ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

REPORT ON

WATER QUALITY SOURCES OF POLLUTION AND ABATEMENT NEEDS FOR SAN FRANCISCO BAY, CALIFORNIA

PRELIMINARY DRAFT

NATIONAL FIELD INVESTIGATIONS CENTER-DENVER
DENVER, COLORADO
AND
REGION IX SAN FRANCISCO CALIFORNIA

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ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

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National Field Investigations Center-Denver
Denver, Colorado
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Region IX
San Francisco, California

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I. INTRODUCTION

In October 1972, the Federal Water Pollution Control Act Amendments of 1972 became law.[1/] This new legislation sets forth the basis for restoring and maintaining the chemical, physical and biological integrity of the Nation's waters. Implementation of the various programs established by this comprehensive legislation will have a major impact on the San Francisco Bay area both in terms of the costs of abating existing pollution and the benefits of improved water quality. To meet the requirements of the 1972 amendments, the present local, State and Federal water pollution control programs will need to be expanded and accelerated.

A national goal to eliminate the discharge of pollutants into navigable waters by 1985 has been established by Congress.[1/] A second national goal established was that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983. It is also the national policy that the discharge of toxic pollutants in toxic amounts be prohibited.

In order to meet these national goals, a major change in the present Federal-State water pollution control program has been directed by the 1972 amendments. Emphasis is to be placed on maximizing the control of pollution through implementation of high levels of waste treatment or control for all point sources of pollution. Effluent limitations are to be established for all waste discharges based on the application of the best practicable control technology currently available for industrial sources of pollution and based on secondary treatment for all publicly owned treatment facilities must provide pre-treatment if such wastes are not susceptible to treatment in these facilities.

The new legislation continued the water quality standards program established under the Water Quality Act of 1965. Implementation plans established by the State to bring all sources of pollution in compliance with these standards also remain in effect.

A number of waste sources discharging to the San Francisco Bay system are not in compliance with State imposed implementation plans for improved treatment. A majority of the waste sources in the Bay area provide treatment that will not meet the requirements of the new legislation and substantial upgrading of treatment facilities will be required. Water quality in the Bay system does not meet all applicable standards.

This report summarizes presently available information pertaining to the water quality in the San Francisco Bay system; evaluates that information with respect to applicable standards, statutes, regulations, or critieria; and recommends a program that will lead to compliance with established water quality uses.

Specific objectives of the report are:

A. To evaluate the water quality in San Francisco Bay.

B. To determine what beneficial uses of the Bay are being impaired by water pollution and to estimate the economic impact of such impairment.

C. To determine if water quality in the Bay system is suitable for a balanced population of fish, shellfish and wildlife.

D. To ascertain if existing and scheduled pollution abatement measures for major municipal and industrial waste sources are satisfactory in light of new federal responsibilities.

E. To ascertain if violations of water quality standards are occurring in San Francisco Bay.

F. To develop recommendations for appropriate abatement action(s).

Sources of information used in the development of this report include: The California State Water Resources Control Board; the California State Department of Health; the California Department of Fish and Game; California Academy of Science; San Francisco Regional Water Quality Control Board; Central Valley Regional Water Quality Control Board; National Marine Fisheries Service; National Oceanic and Atmospheric Administration (NOAA); Marine Minerals Technical Center; U. S. Geological Survey; the University of California; the United States Public Health Service; Food and Drug Administration (FDA); and the Environmental Protection Agency (EPA). Limited field studies were also conducted by the EPA National Field Investigations Center-Denver (NFIC-D), Office of Enforcement, and by EPA Region IX personnel in San Francisco. The co-operation and contribution of the various state, local, and private organizations are gratefully appreciated.

II. SUMMARY AND CONCLUSIONS

A large and complex pollution load is discharged to the San Francisco Bay system from a variety of sources. The largest pollution load is contributed by waste discharges from municipal and industrial sources. Other significant sources include combined sewer overflows, dredging activities, agricultural drainage, vessel pollution, and Federal installations.

Three sources of data were used to define the magnitude and characteristics of pollution from municipal and industrial sources. All waste sources are required to monitor their effluents and submit data reports to State regulatory agencies. Data reports for 1971 were the primary source of information on waste discharges. For industrial sources, information was also available from applications submitted in mid-1971 for permits to discharge in accordance with the Refuse Act of 1899. In addition, 16 major municipal and industrial sources were sampled on a short-term basis by EPA regional staff during mid-1972.

A total of about 250 discrete sources of municipal and industrial wastes are located in the drainage area tributary to the Bay system between the confluence of the San Joaquin and Sacramento Rivers and the Pacific Ocean. About 150 sources are located in close proximity to San Francisco, San Pablo, and Suisun Bays. The total volume of wastewater discharged by these 150 sources (excluding power-plant cooling water use of 3,300 mgd) averaged 820 mgd in 1971.

Municipal sources contribute about 58 percent (490 mgd) of the total wastewater volume. These sources are relatively uniformly spaced along the western, eastern, and southern shores of the Bay system with the largest sources discharging to central and southern San Francisco Bay.

Major sources of industrial wastes are oil refineries, petrochemical plants, chemical plants, pulp and paper mills, and food processing plants. These industries are primarily located along the southern shore of Suisun and San Pablo Bays between Antioch and Richmond. In other Bay areas, industrial wastes are usually discharged to municipal treatment systems.

In 1971, BOD loads discharged to the Bay system as reported by municipal sources averaged about 400,000 lb/day. Only a few industries are required by the State to monitor effluent BOD. Thus, the total BOD load to the Bay system cannot be determined. Discharges of COD reported by industries in 1971 averaged about 310,000 lb/day. The State requires only a few municipal sources to monitor effluent COD. The East Bay Municipal Utility District alone discharges more than 400,000 lb/day of COD indicating that COD loads from municipal sources are substantially greater than from industrial sources.

Municipal and industrial sources together contributed an average oil and grease load of 91,000 lb/day to the Bay system in 1971. The major portion (87 percent) of this load was from municipal sources. Discharges of suspended solids to the Bay system in 1971 averaged about 409,000 lb/day with municipal sources contributing the major load (73 percent).

Only limited data are available on heavy metals discharged to the Bay system. Three municipal sources (East Bay Municipal Utility District, 1000 lb/day; City of San Francisco-Southeast Plant, 500 lb/day; and South San Francisco-San Bruno, 90 lb/day) are known to discharge large loads of heavy metals (chromium, copper, lead and zinc).

There are 52 municipal sources that discharge an average of more than 0.5 mgd of wastewater each. The three largest sources (City of San Jose, 83 mgd; East Bay Municipal Utility District, 79 mgd; City of San Francisco-North Point Plant, 64 mgd) together discharge about 28 percent of the total wastewater volume.

The Federal Water Pollution Control Act Amendments of 1972 require that all publicly owned treatment facilities must meet effluent requirements based on secondary treatment by July 1977. The following twenty municipal sources provide only primary treatment:

Source	Flow (mgd)
Antioch, City of	2.9
Benicia, City of	1.1
Central Contra Costa County Sanitary District	22.8
Contra Costa County Sanitary District No. 7A	0.8
East Bay Municipal Utility District	78.9
Estero Municipal Improvement District	1.4
Marin County Sanitary District No. 5	0.6
Martinez, City of	1.4
Menlo Park, City of	5.9
Pinole, City	1.0
Pittsburg, City of-Camp Stoneman Plant	0.9
Pittsburg, City of-Montezuma Plant	1.4
Rodeo Sanitary District	0.6
San Francisco International Airport	0.9
San Francisco, City of-North Point Plant	64.1
San Francisco, City of-Southeast Plant	22.1
San Mateo, City of	11.0
San Pablo Sanitary District	7.6
Sausalito-Marin City	1.7
Vallejo County Sanitatation and Flood Control District	7.2
TOTAL	234.3

In addition to the above primary treatment facilities, 21 municipal sources presently provide secondary treatment but discharge wastes that will not meet effluent limitations based on secondary treatment (20 mg/l

BOD, 30 mg/l suspended solids, and 10 mg/l oil and grease). Sources providing inadequate secondary seconary treatment include:

Source	Flow (mgd)
Fairfield-Suisun Sewer District	3.9
Hayward, City of	11.9
Las Gallinas Valley Sanitary District	2.3
Marin County Sanitary District No. 1	4.8
Marin County Sanitary District No. 6, Ignacio Plant	0.8
Marin County Sanitary District No. 6, Novato Plant	2.2
Mill Valley, City of	2.0
Mountain View Sanitary District	0.8
Oro Loma Sanitary District	13.2
Redwood City, City of	7.7
Richmond, City of	9.8
San Carlos, City of	4.0
San Jose, City of	82.8
San Leandro, City of	7.0
San Rafael Sanitary District	2.5
San Quentin Prison	0.6
South San Francisco-San Bruno	7.2
Sunnyvale, City of	14.0
Union Sanitary District-Alvarado	2.3
Union Sanitary District-Irvington	5.5
Union Sanitary District-Newark	5.4
TOTAL	190.7

Municipal wastes receiving only primary treatment (234 mgd) constitute about 48 percent of the total municipal waste volume. Wastes receiving inadequate secondary treatment (191 mgd) constitute an additional 39 percent of the total municipal discharge. Therefore, only 13 percent of the municipal wastes discharged to the Bay system receive adequate treatment.

Based on 1971 self-monitoring data, upgrading treatment provided by the 41 sources listed above to meet Federal effluent limitations would result in: (a) an 81 percent reduction in BOD loading to 77,000 lb/day,

(b) a 46 percent reduction in suspended solids loading to 111,000 lb/day, and (c) a 60 percent reduction in oil and grease loading to 36,000 lb/day.

In the urban areas adjacent to central and southern San Francisco Bay, almost all industries discharge their wastes to municipal sewage systems for treatment. A number of municipal facilities receive a substantial fraction of their inflow (about 75 mgd or 15 percent of total municipal wastes) from industrial sources. Industrial wastes frequently contain materials that are toxic or not susceptible to treatment in municipal facilities. The Federal Water Pollution Control Act Amendments of 1972 require that pre-treatment standards be established by mid-1973 to control the introduction of such deleterious industrial wastes into publicly owned treatment systems. Ten publicly owned treatment facilities are known to receive substantial volumes of industrial wastes and to discharge inadequately treated wastes. Implementation of pre-treatment of industrial wastes in compliance with Federal standards is needed for industries connected to these ten systems (listed below) in order to reduce the excessive loads of BOD, COD, suspended solids, heavy metals, and oil and grease presently being discharged. Deleterious industrial wastes discharged to other publicly owned systems will also require pretreatment.

Source	Flow (mgd)	Percent Industrial
Primary Treatment		
Central Contra Costa County S.D.	22.8	10-15
East Bay Municipal Utility Distr.	78.9	25
San Francisco, City of-North Point Plant	64.1	15-20
San Francisco, City of-Southeast Plant	22.1	15-25
Subtotal	187.9	

Inadequate Secondary Treatment

Hayward, City	11.9	12
San Carlos, City of	4.0	15
San Jose, City of	82.8	20-30
San Leandro, City of	7.0	40
South San Francisco-San Bruno	7.2	33
Union Sanitary District-Newark Plant	5.4	25
Subtotal	118.3	
TOTAL	306.2	

Fish bioassays of several municipal effluents conducted by EPA in 1972 confirmed self-monitoring data that indicated these effluents are toxic to aquatic life. Toxic effluents were observed at the sources listed below. The self-monitoring data indicate that additional sources also discharge toxic wastes. Discharges of toxic materials must be abated in accordance with the provisions of the Federal Water Pollution Control Act Amendments of 1972.

Sources of Toxic Wastes	Flow (mgd)
Central Contra Costa County Sanitary District	22.8
East Bay Municipal Utility District	78.9
San Francisco, City of-North Point Plant	64.1
San Jose, City of	82.8
San Mateo, City of	11.0
TOTAL	259.6

The bioassay procedure used to monitor the toxicity of wastes discharged to the San Francisco Bay system is a static test with pre-exposure aeration. This procedure tends to reduce the toxicity of the effluents to the test organism. Thus, the bioassay procedure currently used cannot be expected to provide the basis for determining if wastes are toxic to aquatic life within the context of Sections 307 and 502 of the Federal

Water Pollution Control Act Amendments of 1972. The toxicity of wastes discharged to the Bay system is greatly understated by the self-monitoring data.

A total of 39 significant industrial sources discharge wastes directly to the Bay system. Excluding 3,300 mgd of cooling water from electric power plants, the average discharge from these sources was about 320 mgd (42 percent of total waste flow) in 1971. Average waste loads include 310,000 lb/day of COD, 111,000 lb/day of suspended solids, and 13,000 lb/day of oil and grease.

The Federal Water Pollution Control Act Amendments of 1972 require that all industrial waste discharges must, by July 1977. meet effluent limitations based on the best practicable control technology currently available. Twenty-six sources that together contribute 98 percent of the industrial waste load to the Bay system are discharging effluents that contain one or more constituents in excess of levels achievable by best practicable control technology. Application of such control technology would thus result in a major reduction in pollution loads from industrial sources. The following industries provide less than best practicable control technology:

Industry	Flow (mgd)
Allied Chemical Corporation, Industrial Chemicals Division	0.1
Allied Chemical Corporation, Nichols	3.2
California and Hawaii Sugar Company	25.5
Cerro Metal Products	0.1
Colgate-Palmolive Company	1.5
Crown Zellerbach, Antioch	14.8
Dow Chemical Company, Pittsburg	24.1

E. I. duPont deNemours & Co., Inc., Antioch	1.3
FMC Corporation-Inorganic Chemical Division	1.5
Fibreboard Corporation, Plant No. 2	4.8
Fibreboard Corporation, San Joaquin Mill	15.6
Hercules, Incorporated	1.6
Hickmott Foods, Inc., Antioch	2.9
Humble Oil and Refining Company, Benicia	3.1
Kaiser Gypsum Company	0.1
Kaiser Gypsum Company, Antioch	0.5
Merck and Company, Merck Chemical Division	4.8
Phillips Petroleum Company, Avon	15.2
Sequoia Refining Corporation	0.1
Shell Chemical Company, West Pittsburg	6.5
Shell Oil Company, Martinez	4.5
Standard Oil Company of California	112.0
Stauffer Chemical Company, Agricultural Chemical Division	1.3
Tillie Lewis Foods, Inc., Antioch	12.0
Union Oil Company of California	47.0
United States Steel Corporation, Pittsburg	17.7
TOTAL	321.8

The Federal Water Pollution Control Act Amendments of 1972 require the development of an effluent permit system for all point sources of pollution including municipal and industrial waste discharges. The permit system must include provisions for the adequate monitoring of waste effluents. To provide adequate monitoring, the existing self-monitoring program will need to be augmented by a monitoring program conducted by governmental regulatory agencies. The self-monitoring program will also need to be expanded to provide additional data on each source.

Federal installations discharge about 22 mgd of domestic and industrial wastes to the Bay system. About 75 percent of this wastewater (16.3 mgd) is from industrial sources, primarily cooling water from the Mare Island Naval Shipyard power plant (16.0 mgd). Eleven Federal installations discharge part or all of their wastes directly to the Bay system. These installations are all under the control of the Department of Defense (nine U.S. Navy installations and two U.S. Air Force installations). Part of the waste load from these eleven sources as well as all wastes from numerous other Federal installations are discharged to municipal sewerage systems. Federal installations discharging industrial wastes to municipal systems must provide pre-treatment if such wastes are not susceptible to treatment in municipal facilities.

Wastewater treatment practices at nine of the eleven Federal installations are not adequate. The volume of inadequately treated waste is small, however, averaging about 3.6 mgd. Three sources (1.6 mgd) are scheduled to connect to municipal systems. An additional three sources (0.5 mgd) will provide on-site secondary treatment. Abatement plans for the other three sources providing inadequate treatment (1.4 mgd) are unknown.

Overflows of mixed storm and sanitary sewage from combined sewer systems during periods of storm runoff are a significant source of pollution of the Bay system. By-passing of untreated sewage from municipal sewerage systems subject to excessive infiltration is also a source of significant pollution with the by-passing problem the most severe in the Oakland area. The East Bay M.U.D. sewerage system serving this area by-passed an estimated 2.3 billion gallons during the 1968-69 rainy season. Combined sewer overflows are a major problem in San Francisco. Combined sewer overflows from the San Francisco system were estimated to total 6 billion gallons in 1971. In comparison to dry weather discharges of municipal and industrial wastes, combined sewer overflows and system by-passes represent a small fraction (3 percent) of the total waste volume discharged to the Bay system over the entire year. Such discharges, however, exert a detrimental influence on water quality conditions because these occur as slug loadings and only during part of the year.

Dredging and maintenance of navigation channels in the Bay system result in the movement of about 7 to 11 million cubic yards of sediments annually. These sediments contain pollutants that can degrade water quality in the vicinity of spoil areas and dredging activities. Most sediments dredged from the Bay system will not meet current EPA guidelines for disposal of spoil in estuarine areas necessitating higher cost land or ocean disposal. The EPA guidelines are currently undergoing review to determine if revision is necessary to minimize the economic impact of spoil disposal while providing adequate protection of water quality.

Despite continued attempts at implementing disinfection practices in order to control coliform bacterial densities in San Francisco Bay as well as abatement and control programs for reducing other deliterious contaminants, the EPA investigation, in the spring of 1972, indicated that bacterial and other contamination interferes with the propagation or harvest of commercially important shellfish.

Repeated bacteriological analyses of water samples from throughout the Bay system reveal that, except for Carquinez Strait and Suisun Bay, mid-channel waters contain low coliform bacterial densities. In contrast, more than fifty percent of the waters directly over known shellfish beds, on the periphery of the Bay system, contained coliform bacterial densities in excess of State and Federal criteria for "approved" shellfish growing waters (the coliform median MPN of the water does not exceed 70/100 ml, and not more than 10 percent of the samples oridinarily exceed an MPN of 230/100 ml measured under the most unfavorable hydrographic and pollution conditions).

The occurrence of these unacceptably high concentrations of coliform bacteria were in the western and southwestern sectors of South Bay and in the vicinity of the densely populated area of Oakland and Alameda. The central area of the bay system contained two distinct localities of high coliform densities, one being the inner waters of Richardson Bay and the other the waters adjacent to Point Richmond on the northeastern shore. Of several shellfish areas in San Pablo Bay only Molate Point, north of the eastern side of the San Rafael-Richmond Bridge, was surrounded by waters of an unsatisfactory bacteriological quality. Waters overlying one shellfish growing area in Carquinez Strait were of poor bacteriological quality.

Most shellfish samples collected from the intertidal zone throughout the bay system contained bacterial contamination in violation of shellfish quality standards (230 fecal coliforms per 100 gm of shellfish meat) adopted by the State of California and the National Shellfish Sanitation Program.

At one time or another during the EPA surveys, shellfish collected from all Central and South Bay stations showed coliform bacterial densities in violation of adopted market standards. Samples collected from four of the seven locations in San Pablo Bay were in violation of bacteriological standards, and the only sample obtained from Carquinez Strait also proved to be of unsatisfactory bacteriological quality.

In addition to the analyses for the accepted coliform indicator organisms each shellfish sample was examined for enteric pathogens. Two species of *Salmonella* were found; *S. kentucky* was recovered from a sample collected at Burlingame (on the western side of South Bay), and *S. typhimurium* was isolated from a sample collected in San Leandro Bay. These findings indicate contamination of shellfish by inadequately treated sewage and, consequently, a severe health hazard to anyone consuming the sea food.

Shellfish from the San Francisco Bay area were found to be contaminated with heavy metals, notably cadmium, chromium, copper, mercury, lead, and zinc. At many bay locations heavy metal contaminations in the shellfish were substantially greater than the background levels. Alert levels of heavy metals that have been proposed by the FDA as indicators of municipal and industrial pollution in shellfish were exceeded in eighteen samples. Zinc and lead were the most widespread contaminants observed during the study.

In Carquinez Strait mercury concentrations in soft clams exceeded the FDA recommended levels for shellfish.

Chlorinated insecticides and polychlorinated biphenyls were found in the shellfish and sediments from most stations. Although the concentrations exceeded background levels, these were not sufficiently high at this time to warrant regulatory action according to presently accepted alert levels.

Shellfish in San Francisco Bay were found to be contaminated with petroleum related hydrocarbons of industrial origin.

A major commercial shellfishery existed in the bay system near the turn of the century. This industry was essentially eliminated during the early 1900's by water quality degradation. The propagation and harvesting of shellfish is presently impaired, to a major degree, by water pollution resulting from the discharge to the bay system of inadequately treated municipal and industrial wastes and by dredging, landfill, and spoil disposal practices.—/ The potential exists for reestablishment of a major shellfishery in the bay system, should existing water quality be enhanced.

A sizeable standing crop of clams and native oysters is present in the bay system. Research has shown that Pacific and Eastern oysters can be grown using modern cultural methods.

Estimates of the oyster productive potential of the San Francisco Bay system range from 1 to 13 million pounds of oyster meats annually. At a dockside price of $0.40 per pound, this production would have an annual value of $400,000 to $5,200,000. The large supply associated with the upper limit of potential production would probably result in reduced prices, making an upper limit of $2,600,000 a more realistic potential value of the fishery.

The total impact, on the economy of the San Francisco area, as the result of the loss of the oyster fishery, caused by water pollution is in the range of $820,000 to $10,200,000. This estimate considers only the economic effect of the harvested oysters. The additional economic impact produced by the importation of seed oysters to supply cultural requirements is unknown.

The San Francisco Bay system exhibits evidence of enrichment at various locations, mainly along the shores and in tidal reaches of some tributaries. Nitrogen and phosphrous concentrations in the waters of the bay system are substantially higher than levels necessary for stimulation of aquatic growths. Decaying aquatic vegetation has reached nuisance proportions in the Albany tide flats, by producing hydrogen sulfide odors and by causing blackening of the lead-based paints found on surrounding shoreline homes.

Agricultural drainage from the Central Valley. entering the bay system through the Delta, is one main source of nitrogen and phosphrous. Municipal and industrial waste discharges also contribute substantial nutrient loads to the bay.

Fish kills have occurred annually in San Francisco Bay, particularly in the Suisun Bay and Carquinez Strait area. These kills have generally occurred during the spring and summer in the vicinity of municipal waste treatment plants and industrial waste discharges and involve thousands of fish [Appendix F]. More than 56 percent of the reported fish kills were from unknown causes; however, of those from known causes about 20 percent resulted from low dissolved oxygen, 7 percent from sewage, 9 percent from an industrial pollutant, and 8 percent from other causes. Most of these kills were investigated by the California Department of Fish and Game.

III. RECOMMENDATIONS

THIS SECTION TO BE

INSERTED LATER

IV. DESCRIPTION OF THE AREA

A. PHYSICAL DESCRIPTION

San Francisco Bay is a destinctive geographical feature in the Northern California area. The Bay system covers approximately 435 square miles and ranges from 3 to 12 miles in width to about 50 miles in length [Figure IV-1].

Westernmost of the numerous large metropolitan areas is the City of San Francisco, situated on a land mass immediately south of the Golden Gate Strait, the bay connection with the Pacific Ocean. The cities of Richmond, Oakland, and Berkeley are east of San Francisco across the Bay from Golden Gate. To the northeast are Martinez, Vallejo, Pittsburg, and Antioch. South of the San Francisco area lie the cities of San Mateo, Burlingame, Redwood City, San Jose, Hayward, San Leandro, and Palo Alto. North of the area are Rodeo, San Rafael, Walnut Creek, Napa, and Petaluma.

The shoreline of the bay is characterized by flatlands and tidal marshland. Approximately 80 percent of this marshland has been "reclaimed," chiefly for agricultural use and salt ponds. A great amount of these lands, or shoreline, has a flat slope. As a result, the area between mean high and low water is large, totaling 64 square miles. As a result of this flat-slope topography the bay is shallow with average depths of about 20 feet. Immediately east of the Golden Gate, which averages three miles wide, the average depth of the bay increases to 43 feet, while at the northern and southern reaches the average depth

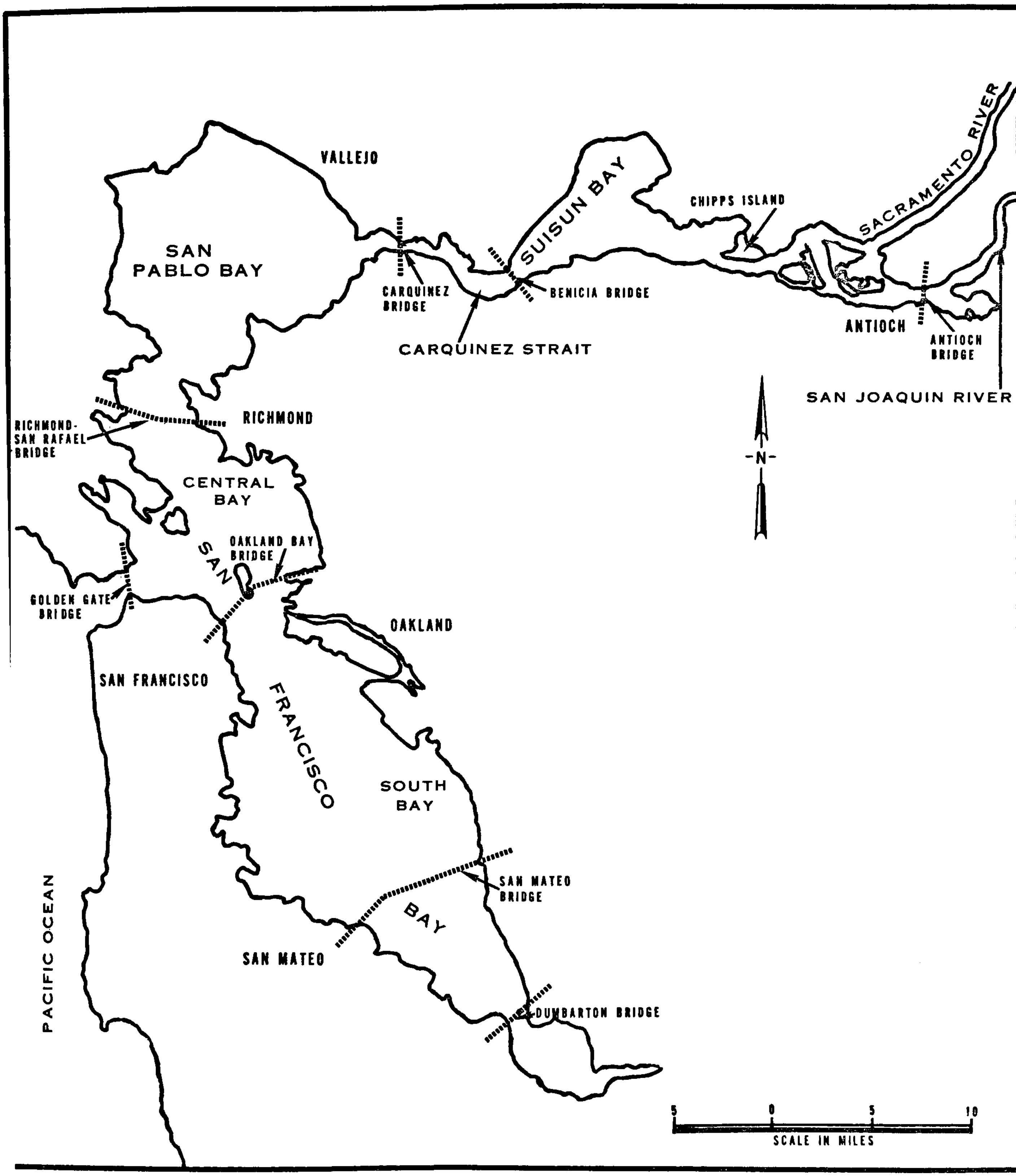


Figure IV-1 San Francisco Bay System

remains 18 to 20 feet. In contrast, the scouring action of high-velocity currents through the Carquinez Strait maintains a maximum depth of 90 feet.

The San Francisco Bay estuarine system consists of South, San Francisco, San Pablo, and Suisun Bays, the Carquinez Strait, and the Delta of the San Joaquin and Sacramento Rivers. Within the boundaries of San Francisco Bay there are several islands including Angel Island, Alcatraz, Yerba Buena, and the man-made Treasure Island.

For purposes of later discussion, the San Francisco Bay system has been divided into four hydrographic units. These are: South Bay, Central Bay, San Pablo Bay and Suisun Bay. South Bay is the portion of San Francisco Bay lying south of the Oakland Bay Bridge. Central Bay boundaries are from the Richmond-San Rafael Bridge south to the Oakland Bay Bridge. San Pablo Bay lies between the Richmond-San Rafael Bridge and the Carquinez Strait Bridge. Suisun Bay extends easterly from the Carquinez Strait Bridge to the west end of Chipps Island (including Grizzly and Honker Bays).

B. CLIMATE

The San Francisco Bay area is characterized by a mild and temperate climate. The warmest weather occurs in the late spring and early autumn. Average temperatures in the City of San Francisco are about 50°F in January and about 60°F in July. This slight variation in annual temperature in the vicinity of the ocean contrasts to much wider ranges in the inland areas.

The rainy season extends from November through April, with maximums occurring in December and January. Mean annual rainfall varies geographically, with a high of 22 inches in the City of San Francisco to a low of about 13 inches in the southern and eastern sections of the Bay system. The average annual rainfall for the general Bay area is about 19 inches.

In contrast to precipitation, the average annual evaporation is about 48 inches which is more than twice the annual precipitation. This extensive rate of evaporation, highest in July. accounts for a loss of more than 650,000 acre feet of water annually from the Bay system.

C. HYDROLOGY

Along the Pacific Coast, including San Francisco Bay, one of the chief characteristics of the tide is diurnal inequality (successive high or low water heights differ). The largest inequality is usually found in the low waters. The mean tidal range at Golden Gate is about 4 feet. At the Dumbarton Bridge, in South Bay, the mean tidal range increases to 7.5 feet, a noticeable change. In the northern section, the mean tidal range gradually decreases from 4.6 feet in upper San Pablo Bay to 3.1 feet at Antioch in Suisun Bay. These tidal differences in the northern section are attributed to a progressively dampened tidal surge. In addition to affecting the tidal range, this restrained tidal surge causes conspicuous variations in times of tidal peaks within the system. Tidal delays, using the Golden Gate as reference, are about 50 minutes at Dumbarton Bridge, one to two hours in eastern San Pablo Bay, and nearly four hours at Antioch in Suisun Bay. Tidal velocities (sometimes exceeding five knots) are variable in the Bay system and are influenced by winds and run-off from the Sacramento and San Joaquin Rivers.

Despite its shallow depths, San Francisco Bay (435 sq mi) contains a relatively large volume of water; at mean tide the volume is approximately 5.4 million acre feet. The tidal prism (the volume of water between mean high and low tides) is about 1.1 million acre feet or 21 percent of the average total volume of water in the Bay. On each tidal cycle about 4 percent of the total volume of the Bay is replaced by new ocean water, serving to dilute and remove pollutants from the Bay. However, most of this replacement occurs near Golden Gate, with progressively decreasing amounts of flushing in the Bay system's interior.

Water transport within the Bay complex is controlled by tides and advective flow (flow or movement of water resulting from causes other than the tides). In the northern section of the Bay system the advective flow is basically the result of river discharge from the Delta region. However, in the southern section there is very little discharge from natural streams. The result is that the advective flow is minor and is governed by waste discharges and evaporation. In general, dominant control of Bay water transport is achieved by the effects of tides which far outweigh the effects of waste discharges, precipitation, groundwater movement, or stream flows, including even the large flow from the Delta.

D. WATER USES

The San Francisco Bay system provides a wide variety of beneficial uses, recreational and economical, to people in the area. Some of the most important include water supplies for industrial, agricultural, and municipal use; a natural habitat for fish and wildlife; a vast, water-oriented recreational area; accessibility to ocean-going water transport; and an aesthetically pleasing environment.

In order to protect these beneficial uses the California State Water Quality Control Board has established water quality standards that have been subsequently approved by the United States Environmental Protection Agency. (These different uses and the water quality criteria will be discussed more thoroughly later in the text.)

V. WATER QUALITY CONDITIONS

A. APPLICABLE WATER QUALITY REGULATIONS

State Regulatory Activity

The State Water Resources Control Board and nine regional boards regulate water quality, including that of the San Francisco Bay and the Delta area through a system of permits, monitored by self-reporting data. Abatement of pollution is attained through review of these self-monitoring data, issuance of Cease-and-Desist orders, and court actions. A more detailed discussion of these procedures, together with a summary of current abatement status, is presented in Chapter VIII.

Federal-State Water Quality Standards

The waters of the San Francisco Bay system and tributary streams are contained entirely within California. The tidal portions, affected by the ebb and flow of the tides, as well as the territorial waters extending seaward a distance of three miles, are subject to the provisions of the Federal Water Pollution Control Act Amendments of 1972. In 1967, the California State Water Quality Control Board established Standards for the tidal waters of the Bay system pursuant to the Water Quality Act of 1965.[1/] These Standards subsequently were approved as Federal Standards, except for the temperature criteria, in January, 1969, and remain in effect.

The Standards consist of three components: 1) a designation of beneficial water uses to be protected, 2) water quality objectives (criteria) that specify limits on various water quality parameters, and 3) an implementation plan that sets forth enforcement procedures and time schedules for abatement of pollution.

Waters of the San Francisco Bay system are used for a wide variety of purposes. The standards designate that the following beneficial uses are to be protected:

1. Whole or limited body water-contact recreation;
2. The historic usability of domestic, industrial, and agricultural water supplies, east of the westerly end of Chipps Island, to the extent that it is reasonably practicable until alternate supplies are provided;
3. Industrial water supplies, westerly of Chipps Island, at all times with respect to all water quality factors except salinity incursion;
4. Fishing, hunting, and fish-and-wildlife propagation and sustenance [as shown in Figures V-1 and V-2];
5. Shellfish;
6. Pleasure boating, marinas, and navigation;
7. Esthetic appeal;
8. Dispersion and assimilation of wastes.

Water quality criteria were established to protect the designated beneficial uses. These criteria [Appendix A] specify numerical or narrative limits for important water quality parameters. Criteria of special interest are discussed in the following sections.

B. BACTFRIOLOGICAI CONDITIONS

The Standards established in 1967 did not designate specific areas

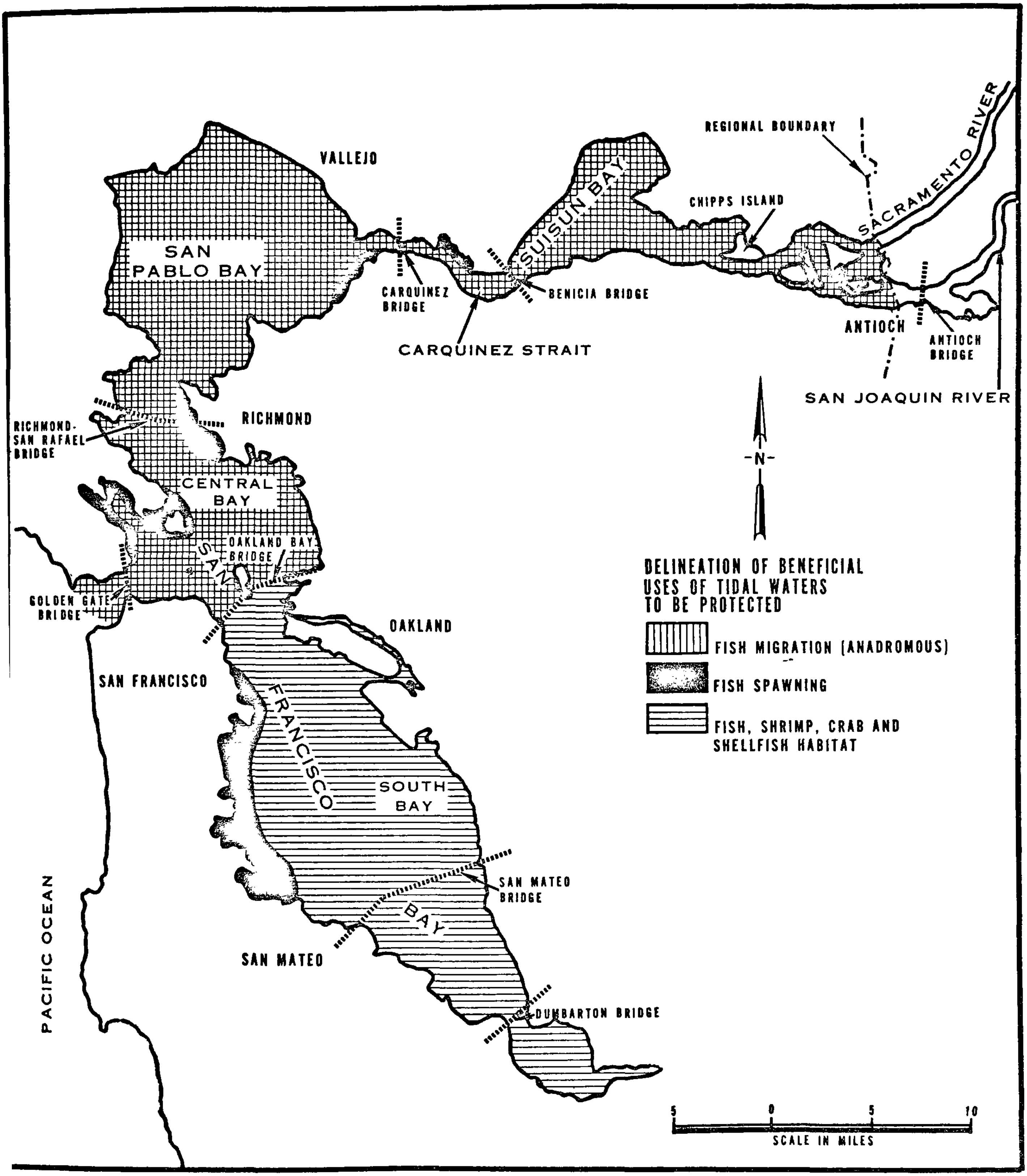


Figure V-1 Beneficial Uses of Tidal Waters to be Protected-Fish Migration; Fish Spawning; Fish, Shrimp, Crab and Shellfish Habitat

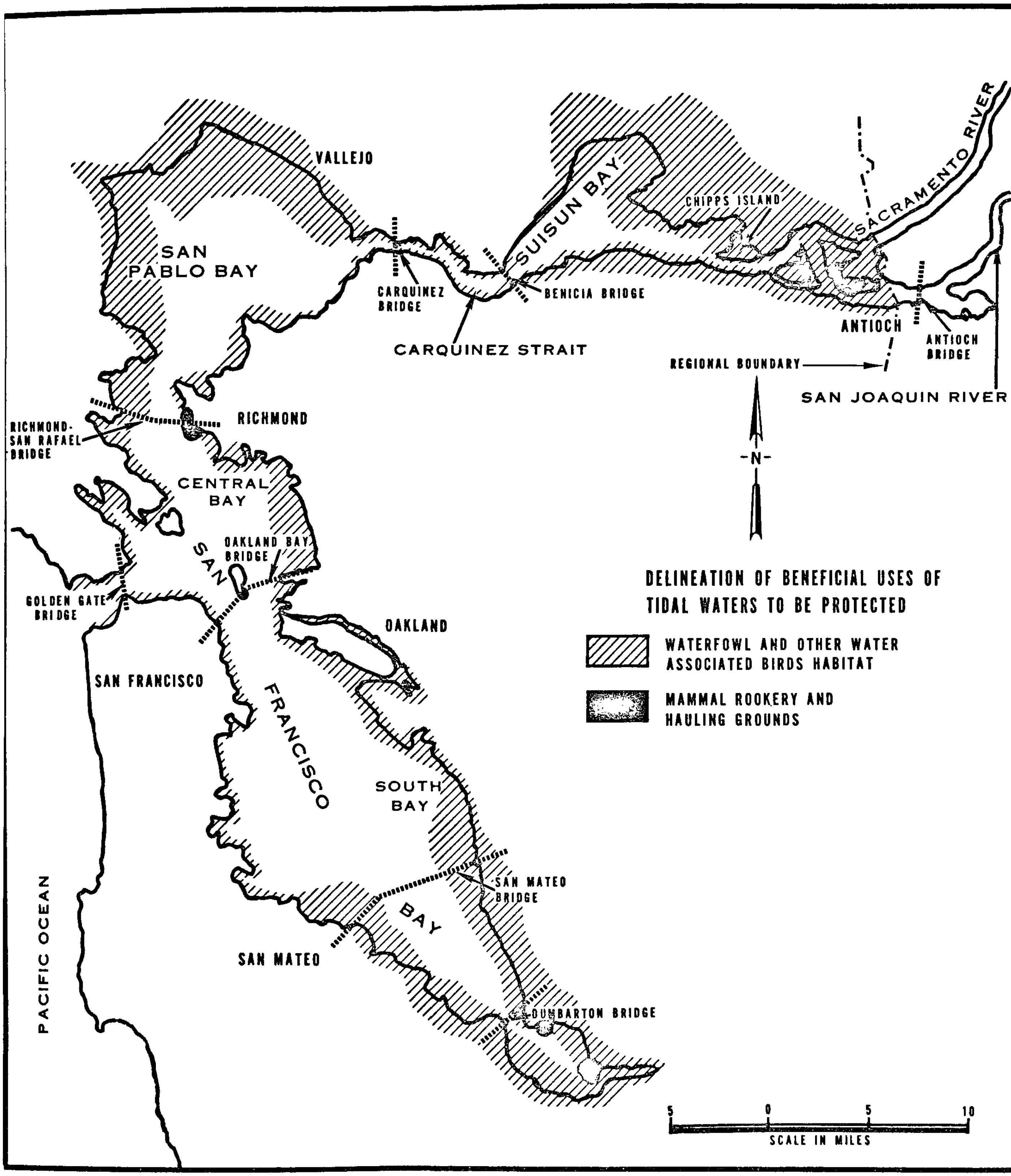


Figure V-2 Beneficial Uses of Tidal Waters to be Protected-Waterfowl and Other Water Associated Birds Habitat; Mammal Rookery and Hauling Grounds to be protected for shellfish harvesting but indicated such areas would be designated when studies by the State Department of Fish and Game and Public Health had been completed. A total of 42 potential shellfish harvesting areas were subsequently indentified, in 1968, by the Department of Fish and Game [Figure V-3]. Bacteriological quality of waters overlying these shellfish beds was found to be unacceptable for safe consumption of shellfish, when evaluated by the Department of Public Health during the period 1966 to 1970. These waters failed to meet the requirements based upon criteria contained in the U. S. Public Health Service manual, "Sanitation of Shellfish Growing Areas," 1965, revised. The criteria for approved shellfish areas are, in summary form:

1. The area is not so contaminated with fecal material that consumption of shellfish might be hazardous.
2. The area is not so contaminated with radionuclides or industrial wastes that the consumption of the shellfish might be hazardous.
3. The coliform median MPN of the water does not exceed 70/100 ml, and not more than 10 percent of the samples ordinarily exceed an MPN of 230/100 ml (5-tube decimal dilution test) measured under the most unfavorable hydrographic and pollution conditions.

In addition to the above criteria, which were formulated to safely classify shellfish growing waters, the State of California also complies with standards adopted by the National Shellfish Sanitation Program (NSSP) for all species of fresh and frozen oysters (includes all shellfish within the NSSP) at the wholesale market level. Shellfish at the wholesale market level are considered "satisfactory" when a fecal coliform density

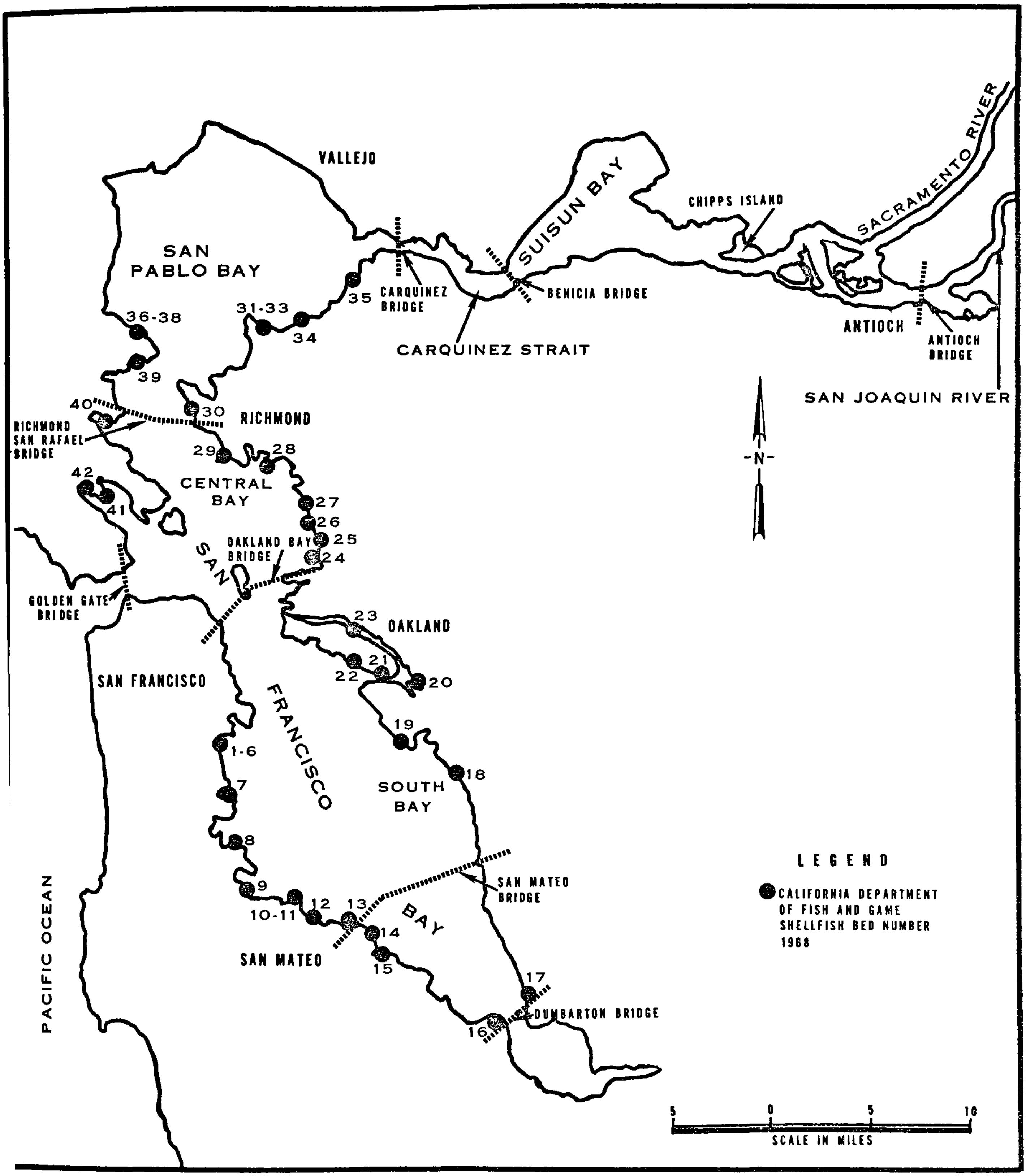


Figure V-3 Shellfish Bed Locations, San Francisco Bay System of not more than 230 MPN per 100 grams of meat or a 35°C Standard Plate Count of not more than 500,000 per gram is exceeded.

Prior to the 1972 EPA investigations the most recent comprehensive water quality study covering the entire San Francisco Bay system was conducted from 1960 to 1964 by the University of California.[2/] During this earlier study, samples were collected from a total of 51 stations distributed among 6 main areas of the Bay system. [Average coliform density characteristics observed during the study are summarized below, Table V-1, according to the areas of the Bay designated by the University, as shown in Figure V-4.]

Improvements in waste treatment practices since the 1960-1964 University of California study period (installation of secondary treatment facilities by several municipal waste sources, including the large City of San Jose facility, and disinfection of essentially all municipal wastes) have resulted in some water-quality enhancement.

Prior to the implementation of these disinfection practices by all municipal waste treatment facilities, bacterial concentrations throughout the Bay system were generally in excess of acceptable limits for water-contact recreation and far in excess of allowable levels for shellfish harvesting. Improved disinfection has resulted in a reduction in average bacterial levels in open water areas. Water quality at several bathing beaches is now acceptable for water-contact sports during much of the recreation season.[3/] Sanitary surveys of a number of shellfish beds during 1969 and 1970 by the State of California Department of Health, indicated that water overlying several beds was of suitable bacterial quality to meet the U. S. Public Health Service limits for "Approved or

TABLE V-1

AVERAGE COLIFORM BACTERIA

(MPN/100 ml)

IN SAN FRANCISCO BAY, CALIFORNIA

1960-1961

South Bay	Lower Bay	Central Bay	North Bay	San Pablo Bay	Suisun Bay
20,000	500	1,000	500	1,000	2,000

Source: Extracts from Final Report, A Comprehensive Study of San Francisco Bay, Volume V, SERL Report No. 67-2.

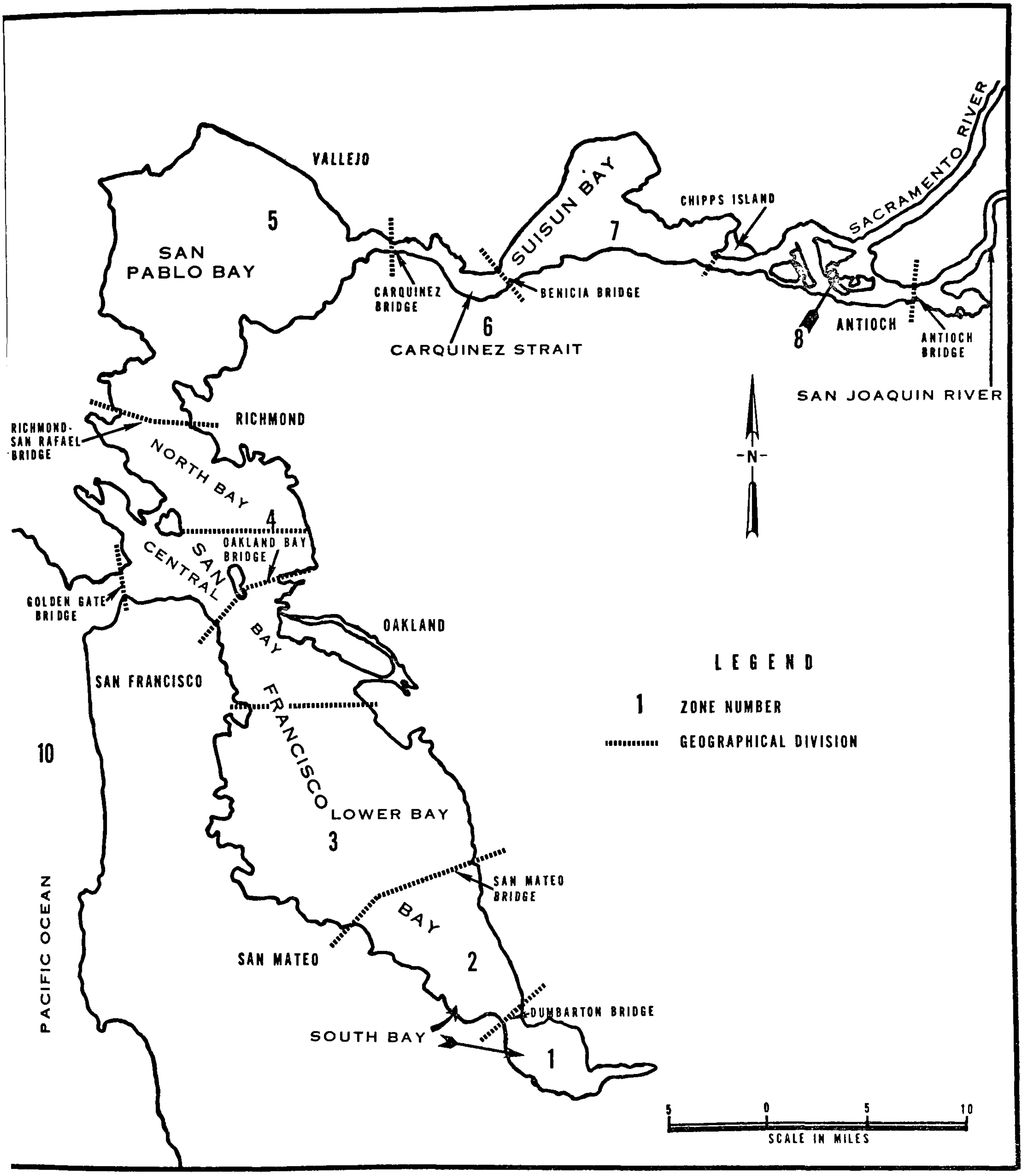


Figure V-4 Geographical and Zone Divisions of the San Francisco Bay System

Conditionally Approved" shellfish harvesting areas.[4/] However, bacterial levels near most shellfish beds still posed a health hazard to human consumption of shellfish. Also, shellfish from beds with acceptable water quality were found to have unacceptably high bacterial levels in their meat.[4/] Proximity to waste outfalls, unreliability of disinfection facilities at waste treatment plants, and uncontrolled sources of bacterial contamination were, during this survey period, factors contributing to unacceptable levels of bacteria near shellfish beds.

Despite continued attempts at implementing disinfection practices to control coliform bacterial densities in San Francisco Bay as well as abatement and control programs to reduce other deleterious contaminants, investigations by the Environmental Protection Agency indicate that bacterial and other contamination interferes with the propagation or harvest of commercially important shellfish.

These recent bacteriological studies were conducted in the spring of 1972 and included all of the waters of the San Francisco Bay system as well as shellfish from certain sections of the surrounding shoreline.

In order to determine bacteriological quality, water samples were collected for examination twice daily during the peak of each tidal phase for the open waters and once a day, for a ten-day period, for water over shellfish beds. All coliform analyses were performed according to methods prescribed in the 13th Edition, *Standard Methods for the Examination of Water and Wastewater,* using the Most Probable Number technique.[5/] [Results of these bacteriological determinations are presented in Tables V-2 through V-5.] Isolation of pathogenic (*Salmonella*) bacteria from shellfish meats was attempted at 33 locations.

TABLE V-2
BACTERIOLOGICAL DENSITIES - SAN FRANCISCO BAY SURVEY[a/]
WATER SAMPLES
SPRING, 1972

Station Number	Station Description	Tide	No. of Samples	Total Coliforms, MPN/100 ml				% Samples >230	% Samples >1,000	Fecal Coliforms, MPN/100ml			
				Maximum	Minimum	Median	Log Mean			Maximum	Minimum	Median	Log Mean
1	Towers Opposite Beards Creek	High	10	920	8	20	37	20*	0	700	2	8	12
		Low	8	3,500	33	120*	210	38*	25**	1,700	8	79	94
2	Buoy FIR 4	High	10	3,500	14	240*	250	50*	30**	350	2	31	29
		Low	8	540	7	240*	140	62*	0	130	7	41	36
3	Northeast of Mouth of Redwood Creek	High	10	1,100	2	5	6	10	10	170	<2	2	4
		Low	8	5	<2	2	<2	0	0	5	<2	2	<2
4	Buoy FI 2.5 Sec	High	10	920	<2	41	<33	10	0	49	<2	<2	<4
		Low	8	350	14	95*	72	25*	0	170	2	13	10
6	Just South of San Mateo Bridge	High	9	49	<2	<2	<4	0	0	13	<2	<2	<2
		Low	8	5	<2	<2	<2	0	0	2	<2	<2	<2
7	Buoy FI 4.0 Sec #3	High	9	2	<2	<2	<2	0	0	<2	<2	<2	<2
		Low	9	70	<2	<2	<4	0	0	5	<2	<2	<2
8	Buoy FI 4.0 Sec #5	High	9	8	<2	<2	<3	0	0	<2	<2	<2	<2
		Low	9	240	5	46	54	22*	0	13	<2	4	<5
9	West of Point San Bruno	High	6	2	<2	<2	<2	0	0	<2	<2	<2	<2
		Low	6	<2	<2	<2	<2	0	0	<2	<2	<2	<2
10	Buoy F14 Sec #1	High	9	110	<2	<2	<3	0	0	110	<2	<2	<3
		Low	9	8	<2	<2	<2	0	0	2	<2	<2	<2
11	Half Point Off Sierra Point	High	9	540	2	49	27	11*	0	14	<2	<2	<4
		Low	7	350	<2	27	<23	14*	0	23	<2	<17	<8
13	Buoy FI 6 Sec Ex-A	High	9	17	<2	7	<6	0	0	11	<2	<2	<3
		Low	8	33	<2	<2	<3	0	0	5	<2	<2	<2
14	West of Grounded Hulks	High	8	5	<2	<2	<2	0	0	<2	<2	<2	<2
		Low	8	2	<2	<2	<2	0	0	2	<2	<2	<2

TABLE V-2 (CONTINUED)
BACTERIOLOGICAL DENSITIES - SAN FRANCISCO BAY SURVEY[a/]
WATER SAMPLES
SPRING, 1972

Station Number	Station Description	Tide	No. of Samples	Total Coliforms, MPN/100 ml Maximum	Minimum	Median	Log Mean	% Samples >230	% Samples >1,000	Fecal Coliforms, MPN/100 ml Maximum	Minimum	Median	Log Mean
15	Half Mile East of Potrero Point	High	9	1,600	22	70	75	11*	11.1	79	2	17	13
		Low	8	1,100	8	79*	75	12.5*	12.5	140	<2	8	<12
17	Buoy FIR 4 Sec #2	High	9	27	2	13	8	0	0	8	<2	2	<3
		Low	8	23	<2	<2	<3	0	0	2	<2	<2	<2
19	Mid-channel Off North Point Buoy #BR	High	8	330	<2	41	<47	25*	0	22	<2	13	<8
		Low	8	33	4	10	9	0	0	8	<2	2	<3
21	End of Berkeley Pier	High	8	33	<2	5	<4	0	0	5	<2	<2	<2
		Low	8	49	<2	3	<6	0	0	33	2	2	3
23	Off Berkeley Pier Near Yacht Harbor	High	8	79	<2	<2	<3						<3
		Low	8	49	<2	5	<6	0	0	5	<2	<2	<3
24	Black Point Buoy A	High	8	490	17	90*	89	25*	0	27	5	12	12
		Low	8	34	2	14	12	0	0	13	<2	4	<4
26	Richardson Bay Buoy 6	High	8	70	<2	5	<7	0	0	8	<2	2	<3
		Low	8	49	2	7	8	0	0	17	<2	4	<4
29	Off Pt. Richmond Mid-channel Buoy #2	High	8	23	<2	6	<6	0	0	5	<2	3	<3
		Low	8	49	<2	4	<4	0	0	5	<2	2	<2
31	Buoy FIR #6 Richmond Channel	High	8	23	<2	<2	<3	0	0	8	<2	<2	<2
		Low	8	13	<2	3	<4	0	0	4	<2	2	<2
33	27 Ft. White Marker, Left Side of Channel	High	8	5	<2	2	<3	0	0	5	<2	<2	<2
		Low	8	11	<2	<2	<3	0	0	5	<2	<2	<2
35	Off Pier at Pt. Orient	High	8	79	<2	8	<6	0	0	33	<2	2	<4
		Low	8	17	<2	4	<4	0	0	5	<2	<2	<2
36	Buoy FIG 4, Sec #3 Petaluma River Channel	High	8	23	2	8	6	0	0	8	<2	2	<3
		Low	7	2	<2	<2	<2	0	0	<2	<2	<2	<2
37	Mid-San Pablo Bay Off Pinole Point	High	8	49	<2	6	<8	0	0	11	<2	<2	<3
		Low	7	23	2	5	6	0	0	8	<2	<2	<2
38	Off Pinole Point Channel Buoy #5	High	8	49	<2	4	<6	0	0	8	<2	<2	<3
		Low	8	110	7	33	32	0	0	33	2	10	9
39	Off Pier at Pinole Point	High	8	33	<2	8	<7	0	0	8	<2	2	<3
		Low	8	13	2	8	9	0	0	8	2	4	3

TABLE V-2 (CONTINUED)
BACTERIOLOGICAL DENSITIES - SAN FRANCISCO BAY SURVEY [a]
WATER SAMPLES
SPRING, 1972

Station Number	Station Description	Tide	No. of Samples	Total Coliforms, MPN/100 ml Maximum	Minimum	Median	Log Mean	% Samples > 230	% Samples >1,000	Fecal Coliforms, MPN/100 ml Maximum	Minimum	Median	Log Mean
41	Off Lone Tree Point Mid-Channel	High	6	130	11	64	54	0	0	23	5	18	14
		Low	7	330	79	130*	150	28.6	0	79	22	33	33
42	Marina Right Side of Carquinez Strait	High	8	13,000	130	1,500*	1,400	75*	75**	2,300	33	570	330
		Low	8	3,500	330	900*	930	100*	50**	330	8	150	95
43	Mid-Channel I-80 Bridge	High	6	110	33	74*	69	0	0	49	2	17	14
		Low	7	490	49	130*	150	42.8*	0	84	22	33	40
44	Dike Nine Entrance to Napa River	High	6	130	33	110*	78	0	0	70	17	46	37
		Low	7	2,200	330	700*	850	100*	42.9**	330	63	220	170
45	Buoy FIG 4, Sec #7 Off Benicia	High	6	490	33	140	130	16.7*	0	220	22	54	54
		Low	7	130	70	79*	90	0	0	79	13	33	38
46	Mid-Channel Benicia Bridge Buoy 2	High	6	330	49	110*	130	33*	0	79	17	48	45
		Low	7	330	33	110*	110	14.3*	0	110	33	49	58
47	Buoy #4 Suisun Bay	High	6	330	33	190*	150	33*	0	79	33	60	53
		Low	7	220	70	130*	120	0	0	140	23	49	61
48	Buoy FI 4 Sec #1	High	6	230	70	160*	140	0	0	130	23	48	53
		Low	7	130	70	110*	100	0	0	94	22	79	54
49	Buoy FIR 4 Sec #8 Off Point Edith	High	6	790	70	280*	260	50*	0	230	33	79	71
		Low	7	490	79	170*	150	14.3*	0	130	23	49	52
50	Buoy FIG 4 Sec #17 Off Middle Point	High	7	790	79	170*	180	14.3*	0	330	46	49	77
		Low	7	1,300	79	230*	300	42.8*	14.3	700	33	49	99

TABLE V-2 (CONTINUED)
BACTERIOLOGICAL DENSITIES - SAN FRANCISCO BAY SURVEY a/
WATER SAMPLES
SPRING, 1972

Station Number	Station Description	Tide	No. of Samples	Total Coliforms, MPN/100 ml Maximum	Minimum	Median	Log Mean	% Samples > 1,000	Fecal Coliforms, MPN/100 ml Maximum	Minimum	Median	Log Mean
51	Buoy FIG 4, Sec #25 Off Simmons Point	High	7	2,300	79	330	440	42.8**	490	17	49	70
		Low	7	700	79	230	240		110	13	49	48
52	Buoy NY Off New York Point	High	7	2,300	49	490	390	14.3	490	8	49	47
		Low	7	1,300	70	490	350	28.6**	330	13	110	80
54	Buoy #16, Sacramento Ship Channel	High	7	1,300	33	220	160	14.3	70	4	13	12
		Low	7	110	27	49	55		11	<2	5	5
55	Off Antioch Point, Buoy #4	High	7	2,300	79	230	290	14.3	1,300	13	17	36
		Low	7	1,700	220	330	470	14.3	330	17	46	44
57	Mid-Channel Antioch Bridge Buoy #12	High	7	1,700	49	170	220	14.3	94	2	13	14
		Low	7	230	110	130	140		33	5	13	12

*Violation of U. S. Public Health Water Quality Recommendations for Shellfish Growing Areas (Median MPN of water not to exceed 70 Total Coliforms/100 ml and not more than 10 percent of samples to ordinarily exceed an MPN of 230/100 ml).

