD from the San Francisco area, less than 1 MGD from Bolinas-Stinson Beach, 9 MGD from the Gilroy-Morgan Hill area which would reach the Pacific Ocean via Llagas Creek and the Pajaro River. These subsystems are identical to Alternative B-1.

186. A major difference between Alternatives B-1 and D-1 is that in D-1 there would be no discharge to Central Bay and only 2 MGD discharged in the Delta from three tertiary plants at Isleton, Rio Vista, and Walnut Grove. A total of 681 MGD (47 percent of the year 2000 flow) would be discharged to water after tertiary treatment compared to 945 MGD in Alternative B-1. Wastewater constituents discharged to the various water quality zones are summarized in Table 23.

187. More wastewater would be directed to the land areas in this alternative than in Alternative B-1 (510 MGD). Site 18 would receive 81 MGD from Marin County (except the Bolinas-Stinson Beach area) and central and southern Sonoma County. Site 4 would receive 15 MGD from the Fairfield-Suisun-Travis AFB area. Site 5 would receive 218 MGD from Sacramento, Yolo, and Solano Counties. Site 28 would receive 5 MGD from San Mateo County coastal communities. All of these subsystems are identical in configuration to Alternative B-1.

188. The other land areas would be more intensely used than in Alternative B-1 (although as in B-1, Site 27 would be excluded). Site 21 usage would be increased from 55 MGD in B-1 to 80 MGD in D-1. The additional 25 MGD would come from the Vallejo-Mare Island-American Canyon area. Land area 21 would then handle all of the wastewater from northern Sonoma County, the entire Napa Valley and the Vallejo area. Use of Site 42 would increase from 118 MGD to 259 MGD. This comprises all of the wastewaters in Contra Costa County (with the exception of 30 MGD to be reused locally) and also includes the Benicia area. All of San Joaquin County's wastewaters (plus Elk Grove), 115 MGD, would be conveyed to Site 43 for treatment and land application. A total of 773 MGD (53 percent of the year 2000 flow) would be applied to the land under this alternative.

189. Site development details are discussed below for the land treatment of wastewater at the seven application sites. Land application data, including waste quantities and major acreage requirements by site, are shown in Table 24. Total land requirements in the vicinity of the seven landsites are about 213,200 acres.

a. Raw sewage destined for Site 4 would be pumped from the Fairfield-Travis AFB area to aeration lagoons near the Potrero Hills. The treated effluent would then be conveyed to a reservoir located adjacent to the aeration lagoons. Plate 22 shows the aeration lagoons, the storage reservoir, the main distribution pipeline, and the application area. Sludge would not be applied at this site. A total of 3,700 acres would be used at this landsite for wastewater application.

TABLE 23

WASTEWATER CONSTITUENT DISCHARGE SUMMARY

Alternative D-1

(Discharge to Surface Waters)

	Base Condition					Alternative D-1				
LOCATION	FLOW	BOD	TN	TP	GHM	FLOW	BOD	TN	TP	GHM
PACIFIC OCEAN	115	57.6	13.8	3.8	1.9	129	2.1	0.6	0.1	0.6
SOUTH SF BAY	372	58.6	31.1	22.7	9.9	550	5.1	2.1	0.4	2.4
CENTRAL SF BAY	130	24.9	12.5	7.5	3.3	0	0	0	0	0
CARQUINEZ STRAIT - SUISUN BAY	107	16.9	10.1	6.5	2.9	0	0	0	0	0
DELTA	207	27.0	14.7	9.7	4.3	2	*	*	*	*
TOTAL	931	185.0	82.2	50.2	22.3	681	7.2	2.7	0.5	3.0

NOTES:

Flow reported in MGD.

Constituents reported in 1,000 lbs/day.

* Constituent is less than 50 lbs/day.

TABLE 24

LAND APPLICATION DATA - ALTERNATIVE D-1

Land Site	WASTE QUANTITIES		ACRES				
				Proposed For Use			
	Wastewater (MGD)	Sludge (dry tons/yr)	Suitable for Wastewater and Sludge Application	Wastewater	Sludge	Wastewater 1/ and Sludge Storage 2/	Total
4	15	0	3,700	3,700	0	480	4,180
5	218	147,800	192,000	40,940	29,400	6,320	76,660
18	81	12,800	53,900	16,500	2,518	1,120	20,130
21	80	15,000	45,300	17,120	3,030	1,470	21,620
27	Not Used	-	57,900	-	-	-	-
28	5	800	14,000	890	150	480	1,520
42	259	45,600	37,700	25,010	9,100	4,260	38,370
43	115	18,300	53,700	44,170	3,670	3,080	50,920
TOTAL 3/	773	240,200	458,200	148,000	48,000	17,200	213,200

1/ Excludes reuse reservoirs but includes aeration lagoons.
2/ Includes storage at offsite facilities.
3/ Some totals rounded.

LEGEND

─── CONVEYANCE FACILITIES

■ AREA PROPOSED FOR WASTEWATER APPLICATION

▨ AREA PROPOSED FOR SLUDGE APPLICATION

GRAPHIC SCALE

SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO–SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 4
ALTERNATIVES D-1, D-2 AND D-3

PLATE 22

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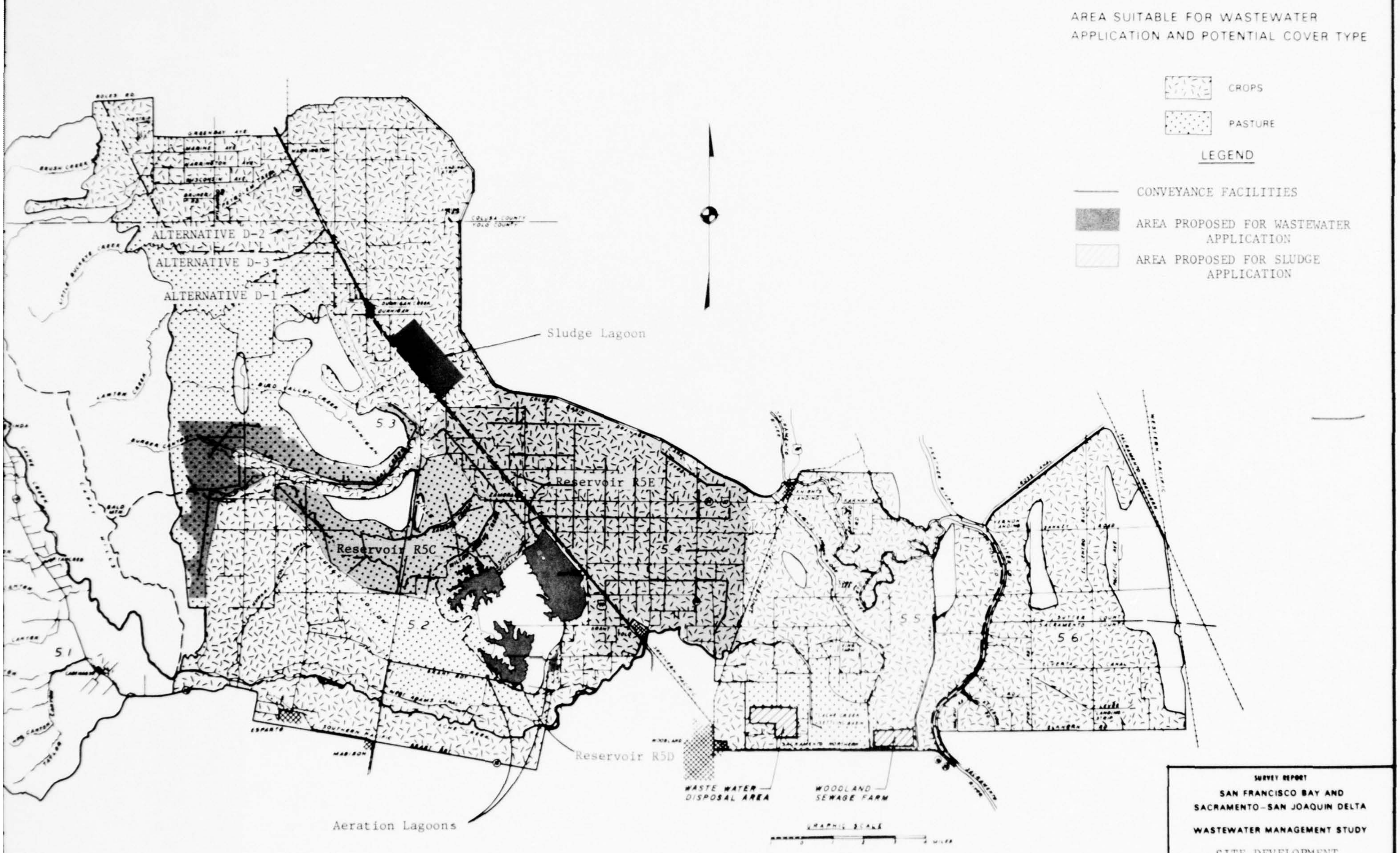
b. Site 5 would receive and treat in aeration lagoons approximately 218 MGD of raw sewage prior to conveyance to the three small onsite wastewater reservoirs used in Alternative B-1. Plate 23 shows the application areas for wastewater and sludge, the reservoir locations, and the main distribution pipelines as well as the location of the aeration and sludge lagoons. The wastewater and sludge application areas are generally the same as would be used in Alternative B-1. A total of 70,300 acres (37 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

c. Site 18 (see Plate 24) would receive and treat approximately 81 MGD of raw sewage in aeration lagoons. Effluent would then be conveyed to storage reservoirs. The same site development configuration used in Alternative B-1 (Plate 13) is also used under this alternative. A total of 19,000 acres (35 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

d. Site 21 would receive approximately 80 MGD of raw sewage from several locations. This is about 25 MGD more than under Alternative B-1. The raw sewage would undergo secondary treatment in aeration lagoons near the reservoir sites before being stored. Plate 25 shows the site development facilities used in this alternative. Additional crop and pasturelands north of Reservoir R21B would be required to properly apply the additional 25 MGD over Alternative B-1. A total of 20,200 acres (44 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

e. Plate 26 shows the reservoir location, application areas, the main distribution pipelines and other details for Site 28. The configuration used is the same as that in Alternative B-1 except raw sewage (5 MGD) will be treated in aeration lagoons located near the reservoir. A total of 1,040 acres (7.5 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

f. Sewage from all sources in Contra Costa County except 30 MGD which would be reused locally would be pumped to Site 42. The reservoir site selected was in Lone Tree Valley. The necessary capacity would be obtained by placing a dam across the entrance of the valley and building saddle dams along the ridge around the valley. The aeration lagoons would be located just north of the reservoir to treat the expected 259 MGD (290,000 acre-feet/year) of raw sewage. Plate 27 shows the site development configuration for this site. The land proposed for sludge application would amount to 9,100 acres. This land would not be used for wastewater application. In order to utilize the remaining area to the maximum degree possible, most potential croplands would be converted to a pasture cover which allows a higher application rate. Not all croplands would be converted to pasture as this would be too disruptive on existing agricultural practices. Even with the proposed vegetative cover changes, there is not sufficient capacity within the site to take all of the flow. The remaining wastewater (68,600 acre-feet/year) would be conveyed to site 43. A total of 25,000 acres would be used at this site for the land application of wastewater.

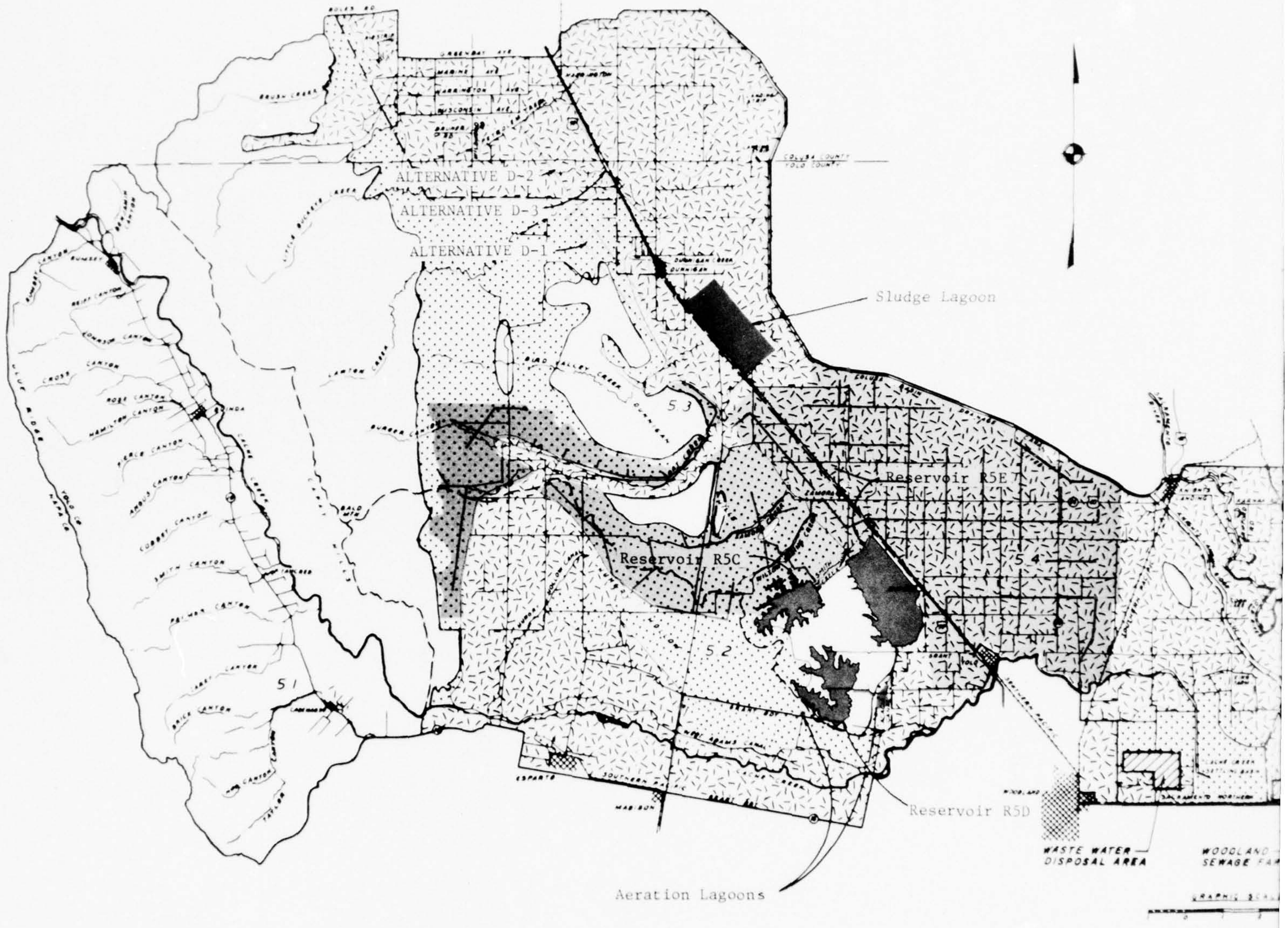


SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO-SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 5
ALTERNATIVES D-1, D-2 AND D-3

PLATE 23


COLUSA COUNTY
YOLO COUNTY
ALTERNATIVE D-2
ALTERNATIVE D-3
ALTERNATIVE D-1
Sludge Lagoon
53
Reservoir R5E
Reservoir R5C
54
52
51
Reservoir R5D
Aeration Lagoons
WOODLAND
SACRAMENTO NORTHERN
WASTE WATER DISPOSAL AREA
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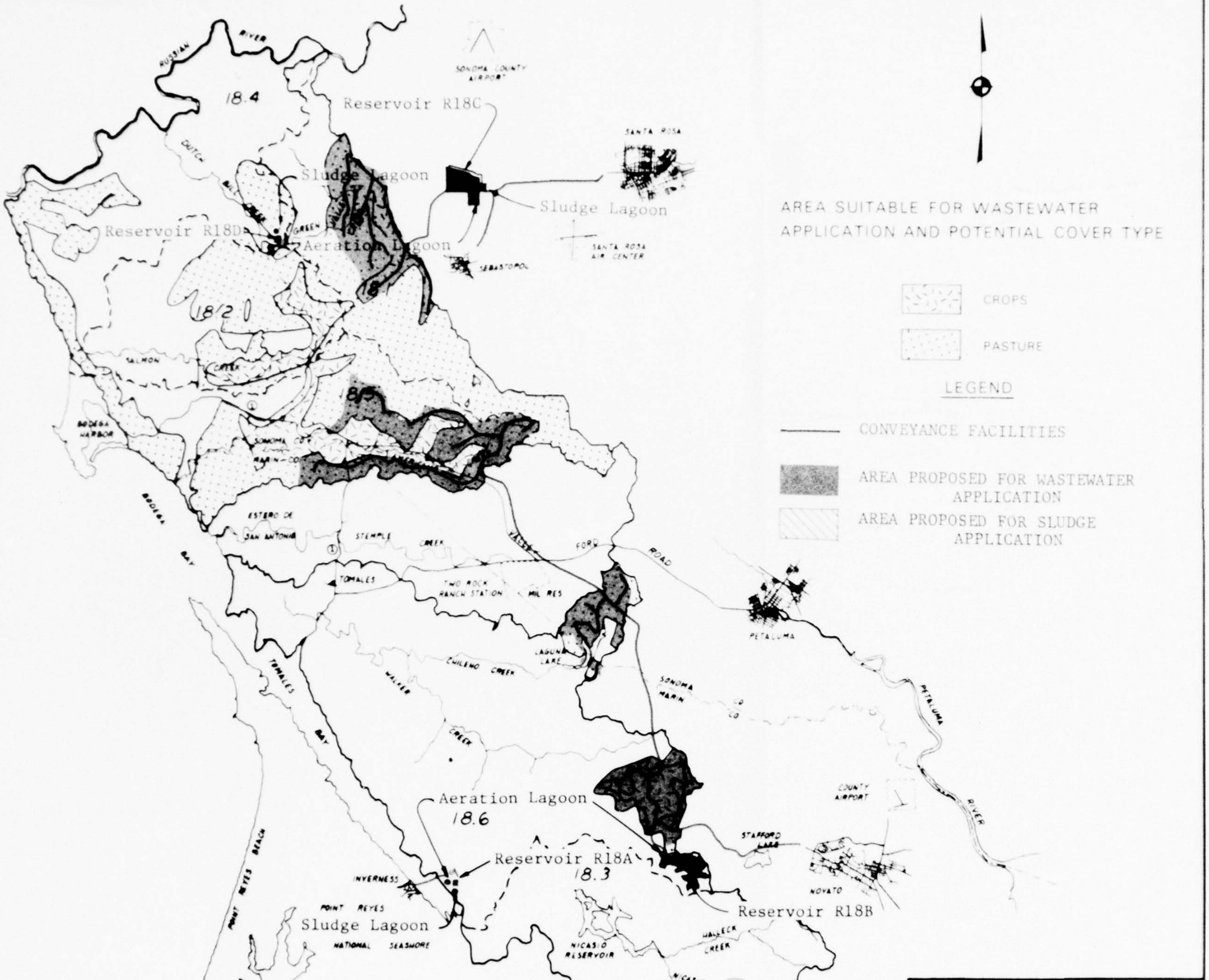
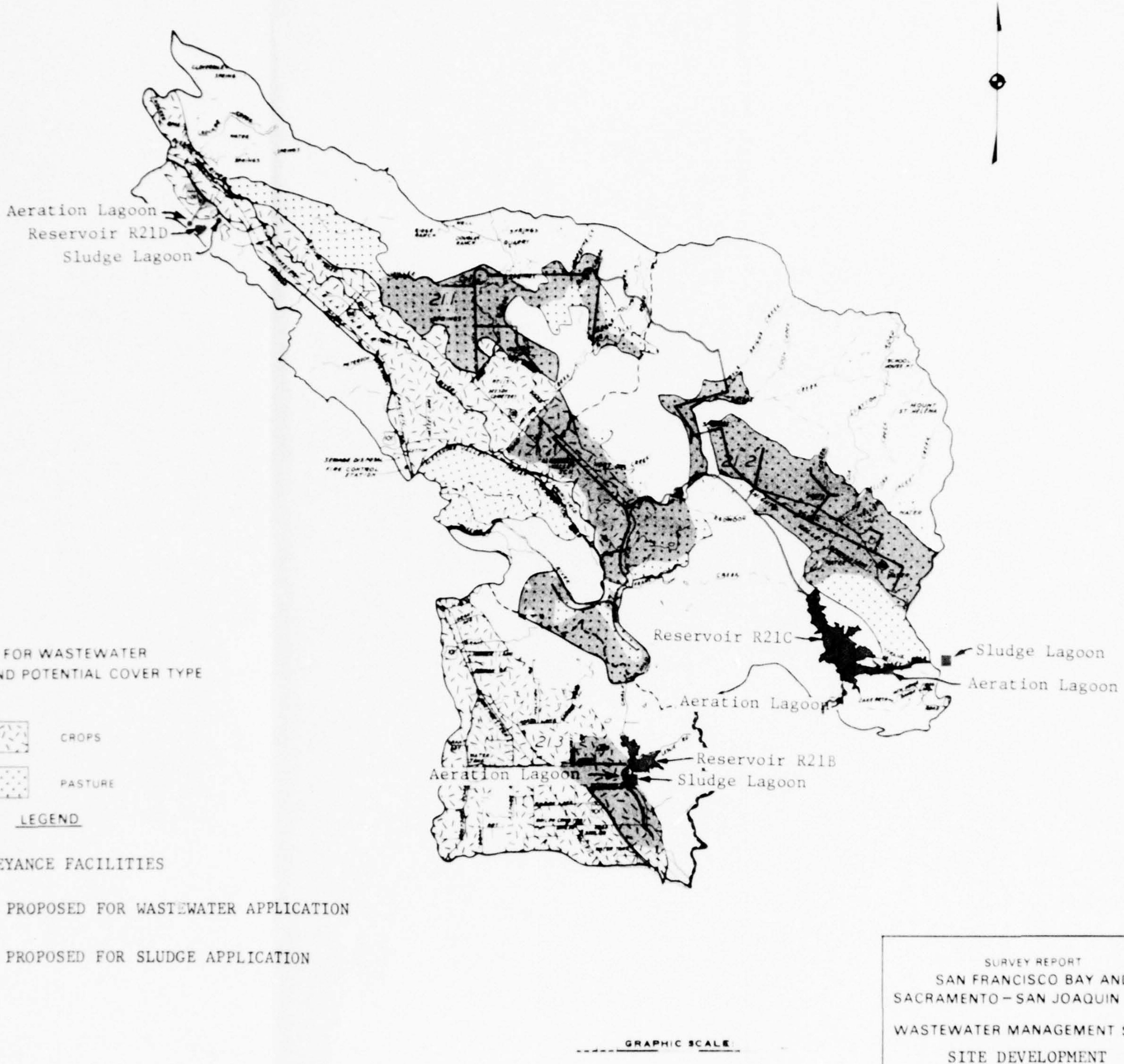


SURVEY REPORT

SAN FRANCISCO BAY AND
SACRAMENTO–SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 18



AREA SUITABLE FOR WASTEWATER
APPLICATION AND POTENTIAL COVER TYPE

▨ CROPS

░ PASTURE

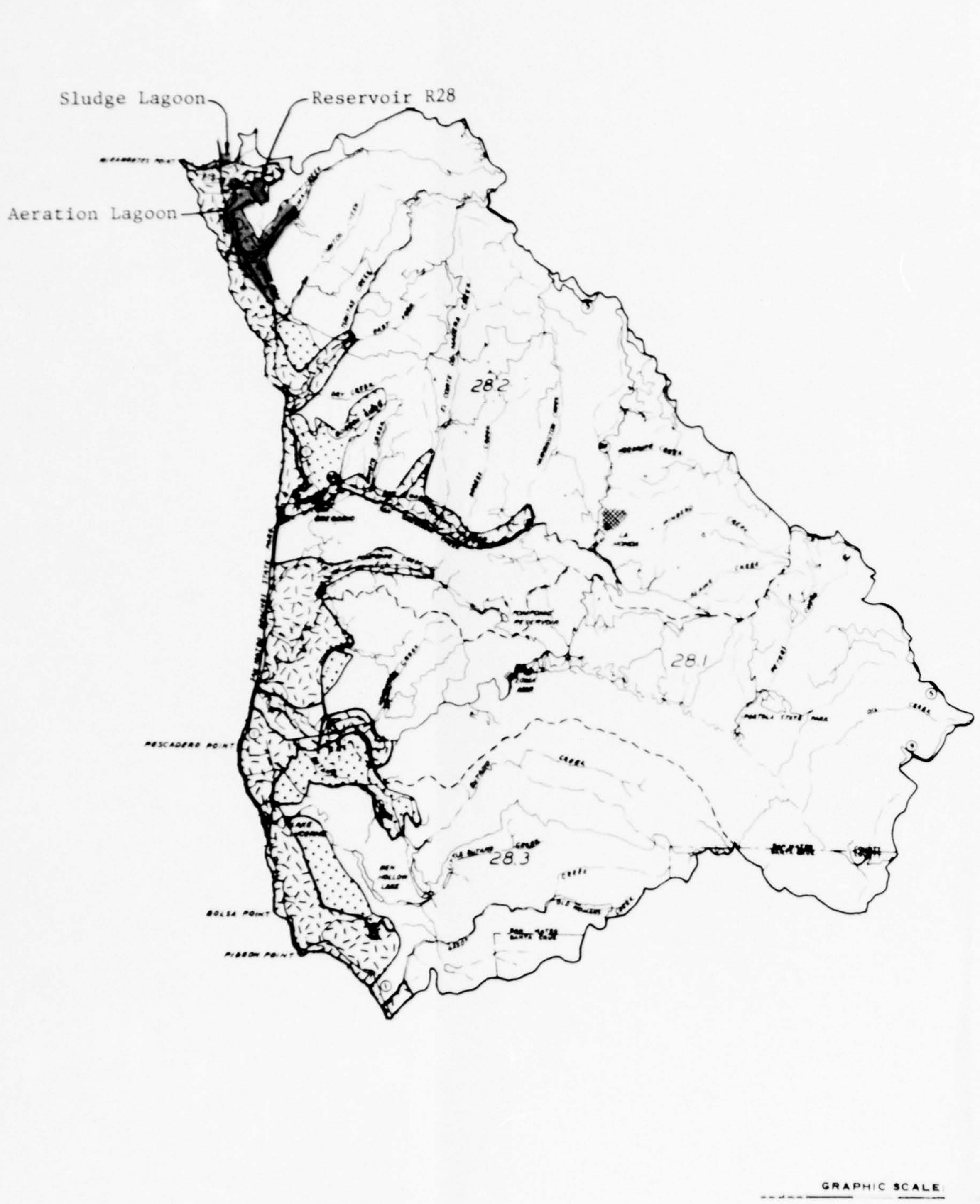
LEGEND

— CONVEYANCE FACILITIES

▓ AREA PROPOSED FOR WASTEWATER APPLICATION

▨ AREA PROPOSED FOR SLUDGE APPLICATION

SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
SITE DEVELOPMENT
SITE 21
ALTERNATIVES D-1, D-2 AND D-3



AREA SUITABLE FOR WASTEWATER APPLICATION AND POTENTIAL COVER TYPE

▨ CROPS

▨ PASTURE

LEGEND

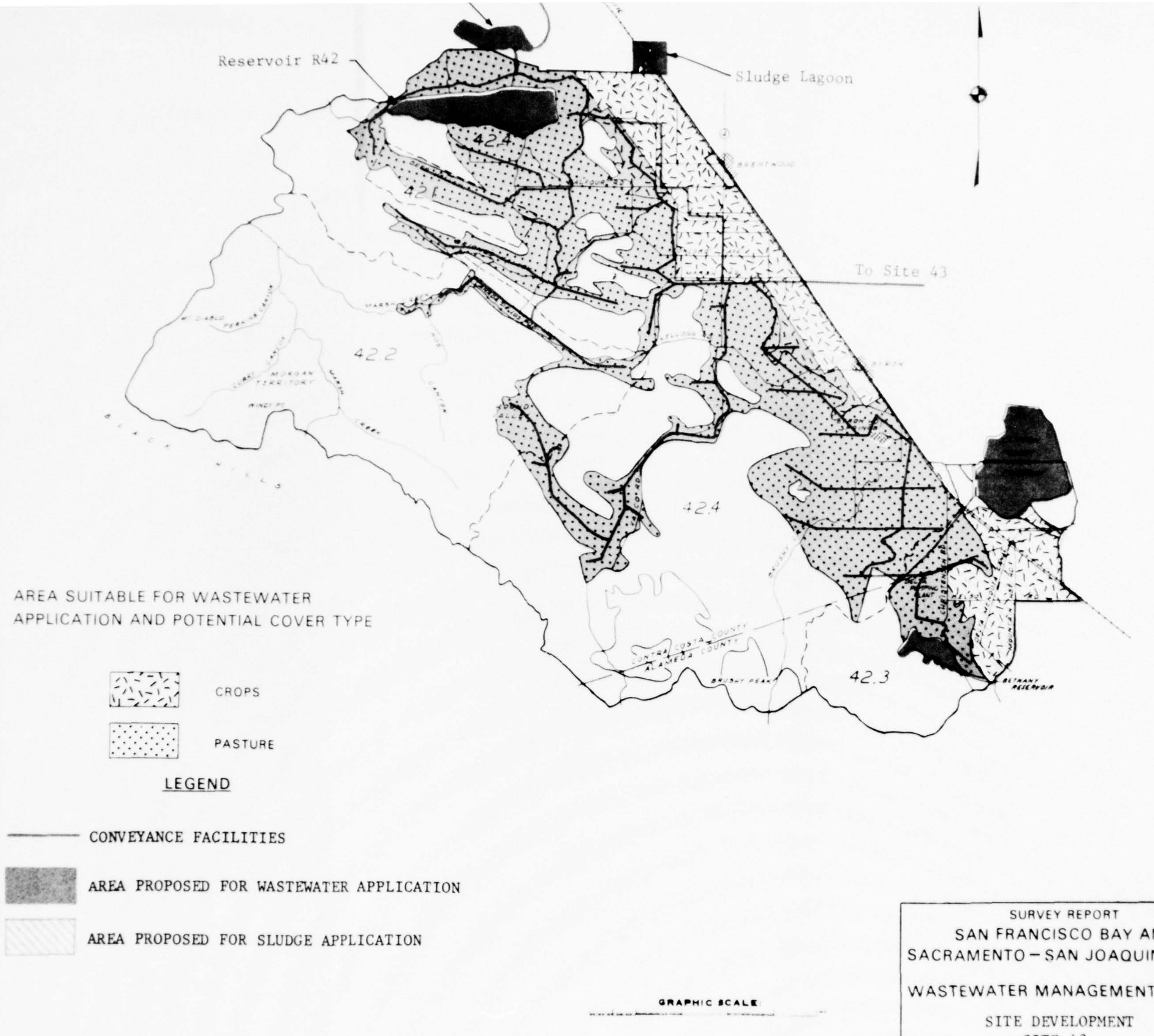
— CONVEYANCE FACILITIES

▨ AREA PROPOSED FOR WASTEWATER APPLICATION

▨ AREA PROPOSED FOR SLUDGE APPLICATION

SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY
SITE DEVELOPMENT
SITE 28
ALTERNATIVES D-1, D-2 AND D-3



SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 42
ALTERNATIVES D-1, D-2 AND D-3

PLATE 27

g. Sewage, approximately 115 MGD, from San Joaquin County as well as that from Galt in Sacramento County, would be pumped to one of two aeration lagoons at Site 43. Plate 28 shows the site development configuration. Almost the entire site would be utilized for wastewater application. The land areas in the southwestern portion of the site would be used for the wastewater pumped from Site 42. This area consists of cropland and a small portion of pastureland north of the Grant Line Canal and east of Tracy Road. A total of 47,800 acres (89 percent of the total suitable acreage) would be used at this site for the land application of wastewater and sludge.

190. Sludge lagoons would be located near the land treatment facilities in order to allow pumping of the digested sludge directly to the drying lagoons. Relatively flat areas are required for these lagoons to maintain the shallow depth required. The site development maps for this alternative (Plates 22 through 28) show the locations of the lagoons and application areas at each site.

191. Sludge System S-2 (see Plate 8) would be applicable to Alternative D-1. System S-2 is very similar to System S-1. The rail line from San Jose to San Francisco would be used for sludge generated along the west side of the bay, as well as for Gilroy-Morgan Hill sludge which would be trucked to San Jose. The East Bay concept, combining truck and rail, would terminate at Oakland. Sludge from water-oriented disposal facilities in San Mateo and San Francisco Counties would be transported to the San Francisco Southeast Plant. The barge would pick up sludge at San Francisco and Oakland and unload it near Sacramento, where it would be transported by rail and then truck to Site 5.

192. A Napa Valley rail line, starting at Napa and ending at Calistoga, would handle the sludge generated at Site 4. Sludge would be trucked from Site 4 to Napa and from Calistoga to Site 21. The Bolinas-Stinson Beach area would truck sludge directly to Site 18.

193. A truck would be used to convey sludge from the Contra Costa tertiary facility (CC05) to Site 42. The three small tertiary plants at Rio Vista, Isleton, and Walnut Grove would truck their sludge to Site 43.

194. All other wastewater sources would be conveying raw wastewater to land areas for aeration lagoon treatment where sludge would be removed from the sedimentation basins, digested, stored and trucked within the sites to the proposed sludge application areas.

195. Alternative D-2 - This alternative (see Plate 29) is a modification of Alternative D-1 using a lower degree of treatment for facilities discharging to surface water bodies. Alternative D-2 is no different than Alternative D-1 with respect to quantities of effluent conveyed to various water quality zones or land areas. A total of 681 MGD (47 percent of the year 2000 flow) would receive advanced treatment and 773 MGD (53 percent of the year 2000 flow) would be applied to the land. As in Alternative

AREA SUITABLE FOR WASTEWATER APPLICATION AND POTENTIAL COVER TYPE

▨ CROPS

▨ PASTURE

LEGEND

——— CONVEYANCE FACILITIES

■ AREA PROPOSED FOR WASTEWATER APPLICATION

▨ AREA PROPOSED FOR SLUDGE APPLICATION

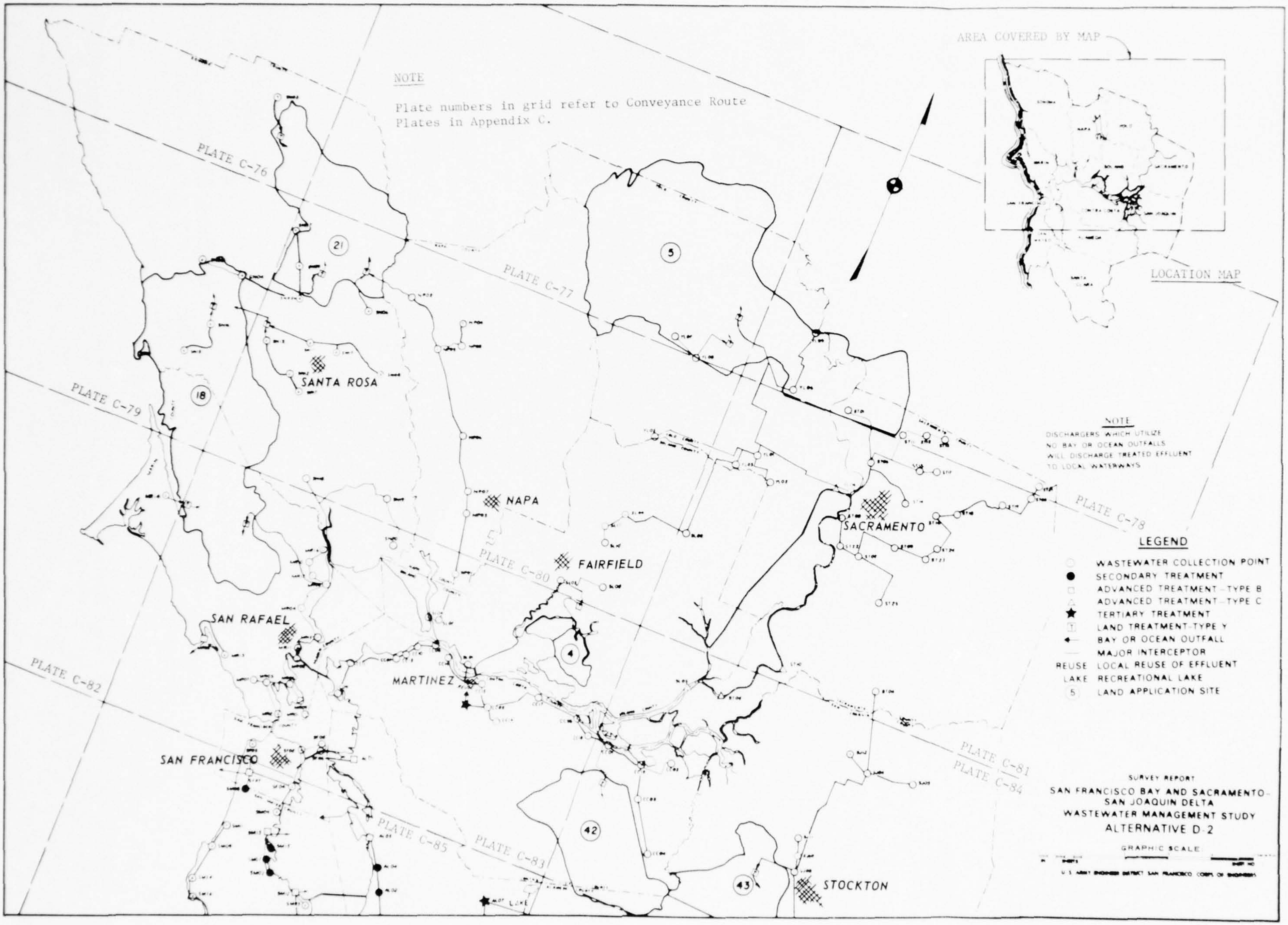
GRAPHIC SCALE

SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 43
ALTERNATIVES D-1, D-2 AND D-3

PLATE 28



NOTE

Plate numbers in grid refer to Conveyance Route Plates in Appendix C.

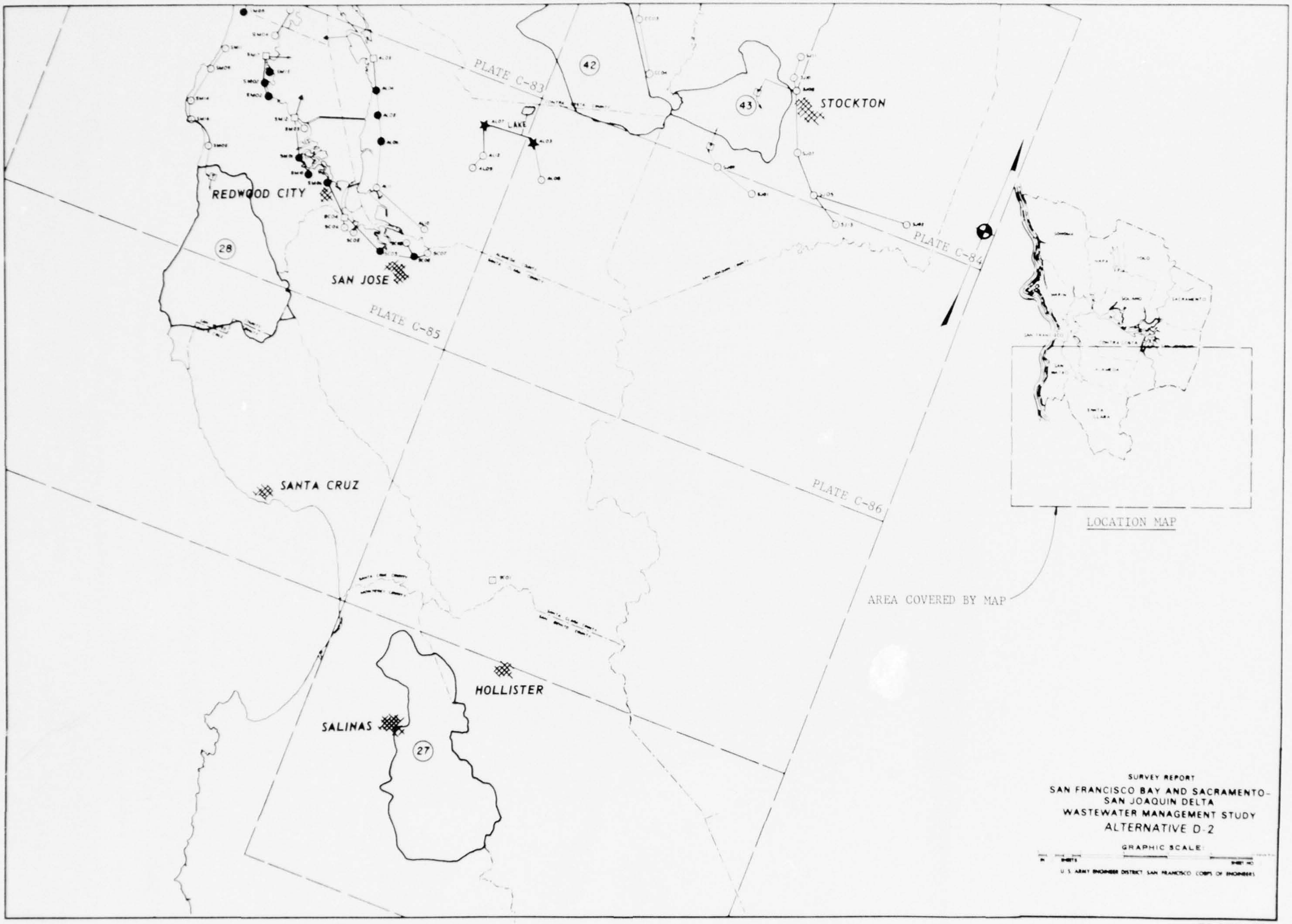
NOTE

DISCHARGERS WHICH UTILIZE NO BAY OR OCEAN OUTFALLS WILL DISCHARGE TREATED EFFLUENT TO LOCAL WATERWAYS

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE D-2

U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 29 A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE D-2

U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 29B

Delta, secondary treatment would be adequate for the three minor discharges. The wastewater constituents discharged to the various water quality zones are summarized in Table 25.

196. This alternative uses Sludge System S-2 as did Alternative D-1. The sludge lagoons for this alternative would be in the same physical location and have the same operation and maintenance considerations as those in Alternative D-1. Also, the sludge application areas would remain the same as in Alternative D-1. Smaller quantities of sludge would be produced as a result of the lower degree of treatment provided water-oriented discharges. Consequently, the land area required for sludge application would be reduced slightly. The sludge lagoon sites and application areas are shown in Plates 22 through 28. Total land requirements in the vicinity of the seven landsites are about 212,000 acres.

197. Alternative D-3 - This alternative (see Plate 30) is another variation of Alternative D-1. The wastewater from San Jose, Milpitas, and Alviso (178 MGD) would be pumped to the Gilroy-Morgan Hill area (9 MGD) were raw sewage would be treated in aeration lagoons. This wastewater would then be conveyed to Site 27. Except for the use of Site 27 (with corresponding higher waste flows to land and local sludge application) this alternative is similar to Alternative D-1. Quantities of wastewater discharged to the ocean would be reduced from 129 to 120 MGD and to South Bay from 550 MGD to 372 MGD as compared to Alternative D-1. A total of 494 MGD (34 percent of the year 2000 flow) would receive tertiary treatment and 960 MGD (66 percent of the year 2000 flow) would be applied to the land. The wastewater constituents discharged to the various water quality zones are summarized in Table 26.

198. Plate 31 shows the location of the reservoirs, the land application areas, the main distribution pipelines and other site development features for Site 27. As with the other sites, the land nearest the reservoirs would be most economical to irrigate. The same land areas would be irrigated with wastewater under this alternative as were in Alternative B-3. A total of 43,800 acres (76 percent of the total suitable acreage) would be used in this site for the land application of wastewater and sludge.

199. The sludge transportation, treatment, and application systems for this alternative would be similar to those of Alternative D-1 except for the addition of Site 27. Sludge to be applied in this area would be stored in sludge lagoons located near the aeration lagoons. The sludge would be placed along Gabilan Creek and north of Camp McCallum.

200. Sludge System S-3 (see Plate 8) is for Alternative D-3 and is identical to System S-2 with two configuration exceptions. The rail line from San Jose to Sunnyvale would not be utilized and Morgan Hill-Gilroy would not truck its sludge to San Jose. Also, site quantities differ.

TABLE 25

WASTEWATER CONSTITUENT DISCHARGE SUMMARY

Alternative D-2

(Discharge to Surface Waters)

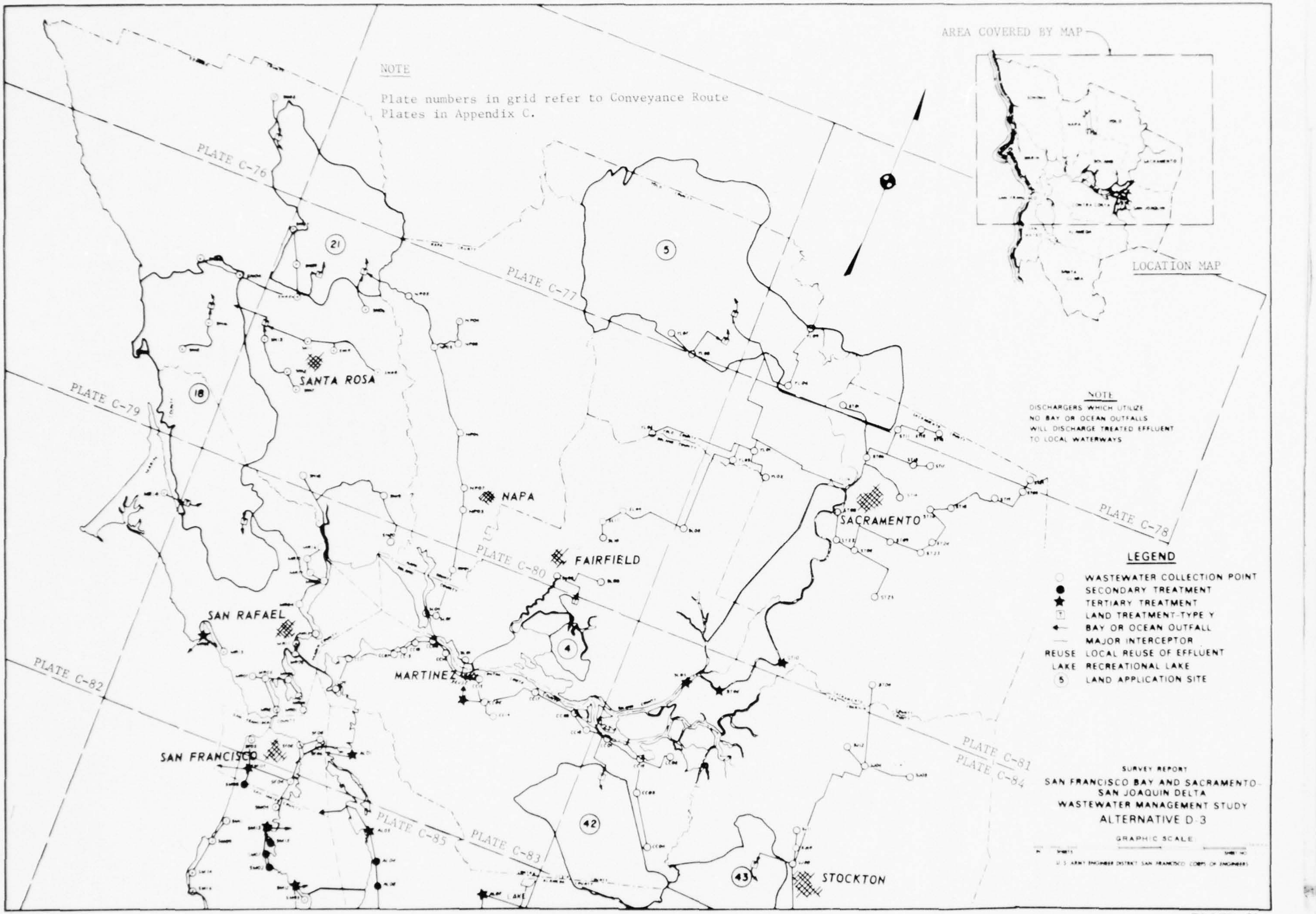
	Base Condition					Alternative D-2				
LOCATION	FLOW	BOD	TN	TP	GHM	FLOW	BOD	TN	TP	GHM
PACIFIC OCEAN	115	57.6	13.8	3.8	1.9	129	7.7	8.1	1.3	0.8
SOUTH SF BAY	372	58.6	31.1	22.7	9.9	550	30.0	27.9	6.1	3.2
CENTRAL SF BAY	130	24.9	12.5	7.5	3.3	0	0	0	0	0
CARQUINEZ STRAIT - SUISUN BAY	107	16.9	10.1	6.5	2.9	0	0	0	0	0
DELTA	207	27.0	14.7	9.7	4.3	2	0.3	0.2	0.1	*
TOTAL	931	185.0	82.2	50.2	22.3	681	38.0	36.2	7.5	4.0

NOTES:

Flow reported in MGD.

