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BATIQUITOS LAGOON

ENHANCEMENT PLAN

COASTAL ZONE
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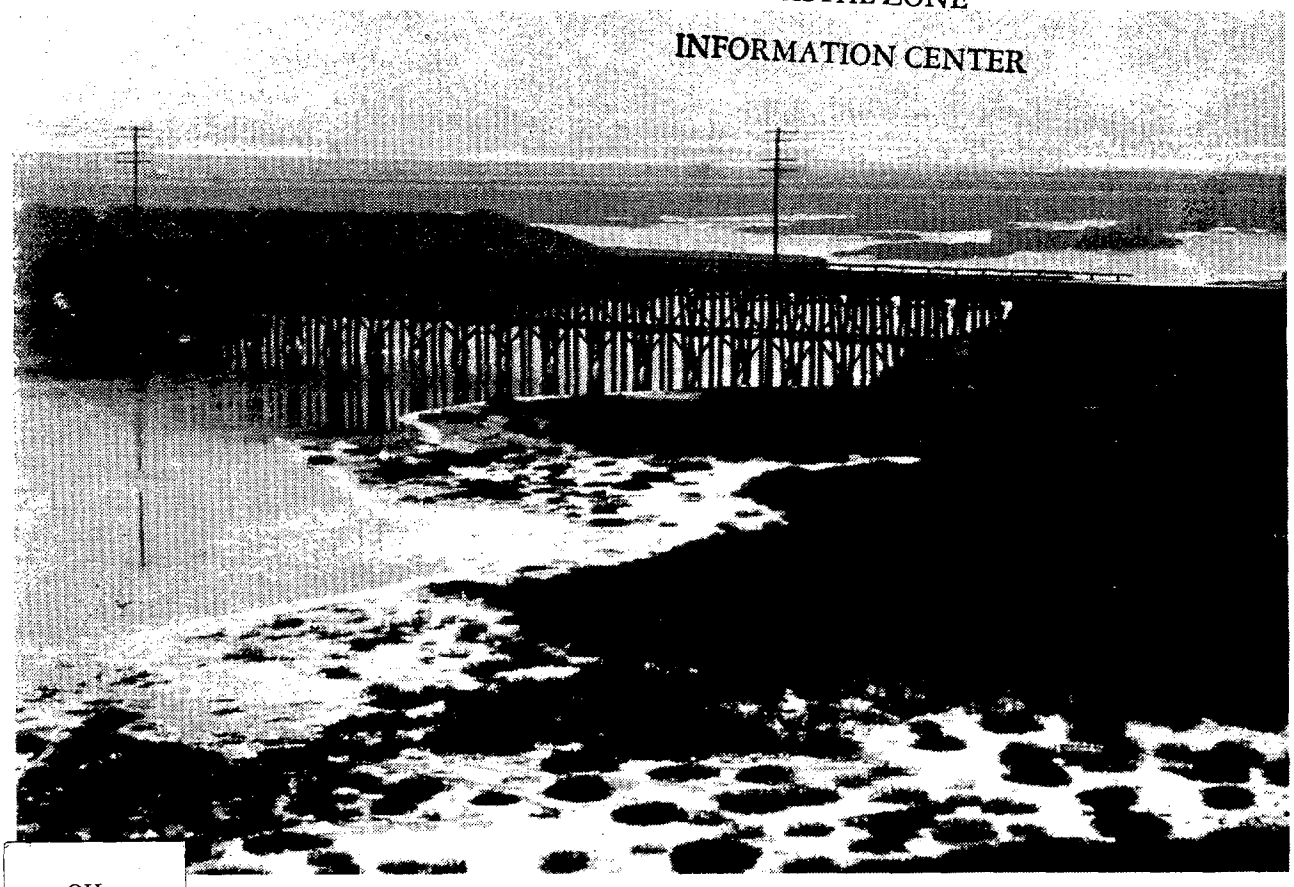

California State Coastal Conservancy

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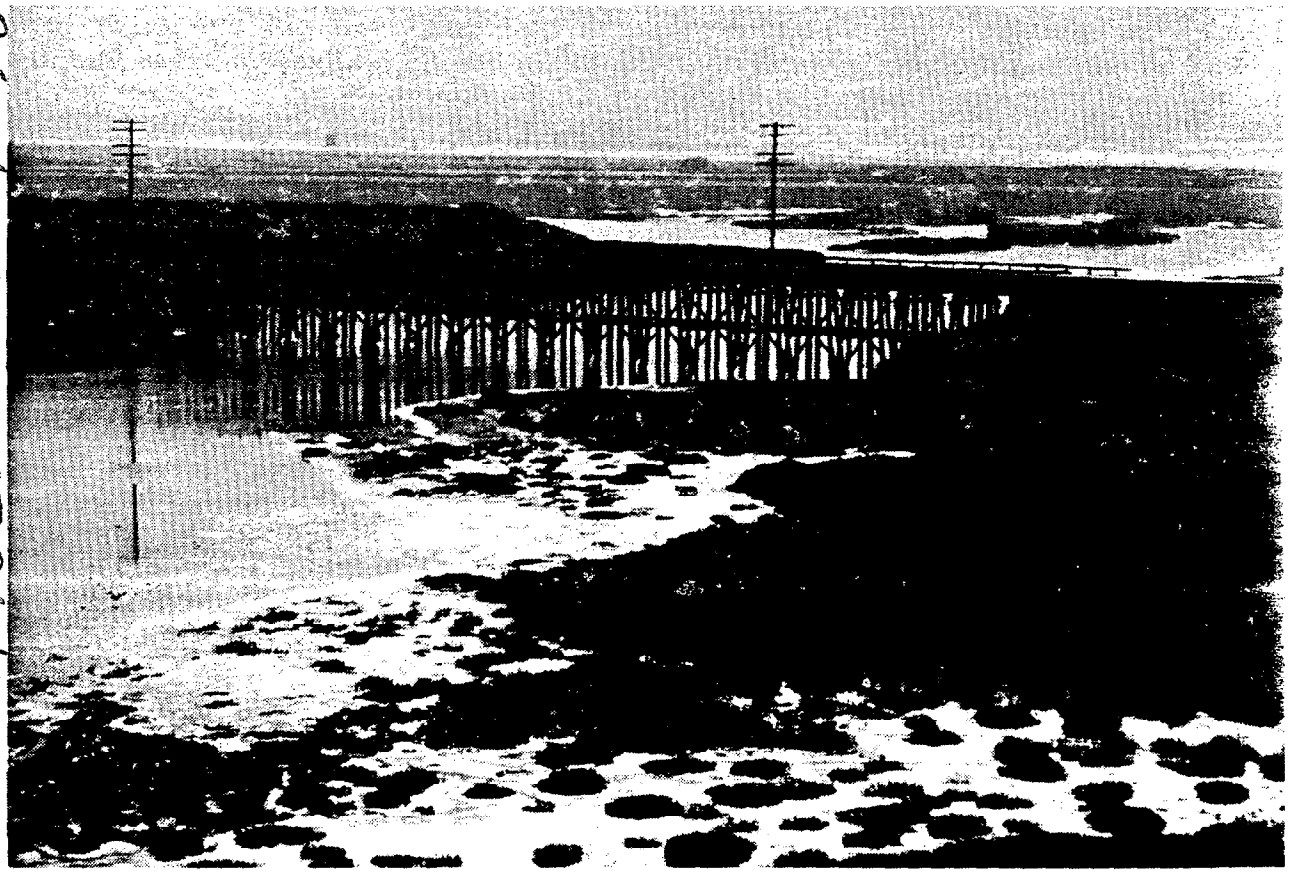

California State Coastal Conservancy, 1987

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"We do not inherit the earth from our fathers,
we borrow it from our children."