**Violation of California Water Quality Bacterial Standards for Water-Contact Sports Area (20 percent of samples not to exceed 1,000 Coliforms/100 ml).

a/ Samples collected by National Field Investigations Center-Denver.

TABLE V-3

BACTERIOLOGICAL DENSITIES-SAN FRANCISCO BAY SURVEY a/

SHELLFISH SAMPLES

SPRING, 1972

Station	Number(s)	Date	Shellfish	Total Coliforms MPN/100 gms	Fecal Coliforms MPN/100 gms
Coyote Point	10-11	3/30/72	Soft-shell Clam	63,000	46,000*
Coyote Point	10-11	3/30/72	Olympia Oyster	1,800	630*
Forster City	14	3/30/72	Soft-shell Clam	5,400	3,500*
San Leandro	18	3/31/72	Olympia Oyster	3,500	790*
Dumbarton Bridge(East Side)	17	3/31/72	Soft-shell Clam	3,500	490*
Dumbarton Bridge(West Side)	16	3/31/72	Soft-shell Clam	1,300	490*
Candlestick	1-6	4/2/72	Soft-shell Clam	160,000	1,300*
Oyster Point	7	4/2/72	Soft-shell Clam	3,500	330*
Redwood Creek	15	4/3/72	Soft-shell Clam	2,200	400*
Pinole Point	34	4/29/72	Soft-shell Clam	330	50
Molate Point	30	4/29/72	Soft-shell Clam	790	490*
Rodeo	35	4/29/72	Soft-shell Clam	49,000	13,000*
China Camp	36-38	4/30/72	Soft-shell Clam	170	20
Benicia	43	4/23/72	Soft-shell Clam	3,300	1,100*
Drakes Estero Control		4/3/72	Pacific Oyster	50	<20
Drakes Estero Control		4/3/72	Eastern Oyster	230	230

*Violation of Federal Shellfish Standard "Not to exceed 230 Fecal Coliforms/100 gms".
a/ Samples collected by National Field Investigations Center-Denver.

TOTAL COLIFORMS IN WATER OVERLAYING SHELLFISH BEDS:
MEDIAN VALUES PER 100 ml AND PERCENT EXCEEDING
230 PER 100 ml, BY STATION[a]

Station Number	Station Description	Number of Observations	Total Coliforms		
			Median per 100 ml	Percent Above 230 per 100 ml	Percent Above 1,000 per 100 ml
3	Bayview Park	27	4	7	3.7
9	Burlingame	29	59	21	6.9
10	Coyote Point (north of)	27	2	11	7.4
14	Foster City	27	13	15	0
19	Oakland Airport	24	79	29	25*
20	San Leandro Bay	30	104	40	36.7*
22	Alameda Beach	27	11	0	0
23	Oakland Inner Harbor	30	50	17	0
27	Albany Hill	30	33	0	0
29	Point Richmond	30	25	13	0
30	Malate Point	30	94	37	13
31	Tara Hills, Left	30	1	0	0
32	Tara Hills, Middle	30	2	0	0
33	Tara Hills, Right	30	2	0	0
41	Strawberry Point West Side	30	63	10	0

TABLE V-4 (CONTINUED)
TOTAL COLIFORMS IN WATER OVERLAYING SHELLFISH BEDS:
MEDIAN VALUES PER 100 ml AND PERCENT EXCEEDING
230 PER 100 ml, BY STATION[a/]

Station Number	Station Description	Number of Observations	Total Coliforms: Median per 100 ml	Total Coliforms: Percent Above 230 per 100 ml	Total Coliforms: Percent Above 1,000 per 100 ml
42	Richardson Bay, North End	30	170	40	16.7
Control	Drake's Estero	3	<2	0	0

*Violation of California Water Quality Bacterial Standards for Water-Contact Sports Area (20 percent of samples not to exceed 1,000 Coliforms/100 ml).

a/ Samples collected by Environmental Protection Agency - Region IX.

TABLE V-5
FECAL COLIFORMS PER 100 gm SHELLFISH MEAT:
RANGE OF VALUES AND COMPARISON TO STANDARD, BY STATION [a/]

Station Number	Station Location	No. Times Sampled	Fecal Coliforms per 100 gm Range	Sample Exceeds 230 FC per 100 gm No. Times	Sample Exceeds 230 FC per 100 gm Percent
3	Bayview Park	3	230- 1,700	2	67
9	Burlingame	3	490- 4,900	3	100*
10	Coyote Point (north of)	3	50- 80	0	0
14	Foster City	3	490- 2,300	3	100
19	Oakland Airport	3	1,100-17,000	3	100
20	San Leandro Bay	3	170-23,000	2	67**
22	Alameda Beach	3	<20- 330	1	33
23	Oakland Inner Harbor	3	490- 1,100	3	100
27	Albany Hill	3	1,700-13,000	3	100
29	Point Richmond	3	<20- 1,400	2	67
30	Malate Point	3	110- 700	2	67
31	Tara Hills, Left	3	20- 330	1	33
32	Tara Hills, Middle	3	170- 1,700	1	33
33	Tara Hills, Right	3	20- 130	0	0
41	Strawberry Point West Side	3	330- 3,300	3	100

TABLE V-5 (CONTINUED)
FECAL COLIFORMS PER 100 gm SHELLFISH MEAT:
RANGE OF VALUES AND COMPARISON TO STANDARD, BY STATION [a/]

Station Number	Station Location	No. Times Sampled	Fecal Coliforms per 100 gm Range	Sample Exceeds 230 FC per 100 gm	
				No. Times	Percent
42	Richardson Bay, North End	3	<20-23,000	2	67
Control	Drake's Estero	3	<2- 13	0	0

*_Salmonella kentucky_ isolated

**_Salmonella typhimurium_ isolated

[a/] Samples collected by Environmental Protection Agency - Region IX.

South Bay

At 12 of the 24 sample stations in this section of the bay, violations of the NSSP bacteriological criteria for shellfish harvesting waters occurred [Table V-2, Figure V-5a]. At Station 1 twenty percent of the samples were greater than 230/100 ml during high tide and 38 percent were greater than 230 for the low tide period. Station 2 had 50 percent of the samples greater than 230 during high tide and 62 percent for the low tide period, the median value was 240 coliforms per 100 ml. Stations 11 and 15 also showed violations during both tidal phases with more than 10 percent of the samples greater than 230 coliforms per 100 ml. Stations 4 and 8 showed violations during low tide only. Of the waters directly overlying known shellfish beds violations occurred at 6 of the 10 sampling stations [Table V-4]. The majority of these stations are located on the western shoreline in the vicinity of major sewage discharges. All shellfish samples (13) collected in the South Bay were in violation of sanitary quality criteria (fecal coliforms in excess of 230/100 gm shellfish meat with values as high as 46,000 fecal coliforms per 100 gm [Tables V-3, V-5, Figure V-6a]). In contrast, shellfish samples collected from Drakes Estero,* for control purposes, were not in violation of sanitary quality criteria.

Pathogenic bacteria were isolated from shellfish meats at two locations in South Bay. *Salmonella kentucky* was isolated from shellfish taken from the Burlingame (9) beds and *S. typhimurium* from samples taken at San Leandro Bay (20) [Table V-5]. The presence of pathogenic *Salmonella*

* Drakes Estero is located on the Pacific Ocean about 30 miles north of the Golden Gate.

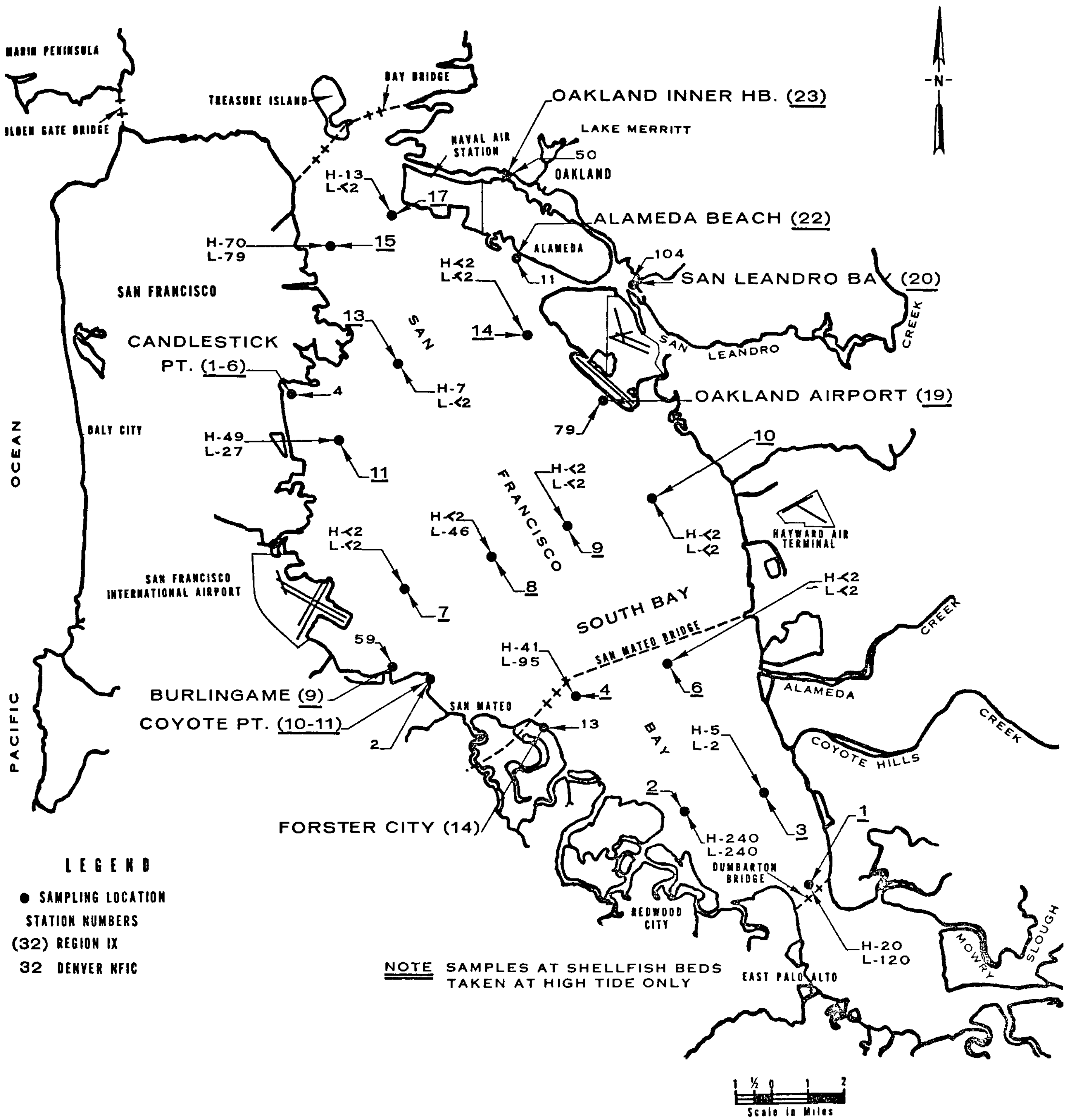


Figure V-5a Water Sampling Locations and Total Coliform Concentrations-South Bay-Spring 1972

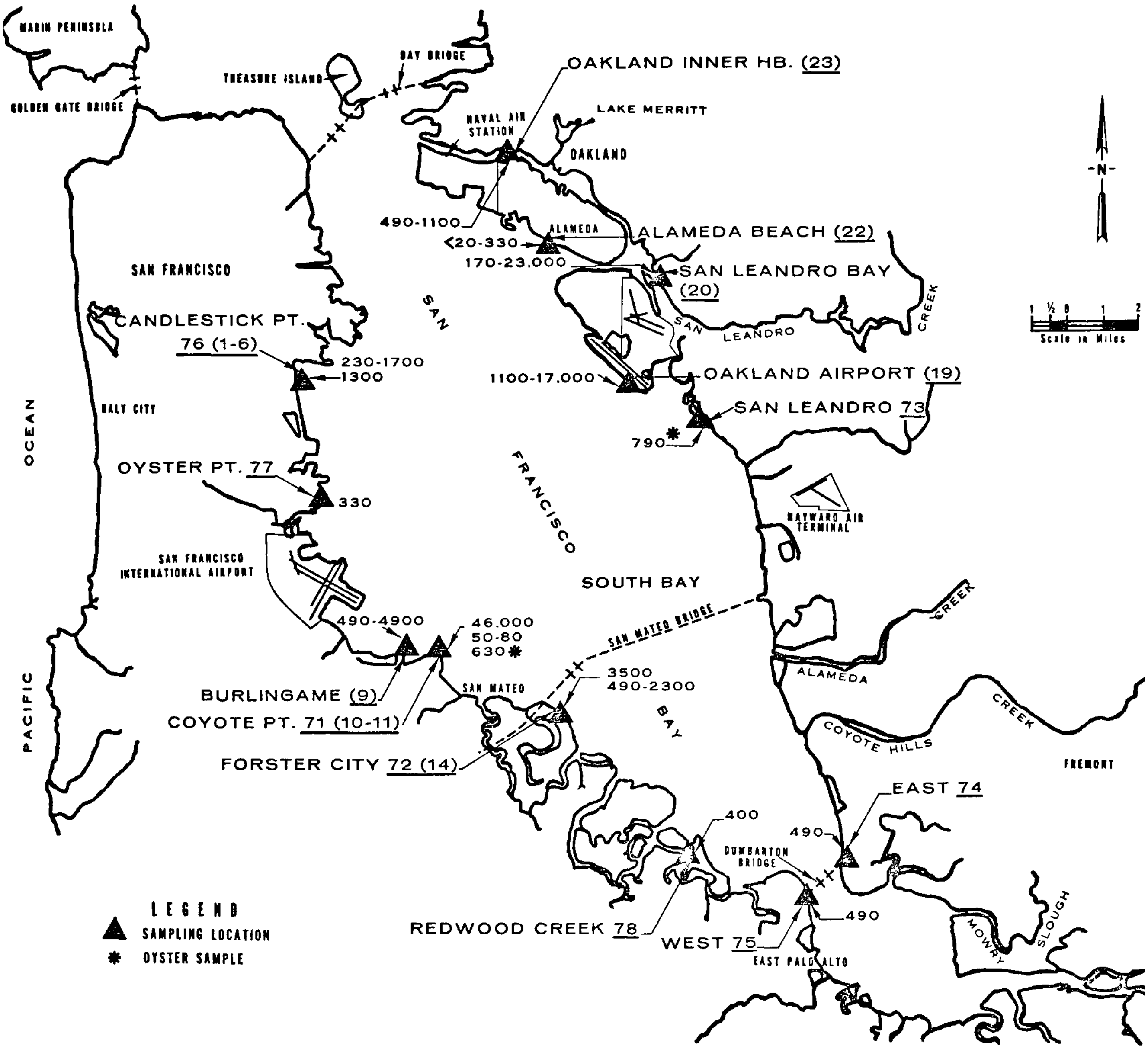


Figure V-6a Shellfish Sampling Locations and Fecal Coliform Concentrations-South Bay-Spring 1972 constitutes a severe health hazard to anyone consuming or even contacting the shellfish. The lack of recovery of similar organisms from other shellfish beds does not necessarily mean that the organisms are absent but that the recovery technique used was unsuccessful [Appendix B].

Central Bay

Five sampling stations located in this section of San Francisco Bay did not meet the NSSP bacteriological requirements for waters overlying shellfish growing areas [Table V-2, Figure V-5b]. Stations 19 and 24, located near the San Francisco North Point plant, had bacterial counts which were in violation during high tide only, both with 25 percent of the samples greater than 230 coliforms per 100 ml. Station 24 had a median value of 90 coliforms per 100 ml. Also, waters in the vicinity of Point Richmond, Strawberry Point, and Richardson Bay contained excessive amounts of coliform bacteria [Table V-4]. Shellfish samples collected from the intertidal zone near Richmond, Albany Hill, Strawberry Point, and Richardson Bay [Table V-5] had bacterial densities which were in violation of the established market standard for shellfish meats [Figure V-6b].

San Pablo Bay

Results of bacteriological analyses of water samples from San Pablo Bay show that sampling stations, 42 and 44, had bacterial counts that were in violation during both tidal phases. During the low tide periods 100 percent of the water samples from both stations were greater than 230 coliforms per 100 ml with median values of 900 and 700 coliforms respectively. Station 42, at high tide, had a median value of 1,500

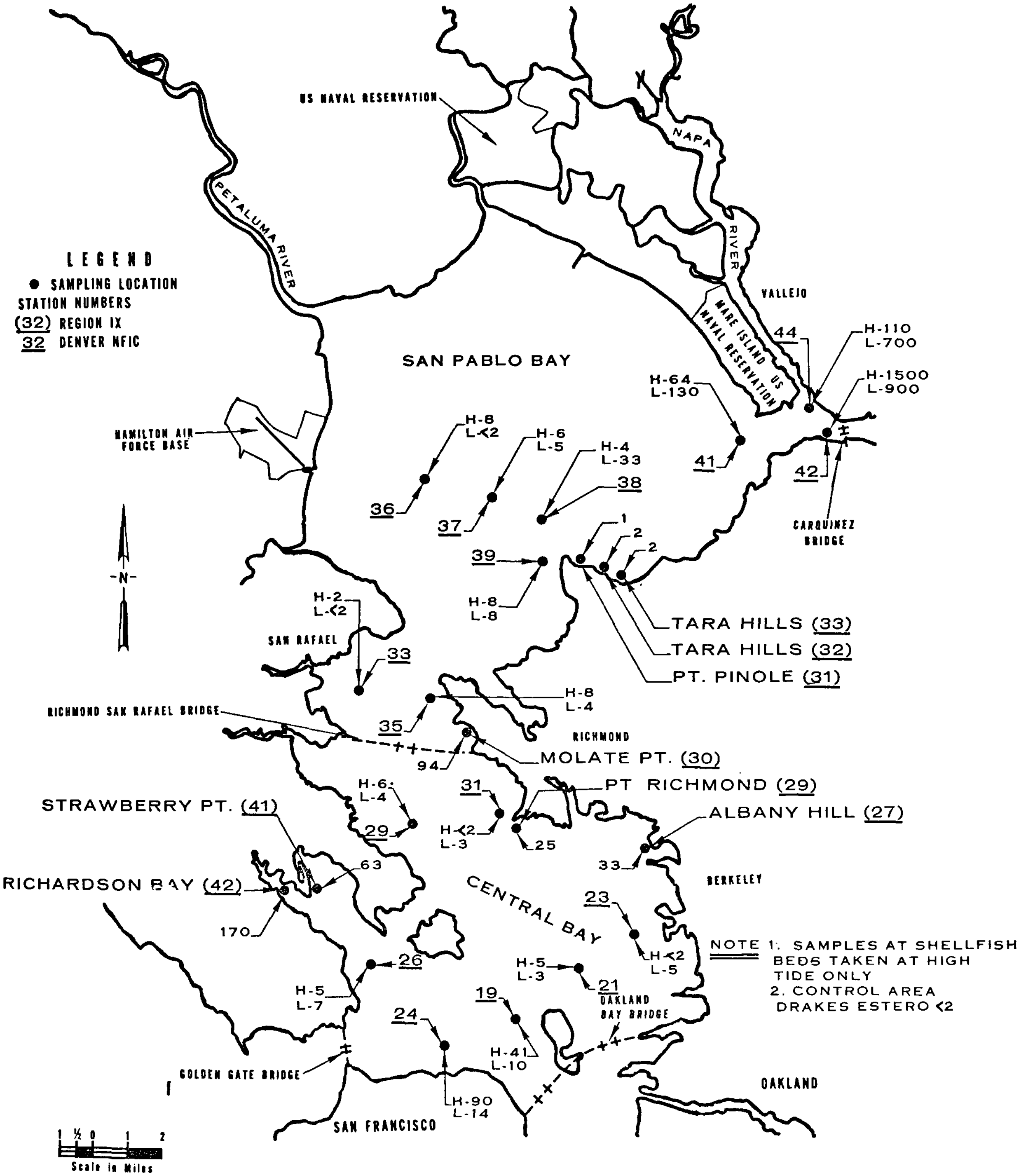


Figure V-5b Water Sampling Locations and Total Coliform Concentrations-Central Bay-San Pablo Bay-Spring 1972

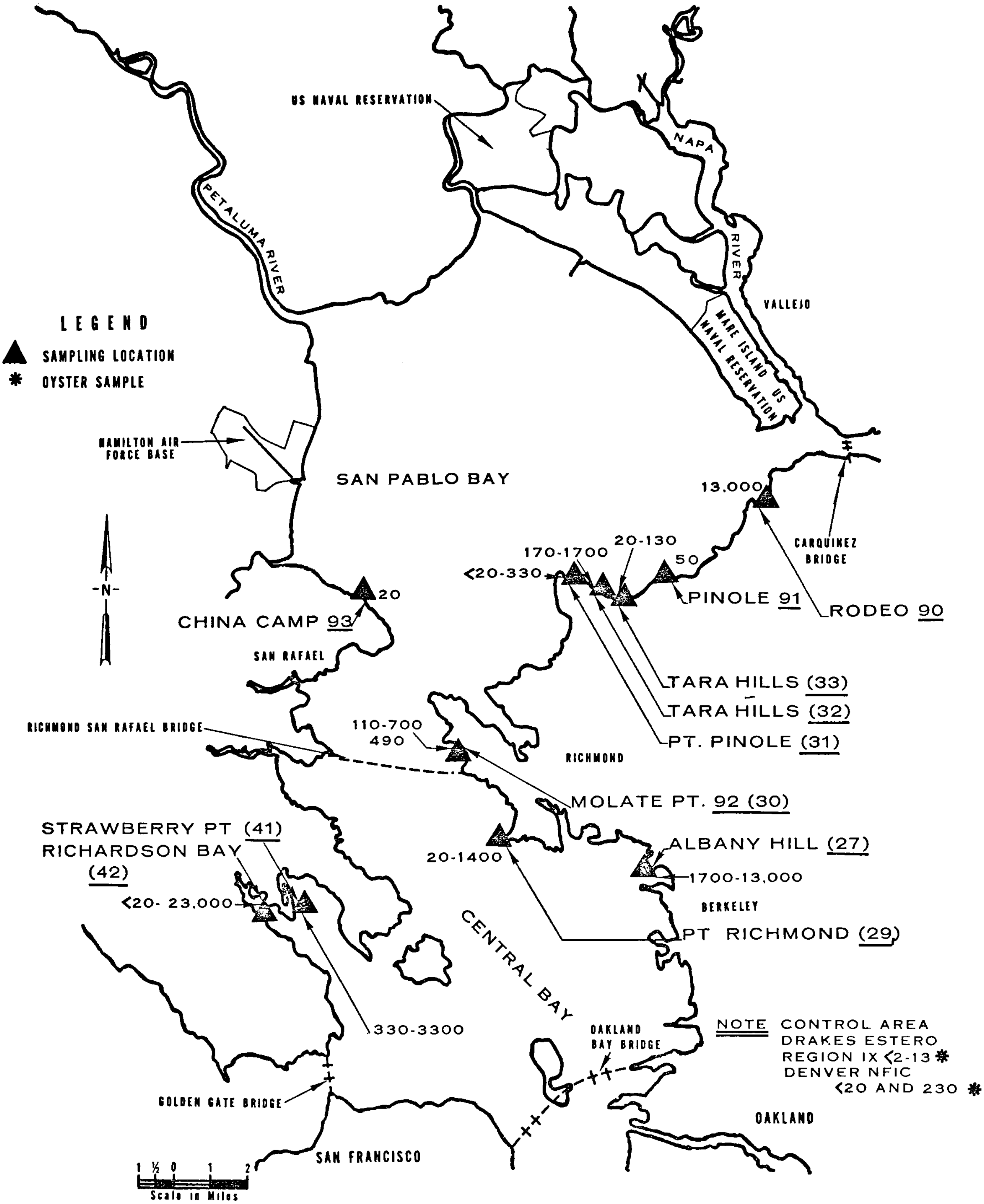


Figure V-6b Shellfish Sampling Locations and Fecal Coliform Concentrations-
Central Bay-San Pablo Bay-Spring 1972

with 75 percent of the samples greater than 230 coliforms per 100 ml. Station 44, at high tide, had a median value of 100. Water samples from station 41 were in violation during low tide only having 28.6 percent greater than 230 coliforms per 100 ml. Stations 33 and 35 through 39 were of good quality [Table V-2, Figure V-5b].

Shellfish samples collected at China Camp, Tara Hills (33), and Pinole in San Pablo Bay were within the U. S. Public Health Service bacteriological requirements [Table V-3, V-5, Figure V-6b]. Samples from Point Pinole, Tara Hills (32), and Molate Point were in excess of required standards. A shellfish sample collected near Rodeo (13,000 fecal coliforms/100 gms of meat) greatly exceeded the U. S. Public Health Service bacteriological standards as did water from sampling stations 41, 42, and 44 located nearby. High coliform counts in all of the water samples collected at low tide from stations 42 and 44 demonstrate the poor quality of water flowing into San Pablo Bay from Suisun Bay and Carquinez Strait. Contributing sources of pollution to these areas include discharges from the Maritime Academy, Mare Island Naval Ship Yard, Vallejo County Sanitation Plant, and numerous commercial vessels which periodically dock in the area.

Carquinez Strait, Suisun Bay and the Sacramento-San Joaquin Delta

All sampling stations from Carquinez Strait and Suisun Bay exceeded NSSP bacteriological requirements for shellfish harvesting areas [Table V-2, Figure V-5c]. The shellfish sample collected from the shoreline of Carquinez Strait near Benicia exceeded NSSP bacteriological requirements for market shellfish [Table V-3 and Figure V-6c].

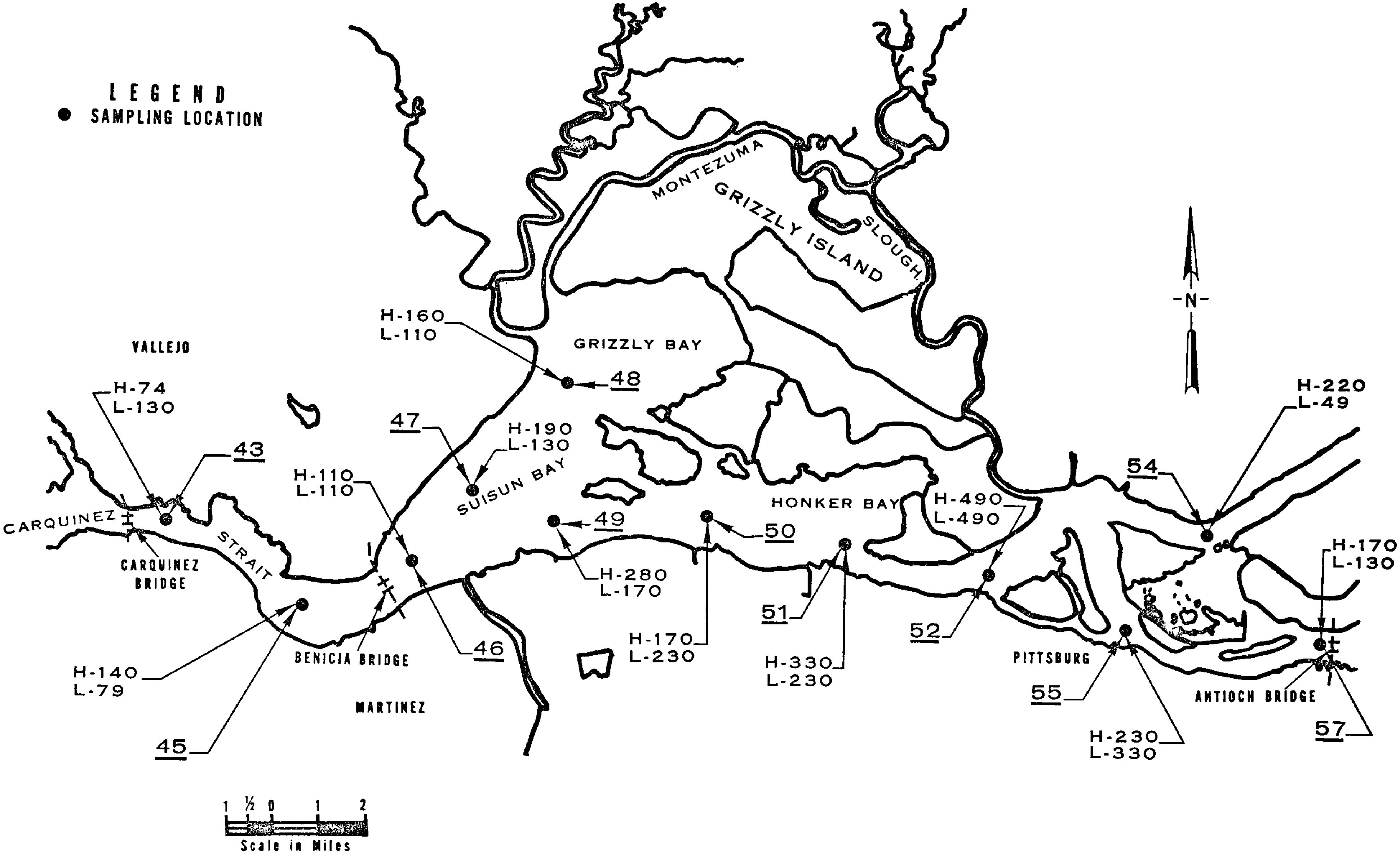


Figure V-5c Water Sampling Locations and Total Coliform Concentrations-Carquinez Strait, Suisun Bay, and Sacramento-San Joaquin Delta-Spring 1972

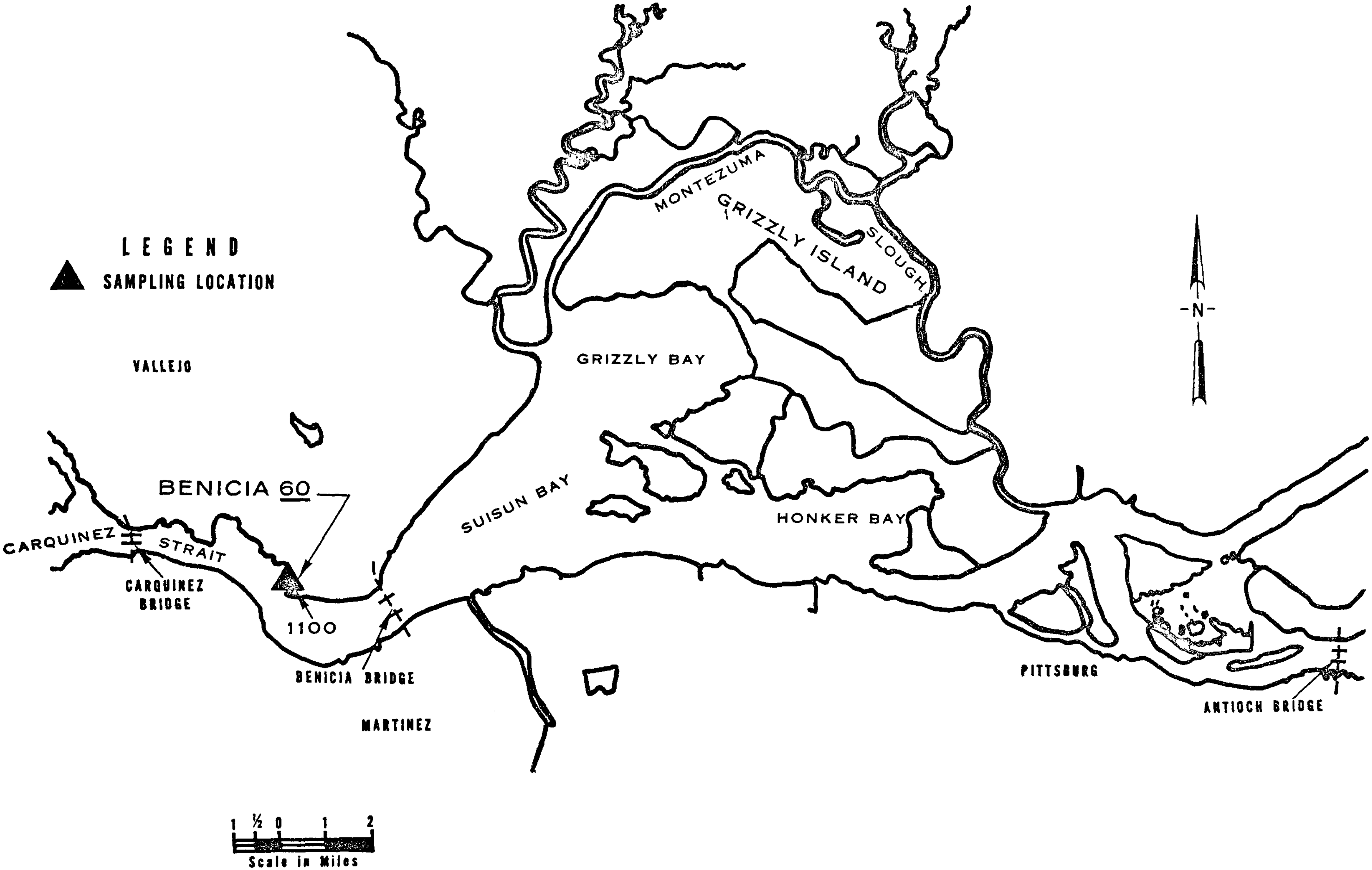


Figure V-6c Shellfish Sampling Locations and Fecal Coliform Concentrations-Carquinez Strait, High coliform bacterial densities in the Delta and Suisun Bay are attributable to agricultural wastewaters, inadequately treated effluents from municipal sewage treatment plants and industrial complexes, and untreated sewage from U. S. Naval ships, freighters, and pleasure boats. In addition, lower salinities in these locations are less toxic to bacteria.

Bacterial densities in water samples from stations located in the Sacramento-San Joaquin Delta (Nos. 51 and 52); San Pablo Bay (Nos. 42 and 44); South Bay (Nos. 1 and 2, Oakland Airport-19, and San Leandro Bay-20) exceeded California Water Quality Standards for water-contact sports areas which state that, "20 percent of samples not to exceed an MPN of 1,000 total coliforms/100 ml in any 30-day sampling period [Tables V-2, V-4].

C. CHEMICAL CONDITIONS

Samples of bay water, bottom sediment, and of shellfish were collected, in the spring of 1972, to determine whether shellfish from San Francisco Bay were being exposed to chemical pollution. The EPA laboratory staff analyzed these samples for the presence of heavy metals, chlorinated insecticides, polychlorinated biphenyls, and petroleum hydrocarbons. [Sampling locations are shown in Figures V-7, 8, and 9.] Results of these analyses are discussed in the following sections.

Heavy Metals

During this investigation, samples were analyzed for cadmium, chromium, copper, lead, zinc, and mercury. Individual results are

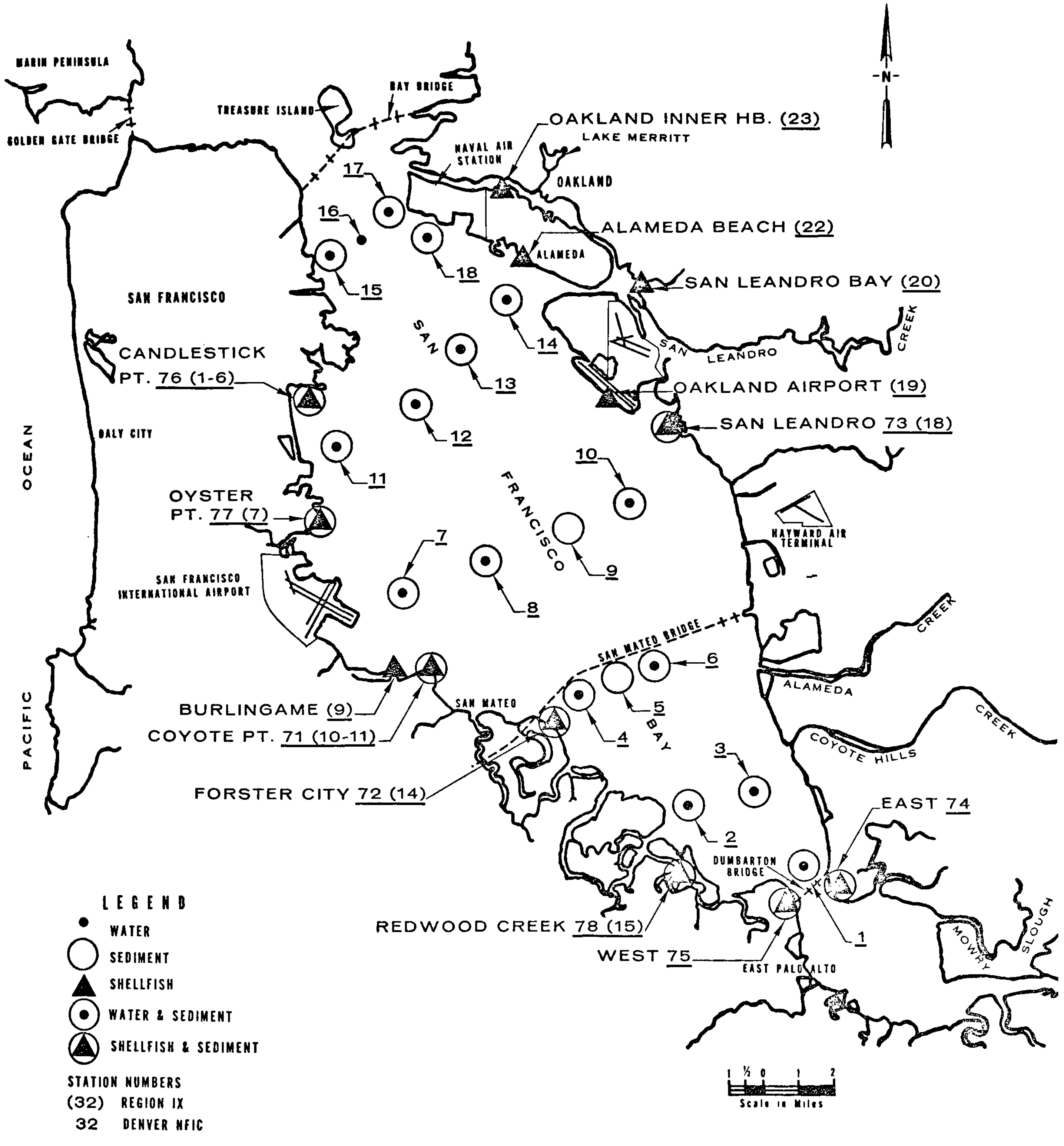


Figure V-7 Sampling Stations, San Francisco Bay South Bay-Spring 1972

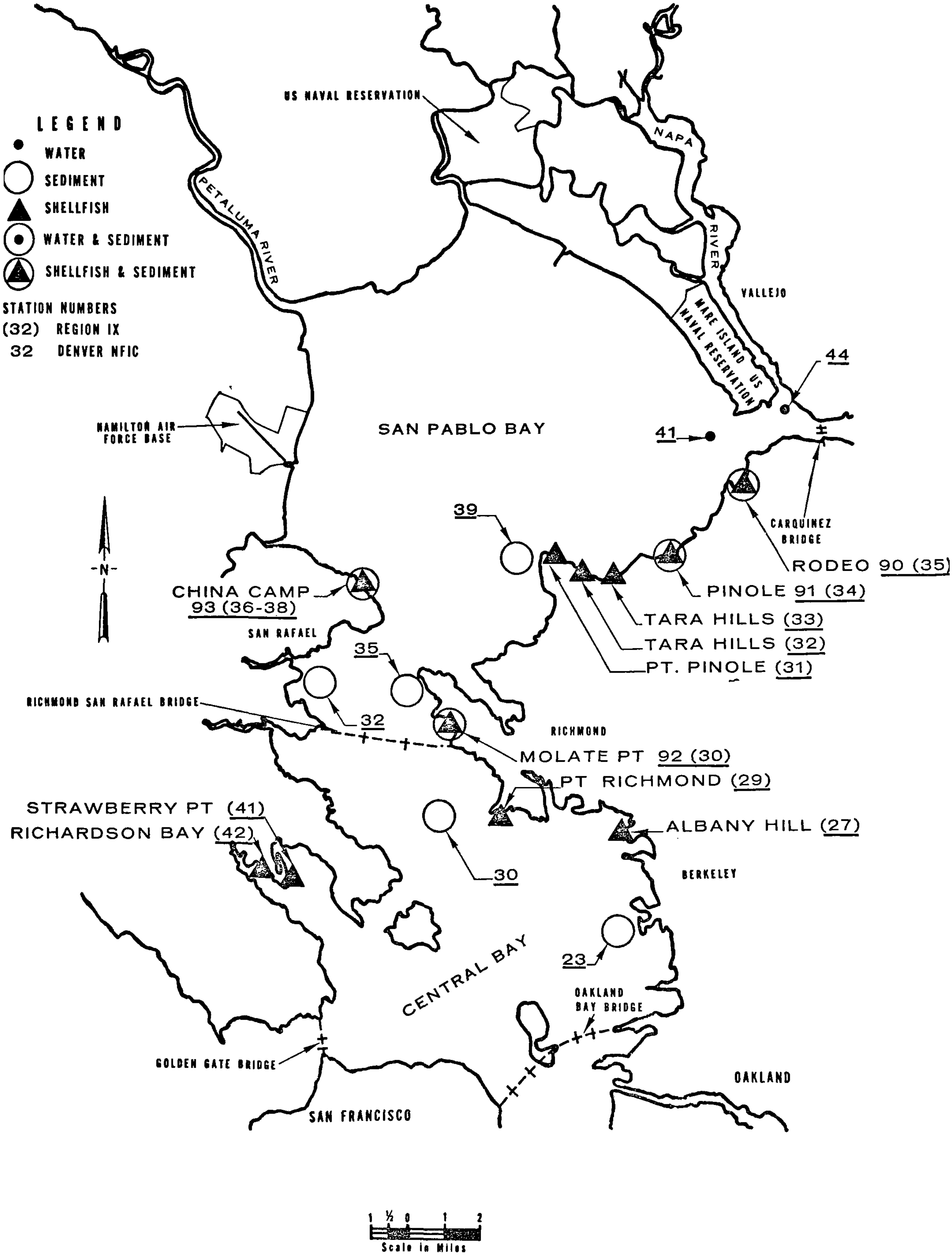


Figure V-8 Sampling Stations, San Francisco Bay Central Bay-San Pablo Bay-Spring 1972

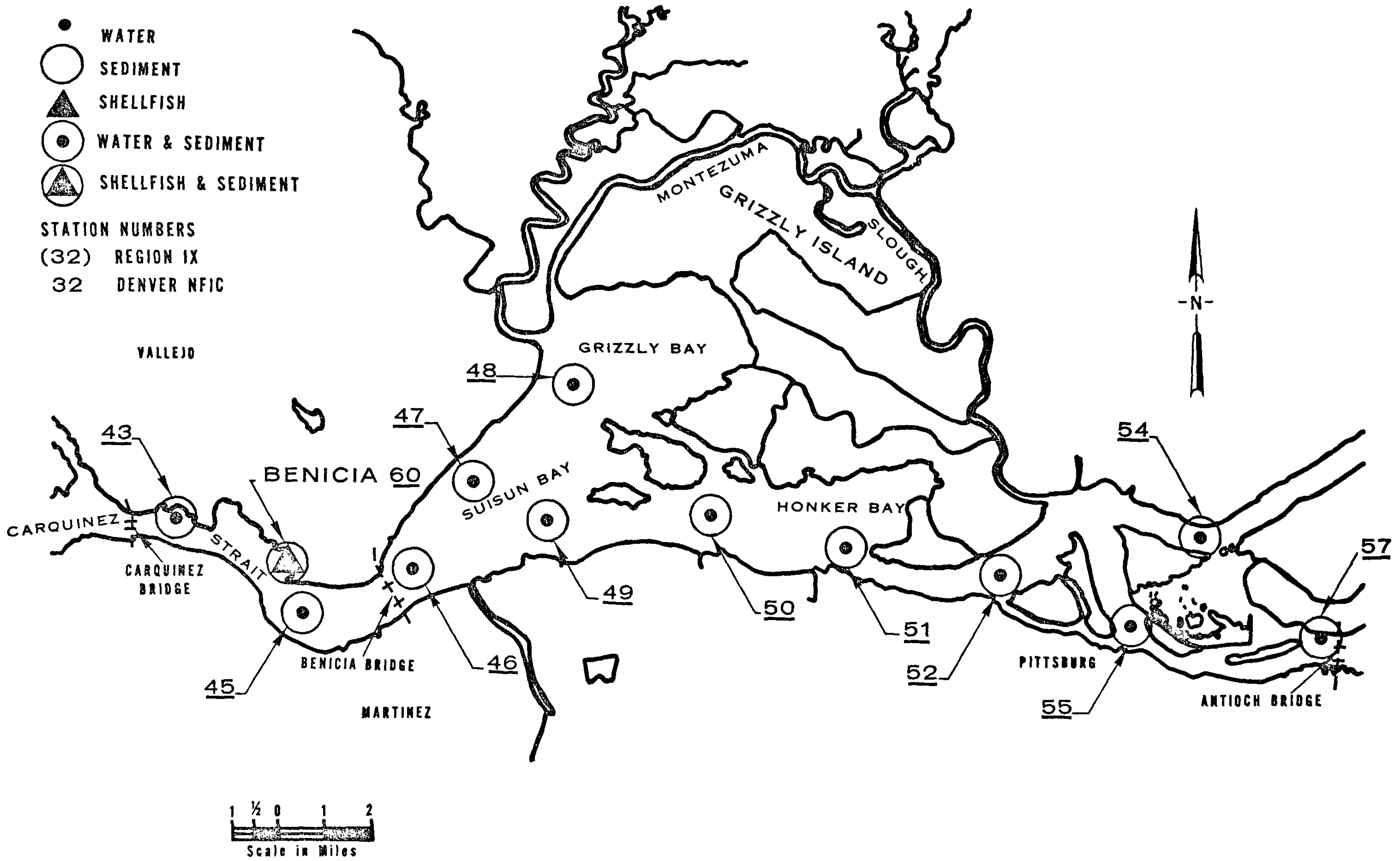


Figure V-9 Sampling Stations, San Francisco Bay Carquinez Strait-Suisun Bay-Spring 1972 summarized by sample type: water [Table V-6]; bottom sediment [Table V-7]; and shellfish [Table V-8, V-8a]. As noted [Table V-6], water samples were collected and analyzed from each station during ebb (parameters No. 01 and No. 03) and flood tides (parameters No. 02 and No. 04).

Contamination by heavy metals can be a serious pollution problem in an estuarine environment. They are persistent and can often be accumulated by living organisms to levels that are many times greater than those in the surrounding environment. The metals identified in this investigation are all relatively toxic to aquatic life. Combinations of these elements, notably copper and zinc or cadmium and copper, etc., can produce synergistic effects that greatly increase the toxic effect of the individual elements. [Toxicological effects of metals and other pollutants are discussed in more detail in Appendix E.]

In San Francisco Bay the concentrations of cadmium in the water and in bottom sediments were found to be at or below detectable concentrations. Only trace amounts were observed in clams throughout the bay; however, oysters collected near Redwood City (Station No. 78) and San Leandro (Station No. 73) contained from 2.0 to 4.5 mg/kg of cadmium. These concentrations are in excess of the alert levels [Appendix J] for heavy metals proposed by the FDA in 1968, as well as of the levels proposed in 1971 which recommended that cadmium not exceed the range 1.5 to 3.5 mg/kg in oysters.[6/] The source of these high concentrations of cadmium are presently unknown and warrant further investigation.

Chromium concentrations in the waters of San Francisco Bay were below detectable levels (0.01 mg/l) at all but one station (located at the far

TABLE V-6

Results of Metals Analysis of San Francisco Bay Area Water Samples[a/]

Sample Number*	Cadmium	Chromium	Copper	Lead	Zinc
	Concentration (mg/1)				
01-01-03-0327	<0.02	<0.01	0.17	<0.1	0.09
01-01-04-0327	<0.02	0.05	0.18	<0.1	0.15
01-02-03-0327	<0.02	<0.01	0.16	<0.1	0.06
01-02-04-0327	<0.02	<0.01	0.14	<0.1	0.07
01-03-03-0327	<0.02	<0.01	0.12	<0.1	0.04
01-03-04-0327	<0.02	<0.01	0.12	<0.1	0.06
01-04-03-0327	<0.02	<0.01	0.11	<0.1	0.04
01-04-04-0327	<0.02	<0.01	0.60	<0.1	0.05
01-06-03-0327	<0.02	<0.01	0.05	<0.1	0.04
01-06-04-0327	<0.02	<0.01	0.05	<0.1	0.04
01-07-03-0327	<0.02	<0.01	0.04	<0.1	0.06
01-07-04-0327	<0.02	<0.01	0.01	<0.1	0.04
01-08-04-0327	<0.02	<0.01	0.03	<0.1	0.04
01-08-04-0327	<0.02	<0.01	0.02	<0.1	0.05
01-10-03-0327	<0.02	<0.01	0.02	<0.1	0.04
01-10-04-0327	<0.02	<0.01	0.01	<0.1	0.07
01-11-03-0327	<0.02	<0.01	<0.01	<0.1	0.05
01-11-04-0327	<0.02	<0.01	<0.01	<0.1	0.04
01-12-03-0327	<0.02	<0.01	<0.01	<0.1	0.03
01-12-04-0327	<0.02	<0.01	<0.01	<0.1	0.04
01-13-03-0327	<0.02	<0.01	<0.01	<0.1	0.03

TABLE V-6

Results of Metals Analysis of San Francisco Bay Area Water Samples [a/]
(continued)

Sample Number*	Cadmium	Chromium	Copper	Lead	Zinc
	Concentration (mg/l)				
01-13-04-0327	<0.02	<0.01	<0.01	<0.1	0.03
01-14-03-0327	<0.02	<0.01	<0.01	<0.1	0.03
01-14-04-0327	<0.02	<0.01	<0.01	<0.1	0.03
01-15-03-0327	<0.02	<0.01	<0.01	<0.1	0.03
01-15-04-0327	<0.02	<0.01	<0.01	<0.1	0.03
01-16-03-0327	<0.02	<0.01	<0.01	<0.1	0.03
01-16-04-0327	<0.02	<0.01	<0.01	<0.1	0.03
01-17-03-0327	<0.02	<0.01	<0.01	<0.1	0.02
01-17-04-0327	<0.02	<0.01	<0.01	<0.1	0.02
01-18-03-0327	<0.02	<0.01	<0.01	<0.1	0.04
01-18-04-0327	<0.02	<0.01	<0.01	<0.1	0.02
01-41-01-0423	<0.01	<0.01	<0.01	<0.01	0.05
01-41-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-43-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-43-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-44-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-44-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-45-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-45-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-46-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-46-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-47-01-0423	<0.01	<0.01	<0.01	<0.01	0.02

TABLE V-6

Results of Metals Analysis of San Francisco Bay Area Water Samples [a]
(continued)

	Concentration (mg/l)				
Sample Number*	Cadmium	Chromium	Copper	Lead	Zinc
01-47-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-48-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-48-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-49-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-49-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-50-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-50-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-51-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-51-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-52-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-52-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-54-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-54-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-55-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-55-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-57-01-0423	<0.01	<0.01	<0.01	<0.01	<0.01
01-57-02-0423	<0.01	<0.01	<0.01	<0.01	<0.01

*Sample Number = Survey Number - Station Number - Parameter Number - Date

[a] Samples collected by National Field Investigations Center-Denver.

TABLE V-7

Results of Metals Analysis of San Francisco Bay
Bottom Sediment Samples a/

Sample Number*	Concentration (mg/kg, dry weight) Cadmium	Chromium	Copper	Lead	Zinc
01-01-03-0326	<1	<0.5	35	<5	95
01-02-03-0326	<1	30	30	<5	85
01-03-03-0326	<1	25	NR	NR	70
01-04-03-0326	<1	40	NR	NR	65
01-05-03-0326	<1	30	25	<5	70
01-06-03-0326	<1	35	30	<5	80
01-07-03-0326	<1	45	35	<5	100
01-08-03-0326	<0.5	50	24	<5	90
01-09-03-0326	<0.5	27	22	<5	70
01-10-03-0326	<0.5	39	32	<5	120
01-11-03-0326	<0.5	46	23	15	70
01-12-03-0326	<0.5	34	20	10	55
01-13-03-0326	<0.5	35	20	<5	63
01-14-03-0326	<0.5	38	20	<5	67
01-15-03-0326	0.5	40	23	<5	68
01-17-03-0326	<0.5	31	15	14	55
01-18-03-0326	0.7	39	15	<7	94
01-23-05-0501	0.7	58	45	38	121
01-30-05-0501	0.5	33	20	19	72
01-32-05-0501	1.4	71	68	41	140
01-35-05-0501	1.3	51	45	39	115

TABLE V-7

Results of Metals Analysis of San Francisco Bay
Bottom Sediment Samples a/
(continued)

Sample Number*	Concentration (mg/kg, dry weight)				
	Cadmium	Chromium	Copper	Lead	Zinc
01-39-05-0501	0.9	54	32	20	70
01-43-05-0423	<1	12	59	87	134
01-45-05-0423	<1	<1	88	45	141
01-46-05-0423	<1	27	54	28	111
01-47-05-0423	<1	26	38	18	69
01-48-05-0423	<1	<1	59	29	58
01-49-05-0423	<1	17	11	11	32
01-50-05-0423	1	18	60	34	89
01-51-05-0423	<1	19	9	7	38
01-52-05-0423	<1	16	18	14	47
01-54-05-0423	<1	22	21	13	62
01-55-05-0423	1	<1	55	21	152
01-57-05-0423	<1	<1	10	13	41
01-60-10-0423	<1	28	31	37	88
01-71-09-0330	<0.5	22	7	<5	28
01-72-09-0330	<0.5	9	4	7	16
01-73-08-0331	<0.5	12	12	<5	26
01-74-08-0331	<0.3	13	4	16	30
01-75-08-0331	<0.3	21	4	21	16
01-76-09-0402	<0.2	7	3	<2	10
01-77-15-0402	<0.3	12	3	<3	22
01-78-08-0403	<0.3	15	10	12	24

TABLE V-7

Results of Metals Analysis of San Francisco Bay
Bottom Sediment Samples a/
(continued)

Sample Number*	Cadmium	Chromium	Copper	Lead	Zinc
	Concentration (mg/kg, dry weight)				
01-79-20-0403	<0.2	8.5	<0.2	<2	10
01-90-06-0429	0.6	22	19	26	57
01-91-05-0429	0.4	29	23	18	49
01-92-06-0429	0.6	21	17	25	60
01-93-06-0430	0.8	39	33	28	81

*Sample Number = Survey Number - Station Number - Parameter Number - Date.