Constituents reported in 1,000 lbs/day.

* Constituent is less than 50 lbs/day.



NOTE

Plate numbers in grid refer to Conveyance Route Plates in Appendix C.

NOTE

DISCHARGERS WHICH UTILIZE NO BAY OR OCEAN OUTFALLS WILL DISCHARGE TREATED EFFLUENT TO LOCAL WATERWAYS

LEGEND

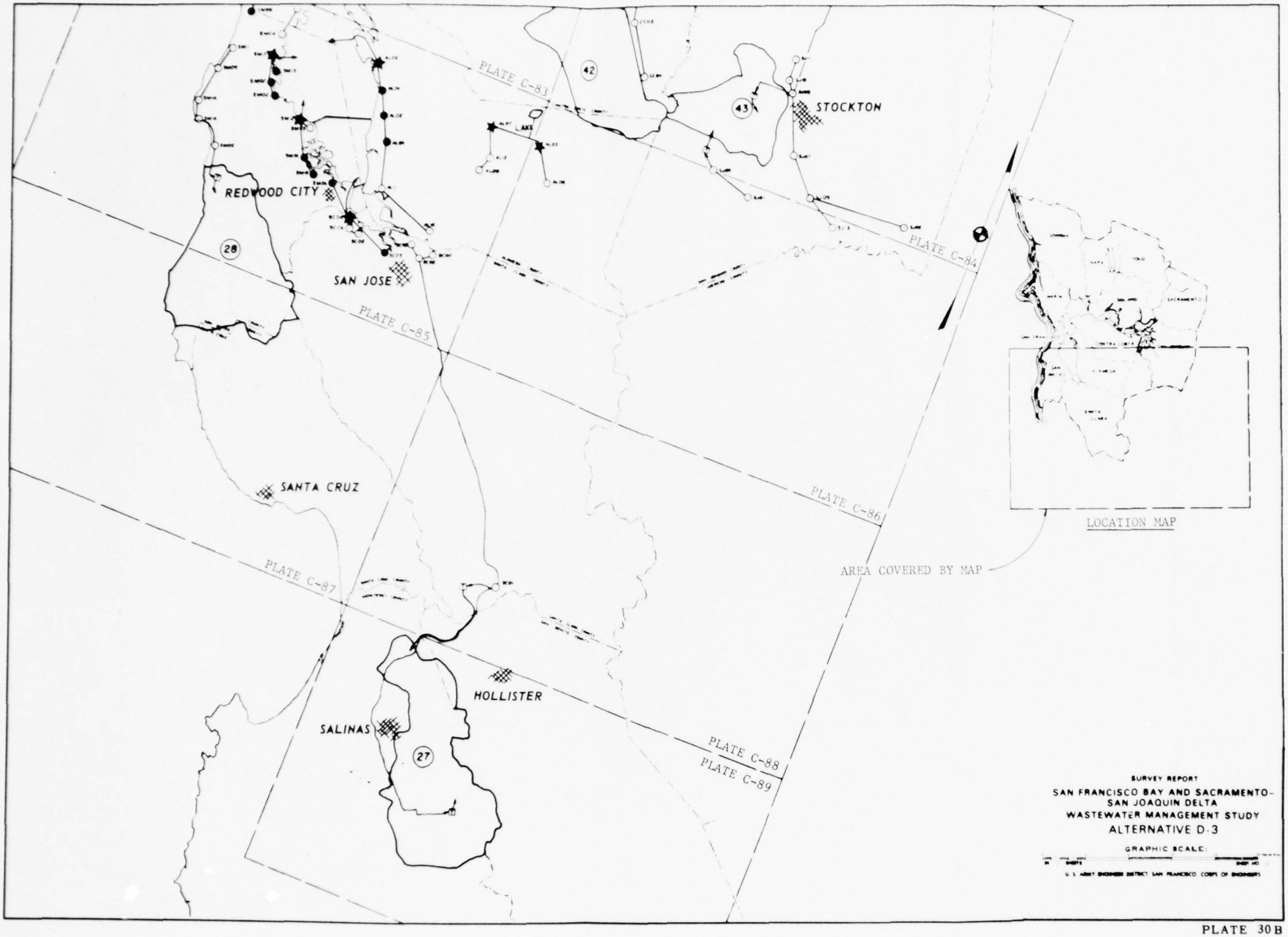
○	WASTEWATER COLLECTION POINT
●	SECONDARY TREATMENT
★	TERTIARY TREATMENT
T	LAND TREATMENT-TYPE Y
←	BAY OR OCEAN OUTFALL
—	MAJOR INTERCEPTOR
REUSE	LOCAL REUSE OF EFFLUENT
LAKE	RECREATIONAL LAKE
(5)	LAND APPLICATION SITE

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE D-3

GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 30 A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE D-3

U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 30B

TABLE 26

WASTEWATER CONSTITUENT DISCHARGE SUMMARY

Alternative D-3

(Discharge to Surface Waters)

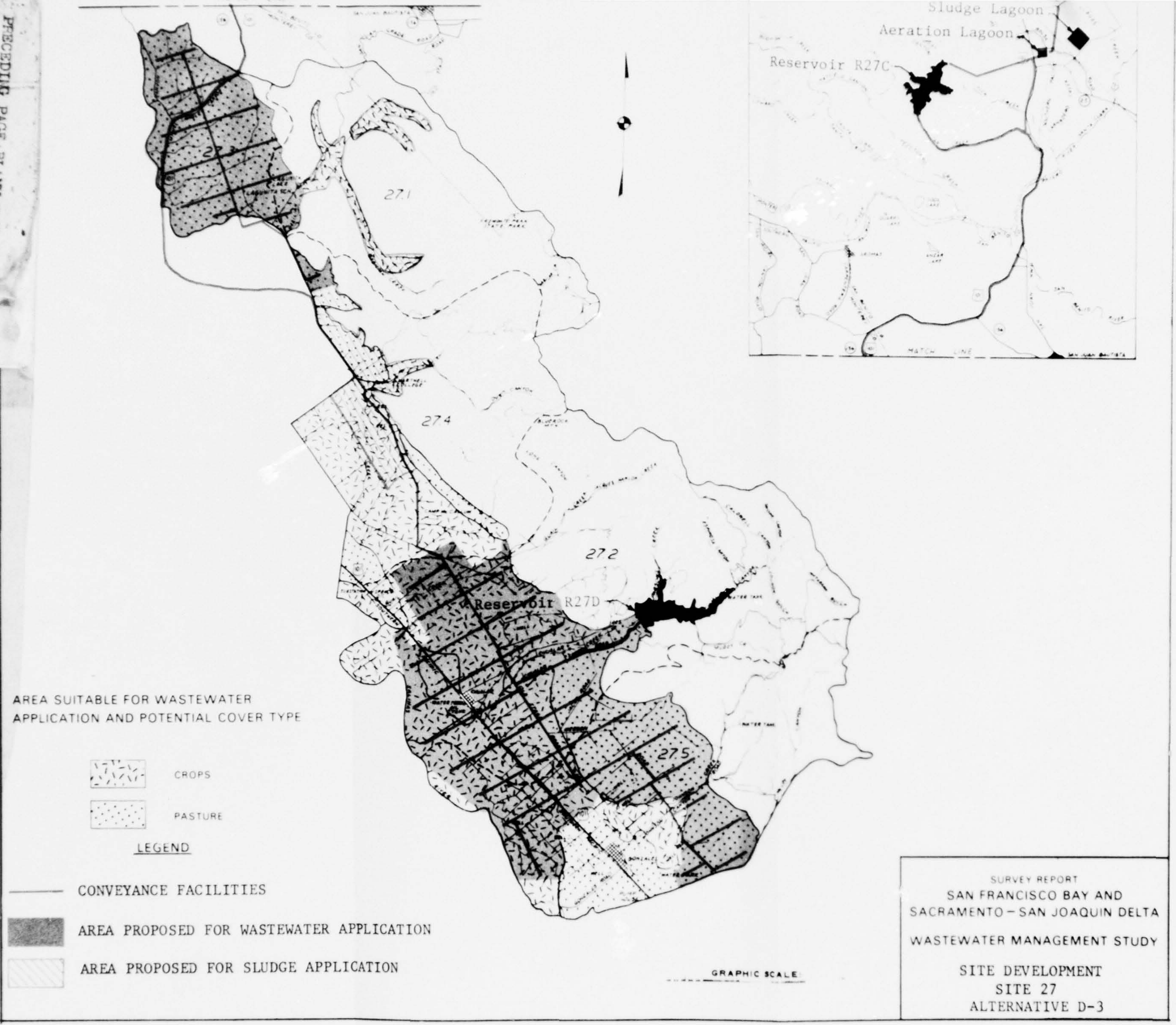
	Base Condition					Alternative D-3				
LOCATION	FLOW	BOD	TN	TP	GHM	FLOW	BOD	TN	TP	GHM
PACIFIC OCEAN	115	57.6	13.8	3.8	1.9	120	1.9	0.6	0.1	0.5
SOUTH SF BAY	372	58.6	31.1	22.7	9.9	372	4.5	1.6	0.3	1.6
CENTRAL SF BAY	130	24.9	12.5	7.5	3.3	0	0	0	0	0
CARQUINEZ STRAIT - SUISUN BAY	107	16.9	10.1	6.5	2.9	0	0	0	0	0
DELTA	207	27.0	14.7	9.7	4.3	2	*	*	*	*
TOTAL	931	185.0	82.2	50.2	22.3	494	6.4	2.2	0.4	2.1

NOTES:

Flow reported in MGD.

Constituents reported in 1,000 lbs/day.

* Constituent is less than 50 lbs/day.



SURVEY REPORT
SAN FRANCISCO BAY AND
SACRAMENTO – SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY

SITE DEVELOPMENT
SITE 27
ALTERNATIVE D-3

PLATE 31

These changes are due to the D-3 alternative in which the raw wastewaters from San Jose and Morgan Hill-Gilroy are conveyed to Site 27 for treatment and land application.

201. Tertiary Treatment System - This system (see Plate 32) uses a full tertiary- level treatment for all discharges. It was developed chiefly to provide a cost comparison to the other systems and to depict how the sludge from such a system could be ultimately disposed of by land application. In the South Bay, 550 MGD would be discharged from 6 tertiary facilities. Approximately 165 MGD (from 12 facilities) would be discharged to the ocean. This includes San Francisco, the San Mateo Coastal communities, Bolinas-Stinson Beach-Inverness the inland discharges in Sonoma County in the Russian River Basin, and the Morgan Hill-Gilroy area which discharges to the ocean via the Pajaro River. Central Bay would receive 271 MGD (from 5 facilities) from Treasure Island, western Contra Costa County, northern Marin and southern Sonoma Counties, central Marin County and Napa Valley. About 147 MGD would be discharged into Carquinez Strait from central and eastern Contra Costa County and from most of Solano County. Additionally two discharges, Esparto and Winters, were summed in this zone. There would be 7 discharges to the Delta totalling 321 MGD; Woodland, Sacramento Region, Stockton area, southern San Joaquin County, and the three small discharges at Rio Vista, Isleton and Walnut Grove. Local reuse facilities in Livermore Valley and Contra Costa County account for 42 MGD.

202. Under this system, no land sites would be required for the application of wastewater. The wastewater constituents discharged to the various water quality zones are summarized in Table 27. This system uses a total of 47,000 acres (10 percent of the total suitable land) for the land application of sludge at five sites.

203. All sludge produced at the tertiary treatment facilities would be transported to land application sites for final disposal. Land application sites used would contain sludge lagoons and an application area for the disposal of the sludge. The use of each site with this system is as follows:

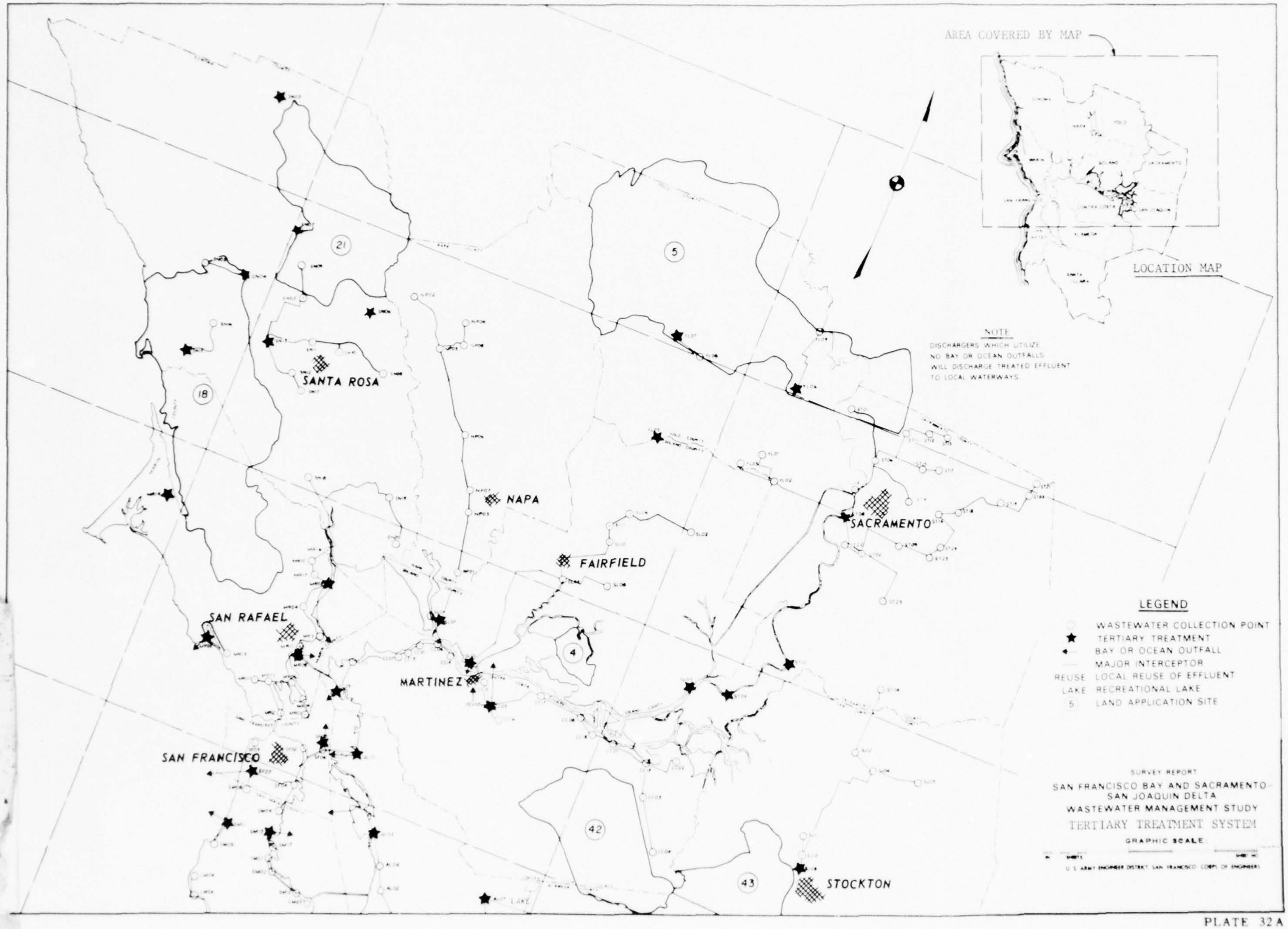
a. Site 4 - Not used.

b. Site 5 - About 40,000 acres would be used in the same general area that sludge was applied in the B-Series and D-Series alternatives.

c. Site 18 - Only a small portion of the suitable land would be utilized; about 2,600 acres along Americano Creek in the northern portion of the land site.

d. Site 21 - Only a small portion of land (150 acres) in the southwestern portion of the land site would be used.

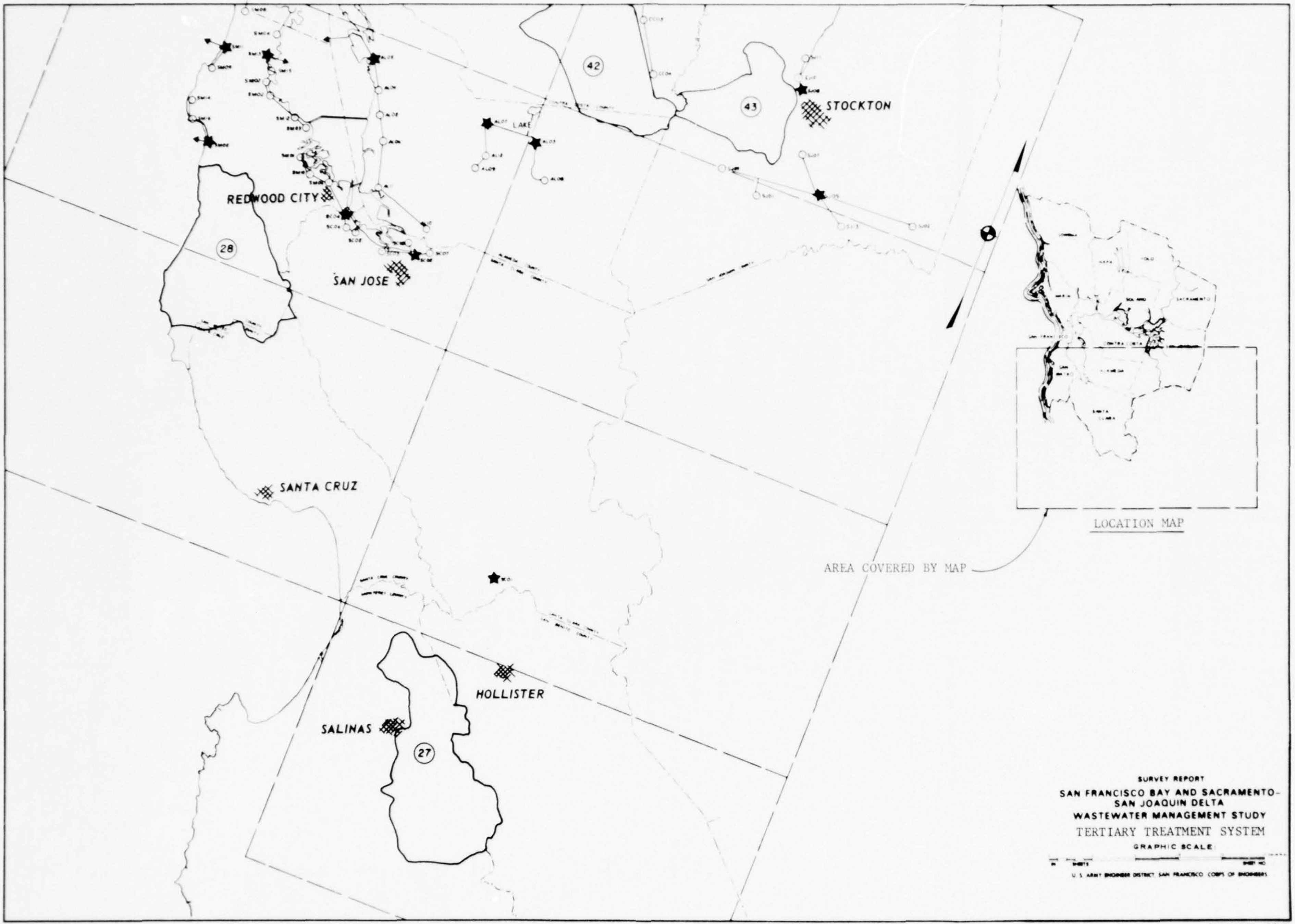
e. Site 27 - Not used.



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
TERTIARY TREATMENT SYSTEM

U S ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 32 A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
TERTIARY TREATMENT SYSTEM

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 32B

TABLE 27

WASTEWATER CONSTITUENT DISCHARGE SUMMARY
Tertiary Treatment System
(Discharge to Surface Waters)

	Base Condition					Tertiary Treament System				
LOCATION	FLOW	BOD	TN	TP	GHM	FLOW	BOD	TN	TP	GHM
PACIFIC OCEAN	115	57.6	13.8	3.8	1.9	165	2.7	0.8	0.1	0.7
SOUTH SF BAY	372	58.6	31.1	22.7	9.9	550	9.1	2.6	0.5	2.4
CENTRAL SF BAY	130	24.9	12.5	7.5	3.3	271	4.5	1.3	0.2	1.2
CARQUINEZ STRAIT - SUISUN BAY	107	16.9	10.1	6.5	2.9	147	2.9	0.9	0.2	0.8
DELTA	207	27.0	14.7	9.7	4.3	321	5.3	1.6	0.3	1.4
TOTAL	931	185.0	82.0	50.2	22.3	1,454	24.5	7.2	1.3	6.5

NOTES:

Flow reported in MGD.

Constituents reported in 1,000 lbs/day.

f. Site 28 - Only a small portion of the land near Miramontes Point would be required.

g. Site 42 - Not used.

h. Site 43 - Sludge would be applied to 3,600 acres in the south central portion of Union Island which consists mainly of pastureland.

204. Detailed development schemes to be used for these landsites are shown on Plates C-98 through C-102 in Appendix C.

205. Sludge System S-4 (see Plate 9) was developed for the tertiary treatment system. Sludge from the Half Moon Bay facility in San Mateo County would be trucked to Site 28. The rail line from San Jose to San Francisco would be used for the west side Bay dischargers. Morgan Hill-Gilroy would truck sludge to San Jose. Livermore Valley would truck its sludge to San Leandro where a rail line would start, terminating at Richmond, picking up sludge from Oakland. Sludge from Vallejo, Central Contra Costa County, and Benicia would be trucked to a rail line along the north Contra Costa shore, also terminating at Richmond. North San Mateo County would truck its sludge to San Francisco and the Lake Merced facility would pipe its sludge to the barge facility at the Southeast Plant. A barge system would transport sludge from San Francisco and Richmond to the Sacramento unloading facility where it would go to Site 5 by pipeline. A rail line in Marin County would pick up sludge from Hamilton Air Force Base and terminate at Sebastopol where the sludge would be trucked into Site 18. Sludge from small communities in Marin and Sonoma would be trucked directly to Sites 18 and 21. Sludge from the two San Joaquin facilities and the three small dischargers at Rio Vista, Isleton, and Walnut Grove would be trucked to Site 43. Sluuge generated at the facilities in Yolo and Sacramento Counties would be trucked or railed into Site 5.

WASTEWATER RECLAMATION OPPORTUNITIES

Introduction

206. In the living filter concept, secondary treated wastewaters would be applied to land areas as irrigation water. This, in itself, constitutes a reuse of wastewaters. During the initial wastewater application phase, all the water that percolates below the vegetative root zone will reach the groundwater table. Additional reuse potential also exists since some of the applied water would be recollected in underdrain systems and would be available for additional reuse once the groundwater table has been built up. It should be noted, however, that basically only the cropped land areas would be underdrained and, except for certain portions of Sites 42 and 43 in the D-Series of alternatives, pasture areas would not be underdrained. Cropped lands are generally flat and can be easily underdrained. Pasturelands are generally rolling terrain which cannot be underdrained without excessive cost.

207. As previously stated, the water collected in underdrains would be available for further reuse opportunities. The word "further" should be emphasized since the treated wastewaters have already undergone one reuse as irrigation water on the land areas. At the same time water is being used by the plants, constituents are being removed by the soil-plant system. In this sense the living filter is a unique treatment unit since wastewater is being renovated at the same time it is being reused. Table 28 shows the quantities of water expected to be recollected in the underdrains for reuse at the year 2000 level of development. These quantities are based on the assumptions that the groundwater table has been built up to the level of the underdrains and that the underdrains are 90 percent efficient. Recollected waters would be available for a variety of beneficial purposes such as flow augmentation, agricultural irrigation, recreational lakes, industrial cooling, and groundwater recharge as shown on the sketch on page 123.

208. Recollected water could be used not only to meet future local deficiencies but could also serve as a local substitute water source (for example, irrigation) allowing localities either to decrease their requirements for present supplies or use existing water supplies for other purposes.

209. By the year 2000 other potential opportunities, not considered in detail today, could become desirable. An example of this is the current interest in artificial recreational lakes created from reclaimed wastewater. Thirty years ago the demand for this reuse opportunity was virtually non-existent. Similarly, in twenty or thirty years time the demand for water supplies could easily encompass concepts totally unknown to planners today.

Quality Considerations

210. Quality considerations at the landsites for both applied wastewater and water percolating below the root zone are shown in Table 29. Quality levels for applied wastewater represent an average of aerated lagoon and activated sludge effluents with additional constituent removal as a result of storage in the wastewater holding reservoirs.

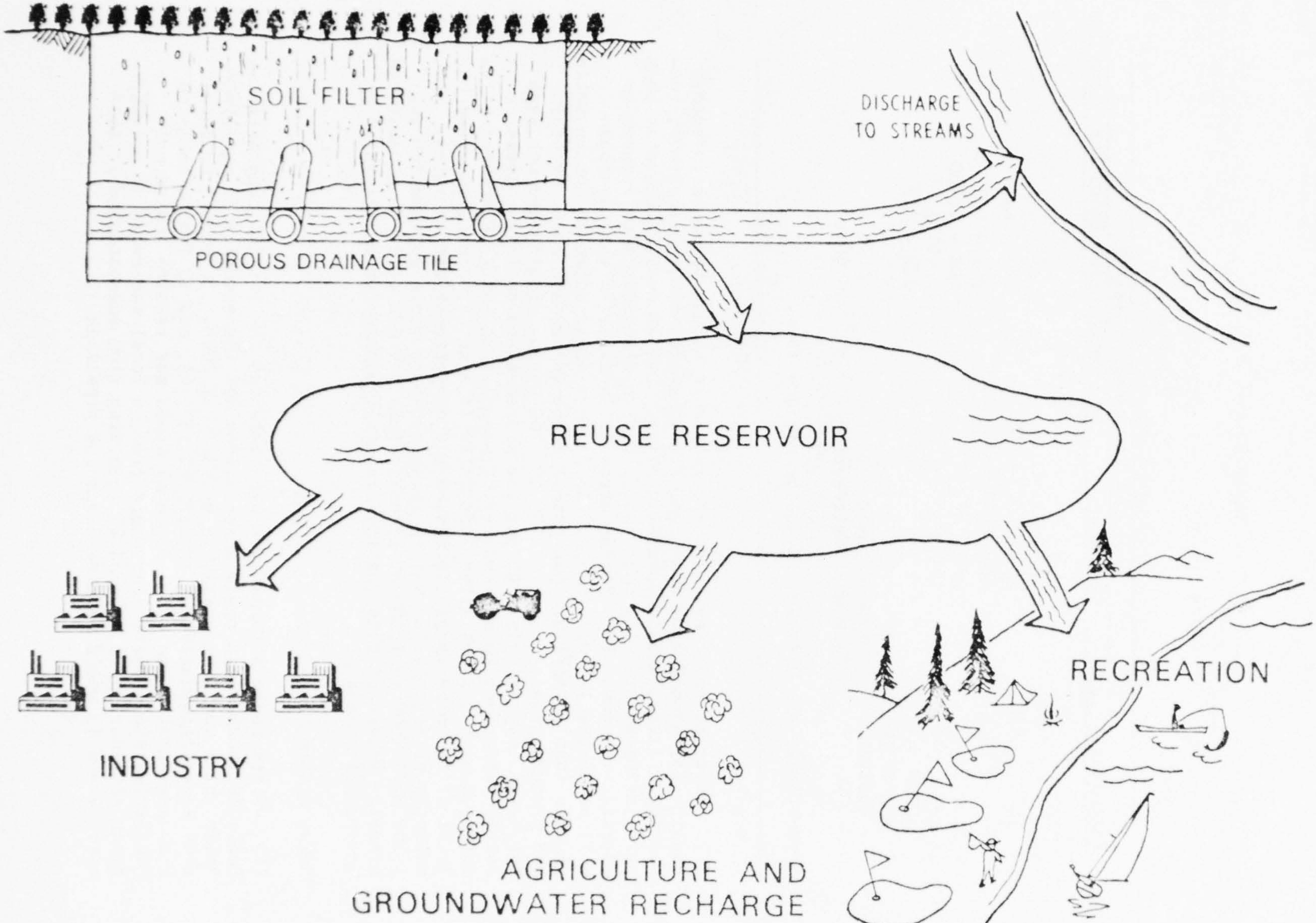
211. Secondary-level wastewater effluent applied to crop and pasturelands would be satisfactory for normal irrigation purposes except for use on truck crops which could be eaten raw. As discussed later, additional measures are available (at additional cost) to avoid this exception.

TABLE 28

EXPECTED VOLUME OF RECOLLECTED WATER AVAILABLE FOR REUSE

YEAR 2000 - ACRE-FEET PER YEAR

Land Area	Alternative					
	B-1	B-2	B-3	D-1	D-2	D-3
4	8,000	8,000	8,000	8,000	8,000	8,000
5	69,000	69,000	69,000	69,000	69,000	69,000
18	9,700	9,700	9,700	9,700	9,700	9,700
21	6,900	6,900	6,900	16,500	16,500	16,500
27	0	0	19,700	0	0	19,700
28	0	0	0	0	0	0
42	22,200	22,200	22,200	37,300	37,300	37,300
43	10,000	10,000	10,000	91,300	91,300	91,300
TOTAL	125,800	125,800	145,500	231,800	231,800	251,500



REUSE ALTERNATIVES

Parameter	Quality of Water (mg/1) Applied	 Percolating Below Root Zone
BOD	20	1 - 2
TSS	20	1 - 2
TN	17	1 - 9*
TP	8	0.1 - 0.2
TDS	550	600 - 1,100
GHM	1	<0.01
BORON	0.3 - 1.0	0.2 - 0.7
BACTERIO-LOGICAL	Depends on Crop Type and Disinfection	NONE

*Essentially all nitrogen is in the nitrate form.

212. Water percolating below the root zone should be of satisfactory quality for groundwater recharge, flow augmentation, agriculture, recreational lakes, and industrial cooling. System design indicates that percolating waters will meet public health standards with respect to nitrate nitrogen. For cropped areas it is expected that nitrogen will be in the 1-3 mg/1 range. In pasture areas nitrogen concentrations of less than 10 mg/1 are expected. These values are based on crops and pasture grasses removing 150 and 200 pounds of nitrogen per acre per year, respectively. Except for nitrogen and salinity, there is little difference in the quality of percolating water at cropped sites compared with pasture sites. Salinity is site dependent, governed by local differences in precipitation and evapotranspiration rates. The salinity of percolating waters is expected to range between 600 and 1,100 mg/1 (600 to 1,100 at cropped sites and 800 to 1,100 at pastured sites). Waters of this quality are still usable for a variety of beneficial purposes.

Reuse Alternatives

213. Fifty reuse alternatives were selected for initial consideration. Table 30 shows these reuse alternatives and the quantity of reclaimed water which would be available by the year 2000. It should be noted that Reuse Alternatives 2, 8, 17, 25, 37, 41, and 43 (which envision flow augmentation to local streams) would not require additional facilities since wastewater could flow to local waterways by gravity. Reuse Alternatives 1, 45 and 47 involving flow augmentation at land sites 4 and 43 would require pumps and pipelines.

TABLE 30

WASTEWATER MANAGEMENT
REUSE ALTERNATIVES

Reuse Alt. No.	Land Site & Alt.1/	Description of Reuse Alternative	Recollection Quantity-Year 2000 Acre Feet/Year
1 *	4BD	Flow Augmentation to Suisun Marsh	8,000
2 *	5BD	Flow Augmentation to Sacramento River	69,000
3	5BD	Flow Augmentation to Sacramento River	69,000
4	5BD	Flow Augmentation to Suisun Marsh	69,000
5	5BD	Flow Augmentation to Suisun Marsh	69,000
6 *	5BD	Industrial Cooling at Site 5	69,000
7 *	5BD	Irrigation - Northern Portion of Area 5	69,000
8 *	18BD	Flow Augmentation to Local Stream	9,700
9 *	18BD	Flow Augmentation to Petaluma River	9,700
10	18BD	Flow Augmentation to Petaluma River	9,700
11	18BD	Irrigation in Petaluma Valley	9,700
12	18BD	Irrigation in Sonoma Valley	9,700
13	18BD	Irrigation in Northern Marin	9,700
14	18BD	Recreation at Chileno Lake	9,700
15	18BD	Recreation at Tolay Lake	9,700
16 *	18BD	Recreation at Chileno Lake	9,700
17 *	21B	Flow Augmentation to Local Stream	6,900
18 *	21B	Flow Augmentation to Napa River	6,900
19	21B	Flow Augmentation to Napa River	6,900
20	21B	Irrigation in Petaluma Valley	6,900

TABLE 30 (Cont'd)

Reuse Alt. No.	Land Site & Alt.[1/]	Description of Reuse Alternative	Recollection Quantity-Year 2000 Acre Feet/Year
21	21B	Irrigation in Sonoma Valley	6,900
22	21B	Irrigation in Southern Napa Valley	6,900
23	21B	Recreation at Chileno Lake	6,900
24	21B	Recreation at Tolay Lake	6,900
25 *	21D	Flow Augmentation to Local Stream	16,500
26 *	21D	Flow Augmentation to Napa River	16,500
27	21D	Flow Augmentation to Napa River	16,500
28	21D	Irrigation in Petaluma Valley	16,500
29	21D	Irrigation in Sonoma Valley	16,500
30	21D	Irrigation in Southern Napa Valley	16,500
31	21D	Recreation at Chileno Lake	16,500
32	21D	Recreation at Tolay Lake	16,500
33 *	18 & 21B	Irrigation in Petaluma Valley	16,600
34	18 & 21B	Recreation at Chileno Lake	16,600
35 *	18 & 21D	Irrigation in Petaluma Valley	26,200
36	18 & 21D	Recreation at Chileno Lake	26,200
37 *	27	Flow Augmentation to Local Stream	19,700
38	27	Flow Augmentation to Salinas River	19,700
39 *	27	Irrigation at Castroville	19,700
40 *	27	Groundwater Recharge - Eastside Area	19,700
41 *	42B	Flow Augmentation to Local Stream	22,200

TABLE 30 (Cont'd)

Reuse Alt. No.	Land Site & Alt.1/	Description of Reuse Alternative	Recollection Quantity-Year 2000 Acre Feet/Year
42 *	42B	Industrial Cooling at Antioch	22,200
43 *	42D	Flow Augmentation to Local Stream	37,300
44 *	42D	Industrial Cooling at Antioch	37,300
45 *	43B	Flow Augmentation to Local Stream	10,000
46	43B	Industrial Cooling at Antioch	10,000
47 *	43D	Flow Augmentation to Local Stream	91,300
48 *	43D	Industrial Cooling at Antioch	91,300
49 *	42 & 43B	Industrial Cooling at Antioch	32,200
50 *	42 & 43D	Industrial Cooling at Antioch	128,600

1/ "B" refers to Alternatives B-1, B-2, and B-3. "D" refers to Alternatives D-1, D-2, and D-3 except for Area 27 which is in Alternative B-3 and D-3 only.

* Selected for additional study.

214. Following preliminary screening, twenty-five of the reuse alternatives (as indicated on Table 30) were selected for further study. Those twenty-five reuse alternatives selected for additional study are delineated on Plate 33 and are described as follows:

a. Reuse Alternative 1 - This alternative involves collecting the water from the subdrains at Site 4 and pumping it into Suisun Marsh for flow augmentation.

b. Reuse Alternatives 2, 8, 17, 25, 37, 41, and 43 - These alternatives involve flow augmentation to local streams and therefore have no additional pumps or pipelines. Since no new facilities are required, no additional cost is involved.

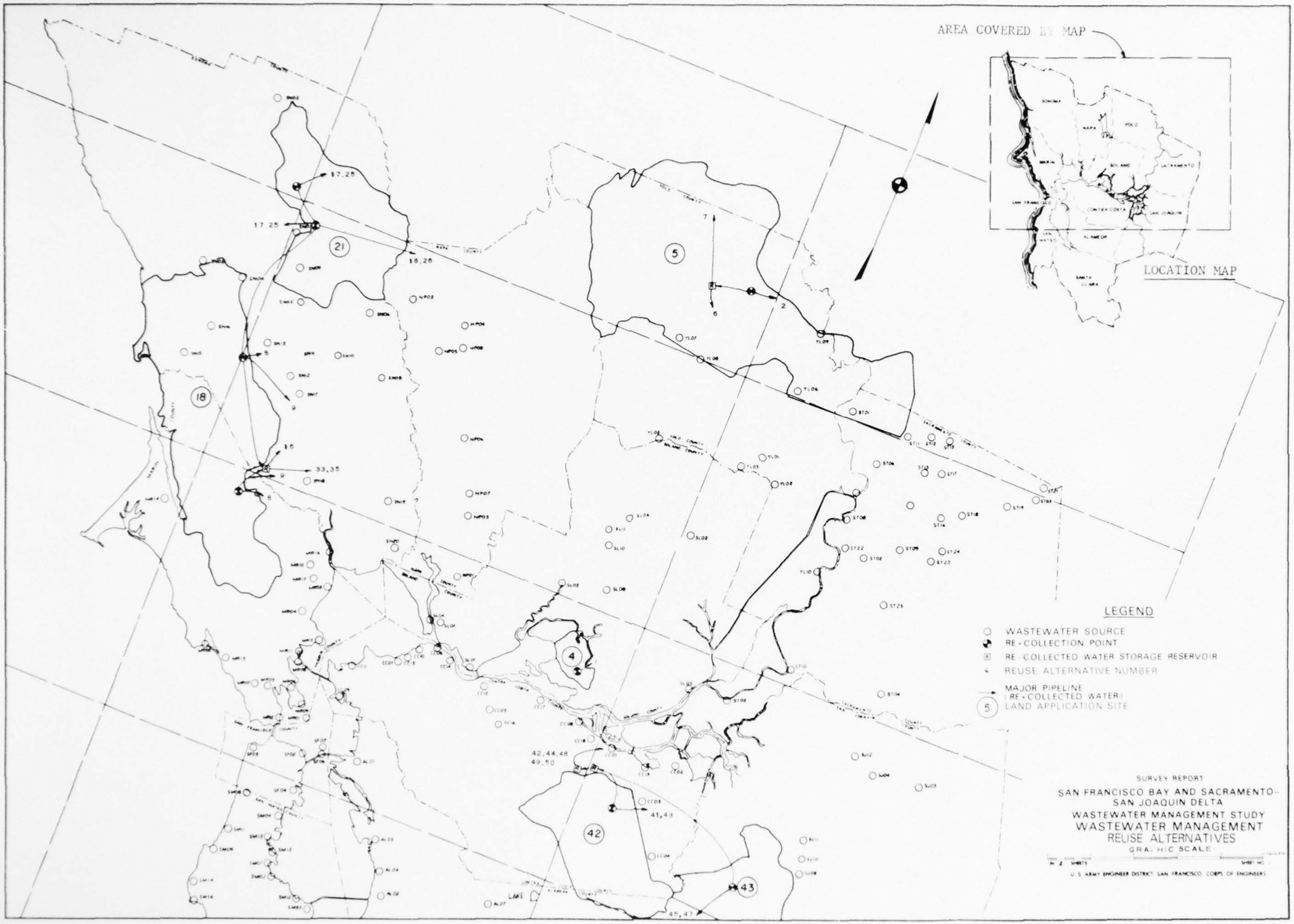
c. Reuse Alternatives 6 and 7 - In these alternatives the recollected water from Site 5 would be pumped to a reservoir on Bird Creek. In Alternative 6, water from the reservoir would be used for future industrial cooling near the site. In Alternative 7, water would be pumped to the northern portion of Site 5 and would be used for irrigation.

d. Reuse Alternative 9 - In this alternative the reclaimed water would be collected at two points near the croplands in Site 18. From these points it would be pumped to the headwaters of tributaries to the Petaluma River for flow augmentation.

e. Reuse Alternative 16 - The recollected water from the southern portion of Site 18 would be collected and pumped to Chileno Lake. This reservoir site was proposed as a recreational lake created from reclaimed wastewater in the 1972 North Marin - South Sonoma Subregional Water Quality Management program. The dam proposed in that report would be raised to provide the capacity for additional water. This would provide for a larger surface area and hence greater recreational benefits.

f. Reuse Alternative 18 - This alternative collects and conveys recollected water from the southern crop area in Site 21 for the B-series of wastewater alternatives. This water would be collected and pumped to the headwaters of the Napa River for flow augmentation.

g. Reuse Alternative 27 - This alternative is similar to Alternative 18. The difference is that this alternative applies to the D-series of wastewater alternatives. The D-series alternatives envisions that an additional area of cropland in the central portion of Site 21 would be irrigated and therefore underdrained. This water would be collected and pumped to the southern crop area and the combined flow would then be pumped to the headwaters of the Napa River for flow augmentation.



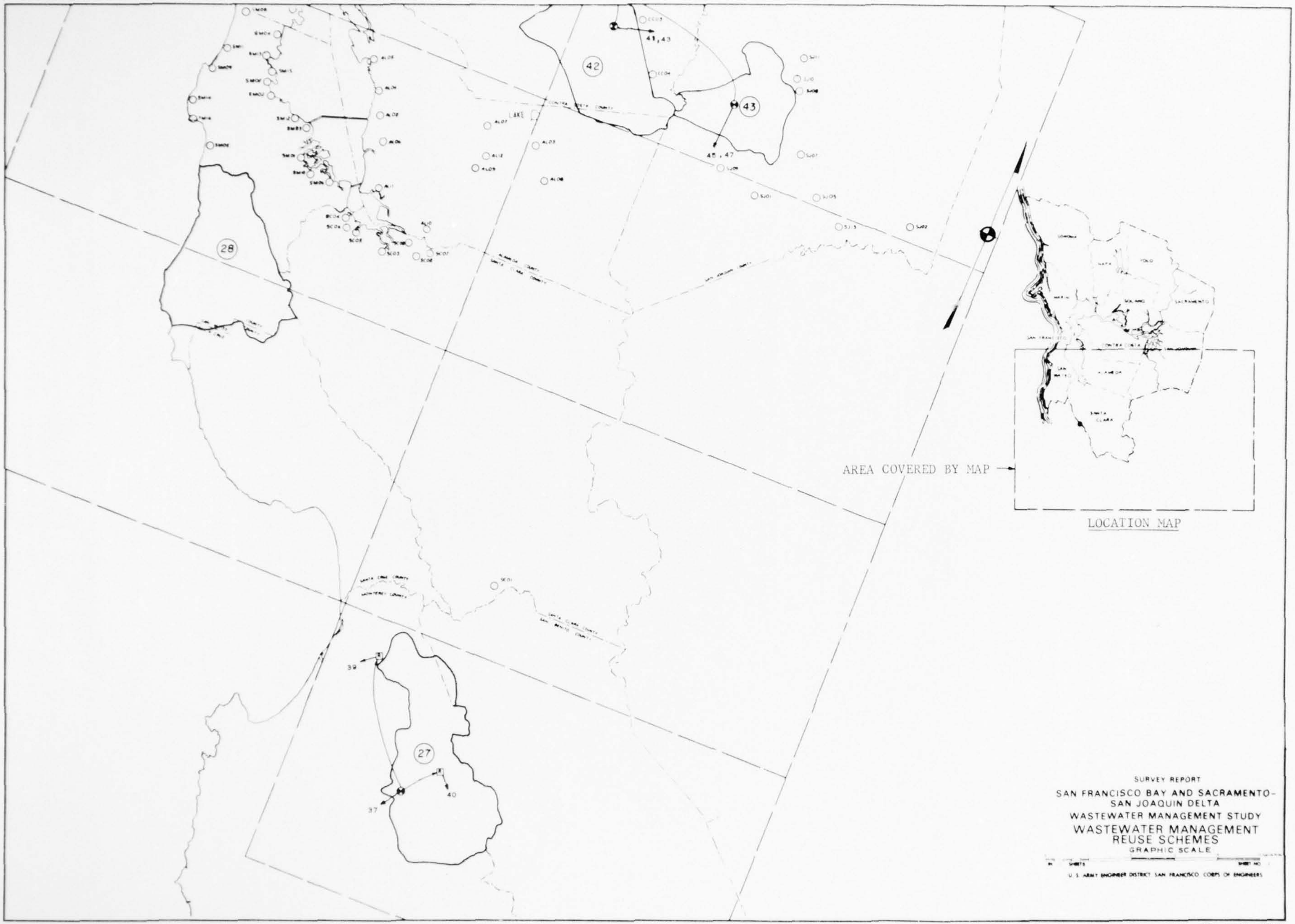
SURVEY REPORT

SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
WASTEWATER MANAGEMENT
REUSE ALTERNATIVES
GRAPHIC SCALE

IN 2 SHEETS SHEET NO.