BATIQUITOS LAGOON ENHANCEMENT PLAN

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BATIQUITOS LAGOON ENHANCEMENT PLAN

SUMMARY

INTRODUCTION

Batiquitos Lagoon is one of a series of six lagoons on the northern coast of San Diego County. It lies at the southern edge of the City of Carlsbad extending inland for 2 1/2 miles from its ocean mouth and averaging 1/2 mile in width. As a coastal wetland, the lagoon provides wildlife habitat for many resident and migratory species as well as an open space and recreational area for its human neighbors.

Less than 150 years ago Batiquitos Lagoon was a fully tidal system, nourished by daily infusions of ocean water. Archaeological evidence shows the lagoon held marine shellfish which the local indians harvested in abundance. The lagoon has changed significantly since this time with the advent of European and American settlement. Roads and railroads now crisscross the lagoon restricting water flows; vast amounts of sediment, washed down from plowed and graded lands in the watershed, have filled in the lagoon. Portions of the original eastern lagoon have been filled for developments; waterflows from the upper watershed have been caught behind a dam and diverted to other uses. All these alterations, perceived and carried forth as isolated actions over the years, combine to drastically alter the lagoon. Batiquitos Lagoon now contains water only seasonally, when tributary streams flow; tidal inflows have largely stopped.

The changes which have occurred at Batiquitos Lagoon are exemplary of the problems associated with many coastal wetlands in this region. Filling for urban use, port and harbor development, and sedimentation have replaced marshes, lagoons and estuaries along much of the California coast. Southern California has experienced the highest rate of loss with over 75% of its coastal wetlands gone. Los Angeles/Orange counties have experienced a 90% reduction of coastal wetland acreage. This nearly complete destruction of wetland habitats in southern California has made those areas which do remain extremely valuable.

Despite all the changes Batiquitos Lagoon has undergone, large numbers of migratory birds stop here every year on their annual journey. The lagoon contains many acres of salt and brackish marsh and is a home for several endangered species. While diminished in its capacity as a tidal system, the lagoon is a rare and valuable habitat worth preserving and enhancing. Without some human intervention to benefit the lagoon environment, it will continue to fill with sediment and lose many of its wetland values in the next few decades.

The State Coastal Conservancy has coordinated and produced this plan. The Conservancy was created in 1976 as an implementation agency for the California Coastal Act. As a primary mandate of its enabling legislation, the Conservancy is responsible for resolving coastal land issues and for planning and implementing habitat enhancement projects. The Conservancy also has funds for design and construction of public accessways and provides planning and implementation assistance for watershed management programs. The Batiquitos

Lagoon Enhancement Plan has elements of all these programs and is representative of our efforts to improve the resources of the coastal zone both for people and wildlife.

This enhancement plan consists of two volumes. The first volume concerns the enhancement of the lagoon only; the second volume address problems in the lagoon watershed. Together, these two volumes present a comprehensive program for enhancing the entire lagoon environment.

EXISTING ENVIRONMENT

Soils, Water and Streams

For thousands of years prior to European settlement the mouth of Batiquitos Lagoon was open on a continuous basis. The channel was able to remain open because the actual tidal prism of the lagoon had adequate capacity on the ebb flow to scour a channel through the beach and offset the effect of sand build-up in the channel. However, since settlement of the area, the lagoon has experienced significant filling from erosion in the watershed and constriction of water flows from the fills and bridges for Highways 101 and 5 and the railroad. These bridges now represent choke points to tidal inflows. Sedimentation has reduced the tidal prism of the lagoon to the point where the mouth rarely opens and not enough tidewater is able to enter and leave the lagoon to keep the mouth open. When the mouth does open, due to high freshwater levels, tidal inflows now stop after a maximum of several days.

Now that the lagoon is dependent upon seasonal freshwater inflows, its water level may vary considerably from year to year. In some summer and fall months the lagoon may dry out, while in other years the lagoon retains shallow water year round. Some winters the lagoon may have water depths over eight feet. The amount of rain, number and timing of openings of the lagoon mouth and draining of the lagoon, inflow of groundwater from springs and seeps and the evaporative rate during summer now largely control the lagoon water level.

Monthly water quality data are available for the years 1979-1983. The results show that water quality in the lagoon is controlled by the frequency of opening of the lagoon mouth, by evaporative concentration of salts, and by the inflow of fresh nutrient-rich water from tributary creeks. Midsummer salinity in the lagoon exceeds that of seawater, ranging from 2.5 times the salinity of seawater in the upper lagoon to almost 4 times higher in the lower lagoon. The inflow of water rich in ammonium, nitrate and phosphorous from San Marcos Creek and probably other tributary streams stimulates blooms of ditch grass (Ruppia maritima) and filamentous green algae. Increasing salinity and temperature levels later in the summer cause the aquatic plants to die off. Decomposition of the dead plants depletes the supply of dissolved oxygen in lagoon water and further increases nutrient levels. Occasional sewage spills into the lagoon further increase nutrient levels. With no tidal exchange and little summer water inflow, water temperatures in the lagoon increase, further reducing the dissolved oxygen. In summary, water quality conditions and water depths fluctuate widely over one year's time with extremely harsh conditions prevailing during mid to late summer.

The Batiquitos Lagoon watershed consists of 52 square miles with the primary tributary being San Marcos Creek. A dam on San Marcos Creek impounds water into San Marcos Lake which acts as a silt basin for the upper portion of the creek. The remaining area below the dam is incised in a canyon until it spills out onto an alluvial plain which has been filled and developed for the La Costa Golf Course. Encinitas Creek is the other major tributary. Most of the floodplain of this creek is covered with riparian forest and marsh which traps and holds most of the heavy sediment carried by the creek.