NR = Not Requested.

a/ Samples collected by NFIC-D.

TABLE V-8

Results of Metals Analysis of San Francisco Bay Area Shellfish [a]

Sample Number	Shellfish Type	Cadmium	Chromium	Copper	Lead	Mercury	Zinc
		Concentration (mg/kg, wet weight)					
01-60-08-0423	Soft Clam	0.6	0.9	4.8	0.8	0.79	35
01-71-06-0330	" "	<0.5	<0.5	8.0	<5	<0.1	59
01-72-06-0330	" "	<0.5	<0.5	<0.5	<5	<0.1	21
01-73-05-0331	" "	<0.5	<0.5	<0.5	<5	<0.1	20
01-73-11-0331	Olympia Oyster	2.0	<0.5	68.5	<5	<0.1	14
01-74-05-0331	Soft Clam	<0.5	1.5	<0.5	<5	<0.1	25
01-75-05-0331	" "	<0.5	1.0	<0.5	<5	<0.1	30
01-76-05-0402	" "	<0.5	<0.5	<0.5	<5	<0.1	16
01-77-12-0402	" "	<0.5	20.0	<0.5	<5	<0.1	20
01-78-05-0403	" "	<0.5	<0.5	<0.5	<5	0.1	25
01-78-24-0330	Eastern Oyster	2.0	<0.5	30.0	<5	0.1	608
01-78-22-0330	Pacific Oyster	4.5	<0.5	45.5	<5	0.2	336
01-79-11-0403	Soft Clam	<0.5	<0.5	<0.5	<5	<0.1	14
01-79-14-0403	Eastern Oyster	NR	NR	NR	NR	<0.1	NR
01-79-17-0403	Pacific Oyster	<0.5	<0.5	<0.5	<5	<0.1	111
01-90-03-0429	Soft Clam	0.2	0.3	5.9	0.7	0.25	25

TABLE V-8

Results of Metals Analysis of San Francisco Bay
Area Shellfish[a/]
(continued)

Sample Number	Shellfish Type	Cadmium	Chromium	Copper	Lead	Mercury	Zinc
		Concentration (mg/kg, wet weight)					
01-91-03-0429	Soft Clam	0.6	1.0	3.9	4.2	0.42	18
01-92-03-0429	" "	0.9	0.3	34	2.0	0.25	29
01-93-03-0429	" "	0.3	0.4	3.5	1.0	<0.02	21

*Sample Number = Survey Number - Station Number - Parameter Number - Date.

NR = Not Requested.

[a/] Data collected by National Field Investigations Center-Denver.

TABLE V- 8a

Concentration of Selected Heavy Metals In Shellfish
Wet Weight by Station[a]
(In mg/kg)

EPA Lab Number	Coll. Date	Sample Description	Cadmium	Chromium	Copper	Lead	Mercury	Zinc
16SF042	4/7/72	#3/Bayview	0.21	2.62	5.73	10.53	0.03	18.71
5SF042	4/7/72	#9/Burlingame	0.15	0.88	1.20	1.32	0.01	8.48
15SF042	4/7/72	#10 Coyote Pt-N	1.41	0.79	48.19	1.75	0.15	156.63
6SF042	4/7/72	#14 Foster City	0.21	0.30	1.38	0.41	0.03	10.47
7SF042	4/7/72	#19 Oakland Airport	0.13	0.53	1.12	0.42	0.02	9.30
8SF042	4/7/72	#20 San Leandro Bay	0.33	0.56	1.34	1.22	0.02	10.62
14SF042	4/8/72	#22 Alameda Memorial State Park	0.35	1.17	1.98	0.93	0.05	24.03
13SF042	4/7/72	#23 Oakland Inner Harbor	0.58	0.67	1.21	3.82	0.06	35.05
28SF042	4/8/72	#27 Albany Hills	0.21	3.64	6.60	18.70	0.06	24.53
36SF042	4/8/72	#29 Pt. Richmond	0.25	0.31	1.94	0.71	0.09	20.25
35SF042	4/8/72	#30 Castro Pt. et al.	0.06	0.84	1.25	0.23	0.03	9.11
29SF042	4/8/72	#31 Tara Hills (L)	0.14	1.70	2.47	1.53	0.04	17.41
30SF042	4/8/72	#32 Tara Hills (M)	0.09	6.65	4.66	1.84	0.09	14.93
31SF042	4/8/72	#33 Tara Hills (R)	0.06	3.99	2.62	2.17	0.05	14.60

TABLE V- 8a

Concentration of Selected Heavy Metals In Shellfish
Wet Weight by Station[a/]
(In mg/kg)

EPA Lab Number	Coll. Date	Sample Description	Cadmium	Chromium	Copper	Lead	Mercury	Zinc
33SF042	4/8/72	#41 Strawberry Pt-W	0.29	1.47	4.05	1.79	0.06	19.32
32SF042	4/8/72	#42 Richardson Bay	0.16	2.96	3.52	2.92	0.06	18.27
Control[b/]	5/23/72	Johnson Oyster Company Drakes Estero	0.33	0.10	2.03	0.93	0.04	57.57

a/ EPA, Region IX

b/ Control is sample of oysters from Johnson Oyster Company, Drake's Estero.

end of South Bay) where a concentration of 0.05 mg/l was observed. In the bottom sediments the chromium concentrations ranged from less than 1 to 71 mg/kg. Oysters from both San Francisco Bay and Drakes Estereo (Control Station No. 79) contained less-than-detectable concentrations. Several of the clam samples contained low levels of chromium (0.9 to 1.5 mg/kg); however, a sample from Oyster Point (Station No. 77) contained 20 mg/kg, a value that is four times greater than the proposed FDA alert level (5 mg/kg) for chromium in soft clams. One other sample in San Pablo Bay, Tara Hills (No. 32), was also in excess of the FDA alert level with a concentration of 6.7 mg/kg. Bottom sediments at Oyster Point contained 12 mg/kg of chromium; contamination of the shellfish by soluble chromium salts could have occurred.

The State of California has set a threshold limit of 0.05 mg/l for the concentration of copper in fresh water, but does not have a standard value applicable to saline waters. Levels in excess of 0.1 mg/l are considered sufficient for oysters to accumulate excessive amounts, while copper concentrations above 0.5 mg/l become toxic to shellfish upon chronic exposure.[7,8]

In most of the San Francisco Bay waters tested, copper concentrations were below detectable levels (<0.01 mg/l). In South Bay measurable concentrations ranged from 0.01 to 0.60 mg/l. With the exception of the highest value (0.60 mg/l), observed just northwest of the San Mateo Bridge (Station No. 4), little variation was detected between high and low tide, and into the south end of the bay the values generally increased. The significantly higher concentration of Station No. 4 is likely caused by a point-source discharge.

Concentrations of copper in the bottom sediments ranged widely, from less than 1 to 88 mg/kg, but showed no apparent trends nor appeared to have any direct relationship to the concentration observed in shellfish.

Oysters collected near Redwood City (Station No. 78) and San Leandro (Station No. 73) contained copper concentrations from 60 to 140 times greater than in those from uncontaminated locations in Drakes Estero (Station No. 79). These greater concentrations approached the proposed FDA alert level of 100 mg/kg. Soft clams from near Redwood City (Station No. 78) did not contain detectable copper (<0.5 mg/kg). Gross copper contamination was observed near Molate Point (Station No. 92) where clams contained 34 mg/kg. The proposed FDA alert level for soft clams is 25 mg/kg.

Previous work by the U. S. Geological Survey had shown that mercury contamination was not a serious problem in the bottom sediments from San Francisco Bay.[9/] During this study EPA investigators detected concentrations of mercury in edible tissue samples for shellfish collected at various parts of the Bay [Table V-8, 8a]. Although most of the mercury levels were low, one sample of soft calms from Carquinez Strait (Station No. 60) contained 0.79 mg/kg, or significantly more than the FDA recommended limit (0.5 mg/kg) of mercury in fish and shellfish.[10/] Another sample of soft clams from San Pablo Bay (Station No. 91) contained mercury concentrations (0.42 mg/kg) approaching the recommended limit. The sources of this contamination are not known, but may be from industrial discharges within the area.

Concentrations of lead in San Francisco Bay waters were found to be very low. Samples of water collected south of the Bay Bridge all contained less than 0.1 mg/l of lead. Water samples collected further north, in Suisun Bay, contained less than 0.01 mg/l of lead. Bottom sediment samples contained variable amounts of lead, ranging from less than 2 mg/kg near Candlestick Park (Station No. 76) to 87 mg/kg at the mouth of Carquinez Strait (Station No. 43). The control station in Drakes Estero (Station No. 79) contained lead concentrations to less than 2 mg/kg.

At a number of shellfish sampling stations the concentration of lead in soft clams exceeded the proposed FDA alert levels that call for less than 2.0 mg/kg lead, cadmium, chromium, and mercury combined. The most seriously contaminated stations were: Albany Hills, No. 27 with 19 mg/kg; Bay View Park, No. 3 with 11 mg/kg; No. 91 with 4.2 mg/kg; Oakland Inner Harbor, No. 23 with 3.8 mg/kg; Richardson Bay, No. 42 with 2.9 mg/kg; Tara Hills, No. 33 with 2.2 mg/kg; and Molate Point, No. 92 with 2.0 mg/kg of lead [Tables V-8 and V-8a]. At Stations No. 91 and No. 92 the sediment concentrations of lead were relatively low (18 and 25 mg/kg, respectively); even greater shellfish contamination could occur at the stations with greater lead concentrations in the bottom sediments. Unfortunately, the detection limit of lead in many shellfish samples was not sufficiently low to determine whether significant uptake of this toxic element was occurring.

During this investigation of the waters of San Francisco Bay the levels of zinc found [Table V-6] were low. Concentrations in the bay south of the City of San Francisco ranged from 0.02 to 0.15 mg/l. In general, the amounts of zinc tended to increase in concentration toward the south end of the bay. North of the City, zinc concentrations in the water were lower. In Suisun Bay all but one water sample contained less than 0.01 mg/l which is the zinc concentration normally found in the open ocean.[7]

Measurable quantities of zinc were found in all bottom sediments collected from the bay. Acid-extractable zinc ranged, in the sediments, from 10 to 152 mg/kg. For comparison, a control station in Drakes Estero (Station No. 79) also contained 10 mg/kg of zinc in the sediments. Such an abundance of zinc throughout the bay indicates multiple sources of contamination. In addition, it is evident that zinc is readily incorporated into the sediments and is, therefore, transported primarily in the particulate phase.

Oysters tend to concentrate zinc from the environment in their tissues to a greater extent than do clams.—/ Eastern and Pacific oysters collected at Station No. 78, near Redwood City, contained 608 and 336 mg/kg zinc, respectively, while clams contained only 25 mg/kg. At the control station (No. 79) Pacific oysters contained 111 mg/kg, or one-third the concentration found in the bay. The proposed FDA alert level of zinc in oysters is 1500 mg/kg, three times greater than the highest concentration found.

Although the zinc concentrations were lower in clams, these organisms were apparently exposed to more zinc contamination than were the oysters. Most clam samples in the bay contained more zinc than the 14 mg/kg in soft clams observed at Control Station No. 79. Serious contamination was evident near Foster City (Station No. 71) where clams contained 59 mg/kg zinc and, to a lesser extent, near Carqinez Strait (Station No. 60), Palo Alto (Station No. 75), and Oakland Inner Harbor (No. 23) where zinc concentrations in soft calms were 35, 30, and 35 mg/kg, respectively. Each of these samples contained more zinc than recommended by the proposed FDA alert level (30 mg/kg) in soft clams. Therefore, this finding demonstrates that zinc contamination of shellfish is definitely a problem in San Francisco Bay.

Chlorinated Insecticides and Polychlorinated Biphenyls

During this investigation samples of bottom sediment, shellfish tissue, and plankton were tested for the more common chlorinated insecticides, as well as for the polychlorinated biphenyl (PCB) mixtures (known by their Monsanto trade name of Aroclor). [Results of these analyses are summarized in Tables V-9 and V-9a.]

Chlorinated pesticides are highly toxic chemicals. Typically, they are persistent compounds, though some may be degraded by living systems into less toxic metabolities. As residues in the aquatic environment they may persist unchanged for many years and, consequently, present a continuing threat to animal communities. Shellfish have the ability to accumulate these residues in their body fats when only minute amounts exist in the surrounding environment. As a general rule, the acute toxicity of these pesticides increases with metabolic activity, being two or three times more toxic in the summer than in the winter.[7/] More subtle changes, such as reduced growth, reproduction changes, altered physiology, and induced abnormal behavior patterns, can occur at much

TABLE V-9

Results of Analysis of San Francisco Bay Area Bottom Sediment, Shellfish, and Plankton Samples for Chlorinated Insecticides and Polychlorinated Biphenyls[a]

Sample Number*	Sample Type	Chlorinated Insecticides (ng/g*)					Polychlorinated Biphenyls (ng/g*)		
		Chlordane	DDD	DDE	DDT	Dieldrin	Aroclor 1248	Aroclor 1254	Aroclor 1260
01-01-02-0326	Sediment	ND	ND	ND	ND	ND	ND	40	ND
01-02-02-0326	"	ND	ND	ND	ND	ND	ND	38	ND
01-03-02-0326	"	ND	ND	ND	ND	ND	ND	18	ND
01-03-03-0329	Plankton	ND	ND	ND	ND	ND	ND	ND	ND
01-04-02-0326	Sediment	ND	ND	ND	ND	ND	ND	15	ND
01-05-02-0326	"	ND	ND	ND	ND	ND	ND	17	ND
01-06-02-0326	"	ND	ND	ND	ND	ND	ND	18	ND
01-07-02-0326	"	ND	ND	ND	ND	8	ND	48	ND
01-07-03-0402	Plankton	ND	ND	ND	ND	ND	ND	ND	ND
01-08-02-0326	Sediment	ND	ND	ND	ND	ND	ND	30	ND
01-09-02-0326	"	ND	ND	ND	ND	3	ND	22	ND
01-10-02-0326	"	ND	ND	ND	ND	3	ND	38	ND
01-11-02-0326	"	ND	ND	ND	ND	ND	ND	25	25
01-11-05-0327	Plankton	ND	ND	ND	ND	ND	ND	ND	ND
01-12-02-0326	Sediment	ND	ND	ND	ND	ND	ND	89	ND
01-13-02-0326	"	ND	ND	ND	ND	ND	ND	58	ND

TABLE V-9

Results of Analysis of San Francisco Bay Area Bottom Sediment, Shellfish, and Plankton Samples for Chlorinated Insecticides and Polychlorinated Biphenyls a/ (continued)

Sample Number*	Sample Type	Chlorinated Insecticides (ng/g*)					Polychlorinated Biphenyls (ng/g*)		
		Chlordane	DDD	DDE	DDT	Dieldrin	Aroclor 1248	Aroclor 1254	Aroclor 1260
01-14-02-0326	Sediment	ND	ND	ND	ND	ND	ND	69	ND
01-15-02-0326	"	ND	ND	ND	ND	ND	ND	74	ND
01-17-02-0326	"	ND	ND	ND	ND	ND	ND	48	ND
01-18-02-0326	"	ND	ND	ND	ND	ND	ND	33	ND
01-21-07-0502	Plankton	ND	ND	ND	ND	ND	ND	ND	ND
01-23-03-0501	Sediment	ND	2	1	ND	ND	ND	20	ND
01-30-03-0501	"	ND	1	1	2	ND	9	26	18
01-32-03-0501	"	ND	1	1	4	ND	4	11	8
01-35-03-0501	"	ND	2	ND	3	ND	ND	25	ND
01-39-03-0501	"	ND	ND	ND	1	ND	ND	10	ND
01-43-03-0423	"	ND	3	ND	ND	1	ND	10	ND
01-45-03-0423	"	ND	ND	ND	4	ND	ND	8	ND
01-46-03-0423	"	ND	1	ND	ND	ND	ND	40	ND
01-47-03-0423	"	ND	1	ND	ND	ND	ND	ND	ND
01-48-03-0423	"	ND	7	ND	3	ND	ND	20	ND
01-49-03-0423	"	ND	ND	ND	ND	ND	ND	ND	ND

TABLE V-9

Results of Analysis of San Francisco Bay Area Bottom Sediment, Shellfish, and Plankton Samples for Chlorinated Insecticides and Polychlorinated Biphenyls a/
(continued)

Sample Number *	Sample Type	Chlorinated Insecticides (ng/g*) Chlordane	DDD	DDE	DDT	Dieldrin	Polychlorinated Biphenyls (ng/g*) Aroclor 1248	Aroclor 1254	Aroclor 1260
01-50-03-0423	Sediment	ND	2	1	2	ND	ND	14	ND
01-51-03-0423	"	ND	ND	ND	ND	ND	ND	ND	ND
01-52-03-0423	"	ND	ND	ND	ND	ND	ND	ND	ND
01-54-03-0423	"	ND	ND	ND	ND	1	ND	12	ND
01-54-03-0423	Plankton	ND	ND	ND	ND	ND	ND	ND	ND
01-55-03-0423	Sediment	ND	3	1	ND	ND	ND	22	ND
01-55-03-0425	Plankton	ND	ND	ND	ND	ND	ND	ND	ND
01-57-03-0423	Sediment	ND	ND	ND	ND	ND	ND	4	ND
01-60-09-0423	"	ND	1	ND	3	ND	ND	6	ND
01-60-07-0423	Soft Clam	ND	8	3	8	2	ND	36	ND
01-71-08-0330	Sediment	ND	ND	ND	ND	ND	ND	ND	ND
01-71-05-0330	Soft Clam	30	8	4	5	7	ND	85	ND
01-72-11-0330	Sediment	ND	ND	ND	ND	4	ND	9	ND
01-72-05-0330	Soft Clam	ND	3	3	2	3	ND	41	ND
01-73-07-0331	Sediment	ND	ND	ND	ND	ND	ND	45	ND
01-73-10-0331	Olympia Oyster	35	29	24	9	17	170	285	ND
01-73-04-0331	Soft Clam	132	33	16	4	1	200	120	ND

TABLE V-9

Results of Analysis of San Francisco Bay Area Bottom Sediment, Shellfish, and Plankton Samples for Chlorinated Insecticides and Polychlorinated Biphenyls[a/]
(continued)

Sample Number*	Sample Type	Chlordane	DDD	DDE	DDT	Dieldrin	Polychlorinated Biphenyls (ng/g*) Aroclor 1248	Aroclor 1254	Aroclor 1260
01-74-07-0331	Sediment	ND	ND	ND	ND	ND	50	50	ND
01-74-04-0331	Soft Clam	18	4	3	3	ND	ND	38	ND
01-75-07-0331	Sediment	ND	ND	ND	ND	ND	ND	13	ND
01-75-04-0331	Soft Clam	25	6	3	3	6	15	25	ND
01-76-08-0402	Sediment	ND	ND	ND	ND	ND	ND	5	ND
01-76-05-0402	Soft Clam	ND	ND	ND	ND	2	ND	22	ND
01-77-14-0402	Sediment	ND	ND	ND	ND	ND	ND	ND	ND
01-77-11-0402	Soft Clam	12	4	ND	ND	4	43	43	ND
01-78-07-0403	Sediment	ND	ND	ND	ND	ND	ND	275	ND
01-78-04-0403	Soft Clam	26	5	2	4	7	ND	63	ND
01-78-21-0330	Pacific Oyster	99	4	9	11	25	ND	275	ND
01-78-23-0330	Eastern Oyster	33	10	9	6	11	ND	105	ND
01-79-19-0403	Sediment	ND	ND	ND	ND	ND	ND	21	21
01-79-10-0403	Soft Clam	ND	ND	ND	ND	ND	ND	3	ND
01-79-13-0403	Eastern Oyster	ND	ND	ND	ND	ND	ND	6	ND
01-79-16-0403	Pacific Oyster	7	5	6	2	2	ND	18	ND

TABLE V-9

Results of Analysis of San Francisco Bay Area Bottom Sediment, Shellfish, and Plankton Samples for Chlorinated Insecticides and Polychlorinated Biphenyls a/
(continued)

Sample Number*	Sample Type	Chlordane	DDD	DDE	DDT	Dieldrin	Polychlorinated Biphenyls (ng/g*) Aroclor 1248	Aroclor 1254	Aroclor 1260
01-90-04-0429	Sediment	ND	1	ND	3	ND	ND	35	ND
01-90-02-0429	Soft Clam	ND	8	2	3	1	ND	20	ND
01-91-04-0429	Sediment	ND	1	ND	4	ND	ND	13	ND
01-91-02-0429	Soft Clam	ND	13	2	9	1	ND	4	ND
01-92-04-0429	Sediment	ND	2	ND	1	ND	ND	13	ND
01-92-02-0429	Soft Clam	ND	8	1	3	1	ND	17	ND
01-93-04-0430	Sediment	ND	1	1	2	ND	ND	33	13
01-93-02-0430	Soft Clam	ND	25	3	3	2	ND	36	ND

Sample Number = Survey Number - Station Number - Parameter Number - Date.

ND = None Detected.

Concentration in ng/g, dry weight for sediments, wet weight for shellfish and plankton.

Detection limit = 1 ng/g.

a/ Samples collected by National Field Investigations Center-Denver.

TABLE V-9a

Concentration, in ppb, of Selected Chlorinated Hydrocarbons by Station - San Francisco Bay Study[a]

Chlorinated Hydrocarbon	3	9	10	14	19	20	22	23	27	29	30	31	32	33	41	42	C_1	C_2
Aroclor 1242-1254	26.5	10.5	446.0	23.8	91.0	75.0	64.7	119.	88.0	252.0	25.9	25.4	37.8	39.4	18.0	29.1	4.7	3.8
Dieldrin	-	0.9	2.8	0.9	1.2	1.0	1.0	0.4	4.0	-	-	1.0	1.2	0.8	-	0.6	-	-
op´ DDE	4.2	7.2	28.0	1.9	4.3	5.5	5.8	4.0	7.2	1.6	1.4	2.2	7.0	3.4	2.2	1.8	1.2	tr
pp´ DDE	1.3	4.4	13.0	0.8	2.0	3.5	2.9	2.1	2.0	1.2	1.3	0.8	1.7	2.0	2.0	1.9	2.6	2.1
op´ DDD		tr	-	-	-	-	-	-	1.2	tr	tr	tr	-	tr	-	tr	-	-
op´ DDT	1.2	3.6	22.0	0.8	2.3	8.0	2.4	1.0	1.6	0.4	0.5	0.4	-	1.2	0.9	0.7	1.8	1.3
pp´ DDD	1.1	3.6	7.0	0.5	1.7	2.5	1.4	2.0	2.8	1.2	1.2	1.2	1.7	2.2	0.9	0.7	1.2	0.6
pp´ DDT	2.3	4.8	24.0	1.1	3.0	3.5	2.4	2.0	3.6	1.0	1.2	0.6	0.8	1.6	0.3	1.3	-	-
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.8	2.2

a/ Samples collected by Environmental Protection Agency - Region IX lower levels of exposure than those which cause acute toxicity. [See Appendix E for a more detailed discussion.]

Polychlorinated biphenyls (PCBs) are also very stable compounds that have only recently been found to be widespread in the environment. The higher levels of contamination can usually be traced directly to industrial activity where these compounds are used for a variety of purposes. These materials impact the environment in a manner similar to the chlorinated insecticides. To many organisms, they are nearly as toxic as the chlorinated insecticides, and, through food chain magnification canrapidly reach acute levels.

With the exception of plankton* all samples collected in San Francisco Bay contained measurable amounts of chlorinated hydrocarbon residues. Of the more common chlorinated insecticides only chlordane, dieldrin, DDT, DDD, and DDE were detected. Four different polychlorinated biphenyls were observed: namely, Aroclors 1242, 1248, 1254, and 1260, compounds that differ primarily by the degree of chlorination.

The bottom sediments contained only very low concentrations of chlorinated insecticides. Because of biological magnification the shellfish contained greater concentrations.

Oysters in samples from San Leandro (Station No. 73) and Redwood City (Station No. 78) contained the highest levels of insecticides, even though sediments at the same location contained no detectable residues. The observed concentrations were from one to two orders of magnitude less

* Samples of plankton were not of great enough volume to permit the size of sample necessary for the method employed to detect chlorinated hydrocarbon residues.

than those reported in past years for the Bay system.[7/] However, while the current levels do not presently require regulatory action, they do indicate that contamination levels are at borderline values with regard to the onset of deleterious effects on growth, reproduction, and behavior to aquatic life. Thus, they represent a cause of concern.

In general, concentrations of PCB were higher than those of the insecticides. Sediment samples contained from less than one to 275 ng/g of Aroclor 1254, as observed at Redwood City (Station No. 78). Again, the shellfish contained more PCB than did the sediments. Oysters at Redwood City (Station No. 78), San Leandro (Station No. 73), and Coyote Pt. (No. 10) were the most grossly contaminated. These levels of PCBs, while below levels necessitating regulatory action, are of sufficient magnitude to demonstrate definite industrial contamination.

Oil and Petrochemical Residues

Samples of soft-shell clams, *Mya arenaria*, were tested for petroleum contamination by analyzing each sample for aliphatic hydrocarbons. Using gas chromatography, hydrocarbons of petroleum origin can be easily differentiated from the small amount of aliphatic hydrocarbons that occur naturally in most aquatic organisms.

The clam samples (6 to 10 organisms/sample) were collected along the eastern shores of Central and San Pablo Bays between the Oakland Bay Bridge and Carquinez Bridge. All of the samples tested contained measurable amounts of petroleum contamination. Hydrocarbons residues in the shellfish ranged from 14 to 29 μg/g [Table V-10].

TABLE V-10

RESULTS OF ANALYSIS OF SAN FRANCISCO AREA SHELLFISH FOR PETROLEUM HYDROCARBONS [a]

Sample No.	Shellfish Bed (Station)	Petroleum Hydrocarbons, µg/g* gas chromatography (gravimetric)
01-01-01-0811	Berkeley (25)	18 (17)
01-01-02-0812	Emeryville (24)	22 (17)
01-01-03-0812	Pt. Isabel (28)	13
01-01-04-0813	Pt. Pinole (31)	29 (20)
01-01-05-0813	Pt. Pinole (34)	14 (14)
01-01-06-0813	Rodeo (35)	15 (21)

*Wet weight based on drained meats.

a/ Samples collected by National Field Investigations Center-Denver.

Although the levels of petroleum contamination appear low as compared to values found in contaminated oyster samples from other areas,[/] the deficiency of information relative to petroleum uptake by softshell clams is such that the degree of contamination is defficult to assess. However, the lack of a clearly defined, homologous series of n-alkanes, as determined by gas chromatographic analysis, suggests that petroleum contamination of the samples is not of recent origin.

Still presently unknown is the magnitude of health hazard of these petroleum resudues for the consumption of shellfish. However, it is clear that shellfish in San Francisco Bay are definitely contaminated by petroleum that originates from industrial sources, such as discharges from petrochemical and related industries, and leakage or spills from oil-carrying transport vessels.

D. BIOSTIMULANTS AND ALGAL POPULATIONS

In 1954 in order to protect water quality throughout the San Joaquin Valley the U. S. Bureau of Reclamation recommended that an agricultural waste drainage system be constructed throughout this California valley. With the enactment, in 1960, of the Burns-Porter Act and Public Law 86-488 construction of a "Master Drain" was authorized as part of the California State Water Facilities. A feasibility study, conducted by the California Department of Water Resources, concluded, among other things, that the most practicable and economical method of agricultural waste disposal was, by way of the western Sacramento-San Joaquin Delta, into San Francisco Bay.[11/]

Preliminary data compiled in 1968 by the Federal Water Pollution Control Administration (FWPCA, now part of EPA) indicated that the drainage water would be high in nitrogen (30 mg/l NO_3-N). and in 1967, the agency conducted further studies to determine the effect (on biostimulation) of discharging such water into the Bay-Delta system.[12/] In summary. the investigation revealed that "untreated" drainage water could have significant adverse effects upon the fish and recreation benefits of the receiving waters.

Subsequent studies by various State, Federal, and private agencies have substantiated earlier findings. A 1969 study concluded that nitrate-rich agricultural drainage, when mixed with San Joaquin River Delta water, stimulated algal growth and recommended nitrogen removal from wastewater.[13/] Also, another study in 1969 found that nitrogen and phosphorus were 10 to 100 times greater in the Delta than those reported necessary for a substantial growth of algae. This same study found that these two nutrients have increased significantly over the past 4 to 6 years and that algal blooms were occurring in certain areas. The blooms are both highly undesirable and indicative of excessive enrichment of Delta waters.[14/]

Further investigations of algal growths found that certain of these excessive blooms occur along the shore and sloughs in South Bay receiving wastewater dischargers.[15/] Highest measurements of algal growth are being consistently found in Suisun Bay.[18,19/]

In contrast to the stimulatory effects of agricultural wastewaters there appears to be acting, in the bay waters, both industrial-municipal and natural inhibatory variables that have a locally limiting effect on excessive algal growth. Past studies have shown that effluents from municipal treatment plants and industrial complexes containing high concentrations of ammonia and chlorine convey a toxic effect on algae by limiting their growth and reproduction.[16,18] Productivity measurements throughout San Francisco Bay have shown that the natural phenomona of high turbidity or low concentrations of silica may also be important factors limiting algal growth.[18]

Extensive studies, conducted for water quality management purposes, have recommended that waste discharges be removed from tidal sloughs and from the southern and eastern extremities of the Bay system as a means of reducing the adverse effects of biostimulants in these areas of limited tidal interchange.__/

E. RELATIVE TOXICITY

A parameter that has come into common usage in describing the water quality condition of the San Francisco Bay system is relative toxicity. This parameter takes into account both the amount and strength of the waste and, thus, allows comparison of the relative effects of many discharges. The relative toxicity of a wastewater discharge is defined as the volumetric flow of the discharge divided by the 48-hour median tolerance limit (expressed as a decimal fraction) determined from a bioassay using fish.

In the University of California Comprehensive Study of San Francisco Bay it was concluded that the most significant pollutant discharged to the bay appeared to be acute toxicity.__/ The occurrence of toxicity may be found to a greater or lesser degree in selected areas throughout the

Bay system. Relative toxicity has been of particular concern in the South Bay south of Dumbarton Bridge and in Suisun Bay and the Sacramento, San Joaquin delta upstream from Carquinez Bridge.

The source of toxicity in the San Francisco Bay system has been shown, by one study, to be approximately 56 percent from municipal sources and 44 percent from industrial sources.[1/] Evaluation of the toxicity of many municipal and industrial sources has shown that almost all of these wastes are toxic in varying degrees to fish. Moreover, the toxicity of wastewater has been shown to vary with the degree of treatment provided. Municipal and industrial discharges receiving only primary or marginal-secondary treatment are the major sources of toxicity. Many of the constituents of wastewaters are toxic to aquatic life either occurring alone or as a result of synergistic effects with other compounds. [Some of these constituents exhibiting toxicity are tabulated in Appendix F.]

Studies on the San Francisco Bay system have shown a direct relation between relative toxicity and serious reductions of the variety of bottom-dwelling organisms which are an essential link in the natural food chain. The benthic animals in the food chain represent about 85 percent of the total protein in the bay waters. The effect of toxicity on fish may be far more serious than what the value, measured by the relative toxicity test, would indicate. Problems of long-term, chronic damage (occurring at low toxicant concentrations) cannot be measured by the relative toxicity determination.

F. DISSOLVED OXYGEN

Throughout most of the San Francisco Bay system dissolved oxygen concentrations are usually 80 percent of saturation; however, significant dissolved-oxygen depletions occur in several critical areas of the bay. Depression of dissolved-oxygen levels to below acceptable limits occur in tidal streams and sloughs along the westerly shore of South Bay south of Dumbarton Bridge and the northerly shore of San Pablo and Suisun Bays. This problem is most severe in Coyote Creek, Guadalupe River, Mountain View Slough, Redwood Creek, Petaluma River, and Sonoma and Suisun Sloughs.

The primary factor contributing to dissolved-oxygen depletions is the discharge of organic materials from municipal waste sources. Waste sources discharging to somewhat confined areas where dilution water, and thus assimilative capacity, is limited result in the largest dissolved oxygen deficits. These discharges are the most damaging during the canning season in late summer and early fall, when a number of plants receive large loads of organic wastes from food processing plants.

The low dissolved oxygen levels have resulted in the elimination or reduction of fish and other aquatic life populations in several areas of the bay, especially the South Bay. Some of this exhaustion of aquatic life may be caused by toxic materials as well as by dissolved-oxygen depletions.

VI. SOURCES OF POLLUTION

A. GENERAL

The San Francisco Bay system is surrounded by the sixth largest urban area in the United States, with a population of more than six million people. As a result, a large and complex pollution load is discharged to the Bay system from a variety of sources. Discharges of municipal and industrial wastes contribute a major portion of the pollution load. Other sources of pollution include combined sewer overflows, dredging and landfill activities, agricultural drainage, and vessel pollution.

All municipal and industrial sources discharging wastes to the Bay system are required to monitor their effluents and to report selected data to the appropriate State regulatory agency. The 1971 self-monitoring data were reviewed and summarized as the basis for determining the magnitude of waste loadings discharged to the Bay system. It should be noted that not all characteristics of interest are monitored on each effluent, thus preventing the determination of complete waste loadings for all parameters. Also, these data are developed by a large number of analytical laboratories. The extent of quality control and correlation of analytical techniques and data among laboratories are unknown. The self-monitoring data were also used to identify sources discharging wastes in violation of State effluent requirements and to evaluate the present quality of waste discharges with respect to effluent quality achievable by the high levels of treatment required by the Federal Water Pollution Control Act Amendments of 1972.

In mid-1971, under provisions of the Refuse Act of 1899, all sources of industrial wastes submitted applications for discharge permits. These applications contained detailed data on effluent characteristics. These data were used to supplement the self-monitoring data in characterizing and evaluating industrial waste discharges.

Sixteen major municipal and industrial waste sources were selected for further characterization of their effluents [Table VI-1]. Together these sources contribute about two-thirds of the total waste volume from all municipal and industrial waste sources in the Bay system. The eight municipal sources selected represent half of the municipal sources that discharged an average flow of more than 7 mgd in 1971 and include the five largest discharges. The industrial sources selected include the seven largest industrial sources (excluding power plants) in the Bay area and represent two-thirds of the industrial dischargers with average flows of more than 4 mgd in 1971.

Short-term sampling and analysis of the selected waste discharges was conducted by EPA Region IX staff during Spring 1972. [Waste-source evalution techniques are discussed in Appendix G, Table G-1.] Specific results for each waste source are discussed in the following sections.

Aerial remote-sensing missions were flown over the entire Bay system during April and July 1972 to verify the locations of known waste discharges, to define waste dispersal patterns, to assess the visual impacts of waste effluents, and to locate unknown or spurious waste discharges. The missions were flown with high-performance aircraft equipped with a variety of remote sensing equipment. On April 26 and 27, 1972, daytime

TABLE VI-1

SELECTED MAJOR MUNICIPAL AND INDUSTRIAL SOURCES OF POLLUTION

Source	Flow (mgd)	Percent Total Waste Volume
Municipal		
City of San Jose	82.8	10.2
East Bay M.U.D., Oakland	78.9	9.7
City of San Francisco, North Point Plant	64.1	7.9
Central Contra Costa County Sanitary District, Martinez	22.8	2.8
City of San Francisco, Southeast Plant	22.1	2.7
City of San Mateo	11.0	1.3
San Pablo Sanitary District	7.6	0.9
City of South San Francisco	7.2	0.9
Municipal Subtotal	296.5	36.4
Industrial		
Standard Oil Co., Richmond	112.0	13.7
Union Oil Co., Rodeo	47.0	5.8
California & Hawaiian Sugar Co., Crockett	25.5	3.1
Dow Chemical Co., Pittsburg	24.1	3.0
United States Steel Corp., Pittsburg	17.7	2.2
Fiberboard Corp., Antioch	15.6	1.9
Phillips Petroleum Co., Avon Refinery	15.2	1.9
Shell Oil Co., Martinez	4.5	0.5
Industrial Subtotal	261.6	32.1
TOTAL	558.1	68.5

low-altitude aerial imagery of shoreline areas and high-altitude aerial imagery of the entire Bay system was recorded using ultra-violet, true color, and false color infra-red films and an infra-red line scanner. The daytime low-altitude coverage was repeated in late July for selected target areas. Night time flights with the infra-red line scanner over selected target areas were also conducted in July.

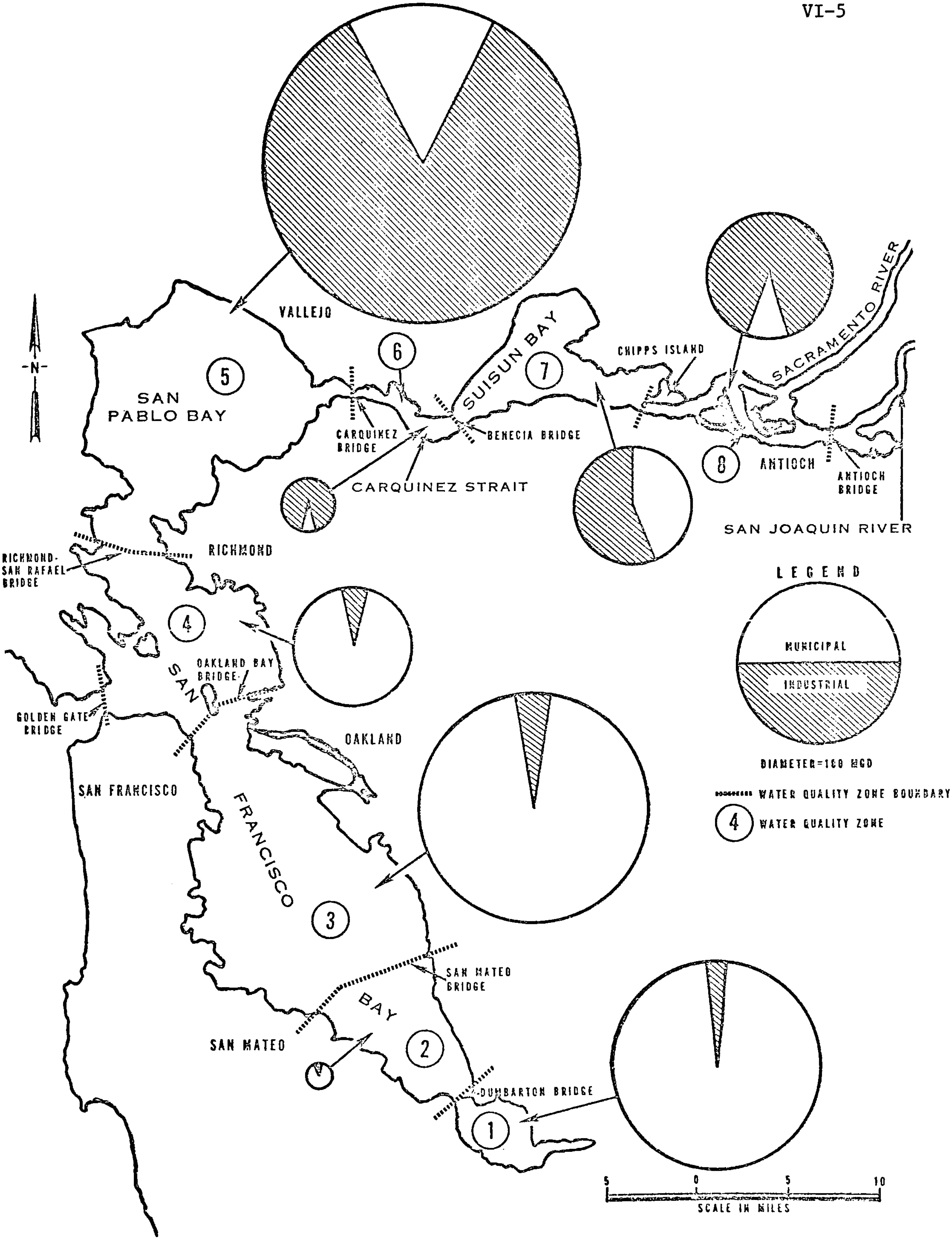
This chapter summarizes data obtained from the self-monitoring reports, from Refuse Act permit applications, and from the limited effluent sampling conducted by EPA.

B. SUMMARY OF MUNICIPAL AND INDUSTRIAL WASTE DISCHARGES

A total of about 250 discrete sources of municipal and industrial wastes are located in the drainage area tributary to the Bay system between the confluence of the San Joaquin and Sacramento Rivers and the Pacific Ocean. About 150 of these sources are located on or in close proximity to San Francisco, San Pablo, and Suisun Bays. The total volume of water discharged by the 150 sources (excluding power-plant cooling water use of 3,300 mgd) averaged 820 mgd in 1971.

For water quality management purposes the Bay system has been divided into eight zones by the State Water Resources Control Board. [Zone boundaries and distributions, by zone, of municipal and industrial waste discharges from the 91 most significant sources (1971 average flows) are shown in Figure VI-1.]

Municipal sources contribute about 58 percent (490 mgd) of the wastewater volume [Table VI-2]. These sources are relatively uniformly spaced



Discharges to the San Francisco Bay System

TABLE VI-2
SUMMARY OF MUNICIPAL AND INDUSTRIAL WASTE DISCHARGES[a] TO THE SAN FRANCISCO BAY SYSTEM BY WATER QUALITY ZONE

		Flow		BOD		COD		Susp. Solids		Oil & Grease	
Zone	Type Waste	mgd	percent	lb/day	percent	lb/day	percent	lb/day	percent	lb/day	percent
1	Municipal	133.4	16.8	60,400	15.0			69,900	17.1	12,700	14.1
	Industrial	1.6	0.2			700	0.2				
	Subtotal	135.0	17.0	60,400	15.0	700	0.2	69,900	17.1	12,700	14.1
2	Municipal	19.9	2.5	12,600	3.1			4,900	1.2	1,100	1.2
	Industrial	0.3	0.0			600	0.2	50	0		
	Subtotal	20.2	2.5	12.600	3.1	600	0.2	4,950	1.2	1,100	1.2
3	Municipal	158.9	20.0	194,300	48.2			156,700	38.4	36,050	39.9
	Industrial	4.9	0.6					17,300	4.2		
	Subtotal	163.8	20.6	194,300	48.2			174,000	42.6	36,050	39.9
4	Municipal	83.6	10.5	71,700	17.8			29,900	7.3	14,000	15.5
	Industrial	2.9	0.4			600	0.2	160	0.0		
	Subtotal	86.5	10.9	71,700	17.8	600	0.2	30,060	7.3	14,000	15.5
5	Municipal	33.9	4.3	27,500	6.8			16,600	4.1	6,200	6.9
	Industrial	160.9	20.3			139,450	44.8	70	0.0	6,990	7.7
	Subtotal	194.8	24.6	27,500	6.8	139,450	44.8	16,670	4.1	13,190	14.6
6	Municipal	2.5	0.3	2,700	0.7			1,400	0.3	500	0.6
	Industrial	33.1	4.2			61,400	19.7	14,600	3.6	1,450	1.6
	Subtotal	35.6	4.5	2,700	0.7	61,400	19.7	16,000	3.9	1,950	2.2
7	Municipal	33.3	4.2	27,800	6.9			17,000	4.2	7,600	8.4
	Industrial	25.0	3.2			21,800	7.0	5,820	1.4		
	Subtotal	58.3	7.4	27,800	6.9	21,800	7.0	22,820	5.6	7,600	8.4
8	Municipal	5.2	0.7	5,900	1.5			1,600	0.4	900	1.0
	Industrial	93.7	11.8			86,600	27.9	72,600	17.8	2,790	3.1
	Subtotal	98.9	12.5	5,900	1.5	86,600	27.9	74,200	18.2	3,690	4.1
Total	Municipal	470.7	59.3	402,900	100.0			298,000	73.0	79,050	87.6
Total	Industrial	322.4	40.7			311,150	100.0	110,600	27.0	11,230	12.4
Grand	Total	793.1	100.0	402,900	100.0	311,150	100.0	408,600	100.0	90,280	100.0

[a] Does not include power plant cooling water or federal installation discharges.

along the western, eastern, and southern shores of the Bay system with the largest sources discharging to central and southern San Francisco Bay. Together the eight largest municipal sources serve a population of about 2.5 million and contribute 36 percent of the wastewater from all sources.

The Federal Water Pollution Control Act Amendments of 1972 require that all publicly owned treatment facilities must meet, as a minimum, effluent limitations based on secondary treatment by July 1977. Twenty of the 52 most significant municipal sources [Greater than 0.5 mgd) presently provide primary treatment only. In addition, 21 municipal sources presently provide secondary treatment but discharge wastes that will not meet effluent limitations based on adequate secondary treatment (BOD, 20 mg/l; suspended solids, 30 mg/l; oil and grease, 10 mg/l). Municipal effluents receiving primary treatment (234 mgd) constitute 48 percent of the total municipal waste volume. Wastes receiving inadequate secondary treatment (191 mgd) constitute an additional 39 percent of the total municipal flow. Therefore, in 1971 only 13 percent of the municipal wastes discharged to the Bay system received adequate secondary treatment.

Biochemical oxygen demand is a commonly accepted indicator of the pollution potential of municipal wastes. Essentially all municipal sources in the bay area are required to monitor and report effluent BOD. In 1971, the BOD load discharged to the Bay system from the 52 most significant municipal sources averaged about 400,000 lb/day. [The areal distribution of reported 1971 average BOD loadings from municipal sources is shown in Figure VI-2.] The State regulatory agencies at present do not require all industries to monitor effluent BOD. Therefore, it is not possible to estimate the BOD loading from industrial sources. Industrial discharges of BOD to Zones 1, 2, 3, and 4 are known to be small while the remaining four zones receive major BOD loadings from industry.

The provision of adequate secondary treatment for all municipal sources would achieve a major reduction (81 percent) in the BOD load discharged to the Bay system by municipal sources. If all municipal effluents were reduced to a maximum BOD of 20 mg/l, at 1971 flow rates the total BOD load from municipal sources would be 77,000 lb/day. The largest reductions would occur in Zone 3 (86 percent) and Zone 4 (81 percent).

Two large sources (East Bay M.U.D. and City of San Francisco-Southeast Plant), together discharging approximately 100 mgd of municipal wastes which have received only primary treatment, are the main contributors of the large BOD load in Zone 3. It should be noted that these two sources are located near the northern boundary of Zone 3. As a result, their waste discharges directly affect water quality in Zone 4 during ebb-tide conditions. Another large source providing only primary treatment (City of San Francisco-North Point Plant, 64 mgd) is located near the same zone boundary in Zone 4 and affects water quality in Zone 3 during flood tide conditions. These three large sources together contribute about 54 percent (218,000 lb/day) of the BOD load from municipal sources. Upgrading these three sources to secondary treatment would reduce their BOD load discharged to 28,000 lb/day, achieving a 47 percent reduction in the total municipal BOD load.

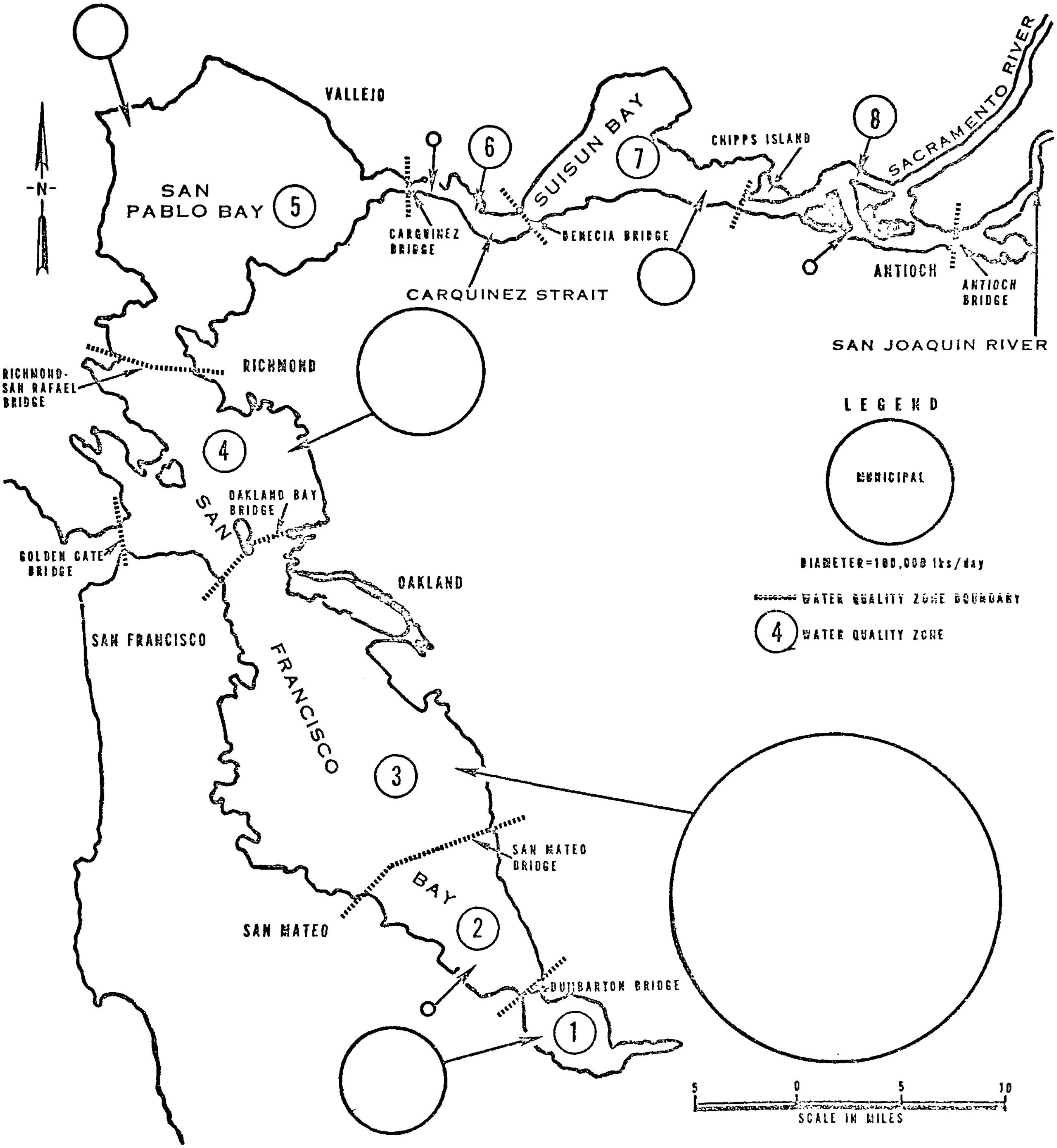


Figure VI-2. Municipal Discharges of BOD to the San Francisco Bay System

Suspended solids concentrations are another measure of the relative pollution potential of waste discharges. In 1971, suspended solids loads discharged by both municipal and industrial sources averaged about 409,000 lb/day of which municipal sources contributed 73 percent. [The areal distribution of suspended solids discharges from both municipal and industrial sources is shown in Figure VI-3.] The large load discharged to Zone 3 can again be attributed to the two large sources discussed above and the inadequacy of primary treatment in reducing suspended solids concentrations.

Provision of adequate secondary treatment for all municipal sources would achieve a 46 percent (187,000 lb/day) reduction in the suspended solids load. An additional significant reduction in suspended solids loads could be achieved by the application of the best practicable control technology currently available to all industrial waste-sources as required by the Federal Water Pollution Control Act amendments of 1972.

About 15 percent (75 mgd) of the total waste volume treated by municipal facilities is from industrial sources. Ten plants together treat about 65 mgd of industrial wastes. Individual plants receive as much as 40 percent of their waste flow from industrial sources. As a result, major loads of COD, oil and grease, and heavy metals are discharged. Self-monitoring data on COD are available for only a few municipal sources; therefore, complete loading estimates cannot be made. The largest source reporting COD data (City of San Francisco-Southeast Plant, 116,000 lb COD per day) discharges more COD than the largest industrial sources. EPA sampling in 1972 indicated that the East Bay M.U.D. discharge could contain a COD load as much as four times larger than that reported for the

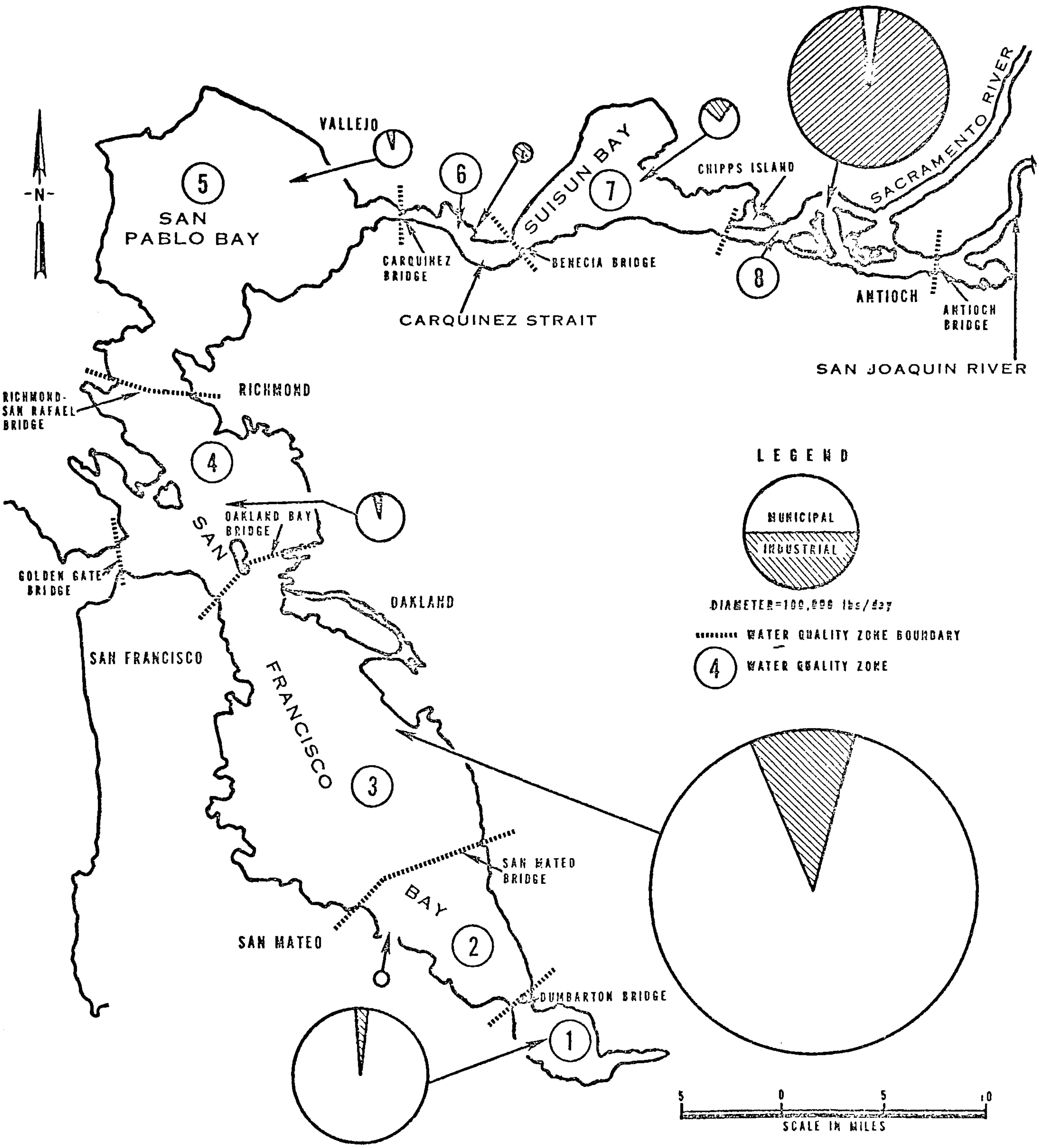


Figure VI-3. Discharges of Suspended Solids to the San Francisco Bay System

Southeast Plant. Thus, it is apparent that municipal discharges of COD total several times the industrial COD load. Most of the municipal load is discharged to Zones 1 through 4, with the major portion to Zone 3.

Only limited data are available on heavy metals discharged to the Bay system. Three municipal sources (East Bay M.U.D., 1000 lb/day; City of San Francisco-Southeast Plant, 500 lb/day; and South San Francisco-San Bruno, 90 lb/day) are known to discharge substantial loads of heavy metals (chromium, copper, lead, and zinc). Other municipal sources may discharge significant loads of heavy metals.

Oil and grease data are available for most sources. The majority (87 percent) of the total oil and grease load (91,000 lb/day) is contributed by municipal sources [Figure VI-4] with the largest load again in Zone 3.

Self-monitoring bioassay data show that many of the municipal discharges to the Bay are toxic to aquatic life. [Constituents of waste effluents toxic to aquatic life and selected municipal and industrial sources that discharge potentially toxic substances are discussed in Appendix E.]

High concentrations of COD, oil and grease, and heavy metals as well as toxicity in municipal effluents are primarily the result of the discharge to municipal treatment facilities of industrial wastes that are toxic or not susceptible to treatment in such facilities. The Federal Water Pollution Control Act Amendments of 1972 require that pre-treatment standards be established by mid-1973 to control the introduction of such wastes into publicly owned treatment facilities. Implementation of

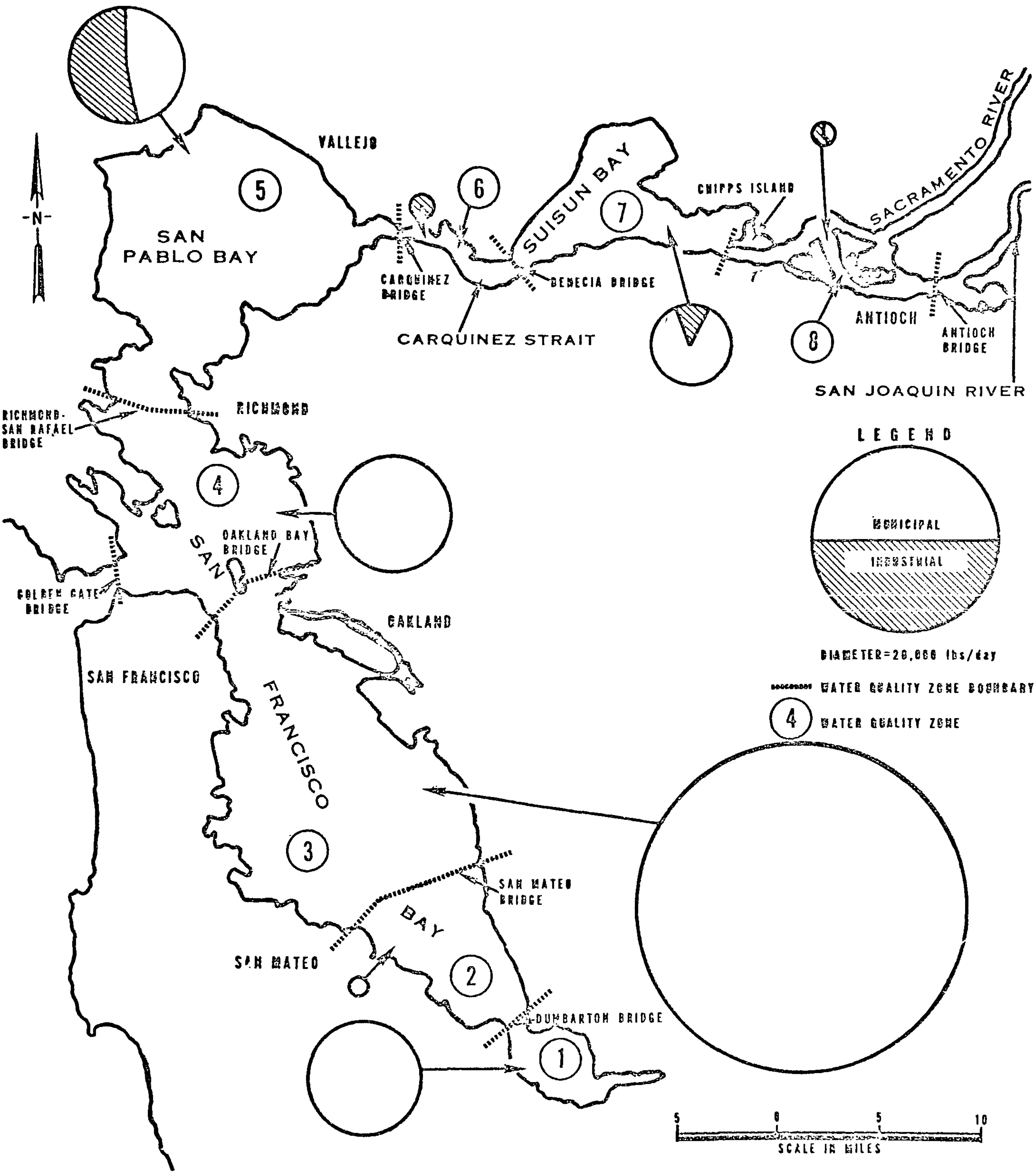


Figure VI-4. Discharges of Oil and Grease to the San Francisco Bay System adequate pre-treatment by industrial waste sources in combination with secondary treatment by municipal facilities would result in major reductions in pollution loads discharged to the Bay system. Oil and grease loads would be reduced by 60 percent to 36,000 lb/day. Reductions in COD and heavy metals loads would be substantial. Lack of data precludes an accurate assessment of the magnitude of reduction.