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 33A



SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY

WASTEWATER MANAGEMENT
REUSE SCHEMES

GRAPHIC SCALE

IN SHEETS SHEET NO

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

PLATE 33 B

h. Reuse Alternatives 33 and 35 - Reuse Alternative 33 applies to the B-series of wastewater alternatives and Reuse Alternative 35 applies to the D-series of wastewater alternatives. Reclaimed water would be collected in Sites 18 and 21 as in the previous alternatives. From Site 21, this water would be pumped to the northern collection point in Site 18. The combined flow would continue from this point to Chileno Lake. The recollected water from the southern portion of Site 18 would be pumped directly to Chileno Lake where it would be available for an irrigation supply for Petaluma Valley.

i. Reuse Alternatives 39 and 40 - In these alternatives, water would be recollected from the irrigated area west of Highway 101 in Site 27. In the remaining irrigated crop area, underdrains would not be effective. In Alternative 39 water would be collected by gravity and pumped to a regulating reservoir east of Castroville. During the irrigation season, water would be pumped from the reservoir to the vicinity of Castroville for irrigation. In Alternative 40, the water would be collected as in the previous alternative. From the collection point it would be pumped to a groundwater recharge reservoir on Quail Creek. This reservoir would be located above elevation 180, where the percolation rate has been estimated at approximately 2.5 feet per day.

j. Reuse Alternatives 42 and 44 - Alternative 42 applies to the B-series of wastewater alternatives and Alternative 44 applies to the D-series of wastewater alternatives in Site 42. Reclaimed water would be collected by gravity and pumped to a regulating reservoir south of Antioch. During the summer when salinity intrusion makes the river water unsuitable for cooling, water from the reservoir could be used.

k. Reuse Alternatives 45 and 47 - These reuse alternatives would supply additional outflow to the Sacramento-San Joaquin Delta. Alternative 45 applies to the B-series of wastewater alternatives and Alternative 47 applies to the D-series for Site 43. Water in these alternatives would be collected by gravity and pumped over the levee surrounding the area into the Delta.

l. Reuse Alternative 48 - In this alternative, water would be recollected by gravity from Site 43 for the D-series of wastewater alternatives. This water would then be pumped to reservoirs south of Antioch. Two reservoirs would be required since no single site could be located with sufficient capacity for the total volume. The water from these reservoirs would be used for industrial cooling as described in Alternatives 42 and 44.

m. Reuse Alternative 49 - In this alternative, reclaimed water from Sites 42 and 43 would be collected and pumped to a regulating reservoir. This reuse alternative applies to the B-series of wastewater alternatives. The water from Site 43 would be collected by gravity and pumped to Site 42 where it would join the flow from that area. The combined flow would then be pumped to a reservoir south of Antioch. Water from this reservoir would be used for industrial cooling as described in Alternatives 42 and 44.

n. Reuse Alternative 50 - This alternative combines reuse Alternatives 44 and 48. In this alternative, the combined flow of recollected water from Sites 42 and 43 would be pumped to storage reservoirs. As in Alternative 48, two reservoirs would be required since no single site of sufficient capacity could be located. The water from these reservoirs would be used for industrial cooling as described in Alternatives 42 and 44.

215. Except at Sites 4 and 43 no additional costs are envisioned for the flow augmentation reuse alternatives. Costs for flow augmentation reuse at Sites 4 and 43 have been included in the costs of the wastewater management alternatives. Use of the other alternatives would require regulation reservoirs since the demand is not constant but occurs only during a few months. Conveyance facilities would also be required to convey the water from the land application sites to the reservoirs or the reuse areas. Estimated costs associated with implementing the remainder of the 25 selected reuse alternatives are discussed later under economic considerations.

Groundwater Replenishment

216. So far, reuse opportunities associated with the applied wastewaters and the recollected waters have been discussed. Limited reuse opportunities can be associated with that portion of the applied waters which percolates directly to groundwater from the non-underdrained pastured areas. Table 31 shows these quantities for the year 2000 level of development. Quality of water percolating below the root zone has previously been discussed. Except for total nitrogen and salinity, quality of this water is the same as that recollected in underdrains.

MONITORING PROGRAMS

Introduction

217. A necessary requirement for any wastewater management system is the development and implementation of a monitoring program to measure the effectiveness of the plan. A monitoring system normally consists of three parts: collection of samples; analysis of the samples; and reporting, storage and retrieval of the resulting data. If an electronic data processing system is employed to store the information, it is possible to program the production of standard reports for the easy retrieval of data.

Monitoring Requirements

218. Objectives of the monitoring program determine the type of tests to be taken, frequency of testing, location of test sites, and requirements for laboratory facilities. Such a monitoring program would be operated by the wastewater management agency which

TABLE 31

QUANTITIES OF WATER PERCOLATING DIRECTLY TO GROUNDWATER FROM PASTURED AREAS (AFY)

Area	Alternative					
	B1	B2	B3	D1	D2	D3
4	0	0	0	0	0	0
5	85,370	85,370	85,370	85,370	85,370	85,370
18	53,180	53,180	53,180	53,180	53,180	53,180
21	38,870	38,870	38,870	53,070	53,070	53,070
27	0	0	90,900	0	0	90,900
28	3,740	3,740	3,740	3,740	3,740	3,740
42	61,400	61,400	61,400	104,700	104,700	104,700
43	1,120	1,120	1,120	10,120	10,120	10,120
Total	243,680	243,680	334,580	310,180	310,180	401,080

would normally be responsible for the complete and proper operation of the wastewater management system. Any wastewater management monitoring program must:

a. Determine the qualitative and quantitative effects of the implementation of a wastewater management alternative on surface and groundwaters, soil structure, and vegetation;

b. Detect, identify, and determine the source of any condition which could degrade the quality of surface and groundwaters; and,

c. Provide an environmental evaluation of the wastewater system.

219. In order to insure that these objectives have been met, a monitoring program for land application of wastewater would consist of: (a) a monitoring network; (b) laboratory support for the quantitative analysis of the samples; and, (c) data evaluation, storage, and retrieval. The monitoring network would consist of permanent sampling points established in all the landsites, including stations for monitoring land quality, ecological conditions, recollected water quality, and possible groundwater degradation. Several stations would be located in each land area where wastewater and sludge are applied. In addition to normal sewage treatment plant tests, the following parameters would be tested:

a. Groundwater - total nitrogen, nitrate nitrogen, total dissolved solids, heavy metals, total phosphorus and pathogenic organisms;

b. Recollected water - total dissolved solids, total nitrogen, nitrate nitrogen, total phosphorus, heavy metals and pathogenic organisms;

c. Soil - heavy metals and total nitrogen at various depths;

d. Vegetation - heavy metals and total nitrogen;

e. Air - odors and aerosol emissions;

f. Wildlife - possible vectors such as mosquitoes, flies, and rodents; and,

g. Surface runoff (during the winter when the spray application of wastewater is halted) - heavy metals, total nitrogen, total phosphorus and pathogenic organisms.

ECONOMIC CONSIDERATIONS AND DESIGN FLEXIBILITY

ENGINEERING ECONOMIC ASSUMPTIONS

220. The following factors and assumptions were used in developing the first and annual costs used in this study:

a. Design Life - The design life of pumping stations and treatment facilities, including land disposal systems, was assumed to be 30 years. The design life of conveyance lines was assumed to be 50 years.

b. Project Life - The project life was assumed to be 50 years and all capital costs were amortized over this period in order to compute annual costs.

c. Replacement of Facilities - Replacement costs for facilities which are to be replaced at specific intervals (10, 25, and 30 years) were all put on a present worth basis by discounting at the appropriate interest rate.

d. Salvage Value - No salvage value was assumed for treatment facilities and pumping stations.

e. Use Contract - It was assumed that the landowner would be paid 25 percent of the lease cost for the use of the land. Average compensation to the landowner would be about $40 per acre per year. This would be in addition to all agricultural profits the landowner would normally make.

COST DETERMINATIONS

221. Detailed cost estimates were made for each wastewater management alternative based on two concepts of two land acquisition and system operations. Monitoring program costs have not been included. Under the first concept, all land required would be purchased directly in fee: system-required lands would be owned and operated by a wastewater management agency. Under the second concept and the one evaluated in this report, use contracts would be established between the wastewater management agency and the landowners. Under the use contract concept, the following assumptions were made:

a. All land required for treatment facilities, pumping stations, storage reservoirs, and reuse reservoirs would be purchased by the wastewater management agency.

b. All land required for pipelines would be acquired by the agency under a permanent easement.

c. The agency would own and operate all treatment facilities, transmission facilities, storage reservoirs, and reuse system components.

d. Wastewater and sludge application areas would be acquired by use contracts between landowners and the wastewater management agency.

e. The agency would furnish and the landowner would operate the underdrain system, runoff control works and distribution system. Use contracts would pay the landowners to operate these systems in accordance with needs for wastewater treatment.

f. Landowners would operate the wastewater application system and the sludge application system as well as being responsible for farming operations in both the wastewater and sludge application areas. All profits from farming operations would be retained by the landowners.

222. The costs for each wastewater alternative using both types of land acquisition concepts were based on an interest rate of 5-1/2 percent.[1/] Pipeline costs were determined by the type of construction, design pressure, and pipe diameter; pumping station costs were based on pumping pressure and horsepower requirements; and treatment plant costs were based on the quantity of wastewater being treated and the types of treatment required. Table 32 provides a summary of costs for the Base Condition, each wastewater management alternative and the tertiary treatment system based on the fee purchase concept. Table 33 summarizes the costs for the B- and D-Series of wastewater management alternatives based on use contract operation of the land application sites. It should be noted that total construction costs for alternatives are incremental to Base Condition costs. The average annual costs for each alternative do not vary greatly between the two land acquisition concepts. Costs for the tertiary treatment system were developed on the basis of fee purchase of all system-required lands, since there would not be any land requirements for wastewater application and only a small amount of land required for sludge application.

223. As indicated previously, it has been assumed that recollected water at each landsite would be available for flow augmentation to local streams at project year 2000. Only at Land Sites 4 and 43 (Reuse Alternatives 1, 45 and 47) would additional costs for conveyance and pumping be required for flow augmentation. Using the use contract concept average annual costs (in millions) for each wastewater management alternative including flow augmentation reuse is as follows:

Alternative B-1 - $447
Alternative B-2 - $355
Alternative B-3 - $482
Alternative D-1 - $437
Alternative D-2 - $366
Alternative D-3 - $477

[1/] Although preliminary screening of alternatives was based on an interest rate of 5-3/8 percent, final costs were developed using an interest rate of 5-1/2 percent.

TABLE 32

FEE PURCHASE ESTIMATE SUMMARY

Description	Base Condition ($1,000)	WASTEWATER MANAGEMENT ALTERNATIVES B-1 ($1,000)	B-2 ($1,000)	B-3 ($1,000)	D-1 ($1,000)	D-2 ($1,000)	D-3 ($1,000)	Tertiary Treatment System ($1,000)
Construction Costs	1,500,000	2,800,000	2,300,000	3,300,000	3,300,000	2,900,000	3,800,000	2,100,000
Total Construction Costs	1,500,000	2,800,000	2,300,000	3,300,000	3,300,000	2,900,000	3,800,000	2,100,000
Annual Costs								
Base Condition Facilities								
Capital Cost 1/	46,600	46,600	46,600	46,600	46,600	46,600	46,600	46,600
Alternate Facilities								
Capital Costs	-	123,600	102,200	146,500	146,200	129,100	168,800	91,800
Replacement Costs	8,900	27,200	21,200	29,300	27,700	23,200	30,700	19,000
Operations and Maintenance Costs	65,000	250,000	190,000	270,000	220,000	180,000	250,000	200,000
Total Annual Costs	120,500	447,400	360,000	492,400	440,500	378,900	496,100	357,400

1/ To compensate for the depreciated value of existing Base Condition facilities, 50 percent of the annual costs for new construction was used.

NOTE: Alternative and tertiary treatment system total construction costs are incremental to the Base Condition.

TABLE 33

CONTRACT OPERATION OF LAND APPLICATION SITES
ESTIMATE SUMMARY

DESCRIPTION	WASTEWATER MANAGEMENT ALTERNATIVES B-1 (1,000)	 B-2 (1,000)	 B-3 (1,000)	 D-1 (1,000)	 D-2 (1,000)	 D-3 (1,000)
Construction Costs						
Government Owned Facilities	2,300,000	1,700,000	2,500,000	2,650,000	2,150,000	2,900,000
Contractor Owned Facilities	300,000	300,000	400,000	350,000	350,000	400,000
Total Construction Costs	2,600,000	2,000,000	2,900,000	3,000,000	2,500,000	3,300,000
Annual Costs						
Government Owned and Operated						
Base Condition Facilities						
Capital Costs 1/	46,600	46,600	46,600	46,600	46,600	46,600
Alternate Facilities						
Capital Costs	99,500	73,800	108,000	114,500	92,900	125,200
Replacement Costs	16,800	10,900	16,000	15,200	10,800	15,100
Operation and Maintenance	170,000	110,000	170,000	130,000	85,000	130,000
Subtotal	332,900	241,300	340,600	306,300	235,300	316,900
Contractor Owned and Operated						
Alternate Facilities						
Capital Costs	12,800	12,800	17,100	15,000	15,000	17,100
Replacement Costs	10,300	10,300	13,200	13,000	13,000	15,000
Operation and Maintenance	90,000	90,000	110,000	100,000	100,000	120,000
Subtotal	113,100	113,100	140,300	128,000	128,000	152,100
Total Annual Costs	446,000	354,400	480,900	434,300	363,300	469,000

1/ To compensate for the depreciated value of existing Base Condition facilities, 50 percent of the annual costs for new construction was used.

NOTE: Alternative total construction costs are incremental to the Base Condition.

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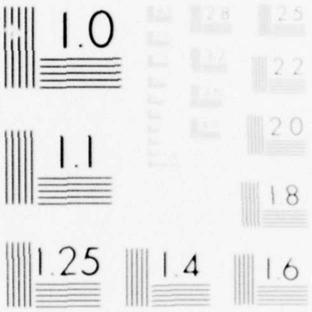


MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Costs do not reflect any consideration of financial benefits which might be achieved from the use of reclaimed water and fertilizer. Construction costs and annual costs for the selected reuse alternatives are shown on Table 34. As indicated earlier under the section on Wastewater Reclamation Opportunities, Reuse Alternatives 2, 8, 17, 25, 37, 41 and 43 have no additional costs.

COST SHARING

224. For the past several years, it has been the practice for the Federal Government to share the construction cost of publicly owned wastewater treatment works with local interests. In 1970, with the passage of the Clean Water Bond Act, California became a partner to the concept of cost sharing. Present State and Federal policy, as expressed in the California Clean Water Bond Act of 1970 and its amendments and the Federal Water Pollution Control Act Amendments of 1972, indicate that the sharing percentages of eligible portions of project costs are as follows: Local interests - 12.5 percent, State of California - 12.5 percent and the United States - 75 percent. Grants are made for eligible portions of project costs subject to rules and regulations established by the California State Water Resources Control Board and the Federal Environmental Protection Agency.

225. With respect to granting procedures, the term "construction" has been given a broad meaning and includes, in addition to the actual building and alteration of works, all the necessary planning, engineering, legal, fiscal and economic investigations necessary for the implementation of a project. With respect to eligible portions of project costs, Federal statutes indicate that "treatment works" include devices and systems used in the storage, treatment, recycling and reclamation of wastewater, or are necessary to recycle or reuse water at the most economical cost over the estimated life of the works. Land acquisition is an eligible project feature so long as the land is an integral portion of the treatment process or is used for ultimate disposal of residues. Reuse facilities also would be considered eligible project features if such facilities were necessary to the operation of the project. All grants made are subject to user charges and industrial recovery charges required by State and Federal statutes. Both the State of California and the Federal Government have established priority systems for the allocation of grant funds.

226. For the purpose of this study in allocating costs among local, State and Federal interests, it has been assumed that all features of the wastewater management alternatives are eligible for construction grants. Capital costs of the alternatives (and that portion of the average annual costs which represents amortization of capital investment) have been apportioned on the basis of 12.5 percent local, 12.5 percent State of California and 75 percent Federal. Cost for operation and

TABLE 34

SELECTED REUSE ALTERNATIVES

ESTIMATED AVERAGE ANNUAL COSTS COMPARISON SUMMARY

Reuse Alt. No.	Description	Construction Costs 1/ ($1,000)	ANNUAL COSTS Capital ($1,000)	Replacement ($1,000)	Operation & Maintenance ($1,000)	Total 1/ ($1,000)
1	Flow augmentation to Suisun Marsh	4,200	170	10	80	260
6	Industrial Cooling at Site 5	40,000	1,400	100	1,000	2,500
7	Irrigation - northern portion of Area 5	48,000	1,670	100	1,000	2,770
9	Flow augmentation to Petaluma River	11,000	450	20	280	750
16	Recreation at Chileno Lake	5,100	220	20	90	330
18	Flow augmentation to Napa River	14,000	570	30	390	990
26	Flow augmentation to Napa River	27,000	1,100	80	900	2,080
33	Irrigation in Petaluma Valley	36,000	1,470	60	670	2,200
35	Irrigation in Petaluma Valley	51,000	2,090	90	1,100	3,280
39	Irrigation at Castroville	25,000	750	20	330	1,100
40	Groundwater Recharge - Eastside Area	14,000	430	40	270	740
42	Industrial Cooling at Antioch	14,000	570	30	340	940
44	Industrial Cooling at Antioch	16,000	650	30	330	1,010
45	Flow augmentation to Local Stream	10,000	408	2	110	520
47	Flow augmentation to Local Stream	46,000	1,870	10	500	2,380
48	Industrial Cooling at Antioch	125,000	5,080	220	200	8,500
49	Industrial Cooling at Antioch	44,000	1,790	70	950	2,810
50	Industrial Cooling at Antioch	139,000	5,650	290	3,800	9,740

1/ **Including** contingencies, E&D and S&A.

maintenance and replacement would be paid by local interests. Landowners within the land application sites would be expected to pay a portion of these latter costs equivalent to their normal costs in operating irrigation systems.

INSTITUTIONAL ARRANGEMENTS

227. The institutions considered in this study include the governmental structures of the Bay-Delta Region which have emerged in relation to possible solutions of water quality problems. Governmental studies are concerned with the development, growth, and responses of wastewater management institutions associated with increased demands for allocation of resources to the solution of growing regional water quality and pollution problems. Particular emphasis is placed upon institutional impacts which may be related to land application alternatives of Bay-Delta water quality problems.

228. During recent years increasing attention has been given to waste treatment facilities to solve water quality and pollution problems. Institutional responses were concentrated at local governmental levels. In some instances, existing flood control or water supply agencies assumed waste treatment responsibilities in lieu of creating new single-purpose institutions. This type of institutional adaption was reasonable because flood control systems have often served in the dual capacity of providing both storm drains and sanitary sewers and water supply agencies are concerned with water quality as well as quantity. At the present time, it is generally recognized that the water quality and pollution problems of the Bay-Delta Region have grown to such proportions that the united efforts of Federal and State governments, as well as local governments, must be brought to bear and national as well as State and local economic and technological resources must be allocated to their solution.

229. It is anticipated that the Bay-Delta Region under the 1975 Base Condition will reflect increased institutional accommodation to meet legislative requirements of current and projected technological demands of an increasingly critical Bay-Delta water quality and pollution control problem. The emerging institutional environment will reflect an extrapolation of present institutional accommodation trends.

230. The selection of ultimate institutional arrangements to meet requirements of the selected wastewater management alternatives is the responsibility of State and local agencies and the voters. Interested and cooperating Federal agencies are charged with the responsibility of assisting the State and local agencies and to that extent may offer assistance as needed. Nonetheless, the decision-making process remains a State prerogative.

231. Existing institutional enabling acts of the State of California are generally flexible and adequate to meet most foreseeable needs; however, some changes may be considered in the interest of achieving uniformity and to assure that waste treatment management institutions will meet the criteria for construction grants.

232. The land application portions of the wastewater alternatives examined in this study would appear capable of being implemented by existing institutions. Only one governing institutional entity or wastewater management agency, should control each of the suggested land application subsystems. The formation of a new controlling district or the consolidation of districts could be handled by the local communities involved under existing legal authorities.

STAGING CONSIDERATIONS

233. An alternative is only a concept until it is implemented, then it becomes a program or a project. One of the problems common to all major public works projects is that of developing adequate and economic procedures for financing both the construction and the subsequent operation and maintenance of an alternative. To avoid potential difficulties in financing and administration, it becomes necessary to review financial and legal problems pertaining to public works projects. An engineering report can be of assistance by providing preliminary planning information.

234. The problem of how a particular alternative could be constructed and operated must be considered. All the facilities for an alternative could be built during a relatively short period of time, or a phased construction could be accomplished over a longer period of time. In order to determine which construction method would produce the best results, the following assumptions were used:

a. All interceptor pipelines would be constructed at the same time;

b. All lands would be acquired at the same time;

c. All wastewater storage reservoirs at the landsites would be constructed at the same time;

d. Approximately 75 percent of the wastewater treatment facilities, the pumping stations, and the sludge handling systems would be built during the first part of the construction phase; and,

e. Approximately 50 percent of the land application systems would be built during the first part of the construction phase.

235. Based on a review of the cost data, the effect of these assumptions would be that only about 25 percent of the construction cost could be considered for staged or phased, construction. It was assumed that all system construction, with design capacity to meet year 2000 flows, would be started by 1975 and completed by 1985. There could be a staging of a portion of total system construction during this 10-year period. Assuming a reasonable project construction period, of 10 years for initial construction for year 2000 flows, and six years for further expansion of facilities for year 2020 flows, a further breakdown follows:

a. The number of major construction contracts would be approximately 500.

b. Average duration for each construction contract would be 1-1/2 - 2 years, with the exception of storage reservoirs which would be 1-1/2 - 3 years. Numerous construction contracts would be running concurrently and would be staged throughout the construction period.

c. The first two years of the 10-year period would be for basic engineering, design, and land acquisition, the remaining eight years for final design and construction.

d. Experience on construction projects indicates the peak rate of expenditure occurs at the 60 percent point of the construction period. Design and construction expenditures could be staged based on these assumptions. Figure 9 schematically depicts the time phasing for design and construction costs.

YEAR 2020 MASTER PLAN

236. The six wastewater management alternatives developed can be considered only as intermediate steps in meeting long-range water quality needs. Each alternative can be expanded into a master plan to care for wastewater flows and constituents for the year 2020. As an example, Alternative D-1 was modified to demonstrate the compatibility of the year 2000 land application alternatives with long-range planning. Alternative D-4 (see Plate 34) can be considered as the 2020 Master Plan for the D-Series of wastewater alternatives. Since this alternative is the same as Alternative D-1 except for the quantity of wastewater being generated, the same land application sites used in Alternative D-1 would be used. The amount of land required would be increased but would generally be in the same location as that used under Alternative D-1.

237. Sludge System S-5 (see Plate 35) applies to Alternative D-4 (year 2020 Master Plan) and is similar to Sludge System S-2. In System S-5, the sludge from Sites 42 and 43, as well as that from the Central Contra Costa County Wastewater Treatment Plant and the three small tertiary plants on the Sacramento River, would be conveyed to Site 5. All other routes would remain the same as in Sludge Systems S-2.

SENSITIVITY CONSIDERATIONS

Introduction

238. Changes in assumed design criteria could result in changes or modifications to wastewater management alternatives. The sensitivity of these possible changes should be examined. The areas of greatest potential change

TIME PHASING FOR DESIGN AND CONSTRUCTION COSTS

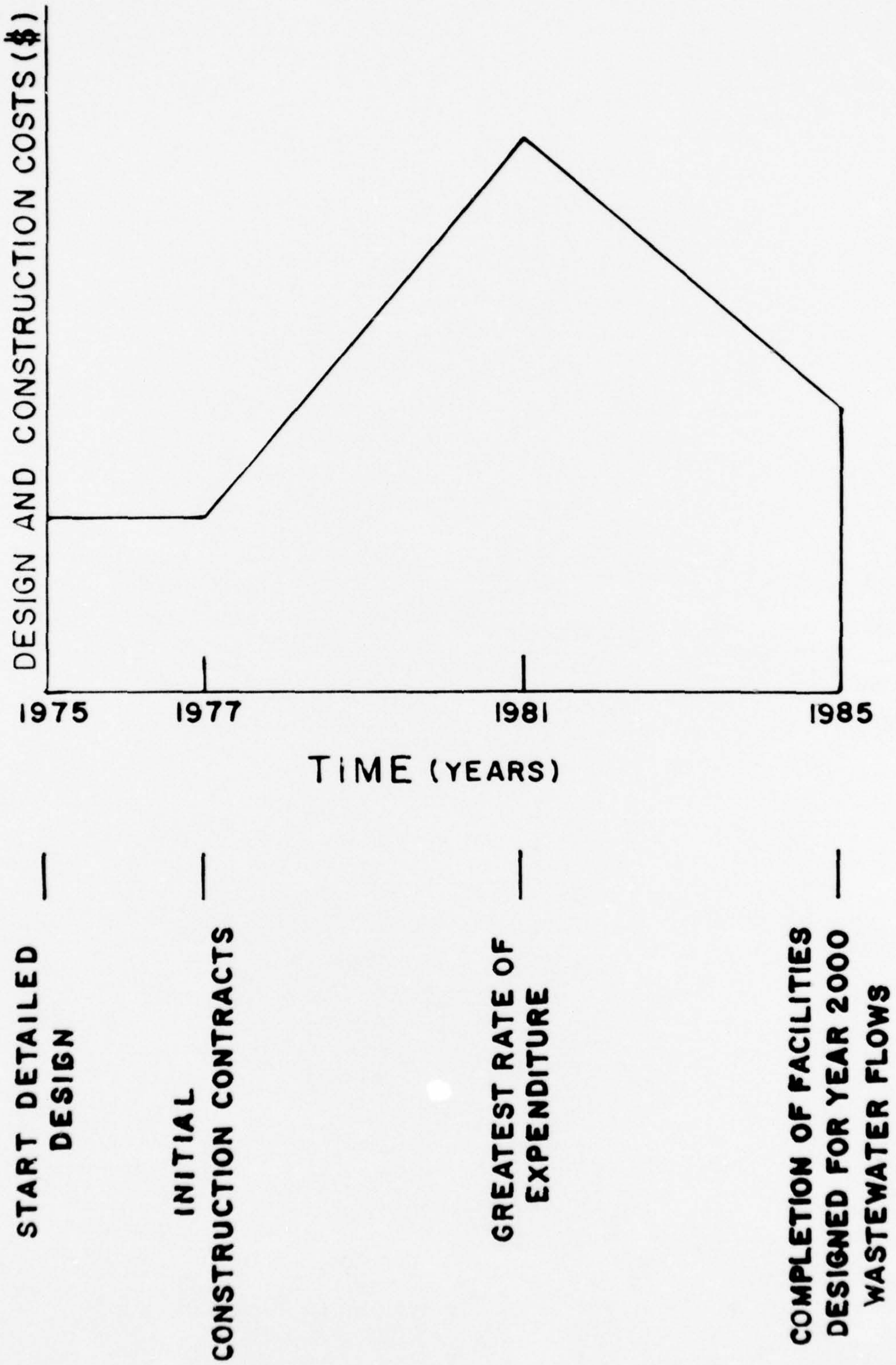
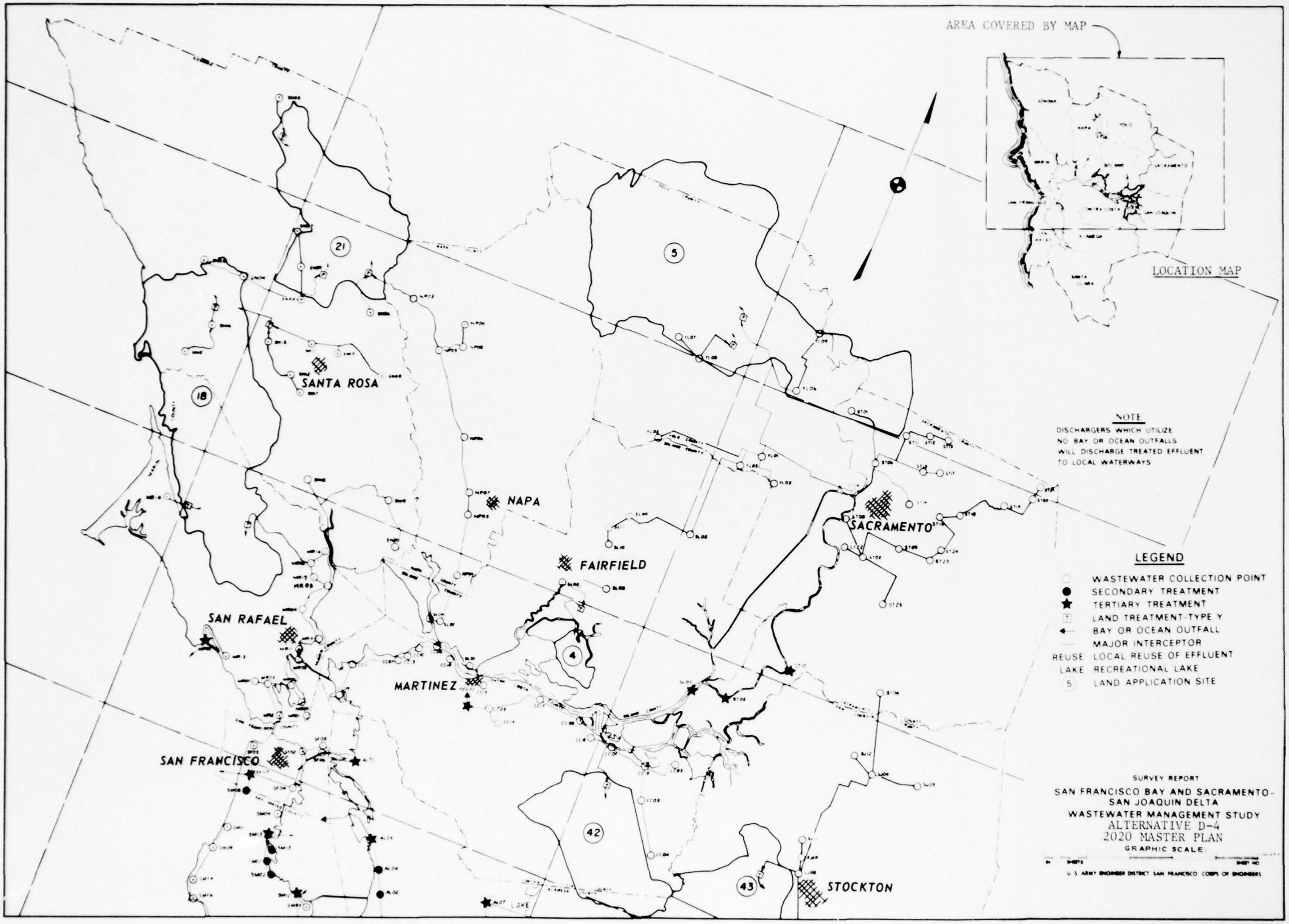


FIGURE 9



SURVEY REPORT

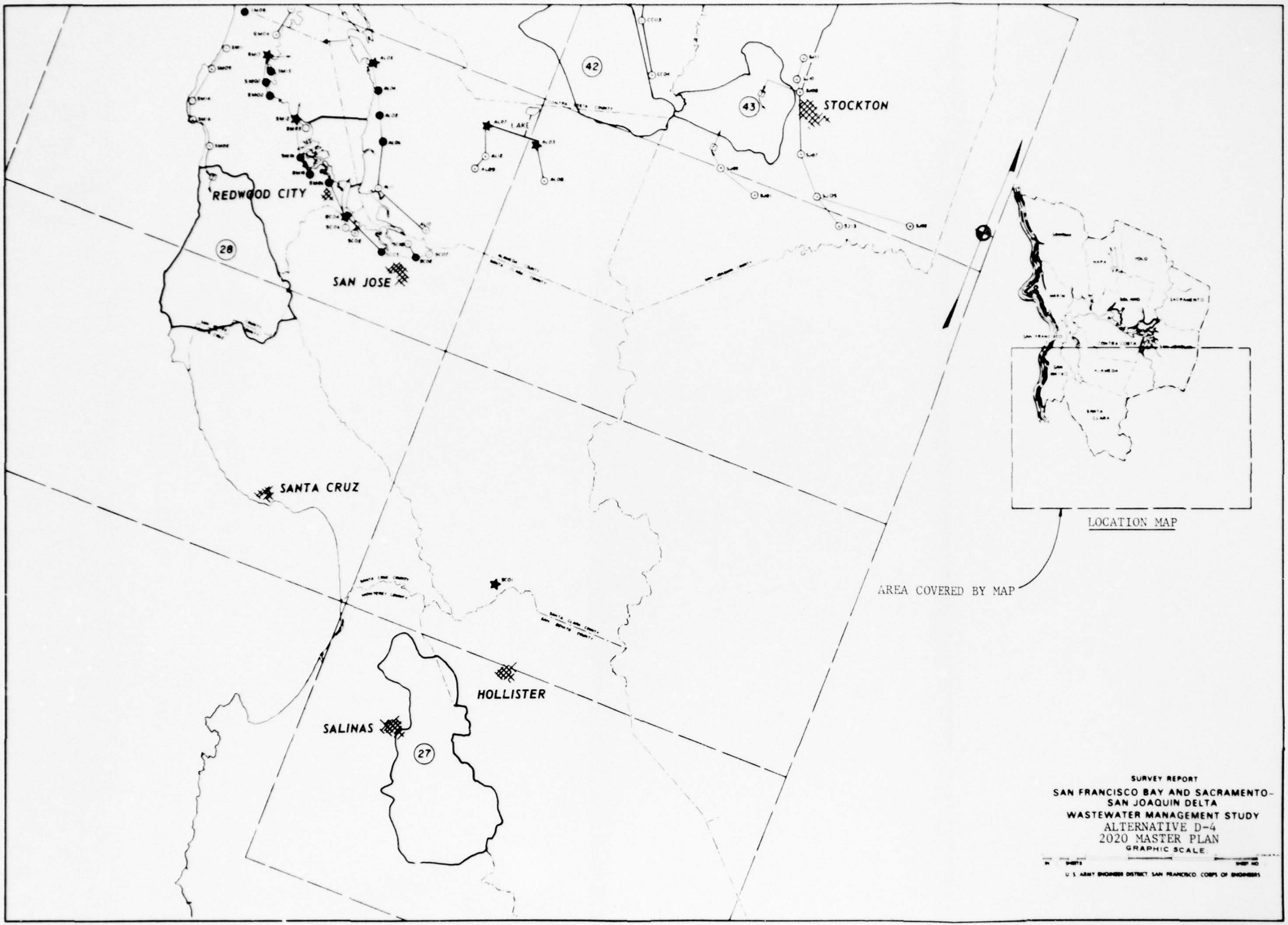
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE D-4
2020 MASTER PLAN

GRAPHIC SCALE

IN SHEETS SHEET NO

U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 34 A



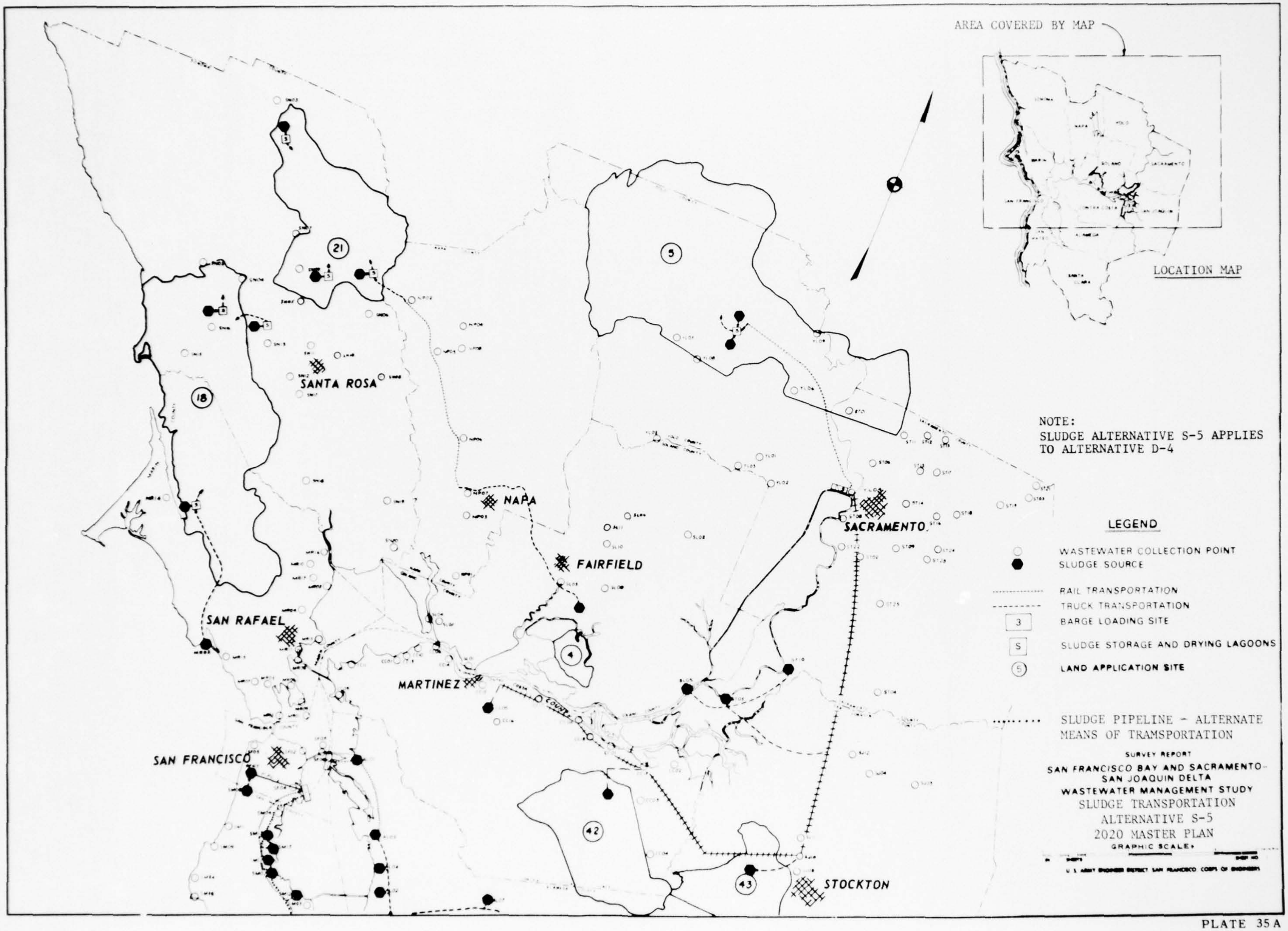
SURVEY REPORT

SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
ALTERNATIVE D-4
2020 MASTER PLAN

GRAPHIC SCALE

U S ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

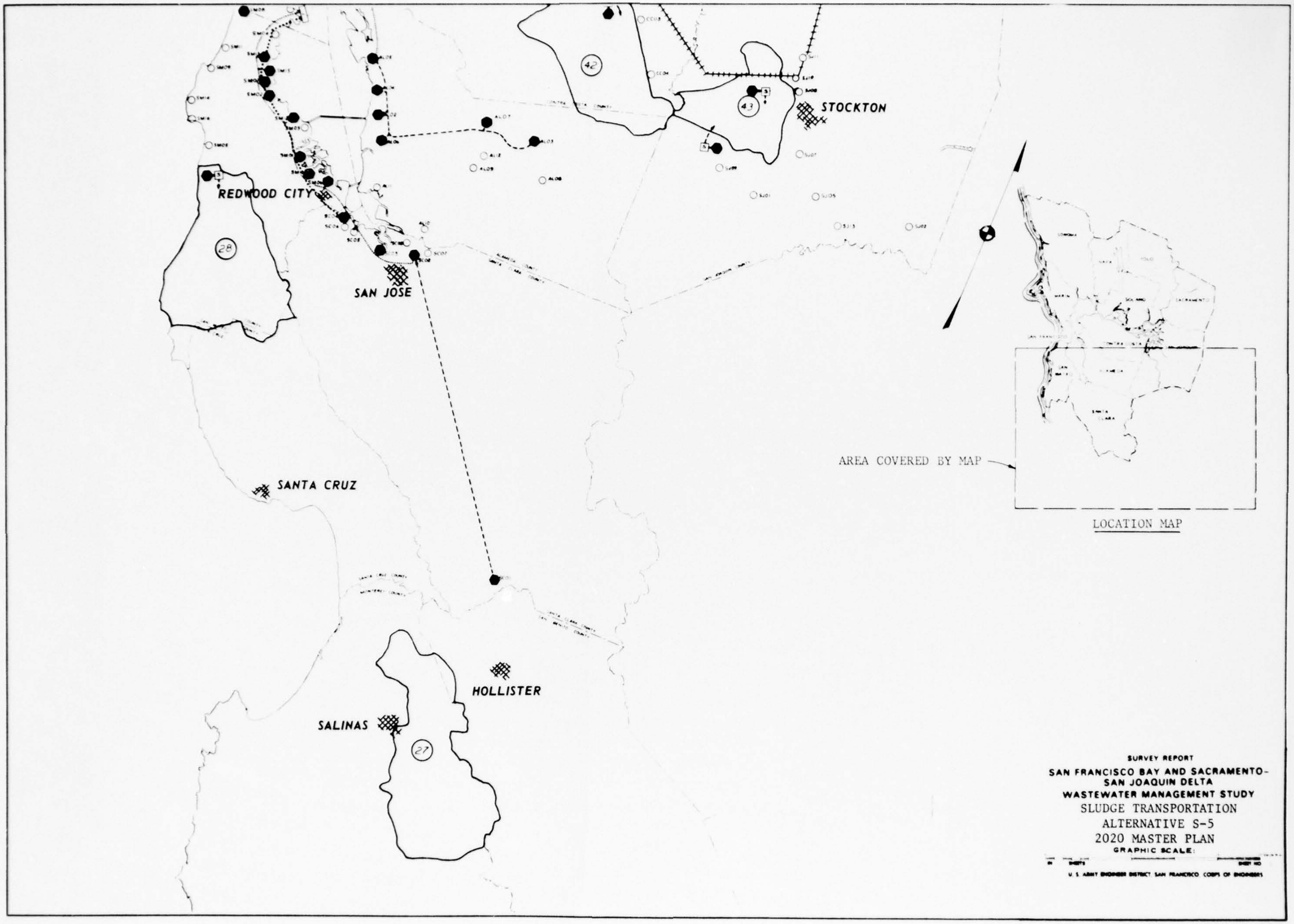
PLATE 34B



NOTE:
SLUDGE ALTERNATIVE S-5 APPLIES
TO ALTERNATIVE D-4

SURVEY REPORT
SAN FRANCISCO BAY AND SACRAMENTO-
SAN JOAQUIN DELTA
WASTEWATER MANAGEMENT STUDY
SLUDGE TRANSPORTATION
ALTERNATIVE S-5
2020 MASTER PLAN
GRAPHIC SCALE:
SHEET NO
U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 35A



SURVEY REPORT

SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN DELTA

WASTEWATER MANAGEMENT STUDY

SLUDGE TRANSPORTATION

ALTERNATIVE S-5

2020 MASTER PLAN

GRAPHIC SCALE:

U. S. ARMY ENGINEER DISTRICT SAN FRANCISCO CORPS OF ENGINEERS

PLATE 35B

in design criteria would be in the projection of wastewater flows (which affect the utilization of each land site), crop patterns to be selected, removal or use of existing orchards, cost development assumptions and the availability of land suitable for land treatment of wastewater.

Projection of Wastewater Flows

239. Projected final municipal wastewater flows were based on the population data presented in the Series D-150 projections prepared by the California Department of Finance. This series of projections is currently considered the standard for State and Federal planning in California, except when overriding reasons dictate the use of other projections. A second series of population projections also has been developed by the California Department of Finance, the Series E-0. E-0 Series projections are based on reaching zero population growth at some time in the future. The Series E-0 data indicate a smaller population forecast than the Series D-150 data (see Table 4). Current trends in population forecasting appear to favor use of the E-0 Series as a frame of reference for future planning. Grant regulations and planning criteria of the State Water Resources Control Board for wastewater treatment facilities make use of these projections in critical air basins. The following counties are in a critical air basin and, as such, population projections could be less than those derived from D-150 Series: San Francisco, San Mateo, Contra Costa, Alameda, and Santa Clara.

240. Of these five counties, only Contra Costa and Santa Clara Counties would contribute significant quantities of waste to land areas. Use of the E-0 projections would result in slightly lower wastewater flows to Site 42 for all alternatives and to Site 27 for Alternatives B-3 and D-3. Also less sludge would be available for land application because of reduced flows. Therefore, the land portions of the wastewater management alternatives presented in this report do not appear to be significantly sensitive to the choice of which population projection is used.

241. Initial coordination with industrial groups in the study area has indicated that the industrial wastewater flows could change depending on which set of technical assumptions were used. In this study, the flows were based on a set of industrial assumptions outlined earlier. The assumptions appear to be reasonable and since the majority of the industrial waste flows originate in Contra Costa County, changes would only materially affect the Site 42 portions of the land application alternatives.

Crop Patterns

242. Several basic assumptions were made regarding the various crop types to be used at the application sites. These assumptions were

made from the best available information. If this information changes, then the original assumptions might also change. As an example, available information from the agricultural community indicated that alfalfa would remove about 170 pounds of nitrogen per acre per year. The assumption made was that if nitrogen were available from the ground, alfalfa would utilize this form of nitrogen prior to fixation of any nitrogen from the atmosphere. Presently, no documented data have been furnished to determine if alfalfa does use one hundred percent of the nitrogen from the ground. Only through continued experimental efforts and pilot plant studies would definite data be available.

243. It also was assumed that no crops would be grown that are normally eaten raw by humans, such as tomatoes. If additional wastewater treatment processes were provided, the water could be used to irrigate crops used for direct human consumption. The additional treatment would consist of a dual media filter and chlorination unit. The treatment cost would be increased. For example, in Site 5, approximately 9,940 acres of tomatoes are currently grown which could be irrigated with 40 MGD of adequately treated wastewater. The additional cost of providing both filtration and chlorination would be about $8.87 per acre-feet of water. Table 35 summarizes the additional cost of treating the wastewater flows to each site, for each series of alternatives, to allow continued cropping of tomatoes, asparagus and other desired crops.

Orchards

244. The original design for the application of wastewater contemplated removing all orchards affected by this application. This concept was considered because crops with good nitrogen removal characteristics were required to insure proper land treatment of wastewater. With this assumption, overall monetary losses would occur unless some of these orchards were replaced. It would be possible to develop new orchards in the proposed sludge application areas. From a cost standpoint, it would not pay to replace orchard crops such as walnuts and prunes. The development time required and recent decreases in harvest prices would make the replacement of these orchard types uneconomical. However, these particular orchards could be replaced by other types: almonds, apples, cherries, pears, and apricots. If orchards were replaced, the total net annual agricultural loss could be reduced or eliminated.

Cost Development

245. The final costs developed for this study were based on an interest rate of 5-1/2 percent. However, this interest rate could change depending on the total national economic situation. It is probable that the interest rate would increase rather than be decreased. This would result in increased costs for all wastewater management systems. If the interest rate increased, for instance to seven percent, an approximate 13 percent increase in average annual costs could be anticipated.

TABLE 35

ADDITIONAL COSTS FOR TREATMENT OF WASTEWATER TO BE USED ON EDIBLE CROPS

Land Area	B-SERIES OF ALTERNATIVES Flow (MGD)	($ MILLION)1/ Dual Media Filter Cost	Chlorination Cost	Total Cost	D-SERIES OF ALTERNATIVES Flow (MGD)	($ MILLION)1/ Dual Media Filter Cost	Chlorination Cost	Total Cost
28	5	0.8	0.2	1.0	5	0.8	0.2	1.0
27	187	10.2	5.8	16.0	187	10.2	5.8	16.0
42	118	6.5	3.7	10.2	259	14.2	8.0	22.2
43	18	1.8	0.7	2.5	115	6.3	3.6	9.9
4	15	1.6	0.6	2.2	15	1.6	0.6	2.2
5	218	11.9	6.8	18.7	218	11.9	6.8	18.6
21	55	3.8	1.8	5.6	80	4.8	2.5	7.3
18	81	4.8	2.5	7.3	81	4.8	2.5	7.3

NOTE: 1/ Average annual costs.