Estimates of the average annual sedimentation rate into the lagoon show accumulation of 1-2 cm/year over the entire lagoon bottom. Estimates of the sedimentation rates for San Marcos and Encinitas Creeks as well as the drainage ditches along I-5 at Piraeus and Eolus are given. Other tributaries around the lagoon either have sediment basins or are planned to have them. The primary sources of this sedimentation are erosion of graded development sites, agricultural areas, and open, un-vegetated land, and channel erosion. Maps of the watershed illustrate the current extent of developed and agricultural lands, natural and channelized streams and disturbed lands. If current sedimentation rates continue, the entire lagoon will be filled in up to the +4.0 MSL elevation in 30-50 years.

Natural Resources

Batiquitos Lagoon contains six habitat types: salt marsh, brackish marsh, sand/mudflats which are seasonally covered by water, deep water, and riparian forest dominated by willows. Salt and brackish marsh are present around the edge of the lagoon and comprise about 178 acres. Deep water areas occur mostly in the middle and western lagoons covering only 29 acres. The mud/sand flats are the most extensive habitat covering 393 acres. These flats may be inundated under eight feet of water some years, dry out completely or have only a few inches of water. The values of this habitat to wildlife varies with the amount of water the lagoon contains.

The abundance and variety of wildlife in the lagoon is a reflection of the extent, type, and quality of habitats. Several species of mammals, such as jackrabbits, ground squirrels and raccoons use the lagoon and live along its edges as do several reptilian species. Fish species are limited in diversity due to the drastic fluctuations in water quality and temperature which occur annually in the lagoon. Likewise, benthic invertebrates (worms, clams and other creatures which inhabit the lagoon bottom) and zooplankton species probably have difficulty surviving the water quality conditions at the lagoon.

Birds, both migratory and resident, are the most conspicuous members of the lagoon fauna. Batiquitos Lagoon supports a seasonal influx of migratory waterfowl and shorebirds. Both shorebirds and waterfowl use the eastern basin of the lagoon more than the western basin. Shorebirds typically use the lagoon in late summer and fall when water levels are shallow and allow feeding by short-legged bird species. In drier years, Batiquitos Lagoon supports greater numbers of shorebirds than either Agua Hedionda or Buena Vista Lagoons. However, in high water years when the Batiquitos Lagoon water levels are deep, shorebird populations are higher at Agua Hedionda Lagoon.

Waterfowl tend to use Batiquitos Lagoon during winter months when water is fresh and levels are higher. Batiquitos usually has higher numbers of waterfowl than either Agua Hedionda or Buena Vista Lagoons. In drier years when Batiquitos water levels are low, Buena Vista Lagoon hosts larger waterfowl populations.

Other resident bird species include small passerine birds such as Long-billed Marsh Wrens, Red-winged Blackbirds, House Finches and Song Sparrows which reside in the marsh or adjacent uplands. Wading birds such as Great Blue Herons and Great Egrets feed in the lagoon as do marine species like Double-crested Cormorants, Forster's Tern and California Gulls.

Several state and federally listed endangered species nest or feed in the lagoon. These include the California Least Tern, Belding's Savannah Sparrow, and Brown Pelican. A candidate species, the Snowy Plover also nests in the lagoon. The riparian forest along Encinitas Creek provides habitat for the Least Bell's Vireo.

In comparison to other San Diego County wetlands, Batiquitos Lagoon has high habitat values for waterfowl and shorebirds. It has a low value for fishery habitat due to the lack of tidal inflows or stable water levels. The lagoon also has a high value for endangered species due to the number of different species nesting and feeding in the area.

Aesthetic Values

One of the most immediately noticeable qualities of Batiquitos Lagoon are its aesthetic values. The diversity of the landscape, the beauty of such a large water feature, and the expansive open space of the lagoon set it apart from other surrounding lands. Steep bluffs ring the lagoon, striking a contrast with the flat basin. The lagoon also provides a wide swath of open space unrestricted by urban developments. Only the roads and railway break up the continuous line of sight along the lagoon.

Plans and Policies

At present, the lagoon lands primarily serve as a wildlife habitat both officially under the ownership of the Department of Fish and Game and the State Lands Commission and unofficially under the ownerships of HPI, Mitsuuchi and Community Bank. The lagoon is bordered and crossed by several transportation corridors and utility lines of various types.

The agricultural uplands along the north shore of the lagoon are slated for mixed use development west of Interstate 5 and proposed for residential and resort development east of Interstate 5. Residential development covers the lagoon's southern bluff tops and the La Costa Resort and various commercial lands border the floodplain of San Marcos Creek to the immediate east of the lagoon. Green Valley and Encinitas Creek still support some agricultural use but much of this area is planned for development. In sum, the lands surrounding the lagoon and comprising its immediate watershed are either already developed as urban areas or are proposed for development within the next ten years. The lagoon itself remains an important open space area and

wildlife habitat/reserve.

Four local governments have jurisdiction over Batiquitos Lagoon and its watershed: the Cities of Carlsbad, San Marcos and Encinitas and the County of San Diego.

The lagoon and its north shore, most of the San Marcos Creek floodplain and two separate portions of the Encinitas Creek floodplain lie within the City of Carlsbad. The City's General Plan Open Space and Conservation element and West Batiquitos Land Use Plan contain goals and policies which support preservation and restoration of the lagoon as open space, protection of wildlife, and retention of public recreation and visual access to the lagoon. The City policies also outline retention of the natural character of waterways. The City's Batiquitos Lagoon Management Plan, although not adopted, contains many goals which guide evaluation of development proposals.

There is a certified Local Coastal Program Land Use Plan (San Dieguito LUP) which includes the bluffs along the southern margin of the lagoon and a small area of Encinitas Creek. These areas have since been incorporated into the City of Encinitas. The San Dieguito LUP, when written, also included the lagoon prior to Carlsbad's annexation of the area in 1984.

The County's San Dieguito Community Plan designates the portion of Encinitas Creek east of the coastal zone boundary (El Camino Real) as an impact sensitive area and for open space. The City of Encinitas will be formulating a new plan for these former county lands and the present LUP and Community Plan may serve as guides.

Within the City of San Marcos lies much of the upper watershed of San Marcos Creek. San Marcos Dam impounds most of this drainage and separates it functionally from the lagoon watershed. The small area of the creek within the City of San Marcos downstream from the dam is zoned for open space use.

Two agencies - the California Coastal Commission and the Army Corps of Engineers, have the primary permit authority over the lagoon area. Advisory to the Corps on permit applications is the U.S. Fish and Wildlife Service, National Marine Fisheries Service and the Department of Fish and Game. These "Resource" agencies have policies which require a project to cause no net loss of fish and wildlife values either through permit denial, redesign of the project or mitigation of project impacts. The Corps must weigh many factors in its permit decision including the "public interest" and makes the final permit decision. In addition to its authority over Batiquitos Lagoon, the Corps may also have authority over the riparian resources and streambeds of San Marcos and Encinitas Creeks.

The Coastal Commission has extensive policies and guidelines regarding protection and restoration of wetland habitats. The Coastal Act identifies Batiquitos Lagoon as one of the nineteen most important coastal wetlands in the state.