Major sources of industrial wastes are oil refineries, petrochemical plants, chemical plants, pulp and paper mills, and food processing plants. These industries are primarily located along the southern shore of Suisun and San Pablo Bays between Antioch and Richmond. In other Bay areas, industrial wastes are usually discharged to municipal treatment systems.

A total of 39 significant industrial sources discharge wastes directly to the Bay system. Excluding 3,300 mgd of cooling water from electric power plants, these sources discharged about 320 mgd (42 percent of total waste flow) on the average in 1971. Average waste loads include 310,000 lb/day of COD, 111,000 lb/day of suspended solids, and 13,000 lb/day of oil and grease. [The areal distributions of suspended solids and oil and grease loads were previously shown in Figures VI-3 and VI-4. The industrial COD load distribution is shown in Figure VI-5.] As discussed previously, large, but undetermined COD loads are also discharged to Zones 1 through 4 by municipal sources.

The Federal Water Pollution Control Act Amendments of 1972 require that all industrial waste discharges must, by July 1977, meet effluent limitations based on the best practicable control technology currently available. These effluent limitations are presently under development

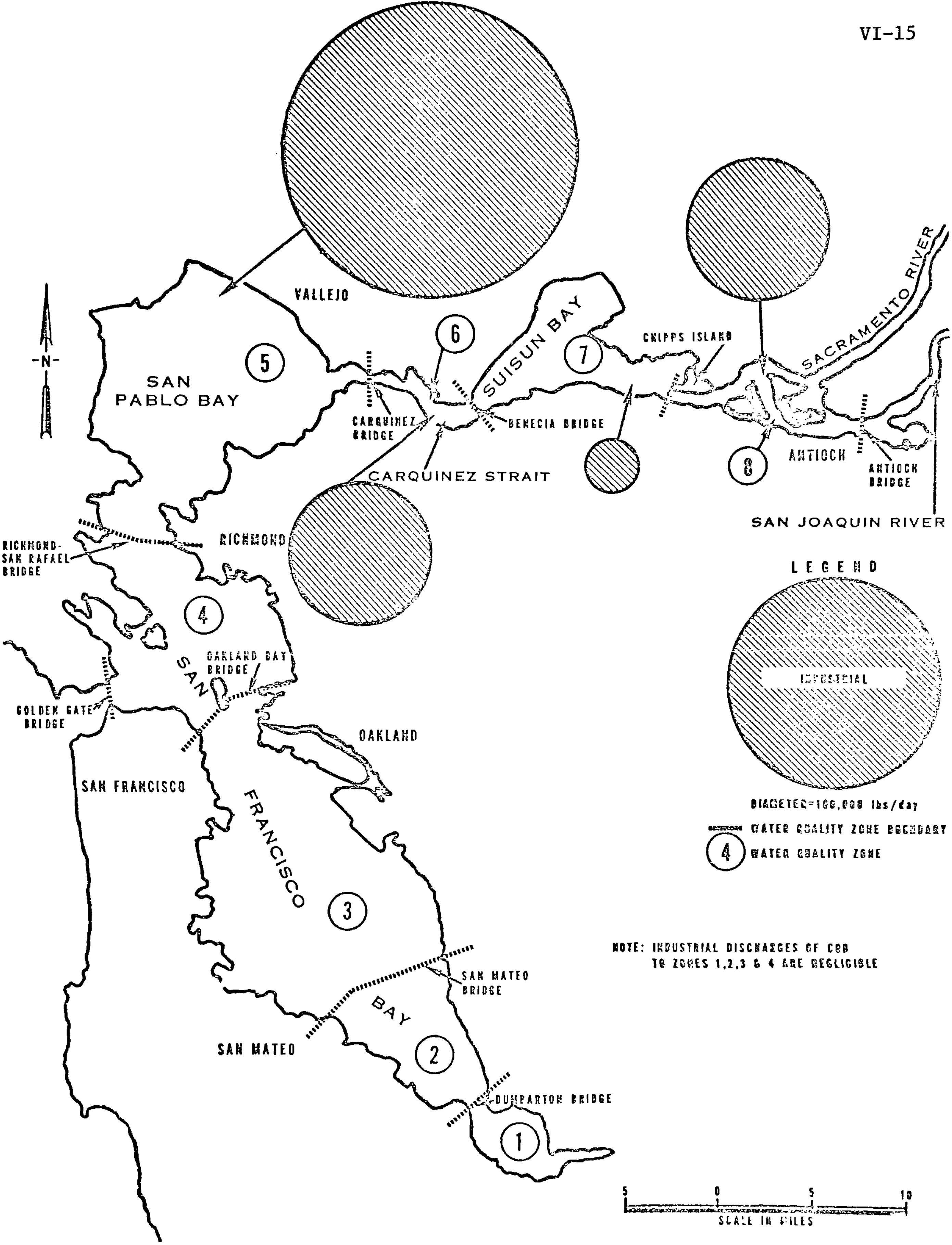


Figure VI-~~3~~5. Industrial Discharges of COD to the San Francisco Bay System by EPA. Twenty-six sources that together contribute 98 percent of the industrial waste load to the Bay system are discharging effluents that contain one or more constituents in excess of levels achievable by best practicable control technology. Application of such control technology would thus result in a major reduction in pollution loads from industrial sources.

C. MUNICIPAL WASTE DISCHARGES

In 1971, municipal sources discharged an average of more than 490 mgd of wastewater to the San Francisco Bay system.[1] Of those sources reporting, the average BOD load was 400,000 lb/day while 300,000 lb/day of suspended solids and 79,000 lb/day of oil and grease were discharged.

The largest volumes of municipal wastes were discharged to Zones 1, 3 and 4 [Figure VI-1]. Three sources within these zones contributed about half of the total municipal waste flow, BOD load, suspended solids load, and oil and grease load.

Zone 1 - South San Francisco Bay

Eight sources [Table VI-3 and Figure VI-6] discharge a total of 133 mgd (28 percent of the total municipal waste flow) to Zone 1. The combined BOD load from these sources (60,400 lb/day) is about 15 percent of the total BOD load discharged to the Bay system from municipal sources. Suspended solids and oil and grease loads are about 23 and 16 percent, respectively, of total municipal loads.

TABLE VI-3

MUNICIPAL WASTE DISCHARGES,[a] ZONES 1 AND 2[b]

Map[c] Key	Discharger	Treatment	Flow (mgd)	BOD Conc. (mg/l)	BOD Load (lb/day)	SS Conc. (mg/l)	SS Load (lb/day)	Oil & Grease Conc. (mg/l)	Oil & Grease Load (lb/day)
	Zone 1								
1-1	San Jose, City of	Secondary	82.8	39	26,900	62	42,800	10	6,800
1-2	Sunnyvale, City of	Secondary & stab. pond	14.0	32	3,700	80	9,300	8	950
1-3	Palo Alto, City of	Primary[d] & chemical	13.1	93	10,200	60	6,600	15	1,700
1-4	Mountain View, City of	Primary[d] & stab. pond	7.4	143	8,800	58	3,600	21	1,300
1-5	Union S. D.-Irvington	Secondary	5.5	59	2,700	56	2,600	11	500
1-6	Union S. D.-Newark	Seconary	5.4	123	5,500	84	3,800	18	800
1-7	Milpitas S. D.	Secondary	2.8	18	400	14	300	12	250
1-8	Los Altos, City of	Primary[d]	2.4	108	2,200	47	900	19	400
	Zone 1 Totals		133.4		60,400		69,900		12,700
	Zone 2								
2-1	Redwood City, City of[e]	Secondary	7.7		7,200				
2-2	Menlo Park, City of	Primary & stab. pond	5.9	30	1,500	18	900	6	300
2-3	San Carlos, City of	Secondary	4.0	95	3,200	100	3,400	21	700
2-4	Union S. D.-Alvarado	Secondary	2.3	35	700	31	600	6	100
	Zone 2 Totals		19.9		12,600		4,900		1,100

a/ Includes those discharges with a flow of 0.5 mgd or greater
b/ Data from 1971 Self-Monitoring Program
c/ See Figure VI-6 for locations of waste discharges
d/ Connected to regional plant providing secondary treatment on 4/72
e/ Data from 1970 Self-Monitoring Program

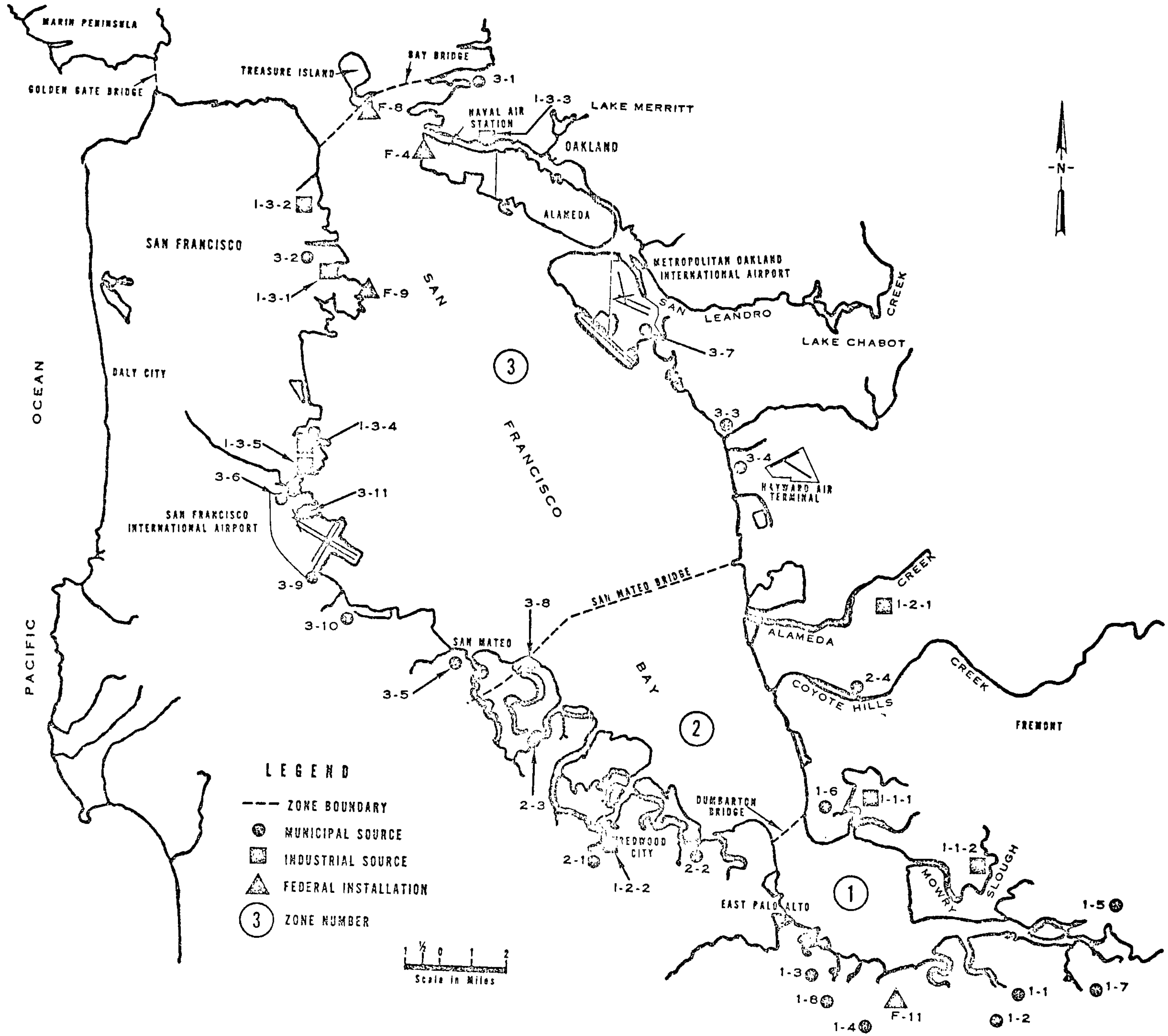


Figure VI-6. Significant Waste Sources, San Francisco Bay System, Water Quality Zones 1, 2 & 3

City of San Jose -- This facility serves a population of about 750,000 in the northern Santa Clara Valley including the cities of San Jose and Santa Clara; Santa Clara County Sanitation Districts Nos. 2, 3 and 4; and Burbank, Cupertino and Sunol Sanitation Districts. This source is the largest municipal discharge (82.8 mgd) in the entire bay area and contributes about ten percent of the waste volume from all municipal and industrial sources.

Constructed in 1964. this facility is an activated sludge plant with a design capacity of 80 mgd. Effluent is discharged to a slough tributary to Coyote Creek which enters the southern end of South San Francisco Bay. The plant has reached hydraulic capacity and is scheduled for expansion to 160 mgd in 1972-73.

About 20-30 percent of the plant influent is industrial wastes. Much of this industrial waste is from food-processing plants and reaches a peak during the late summer canning season. During the canning season, BOD and suspended solids loads significantly above average are discharged.

EPA sampled this source in May 1972 prior to the canning season. [Observed waste characteristics are summarized in Appendix G, Table G-2 and are compared to average 1971 characteristics as defined by self-monitoring data.] Observed BOD was below average as would be expected during the non-canning season. A major COD load (74,000 lb/day) was discharged during the sampling period. Average COD values were not available.

No waste discharge requirements for BOD or COD have been established for this source by the State. Dissolved oxygen levels must be maintained above 5.0 mg/l in the receiving water. In the past, DO levels in the

South Bay were severely depressed by this waste source, but completion of secondary treatment facilities substantially reduced the problem. As late as 1969 violations of the receiving-water DO limit still occurred in much of the confined southern portion of San Francisco Bay.[1]

Fish bioassays* conducted by EPA [Appendix G, Table G-2] found a zero percent survival of test fish in undiluted effluent (after 24 hours of aeration) in violation of State waste discharge requirements.

Bacteriological analysis of the effluent [Appendix G, Table G-3] in August 1972 showed unacceptable levels of total coliform (200 to 7,800/100 ml) Waste-discharge requirements specify that bacterial levels in the receiving water (beyond a defined mixing zone) should not exceed a median of 240 MPN/100 ml in five samples. If this limit is exceeded in the receiving water, it must be met at some point in the waste treatment process. Owing to the confined nature of the receiving water and frequent occurrence of high bacterial levels in the southern extremity of the bay, this source contributes to violations of receiving water standards. As a result, substantially lower effluent bacterial levels are needed.

Under provisions of the Federal Water Pollution Control Act Amendments of 1972, Federal effluent guidelines, based on secondary treatment, are to be established in 1973 for use in issuing effluent permits to all publicly owned waste treatment facilities. Also to be issued are Federal guidelines regarding elimination of waste discharges toxic to aquatic life and establishing pretreatment requirements for industrial sources

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* Limitations of static bioassay tests and pre-exposure aeration are discussed in the 13th Edition of *Standard Methods*, pp. 569-570.

discharging toxic or non-biodegradable wastes to publicly owned treatment facilities. It is anticipated that the expanded San Jose facility will need to achieve a higher quality effluent in order to meet the new effluent guidelines. Also, pretreatment of industrial wastes will be needed to reduce effluent toxicity.

Other Zone 1 Sources -- In 1971 two additional sources, the City of Palo Alto (13.1 mgd) and the City of Mountain View (7.4 mgd), discharged large BOD loads. These two sources, in combination with the San Jose discharge, accounted for 76 percent of the BOD loading to Zone 1 in 1971.

Also in 1971 three municipal facilities in Zone 1 were providing less than secondary treatment. At that time Palo Alto and Los Altos provided only primary treatment while Mountain View provided primary treatment, followed by a stabilization pond. These three sources are now connected to a new 35-mgd regional waste treatment facility at Palo Alto, completed in April 1972 to provide secondary treatment. This new facility is expected to have an effluent BOD averaging 20 mg/l or less, thereby reducing the BOD loading to Zone 1 by about 29 percent.

Aerial imagery recorded in July 1972 showed large algal growths in the Moffett channel (a tributary of Guadalupe Slough) in the vicinity of the discontinued Sunnyvale discharge. A portion of the Palo Alto Yacht Harbor adjacent to the Palo Alto plant was discolored grayish-green.

Biochemical oxygen demand levels in the effluents from the Union Sanitary District plants at Newark (123 mg/l) and Irvington (59 mg/l) indicate the wastes are not receiving adequate secondary treatment.

About 25 percent of the Newark plant influent is industrial wastes. Improved plant operation and pretreatment of industrial wastes will be required to meet the Federal effluent limitations and pretreatment requirements to be established in 1973, as discussed previously.

Pursuant to EPA regulations (18 CFR Part 601), the San Francisco Regional Water Quality Control Board has adopted an Interim Water Quality Control Plan (Interim Plan) for the San Francisco Bay system.—/ This plan divides the Bay system into sub-regions and sets forth a conceptual plan for all waste dischargers in each sub-region. These conceptual plans will be used to guide waste-treatment planning until detailed sub-regional plans are completed in July 1973. For Zone 1, the Interim Plan calls for all waste discharges to be intercepted and conveyed toward a discharge point at least as far north as Dumbarton Bridge.

A recent study undertaken in support of efforts to develop a final sub-regional plan for South Bay recommended that all treated effluent be intercepted and conveyed to a point north of Dumbarton Bridge for discharge to the Lower Bay. Two outfalls would be constructed, one discharging Union Sanitary District effluents from the east side of the bay and the other discharging all remaining effluents from Zone 1 to the west side of the bay. Relocation of these waste discharges would reduce the present water quality degradation in South Bay.

Zone 2 - South San Francisco Bay

Four sources [Table VI-3 and Figure VI-6] discharge municipal waste to Zone 2. The combined discharge from these four sources is 19.9 mgd, or about 4.2 percent of the total municipal waste discharge to the Bay system. Biochemical oxygen demand, suspended solids, and oil and grease loads discharged are approximately three percent of total and municipal discharges.

All four sources provide secondary treatment with effluent disinfection. With the exception of San Carlos which exhibits effluent characteristics comparable to wastes receiving primary treatment [Table VI-3] adequate treatment is achieved. About 15 percent of the wastes treated by the San Carlos facility are from industrial sources. Adequate pretreatment of industrial wastes and improved treatment efficiency will be required to produce an effluent quality that will meet 1973 Federal guidelines.

The Interim Plan calls for the Menlo Park effluent to be intercepted toward Central Bay together with waste effluents from Zone 1. Union Sanitary District-Alvarado plant effluent is to be intercepted toward Central Bay, to the East Bay Municipal Utility District (EBMUD), or connected to South Bay Interceptor. The Cities of San Carlos and Belmont, together with Redwood City will discharge to the bay via a joint deep-water outfall that is currently under construction.

Zone 3 - South San Francisco Bay

The major population concentrations in the bay area are located adjacent to Zone 3. Oakland is situated on the eastern shore of the zone while San Francisco is located on the western shore. Eleven municipal sources [Table VI-4 and Figure VI-6] discharge, to Zone 3, a total of 159 mgd (34 percent of the total municipal waste flow) with a combined BOD load of 194,300 lb/day (48 percent of the total municipal load).

TABLE VI-4

MUNICIPAL WASTE DISCHARGES,[a] ZONE 3[b]

Map Key[c]	Discharger	Treatment	Flow (mgd)	BOD Conc. (mg/l)	BOD Load (lb/day)	SS Conc. (mg/l)	SS Load (lb/day)	Oil & Grease Conc. (mg/l)	Oil & Grease Load (lb/day)
			Zone 3						
3-1	East Bay M.U.D.	Primary	78.9	170	111,900	123	80,900	24	15,800
3-2	San Francisco, City of Southeast Plant	Primary & chemical	22.1	217	40,000	282	52,000	71	13,100
3-3	Oro Loma S.D.	Secondary	13.2	28	3,100	28	3,100	8	900
3-4	Hayward, City of[d]	Secondary & stab. pond	11.9		13,000				
3-5	San Mateo, City of	Primary	11.0	147	13,500	93	8,500	44	4,000
3-6	South San Francisco, City of	Secondary	7.2	104	6,200	72	4,300	16	950
3-7	San Leandro, City of	Secondary	7.0	91	5,300	69	4,000	13	750
3-8	Burlingame, City of	Secondary & chemical	3.0	21	500	33	800	6	150
3-9	Millbrea, City of	Secondary	2.3	17	300	18	300	8	150
3-10	Estero M.I.D.	Primary	1.4	41	500	70	800	22	250
3-11	San Francisco International Airport[d]	Primary	0.9						
	Zone 3 Totals		158.9		194,300		156,700		36,050

a/ Includes those discharges with a flow of 0.5 mgd or greater
b/ Data from 1971 Self-Monitoring Program
c/ See Figure VI-6 for locations of waste discharges
d/ Data from 1970 Self-Monitoring Program

Suspended solids and oil and grease loads discharged in Zone 3 account for about 53 and 46 percent of the total municipal loads in the Bay system.

Of these eleven sources, two discharge 64 percent of the municipal flow to Zone 3 and account for about 80 percent of the BOD, suspended solids, and oil and grease loads. In terms of the BOD load discharged the East Bay Municipal Utility District wastewater treatment plant is the single largest source of pollution in the San Francisco Bay system. The EBMUD plant discharges about 28 percent of the total BOD load discharged to the Bay system by municipal sources. Municipal waste-treatment facilities in the Cities of San Francisco (Southeast plant) and San Mateo constitute the other, two major sources of waste loads in Zone 3.

East Bay Municipal Utility District -- This facility serves Special District No. 1, with an estimated population of 600,000, located in the cities of Alameda, Albany, Berkeley, Emeryville, Oakland, and Piedmont. After primary treatment, the district effluent is discharged through a quarter-mile long outfall to San Francisco Bay east of Treasure Island, near the Oakland Bay Bridge. Owing to the location of this discharge, the effluent, depending upon the direction of tidal flow, affects water quality in both Zone 3 and Zone 4. Digested sludge, formerly sluiced through the outfall line into the bay, is used for commercial purposes or disposed of in a sanitary landfill.

About one-fourth of the EBMUD plant influent is industrial waste. As a result, the effluent contains large loads of COD, oil and grease, and heavy metals and is toxic to aquatic life [Appendix G, Table G-2]. When sampled by EPA in May 1972, effluent BOD was found to be more than

270 mg/l and effluent COD about 700 mg/l. This BOD level was substantially higher than the 1971 average of 170 mg/l reported by the self-monitoring program. Effluent COD is not monitored.

Furthermore, the EPA sampling indicated that the plant is discharging an effluent with a BOD comparable to untreated domestic sewage and a COD almost double that of normal domestic sewage. It is evident that pre-treatment of industrial wastes to reduce oxygen-demanding materials will be needed before an effluent that will meet 1973 Federal guidelines can be produced by a secondary treatment facility.

In 1971 [Appendix G, Table G-2] an average of more than 1000 lb/day of heavy metals (chromium, copper, lead and zinc) was being discharged by this facility. Similar loads were observed during the EPA sampling, with the most significant difference being a 100 lb/day increase in the discharge of lead. These heavy metals are known to be toxic to aquatic life and have been found, in elevated concentrations, in shellfish samples taken from the Bay [as discussed in Chapter V]. No State waste discharge requirements on heavy metals have been established for this source.

Fish bioassays, conducted in the Spring of 1972 by EPA, revealed that the effluent was toxic to aquatic life [Appendix G, Table G-2]. In this case the State waste discharge requirements for toxicity are applicable to the receiving water and not to the effluent. Compliance with the receiving water requirements was not determined.

The San Francisco Bay Regional Water Quality Control Board has adopted a prohibition against any discharge, to the Bay system, of toxic, or deleterious substances, including heavy metals, beyond those levels that can be achieved by source control.—/ Discharges of toxic industrial wastes to the EBMUD system without adequate pretreatment are in violation of this prohibition. As in the case of San Jose, pretreatment will also be needed to meet 1973 Federal guidelines.

When sampled in August 1972 by EPA, the effluent, upstream of its discharge to the outfall line, was found to have bacterial concentrations ranging between 200 and 23,000 MPN/100 ml [Appendix G, Table G-3] The State waste discharge requirements apply to the receiving water only, limiting bacterial concentrations at any point within one foot of the surface to an average of less than 1000 MPN/100 ml. Compliance with this requirement was not determined.

In aerial imagery recorded during July 1972, the EBMUD waste discharge plume was clearly visible. On a flood tide the plume extended about 2000 feet south of the outfall with a width approaching 50 feet.

<u>City of San Francisco, Southeast Plant</u> -- This facility is the second largest waste source in Zone 3. Serving southeastern San Francisco, the plant provides primary treatment for wastes from a tributary population of about 160,000 and numerous industries. About 15 to 25 percent of the plant influent is industrial waste. The effluent is discharged directly to San Francisco Bay through an 800 foot outfall.

Effluent characteristics, as defined by both self-monitoring data and EPA sampling, are similar to those observed for East Bay M.U.D. [Appendix G, Table G-2]. Biochemical oxygen demand (169 to 217 mg/l) and COD (371 to 629 mg/l) in the effluent were high, reflecting the effects of industrial wastes on influent BOD and COD levels. The average, suspended solids levels in 1971 [Table VI-4, 282 mg/l] were also high.

The Southeast Plant is another major source of heavy metals. During 1971 an average of more than 500 lb/day of heavy metals (copper, chromium, lead and zinc) were discharged. EPA sampling detected a heavy-metals load of slightly more than half this amount. In both cases, chromium levels were excessive (about 1-2 mg/l).

In 1970 San Francisco adopted a stringent industrial waste ordinance designed to eliminate discharges to the sewer system of wastes not amenable to secondary treatment.—/ Based on observations of the levels of heavy metals still being discharged by the Southeast Plant, either pretreatment requirements have not yet been fully implemented or enforcement of the ordinance has not been actively pursued. This ordinance should be reviewed when Federal pretreatment requirements are promulgated.

Fish bioassays conducted by EPA found zero percent survival in undiluted waste and a 96-hour TL_m of 45 percent. This indicates that contents of the effluent are highly toxic to aquatic life. The State waste discharge requirement for toxicity is applicable to the receiving water only. Thus, compliance could not be determined from the effluent samples. Low bacterial levels were observed in the effluent, during EPA sampling [Appendix G, Table G-3], also indicating that the effluent was toxic.

Secondary treatment of this waste discharge is needed to produce an effluent that will meet 1973 Federal guidelines. As in the cases of San Jose and East Bay M.U.D., pretreatment of industrial wastes is needed in order to meet State and Federal requirements and to reduce toxicity and the discharge of heavy metals.

The Interim Plan calls for the Southeast Plant to provide "improved treatment" and discharge through a deepwater outfall to Central San Francisco Bay.-/ One plan considered by the City would upgrade the Southeast Plant to provide physical-chemical treatment.-/ A recent plan, considered by the City of San Francisco, called for construction of a complex system of tunnels and pumping stations to intercept combined sewer discharges, as well as municipal and industrial wastes from the entire city, for conveyence to a single new treatment facility with ultimate discharge through a 5-mile long outfall into the Pacific Ocean.-/ The final waste treatment system and discharge point selected could have a major impact on water quality in the Bay system.

City of San Mateo -- This facility provides primary treatment for municipal wastes from a population of about 150,000. Less than five percent of the plant influent is industrial waste. The effluent is discharged, through a 3/4-mile outfall, to South Bay. near the San Mateo-Hayward Bridge.

The average waste discharge presently exceeds the reported design capacity (10 mgd) by about 10 percent. Deleterious waste characteristics are high BOD and COD, excessive oil and grease, suspended-solids and coliform concentrations, and toxicity to aquatic life.

EPA sampling in May 1972 found a BOD level slightly higher than the 1971 average [Appendix G, Table G-2]. The effluent COD was comparable to untreated domestic sewage. Self-monitoring of COD is not required. A BOD-removal requirement specifying treatment efficiencies, comparable to secondary treatment, is contained in the State waste discharge requirements for this source. High BOD removals are required only if the DO concentration in the receiving waters falls below 5 mg/l, a level that DO in this part of the Bay far exceeds.

Discharges of suspended solids (93 mg/l) and oil and grease (44 mg/l) [Table VI-3] reflected the inadequacy of primary treatment to remove these constitutents.

Fish bioassays (conducted by EPA) revealed a zero percent survival in the undiluted effluent and a 96-hr TL_m of 65 percent, indicating a toxic effluent. State waste discharge requirements on toxicity apply to the receiving waters; therefore, compliance could not be determined by sampling of the effluent. No data are available on heavy-metals discharges.

In August 1972 EPA bacteriological sampling found total coliform counts in the effluent ranging from 620 to 360,000 MPN/100 ml [Appendix G, Table G-3]. Chlorine residuals of zero were measured in the effluent after a 35-minute detention time indicating that disinfection was inadequate. The high bacterial densities being discharged would indicate a strong probability that violations of the receiving water standards (240 MPN/100 ml) were occurring.

South San Francisco-San Bruno -- The cities of South San Francisco and San Bruno jointly operate this facility in order to provide secondary treatment for municipal sewage from a population of about 55,000 and a number of industrial sources including chemical producers, paint manufacturers, and meat-packing houses. About one-third of the plant influent is industrial wastes. The effluent is discharged to Colma Creek near the Bay.

EPA effluent sampling and analysis indicated that BOD was almost double the 1971 average [Appendix G, Table G2]. The BOD observed was characteristic of primary treated wastes, thus indicating industrial wastes adversely affect treatment efficiencies resulting in poor effluent quality. High COD concentrations (350 mg/l) were also observed. As for other sources, BOD-removal requirements are tied to violations of DO limits in receiving water.

Average heavy-metals concentrations discharged during 1971 (0.4 mg/l each for chromium, copper and lead) also reflected the presence of industrial wastes in the effluent. These levels are excessive and are indicative of inadequate pretreatment of industrial wastes.

Fish bioassays, conducted by EPA, found zero survival in undiluted effluent and a 96-hr TL_m of 46 percent, in violation of State waste discharge requirements.

Bacterial levels were low with the exception of one sample [Appendix G, Table G-3].

Aerial reconnaissance in July 1972 revealed that the slough receiving the South San Francisco effluent and several other minor discharges was a yellow-brown color in contrast to the greenish cast of Bay waters.

South San Francisco is developing plans for a deep-water outfall to San Francisco Bay that may also serve San Francisco International Airport, Merck Chemical Company, and the cities of Burlingame and Millbrae. In order to meet 1973 Federal guidelines, pretreatment of industrial wastes will be required before discharge to the proposed treatment system.

Other Zone 3 Sources — Of the eleven municipal sources in Zone 3, only three (Oro Loma Sanitary District and the cities of Burlingame and Millbrea) discharge effluent of acceptable quality. Effluent quality [Table VI-3] for these three sources is indicative of domestic sewage receiving good secondary treatment. The volumes of industrial waste that are treated are small. Effluent toxicity is relatively low. No heavy metals data are available.

The City of Hayward facility provides secondary treatment followed by a stabilization pond. However, the quality of the effluent [Table VI-4] is more characteristic of a primary treatment facility. About 12 percent of plant influent is industrial waste. Pretreatment of industrial wastes and improved effluent quality will be necessary to meet 1973 Federal guidelines. The Interim Plan calls for this source to discharge, along with several other east shore sources, through a deep-water outfall to the Bay.

Aerial imagery recorded in July 1972 showed that a poor quality effluent was being discharged from the Hayward facility. Low dissolved oxygen concentrations were detected in both the stabilization ponds and the effluent canal.

The City of San Leandro operates a secondary treatment facility, processing mixed municipal and industrial wastes. Owing to the large industrial flow (40 percent of the municipal plant influent), waste strengths are high, and inadequate reductions in effluent concentrations of BOD and suspended solids are achieved [Table VI-4]. Needed are adequate pretreatment of industrial wastes and improved effluent quality. San Leandro could be a participant in the Hayward deep-water outfall.

The Estero Municipal Improvement District provides only primary treatment. This facility is scheduled to connect to the City of San Mateo plant in 1973, thus eliminating this discharge.

Zone 4 - Central San Francisco Bay

Water quality Zone 4 is bordered in part by the major population centers of San Francisco and Berkeley. Berkeley, however, together with other densely populated areas along the eastern shore of Zone 4, is served by EBMUD which discharges wastes to Zone 3.

Seven municipal sources [Table VI-5 and Figure VI-7] discharge a total of 83.6 mgd (18 percent of the total municipal effluent) to Zone 4, with a combined BOD load of 71,700 lb/day (18 percent of total municipal). Suspended solids and oil and grease loads were 10 and 18 percent, respectively, of the total municipal loads.

City of San Francisco, North Point Plant -- The City of San Francisco North Point plant is the only major source of municipal wastewater effluent in Zone 4. The North Point plant accounts for 77 percent of the flow, 92 percent of the BOD load, 89 percent of the suspended solids load and 91 percent of the oil and grease load discharged to Zone 4, and is the third largest municipal plant in the bay area.

The area served by the North Point plant includes the major business districts of San Francisco. As a result, the estimated daytime population served reaches 800,000. About 15 to 20 percent of the average plant flow (64 mgd) originates from industrial sources. Following primary treatment,

TABLE VI-5

MUNICIPAL WASTE DISCHARGES,[a] ZONE 4[b]

Map[c] Key	Discharger	Treatment	Flow (mgd)	BOD Conc. (mg/l)	BOD Load (lb/day)	SS Conc. (mg/l)	SS Load (lb/day)	Oil & Grease Conc. (mg/l)	Oil & Grease Load (lb/day)
				Zone 4					
4-1	San Francisco, City of North Point Plant	Primary & chemical	64.1	124	66,300	50	26,700	24	12,700
4-2	Richmond, City of[d]	Secondary	9.8						
4-3	Marin County S.D. #1	Secondary	4.8	27	1,100	21	800	10	400
4-4	Mill Valley, City of	Secondary	2.0	25	400	29	500	4	100
4-5	Sausalito-Marin City	Primary	1.7	163	2,300	79	1,100	31	400
4-6	San Quentin Prison	Secondary	0.6	159	700	93	400	50	200
4-7	Marin Co. S.D. #5	Primary	0.6	180	900	85	400	38	200
	Zone 4 Totals		83.6		71,700		29,900		14,000

a/ Includes those discharges with a flow of 0.5 mgd or greater
b/ Data from 1971 Self-Monitoring Program
c/ See Figure VI-7 for locations of waste discharges
d/ Data from 1970 Self-Monitoring Program

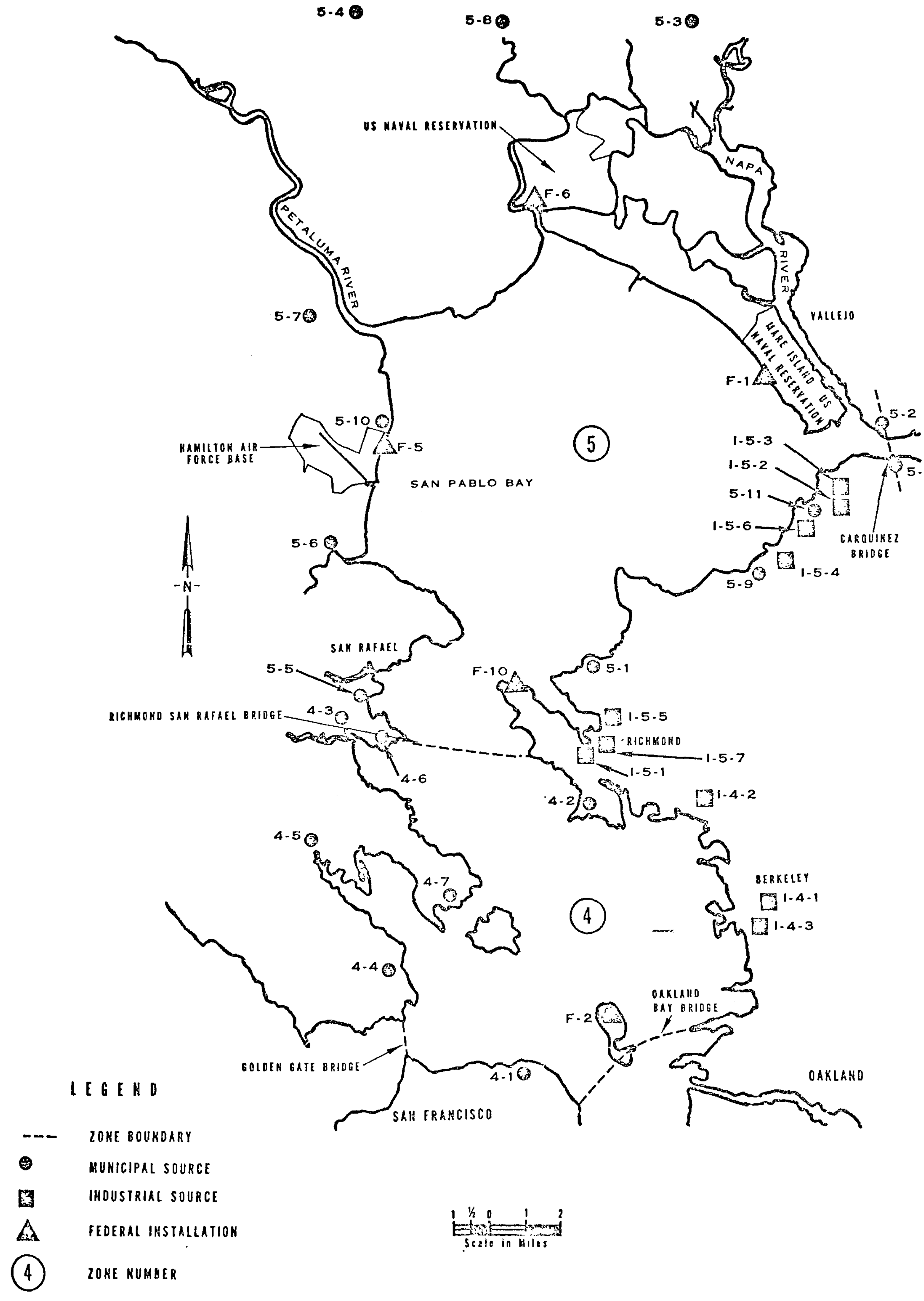

Figure VI-7. Significant Waste Sources, San Francisco Bay System, Water Quality Zones 4 & 5 the plant effluent is discharged about 800 feet offshore, in the vicinity of Piers 33 and 35.

EPA effluent sampling confirmed the waste characteristics reported by the self-monitoring program [Appendix G, Table G-2]. Effluent characteristics were average for domestic wastes receiving primary treatment. A higher degree of treatment will be required to meet 1973 Federal guidelines. As previously discussed for the San Francisco Southeast Plant, a number of waste-disposal schemes including an ocean outfall are under consideration for San Francisco.

Heavy-metals concentrations [Appendix G, Table G-2] in this effluent were significantly lower than in other municipal waste discharges for which heavy-metals data were available. However, fish bioassays, conducted by EPA, found zero percent survival in the undiluted effluent and a 96-hr TL_m of 92 percent, thus indicating the effluent contains materials toxic to aquatic life. The waste discharge requirement for this source is applicable to the receiving water. Thus, compliance could not be determined.

During the EPA sampling in July 1972 bacterial levels were low in the effluent.

Aerial photographs taken during April and July 1972 show a brownish discoloration of the Bay surrounding Piers 33 and 35, the location of the North Point discharge.

<u>Other Zone 4 Sources</u> -- In addition to the North Point plant, two other sources (Sausalito-Marin City and Marin County Sanitary District No. 5) provide only primary treatment. The Interim Plan calls for these two effluents to be intercepted together with the City of Mill Valley

effluent and all discharged, by 1974, to the Pacific Ocean via Tennessee Valley. Marin County S.D. No. 5 has resisted joining the sub-regional system and wishes to implement a tertiary treatment facility.

The City of Mill Valley provides secondary treatment for its municipal wastes, but excessive infiltration during wet weather results in by-passing of untreated sewage and violations of waste discharge requirements. A State ban has been imposed on additional connections to the collecting sewer system. Reduction of sewer system infiltration, increased treatment capacity, and an ocean outfall are needed. As proposed, removal of waste discharges from Richardson Bay is needed in order to protect beneficial water uses in this confined embayment.

Marin County Sanitary District No. 1 provides secondary treatment for its municipal wastes and normally produces, during dry weather, a reasonably good quality effluent [Table VI-5]. However, as in the case of Mill Valley, excessive infiltration occurs during wet weather, causing by-passing of untreated sewage and waste discharge requirement violations. A State ban has been issued on additional sewer connections. The Interim Plan calls for this discharge to be intercepted toward Central Bay, at least as far as Point San Quentin, with improved treatment for wet weather flows. Litigation has held up implementation of the initial phases of this plan.

San Quentin Prison provides secondary treatment, but discharges a poor quality effluent [Table VI-5]. Improved operation of this facility is needed. The Interim Plan calls for connection of this facility to the proposed Marin County S.D. No. 1 deep-water outfall.

Zone 5 - San Pablo Bay

Zone 5 includes San Pablo Bay and adjacent tidal waters between the Richmond-San Rafael Bridge and the Carquinez Bridge.

A total of 33.9 mgd of municipal wastewater effluent is discharged to Zone 5 [Table VI-6 and Figure VI-7]. In 1971 the BOD loading averaged 27,500 lb/day. Suspended solids and oil and grease were discharged at the rate of 16,600 and 6,200 lb/day, respectively. These loads originate from twelve treatment plants, the largest of which discharges an average flow of 7.6 mgd. As discussed in a later section, a large volume of industrial wastes is discharged to this zone [Figure VI-1].

Two sources (San Pablo Sanitary District-Main Plant and Vallejo County Sanitation and Flood Control District) discharge 44 percent of the municipal flow to Zone 5. In 1971 the same two sources also accounted for 83 percent of the BOD load, 70 percent of the suspended solids load and 85 percent of the oil and grease load based on self-monitoring data.

San Pablo Sanitary District -- Until March 1972 this facility discharged the largest pollution load in Zone 5. Upgrading the plant from primary to secondary treatment has substantially reduced the pollution load discharged.

Serving a population of about 60,000, the plant receives only small amounts (5-10 percent) of industrial wastes. Effluent is discharged directly to the east side of San Pablo Bay.

EPA sampling showed that the new secondary treatment facility was producing acceptable effluent quality [Appendix G, Table G-2] and that a major reduction in BOD discharged had occurred. Samples of heavy metals

TABLE VI-6

MUNICIPAL WASTE DISCHARGES,[a] ZONE 5[b]

Map[c] Key	Discharger	Treatment	Flow (mgd)	BOD Conc. (mg/1)	BOD Load (lb/day)	SS Conc. (mg/1)	SS Load (lb/day)	Oil & Grease Conc. (mg/1)	Oil & Grease Load (lb/day)
				Zone 5					
5-1	San Pablo S.D.- San Pablo Plant	Primary[d]	7.6	211	13,400	105	6,700	46	2,900
5-2	Vallejo Co. Sanitation & Flood Control Dist.	Primary	7.2	156	9,400	84	5,000	40	2,400
5-3	Napa County S.D.	Stab. pond	4.7	16	600	66	2,600	8	300
5-4	Petaluma, City of	Secondary	2.7	18	400	21	500	9	200
5-5	San Rafael S.D.- Main Plant	Secondary	2.5	48	1,000	36	800	6	100
5-6	Las Gallinas Valley S.D.	Secondary	2.3	48	900	39	800	9	200
5-7	Marin County S.D.[e] No. 6-Novato	Secondary	2.2		800				
5-8	Sonoma Valley Co., S.D.	Secondary	1.8	20	300	14	200	8	100
5-9	Pinole, City of[e]	Primary	1.0		1,200				
5-10	Marin County S.D.[e] No. 6-Ignacio	Secondary	0.8		800				
5-11	Rodeo S.D.[e]	Primary	0.6		500				
5-12	American Canyon Company[e] Water District	Stab. pond	0.5						
	Zone 5 Totals		33.9		27,500		16,600		6,200

a/ Includes those discharges with a flow of 0.5 mgd or greater
b/ Data from 1971 Self-Monitoring Program
c/ See Figure VI-7 for locations of waste discharges
d/ Secondary treatment facility completed March 1972
e/ Data from 1970 Self-Monitoring Program

were not taken, but 1971 data indicated low concentrations in the primary plant effluent. Fish bioassays (EPA) found 100 percent survival in undiluted effluent, a major improvement from the zero percent survival reported in 1971 for the primary effluent. Bacterial concentrations in the effluent were low [Appendix G, Table G-1].

The Interim Plan calls for San Pablo, by about 1976, to connect to a deepwater outfall serving Contra Costa County dischargers.

Other Zone 5 Sources -- Vallejo County Sanitary and Flood Control District, the second largest source in Zone 5 [Table VI-6], provides only primary treatment. As a result, BOD, suspended solids, and oil and grease loads are excessive. The City of Pinole and the Rodeo Sanitary District also provide only primary treatment. These sources should provide secondary treatment.

The San Rafael Sanitary District's Main Plant and the Las Gallinas Valley Sanitary District provide secondary treatment. Effluent quality is marginal, however, and improved treatment efficiency is needed to provide an effluent that will meet 1973 Federal guidelines. Napa County Sanitary District, the City of Petaluma, and Sonoma Valley County Sanitary District provide secondary treatment and discharge an effluent of acceptable quality. The Marin County Sanitary District Plants (Ignacio and Novato) both provide secondary treatment; however, information as to effluent quality was not available [Table VI-6].

The Interim Plan calls for all Zone 5 sources to connect to deepwater outfalls that discharge to San Pablo Bay with an alternative ocean discharge point for west shore sources.

Zone 6 - Carquinez Strait

Connecting San Pablo Bay and Suisun Bay is Carquinez Strait, a narrow channel of water bounded by Carquinez Bridge on the west and Benicia Bridge on the east. Only small communities are located adjacent to Carquinez Strait. Therefore, there are only minor discharges of municipal waste in Zone 6.

Two significant municipal sources [Table VI-7 and Figure VI-8], the City of Benicia and City of Martinez facilities -- both providing primary treatment effluent, are located in Zone 6.

The Interim Plan calls for re-use of the Benicia effluent by Humble Oil Company with possible connection to the Contra Costa Interceptor; the Martinez effluent could also be connected to this Interceptor. In any case, these effluents should receive secondary treatment prior to discharging them to the Bay system.

Zone 7 - Suisun Bay

Zone 7 extends from Benicia Bridge east to the western tip of Chipps Island and encompasses the area known as Suisun Bay including Grizzly and Honker Bays. With the expection of the Fairfield-Suisun Sewer District, all municipal sources discharging to Zone 7 are located on the south shore of Suisun Bay in Contra Costa County [Figure VI-8]. A number of major industries discharge a large waste load to this zone [Figure VI-2].

Five sources discharge a total of more than 34 mgd to this zone [Table VI-7]. The Central Contra Costa County Sanitary District Main Plant (22.8 mgd) is the only major municipal source in this zone.

TABLE VI-7

MUNICIPAL WASTE DISCHARGES,[a] ZONES 6, 7 & 8[b]

Map[c] Key	Discharger	Treatment	Flow (mgd)	BOD Conc. (mg/l)	BOD Load (lb/day)	SS Conc. (mg/l)	SS Load (lb/day)	Oil & Grease Conc. (mg/l)	Oil & Grease Load (lb/day)
				Zone 6					
6-1	Benicia, City of	Primary	1.1	301	2,700	151	1,400	52	500
6-2	Martinez, City of[d]	Primary	1.4						
	Zone 6 Totals		2.5		2,700		1,400		500
				Zone 7					
7-1	Central Contra Costa County S.D.-Main Plant	Primary	22.8	136	25,900	74	14,100	38	7,200
7-2	Concord, City of	Secondary & stab. pond	5.0	13	500	26	1,100	10	400
7-3	Fairfield-Suisun Sewer D.	Secondary	3.9	36	1,200	50	1,600		
7-4	Mountain View S.D.	Secondary	0.8	24	200	24	200		
7-5	Contra Costa County S.D. No. 7A	Primary	0.8						
	Zone 7 Totals		33.3		27,800		17,000		7,600
				Zone 8					
8-1	Antioch, City of	Primary	2.9	137	3,300				
8-2	Pittsburg, City of Montezuma Plant	Primary	1.4	173	2,000	76	900	55	600
8-3	Pittsburg, City of Camp Stoneman Plant	Primary	0.9	77	600	94	700	39	300
	Zone 8 Totals		5.2		5,900		1,600		900

a/ Includes those discharges with a flow of 0.5 mgd or greater
b/ Data from 1971 Self-Monitoring Program
c/ See Figure VI-8 for location of waste discharges
d/ Data from 1970 Self-Monitoring Program

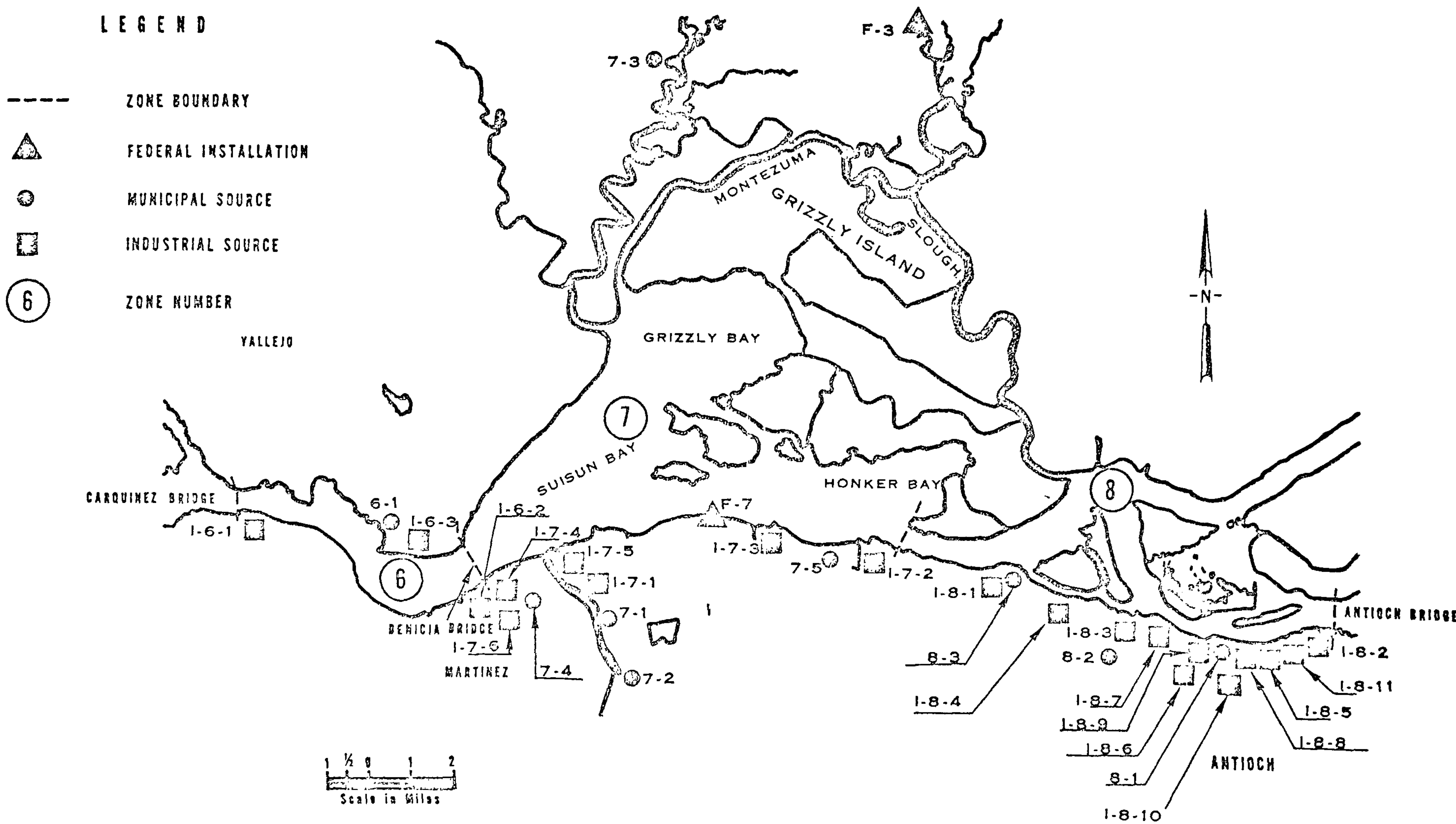

Figure VI-8. Significant Waste Sources, San Francisco Bay System, Water Quality Zones 6, 7 & 8

Central Contra Costa County Sanitary District-Main Plant -- This facility serves portions of Walnut Creek, Orinda, and Moraga with an estimated population of 275,000. Influent COD levels indicate that this plant receives as much as 10 to 15 percent industrial wastes. The plant provides primary treatment with about 20 percent of the waste flow receiving secondary treatment. The effluent is discharged to the west end of Suisun Bay through a 4-mile-long outfall.

Results of the EPA sampling were comparable to the 1971 self-monitoring data [Appendix G, Table G-2]. Fish bioassays (EPA) yielded zero percent survival in undiluted effluent and a 96-hr TL_m of 51 percent, thus indicating that the effluent contains highly toxic materials. The State waste discharge requirement is applicable to the receiving water. Compliance with this requirement could not be evaluated from effluent data. No data on heavy metals are available for this source.

The Interim Plan calls for all of the Contra Costa County effluents in this zone to be intercepted toward Central Bay at least as far west as Carquinez Bridge. Reclamation of wastes for industrial re-use is also planned. No treatment improvements are specified. Upgrading of the Central Contra Costa County Sanitary District Main Plant to provide secondary treatment of all wastes will be needed to meet 1973 Federal guidelines.

Other Zone 7 Sources -- Two sources, the City of Concord and Mountain View Sanitary District, provide secondary treatment and discharge effluents of acceptable quality. Fairfield-Suisun Sewer District, located on the north shore of the zone, provides secondary treatment that produces an effluent of marginal quality. The Interim Plan indicates that this effluent is to be reclaimed for agricultural re-use or ground-water recharge. Contra Costa County Sanitary District No. 7A provides only primary treatment; it needs to be upgraded to secondary treatment.

Zone 8 - Delta

This zone encompasses the western portions of the Sacramento-San Joaquin Delta, a low-lying area of interconnected channels and islands surrounding the confluence of the Sacramento and San Joaquin Rivers. The area is primarily agricultural. Only three small municipal discharges are located in this zone [Table VI-7 and Figure VI-8], where, however, there are several large industries discharging [Figure VI-1].

The three municipal sources provide only primary treatment. The Interim Plan calls for these sources to be intercepted westward toward Central Bay along with other Contra Costa County sources in Zone 7. Some industrial re-use may also be possible. A minimum of secondary treatment of these wastes is needed to achieve acceptable effluent quality.

D. INDUSTRIAL WASTE DISCHARGES

Industrial wastes discharged, in 1971, to San Francisco Bay averaged more than 320 mgd. This is in addition to 3,300 million gallons of power-plant cooling water that was being discharged every day. The dischargers reporting account for a total COD load of 310,000 lb/day. plus the 111,000 lb/day of suspended solids and 13,000 lb/day of oil and grease that are discharged.

The Federal Water Pollution Control Act Amendments of 1972 require that, no later than July 1, 1977, effluent limitations be established for all point sources of industrial wastes which require the application of the best practicable control technology currently available (best practicable control technology). Where sufficient data are available, waste discharges with deleterious characteristics that can be reduced by application of the best practicable control technology are identified in the following discussion.

The major sources of industrial wastes discharging directly to the Bay system are located in Zones 5, 6, 7 and 8 [Figure VI-1]. In Zones 1 through 4, most industrial wastes are discharged to municipal sewage systems.

Zone 1 - South San Francisco Bay

Direct discharges of industrial wastes to Zone 1 total only 1.6 mgd [Table VI-8 and Figure VI-6]. At least 18 mgd of industrial wastes are discharged to the municipal facilities located in this zone. The City of San Jose facility receives most of these wastes while industrial wastes are also a significant fraction of the wastes treated by the City of Sunnyvale and Union Sanitary District-Newark facilities.

The FMC Corporation, Inorganic Chemicals Division, operates a plant in Newark, manufacturing phosphoric acid and sodium phosphates. Cooling water and process wastes are treated in an aerated pond and discharged to Plummer Creek about two miles upstream from the Bay. In 1971 the pond effluent contained phosphate concentrations (220 mg/l) far in excess of effluent levels achievable by currently available treatment methods (2 mg/l). Suspended solids concentrations (54 mg/l) were also excessive.