Land Availability

246. This study used seven primary land application areas (Sites 28, 42, 43, 4, 5, 21, 18) and one alternate area (Site 27) for the application of treated wastewater and sludge. These sites were chosen based on several parameters discussed earlier. If certain sites were not to be used, such as Site 5 with a total of 192,000 potentially available acres, other sites which were identified but not investigated in detail could be used. Use of these additional sites would be expected to present a range of positive and negative effects comparable to those described in this report. Proposed use of the primary seven land application sites was based on their locations relative to the major wastewater sources. Other land application areas, such as Sites 38, 39, 41, and 53 (Plate 6), could be considered if a primary site became non-available. As discussed earlier, Site 27 was used in two of the six alternatives to provide an additional option to South San Francisco Bay area wastewater dischargers and to permit evaluation of the concept of interbasin transport of wastewater.

IDENTIFICATION OF IMPACTS
AND SYSTEM PERFORMANCE

PUBLIC LAW 92-500

247. On 18 October 1972 the "Federal Water Pollution Control Amendments of 1972" (PL 92-500) became law. The law establishes two national goals:

a. To achieve wherever possible by 1 July 1983 water that is clean enough for swimming and other recreational uses, and clean enough for the protection and propagation of fish, shellfish and wildlife.

b. To have by 1985 no discharge of pollutants into the nation's waters.

248. The law also increases Federal aid to help local government build sewage treatment facilities and sets the following deadlines for actions to control water pollution from industrial and municipal sources.

a. Industries discharging pollutants into the nation's waters must use the "best practicable" water pollution control technology by 1 July 1977 and the "best available" technology by 1 July 1983.

b. All publicly owned treatment works in operation on 1 July 1977 must provide a minimum of secondary treatment.

c. All publicly owned treatment works must use "best practicable" treatment by 1 July 1983.

249. Insofar as possible, the water quality provisions of PL 92-500 have been considered in identifying the impacts and characterizing the performance of the final wastewater management alternatives.

IDENTIFICATION OF IMPACTS

Introduction

250. In the planning process sequence of events, impact identification falls between the formulation of alternatives and their evaluation. It serves as a bridge between these two planning events, as it supplies information to finish the former and to start the latter. When displayed, identified impacts describe the changes which will result from implementation of the final wastewater management alternatives. These impacts then become the indicators for evaluation.

Scope of Accounts

251. The first step in the impact identification process is to define a set of categories and impact parameters so that the impacts can be organized and assembled according to their effects on man and his surroundings. These categories represent areas of concern which planners have found to be essential in plan formulation and/or sensitive to public interest. For this study environmental quality,

social well-being, economic, and institutional categories were selected as representative general areas within which to identify impacts. Impact parameters represent those specific areas in which changes are likely to be produced.

252. Environmental quality involves the relationship between human environment and the natural environment. Many of man's actions affect the natural biological processes and life cycles of a region by altering the chemical or physical components of the natural environment. Usually the effects of these actions appear in the biological sector as either temporary or permanent changes in the growth, maintenance, and reproduction of organisms or the relationship that exists between biological communities and entire ecoysystems. By identifying changes in chemical/physical factors, ecological associations, aesthetics, recreation and use of natural resources, it is possible to assess the impact of an alternative action on environmental quality.

253. Social well-being involves a condition, existing or desired, expressed in terms of individual and group quality of life. This quality of life concerns those activities, institutions, and interrelationships of man involved in the maintenance, growth, and development of society within the physical environment. By determining the effect of an alternative on area viability (in terms of stability, growth and development of localities), public attitudes, distributive equity and public health, it is possible to assess social well-being sensitivity.

254. The development of water resources affects the environmental quality and social well-being of the region. In turn, these changes can affect the region's economic base and institutional framework. Although much criticism is given to the use of dollar benefits and costs in evaluating alternative solutions in the context of coexistence with environmental and social well-being considerations, the dollar aspect of regional development must be considered. In this light, information on project costs, agricultural production, public finance, land values, reclamation of resources, and changes in existing institutional structure is considered necessary. Table 36 summarizes the basic impact categories and parameters used in this study.

Matrix Preparation

255. After the impact categories and parameters have been established and the impacts identified and assembled, the next step is to develop a format for their display. It also becomes necessary to equate the impacts to the various groups that will be affected by the alternative. For this study, any change in the impact parameters could potentially have an effect on the San Francisco Bay-Delta Region, the State of California, or the United States. Although some impacts may be relatively unimportant the further from the study area a planner considers, their synergistic effects may be extremely important and therefore must be considered. In addition, the impacts produced from the interbasin transfer of wastewater need to be considered.

SUMMARY OF IMPACTS PRODUCED BY ALTERNATIVE B-1

IMPACT PARAMETERS	SAN FRANCISCO BAY-DELTA REGION					CALIFORNIA		UNITED STATES	
	GENERAL POPULATION	SITE POPULATION		CONVEYANCE LINE POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS
		FARMERS	SETTLEMENTS						
ENVIRONMENTAL QUALITY CHEMICAL/PHYSICAL FACTORS	PROVIDES BEST PRACTICABLE TREATMENT TECHNOLOGY IN PROJECT YEAR 2000. NINETY-EIGHT PERCENT REMOVAL OF PHOSPHORUS, NITROGEN AND BOD.	SLIGHT INCREASE IN T.D.S. OF LOCAL STREAMS. POSSIBLE INCREASE IN T.D.S. OF GROUNDWATERS. CHANGE IN LAND USE AND CROPPING PATTERNS IN LAND AREAS AND PLACEMENT OF BUFFER ZONES.		REQUIRES ABOUT 450 MILES OF PIPE LINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	MEETS WATER QUALITY PLANNING OBJECTIVES OF REGIONAL PLANNING AGENCIES. ASSISTS IN ENSURING OPEN SPACE PRESERVES.	MEETS THE INTENT AND TIME PHASING GOALS OF THE STATE WATER RESOURCES CONTROL BOARD.		MEETS THE INTENT AND TIME PHASING GOALS OF PUBLIC LAW 92-500.	
ECOLOGICAL	IMPROVES WATER QUALITY IN THE ESTUARY, HENCE ENHANCES THE VIABILITY OF THE REGION'S ESTUARINE FISH AND WILDLIFE RESOURCES. ALLOWS NATURAL REJUVENATION OF WATERWAYS.	POTENTIAL IMPROVEMENT OF HABITAT FOR DESIRABLE SMALL GAME SPECIES. INSURES OPEN SPACE PRESERVES. PROVIDES ADDITIONAL ROUTES OF WATER AND NEW WATER SOURCES.		TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.	CONTRIBUTES TO OVERALL GOAL OF REDUCING THE POLLUTION OF THE INLAND AND OCEAN WATERS OF CALIFORNIA.		CONTRIBUTES TO THE MAINTENANCE OF NATIONAL WATERFOWL SPECIES. CONTRIBUTES TO NATIONAL ENVIRONMENTAL QUALITY GOALS.	
AESTHETIC	ENHANCES THE ESUTARY BY REDUCING THE POTENTIAL FOR ALGAL BLOOMS. ELIMINATES UNSLIGHTLY SEWAGE OUT-FALL PLUMES. INSURES OPEN SPACE GREEN AREAS.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS. IMPROVEMENTS MAY, IN SOME MINDS, INFRINGE UPON NATURAL AESTHETIC VALUES.		INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION IN SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS.	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.		MINIMUM IMPACT	MINIMUM IMPACT
RECREATION	INCREASES WATER CONTACT SPORT OPPORTUNITIES IN THE ESTUARY. POTENTIAL INCREASE IN SPORT SHELL-FISHING IN THE ESUTARY. ENHANCES SPORT FISHING AND WATER FOWL HUNTING POTENTIAL. INCREASED POTENTIAL FOR PASSIVE SPORTS SUCH AS BIRD WATCHING, WALKING ETC.	POSSIBLE INCREASE IN UPLAND GAME HUNTING AND SPORT FISHING POTENTIAL		POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATION AREAS.	INCREASE IN TOTAL RECREATION OPPORTUNITIES.		INCREASE IN TOTAL RECREATION OPPORTUNITIES.	
USE OF NATURAL RESOURCES	MINIMUM IMPACT	97,000 ACRES FOR WASTEWATER APPLICATION; 48,253 ACRES FOR SLUDGE APPLICATION; 2,148 ACRES FOR LAND TREATMENT FACILITIES; 9,261 ACRES FOR WASTEWATER STORAGE FACILITIES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	995 TONS/DAY OF TREATMENT CHEMICALS; 9,130 MEGAWATT HOURS/DAY OF POWER: 18,900 CUBIC FEET/DAY OF NATURAL GAS ARE REQUIRED.
SOCIAL WELL-BEING AREA VIABILITY	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 154,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	35,800 ACRES OF CROP CHANGES WOULD RESULT IN NET AVERAGE ANNUAL INCOME LOSS (1975-2025). (SEE "ECONOMIC" FOR INCOME CHANGES). POTENTIAL ORCHARD REPLACEMENT OF 5,900 ACRES WOULD RESULT IN NET AVERAGE ANNUAL INCOME GAIN OF $1,140 THOUSAND.	OF TOTAL POPULATION OF 9,450 IN TEN SETTLEMENTS, 3010 JOBS POTENTIALLY AFFECTED, 200 INTERNAL AND 2,810 FRINGE POPULATION, OF WHICH NET EMPLOYMENT OF 780 AFFECTED DIRECTLY BY CROP CHANGES. POTENTIAL NET CULTURE LABOR COST (PER PRODUCTION CYCLE) LOSS OF $1.5 MILLION. OTHER FACTORS, SUCH AS ORCHARD REPLACEMENT, AGRICULTURAL SERVICE, AND HARVEST LABOR, MAY MITIGATE EMPLOYMENT AND ECONOMIC IMPACTS. POTENTIAL AFFECT OF SYSTEM TO HELP RETAIN RURAL LIFE-STYLE OF AREAS. MINIMAL HOUSING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSINESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	20,000 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (25 PERCENT OF SITE POPULATION) AND ELDERLY (12 PERCENT OF SITE POPULATION).	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR; SOME EFFECT TO THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY AND AGRICULTURAL PRODUCTION EMPLOYMENT, ESPECIALLY IN NORTHERN PART OF STATE.	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR.
PUBLIC ATTITUDES	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	CONCERN OF SYSTEM TO FORCE SIGNIFICANT ALTERATION TO FARM OPERATION AND INCOME, AS WELL AS HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	CONCERN OF SYSTEM TO FORCE ALTERATION OF RURAL LIFE-STYLE, AS WELL AS JOB AND HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS. CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAN ALTERATIONS DUE TO CROP CHANGES.
DISTRIBUTIVE EQUITY (CONSTRUCTION, OPERATION & MAINTENANCE WAGES)	POTENTIAL OF 30 MILLION MAN DAYS OR MORE NEEDED FOR SYSTEM CONSTRUCTION. SUCH WAGES INCLUDE: $1,749 MILLION FOR TOTAL SYSTEM,287 MILLION FOR MINORITY SHARE OF TOTAL, $988 MILLION FOR CONSTRUCTION ITSELF, AND $231 MILLION FOR MINORITY SHARE OF CONSTRUCTION. POTENTIAL O&M EMPLOYMENT OF SYSTEM IN PLACE WOULD BE 7,000 TO 9,000. ANNUAL O&M WAGES WOULD BE $143 MILLION.				CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	POTENTIAL IMMIGRATION OF SOME CONSTRUCTION WORKERS, ESPECIALLY FROM NORTHERN PARTS OF STATE, DUE TO POTENTIAL SIGNIFICANT SHARE OF EMPLOYMENT WAGES FOR BOTH CONSTRUCTION AND O&M.	CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	MINIMUM IMPACT	MATERIAL MANUFACTURERS AND TRANSPORTATION INDUSTRY INTERESTED IN SHARE OF SYSTEM CONSTRUCTION.
PUBLIC HEALTH	THIS ALTERNATIVE MINIMIZES URBAN WASTEWATER AS A SOURCE OF TOXIC METAL CONTAMINATION IN THE ESTUARY THROUGH PROJECT YEAR 2000. PROVIDES GREATER CONTROL OF WATER-BORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMAL POPULATIONS, AND INCREASE THE POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION THE POTENTIAL EXISTS FOR GREATER CONTROL OF AGRICULTURAL CONTAMINANTS HAZARDOUS TO HEALTH.		MINIMUM IMPACT	THIS ALTERNATIVE WILL ENHANCE THE COMMERCIAL SHELLFISHING INDUSTRY IN ESTUARINE AND OCEAN WATERS.	MEETS THE APPROPRIATE REGULATIONS OF CALIFORNIA STATE HEALTH AGENCIES.		MEETS THE APPROPRIATE REGULATIONS OF FEDERAL HEALTH AGENCIES.	
ECONOMIC 1/ 2/ PROJECT COSTS ($1000)	CAPITAL COST $325,000 AMORTIZ. $ 20,000 O & M 260,000 REPL. 27,000 TOTAL A. A. COST $307,000	PORTIONS OF THE GENERAL POPULATION COSTS WOULD BE BORNE BY LOCAL LANDOWNERS EQUIVALENT TO THEIR NORMAL COSTS FOR INSTALLING AND OPERATING CONVENTIONAL IRRIGATION SYSTEMS.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	CAPITAL COST $325,000 AMORTIZ. $20,000 TOTAL A.A. COST $ 20,000		CAPITAL COST $1,930,000 AMORTIZ. $120,000 TOTAL A. A. COST $ 120,000	
AGRICULTURAL PRODUCTION	SEE GENERAL POPULATION, UNITED STATES	RESTRICTED TO GROWING ONLY HIGH NITROGEN USING CROPS AND CROPS WHICH ARE NOT EATEN RAW. WASTEWATER & DRAIN APPLICATION SYSTEM INSTALLED ON FARMERS PROPERTY WILL BE COMPENSATED ON AVERAGE $40 PER ACRE PER YEAR FOR ANY INCONVENIENCE OR LOSSES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $673,000. INCOME GAIN AT YEAR 2000 OF $127,000.	MINIMUM IMPACT
PUBLIC FINANCE	TAX LOSS FOR PURCHASED LANDS $165,000	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
LAND VALUES	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	PRESERVES AND MAY ULTIMATELY ENHANCE LONG - TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
RECLAMATION OF RESOURCES	MINIMUM IMPACT	PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 97,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,400,000 PER YEAR.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
INSTITUTIONAL	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY EXISTING OR SLIGHTLY MODIFIED INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT OR CREATION OF A NEW WASTEWATER MANAGEMENT AGENCY ARE POSSIBILITIES. ONLY ONE INSTITUTIONAL AGENCY SHOULD CONTROL ANY ONE LAND APPLICATION SUBSYSTEM.			MINIMUM IMPACT	MINIMUM IMPACT	IN GENERAL, STATE STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.		IN GENERAL, FEDERAL STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.	

1/ THE FOLLOWING ASSUMPTIONS WERE MADE IN APPORTIONING PROJECT COSTS:

A. COST SHARING FOR FIRST COST (AND AMORTIZATION) WAS 12.5 PERCENT LOCAL, 12.5 PERCENT STATE OF CALIFORNIA AND 75 PERCENT FEDERAL.

B. REPLACEMENT AND OPERATION AND MAINTENANCE COSTS WERE CONSIDERED TO BE LOCAL RESPONSIBILITY.

2/ VALUES ARE INCREMENTAL TO THE BASE CONDITION.

FIGURE 10

SUMMARY OF IMPACTS PRODUCED BY ALTERNATIVE B-2

IMPACT PARAMETERS	SAN FRANCISCO BAY-DELTA REGION					CALIFORNIA		UNITED STATES	
	GENERAL POPULATION	SITE POPULATION		CONVEYANCE LINE POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS
		FARMERS	SETTLEMENTS						
ENVIRONMENTAL QUALITY CHEMICAL/PHYSICAL FACTORS	PROVIDES NO INCREASE IN THE QUANTITY OF INDIVIDUAL CONSTITUENTS DISCHARGED TO EACH WATER QUALITY ZONE OVER THE 1975 BASE CONDITION.	SLIGHT INCREASE IN T.D.S. OF LOCAL STREAMS. POSSIBLE INCREASE IN T.D.S. OF GROUNDWATERS. CHANGE IN LAND USE AND CROPPING PATTERNS IN LAND AREAS AND PLACEMENT OF BUFFER ZONES.		REQUIRES ABOUT 450 MILES OF PIPELINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	MEETS SHORT-RANGE WATER QUALITY PLANNING OBJECTIVES OF REGIONAL PLANNING AGENCIES. ASSISTS IN INSURING OPEN SPACE PRESERVES.	MEETS SHORT-RANGE GOALS OF STATE WATER RESOURCES CONTROL BOARD.		LAND TREATMENT COMPONENT MEETS LONG-RANGE GOALS OF PUBLIC LAW 92-500. TREATMENT PLANT COMPONENT DOES NOT. OVERALL, THE ALTERNATIVE MEETS PL 92-500 REQUIREMENTS UNTIL 1983.	
ECOLOGICAL	STABLIZES POLLUTION ORIENTED ECOLOGICAL STRESS OF ESTUARINE FISH AND WILDLIFE RESOURCES. LIMITED NATURAL REJUVENATION OF WATERWAYS.	POTENTIAL IMPROVEMENT OF HABITAT FOR DESIRABLE SMALL GAME SPECIES. INSURES OPEN SPACE PRESERVES. PROVIDES ADDITIONAL BODIES OF WATER AND NEW WATER SOURCES.		TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.	CONTRIBUTES TO REDUCING POLLUTION OF GREATEST MOMENT IN THE STATE.		CONTRIBUTES TO THE MAINTANCE OF NATIONAL WATERFOWL SPECIES. CONTRIBUTES TO NATIONAL ENVIRONMENTAL QUALITY GOALS.	
AESTHETIC	ENHANCES THE ESTUARY BY REDUCING THE POTENTIAL FOR ALGAL BLOOMS. ELIMINATES UNSIGHTLY SEWAGE OUTFALL PLUMES. INSURES OPEN SPACE GREEN AREAS.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS. IMPROVEMENTS MAY, IN SOME MINDS, INFRINGE UPON NATURAL AESTHETIC VALUES.		INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION OF SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS.	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.		MINIMUM IMPACT	
RECREATION	INCREASES WATER CONTACT SPORT OPPORTUNITIES IN THE ESTUARY. POTENTIAL INCREASE IN SPORT SHELLFISHING IN THE ESTUARY. ENHANCES SPORT FISHING AND WATER FOWL HUNTING POTENTIAL. INCREASED POTENTIAL FOR PASSIVE SPORTS SUCH AS BIRD WATCHING, WALKING ETC.	POSSIBLE INCREASE IN UPLAND GAME HUNTING AND SPORT FISHING POTENTIAL.		POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATION AREAS.	INCREASE IN TOTAL RECREATION OPPORTUNITIES.		INCREASE IN TOTAL RECREATION OPPORTUNITIES	
USE OF NATURAL RESOURCES	MINIMUM IMPACT	97,000 ACRES FOR WASTEWATER APPLICATION; 46,773 ACRES FOR SLUDGE APPLICATION; 2,078 ACRES FOR LAND TREATMENT FACILITIES; 9,261 ACRES FOR WASTEWATER STORAGE FACILITIES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	160 TONS/DAY OF TREATMENT CHEMICALS; 7,680 MEGAWATT HOURS/DAY OF POWER; 16,9 CUBIC FEET/DAY OF NATURAL GAS ARE REQUIRED. 2/
SOCIAL WELL-BEING AREA VIABILITY	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 153,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	35,800 ACRES OF CROP CHANGES WOULD RESULT IN NET AVERAGE ANNUAL INCOME LOSS (1975-2025). (SEE "ECONOMIC" FOR INCOME CHANGES). POTENTIAL ORCHARD REPLACEMENT OF 5,900 ACRES WOULD RESULT IN NET AVERAGE ANNUAL INCOME GAIN OF 1,140 THOUSAND.	OF TOTAL POPULATION OF 9,450 IN TEN SETTLEMENTS, 3,010 JOBS POTENTIALLY AFFECTED, 200 INTERNAL AND 2,810 FRINGE POPULATION, OF WHICH NET EMPLOYMENT OF 180 AFFECTED DIRECTLY BY CROP CHANGES. POTENTIAL NET CULTURE LABOR COST (PER PRODUCTION CYCLE) LOSS OF $1.5 MILLION. OTHER FACTORS, SUCH AS ORCHARD REPLACEMENT, AGRICULTURAL SERVICE, AND HARVEST LABOR, MAY MITIGATE EMPLOYMENT AND ECONOMIC IMPACTS. POTENTIAL AFFECT OF SYSTEM TO HELP RETAIN RURAL LIFESTYLE OF AREAS. MINIMAL HOUSING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSINESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	20,000 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (25 PERCENT OF SITE POPULATION) AND ELDERLY (12 PERCENT OF SITE POPULATION).	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR; SOME EFFECT TO THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY AND AGRICULTURAL PRODUCTION EMPLOYMENT, ESPECIALLY IN NORTHERN PART OF STATE.	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR.
PUBLIC ATTITUDES	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	CONCERN OF SYSTEM TO FORCE SIGNIFICANT ALTERATION TO FARM OPERATION AND INCOME, AS WELL AS HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	CONCERN OF SYSTEM TO FORCE ALTERATION OF RURAL LIFE-STYLE, AS WELL AS JOB AND HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION, DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS. CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.
DISTRIBUTIVE EQUITY (CONSTRUCTION, OPERATION & MAINTENANCE WAGES)		POTENTIAL OF 24 MILLION MAN DAYS OR MORE NEEDED FOR SYSTEM CONSTRUCTION. SUCH WAGES INCLUDE: $1,380 MILLION FOR TOTAL SYSTEM, $221 MILLION FOR MINORITY SHARE OF TOTAL, $560 MILLION FOR CONSTRUCTION ITSELF, AND $193 MILLION FOR MINORITY SHARE OF CONSTRUCTION. POTENTIAL O&M EMPLOYMENT OF SYSTEM IN PLACE WOULD BE 7,000 TO 9,000. ANNUAL O&M WAGES WOULD BE $121 MILLION.			CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL, AND INSTITUTIONAL PROGRAMS.	POTENTIAL IMMIGRATION OF SOME CONSTRUCTION WORKERS, ESPECIALLY FROM NORTHERN PARTS OF STATE, DUE TO POTENTIAL SIGNIFICANT SHARE OF EMPLOYMENT WAGES FOR BOTH CONSTRUCTION AND O&M.	CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	MINIMUM IMPACT	MATERIAL MANUFACTURERS AND TRANSPORTATION INDUSTRY INTERESTED IN SHARE OF SYSTEM CONSTRUCTION.
PUBLIC HEALTH	THIS ALTERNATIVE MINIMIZES URBAN WASTEWATER AS A SOURCE OF TOXIC METAL CONTAMINATION IN THE ESTUARY ON A SHORT-TERM BASIS. PROVIDES GREATER CONTROL OF WATERBORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMAL POPULATIONS, AND INCREASE THE POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION. THE POTENTIAL EXISTS FOR GREATER CONTROL OF AGRICULTURAL CONTAMINANTS HAZARDOUS TO HEALTH.		MINIMUM IMPACT	THIS ALTERNATIVE WILL ENHANCE THE COMMERCIAL SHELLFISHING INDUSTRY IN ESTUARINE AND OCEAN WATER.	MEETS THE APPROPRIATE REGULATIONS OF CALIFORNIA STATE HEALTH AGENCIES.		MEETS THE APPROPRIATE REGULATIONS OF FEDERAL HEALTH AGENCIES.	
ECONOMIC 1/ 2/ PROJECT COSTS (IN $1,000'S)	CAPITAL COST $250,000 AMORTIZ. $ 16,000 O&M 200,000 REPL. 21,000 TOTAL A. A. COST $237,000	PORTIONS OF THE GENERAL POPULATION COSTS WOULD BE BORNE BY LOCAL LANDOWNERS EQUIVALENT TO THEIR NORMAL COSTS FOR INSTALLING AND OPERATING CONVENTIONAL IRRIGATION SYSTEMS.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	CAPITAL COST $250,000 AMORTIZ. $16,000 TOTAL A. A. COST $16,000		CAPITAL COST $1,500,000 AMORTIZ. $102,000 TOTAL A. A. COST $102,000	
AGRICULTURAL PRODUCTION	SEE GENERAL POPULATION, UNITED STATES.	RESTRICTED TO GROWING ONLY HIGH NITROGEN USING CROPS AND CROPS WHICH ARE NOT EATEN RAW. WASTEWATER AND DRAIN APPLICATION SYSTEM INSTALLED ON FARMERS PROPERTY, WILL BE COMPENSATED ON AVERAGE $40 PER ACRE PER YEAR FOR ANY INCONVENIENCE OR LOSSES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $683,000. INCOME GAIN AT YEAR 2000 OF $108,000.	MINIMUM IMPACT
PUBLIC FINANCE	TAX LOSS FOR PURCHASED LANDS $165,000	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
LAND VALUES	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
RECLAMATION OF RESOURCES	MINIMUM IMPACT	PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 97,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,400,000 PER YEAR.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
INSTITUTIONAL	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY EXISTING OR SLIGHTLY MODIFIED INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT OR CREATION OF A NEW WASTEWATER MANAGEMENT AGENCY ARE POSSIBILITIES. ONLY ONE INSTITUTIONAL AGENCY SHOULD CONTROL ANY ONE LAND APPLICATION SUBSYSTEM.			MINIMUM IMPACT	MINIMUM IMPACT	IN GENERAL, STATE STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION		IN GENERAL, FEDERAL STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION	

1/ THE FOLLOWING ASSUMPTIONS WERE MADE IN APPORTIONING PROJECT COSTS:

a. COST SHARING FOR FIRST COST (AND AMORTIZATION) WAS 12.5 PERCENT LOCAL, 12.5 PERCENT STATE OF CALIFORNIA AND 75 PERCENT FEDERAL.

b. REPLACEMENT AND OPERATION AND MAINTENANCE COSTS WERE CONSIDERED TO BE LOCAL RESPONSIBILITY.

2/ VALUES ARE INCREMENTAL TO THE BASE CONDITION.

FIGURE 11

SUMMARY OF IMPACTS PRODUCED BY ALTERNATIVE B-3

IMPACT PARAMETERS	SAN FRANCISCO BAY-DELTA REGION					CALIFORNIA		UNITED STATES	
	GENERAL POPULATION	SITE POPULATION		CONVEYANCE LINE POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS
		FARMERS	SETTLEMENTS						
ENVIRONMENTAL QUALITY CHEMICAL/PHYSICAL FACTORS	PROVIDES BEST PRACTICABLE TREATMENT TECHNOLOGY IN PROJECT YEAR 2000. NINETY-EIGHT PERCENT REMOVAL OF PHOSPHORUS, NITROGEN AND B.O.D.	SLIGHT INCREASE IN T.D.S. OF LOCAL STREAMS. POSSIBLE INCREASE IN T.D.S. OF GROUNDWATERS. CHANGE IN LAND USE AND CROPPING PATTERNS IN LAND AREAS AND PLACEMENT OF BUFFER ZONES.		REQUIRES ABOUT 490 MILES OF PIPELINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	MEETS WATER QUALITY PLANNING OBJECTIVES OF REGIONAL PLANNING AGENCIES. ASSISTS IN INSURING OPEN SPACE PRESERVES.	MEETS THE INTENT AND TIME PHASING GOALS OF THE STATE WATER RESOURCES CONTROL BOARD.		MEETS THE INTENT AND TIME PHASING GOALS OF PUBLIC LAW 92-500.	
ECOLOGICAL	IMPROVES WATER QUALITY IN THE ESTUARY, HENCE ENHANCES THE VIABILITY OF THE REGION'S ESTUARINE FISH AND WILDLIFE RESOURCES. ALLOWS NATURAL REJUVENATION OF WATERWAYS.	POTENTIAL IMPROVEMENT OF HABITAT FOR DESIRABLE SMALL GAME SPECIES. INSURES OPEN SPACE PRESERVES. PROVIDES ADDITIONAL BODIES OF WATER AND NEW WATER SOURCES.		TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.	CONTRIBUTES TO OVERALL GOAL OF REDUCING THE POLLUTION OF THE INLAND AND OCEAN WATERS OF CALIFORNIA.		CONTRIBUTES TO THE MAINTANCE OF NATIONAL WATERFOWL SPECIES. CONTRIBUTES TO NATIONAL ENVIRONMENTAL QUALITY GOALS.	
AESTHETIC	ENHANCES THE ESTUARY BY REDUCING THE POTENTIAL FOR ALGAL BLOOMS. ELIMINATES UNSIGHTLY SEWAGE OUTFALL PLUMES. INSURES OPEN SPACE GREEN AREAS.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS. IMPROVEMENTS MAY, IN SOME MINDS, INFRINGE UPON NATURAL AESTHETIC VALUES.		INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION IN SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS, INCREASES FLOW IN LOCAL STREAMS.	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.		MINIMUM IMPACT	
RECREATION	INCREASES WATER CONTACT SPORT OPPORTUNITIES IN THE ESTUARY. POTENTIAL INCREASE IN SPORT SHELLFISHING IN THE ESTUARY. ENHANCED SPORT FISHING AND WATER FOWL HUNTING POTENTIAL. INCREASED POTENTIAL FOR PASSIVE SPORTS SUCH AS BIRD WATCHING, WALKING ETC.	POSSIBLE INCREASE IN UPLAND GAME HUNTING AND SPORT FISHING POTENTIAL.		POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATION AREAS.	INCREASE IN TOTAL RECREATION OPPORTUNITIES.		INCREASE IN TOTAL RECREATION OPPORTUNITIES.	
USE OF NATURAL RESOURCES	MINIMUM IMPACT	97,000 ACRES FOR WASTEWATER APPLICATION; 48,250 ACRES FOR SLUDGE APPLICATION; 2,150 ACRES FOR LAND TREATMENT FACILITIES; 9,800 ACRES FOR WASTEWATER STORAGE FACILITIES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	805 TONS/DAY OF TREATMENT CHEMICALS; 11,350 MEGAWATT HOURS/DAY OF POWER; 18,900 CUBIC FEET/DAY OF NATURAL GAS ARE REQUIRED. 2/
SOCIAL WELL-BEING AREA VIABILITY	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 155,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	35,400 ACRES OF CROP CHANGES WOULD RESULT IN NET AVERAGE ANNUAL INCOME LOSS (1975-2025). (SEE "ECONOMIC" FOR INCOME CHANGES). POTENTIAL ORCHARD REPLACEMENT OF 5,830 ACRES WOULD RESULT IN NET AVERAGE ANNUAL INCOME GAIN OF $1,140 THOUSAND.	OF TOTAL POPULATION OF 9,450 IN TEN SETTLEMENTS, 3,010 JOBS POTENTIALLY AFFECTED, 200 INTERNAL AND 2,810 FRINGE POPULATION, OF WHICH NET EMPLOYMENT OF 780 AFFECTED DIRECTLY BY CROP CHANGES. POTENTIAL NET CULTURE LABOR COST (PER PRODUCTION CYCLE) LOSS OF $1.5 MILLION. OTHER FACTORS, SUCH AS ORCHARD REPLACEMENT, AGRICULTURAL SERVICE, AND HARVEST LABOR, MAY MITIGATE EMPLOYMENT AND-ECONOMIC IMPACTS. POTENTIAL AFFECT OF SYSTEM TO HELP RETAIN RURAL LIFESTYLE OF AREAS. MINIMAL HOUSING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSNIESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	20,000 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (25 PERCENT OF SITE POPULATION) AND ELDERLY (12 PERCENT OF SITE POPULATION.	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR; SOME AFFECT TO THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY AND AGRICULTURAL PRODUCTION EMPLOYMENT, ESPECIALLY IN NORTHERN PART OF STATE.	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR.
PUBLIC ATTITUDES	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	CONCERN OF SYSTEM TO FORCE SIGNIFICANT ALTERATION TO FARM OPERATION AND INCOME, AS WELL AS HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	CONCERN OF SYSTEM TO FORCE ALTERATION OF RURAL LIFE-STYLE, AS WELL AS JOB AND HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION, DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS, CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.	OPPOSITION FROM MONTEREY COUNTY INTERESTS TO THE CONCEPT OF INTER-BASIN TRANSPORT OF TREATED WASTEWATER.	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.
DISTRIBUTIVE EQUITY (CONSTRUCTION, OPERATION & MAINTENANCE WAGES)		POTENTIAL OF 28 MILLION MAN DAYS OR MORE NEEDED FOR SYSTEM CONSTRUCTION. SUCH WAGES INCLUDE: $1,601 MILLION FOR TOTAL SYSTEM, $256 MILLION FOR MINORITY SHARE OF TOTAL, $882 MILLION FOR CONSTRUCTION ITSELF, AND $244 MILLION FOR MINORITY SHARE OF CONSTRUCTION. POTENTIAL O&M EMPLOYMENT OF SYSTEM IN PLACE WOULD BE 5,000 TO 7,000, ANNUAL O&M WAGES WOULD BE $121 MILLION.			CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	POTENTIAL IMMIGRATION OF SOME CONSTRUCTION WORKERS, ESPECIALLY FROM NORTHERN PARTS OF STATE, DUE TO POTENTIAL SIGNIFICANT SHARE OF EMPLOYMENT WAGES FOR BOTH CONSTRUCTION AND O&M.	CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	MINIMUM IMPACT	MATERIAL MANUFACTURERS, AND TRANSPORTATION INDUSTRY INTERESTED IN SHARE OF SYSTEM CONSTRUCTION.
PUBLIC HEALTH	THIS ALTERNATIVE MINIMIZES URBAN WASTEWATER AS A SOURCE OF TOXIC METAL CONTAMINATION IN THE ESTUARY THROUGH PROJECT YEAR 2000. PROVIDES GREATER CONTROL OF WATERBORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMAL POPULATIONS, AND INCREASE THE POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION. THE POTENTIAL EXISTS FOR GREATER CONTROL OF AGRICULTURAL CONTAMINANTS HAZARDOUS TO HEALTH.		MINIMUM IMPACT	THIS ALTERNATIVE WILL ENHANCE THE COMMERCIAL SHELLFISHING INDUSTRY IN ESTUARINE AND OCEAN WATERS.	MEETS THE APPROPRIATE REGULATIONS OF CALIFORNIA STATE HEALTH AGENCIES.		MEETS THE APPROPRIATE REGULATIONS OF FEDERAL HEALTH AGENCIES.	
ECONOMIC 1/ 2/ PROJECT COSTS ($1000)	CAPITAL COST $360,000 AMORTIZ. $ 22,000 O&M 280,000 REPL. 30,000 TOTAL A. A. COST $332,000	PORTIONS OF THE GENERAL POPULATION COSTS WOULD BE BORNE BY LOCAL LANDOWNERS EQUIVALENT TO THEIR NORMAL COSTS FOR INSTALLING AND OPERATING CONVENTIONAL IRRIGATION SYSTEMS.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	CAPITAL COST $360,000 AMORTIZ. $22,000 TOTAL A. A. COST $ 22,000		CAPITAL COST $2,180,000 AMORTIZ. $128,000 TOTAL A. A. COST $128,000	
AGRICULTURAL PRODUCTION	SEE GENERAL POPULATION, UNITED STATES.	RESTRICTED TO GROWING ONLY HIGH NITROGEN USING CROPS, AND CROPS WHICH ARE NOT EATEN RAW. WASTEWATER & DRAIN APPLICATION SYSTEM INSTALLED ON FARMERS PROPERTY, WILL BE COMPENSATED ON AVERAGE $40 PER ACRE PER YEAR FOR ANY INCONVENIENCE OR LOSSES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $671,[illegible]. INCOME GAIN AT YEAR 2000 OF $120,000.	MINIMUM IMPACT
PUBLIC FINANCE	TAX LOSS FOR PURCHASED LANDS $165,000.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
LAND VALUES	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
RECLAMATION OF RESOURCES	MINIMUM IMPACT	PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 97,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,420,000 PER YEAR.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
INSTITUTIONAL	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY EXISTING OR SLIGHTLY MODIFIED INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT OR CREATION OF A NEW WASTEWATER MANAGEMENT AGENCY ARE POSSIBILITIES. ONLY ONE INSTITUTIONAL AGENCY SHOULD CONTROL ANY ONE LAND APPLICATION SUBSYSTEM.			MINIMUM IMPACT	MINIMUM IMPACT	IN GENERAL, STATE STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.		IN GENERAL, FEDERAL STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.	

1/ THE FOLLOWING ASSUMPTIONS WERE MADE IN APPORTIONING PROJECT COSTS:

a. COST SHARING FOR FIRST COST (AND AMORTIZATION) WAS 12.5 PERCENT LOCAL, 12.5 PERCENT STATE OF CALIFORNIA AND 75 PERCENT FEDERAL.

b. REPLACEMENT AND OPERATION AND MAINTENANCE COSTS WERE CONSIDERED TO BE LOCAL RESPONSIBILITY.

2/ VALUES ARE INCREMENTAL TO THE BASE CONDITION.

FIGURE 12

SUMMARY OF IMPACTS PRODUCED BY ALTERNATIVE B-3

IMPACT PARAMETERS	SAN FRANCISCO BAY-DELTA REGION					CALIFORNIA		UNITED STATES	
	GENERAL POPULATION	SITE POPULATION		CONVEYANCE LINE POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS
		FARMERS	SETTLEMENTS						
ENVIRONMENTAL QUALITY CHEMICAL/PHYSICAL FACTORS	PROVIDES BEST PRACTICABLE TREATMENT TECHNOLOGY IN PROJECT YEAR 2000. NINETY-EIGHT PERCENT REMOVAL OF PHOSPHORUS, NITROGEN AND B.O.D.	SLIGHT INCREASE IN T.D.S. OF LOCAL STREAMS. POSSIBLE INCREASE IN T.D.S. OF GROUNDWATERS. CHANGE IN LAND USE AND CROPPING PATTERNS IN LAND AREAS AND PLACEMENT OF BUFFER ZONES.		REQUIRES ABOUT 490 MILES OF PIPELINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	MEETS WATER QUALITY PLANNING OBJECTIVES OF REGIONAL PLANNING AGENCIES. ASSISTS IN INSURING OPEN SPACE PRESERVES.	MEETS THE INTENT AND TIME PHASING GOALS OF THE STATE WATER RESOURCES CONTROL BOARD.		MEETS THE INTENT AND TIME PHASING GOALS OF PUBLIC LAW 92-500.	
ECOLOGICAL	IMPROVES WATER QUALITY IN THE ESTUARY, HENCE ENHANCES THE VIABILITY OF THE REGION'S ESTUARINE FISH AND WILDLIFE RESOURCES. ALLOWS NATURAL REJUVENATION OF WATERWAYS.	POTENTIAL IMPROVEMENT OF HABITAT FOR DESIRABLE SMALL GAME SPECIES. INSURES OPEN SPACE PRESERVES. PROVIDES ADDITIONAL BODIES OF WATER AND NEW WATER SOURCES.		TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.	CONTRIBUTES TO OVERALL GOAL OF REDUCING THE POLLUTION OF THE INLAND AND OCEAN WATERS OF CALIFORNIA.		CONTRIBUTES TO THE MAINTANCE OF NATIONAL WATERFOWL SPECIES. CONTRIBUTES TO NATIONAL ENVIRONMENTAL QUALITY GOALS.	
AESTHETIC	ENHANCES THE ESTUARY BY REDUCING THE POTENTIAL FOR ALGAL BLOOMS. ELIMINATES UNSIGHTLY SEWAGE OUTFALL PLUMES. INSURES OPEN SPACE GREEN AREAS.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS. IMPROVEMENTS MAY, IN SOME MINDS, INFRINGE UPON NATURAL AESTHETIC VALUES.		INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION IN SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS, INCREASES FLOW IN LOCAL STREAMS.	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.		MINIMUM IMPACT	
RECREATION	INCREASES WATER CONTACT SPORT OPPORTUNITIES IN THE ESTUARY. POTENTIAL INCREASE IN SPORT SHELLFISHING IN THE ESTUARY. ENHANCES SPORT FISHING AND WATER FOWL HUNTING POTENTIAL. INCREASED POTENTIAL FOR PASSIVE SPORTS SUCH AS BIRD WATCHING, WALKING ETC.	POSSIBLE INCREASE IN UPLAND GAME HUNTING AND SPORT FISHING POTENTIAL.		POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATION AREAS.	INCREASE IN TOTAL RECREATION OPPORTUNITIES.		INCREASE IN TOTAL RECREATION OPPORTUNITIES	
USE OF NATURAL RESOURCES	MINIMUM IMPACT	97,000 ACRES FOR WASTEWATER APPLICATION; 48,250 ACRES FOR SLUDGE APPLICATION; 2,150 ACRES FOR LAND TREATMENT FACILITIES; 9,800 ACRES FOR WASTEWATER STORAGE FACILITIES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	805 TONS/DAY OF TREATMENT CHEMICALS; 11,350 MEGAWATT HOURS/DAY OF POWER; 18,900 CUBIC FEET/DAY OF NATURAL GAS ARE REQUIRED. 2/
SOCIAL WELL-BEING AREA VIABILITY	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 155,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	35,400 ACRES OF CROP CHANGES WOULD RESULT IN NET AVERAGE ANNUAL INCOME LOSS (1975-2025). (SEE "ECONOMIC" FOR INCOME CHANGES). POTENTIAL ORCHARD REPLACEMENT OF 5,830 ACRES WOULD RESULT IN NET AVERAGE ANNUAL INCOME GAIN OF $1,140 THOUSAND.	OF TOTAL POPULATION OF 9,450 IN TEN SETTLEMENTS, 3,010 JOBS POTENTIALLY AFFECTED, 200 INTERNAL AND 2,810 FRINGE POPULATION, OF WHICH NET EMPLOYMENT OF 780 AFFECTED DIRECTLY BY CROP CHANGES. POTENTIAL NET CULTURE LABOR COST (PER PRODUCTION CYCLE) LOSS OF $1.5 MILLION. OTHER FACTORS, SUCH AS ORCHARD REPLACEMENT, AGRICULTURAL SERVICE, AND HARVEST LABOR, MAY MITIGATE EMPLOYMENT AND-ECONOMIC IMPACTS. POTENTIAL AFFECT OF SYSTEM TO HELP RETAIN RURAL LIFESTYLE OF AREAS. MINIMAL HOUSING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSNIESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	20,000 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (25 PERCENT OF SITE POPULATION) AND ELDERLY (12 PERCENT OF SITE POPULATION.	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR; SOME AFFECT TO THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY AND AGRICULTURAL PRODUCTION EMPLOYMENT, ESPECIALLY IN NORTHERN PART OF STATE.	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR.
PUBLIC ATITUDES	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	CONCERN OF SYSTEM TO FORCE SIGNIFICANT ALTERATION TO FARM OPERATION AND INCOME, AS WELL AS HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	CONCERN OF SYSTEM TO FORCE ALTERATION OF RURAL LIFE-STYLE, AS WELL AS JOB AND HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION, DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS. CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.	OPPOSITION FROM MONTEREY COUNTY INTERESTS TO THE CONCEPT OF INTERBASIN TRANSPORT OF TREATED WASTEWATER.	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.
DISTRIBUTIVE EQUITY (CONSTRUCTION, OPERATION & MAINTENANCE WAGES)		POTENTIAL OF 28 MILLION MAN DAYS OR MORE NEEDED FOR SYSTEM CONSTRUCTION. SUCH WAGES INCLUDE: $1,601 MILLION FOR TOTAL SYSTEM, $256 MILLION FOR MINORITY SHARE OF TOTAL, $882 MILLION FOR CONSTRUCTION ITSELF, AND $244 MILLION FOR MINORITY SHARE OF CONSTRUCTION. POTENTIAL O&M EMPLOYMENT OF SYSTEM IN PLACE WOULD BE 5,000 TO 7,000, ANNUAL O&M WAGES WOULD BE $121 MILLION.			CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	POTENTIAL IMMIGRATION OF SOME CONSTRUCTION WORKERS, ESPECIALLY FROM NORTHERN PARTS OF STATE, DUE TO POTENTIAL SIGNIFICANT SHARE OF EMPLOYMENT WAGES FOR BOTH CONSTRUCTION AND O&M.	CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	MINIMUM IMPACT	MATERIAL MANUFACTURERS, AND TRANSPORTATION INDUSTRY INTERESTED IN SHARE OF SYSTEM CONSTRUCTION.
PUBLIC HEALTH	THIS ALTERNATIVE MINIMIZES URBAN WASTEWATER AS A SOURCE OF TOXIC METAL CONTAMINATION IN THE ESTUARY THROUGH PROJECT YEAR 2000. PROVIDES GREATER CONTROL OF WATERBORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMAL POPULATIONS, AND INCREASE THE POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION. THE POTENTIAL EXISTS FOR GREATER CONTROL OF AGRICULTURAL CONTAMINANTS HAZARDOUS TO HEALTH.		MINIMUM IMPACT	THIS ALTERNATIVE WILL ENHANCE THE COMMERCIAL SHELLFISHING INDUSTRY IN ESTUARINE AND OCEAN WATERS.	MEETS THE APPROPRIATE REGULATIONS OF CALIFORNIA STATE HEALTH AGENCIES.		MEETS THE APPROPRIATE REGULATIONS OF FEDERAL HEALTH AGENCIES.	
ECONOMIC 1/ 2/ PROJECT COSTS ($1000)	CAPITAL COST $360,000 AMORTIZ. $ 22,000 O&M 280,000 REPL. 30,000 TOTAL A. A. COST $332,000	PORTIONS OF THE GENERAL POPULATION COSTS WOULD BE BORNE BY LOCAL LANDOWNERS EQUIVALENT TO THEIR NORMAL COSTS FOR INSTALLING AND OPERATING CONVENTIONAL IRRIGATION SYSTEMS.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	CAPITAL COST $360,000 AMORTIZ. $22,000 TOTAL A. A. COST $ 22,000		CAPITAL COST $2,180,000 AMORTIZ. $128,000 TOTAL A. A. COST $128,000	
AGRICULTURAL PRODUCTION	SEE GENERAL POPULATION, UNITED STATES.	RESTRICTED TO GROWING ONLY HIGH NITROGEN USING CROPS, AND CROPS WHICH ARE NOT EATEN RAW. WASTEWATER & DRAIN APPLICATION SYSTEM INSTALLED ON FARMERS PROPERTY, WILL BE COMPENSATED ON AVERAGE $40 PER ACRE PER YEAR FOR ANY INCONVENIENCE OR LOSSES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $671,[illegible]. INCOME GAIN AT YEAR 2000 OF $120,000.	MINIMUM IMPACT
PUBLIC FINANCE	TAX LOSS FOR PURCHASED LANDS $165,000.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
LAND VALUES	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
RECLAMATION OF RESOURCES	MINIMUM IMPACT	PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 97,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,420,000 PER YEAR.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
INSTITUTIONAL	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY EXISTING OR SLIGHTLY MODIFIED INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT OR CREATION OF A NEW WASTEWATER MANAGEMENT AGENCY ARE POSSIBILITIES. ONLY ONE INSTITUTIONAL AGENCY SHOULD CONTROL ANY ONE LAND APPLICATION SUBSYSTEM.			MINIMUM IMPACT	MINIMUM IMPACT	IN GENERAL, STATE STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.		IN GENERAL, FEDERAL STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.	