The State Lands Commission and Department of Fish and Game have additional authority over the lagoon to protect the public trust and fish and wildlife

resources, respectively. Department of Fish and Game must issue stream alteration permits for any changes in the tributaries to the lagoon.

SUMMARY OF EXISTING ENVIRONMENTAL FEATURES

- o Road fills and bridges which cross the lagoon restrict water movements and act as choke points to tidal flows

- o Sediment from agriculture and urban development in the watershed has filled in the lagoon, significantly reducing the tidal prism. Sedimentation continues to flow into the lagoon and is expected to fill the lagoon up to the +4.0 ft (MSL) elevation in 30-50 years

- o Water quality data for the lagoon shows salinity and temperature levels undergo enormous variation over a year, nutrient levels for nitrogen and phosphate are very high and water quality conditions exceed the tolerance levels of most aquatic animals

- o Fluctuations in water levels in the lagoon create areas of varying water depth. Depth of water dictates the species of migratory shorebirds and waterfowl able to use the lagoon as a feeding site. Most years the lagoon provides significant migratory bird feeding habitat during winter months

- o Variation in water levels determines the location and size of nesting areas for endangered California Least Terns and Snowy Plovers

- o Major portions of the lagoon are in private ownership and not managed as wildlife habitat

- o Local City of Carlsbad General Plan policies and land use designations support preservation of the lagoon as "open space"

- o A 16 inch gas line crosses the western lagoon as do several utility lines and transportation corridors

- o The lagoon watershed lies in the jurisdiction of four local governments - City of Carlsbad, City of San Marcos, the newly incorporated City of Encinitas, and San Diego County. Each has different zoning and land use policies for their portion of the watershed streams

THE PLAN PROCESS

In January, 1985, the Conservancy established a Batiquitos Lagoon Enhancement Group to set enhancement goals and help guide the progress of the enhancement plan. Table i lists these goals. This group included members of government agencies, local landowners, members of the lagoon foundation and others. All the meetings of the group were open to the public and several public workshops were held. The Conservancy hired a consulting team to summarize existing knowledge on the lagoon and to formulate enhancement alternatives.

During the time that the enhancement group was deliberating over enhancement alternatives, the Port of Los Angeles (Port) and the Pacific Texas Pipeline

Company (PacTex) approached both the Conservancy and the lagoon enhancement group. These two entities were proposing to fill a subtidal area of the Port to create an oil tanker facility and a pipeline to carry oil from California to Texas. Since the fill would permanently fill a marine habitat in the Port, the Port and PacTex were required under federal and state permit processes to compensate for the loss of habitat. Within the Port boundaries there was not adequate room for creation or improvement of enough area to act as compensation. A site on the southern California coast was needed and after a review of several locations by the Resource Agencies, Batiquitos Lagoon was the prime candidate.

The involvement of the Port of Los Angeles and PacTex significantly changed the enhancement opportunities for Batiquitos Lagoon. A potential funding source for enhancement of Batiquitos Lagoon to a fully tidal system had appeared.

Within several months, the Conservancy staff and their consultants developed three enhancement alternatives for the lagoon. The tidal cycle of each of these was simulated by computer to evaluate tidal heights and thus calculate habitat types created.

The three Resource Agencies - Department of Fish and Game, U.S. Fish and Wildlife Service and National Marine Fisheries Service evaluated the existing habitat values of Batiquitos Lagoon and those which would be created by the three alternatives. Using the Habitat Evaluation Procedure (HEP) developed by the Fish and Wildlife Service, these agencies identified the minimum acceptable habitat acreages which had to be used in the plan to sustain existing values. These acreage figures are contained in Alternative One. The Resource Agencies, landowners, City of Carlsbad, Port of Los Angeles, and others endorsed Alternative One as the "preferred alternative".

Other issues which were investigated and negotiated include: alignment of a public access trail along the north shore of the lagoon, a plan for controlling sedimentation into the lagoon, and operation and maintenance program for the lagoon and an implementation plan for the project. Proposed actions to solve these problems are included in this plan.

The Draft Batiquitos Lagoon Enhancement Plan was released in October, 1986, and the Conservancy held a public hearing January 15, 1987. Due to the level of public comment regarding the biological effects of Alternative One, and the lack of substantiation for the HEP determination, the Conservancy no longer endorses any of the alternatives as a preferred plan. The EIR/EIS being completed by the City of Carlsbad and the Army Corps of Engineers will determine the preferred enhancement alternative.

TABLE i

BATIQUITOS LAGOON ENHANCEMENT GOALS

Habitat Types

- The overall goal is to enhance the lagoon environment for wildlife habitat.
- Open the lagoon to tidal action while retaining migratory bird habitats to the greatest degree feasible.
- Protect endangered species habitat and create additional habitat where possible.
- Maintain existing areas of wetland and create additional marsh.
- Maintain existing riparian habitat.
- Maintain natural buffer (e.g. bluffs) where possible and adequate lateral buffer (e.g. 100 ft.) in other areas.

Hydrology

- Restore tidal action.
- Provide for a fluctuation of water level.
- Maintain good water quality.
- Keep the lagoon wet as much of the year as is possible.

Public Access

- Create a north shore trail.
- Establish viewing points around the lagoon with interpretive signs.
- Recommend the City of Carlsbad include a bike trail in any expansion of La Costa Blvd.
- No water sports, boats or fishing should be allowed in the lagoon.

Visual Qualities

- Minimize the use of man-made structures.
- Retain a natural look.
- Biological viability takes precedence over aesthetic values should the two ever conflict.

Sedimentation

- Reduce sedimentation into the lagoon using the most cost effective remedies.
- A mixture of public and private funding should be used to operate and maintain lagoon improvements.

THE ENHANCEMENT PLAN

The enhancement of coastal wetlands is still an uncertain process. Despite ten years of enhancement efforts in California wetlands, there are still many unknowns and always the possibility that what is planned in an enhancement project will not be realized in the final result. Consequently, there is a degree of risk involved in undertaking any enhancement efforts at Batiquitos Lagoon. But there is a more assured risk in leaving Batiquitos Lagoon in its present condition. Sedimentation levels into the lagoon far exceed natural levels and the lagoon is quickly filling in. Now that the mouth rarely opens except in large floods, nearly all the sediment entering the lagoon remains there, progressively building up the bottom elevations and transforming the lagoon into an upland. Calculations using current sedimentation rates and lagoon bottom elevations found Batiquitos Lagoon will be filled in its entirety to the +4.0 ft MSL elevation in 30-50 years. As such an event occurs, the shallow water habitat so valuable to migratory bird species will disappear, replaced by marsh and eventually riparian forest and upland.