Cerro Metal Products is engaged in the melting, extrusion, and

TABLE VI-8

INDUSTRIAL WASTE DISCHARGES, WATER QUALITY ZONES 1, 2 and 3[a]

Map[b] Key	Discharger	Flow (mgd)	COD Conc. (mg/l)	COD Load (lb/day)	SS Conc. (mg/l)	SS Load (lb/day)	Oil & Grease Conc. (mg/l)	Oil & Grease Load (lb/day)	Other Significant Pollutant Loads (lb/day)[c]
	Zone 1								
I-1-1	FMC Corp., Inorg. Chem. Div.	1.49			54	700			PO_4=2700,220 mg/l
I-1-2	Cerro Metal Products	0.083				—			Cr^{+6}=.3 mg/l Cr^{total}=.6 mg/l
	Zone 1 Total	1.573				700			
	Zone 2								
I-2-1	Campbell Chain Division	0.25							
I-2-2	Kaiser Gypsum Company	0.072	1,000	600	85	50			
	Zone 2 Total	0.322		600		50			
	Zone 3								
I-3-1	PG&E - Hunters Point	490							5-12°F temp. rise
I-3-2	PG&E - Potrero	455							11-13°F temp rise
I-3-3	PG&E - Oakland	140							
I-3-4	Merck Chemical Division	4.83			54-10,200	17,300			
I-3-5	Fuller O'Brien Corp.	0.07				—			
	Zone 3 Total	1,089.90				17,300			

a/ Data from 1971 Self-Monitoring Program
b/ See Figure VI-6 for locations of waste discharges
c/ Units are lb/day unless otherwise noted

forging of copper-alloy metal products. Process wastes receive chemical treatment and neutralization prior to discharge to Mowry Slough. Hexavalent-chromium and total-chromium concentrations in the waste discharge average 0.3 mg/l and 0.6 mg/l, respectively. Practicable treatment technology is currently available that will reduce chromium concentrations to lower levels. Thus, this discharge is in violation of the Regional Board prohibition against discharges of wastes containing heavy metals in excess of levels that can be achieved by source control.—/

Zone 2 - South San Francisco Bay

Industrial waste discharges in Zone 2 are very small. Only 0.3 mgd are discharged directly to the Bay [Table VI-8 and Figure VI-6]. Discharges of industrial waste to municipal facilities are probably less than two mgd, with the City of San Carlos being the only municipal facility to treat a significant volume of industrial wastes.

The Kaiser Gypsum Company operates a facility at Redwood City that produces crushed gypsum rock for a cement plant. Effluent from a wet scrubber is treated in a settling pond and then discharged through a ditch to Redwood Creek. Suspended solids concentrations in the pond effluent (85 mg/l) were, in 1971, in excess of levels achievable by the best practicable control technology for this industry.

The Campbell Chain Division of Unitec Industries, Inc., operates a plant in Union City engaged in the manufacturing of welded and unwelded chain. A small volume of cooling water used to cool equipment and quench heat-treated chain is discharged to Alameda Creek.

Zone 3 - South San Francisco Bay

Three thermal-electric power plants discharge large volumes of cooling water to Zone 3 [Table VI-8 and Figure VI-6]. Direct discharges of other industrial wastes to this zone total less than five mgd. At least 30 mgd of industrial wastes are discharged to municipal facilities for treatment. The East Bay M.U.D. facility treats about two-thirds of these wastes. Other municipal plants treating significant industrial discharges (more than 10 percent of plant inflow) include the City of San Francisco Southeast Plant and the cities of South San Francisco, Hayward, and San Leandro.

The Pacific Gas and Electric Company operates three gas- and oil-fired, thermal-electric power plants in Zone 3, two located in San Francisco and the other in Oakland. The largest plant, located on Hunter's Point in southeastern San Francisco, has four units with a total generating capacity of 440 mw. Once-through cooling water, averaging 490 mgd, is drawn from the Bay and returned directly to the Bay through three outfalls. The temperature of the discharge is, on the average, 12°F. warmer than intake temperatures.[1]

The Potrero Power Plant, located on the east side of the City of San Francisco, has three units with a total generating capacity of 321 mw. Once-through cooling water, averaging 455 mgd, is drawn from the Bay and returned through two outfalls. The average temperature rise, over intake temperatures, is between 11° and 13°F. Infra-red line scan imagery of the thermal plume recorded in July 1972 indicated the plume was about 1000 feet wide and extended 3000 feet offshore.

The Oakland Power Plant is much smaller, with a generating capacity of 106 mw. Cooling water averaging 140 mgd is discharged to Oakland Harbor.

A large suspended solids load (17,300 lb/day) is discharged directly into the Bay by the plant of the Merck Chemical Division of Merck and Company in South San Francisco. This plant manufactures inorganic industrial and pharmaceutical products derived largely from the precipitation of magnesium hydroxide from Bay water. The suspended solids are primarily waste magnesium hydroxide, a compound which, because of being slightly soluble in water, is only slowly leachable. The effluent is discharged through multiple near-shore outfalls. Aerial imagery recorded in July 1972 revealed that a bottom area of about 20,000 square feet was discolored white by precipitated solids.

No treatment other than in-plant controls was provided in 1971. Additional in-plant controls designed to reduce waste solids were scheduled for construction in 1972. The plant effluent is to be connected to the City of South San Francisco deep-water outfall, when completed by the City. Additional treatment of the effluent will be required to meet the Federal best practicable control technology requirement.

Fuller-O'Brien Corporation operates a plant on Pt. San Pedro, in South San Francisco, to manufacture paints, varnishes, lacquers and enamels. A small volume of once-through cooling water is discharged directly to San Francisco Bay. Process and sanitary wastes (0.034 mgd) are discharged to the South San Francisco municipal system.

Zone 4 - Central San Francisco Bay

Direct discharges of industrial wastes to this zone are minor, averaging less than three mgd [Table VI-9 and Figure VI-7]. The City of San Francisco North Point Plant is the only municipal facility treating significant industrial waste loads.

A soap and glycerine manufacturing plant is operated in Berkeley by the Colgate-Palmolive Company. Until late 1972 this plant was returning barometric condenser water (1.45 mgd), obtained from the Berkeley Aquatic Park Lagoon, back to the lagoon. This discharge was about 9° to 11°F. warmer than intake-water temperatures and had an average BOD and COD concentration of 42 and 81 mg/l respectively.[1] Now the discharge is connected to the Aquatic Park Interceptor Drain which discharges to San Francisco Bay through the Potter Street Outfall. An effluent ofhigher quality could be produced by application of best practicable control technology.

The Agricultural Chemical Division of Stauffer Chemical Company in Richmond operates both an industrial, inorganic chemicals plant which manufacturers ferric sulfate and aluminum sulfate and a pesticide pilot plant. Industrial wastes (1.3 mgd) receive lime neutralization, followed by sedimentation in settling ponds prior to discharge to Richmond Inner Harbor. Waste characteristics indicate that this source will probably need additional treatment in order to meet effluent limitations based on best practicable control technology. Aerial imagery recorded in July 1972 revealed that the settling ponds and the discharge canal contained orange colored solids, some of which were being discharged to tidal waters.

TABLE VI-9

INDUSTRIAL WASTE DISCHARGES, WATER QUALITY ZONES 4 AND 5[a]

Map[b] Key	Discharger	Flow (mgd)	COD Conc. (mg/l)	COD Load (lb/day)	SS Conc. (mg/l)	SS Load (lb/day)	Oil & Grease Conc. (mg/l)	Oil & Grease Load (lb/day)	Other Significant Pollutant Loads (lb/day)[c]
				Zone 4					
I-4-1	Colgate-Polmolive Co.	1.45	51-89	600					BOD=500, 18-39 mg/l
I-4-2	Stauffer Chem. Co.- Richmond	1.3			15	160			
I-4-3	Pfizer Co.	0.1							
	Zone 4 Total	2.85		600		160			
				Zone 5					
I-5-1	Standard Oil Co.	112	83	86,000			5	4,200	BOD=15,500, 15 mg/l, NH_3=10,300
I-5-2	PG&E - Oleum	58							6°F temp. rise
I-5-3	Union Oil Co.	47	172	53,100			1-9	2,750	Phenols=10.8 BOD=5,700, NH_3=740
I-5-4	Hercules, Inc.	1.6	57-133	1,650	23	50	2	30	BOD=70, 4.6-10 mg/l, N=680
I-5-5	Chevron Chem. Co.-Ortho	0.1	77	100					NH_3=750, NO_3=500
I-5-6	Sequoia Refin. Co.	0.1	321	250	15-46	20	4-9	10	NH_3=250, K-N=270, NO_3=30, BOD=200, 243 mg/l
I-5-7	Allied Chem. Corp.-Richmond	0.07							pH=4.3, temp=87°F, BOD=32, 54 mg/l, TOC=450 mg/l, SO_4=800, 1,300 mg/l
	Zone 5 Total	218.87		139,450		70		6,990	

a/ Data from 1971 Self-Monitoring Program
b/ See Figure VI-7 for locations of waste discharges
c/ Units are lb/day unless otherwise noted

Zone 5 - San Pablo Bay

This zone receives the largest volume of industrial wastewater (excluding power-plant cooling water) of all the zones in the Bay system [Figure VI-1]. About 219 mgd of industrial wastewater is discharged by seven sources [Table VI-9 and Figure VI-7]. Excluding cooling water from the Oleum Power Plant, the other six sources discharge approximately 50 percent of the total industrial waste flow to the Bay system. The total COD load (139,000 lb/day) to Zone 5 is about 45 percent of the COD load from all industrial sources reporting. The two largest discharges of industrial waste in the Bay system (Standard Oil Company and Union Oil Company) are located in Zone 5.

Standard Oil Company of California -- The Standard Oil Richmond Refinery is the largest discharger of industrial waste (112 mgd) in the bay area, contributing about 35 percent of the total industrial flow from all sources. A fully integrated refinery including petrochemical processes, the plant manufactures a complete line of petroleum products. Crude-oil processed averages 190,000 barrels per day.

About 90 percent of this waste stream is salt water, from the Bay, used for once-through cooling. Before being mixed with the cooling water for treatment in three large bio-oxidation ponds (totalling 300 acres), process wastes are treated in six major, parallel systems and numerous minor systems. Treatment practices on the process waste streams include sulfide, ammonia, and phenol strippers, and oil-water separators as well as various other practices. A portion of the oxidation ponds is mechanically aerated. A single effluent from the treatment ponds is discharged into

Castro Creek, a tidal tributary of San Pablo Bay. Castro Creek was discolored greyish-brown in July 1972 when photographed during the remote-sensing mission.

The July aerial imagery also indicated the possible presence of three intermittent discharges not reported by Standard. These effluents are located about one-half mile west of the main outfall. Several waste treatment units, connected to the main treatment ponds are located in the vicinity of the discharges.

Based on the COD load of 86,000 lb/day reported by the Company in its Refuse Act permit application, this source contributes about 28 percent of the reported COD load from all industrial sources.[/] EPA effluent sampling measured a COD load 20 percent greater than the reported average [Appendix G, Table G-4]. With the exception of nickel and total coliform concentrations, the effluent characteristics observed by EPA were comparable to Company data. A nickel load of 234 lb/day, measured by EPA, was more than ten times greater than the reported average load. Other heavy-metals loads were small. Coliform bacteria in the effluent sampled by EPA were too numerous to count, thus indicating a violation of State waste discharge requirements.

Concentrations of BOD, COD, ammonia, and oil and grease being discharged by this refinery are in excess of effluent levels achievable by best practicable control technology for this industry. Water use is also excessive for the reported production level.

Union Oil Company of California -- This Company's San Francisco Refinery, located in Rodeo, produces a variety of petroleum products by processing an average of 60,000 barrels of crude oil per day.

Two waste streams are discharged directly to the eastern end of San Pablo Bay. Discharge 001* (7.2 mgd) is once-through salt water that is used for non-contact cooling. This water stream receives no treatment. Discharge 002 contains process wastes, storm runoff, and sanitary sewage. Sanitary sewage is chlorinated before its release to the process waste system. Ammonia- and sulfide-bearing waters are steam-stripped in advance of their release to the process waste system. All process wastes and storm runoff pass through an API separator, a dissolved-air flotation unit, and a series of settling ponds prior to discharge to the Bay.

Several significant differences in effluent characteristics were noted between the results from the EPA sampling and either the self-monitoring data or Refuse Act permit application data [Appendix G, Table G-4]. For example, the COD load discharged by outfall 002 was about 40 percent higher than indicated by the self-monitoring data. This difference could be partially explained by the COD load present in the water supply (Bay water), not sampled by EPA. In both waste streams oil and grease concentrations were substantially higher than those reported by the Company. Concentrations of heavy metals were low, except for nickel concentrations (in both waste streams) which were substantially higher than those values reported by the Company. A nickel load of almost 100 lb/day was discharged during the EPA sampling period. Coliform counts were low in both waste

* Discharge numbers refer to outfall designations in the Refuse Act permit applications.

streams and fish bioassays showed no toxic effects.

Ammonia, oil and grease, phenols, and BOD and COD concentrations in the Union effluents are in excess of levels attainable by best practicable control technology. Water use is also excessive for the reported level of production.

The thermal plume from the two Union outfalls was observed to merge with the Oleum Power Plant plume, discussed in the following paragraphs. Elevated surface temperatures were observed over an area about 1000-by-3000 feet.

Other Zone 5 Sources -- With the exception of the Oleum Power Plant of the Pacific Gas and Electric Company, the remaining industrial sources in this zone are small [Table VI-9]. The Oleum Power Plant is adjacent to the Union Oil Company refinery. With a generating capacity of 100 mw, the plant discharges about 58 mgd of once-through cooling water to San Pablo Bay. Discharge temperatures average 6°F. above intake temperatures. The thermal plume from this source combines with the Union Oil Company plume.

Hercules, Inc. operates a plant, at Hercules, to produce formaldehyde solutions, anhydrous ammonia, ammonium nitrate, and urea. Two waste streams are discharged to San Pablo Bay.

The activities that are tributary to waste stream 001 are production of nitric acid and of the ammonium nitrate and urea solutions. The treatment provided this waste stream (1.4 mgd) includes neutralization, equalization and sedimentation, and chlorination (septic tank effluents). Waste stream 002 (0.2 mgd) originates with the production of anhydrous ammonia, ammonium nitrate prills, and formaldehyde solutions. The treatment provided this waste stream includes neutralization, addition of nutrients, aeration in a lagoon, biological sedimentation, and chlorination. Concentrations of COD, ammonia and nitrate in waste stream 001 are in excess of effluent limitations achievable by best practicable control technology. Low altitude aerial imagery revealed algal mats along the shore between the two outfalls.

The Richmond Fertilizer Plant of Chevron Chemical Company, Ortho Division manufactures ammonium sulfate and mixed fertilizers (both liquid and dry pelleted forms) containing nitrogen, phosphoric acid, and potash. During 1971 the plant discharged wastes, high in ammonia and nitrates, to Herman's Slough, (a tributary of San Pablo Bay) which is adjacent to the Standard Oil Company refinery. In early 1972 the Chevron Company completed plant modifications, including the construction of cooling and evaporation ponds to allow re-use or evaporation of most of the waste effluent from the manufacturing operation.

Sequoia Refining Corporation operates a small gasoline refinery, adjacent to the City of Rodeo. The average production is 25,000 barrels of crude oil per day. Process wastes and cooling water are batch-discharged twice daily through a 2,000-foot outfall to San Pablo Bay. Surface drainage is discharged to the Bay from two on-shore outfalls.

During 1971, effluent characteristics, including high BOD (243 mg/l), COD (321 mg/l), ammonia (257 mg/l), and nitrate (27 mg/l), were indicative of poor treatment practices [Table VI-9]. The refinery was scheduled to implement varioous pollution controls during 1971 and 1972 in order to abate this pollution. These control measures include pH control, air flotation, pond aerators, ammonia strippers, and crude-water re-use. Evaluation of the performance of the new equipment is required in order to determine whether additional treatment will be necessary to comply with the best practicable control requirement.

The Richmond Works of Allied Chemical Corporation, Industrial Chemicals Division, manufactures sulfuric acid and converts hydrogen sulfide to sulfur. The plant is located adjacent to the Standard Oil Company refinery. Wastes consisting of dilute sulfuric acid are discharged to a slough that is tributary to San Pablo Bay. Although the wastes are neutralized with a caustic solution, in the past inadequate pH control has resulted in low-pH wastes being discharged to the slough. The neutralization equipment was improved in May 1972, but pH violations were again observed in June 1972.

Bethlehem Steel Corporation operates a plant on Pinole Point. There are no effluent data available. Therefore, the magnitude and characteristics of waste discharges are unknown. During the April flights a large thermal plume (7000 feet long) was observed extending eastward from Pinole Point. This thermal plume was not observed during the July day or night flights. However, a reddish-brown discoloration was observed during the July daytime flight at Pinole Point.

Zone 6 - Carquinez Strait

Three sources discharge industrial wastewater (33.1 mgd) to Zone 6 [Table VI-10 and Figure VI-8]. The COD load (61,400 lb/day) discharged to this zone is approximately 20 percent of the total industrial waste COD load to the Bay. Suspended solids and oil and grease are discharged to

TABLE VI-10

INDUSTRIAL WASTE DISCHARGES, WATER QUALITY ZONES 6 AND 7[a/]

Map[b/] Key	Discharger	Flow (mgd)	COD Conc. (mg/1)	COD Load (lb/day)	SS Conc. (mg/1)	SS Load (lb/day)	Oil & Grease Conc. (mg/1)	Oil & Grease Load (lb/day)	Other Significant Pollutant Loads (lb/day)[c/]
				Zone 6					
I-6-1	C & H Sugar Refin. Corp.	25.5	180-2,253	55,500		12,700		200	BOD=12,800
I-6-2	Shell Oil Co.-Martinez	4.5	348	13,100	30	1,100	31	1,200	BOD=900, 25 mg/1 D.O.=nil
I-6-3	Humble Oil & Refining	3.1		5,900	42	1,100	2	50	BOD=2,000, 77 mg/1 Phenols=16, NH_3=2,200 D.O.=1.7 mg/1
	Zone 6 Totals	33.1		61,400		14,600		1,450	
				Zone 7					
I-7-1	Phillips Petroleum-Avon	15.2		19,500	27-41	5,100	3.6-5.2	400	Phenols=12.3, BOD=4,200 NH_3=3,500, 35 mg/1, K-N=4,300, 43 mg/1
I-7-2	Shell Chemical Co.-Pittsburg	6.5	43	2,300					
I-7-3	Allied Chemical Co.-Nichols	3.2			25	700	0.8	20	BOD=100, 3.5 mg/1
I-7-4	Stauffer Chemical-Martinez	0.1			40	20	1.6		BOD=6, 7.8 mg/1
I-7-5	PG&E-Avon								
I-7-6	PG&E-Martinez								
	Zone 7 Totals	25.0		21,800		5,820		420	

a/ Data from 1971 Self-Monitoring Program
b/ See Figure VI-8 for locations of waste discharges
c/ Units are lb/day unless otherwise noted

Zone 6 at the rate of 14,600 lb/day and 1,450 lb/day. respectively.

California and Hawaii Sugar Company -- At Crockett, near the west end of Carquinez Strait, this Company operates the largest raw cane-sugar refinery in the world. The refinery processes, daily, about 3,500 tons of molasses or brown sugar shipped by ocean freighter from the Company's Hawaiian sugar-cane processing plant.

Wastes totalling about 25.5 mgd are discharged directly into Carquinez Strait through 11 outfalls. Five outfalls, representative of the pollutional load discharged by this plant, were selected for sampling in order to further characterize the wastes and to verify the Company reported data.

Outfall 004 discharges cooling water (4 mgd) from barometric condensers. Bone char wash water and condenser water from vacuum filters (0.35 mgd) is discharged through Outfall 005. Outfall 006 carries non-contact cooling water, boiler blow-down, and ion-exchanger back washings. An intermittent discharge from the washing of trucks, employed to transport processed sugar, is carried by Outfall 008. During washing operations, the flow is estimated to average 6000 gallons per hour. Outfall 014 conveys waste from the bone char de-ashing column, intermittent discharges of kieselguhr-bearing cooling waters, cleaning wastes from the filtration station, vacuum-pan cleaning water, and solids from the silica-reactor blow-down (total flow 0.58 mgd). Wastestream 014 receives pH adjustment and settling to remove solids prior to discharge to the Strait. The other four discharges receive no treatment.

Wastes from the five outfalls have substantially different characteristics. A comparison of results of the EPA sampling, the 1971 self-monitoring data, and Refuse Act permit application data is contained in

[Appendix G, Table G-4]. Data from EPA sampling showed characteristics similar to those reported by the Company. The largest difference were noted for BOD and COD, especially for Outfall 014. (Such differences can be expected where short-term sampling is compared to long-term averages for variable waste discharges.)

Bacterial concentrations in the effluent of Outfall 014 (total coliform, 36,000 MPN/100 ml and fecal coliform, 20,000 MPN/100 ml) were excessive and substantially greater than in intake water levels (total coliform, 2,400 MPN/100 ml and fecal coliform, 900 MPN/100 ml). The State waste discharge requirements do not specify bacterial limits.

Fish bioassays, conducted by EPA, of all five effluents showed that there were no toxic effects.

Effluents from the C and H Sugar Company contain BOD, COD, and suspended solids levels in excess of effluent quality achievable by best practicable control technology. Substantial upgrading of the waste control and treatment program is needed.

Shell Oil Company, Martinez -- The Martinez Refinery is primarily engaged in the production of gasoline from crude oil and of tertiary butyl acohol from isobutylene. Raw-material consumption averages 103,000 barrels per day of crude oil and 4,000 gallons per day of isobutylene.

Process wastes and cooling water (4.5 mgd) are treated and then discharged, to Carquinez Strait, through a submerged diffuser off the end of the Shell dock (Outfall 001). These wastes are batch-discharged twice a day on ebb tide, with the discharge rate controlled by tidal velocities at the diffuser to ensure a 100:1 dilution ratio. Waste treatment processes and in-plant controls are complex. Added in late 1971 was an activated-sludge bio-treatment unit that substantially improved the quality of the effluent. This improvement is reflected by observing the differences between the results of the EPA sampling (in mid-1972) and the self-monitoring (1971) data [Appendix G, Table G-4].

Although substantial improvement of effluent quality has been achieved, effluent BOD, COD, suspended solids, oil and grease, and total chromium concentrations are in excess of levels achievable by best practicable control technology. Fish (EPA) bioassays yielded a 10 percent survival of test fishes in undiluted effluent and a 96-hr TL_m of 41 percent, thus indicating the waste is toxic to aquatic life. The State waste discharge requirement is applicable to receiving waters only.

The Martinez Refinery has two additional waste discharges associated with the storm water system. Flows in excess of treatment-system capacity are diverted to holding ponds and returned, when capacity is available, to the system. If storm runoff is excessive, there can be some discharge through two onshore outfalls.

Humble Oil and Refining Company, Benicia -- This refinery, located on the boundary between Zones 6 and 7, processes an average of 63,000 barrels of crude oil per day. Wastes from refinery operations are discharged to both zones.

Ballast water from tanker and barge operations is pumped to a separation tank where it is held for several days for the gravity separation of oil to take place. The tank is batch-discharged through a submerged outfall, 800 feet offshore in Carquinez Strait (Zone 6) about one mile west of Benicia Bridge (Outfall 002). About 1.2 million gallons are discharged per batch.

Process wastes and cooling-system blowdown (3.1 mgd) are treated in a complex system and then discharged to Carquinez Strait (Zone 7) through a submerged outfall, about 1000 feet offshore east of Benecia Bridge (Outfall 001). Oily waters and chemically contaminated wastes are treated separately. Oily wastes are treated in an API separator and in a dissolved air flotation unit that includes neutralization and chemical flocculation. Chemically contaminated wastes are stripped for removal of volatile contaminants and treated in an activated sludge unit.

The main waste discharge contains BOD, COD, suspended solids, phenols, and ammonia in excess of effluent levels achievable by best practicable control technology.

Zone 7 - Suisun Bay

Four sources discharge to Zone 7 an average of about 25 mgd of industrial wastes [Table VI-10 and Figure VI-8]. In addition, an unknown amount of blowdown from closed cooling systems is discharged by the Avon and Martinez Power Plants of Pacific Gas and Electric Company. These are small gas-and-oil fired plants, with a generating capacity of 46 mw each.

Phillips Petroleum Company, Avon Refinery -- This Phillips refinery. with a capacity of 95,000 barrels per day. is the largest waste source in Zone 7, discharging an average of 15 mgd. Process wastes, cooling-system blowdown, boiler blowdown, and sanitary wastes are treated and discharged through a deepwater outfall (001) at the end of the Phillips Pier. Treatment practices and facilities include ammonia and H_2S stripping, pH adjustment, gravity oil separators, air-flotation separators, an equalization pond equipped with surface aerators, a lagoon with an aeration basin, and stabilization ponds. Residence time in the stabilization ponds is about 28 days. The pond effluent is pumped to the outfall.

Prior to 1972 whenever the pumps were out of service, the effluent (effluent 002) was discharged to a slough paralleling the pier. This practice has been discontinued. Aerial imagery, recorded in April 1972, showed a grey-green discoloration in Suisun Bay near the mouth of this slough.

Petroleum coke is sluiced from a coker unit to a storage pile. Water used in this process is pumped from Hastings Slough. After use, the water separates from the coke on the ground surface, then runs via a ditch back to Hastings Slough. The volume of flow is estimated to be about 0.04 mgd. During the April 1972 aerial reconnaissance Hastings Slough near its mouth was discolored reddish-brown.

At the time of the July night remote-sensing flights, two outfalls on the west edge of the refinery were discharging hot liquids to Pacheco Creek, about one-half mile south of Waterfront Road. No waste discharges at these locations were observed during the daytime flights. These discharges were not included in the Refuse Act permit application.

Results of EPA sampling are similar to the Company reported data [Appendix G, Table G-4]. The major exception is bacteriological data on effluent 001. Observed were fecal-coliform bacteria densities greater than 600 MPN/100 ml and total coliforms too numerous to count. The

State waste discharge requirements specify a median total coliform limit of 1000 MPN/100 ml, based on five samples. The high bacterial level observed would indicate a potential violation of this requirement. However, only one sample was obtained. Thus, a violation of the waste discharge requirements was not verified.

Wastes discharged by the Company contain BOD, COD, oil and grease, ammonia and phenols in excess of effluent levels attainable by best practicable control technology. Water use is excessive for the reported level of production.

Shell Chemical Company, West Pittsburg -- The Shell Point Plant of this division of the Shell Oil Company reclaims carbon for synthetic rubber and steel manufacturing, formulates epoxy-based adhesives, and manufactures a solid catalyst. Industrial wastes are diluted with a large volume of Bay water and discharged into a 72 acre settling pond. The pond effluent (6.5 mgd) flows through a half-mile-long canal to the east end of Suisun Bay. The limited amount of data on the effluent indicates that COD (43 mg/l) is marginal with respect to levels achievable by best practicable control technology.

Allied Chemical Corporation, Nichols -- The Industrial Chemicals Division of Allied operates this Bay Point Works to manufacture sulfuric acid, hydrofluoric acid, CP acids, and aluminum sulfate. Average production is 200 tons per day of sulfuric acid, 25 tons per day of hydrofluoric acid and 30 tons per day of aluminum sulfate.

Process wastes receive sedimentation and neutralization before being discharged to a rectangular canal that serves as a settling pond. Sanitary wastes receive chemical treatment and sedimentation prior to their discharge to the pond. The canal effluent (3.2 mgd) is neutralized for pH control and pumped, through a short submerged outfall, into Suisun Bay.

This waste discharge contains total organic carbon (144 mg/l), organic nitrogen (18 mg/l), fluoride (2 mg/l), and aluminum (17 mg/l) in excess of effluent levels achievable with best practicable control technology.

Stauffer Chemical Company, Martinez -- The Industrial Chemical Division of Stauffer operates a plant on Bulls Head Point to produce about 400 tons of sulfuric acid per day.

A small volume of process wastes (0.1 mgd) is neutralized and discharged to a retention pond. The pond contents are recirculated, as is necessary for pH control, to the neutralization tank. The pond effluent flows about one-half mile in a small slough to Carquinez Strait at the West end of Suisun Bay.

In August 1972 the State issued a Cease-and-Desist Order to Allied for violations of waste-discharge requirements for settleable matter.

April and July aerial reconnaissance indicated that the slough receiving the Allied effluent was discharging a greenish-brown substance into Carquinez Strait.

Zone 8 - Delta

Excluding power-plant cooling water, about 94 mgd of industrial wastes are discharged to this zone from nine sources [Table VI-11 and Figure VI-8]. Two large thermal-power plants discharge about 2,020 mgd of cooling water, with an additional 50 mgd to be added soon. Five large industries discharge more than 10 mgd each.

TABLE VI-11

INDUSTRIAL WASTE DISCHARGES, WATER QUALITY ZONE 8[a]

Map[b] Key	Discharger	Flow (mgd)	COD Conc. (mg/l)	COD Load (lb/day)	SS Conc. (mg/l)	SS Load (lb/day)	Oil & Grease Conc. (mg/l)	Oil & Grease Load (lb/day)	Other Significant Pollutant Loads (lb/day)[c]
				Zone 8					
I-8-1	PG&E-Pittsburg	1050							
I-8-2	PG&E-Contra Costa	970							
I-8-3	Dow Chemical	24.1	28	5,500	29	5,800	0.9	200	Pb=4.6, BOD=5,800
I-8-4	U. S. Steel Corp.-Pittsburg	17.7		5,100			7-11	1,200	Phenols=15.1, Cr=9.7
I-8-5	Fibreboard Corp.-Pulp-paper mill	15.6			55-263	42,800	5.2	700	BOD=71,800
I-8-6	Crown Zellerback Corp.	14.8	180	18,000	110	13,600	3	300	BOD=8,500
I-8-7	Tillie Lewis Foods	12	914	27,800	465	14,000	0.2	5	BOD=8,500, 282 mg/l
I-8-8	Fibreboard Corp.-Board mill	4.8		18,000	160	7,700	3	300	Coliform >24,000/100 ml
I-8-9	Hickmott Foods, Inc.	2.9		1,600	53-88	1,000	2	30	BOD=600, 31-42 mg/l
I-8-10	E. I. duPont deNemours and Co.	1.3			14	100	4.5	50	Pb=29, 2.7 mg/l SO_4=6,600, Cr.=3.7
I-8-11	Kaiser Gypsum Co.-Antioch	0.5		600	55-158	300	1.1	5	BOD=150, 1.7-45 mg/l
	Zone 8 Totals	2113.7		86,600		72,600		2,790	

a/ Data from 1971 Self-Monitoring Program
b/ See Figure VI-8 for locations of waste discharges
c/ Units are lb/day unless otherwise noted

Dow Chemical Company, Pittsburg -- The largest source in Zone 8, the Dow Pittsburg Plant, is a producer of organic and inorganic chemicals. Specific products include sodium hydrozide and chlorine, manufactured using the diaphram process; chlorinated solvents; carbon tetrachloride; perchloroethylene; various mining chemicals; styrene butadiene latex; and sulfonated chloropyridine fungicide.

Wastes from the fungicide production are contained in a solar evaporation pond. All other wastes (24 mgd) are chlorinated, neutralized, equalized, and passed through a small settling pond before diffusion through a short, sub-surface outfall into New York Slough (002). A small discharge (003) results from the clarification of river water for cooling-water use. The clarifier underflow, containing river sediments, is discharged to a settling pond with the decant returned to New York Slough via a surface channel.

With the exception of oil and grease and mercury loads, a comparison [Appendix G, Table G-4] of the EPA sampling results for the main waste discharge and Company reported data shows that EPA sampling detected lower pollutant concentrations. In the case of mercury a major difference is noted. EPA results indicate a daily mercury load of 0.9 lb. Whereas the Company-reported daily mercury average is 0.08 lb. This mercury load exceeds the 0.5 lb/day EPA guideline. Other waste characteristics occur in the range of the effluent quality that is achievable by best practicable control technology.

United States Steel Corporation, Pittsburg — The Pittsburg Works of U. S. Steel is a rolling and finishing mill located on the south bank of

New York Slough. Principal products are semi-finished and finished steel sheets, coils, tin plate, wire, and wire products. About 3,500 tons of steel coil and 850 tons of steel billets, shipped in from other steel mills, are used daily.

Wastes are discharged, via two surface outfalls, into New York Slough. Outfall 001 is no longer used so that wastes are discharged through outfall 002. Outfall 002 serves the facilities producing steel sheets and coils, tin plate, and wire products. Waste treatment includes equalization, neutralization, and sedimentation. During the July aerial reconnaissance this outfall was discharging a reddish-brown effluent with a plume extending out 250 feet from shore and 600 feet westward in New York Slough.

Outfall 003 serves the facilities producing galvanized steel sheets, coils and pipes. Waste treatment provided is the same as for Outfall 002.

A direct comparison of the EPA sampling results and Corporation-reported data [Appendix G, Table G-4] is not possible for the combined outfalls 001 and 002 because self-monitoring data were not available for the combined waste streams. EPA heavy-metal analyses did not detect any violations of State waste discharge requirements.

The self-monitoring data indicate that discharges of suspended solids, BOD, oil and grease, and zinc are excessive for the reported level of production in comparison to effluent loads achieveable with best practicable control technology.

Fiberboard Corporation, San Joaquin Mill -- This facility is an integrated Kraft pulp-and-paperboard mill located east of Antioch on the San Joaquin River. The mill produces about 765 tons per day of corrugating medium, bleached Kraft food board, and line board from wood.

The wastes are discharged from the mill through two outfalls. Combined process wastes (15.4 mgd) are discharged, through a 3700 foot outfall (001), to the ship channel on the north side of West Island. Other than being subject to in-plant controls, such as Save-Alls, this waste stream receives no treatment other than pH adjustment.

Barometric condenser water (9.3 mgd) from four sets of sextuple evaporators is discharged, through a 500-foot outfall (002), to a deep water channel in the San Joaquin River. No treatment is provided.

Comparison of EPA sampling results with Corporation data [Appendix G, Table G-4] indicates that waste loads discharged during the EPA sampling were lower than average for most parameters. Even then waste loads were far in excess of effluent levels achievable by best practicable control technology.

High total-coliform concentrations (36,000 MPN/100 ml) in discharge 001 made this source the largest industrial contributor of coliform bacteria in the Bay area. No State waste discharge requirement for coliform bacteria has been established for this source.

Crown Zellerbach, Antioch -- Crown Zellerbach operates a paper-and-paperboard mill, adjacent to Fibreboard Corporation in Antioch. The mill produces about 500 tons per day of paperboard, towel, and tissue from waste paper and slush virgin pulp.

Cooling water and process wastes are discharged through a short common outfall to the near-shore deepwater channel of the San Joaquin River. Process wastes receive only neutralization.

As would be expected for the low degree of treatment, waste loads [Table VI-10] are far in excess of levels achievable by best practicable control technology. Crown Zellerbach is scheduled to provide additional treatment by the end of 1973.

Tillie Lewis Foods, Inc., Antioch -- This is a seasonal cannery operation processing only tomatoes. The production capacity and length of the canning season are unknown. (The plant is located on the west edge of Antioch.)

All wastes (12 mgd) are discharged through a single outfall to a small slough about 100 feet from the San Joaquin River. Caustic rinse waters are neutralized before their discharge. All wastes are screened. The effluent is monitored and the pH adjusted as necessary to meet State waste discharge requirements. As indicated [Table VI-11], waste concentrations are strong and far exceed effluent levels attainable by best practicable control technology.

This source is scheduled to provide improved treatment to meet new State waste discharge requirements by July 1973.

Fibreboard Corporation, Plant No. 2 -- The Fibreboard Corporation operates a paperboard mill in west Antioch, adjacent to Tillie Lewis Foods. The mill uses about 110 tons of waste paper fiber per day to produce boxboard, paperboard, folding boxboard, linerboard, and new board.

The plant effluent (4.8 mgd) is discharged, through a surface outfall, to the same unnamed slough receiving the Tillie Lewis effluent. The effluent is screened, filtered by vacuum filters, and neutralized before discharge.

Waste loads discharged [Table VI-10] are far in excess of effluent levels achievable with best practical control technology. This plant might close rather than install additonal treatment facilities.

Hickmott Foods, Inc., Antioch -- A seasonal cannery is operated by this corporation in Antioch on the San Joaquin River. The cannery processes both tomatoes (90-day season) and asparagus (70-day season). During the seasons the plant processes about 500 tons per day of tomatoes and 50 tons per day of asparagus.

Wastes are discharged from the cannery to the San Joaquin River through three outfalls. The largest volume (1.3 mgd) of process wastes is discharged through Outfall 001. This waste receives screening, pH control, and chlorination. A small volume of process wastes (0.2 mgd) is discharged through Outfall 002, with the same treatment as waste stream 001. Cooling water (0.7 mgd) is discharged through Outfall 003. All three outfalls are used during tomato-canning operations, while only Outfall 001 is used during asparagus canning.

These canning wastes are not receiving best practicable control and waste loads, as a result, are excessive.

E. I. duPont deNemours & Co., Inc., Antioch -- The Antioch Works is engaged in the manufacture of titanium dioxide pigments, tetraethyl lead (about 135 tons/day), and Freon (approx. 37 tons/day).

Process wastes (1.3 mgd) are discharged through a 200-foot outfall to the San Joaquin River, just upstream of the Antioch Bridge. The waste stream is neutralized and treated for clarification and solids removal.

Extensive use is made of recirculation and settling ponds. The effluent pH is automatically controlled. About 700 to 1200 lb/day of organic liquids are disposed of by deep-well injection, 6000 feet undergound.

Discharges of COD, chromium, lead and sulfate [Table VI-10] are in excess of levels achievable by best practicable control technology.

Kaiser Gypsum Company, Antioch -- The Kaiser Antioch Plant manufactures gypsum wallboard. The only waste from this operation discharged to the San Joaquin River is a wet scrubber effluent (0.5 mgd) containing gypsum dust. In early 1972 a cooling tower was installed in order to cool this discharge. The suspended solids concentrations in this effluent are excessive [Table VI-10].

Pacific Gas and Electric Company, Pittsburg -- The Pittsburg Power Plant is the largest thermal-electric generating plant in the Bay area. Currently on line are six generating units with a capacity of 1,340 mw. A seventh unit, with a generating capacity of 750 mw, is under construction, with completion scheduled for late 1972. The existing discharge from once-through cooling is about 1050 mgd. The temperature rise above ambient is about 15°-17°F.

The seventh unit was originally scheduled to have once-through cooling (500 mgd) also, but has been modified to a semi-closed cooling system using about 50 mgd of cooling water.

Infra-red imagery of this discharge, during July, showed that the thermal plume above ambient water temperature extended for 800 feet in width and 2500 feet in length.

Pacific Gas and Electric Company, Antioch -- The Contra Costa Power Plant is comparable in size to the existing Pittsburg plant. Its seven units have a generating capacity of 1260 mw. The cooling water discharge averages about 970 mgd.

Infra-red imagery of this discharge, taken in July 1972, showed that the thermal plume extends for about 900 feet offshore and 3500 feet in length.

E. FEDERAL INSTALLATIONS

With the exception of a single source, the volume of all waste discharges from Federal installations is two mgd or less. Collectively, eleven Federal installations [Table VI-12] discharge, to the San Francisco Bay system, 21.9 mgd. Of that total wastewater, 16.3 mgd is identified as industrial discharges and 5.6 mgd as domestic discharges. Among the major constituents comprising the wastewater are: 1,700 lb/day of BOD; 1,500 lb/day of COD; 1,700 lb/day of suspended solids; and an undetermined amount of oil and grease.

The largest discharges among the Federal installations are: Mare Island Naval Shipyard, Vallejo, with a 16.0 mgd industrial discharge and 1.5 mgd domestic discharge; and Travis Air Force Base with a 1.55 mgd domestic discharge. Of the twelve wastestreams from eleven Federal installations, five do not receive any treatment, five receive primary treatment, and two secondary treatment.

The Federal Water Pollution Control Act Amendments of 1972 require that Federal installations must meet the same requirements as other point

TABLE VI-12

WASTE DISCHARGES FROM FEDERAL FACILITIES

Map Key	Zone	Discharger	Treatment	Flow (mgd)
F-1	5	Mare Island Naval Shipyard		
		Power Plant	None	16.0
		Municipal	Primary	1.5
F-2	4	U. S. Navy - Treasure Island	Secondary	2.0
F-3	7	Travis Air Force Base	Primary and Stabilization Pond	1.55
F-4	3	Alameda Naval Air Station	None	0.3
F-5	5	Hamilton Air Force Base	Secondary	0.3
F-6	5	Naval Security Group Activity, Skaggs Island	Primary	0.15
F-7	7	U. S. Naval Weapons Station-Concord	None	0.07
F-8	3	U. S. Navy - Yerba Buena Island	Primary	0.02
F-9	3	Hunters Point Naval Shipyard-Industrial	None	0.012
F-10	5	Naval Fuel Department, Point Molate, Richmond	Primary	0.006
F-11	1	Moffett Field Naval Air Station, Mountain View - Industrial	None	0.004
				21.912 mgd

sources of pollution. Thus, all domestic sewage discharges must receive secondary treatment by July 1977. All industrial waste discharges must receive the best practicable control technology currently available by the same date. If industrial wastes are discharged to publicly owned treatment facilities, pre-treatment of such wastes could be required.

Mare Island Naval Shipyard, Vallejo

Domestic wastes (1.5 mgd) presently receive primary treatment before discharge to Mare Island Strait. During wet weather raw domestic wastewater frequently is discharged. Industrial wastes from ship repairing operations; including acids, alkalis, heavy metals, cyanides, and phenolic materials; are discharged, without treatment, to the Strait. Oil from cleaning rail and truck tank cars and oil spills from transfer operations are discharged without treatment. In addition, 16.0 mgd of power-plant cooling water is discharged.

Proposed abatement measures include separation of storm and sanitary sewers in order to eliminate the overflow of domestic wastes to Mare Island Strait. The domestic wastes will be routed to the Vallejo municipal treatment system. Proposed measures for treatment of the industrial wastes include collection, pretreatment, and eventual connection to the Vallejo system.

Completion of the industrial-waste collection system and of the domestic waste connection to the Vallejo municipal system are scheduled for fiscal year 1974.

Naval Station, Treasure Island, San Francisco

Domestic wastewater (approximately 2.0 mgd) from a secondary treatment plant is discharged to Central San Francisco Bay through an outfall 65 feet below the bay surface. The plant is currently operating at its design capacity (2.0 mgd). Industrial wastewater from the washing and sterilizing of garbage cans is discharged to Central San Francisco Bay through storm drains.

Travis Air Force Base - Solano County

Domestic wastes are collected from housing, administrative operational, maintenance, and recreational areas. Non-domestic wastes include irrigation and cooling water, aircraft and vehicle wash waters, occasional formaldehyde wastes from aircraft disinfection stations, and waste oils from maintenance areas.

The base has a separate sanitary and storm sewer system. Domestic wastes (except those discharging to septic tanks) are connected by sanitary sewers to one of two sewage treatment plants. The storm sewer system carries off irrigation wastewater, cooling waters, and storm runoff. Vehicle- and aircraft-wash waters are primarily carried by the storm system directly to Union Creek. Wash waters from Strategic Air Command (SAC) and Military Airlift Command (MAC) washracks pass through oil separators before discharge to the storm sewer system. The base fire departments collect and burn waste oils from maintenance areas.

Domestic waste is presently being treated at one of two plants located on the base. Wastewater Treatment Plant No. 1 has a design capacity of 2.5 mgd. The average daily flow to the plant is 1.5 mgd, with a maximum of 2.6 mgd and a minimum of 1.3 mgd. Treatment provided is screening, primary sedimentation (with continuous sludge and scum removal to separate digesters in series), sludge-drying beds and stabilization ponds. Effluent is discharged to Union Creek. Wastewater Treatment Plant No. 2 has a design capacity of 0.07 mgd and is presently treating an average flow of 0.05 mgd. Treatment units at this plant consist of a manually cleaned bar screen, Imhoff tank, biofilter, secondary sedimentation tank, and sludge-drying beds.

Naval Air Station Alameda, Alameda

The Station discharges untreated industrial wastes (0.3 mgd) containing acids; alkalis; heavy metals; cyanides; paint stripping; filter backwash (from swimming pool and cooling tower bleed off); boiler blowdown; and soft-water, de-alkalizer wastes. In addition, deficiencies in septic tanks allow for the discharge of inadequately treated wastewater. There is minor treatment provided for source wastes in order to remove free oil and sludge before discharge. Removal of concentrated solutions of oils and solvents is accomplished by a hauling contractor. Proposed abatement actions call for an industrial waste treatment plant and collection system which has been designed; construction is planned in fiscal year 1973. When completed in mid-1973, the proposed system will discharge the pretreated industrial wastes into the East Bay MUD System. This construction will eliminate all industrial discharges from NAS Alameda into bay waters.

Hamilton Air Force Base (Near Novato)

The base discharges an average of about 0.3 mgd of industrial and municipal wastewater. The industrial waste plant provides pretreatment by removing gasoline and oils and by neutralizing acids with the addition of lime. The effluent of this plant is sent to the domestic plant for further treatment. The domestic plant provides secondary treatment for the base's domestic wastes and pretreated industrial wastes. The plant, of a trickling filter design, has an outfall discharging to San Pablo Bay.

Naval Security Group Activity, Skaggs Island

The Skaggs Island facility discharges approximately 0.15 mgd of domestic wastewater. This waste is treated in a primary treatment plant that discharges at several locations to the Napa and Second Napa sloughs. One septic tank discharges to a leaching field.

Proposed measures for improving this treatment include construction of an oxidation evaporation pond system that will remove essentially all BOD and suspended solids. Completion of this project is scheduled for fiscal 1973.

Naval Weapons Station, Concord

The station discharges 0.07 mgd of primary treated and untreated domestic waste. In addition, unknown amounts of boiler blowdown, cooling tower blowdown, and steam cleaning water are discharged. Existing treatment consists of septic tanks for 5,000 gallons per day of the domestic waste. All other waste is untreated.

Proposed measures call for a sewage collection system with all wastes pumped to the Contra Costa County Sanitation District sewerage system for treatment and final discharge. The proposed schedule stipulates that connection of the domestic waste be completed during fiscal 1973 and of the industrial waste, during fiscal 1974.

U. S. Navy, Yerba Buena Island

Approximately 0.02 mgd of domestic wastes are treated through a primary treatment plant. The plant consists of an Imhoff tank and chlorination facility. About 35 percent of the BOD and 45 percent of the suspended solids are removed prior to discharge.

Hunters Point Naval Shipyard

The shipyard discharges most of its domestic and industrial waste to the City of San Francisco municipal system. Rinse water (12,000 gallons/day) from a metal plating shop and battery overhaul shop is the only direct discharge to the bay. Future treatment proposals for this effluent have not been made available.

Naval Fuel Department Point Molate, Richmond

Unchlorinated primary effluent from the Point Molate wastewater treatment facility is discharged to San Francisco Bay through an outfall terminating at the low water level. Raw sewage from restrooms (serving 6-8 men) on the pier discharges directly to the bay. In the event of major spillage, or rupture of tanks or fuel lines, fuel can flow directly into San Francisco Bay at Point Molate. Pollution is also caused by spillage of oil to San Francisco Bay during fuel- or balast-transfer operations.

The discharge (0.006 mgd) from the station sewer is currently treated in an Imhoff tank (design capacity 0.002 mgd). The treatment achieves about 35 percent reduction in BOD and 55 percent reduction in suspended solids. There is no disinfection. Spills are now handled by commercial contractor, and the cost is often excessive. Proposed remedial measures are to replace the Imhoff tank with a package plant, incorporating advanced treatment processes for production of a high quality effluent. It is planned to lengthen the outfall. A diked catch basin will be constructed to contain oil spills. Also for spillage during oil transfer operations, an oil recovery pipeline and accessories linking a suction type oil skimming apparatus will be provided. Existing piping will convey the skimmer discharge to existing storage and clarification facilities.

Moffett Field Naval Air Station, Mountain View

Moffett Field generates industrial wastewater from hobby shop washracks (automobile), boiler blowdown, and swimming pool filter backwash. These sources except for one washrack have been connected, together with all base domestic waste, to the City of Sunnyvale Municipal plant. Therefore essentially all discharge of wastes to the bay have been eliminated. Connection of the remaining washrack (4,000 gpd) to the sanitary system is in the planning stage.

F. COMBINED SEWER OVERFLOWS

Initially, the older urban developments in the bay area were usually served by combined sewer systems that were used to convey both domestic sewage and storm runoff directly to San Francisco Bay. The largest combined sewer systems were found in San Francisco, Oakland, and Berkeley. Extensive programs have been undertaken in order to separate storm and sanitary sewers. San Francisco still has large areas served by combined sewers. Minor areas of Oakland and other East Bay cities are also served by combined sewers. In addition, storm water infiltration is a problem in older sanitary sewer systems in a number of cities in the area.

Normal operation of a combined sewer system, during dry weather periods, provides for interception and treatment of all waste flows. During wet weather periods combined sewage flows, in excess of treatment plant capacity, are normally by-passed directly to the receiving waters. Combined sewage during the early stages of storm runoff may have characteristics comparable to domestic sewage. Thus, the combined sewer overflows can have an impact on receving waters comparable to raw-sewage by-passes.

In the Bay system, the water quality characterisitics most affected are coliform bacteria levels and concentrations of oil and grease and other floatable materials. Combined sewer overflows are a major source of high bacterial levels observed during wet weather periods. Floating materials including oil and grease discharged by combined sewers cause unsightly conditions over large areas following periods of storm runoff.

An extensive study of storm water induced problems in the sanitary sewer system serving the East Bay Municipal Utility District was made during the 1968-69 rainy season.—/ The EBMUD is an area of about 51,400 acres encompassing the cities of Alameda, Albany, Berkeley, Emeryville, Oakland, and Piedmont. About four percent of the area is still served by combined sewers, primarily in Oakland and Berkeley. The entire dryweather flow from the District is treated in the EBMUD primary treatment plant.

During the 1968-69 rainy season it was estimated that about one-third of the increased flow in the sanitary sewer system, attributed to storm water infiltration, originated in the small area of combined sewers. The remaining increase in flow was attributed to infiltration of storm water throughout the system with the heaviest infiltration occurring in old sewer sections.

A number of problems result from the increased sewage flow during storms. Some sewers become overloaded and overflow at manholes, causing public health hazards. In other cases, relief devices by-pass sewage to the storm sewer system or directly to the Bay. By-passing also occurs at the EBMUD treatment plant. Because the storm water carries a heavy load of silt and grease, operational difficulties are encountered at the treatment facility.

During the 1968-69 rainy season, bypasses at the EBMUD treatment plant occurred for a total of 186 hours with an estimated 1,300 million gallons by-passed. Overflows at other points in the system resulted in the discharge of an estimated 1,030 million gallons.

With the use of water quality simulation models, the effects of the EBMUD overflows on water quality in Zones 3 and 4 were estimated.—/ Oil and grease in excess of allowable limits would persist for two to six days following a major storm event and would affect about 22 square miles of the Bay. Violations of applicable bacterial limits would occur for 23 days per year in Zones 3 and 4 as a result of the EBMUD sewer overflows alone. Some depressions of DO levels below allowable limits would also occur in the vicinity of overflow points.

Improvements of sewers in order to reduce infiltration and increase capacity and the treatment of system overflows prior to discharge to the Bay were recommended solutions to the EBMUD stormwater problem. Such improvements and facilities would cost an estimated $50 million.—/

Similar, combined sewer problems occur in San Francisco. Owing to the large area served by combined sewers, the problems are of a larger scale than those encountered in the EBMUD and water quality impacts more severe. The San Francisco treatment plants were designed to process approximately three times the average dry weather flow. Therefore, by-passing and combined sewer overflow would occur when a precipitation greater than just a light rain occurred. This would result in raw sewage and storm water overflows from 40 outfalls which discharge into the Bay and Pacific Ocean.

A study of the San Francisco system, completed in 1967, concluded that separation of storm and sanitary sewers would not substantially reduce pollution from storm runoff.[/] The most effective means of abating this pollution was determined to be treatment of combined sewer overflows using the dissolved air flotation process, followed by chlorination. A demonstration project employing this treatment process was initiated in 1970. The project results and current estimates of costs for abatement of pollution from combined sewers in San Francisco are not available.

A recent study prepared by the San Francisco Department of Public Works in 1971 revealed the magnitude of the problem and recommended a solution.[/] Currently, during an average year, combined sewer overflow occurs 82 times for a total of 205 hours, with a total volume of 6 billion gallons. The study indicates that such overflow causes the emission of 42 million pounds of suspended solids, 11 million pounds of grease, and nearly 5 million pounds of phosphates.

As a solution to the problem of wet weather by-passing, the Master Plan recommended an extensive construction program consisting of four major components:

1. A new 15-ft. diameter, five-mile-long outfall to the Pacific Ocean, offshore of Fort Funston.
2. A new 1000 mgd treatment plant, westerly of Lake Merced, for wet weather treatment.
3. A system of inland and shoreline underground retention basins to retain the combined flow for subsequent treatment.
4. A tunnel transport and storage system to provide the option of intercepting, storing and transporting flow to the new treatment plant.

The Board of Supervisors must decide on the design overflow frequency. This in turn will determine the cost of the project that has been estimated, in 1974 dollars, at from $395 million for eight overflows per year to $864 million for one overflow in five years.

G. DREDGING ACTIVITIES

A total of about 14 million cubic yards of sediments have been deposited in the San Francisco Bay system during the past century. An additional seven million cubic yards enter the estuary annually. Most of these sediments are carried on through the estuary to the Pacific Ocean by tidal flows. Significant volumes of the incoming sediments are deposited in the estuary, however, and, in combination with movement of sediments already in the estuary, cause shoaling of navigable channels.

Dredging of navigational channels to maintain suitable water depths, in combination with construction of new channels, results in the excavation and transfer of about 7 to 11 million cubic yards of sediments annually. Both the dredging activities and the disposal of the excavated material (spoil) can cause pollution problems.

The excavation of bottom materials results in the suspension of finer sediments in the waters surrounding the dredging activities. Increased turbidity can result, causing aesthetic problems. More importantly, pollutants trapped in the sediments can be released into overlying waters resulting in water-quality degradation. Suspended sediments can be transported substantial distances before settling out. If the volume of sediments is large, blanketing of bottom areas with adverse effects on the benthos can result.

In the San Francisco Bay area, spoil from dredging activities is disposed of in three ways: 1) barged to the open ocean and dumped, 2) used for landfill, and 3) dumped at one of six designated spoil disposal areas in the Bay system. Both the ocean and bay disposal of spoil can produce water quality problems as a result of suspension of sediments and disperson of pollutants.

EPA has developed guidelines for disposal of spoil in estuarine areas.[1] These guidelines specify limits on various pollutants that must be met if the spoil is discharged to water areas. Much of the sediment dredged from San Francisco Bay areas will not meet these limits, thus necessitating higher cost land or ocean disposal. The EPA guidelines are currently undergoing review to determine whether regional revision of the criteria is necessary in order to minimize the economic impact on dredging activities while providing adequate protection of water quality in spoil disposal areas.

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VII. IMPACT OF POLLUTION ON WATER USES

A. COMMERCIAL SHELLFISH HARVESTING

The State of California Regional Water Quality Control Board has designated propagation and harvesting of shellfish a beneficial use to be protected in the San Francisco Bay system.[1/] This beneficial use is impaired, to a major degree, by water pollution resulting from the discharge, to the bay system, of inadequately treated municipal and industrial wastes, by combined sewer overflows, by urban runoff, and by dredging, landfill, and spoil disposal practices.

A century ago, a major commercial shellfishing industry was centered on San Francisco Bay. Harvests of oysters and clams reached a peak in the 1890's and then declined sharply after 1900. Presently, this industry is non-existent. Water pollution, resulting primarily from discharges of untreated sewage, has been the most important cause of the elimination of shellfish harvesting from the Bay system.[G/]

If existing water quality constraints are eliminated, the potential exists for reestablishment of a major shellfishery in the Bay. Although illegal -- owing to the closure of shellfish beds because of bacterial contamination, some harvesting of shellfish, by individuals, for food presently occurs. A sizeable standing crop of clams and native oysters is present in the bay system. Research has shown that Pacific and Eastern oysters can be grown using modern cultural methods.

The following sections discuss the history, present status, and potential development of the oyster and clam fisheries in the bay system and the estimated economic impact of pollution on the shellfish industry.

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Oyster Fishery

History -- The native western oyster (*Ostrea lurida*) was present in San Francisco Bay in prodigious quantities before the 1890's, and clams and mussels were plentiful, too. Extensive beds of the oysters were located in shallow areas along the west side of the South Bay. The extent to which the shell deposits were built up by the native oysters is reflected by the more than 50 million cubic yards of shell that have been dredged from the bay over the past 30 years; an estimated 75 million cubic yards still remain in the bay.

The native oyster was exploited commercially by simply harvesting oysters from the natural beds. No attempt at oyster culture was made. The introduction of other commercially important oyster species combined with destruction of oyster beds by siltation and pollution rapidly decreased the importance of the native oyster. Since 1945, there has been little or no commercial harvest of the native oyster in California.[V/]

In 1869, the eastern oyster (*Crassostrea virginica*) was introduced to San Francisco Bay. This oyster thrived under culture and provided a major source of oysters during the next 30 years. The method of culture was simple. Seed oysters (spat) were imported from East-coast locations. The spat attached to shell pieces were set out in suitable beds and allowed to reach market size. The adult oysters were then harvested by hand.

The first commercial beds were located at Sausalito, Point San Quentin, Sheep Island, Oakland Creek, and Alameda Creek.[22/] These beds were soon abandoned owing to bacterial contamination or adverse physical conditions and, by 1875, all beds were located only in the southern portions

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of San Francisco Bay.[22/] [Historical locations of commercial oyster beds are shown in Figure VII-1.] The Oakland and Alameda Creek beds were abandoned because of sewage and traffic on the bay.[22/] The Alvarado beds were abandoned because of adverse hydrographic conditions.