1/ THE FOLLOWING ASSUMPTIONS WERE MADE IN APPORTIONING PROJECT COSTS:

a. COST SHARING FOR FIRST COST (AND AMORTIZATION) WAS 12.5 PERCENT LOCAL, 12.5 PERCENT STATE OF CALIFORNIA AND 75 PERCENT FEDERAL.

b. REPLACEMENT AND OPERATION AND MAINTENANCE COSTS WERE CONSIDERED TO BE LOCAL RESPONSIBILITY.

2/ VALUES ARE INCREMENTAL TO THE BASE CONDITION.

FIGURE 12

SUMMARY OF IMPACTS PRODUCED BY ALTERNATIVE D-1

IMPACT PARAMETERS	SAN FRANCISCO BAY-DELTA REGION					CALIFORNIA		UNITED STATES	
	GENERAL POPULATION	SITE POPULATION		CONVEYANCE LINE POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS
		FARMERS	SETTLEMENTS						
ENVIRONMENTAL QUALITY CHEMICAL/PHYSICAL FACTORS	PROVIDES BEST PRACTICABLE TREATMENT TECHNOLOGY IN PROJECT YEAR 2000. NINETY-EIGHT PERCENT REMOVAL OF PHOSPHORUS, NITROGEN AND B.O.D.	SLIGHT INCREASE IN T.D.S. OF LOCAL STREAMS. POSSIBLE INCREASE IN T.D.S. OF GROUNDWATERS. CHANGE IN LAND USE AND CROPPING PATTERNS IN LAND AREAS AND PLACEMENT OF BUFFER ZONES.		REQUIRES ABOUT 450 MILES OF PIPELINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	MEETS WATER QUALITY PLANNING OBJECTIVES OF REGIONAL PLANNING AGENCIES. ASSISTS IN INSURING OPEN SPACE PRESERVES.	MEETS THE INTENT AND TIME PHASING GOALS OF THE STATE WATER RESOURCES CONTROL BOARD.		MEETS THE INTENT AND TIME PHASING GOALS OF PUBLIC LAW 92-500.	
ECOLOGICAL	IMPROVES WATER QUALITY IN THE ESTUARY, HENCE ENHANCES THE VIABILITY OF THE REGION'S ESTUARINE FISH AND WILDLIFE RESOURCES. ALLOWS NATURAL REJUVENATION OF WATERWAYS.	POTENTIAL IMPROVEMENT OF HABITAT FOR DESIRABLE SMALL GAME SPECIES. INSURES OPEN SPACE PRESERVES. PROVIDES ADDITIONAL BODIES OF WATER AND NEW WATER SOURCES.		TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.	CONTRIBUTES TO OVERALL GOAL OF REDUCING THE POLLUTION OF THE INLAND AND OCEAN WATERS OF CALIFORNIA.		CONTRIBUTES TO THE MAINTENANCE OF NATIONAL WATERFOWL SPECIES. CONTRIBUTES TO NATIONAL ENVIRONMENTAL QUALITY GOALS.	
AESTHETIC	ENHANCES THE ESTUARY BY REDUCING THE POTENTIAL FOR ALGAL BLOOMS. ELIMINATES UNSLIGHTLY SEWAGE OUTFALL PLUMES. INSURES OPEN SPACE GREEN AREAS.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS. IMPROVEMENTS MAY, IN SOME MINDS, INFRINGE UPON NATURAL AESTHETIC VALUES.		INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION IN SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS.	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.		MINIMUM IMPACT	
RECREATION	INCREASES WATER CONTACT SPORT OPPORTUNITIES IN THE ESTUARY. POTENTIAL INCREASE IN SPORT SHELLFISHING IN THE ESTUARY. ENHANCES SPORT FISHING AND WATER FOWL HUNTING POTENTIAL. INCREASED POTENTIAL FOR PASSIVE SPORTS SUCH AS BIRD WATCHING, WALKING ETC.	POSSIBLE INCREASE IN UPLAND GAME HUNTING AND SPORT FISHING POTENTIAL.		POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATION AREAS.	INCREASE IN TOTAL RECREATION OPPORTUNITIES.		INCREASE TOTAL RECREATION OPPORTUNITIES.	
USE OF NATURAL RESOURCES	MINIMUM IMPACT	148,330 ACRES FOR WASTEWATER APPLICATION; 47,868 ACRES FOR SLUDGE APPLICATION; 2,884 ACRES FOR LAND TREATMENT FACILITIES; 14,331 ACRES FOR WASTEWATER STORAGE FACILITIES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT		MINIMUM IMPACT	765 TONS/DAY OF TREATMENT CHEMICALS; 13,100 MEGAWATT HOURS/DAY OF POWER; 20,550 CUBIC FEET/DAY OF NATURAL GAS ARE REQUIRED. 2/
SOCIAL WELL-BEING AREA VIABILITY	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 210,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	54,230 ACRES OF CROP CHANGES WOULD RESULT IN NET AVERAGE ANNUAL INCOME LOSS (1975 - 2025). (SEE "ECONOMIC" FOR INCOME CHANGES). POTENTIAL ORCHARD REPLACEMENT OF 5,700 ACRES WOULD RESULT IN NET AVERAGE ANNUAL INCOME GAIN OF 1,122 THOUSAND.	OF TOTAL POPULATION OF 9,450 IN TEN SETTLEMENTS, 3,010 POTENTIALLY AFFECTED, 200 INTERNAL AND 2,810 FRINGE POPULATION, OF WHICH NET EMPLOYMENT OF 780 AFFECTED DIRECTLY BY CROP CHANGES. POTENTIAL NET CULTURE LABOR COST (PER PRODUCTION CYCLE) LOSS OF $1.3 MILLION. OTHER FACTORS, SUCH AS ORCHARD REPLACEMENT, AGRICULTURAL SERVICE, AND HARVEST LABOR, MAY MITIGATE EMPLOYMENT AND ECONOMIC IMPACTS. POTENTIAL AFFECT OF SYSTEM TO HELP RETAIN RURAL LIFE-STYLE OF AREAS. MINIMAL HOUSING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSINESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	34,000 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (25 PERCENT OF SITE POPULATION) AND ELDERLY (12 PERCENT OF SITE POPULATION).	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR; SOME EFFECT TO THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY AND AGRICULTURAL PRODUCTION EMPLOYMENT, ESPECIALLY IN NORTHERN PART OF STATE.	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR.
PUBLIC ATTITUDES	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	CONCERN OF SYSTEM TO FORCE SIGNIFICANT ALTERATION TO FARM OPERATION AND INCOME, AS WELL AS HOUSING DISRUPTION. POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	CONCERN OF SYSTEM TO FORCE ALTERATION OF RURAL LIFE-STYLE, AS WELL AS JOB AND HOUSING DISRUPTION. POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION, DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS. CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.
DISTRIBUTIVE EQUITY (CONSTRUCTION, OPERATION & MAINTENANCE WAGES)		POTENTIAL OF 36 MILLION MAN DAYS OR MORE NEEDED FOR SYSTEM CONSTRUCTION. SUCH WAGES INCLUDE: $2,070 MILLION FOR TOTAL SYSTEM, $331 MILLION FOR MINORITY SHARE OF TOTAL. $1,140 MILLION FOR CONSTRUCTION ITSELF, AND $290 MILLION FOR MINORITY SHARE OF CONSTRUCTION. POTENTIAL O&M EMPLOYMENT OF SYSTEM IN PLACE WOULD BE 7,000 TO 9,000. ANNUAL O&M WAGES WOULD BE $129 MILLION.			CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	POTENTIAL IMMIGRATION OF SOME CONSTRUCTION WORKERS, ESPECIALLY FROM NORTHERN PARTS OF STATE, DUE TO POTENTIAL SIGNIFICANT SHARE OF EMPLOYMENT WAGES FOR BOTH CONSTRUCTION AND O&M.	CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	MINIMUM IMPACT	MATERIAL MANUFACTURERS AND TRANSPORTATION INDUSTRY INTERESTED IN SHARE OF SYSTEM CONSTRUCTION.
PUBLIC HEALTH	THIS ALTERNATIVE MINIMIZES URBAN WASTEWATER AS A SOURCE OF TOXIC METAL CONTAMINATION IN THE ESTUARY THROUGH PROJECT YEAR 2000. PROVIDES GREATER CONTROL OF WATERBORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMAL POPULATIONS, AND INCREASE THE POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION. THE POTENTIAL EXISTS FOR GREATER CONTROL OF AGRICULTURAL CONTAMINANTS HAZARDOUS TO HEALTH.		MINIMUM IMPACT	THIS ALTERNATIVE WILL ENHANCE THE COMMERICAL SHELLFISHING INDUSTRY IN ESTUARINE AND OCEAN WATERS.	MEETS THE APPROPRIATE REGULATIONS OF CALIFORNIA STATE HEALTH AGENCIES		MEETS THE APPROPRIATE REGULATIONS OF FEDERAL HEALTH AGENCIES.	
ECONOMIC 1/ 2/ PROJECT COSTS ($1000)	CAPITAL COST $375,000 AMORTIZ. $22,000 O&M 231,000 REPL. 28,000 TOTAL A. A. COST $281,000	PORTIONS OF THE GENERAL POPULATION COSTS WOULD BE BORNE BY LOCAL LANDOWNERS EQUIVALENT TO THEIR NORMAL COSTS FOR INSTALLING AND OPERATING CONVENTIONAL IRRIGATION SYSTEMS.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	CAPITAL COST $375,000 AMORTIZ $22,000 TOTAL A. A. COST $ 22,000		CAPITAL COST $2,250,000 AMORTIZ $134,000 TOTAL A. A. COST $ 134,000	
AGRICULTURAL PRODUCTION	SEE GENERAL POPULATION, UNITED STATES	RESTRICTED TO GROWING ONLY HIGH NITROGEN USING CROPS, AND CROPS WHICH ARE NOT EATEN RAW. WASTEWATER & DRAIN APPLICATION SYSTEM INSTALLED ON FARMERS PROPERTY WILL BE COMPENSATED ON AVERAGE $40 PER ACRE PER YEAR FOR ANY INCONVENIENCE OR LOSSES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $684,000. INCOME GAIN AT YEAR 2000 OF $691,000	MINIMUM IMPACT
PUBLIC FINANCE	TAX LOSS FOR PURCHASED LANDS $287,000.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
LAND VALUES	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
RECLAMATION OF RESOURCES	MINIMUM IMPACT	PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 148,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,990,000 PER YEAR.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
INSTITUTIONAL	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY EXISTING OR SLIGHTLY MODIFIED INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT OR CREATION OF A NEW WASTEWATER MANAGEMENT AGENCY ARE POSSIBILITIES. ONLY ONE INSTITUTIONAL AGENCY SHOULD CONTROL ANY ONE LAND APPLICATION SUBSYSTEM.			MINIMUM IMPACT	MINIMUM IMPACT	IN GENERAL, STATE STATUES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.		IN GENERAL, FEDERAL STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.	

1/ THE FOLLOWING ASSUMPTIONS WERE MADE IN APPORTIONING PROJECT COSTS:

A. COST SHARING FOR FIRST COST (AND AMORTIZATION) WAS 12.5 PERCENT LOCAL, 12.5 PERCENT STATE OF CALIFORNIA AND 75 PERCENT FEDERAL.

B. REPLACEMENT AND OPERATION AND MAINTENANCE COSTS WERE CONSIDERED TO BE LOCAL RESPONSIBILITY.

2/ VALUES ARE INCREMENTAL TO THE BASE CONDITION.

FIGURE 13

SUMMARY OF IMPACTS PRODUCED BY ALTERNATIVE D-2

IMPACT PARAMETERS	SAN FRANCISCO BAY-DELTA REGION					CALIFORNIA		UNITED STATES	
	GENERAL POPULATION	SITE POPULATION		CONVEYANCE LINE POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS
		FARMERS	SETTLEMENTS						
ENVIRONMENTAL QUALITY CHEMICAL/PHYSICAL FACTORS	PROVIDES NO INCREASE IN THE QUANTITY OF INDIVIDUAL CONSTITUENTS DISCHARGED TO EACH WATER QUALITY ZONE OVER THE 1975 BASE CONDITION.	SLIGHT INCREASE IN T.D.S. OF LOCAL STREAMS. POSSIBLE INCREASE IN T.D.S. OF GROUNDWATERS. CHANGE IN LAND USE AND CROPPING PATTERNS IN LAND AREAS AND PLACEMENT OF BUFFER ZONES.		REQUIRES ABOUT 450 MILES OF PIPELINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	MEETS SHORT-RANGE WATER QUALITY PLANNING OBJECTIVES OF REGIONAL PLANNING AGENCIES. ASSISTS IN INSURING OPEN SPACE PRESERVES.	MEETS SHORT-RANGE GOALS OF STATE WATER RESOURCES CONTROL BOARD.		LAND TREATMENT COMPONENT MEETS LONG-RANGE GOALS OF PUBLIC LAW 92-500. TREATMENT PLANT COMPONENT DOES NOT. OVERALL, THE ALTERNATIVE MEETS PL 92-500 REQUIREMENTS UNTIL 1983.	
ECOLOGICAL	STABLIZES POLLUTION ORIENTED ECOLOGICAL STRESS ON ESTUARINE FISH AND WILDLIFE RESOURCES. LIMITED NATURAL REJUVENATION OF WATERWAYS.	POTENTIAL IMPROVEMENT OF HABITAT FOR DESIRABLE SMALL GAME SPECIES. INSURES OPEN SPACE PRESERVES. PROVIDES ADDITIONAL BODIES OF WATER AND NEW WATER SOURCES.		TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.	CONTRIBUTES TO REDUCING POLLUTION OF GREATEST MOMENT IN THE STATE.		CONTRIBUTES TO THE MAINTANCE OF NATIONAL WATERFOWL SPECIES, CONTRIBUTES TO NATIONAL ENVIRONMENTAL QUALITY GOALS.	
AESTHETIC	ENHANCES THE ESTUARY BY REDUCING THE POTENTIAL FOR ALGAL BLOOMS. ELIMINATES UNSLIGHTLY SEWAGE OUTFALL PLUMES. INSURES OPEN SPACE GREEN AREAS.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS. IMPROVEMENTS MAY, IN SOME MINDS, INFRINGE UPON NATURAL AESTHETIC VALUES.		INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION IN SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS.	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.		MINIMUM IMPACT	
RECREATION	INCREASES WATER CONTACT SPORT OPPORTUNITIES IN THE ESTUARY. POTENTIAL INCREASE IN SPORT SHELL-FISHING IN THE ESTUARY. ENHANCES SPORT FISHING AND WATER FOWL HUNTING POTENTIAL. INCREASED POTENTIAL FOR PASSIVE SPORTS SUCH AS BIRD WATCHING, WALKING ETC.	POSSIBLE INCREASE IN UPLAND GAME HUNTING AND SPORT FISHING POTENTIAL.		POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATION AREAS.	INCREASE IN TOTAL RECREATION OPPORTUNITIES.		INCREASE IN TOTAL RECREATION OPPORTUNITIES.	
USE OF NATURAL RESOURCES	MINIMUM IMPACT	148,300 FOR WASTEWATER APPLICATION; 46,868 ACRES FOR SLUDGE APPLICATION; 2,884 ACRES FOR LAND TREATMENT FACILITIES; 14,331 ACRES FOR WASTEWATER STORAGE FACILITIES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	80 TONS/DAY OF TREATMENT CHEMICALS; 11,900 MEGAWATT HOURS/DAY OF POWER; 20,550 CUBIC FEET/DAY OF NATURAL GAS ARE REQUIRED.
SOCIAL WELL-BEING AREA VIABILITY	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 209,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	54,230 ACRES OF CROP CHANGES WOULD RESULT IN NET AVERAGE ANNUAL INCOME LOSS (1975-2025). (SEE "ECONOMIC" FOR INCOME CHANGES). POTENTIAL ORCHARD REPLACEMENT OF 5,700 ACRES WOULD RESULT IN NET AVERAGE ANNUAL INCOME GAIN OF $1,122 THOUSAND.	OF TOTAL POPULATION OF 9,450 IN TEN SETTLEMENTS, 3,010 JOBS POTENTIALLY AFFECTED, 200 INTERNAL AND 2,810 FRINGE POPULATION, OF WHICH NET EMPLOYMENT OF 780 AFFECTED DIRECTLY BY CROP CHANGES. POTENTIAL NET CULTURE LABOR COST (PER PRODUCTION CYCLE) LOSS OF $1.3 MILLION. OTHER FACTORS, SUCH AS ORCHARD REPLACEMENT, AGRICULTURAL SERVICE, AND HARVEST LABOR, MAY MITIGATE EMPLOYMENT AND ECONOMIC IMPACTS. POTENTIAL AFFECT OF SYSTEM TO HELP RETAIN RURAL LIFE-STYLE OF AREAS. MINIMAL HOUSING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSINESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	34,000 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (25 PERCENT OF SITE POPULATION) AND ELDERLY (12 PERCENT OF SITE POPULATION).	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR; SOME EFFECT TO THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY AND AGRICULTURAL PRODUCTION EMPLOYMENT, ESPECIALLY IN NORTHERN PART OF STATE.	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR.
PUBLIC ATTITUDES	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	CONCERN OF SYSTEM TO FORCE SIGNIFICANT ALTERATION TO FARM OPERATION AND INCOME, AS WELL AS HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	CONCERN OF SYSTEM TO FORCE ALTERATION OF RURAL LIFE-STYLE, AS WELL AS JOB AND HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION, DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS. CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.
DISTRIBUTIVE EQUITY (CONSTRUCTION OPERATION & MAINTENANCE WAGES)		POTENTIAL OF 30 MILLION MAN DAYS OR MORE NEEDED FOR SYSTEM CONSTRUCTION. SUCH WAGES INCLUDE: $1,725 MILLION FOR TOTAL SYSTEM, $276 MILLION FOR MINORITY SHARE OF TOTAL, $950 MILLION FOR CONSTRUCTION ITSELF, AND $241 MILLION FOR MINORITY SHARE OF CONSTRUCTION. POTENTIAL O&M EMPLOYMENT OF SYSTEM IN PLACE WOULD BE 7,000 TO 9,000. ANNUAL O&M WAGES WOULD BE $105 MILLION.			CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	POTENTIAL IMMIGRATION OF SOME CONSTRUCTION WORKERS, ESPECIALLY FROM NORTHERN PARTS OF STATE, DUE TO POTENTIAL SIGNIFICANT SHARE OF EMPLOYMENT WAGES FOR BOTH CONSTRUCTION AND O&M.	CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	MINIMUM IMPACT	MATERIAL MANUFACTURERS AND TRANSPORTATION INDUSTRY INTERESTED IN SHARE OF SYSTEM CONSTRUCTION.
PUBLIC HEALTH	THIS ALTERNATIVE MINIMIZES URBAN WASTEWATER AS A SOURCE OF TOXIC METAL CONTAMINATION IN THE ESTUARY ON A SHORT-TERM BASIS. PROVIDES GREATER CONTROL OF WATERBORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMAL POPULATIONS, AND INCREASE THE POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION. THE POTENTIAL EXISTS FOR GREATER CONTROL OF AGRICULTURAL CONTAMINANTS HAZARDOUS TO HEALTH.		MINIMUM IMPACT	THIS ALTERNATIVE WILL ENHANCE THE COMMERCIAL SHELLFISHING INDUSTRY IN ESTUARINE AND OCEAN WATERS.	MEETS THE APPROPRIATE REGULATIONS OF CALIFORNIA STATE HEALTH AGENCIES.		MEETS THE APPROPRIATE REGULATIONS OF FEDERAL HEALTH AGENCIES.	
ECONOMIC 1/ 2/ PROJECT COSTS ($1000)	CAPITAL COST $310,000 AMORTIZ. $20,000 O&M 185,000 REPL. 24,000 TOTAL A. A. COST $229,000	PORTIONS OF THE GENERAL POPULATION COSTS WOULD BE BORNE BY LOCAL LANDOWNERS EQUIVALENT TO THEIR NORMAL COSTS FOR INSTALLING AND OPERATING CONVENTIONAL IRRIGATION SYSTEMS.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	CAPITAL COST $310,000 AMORTIZ. $20,000 TOTAL A. A. COST $ 20,000		CAPITAL COST $1,880,000 AMORTIZ. $117,000 TOTAL A. A. COST $ 117,000	
AGRICULTURAL PRODUCTION	SEE GENERAL POPULATION, UNITED STATES	RESTRICTED TO GROWING ONLY HIGH NITROGEN USING CROPS AND CROPS WHICH ARE NOT EATEN RAW. WASTEWATER AND DRAIN APPLICATION SYSTEM INSTALLED ON FARMERS PROPERTY WILL BE COMPENSATED ON AVERAGE $40 PER ACRE PER YEAR FOR ANY INCONVENIENCE OR LOSSES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $717,000. INCOME GAIN AT YEAR 2000 OF $644,000.	MINIMUM IMPACT
PUBLIC FINANCE	TAX LOSS FOR PURCHASED LANDS $287,000.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT		MINIMUM IMPACT	
LAND VALUES	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT		MINIMUM IMPACT	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION	MINIMUM IMPACT		MINIMUM IMPACT	
RECLAMATION OF RESOURCES	MINIMUM IMPACT	PROVIDES TREATED WASTEWATER FOR IRRIGATION OF 148,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,900,000 PER YEAR.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT		MINIMUM IMPACT	
INSTITUTIONAL	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY EXISTING OR SLIGHTLY MODIFIED INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT OR CREATION OF A NEW WASTEWATER MANAGEMENT AGENCY ARE POSSIBILITIES. ONLY ONE INSTITUTIONAL AGENCY SHOULD CONTROL ANY ONE LAND APPLICATION SUBSYSTEM.			MINIMUM IMPACT	MINIMUM IMPACT	IN GENERAL, STATE STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.		IN GENERAL, FEDERAL STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.	

1/ THE FOLLOWING ASSUMPTIONS WERE MADE IN APPORTIONING PROJECT COSTS:

A. COST SHARING FOR FIRST COST (AND AMORTIZATION) WAS 12.5 PERCENT LOCAL, 12.5 PERCENT STATE OF CALIFORNIA AND 75 PERCENT FEDERAL.

B. REPLACEMENT AND OPERATION AND MAINTENANCE COSTS WERE CONSIDERED TO BE LOCAL RESPONSIBILITY.

2/ VALUES ARE INCREMENTAL TO THE BASE CONDITION.

FIGURE 14

SUMMARY OF IMPACTS PRODUCED BY ALTERNATIVE D-3

IMPACT PARAMETERS	SAN FRANCISCO BAY-DELTA REGION					CALIFORNIA		UNITED STATES	
	GENERAL POPULATION	SITE POPULATION		CONVEYANCE LINE POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS	GENERAL POPULATION	INTEREST GROUPS
		FARMERS	SETTLEMENTS						
ENVIRONMENTAL QUALITY CHEMICAL/PHYSICAL FACTORS	PROVIDES BEST PRACTICABLE TREATMENT TECHNOLOGY IN PROJECT YEAR 2000. NINETY-EIGHT PERCENT REMOVAL OF PHOSPHORUS, NITROGEN AND B.O.D.	SLIGHT INCREASE IN T.D.S. OF LOCAL STREAMS. POSSIBLE INCREASE IN T.D.S. OF GROUNDWATERS. CHANGE IN LAND USE AND CROPPING PATTERNS IN LAND AREAS AND PLACEMENT OF BUFFER ZONES.		REQUIRES ABOUT 490 MILES OF PIPELINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	MEETS WATER QUALITY PLANNING OBJECTIVES OF REGIONAL PLANNING AGENCIES. ASSISTS IN INSURING OPEN SPACE PRESERVES.	MEETS THE INTENT AND TIME PHASING GOALS OF THE STATE WATER RESOURCES CONTROL BOARD.		MEETS THE INTENT AND TIME PHASING GOALS OF PUBLIC LAW 92-500.	
ECOLOGICAL	IMPROVES WATER QUALITY IN THE ESTUARY, HENCE ENHANCES THE VIABILITY OF THE REGION'S ESTUARINE FISH AND WILDLIFE RESOURCES. ALLOWS NATURAL REJUVENATION OF WATERWAYS.	POTENTIAL IMPROVEMENT OF HABITAT FOR DESIRABLE SMALL GAME SPECIES. INSURES OPEN SPACE PRESERVES. PROVIDES ADDITIONAL BODIES OF WATER AND NEW WATER SOURCES.		TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.	CONTRIBUTES TO OVERALL GOAL OF REDUCING THE POLLUTION OF THE INLAND AND OCEAN WATERS OF CALIFORNIA.		CONTRIBUTES TO THE MAINTANCE OF NATIONAL WATERFOWL SPECIES. CONTRIBUTES TO NATIONAL ENVIRONMENTAL QUALITY GOALS.	
AESTHETIC	ENHANCES THE ESTUARY BY REDUCING THE POTENTIAL FOR ALGAL BLOOMS. ELIMINATES UNSIGHTLY SEWAGE OUTFALL PLUMES. INSURES OPEN SPACE GREEN AREAS.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS. IMPROVEMENTS MAY, IN SOME MINDS, INFRINGE UPON NATURAL AESTHETIC VALUES.		INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION IN SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS; INCREASES FLOW IN LOCAL STREAMS.	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.		MINIMUM IMPACT	
RECREATION	INCREASES WATER CONTACT SPORT OPPORTUNITIES IN THE ESTUARY. POTENTIAL INCREASE IN SPORT SHELL-FISHING IN THE ESTUARY. ENHANCES SPORT FISHING AND WATER FOWL HUNTING POTENTIAL. INCREASED POTENTIAL FOR PASSIVE SPORTS SUCH AS BIRD WATCHING, WALKING ETC.	POSSIBLE INCREASE IN UPLAND GAME HUNTING AND SPORT FISHING POTENTIAL.		POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATION AREAS.	INCREASE IN TOTAL RECREATION OPPORTUNITIES.		INCREASE IN TOTAL RECREATION OPPORTUNITIES.	
USE OF NATURAL RESOURCES	MINIMUM IMPACT	148,000 ACRES FOR WASTEWATER APPLICATION; 42,200 ACRES FOR SLUDGE APPLICATION; 3,000 ACRES FOR LAND TREATMENT FACILITIES; 14,900 ACRES FOR WASTEWATER STORAGE FACILITIES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT		MINIMUM IMPACT	540 TONS/DAY OF TREATMENT CHEMICALS; 15,650 MEGAWATT HOURS/DAY OF POWER; 20,550 CUBIC FEET/DAY OF NATURAL GAS ARE REQUIRED. 2/
SOCIAL WELL-BEING AREA VIABILITY	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 205,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	53,880 ACRES OF CROP CHANGES WOULD RESULT IN NET AVERAGE ANNUAL INCOME LOSS (1975-2025). (SEE "ECONOMIC" FOR INCOME CHANGES). POTENTIAL ORCHARD REPLACEMENT OF 5,730 ACRES WOULD RESULT IN NET AVERAGE ANNUAL INCOME GAIN OF $1,122 THOUSAND.	OF TOTAL POPULATION OF 9,450 IN TEN SETTLEMENTS, 3,010 JOBS POTENTIALLY AFFECTED, 200 INTERNAL AND 2,810 FRINGE POPULATION, OF WHICH NET EMPLOYMENT OF 780 AFFECTED DIRECTLY BY CROP CHANGES. POTENTIAL NET CULTURE LABOR COST (PER PRODUCTION CYCLE) LOSS OF $1.3 MILLION. OTHER FACTORS, SUCH AS ORCHARD REPLACEMENT, AGRICULTURAL SERVICE, AND HARVEST LABOR, MAY MITIGATE EMPLOYMENT AND ECONOMIC IMPACTS. POTENTIAL AFFECT OF SYSTEM TO HELP RETAIN RURAL LIFE-STYLE OF AREAS. MINIMAL HOUSING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSINESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	34,000 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (25 PERCENT OF SITE POPULATION) AND ELDERLY (12 PERCENT OF SITE POPULATION).	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR; SOME EFFECT TO THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY AND AGRICULTURAL PRODUCTION EMPLOYMENT, ESPECIALLY IN NORTHERN PART OF STATE.	MINIMUM IMPACT	POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR.
PUBLIC ATTITUDES	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	CONCERN OF SYSTEM TO FORCE SIGNIFICANT ALTERATION TO FARM OPERATION AND INCOME, AS WELL AS HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	CONCERN OF SYSTEM TO FORCE ALTERATION OF RURAL LIFE-STYLE, AS WELL AS JOB AND HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION, DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS. CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.	OPPOSITION FROM MONTEREY COUNTY INTERESTS TO THE CONCEPT OF INTER-BASIN TRANSPORT OF WASTEWATER.	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.	MINIMUM IMPACT	CONCERN OF MIGRANT WORKERS OVER AGRICULTURAL JOB DEMAND ALTERATIONS DUE TO CROP CHANGES.
DISTRIBUTIVE EQUITY (CONSTRUCTION, OPERATION & MAINTENANCE WAGES)		POTENTIAL OF 33 MILLION MAN DAYS OR MORE NEEDED FOR SYSTEM CONSTRUCTION. SUCH WAGES INCLUDE: $1,844 MILLION FOR TOTAL SYSTEM, $285 MILLION FOR MINORITY SHARE OF TOTAL, $1,016 MILLION FOR CONSTRUCTION ITSELF, AND $258 MILLION FOR MINORITY SHARE OF CONSTRUCTION. POTENTIAL O&M EMPLOYMENT OF SYSTEM IN PLACE WOULD BE 5,000 TO 7,000. ANNUAL O&M WAGES WOULD BE $113 MILLION.			CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	POTENTIAL IMMIGRATION OF SOME CONSTRUCTION WORKERS, ESPECIALLY FROM NORTHERN PARTS OF STATE, DUE TO POTENTIAL SIGNIFICANT SHARE OF EMPLOYMENT WAGES FOR BOTH CONSTRUCTION AND O&M.	CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	MINIMUM IMPACT	MATERIAL MANUFACTURERS AND TRANSPORTATION INDUSTRY INTERESTED IN SHARE OF SYSTEM CONSTRUCTION.
PUBLIC HEALTH	THIS ALTERNATIVE MINIMIZES URBAN WASTEWATER AS A SOURCE OF TOXIC METAL CONTAMINATION IN THE ESTUARY THROUGH PROJECT YEAR 2000. PROVIDES GREATER CONTROL OF WATERBORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMAL POPULATIONS, AND INCREASE THE POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION. THE POTENTIAL EXISTS FOR GREATER CONTROL OF AGRICULTURAL CONTAMINANTS HAZARDOUS TO HEALTH.		MINIMUM IMPACT	THIS ALTERNATIVE WILL ENHANCE THE COMMERCIAL SHELLFISHING INDUSTRY IN ESTUARINE AND OCEAN WATERS.	MEETS THE APPROPRIATE REGULATIONS OF CALIFORNIA STATE HEALTH AGENCIES.		MEETS THE APPROPRIATE REGULATIONS OF FEDERAL HEALTH AGENCIES.	
ECONOMIC 1/ 2/ PROJECT COSTS ($1000)	CAPITAL COST $410,000 AMORTIZ. $ 24,000 O&M 251,000 REPL. 30,000 TOTAL A. A. COST $305,000	PORTIONS OF THE GENERAL POPULATION COSTS WOULD BE BORNE BY LOCAL LANDOWNERS EQUIVALENT TO THEIR NORMAL COSTS IN INSTALLING AND OPERATING CONVENTIONAL IRRIGATION SYSTEMS.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	CAPITAL COST $410,000 AMORTIZ. $24,000 TOTAL A. A. COST $ 24,000		CAPITAL COST $2,480,000 AMORTIZ. $143,000 TOTAL A. A. COST $ 143,000	
AGRICULTURAL PRODUCTION	SEE GENERAL POPULATION, UNITED STATES.	RESTRICTED TO GROWING ONLY HIGH NITROGEN USING CROPS AND CROPS WHICH ARE NOT EATEN RAW. WASTEWATER AND DRAIN APPLICATION SYSTEM INSTALLED ON FARMERS PROPERTY WILL BE COMPENSATED ON AVERAGE $40 PER ACRE PER YEAR FOR ANY INCONVENIENCE OR LOSSES.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT		AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $711,000. INCOME GAIN AT YEAR 2000 OF $593,000.	MINIMUM IMPACT
PUBLIC FINANCE	TAX LOSS FOR PURCHASED LANDS $287,000	MINIMUM IMPACT		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT		MINIMUM IMPACT	
LAND VALUES	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT		MINIMUM IMPACT	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.	MINIMUM IMPACT		MINIMUM IMPACT	
RECLAMATION OF RESOURCES	MINIMUM IMPACT	PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 148,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,850,000 PER YEAR.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT		MINIMUM IMPACT	
INSTITUTIONAL	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY EXISTING OR SLIGHTLY MODIFIED INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT OR CREATION OF A NEW WASTEWATER MANAGEMENT AGENCY ARE POSSIBILITIES. ONLY ONE INSTITUTIONAL AGENCY SHOULD CONTROL ANY ONE LAND APPLICATION SUBSYSTEM.			MINIMUM IMPACT	MINIMUM IMPACT	IN GENERAL, STATE STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.		IN GENERAL, FEDERAL STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.	

1/ THE FOLLOWING ASSUMPTION WERE MADE IN APPORTIONING PROJECT COSTS:

a. COST SHARING FOR FIRST COST (AND AMORTIZATION) WAS 12.5 PERCENT LOCAL, 12.5 PERCENT STATE OF CALIFORNIA AND 75 PERCENT FEDERAL.

b. REPLACEMENT AND OPERATION AND MAINTENANCE COSTS WERE CONSIDERED TO BE LOCAL RESPONSIBILITY.

2/ VALUES ARE INCREMENTAL TO THE BASE CONDITION.

FIGURE 15

IPACTS PRODUCED FROM INTERBASIN TRANSFER OF WASTEWATER

ATIVE B-3			ALTERNATIVE D-3				
ON	CONVEYANCE LINE POPULATION	INTEREST GROUPS	GENERAL POPULATION	SITE POPULATION		CONVEYANCE LINE POPULATION	INTEREST GROUPS
TTLEMENTS				FARMERS	SETTLEMENTS		
ASE IN TDS OF GROUNDWATERS. D PLACEMENT OF BUFFER ZONES.	REQUIRES ABOUT 40 MILES OF PIPELINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	WOULD PROVIDE A MEANS FOR LOCAL COMPLIANCE WITH FEDERAL, STATE AND REGIONAL WATER QUALITY PLANNING OBJECTIVES. ASSISTS IN INSURING OPEN SPACE PRESERVES.	PROVIDES CAPACITY FOR LAND TREATMENT OF LOCAL WASTES. NINETY-EIGHT PERCENT REMOVAL OF PHOSPHORUS, NITROGEN AND BOD FROM WASTEWATER WOULD BE POSSIBLE.	SLIGHT INCREASE IN TDS OF LOCAL STREAMS. POSSIBLE INCREASE IN TDS OF GROUNDWATERS. CHANGE IN LAND USE AND CROPPING PATTERNS IN LAND AREAS AND PLACEMENT OF BUFFER ZONES.		REQUIRES ABOUT 40 MILES OF PIPELINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	WOULD PROVIDE A MEANS FOR LOCAL COMPLIANCE WITH FEDERAL, STATE AND REGIONAL WATER QUALITY PLANNING OBJECTIVES. ASSISTS IN INSURING OPEN SPACE PRESERVES
	TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.	POTENTIAL IMPROVEMENT OF HABITAT FOR DESIRABLE SMALL GAME SPECIES, IMPROVES EXISTING AND PROVIDES NEW AQUATIC HABITATS. INSURES OPEN SPACE AREAS.			TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.
CAL STREAMS. IMPROVEMENTS VALUES.	INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION IN SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS. INCREASES FLOW IN LOCAL STREAMS.	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.	INSURES OPEN SPACE GREEN AREAS. INCREASES FLOW IN LOCAL STREAMS. IMPROVEMENTS MAY, IN SOME MINDS, INFRINGE UPON NATURAL AESTHETIC VALUES.		INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION IN SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS. INCREASES FLOW IN LOCAL STREAMS.
S	POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATIONAL AREAS.	POTENTIAL INCREASE IN WATER-ORIENTED RECREATION, SPORT FISHING AND UPLAND GAME HUNTING OPPORTUNITIES. POTENTIAL INCREASE IN PASSIVE WATER ENHANCED ACTIVITIES SUCH AS BIRD WATCHING AND WALKING.			POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATIONAL AREAS.
FOR WASTEWATER STORAGE	MINIMUM IMPACT.	150 MEGAWATT HOURS/DAY OF POWER ARE REQUIRED.	MINIMUM IMPACT	38,000 ACRES FOR WASTEWATER APPLICATION; 5,800 ACRES FOR SLUDGE APPLICATION; 900 ACRES FOR WASTEWATER STORAGE FACILITIES.		MINIMUM IMPACT.	150 MEGAWATT HOURS/DAY OF POWER ARE REQUIRED.
ULATION OF 550 IN ONE SETTLE- OBS POTENTIALLY AFFECTED, OPULATION, OF WHICH NET EM- 120 AFFECTED DIRECTLY BY . POTENTIAL NET CULTURE (PER PRODUCTION CYCLE) LOSS SAND. OTHER FACTORS, SUCH EPLACEMENT, AGRICULTURAL HARVEST LABOR, MAY MITIGATE ND ECONOMIC IMPACTS. FECT OF SYSTEM TO HELP LIFE-STYLE OF AREAS. ING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSINESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	2,900 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (48 PERCENT OF SITE POPULATION) AND ELDERLY (6 PERCENT OF SITE POPULATION).	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 45,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	15,500 ACRES OF CROP CHANGES WOULD RESULT IN NET AVERAGE ANNUAL INCOME LOSS (1975-2025). (SEE "ECONOMIC" FOR INCOME CHANGES). POTENTIAL ORCHARD REPLACEMENT OF 270 ACRES WOULD RESULT IN NET AVERAGE ANNUAL INCOME GAIN OF $72 THOUSAND.	OF TOTAL POPULATION OF 550 IN ONE SETTLEMENT, 220 JOBS POTENTIALLY AFFECTED, ALL FRINGE POPULATION, OF WHICH NET EMPLOYMENT OF 120 AFFECTED DIRECTLY BY CROP CHANGES. POTENTIAL NET CULTURE LABOR COST (PER PRODUCTION CYCLE) LOSS OF $400 THOUSAND. OTHER FACTORS, SUCH AS ORCHARD REPLACEMENT, AGRICULTURAL SERVICE, AND HARVEST LABOR, MAY MITIGATE EMPLOYMENT AND ECONOMIC IMPACTS. POTENTIAL AFFECT OF SYSTEM TO HELP RETAIN RURAL LIFE-STYLE OF AREAS. MINIMAL HOUSING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSINESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	2,900 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (48 PERCENT OF SITE POPULATION) AND ELDERLY (6 PERCENT OF SITE POPULATION).
SYSTEM TO FORCE ALTERATION FE-STYLE, AS WELL AS JOB AND RUPTION, POTENTIAL NUISANCE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION, DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS. CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.	OPPOSITION FROM MONTEREY COUNTY INTERESTS TO THE CONCEPT OF INTERBASIN TRANSPORT OF WASTEWATER. CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION.	CONCERN OF SYSTEM TO FORCE SIGNIFICANT ALTERATION TO FARM OPERATION AND INCOME, AS WELL AS HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	CONCERN OF SYSTEM TO FORCE ALTERATION OF RURAL LIFE-STYLE, AS WELL AS JOB AND HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION, DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS, CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.
FOR SYSTEM CONSTRUCTION. TEM, $64 MILLION FOR RUCTION ITSELF, AND ULD BE ABOUT $2,000.		CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	POTENTIAL OF 7 MILLION MAN DAYS OR MORE NEEDED FOR SYSTEM CONSTRUCTION. SUCH WAGES INCLUDE: $433 MILLION FOR TOTAL SYSTEM, $79 MILLION FOR MINORITY SHARE OF TOTAL, $238 MILLION FOR CONSTRUCTION ITSELF, AND $61 MILLION FOR MINORITY SHARE OF CONSTRUCTION. POTENTIAL O&M EMPLOYMENT OF SYSTEM IN PLACE WOULD BE ABOUT $2,000. ANNUAL O&M WAGES WOULD BE $26 MILLION.				CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.
TEBRATE NUISANCE ANIMAL OTIC DISEASE TRANSMISSION NIA STATE HEALTH AGENCIES. TURAL CONTAMINANTS HAZARDOUS	MINIMUM IMPACT	MINIMUM IMPACT	PROVIDES GREATER CONTROL OF WATERBORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL INCREASE ANTHROPOD AND VERTEBRATE NUISANCE ANIMAL POPULATIONS, AND INCREASE THE POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION BUT WILL MEET APPROPRIATE REGULATIONS OF CALIFORNIA STATE HEALTH AGENCIES. THE POTENTIAL EXISTS FOR GREATER CONTROL OF AGRICULTURAL CONTAMINANTS HAZARDOUS TO HEALTH.		MINIMUM IMPACT	MINIMUM IMPACT
MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	BASIN POPULATION WILL BEAR A PORTION OF STATE COSTS ($24 MILLION, FIGURE 15).	PORTIONS OF THE BASIN'S GENERAL POPULATION COST WILL BE BORNE BY LOCAL LANDOWNERS EQUIVALENT TO THEIR NORMAL COSTS FOR INSTALLING AND OPERATING CONVENTIONAL IRRIGATION SYSTEMS.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
AND CROPS WHICH ARE NOT NSTALLED ON FARMERS PER YEAR FOR ANY IN-	MINIMUM IMPACT	MINIMUM IMPACT	AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $519,000. INCOME LOSS AT YEAR 2000 OF $227,000.	RESTRICTED TO GROWING ONLY HIGH NITROGEN USING CROPS AND CROPS WHICH ARE NOT EATEN RAW. WASTEWATER AND DRAIN APPLICATION SYSTEM INSTALLED ON FARMERS PROPERTY WILL BE COMPENSATED ON AVERAGE $40 PER ACRE PER YEAR FOR ANY INCONVENIENCE OR LOSSES.		MINIMUM IMPACT	MINIMUM IMPACT
MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	TAX LOSS FOR PURCHASED LANDS $30,000.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT
OF 38,000 ACRES. $380,000 PER YEAR.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 38,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION $450,000 PER YEAR.		MINIMUM IMPACT	MINIMUM IMPACT
	MINIMUM IMPACT	MINIMUM IMPACT	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY EXISTING OR SLIGHTLY MODIFIED INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT OR CREATION OF A NEW WASTEWATER MANAGEMENT AGENCY ARE POSSIBILITIES. ONLY ONE INSTITUTIONAL AGENCY SHOULD CONTROL ANY ONE LAND APPLICATION SUBSYSTEM. IN GENERAL, STATE AND FEDERAL STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.			MINIMUM IMPACT	MINIMUM IMPACT