The primary goals of the enhancement program are to: "enhance Batiquitos Lagoon for wildlife habitat" and to "open the lagoon to tidal action while retaining migratory bird habitats to the greatest degree feasible". Turning these goals into plan alternatives necessitates looking at the entire lagoon system, not just a single component of the system. The hydrology, water quality, sediment mechanics, each floral and faunal component as well as economic and engineering factors, have to be considered.

At present, most of the lagoons' habitat values are directly related to the lagoon's varied hydrologic regime. Batiquitos Lagoon functions as a seasonally flooded wetland subject to varied water depths. The lagoon undergoes yearly and seasonal extremes in water quality and supports few resident aquatic species.Emergent marsh rings the lagoon varying in species composition due to differences in salinity levels around the lagoon. The lagoon's value to migratory shorebirds and waterfowl fluctuates with its water depths and cannot be determined at a consistent yearly value. Likewise, the availability of nesting areas for endangered Lest Terns and Snowy Plovers varies with water levels. Unfortunately, the bird counts and data which exist for the Batiquitos Lagoon are not comprehensive enough in scope to relate bird populations and water levels over a long period of time. Therefore, any evaluation of the value of the lagoon habitat for migratory birds is a judgement made by trained experts after review of what data is available. These experts, drawn from both the Resource Agencies and conservation organizations, do not agree on the lagoon's existing habitat values nor do they agree on how to translate these existing habitat values of seasonal wetland into habitat values for intertidal mudflats. The intertidal system provides a different food base for bird species and can be considered a more "stable" system of predictably fluctuating water levels and habitat acreages. There are no previous models to review where a seasonal wetland and a tidal wetland have been compared for value to migratory birds.

The other evaluation inherent in a plan for a tidal system is an analysis of the hydraulic function of the lagoon under different tidal prisms. Road fills now constrict water flows through the lagoon and the mouth is confined to a

small opening which is blocked by sand and cobbles. The ability of the lagoon to maintain a clear channel can be evaluated using different computer models and approaches, but this evaluation also falls within the category of expert opinion. Scientific expertise in predicting coastal processes is not yet well developed.

This Revised Draft Plan reviews a number of alternatives for enhancement of Batiquitos Lagoon. The determination of what alternative is the environmentally preferred plan will be made through the EIR/EIS process following preliminary engineering studies. This Draft Plan sets forth a number of conceptual plans for evaluation.

The plan reviews three fully tidal alternatives involving different amounts of dredging and various size tidal prisms. Alternative One contains the largest mean diurnal tidal prism of 67 million cubic feet. Alternative Two is slightly smaller with a mean diurnal tidal prism of 60 million cubic feet. Alternative Three contains a mean diurnal tidal prism of 46 million cubic feet.

Tidal Prism and Lagoon Channel Closure Conditions

The single most important hydrologic design constraint for Batiquitos Lagoon is to ensure that there is a sufficiently large tidal prism to keep the entrance channel open. The lagoon channel can only retain an "always open" state if the scouring power of the ebb tidal prism is greater than the wave power along the beach to move sand into the channel. This wave power reaches a peak during storms. The complexity of the hydrodynamic processes involved and the difficulty in their measurement, make it difficult to predict a critical value for the tidal prism needed to assure the lagoon entrance channel will always remain open. This plan uses an empirical approach to predict the needed tidal prism for Batiquitos Lagoon. This approach allows us to graph deepwater wavepower against the potential mean tidal prism and observed closure conditions for 22 California lagoons and estuaries and the three tidal alternatives for Batiquitos Lagoon (see Figure 7). As the separation line between "always open" estuary entrance channels and "sometimes closed" channels is approximate, we have shifted the line downward by a factor of two to conservatively predict the function of these proposed alternatives. When this analysis is done, Alternatives One and Two remain in the "always open" category and Alternative Three falls on the dividing line between "always open" and "sometimes closed".

Another way of looking at the size of the tidal prism created under each alternative is to compare them to the historic condition which existed in Batiquitos Lagoon. In 1850, Batiquitos Lagoon had an estimated mean diurnal tidal prism of 90 million cubic feet. Alternative One would re-create 75% of this original tidal prism, Alternative Two would create 66% and Alternative Three, 51% of the original tidal prism.

For each of the alternatives, the lagoon would be dredged to create a tidal basin. In the eastern basin, material would be excavated from the -2.5 foot MSL contour down to the -6.0 foot contour. The western basins would be excavated down to the -8.0 foot contour. A hydrodynamic computer program was used to analyze tidal heights in the entire lagoon for an average tidal cycle.

In order to decrease the amount of friction between the lagoon bottom and tidal flows, to create subtidal habitat and to overdredge the lagoon slightly, these bottom elevations were decided upon. This analysis also showed that deeper dredging in either basin provided no additional benefits to tidal flows. Ebb flows through the entrance channel would be slowed by energy losses and the mean lower low tide level in the main section of the lagoon is increased by .4 feet over the level present at the beach. Most of this dampening effect is due to the constriction of the entrance channel by the Highway 101 bridge.

For the most part, the dredging area is confined to the presently un-vegetated portions of the lagoon. The dredging was designed in this way to avoid loss of existing marshland. The dredging contours would create an un-vegetated intertidal zone below existing marshes; a subtidal zone would be created below the intertidal band. This subtidal zone would include a defined bottom channel to help transport the sediment out of the lagoon.

Alternative Four describes an intermittent tidal system. This type of system would require a greater deal of maintenance and less initial dredging. The potential mean diurnal tidal prism created under this alternative would equal 30 million cubic feet. This size tidal prism, when compared with other California estuaries and the other alternatives, would fall into the "frequently closed" category. To restore tidal flushing, the lagoon mouth would have to be cleared of sand and cobbles as often as it closed. The lagoon could vary considerably from a continuously tidal system under this alternative due to the difficulty of opening the channel promptly following closure.

Habitat Acreages

Table ii lists the habitat acreages created under each enhancement alternative.

The subtidal habitat is a shallow water area which is covered by 5 to 10 feet of water during most tidal cycles. Certain fish and invertebrate species would be expected to colonize the subtidal area following the enhancement. Typical fish species which would inhabit the lagoon include: California halibut, white, spot-fin, and yellow croaker, and deep-body anchovy.

The intertidal habitat consists of mudflats which are covered and exposed twice daily by the tides. The invertebrate worms, molluscs, crustaceans and others which would colonize this zone are the primary food source for migratory shorebirds.

Following the dredging, the abundance and variety of animals colonizing both the intertidal and subtidal habitats will be a function of the subtrate type in the lagoon bottom, water quality, nutrient conditions and soil chemistry. These factors will undergo changes following the initial dredging and the system may not reach an equilibrium for several years.

The salt/brackish marsh areas will not be mechanically manipulated. The introduction of tidal inundation could change the composition of plant species and areal extent of marsh in the lagoon.