Between 1880 and 1900 the culture of eastern oysters in San Francisco Bay and the importing of seed oysters from the East Coast was a million-dollar-a-year business. During the 1890's the oyster industry of San Francisco Bay was the single most valuable fishery in California. Records of oyster harvests during this peak period are incomplete and conflicting, but they do provide an idea of the major oyster production then existing. Between the years 1888 and 1895 the annual oyster production (whole oysters including shells) was estimated to range from 9 to 15 million pounds, with a value of 500 to 700 thousand dollars.[20/] Other records of oyster harvests (meats only) indicated that a peak production of 3,060,000 pounds of oyster meat, valued at $867,000, was reached in 1899.[22/] During the 1887 to 1895 period imports of seed oysters ranged from 1.0 to 3.3 million pounds annually. Most of the oyster harvest was obtained from commercial beds, totalling 3,000 to 4,000 acres in area.[23/]

About 1900 in the southern end of San Francisco Bay, unknown events caused a radical change that adversely affected the growth rate and market condition of oysters grown there. Pollution also affected conditions in much of the bay. The choicest oyster growing locations were heavily contaminated, yielding oysters of poor quality. As a result, the oyster industry was short-lived. By 1908, oyster production had decreased 95 percent from reported landings in 1892.[23/]

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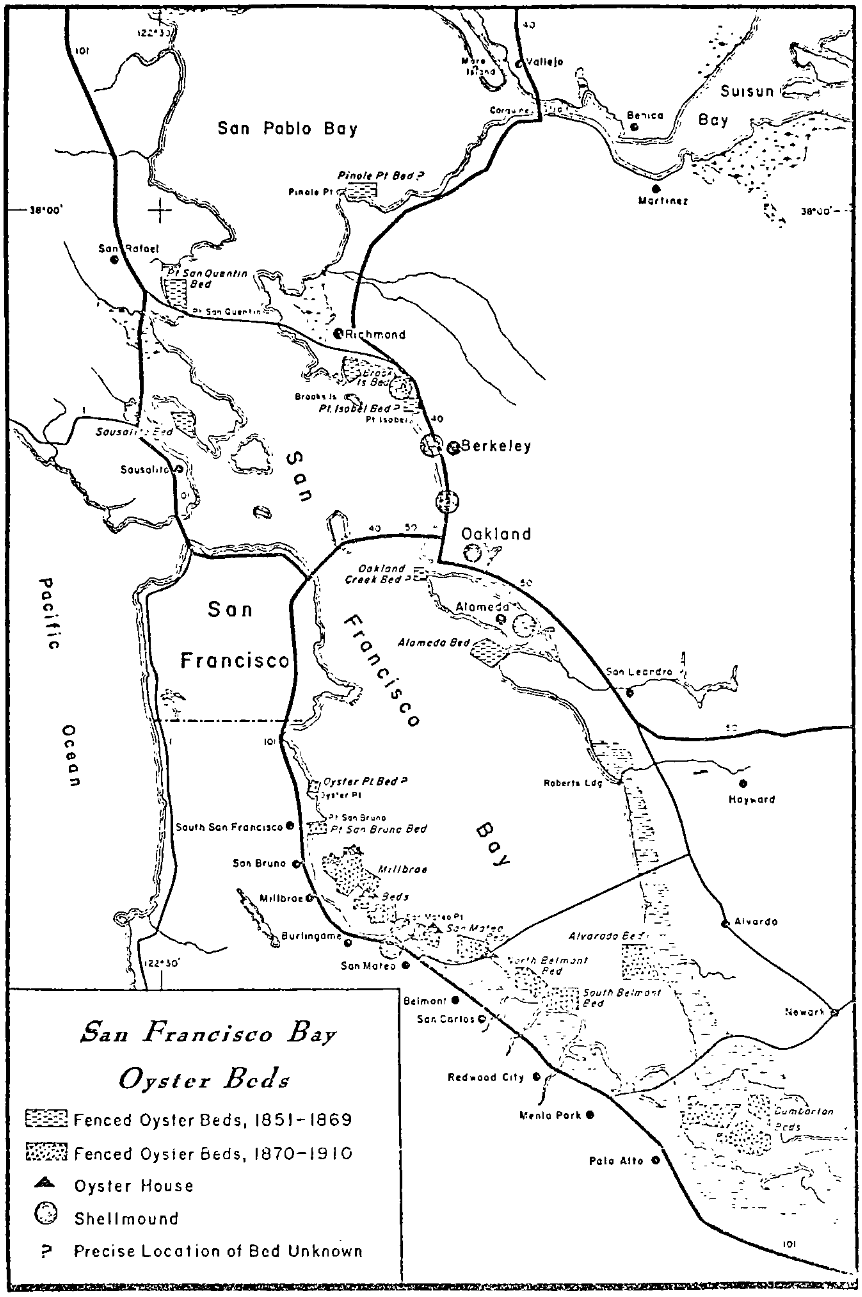

Figure VII-1. Historic Commercial Shellfish Bed Locations

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Attempts were made to grow eastern oysters in other California waters, but met with little success. Shellfish harvests in California continued a long decline until 1931, when the pacific oyster (*Crassostrea gigas*) was imported from Japan. Commercial beds were successfully established in Bodega Lagoon, Tomales Bay, and Drakes Estero, small bays on the coast a short distance north of San Francisco Bay. Culture of the Pacific oyster was also successful in coastal Humboldt and Morro Bays. Pacific oysters were not cultured in San Francisco Bay, owing to the water pollution still being present.

The culture of Pacific oysters revived the California oyster industry and statewide landings steadily increased except during and immediately after World War II when imports of seed oysters from Japan were stopped. At the same time the San Francisco Bay oyster fishery steadily declined and is, at present, non-existent.

Present Status -- A survey of the intertidal zone of the Bay system in 1967 located 42 shellfish beds containing sizeable standing crops of shellfish.[24/] Native oysters were present in half these beds and numerous at 11 locations. Five beds contained an abundance of native oysters. No recent survey has been made of the distribution and populations of native oysters in areas of the bay lying below low tide elevation.

Eastern and Pacific oysters do not spawn well in the bay system because water temperatures are unfavorable. These oysters are thus rarely found except where artifically cultured.

There are no existing commercial oyster beds in the bay system. A state allotment, for oyster cultural purposes, of 3,000 acreas in San

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Pablo Bay, was held by an oyster company during the 1960's, but was abandoned without development. Oystermen express an interest in developing an oyster fishery in the bay system if restrictions on harvesting are lifted.[G/]

Since 1960 the State Department of Fish and Game has been conducting studies of the rack culture of Eastern and Pacific oysters in Redwood Creek (in southern San Francisco Bay). The Leslie Salt Company also experimented with oyster culture in the same area. These studies indicated favorable growth rates can be achieved under present water quality conditions.

All of the bay system is closed to commercial harvesting of shellfish for human consumption because of the bacterial contamination of shellfish growing areas. In addition, the State Department of Health has recommended, to local health departments, the posting of most known shellfish beds in order to prevent sport harvesting of shellfish for human consumption. A number of beds have been posted. In spite of these prohibitions and postings, illegal harvesting of shellfish has been observed. In most cases, the shellfish taken were clams; the extent of illegal harvesting of native oysters is unknown. The State of California Department of Health studies have shown that shellfish from many of the beds are contaminated with bacteria, and, in some cases, with heavy metals and pesticides, to a degree that poses a health hazard to human consumption.[25/]

Studies, conducted during 1969 and 1970 by the State Department of Health, showed that, in several limited areas, bacterial concentrations in waters overlying shellfish beds met applicable limits for "Approved"

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or "Conditionally Approved" shellfish harvesting areas.[25,26/] In most cases, however, shellfish taken from these beds had unacceptable levels of bacterial contamination. Waste disposal and disinfection practices at nearby municipal waste sources were also found to be inadequate for guaranteeing the continued safety of shellfish harvesting, even if acceptable water quality existed over the beds. Thus, improvement in both water quality conditions and waste disposal practices will be needed before acceptable conditions will exist for approval of any shellfish harvesting areas.

Potential Development -- In view of the physical conditions of the bay system and of the capability for high oyster production that has been demonstrated in the past, it is possible that an oyster fishery of exceptional proportions could be developed using rack culture techniques. About 175,000 acres of the bay system are potential oyster grounds, based on physical conditions.[26/] In the past about 3,000 to 4,000 acres of oyster beds were commercially maintained. Thus, development of at least 4,000 acres of oyster beds in the bay system would appear to be readily achievable.

During the 1890's, oyster production was in the range of 2,500 to 5,000 pounds of oysters per acre per year.[26/] This corresponds to an oyster meat production of 400 to 750 pounds per acre. From 1958 to 1967 oyster meat production in California averaged about one million pounds annually. If it is assumed that this harvest was taken from the 4,400 acres of registered shellfish areas, the average oyster meat production was about 230 pounds per acre. This compares favorably with a California

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Department of Fish and Game estimate of yields of 150 to 300 pounds per acre for culture of Pacific oysters.[27] The oysters harvested in the 1890's were eastern oysters, while recent harvests in California were primarily Pacific oysters.

A yield of 250 pounds of oyster meat per acre, from 4,000 acres, would produce an annual harvest of about 1 million pounds of oyster meat. Thus San Francisco Bay has the potential to match or exceed the oyster production of all other California growing areas combined.

The oyster production figures just mentioned are based on bottom culture methods historically used in San Francisco Bay. Modern rack culture methods hold the promise of even greater production levels. State Department of Fish and Game biologists have estimated that it would be possible to produce, using rack culture for about 80 percent of the production,[28] a total of about 13 millions pounds of oyster meat annually from the bay system. About 70 percent of the oysters would be grown in the southern portions of San Francisco Bay and the remainder in San Pablo Bay.

Clam Fishery

History -- The early shellfish fauna of the Bay system was extensive, but few species were of commercial importance. The most common edible species was the bent-nose clam (*Macoma nasuta*). Large quantities of these clams were probably dug from the South Bay for the market prior to 1876.[26]

The soft-shelled clam was accidentally introduced in oyster shipments about 1870. It soon displaced some native species and became widely distributed. It is an excellent food clam and formed the bulk of the San

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Francisco clam trade. The mud flats of San Pablo Bay and the southern portions of San Francisco Bay were particularly favorable locations.

Harvests of clams from the bay system exhibited the same rise and fall as did oyster fishery. Between 1880 and 1900 clam production ranged between one and three million pounds annually, the highest production recorded.[23/] After 1900 clam production decreased sharply. Pollution and excessive digging contributed to this decline. Between 1916 and 1935 the annual commercial harvest ranged from 100 to 300 thousand pounds. The production continued to decline after 1935 and, after 1949, was essentially zero.

Present Status -- A survey of the intertidal zone of the Bay system in 1967 located 42 definable shellfish beds containing sizeable standing crops of clams.[24/] [Bed locations and clam populations observed in 1967 are summarized in Table VII-1. Bed locations are shown in Figure V-3.] In addition to the 42 beds, clams were found scattered throughout most of the intertidal zone. Sizeable clam populations are also believed to exist in areas below low tide elevation, although no recent surveys of these areas have been made.

A total of 19 of the 42 beds identified in 1967 were re-surveyed in early 1972 in order to evaluate possible changes in the size and number of clams present [Appendix C]. Fifteen of the 19 beds were found to have significantly smaller total weights of clams than in 1967. Shellfish beds surveyed and associated changes in clam populations have been summarized [Appendix C, Table C-3]. The beds that were re-surveyed were the larger beds with the some potential for commercial or sport shellfishing. Small

TABLE VII-1
SUMMARY OF SHELLFISH BED CHARACTERISTICS

Bed No.	Location	Area (1,000 ft^2)	Shellfish Populations[a] Clams	Shellfish Populations[a] Oysters	Present Uses	Potential Uses	Limiting Factors
1	Candlestick Point	0.5	small	present	bait	fully utilized	--
2	Bayview Park, northeast of	0.2	small	present	bait	bait	--
3	Bayview Park	19.0	medium	--	bait	--	--
4	Bayshore, to the east of	1.5	small	--	minor bait	bait	Storm drainage and sewer overflows
5	Visitation Valley, to the east of	15.5	small	present	minor bait	bait	--
6	Brisbane, to the east of	5.4	small	numerous	fish food	bait and sport	Access, bacterial contamination
7	Oyster Point	0.6	small	numerous	minor bait	bait	Access
8	Point San Bruno, South Side	17.9	medium	numerous	minor bait	bait and sport	Municipal and Industrial Wastes. Bacterial contamination
9	Burlingame	250.0	large	numerous	fish food	commercial bait, sport shellfishing	Bacterial Contamination. Most of area recently filled.
10	Coyote Point, north of	102.6	large	large	bait and sport	bait and sport	Bacterial Contamination.
11	Coyote Point, south of	78.0	medium	numerous	bait and sport	bait and sport	Bacterial Contamination. Municipal Wastes.
12	San Mateo Creek	1.0	small	(Old Commercial Bed)	fish food	bait	Municipal Wastes.
13	West end of San Mateo Bridge	1.2	small	--	minor bait	limited sport	Municipal Wastes.
14	Foster City	799.0	large	present (Old Commercial Bed)	minor bait	bait and major sport	Bacterial Contamination. Municipal Wastes.
15	Redwood City	18.0	small	numerous (Experimental Culture area)	fish food	bait and minor sport	Bacterial Contamination. Oil Spills.

TABLE VII-1 (CONTINUED)
SUMMARY OF SHELLFISH BED CHARACTERISTICS

Bed No.	Location	Area (1,000 ft^2)	Shellfish Populations[a/] Clams	Shellfish Populations[a/] Oysters	Present Uses	Potential Uses	Limiting Factors
16	Dumbarton Bridge, west end of	1.9	small	--	minor bait	bait	--
17	Dumbarton Bridge, east side of	7.2	medium	--	fish food	bait and minor sport	Bacterial Contamination.
18	San Leandro Marina	41.4	large	--	bait	commercial bait	--
19	Oakland Airport	84.0	small	large (Major Native Oyster Bed)	fish food	bait and sport commercial oyster culturing	Bacterial Contamination. Municipal Wastes. Dredging Sediment Blanket.
20	San Leandro Bay	100.8	large	numerous (Old Commercial Bed)	bait and sport	commercial bait	Municipal and Industrial Wastes, Bacterial Contamination.
21	Alameda Island, southwest corner	7.2	medium	present	bait	bait and sport	Bacterial Contamination.
22	Alameda Memorial State Beach	17.4	medium	numerous	bait and sport	major sport	Bacterial Contamination.
23	Oakland Inner Harbor, foot of Alice Street	39.0	large	present	--	--	--
24	Emeryville, foot of Ashby Ave.	1.6	small	present	bait	bait	--
25	Berkeley, foot of Bancroft Way	22.8	medium	present	bait	bait	--
26	Berkeley, foot of University Ave.	0.8	small	--	bait and sport	bait and minor sport	Bacterial Contamination.
27	Albany Hill	3,780.0	large	--	fish food	commercial bait major sport	Bacterial Contamination. Municipal Wastes
28	Point Isabel, north of	1.1	small	numerous	fish food	commercial bait minor sport	Bacterial Contamination. Municipal Wastes.
29	Point Richmond	90.0	medium	present	minor bait	bait and minor sport	Bacterial Contamination. Municipal Wastes

TABLE VII-1 (CONTINUED)
SUMMARY OF SHELLFISH BED CHARACTERISTICS

Bed No.	Location	Area (1,000 ft^2)	Shellfish Populations[a] Clams	Oysters	Present Uses	Potential Uses	Limiting Factors
30	Castro Point, Molate Point, Point Orient, & Point San Pablo	128.4	medium	numerous	fish food	bait and sport	Bacterial Contamination.
31	Point Pinole, north side	unknown	unknown	unknown	unknown	unknown	Access.
32	Tara Hills	48.0	large (Old Commercial Bed)	--	sport	sport	Bacterial Contamination. Municipal Wastes.
33	Between Tara Hills & Pinole Beds	61.5	medium	--	--	--	--
34	Pinole	60.0	large	--	fish food	bait	Bacterial Contamination. Municipal Wastes.
35	Rodeo	5.0	small	dead	--	unknown	Municipal and Industrial Pollution.
36	Gallinas Creek, south of	2.3	small	--	fish food	bait	Municipal Wastes.
37	Area between Gallinas Creek & Rat Rock	1.1	small	--	unknown	unknown	--
38	Rat Rock Area	2.0	small	--	bait	bait	--
39	San Rafael Bay	25.0	large	numerous	unknown	unknown	Access
40	San Quentin	9.6	large	--	unknown	unknown	--
41	Strawberry Point, west side of	28.8	medium	present	bait and sport	major sport	Bacterial Contamination.
42	Richardson Bay, north end of Highway 101 Bridge	12.0	medium	--	unknown	unknown	--

[a] Population Legend
Small - Less than 50,000 clams
Medium - 50,000 to 200,000 clams
Large - More than 200,000 clams
Present - Live native oysters present
Numerous - More than 5 native oysters per square foot on rocks and other suitable substrate

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beds as well as beds located near sewage outfalls were not re-surveyed. The Point San Bruno Bed was also not surveyed for this bed has been essentially completely destroyed by landfill. As measured by changes in the standing crop of legal harvest size clams, the total clam resource, in the 19 beds evaluated, decreased by about 42 percent. With the loss of the Point San Bruno Bed, it is probable that the clam resource in San Francisco Bay has been depleted by about half in the past five years.

Present use of the clam fishery is primarily for fish bait [Table VII-1], although some sport shellfishing takes place. As previously discussed in the section on oysters, such harvesting of clams for human consumption is illegal for it poses a health hazard to the consumer.

Potential Development -- Should public health restrictions be lifted, the present clam fishery is not considered adequate to support any significant commercial harvesting for human consumption. Substantial habitat improvement would be required to maintain a commercially harvestable clam population. The cost of such improvements could likely make commercial development uneconomical.

Based on the 1967 survey are the estimates that the clam fishery could support more than 400,000 man-days of sport shellfishing.[24/] The 1972 re-survey indicates that the present clam fishery would support only about half this much sport fishing [Appendix C, Table C-3]. This sport fishing would include the taking of clams for both fish bait and human consumption. The primary reason presently limiting full use of the clam resource is bacterial contamination of growing areas. Several beds could potentially support a commercial fish bait operation.[24/]

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Reductions in clam populations are caused by discharges of municipal and industrial wastes in close proximity to shellfish beds and by destruction of habitat by landfill, dredging, and spoil disposal practices. Control of these variables, in order to minimize their impact on the clam fishery, could result in a greater use of this resource.

Economic Impacts

Commercial shellfish harvesting from the San Francisco Bay system has been eliminated by pollution as a beneficial use of the waters. The major shellfishing industry existing prior to 1900 has been eliminated as a ingredient of the regional economy. Since 1930 a major increase has occurred in the oyster fishery at other California locations, thus indicating the probability that the San Francisco oyster industry would have thrived economically if water quality constraints had been removed.

Elimination of an industry generating a million dollars annually in 1900 undoubtedly created a major impact on the San Francisco area economy. It is impossible to estimate the total economic effect the loss of this fishery has produced during the last 70 years. Two possible approaches can be taken, however, to estimate the current economic impact. Owing to the fact that the growth of the shellfish industry in other areas of California was primarily the result of a shift in commercial beds from San Francisco Bay to these areas as bay beds became polluted, the value of the out-state fishery could be considered one measure of the value of the lost fishery. A second estimate can be obtained from the value of the potential production discussed previously.

Statistics on California oyster harvest are available for several

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years, between 1892 and 1922, and for every year thereafter [Table VII-2].[20] Since the year 1939, the statisitics are also available, categorized by fishing region.[29] The San Francisco fishing region includes the bay system and the coastal waters from Point Arena to Pigeon Point including Tomales Bay, Bodega Bay, Bolinas Lagoon, and Drakes Estero. Prior to 1939 essentially all of the California oyster harvest came from San Francisco Bay. In recent years, all of the oyster harvest reported for the San Francisco fishing region came from coastal waters other than San Francisco Bay.

By subtracting the value of the oyster harvest in the San Francisco region from the total California harvest [Table VII-2], one can determine the value of the oyster harvest from all other California regions. For the period 1958 to 1967 the total value of the harvest from other regions was $2,050,000, an annual average of $205,000.

The California fishery does not produce an oyster supply adequate to meet the California demand for oysters. Therefore supplies are shipped in from out-of-state. If water quality constraints are removed, San Francisco Bay has the potential to produce more oysters than the existing California fishery. An annual value of $205,000 for the lost fishery is considered a conservative estimate, as a larger oyster production would probably have occurred to meet local demands if restrictions on harvesting were to be removed.

As discussed previously, estimates of the oyster production potential of the San Francisco Bay system range from 1 to 13 million pounds of oyster meats annually. At a dockside price of $0.40 per pound this production would have an annual value of $400,000 tp $5,200,000. The large

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Table VII-2 Summary of Oyster Harvest Statistics

	Total Oyster Harvest (1,000 pounds of meat)		Value ($1,000)		Unit Price ($/lb)	
Year	California	San Francisco*	California	San Francisco	California	San Francisco
1892	1,316					
1895	1,145					
1899	3,060		867		0.28	
1904	1,406		536		0.38	
1908	729		337		0.46	
1915	387		166		0.43	
1922	74					
1923	69		24		0.35	
1924	53		23		0.43	
1925	57		24		0.43	
1926	61		26		0.43	
1927	55		24		0.43	
1928	77		32		0.43	
1929	53		27		0.50	
1930	78		32		0.42	
1931	245		76		0.32	
1932	59		19		0.33	
1933	86		29		0.33	
1934	101		43		0.43	
1935	107		40		0.37	
1936	105		27		0.26	
1937	163		38		0.24	
1938	213		50		0.23	
1939	246	242	51	50	0.21	0.21
1940	193	180	27	25	0.14	0.14
1941	256	240	48	42	0.19	0.18
1942	85	50	29	17	0.34	0.34
1943	117	57	38	19	0.33	0.33
1944	90	35	48	24	0.53	0.69
1945	48	19	28	17	0.59	0.90
1946	22	12	19	14	0.86	1.17
1947	24	19	26	22	1.05	1.16
1948	66	48	63	53	0.95	1.10
1949	35	20	26	18	0.76	0.90
1950	39	32	36	35	0.94	1.09

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Table VII-2. Summary of Oyster Harvest Statistics

Year	Total Oyster Harvest (1,000 pounds of meat)		Value ($1,000)		Unit Price ($/lb)	
	California	San Francisco *	California	San Francisco	California	San Francisco
1951	43	41	46	53	1.06	1.29
1952	45	39	47	46	1.04	1.18
1953	38	34	44	43	1.18	1.26
1954	74	36	54	47	0.73	1.30
1955	218	42	89	56	0.40	1.33
1956	756	59	178	75	0.23	1.27
1957	1,359	64	287	41	0.21	0.64
1958	1,159	75	242	54	0.21	0.72
1959	1,653	54	309	42	0.19	0.78
1960	1,283	32	289	34	0.23	1.06
1961	1,221	79	296	63	0.25	0.80
1962	1,339	61	306	46	0.23	0.75
1963	1,300	186	226	36	0.17	0.19
1964	1,360	213	254	47	0.19	0.22
1965	1,063	195	263	64	0.25	0.33
1966	790	234	222	92	0.28	0.39
1967	742	199	207	81	0.28	0.40

* San Francisco Fishing Region including the San Francisco Bay System and coastal waters from Point Arena to Pigeon Point.

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supply associated with the upper limit of potential production would probably result in reduced prices, making an upper limit of $2,600,000 ($0.20 per pound) for the potential value of the fishery more realistic.

It is doubtful whether a significant commercial clam industry can be established in the bay. The value of the potential commercial bait industry is unknown, but is probably small. It is probable that water quality constraints are the primary elements preventing the development of at least one-third of potential recreational shellfishing based on the existing clam fishery. As previously discussed, the potential recreational shellfishery has decreased from a value of about 400,000 man-days in 1967 to about 200,000 man-days in 1972. At a value of two dollars per man-day this decrease represents an economic loss of about $400,000 over a five-day period. The portion of this loss that can be attributed to water pollution is unknown, but it is believed to be substantial. Pollution also prevents the use of much of the remaining potential clam resource, valued on the same basis at $400,000.

Various studies have shown that the economic impact of the shellfish industry on the regional economy is about four times the dockside value of shellfish products.[30/] With this multiplier, the total economic impact of pollution on the economy of the San Francisco area, as the result of the loss of the oyster fishery. is in the range of $820,000 to $10,400,000.

This estimate considers only the multiplied economic effect of the harvested oysters. An additional economic impact would be produced by the importation of seed oysters to supply cultural requirements. That economic effect is unknown. Further, an additional but unknown economic impact is also produced by the loss of the clam fishery.

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San Francisco Bay has the potential to produce a shellfish supply adequate to meet local needs and create a surplus that could be marketed in interstate commerce. Pollution of the bay prevents the realization of this potential.

Large-scale commercial production of oysters in San Francisco Bay would require culture of either Eastern or Pacific oysters. Such cultural practices would require the interstate importation of large numbers of seed oysters. Pollution of San Francisco Bay prevents the practice of oyster culture and, thus, prevents the market of seed oysters in interstate commerce to provide the basis for oyster production.

B. DETRIMENTAL EFFECTS ON AQUATIC LIFE

San Francisco Bay has been richly endowed with fish life. The fishes of San Francisco Bay can be divided into six categories: 1) schooling, pelagic, bait, and forage fishes; 2) flatfishes; 3) bottom fishes; 4) sharks, skates, and rays; 5) croakers; and 6) anadromous fishes. The most valuable (both commercial and sport fishing) group of fishes in San Francisco Bay are the anadromous fishes; the category includes such fishes as the striped bass and chinook salmon. The bait and forage fishes, such as smelt and whitebait, are extremely important as food for other fishes. Some species of whitebait inhabit the bay throughout the year; thus, water quality in the bay would affect them more than fish that occupy the bay only a portion of the year. During the period from 1916-1958, the commercial harvest of whitebait ranged from a high of 161,797 lb in 1916 to a low of 3,487 lb in 1943. The opinion has been expressed that the polluted condition of South Bay is probably among the pra

chief reasons these fish have not been seen in the same numbers as in former years.[20]

Fish kills have occurred annually in San Francisco Bay, particularly in the Suisun Bay and Carquinez Strait area. These kills generally occur during the spring and summer in the vicinity of municipal waste treatment plants and industrial waste discharges and involve thousands of fish [Appendix F]. More than 56 percent of the reported fish kills were from unknown causes; however, of those from known causes, about 20 percent resulted from low dissolved oxygen, 7 percent from sewage, 9 percent from an industrial pollutant and the remainder (8 percent) from other causes. Most of these kills were investigated by the California Department of Fish and Game.

Food supply can also limit fish populations. The opossum shrimp is the most important source of food of a number of fishes at some stage during their life in San Francisco Bay. This crustacean requires 7-8 mg/l of dissolved oxygen[12] and water temperatures below 22.8°C.[22] The eutrophication of Suisun Bay and Western Delta waters that is projected is expected to lead to a dissolved oxygen depression.[20] If the oxygen concentration drops below 6 mg/l, the anadromous fish population, including striped bass, king salmon, and American shad, is expected to decline.[20]

Water temperatures in that area approached the critical temperature for opossum shrimp. When water temperatures exceed 22.2°C, opossum shrimp populations in the Sacramento-San Joaquin estuary generally decrease.[20]

C. RECREATION

Waters of the San Francisco Bay system are heavily employed for non-contact recreation including boating, sailing, and fishing. Some areas of the bay also support contact recreation including swimming and water skiing. Prior to the late 1960's when widespread improvements in disinfection of waste effluents were made, bacterial contamination made most of the bay system unsafe for water contact recreation. In the vicinity of waste discharges bacterial concentrations posed a serious health hazard.

As a result of the improved disinfection practices, most of the bay system has water quality acceptable for water contact recreation during dry weather periods. Applicable water quality criteria are met most of the time at the Alameda, Coyote Point, and Point Molate beaches and part of the time at the San Francisco Aquatic Park and Marina beaches.[1] During wet weather, however, combined sewer overflows and sewage treatment plant bypassing caused by excessive infiltration produce bacterial contamination of recreation areas. Occasional malfunctioning of disinfection equipment at waste sources also contributes to bacterial contamination. In many areas bacterial levels are high enough to pose a health hazard to recreational shellfishing although such shellfishing continues.

Thus, impairment of recreational uses of the bay system has been substantially reduced in the last decade. However, impairment of such uses continues and will continue until combined sewer overflows and treatment plant bypasses are controlled, adequate controls are installed to ensure continuous disinfection of waste effluents, and until waste discharge points are relocated to offshore locations remote from beaches and recreational areas.

VIII. STATUS OF POLLUTION ABATEMENT

A. PRESENT AND PAST POLLUTION ABATEMENT ACTIONS

All sources of municipal and industrial wastes discharged to the San Francisco Bay system are subject to regulation by the California water pollution control program. This program is under the jurisdiction of the State Water Resources Control Board and nine regional boards. The majority of the San Francisco Bay system is under the jurisdication of the San Francisco Bay Regional Water Quality Control Board headquartered in Oakland. Waste sources in the Delta area are regulated by the Central Valley Regional Water Quality Control Board with headquarters in Sacramento.

All waste dischargers are required to have a discharge permit from the appropriate regional board. These permits specify effluent limitations, receiving water standards, monitoring requirements, and an implementation schedule. The waste discharge requirements are designed to be compatible with and to supplement the Federal-State water quality standards [Appendix A] established in accordance with the Water Quality Act of 1965.

Three types of actions are taken by the regional boards to secure abatement of pollution. The first step is the issuance of resolutions. General policy, waste discharge requirements, and compliance time schedules are all issued by resolution. Individual dischargers are required to report periodically to the regional boards on their status of compliance with applicable resolutions and to submit self-monitoring data on their waste discharge and affected receiving waters. The boards then review the reports and self-monitoring data to assess the status of compliance with applicable requirements.

In cases where a discharger is found to be in non-compliance with either waste discharge requirements or compliance time schedules, the regional board may issue a Cease and Desist Order which specifies corrective actions to be taken including a time schedule for compliance. The Cease and Desist Order is the first step in the State's enforcement action.

If a waste discharger does not comply with the requirements of a Cease and Desist Order, the regional board may then refer the case to the appropriate legal authority for court action, the second and final State enforcement action. The State's timetable for completing abatement actions for all waste sources was set forth in the implementation plan developed as a part of the Federal-State water quality standards [Appendix H, Table H-1].

Although the self-monitoring program, supplemented in some cases by independent State sampling, may adequately assess compliance with waste discharge requirements, the program in the past has not required as complete a monitoring program as possible in order to assess overall adequacy of treatment facilities. In many cases, significant sources of pollution or waste quality parameters were not included in self-monitoring data and adequate definition of abatement needs was virtually impossible. Presently, the self-monitoring requirements are being revised and it is anticipated that all significant parameters will be included in the revised requirements.

All major dischargers to San Francisco Bay are under resolutions issued by the appropriate regional boards. In almost all cases, resolutions have been or are presently being revised to reflect new State policies which include the water quality standards and the interim water quality management plans. Further revisions of the waste discharge requirements will be needed as the sub-regional water quality management plans are finalized and to achieve compliance with the Federal Water Pollution Control Act Amendments of 1972 discussed in the next section.

The San Francisco Bay Regional Water Quality Control Board summarized pollution abatement actions taken by the Board and resulting accomplishments in an informal report to EPA submitted on August 31, 1972. Pertinent excerpts follow:

".. Forty Three (43) per cent of the volume of municipal waste discharged to the Bay system now receives secondary treatment while the remaining fifty-seven (57) per cent which now receives primary treatment will receive secondary treatment or better when the subregional wastewater management programs now being implemented are complete.

".. All industries with the exception of Alameda Naval Air Station and Hunters Point Naval Shipyard provide treatment prior to discharge to the Bay System. Many of these industries provide a degree of treatment equivalent to secondary and the Regional Boards has initiated hearings on the establishment of secondary level treatment for all major industrial waste dischargers in the Region.

".. A total of one hundred twenty-two (122) cease and desist orders have been issued for violation of waste discharge requirements, nineteen (19) to industries, seventy-nine (79) to communities and twenty-four (24) to other types of waste dischargers. Sixty (60) orders have been issued subsequent to January 1, 1970.

".. Fourteen (14) cleanup and abatement orders have been issued to persons depositing waste that caused pollution or nuisance.

".. United States Navy (USS Midway) and Phillips Petroleum Company have been cited to the State Attorney General for causing oil to be deposited in waters of the State.

".. Six (6) waste dischargers were referred to the county district attorneys prior to 1970 all resulting in correction of violations. Twelve (12) waste dischargers have been referred to the State Attorney General for action since January 1, 1970;

four of these cases have resulted in decisions supportive of the State, corrective action was taken by four dischargers prior to court action and four cases are now in process of litigation or awaiting trial dates.

".. Adoption of requirements which provide for the implementation of subregional studies by including compliance time schedules consistent with timing of the subregional facilities. These actions include interim requirements providing improvement in treatment during the interim period, require source control of conservative toxicants and minimization of infiltration."

The present status of compliance with applicable resolutions and orders for all major waste dischargers and resulting actions by the State and/or Federal government for cases in non-compliance are summarized in tabular form in Appendix H [Municipal sources, Table H-2; Industrial sources, Table H-3; Federal facilities, Table H-4].

Review of the State enforcement actions and the status of abatement tables indicates one obvious trend. Many waste sources in the past have delayed construction of necessary treatment facilities. This is indicated by the numerous revisions of time schedules included in State resolutions. Recently major progress has been made in some instances, however, progress is still lacking in other cases.

As shown in Table VIII-1, about 20 percent of the major waste sources listed in Table H-2, H-3, and H-4 are presently known to not be in compliance with State waste discharge requirements. Table VIII-2 summarizes the State enforcement actions initiated to bring these sources into compliance with applicable requirements.

No enforcement measures against pollution of interstate or navigable waters have been taken by EPA in the Bay area pursuant to the provisions of the Federal Water Pollution Control Act. During 1971, however, settlements were achieved, in cooperation with the State, with two industrial

TABLE VIII-1

SUMMARY OF COMPLIANCE WITH STATE RESOLUTIONS

Source Category	Total Sources In Category	Sources Not Complying With Waste Discharge Requirements	
		Total	Percent
Major Municipal	47	17	36
Major Industrial	22		
Federal Installation	8		
Total			

TABLE VIII-2

SUMMARY OF STATE ENFORCEMENT ACTIONS

Source Category	Total Not In Compliance	Cease and Desist Orders	Time Schedule Established	Presently Meeting Time Schedule	Court Actions
Major Municipal	17	19	14	6	3
Major Industrial		8	8	8	2
Federal Installations					
Total					

dischargers in an effort to abate pollution or achieve compliance with State discharge requirements. The dischargers were Merck Chemical in South San Francisco and United States Steel in Pittsburg. In July 1972, a commitment letter was obtained from Fiberboard Corp. in Antioch.

The U.S. Attorney's office has taken action to prosecute several Refuse Act violations. Beginning in the Fall of 1970, information was received by the U.S. Attorney's office from private citizens concerning alleged industrial pollution of San Francisco Bay. These cases were referred to EPA for investigation. Several industries involved were subject to Cease and Desist Orders issued by the State Water Quality Control Board establishing dates for compliance, and installation of improved facilites.

The U.S. Attorney's office currently has 22 cases under investigation for alleged water pollution by industrial waste or unauthorized filling of navigable waters. The U.S. Army Corps of Engineers has issued warnings and demands to correct unauthorized fill operations. The companies involved are correcting the situation and the U.S. Attorney expects the Army to refer only two cases for injunctive relief. All fill occurrences, except one, were referred by private citizens and turned over to the Corps for investigation.

As can be seen by the above status report, much can be done to improve on the Federal-State program to achieve discharger compliance. A review of the large number of dischargers still not in compliance, indicates the need for a more agressive abatement program.

The state is strenghtening their program and are developing requirements consistent with interim water quality management plans and water quality standards. In addition to establishment of discharge requirements, strict but practicable time schedules must be developed. These schedules, which should be both Federally and State enforceable, should lead to compliance with water quality standards in the shortest possible time. Where long range goals are too far off and immediate improvements are necessary, interim requirements and time schedules must be established.

B. FUTURE POLLUTION ABATEMENT ACTIONS

The Federal Water Pollution Control Act Amendments of 1972 require EPA to promulgate of standards, guidelines, and regulations that govern many of the enforceable requirements of the Act.

Most important are the limitations on the quantity and quality of effluents which may be discharged into any of the Nation's waters. All point sources of pollution (including Federal facilities), other than publicly owned treatment works, that discharge directly into the navigable waters (defined as the "waters of the United States including the territorial seas") are required to achieve, not later than July 1, 1977, effluent limitations which shall require the application of the best practicable control technology currently avialable, as determined by the EPA. Not later than July 1, 1983, the same point sources must achieve effluent limitations that shall require the application of the best available technology economically achievable.

Industries, including Federal facilties, discharging into publicly owned treatment works must comply with pretreatment standards which are to be promulgated by the EPA.

Publicly owned treatment works must meet by July 1, 1977, effluent limitations which are based on secondary treatment, and by July 1, 1983, the best practicable waste treatment technology.

The 1972 Amendments provide for the continuation of the framework of State water quality standards required under the Water Quality Act of 1965. In addition, water quality standards applicable to intrastate waters must be submitted to the EPA within a required time frame. In every case, the promulgated effluent limitations must be sufficiently stringent to maintain water quality as prescribed by the standards. Authority is reserved to each State to impose effluent limitations more stringent than those required by the EPA where the State deems such action necessary to meet its own State water quality standards.

National Standards of Performance must be prescribed by EPA which require effluent limitations for new sources of pollution reflecting the best available demonstrated control technology, including where practicable, no discharge of pollution.

Effluent standards must also be established for the control of toxic pollutants. Pretreatment standards must be met by industrial waste sources discharging to publicly owned treatment works.

The discharge of any pollutant by any person is unlawful unless permitted under the National Pollutant Discharge Elimination System (Permit Program). The EPA is authorized to issue permits for the discharge of pollutants. The issuance of permits is a practical device whereby the various effluent limitations, standards, and other requirements of the Act are actually applied to individual source of pollution.

The Permit Program (NPDES) established under the 1972 Amendments, supplants the permit program previously established pursuant to Section 13 of the Rivers and Harbors Act of March 3, 1899.

The EPA must establish guidelines within which the separate States must operate their permit programs if they desire to assume this responsibility. Each State program must be approved by EPA and is subject to assumption of operation by EPA if the State does not administer the program consistent with the 1972 Act. When a State permit program has been approved by the EPA, the State becomes the permit-issuing authority for sources within its jurisdiction and the EPA ceases to issue permits within that State. EPA, however, retains a permit-by-permit veto power in cases where a State permit does not conform to the guidelines and requirements of the law or where waters of a downstream State are being polluted by a permitted effluent discharge in another State. Violations of the conditions (effluent limitations compliance schedules, etc.) of a permit issued by the Administrator or by a State pursuant to the NPDES, are subject to enforcement.

Enforcement prerogatives are available to the EPA when any person violates Effluent Limitations, Water Quality Related Effluent Limitations, National Standards of Performance, Toxic and Pretreatment Effluent Standards, Inspection and Monitoring requirements or any permit condition including compliance schedules.

The present Regional Board Permit Program, regulating discharges to San Francisco Bay, partially fulfills the requirements of the 1972 Amendments. Some of the actions that will be necessary in order to fully comply are as follows:

1. The requirement that all publicly owned treatment works provide secondary treatment of all wastes discharged to the Bay by no later than July 1, 1977.
2. The requirement that the best practicable control technology currently available be applied to all industrial waste discharges to the Bay by no later than July 1, 1977.
3. The requirement that industrial wastes, discharged to publicly owned treatment works, be pretreated to remove toxic substances to levels which will not inhibit treatment of the combined wastes by biological treatment systems, no pass through the public systems in concentrations which are deleterious to the established uses of the waters of the Bay.
4. Revision of toxicity provisions of present Board Resolutions in order to conform with the requirements of Sections 307 and 502(13) of the 1972 Amendments, and the list of toxic substances which is to be promulgated by EPA.
5. Augmentation of present self-monitoring requirements to provide for systematic monitoring of effluents by appropriate regulatory agencies.
6. The promulgation with Federal approval, of Water Quality Standards for intrastate waters of the Bay area.

Detailed requirements for approval of State permit programs are contained in the Federal Register, Volume 39, Number 219. "State Program Elements Necessary for Participation in National Pollution Discharge Elimination System," published November 11, 1972. Final guidelines are expected to be published shortly.

Federal activities discharging wastewaters directly to the Bay must conform to the requirements for best practicable control technology by July 1, 1977, best available technology economically achievable by July 1, 1983, and the pretreatment provision applicable to industrial wastewater discharges.

APPENDIX A

APPENDIX A

WATER QUALITY CRITERIA (OBJECTIVES)
APPLICABLE TO THE TIDAL WATERS OF
THE SAN FRANCISCO BAY SYSTEM*

A. WATER QUALITY OBJECTIVES APPLICABLE TO ALL TIDAL WATERS

Temperature
No significant variation beyond present natural background levels (Notes A and B);

Turbidity
No significant variation beyond present natural background levels (Notes A and B);

Apparent Color
No significant variation beyond present natural background levels (Notes A and B);

Bottom Deposits
None other than of natural causes (Note A);

Floating Materials
None other than of natural causes at any place;

Oil or Materials of Petroleum Origin or Products
None floating in quantities sufficient to cause an iridescence, or none suspended, or deposited on the substrate at any place;

Odors
None other than of natural causes at any place;

Dissolved Oxygen
Minimum of 5 mg/l; when natural factors cause lesser concentrations, then controllable water quality factors shall not cause further reduction in the concentration of dissolved oxygen;

Pesticides
No individual pesticide or combination of pesticides shall reach concentrations found to be deleterious to fish or wildlife at any place (Note A);

---

* Excerpts from "Water Quality Control Policy for Tidal Waters Inland from the Golden Gate within the San Francisco Bay Region," San Francisco Bay Regional Water Quality Control Board, State of California, 1967.

Toxic or Deleterious Substances

None present in concentrations which are deleterious to any of the beneficial water uses to be protected; none at levels which render aquatic life or wildlife unfit for human consumption (Note A);

Coliform Organisms

Sewage-bearing waste discharges shall at not time cause the quality of tidal waters which are determined by this Regional Board to be physically accessible at any time to the public for whole or limited body water-contact recreation uses and that are otherwise suitable for such uses to fail to meet the physical and bacteriological standards as set forth in California Administrative Code, Title 17, Sections 7957 and 7958;

> California Administrative Code, Title 17
>
> 7957. Physical Standard. No sewage, sludge, grease or other physical evidence of sewage discharge shall be visible at any time on any public beaches or water-contact sports areas.
>
> 7958. Bacteriological Standards. Bacteriological standards for each public beach or water-contact sports area shall be as follows:
>
> Samples of water from each sampling station at a public beach or public water-contact sports area shall have a most probable number of coliform organisms less than 1,000 per 100 ml. (10 per ml.); provided that not more than 20 percent of the samples at any sampling station, in any 30-day period, may exceed 1,000 per 100 ml. (10 per ml.), and provided further that no single sample when verified by a repeat sample taken within 48 hours shall exceed 10,000 per 100 ml. (100 per ml.).

Sewage-bearing waste discharges shall at no time cause areas protected by this Regional Board pursuant to Paragraph XVII of Resolution No. 803 for shellfishing for human consumption to exceed bacteriological standards to be adopted by this Board;

Nutrients

Total nitrogen concentration shall not exceed 2.0 mg/l as nitrogen at any point within the Region easterly of Carquines Strait; in no case shall nutrients be present in concentrations sufficient to cause deleterious or abnormal biotic growths except when factors which are not controllable cause greater concentrations (Note A);

Radioactivity

None present in concentrations exceeding levels set forth in California Radiation Control Regulations, Subchapter 4, Chapter 5, Title 17, California Administrative Code at any place; and

Hydrogen Ion Concentration - pH
The pH shall remain within the limits of 7.0 to 8.5; when natural factors cause the pH to be less than 7.0, then further depression by controllable factors will be determined by the Regional Board on a case-by-case basis.

B. WATER QUALITY OBJECTIVES APPLICABLE TO TIDAL WATERS EAST OF THE WESTERLY END OF CHIPPS ISLAND

Following levels in mg/l shall not be exceeded within 2,000 feet of diversions when tidal waters are used for domestic water supplies (Notes C and D):

Lead	0.05	Sulfates	250.
Selenium	0.01	Alkyl Benzene Sulfonates	0.5
Arsenic	0.01	Carbon Chloroform Extract	0.2
Chromium, Hexavalent	0.05	Cadmium	0.01
Cyanide	0.01	Barium	0.1
Silver	0.05	Zinc	0.1
Fluoride	0.5	Manganese	0.05
Phenols	0.001	Copper	0.01
		Total Dissolved Solids	500.

Boron shall not excees 0.5 mg/l within 1,000 feet of diversions when tidal waters are used for agricultural supplies (Note C); and

No substance or combination of substances shall be present in concentrations sufficient to cause taste and odors in domestic water supplies, within 2,000 feet of diversions when tidal waters are used for domestic water supplies (Note C).

NOTES

A. The water quality objective will generally apply at the outer limit of the rising waste plume or beyond a limited dilution area as determined by the Regional Board on a case-by-case basis pursuant to the intent stated in the second paragraph of Section II-A. In prescribing requirements for a particular waste discharge, the Regional Board may specify receiving water quality limits, other than the water quality objective contained herein, to apply at control points at or near the outer edge of the rising waste plume if time of exposure and other considerations indicate that adequate protection of beneficial uses is assured.

B. A significant variation beyond present natural background levels will be any level of water quality which has an adverse and unreasonable effect on beneficial water uses or causes nuisance; present natural background levels are not known precisely and will be determined on a case-by-case basis.

C. This objective shall be maintained to the extent that it is reasonably practicable until the domestic, industrial and agricultural water supplies are provided by alternate means to the satisfaction of the Regional Board.

D. Lower levels of these constituents may be adopted by the Regional Board at some future time if evidence becomes available to show that such limits are necessary for protection of aquatic life or wildlife.

APPENDIX B

APPENDIX B

SALMONELLA ANALYSES METHOD

National Field Investigations Center-Denver used a slight variation of the outlined procedure below in all their attempts to recover *Salmonella* in the shellfish.

The successful isolation of *Salmonella* is to be accredited to the Region IX, Environmental Protection Agency Laboratory which utilized the below described procedure.

Enrichments for *Salmonella* organisms consisted of the following steps. Ten gm shellfish meat (suspended in buffered dilution water and homogenized) was added to each of six flasks - three containing Tetrathionate Broth (Difco) and three containing Selenite Broth (Difco). A set of broths was incubated at each of three temperatures - 37°, 41.5°, 43°C. On three to five successive days, a sample from the contents of each flask was streaked onto XLD (Difco) and Brilliant Green (Difco) Agar plates. Colonies with morphologies typical of salmonellae were isolated in pure culture, transferred to Brain Heart Infusion (BHI, Difco) slants, gramstained and screened for biochemical reactions in Enterotubes (Roche Diagnostics). Biochemical characters observed in the Enterotubes were as follows: fermentation of dextrose, dulcitol, and lactose; production of hydrogen sulfide and indole, phenylalanine deaminase, urease, and lysine decarboxglase; and citrate utilization. Isolates giving physiological reactions typical of *Salmonella* reaction patterns were screened for serological reactions with salmonella Vi and somatic group antisera (Difco) and positive cultures were sent to State of California, Department of Health, for final typing and identification.

Initial screening for *Salmonellae* was performed by the fluorescent antibody (FA) technique. Plates were prepared (XLD and Brilliant Green Agars) from enrichment broths after 18 to 24 hours incubation. The inoculated plates were incubated two to three hours, and colony smears were made on FA slides. The slides were then stained with FA salmonella polyvalent serum (Difco) and examined under a Leitz Fluorescence microscope. *Salmonella* enrichment procedures were discontinued for those samples giving less than 3+ fluorescence.

APPENDIX C

APPENDIX C

SHELLFISH POPULATION SURVEY

INTRODUCTION

The biological survey of the shellfish of San Francisco Bay consisted of three parts:

1. An appraisal of the changes in species composition and density between 1967 and 1972 of 19 selected shellfish beds.
2. A review of the ecological factors and space requirements needed for re-establishing oyster beds in San Francisco Bay.
3. A comparison between young market crabs caught in the San Francisco Bay and those caught in Eureka, California, regarding their pesticide and heavy metals content.

Shellfish of present and past importance in San Francisco Bay are listed in Table C-1.

The most extensive part of the survey was that of the shellfish beds to see if they had changed since the survey by Theodore Wooster of the California Fish and Game Department (1968).

The oyster industry had ceased being profitable about 1940 (Barrett, 1963). Pollution of the Bay has been mentioned as one of the reasons for the decline of oyster productivity in San Francisco Bay. The amount of oysters marketed in 1888 was close to a million pounds, but declined to slightly over one thousand pounds by 1939. Re-establishment of these beds would appear feasible if pollution discharges into the Bay were stopped.

Market crab catches off the California coastline have been declining for the last 10 years. San Francisco Bay serves as a nursery ground for the market crabs, although legal-sized crabs are not abundant in the Bay, so commercial fishermen do not attempt to catch them. Some crabs tagged by the California Fish and Game in the Bay have been caught outside of the Bay in the ocean. California Fish and Game personnel feel that more crabs should be found outside the Bay and there is some cause for their decline relating to their survival in the Bay. There has been insufficient data on metal and pesticide content of the crabs in their juvenile stages for these analyses to be useful in understanding the decrease in market crab harvest.

METHODS

The shellfish beds, previously surveyed by Wooster (1968), were sampled for species composition and density following his methods. Basically this involved taking a square foot of substrate to a depth that would include all available shellfish, and placing the material in a wooden-frame sampler having a 1/4 inch hardware cloth bottom. By shaking the sampler in water, the sand, mud, and small gravel would be removed, retaining larger material along with any clams. The shellfish from each square foot of sample were then put into a plastic bag and taken back to the laboratory. Each shellfish was measured for size, and all shellfish of the same species combined to obtain a total weight for each sample.

Analyses of the differences between Wooster's data and the 1972 data were done by non-parametric methods. This was necessary because sampling sites were not chosen, nor sample distribution tested, so that parametric tests could be utilized (Steele and Torrie, 1960). Where too few samples were taken or no shellfish found, no statistical analysis was performed. The survey procedure and the validity of the resulting data was enhanced because of the assistance of Theodore Wooster in the survey. His assistance was provided by the courtesy of the California Fish and Game Department.

Possible commercial oyster bed locations were examined and evaluated in relation to water uses which now exist in San Francisco Bay.

California Fish and Game personnel caught commercial crabs in three locations of San Francisco Bay: Paradise Park Pier on Tiburon Point, a pier near the Carquinez Bridge, and the Red Rock Marina Pier near the Richmond-San Rafael Bridge. Other samples of crabs were collected at Eureka, California. Male and female juvenile crabs were separated, and the flesh from each put into separate jars, packed in ice, and then subsequently frozen until analyzed. The flesh from the crabs was to be analyzed for heavy metals and pesticides by standard EPA methods.

CLAM BED SURVEY

Nineteen beds were sampled to compare their present clam populations with those found by Wooster in 1967. The three principal species that were encountered were the Japanese Littleneck - JL (*Tapes semidecussata*), the soft-shelled clam - SS (*Mya arenaria*), and the Macoma - Mc (*Macoma inconspicua*). The first two species attain legal sizes (ca. 38mm); whereas the third species is too small for practical use.

The comparisons, between the clams found in 1967 and in 1972, concerning their average weights per square foot and size and the economic values of the "angler" days were most important. "Angler" days are found by dividing the total number of legal clams in a bed by 50, the legal daily limit.

Results

The location of the shellfish beds are shown numerically in Figure C-1, with the numbered beds identified in Table C-2. The sampling results are summarized in Table C-3 which compares for 1967 and 1972 values of nineteen beds sampled in both years. This Table gives the mean weight of clams per square foot, the total "angler days", the total weight of clams, and the square foot samples taken in the beds. Figure C-2 is a graphical presentation of the total weights of clams in the beds sampled.

Discussion

The main data from over 100 square foot samples taken from 19 clam beds is given in Table C-3. Approximately the same number of samples were taken from each bed in each year, with more samples taken from the larger beds.

The three parameters compared for the two years - mean gms/ft^2, total "angler days", and total clam weight - all showed approximately 50 percent decrease from 1967 to 1972.

The mean weight of all clams in grams per square foot of sample declined from 196 to 113, a 42 percent decrease. The total weight of clams was derived by multiplying the mean weight in grams/ft^2 for each bed by the size of the bed. Thus large decreases in the weights per square foot would be of more significance if they occurred in the large beds. The total weight decreased by 53 percent from 1967 to 1972. The "angler days" based on legal-size clams in the beds declined by 50 percent from 1967 to 1972. However, not all legal-size clams could be used in calculating economic loss. Only the beds away from sewage outfalls were utlized in this calculation.

The value of the "angler days" was established by finding the prevailing commercial price for 50 legal sized clams, now approximately $2.00, depending on the weight of the clams. Other approaches to establishing economic value, e.g. basing it on recreational use could lead to higher "angler day" values.

Utilizing a value of $2.00 per angling day (a limit of 50 clams, all 38 mm or above in size), the decrease in value of the beds sampled is about $325,000. This represents a 42 percent decrease in the value of this resource. It must be stressed that this only includes the beds surveyed, and also leaves out the loss of the completely covered Point San Bruno Bed. There are also available an unknown amount of areas of South San Francisco Bay which do not become exposed at low tides, but could be harvested by commercial digging machines.

Conclusion

A loss of $325,000 to the clam sport fishery of San Francisco Bay has been sustained since 1967. However, in most beds there are many legal and young clams remaining that could be utilized if they were safe to eat.

Water quality in the Bay should be enhanced in order to prevent further deterioration of the clam population, and to enable harvesting activities to resume.

OYSTER BEDS

The presence of commercial oyster beds in San Francisco Bay before 1940 raises the question of whether or not they could be re-established. The following facts should be noted before proposals to re-establish the beds are made:

1. The California Fish and Game have successfully raised oysters on a limited basis near Redwood City.

2. At present, about 6,000 acres are available for raising oysters in South Bay in hanging cultures, with an equal area available for bottom cultures. About the same area is available in San Pablo Bay for oyster culturing.

3. If these areas were utilized, the productivity should be equal to the total oyster productivity in the United States. Much of the eastern productivity is not in a hanging culture form. Productivity is lower when oysters grow on substrate.

4. The productivity of the beds started declining in the early 1900's. About that time, oyster seed planted in the Bay took longer to develop than elsewhere, and the oysters were thin and watery (Barrett, 1963).

5. Industrial pollution appeared primarily responsible for the decline in productivity. The amelioration of conditions which were bad in 1910 appears increasingly necessary.

6. Hanging cultures of oyster racks are now widely used. These are put in deep water where they will be regularly inundated by the changing tides. Oysters are still cultivated on shallow intertidal zones. However, this means that the area must be fenced to keep out rays and the oysters are subjected to siltation.

7. Many of the sites of the old oyster beds and possible new locations are not usable for the following reasons:

   a. Many old oyster beds sites are now partially filled (i.e. Bay Farm Island, San Rafael Bay, Oyster Point).

   b. Areas of restricted rights, such as shipping lanes, throughout the Bay and the Dumbarton Straits preclude oyster planting in many previously acceptable beds.

   c. Other areas of restricted rights, such as landing zones for amphibious airplanes, and anchorage locations for explosive-containing and regular vessels.

d. Some areas are serving in other capacities such as:

1) Access lanes for marinas.

2) Near-shore waterskiing and sailing areas.

3) Near-shore zones througout the Bay with good troll and bait fishing areas.

8. Esthetic reasons preclude putting the hanging cultures in some locations.

9. There is dispute over ownership of many submerged parts of the Bay

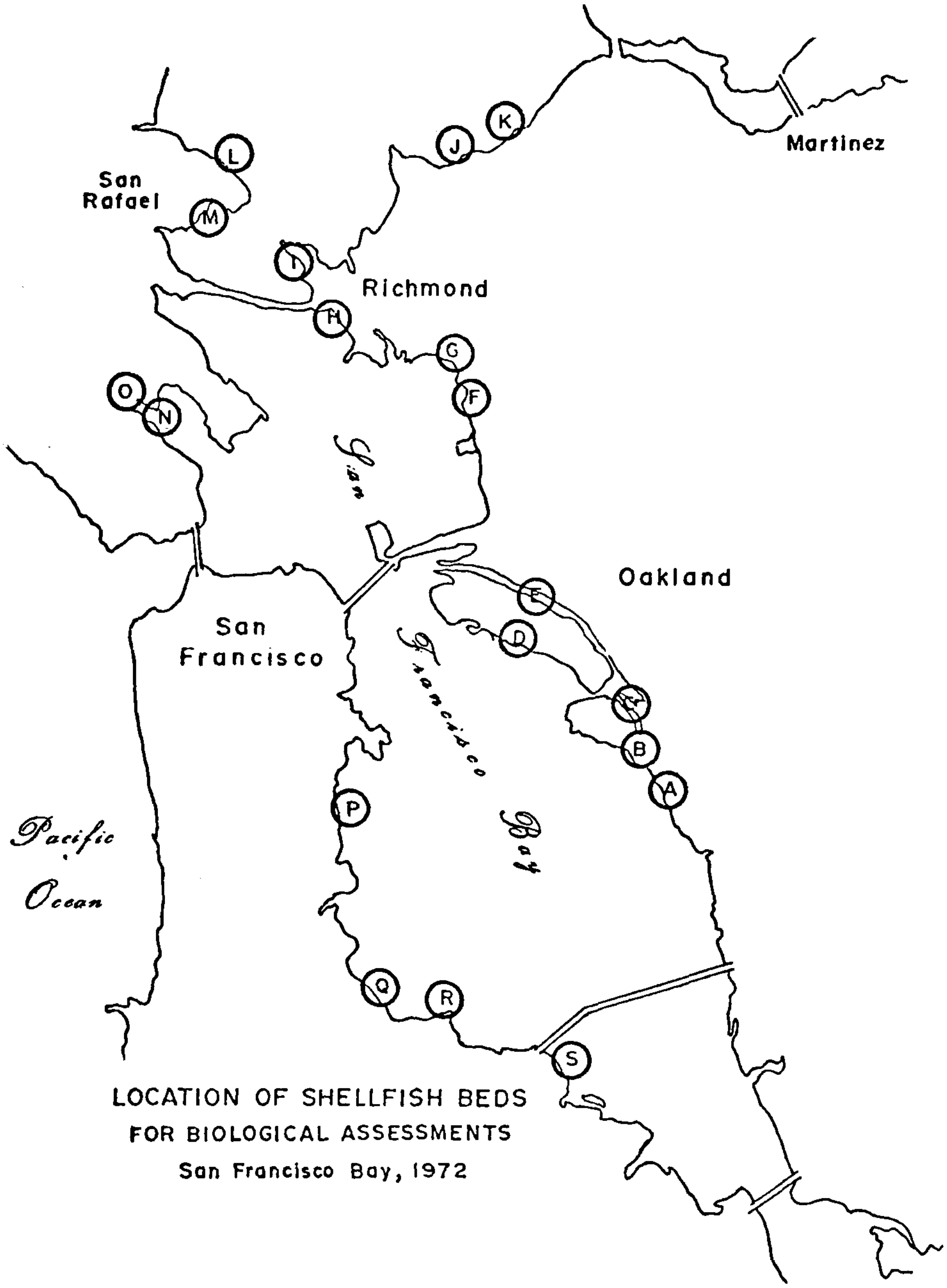
10. BCDC would have to approve the plantings.

11. Market oysters are now easily flown from the east, making the economic feasibility of plantings uncertain.

Conclusions

Although there are sites in the Bay available for oyster culturing, no attempts can be made to do this unless the waters of San Francisco Bay meet Public Health Standards for shellfish.

The re-established oyster beds in the Bay could yield productivity comparable to that in the entire United States, which is about 10,000,000 gallons per year. This would be worth $70,000,000 as Pacific oysters.