FIGURE 16

SUMMARY OF IMPACTS PRODUCED FROM INTERBASIN TRANSFER

IMPACT PARAMETERS	ALTERNATIVE B-3						
	GENERAL POPULATION	SITE POPULATION		CONVEYANCE LINE POPULATION	INTEREST GROUPS	GENERAL POPULATION	FARME
		FARMERS	SETTLEMENTS				
ENVIRONMENTAL QUALITY CHEMICAL/PHYSICAL FACTORS	PROVIDES CAPACITY FOR LAND TREATMENT OF LOCAL WASTES. NINETY-EIGHT PERCENT REMOVAL OF PHOSPHORUS, NITROGEN AND BOD FROM WASTEWATER WOULD BE POSSIBLE.	SLIGHT INCREASE IN TDS OF LOCAL STREAMS. POSSIBLE INCREASE IN TDS OF GROUNDWATERS. CHANGE IN LAND USE AND CROPPING PATTERNS IN LAND AREA AND PLACEMENT OF BUFFER ZONES.		REQUIRES ABOUT 40 MILES OF PIPELINE. SHORT-TERM DISRUPTION OF PHYSICAL FEATURES DUE TO CONSTRUCTION.	WOULD PROVIDE A MEANS FOR LOCAL COMPLIANCE WITH FEDERAL, STATE AND REGIONAL WATER QUALITY PLANNING OBJECTIVES. ASSISTS IN INSURING OPEN SPACE PRESERVES.	PROVIDES CAPACITY FOR LAND TREATMENT OF LOCAL WASTES. NINETY-EIGHT PERCENT REMOVAL OF PHOSPHORUS, NITROGEN AND BOD FROM WASTEWATER WOULD BE POSSIBLE.	SLIGHT INCREASE IN WATERS. CHANGE IN OF BUFFER ZONES.
ECOLOGICAL	POTENTIAL IMPROVEMENT OF HABITAT FOR DESIRABLE SMALL GAME SPECIES. IMPROVES EXISTING AND PROVIDES NEW AQUATIC HABITATS. INSURES OPEN SPACE AREAS.			TEMPORARY INCREASE IN NOISE AND DUST DURING CONSTRUCTION WITH ASSOCIATED EFFECTS ON WILDLIFE.	PROVIDES WATER AND RESOURCE RECYCLING. PROMOTES WILDLIFE MANAGEMENT.	POTENTIAL IMPROVEMENT OF HABITAT FOR DE EXISTING AND PROVIDES NEW AQUATIC HABITATS	
AESTHETIC	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.	INSURES OPEN SPACE GREEN AREAS, INCREASES FLOW IN LOCAL STREAMS. IMPROVEMENTS MAY, IN SOME MINDS, INFRINGE UPON NATURAL AESTHETIC VALUES.		INCREASED CONSTRUCTION ACTIVITY. POTENTIAL FOR DEVELOPMENT OF GREEN BELTS. POSSIBLE REDUCTION IN SCENIC VALUES.	INSURES OPEN SPACE GREEN AREAS. INCREASED FLOW IN LOCAL STREAMS.	COMPATIBLE WITH CALIFORNIA PROTECTED WATERWAYS PLAN AND CALIFORNIA SCENIC HIGHWAY PLAN.	INSURES OPEN SPACE MAY, IN SOME MINDS,
RECREATION	POTENTIAL INCREASE IN WATER-ORIENTED RECREATION, SPORT FISHING AND UPLAND GAME HUNTING OPPORTUNITIES. POTENTIAL INCREASE IN PASSIVE WATER ENHANCED ACTIVITIES SUCH AS BIRD WATCHING AND WALKING.			POTENTIAL FOR WALKING AND BICYCLING PATHS, AND MINI-PARKS.	INCREASED USE OF EXISTING AND NEWLY DEVELOPED WATER BASED RECREATIONAL AREAS.	POTENTIAL INCREASE IN WATER-ORIENTED REC HUNTING OPPORTUNITIES. POTENTIAL INCREA SUCH AS BIRD WATCHING AND WALKING.	
USE OF NATURAL RESOURCES	MINIMUM IMPACT	38,000 ACRES FOR WASTEWATER APPLICATION, 900 ACRES FOR WASTEWATER STORAGE FACILITIES.		MINIMUM IMPACT.	150 MEGAWATT HOURS/DAY OF POWER ARE REQUIRED.	MINIMUM IMPACT	38,000 ACRES FOR WA 900 ACRES FOR WASTEWA
SOCIAL WELL-BEING AREA VIABILITY	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 39,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	15,500 ACRES OF CROP CHANGES WOULD RESULT IN NET AVERAGE ANNUAL INCOME LOSS (1975-2025). (SEE "ECONOMIC" FOR INCOME CHANGES). POTENTIAL ORCHARD REPLACEMENT OF 270 ACRES WOULD RESULT IN NET AVERAGE ANNUAL INCOME GAIN OF $72 THOUSAND.	OF TOTAL POPULATION OF 550 IN ONE SETTLEMENT, 220 JOBS POTENTIALLY AFFECTED, ALL FRINGE POPULATION, OF WHICH NET EMPLOYMENT OF 120 AFFECTED DIRECTLY BY CROP CHANGES. POTENTIAL NET CULTURE LABOR COST (PER PRODUCTION CYCLE) LOSS OF $400 THOUSAND. OTHER FACTORS, SUCH AS ORCHARD REPLACEMENT, AGRICULTURAL SERVICE, AND HARVEST LABOR, MAY MITIGATE EMPLOYMENT AND ECONOMIC IMPACTS. POTENTIAL AFFECT OF SYSTEM TO HELP RETAIN RURAL LIFE-STYLE OF AREAS. MINIMAL HOUSING DISRUPTION.	IMPACT BASICALLY TRANSITORY, WITH SOME POTENTIAL BUSINESS INCOME LOSS IN IMMEDIATE VICINITY OF ALIGNMENT DURING CONSTRUCTION PHASE DUE TO ACCESS DISRUPTION. POTENTIAL ENHANCEMENT OF COMMUNITY COHESION WITH PERMANENT MISC. FACILITIES OF PARKS AND OPEN SPACE. POSSIBLE MINOR HOUSING DISRUPTION WITHIN URBAN CORE AREAS OF ALIGNMENT.	2,900 ACRES OF THE CROP CHANGES WOULD PARTICULARLY AFFECT THE ECONOMIC AND OPERATION CHARACTER OF FOOD PROCESSING INDUSTRY. POTENTIAL ALTERATION OF WORKER DEMAND FOR MIGRANT LABOR. PARTICULARLY VULNERABLE GROUPS WITHIN SITES AFFECTED BY JOB AND/OR RELOCATION DISRUPTION INCLUDE MINORITY (48 PERCENT OF SITE POPULATION) AND ELDERLY (6 PERCENT OF SITE POPULATION).	SYSTEM COULD POTENTIALLY HELP TO IMPLEMENT GENERAL LAND USE AND DEVELOPMENT PATTERN POLICIES. 45,000 ACRES OF SYSTEM USED LAND WOULD BE DEDICATED TO USES THAT WOULD INSURE RETENTION AS OPEN SPACE.	15,500 ACRES OF CR RESULT IN NET AVERA LOSS (1975-2025). FOR INCOME CHANGES ORCHARD REPLACEMENT WOULD RESULT IN NET INCOME GAIN OF
PUBLIC ATTITUDES	OPPOSITION FROM MONTEREY COUNTY INTERESTS TO THE CONCEPT OF INTERBASIN TRANSPORT OF TREATED WASTEWATER. CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION.	CONCERN OF SYSTEM TO FORCE SIGNIFICANT ALTERATION TO FARM OPERATION AND INCOME, AS WELL AS HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	CONCERN OF SYSTEM TO FORCE ALTERATION OF RURAL LIFE-STYLE, AS WELL AS JOB AND HOUSING DISRUPTION, POTENTIAL NUISANCE AND ADVERSE PUBLIC HEALTH EFFECTS.	INCONVENIENCE OF PATRONS, SERVICE USERS AND IMMEDIATE ALIGNMENT RESIDENTS, DUE TO ACCESS DISRUPTION, DIRT, DUST, AND NOISE DURING CONSTRUCTION PHASE.	ANXIETY OVER LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS, ESPECIALLY SPANISH-AMERICANS. CONCERN OF BUSINESS AND SERVICES ESTABLISHMENTS OVER ACCESS DISRUPTION DURING CONSTRUCTION PHASES. CONCERN OF TOURISTS AND RECREATION SEEKERS OVER POSSIBLE ENVIRONMENTAL PHYSICAL IMPAIRMENT OF SYSTEM PLACEMENT.	OPPOSITION FROM MONTEREY COUNTY INTERESTS TO THE OF WASTEWATER. CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION OF REGION.	CONCERN OF SYSTEM TO ALTERATION TO FARM AS WELL AS HOUSING NUISANCE AND ADVERSE EFFECTS.
DISTRIBUTIVE EQUITY (CONSTRUCTION, OPERATION & MAINTENANCE WAGES)	POTENTIAL OF 7 MILLION MAN DAYS OR MORE NEEDED FOR SYSTEM CONSTRUCTION. SUCH WAGES INCLUDE: $400 MILLION FOR TOTAL SYSTEM, $64 MILLION FOR MINORITY SHARE OF TOTAL, $220 MILLION FOR CONSTRUCTION ITSELF, AND $56 MILLION FOR MINORITY SHARE OF CONSTRUCTION. POTENTIAL O&M EMPLOYMENT OF SYSTEM IN PLACE WOULD BE ABOUT 52,000. ANNUAL O&M WAGES WOULD BE $30 MILLION.				CONSTRUCTION WORKERS, CONSTRUCTION CONTRACTORS, TRADE UNIONS, MATERIAL MANUFACTURERS, TRANSPORTATION INDUSTRY, ENGINEERING FIRMS, AND GROUPS ACTIVE IN MINORITY INTERESTS WOULD ALL BE AFFECTED BY SYSTEM DESIGN AND CONSTRUCTION PROGRAMS, AND BE PROVIDED WITH OPPORTUNITY FOR INCOME, JOBS, AND DEVELOPMENT OF SOCIAL AND INSTITUTIONAL PROGRAMS.	POTENTIAL OF 7 MILLION MA INCLUDE: $433 MILLION FO $238 MILLION FOR CONSTRU STRUCTION. POTENTIA ABOUT	
PUBLIC HEALTH	PROVIDES GREATER CONTROL OF WATERBORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMAL POPULATIONS, AND INCREASE THE POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION BUT WILL MEET APPROPRIATE REGULATIONS OF CALIFORNIA STATE HEALTH AGENCIES. THE POTENTIAL EXISTS FOR GREATER CONTROL OF AGRICULTURAL CONTAMINANTS HAZARDOUS TO HEALTH.		MINIMUM IMPACT	MINIMUM IMPACT	PROVIDES GREATER CONTROL OF WATERBORNE INFECTIOUS DISEASE UNDER EMERGENCY OR OVERLOAD CONDITIONS.	THIS ALTERNATIVE WILL POPULATIONS, AND INCREA BUT WILL MEET APPROPR THE POTENTIAL EXISTS F TO HEALTH.
ECONOMIC PROJECT COSTS ($1000)	BASIN POPULATION WILL BEAR A PORTION OF STATE COSTS ($22 MILLION, FIGURE 12).	PORTIONS OF THE BASIN'S GENERAL POPULATION COST WILL BE BORNE BY LOCAL LANDOWNERS EQUIVALENT TO THEIR NORMAL COSTS FOR INSTALLING AND OPERATING CONVENTIONAL IRRIGATION SYSTEMS.	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	BASIN POPULATION WILL BEAR A PORTION OF STATE COSTS ($14 MILLION, FIGURE 13).	PORTIONS OF THE BASIN'S TION COST WILL BE BORNE OWNERS EQUIVALENT TO THE FOR INSTALLING AND OPERA IRRIGATION SYSTEMS.
AGRICULTURAL PRODUCTION	AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $519,000. INCOME LOSS AT YEAR 2000 OF $281,000.	RESTRICTED TO GROWING ONLY HIGH NITROGEN USING CROPS AND CROPS WHICH ARE NOT EATEN RAW. WASTEWATER AND DRAIN APPLICATION SYSTEM INSTALLED ON FARMERS PROPERTY WILL BE COMPENSATED ON AVERAGE $40 PER ACRE PER YEAR FOR ANY INCONVENIENCE OR LOSSES.		MINIMUM IMPACT	MINIMUM IMPACT	AVERAGE ANNUAL AGRICULTURAL INCOME LOSS $519,000. INCOME LOSS AT YEAR 2000 OF $222,000.	RESTRICTED TO GROWIN EATEN RAW. WASTEWATE PROPERTY WILL BE COMP CONVENIENCE OR LOSSES.
PUBLIC FINANCE	TAX LOSS FOR PURCHASED LANDS $24,000	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	TAX LOSS FOR PURCHASED LANDS $30,000.	MINIMUM IMP
LAND VALUES	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM
RECLAMATION OF RESOURCES	MINIMUM IMPACT	PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 38,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER APPLICATION $380,000 PER YEAR.		MINIMUM IMPACT	MINIMUM IMPACT	MINIMUM IMPACT	PROVIDES TREATED WA VALUE DUE TO WASTEWA
INSTITUTIONAL	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY EXISTING OR SLIGHTLY MODIFIED INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT OR CREATION OF A NEW WASTEWATER MANAGEMENT AGENCY ARE POSSIBILITIES. ONLY ONE INSTITUTIONAL AGENCY SHOULD CONTROL ANY ONE LAND APPLICATION SUBSYSTEM. IN GENERAL, STATE AND FEDERAL STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAND PORTION.			MINIMUM IMPACT	MINIMUM IMPACT	LAND APPLICATION PORTION COULD BE IMPLEMENTED BY INSTITUTIONS. JOINT EXERCISE OF POWERS ARRANGEMENT WATER MANAGEMENT AGENCY ARE POSSIBILITIES. CONTROL ANY ONE LAND APPLICATION SUBSYSTEM. STATUTES ARE ADEQUATE TO AID IN IMPLEMENTING LAN	

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TAB[illegible]7

USE OF RESOURCES 1/

RESOURCE	B-1	B-2	B-3	D-1	D-2	D-3	TERTIARY TREATMENT SYSTEM **
First Cost ($ Billion) 2/	2.6	2.0	2.9	3.0	2.5	3.3	2.1
Average Annual Cost ($ Million)*	447	355	482	437	366	472	357
Electricity (Megawatt Hrs/Day) 2/	9,330	7,680	11,510	13,100	11,900	15,800	5,710
Natural Gas (Cubic Feet/Day) 2/	18,900	18,900	18,900	20,550	20,550	20,550	20,800
Chemicals (Tons/Day) 2/							
Lime	700	90	565	530	30	365	1,100
Methanol	220	30	175	165	10	115	350
Carbon	25	0	20	20	0	15	40
Chlorine	50	40	45	50	40	45	40
Land Application of Wastewater							
Acre-Feet/Year	560,000	560,000	770,000	850,000	850,000	1,050,000	-
Million Gallons/Day	510	510	700	770	770	960	-
Land Required (acres)							
Agency Use							
Land Treatment Facilities	2,150	2,100	2,150	2,900	2,900	3,000	-
Open Space Use							
Wastewater Application	97,000	97,000	135,000	148,000	148,000	186,000	-
Sludge Disposal	48,000	47,000	48,000	48,000	47,000	48,000	47,000
Wastewater Storage	9,300	9,300	10,700	14,300	14,300	15,800	-
Subtotal	154,300	153,300	193,700	210,300	209,300	249,800	47,000
TOTAL (Rounded)	156,500	155,400	195,900	213,200	212,200	252,800	47,000

1/ All systems handle year 2000 regional flow of 1.5 billion gallons per day.

2/ Costs and resource requirements for electricity, gas and chemicals are incremental to the Base Condition. Base Condition costs are shown in Table 32. Base Condition resource requirements are as follows: Electricty, 1,280 Megawatt Hrs/Day - Natural gas, 13,430 Cubic Ft/Day, Chemicals in tons/day Lime, 175 - Chlorine, 30.

* Costs do not reflect financial benefits from the use of reclaimed water and nutrients.

** This illustrative tertiary treatment system is included for general comparison purposes only and does not reflect the same level of detailed analysis as the land application alternatives.

TABLE 38

FEATURES AND EXPECTED ACCOMPLISHMENTS

	FEATURES. Surface water disposal for 940 mgd after full tertiary treatment. Land application at 7 sites within the study area for 510 mgd after treatment in biological secondary treatment plants and storage in reservoirs. Regionwide sludge disposal system. Annual costs ($ million) 307 Local, 20 State and 120 Federal. For the Bay-Delta Region population, per capita local annual costs would be about $33 by the year 2000.
ALTERNATIVE B-1	EXPECTED ACCOMPLISHMENTS. Meets 1983 requirements of PL 92-500. Provides recycled irrigation water for 97,000 acres. Insures over 150,000 acres of open space. Reclaims over $1.4 million in fertilizer benefits yearly and up to 125,000 acre-feet/year of purified water for streamflow augmentation, industrial cooling or additional irrigation water. Within the B-Series alternatives this alternative minimizes land requirements and along with Alternative B-3 provides the highest level of treatment for both water and land-oriented discharges.
	FEATURES. Surface water disposal for 940 mgd after advanced wastewater treatment. Land application at 7 sites within the study area for 510 mgd after treatment in biological secondary treatment plants and storage in reservoirs. Regionwide sludge disposal system. Annual costs ($ million 237 Local, 16 State and 102 Federal. For the Bay-Delta Region population, per capita local annual costs would be about $26 by the year 2000.
ALTERNATIVE B-2	EXPECTED ACCOMPLISHMENTS. Meets 1977 requirements of PL 92-500. Provides recycled irrigation water for 97,000 acres. Insures over 150,000 acres of open space. Reclaims over $1.4 million in fertilizer benefits yearly and up to 125,000 acre-feet/year of purified water for streamflow augmentation, industrial cooling or additional irrigation water. Within the B-Series alternatives this alternative also minimizes land requirements but allows more pollutants to be discharged to surface waters than do Alternatives B-1 and B-3.
	FEATURES. Surface water disposal for 750 mgd after full tertiary treatment. Land application at 8 sites (including interbasin transfer) for 700 mgd after treatment in biological secondary treatment plants and storage in reservoirs. Regionwide sludge disposal system. Annual costs ($ million) 332 Local, 22 State and 128 Federal. For the Bay-Delta Region population, per capita local annual costs would be about $36 by the year 2000.
ALTERNATIVE B-3	EXPECTED ACCOMPLISHMENTS. Meets 1983 requirements of PL 92-500. Provides recycled irrigation water for 135,000 acres. Insures over 190,000 acres of open space. Reclaims over $1.8 million in fertilizer benefits yearly and up to 145,000 acre-feet/year of purified water for streamflow augmentation, industrial cooling or additional irrigation water. Within the B-Series alternatives this alternative had the largest requirement for land. It provides, along with Alternative B-1, the highest level of treatment for both land and water-oriented discharges. Because of the larger flows to land this alternative minimizes the discharge of pollutants to surface water within the B-Series.

TABLE 38 (Cont'd)

ALTERNATIVE D-1	FEATURES. Surface water disposal for 680 mgd after full tertiary treatment. Land application at 7 sites within the study area for 770 mgd after biological secondary treatment in aeration lagoons and storage in reservoirs. Regionwide sludge disposal system. Annual costs ($ million) 281 Local, 22 State, 134 Federal. For the Bay-Delta Region population, per capita local annual costs would be about $31 by the year 2000. EXPECTED ACCOMPLISHMENTS. Meets 1983 Requirements of PL 92-500. Provides recycled irrigation water for 148,000 acres. Insures about 210,000 acres of open space. Reclaims over $1.9 million in fertilizer benefits yearly and up to 230,000 acre-feet/year of purified water for streamflow augmentation, industrial cooling or additional irrigation water. Within the D-Series alternatives this alternative minimizes land requirements and along with Alternative D-3 provides the highest level of treatment for both land and water-oriented discharges.
ALTERNATIVE D-2	FEATURES. Surface water disposal for 680 mgd after advanced watewater treatment. Land application at 7 sites within the study area for 770 mgd after biological secondary treatment in aeration lagoons and storage in reservoirs. Regionwide sludge disposal system. Annual costs ($ million) 229 Local, 20 State and 117 Federal. For the Bay-Delta Region population, per capita local annual costs would be about $25 by the year 2000. EXPECTED ACCOMPLISHMENTS. Meets 1977 requirements of PL 92-500. Provides recycled irrigation water for 148,000 acres. Insures about 210,000 acres of open space. Reclaims over $1.9 million in fertilizer benefits yearly and up to 230,000 acre-feet/year of purified water for streamflow augmentation, industrial cooling or additional irrigation water. Within the D-Series alternatives this alternative also minimizes land requirements but allows more pollutants to be discharged to surface water than do Alternatives D-1 and D-3.
ALTERNATIVE D-3	FEATURES. Surface water disposal for 490 mgd after full tertiary treatment. Land application at 8 sites (including interbasin transfer) for 960 mgd after biological secondary treatment in aeration lagoons and storage in reservoirs. Regionwide sludge disposal system. Annual costs ($ million) 305 Local, 24 State and 143 Federal. For the Bay-Delta Region population, per capita local annual costs would be about $36 by the year 2000. EXPECTED ACCOMPLISHMENTS. Meets 1983 requirements of PL 92-500. Provides recycled irrigation water for 186,000 acres. Insures up to 250,000 acres of open space. Reclaims over $2.3 million in fertilizer benefits yearly and up to 250,000 acre-feet/year of purified water for streamflow augmentation, industrial cooling or additional irrigation water. Of all the alternatives this alternative has the largest requirement for land. Within the D-Series alternatives it provides, along with Alternative D-1, the highest level of treatment for both land and water-oriented discharges. Because of the larger flows to land, this alternative allows fewer pollutants to be discharged to surface waters than any of the other alternatives.

TABLE 38 (Cont'd)

TERTIARY TREATMENT SYSTEM	FEATURES. This system was developed to provide a cost comparison to the land application alternatives and to present a regionwide sludge disposal system. The system provides surface water disposal for 1,450 mgd after full tertiary treatment. Annual costs ($ million) 246 Local, 17 State, 194 Federal. For the Bay-Delta Region population, per capita local annual costs would be about $26 by the year 2000. EXPECTED ACCOMPLISHMENTS. Meets 1983 requirements of PL 92-500. Insures up to 47,000 acres of open space. Reclaims over $470,000 in fertilizer benefits yearly.

NOTES:

1. Renovated water from the tertiary and advanced treatment facilities in all alternatives (and from the full tertiary treatment system) could also be available for local reuse.
2. The following assumptions were made in apportioning annual costs:
   a. Cost sharing for amortization of first cost was 12.5 percent local, 12.5 percent State and 75 percent Federal.
   b. Replacement and operation and maintenance costs were considered to be local responsibility.
3. Total flows (in mgd) have been rounded.

EVALUATION

260. Six final alternatives, incorporating various degrees of land application, have been developed by this study for wastewater and sludge management in the San Francisco Bay and Sacramento - San Joaquin Delta Region. Up to this point these alternatives have been fully discussed from an engineering viewpoint and their impacts on the Bay-Delta Region (including the northern portion of the Central Coastal Basin), the State of California and the United States have been identified. The next planning event scheduled for the alternatives is that of evaluation.

261. Evaluating a program or a proposal usually requires the identification of two aspects of the action, its magnitude (meaning its extensiveness or scale) and its importance (which is a value judgment). In this evaluation, however, only the magnitude aspect of the alternative action will be considered, since analysis of this aspect is based on fact and since it is outside the scope of this study to make value judgments on the alternatives. The goal of this evaluation then, is to objectively describe the degree of change that each of the six final alternatives (B-1, B-2, B-3, D-1, D-2, and D-3) would likely produce if it were employed in the solution of wastewater management problems in the Bay-Delta Region without making any preference decisions on a specific alternative.

262. In the evaluation methodology, each alternative was conceptually implemented in the San Francisco Bay-Delta Region, as defined by the 1975 Base Condition and its regional characteristics. The changes likely to occur in the region as a result of an alternative were then recorded under four general accounts characterized by parameters used in the summary impact display (Figures 10 through 16) presented earlier. The four evaluation accounts were Environmental, Social, Economic, and Special Considerations. The first three accounts are more or less traditional evaluation accounts while the last was added as a miscellaneous account. To define the evaluation accounts and to further categorize impacts, each account was divided into its component parts. For example, the Environmental Account was divided into four components: Chemical/Physical Factors, Ecological Associations, Aesthetic/Cultural and Recreation. Table 39 shows the breakdown of all the evaluation accounts.

263. To obtain a certain degree of objectivity both beneficial and detrimental aspects were considered as well as certain and potential opportunities and concerns. Accordingly, the evaluation is consistent with the following:

Beneficial Aspects	Detrimental Aspects
Beneficial Effects are those positive changes that would occur if the plan were implemented.	Detrimental Effects are those negative changes that would occur if the plan were implemented.

Beneficial Opportunities are those positive changes that could occur if appropriate actions were taken over and above plan implementation.

Detrimental Concerns are those changes that could occur if appropriate actions were not taken over and above plan implementation.

264. The scope of the evaluation is regional and emphasizes the effects of greatest moment associated with the total alternative, rather than a display of specific effects by area or population group. Because of the similarities between alternatives, some of the effects recorded are common to all of the alternatives. Figures 17 through 40 present the evaluation of the six final wastewater management alternative (B-1, B-2, B-3, D-1, D-2, and D-3) developed by this study. Four figures (one for each evaluation account) are provided for each of the six alternatives. A more detailed discussion of the procedure for evaluating the alternatives can be found in Appendix B-7, Evaluation.

TABLE 39

EVALUATION ACCOUNTS AND COMPONENTS

ENVIRONMENTAL	SOCIAL	ECONOMIC	SPECIAL CONSIDERATIONS
Chemical/Physical Factors	Area Viability	Costs	Reclamation of Resources
Ecological Associations	Public Attitudes	Production	Use of Resources
Aesthetic/Cultural	Distributive Equity	Public Finance	
Recreation	Public Health		

ENVIRONMENTAL EVALUATION-ALTERNATIVE B-1

CHEMICAL/PHYSICAL FACTORS	ECOLOGICAL ASSOCIATIONS	AESTHETICS/CULTURAL	RECREATION
(BENEFICIAL)			
THE TREATMENT PROCESSES (LAND AND FULL TERTIARY) IN THIS ALTERNATIVE REMOVE FROM 98 TO 99 PERCENT OF THE BIO-CHEMICAL OXYGEN DEMAND (BOD), TOTAL NITROGEN (TN) AND TOTAL PHOSPHORUS (TP) FROM THE WASTE STREAM. WHILE TERTIARY TREATMENT IS NOT AS EFFICIENT IN REMOVING TOXIC METALS (85%) AS LAND TREATMENT (98%), THE OVERALL REMOVAL OF TOXIC METALS IS AT THE HIGHEST PRACTICABLE LEVEL. BECAUSE OF HIGH REMOVAL RATES AND NO DISCHARGE TO SUISUN BAY, THIS ALTERNATIVE WILL AID NATURAL PROCESS IN FLUSHING IN-SITU POLLUTANTS FROM THE ESTUARY. THE AVAILABILITY OF WATER, "FERTILIZER" AND SOIL CONDITIONERS WILL ENHANCE AGRICULTURAL PRODUCTIVITY OF THE LAND AREAS. OPEN SPACE PRESERVES WILL BE CREATED AND MAINTAINED.	THIS ALTERNATIVE WILL GREATLY REDUCE THE ENVIRONMENTAL STRESS EXERTED ON THE BIOTIC COMMUNITIES OF THE BAY-DELTA ESTUARY BY MUNICIPAL AND INDUSTRIAL WASTES. IT WILL IMPACT MOST ON ACUTE TOXICITY STRESS AS THE CONSTITUENTS RESPONSIBLE FOR THIS STRESS ARE FOUND PRIMARILY WITHIN THE MUNICIPAL AND INDUSTRIAL WASTE STREAM. CHRONIC TOXICITY DUE TO BIOACCUMULATION OF HEAVY METALS AND PESTICIDES WOULD ALSO BE REDUCED. BIOSTIMULATION POTENTIAL WOULD BE GREATLY CURBED IN THE SOUTH BAY AND AT LEAST STABILIZED AT 1975 LEVELS IN SAN PABLO BAY, SUISUN BAY AND THE DELTA. THE BIOLOGICAL RESPONSE TO THIS ALTERNATIVE, ALTHOUGH BUFFERED BY OTHER WATER QUALITY AND QUANTITY PROBLEMS, WOULD BE A SUSTAINED INCREASE IN THE CARRYING CAPACITY OF THE ESTUARY AND CONTIGUOUS WETLANDS.	THIS ALTERNATIVE WILL PROVIDE PERMANENT OPEN SPACE AND OPEN WATER PRESERVES. IN CROP AREAS THE RURAL AGRICULTURAL CHARACTER OF THE AREA WOULD BE PERMANENTLY RETAINED AND IN GRAZING AREAS THE CHANGE IN VEGETATIVE COVER WOULD COMPLEMENT THE SURROUNDING NATIVE COVER TYPE. THE BEAUTIFICATION PROGRAM ACCOMPANYING THE CONVERSION OF TREATMENT PLANTS TO PUMPING STATIONS WILL ENHANCE THEIR VISUAL PROFILE. SINCE PIPELINE ROUTES WILL HAVE TO REMAIN OPEN FOR MAINTENANCE PURPOSES, A POTENTIAL FOR GREEN BELTS IN URBAN AREAS EXISTS. IMPROVED WATER QUALITY IN THE ESTUARY AND INCREASED FLOW IN LOCAL STREAMS WILL ENHANCE THE SENSORY VALUE OF THE REGION'S WATERWAYS.	BY IMPROVING WATER QUALITY THIS ALTERNATIVE COULD INCREASE ACTIVE AND PASSIVE WATER-ORIENTED RECREATIONAL ACTIVITIES ASSOCIATED WITH THE BAY-DELTA ESTUARY. PLANNING AND DEVELOPMENT IN THE APPLICATION SITES ARE DIRECTED TOWARD THE PRESERVATION OF FARM AND NATURAL LANDS AS OPEN SPACE, SCENIC ELEMENTS AND POSSIBLE RECREATIONAL AREAS. WITH 47% OF THE OUTDOOR RECREATION PARTICIPATION OCCURRING WITHIN THE ZERO TO ONE HOUR TRAVEL ZONE FROM METROPOLITAN AREAS, THE RECREATIONAL USE OF OPEN SPACE PROVIDED BY THIS ALTERNATIVE WOULD BE BENEFICIAL IN MEETING INCREASING ACTIVE AND PASSIVE WATER-ORIENTED AND PASSIVE LAND-ORIENTED RECREATIONAL DEMANDS.
(DETRIMENTAL)			
THE TREATMENT PROCESSES (LAND AND FULL TERTIARY) WILL NOT EFFECTIVELY REMOVE TOTAL DISSOLVED SOLIDS (TDS) FROM THE WASTE STREAM. IN FACT LAND TREATMENT MAY INCREASE THE TDS OF RETURN WATER. THE MAGNITUDE OF IMPACT RESULTING FROM THE DISCHARGE OF HIGH TDS WATER WILL VARY WITH THE USE OF THE RECEIVING WATER. THE LAND WILL UNDERGO EXTENSIVE SHORT-TERM ALTERATION DUE TO THE CONSTRUCTION AND PLACEMENT OF TREATMENT FACILITIES AND UNDERDRAINS. LONG-TERM IMPACTS MAY BE REALIZED IN THE CONVERSION OF WILD LAND TO MANAGED LAND, THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES AND THE POSSIBLE BUILD-UP OF HEAVY METALS IN THE SOIL.	CONSTRUCTION ON SYSTEM REQUIRED LANDS WILL CAUSE AN INITIAL REDUCTION IN INDIGENOUS ANIMAL SPECIES DUE TO DIRECT LOSS OR AVOIDANCE MIGRATION. POST CONSTRUCTION RECOVERY SUCCESS WILL VARY WITH THE NEW HABITAT TYPE. IN AREAS WHERE A RADICAL CHANGE OF COVER TYPE HAS OCCURRED DUE TO INCREASED MOISTURE, NEW BIOTIC COMMUNITIES WILL DISPLACE THE EXISTING ONES. IN AREAS WHERE PLANNING HAS PROVIDED FOR RESTORATION OF NATIVE VEGETATION, RE-INHABITATION WILL BE SLOW. IN INUNDATED AREAS THERE WILL BE NO RECOVERY. AQUATIC CONDITIONS IN THE STREAMS RECEIVING RETURN WATER FROM THE LAND AREAS WILL BE MODIFIED BY INCREASED TDS. THIS IMPACT WOULD BE CHARACTERIZED BY A SHIFT IN THE AQUATIC AND RIPARIAN COMMUNITIES TO MORE SALT TOLERANT SPECIES IN STREAMS WHERE TDS VALUES AND DILUTION RATES ARE LOW.	CONSTRUCTION WILL CAUSE TEMPORARY VISUAL DEGRADATION OF EXISTING SYSTEM REQUIRED LANDS. EVEN AFTER LANDSCAPING, BUFFER ZONES AND OTHER MITIGATIVE MEASURES HAVE ACHIEVED MATURITY THERE MAY REMAIN AN INTRUSIVE IMPACT OF MAN-MADE SYSTEMS IN THE NATURAL ENVIRONMENT. ALTHOUGH HISTORICAL SITES AND ARCHAEOLOGICAL SITES WILL BE PROTECTED BY BUFFER ZONES AND VEGETATION SCREENS SOME OF THEIR SIGNIFICANCE MAY BE LOST BY OBSTRUCTION OF SETTING.	ACTIVE RECREATIONAL PURSUITS ON THE LAND SITES WILL BE LIMITED. CONSTRUCTION AND THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES COULD DEGRADE AND/OR DISPLACE THE CURRENT RECREATIONAL USE OF THE LAND.

FIGURE 17

<table>
<tr><th colspan="4">ENVIRONMENTAL EVALUATION - ALTERNATIVE B-2</th></tr>
<tr><th colspan="4">(BENEFICIAL)</th></tr>
<tr><th>CHEMICAL/PHYSICAL FACTORS</th><th>ECOLOGICAL ASSOCIATIONS</th><th>AESTHETICS/CULTURAL</th><th>RECREATION</th></tr>
<tr><td>THE TREATMENT PROCESSES (LAND AND ADVANCED TREATMENT) IN THIS ALTERNATIVE LIMIT MASS EMISSION OF CONSTITUENTS TO TOTALS WHICH DO NOT EXCEED THOSE OF THE BASE CONDITION. ALTHOUGH, THE TREATMENT PLANT COMPONENTS OF THIS ALTERNATIVE ARE NOT AS EFFICIENT AS TERTIARY TREATMENT IN REMOVING CONSTITUENTS, ITS REMOVAL OF TN, TP, BOD AND HEAVY METALS APPROACHES TERTIARY LEVELS AND CERTAINLY IS ABOVE SECONDARY TREATMENT LEVELS. LIKE ALTERNATIVE B1, THIS ALTERNATIVE PROVIDES NO DISCHARGE OF TREATED WATER TO SUISUN BAY.

THE AVAILABILITY OF WATER, "FERTILIZER" AND SOIL CONDITIONERS WILL ENHANCE THE AGRICULTURAL PRODUCTIVITY OF THE LAND AREAS. OPEN SPACE PRESERVES WILL BE CREATED AND MAINTAINED.</td><td>UNDER THIS ALTERNATIVE ECOLOGICAL STRESS IN THE ESTUARY DUE TO MUNICIPAL AND INDUSTRIAL WASTE DISCHARGES WOULD BE AT LEAST STABILIZED AT 1975 LEVELS IN SPITE OF FUTURE INCREASES IN FLOW. INITIALLY, THE TREATMENT PROCESS WOULD REDUCE TOXICITY, EUTROPHICATION POTENTIAL AND PERSISTANT POLLUTANT CONCENTRATIONS IN THE RECEIVING WATERS. HOWEVER, AS WASTE FLOWS INCREASE AND FLUSHING FLOWS DECREASE, AS EXPECTED IN THE FUTURE, THE CONSTITUENTS RESPONSIBLE FOR THESE PROBLEMS WOULD GRADUALLY INCREASE TO A POINT WHERE BY PROJECT YEAR 2000 THEIR LOADS WOULD AGAIN BE AT 1975 LEVELS. THE IMMEDIATE BIOLOGICAL RESPONSE TO IMPROVED HABITAT CONDITIONS WOULD BE AN INCREASE IN THE CARRYING CAPACITY OF AREAS IN THE ESTUARY THAT ARE CURRENTLY EXPERIENCING ACUTE WATER QUALITY DEGRADATION.</td><td>THIS ALTERNATIVE WILL PROVIDE PERMANENT OPEN SPACE AND OPEN WATER PRESERVES. IN CROP AREAS THE RURAL AGRICULTURAL CHARACTER OF THE AREA WOULD BE PERMANENTLY RETAINED AND IN GRAZING AREAS THE CHANGE IN VEGETATIVE COVER WOULD COMPLEMENT THE SURROUNDING NATIVE COVER TYPE. THE BEAUTIFICATION PROGRAM ACCOMPANYING THE CONVERSION OF TREATMENT PLANTS TO PUMPING STATIONS WILL ENHANCE THEIR VISUAL PROFILE. SINCE PIPELINE ROUTES WILL HAVE TO REMAIN OPEN FOR MAINTENANCE PURPOSES, A POTENTIAL FOR GREEN BELTS IN URBAN AREAS EXISTS.

IMPROVED WATER QUALITY IN THE ESTUARY AND INCREASED FLOW IN LOCAL STREAMS WILL ENHANCE THE SENSORY VALUE OF THE REGION'S WATERWAYS.</td><td>BY IMPROVING WATER QUALITY THIS ALTERNATIVE COULD INCREASE ACTIVE AND PASSIVE WATER-ORIENTED RECREATIONAL ACTIVITIES ASSOCIATED WITH THE BAY-DELTA ESTUARY. PLANNING AND DEVELOPMENT IN THE APPLICATION SITES ARE DIRECTED TOWARD THE PRESERVATION OF FARM AND NATURAL LANDS AS OPEN SPACE, SCENIC ELEMENTS AND POSSIBLE RECREATIONAL AREAS. WITH 47% OF THE OUTDOOR RECREATION PARTICIPATION OCCURRING WITHIN THE ZERO TO ONE HOUR TRAVEL ZONE FROM METROPOLITAN AREAS, THE RECREATIONAL USE OF OPEN SPACE PROVIDED BY THIS ALTERNATIVE WOULD BE BENEFICIAL IN MEETING INCREASING ACTIVE AND PASSIVE WATER-ORIENTED AND PASSIVE LAND-ORIENTED RECREATIONAL DEMANDS.</td></tr>
<tr><th colspan="4">(DETRIMENTAL)</th></tr>
<tr><td>THIS ALTERNATIVE'S EFFECTIVENESS IN CONTROLLING POLLUTANTS IS ONLY TEMPORARY SINCE ITS OPERATING DISCHARGE WILL HAMPER NATURAL PROCESSES IN FLUSHING IN-SITU POLLUTANTS FROM THE ESTUARY AND SINCE CONSTITUENT LOADS IN THE ESTUARY WILL EVENTUALLY REACH 1975 LEVELS BY THE PROJECT YEAR 2000. THE TREATMENT PROCESS WILL NOT EFFECTIVELY REMOVE TDS FROM THE WASTE STREAM. IN FACT LAND TREATMENT MAY INCREASE THE TDS OF RETURN WATER. THE MAGNITUDE OF IMPACT RESULTING FROM THE DISCHARGE OF HIGH TDS WATER WILL VARY WITH THE USE OF THE RECEIVING WATER.

THE LAND WILL UNDERGO EXTENSIVE SHORT-TERM ALTERATION DUE TO THE CONSTRUCTION AND PLACEMENT OF TREATMENT FACILITIES AND UNDERDRAINS. LONG-TERM IMPACTS MAY BE REALIZED IN THE CONVERSION OF WILD LAND TO MANAGED LAND, THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES AND THE POSSIBLE BUILD-UP OF HEAVY METALS IN THE SOIL.</td><td>ALTHOUGH THIS ALTERNATIVE WOULD INITIALLY EASE ECOLOGICAL STRESS IN THE CRITICAL AREAS OF THE ESTUARY, ITS IMPACT OVER THE LONG-TERM ON THE CARRYING CAPACITY OF THE ESTUARY WOULD NOT BE SUSTAINING AS WASTE FLOWS APPROACH THE DESIGN CAPACITY OF THE UNIT PROCESSES. AQUATIC CONDITIONS IN THE STREAMS RECEIVING RETURN WATER FROM THE LAND AREAS WILL BE MODIFIED BY INCREASED TDS. THIS IMPACT WOULD BE CHARACTERIZED BY A SHIFT IN THE AQUATIC AND RIPARIAN COMMUNITIES TO MORE SALT TOLERANT SPECIES IN STREAMS WHERE TDS VALUES AND DILUTION RATES ARE LOW. DETRIMENTAL ECOLOGICAL IMPACTS OF THIS ALTERNATIVE ON THE LAND ARE THE SAME AS THOSE EXPRESSED FOR ALTERNATIVE B1.</td><td>CONSTRUCTION WILL CAUSE TEMPORARY VISUAL DEGRADATION OF EXISTING SYSTEM REQURIED LANDS. EVEN AFTER LANDSCAPING BUFFER ZONES AND OTHER MITIGATIVE MEASURES HAVE ACHIEVED MATURITY THERE MAY REMAIN AN INTRUSIVE IMPACT OF MAN-MADE SYSTEMS IN THE NATURAL ENVIRONMENT.

ALTHOUGH HISTORICAL SITES AND ARCHAEOLOGICAL SITES WILL BE PROTECTED BY BUFFER ZONES AND VEGETATION SCREENS SOME OF THEIR SIGNIFICANCE MAY BE LOST BY OBSTRUCTION OF SETTING.</td><td>ACTIVE RECREATIONAL PURSUITS ON THE LAND SITES WILL BE LIMITED. CONSTRUCTION AND THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES COULD DEGRADE AND/OR DISPLACE THE CURRENT RECREATIONAL USE OF THE LAND.</td></tr>
</table>

FIGURE 18

ENVIRONMENTAL EVALUATION – ALTERNATIVE B-3

(BENEFICIAL)

CHEMICAL/PHYSICAL FACTORS	ECOLOGICAL ASSOCIATIONS	AESTHETICS/CULTURAL	RECREATION
THIS ALTERNATIVE INCLUDES LAND AREA 27 IN MONTEREY COUNTY AND ENVISIONS THE INTER-BASIN TRANSFER OF WASTEWATER. TREATED WASTEWATER FROM THE SAN JOSE - MILPITAS - ALVISO AREA WOULD BE DIVERTED TO SITE 27 FOR LAND TREATMENT INSTEAD OF DISCHARGING TO SOUTH BAY AFTER TERTIARY TREATMENT AS IN ALTERNATIVE B-1. SINCE DISCHARGE TO SOUTH BAY IS REDUCED, CONSTITUENT LOADS ARE REDUCED PROPORTIONALLY. OTHER CHEMICAL/PHYSICAL IMPACTS ARE THE SAME AS INDICATED FOR ALTERNATIVE B-1. THE AVAILABILITY OF WATER, "FERTILIZER" AND SOIL CONDITIONERS WILL ENHANCE AGRICULTURAL PRODUCTIVITY OF THE LAND AREAS. OPEN SPACE RESERVES WILL BE CREATED AND MAINTAINED.	THIS ALTERNATIVE WILL REDUCE ENVIRONMENTAL STRESSES (TOXICITY AND EUTROPHICATION) EXERTED ON THE BIOTIC COMMUNITIES OF CENTRAL AND SUISUN BAYS AS INDICATED UNDER ALTERNATIVE B-1. IN ADDITION, BASED ON REDUCED CONSTITUENT LOADS IN A HYDROLOGICALLY NEGATIVE ESTUARY, AQUATIC CONDITIONS FOR BENTHIC AND OTHER LOWER FOOD CHAIN SPECIES WILL BE FURTHER IMPROVED IN SOUTH BAY BY REDUCED DISCHARGES.	THIS ALTERNATIVE WILL PROVIDE PERMANENT OPEN SPACE AND OPEN WATER PRESERVES. IN CROP AREAS THE RURAL AGRICULTURAL CHARACTER OF THE AREA WOULD BE PERMANENTLY RETAINED AND IN GRAZING AREAS THE CHANGE IN VEGETATIVE COVER WOULD COMPLEMENT THE SURROUNDING NATIVE COVER TYPE. THE BEAUTIFICATION PROGRAM ACCOMPANYING THE CONVERSION OF TREATMENT PLANTS TO PUMPING STATIONS WILL ENHANCE THEIR VISUAL PROFILE. SINCE PIPELINE ROUTES WILL HAVE TO REMAIN OPEN FOR MAINTENANCE PURPOSES, A POTENTIAL FOR GREEN BELTS IN URBAN AREAS EXISTS. IMPROVED WATER QUALITY IN THE ESTUARY AND INCREASED FLOW IN LOCAL STREAMS WILL ENHANCE THE SENSORY VALUE OF THE REGION'S WATERWAYS.	BY IMPROVING WATER QUALITY THIS ALTERNATIVE COULD INCREASE ACTIVE AND PASSIVE WATER-ORIENTED RECREATIONAL ACTIVITIES ASSOCIATED WITH THE BAY-DELTA ESTUARY. PLANNING AND DEVELOPMENT IN THE APPLICATION SITES ARE DIRECTED TOWARD THE PRESERVATION OF FARM AND NATURAL LANDS AS OPEN SPACE, SCENIC ELEMENTS AND POSSIBLE RECREATIONAL AREAS. WITH 47% OF THE OUTDOOR RECREATION PARTICIPATION OCCURRING WITHIN THE ZERO TO ONE HOUR TRAVEL ZONE FROM METROPOLITAN AREAS, THE RECREATIONAL USE OF OPEN SPACE PROVIDED BY THIS ALTERNATIVE WOULD BE BENEFICIAL IN MEETING INCREASING ACTIVE AND PASSIVE WATER-ORIENTED AND PASSIVE LAND-ORIENTED RECREATIONAL DEMANDS.
(DETRIMENTAL)			
THE TREATMENT PROCESSES (LAND AND FULL TERTIARY) WILL NOT EFFECTIVELY REMOVE TDS FROM THE WASTE STREAM. IN FACT LAND TREATMENT MAY INCREASE THE TDS OF RETURN WATER. ALTHOUGH REDUCED DISCHARGE TO THE SOUTH BAY REDUCES THE CONSTITUENT LOAD IT MAY ALSO CONTRIBUTE TO INCREASED SALINITY IN THIS HYDROLOGICAL NEGATIVE ESTUARY. THE MAGNITUDE OF IMPACT RESULTING FROM THE INCREASED SALINITY IN BOTH CASES WILL VARY WITH THE USE OF THE RECEIVING WATER. THE LAND WILL UNDERGO EXTENSIVE SHORT-TERM ALTERATION DUE TO THE CONSTRUCTION AND PLACEMENT OF TREATMENT FACILITIES AND UNDERDRAINS. LONG-TERM IMPACTS MAY BE REALIZED IN THE CONVERSION OF WILD LAND TO MANAGED LAND, THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES AND THE POSSIBLE BUILD-UP OF HEAVY METALS IN THE SOIL. AS INDICATED ABOVE THIS ALTERNATIVE INCLUDES LAND AREA 27 LOCATED IN MONTEREY COUNTY.	CONSTRUCTION ON SYSTEM REQUIRED LANDS WILL CAUSE AN INITIAL REDUCTION IN INDIGENOUS ANIMAL SPECIES DUE TO DIRECT LOSS OR AVOIDANCE MIGRATION. POST CONSTRUCTION RECOVERY SUCCESS WILL VARY WITH THE NEW HABITAT TYPE. IN AREAS WHERE A RADICAL CHANGE OF COVER TYPE HAS OCCURRED DUE TO INCREASED MOISTURE, NEW BIOTIC COMMUNITIES WILL DISPLACE THE EXISTING ONES. IN AREAS WHERE PLANNING HAS PROVIDED FOR RESTORATION OF NATIVE VEGETATION, RE-INHABITATION WILL BE SLOW AND IN INUNDATED AREAS THERE WILL BE NO RECOVERY. AQUATIC CONDITIONS IN THE STREAMS RECEIVING RETURN WATER FROM THE LAND AREAS WILL BE MODIFIED BY INCREASED TDS. THIS IMPACT WOULD BE CHARACTERIZED BY A SHIFT IN THE AQUATIC AND RIPARIAN COMMUNITIES TO MORE SALT TOLERANT SPECIES IN STREAMS WHERE TDS VALUES AND DILUTION RATES ARE LOW.	CONSTRUCTION WILL CAUSE TEMPORARY VISUAL DEGRADATION OF EXISTING SYSTEM REQUIRED LANDS. EVEN AFTER LANDSCAPING BUFFER ZONES AND OTHER MITIGATIVE MEASURES HAVE ACHIEVED MATURITY THERE MAY REMAIN AN INTRUSIVE IMPACT OF MAN-MADE SYSTEMS IN THE NATURAL ENVIRONMENT. ALTHOUGH HISTORICAL SITES AND ARCHAEOLOGICAL SITES WILL BE PROTECTED BY BUFFER ZONES AND VEGETATION SCREENS SOME OF THEIR SIGNIFICANCE MAY BE LOST BY OBSTRUCTION OF SETTING.	ACTIVE RECREATIONAL PURSUITS ON THE LAND SITES WILL BE LIMITED. CONSTRUCTION AND THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES COULD DEGRADE AND/OR DISPLACE THE CURRENT RECREATIONAL USE OF THE LAND.