Table ii

SUMMARY OF ALTERNATIVES - BATIQUITOS LAGOON ENHANCEMENT PLAN

	1	2	3	4
Intertidal Area (acres) (+2.5′ to -2.5′ NGVD*)	170	217	317	338-348
Subtidal area (acres) (below -2.5′ NGVD)	220	171	71	35-45
Area of salt/brackish marsh (acres) (above +2.5′ NGVD)	139	141	141	141
Area of Least Tern habitat (acres)	34	34	34	34
Area of freshwater marsh (acres)	33	33	33	33
Potential mean diurnal tidal prism (million cubic feet)	67	60	46	30
Potential perigean spring tidal prism (million cubic feet)	99	89	68	40
Approximate volume of dredge material (million cubic yards)	3.0	2.1	1.3	--
Entrance channel area (below 0′ NGVD) (square feet)	1700	1500	1200	--
Total Capital Costs (includes dredging @ $4.00/yd, drag bucket system, beach groins, levee, in million dollars)	12.4	8.8	5.6	--

*NGVD = National Geodetic Vertical Datum - approximately equal to Mean Sea Level

The plan includes a managed freshwater marsh to be constructed in the northeastern corner of the lagoon. The primary reason for creation of a freshwater marsh is to assure that the lagoon provides habitat for dabbling ducks which currently use the lagoon during the winter. The marsh would be enclosed within a levee and filled with six inches to one foot of water derived from San Marcos Creek. A weir would be placed in San Marcos Creek to pond and divert water. The levee would contain slide/flap gates to allow for release of freshwater and occasional flooding by salt water. The water regime and vegetation of the marsh would be managed to maximize waterfowl habitat.

The enhancement plan specifies creation of four Least Tern nesting sites to preserve nesting habitat for this endangered species. Each site would be created from sandy dredge spoils, capped with clean beach sand and protected from predators by fencing. Fencing will be placed at a distance from each site such that it deters domestic animals and other mammals, but doesn't provide a hunting perch for avian predators.

The habitat types created under Alternative Four may vary from those created under a continuously tidal system. The frequency with which the lagoon mouth is kept open will largely determine if the lagoon is marine and tidal in function or if it ponds freshwater and is brackish. It is difficult to predict how the water regime would function and thus what type of habitat would occur.

Construction Methods

All the alternatives will require dredging and disposal of large amounts of sand and silt material from the lagoon. The physical and chemical studies necessary to determine a dredge spoils disposal program are currently underway as part of the preliminary engineering and environmental analysis. Generally, the preferable disposal option is to place sandy dredge spoils on local beaches if feasible and dispose of clay/silt spoils on adjacent properties or as landscape fill for other areas.

The most inexpensive method of dredging the lagoon is to use dry land techniques rather than hydraulic dredging. Construction would begin in the east basin and progress to the west. The beginning of project construction must be scheduled either prior to the beginning of the nesting season of the Least Tern or following fledging of all chicks. The location of haul roads must also be arranged to minimize trampling and destruction of salt marsh or other sensitive areas.

Lagoon Channel Maintenance

Under Alternatives One, Two, and Three, the lagoon channel would require maintenance should a large enough storm fill it with sand. The system outlined under Alternative Four could require frequent channel maintenance.

The plan proposes two alternative maintenance methods: drag bucket with an offshore block and tackle or a short pier with a drag bucket operated by a crane. The drag bucket system basically consists of a Sauerman drag-scraper which is pulled along a cable through the channel. The bucket scoops up material from the channel and then re-deposits it offshore.

Sediment Control System

A sediment control plan for the Batiquitos Lagoon watershed specifies both structural and non-structural control methods as well as a survey of existing conditions in the watershed. It is not practical to construct sediment control facilities which will capture both the heavy and the fine sediments entering the lagoon from the watershed. The sediment basins described here are designed to catch only the heavy sediments; the fine sediments (about 80% of the total sediment inflow) would pass into the lagoon and, if the lagoon is enhanced, be carried out with the tide.

Structural sediment control facilities would be constructed at four sites:

San Marcos Creek Sediment Basin This basin would be 300 feet wide and 500 feet long and the channel through the golf course would be deepened. A weir set at +5.0 feet MSL would cross the channel at the bridge. This weir would slow flows for both the 2 year and 100 year storms enough to efficiently trap heavy sediments.

Encinitas Creek The riparian trees in Green Valley are functioning as a natural sandtrap and are protecting the lagoon from accumulation of heavy sediment. The riparian areas and natural floodplain in this entire creek should be preserved and managed to avoid downcutting and loss of natural vegetation. To improve the ability of this corridor to trap sand, a low dam would be constructed across the channel with several culvert outlets set at the same elevation to disperse flow across the corridor. A five acre trap above this dam would be cleared of sand every five years with a minimum of disturbance to riparian vegetation.

Drainage ditches adjacent to I-5 at Piraeus and Eolus These drainage ditches contribute sand to the lagoon. Two debris basins would be constructed on the trapezoidal channels to enhance sediment trapping.

The primary causes of erosion and sedimentation in the watershed are: runoff of loose sediment from graded development sites and agricultural lands; erosion of natural streambeds from increased stormflows due to paving of adjacent lands and concrete lining of portions of streams; discharge of stormdrains into natural stream channels and canyons causing gully formation and channel erosion.

The most effective method of controlling these problems is to limit the amount and type of ground disturbance in the watershed through local ordinances. Implementation of the following non-structural control measures is recommended:

Revision and adoption of erosion control ordinances (Best Management Practices) in the Cities of Carlsbad, San Marcos and Encinitas and County of San Diego. The watershed plan reviews the City of Carlsbad erosion control ordinance and suggests adoption of this ordinance, with several additions and revisions by the other jurisdictions. Grading on large areas, during the rainy season, road-building on steep slopes and other kinds of intensive site disturbance could negate any downstream sediment control efforts. Implementation of this ordinance as well as the following features are

essential to reducing sediment inputs to the lagoon.

Changing agricultural practices in the watershed to relect Resource Management Practices as suggested by the U.S. Soil Conservation Service.

Adoption of floodplain management criteria for stream channels in the Cities of Carlsbad, San Marcos, and Encinitas. The watershed plan reviews the sediment retention features of natural floodplains and offers two options to retain these features during the development process.

Adoption of stormwater management criteria in the Batiquitos watershed by the Cities of Carlsbad, San Marcos and Encinitas. These criteria should reduce the amount of peak runoff produced by new developments in the watershed and decrease the problem of streambed erosion and sediment deposition into the lagoon.

The combination of sand-catching sediment basins, tidal flushing of fine sediment, and the implementation of watershed erosion controls, and floodplain management, is the most cost effective means of reducing sedimentation into the lagoon.

Public Access

A public access trail is proposed for the north shore of the lagoon. Beginning in the northeastern corner of the lagoon, the trailhead will be located on Rancho La Costa/Newport Shores property over which the Conservancy holds an open space/public access easement. The trail follows the existing dirt road along the north shore and begins to divert from this road on the HPI property. The trail moves to border the lagoon wetlands and will be located within the outer 50 feet of the 100 foot wetland buffer. The trail moves from the lagoon border to the dirt road and back along the shoreline in this section. The dirt road then intersects Lagoon Lane where another trailhead would be located.