LOCATION OF SHELLFISH BEDS
FOR BIOLOGICAL ASSESSMENTS
San Francisco Bay, 1972

FIGURE C-1

TABLE C-1

THE SAN FRANCISCO BAY STUDY-SHELLFISH OF IMPORTANCE

Scientific Name	Common Names or Names	Comments
(Clams)		
Mya arenaria	Soft-shell clam, eastern soft-shell clam, long clam, mud clam	Perhaps indigenous in Bay
Tapes semidecussata	Japanese littleneck	This clam and the soft-shell are of the most important to sportsmen
Protothaca staminea	Littleneck, hard shell, rock clam, rock cockle, Tomales Bay Cockle	Very few now found in Bay. usually near Strawberry Point
Macoma inconspicus		Found frequently in most beds, but too small for practical uses
Macoma nasuta	Bent-nose clam	Shells found frequently
(Oysters)		
Ostrea lurida	Native oyster, Olympia oyster in Puget Sound	Small, widespread, but not commercially important in San Francisco Bay because of size and poor flesh
Crassostrea virginica	Eastern oyster	Shells found in great abundance. Once commercially important, but imported in half-grown or near marketing size and held in Bay until needed. Commercially important in east
Crassostrea gigas	Japanese oyster, giant pacific oyster, pacific oyster	This is the commercially important oyster grown from imported seed along the Pacific Coast
(Mussels)		
Volsella demissa	Ribbed horse mussel	Prominent in South San Francisco Bay in Cord Grass
Mytilus edulis	Bay Mussel	Found in rock and pilings throughout Bay
(Crab)		
Cancer magister	"Edible" crab, Dungeness crab	The Bay is a nursery area for females

TABLE C-2

IDENTIFICATION OF BEDS
NUMBERED IN FIGURE C-1

Code	Bed
A	San Leandro Marina
B	Oakland Airport
C	San Leandro Bay
D	Alameda Memorial State Beach
E	Oakland Inner Harbor
F	Albany Hills
G	Point Isabel
H	North of Keller Beach
I	Point Castro-Point San Pablo
J	Tara Hills
K	Pinole
L	China Camp
M	Beach Drive - San Rafael Bay
N	Strawberry Point
O	Richardson Bridge
P	Brisbane
Q	Burlingame
R	Coyote Point
S	Foster City

TABLE C-3

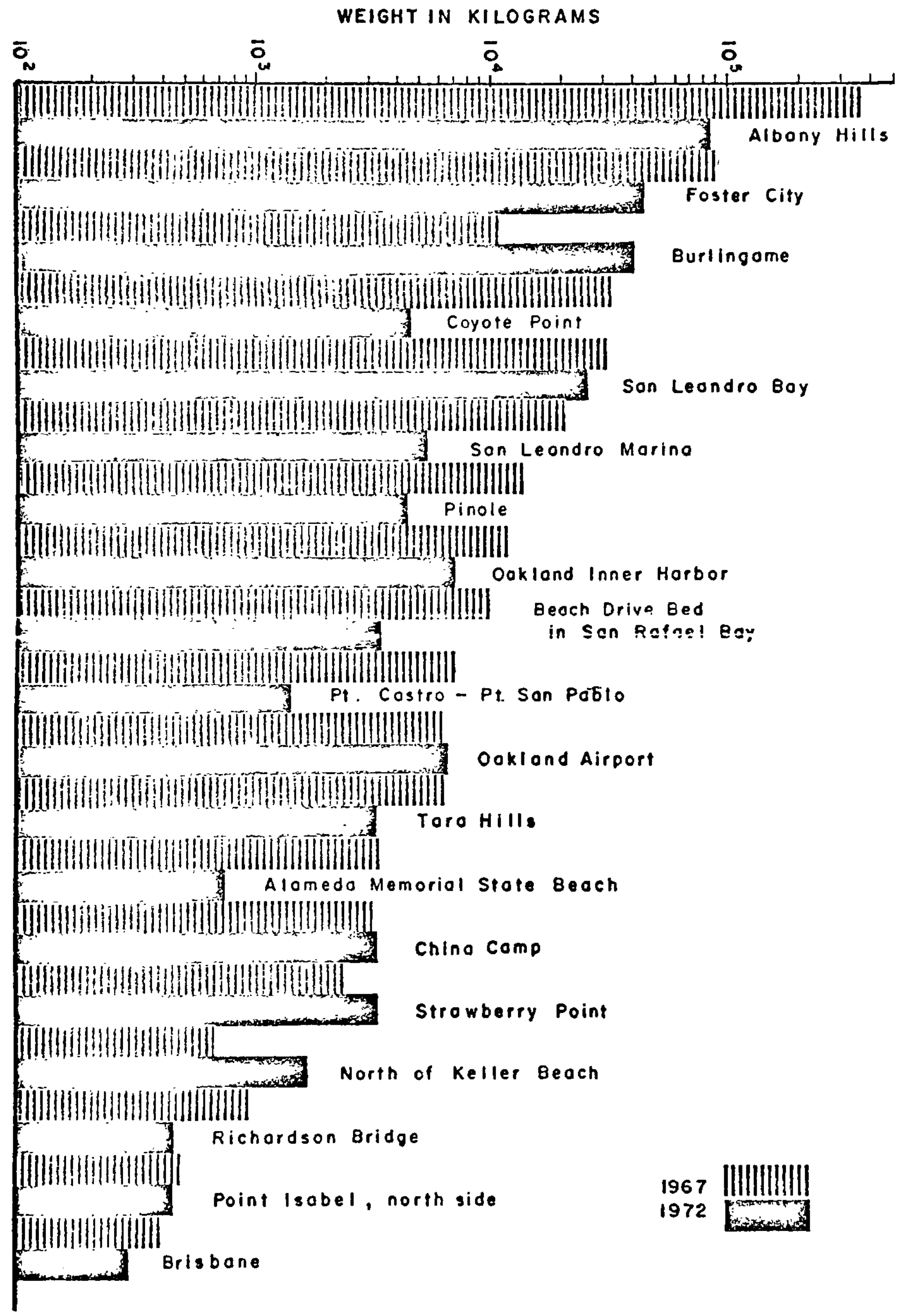
CHANGES IN CLAM POPULATION AND "ANGLER DAYS"

BETWEEN 1967 AND 1972 IN NINETEEN SAN FRANCISCO BAY BEDS

	Clam weight gms/ft^2 (mean)	Total "Angler Days"	Total Clam Weight in kg	Total Number of ft^2 Samples
1967	196	418911	618033	104
1972	113	208615	287550	116
Decrease	83	210296	330483	

FIGURE C-2

TOTAL WEIGHT PER BED OF CLAMS FOR THE 1967 AND 1972 SAMPLINGS



APPENDIX D

'ATE OF CALIFORNIA—RESOURCES AGENCY RONALD REAGAN, Governor

EPARTMENT OF FISH AND GAME
ARINE RESOURCES REGION

Marine Resources Laboratory
411 Burgess Drive
Menlo Park, California 94025

June 28, 1972

Mr. Bob Campbell
Environmental Protection Agency
Division of Field Investigation - Denver Center
Building 22 - Room 410 - Denver Federal Center
Denver, Colorado 80225

Dear Bob:

Thank you for your letter and data from Suisun and San Francisco Bays.

In my opinion the possibility of growing oysters in Suisun Bay does not look promising. Low salinity and lack of suitable oyster food are probably the main limiting factors. The fact that you found only limited quantities of soft shell clams and no littleneck clams or native oysters suggests that conditions are not favorable for growing Pacific or Eastern oysters.

San Pablo Bay, I feel, has some potential because of higher salinities and more oyster food production. South San Francisco Bay has the best potential. Salinities and temperatures are more favorable and there is probably a greater production of oyster food. The food supply could probably be enhanced ty the elimination of the contaminants.

I can not offer an explanation for the high cadmium count in the Pacific oysters. Dr. Craig Ruddell at Davis has obtained similar results from the same lot of oysters.

I hope that this information will be of help to you. If you need further information, please contact me.

Sincerely,

Walt Dahlstrom

Walter A. Dahlstrom
Assoc. Marine Biologist

WAD:gb

APPENDIX E

APPENDIX E

TOXIC EFFECTS ON AQUATIC LIFE

TOXIC MATERIALS

Discharges to the Bay system of wastes containing materials toxic to aquatic life have occurred from both municipal and industrial sources. Both acute and chronic toxicity problems are believed to result from these discharges. In addition, spills of toxic materials have resulted in damage to aquatic life.

A survey of the literature on the toxicity of metals and pesticides to marine aquatic life is presented in the Appendix [Table E-3].

A brief comparison of the data collected during this study to reported toxic values is discussed below.

HEAVY METALS

Data on the heavy metals cadmium, chromium, copper, lead, zinc and mercury are available from the recent survey of the San Francisco Bay Area [Table E-1].

Analysis showed that cadmium, a very common metal, ranged from <0.01-<0.02 mg/l in the water. Table E-1 shows the LC_{50} (for explanation see appendix) for the oyster *Crassostrea virginica* to be 0.1-0.2 mg/l thus the water concentrations found during this survey are about 1/100 of the determined toxic level.

Chromium, which is toxic to *Nereis virens* (polychaete worm) at <5.0 mg/l ranged from <0.01-0.05 mg/l in the water. Sediment samples ranged from <1.0-90.0 mg/kg while shellfish contained <0.05-20.0 mg/kg.

Chromium levels in the water are about 100 times less than the reported toxic values. However, the shellfish contained levels up to four times the proposed FDA alert levels. As discussed elsewhere in this report the high sediment values may lead to contamination of the shellfish.

Copper, one of the most toxic heavy metals, ranged from <0.01-0.6 mg/l in the water. Data in Table E-1 shows that marine phytoplankton are killed by concentrations of 0.027-0.5 mg/l. Because these species of phytoplankton are important in the food chain of fish their elimination could reduce or completely eliminate the fish population of that area. In addition, copper is lethal to several molluscs in the range of 0.05-0.2 mg/l [Table E-1].

Lead concentrations of 0.7-<5.0 mg/l in water, as reported in this study, are about 10 times the lethal value of 0.5 mg/l for *C. virginica* (eastern oyster) [Table E-1]. However, California Fish and Game personnel have grown several species of molluscs in the Redwood City area for several years at a sub-chronic level.

Zinc levels of <0.01-0.15 mg/l in the water are well below toxic levels. However, oysters tend to accumulate the metal and values of 336 and 608 mg/kg were recorded. These values are about one-third the FDA alert level of 1,500 mg/kg.

PESTICIDES AND PCB'S

Data on the chlorinated hydrocarbon pesticides chlordane, DDT, DDD, DDE and dieldrin and the PCB (polychlorinated biphenyl) complex also are available from this investigation of the San Francisco Bay Area.

DDT and its metabolites DDE and DDD are generally toxic under acute conditions to marine invertebrates in the range of 0.002-0.02 mg/l (or parts per billion); values that are approached or exceeded in the Bay area. Table E-2 shows the oyster C. virginica to have an LC_{50}(DDT) of 0.005 mg/1, a value that was exceeded in portions of the Bay. However, most values are below the acute toxic level and lead to conditions of reduced shell growth. Monochrysis lutheri, a plankton-flagellate, illustrates the point by exhibiting a 43 percent reduction in growth when exposed to 0.02 mg/1 DDT for 96 hours [Table E-2]. Under similar conditions shellfish will often show a 50 percent reduction in growth.

Reported values for dieldrin range from 0.0055 mg/1 (96 hour LC_{50}) for Leiostomus xanthurus (juvenile spot) to 0.005 mg/1 for Palaemonetes vulgaris (grass shrimp). The oyster C. virginica has a reported value of 0.034 mg/1 [Table E-2]. These values are all greater than the value obtained during this study [Table E-2]. However, the problem of sub-lethal concentrations again arises and the fact that although not killed by the compound significant reductions in growth rates, reproductive capabilities and physiological damage can and does result.

The PCB complex, virtually unstudied until the late 1960's, poses a threat unsurpassed by chlorinated hydrocarbon pesticides. Toxic levels with these compounds range from 0.005 mg/1 for spot (L. xanthurus) to $<$0.0001 mg/1 for Daphnia magna. Current trends at the Federal level are to establish a maximum water concentration of 0.002 mg/1 and maximum concentration of 0.5 mg/1 in tissue. Japan has recently established a maximum tissue level of 0.5 mg/1 for off-shore and high seas organisms.

TABLE E-1

TOXICITY OF METALS*TO SELECTED MARINE ORGANISMS

	Al	As	Cd	Cr	Cu	Pb	Hg	Sn	Zn
Bacteria	132 ppm								
Green algae					0.1 ppm(no time span given)			0.002 ppm (no time span given)	
Phytoplankton (various species)					0.027 mg/1-0.050 mg/1				
Psammechinus miliavis (sea urchin)						200 mg/1 egg abnormalities (no time span given)			
Balanus balanoides (adult barnacles)							0.5 mg/1 (*B. balanoides*)		8 mg/1 (*B. balanoides*)
Nereis virens (polychaete worm)				1 mg/1 threshold	0.1 mg/1 threshold				
Fusinus kobelti - snail (mollusk)					0.20 ppm threshold 0.10 ppm <100% mort.				
Haliotis fulgens - abalone (mollusk)					0.05 ppm <100% mort.				
Ischnochiton conspicuus (mollusk)					0.15 ppm threshold 0.10 ppm <100% mort.				
Paphia staminea var. *laciniata* (mollusk)					3 ppm ≈50% lethal				
Tegula gallina (mollusk)					0.10 ppm threshold 0.05 ppm <100% mort.				
T. viridula var. *ligulata*					0.10 ppm threshold 0.05 ppm < 100% mort.				

TABLE E-1 (CONTINUED)

TOXICITY OF METALS* TO SELECTED MARINE ORGANISMS

	Al	As	Cd	Cr	Cu	Pb	Hg	Sn	Zn
E. oyster (Crassostrea virginica)			0.2 mg/l LC_{50} 0.1 mg/l LC_{50}			0.5 mg/l LC_{50} (12wks) 0.3 mg/l LC_{50} (18wks) 0.1-0.2 mg/l (12 weeks) Noticeable tissue changes			
Mytilus californianus (mussel)					0.15 ppm <100% mort. (30 days) 0.10 ppm <100% mort. (60 days)				
M. edulis (mussel)					0.20 ppm (17 days) LC_{50} 0.10 ppm (35 days) <100% mort.				
Carcinus maenas (shore crab)				40-60 ppm threshold	1-2 ppm threshold				
Leander squilla (small prawn)				5 ppm threshold	0.5 ppm threshold				

*Toxicities are for 96 hours (4 days) or more, except where no time span is given.
and manganese (Mn).
LC_{50} = Concentration required to kill 50% of the organisms in a specified length of time (e.g. 96 hours).
Source: Oregon State University. 1971. *Oceanography of the nearshore coastal waters of the Pacific Northwest relating to possible pollution.* Vol. II. Environmental Protection Agency, p. 84-98.

TABLE E-2

TOXICITY OF PESTICIDES TO SELECTED MARINE ORGANISMS

	Aldrin	DDT	Dieldrin	Endrin	Heptachlor	Lindane	Methoxychlor	Sevin	1 Naphthol	Toxaphene	Malathion	Methyl Parathion	Parathion	Phosdrin R
Dunaliella euchlora (plankton-flagellate)		0.02 mg/l 17% growth inhibition				7.5 mg/l 27% growth inhibition		0.1 mg/l 10% growth inhibition		0.01 mg/l 10% growth inhibition				
Monochrysis lutheri (plankton-flagellate)		0.02 mg/l 43% growth inhibition				1 mg/l 14% growth inhibition		0.1 mg/l 13% growth inhibition		0.000015 mg/l 22% growth inhibition				
Crassostrea virginica (oyster)	0.025mg/l 50% decrease in shell growth	.005 mg/l LC_{50}	0.034mg/l 50% decrease in shell growth	0.033mg/l 50% decrease in shell growth								1.0 mg/l 22% decrease in shell growth		
Crassostrea gigas (Pacific oyster larvae)								2.2 mg/l 50% development prevented	0.8 mg/l 50% development prevented					
Mytilus edulis (bay mussel, larvae)								2.3 mg/l 50% development prevented	1.3 mg/l 50% development prevented					
Crangon septemspinosa (sand shrimp)	8 μg/l LC_{50}	0.6 μg/l LC_{50}	7 μg/l LC_{50}	1.7 μg/l LC_{50}	8 μg/l LC_{50}	5 μg/l LC_{50}	4 μg/l LC_{50}				33 μg/l LC_{50}	2 μg/l LC_{50}		1 μg/l LC_{50}
Palaemonetes vulgaris (grass shrimp)	9 μg/l LC_{50}	2.0 μg/l LC_{50}	50 μg/l LC_{50}	1.8 μg/l LC_{50}	440 μg/l LC_{50}	10 μg/l LC_{50}	12 μg/l LC_{50}				82 μg/l LC_{50}	3 μg/l LC_{50}		69 μg/l LC_{50}

TABLE E-2 (CONTINUED)

TOXICITY OF PESTICIDES TO SELECTED MARINE ORGANISMS

	Aldrin	DDT	Dieldrin	Endrin	Heptachlor	Lindane	Methoxychlor	Sevin	1 - Naphthol	Toxaphene	Malathion	Methyl Parathion	Parathion	Phosdrin R
Penaeus aztecus (brown shrimp)												0.0055 mg/l 50% loss of equilibrium	0.001mg/l LC_{50}	0.25 mg/l LC_{50}
Leiostomus xanthurns (juvenile spot)	0.0055 mg/l LC_{50}	0.002mg/l LC_{50}	0.0055 mg/l LC_{50}	0.0006 mg/l LC_{50}	0.025mg/l LC_{50}	0.03mg/l LC_{50}	0.03mg/l LC_{50}			0.001mg/l LC_{50}	0.55mg/l LC_{50}			
Cyprinodon variegatus (juvenile sheepshead minnow)		0.005mg/l LC_{50}											0.06mg/l LC_{50}	0.83mg/l LC_{50}

*Toxicities are for 48 hour (2 days) periods or longer.

LC_{50} = Concentration required to kill 50% of the organisms in a specified length of time (e.g. 96 hours).

Source: Oregon State University. 1971. *Oceanography of the nearshore coastal waters of the Pacific Northwest relating to possible pollution.* Vol. II. Environmental Protection Agency. p. 101-110.

TABLE E-3

MAMMALIAN TOXICITY OF SELECTED METALS

Metal	Species	Dose	Effects	Reference
Arsenic	Man	Chronic intoxication	Neurologic changes, increased salivation, hoarseness, cough, laryngitis, conjunctivitis, colicky abdominal pain and various skin changes.	Vallee, B. L., D. D. Ulmer and W. E. C. Wacker. 1960. *Arsenic toxicology and biochemistry.* AMA Arch. Ind. Health 21(2): 132-151.
Cadmium (Undefined)	Man	From water and food	Hypertension linked to increased retention of Cd in kidneys.	Lucis, O. J. and R. Lucis. 1969. *Distribution of cadmium^{109} and zinc^{65} in mice of inbred strains.* Arch. Environ. Health 19(3): 334-336. Stokinger, H. E. 1969. *The spectre of today's environmental pollution--U.S.A. brand: new perspectives from an old scout.* American Ind. Hyg. Assoc. J. 30: 195-217. Anon. 1970a. *When metal can mean hypertension.* Med. World News 11: 30
	Man	From water - "high concentration"	Disorders of renal function; phosphate level in the blood serum decreases; sizeable loss of minerals from the bones, "Itai Itai" disease.	Anon. 1970b. *Cadmium in Ouch Ouch.* Chem. Eng. News 48: 16. Anon. 1971. *Cadmium pollution and Itai-Itai disease.* Lancet 1: 382-383.
Chromium ion Cr^{+6}	Man	25 mg/l in drinking water for 3 years (<0.9 mg/kg/day)	No harmful effects	Zehnpfennig, R. G. 1967. *Possible toxic effects of cyanates, thiocyanates, ferricyanides, ferrocyanides, and chromates discharged to surface water.* In: Proc. 22nd Ind. Waste Conf. (2): 879-883. Purdue Univ., Eng. Ext. Ser. 129.
Chromium ion Cr^{+3}	Rat	Diet deficient in Cr.	Antherosclerosis; relative hypercholesteremia which increased with age, with mild to moderate hyperglycemia; increased incidence of aortic plaques.	Schroeder, H. A. 1970. *Metallic micronutrients and intermediary metabolism.* U. S. Clearinghouse Fed. Sci. Tech. Inform., AD 708581. 22 p.
Copper (Undefined) (only acute dosages given)	Man	10,000 mg/kg	Lethal	Grunau, E. B. 1967. *Significance of copper in drinking water.* Staedtehygiene 18(7): 153-164.
	Man	60-100 mg	Gastroenteritis with nausea and intestinal irritation.	McKee, J. E. and H. W. Wolf (ed). 1963. *Water quality criteria.* The Resources Agency of California, State Water Quality Control Board, No. 3-A. 548 p.
	Man	10-30 mg	No poisoning even after many days.	McKee and Wolf (1963).
Lead (Undefined)	Man	2.0-4.0 mg/l for 3 months (<.07-.14 mg/kg/day)	Harmful range.	Offner, H. G. and E. F. Witucki. 1968. *Toxic inorganic materials and their emergency detection by polarographic method.* J. Amer. Water Works Assoc. 60(8): 947-952.
	Man	From drinking water - high concentration	Disorder of renal function; phosphate level in the blood serum decreases; sizeable loss of minerals from bone.	Anon. (1970b)
	Man	Chronic lead poisoning	Microcytic anemia and encephalopathy	Shaw, M. W. 1970. *Human chromosome damage by chemical agents.* Ann. Rev. Med. 21: 409-432.

MAMMALIAN TOXICITY OF SELECTED METALS

Metal	Species	Dose	Effects	Reference
Lead Pb	Man		Much like multiple sclerosis; CNS damage	Wilber, C. G. 1969. *The biological aspects of water pollution.* Charles C. Thomas, Springfield, Ill. 96 p.
	Rat (and mouse)	25 mg/l for life (2.5 and 3.6 mg/kg/day)	Significant decrease in survival and longevity; no effect on growth rate.	Schroeder (1970).
	Rat		Significant increase in serum cholesterol in female only; decrease in serum glucose in male; no effect on blood pressure or aortic plagues.	Schroeder (1970).
Manganese (Undefined)	Man		Three persons died as a result of poisoning by well water contaminated by manganese derived from dry cell batteries buried nearby.	McKee and Wolf (1963).
Mercury*	Man	Over a long period of time - in food, water, etc.	Anxiety, excessive self-consciousness, difficulty in concentrating, irritability, resentment of criticism, headache, fatigue, blushing and excessive perspiration.	Anon. 1970c. *Mercury menace prompts firm to offer test data.* Ind. Res. 12(10): 25.
	Man	Small amounts	Produce kidney damage, muscular tremors, irritability, and depression.	Anon. 1970d. *Mercury and mud.* Sci. Amer. 223(3): 82-86.
Nickel (Undefined)	Rat		Decrease in serum cholesterol in male; decrease in serum glucose in female; no effect on blood pressure or aortic plagues.	Schroeder (1970).
Zinc (Undefined)	Man	From drinking water - high concentration.	Disorder of renal function; phosphate level in the blood serum decreases; sizeable loss of minerals from the bones; "Itai Itai" disease.	Anon. (1970b).

*U.S. Department of Commerce Fishery Market News Report, dated Thursday, August 10, 1972, states that in Italy the mercury tolerance level for frozen fish is 0.7 ppm and for canned tuna 1.0 ppm. The FDA has set a limit of 0.5 ppm of mercury in fish for the United States.

Source: Little, A. D. 1971. Water Quality Criteria Data Book, Vol. 2. *Inorganic chemical pollution of freshwater.* Environmental Protection Agency. p. 139-187.

TABLE E-4
INDUSTRIAL POLLUTIONAL SOURCES CONTRIBUTING TO THE DETERIORATION
OR TOXICITY OF AQUATIC LIFE IN SAN FRANCISCO BAY
1971[a]

Source	Settleable Matter mg/1/hr.	Suspended Solids mg/1	Oil and Grease mg/1	pH	Cr mg/1	Cu[c] mg/1	Pb mg/1	Zn mg/1	Phenol mg/1	Fish Toxicity 96 hr. % Survival	Fish Toxicity TLm	BOD mg/1	Temp °C
Union Oil E-2										0-100 (81)		0	
California and Hawaiian Sugar Co. E-E	Tr-17.7 (1.9)	14-3,236 (353)		6.1-8.6 (7.1)						45-100 (88.2)		510-2,820 (1,395)	24.3-52.7 (41.0)
E-H	Tr-3.7 (0.97)	9.3-177 (54.9)		9.3-11.7 (10.5)									27.7-50.5 (37.5)
E-V	Tr-0.75 (.116)	13-128 (65)		6.8*-8.7 (7.8)						50-100 (89.2)		320-2,580 (1,342)	
Phillips Petroleum Co. Avon Refinery					0.11-1.14 (0.43)					0-100 (37.1)	25-100 (74)		
EA-2	0.03-0.48* (0.12)												
U. S. Steel Corp E-1						N.D.-0.06 (0.022)	N.D.-.27 (0.06)						
E-2	<.02-3.07* (0.40)					N.D.-0.06 (0.02)			0.04-0.48 (0.21)	40-100 (84.2)			
E-3						N.D.-0.06 (0.02)							
Shell Oil Co. Pond #5			19-73 (30.7)									13-352 (182)	23-94 (34)
Shell Oil Co. Merck Chemical Division Stream A	0-43 (7.1)	170-472 (335)		7.9-9.1* (8.6)									
Stream B	0-100 (11.3)	25-71 (53.5)		8.1-10.3* (8.9)*									
Stream C	.2-407 (236)	1,246-3,520 (2,330)		8.2-10.4* (9.6)						0-100 (63.5)	0.5-25		
Stream D	92-331 (195)	2,216-44,300 (10,200)		9.7-10.4* (10.1)*						0-100 (41.5)	0.28-25 (9.9)		
Stream E	.2-405 (77.8)	770-7,564 (2,740)		8.3-10.3* (9.4)*						0-100 (71.5)	6.7-25		
Stream F	0-23 (4.4)	30-380 (224)		9.0-10.3* (9.6)*						60-100 (94)			
Stream G	0-16 (1.8)	66-290 (179)		8.9-10.8* (9.8)*						0-100 (35)	36-100 (80)		
Humble Oil & Refinery Co.									<0.1-1.7 (0.6)	43-100 (69)		33-186 (77)	
Colgate Palmolive Company E-1													

TABLE E-4 (CONTINUED)
INDUSTRIAL POLLUTIONAL SOURCES CONTRIBUTING TO THE DETERIORATION
OR TOXICITY OF AQUATIC LIFE IN SAN FRANCISCO BAY
1971[a/]

	Settleable Matter mg/l/hr.	Suspended Solids mg/l	Oil and Grease mg/l	pH	Cr mg/l	Cu[c/] mg/l	Pb mg/l	Zn mg/l	Phenol mg/l	Fish Toxicity 96 hr. % Survival	Fish Toxicity TLm	BOD mg/l	Temp °C
Hercules, Inc. Stream A						0-0.09 (0.02)							
Stream B				5.8*-8.1 (7.5)		Nil-0.09 (0.03)							
Chevron Chemical Co. Ortho Division	0.0-5.5 (0.5)			4.9-7.4 (6.6)							1.5-75 (20)		
Sequoia Refining Co.			5.2-18.5* (10.6)						0.1-0.8* (0.3)		32-100 (68)	74*-416* (243)*	
Cerro Copper and Brass Company					.05-.48*b/ (.21)	0.05-.55 (.24)		0.52-.97 (.83)					
E. I. Dupont			0.8-15.2 (4.5)		0.10-.70 (0.34)		1.8-5.3 (2.7)			0-53 (25)			
Tillie Lewis Food	31	560		5.5									
Crown Zellerbach		95-132 (110)											
Kaiser Gypsum		54-147 (85)											
Stauffer Chemical Co. Martinez						0.005-.07 (0.032)	0.04-0.09 (0.07)	0.10-1.04 (0.62)		0*-100			
Pfizer Minerals Pigments & Metals Division 2" pipe				10.3-10.7									
Kaiser Steel Corporation Metals Products Division Drain No. 4			21-36 (28)										
Drain No. 7			7.6-33 (20.3)										
Stanford Linear Accelerator Center										30-100 (87.5)			
Granada Sanitary District		92-136 (116)	52-57 (55)									230-290 (269)	
Allied Chemical Corp.				3.2-5.4 (4.3)									29.4-36.7 (30.6)
Shell Development Co. Temescal Creek				7.3-9.2 (8.5)									
Fiberboard Corp. San Joaquin	9-24 (17)	215-295 (239)											21.7-45.6 (36)
Stauffer Chemical Co. Richmond	<0.1-4* (0.7)					0.02-0.11 (0.06)							
Campbell Chain Div. of United Industries	0.2-3.5 (1.8)	6.8-137.4 (54.3)				0.04							
FMC Corporation	0.2-3.5 (1.8)	6.8-137.4 (54.3)											27-41 (33)

*Violation of effluent requirements.
a/ Figures represent the range in concentration; with the mean concentration in parentheses.
b/ Cr^{+6}
c/ N.D. + Not detectable.

MUNICIPAL

TABLE E-5

~~DOMESTIC~~ POLLUTION CONTRIBUTING TO THE DETERIORATION OR TOXICITY OF AQUATIC LIFE IN SAN FRANCISCO BAY, AND IS A HUMAN HEALTH HAZARD

1971[a]/

Source	Settleable Matter mg/1/hr.	Suspended Solids mg/1	Oil and Grease mg/1	Cr mg/1	Cu mg/1	Cd mg/1	Pb mg/1	Phenol mg/1	Fish Toxicity 96 hr. % Survival	Fish Toxicity TLm	BOD mg/1	Turbidity J.T.U.	Coliform MPN/100 ml
NAPA Sewage District		36-90 (66)	1.0-19.0 (8.3)										
City of San Carlos Sewage Treatment Plant		55-126 (101)	14.0-33.0 (21.4)								40-131 (95)		
North San Mateo County Sewage District		98-144 (118)	48.7-71.5 (55.8)								176-206 (188)		
Milpitas Sewage District			4.0-19.7 (11.5)										
City of Petaluma			5.9-18.3* (9.2)						0*-100 (45)*	57*-100 (83)		4.6-12.4* (7.8)	
San Rafael Sewage District									20-80 (38)				
City of Los Altos Sewage District		30-96 (47)	13.6-26.9* (18.6)*								69-153 (108)		
Las Gallinas Valley Sewage District			5.0-15.4* (8.9)								41-65* (48)		24-15,900 (7,364)
City of Millbrae Sewage Treatment Plant									10	68-88			
Sausalito-Marin City Sewage District		61-129 (79)	24-36 (31)						0-0* (0)	6*-71* (34)*	130-212 (163)		
City of Pittsburg Montezuma Plant		68-85 (76)	49.5-61.4 (55.4)								107-240 (173)		
City of Pittsburg Camp Stoneman		62-126 (94)	35.1-43 (39)								47-108 (77)		
Estro Municipal Improvement District		43-142 (70)	3.6-40.3 (21.5)								16.8-115 (40.9)		
City of Pacifica Linda Mae Plant		82-118 (92)	34.1-55.7 (43)							20-33 (24)	103-130 (118)		
City of Benicia		123-211 (151)	18.2-138 (52.4)								184-423 (301)		
Contra Costa County Sewage District #7-A		74-222 (121)	27-37 (32)						0-0 (0)	14-25 (20)	85-150 (112)		
Marin County Sewage District #5		62-106 (85)	20*-94* (38)*						0-30* (15)*	21*-69* (45)*	157-206 (108)		
San Quentin Prison		63-136 (93)	47*-68* (50)*								76-189 (159)		
Crockett-Valona Sewage District		91-158 (134)	38*-51.4* (43)*								93-148 (125)		
Antioch Waste Treatment Plant											70-275 (137)		

TABLE E-5 (CONTINUED)
DOMESTIC POLLUTION CONTRIBUTING TO THE DETERIORATION OR TOXICITY OF AQUATIC LIFE
IN SAN FRANCISCO BAY, AND IS A HUMAN HEALTH HAZARD
1971[a]

Source	Settleable Matter mg/l/hr.	Suspended Solids mg/l	Oil and Grease mg/l	Cr mg/l	Cu mg/l	Cd mg/l	Pb mg/l	Phenol mg/l	Fish Toxicity 96 hr. % Survival	Fish Toxicity TLm	BOD mg/l	Turbidity J.T.U.	Coliform MPN/100 ml
San Jose-Santa Clara	0-7.4* (1.5)		5.4-22.3 (9.8)										
East Bay MUD - Sewage District #1		113-205 (107)	16-38 (24)	0.121-1.20 (.445)	0.08-0.36 (0.19)	0.10-0.23 (0.15)	0.02-0.36 (0.13)		0-70 (9.2)	15-100 (38)	113-242 (170)		
City and County of San Francisco North Point Plant			16.6-33.3 (23.7)		0.08-0.14 (0.10)				0-100 (55)	36->100 (88)	102-148 (124)		
Southeast Plant	0.58-4.75* (2.19)*	184-368 (282)	58*-89* (71)	1.05-3.3 (2.16)	0.11-0.46 (0.24)		0.02-0.81 (0.20)		0-100 (15)	12-100 (51)	176-281 (217)		1,406,000-61,910,000* (44,201,285)*
Richmond-Sunset		54-102 (69)	35-47.5 (38.2)								122-146 (139)		
Central Contra Costa Sewage District		65-82 (74)	29-45 (38)						0 (0)	27-65 (51)	114-173 (136)		
Sunnyvale		38-125 (80)							0-100 (40)	38-100 (72)			
City of Palo Alto Sewage Treatment Plant		49.0-76.0 (59.9)	4.8-27.0* (15.3)*								53-133 (93)		
San Mateo, City of		79-103 (92.5)	32-52 (44)								118-179 (147)		
San Pablo Sewage District San Pablo Plant		48-129 (105)	25-55 (46)		<0.02-0.23 (0.11)				0-70 (6.4)	14.5-100 (40)*	145-250 (211)		
Tara Hills Plant		103-211 (162)	62-101 (75)						0 (0)	5.6-21 (8.9)	220-363 (255)		
City of Mountain View		34-86 (58)	18.4*-22.9* (21.2)*								109-179 (143)		
City of South San Francisco San Bruno Treatment Plant		31-146 (72)	7-26 (16)	0.1-1.2 (0.38)	0.25-0.6 (0.44)	0.0-0.1 (0.06)	0.0-1.0 (0.45)	.007-.251 (0.070)	0 (0)	17-86 (52)	66-139 (104)		
Vallejo Sewage District		72-102 (84)	30-44 (40)							25-49 (34)	113-195 (156)		28-599* (198)
City of San Leandro		25-105 (69)	8.7-19.3 (12.8)						0-100 (41)	26-100 (60)	48-143 (91)		
Menlo Park Sewage District									0-0				
Union Sewage District Plant #1		70-100 (84)	14.7-20.0 (18.4)								109-141 (123)		
Plant #2		50-66 (56)									41-86 (59)		

*Violation of effluent requirements.

[a] Figures represent the range in concentration; with the mean concentration in parentheses.

APPENDIX F

San Francisco Bay Area Fish Kill Reports for Period
of January 1, 1965 through April, 1972

Reference No.	Date	Location	Species	Number	Cause
1	July 21, 1965	Tidewater Pier at Avon-Suisun Bay, Contra Costa County	Striped Bass Minnow Starry Flounder	90,000 1,000 100	Oil, Refinery waste
2	August 24, 1965	Oyster Point San Francisco Bay, San Mateo County	Striped Bass Halibut Other Fish Mollusk	75 25 750 10,000+	Bay Fill
3	May 2, 1966	Novato Creek, Bell Marin Keyes Lagoon and San Pablo Bay, Marin and Sonoma Counties	Striped Bass	120	Unknown
4	May 14, 1966	Carquinez Strait at Port Costa, Contra Costa County	Striped Bass	9	Unknown
5	May 25, 1966	San Pablo Bay at Union Oil Refinery Rodeo, Contra Costa County	Striped Bass	7,000	Phenol
6	June 1, 1966	Mission Rock Resourt Center and Boat Center San Francisco, S. F. County	Anchovy	7,200	Unknown
7	June 13, 1966	Railroad Bridge at Martinez, Contra Costa County	Striped Bass		Possibly Oil

Reference No.	Date	Location	Species	Number	Cause
8	June 16, 1966	Petaluma River, Sonoma County	Striped Bass	150	Low D.O.
9	June 24, 1966	Suisun Bay Near Mothball fleet, Solano County	Striped Bass	25	Unknown
10	July 22, 1966	Petaluma River, Sonoma County	Carp	90	Unknown
11	August 9, 1966	Leslie Salt Co. Sears Point, Solano County	Striped Bass	1,000+	High Salt concentration
12	May 21, 1967	San Leandro Marina, Alameda County	Striped Bass	162	Low D.O.
13	Sept. 7, 1967	Mare Island, Solano County	Shiners Striped Bass Staghorn Sculpins	2,000 500+ 20	Oil
14	Dec. 15, 1967	Foster City Lagoon, San Mateo County	Topsmelt Anchovy	18,000 2,000	Unknown
15	June 7, 1968	Suisun Bay, Contra Costa County	Striped Bass	25	Unknown
16	August 6, 1968	Ross Post Office Ross, Marin County	Steelhead Sculpin Roach	25 250 250	Raw Sewage
17	June 8, 1969	Alameda Beach S. F. Bay, Alameda County	Striped Bass Spiny Dog Shark	2 3	Possibly Pesticide

Table F-1 (Continued)

Reference No.	Date	Location	Species	Number	Cause
18	June 11, 1969	Bel Marin Keys Near Novato, Marin County	Carp Striped Bass	15 6	Unknown
19	June 14, 1969	Alameda Estuary Near Government Island, Alameda County	Striped Bass	6	Unknown
20	July 19, 1969	Port Chicago and Martinez, Contra Costa County	Striped Bass Catfish Shad	75 12 2	Unknown
21	August 21, 1969	Larkspur Lagoon, Marin County	Striped Bass	25	Pollution
22	Sept. 1, 1969	West of Sears Point Bridge, Solano County	Striped Bass	2,500	Low D.O.
23	Oct. 23, 1969	Westerly & off Crawford Slough (area adjacent to Grizzly Island), Solano County	Striped Bass Sucker Perch	450 1 1	Unknown
24	May 18, 1970	Bel Marin Keys, Marin County	Bay Mussels Striped Bass	15	Unknown Algal Bloom with possible Low D.O.
25	May 20, 1970	West Leslie Salt Pond, Hwy. 37 and Sonoma Creek, Solano County	Striped Bass Flounder Bullhead	2,000 1 75	Unknown Algal Bloom with possible Low D.O.

Table F-1 (Continued)

Reference No.	Date	Location	Species	Number	Cause
26	May 20, 1970	Port Costa Waterfront, Contra Costa County	Striped Bass	Several Hundred	Unknown (Annual Loss)
27	May 20, 1970	Nelson Resort downstream to mouth of Mare Island Channel and Carquinez Straits, Solano and Napa Counties	Striped Bass	1,100	Unknown
28	May 24, 1970	Suisun Bay, Contra Costa and Solano Counties	Striped Bass	25	Unknown (Annual Loss)
29	May 30, 1970	Carquinez Straits from Crockett upstream to Antioch, Contra Costa and Solano Counties	Striped Bass Shad Catfish	123 5 8	Unknown (Annual Loss)
30	June 1, 1970	Antioch Bridge to Crockett, Solano County	Striped Bass Sturgeon Shad Rough Fish	750 25 25 25	Unknown (Annual Loss)
31	June 23, 1970	Napa River between Vallejo and Cuttings Wharf, Napa County	Striped Bass	80	Unknown

Table F-1 (Continued)

Reference No.	Date	Location	Species	Number	Cause
32	Nov. 8, 1970	Redwood City Municipal Marina, San Mateo County	Black Perch Shiner Perch Walleye Perch	1,000 10,000 1,000	Unknown Low D.O. a contributing factor
33	April 8, 1971	Pier 35, South Side San Francisco, San Francisco County	Northern Anchovy Rock Cod Starry Flounder Assorted Perches	500 40 10 70	Unknown
34	May 6, 1971	Lake Merritt, Oakland, Alameda County	Shrimp Perch Gobie Bullhead Shiner Perch	5,000 1,000 100 75 2	Unknown
35	May 19, 1971	Redwood City Municipal Yacht Harbor, San Mateo County	Anchovy	15	Possibly Redwood City S.T.P
36	May 20, 1971	Canal off Petaluma River and at Bel Marin Keys off Novato Creek, Marin County	Striped Bass	500	Probably D.O. Extensive algal bloom
37	May 22, 1971	Benecia Flats, Contra Costa County	Striped Bass	1	Unknown, Red tide condition in Carquinez Strait from Port Costa to Crockett
38	May 22, 1971	Off Antioch near Kimbal Island, Contra Costa County	Carp Squawfish	1 1	Unknown, Red Tide conditions in Carquinez Strait from Port Costa to Crockett

Table F-1 (Continued)

Reference No.	Date	Location	Species	Number	Cause
39	May 29, 1971	Midshipmen Point--Tubbs Island, Solano County	Striped Bass	80-85	Entrapment and Elevated Temperatures Low Tides, Low D.O.
40	June 30, 1971	San Leandro Bay near mouth of San Leandro Creek, Oakland, and San Leandro Creek from mouth of Hagenberger Road, Alameda County	Striped Bass	100	Unknown
41	June 7 to July 12, 1971	Lower Napa River, Napa County	Striped Bass	90 (Boat count)	Unknown
42	June 7 to July 12, 1971	Eastern San Pablo Bay, Napa and Contra Costa Counties	Striped Bass	89 (Boat count)	Unknown
43	June 7 to July 12, 1971	Carquinez Strait, Solano and Contra Costa Counties	Striped Bass	362 (Boat count)	Unknown
44	June 7 to July 12, 1971	Suisun Bay, Solano and Contra Costa Counties	Striped Bass	122 (Boat count)	Unknown
45	Sept. 17, 1971	Redwood Shores Redwood City, San Mateo County	Bait Fish Shrimp Turbot Mudsucker & Unknown Amount of Cleaned-up Fish	2,000 8,000 1 300	Poor Water Circulation in a Closed Lagoon System. Possibly Low D.O.
46	Oct. 15, 1971	Tidal Creek behind 440 DuBois Street San Rafael, Marin County	Unknown Fry Stickleback	35 15	Possibly Sewage

APPENDIX G

APPENDIX G

WASTE SOURCE EVALUATION TECHNIQUES

The sampling program for the industrial and municipal dischargers included two visits to each facility. A preliminary visit was made to determine the unit processes in operation and the general operating condition of each plant. The effluent sampling point designated by the Regional Board for plant self-monitoring reports was inspected at that time and in most cases selected as the EPA sampling point for the study. In addition, at each municipal treatment plant an inventory questionnaire, routinely required by the EPA, and a San Francisco Bay study questionnaire were filled out to provide general information on the facility for future reference.

During the second visit, EPA collected both 24-hour composite samples, and four-hour composite samples, depending on the nature of the parameter. Table G-1 denotes the type of composite samples taken for each specific parameter.

TABLE G-1

WASTE SOURCE SAMPLING

PARAMETER	TYPE OF SAMPLE
BOD	4 hour composite
COD	24 and 4 hour composite
Set Solids	4 hour composite
NO_3-N	24 and 4 hour composite
Kjeldahl-N	24 and 4 hour composite
Total P	24 and 4 hour composite
Oil and grease	24 and 4 hour composite
Toxicity	4 hour composite
Total coliform	GRAB
Sulfide	4 hour composite
Phenols	4 hour composite
Cr (total chromium)	4 hour composite
Ni (nickel)	4 hour composite
Zn (zinc)	4 hour composite
Cu (copper)	4 hour composite
Cd (cadmium)	4 hour composite
Suspended solids	4 hour composite
Mercaptans	4 hour composite
pH	Hourly
Temperature	Hourly

TABLE G-2

MUNICIPAL DISCHARGES--COMPARISON OF WASTE-SOURCE DATA[a]

DISCHARGER	Flow mgd	BOD mg/l	BOD lb/d (x 10³)	COD mg/l	COD lb/d (x 10³)	Oil & Grease mg/l	Oil & Grease lb/d (x 10³)	NO_3-N mg/l	NO_3-N lb/d	Total Kj-N mg/l	Total Kj-N lb/d (x 10³)	Total P mg/l	Total P lb/d (x 10³)	Sett. Solids ml/l/hr
City of San Jose														
Self-monitoring reports[b]	82.9	39	26.9			9.8	6.8							
EPA testing[c]		22	15.2	107	73.7			0.05	34	44.8	30.9	8.9	6.1	<1.0
	[94][d]													[1.0]
City of Oakland, East Bay MUD														
Self-monitoring reports	78.9	170	111.9			24	15.8							0.21
EPA testing		>277	>180.0	699	458.9			2.6	1,707	46.8	30.7	8.6	5.6	0.17
City of San Francisco Southeast plant														
Self-monitoring reports	22.1	217	40.0	629	115.7	71	13.1	0.50	92					
EPA testing		169	31.1	371	68.2	23	4.2	0.29	53	44.5	8.2	3.4	0.6	1.88
						[30]								
City of San Mateo														
Self-monitoring reports	11.0	147	13.5			44	4.0							0.6
EPA testing		175	16.0	420	38.4			0.04	4	49.7	4.5	10.7	1.0	0.6
City of South San Francisco														
Self-monitoring reports	7.2	104	6.2	381	22.8	16	1.0	0.46	27					
EPA testing		187	11.2	350	21.0			0.06	4	46.0	2.8	7.5	0.4	<0.1
City of San Francisco North Point plant														
Self-monitoring reports	64.1	124	66.3	191	101.9	24	12.7	1.3	693					
EPA testing		114	60.8	230	122.7			0.29	155	23.0	12.3	2.9	1.5	0.8
City of San Pablo[e]														
Self-monitoring reports	7.6	211	13.4			46	2.9	1.9	120					
EPA testing		34	2.2	51	3.2			14.24	900	4.5	0.3	13.9	0.9	<0.1
Central Contra Costa County San. Dist.														
Self-monitoring reports	22.8[f]	136	25.9			38	7.2							0.13
EPA testing		103	19.5	236	44.8			0.04	7.6	37.8	7.2	9.0	1.7	<0.1

TABLE G-2

MUNICIPAL DISCHARGES--COMPARISON OF WASTE-SOURCES DATA (cont.)[a/]

DISCHARGER	pH	Toxicity: Survival %	Toxicity: 96-hr TL_{50}	Chromium mg/l	Chromium lb/d	Copper mg/l	Copper lb/d	Mercury mg/l	Mercury lb/d	Lead mg/l	Lead lb/d	Zinc mg/l	Zinc lb/d
City of San Jose													
self-monitoring reports	8.0												
EPA testing		0 [≥/70][d/]	76										
City of Oakland, East Bay MUD													
self-monitoring reports	6.7	9.2	38	0.44	292	0.19	125			0.13	85	0.81	534
EPA testing		0	22	0.46	302	0.11	72	0.001	0.6	0.28	184	0.48	315
City of San Francisco Southeast plant													
self-monitoring reports	7.2			2.16	397	0.24	44			0.20	37	0.90	165
EPA testing		0	45	1.18	217	0.06	11	0.002	0.3	0.08	15	0.18	33
City of San Mateo													
self-monitoring reports	6.9												
EPA testing	[6.5-8.5][d/]	0	65										
City of South San Francisco													
self-monitoring reports		0	52	0.83	22.8	0.44	26	0.004	0.2	0.45	27	0.2	12
EPA testing	6.9 g/	0 [≥/70][d/]	46										
City of San Francisco North Point plant													
self-monitoring plant		55		0.06	32	0.10	53	0.07	36	0.18	96		
EPA testing		0	92										
City of San Pablo													
self-monitoring reports		6.4	40	0.04	253	0.11	7			0.11	7	0.35	22
EPA testing	g/	100 [≥/75][d/]											
Central Contra Costa County San. Dist.													
self-monitoring reports	7.5	0											
EPA testing	g/	0	51										

a/ There are no "self-monitoring" data reported for coliforms and chlorine residuals.
b/ All reports are dated 1971.
c/ All testing was carried out in 1972.
d/ Bracketed figures indicate State Regional Board Requirements.
e/ Recent improvements include a secondary treatment plant.
f/ State Regional Board Requirements call for a value not to exceed 45 mgd for any consecutive 7-day average.
g/ State Regional Board Requirements call for pH values to be between 7.0 (min) and 8.5 (max).

TABLE G-3

MUNICIPAL DISCHARGERS-COLIFORM DATA
1972 SAMPLING BY ENVIRONMENTAL PROTECTION AGENCY

	Sample Nos.	Time/Date Collected	Coliform Bacteria/100 ml Total	Coliform Bacteria/100 ml Fecal	Chlorine Residual ppm	Minutes Holding Time
SAN JOSE S.T.P.	SJ-1	1000/Aug. 2	200	200	2.40	0
	SJ-2	1100/Aug. 2	6,600	3,200	2.10	0
	SJ-3	1200/Aug. 2	7,800	3,700	2.10	0
	SJ-4	1300/Aug. 2	5,300	4,500	1.90	0
	SJ-5	1400/Aug. 2	2,000	1,400	2.10	0
	SJ-6	1500/Aug. 2	6,100	4,500	2.10	0
North Point WPCP	NP-1	1115/Jul. 31	580	200	4.00	10
	NP-2	1236/Jul. 31	290	200	4.25	10
	NP-3	1336/Jul. 31	200	200	3.98	10
	NP-4	1435/Jul. 31	200	200	5.50	10
San Mateo WPCP	SM-1	1125/Aug. 1	620	200	0.53	35
	SM-2	1225/Aug. 1	27,000	2,800	0	35
	SM-3	1325/Aug. 1	360,000	160,000	0	35
	SM-4	1425/Aug. 1	360,000	6,000	0.20	35
Southeast S.F. WPCP	SE-1	1235/Jul. 31	200	200	5.8	0
	SE-2	1335/Jul. 31	200	200	4.8	0
	SE-3	1435/Jul. 31	280	200	1.3	0
	SE-4	1535/Jul. 31	200	200	6.9	0
Joint, South S.F. & San Bruno WPCP	SS-1	1020/Aug. 1	200	200	8.5	0
	SS-2	1120/Aug. 1	200	200	8.2	0
	SS-3	1220/Aug. 1	260,000	200,000	8.0	0
	SS-4	1320/Aug. 1	200	200	8.8	0

TABLE G-3 (Cont.)

MUNICIPAL DISCHARGERS-COLIFORM DATA
1972 SAMPLING BY ENVIRONMENTAL PROTECTION AGENCY

	Sample Nos.	Time/Date Collected	Coliform Bacteria/100 ml Total	Coliform Bacteria/100 ml Fecal	Chlorine Residual ppm	Minutes Holding Time
East Bay MUD WPCP	EB-1	1015/Aug. 9	4,900	350	7.3	0
	EB-2	1115/Aug. 9	7,900	960	5.4	0
	EB-3	1215/Aug. 9	14,000	2,400	6.45	0
	EB-4	1320/Aug. 9	8,300	1,100	6.05	0
	EB-5	1415/Aug. 9	23,000	2,800	10.03	0
	EB-6	1520/Aug. 9	200	200	11.7	0
Redwood City WPCP	RC-1	1200/Aug. 8	266,000	51,000	7.5	
	RC-2	1300/Aug. 8	77,000	11,300	9.4	
	RC-3	1400/Aug. 8	180,000	33,000	8.9	
	RC-4	1500/Aug. 8	153,000	3,200	9.7	
	RC-5	1600/Aug. 8	133,000	6,200		
	RC-6	1700/Aug. 8	200	200	8.7	
Joint San Carlos & Belmont WPCP	SB-1	1300/Aug. 8	580	200	2.7	30
	SB-2	1450/Aug. 8	200	200	3.5	30
	SB-3	1500/Aug. 8	200	200	3.4	30
San Pablo WPCP	SP-1	1025/Aug. 14	380	200	1.85	0
	SP-2	1125/Aug. 14	580	200	1.10	0
	SP-3	1230/Aug. 14	200	200	2.25	0
	SP-4	1325/Aug. 14	200	200	2.70	0
	SP-5	1425/Aug. 14	200	200	4.20	0
	SP-6	1525/Aug. 14	200	200	4.4	0

TABLE G-4

INDUSTRIAL DISCHARGES--COMPARISON OF WASTE-SOURCE DATA

DISCHARGER	Avg. Flow (mgd)	BOD mg/l	BOD lb/d (x 10^3)	COD mg/l	COD lb/d (x 10^3)	Oil & Grease mg/l	Oil & Grease lb/d (x 10^3)	NO_3-N mg/l	NO_3-N lb/d	NH_3-N mg/l	NH_3-N lb/d	Total Kj-N mg/l	Total Kj-N lb/d	Total P mg/l	Total P lb/d
Standard Oil Co. (Richmond)[a/]															
Testing program[b/]	112.6	8.0	7.5	111	104.0	3.4	3.2	0.18	168	8.2	7,680	10.6	9,930	0.18	168
Self-monitoring data	112					4.5	4.2								
C/E Permit data	121	15	15.5	83	86.0	4.0	4.1	0.17	175	10	10,300	9	9,060	0.64	660
Union Oil Co. (Rodeo)															
OUTFALL 001															
Testing program	7.2	0.4	0.02	65	3.9	11.9	0.71	0.29	17	0.14	8	0.35	21	0.11	7
Self-monitoring data[c/]	10.1	1.0	0.08			0.6	0.05								
C/E Permit data	7.2		0.09		7.9	1.1	0.07		16		18		38	0.12	10
OUTFALL 002															
Testing program	38	7.8	2.5	233	73.7	16.3	5.2	0.18	57	0.42	133	0.95	300	0.09	28
Self-monitoring data[c/]	37	18	5.6	172	52.9	8.6	2.6	-0.11	34	2.4	741			0.16	49.4
C/E Permit data	48.4	16	6.5	153	61.8	6.9	2.8	0.14	57	1.0	404	1.5	606	0.19	77
Shell Oil Co. (W. Pittsburg)															
OUTFALL 001															
Testing program	4.4	7.8	0.3	190	6.9	20	0.7	0.05	1.8	2.35	85.2	7.15	259	4.67	169
Self-monitoring data	4.5	182	6.8	699	26.2	30.7	1.2	16.3	612	3.32	125	8.19	307		
C/E Permit data	4.3	330	11.9	1,010	36.5	80	2.9	25.2	910	6.6	240	10.2	370	0.38	14
Phillips Petroleum (Avon)															
OUTFALL 001															
Testing program	10.9	22	2.0	136	12.3	6.2	0.6	0.04	3.6	23.6	2,140	29.7	2,693	0.64	58
Self-monitoring data	14.9	23	2.8	157	19.1	3.6	0.4			16	1,948				
C/E Permit data	12.1	43	4.4	230	23.2	5.9	0.6	0.20	20.2	35	3,540	43	4,350	0.28	28.2
			d/	e/		f/									
OUTFALL 003															
Testing program		2.9		92				0.03		0.19		0.81		0.11	
Self-monitoring data	0.04														
C/E Permit data	1	3.6	0.03	166	1.4	5.2	0.04	<0.1	0.83	0.07	0.58	0.1	0.83	0.09	0.75
Dow Chemical Co. (Pittsburg)															
Testing program	26.2	7.2	1.6	25	5.4	2	0.4	0.22	48			0.48	104.6	0.10	22
Self-monitoring data	24.1					0.9	0.2	0.22	44					0.56	113
C/E Permit data	25	30	7.3	40	9.0	0.5	0.1	0.50	110			0.50	100	0.5	100
						f/									

TABLE G-4

INDUSTRIAL DISCHARGES—COMPARISON OF WASTE-SOURCE DATA (Cont.)

DISCHARGER	PARAMETERS: Susp. Solids mg/l	Susp. Solids lb/d (x 10^3)	Coliforms Total MPN/100 ml	Coliforms Fecal MPN/100 ml	Toxicity 96-hr TL_{50}	Toxicity Survival %
Standard Oil Co. (Richmond)			g/	g/		
Testing program	29	27.2	Confluent	colonies		90
Self-monitoring data			268			98
C/E Permit data	26	26.9	350			
Union Oil Co. (Rodeo)						
OUTFALL 001			h/	h/	i/	
Testing program	23	1.4	<200	<200		100
Self-monitoring data c/	-22.7	-1.9				99.1
C/E Permit data	75	4.5				
OUTFALL 002					i/	
Testing program	15	4.7	<200	<200		100
Self-monitoring data c/	-8.33	-2.6	1,817			81
C/E Permit data	106	42.8				
Shell Oil Co. (W. Pittsburg)						
OUTFALL 001			j/	j/		
Testing program	29	1.1	68,000	< 67	41	10
Self-monitoring data	21	0.8			27	
C/E Permit data	17	0.6	830			
Phillips Petroleum (Avon)						
OUTFALL 001			k/	k/	i/	
Testing program	23	2.1 l/	m/	>600		100
Self-monitoring data	41	5.0 l/			74	37.1
C/E Permit data	47	4.8 l/	3,860			
	n/					
OUTFALL 003						
Testing program	15					
Self-monitoring data						98
C/E Permit data	73	0.6	2,400			
Dow Chemical Co. (Pittsburg)			o/		i/	
Testing program			< 67	< 67		100
Self-monitoring data						100
C/E Permit data			< 45	< 45		

TABLE G-4

INDUSTRIAL DISCHARGES—COMPARISON OF WASTE-SOURCE DATA (Cont.)

DISCHARGER	Cadmium		Chromium		Copper		Nickel		Zinc		Mercury	
	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d
Standard Oil Co. (Richmond)												
Testing program	0.03	28.1	0.02	18.7	0.05	46.8	0.25	234	0.01	9.4		
Self-monitoring data			<0.01	< 9.3	<0.02	<18.7			<0.05	<46.7		
C/E Permit data			<0.01	<10	<0.02	20	0.02	20	0.02	20		
			p/		q/				r/			
Union Oil Co. (Rodeo)												
OUTFALL 001												
Testing program	0.03	1.8	0.03	1.08	0.04	2.4	0.25	14.9	0.04	2.4		
Self-monitoring data c/												
C/E Permit data	<0.01	1	0.007	0.4	<0.01	<1	<0.02	<1.2	0.07	4.2		
OUTFALL 002												
Testing program	0.03	9.4	0.03	9.4	0.05	15.8	0.26	82	0.04	12.6		
Self-monitoring data c/			0.03	9.3	-0.03	-9.3			0.02	6.2		
C/E Permit data	0.01	<4	0.022	9	0.026	11	<0.02	<8	0.085	34.3		
			p/		s/				t/			
Shell Oil Co (W. Pittsburg)												
OUTFALL 001												
Testing program	0.005	0.18	0.12	4.3	0.007	0.25	0.05	1.8	0.02	0.72		
Self-monitoring data			0.29	10.9	0.02	0.75			0.03	1.13		
C/E Permit data	<0.010	<0.4	0.40	14	0.02	0.7	0.270	10	0.06	2		
Phillips Petroleum (Avon)												
OUTFALL 001												
Testing program	0.005	0.5	0.22	19.9	0.01	0.9	0.06	5.4	0.03	2.7		
Self-monitoring data												
C/E Permit data			0.68	68	0.056	5.7			0.083	8.3		
OUTFALL 003												
Testing program	0.01		0.09		0.02		0.11		0.004			
Self-monitoring data			0.43	0.52	0.055	6.7			0.08	9.7		
C/E Permit data	0.005	0.04	0.034	0.32	0.047	0.39	0.880	7.3	0.041	0.34		
Dow Chemical Co. (Pittsburg)												
Testing program											0.004	0.9
Self-monitoring data											0.0004	0.08
C/E Permit data											0.00021	0.044
											u/	

TABLE G-4

INDUSTRIAL DISCHARGES—COMPARISON OF WASTE-SOURCE DATA (Cont.)