FIGURE 19

ENVIRONMENTAL EVALUATION – ALTERNATIVE D-1

(BENEFICIAL)

CHEMICAL/PHYSICAL FACTORS	ECOLOGICAL ASSOCIATIONS	AESTHETICS/CULTURAL	RECREATION
WITH THIS ALTERNATIVE THE GREATER USE OF LAND AREAS AS A TREATMENT PROCESS AND THE SUBSEQUENT REDUCTION IN THE NUMBER OF TERTIARY TREATMENT PLANT DISCHARGES WILL REDUCE CONSTITUENT LOADS IN THE BAY-DELTA ESTUARY TO LEVELS BELOW THOSE INDICATED BY THE B-SERIES OF ALTERNATIVES. THERE WOULD BE NO DISCHARGE TO THE CENTRAL BAY OR SUISUN BAY AND ONLY 2 MGD OF TREATED WATER WOULD BE DISCHARGED IN THE DELTA. THIS GREATER REDUCTION IN POLLUTANT LOAD IN THE ESTUARY WOULD AMPLIFY THE BENEFICIAL IMPACTS RECORDED UNDER CHEMICAL/PHYSICAL FACTORS FOR ALTERNATIVE B-1.	THIS ALTERNATIVE WILL ALMOST ELIMINATE THE ENVIRONMENTAL STRESS EXERTED ON THE BIOTIC COMMUNITIES OF THE BAY-DELTA ESTUARY BY MUNICIPAL AND INDUSTRIAL WASTES IT WILL IMPACT MOST ON ACUTE TOXICITY STRESS AS THE CONSTITUENTS RESPONSIBLE FOR THIS STRESS ARE FOUND PRIMARILY WITHIN THE MUNICIPAL AND INDUSTRIAL WASTE STREAM. CHRONIC TOXICITY DUE TO BIO-ACCUMULATION OF HEAVY METALS AND PESTICIDES WOULD ALSO BE REDUCED. BIOSTIMULATION POTENTIAL WOULD BE GREATLY CURBED IN THE SOUTH BAY AND GREATLY REDUCED IN SAN PABLO BAY, SUISUN BAY AND THE DELTA. THE BIOLOGICAL RESPONSE TO THIS ALTERNATIVE, ALTHOUGH BUFFERED BY OTHER WATER QUALITY AND QUANTITY PROBLEMS, WOULD BE A SUSTAINED INCREASE IN THE CARRYING CAPACITY OF THE ESTUARY AND CONTIGUOUS WETLANDS.	THIS ALTERNATIVE WILL PROVIDE PERMANENT OPEN SPACE AND OPEN WATER PRESERVES. IN CROP AREAS THE RURAL AGRICULTURAL CHARACTER OF THE AREA WOULD BE PERMANENTLY RETAINED AND IN GRAZING AREAS THE CHANGE IN VEGETATIVE COVER WOULD COMPLEMENT THE SURROUNDING NATIVE COVER TYPE. THE BEAUTIFICATION PROGRAM ACCOMPANYING THE CONVERSION OF TREATMENT PLANTS TO PUMPING STATIONS WILL ENHANCE THEIR VISUAL PROFILE. SINCE PIPELINE ROUTES WILL HAVE TO REMAIN OPEN FOR MAINTENANCE PURPOSES, A POTENTIAL FOR GREEN BELTS IN URBAN AREAS EXISTS.	BY IMPROVING WATER QUALITY THIS ALTERNATIVE COULD INCREASE ACTIVE AND PASSIVE WATER-ORIENTED RECREATIONAL ACTIVITIES ASSOCIATED WITH THE BAY-DELTA ESTUARY. PLANNING AND DEVELOPMENT IN THE APPLICATION SITES ARE DIRECTED TOWARD THE PRESERVATION OF FARM AND NATURAL LANDS AS OPEN SPACE, SCENIC ELEMENTS AND POSSIBLE RECREATIONAL AREAS. WITH 47% OF THE OUTDOOR RECREATION PARTICIPATION OCCURRING WITHIN THE ZERO TO ONE HOUR TRAVEL ZONE FROM METROPOLITAN AREAS, THE RECREATIONAL USE OF OPEN SPACE PROVIDED BY THIS ALTERNATIVE WOULD BE BENEFICIAL IN MEETING INCREASING ACTIVE AND PASSIVE WATER-ORIENTED AND PASSIVE LAND-ORIENTED RECREATIONAL DEMANDS.

(DETRIMENTAL)

THE TREATMENT PROCESSES (LAND AND FULL TERTIARY) WILL NOT EFFECTIVELY REMOVE TDS FROM THE WASTE STREAM. IN FACT, LAND TREATMENT MAY INCREASE THE TDS OF RETURN WATER. THE MAGNITUDE OF IMPACT RESULTING FROM THE DISCHARGE OF HIGH TDS WATER WILL VARY WITH THE USE OF THE RECEIVING WATER. IN ADDITION REDUCED WASTEWATER FLOW TO CENTRAL AND SUISUN BAYS AND THE DELTA MAY ALTER THE FLUSHING REGIMEN OF THE ESTUARY, THUS INCREASING TDS LEVELS IN ITS EXTREMITIES. THE LAND WILL UNDERGO EXTENSIVE SHORT-TERM ALTERATION DUE TO THE CONSTRUCTION AND PLACEMENT OF TREATMENT FACILITIES AND UNDERDRAINS. LONG-TERM IMPACTS MAY BE REALIZED IN THE CONVERSION OF WILD LAND TO MANAGED LAND, THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES AND POSSIBLE BUILD-UP OF HEAVY METALS IN THE SOIL.	CONSTRUCTION ON SYSTEM REQUIRED LANDS WILL CAUSE AN INITIAL REDUCTION IN INDIGENOUS ANIMAL SPECIES DUE TO DIRECT LOSS OR AVOIDANCE MIGRATION. POST CONSTRUCTION RECOVERY SUCCESS WILL VARY WITH THE NEW HABITAT TYPE. IN AREAS WHERE A RADICAL CHANGE OF COVER TYPE HAS OCCURRED DUE TO INCREASED MOISTURE, NEW BIOTIC COMMUNITIES WILL DISPLACE THE EXISTING ONES. IN AREAS WHERE PLANNING HAS PROVIDED FOR RESTORATION OF NATIVE VEGETATION, REINHABITATION WILL BE SLOW AND IN INUNDATED AREAS THERE WILL BE NO RECOVERY. AQUATIC CONDITIONS IN THE STREAMS RECEIVING RETURN WATER FROM THE LAND AREAS WILL BE MODIFIED BY INCREASED TDS. THIS IMPACT WOULD BE CHARACTERIZED BY A SHIFT IN THE AQUATIC AND RIPARIAN COMMUNITIES TO MORE SALT TOLERANT SPECIES IN STREAMS WHERE TDS VALUES AND DILUTION RATES ARE LOW.	CONSTRUCTION WILL CAUSE TEMPORARY VISUAL DEGRADATION OF EXISTING SYSTEM REQUIRED LANDS. EVEN AFTER LANDSCAPING BUFFER ZONES AND OTHER MITIGATIVE MEASURES HAVE ACHIEVED MATURITY THERE MAY REMAIN AN INTRUSIVE IMPACT OF MAN-MADE SYSTEMS IN THE NATURAL ENVIRONMENT. ALTHOUGH HISTORICAL SITES AND ARCHAEOLOGICAL SITES WILL BE PROTECTED BY BUFFER ZONES AND VEGETATION SCREENS SOME OF THEIR SIGNIFICANCE MAY BE LOST BY OBSTRUCTION OF SETTING.	ACTIVE RECREATIONAL PURSUITS ON THE LAND SITES WILL BE LIMITED. CONSTRUCTION AND THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES COULD DEGRADE AND/OR DISPLACE THE CURRENT RECREATIONAL USE OF THE LAND.

FIGURE 20

ENVIRONMENTAL EVALUATION-ALTERNATIVE D-2

CHEMICAL/PHYSICAL FACTORS	ECOLOGICAL ASSOCIATIONS	AESTHETICS/CULTURAL	RECREATION
(BENEFICIAL)			
THE TREATMENT PROCESSES (LAND AND ADVANCED TREATMENT) IN THIS ALTERNATIVE LIMIT MASS EMISSION OF CONSTITUENTS TO TOTALS WHICH DO NOT EXCEED THOSE OF THE BASE CONDITION. ALTHOUGH THE TREATMENT PLANT COMPONENT IS NOT AS EFFICIENT AS TERTIARY TREATMENT, THE INCREASED USE OF LAND TREATMENT ALLOWING NO DISCHARGE TO SUISUN BAY AND THE CENTRAL BAY AND REDUCED FLOWS IN THE DELTA REDUCES OVERALL CONSTITUENT LOADS IN THE ESTUARY TO LEVELS BELOW THOSE OF ALTERNATIVE B-2.	UNDER THIS ALTERNATIVE ECOLOGICAL STRESS IN THE ESTUARY DUE TO MUNICIPAL AND INDUSTRIAL WASTE DISCHARGES WOULD BE AT LEAST STABALIZED AT 1975 LEVELS IN SPITE OF INCREASES IN FLOW. INITIALLY THE TREATMENT PROCESSES WOULD REDUCE TOXICITY, EUTROPHICATION POTENTIAL AND PERSISTANT POLLUTANT CONCENTRATIONS IN THE RECEIVING WATERS. HOWEVER, AS WASTE FLOWS INCREASE AND FLUSHING FLOWS DECREASE, AS EXPECTED IN THE FUTURE, THE CONSTITUENTS RESPONSIBLE FOR THESE PROBLEMS WOULD GRADUALLY INCREASE TO A POINT WHERE BY PROJECT YEAR 2000 THEIR LOADS WOULD AGAIN BE AT 1975 LEVELS. THE IMMEDIATE BIOLOGICAL RESPONSE TO IMPROVED HABITAT CONDITIONS WOULD BE AN INCREASE IN THE CARRYING CAPACITY OF AREAS IN THE ESTUARY THAT ARE CURRENTLY EXPERIENCING ACUTE WATER QUALITY DEGRADATION.	THIS ALTERNATIVE WILL PROVIDE PERMANENT SPACE AND OPEN WATER PRESERVES. IN CROP AREAS THE RURAL AGRICULTURAL CHARACTER OF THE AREA WOULD BE PERMANENTLY RETAINED AND IN GRAZING AREAS THE CHANGE IN VEGETATIVE COVER WOULD COMPLEMENT THE SURROUNDING NATIVE COVER TYPE. THE BEAUTIFICATION PROGRAM ACCOMPANYING THE CONVERSION OF TREATMENT PLANTS TO PUMPING STATIONS WILL ENHANCE THEIR VISUAL PROFILE. SINCE PIPELINE ROUTES WILL HAVE TO REMAIN OPEN FOR MAINTENANCE PURPOSES, A POTENTIAL FOR GREEN BELTS IN URBAN AREAS EXISTS. IMPROVED WATER QUALITY IN THE ESTUARY AND INCREASED FLOW IN LOCAL STREAMS WILL ENHANCE THE SENSORY VALUE OF THE REGION'S WATERWAYS.	BY IMPROVING WATER QUALITY THIS ALTERNATIVE COULD INCREASE ACTIVE AND PASSIVE WATER-ORIENTED RECREATIONAL ACTIVITIES ASSOCIATED WITH THE BAY-DELTA ESTUARY. PLANNING AND DEVELOPMENT IN THE APPLICATION SITES ARE DIRECTED TOWARD THE PRESERVATION OF FARM AND NATURAL LANDS AS OPEN SPACE, SCENIC ELEMENTS AND POSSIBLE RECREATIONAL AREAS. WITH 47% OF THE OUTDOOR RECREATION PARTICIPATION OCCURRING WITHIN THE ZERO TO ONE HOUR TRAVEL ZONE FROM METROPOLITAN AREAS, THE RECREATIONAL USE OF OPEN SPACE PROVIDED BY THIS ALTERNATIVE WOULD BE BENEFICIAL IN MEETING INCREASING ACTIVE AND PASSIVE WATER-ORIENTED AND PASSIVE LAND-ORIENTED RECREATIONAL DEMANDS.
(DETRIMENTAL)			
THIS ALTERNATIVE'S EFFECTIVENESS IN CONTROLLING POLLUTANTS IS ONLY TEMPORARY SINCE ITS OPERATING DISCHARGE WILL ALLOW CONSTITUENT LOADS IN THE ESTUARY TO EVENTUALLY REACH 1975 LEVELS BY THE PROJECT YEAR 2000. THE TREATMENT PROCESS WILL NOT EFFECTIVELY REMOVE TDS FROM THE WASTE STREAM. IN FACT LAND TREATMENT MAY INCREASE THE TDS OF RETURN WATER. THE MAGNITUDE OF IMPACT RESULTING FROM THE DISCHARGE OF HIGH TDS WATER WILL VARY WITH THE USE OF THE RECEIVING WATER. IN ADDITION, REDUCED WASTEWATER FLOW TO CENTRAL AND SUISUN BAYS AND THE DELTA MAY ALTER THE FLUSHING REGIMEN OF THE ESTUARY, THUS INCREASING TDS LEVELS IN ITS EXTREMITIES. THE LAND WILL UNDERGO EXTENSIVE SHORT-TERM ALTERATION DUE TO THE CONSTRUCTION AND PLACEMENT OF TREATMENT FACILITIES AND UNDERDRAINS. LONG-TERM IMPACTS MAY BE REALIZED IN THE CONVERSION OF WILD LAND TO MANAGED LAND, THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES AND THE POSSIBLE BUILD-UP OF HEAVY METALS IN THE SOIL.	ALTHOUGH THIS ALTERNATIVE WOULD INITIALLY EASE ECOLOGICAL STRESS IN THE CRITICAL AREAS OF THE ESTUARY, ITS IMPACT OVER THE LONG-TERM ON THE CARRYING CAPACITY OF THE ESTUARY WOULD NOT BE SUSTAINING AS WASTE FLOWS APPROACH THE DESIGN CAPACITY OF THE UNIT PROCESSES. AQUATIC CONDITIONS IN THE STREAMS RECEIVING RETURN WATER FROM THE LAND AREAS WILL BE MODIFIED BY INCREASED TDS. THIS IMPACT WOULD BE CHARACTERIZED BY A SHIFT IN THE AQUATIC AND RIPARIAN COMMUNITIES TO MORE SALT TOLERANT SPECIES IN STREAMS WHERE TDS VALUES AND DILUTION RATES ARE LOW. DETRIMENTAL ECOLOGICAL IMPACTS OF THIS ALTERNATIVE ON THE LAND ARE THE SAME AS THOSE EXPRESSED FOR ALTERNATIVE D-1.	CONSTRUCTION WILL CAUSE TEMPORARY VISUAL DEGRADATION OF EXISTING SYSTEM REQUIRED LANDS. EVEN AFTER LANDSCAPING, BUFFER ZONES AND OTHER MITIGATIVE MEASURES HAVE ACHIEVED MATURITY THERE MAY REMAIN AN INTRUSIVE IMPACT OF MAN-MADE SYSTEMS IN THE NATURAL ENVIRONMENT. ALTHOUGH HISTORICAL SITES AND ARCHAEOLOGICAL SITES WILL BE PROTECTED BY BUFFER ZONES AND VEGETATION SCREENS SOME OF THEIR SIGNIFICANCE MAY BE LOST BY OBSTRUCTION OF SETTING.	ACTIVE RECREATIONAL PURSUITS ON THE LAND SITES WILL BE LIMITED. CONSTRUCTION AND THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES COULD DEGRADE AND/OR DISPLACE THE CURRENT RECREATIONAL USE OF THE LAND.

FIGURE 21

ENVIRONMENTAL EVALUATION - ALTERNATIVE D-3

(BENEFICIAL)

CHEMICAL/PHYSICAL FACTORS	ECOLOGICAL ASSOCIATIONS	AESTHETICS/CULTURAL	RECREATION
THIS ALTERNATIVE, LIKE ALTERNATIVE B-3, INCLUDES LAND AREA 27 IN MONTEREY COUNTY AND ENVISIONS THE INTERBASIN TRANSFER OF WASTEWATER FROM THE SAN JOSE - MILPITAS - ALVISO AREA. AS A RESULT, LESS FLOW, HENCE LESS CONSTITUENTS, WILL ENTER THE SOUTH BAY AND PACIFIC OCEAN. OVERALL, THE COMBINATION OF TERTIARY TREATMENT AND MAXIMUM USE OF THE LAND AREAS AS A TREATMENT PROCESS REDUCES CONSTITUENT LOADS IN ALL WATER QUALITY ZONES OF THE ESTUARY TO LEVELS APPROACHING ZERO DISCHARGE.	BASED ON THE RELATIONSHIP BETWEEN CONSTITUENT LOAD AND ENVIRONMENTAL STRESS THIS ALTERNATIVE PROVIDES AQUATIC SPECIES AND OTHER ASSOCIATED SPECIES WITH A PHYSICAL ENVIRONMENT RELATIVELY FREE OF MUNICIPAL AND INDUSTRIAL WASTE STRESS. ACUTE TOXICITY, INCLUDING CHLORINE TOXICITY, CHRONIC TOXICITY INCLUDING THAT OF BIOACCUMULATION OF PESTICIDES AND HEAVY METALS, WOULD BE AT MINIMUM LEVELS. THE PROBLEM OF REDUCED OR FLUCTUATING DISSOLVED OXYGEN LEVELS RESULTING FROM EUTROPHICATION OR HIGH ORGANIC WASTE LOADS WOULD BE MINIMIZED IN THE BIOLOGICALLY SENSITIVE AREAS OF THE ESTUARY AND LIMITED ONLY BY FRESHWATER OUTFLOW AND AGRICULTURAL WASTE DISCHARGE. AS A RESULT, REPRODUCTION AND GROWTH AND SURVIVAL RATES OF FISHES AND LOWER FOOD CHAIN SPECIES WOULD BE SIGNIFICANTLY ENHANCED.	THIS ALTERNATIVE WILL PROVIDE PERMANENT OPEN SPACE AND OPEN WATER PRESERVES. IN CROP AREAS THE RURAL AGRICULTURAL CHARACTER OF THE AREA WOULD BE PERMANENTLY RETAINED AND IN GRAZING AREAS THE CHANGE IN VEGETATIVE COVER WOULD COMPLEMENT THE SURROUNDING NATIVE COVER TYPE. THE BEAUTIFICATION PROGRAM ACCOMPANYING THE CONVERSION OF TREATMENT PLANTS TO PUMPING STATIONS WILL ENHANCE THEIR VISUAL PROFILE. SINCE PIPELINE ROUTES WILL HAVE TO REMAIN OPEN FOR MAINTENANCE PURPOSES, A POTENTIAL FOR GREEN BELTS IN URBAN AREAS EXISTS. IMPROVED WATER QUALITY IN THE ESTUARY AND INCREASED FLOW IN LOCAL STREAMS WILL ENHANCE THE SENSORY VALUE OF THE REGION'S WATERWAYS.	BY IMPROVING WATER QUALITY THIS ALTERNATIVE COULD INCREASE ACTIVE AND PASSIVE WATER-ORIENTED RECREATIONAL ACTIVITIES ASSOCIATED WITH THE BAY-DELTA ESTUARY. PLANNING AND DEVELOPMENT IN THE APPLICATION SITES ARE DIRECTED TOWARD THE PRESERVATION OF FARM AND NATURAL LANDS AS OPEN SPACE, SCENIC ELEMENTS AND POSSIBLE RECREATIONAL AREAS. WITH 47% OF THE OUTDOOR RECREATION PARTICIPATION OCCURRING WITHIN THE ZERO TO ONE HOUR TRAVEL ZONE FROM METROPOLITAN AREAS, THE RECREATIONAL USE OF OPEN SPACE PROVIDED BY THIS ALTERNATIVE WOULD BE BENEFICIAL IN MEETING INCREASING ACTIVE AND PASSIVE WATER-ORIENTED AND PASSIVE LAND-ORIENTED RECREATIONAL DEMANDS.
(DETRIMENTAL)			
THE TREATMENT PROCESSES (LAND AND FULL TERTIARY) WILL NOT EFFECTIVELY REMOVE TDS FROM THE WASTE STREAM. IN FACT, LAND TREATMENT MAY INCREASE THE TDS OF RETURN WATER. THE MAGNITUDE OF IMPACT RESULTING FROM THE DISCHARGE OF HIGH TDS WATER WILL VARY WITH THE USE OF THE RECEIVING WATER. IN ADDITION REDUCED WASTEWATER FLOW TO CENTRAL AND SUISUN BAYS MAY ALTER THE FLUSHING REGIMEN OF THE ESTUARY THUS INCREASING TDS LEVEL, IN ITS EXTREMITIES. THE LAND WILL UNDERGO EXTENSIVE SHORT-TERM ALTERATION DUE TO THE CONSTRUCTION AND PLACEMENT OF TREATMENT FACILITIES AND UNDERDRAINS. LONG-TERM IMPACTS MAY BE REALIZED IN THE CONVERSION OF WILD LAND TO MANAGED LAND, THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES AND THE POSSIBLE BUILD-UP OF HEAVY METALS IN THE SOIL.	CONSTRUCTION ON SYSTEM REQUIRED LANDS WILL CAUSE AN INITIAL REDUCTION IN INDIGENOUS ANIMAL SPECIES DUE TO DIRECT LOSS OR AVOIDANCE MIGRATION. POST CONSTRUCTION RECOVERY SUCCESS WILL VARY WITH THE NEW HABITAT TYPE. IN AREAS WHERE A RADICAL CHANGE OF COVER TYPE HAS OCCURRED DUE TO INCREASED MOISTURE, NEW BIOTIC COMMUNITIES WILL DISPLACE THE EXISTING ONES. IN AREAS WHERE PLANNING HAS PROVIDED FOR RESTORATION OF NATIVE VEGETATION, REINHABITATION WILL BE SLOW AND IN INUNDATED AREAS THERE WILL BE NO RECOVERY. AQUATIC CONDITIONS IS THE STREAMS RECEIVING RETURN WATER FROM THE LAND AREAS WILL BE MODIFIED BY INCREASED TDS. THIS IMPACT WOULD BE CHARACTERIZED BY A SHIFT IN THE AQUATIC AND RIPARIAN COMMUNITIES TO MERE SALT TOLERANT SPECIES IN STREAMS WHERE TDS VALUES AND DILUTION RATES ARE LOW.	CONSTRUCTION WILL CAUSE TEMPORARY VISUAL DEGRADATION OF EXISTING SYSTEM REQUIRED LANDS. EVEN AFTER LANDSCAPING BUFFER ZONES AND OTHER MITIGATIVE MEASURES HAVE ACHIEVED MATURITY THERE MAY REMAIN AN INTRUSIVE IMPACT OF MAN-MADE SYSTEMS IN THE NATURAL ENVIRONMENT. ALTHOUGH HISTORICAL SITES AND ARCHAEOLOGICAL SITES WILL BE PROTECTED BY BUFFER ZONES AND VEGETATION SCREENS SOME OF THEIR SIGNIFICANCE MAY BE LOST BY OBSTRUCTION OF SETTING.	ACTIVE RECREATIONAL PURSUITS ON THE LAND SITES WILL BE LIMITED. CONSTRUCTION AND THE PERMANENT COMMITMENT OF LAND TO TREATMENT FACILITIES COULD DEGRADE AND/OR DISPLACE THE CURRENT RECREATIONAL USE OF THE LAND.

FIGURE 22

SOCIAL EVALUATION - ALTERNATIVE B-1

AREA VIABILITY	PUBLIC ATTITUDES	DISTRIBUTIVE EQUITY	PUBLIC HEALTH
(BENEFICIAL)			
THIS ALTERNATIVE HELPS IMPLEMENT LAND USE AND DEVELOPMENT PATTERN POLICIES. HELPS RETAIN RURAL, AGRICULTURAL LIFESTYLE OF RESIDENTS OF SITES, AND ENHANCES NEIGHBORHOOD COHESION WITH PARKS AND OPEN SPACES OF PIPELINE ROUTES IN URBAN CORES. 154,000 ACRES OF LAND WITHIN SEVEN SITES ASSURED OF RETENTION AS OPEN SPACE USES. POTENTIAL ORCHARD REPLACEMENT IN SLUDGE AREAS OF 5,900 ACRES RESULT IN ANNUAL INCOME GAIN OF $1,140,000.	ASSURANCE OF MEETING ADEQUATE WASTEWATER QUALITY STANDARDS. POSITIVE REACTION TO ASSURANCE OF SYSTEM TO HELP RETAIN OPEN SPACE USES ON SITES AND ENVIRONMENTAL ENHANCEMENT OF POTENTIAL PARKS, OPEN SPACE, AND RESERVOIRS. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	30 MILLION MAN DAYS OF TOTAL CONSTRUCTION EMPLOYMENT; $1,749 MILLION TOTAL WAGES, $287 MILLION OF WHICH IS MINORITY SHARE. 7,000-9,000 EMPLOYMENT FORCE FOR SYSTEM O&M, WITH TOTAL ANNUAL WAGES OF $143 MILLION. OPPORTUNITY FOR INCREASED SHARE OF MINORITY WORKERS IN JOB TRAINING, HIGHER JOB LEVELS, JOB PARTICIPATION, AND JOB INCOME FOR BOTH CONSTRUCTION AND O&M PHASES.	THE TREATMENT PLANT COMPONENT APPLIES THE BEST PRACTICABLE TREATMENT TECHNOLOGY FOR REMOVAL OF TOXIC CHEMICALS. AS A RESULT OF THE LAND TREATMENT COMPONENT OF THE ALTERNATIVE THERE WOULD BE AN OVERALL REDUCTION IN THE NUMBER OF WATERBORNE PATHOGENS ENTERING THE ESTUARY UNDER NORMAL OPERATING CONDITIONS, GREATER CONTROL OF WATERBORNE PATHOGENS IN EMERGENCY CONDITIONS, A REDUCTION IN THE OVERALL DISCHARGE OF TOXIC CHEMICALS AND A REDUCTION IN CHLORINE TOXICITY IN THE ESTUARY. THE SIGNIFICANT REDUCTION OF TOXIC CHEMICALS IN THE RECEIVING WATER WOULD AID NATURAL PROCESSES IN FLUSHING TOXICANTS FROM ESTUARINE SEDIMENTS.
(DETRIMENTAL)			
NET AVERAGE ANNUAL AGRICULTURAL INCOME LOSS FROM 35,800 ACRES OF CROP CHANGES. POTENTIAL AGRICULTURAL JOB DISRUPTION FOR 780 WORKERS AND LABOR INCOME LOSS OF $1,520,000 PER CROP CYCLE DUE TO CROP CHANGES. NUISANCE OF DIRT, DUST, NOISE AND ACCESS DISRUPTION DURING CONSTRUCTION PHASE MAY CAUSE POSSIBLE BUSINESS AND SERVICE ESTABLISHMENT LOSSES. POTENTIAL ALTERATION OF JOB DEMAND FOR AGRICULTURAL MIGRANT WORKERS.	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION, ENVIRONMENTAL IMPAIRMENT, CHANGE OF LIFE-STYLE, CHANGE OF FARM OPERATION AND INCOME, DISRUPTION OF RESIDENT JOBS AND HOUSING AND WASTEWATER NUISANCES. INCONVENIENCE OF PATRONS, SERVICE USERS, AND RESIDENTS DURING CONSTRUCTION PHASES. ANXIETY OVER POSSIBLE LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS. CONCERN OF BUSINESS AND SERVICE ESTABLISHMENTS OVER ACCESS DISRUPTION.	NOT APPLICABLE	THE APPLICATION OF WASTEWATER TO LAND WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMALS ASSOCIATED WITH WETLANDS. WITH PROPER WATER MANAGEMENT AND ABATEMENT MEASURES THE MAGNITUDE OF THIS INCREASE WILL BE EQUAL TO THAT OF A NORMAL IRRIGATION PROJECT. SINCE HABITAT, VECTORS, HOSTS AND AGENTS WILL BE PRESENT IN THE APPLICATION AREAS, A POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION WILL EXIST. THE RISK FACTOR WILL DEPEND ON HUMAN EXPOSURE AND VECTOR CONTROL.

FIGURE 23

SOCIAL EVALUATION-ALTERNATIVE B-2

(BENEFICIAL)

AREA VIABILITY	PUBLIC ATTITUDES	DISTRIBUTIVE EQUITY	PUBLIC HEALTH
THIS ALTERNATIVE HELPS IMPLEMENT LAND USE AND DEVELOPMENT PATTERN POLICIES. HELPS RETAIN RURAL, AGRICULTURAL LIFE-STYLE OF RESIDENTS OF SITES, AND ENHANCES NEIGHBORHOOD COHESION WITH PARKS AND OPEN SPACES OF PIPELINE ROUTES IN URBAN CORES. 153,000 ACRES OF LAND WITHIN SEVEN SITES ASSURED OF RETENTION AS OPEN SPACE USES. POTENTIAL ORCHARD REPLACEMENT IN SLUDGE AREAS OF 5,900 ACRES RESULT IN ANNUAL INCOME GAIN OF $1,140,000.	ASSURANCE OF MEETING ADEQUATE WASTEWATER QUALITY STANDARDS. POSITIVE REACTION TO ASSURANCE OF SYSTEM TO HELP RETAIN OPEN SPACE USES ON SITES AND ENVIRONMENTAL ENHANCEMENT OF POTENTIAL PARKS, OPEN SPACE, AND RESERVOIRS. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	24 MILLION MAN DAYS OF TOTAL CONSTRUCTION EMPLOYMENT; $1,380 MILLION TOTAL WAGES, $221 MILLION OF WHICH IS MINORITY SHARE. 7,000 - 9,000 EMPLOYMENT FORCE FOR SYSTEM O&M, WITH TOTAL ANNUAL WAGES OF $121 MILLION. OPPORTUNITY FOR INCREASED SHARE OF MINORITY WORKERS IN JOB TRAINING, HIGHER JOB LEVELS, JOB PARTICIPATION, AND JOB INCOME FOR BOTH CONSTRUCTION AND O&M PHASES.	THE TREATMENT PLANT COMPONENT APPROACHES THE BEST PRACTICABLE TREATMENT TECHNOLOGY FOR REMOVAL OF TOXIC CHEMICALS. THE LAND TREATMENT COMPONENT WOULD REDUCE THE NUMBER OF WATERBORNE PATHOGENS ENTERING THE ESTUARY UNDER NORMAL OPERATING CONDITIONS, GREATER CONTROL OF WATERBORNE PATHOGENS IN EMERGENCY CONDITIONS, A REDUCTION IN THE OVERALL DISCHARGE OF TOXIC CHEMICALS AND A REDUCTION IN CHLORINE TOXICITY IN THE ESTUARY. **THE INITIAL REDUCTION OF TOXIC CHEMICALS IN THE RECEIVING WATER WOULD TEMPORARILY AID NATURAL PROCESSES IN FLUSHING TOXICANTS FROM ESTUARINE SEDIMENTS.**
(DETRIMENTAL)			
NET AVERAGE ANNUAL INCOME LOSS FROM 35,800 ACRES OF CROP CHANGES. POTENTIAL AGRICULTURAL JOB DISRUPTION FOR 780 WORKERS AND LABOR INCOME LOSS OF $1,520,000 PER CROP CYCLE DUE TO CROP CHANGES. NUISANCE OF DIRT, DUST, NOISE AND ACCESS DISRUPTION DURING CONSTRUCTION PHASE MAY CAUSE POSSIBLE BUSINESS AND SERVICE ESTABLISHMENT LOSSES. POTENTIAL ALTERATION OF JOB DEMAND FOR AGRICULTURAL MIGRANT WORKERS.	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION, ENVIRONMENTAL IMPAIRMENT, CHANGE OF LIFE-STYLE, CHANGE OF FARM OPERATION AND INCOME, DISRUPTION OF RESIDENT JOBS AND HOUSING AND WASTEWATER NUISANCES. INCONVENIENCE OF PATRONS, SERVICE USERS, AND RESIDENTS DURING CONSTRUCTION PHASES. ANXIETY OVER POSSIBLE LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS. CONCERN OF BUSINESS AND SERVICE ESTABLISHMENTS OVER ACCESS DISRUPTION.	NOT APPLICABLE	ALTHOUGH THE TREATMENT PLANT COMPONENT WILL REDUCE TOXIC CHEMICALS TO LEVELS BELOW BASE LEVELS IT WILL NOT MAINTAIN THOSE LEVELS PAST 2000. THE APPLICATION OF WASTEWATER TO LAND WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMALS ASSOCIATED WITH WETLANDS. WITH PROPER WATER MANAGEMENT AND ABATEMENT MEASURES THE MAGNITUDE OF THIS INCREASE WILL BE EQUAL TO THAT OF A NORMAL IRRIGATION PROJECT. SINCE HABITAT, VECTORS, HOSTS AND AGENTS WILL BE PRESENT IN THE APPLICATION AREAS, A POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION WILL EXIST. THE RISK FACTOR WILL DEPEND ON HUMAN EXPOSURE AND VECTOR CONTROL.

FIGURE 24

SOCIAL EVALUATION-ALTERNATIVE B-3

AREA VIABILITY	PUBLIC ATTITUDES	DISTRIBUTIVE EQUITY	PUBLIC HEALTH
(BENEFICIAL)			
THIS ALTERNATIVE HELPS IMPLEMENT LAND USE AND DEVELOPMENT PATTERN POLICIES. HELPS RETAIN RURAL, AGRICULTURAL LIFE-STYLE OF RESIDENTS OF SITES, AND ENHANCES NEIGHBORHOOD COHESION WITH PARKS AND OPEN SPACES OF PIPELINE ROUTES IN URBAN CORES. 194,000 ACRES OF LAND WITHIN EIGHT SITES ASSURED OF RETENTION AS OPEN SPACE USES. POTENTIAL ORCHARD REPLACEMENT IN SLUDGE AREAS OF 6,100 ACRES RESULT IN ANNUAL INCOME GAIN OF $1,212,000.	ASSURANCE OF MEETING ADEQUATE WASTEWATER QUALITY STANDARDS. POSITIVE REACTION TO ASSURANCE OF SYSTEM TO HELP RETAIN OPEN SPACE USES ON SITES AND ENVIRONMENTAL ENHANCEMENT OF POTENTIAL PARKS, OPEN SPACE, AND RESERVOIRS. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	35 MILLION MAN DAYS OF TOTAL CONSTRUCTION EMPLOYMENT; $2,001 MILLION TOTAL WAGES, $320 MILLION OF WHICH IS MINORITY SHARE. 7,000 - 9,000 EMPLOYMENT FORCE FOR SYSTEM O&M, WITH TOTAL ANNUAL WAGES OF $151 MILLION. OPPORTUNITY FOR INCREASED SHARE OF MINORITY WORKERS IN JOB TRAINING, HIGHER JOB LEVELS, JOB PARTICIPATION, AND JOB INCOME FOR BOTH CONSTRUCTION AND O&M PHASES.	THE TREATMENT PLANT COMPONENT APPLIES THE BEST PRACTICABLE TREATMENT TECHNOLOGY FOR REMOVAL OF TOXIC CHEMICALS. AS A RESULT OF THE LAND TREATMENT COMPONENT OF THE ALTERNATIVE THERE WOULD BE AN OVERALL REDUCTION IN THE NUMBER OF WATERBORNE PATHOGENS ENTERING THE ESTUARY UNDER NORMAL OPERATING CONDITIONS, GREATER CONTROL OF WATERBORNE PATHOGENS IN EMERGENCY CONDITIONS, A REDUCTION IN THE OVERALL DISCHARGE OF TOXIC CHEMICALS AND A REDUCTION IN CHLORINE TOXICITY IN THE ESTUARY. THE SIGNIFICANT REDUCTION OF TOXIC CHEMICALS IN THE RECEIVING WATER WOULD AID NATURAL PROCESSES IN FLUSHING TOXICANTS FROM ESTUARINE SEDIMENTS. THIS ALTERNATIVE PROVIDES THE LOWEST DISCHARGE OF TOXIC CHEMICALS TO THE SOUTH BAY OF THE B-SERIES ALTERNATIVES.
(DETRIMENTAL)			
NET AVERAGE ANNUAL INCOME LOSS FROM 50,900 ACRES OF CROP CHANGES. POTENTIAL AGRICULTURAL JOB DISRUPTION FOR 900 WORKERS AND LABOR INCOME LOSS OF $1,900,000 PER CROP CYCLE DUE TO CROP CHANGES. NUISANCE OF DIRT, DUST, NOISE AND ACCESS DISRUPTION DURING CONSTRUCTION PHASE MAY CAUSE POSSIBLE BUSINESS AND SERVICE ESTABLISHMENT LOSSES. POTENTIAL ALTERATION OF JOB DEMAND FOR AGRICULTURAL MIGRANT WORKERS.	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION, ENVIRONMENTAL IMPAIRMENT, CHANGE OF LIFE-STYLE, CHANGE OF FARM OPERATION AND INCOME, DISRUPTION OF RESIDENT JOBS AND HOUSING AND WASTEWATER NUISANCES. INCONVENIENCE OF PATRONS, SERVICE USERS, AND RESIDENTS DURING CONSTRUCTION PHASES. ANXIETY OVER POSSIBLE LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS. CONCERN OF BUSINESS AND SERVICE ESTABLISHMENTS OVER ACCESS DISRUPTION. OPPOSITION TO THE INTERBASIN TRANSFER OF TREATED WASTEWATER.	NOT APPLICABLE	THE APPLICATION OF WASTEWATER TO LAND WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMALS ASSOCIATED WITH WETLANDS. WITH PROPER WATER MANAGEMENT AND ABATEMENT MEASURES THE MAGNITUDE OF THIS INCREASE WILL BE EQUAL TO THAT OF A NORMAL IRRIGATION PROJECT. SINCE HABITAT, VECTORS, HOSTS AND AGENTS WILL BE PRESENT IN THE APPLICATION AREAS A POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION WILL EXIST. THE RISK FACTOR WILL DEPEND ON HUMAN EXPOSURE AND VECTOR CONTROL. THIS ALTERNATIVE WILL BRING THESE IMPACTS TO LAND AREA 27.

FIGURE 25

SOCIAL EVALUATION - ALTERNATIVE D-1

(BENEFICIAL)

AREA VIABILITY	PUBLIC ATTITUDES	DISTRIBUTIVE EQUITY	PUBLIC HEALTH
THIS ALTERNATIVE HELPS IMPLEMENT LAND USE AND DEVELOPMENT PATTERN POLICIES. HELPS RETAIN RURAL, AGRICULTURAL LIFE-STYLE OF RESIDENTS OF SITES, AND ENHANCES NEIGHBORHOOD COHESION WITH PARKS AND OPEN SPACES OF PIPELINE ROUTES IN URBAN CORES. 210,000 ACRES OF LAND WITHIN SEVEN SITES ASSURED OF RETENTION AS OPEN SPACE USES. POTENTIAL ORCHARD REPLACEMENT IN SLUDGE AREAS OF 5,700 ACRES RESULT IN ANNUAL INCOME GAIN OF $1,122,000.	ASSURANCE OF MEETING ADEQUATE WASTEWATER QUALITY STANDARDS. POSITIVE REACTION TO ASSURANCE OF SYSTEM TO HELP RETAIN OPEN SPACE USES ON SITES AND ENVIRONMENTAL ENHANCEMENT OF POTENTIAL PARKS, OPEN SPACE, AND RESERVOIRS. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIAL AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	36 MILLION MAN DAYS OF TOTAL CONSTRUCTION EMPLOYMENT; $2,070 MILLION TOTAL WAGES, $331 MILLION OF WHICH IS MINORITY SHARE. 7,000 - 9,000 EMPLOYMENT FORCE FOR SYSTEM O&M, WITH TOTAL ANNUAL WAGES OF $129 MILLION. OPPORTUNITY FOR INCREASED SHARE OF MINORITY WORKERS IN JOB TRAINING, HIGHER JOB LEVELS, JOB PARTICIPATION, AND JOB INCOME FOR BOTH CONSTRUCTION AND O&M PHASES.	THE TREATMENT PLANT COMPONENT APPLIES THE BEST PRACTICABLE TREATMENT TECHNOLOGY FOR REMOVAL OF TOXIC CHEMICALS. AS A RESULT OF THE LAND TREATMENT COMPONENT OF THE ALTERNATIVE THERE WOULD BE AN OVERALL REDUCTION IN THE NUMBER OF WATERBORNE PATHOGENS ENTERING THE ESTUARY UNDER NORMAL OPERATING CONDITIONS, GREATER CONTROL OF WATERBORNE PATHOGENS IN EMERGENCY CONDITIONS, A REDUCTION IN THE OVERALL DISCHARGE OF TOXIC CHEMICALS AND A REDUCTION IN CHLORINE TOXICITY IN THE ESTUARY. THE SIGNIFICANT REDUCTION OF TOXIC CHEMICALS IN THE RECEIVING WATER WOULD AID NATURAL PROCESSES IN FLUSHING TOXICANTS FROM ESTUARINE SEDIMENTS. THIS ALTERNATIVE PROVIDES FOR NO DISCHARGE OF HEAVY METALS INTO THE CENTRAL BAY AND SUISUN BAY AND ONLY SMALL AMOUNTS (50 lbs/day) INTO THE DELTA.
(DETRIMENTAL)			
NET AVERAGE ANNUAL INCOME LOSS FROM 54,230 ACRES OF CROP CHANGES. POTENTIAL AGRICULTURAL JOB DISRUPTION FOR 780 WORKERS AND LABOR INCOME LOSS OF $1,340,000 PER CROP CYCLE DUE TO CROP CHANGES. NUISANCE OF DIRT, DUST, NOISE AND ACCESS DISRUPTION DURING CONSTRUCTION PHASE MAY CAUSE POSSIBLE BUSINESS AND SERVICE ESTABLISHMENT LOSSES. POTENTIAL ALTERATION OF JOB DEMAND FOR AGRICULTURAL MIGRANT WORKERS.	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION, ENVIRONMENTAL IMPAIRMENT, CHANGE OF LIFE-STYLE, CHANGE OF FARM OPERATION AND INCOME, DISRUPTION OF RESIDENT JOBS AND HOUSING AND WASTEWATER NUISANCES. INCONVENIENCE OF PATRONS, SERVICE USERS, AND RESIDENTS DURING CONSTRUCTION PHASES. ANXIETY OVER POSSIBLE LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS. CONCERN OF BUSINESS AND SERVICE ESTABLISHMENTS OVER ACCESS DISRUPTION.	NOT APPLICABLE	THE APPLICATION OF WASTEWATER TO LAND WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMALS ASSOCIATED WITH WETLANDS. WITH PROPER WATER MANAGEMENT AND ABATEMENT MEASURES THE MAGNITUDE OF THIS INCREASE WILL BE EQUAL TO THAT OF A NORMAL IRRIGATION PROJECT. SINCE HABITAT, VECTORS, HOSTS AND AGENTS WILL BE PRESENT IN THE APPLICATION AREAS A POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION WILL EXIST. AERATION LAGOONS MAY BE THE MOST HAZARDOUS COMPONENT OF THE SYSTEM. THE RISK FACTOR WILL DEPEND ON HUMAN EXPOSURE AND VECTOR CONTROL. UNDER THIS ALTERNATIVE ABOUT 50,000 MORE ACRES OF LAND THAN IN ALTERNATIVE B1 WOULD BE SUSCEPTIBLE TO THESE IMPACTS.

FIGURE 26

SOCIAL EVALUATION - ALTERNATIVE D-2

AREA VIABILITY	PUBLIC ATTITUDES	DISTRIBUTIVE EQUITY	PUBLIC HEALTH
(BENEFICIAL)			
THIS ALTERNATIVE HELPS IMPLEMENT LAND USE AND DEVELOPMENT PATTERN POLICIES. HELPS RETAIN RURAL, AGRICULTURAL LIFE-STYLE OF RESIDENTS OF SITES, AND ENHANCES NEIGHBORHOOD COHESION WITH PARKS AND OPEN SPACES OF PIPELINE ROUTES IN URBAN CORES. 209,000 ACRES OF LAND WITHIN SEVEN SITES ASSURED OF RETENTION AS OPEN SPACE USES. POTENTIAL ORCHARD REPLACEMENT IN SLUDGE AREAS OF 5,700 ACRES RESULT IN ANNUAL INCOME GAIN OF $1,122,000.	ASSURANCE OF MEETING ADEQUATE WASTEWATER QUALITY STANDARDS. POSITIVE REACTION TO ASSURANCE OF SYSTEM TO HELP RETAIN OPEN SPACE USES ON SITES AND ENVIRONMENTAL ENHANCEMENT OF POTENTIAL PARKS, OPEN SPACE, AND RESERVOIRS. SPACE, AND RESERVOIRS. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	30 MILLION MAN DAYS OF TOTAL CONSTRUCTION EMPLOYMENT; $1,725 MILLION TOTAL WAGES, $276 MILLION OF WHICH IS MINORITY SHARE. 7,000 - 9,000 EMPLOYMENT FORCE FOR SYSTEM O&M, WITH TOTAL ANNUAL WAGES OF $105 MILLION. OPPORTUNITY FOR INCREASED SHARE OF MINORITY WORKERS IN JOB TRAINING, HIGHER JOB LEVELS, JOB PARTICIPATION, AND JOB INCOME FOR BOTH CONSTRUCTION AND O&M PHASES.	THE TREATMENT PLANT COMPONENT APPROACHES THE BEST PRACTICABLE TREATMENT TECHNOLOGY FOR REMOVAL OF TOXIC CHEMICALS. THE LAND TREATMENT COMPONENT WOULD REDUCE THE NUMBER OF WATERBORNE PATHOGENS ENTERING THE ESTUARY UNDER NORMAL OPERATING CONDITIONS, GREATER CONTROL OF WATERBORNE PATHOGENS IN EMERGENCY CONDITIONS, A REDUCTION IN THE OVERALL DISCHARGE OF TOXIC CHEMICALS AND A REDUCTION IN CHLORINE TOXICITY IN THE ESTUARY. THE SIGNIFICANT REDUCTION OF TOXIC CHEMICALS IN THE RECEIVING WATER WOULD AID NATURAL PROCESSES IN FLUSHING TOXICANTS FROM ESTUARINE SEDIMENTS. THIS ALTERNATIVE PROVIDES FOR NO DISCHARGE OF HEAVY METALS INTO THE CENTRAL BAY AND SUISUN BAY AND ONLY SMALL AMOUNTS (50 lbs/day) INTO THE DELTA.
(DETRIMENTAL)			
NET AVERAGE ANNUAL INCOME LOSS FROM 54,230 ACRES OF CROP CHANGES. POTENTIAL AGRICULTURAL JOB DISRUPTION FOR 780 WORKERS AND LABOR INCOME LOSS OF $1,340,000 PER CROP CYCLE DUE TO CROP CHANGES. NUISANCE OF DIRT, DUST, NOISE AND ACCESS DISRUPTION DURING CONSTRUCTION PHASE CAUSING POSSIBLE BUSINESS AND SERVICE ESTABLISHMENT LOSSES. POTENTIAL ALTERATION OF JOB DEMAND FOR AGRICULTURAL MIGRANT WORKERS.	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION, ENVIRONMENTAL IMPAIRMENT, CHANGE OF LIFE-STYLE, CHANGE OF FARM OPERATION AND INCOME, DISRUPTION OF RESIDENT JOBS AND HOUSING AND WASTEWATER NUISANCES. INCONVENIENCE OF PATRONS, SERVICE USERS, AND RESIDENTS DURING CONSTRUCTION PHASES. ANXIETY OVER POSSIBLE LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS. CONCERN OF BUSINESS AND SERVICE ESTABLISHMENTS OVER ACCESS DISRUPTION.	NOT APPLICABLE	ALTHOUGH THE TREATMENT PLANT COMPONENT WILL REDUCE TOXIC CHEMICALS TO LEVELS BELOW BASE LEVELS IT WILL NOT MAINTAIN THOSE LEVELS PAST 2000. THE APPLICATION OF WASTEWATER TO LAND WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMALS ASSOCIATED WITH WETLANDS. WITH PROPER WATER MANAGEMENT AND ABATEMENT MEASURES THE MAGNITUDE OF THIS INCREASE WILL BE EQUAL TO THAT OF A NORMAL IRRIGATION PROJECT. SINCE HABITAT, VECTORS, HOSTS AND AGENTS WILL BE PRESENT IN THE APPLICATION AREAS A POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION WILL EXIST. AERATION LAGOONS MAY BE THE MOST HAZARDOUS COMPONENT OF THE SYSTEM. THE RISK FACTOR WILL DEPEND ON HUMAN EXPOSURE AND VECTOR CONTROL. UNDER THIS ALTERNATIVE ABOUT 50,000 MORE ACRES OF LAND THAN IN ALTERNATIVE B1 WOULD BE SUSCEPTIBLE TO THESE IMPACTS.