Continuing the trail around the wetland and under Interstate 5 is both costly and creates a disturbance to the wetlands. Therefore, the recommended alignment consists of the shoreline trail along the eastern basin and a series of trails along the western basins. Public streets connect both trails making it possible to traverse from one end of the lagoon to the other.

The western basin trails may be reached in several ways. A primary access point will be on Windrose Circle in the Sammis development. From this point the trail will proceed both east to a viewing area and west along the bluffs on a pedestrian bridge over the railroad to Highway 101. The entire trail will be designed with an improved surface and be available for pedestrian use only.

As part of the public access improvements, interpretive signs would be placed at various points around the lagoon and viewing areas located near wildlife areas.

Land Ownership and Management

The private lands in the lagoon must be transferred to the State Lands

Table iii
Operation and Maintenance Costs

Plan Element	Task	Cost	Frequency
Overall management of lagoon	Oversight and maintenance of fencing, freshwater marsh, Least Tern nesting sites, sediment facilities, monitoring of lagoon, patrolling reserve	$60,000/yearly for full time manager; only a part-time manager may be required	Continuous oversight; performance and oversight of maintenance activities as needed
Lagoon Channel	Clearance of cobbles and sand	$1000/Clearance	Possibly once in thirty years or more often; no estimates are available
Freshwater Marsh	Management of water levels and vegetation; maintenance of tidegates, water diversion structures, etc.	Not available at this time	Yearly management; replacement of gates, culverts, etc., as needed
Least Tern sites	Removal of vegetation, maintenance of sandy surface	$300-500/acre/year	Yearly management
Sediment Control Facilities	Cleaning and disposal of sediment	Approximate - $68,700	Average annual may vary each year
Public Access Trail	Repair and replacement of signs, interpretive facilities, water bars, resurfacing of trail	Unknown, until designs are completed approximately 2% of construction costs per year	Unknown, trail will be designed with low maintenance criteria

Table iii (continued)
Operation and Maintenance Costs

Plan Element	Task	Cost	Frequency
Monitoring	Measurement of physical, chemical and biological parameters of enhanced lagoon	$30,000-$50,000	Yearly program

Commission before construction of the enhancement project may begin. The State Lands Commission will then lease the property to the Department of Fish and Game and the entire lagoon would be managed as an Ecological Reserve. Nature study, hiking along shoreline trails, sport fishing from designated shoreline areas, and passive recreation will be allowed while boating, swimming, hunting and commercial fishing are not permissable.

Operation and Maintenance

Many features of the lagoon enhancement program will require operation and maintenance. These include: general oversight of lagoon use and conditions, lagoon inlet channel, managed freshwater marsh, Least Tern nest sites, sediment control basins, and the public access trail. Table iii outlines these activities and their costs.

A monitoring program would periodically review the physical contours of the lagoon, record water quality conditions and census benthic organisms, fish and bird species in the lagoon. The purpose of the program is to review changes in the conditions of the physical, floral and faunal components of the lagoon over time.

IMPLEMENTATION PROGRAM

Once constructed, the Batiquitos Lagoon Enhancement project will be one of the largest and most costly habitat enhancement projects ever undertaken. It will require a number of permits, agency agreements, landowner agreements and establishment of several funding mechanisms.

The main agreement to implement both the PacTex fill project and its mitigation, the Batiquitos Lagoon Enhancement project is a Mitigation Agreement between various government agencies. This agreement is a required attachment to both the Army Corps of Engineers 404 permit and the Coastal Commission permit for the PacTex project. The Mitigation Agreement will set forth the manner in which the enhancement project will be constructed and funded, how many mitigation credits will be given to PacTex and the Port, and how operation and maintenance of the lagoon will be funded. In addition to the Mitigation Agreement, a number of other agreements and actions must occur before the enhancement project can go forward. These activities and implementing actions are outlined in detail in the plan.

I. INTRODUCTION

Batiquitos Lagoon lies at the southern edge of the City of Carlsbad in northern San Diego County (see Figure 1). The lagoon extends inland for 2 1/2 miles from its ocean mouth and averages one-half mile in width. Stretched like a sheet between two ridges, Batiquitos Lagoon is a wide, open expanse in a rapidly growing urban area. Although similar in geologic formation to its neighboring lagoons - Buena Vista, Aqua Hedionda and San Elijo, its character is unique. For many of the local residents, Batiquitos Lagoon is a source of beauty, interest, concern and occasional dislike. Beautiful when full of water and lovely birds, the lagoon becomes smelly when algae mats blanket its surface or the water dries leaving a hard salt pan. It is the concern of residents, lagoon landowners, local government and wildlife resource agencies for Batiquitos Lagoon which has prompted this resource enhancement plan and led to a concerted effort to improve the lagoon environment.