DISCHARGER	PARAMETERS												
	Avg Flow (mgd)	BOD		COD		Oil & Grease		NO_3-N		Total Kj-N		Total P	
		mg/l mg/l	lb/d (x 10^3)	mg/l	lb/d (x 10^3)	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d
C & H Sugar Co.													
OUTFALL 004 (D)													
Testing program b/	4.0	43	1.4	47	1.6	8.0	266	1.33	43	0.70	23.3	0.10	3.3
Self-monitoring data													
C/E Permit data	1.6	50	0.7	185	2.5			0.65	8.7	1.32	17.6	0.04	0.50
OUTFALL 005 (E)													
Testing program	0.35	1,670	4.9	2,355	6.8	4.0	12	1.7	4.9	9.80	28.5	0.12	0.3
Self-monitoring data	0.38	1,395	4.4	3,821	12.1	2.4	7.6						
C/E Permit data	0.45	2,200	8.2	4,350	16.3	1.5	4.0	18.1	67.9	11.01	41.3	0.16	0.60
OUTFALL 006 (H)													
Testing program	0.030												
Self-monitoring data	0.060												
C/E Permit data	0.055	1	0	70	30			0.31	0.14	0.52	0.24	0.43	0.20
OUTFALL 008 (J)													
Testing program	0.002	2,700	0.4	49,230	0.8	10.0	0.2			14.9	0.2	1.0	0.02
Self-monitoring data													
C/E Permit data	0.006	24,600	1.2	66,000	3.3			1.9	0.09	47.70	2.4	0	0
OUTFALL 014 (V)													
Testing program	0.58	392	1.9	570	2.8	1.3	6.2	0.29	1.4	14.10	68.0	6.7	94.5
Self-monitoring data	0.68	1,342	7.6	2,077	11.8	1.8	10.2						
C/E Permit data	0.48	480	1.9	1,010	4.0	1.0	6.08	2.9	11.6	5.23	20.9	0.33	1.32
	v/						x/						

TABLE G-4

INDUSTRIAL DISCHARGES—COMPARISON OF WASTE-SOURCE DATA (Cont.)

DISCHARGER	PARAMETERS							
	Toxicity							
	96-hr TL_{50}	Survival %	Total Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Iron mg/l	Iron lb/d	Chromium mg/l	Chromium lb/d
C & H Sugar Co.								
OUTFALL 004 (D)								
Testing program	i/	100	y/ < 67	z/ < 67	0.35	12	0.001	0.03
Self-monitoring data								
C/E Permit data			460	460				
OUTFALL 005 (E)								
Testing program			< 67	< 67	4.4	13	0.001	0.003
Self-monitoring data		88.2						
C/E Permit data			0	0	28.80	12		
OUTFALL 006 (H)								
Testing program	i/	100	< 67	< 67	0.11	0.03	0.02	0.005
Self-monitoring data								
C/E Permit data							0.02	0.006
OUTFALL 008 (J)								
Testing program					31.6	0.5	0.03	0.0004
Self-monitoring data								
C/E Permit data			240	240				
OUTFALL 014 (V)								
Testing program	i/	100	36,000	20,000	0.11	0.5	0.02	0.09
Self-monitoring data	89.5							
C/E Permit data			0	0	1,410	10		

TABLE G-4

INDUSTRIAL DISCHARGES—COMPARISON OF WASTE SOURCE DATA (Cont.)

DISCHARGERS	PARAMETERS												
	Avg. Flow (mgd)	BOD		COD		Oil & Grease		NO_3-N		Total Kj-N		Total P	
		mg/l	lb/d (x 10^3)	mg/l	lb/d (x 10^3)	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d
U. S. Steel Corp. (Antioch) COMBINED OUTFALLS 001 & 002[a/]													
Testing program	12.48			16.9	1.8			0.21	22	0.77	80	0.14	14.5
Self-monitoring data	11.34		0.8		2.6								
C/E Permit data			0.3		1.7				34				22
OUTFALL 003													
Testing program	9.53			6.7	0.5			0.17	13	0.7	5.5	0.10	7.9
Self-monitoring data	7.9	12.1	0.8	37.9	2.5	6.9	455						
C/E Permit data	8.5	17.5	1.2	40.4	2.9	8.7	623	0.25	17.9		0	0.36	25.8
Fibreboard Corp. OUTFALL 001													
Testing program	15.4	185	23.7	710	91.0	8.0	1,025	0.15	19.2	2.4	307	0.20	25.6
Self-monitoring data													
C/E Permit data	17.5	357	52.1	825	120.0	31.5	3,970	0.5	73	<0.1	<15	0.40	58
OUTFALL 002													
Testing program	9.3	65	5.0	140	10.8	3.4	263	0.04	3.1	1.07	79	0.20	15.5
Self-monitoring data													
C/E Permit data	9.6	248	19.8	405	32.4			0.7	56	<0.1	< 8	<0.1	<8

TABLE G-4

INDUSTRIAL DISCHARGES—COMPARISON OF WASTE-SOURCE DATA (Cont.)

DISCHARGERS	Coliforms: Total MPN/100 ml	Coliforms: Fecal MPN/100 ml	Toxicity: 96-hr TL_{50}	Toxicity: Survival %	Iron mg/l	Iron lb/d	Chromium mg/l ($\times 10^{-2}$)	Chromium lb/d	Mercury mg/l ($\times 10^{-2}$)	Mercury lb/d	Lead mg/l	Lead lb/d	Nickel mg/l	Nickel lb/d	Zinc mg/l	Zinc lb/d
U. S. Steel Corp. (Antioch)																
COMBINED OUTFALLS 001 & 002 aa/																
Testing program	b/ < 67	b/ < 67	c/	100							0.02	2.0	0.04	4.1	0.47	48.7
Self-monitoring data												0.79				43.8
C/E Permit data																45.2
OUTFALL 003																
Testing program	< 67	< 67	i/	100							0.02	1.6	0.03	2.4	0.24	19
Self-monitoring data			>100								0	0			0.27	17.8
C/E Permit data															130	9.3
													Sulfate mg/l	Sulfate lb/d		
Fibreboard Corp.																
OUTFALL 001																
Testing program	dd/ 36,000	ee/ >200	70	0					1.3	0.16	0.05	6.4	255	36,000		
Self-monitoring data																
C/E Permit data	9,800				2.1	310	<0.23	<3.4	<0.5	0.07	0.047	6.9	187	27,400		
OUTFALL																
OUTFALL 002																
Testing program	31,100	< 67	i/	100					2.6	0.20	0.04	3.1	89	6,886		
Self-monitoring data																
C/E Permit data	63.5				3.5	279	<2.0	<1.6	0.5	0.04	<0.002	<1.6	45.8	3,660		

FOOTNOTES TO TABLE G-4

a/ Available information indicates a) that testing program results show the concentration of SO_4 to be 2,195 mg/l or 2,056,346 lb/day; b) that self-monitoring data show 268 lb/day; and c) that, according to C/E Permit data concentration of SO_4 is equal to 1,750 mg/l or 1,790,000 lb/day.

b/ All testing programs (EPA) were carried out in 1972.

c/ Values reported on self-monitoring data are net values (effluent minus influent).

d/ State Waste Discharge Requirements (SWDR) stipulate that the average concentration be 50 mg/l and never greater than 60 mg/l.

e/ SWDR call for a COD limit only when the DO in the receiving water is at or less than 5.

f/ SWDR stipulate that oil and grease concentration never exceed 15 mg/l.

g/ Coliform data for influent from San Francisco Bay are as follows: total coliform - < 200 MPN/100 ml; fecal coliform - < 200 MPN/100 ml.

h/ Coliform data for influent streams are as follows:
Station No. 3: total coliform - confluent colonies; fecal coliform - < 200 MPN/100 ml;
Pt. Orient: total coliform - < 200 MPN/100 ml; fecal coliform - < 200 MPN/100 ml.

i/ There is no toxic effect.

j/ Coliform data for influent canal are as follows: total coliform - < 67 MPN/100 ml; fecal coliform - < 67 MPN/100 ml.

k/ Coliform data for influent streams are as follows:
Hastings Slough: total coliform - 670 MPN/100 ml; fecal coliform - 370 MPN/100 ml;
Contra Costa Canal: total coliform - 67 MPN/100 ml; fecal coliform - 67 MPN/100 ml.

l/ This figure represents a net value.

m/ These are confluent colonies, or "too numerous to count" (80,000 MPN/100 ml).

n/ SWDR stipulate that suspended solids concentration be 60, as an average or below, and never any greater than 100 mg/l.

FOOTNOTES TO TABLE G-4 (cont.)

o/ Coliform data for an influent stream are as follows: total coliform - 10,000 MPN/100 ml; fecal coliform - 2,000 MPN/100 ml.

p/, q/, and r/ For heavy metals the following are maximum values established by SWDR, respectively:

		Max. Limit
p/, q/, and r/	chromium	1.0
	copper	0.5
	zinc	1.0
s/ and t/	copper	0.05
	zinc	0.10

u/ SWDR call for mercury concentration to be no greater than 0.005 mg/1.

v/ SWDR call for average flow never to be less than or equal to 1.3 mgd.

x/ SWDR stipulate that levels not exceed 15 lb/day.

y/ and z/ Coliform data are as follows: Salt water influent: 20 MPN/100 ml each for total and fecal coliforms; EBMUD influent: total coliform - 2,400 MPN/100 ml; fecal coliform - 900 MPN/100 ml.

aa/ Outfalls 001 and 002, listed as separate outfalls on both self-monitoring and C/E Permit data, were combined at the time of the 1972 EPA testing program.

bb/ and cc/ Coliform data on influent are as follows: N. Y. Slough: total coliform - 2,000 MPN/100 ml; fecal coliform - < 67 MPN/100 ml; Contra Costa Canal: total coliform - < 67 MPN/100 ml; fecal coliform - < 67 MPN/100 ml.

dd/ and ee/ Coliform data on influents are as follows: Canal: total coliform, 800 MPN/100 ml and fecal coliform, 220 MPN/100 ml; River: total coliform, 800 MPN/100 ml and fecal coliform, 200 MPN/100 ml.

APPENDIX H

APPENDIX H

Table H-1. Time Schedule for Compliance with Water Quality Objectives*

1. Review data from checking and self-monitoring programs for existing waste discharges to determine compliance with this policy - review data on a continuing basis and complete determination no later than July 1, 1968;

2. Develop waste discharge requirements and self-monitoring programs which will assure compliance with this policy and the policy of Resolution No. 803 as expeditiously as possible and in accordance with the following schedule:

   a. For all new waste discharges - before the discharge commences;

   b. For all existing waste discharge not under requirements at present - give priority to industrial waste discharges and complete no later than December 31, 1968;

   c. For all existing waste discharges under requirements at present - complete review and necessary revisions no later than December 31, 1970; and

3. Initiate formal enforcement proceedings pursuant to the Regional Board's policy in accordance with the following schedule:

   a. For dischargers who are not under waste discharge requirements at the time this policy becomes effective - initiate proceedings no later than December 31, 1970 for those dischargers found to be in violation of requirements which are consistent with this policy.

   b. For dischargers who are under waste discharge requirements which are consistent with this policy - initiate proceedings no later than December 31, 1968 for those dischargers found to be in violation of said requirements.

   c. For dischargers who are under waste discharge requirements which are not consistent with this policy at the time it becomes effective - initiate proceedings no later than December 31, 1970 for those dischargers found to be in violation of said revised requirements.

4. Require all entities to determine and report on conditions contrary to this policy caused by the discharge of combined stormwater runoff and sewage including measures needed and schedule for compliance with this policy no later than July 1, 1968;

TABLE H-1 (Continued)

5. Eliminate dairy wastes as a factor causing conditions contrary to this policy no later than December 31, 1971, through the enforcement of requirements and the support of the dairy industry's self-policing program;

6. Implement, within budget limitations, a basic data program no later than December 31, 1967.

* Source: "Water Quality Control Policy for Tidal Waters Inland from the Golden Gate Within the San Francisco Bay Region," San Francisco Bay Regional Water Quality Control Board, 1967.

TABLE H-1

STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Alviso, City of	Resol. 364(6/15/61) WDR, RWR 69-40(8/28/69) Bact. reg.	(Resol. 364 indicated that peremptory order issued by State Dept. Public Health on 3/8/61. Directs certain actions with schedule.)	(Resol. 364 also states const. of new fac. are contrary to SFWPLB policy favoring consolidation)	(1972-73) Connect to San Jose Main Plant.	Alviso has been annexed by San Jose ( ). STP now operated by City of San Jose. $250,000 interceptor and pumping to San Jose STP defined in State needs list for FY 72-73.
Los Altos, City of	Resol. 212(3/15/56) RWR 641(2/18/65) amends 212 eliminates grease standard 675(6/17/65) schedule for compliance 67-53(10/19/67) WDR, RWR - rescends 212 reg. for alternatives of joint treat. 68-16(4/30/68) C&D order (with schedule) 68-74(12/18/68) amends C&D order (with schedule) 70-60( ) reissue of C&D (with schedule) (Presently not complying with active resol.)	Resol. 70-60* Compliance with Cl_2 reg. by 8/15/70. Other reg. Complete const.& oper. 11/30/71. Demo compli. 6/1/72	Improvements to STP completed 11/65. A contract for expansion of facilities was awarded early 1970. (See Palo Alto)		*Revises schedules that appeared in Resol. 675 (partial schedule), 68-16(complete const. 3/31/70) and 68-74(complete const. & oper 2/28/71). Agreement has been reached between Los Altos, Palo Alto and Mountain View. (See Palo Alto)

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Milpitas Sanitary Dist.	Resol. 124(4/16/53) RWR 442(1/17/63) rescends 124 revises requirements 475(6/20/63) revises 442 519(12/19/63) schedules for compli. 530(1/16/64) C&D order (with schedule) 67-8(2/16/67) amends C&D order & revises schedule 69-27(6/24/69) revises RWR & WDR rescends 442 & 475 70-6(3/14/70) C&D order 70-58(7/23/70) SWRC formal enforcement action ( ) rescinds 70-6 (Presently complying with active resols)		Effluent settling pond completed 9/2/69 SF Bay Board finds SD in compliance.	(1974-75) Interceptor toward central bay with deep water outfall.	C&D order (70-6) included additional connection bin subsequent to 3/14/70. Has been rescinded. On 4/2/70, SWRCB remanded to the SF Bay Board continuing jurisdiction. MSD is now participating with San Jose for connection to facilities. Schedules indicates capacity will be available by 1/1/73 and will discontinue operations at present Milpitas plant.

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Menlo Park S.D.	24(10/10/50) RWR __ (6/20/63) rescinds 24 RWR, WDR 524 (12/10/63) schedule 590 (3/20/64) C&D order 668 (6/17/65) Amends schedule 702 (9/16/65) Amends 590 & 668, RWR, WDR 67-13(4)/25/67) C&D amends 590, 668, 702 67-54(10/19/67) Reg. for joint treatment alternatives 67-59(11/16/67) WDR, RWR for interim fac. 68-55(9/25/68) reg. for proposed M.P. fac. 68-69(12/18/68) C&D order amends 67-13, 702, 668, 590 69-40(3/28/69) Bact. reg. (Presently complying with active resolutions)		Improvements & extensions of stabilization completed late 1969	(1974-74) Interceptor sewer toward Central Bay with deep-water outfall	Menlo Park cannot make decision as to joint treatment with the subregional facilities for San Mateo County or South Bay Dischargers
Redwood City	262(12/19/57) RWR 453(4/18/63) rescinds 262 revises WDR, RWR 523(12/19/63) schedule 702(9/6/65) amends 67-19(4/28/67) amends schedule 67-54(10/19/67) revises WDR, RWR 68-17(4/30/68) C&D order & schedule 68-71(12/18/68). joint treat. alter. revises schedule 70-4(3/14/70) C&D revises sched. 70-62(7/23/70) amends C&D deletes add. connection ban Presently complying with active resolutions	Resolution 70-4* ACC 3/31/70 Complete const. 4/1/71 Demo compli 5/1/71	Limited improvements - made periodically Facility for sludge treat. & disposal & excess chlorination completed 7/70. Add. connections ban dropped. (Continued)		* Order 70-4 revises several past schedule. The C&D also included an add. connection ban. The dischargers filed a stay order 5/12/70. Removed from court calendar because progress was being made thru negotiations. $6,500,000 project for facilities for Redwood City, San Carlos, Bellmont & possibly others defined in State needs list for FY 74 & 75.

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Redwood City, City of (Continued)			(Cont'd) Further improvements to be completed 4/71 - includes joint treatment with San Carlos-Belmont (Joint Auth. for the Strategy Consolidation Sewerage Plan)		
San Carlos,-Belmont Cities of (New tributary to Redwood City System)	303(5/21/59) RWR 343(10/20/60) rescinds 303, revises RWR, WDR (Incomplete)				

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Mountain View, City of	13(8/17/50) RWR 221(10/18/56) revises RWR rescinds 13 640(2/18/65) revises RWR rescinds RWR - rescinds grease & oil standard 650(3/18/65) schedule for 221 788(10/22/66) rescinds 650 requires summary regarding joint treat. 67-53(10/19/67) WDR, RWR for alternatives of joint treatment 67-70(12/21/67) revises WDR, rescinds 221 68-15(4/30/68) C&D order with schedule 68-73( ) amends C&D order & schedule 70-61(7/23/70) reissues C&D order with revised schedule (Presently complying with active resol.)	70-61 C&D order* Demo compli. with Cl_2 req. 8/15/70 Complete all const. and oper. 11/30/71 Demo Compli. 6/1/72	Detention pond (after) primary clarifier) in conjunction with chlorination completed 8/70 (See Palo Alto)	? 1971-72	*Revises schedules established in Resol 650 (comp. const. 5/1/69), 68-15 (complete const. 3/31/70) and 68-73 (complete const. 2/28/71). Agreement reached between Mountain View, Los Altos and Palo Alto for regional system. (See Palo Alto) $600,00 for Class A interceptor defined in State needs list for FY 72-73 for Mountain View Sanitary Dist.
Palo Alto, City of	436(12/20/62) RWR 796(11/17/66) schedule for 436 67-53(10/19/67) WDR, RWR for alternatives of joint treatment 68-3(1/18/68) schedule for 67-53 68-14( ) C&D order & revises schedule	Resol 70-59 C&D order* Demo. compli. with Cl_2 req. 8/15/70 Complete all const. and oper. 11/30/71 Demo compli. 6/1/72	Joint treatment facilities for Palo Alto, Mountain View, and Los Altos completed 4/72 plant includes fac. for treat. of ind. wastes		Will connect to common central bay deepwater outfall with South Bay Dischargers (See Palo Alto)

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Palo Alto, City of (Continued)	68-72(12/18/68) amends C&D & revises schedule 70-59(7/23/70) reissues C&D & revises schedule (Presently not complying with active resol.)	Resol 70-57* Division A - Cl_2 facilities F - Railroad spur Acc for spur 8/24/70 place in oper 2/28/71 Demo with Cl_2 req. 3/31/71	Division A- Completed 5/71 Division F- Completed	(1974-75) Connect to central bay deep water outfall	South Bay Dischargers have submitted report for construction of deep water outfall to Central SF Bay. Tenative schedule calls for Federal & State approval by 12/31/72, complete construction 6/30/77 and commence operation 7/31/77. The following municipalities are involved in the joint outfall: San Jose-Santa Clara system San Jose; Santa Clara; County San. Dist. 2,3 &4; Burbank & Cupertino San. Dist. Palo Alto Los Altos Sunnyvale Mountain View Milpitas San. Dist. $240,000,000 project for subregional treatment plants, interceptors and outfall serving South Bay Dischargers by State needs list for FY 73-74
San Jose, City of	316(11/19/59) WDR 68-11(3/21/68) revises WDR 69-26(6/24/69) C&D order with schedule 70-57(7/30/70) reissue C&D order 70-9(11/24/70) revises WDR 71-36(6/24/71) amends schedule of C&D order 71-78(11/23/71) C&D order for toxitcity with schedule ( ) amends 68-11 (Presently complying with active resol.)	Division B - Prim & Secondary additions C - Sludge cond. & digesters Advertise 9/30/70) receive bids 11/15/70 Acc 12/19/70 comp. const. - to be estab. Division E - Water Reclamation Plant FP 3/31/71 Request auth to Advertise 4/5/71 bids open 5/5/71 Acc 8/5/71 complete const. 8/5/72 Resol 71-78 for toxicity FP 3/15/72 Implement prog. for wastes to system 5/1/72 Report (feas. of removing NH_3) 3/1/72 Report on sources & abatement program 5/1/72 Resol for sub. reg. plan complete st... -/1/72 submit schedule 2/25/72	Division B- Grant offer 6/71 UC C - Grant offer UC D - Sludge lagoon grant offer 6/71 UC E - Water Reclamation Plant		

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Sunnyvale, City of	123 (3/17/53) RWR 642 (2/18/65) C&D order 723 (2/17/66) RWR, WDR ___ (11/25/69) Rescinds 723 revises RWR, WDR 69-61 ( ) revises WDR & schedule 70-13 (2/16/70) requests tighter schedule 70-92 (11/24/72) amends 69-61 and revises schedule (Presently complying with active resolutions)	Resol 70-92* Compli with OC reg. Complete subregion study 1/1/72 submit FP 3/15/72	Facilites complete 1968? New facilites completes 9/72	(1974-75) Connect to central Bay deepwater outfall	*Schedules in past resol and/or orders referred to treatment plant improvements - See Status
Union S.D. - Irvington	Resol 297 (12/18/58) WDR, RWR 646 (3/18/65) 653 (4/15/65) C&D order & schedule 689 (7/18/65) C&D - revised schedule 69-40 (8/28/68) Bact.req. (Presently complying with active resol)	689 C&D order* F 12/15/65 FP 6/15/65 ACC 3/15/66 Complete Const. 3/15/67 Demo.Compli 10/01/67 69-40 for Cl_2 regs. ACC 5/15/70 Complete Const. 7/31/70	Partici-pation in joint study of deep water outfall (See Hayward)	(1974-75) Interceptor sewer toward central Bay with deep-water outfall	*Revises past schedules Part of East Bay Discharges (see Hayward)
Union S.D. - Newark	Resol 487 (8/14/63) RWR, WDR 652 (4/15/65) C&D order & schedule 688 (7/15/67) revises 652 69-40 (8/28/69) Bact.req. 69-46 ( ) rescinds 688 & 67-9 (Presently complying with active resol)	Resol 67-9* Comple Constr. 6/67 Demo. Compli. 10/15/67	New facilities completed 6/67 Partici-pating in joint study of deepwater outfall	(1972-73) Interim improvements 1974-75 Interceptor sewer toward central Bay with deep-water outfall	*Revises past schedules Part of East Bay Dischargers (see Hayward)

STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Union Sanitary District	66 (7/19/51) RWR 395(2/15/62) rescinds 66 revises RWR, WDR (Presently not complying with active resolutions)		Intermediate Plant completed 1960 Now tributary to Union SD - Irvington Plant Participating in joint study of deep water outfall (See Hayward)	(1975-76) Interceptor Sewer toward Central Bay	Part of East Bay Discharges (See Hayward)
Burlingame, City of	Resol. 23 (9/21/50) RWR 254(10/17/57) rescinds 23, revises RWR, WDR 472(6/20/63) rescinds 254, revises RWR, WDR 701(9/16/64) schedule 765(6/16/66) schedule for wet weather flow control 67-11(4/28/67) C & D order 67-51(10/19/67) rescinds 472, revises RWR, WDR 67-52(10/19/67) amends 67-11 68-76(12/18/68) rescinds 765 & 701 (bypassing)	72-40 Forthwith for bypass prohibition Schedule for prohibition of discharges to nearshore Submit PP 10/1/72 FP 5/1/73 ACC 8/1/73 Complete Construction 6/1/74	Improvements to treatment plant - UC (grant offer 2/68) Participating as possible joint outfall to central bay deep waters (See So. San Francisco)	1971-72 Connect to South San Francisco and San Bruno joint plant	72-40 prohibits bypassing and prohibits discharge within 200 feet of shoreline Participating in possible joint outfall (See So. San Francisco) Joint study with Millbrae for common outfall

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Burlingame (cont.)	71-75(10/28/71) req. for So. San Francisco for possible joint project including Burlingame 72-40(7/25/72) amends 67-51 schedule (Presently complying with active resolutions)				$3,200,000 project for interceptor sewer from Burlingame and Millbrae to So. San Francisco defined in State needs list for FY 72-73
East Bay Municipal Utility District - Special District #1	Resol. 73(9/20/51) WDR 718(1/20/66) amends 73 & schedule 68-8(3/21/68) rescinds 73 & 718 revises WDR, RWR 70-37(4/23/70) amends 68-8 70-81(10/22/70) amends 68-8 72-21(5/23/72) amends 70-81 & schedule (Presently not complying with active resolutions)	Resol. 72-21 FP for primary improvements & pumping stations 6/1/72 FP for secondary & sludge treatment & disposal 12/1/72 ACC for primary improvement 12/15/72 ACC for second improvement 6/1/73 FP for bldg. add. & outfall modifications 5/1/73 Complete Construction prim. improve. 7/1/74 bldg. add & outfall modifications 9/1/74 secondary improvements, sludge treatment & disposal 2/15/75	Removal of Discharge of digested sludge (vacuum filtration & trucking to land fill completed 7/71) Presently developing FP for chemical treatment facility (completion expected 4/1/72)	(1971-72) Chemical & expanded primary treatment (1972-73) Sobrante Plant chemical flocc., centrifuge & precoat filter (1973-74) Walnut Creek Filter Plant Chemical floc. centrifuging and precoat filter	Pilot plan tests have indicated best alternative method for achieving 85% removal of BOD EBMUD also participating in joint outfall study for East Bay Discharges (See Haywar EBMUD received grant offer during FY 71-72 for STP improvements. Total eligibl costs $53,200,000

(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Estero Municipal Improvement District	414(5/17/62) WDR, RWR 69-39(8/28/69) Bact. req. (Presently not complying with active resclutions)		Primary Facility & Sludge Disposal facility completed 6/69	(1972-73) Consolidate sludge disposal facilities with San Mateo (1972-73) Connect to City of San Mateo plant enlargements	An interceptor connecting to City of San Mateo defined in State needs list for FY 73-74
Guadalupe Valley M.I.D.	281 (8/21/58) RWR 69-40(8/28/69) Bact. req. (Presently not complying with active resolutions)			(1971-72) Connect to Bayshore S.D.	Guadalupe Valley MID plant completed in 196[illegible] Serves Brisbane and Crocker industrial park. Proposes to abandon plant and become tributary to San Francisco plants.
Hayward, City of	422(7/19/62) 718( ) schedule 704( ) C & D Order & schedule rescinds 422 70-53(6/25/70) WDR to conform with Porter Cologne Act 72-9(8/22/72)	___________ schedule for deep water outfall agree with F & adm. of Phase I project & authorize preparation of EIS & PP 10/72 Final agreements F & adm. 1/73 Initiate studies for reduction of storm water infiltration & adopt sewer ordinance 2/73	•Oxidation pond complete 9/66 New stabilization ponds & appurtenances UC (grant offer 9/70)	(1971-72) interim improvements - extension of ponds, sludge dewatering facilities, and aerators. (1975-76) Interceptor Sewer toward Central Bay.	Outfall project program involve Hayward, San Leandro, Union, Oro Lomo, and Castro Valley Sanitary Districts. Also includes wet weather flow from East Bay MUD.

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Hayward, City of (continued)	(Not presently complying with active resolutions)	PP 3/73 Auth. FP for Phase I 5/73 F 12/73 FP 2/74 ACC 9/74 Complete Const. 12/75 Demo. Compliance 4/76	Also participating in East Bay Discharger plan for joint outfall to central bay deep waters.		$57,000,000 project for East Bay Interceptor sewer and outfall defined in State needs list for FY 73-74/
Millbrae, City of	527(1/16/64) WDR 582(7/16/64) schedule 702(9/16/64) amends 582 736(3/17/68) C & D order & schedule 67-4(11/19/67) amends C & D and revises schedule 69-40(8/28/69) Bact. req. 71-75(10/28/71) WDR for joint treatment 72-39( ) amends 527 and 69-40. Revises WDR, RWR and revises schedule (Presently not complying with active resolutions)	Resol. 72-39* Submit PP 10/1/72 FP 5/1/73 ACC 8/1/73 Complete Const. 6/1/74	Consultant has been authorized to proceed with FP for central bay deep water outfall. Joint project with Burlingame.	(1971-72) Interceptor sewer to eliminate wet weather bypasses.	* Revises several past schedules. $143,000 project for pump station and interceptor defined in State needs list for FY 73-74, Priority III.
Oro Loma Sanitary District	(Presently not complying with active resolutions)		Participating in joint study of deep water outfall (See Hayward)	(1975-76) Interceptor sewer toward central bay	Part of East Bay Discharges (See Hayward)
San Francisco - Southeast			Proposed consolidation with other SF plants to new facility with discharge to ocean		$33,500,000 project listed for outfall from SE plant to Lake Merced outfall defined in State needs list fo FY 72-73.

(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
San Francisco - Southeast (Cont.)	--$30,000,000 project for interception of combined dishcarge (Priority II) --$ 690,000 project replacing airport pressure force main (Priority III) --$30,000,000 project for interception and treatment of combined discharge also listed for FY 74-75 (Priority II) as well as FY 75-76 (Priority II) as well as FY 76-77 (Priority II)			(1971-72) Solids handling, sludge filtration, digesters and effluent outfall changes, grit removal (1972-76) interception and treatment of combined sewer discharges. Not yet defined.	The following are defined on State needs list for FY 73-74: --$67,000,000 project for treatment & secondary solids handling @ SE plant --$10,650,000 project of Northpoint eff. transported to SE Plant --$22,000,000 for treatment and solids handling at Richmond-Sunset Plant.
San Francisco International Airport (Sewage)	70-25( ) WDR, RWR 70-31(3/26/70) C & D order (Presently complying with active resolutions)		New STP completed 7/71.	(1971-72) Treatment of individual wastes with disposal to deep water outfall with sewage--also replace interceptor	Case turned over to State Attorney General 11/10/70. Attorney General advised of improvements No enforcement action taken.
San Leandro, City of	(Presently not complying with active resolutions)		Participating in joint study of deep water outfall (See Hayward)	(1971-72) solids handling and aerators (1975-76) Interceptor sewer toward central bay.	Part of East Bay Discharges (See Hayward

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
San Mateo, City of	(Presently complying with active resolutions)			(1972-73) interim improvements	$1,500,000 project for enlargement of treatment plant and interceptor from Estero MID defined in State needs list for FY 73-74.
So. San Francisco-San Bruno	(Presently not complying with active resolutions)		Participating in joint study for deep water outfall to central SF Bay	(1971-72) improvements & outfall extension	SSF is acting as central agent for SSF, San Bruno, SF International Airport, Merck Chemical, and possibly Millbrae and Burlingame for joint outfall project
California State Prison-San Quentin	575(7/16/64) WDR 67-49(9/21/67) amends 575: better disinfect 68-29(4/30/68) WDR - rescinds 575 & 67-49 69-21(4/23/69) Time Schedule for 68-29 69-41(8/28/69) Revision of 68-29 (Presently complying with active resolutions)			(1972-73) Interceptor to Pt. San Quentin-with deep water outfall to	Flow: dry .94 mgd wet 3.6 design 1.0 pop: 5,000

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Marin County SD #1	351(2/16/61) WDR 68-28(4/30/68) WDR rescinds 351, 409, 67-48 71-43(6/24/71) WDR rescinds 68-28 incl. schedule 71-52(7/22/71) C & D	68-28 incl. 90% BOD removal 71-43 submit comply schedule by 7/1/72 Comply: floating matter: forthwith new const: 7/1/73 no bypass: 4/1/74	7/72-on schedule	(1972-73) Interceptor to Pt. San Quentin with deep water outfall to Bay--also wet weather treatment interim improvements	Flow: dry 4.0 mgd pop: 52,000 wet-15. at plant design 4.5 71-43: incl. stronger stds. for coliform turbidity, BOD, nutrients. Bypass prohib. flow limit 4.5 mgd 71-52 viol: floating matter Bypass Connection Ban Sub-regional programs to be implemented 73-74 part of program held up by law suits (Ross Valley trunk sewer). $10,000,000 project for treatment plant enlargements & joint outfall with Marin Co. SD #1, San Quentin Prison & San Rafael SD (possibly other dischargers will be included). Defined in State needs list for FY 73-74.
	(Presently not complying with active resolutions)				
Marin County SD #5 Main Plant	511(10/17/63)WDR (Paradise Cove only) 69-3(1/15/69) Rescinds 511 287(9/18/58) WDR Main Plant			(1972-73) interim improvements	Main Plant Flow: dry: .7 mgd design: 1.4 mgd pop: 6,000 Outfall to Raccoon Strait

SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Marin County SD #5 Main Plant (Cont.)	70-104(12/22/70) Amend. to 287 incl. schedule (Presently not complying with active resolutions)	70-104: Complete improvements by 5/1/71.		See also Richardson Bay SD	District resists particularly in sub-regional plan. Wants to implement tertiary treatment on its own.
Mill Valley, City of	732(3/16/66)WDR w/schedule 785(9/15/66)Time Sched. 71-13(2/25/71)WDR amends 732 71-34(6/24/71) C & D (Presently not complying with active resolutions)	732: submit sched. by 7/15/66 785: Comply by 7/1/67 71-34: Stop bypass: forthwith, complete compliance plan: 7/1/72	Programs to reduce infiltration are in progress. Bond issue passed, applied to State & EPA for interim improvements.	(1971-72) aerated lagoon and chlorination	Flow: Dry 1.7 mgd design 1.8 mgd pop: 16,000 outfall to Richardson Bay 732: no bypass 71-13: Flow limit: 1.8 mgd Tighter effluent stds. Conforms to interim plan except for outfall specs. 71-34: viol: disinfect BOD, toxicity, turbidity, floating matter, bypass, excessive flow. Connection ban.

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Richardson Bay S.D.	228 (11/15/56) WDR 71-14 (2/25/71) WDR 71-33 (6/24/71) C&D w/ time sched 8/22/72 - Board grants extension of by-pass prohib. (presently not complying with active resols)	71-33: No bypass: 4/1/73 submit comp-sched: 7/1/72	7/6/71: Connection ban appealed to State by dev. 7/27:CB appealled to courts 8/5: State upholds ban 3/15/72: Court upholds ban 7/22: RBSD asks 1 yr extension on bypass prohib so money allocated for interim compliance can be spent on long-range program	1971-72 interim improvements 1972-73 Marin Muni Water Dist-Interceptor from Richardson Bay to ocean. Treatment plant and deep water outfall. Possible joint project with other Marin Co. discharges	Flow (Trestle Glen) dry: .2mgd design: .3mgd pop: 4200 Sewage from rest of dist. pumped to Sausalito plant 71-14: No bypass Flow limit .3mgd 71-33: viol: floating matter foam, BOD, disinfect, turbid, toxicity threatened viol: bypass. Connection ban. Program to cut infil, disinfect, facilities enlarged land disposal of some effluent

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Richmond, City of	130 ( ) WDR 721 (2/17/66) WDR rescinds 130 69-40 (69) Amend. requires disinfect. 69-46 (9/25/69) rescinds 327 (?) 747] C&D rescinded by 68-6] 70-9 (1/29/70)		Plant improvement compl. 10/69	1975-76 interceptor from Antioch toward Richmond-deepwater outfall	flow: design: 12.2mgd pop: design: 98000
San Francisco - North Point				1971-72 deepwater outfall, main sump and pump alteration, turbidity and grease removal 1972-76 interception and treatment of discharges from combined sewers	
Sausalito - Marin City S.D.				1971-72 interim improvements	

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Seafirth Estate					
Stege Sanitary District (Connected to East Bay M.U.D.				1971-72 Chemical and expanded primary treatment	
American Canyon Co. Water District					
Calistoga, City of				1972-73 interim reclamation for irrigation 1974-75 land disposal facilities	

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Contra Costa County S.D. No. 7-A				1971-72 expanded primary treatment or ponding 1975-76 interceptor from Antioch toward Richmond, deepwater outfall.	$35,000,000 project for transportation fac. from Crockett Valona to Richmond plant defined in State needs list for FY 74-75 $712,000 project for new secondary plant defined in State needs list for FY 72-73
Hercules, City of				1972-73 interceptor sewer to City of Pinole 1975-76 interceptor from Antioch toward Richmond, deepwater outfall.	To connect to Pinole $90,000 project for interceptor to Pinole STP defined in State needs list for FY 72-73

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Las Gallinas Valley S.D.	380 (10/19/61) Long Range Plan 396 (2/15/62) WDR 69-40(/28/69) Requires disinfect. Time Sched 72-10 (3/28/72) WDR w/ schedule	72-10 submit compl. sched: 7/1/72 Comply w/flow limit: 12/31/73 No bypass: forthwith	Disinfect begun 4/70	1972-73 interim improvements (See also Marin Co SD #6 - Ignacio)	Flow: dry: 2.1 mgd wet: 10.5 " design: 2.25 " pop: 30,000 outfall to Miller Cr 72-10 conforms to interim plan. flow limit 2.25 mgd sub-reg plan to b- implemented '76-'- Plant may be expanded in interim $400,000 project for disinfection and sludge handling fac. and enlargement of biofilter defined in State needs list for FY 72-73

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Marin County S.D. No. 6-Ignacio	596(8/20/64) WDR 69-8(2/13/69) WDR Rescinds 470 & 596 69-15(3/13/69) C&D w/Sched. 69-286/24/69) amends 69-15 69-49(9/25/69) amends 69-15 & 69-28 70-72(9/24/70) amends 69-8 70-86 (10/22/70) amends 69-15, 69-28 & 69-49 (Presently not complying with active resol)	69-49: comply by 4/15/70 70-86: comply w/70-72 by 2/1/73 submit subreg. sched by 3/15/71	Construction is a little behind sched, but should meet compliance sched.	(75-76) N. Marin Co. & S. Sonoma Co.-Interceptor to Pt. San Pedro with deep water outfall. Interceptor may go as far as Pt. San Quentin or to ocean as joint project with So. Marin discharges	Flow: .7 mgd to be enlarged to 1.2 pop: 10,000 outfall to Novato cr. seasonal irrigation use of effluent. 69-8: strict coliform std. (concern over irrigation use). 70-72: requires dev. of subreg plan with alternative to proposed San Pablo outfall. Bypass prohib. Plan is to upgrade Novato & Ignacio plants, & use combined outfall to S. Pablo bay. Reg. bd wants different outfall location. Grants forthcoming, bonds sold. $33,000,000 project for subreg. transport of treatment and possibly reclamation fac defined in State needs list for FY 73-74

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Marin County S.D. No. 6-Novato	(See Ignacio)			(See Ignacio)	
	(Presently not complying with active resols)				Flow: dry; 1.8 mgd design: 2.7 (to be enlarged to 3.0) pop: 21,700 Outfall to Novato Cr. within 500' of water-oriented residential area. effluent used for seasonal irrigation.
					(See Ignacio)

TABLE H-1
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STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Marin County S.D. No. 6-Bahia	470(6/20/63) WDR 69-8(2/13/69) WDR rescinds 470 & 596 70-72 (9/24/70) 71-16 (2/25/71)	when constr. is complete, parts of 70-72 relating to Bahia are rescinded.		(See Ignacio)	Flow: design: .2 mgd Pop: 2000(design) ultimate flow .8 mgd " pop 8,000 outfall to Petaluma R. To be expanded as development continues & abandoned after tie-in w/subreg plan. State does not want to fund Bahia because it is a one-developer project.
	(Presently not complying with active resols)				71-16: no bypass (See Ignacio)

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Meadowood Development Co.					
Napa County S.D.			1975-76 Interceptor from Napa to Vallejo and plant enlargements at Vallejo.		

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Petaluma, City of				1971-72 pump station, force mains and new oxidation ponds. (See also Marin Co. SD #6-Ignacio)	
Pinole, City of				1975-76 Interceptor from Antioch toward Richmond, deep-water outfall	

TABLE H-1
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
MUNICIPALITIES

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	WQM PLAN	COMMENTS
Rodeo S.D.				1971-72 interim chemical facilities 1975-76 Interceptor from Antioch toward Richmond, deep-water outfall.	
St. Helena, City of				1971-72 Thomas Lane interceptor 1974-75 Land disposal facilities.	$70,000 project for Thomas Lane interceptor defined in State needs list for FY 72-73 (priority III)

TABLE H-2

STATUS OF ABATEMENT
SF BAY DISCHARGERS
INDUSTRY

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
FMC, Inorganic Chem Div Newark	4/16/64 Disch. Reg.			Typ. stds. Process waste 4mg OIS - continued 4, Cooling waste 1.
	69- 11/25/69 Disch. Reg.			
	72- 8/10/72	To be filed 9/15/72 by FMC		Viol. of floating mat settleable solids
Crown Zellerbach Antioch	71-14 WDR (4/20/71) incl. schedule revised sched. 6/25/71	No discharge of toxic or biostim. by 6/76 Complete constr. by 9/1/73 of all treatment facilities		
Fibreboard - Pulp & Paper Antioch	302 WDR (1960) 71-17 WDR (4/20/71) incl. schedule rescinds 302	comply by 1/1/73, later extended to 7/74 No disch of toxic of biostim. mtl. by 6/76		EPA has proposed a compliance plan w/final comp. by 7/7
Fibreboard - Board Mill Antioch	316 (WDR (7/24/58)) 71/18 WDR (4/20/71) (rescinds 316) w/schedule	compliance by 1/1/73		

TABLE H-2
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS
INDUSTRY

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
duPont Antioch	71-13 WDR (4/20/71) w/schedule	comply by 3/1/73		
Hickmont Foods Antioch	172 WDR (4/24/58) 61-99 C&D (7/20/61) (solids) 64-166 C&D (10/27/64) (pH) 71-16 WDR (4/20/71) (rescinds 172) no toxic or biostim discharge after 6/76		new equip. installed early '72	
Tillie Lewis Foods Antioch	173 (4/24/58) WDR 71-15 (1/71) WDR (rescinds 171)	comply by 7/1/73 no toxic or biostim. after 6/76		
Merck & Co South San Francisco	685 Disch. Reg 7/16/65 69-31 Disch. Reg	Reduce Solids Load at Source 12/1/70 Complete wastewater study 8/31/70 Submit final vpt. 4 mos. after staff consultation on study		Typical stds for rece ing wtr. & waste sewa & Ind waste

TABLE H-2
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS

INDUSTRY

DISCHARGER	RESOLUTIONS AND/OR ORDERS		MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
Merck (Cont.)	71-22 4/22/71	C&D	limit loads 5/1/71 get agreement w/SSF for outfall tie-in by 6/1/71 Complete in plant collection system 14 mos after approval of tie-in compliance w/69-31 within 1 month of tie-in	Files indicate compliance w/time schedule	
	71-64	Rescinds 685			685 not needed after sewage is disposed to city system. Ind was covered by 69-31

TABLE H-2
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS

INDUSTRY

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
P G & E San Francisco (Hunters Point)	218 WDR 8/16/72			Minimal stds for oil, toxicity in effluent & receiving wtr.
	541 WDR 2/20/64	Expands & extends monitoring program & stds to include cleaning process waste		Some minor oil spills noted over past few years
Allied Chem. Richmond	____ WDR 1/25/65	Typical rcing water stds (incl. ph 6.5-8.3) but no pH std for effluent	Neutralization facility installed 2/70	
	____ WDR 4/25/72	Adds effluent pH std to be complied w/ forthwith	Facility upgraded 5/72	Sulfuric Acid plant .04 mgd pH 1-3 waste State F & G sued in '69. Allied pleaded guilty. 4/13/72 EPA requests 1899 action. 8/72-Board to consider C & D for violations of effluent pH in 6/72

TABLE H-2
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS

INDUSTRY

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
Stauffer Chem. Richmond				New WDR to conform to interim plan have been drafted, will require compliance by 7/73. EPA questioned CE permit application (didn't match actual operations) 8/1/72
Chevron Chem-Ortho Richmond	627 WDR (1/25/65) (6/13/67) 627 extended to cover new waste 'E' 70/43 (8/6/70) Not in file			Wastes: A, B & D - Toxic wastes from pesticide mfr. B is burned, A & D go to evap. ponds, C is fertilizer waste, released after settling pond treatment. -E is from herbicide mfgr. - evap. ponds. Concern is leakage from ponds & nutrient level of 'c'. Files indicate previous violations have been corrected.

TABLE H-2
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STATUS OF ABATEMENT
SF BAY DISCHARGERS
INDUSTRY

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
SHELL OIL MARTINEZ	71-8 1/28/71 Prohib. of ocean discharge of refinery wastes	Compl. by 12/31/72	Compliance on schedule	Has active program to route storm wastes thru chem. treatment
ALLIED CHEM. NICHOLS	68-41 WDR (7/18/68) 69-30 Schedule (6/24/69) 70-20 WDR (3/26/70)	69-30: Compl. by 12/31/70 70-20: Changes WDR to conform to process changes	5/69 Pesticide mfr. discontinued	Ind. wastes incl. acids, pesticides residues 2/4/71 State F & G sues, wins (2 yr. prolation, fine). F & G finds Allied in compliance by 4/71
	72-_____ C & D (8/10/72)	72-_____: submit sched. 8/15/72	Compliance with 70-20 achieved by 4/71	New WDR under consid to conform to Interi Plan 72-_____ violation: settleable matter
PHILLIPS PETROL. AVON	67-31 WDR (6/13/67) 71-9 C & D (2/25/71)	71-9 Compl. by 8/71 (toxicity)	7/72 In Compliance, on schedule	Refinery waste & sewa 2/6/69 Oil spill. F & sues. Number of compla in 69 from other spi fish kills, odor, explosions
	72-45 Rescinds 71-9 (7/25/72)			71-9 viol: toxicity coliform

TABLE H-2
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STATUS OF ABATEMENT
SF BAY DISCHARGERS

INDUSTRY

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
Phillips Avon (Cont.)				7/72: New WDR to conform to Interim Plan considered. Phillips requests delay until EPA/API Study is out.
SHELL CHEM PITTSBURG	68-36 WDR (6/20/68)			2 mgd ind. waste diluted of 12 mgd bay water & sewage. Board considered C & D, but main plant was shutdown 8/31/70, reducing waste to .2 mgd treated in holding : (monitored)
STAUFFER CHEM MARTINEZ	68-68 WDR (12/18/68) 71-21 C & D (4/22/71) 71-24 72-46 Rescinds 71-21 (7/25/72)	71-24 - To cover new plant ops.	In compliance 7/72 (facilities compl. late '71)	71-21 viol: pH, toxicity
U.S. STEEL PITTSBURG	594 WDR (9/17/64) 70-88 WDR (11/4/70) amends, expands 594 70-97 C & D (11/24/70)		In substantial compliance by 8/72	20 mgd ind waste 70-97 viol: Discoloration, settleables, pH, lead 12/23/70 USS appeal to State WRCB 3/4/71 SWRCB upholds Reg. B (State Res 71-9) 3/9/71 USS appeals SWRCB 3/18/71 SWRCB denies appeal (State Res 71-10)

TABLE H-2
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STATUS OF ABATEMENT
SF BAY DISCHARGERS

INDUSTRY

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
U.S. Steel Pittsburg (Cont.)				4/2/71 USS appeals to courts 8/3/71 Settled out of court: $5000 fine, schedule of improvements
DOW CHEM PITTSBURG	_______ WDR (1/15/69) _______ revision (3/21/68) for new plant process 71-40 WDR (6/24/71) w/schedule	71-40 tighter, more extensive controls for specific discharges - compliance by 3/72 except for thermal waste (1976)	Dow on schedule w/ compliance sched., has been publicly commended by Board for efforts	14 ind. wastes, incl. H CI, pesticide residues. 8/72 - New WDR to conform to interim plan under consideration.
PG & E PITTSBURG	542 WDR (2/20/64) 68-34 WDR (5/23/68) 70-51 WDR (6/25/70) 71-82 WDR (11/23/71) Rescinds 70-51	542: for cleaning waste only 68-34: For units 1-6. Thermal stds not defined 70-51 for unit 7. Thermal std: not to raise receiving water temp. more than 6° 71-82 applies to dredging during unit 7 constr.		Cooling water 724,000 gal./minute (units 1-6) Unit 7 volume: 51 mgd Objections by F & G, FWS, FWQA to once-thru cooling unit 7 cause delay in CoE permit approval. (Reg. Bd. did not object). By 3/71 PG decides to switch to a semi closed system, partly to response to statewide therm. policy adopted 1/7/71 which permitted max 4° rise. #7 to be in op by late '72

TABLE H-2
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS

INDUSTRY

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
Union Oil Rodeo	68-27 WDR (4/30/68) 70-75-Compliance Sched. (9/24/70) 71-51 C & D (7/22/71) 71-62 Amendment to 68-27	(Compliance by 1/15/71 (70-75) Rpt. compl. dates by 1/1/72 (71-51) 71-62 coliform std. restated.	2/72 Union claims compliance on DO, coliform. will meet toxicity by 8/73.	Refinery wastes 40 mgd 71-51 violations DO, toxicity, coliform 8/72 new WDR being drafted to coli-form to interim plan: Compl-iance by '76.
Sequoia Refining	776 WDR (8/18/66) 69-39 Addition to 776: bacterial stds. 71-10 C & D (2/25/71)		71-10: in substantial compliance since 3/71	Sewage & Ind. Waste 0.1 mgd 71-10: viol. of phen Ph, threatened viol. of grease, toxicity ammon. hydrox. 8/72 - Board to consider lifting C & D

TABLE H-2
(CONTINUED)
STATUS OF ABATEMENT
SF BAY DISCHARGERS

DISCHARGER	RESOLUTIONS AND/OR ORDERS	MOST RECENT IMPLEMENTATION SCHEDULE (OR COMMENTS)	STATUS	COMMENTS
C & H Sugar Crockett	68-___ WDR (12/18/68) 70-34 C & D (3/26/70) 70-96 Amends 70-34 (11/24/70) schedule only 71-______ WDR (1/28/71)	70-34 - sched. incl. 70-96 - revised sched - compliance by 3/15/71	70-96 New plant on New plant in compliance	21 separate cooling & process discharges 70-34 viol of toxicity. settleables, unsightliness 70-96 sched. changed due to strike. 71-___ New std for new combined outfall.
Humble Oil Benicia	67-41 WDR (8/17/67) 70-2 C & D (3/14/70) 70-50 Rescinds 70-2 (5/28/70)	Compliance by 5/1/70	In compliance 4/70	Refinery wastes 20 mgd new plant ('69). 70-2: viol. of grease, toxicity 8/72 Interim Plan WDR in draft - will require compliance by '76. May be revised to '74. Several oil spill incidents past few years - no action except surveillance.

TABLE H-3
STATUS OF ABATEMENT S.F. BAY DISCHARGER
FEDERAL INSTALLATIONS

DISCHARGER	RESOLUTIONS AND/OR ORDERS	IMPLEMENTATION SCHEDULES (or comments)	STATUS	WQM PLAN	COMMENTS
U.S.N. Yerba Buena Island	Res#69-47 (25 Sept. 69) Exec. Order 11507 WQCP for Tidal Waters Inland from Golden Gate		P-750 went to bid March 1972. No completion date set		Connect to U.S.N. Treasure Island secondary treatment plant (Project P-750) Abandon existing primary treatment plant and eliminate it as a discharger
U.S.N. Treasure Island	Res#69-47 (25 Sept. 69) Exec. Order 11507 WQCP for Tidal Waters Inland from Golden Gate		P-750 went to bid March 1972. No completion date set		Secondary treatment with effluent chlorination at present
U.S.N. Radio Station Skaggs Island	Letter from S.F. Bay WQCB (9June 70)		Project (P-038)- Going to Bid March 1972-No completion date		(P-038) Spray irrigation for main treatment plant effluent. Effluents from aeration tank and one septic tank to two new evaporation ponds
U.S.N. Mare Island	Res#70-105 (Dec.22,1970) S.F. Bay WQCB Exec. Order 11507 WQCP for Tidal Waters Inland from Golden Gate	Vallejo connection start: summer 1973 finish: fall 1975	Separate sanitation & storm sewer systems-open for bid 8 March 1972		Connect to Vallejo Sanition & Flood Control District Change over to separate sanitary & storm sewers
U.S. Naval Fuel Annex, Pt. Molate	Notification Jan.6,1970 Res#70-46 May 28, 1972 Exec. Order 11507 WQCP for Tidal Waters Inland from Golden Gate		Package Treatment Plant out to bid April 25, 1972		Presently: primary treatment by Imhoff Tank & discharged to S.F. Bay through an outfall

TABLE H-3 (Continued)
STATUS OF ABATEMENT S.F. BAY DISCHARGER
FEDERAL INSTALLATIONS

DISCHARGER	RESOLUTIONS AND/OR ORDERS	IMPLEMENTATION SCHEDULES (or comments)	STATUS	WQM PLAN	COMMENTS
U.S. Naval Weapons Station, Concord	None-except those for Contra Costa S.D. No. 7B	Fall 1972-Begin construction Summer 1973-Complete connection to Central Contra Costa S.D.	28Sept.68-Connection & treatment negotiated with C.C.C.C.S.D. FY'71 Connection funded		Connect to Central Contra Costa County S.D. for sewage treatment. P-011
Hamilton Air Force Base	Res#69-24(May 28, 1969)			1973-74 Sub-regional treatment & possible reclamation - combined plan with S.D. No.6 of Marin County, etc.	Presently: Industrial wastes pretreated & then mixed with sanitary sewage. Mixture receives secondary treatment & is discharged to San Pablo Bay
Travis Air Force Base	Res#95 (april 16, 1952) domestic waste Res#147 (March 18,1954) industrial waste Tentative resolution in 1968 not yet adopted			1975-76 Reclamation for groundwater recharge and irrigation	Present: all wastes given primary treatment followed by aerated lagoons, settling ponds & chlorination. Discharge to Union Creek

APPENDIX I

APPENDIX I

METHODS OF CHEMICAL ANALYSIS

Methods used by NFIC-Denver in general followed established EPA procedures.[1/] These methods are described below showing the exact procedures used where the established procedures were inadequate or nonexistent.

1. Hexane Extractables (Oil and Grease)

Sediment samples were analyzed using Soxhlet extraction. Samples were dried at 105°C overnight and percent moisture calculated. Approximately 30 grams of the ground sample were extracted with n-hexane for four hours. The extract was then evaporated to constant weight. Results were calculated on the dry weight basis.

2. Metals (except mercury)

a. Water Samples. All metals analyses except mercury were determined using a double beam atomic absorption spectrophotometer with a high solids burner head. Optimization procedures were according to manufacturer's recommendations. Matrix effects were compensated for in the standards and blanks by using substitute ocean water[1/] as diluent. One hundred milliliter aliquotes were treated with 5 ml HCl and digested for 15 minutes. Samples were then cooled to room temperature and analyzed by direct aspiration.

b. Shellfish. Approximately 5 grams of the ground shellfish flesh were weighed and digested using concentrated nitric acid. Aqua regia was then added and further digestion carried out to near dryness.

[1/] Methods for Chemical Analysis of Water and Wastes, EPA, National Research Center, AQC Laboratory, Cincinnati, Ohio, 1971.

The samples were then brought to 100 ml using distilled water and analyzed by direct aspiration in an atomic absorption spectrophotometer. Results were calculated on a wet weight (drained meats) basis.

c. Sediments. Moisture contents were determined on approximately 20 grams of wet sample and 5 gram aliquotes of the wet sample were prepared and analyzed as for shellfish. Results were calculated on the dry weight basis.

3. Mercury

Mercury in water, sediment and shellfish tissue was analyzed by the cold vapor technique of absorption of radiation at 253.7 nm by mercury vapor. Water and tissue samples were prepared by digestion with sulfuric and nitric acids at 58°C followed by overnight oxidation with potassium permanganate. Sediments required digestion in aqua regia before oxidation. All samples were subjected to a final oxidation with potassium persulfate before analysis.

4. Chlorinated Pesticides, Polychlorinated Biphenyls, and Petroleum Products

a. Extraction. Aqueous suspensions of plankton were extracted by direct liquid-liquid extraction using a 75 ml portion of hexane followed by a 25 ml portion of hexane.

Two hundred gram samples of air dried sediments were extracted in a blender with 200 ml hexane at high speed for 2 minutes. The centrifuged supernate was then decanted and concentrated to 5 to 10 ml.

Twenty to 40 gram samples of drained shellfish tissue were weighed, frozen, chopped and then extracted in a blender with 200 ml hexane. The centrifuged supernate was then decanted and concentrated to 5 to 10 ml.

b. Acetonitrile Partition. Hexane extracts were diluted to 25 ml and partitioned with four 25-ml portions of hexane-saturated acetonitrile. The acetonitrile fractions were then concentrated to near dryness and taken up to 10 ml with hexane.

c. Alumina Column Cleanup.[2/] Ten ml hexane extracts from the acetonitrile partition were passed through an alumina column (5% H_2O). The column was eluted with 10 percent ethyl ether in hexane. Ten 50-ml fractions are collected and concentrated to 1 to 10 ml.

d. Flame Ionization Gas Chromatography. The hexane layer from the acetonitrile partitioning were concentrated to 1 to 10 ml and added to the top of a 5 percent deactivated alumina column. The column was eluted with hexane. The first 30 ml was collected. Aliphatic hydrocarbons were determined by gas chromatographic response and by weighing the evaporated residue. Petroleum hydrocarbons produce characteristic gas chromatograms that contain a homologus series of n-alkanes, and a broad evelope of branched and cyclic hydrocarbons.

e. Electron-Capture Gas Chromatography. The alumina column fractions were run on the electron capture gas chromatograph and individual or pairs of pesticides and PCB's identified by comparing retention times with those of standards run concurrently. Quantitative estimates are made by peak height comparisons. The order of elution of pesticides from the alumina column gives confirmation of the tentative GC identification as well as do p-value determinations.[3/]

[2/] "Infrared Identification of Chlorinated Insecticides in the Tissues of Poisoned Fish," H. W. Boyle, R. H. Burttschell, and A. A. Rosen. "Organic Pesticides in the Environment," Advances in Chemistry Series, No. 60, 207-218, 1966.

[3/] "Extraction p-Values of Pesticides and Related Compounds in Six Binary Solvent Systems," M. C. Bowman and M. Beroza. J.A.O.A.C.,

APPENDIX J

APPENDIX J

ALERT LEVELS OF TRACE METALS IN SHELLFISH

1968 National Shellfish Sanitation Workshop Proposed Alert Levels in Shellfish*

Metal	Alert Level (ppm drained meats)
Zinc	1,500
Copper	100
Cadmium, lead, mercury, and chromium (combined)	2

*Species not specified.

1971 National Shellfish Sanitation Workshop Proposed Alert Levels in Shellfish

Metal	Species	Alert Level (mg/kg drained meats
Cadmium	Oyster Northeast	3.5
	Oyster Southern	1.5
	Soft Clams	0.5
Lead	Oyster Northern and Southern	2.0
	Soft Clam Northern and Southern	5.0
Chromium	Oyster Northern and Southern	2.0
	Soft Clam Northern and Southern	5.0
Mercury	Oyster Northern and Southern	0.2
	Soft Clam Northern and Southern	0.2
Copper	Oyster Northeast	175
	Oyster Southern	42
	Soft Clams Northern and Southern	25
Zinc	Oyster Northeast	2,000
	Oyster Southern	1,000
	Soft Clams Northern and Southern	30