FIGURE 27

SOCIAL EVALUATION - ALTERNATIVE D-3

(BENEFICIAL)

AREA VIABILITY	PUBLIC ATTITUDES	DISTRIBUTIVE EQUITY	PUBLIC HEALTH
THIS ALTERNATIVE HELPS IMPLEMENT LAND USE AND DEVELOPMENT PATTERN POLICIES. HELPS RETAIN RURAL, AGRICULTURAL LIFE-STYLE OF RESIDENTS OF SITES, AND ENHANCES NEIGHBORHOOD COHESION WITH PARKS AND OPEN SPACES OF PIPELINE ROUTES IN URBAN CORES. 250,000 ACRES OF LAND WITHIN EIGHT SITES ASSURED OF RETENTION AS OPEN SPACE USES. POTENTIAL ORCHARD REPLACEMENT IN SLUDGE AREAS OF 6,000 ACRES RESULT IN ANNUAL INCOME GAIN OF $1,194,000.	ASSURANCE OF MEETING ADEQUATE WASTEWATER QUALITY STANDARDS. POSITIVE REACTION TO ASSURANCE OF SYSTEM TO HELP RETAIN OPEN SPACE USES ON SITES AND ENVIRONMENTAL ENHANCEMENT OF POTENTIAL PARKS, OPEN SPACE, AND RESERVOIRS. SOME EXPRESSION OF AGRICULTURAL BENEFITS FROM OFFICIALS AND INDIVIDUALS IN SAN JOAQUIN, MARIN AND NAPA COUNTIES.	40 MILLION MAN DAYS OF TOTAL CONSTRUCTION EMPLOYMENT; $2,277 MILLION TOTAL WAGES, $364 MILLION OF WHICH IS MINORITY SHARE. 7,000 - 9,000 EMPLOYMENT FORCE FOR SYSTEM O&M, WITH TOTAL ANNUAL WAGES OF $139 MILLION. OPPORTUNITY FOR INCREASED SHARE OF MINORITY WORKERS IN JOB TRAINING, HIGHER JOB LEVELS, JOB PARTICIPATION, AND JOB INCOME FOR BOTH CONSTRUCTION AND O&M PHASES.	THE TREATMENT PLANT COMPONENT APPLIES THE BEST PRACTICABLE TREATMENT TECHNOLOGY FOR REMOVAL OF TOXIC CHEMICALS. AS A RESULT OF THE LAND TREATMENT COMPONENT OF THE ALTERNATIVE THERE WOULD BE AN OVERALL REDUCTION IN THE NUMBER OF WATERBORNE PATHOGENS ENTERING THE ESTUARY UNDER NORMAL OPERATING CONDITIONS, GREATER CONTROL OF WATERBORNE PATHOGENS IN EMERGENCY CONDITIONS, A REDUCTION IN THE OVERALL DISCHARGE OF TOXIC CHEMICALS AND A REDUCTION IN CHLORINE TOXICITY IN THE ESTUARY. THE SIGNIFICANT REDUCTION OF TOXIC CHEMICALS IN THE RECEIVING WATER WOULD AID NATURAL PROCESSES IN FLUSHING TOXICANTS FROM ESTUARINE SEDIMENTS. **THIS ALTERNATIVE PROVIDES THE LOWEST DISCHARGE OF TOXIC CHEMICALS TO THE SOUTH BAY AND NO DISCHARGE OF GROSS HEAVY METALS (GHM) TO CENTRAL BAY AND SUISUN BAY.**
(DETRIMENTAL)			
NET AVERAGE ANNUAL INCOME LOSS FROM 69,380 ACRES OF CROP CHANGES. POTENTIAL AGRICULTURAL JOB DISRUPTION FOR 900 WORKERS AND LABOR INCOME LOSS OF $1,730,000 PER CROP CYCLE DUE TO CROP CHANGES. NUISANCE OF DIRT, DUST, NOISE AND ACCESS DISRUPTION DURING CONSTRUCTION PHASE MAY CAUSE POSSIBLE BUSINESS AND SERVICE ESTABLISHMENT LOSSES. POTENTIAL ALTERATION OF JOB DEMAND FOR AGRICULTURAL MIGRANT WORKERS.	CONCERN OF SYSTEM EFFECT TO POSSIBLY INFLUENCE INCREASED URBANIZATION, ENVIRONMENTAL IMPAIRMENT, CHANGE OF LIFE-STYLE, CHANGE OF FARM OPERATION AND INCOME, DISRUPTION OF RESIDENT JOBS AND HOUSING AND WASTEWATER NUISANCES, INCONVENIENCE OF PATRONS, SERVICE USERS, AND RESIDENTS DURING CONSTRUCTION PHASES. ANXIETY OVER POSSIBLE LOSS OF SOCIAL STRUCTURE AND COHESION AMONG SOME ETHNIC GROUPS. CONCERN OF BUSINESS AND SERVICE ESTABLISHMENTS OVER ACCESS DISRUPTION. OPPOSITION TO THE INTERBASIN TRANSFER OF WASTEWATER.	NOT APPLICABLE	THE APPLICATION OF WASTEWATER TO LAND WILL INCREASE ARTHROPOD AND VERTEBRATE NUISANCE ANIMALS ASSOCIATED WITH WETLANDS, WITH PROPER WATER MANAGEMENT AND ABATEMENT MEASURES THE MAGNITUDE OF THIS INCREASE WILL BE EQUAL TO THAT OF A NORMAL IRRIGATION PROJECT. SINCE HABITAT VECTORS, HOSTS AND AGENTS WILL BE PRESENT IN THE APPLICATION AREAS A POTENTIAL FOR ZOONOTIC DISEASE TRANSMISSION WILL EXIST. AERATION LAGOONS MAY BE THE MOST HAZARDOUS COMPONENT OF THE SYSTEM. THE RISK FACTOR WILL DEPEND ON HUMAN EXPOSURE AND VECTOR CONTROL. THIS ALTERNATIVE REQUIRES THE MOST LAND OF ANY ALTERNATIVE AND WILL BRING THESE IMPACTS TO LAND AREA 27.

FIGURE 28

ECONOMIC EVALUATION - ALTERNATIVE B-1

(BENEFICIAL)

COSTS	PRODUCTION	PUBLIC FINANCE
NOT APPLICABLE	BASED ON A PROJECTION OF 10,000 ACRES OF PRODUCING OYSTER BEDS IN THE SAN FRANCISCO BAY ESTUARY, THERE WOULD BE A POTENTIAL FOR AT LEAST 25 MILLION POUNDS PER YEAR OF UNSHUCKED OYSTERS.	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION. THIS MAY INCREASE TAX BASE.
(DETRIMENTAL)		
THE TOTAL AVERAGE ANNUAL COST FOR THIS ALTERNATIVE WITH REUSE IS $447,000,000. A MAJOR PART OF THIS COST WOULD BE PROVIDED BY THE FEDERAL GOVERNMENT. FOR THE BAY-DELTA REGION POPULATION, PER CAPITA LOCAL ANNUAL COSTS WOULD BE APPROXIMATELY $33 BY THE YEAR 2000. COSTS ARE INCREMENTAL TO THE BASE CONDITION.	THE APPLICATION AREAS TO BE USED BY THIS ALTERNATIVE ARE CURRENTLY PRIMARILY IN AGRICULTURAL USE. THE IMPLEMENTATION OF THE ALTERNATIVE WOULD NOT ELIMINATE AGRICULTURAL USE, BUT WOULD REQUIRE CERTAIN CHANGES IN THE CROPS TO BE GROWN TO ACHIEVE A HIGH NITROGEN REMOVAL AND TO AVOID RAISING CROPS FOR DIRECT HUMAN CONSUMPTION. IRRIGATION AND FERTILIZER REQUIREMENTS OF THE CROPS WOULD BE PROVIDED, THEREBY REDUCING COSTS AND EFFECTIVELY INCREASING NET INCOME; ON THE OTHER HAND, THE RESTRICTION OF CROPS AND LOSS OF ALL CROP OUTPUT FOR AN AVERAGE OF TWO YEARS TO ALLOW FOR THE IMPLEMENTATION OF THE ALTERNATIVE TENDS TO LOWER NET INCOME. FOR THIS ALTERNATIVE THE COMBINED EFFECT OF THESE CHANGES IN AGRICULTURAL PRODUCTION WOULD RESULT IN AN ESTIMATED NET AVERAGE ANNUAL INCOME LOSS OF $673,000.	THE PROPERTY TAX LOSS BASED ON CURRENT TAX RATES FOR PURCHASE OF LANDS USED FOR STORAGE RESERVOIRS, PUMPING STATIONS AND TREATMENT FACILITIES AMOUNTS TO APPROXIMATELY $165,000 PER YEAR. OF ALL THE LAND APPLICATION ALTERNATIVES, THIS ALTERNATIVE (AND ALTERNATIVE B-2) HAS THE LEAST IMPACT IN TERMS OF LOCAL PROPERTY TAXES.

FIGURE 29

ECONOMIC EVALUATION - ALTERNATIVE B-2

	COSTS	PRODUCTION	PUBLIC FINANCE
(BENEFICIAL)	NOT APPLICABLE	BASED ON A PROJECTION OF 10,000 ACRES OF PRODUCING OYSTER BEDS IN THE SAN FRANCISCO BAY ESTUARY, THERE WOULD BE A POTENTIAL FOR AT LEAST 25 MILLION POUNDS PER YEAR OF UNSHUCKED OYSTERS.	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION. THIS MAY INCREASE TAX BASE.
(DETRIMENTAL)	THE TOTAL AVERAGE ANNUAL COST FOR THIS ALTERNATIVE WITH REUSE IS $355,000,000. A MAJOR PART OF THIS COST WOULD BE PROVIDED BY THE FEDERAL GOVERNMENT. FOR THE BAY-DELTA REGION POPULATION, THE PER CAPITA LOCAL ANNUAL COSTS WOULD BE APPROXIMATELY $26 BY THE YEAR 2000. COSTS ARE INCREMENTAL TO THE BASE CONDITION.	THE APPLICATION AREAS TO BE USED BY THIS ALTERNATIVE ARE CURRENTLY PRIMARILY IN AGRICULTURAL USE. THE IMPLEMENTATION OF THE ALTERNATIVE WOULD NOT ELIMINATE AGRICULTURAL USE, BUT WOULD REQUIRE CERTAIN CHANGES IN THE CROPS TO BE GROWN TO ACHIEVE A HIGH NITROGEN REMOVAL AND TO AVOID RAISING CROPS FOR DIRECT HUMAN CONSUMPTION. IRRIGATION AND FERTILIZER REQUIREMENTS OF THE CROPS WOULD BE PROVIDED, THEREBY REDUCING COSTS AND EFFECTIVELY INCREASING NET INCOME; ON THE OTHER HAND, THE RESTRICTION OF CROPS AND LOSS OF ALL CROP OUTPUT FOR AN AVERAGE OF TWO YEARS TO ALLOW FOR THE IMPLEMENTATION OF THE ALTERNATIVE TENDS TO LOWER NET INCOME. FOR THIS ALTERNATIVE THE COMBINED EFFECT OF THESE CHANGES IN AGRICULTURAL PRODUCTION WOULD RESULT IN AN ESTIMATED NET AVERAGE ANNUAL INCOME LOSS OF $683,000.	THE PROPERTY TAX LOSS BASED ON CURRENT TAX RATES FOR PURCHASE OF LANDS USED FOR STORAGE RESERVOIRS, PUMPING STATIONS AND TREATMENT FACILITIES AMOUNTS TO APPROXIMATELY $165,000 PER YEAR. OF ALL THE LAND APPLICATION ALTERNATIVES, THIS ALTERNATIVE (AND ALTERNATIVE B-1) HAS THE LEAST IMPACT IN TERMS OF LOCAL PROPERTY TAXES.

FIGURE 30

ECONOMIC EVALUATION – ALTERNATIVE B-3

(BENEFICIAL)

COSTS	PRODUCTION	PUBLIC FINANCE
NOT APPLICABLE	BASED ON A PROJECTION OF 10,000 ACRES OF PRODUCING OYSTER BEDS IN THE SAN FRANCISCO BAY ESTUARY, THERE WOULD BE A POTENTIAL FOR AT LEAST 25 MILLION POUNDS PER YEAR OF UNSHUCKED OYSTERS.	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION. THIS MAY INCREASE TAX BASE.
	(DETRIMENTAL)	
THE TOTAL AVERAGE ANNUAL COST FOR THIS ALTERNATIVE WITH REUSE IS $482,000,000. A MAJOR PART OF THIS COST WOULD BE PROVIDED BY THE FEDERAL GOVERNMENT. FOR THE BAY-DELTA REGION POPULATION, THE PER CAPITA LOCAL ANNUAL COSTS WOULD BE APPROXIMATELY $36 BY THE YEAR 2000. COSTS ARE INCREMENTAL TO THE BASE CONDITION.	THE APPLICATION AREAS TO BE USED BY THIS ALTERNATIVE ARE CURRENTLY PRIMARILY IN AGRICULTURAL USE. THE IMPLEMENTATION OF THE ALTERNATIVE WOULD NOT ELIMINATE AGRICULTURAL USE, BUT WOULD REQUIRE CERTAIN CHANGES IN THE CROPS TO BE GROWN TO ACHIEVE A HIGH NITROGEN REMOVAL AND TO AVOID RAISING CROPS FOR DIRECT HUMAN CONSUMPTION. IRRIGATION AND FERTILIZER REQUIREMENTS OF THE CROPS WOULD BE PROVIDED, THEREBY REDUCING COSTS AND EFFECTIVELY INCREASING NET INCOME; ON THE OTHER HAND, THE RESTRICTION OF CROPS AND LOSS OF ALL CROP OUTPUT FOR AN AVERAGE OF TWO YEARS TO ALLOW FOR THE IMPLEMENTATION OF THE ALTERNATIVE TENDS TO LOWER NET INCOME. FOR THIS ALTERNATIVE THE COMBINED EFFECT OF THESE CHANGES IN AGRICULTURAL PRODUCTION WOULD RESULT IN AN ESTIMATED NET AVERAGE ANNUAL INCOME LOSS OF $1,192,000.	THE PROPERTY TAX RATE LOSS BASED ON CURRENT TAX RATES FOR PURCHASE OF LANDS USED FOR STORAGE RESERVOIRS, PUMPING STATIONS AND TREATMENT FACILITIES AMOUNTS TO APPROXIMATELY $189,000 PER YEAR.

FIGURE 31

ECONOMIC EVALUATION - ALTERNATIVE D-1

	(BENEFICIAL)	
COSTS	PRODUCTION	PUBLIC FINANCE
NOT APPLICABLE	BASED ON A PROJECTION OF 10,000 ACRES OF PRODUCING OYSTER BEDS IN THE SAN FRANCISCO BAY ESTUARY, THERE WOULD BE A POTENTIAL FOR AT LEAST 25 MILLION POUNDS PER YEAR OF UNSHUCKED OYSTERS.	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION. THIS MAY INCREASE TAX BASE.
	(DETRIMENTAL)	
THE TOTAL AVERAGE ANNUAL COST FOR THIS ALTERNATIVE WITH REUSE IS $437,000,000. A MAJOR PART OF THIS COST WOULD BE PROVIDED BY THE FEDERAL GOVERNMENT. FOR THE BAY-DELTA REGION POPULATION, THE PER CAPITA LOCAL ANNUAL COSTS WOULD BE APPROXIMATELY $31 BY THE YEAR 2000. COSTS ARE INCREMENTAL TO THE BASE CONDITION.	THE APPLICATION AREAS TO BE USED BY THIS ALTERNATIVE ARE CURRENTLY PRIMARILY IN AGRICULTURAL USE. THE IMPLEMENTATION OF THE ALTERNATIVE WOULD NOT ELIMINATE AGRICULTURAL USE, BUT WOULD REQUIRE CERTAIN CHANGES IN THE CROPS TO BE GROWN TO ACHIEVE A HIGH NITROGEN REMOVAL AND TO AVOID RAISING CROPS FOR DIRECT HUMAN CONSUMPTION. IRRIGATION AND FERTILIZER REQUIREMENTS OF THE CROPS WOULD BE PROVIDED, THEREBY REDUCING COSTS AND EFFECTIVELY INCREASING NET INCOME: ON THE OTHER HAND, THE RESTRICTION OF CROPS AND LOSS OF ALL CROP OUTPUT FOR AN AVERAGE OF TWO YEARS TO ALLOW FOR THE IMPLEMENTATION OF THE ALTERNATIVE TENDS TO LOWER NET INCOME. FOR THIS ALTERNATIVE THE COMBINED EFFECT OF THESE CHANGES IN AGRICULTURAL PRODUCTION WOULD RESULT IN AN ESTIMATED NET AVERAGE ANNUAL INCOME LOSS OF $684,000.	THE PROPERTY TAX LOSS BASED ON CURRENT TAX RATES FOR PURCHASE OF LANDS USED FOR STORAGE RESERVOIRS, PUMPING STATIONS AND TREATMENT FACILITIES AMOUNTS TO APPROXIMATELY $287,000 PER YEAR. THIS ALTERNATIVE HAS A GREATER IMPACT ON LOCAL PROPERTY TAXES THAN THE B SERIES ALTERNATIVES.

FIGURE 32

ECONOMIC EVALUATION - ALTERNATIVE D-2

<table>
<tr><th colspan="3">(BENEFICIAL)</th></tr>
<tr><th>COSTS</th><th>PRODUCTION</th><th>PUBLIC FINANCE</th></tr>
<tr><td>NOT APPLICABLE</td><td>BASED ON A PROJECTION OF 10,000 ACRES OF PRODUCING OYSTER BEDS IN THE SAN FRANCISCO BAY ESTUARY, THERE WOULD BE A POTENTIAL FOR AT LEAST 25 MILLION POUNDS PER YEAR OF UNSHUCKED OYSTERS.</td><td>PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION. THIS MAY INCREASE TAX BASE.</td></tr>
<tr><th colspan="3">(DETRIMENTAL)</th></tr>
<tr><td>THE TOTAL AVERAGE ANNUAL COST OF THIS ALTERNATIVE WITH REUSE IS $366,000,000. A MAJOR PART OF THIS COST WOULD BE PROVIDED BY THE FEDERAL GOVERNMENT. FOR THE BAY-DELTA REGION POPULATION, THE PER CAPITA LOCAL ANNUAL COSTS WOULD BE APPROXIMATELY $25 BY THE YEAR 2000. COSTS ARE INCREMENTAL TO THE BASE CONDITION.</td><td>THE APPLICATION AREAS TO BE USED BY THIS ALTERNATIVE ARE CURRENTLY PRIMARILY IN AGRICULTURAL USE. THE IMPLEMENTATION OF THE ALTERNATIVE WOULD NOT ELIMINATE AGRICULTURAL USE, BUT WOULD REQUIRE CERTAIN CHANGES IN THE CROPS TO BE GROWN TO ACHIEVE A HIGH NITROGEN REMOVAL AND TO AVOID RAISING CROPS FOR DIRECT HUMAN CONSUMPTION. IRRIGATION AND FERTILIZER REQUIREMENTS OF THE CROPS WOULD BE PROVIDED, THEREBY REDUCING COSTS AND EFFECTIVELY INCREASING NET INCOME: ON THE OTHER HAND, THE RESTRICTION OF CROPS AND LOSS OF ALL CROP OUTPUT FOR AN AVERAGE OF TWO YEARS TO ALLOW FOR THE IMPLEMENTATION OF THE ALTERNATIVE TENDS TO LOWER NET INCOME. FOR THIS ALTERNATIVE THE COMBINED EFFECT OF THESE CHANGES IN AGRICULTURAL PRODUCTION WOULD RESULT IN AN ESTIMATED NET AVERAGE ANNUAL INCOME LOSS OF $717,000.</td><td>THE PROPERTY TAX LOSS BASED ON CURRENT <u>TAX RATES</u> FOR PURCHASE OF LANDS USED FOR STORAGE <u>RESERVOIRS</u>, PUMPING STATIONS AND TREATMENT FACILITIES AMOUNTS TO APPROXIMATELY $287,000 PER YEAR. THIS ALTERNATIVE HAS GREATER IMPACT ON LOCAL PROPERTY TAXES THAN THE B SERIES ALTERNATIVES.</td></tr>
</table>

FIGURE 33

ECONOMIC EVALUATION-ALTERNATIVE D-3

	COSTS	PRODUCTION	PUBLIC FINANCE
(BENEFICIAL)	NOT APPLICABLE	BASED ON A PROJECTION OF 10,000 ACRES OF PRODUCING OYSTER BEDS IN THE SAN FRANCISCO BAY ESTUARY, THERE WOULD BE A POTENTIAL FOR AT LEAST 25 MILLION POUNDS PER YEAR OF UNSHUCKED OYSTERS.	PRESERVES AND MAY ULTIMATELY ENHANCE LONG-TERM VALUE OF RIPARIAN LAND THRU REVERSAL OF WATER QUALITY DEGRADATION.THIS MAY INCREASE TAX BASE.
(DETRIMENTAL)	THE TOTAL AVERAGE ANNUAL COST OF THIS ALTERNATIVE WITH REUSE IS $472,000,000. A MAJOR PART OF THIS COST WOULD BE PROVIDED BY THE FEDERAL GOVERNMENT. FOR THE BAY-DELTA REGION POPULATION, THE PER CAPITA LOCAL ANNUAL COSTS WOULD BE APPROXIMATELY $36 BY THE YEAR 2000. COSTS ARE INCREMENTAL TO THE BASE CONDITION.	THE APPLICATION AREAS TO BE USED BY THIS ALTERNATIVE ARE CURRENTLY PRIMARILY IN AGRICULTURAL USE. THE IMPLEMENTATION OF THE ALTERNATIVE WOULD NOT ELIMINATE AGRICULTURAL USE, BUT WOULD REQUIRE CERTAIN CHANGES IN THE CROPS TO BE GROWN TO ACHIEVE A HIGH NITROGEN REMOVAL AND TO AVOID RAISING CROPS FOR DIRECT HUMAN CONSUMPTION. IRRIGATION AND FERTILIZER REQUIREMENTS OF THE CROPS WOULD BE PROVIDED, THEREBY REDUCING COSTS AND EFFECTIVELY INCREASING NET INCOME: ON THE OTHER HAND, THE RESTRICTION OF CROPS AND LOSS OF ALL CROP OUTPUT FOR AN AVERAGE OF TWO YEARS TO ALLOW FOR THE IMPLEMENTATION OF THE ALTERNATIVE TENDS TO LOWER NET INCOME. FOR THIS ALTERNATIVE THE COMBINED EFFECT OF THESE CHANGES IN AGRICULTURAL PRODUCTION WOULD RESULT IN AN ESTIMATED NET AVERAGE ANNUAL INCOME LOSS OF $1,230,000.	THE PROPERTY TAX LOSS BASED ON CURRENT TAX RATES FOR PURCHASE OF LANDS USED FOR STORAGE RESERVOIRS, PUMPING STATIONS AND TREATMENT FACILITIES AMOUNTS TO APPROXIMATELY $317,000 PER YEAR. THIS ALTERNATIVE HAS GREATEST IMPACT ON LOCAL PROPERTY TAXES.

FIGURE 34

SPECIAL CONSIDERATIONS EVALUATION –ALTERNATIVE B-1

(BENEFICIAL)

RECLAMATION OF RESOURCES	USE OF RESOURCES
PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 97,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,400,000 PER YEAR. RECLAIMS UP TO 125,000 AF/Y OF PURIFIED WATER FOR STREAM FLOW AUGMENTATION, INDUSTRIAL COOLING OR ADDITIONAL IRRIGATION WATER. PROVIDES A SUPPLY OF COOLING WATER ON PROJECT LANDS TO ALLOW SAFE SITING OF CRITICAL INDUSTRIES SUCH AS POWER PLANTS.	INSURES OVER 150,000 ACRES OF OPEN SPACE.
(DETRIMENTAL)	
NOT APPLICABLE	REQUIRES 995 TONS/DAY OF TREATMENT CHEMICALS, 9,330 MEGAWATT HOURS/DAY OF POWER, AND 18,900 CUBIC FEET/DAY OF NATURAL GAS. VALUES ARE INCREMENTAL TO THE BASE CONDITION. LAND AREA REQUIREMENTS ARE AS FOLLOWS: 97,000 ACRES FOR WASTEWATER APPLICATION, 48,000 ACRES FOR SLUDGE APPLICATION, 2,150 ACRES FOR LAND TREATMENT FACILITIES, AND 9,300 ACRES FOR WASTEWATER STORAGE FACILITIES.

FIGURE 35

<table>
<tr><th colspan="2">SPECIAL CONSIDERATIONS EVALUATION - ALTERNATIVE B-2</th></tr>
<tr><th colspan="2">(BENEFICIAL)</th></tr>
<tr><th>RECLAMATION OF RESOURCES</th><th>USE OF RESOURCES</th></tr>
<tr><td>PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 97,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,400,000 PER YEAR. RECLAIMS UP TO 125,000 AF/Y OF PURIFIED WATER FOR STREAM FLOW AUGMENTATION, INDUSTRIAL COOLING OR ADDITIONAL IRRIGATION WATER. PROVIDES A SUPPLY OF COOLING WATER ON PROJECT LANDS TO ALLOW SAFE SITING OF CRITICAL INDUSTRIES SUCH AS POWER PLANTS.</td><td>INSURES OVER 150,000 ACRES OF OPEN SPACE.</td></tr>
<tr><th colspan="2">(DETRIMENTAL)</th></tr>
<tr><td>NOT APPLICABLE</td><td>REQUIRES 160 TONS/DAY OF TREATMENT CHEMICALS, 7,680 MEGAWATT HOURS/DAY OF POWER AND 18,900 CUBIC FEET/DAY OF NATURAL GAS. VALUES ARE INCREMENTAL TO THE BASE CONDITION.
LAND AREA REQUIREMENTS ARE AS FOLLOWS: 97,000 ACRES FOR WASTEWATER APPLICATION, 47,000 ACRES FOR SLUDGE APPLICATION, 2,100 ACRES FOR LAND TREATMENT FACILITIES AND 9,300 ACRES FOR WASTEWATER STORAGE FACILITIES.</td></tr>
</table>

FIGURE 36

SPECIAL CONSIDERATIONS EVALUATION - ALTERNATIVE B-3

RECLAMATION OF RESOURCES	USE OF RESOURCES
(BENEFICIAL)	
PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 135,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,800,000 PER YEAR. RECLAIMS UP TO 145,000 AF/Y OF PURIFIED WATER FOR STREAM FLOW AUGMENTATION, INDUSTRIAL COOLING OR ADDITIONAL IRRIGATION WATER. PROVIDES A SUPPLY OF COOLING WATER ON PROJECT LANDS TO ALLOW SAFE SITING OF CRITICAL INDUSTRIES SUCH AS POWER PLANTS.	INSURES OVER 190,000 ACRES OF OPEN SPACE.
(DETRIMENTAL)	
NOT APPLICABLE	REQUIRES 805 TONS/DAY OF TREATMENT CHEMICALS, 11,510 MEGAWATT HOURS/DAY OF POWER AND 18,900 CUBIC FEET/DAY OF NATURAL GAS. VALUES ARE INCREMENTAL TO THE BASE CONDITION. LAND REQUIREMENTS ARE AS FOLLOWS: 135,000 ACRES FOR WASTEWATER APPLICATION, 48,000 ACRES FOR SLUDGE APPLICATION 2,150 ACRES FOR LAND TREATMENT FACILITIES AND 10,700 ACRES FOR WASTEWATER STORAGE FACILITIES.

FIGURE 37

SPECIAL CONSIDERATIONS EVALUATION – ALTERNATIVE D-1

(BENEFICIAL)

RECLAMATION OF RESOURCES	USE OF RESOURCES
PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 148,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,900,000 PER YEAR. RECLAIMS UP TO 230,000 AF/Y OF PURIFIED WATER FOR STREAM FLOW AUGMENTATION, INDUSTRIAL COOLING OR ADDITIONAL IRRIGATION WATER. PROVIDES A SUPPLY OF COOLING WATER ON PROJECT LANDS TO ALLOW SAFE SITING OF CRITICAL INDUSTRIES SUCH AS POWER PLANTS.	INSURES OVER 210,000 ACRES OF OPEN SPACE.

(DETRIMENTAL)

NOT APPLICABLE	REQUIRES 765 TONS/DAY OF TREATMENT CHEMICALS, 13,100 MEGAWATT HOURS/DAY OF POWER, AND 20,550 CUBIC FEET/DAT OF NATURAL GAS. VALUES ARE INCREMENTAL TO THE BASE CONDITION. LAND REQUIREMENTS ARE AS FOLLOWS: 148,000 ACRES FOR WASTEWATER APPLICATION, 48,000 ACRES FOR SLUDGE APPLICATION, 2,900 ACRES FOR LAND TREATMENT FACILITIES AND 14,300 ACRES FOR WASTEWATER STORAGE FACILITIES.

FIGURE 38

SPECIAL CONSIDERATIONS EVALUATION -ALTERNATIVE D-2

RECLAMATION OF RESOURCES	USE OF RESOURCES
(BENEFICIAL)	
PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 148,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $1,900,000 PER YEAR. RECLAIMS UP TO 230,000 AF/Y OF PURIFIED WATER FOR STREAM FLOW AUGMENTATION, INDUSTRIAL COOLING OR ADDITIONAL IRRIGATION WATER. PROVIDES A SUPPLY OF COOLING WATER ON PROJECT LANDS TO ALLOW SAFE SITING OF CRITICAL INDUSTRIES SUCH AS POWER PLANTS.	INSURES OVER 209,000 ACRES OF OPEN SPACE.
(DETRIMENTAL)	
NOT APPLICABLE	REQUIRES 80 TONS/DAY OF TREATMENT CHEMICALS, 11,900 MEGAWATT HOURS/DAY OF POWER, AND 20,550 CUBIC FEET/DAY OF NATURAL GAS. VALUES ARE INCREMENTAL TO THE BASE CONDITION. LAND REQUIREMENTS ARE AS FOLLOWS: 148,000 ACRES FOR WASTEWATER APPLICATION, 47,000 ACRES FOR SLUDGE APPLICATION, 2,900 ACRES FOR LAND TREATMENT FACILITIES AND 14,300 ACRES FOR WASTEWATER STORAGE FACILITIES.

FIGURE 39

SPECIAL CONSIDERATIONS EVALUATION - ALTERNATIVE D-3

(BENEFICIAL)

RECLAMATION OF RESOURCES	USE OF RESOURCES
PROVIDES TREATED WASTEWATER FOR THE IRRIGATION OF 186,000 ACRES. FERTILIZER VALUE DUE TO WASTEWATER AND SLUDGE APPLICATION OF $2,300,000 PER YEAR. RECLAIMS UP TO 250,000 AF/Y OF PURIFIED WATER FOR STREAM FLOW AUGMENTATION, INDUSTRIAL COOLING OR ADDITIONAL IRRIGATION WATER. PROVIDES A SUPPLY OF COOLING WATER ON PROJECT LANDS TO ALLOW SAFE SITING OF CRITICAL INDUSTRIES SUCH AS POWER PLANTS.	INSURES ABOUT 250,000 ACRES OF OPEN SPACE.

(DETRIMENTAL)

NOT APPLICABLE	REQUIRES 540 TONS/DAY OF TREATMENT CHEMICALS, 15,800 MEGAWATT HOURS/DAY OF POWER, AND 20,550 CUBIC FEET/DAY OF NATURAL GAS. VALUES ARE INCREMENTAL TO THE BASE CONDITION. LAND REQUIREMENTS ARE AS FOLLOWS: 186,000 ACRES FOR WASTEWATER APPLICATION, 48,000 ACRES FOR SLUDGE APPLICATION, 3,000 ACRES FOR LAND TREATMENT FACILITIES AND 15,800 ACRES FOR WASTEWATER STORAGE FACILITIES.

FIGURE 40

DISCUSSION

INTRODUCTION

265. This study was conducted in cooperation with, and has had active participation of, Region IX of the Federal Environmental Protection Agency, the State of California Water Resources Control Board, and the appropriate California Regional Water Quality Control Boards pursuant to a joint agreement. The final alternatives developed and evaluated reflect the maximum use of previous studies and underway efforts by Federal, State of California, regional and local agencies. In addition, the general public in the San Francisco Bay and Sacramento-San Joaquin Delta Region and the residents affected in Monterey and San Benito Counties, the latter because of the use of optional Land Site 27, have been kept informed of, and have participated in, the Corps' investigation efforts.

COMPATIBILITY WITH CURRENT STUDIES

266. The State of California, under contract with several consulting engineering firms, presently is developing various wastewater management actions and strategies for basins lying entirely or partially within the San Francisco Bay and Delta Region. These actions and strategies will, by July 1 1975, evolve into the State's "Comprehensive Water Quality Control Plans" as required by State and Federal statutes. Development of the joint agreement, previously cited, indicated that the maximum contribution toward overall planning would be accomplished if this report emphasized the near-future and long-range potential of land application of treated wastewater and a regional approach to the land application of residual solids resulting from wastewater treatment. The six alternatives developed in this study, which emphasize land as a treatment mechanism, do not represent a complete range of possible alternatives but do represent cost effective systems. The land application components are technically comparable in precision level and completeness. Investigations of the State of California have used the data and evaluation factors on land application developed in this report. With the work done by the Corps and that being accomplished by the State, a complete range of alternatives and treatment systems for municipal and industrial wastewater discharges will have been considered by the State of California as is required by Public Law 92-500.

STUDY ASSUMPTIONS AND LIMITATIONS

267. All alternatives developed in this study are comprised of combinations of land application components and conventional sewage treatment plants. Conventional treatment portions were included in the final alternatives since evaluation of earlier alternatives indicated that the most viable systems of wastewater management involving land application would be a combination of both types of improvements. Consideration of conventional treatment also was necessary to develop general data on sources and amounts of treatment system sludge which might be disposed of on land and to develop a range of full system cost; however, the level of precision for convention treatment systems was less than that for land treatment components. Moreover,

considerations regarding the abandonment of about one and one-half billion dollars of existing construction, selected for investment by Federal, State and local governments over other critical urban problems, lead to the judgment that long-range plans should utilize conventional treatment systems to the maximum in areas near the well-defined circulatory patterns of estuarine and ocean waters and in isolated areas not compatible with long-distance transport of wastewater due to combinations of quantity of flow and topography. In the final alternatives treatment plant locations and flow-contributing geographical areas considered for conventional treatment components were defined by least-financial cost mathematical modeling.

268. The Corps' study does not address a solution to, or the environmental effects of, combined sewer overflows from the San Francisco and Sacramento collection systems or the problem of urban stormwater runoff in the entire study area. The latter problem could not be addressed because of an inadequate data base. Since San Francisco and Sacramento are making significant progress in solving their local combined sewerage problems and solutions are expected in a near-future timeframe, the State requested that the Corps not address those problems in its study. Also, it was assumed for the Corps' study that no future urbanized area would have combined sewers. The problem of urban stormwater runoff is the subject of recently initiated and future investigations by the Corps to be performed in cooperation with the State of California. The problem is recognized as significant, however, early indications are that solutions may be potentially independent of existing collection and treatment systems.

269. Although the State's basin contractors have projected wastewater flows for both dry weather and wet weather conditions, the Corps' study used projected wastewater flows based on average dry weather conditions. The Corps' study assumed that excess infiltration associated with wet weather conditions would be reduced by sewer rehabilitation and/or other flow reduction techniques over the study period. In connection with the Corps' projections, peaking factors were used in designing pumping, conveyance and treatment facilities. The peaking factors used varied between 1.5 and 3.0, depending on localized conditions. The Corps' flows and peaking factors are fairly well aligned with the average dry weather data currently being used in the State's planning studies.

IMPACTS DUE TO CHANGING CONDITIONS

270. On 18 October 1972 the "Federal Water Pollution Control Amendments of 1972," (PL 92-500) became law. The law establishes two national goals:

a. To achieve wherever possible by 1 July 1983 water that is clean enough for swimming and other recreational uses, and clean enough for the protection and propagation of fish, shellfish, and wildlife.

b. To have by 1985 no discharge of pollutants into the Nation's waters.

271. The law also increases Federal aid to help local governments build sewage treatment facilities and sets the following deadlines for actions to control water pollution from industrial and municipal sources.

a. Industries discharging pollutants into the Nation's waters must use the "best practicable" water pollution control technology by 1 July 1977 and the "best available" technology by 1 July 1983.

b. All publicly owned treatment works in operation on 1 July 1977 must provide a minimum of secondary treatment.

c. All publicly owned treatment works must use "best practicable" treatment by 1 July 1983.

272. Some regulations necessary for implementation of PL 92-500 are still being finalized and those which have been issued were not available in time to have a major impact on the study. Consequently, the goals and criteria of the Federal legislation are not necessarily reflected in the design of the wastewater management alternatives. However, insofar as possible the water quality provisions of PL 92-500 have been considered in identifying the impacts and characterizing the performance of the final wastewater management alternatives and in their evaluation. Review of assumptions and accomplishments [illegible] in the study indicate that all the alternatives would meet the 1977 effluent limitation requirements of the law and that Alternative [illegible], B-3, D-1 and D-3 and the full tertiary system would meet the 1983 water quality requirements.

STUDY RESULTS

273. As a result of the Corps' effort in developing and evaluating alternatives for the management of wastewater and sludge by land application techniques, certain important considerations can be highlighted. These considerations have been arranged according to the major items of Corps involvement in wastewater management planning as required by the State-Federal Interagency Agreement discussed earlier and are:

a. Land application for the treatment of wastewater.

b. Land application for the ultimate disposal of sludge.

c. Alternatives for wastewater reclamation and use.

d. Evaluation encompassing environmental, social and economic considerations.

274. CONCERNING THE USE OF LAND APPLICATION FOR THE TREATMENT OF WASTEWATER:

Land application tends to reduce water related urban impacts on the estuarine system. The discharge of pollutants to surface water is lessened.

Both the B-Series and D-Series wastewater management alternatives would eliminate the majority of pollutants (excluding stormwater pollutants) from entering surface waters when compared to the Base Condition.

- Since the D-Series alternatives contain more land application, less constituents than under the B-Series alternatives would be directly discharged to surface waters.

- Implementation of any wastewater management alternative would cause temporary disruption of the land sites. However, once the project was completed, this factor would be minimimized if not eliminated.

- The use of land application for wastewater treatment would allow various crops (not necessarily those currently produced) to be grown as a part of the overall renovation process.

With land application, nutrients would be returned to the land where they could be beneficially used by the plants.

The fate of waste materials could be more easily monitored and controlled on land areas.

275. CONCERNING THE USE OF LAND APPLICATION FOR THE ULTIMATE DISPOSAL OF SLUDGE:

Biological sludge contains various components which could be beneficial to agricultural activities.

- The nitrogen content of sludge would allow its use as a fertilizer supplement.

- With the use of sludge as a fertilizer supplement, use of commercial fertilizer could be reduced.

The ultimate disposal of sludge could be effectively accomplished at the land sites.

- Since digested sludge would be stored in lagoons for two years, the actual volume of sludge being applied to the land would be about 40 percent of that produced.

Disc harrowing of sludge into the soil would reduce the chance of any sludge being carried from the site by runoff during periods of rainfall.

276. CONCERNING THE RECLAMATION OF RESOURCES AND THE RECOVERY OF TREATED WASTEWATER FOR SUBSEQUENT REUSE:

Treated wastewater would be available as irrigation water; and fertilizer benefits would be realized from the application of wastewater and sludge.

-Depending on the alternative selected, between 97,000 and 186,000 acres of land could be irrigated.

-Increased land application, in a manner similar to increased normal irrigation, could increase animal and insect populations. Any final program selected must consider public health factors and include vector control management techniques.

-Depending on the alternative selected, between \$1.4 and \$2.3 million per year could be realized in fertilizer benefits.

Land-treated wastewater percolating from pastured areas would be available for groundwater recharge.

-Depending on the alternative selected, between 240,000 and 400,000 acre-feet per year of applied wastewater within the eight land sites would percolate to groundwater.

-All applied wastewater entering groundwater would be of an acceptable quality; nitrate nitrogen concentrations would be 9 mg/1 or below and total dissolved solids concentrations would range from 800 to 1,100 mg/1.

-The percolation of wastewater would raise the current levels of available groundwater and could also help retard salt water intrusion in coastal areas.

Land-treated wastewater percolating from cropped areas could be recollected in below-ground underdrain systems.

-Of necessity, ground water aquifers must rise for the underdrains to effectively operate.

-Depending on the alternative selected, between 125,000 and 250,000 acre-feet per year of recollected water within the eight land sites would be available for reuse from the underdrain systems.

-Recollected wastewater would be of a quality acceptable for most reuse opportunities; nitrate nitrogen concentrations in the 1-3 mg/1 range are expected and total dissolved solids concentrations would range from 600 to 1,100 mg/1.

-Recollected wastewater would be available for various modes of reuse such as streamflow augmentation, groundwater recharge, recreation lakes, industrial cooling and further irrigation use.

277. CONCERNING VARIOUS ENVIRONMENTAL EVALUATION CRITERIA:

Both series of wastewater management alternatives would affect wildlife habitats.

-Some loss of game habitats could result.

-Due to the beneficial supplemental flows to local streams, enhancement of other more important habitats could occur.

Significant historical, archeological and geological features, with proper design of a system, would not be adversely affected by the land application of wastewater. However, preproject surveys should be initiated.

-Extensive landscaping included in the design of the alternatives would insure there would be no overall lowering of aesthetic values.

-Buffer zones could be established to insure no adverse effects on historical and populated sites.

Opportunities for public recreation would be increased.

-Reservoirs for recollected water could be made available at the land application sites for boating, camping and picnicking.

-Streamflow augmentation could be expected to enhance fishing and hunting areas.

-Land application provides the opportunity for increasing open space which could be used for mini-parks.

278. CONCERNING VARIOUS SOCIAL EVALUATION CRITERIA:

Implementation of a wastewater management alternative would provide the increased opportunity for various job careers within the region.

-The construction of a wastewater management alternative could provide numerous jobs and increased incomes for both individuals and communities.

-The annual operation and maintenance of a wastewater management alternative could provide millions of dollars of income with the region.

The alternatives suggested tend to integrate urban and rural communities and the impact on rural communities should be carefully evaluated to insure a maximum beneficial program.

-Monterey and Yolo County interests voiced strong opposition to the use of land areas in their counties for the application of wastewater and sludge.

-In addition, Monterey County residents felt that wastewater should not be transported into their area from the San Francisco Bay-Delta Region.

-There was some expression of resulting agricultural benefits from individuals and officials in San Joaquin, Marin and Napa Counties.

279. CONCERNING VARIOUS ECONOMIC CRITERIA:

Regional alternatives with land application components, designed for year 2000 waste loads could cost between $2.0 and $3.3 billion. First costs are incremental to Base Condition facilities. Average annual costs could range from $355 to $482 million.

Because of waste treatment requirements and contraints with respect to agricultural activities, and crop losses during program implementation, average annual agricultural income loss could range between $673,000 and $1,230,000. However, by the year 2000 some of the alternatives show an income gain, in some instances as high as $691,000, derived primarily from system-provided fertilizer supplement and water.

Even with the "use contact" concept for the acquisition of major land needs, some property tax loss would occur for purchased lands. This loss could range from $165,000 to $317,000.

Some offsetting benefits would occur with the use of land application alternatives such as:

-The potential for reclamation of resources.

-The possibility of locating critical industries near wastewater storage lagoons. This latter aspect could increase the local tax base.

-The potential for increased oyster production in the San Francisco Bay Estuary.

Regional alternatives with land application components could also produce non-quantifiable benefits such as open space and new water supplies.

FUTURE REQUIREMENTS

280. Detailed plans for agricultural operation on crop and pasturelands have not been addressed in this study. It was felt that such discussions were premature until a basic land application plan was selected. If and when the detailed designs for land treatment systems are undertaken, the following items must be addressed in detail.

a. Special farm management techniques such as terracing practices, pesticide application and optimum fertilizer schedules.

b. Irrigation schedules.

c. Crop patterns including planting and harvesting schedules.

d. Education of the land owners on the proper operation and maintenance of land application systems.

281. Other issues must be considered in more detail before large-scale land treatment systems are implemented. Such items include the extent of heavy metal translocation from the soil to vegetation due to wastewater and sludge application; exact nitrogen removal percentages by various crops under programmed growth patterns; and, the final total dissolved solids content expected when the steady state condition for land treatment is achieved. Pilot plant programs and/or monitoring of existing land application systems appear to be the logical preparatory step to final implementation of a large-scale land application wastewater management alternative.

CONCLUSIONS

282. As a result [illegible]his study, the Corps has made the following conclusions concerning the feasibility of the development of land application alternatives for wastewater management on a regional basis:

a. The development of land application alternatives for wastewater management on a regional basis is feasible and could produce an effluent comparable to tertiary treatment.

b. The ultimate disposal of sludge could be accomplished through the use of land application.

c. Through the use of land application, a valuable resource, reclaimed water, could be recovered and beneficially used for various enhancement purposes.

d. No major socio-ecological or economic factors have been identified which would negate wastewater management by land application.

RECOMMENDATIONS

283. Two regional wastewater management concepts incorporating land application, each including three separate alternatives for municipal and industrial discharges, have been described and evaluated in this report. It is evident that land application techniques for treating wastewater offer a viable alternative means of meeting Federal and State water quality objectives and goals for many areas of the 12-county San Francisco Bay and Sacramento-San Joaquin Delta Region. Therefore, based on the work accomplished in this study and its resultant conclusions, it is recommended that the Corps of Engineers:

a. Provide technical assistance to the State of California on land treatment systems for the disposal of municipal and industrial effluents, as requested, in completing and/or updating Comprehensive Water Quality Control Plans for basins within the San Francisco Bay and Sacramento-San Joaquin Delta Region;

b. Continue and expand, under the original study authorization and in cooperation with the State of California and the Environmental Protection Agency, data collection and analysis of non-point sources of pollution including urban stormwater runoff; and,

c. Be authorized to prepare, in cooperation with the State of California and its local governmental bodies, subregional feasibility reports on land treatment of municipal, industrial, and non-point discharges in the 12-county San Francisco Bay and Sacramento-San Joaquin Delta Region with the objectives being consistent with comprehensive policies and plans for water quality.

H. A. FLERTZHEIM, JR.
Colonel, CE
District Engineer

STUDY PARTICIPATION GROUPS

A. LAWRENCE BERKELEY LABORATORY (through the Atomic Energy Commission) - Information was provided on industrial flow and constituent projections.

B. PBQ&D, INC - Provided data on the following subjects:

Land site identification and evaluation.

Wastewater application to land.

Land site development and environmental assessments.

Sludge and residual solids characteristics, treatment, and transportation.

Disposal of sludge by various land application methods.

Environmental impact assessments for the representative land sites.

Special consultant reports in the following areas:

JONES AND STOKES ASSOCIATES, INC. - Criteria and considerations for the selection and evaluation of wastewater application sites; preliminary survey of wastewater application sites.

HARDING, MILLER, LAWSON & ASSOCIATES - Wastewater land site identification; soil, geology and groundwater studies.

STONE AND ASSOCIATES - Sewage effluent disposal through utilization by tree covered ecosystems.

SAN FRANCISCO BAY MARINE RESEARCH CENTER, INC. - Environmental considerations.

KENNEDY ENGINEERS, INC. - Water quality and public health criteria.

SEQUOIA GROUP, BERKELEY - Public health considerations at the representative land sites.

DRS. J. W. BIGGAR AND J. N. LUTHIN - Land and water quality, and irrigation and drainage.

C. BERKELEY PLANNING ASSOCIATES - Social well-being considerations.