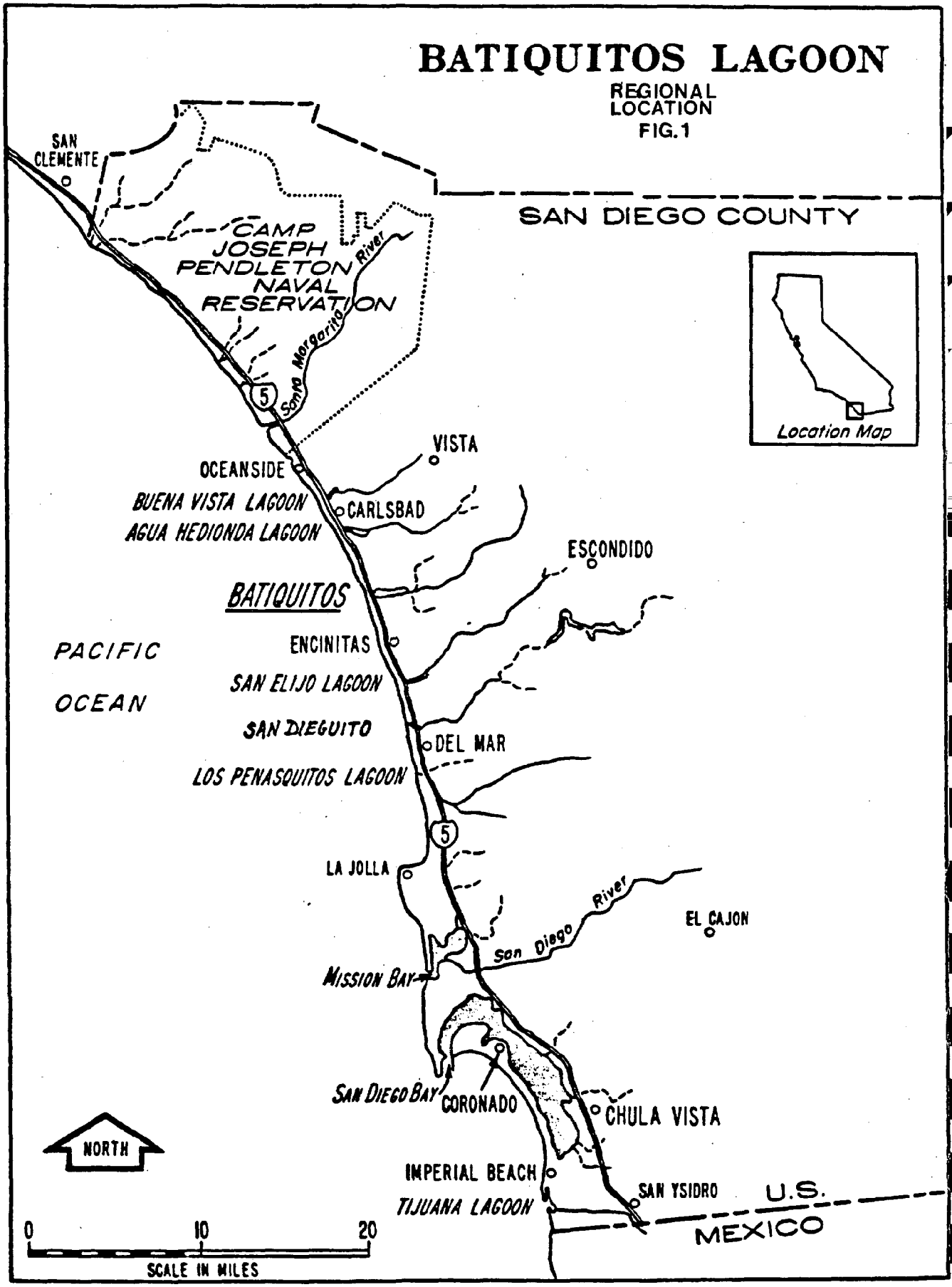
The State Coastal Conservancy has coordinated and produced this plan for the enhancement of Batiquitos Lagoon. The Conservancy was created in 1978 as an implementation agency for the California Coastal Act. As a primary mandate of its authorizing legislation, the Conservancy is responsible for resolving coastal land use issues and for planning and implementing habitat enhancement projects. The Conservancy also provides funds for construction of public accessways and provides planning and implementation assistance for watershed management programs. The Batiquitos Lagoon Enhancement Plan has elements of all these programs and is representative of our efforts to improve the resources of the coastal zone both for people and wildlife.

State bond acts provide funding for these various programs; the Conservancy receives no general fund monies. Funding grants are provided to local governments and nonprofit organizations. The Conservancy has designed and implemented similar plans in San Diego County at both Los Penasquitos and San Diequito Lagoons.

The Batiquitos Lagoon Enhancement Plan is separated into two parts. Volume I includes conceptual plans for enhancement of Batiquitos Lagoon, the background data on the lagoon, a public access plan and the proposed implementation program for lagoon enhancement. Volume II is an erosion control plan for the Batiquitos Lagoon watershed and is an essential part of the enhancement plan. It is bound as a separate volume due to the differences in plan implementation. The implementation of both volumes are essential to the preservation and enhancement of Batiquitos Lagoon.

THE VALUES OF COASTAL WETLANDS

The coast of California holds a string of wetlands along its 1,100 mile edge. These marshes, mudflats and other types of wetlands occur at the tidal mouths of rivers and creeks, the borders of large bays and inlets, and within lagoons. Each wetland is a distinct locale varying in size, habitat types, plants, animals and problems. Although separated by topography, each of these wetlands is linked by their similar nature as estuaries, bays and lagoons and by the yearly movement of their most conspicuous inhabitants - migratory Figure


BATIQUITOS LAGOON
REGIONAL LOCATION FIG. 1
SAN DIEGO COUNTY
SAN CLEMENTE
CAMP JOSEPH PENDLETON NAVAL RESERVATION
Santa Margarita River
5
OCEANSIDE
VISTA
BUENA VISTA LAGOON
AGUA HEDIONDA LAGOON
CARLSBAD
ESCONDIDO
BATIQUITOS
PACIFIC OCEAN
ENCINITAS
SAN ELIJO LAGOON
SAN DIEGUITO
DEL MAR
LOS PENASQUITOS LAGOON
5
LA JOLLA
San Diego River
EL CAJON
MISSION BAY
SAN DIEGO BAY
CORONADO
CHULA VISTA
NORTH
IMPERIAL BEACH
SAN YSIDRO
U.S.
TIJUANA LAGOON
MEXICO
0
10
20
SCALE IN MILES
Location Map

birds. For the human residents of California these wetlands are connected by Highway 1, the coast railroad and a growing interest and concern for their welfare.

In many areas, this string has been broken by the complete loss of a bay or marsh to development. Over the entire California coast nearly 75% of our wetlands are gone. In southern California the loss is much higher - 90% of the wetlands have been filled, dredged or diked and turned into dry lands or harbors (Marcus et al, 1982). No southern California wetland remains in a pristine condition. As links in the chain have been lost, our remaining coastal wetlands have become all the more rare and valuable.

These wetlands have many different values which research is only now bringing to light. While each individual wetland may have its own importance, wetlands as a type of ecosystem have several values in common.

Intrinsic Values

Wetlands have intrinsic values that are neither functional nor quantifiable; their worth to society cannot be bought or sold in ordinary currency. Located within a crowded urban area, the open expansiveness of a wetland can provide a recreation area for local residents - for walking, birdwatching, photographing or just sitting beside the water. Many people enjoy a feeling of refuge from the crowded, often chaotic urban scene. The pattern of marsh, water and wildlife adds variety to the landscape and gives definition to the shore. With a growing public interest in viewing wildlife, visitor use of wetland refuges in the state has reached an all time high. The closer these opportunities are to urban areas the higher value they present. Preserved wetland systems also provide scientific and educational opportunities. Monitoring of enhanced areas should greatly expand our understanding of wetland processes.

Functional Values

Scientists have studied the functional values of physical and biological processes in Pacific Coast wetlands. This body of research is quite large, and we shall only summarize some of it here.

Primary Productivity

The primary productivity of an ecosystem is measured by the amount of plant fiber and algae which grow over an area of ground in a specified time. This productivity supports entire food chains and complex food webs. Salt and freshwater marshes have higher annual rates of primary productivity than forests and many other ecosystems. Exposed to full light for photosynthesis and supplied with copious water, marsh plants and algae typically form a dense cover over wetland mud. Within the mud, micro-organisms that can live with little or no oxygen process nutrients, thus supporting plant production even when plants are submerged or dormant. Studies in southern California tidal marshes have demonstrated especially high levels of algae productivity (Zedler 1982).

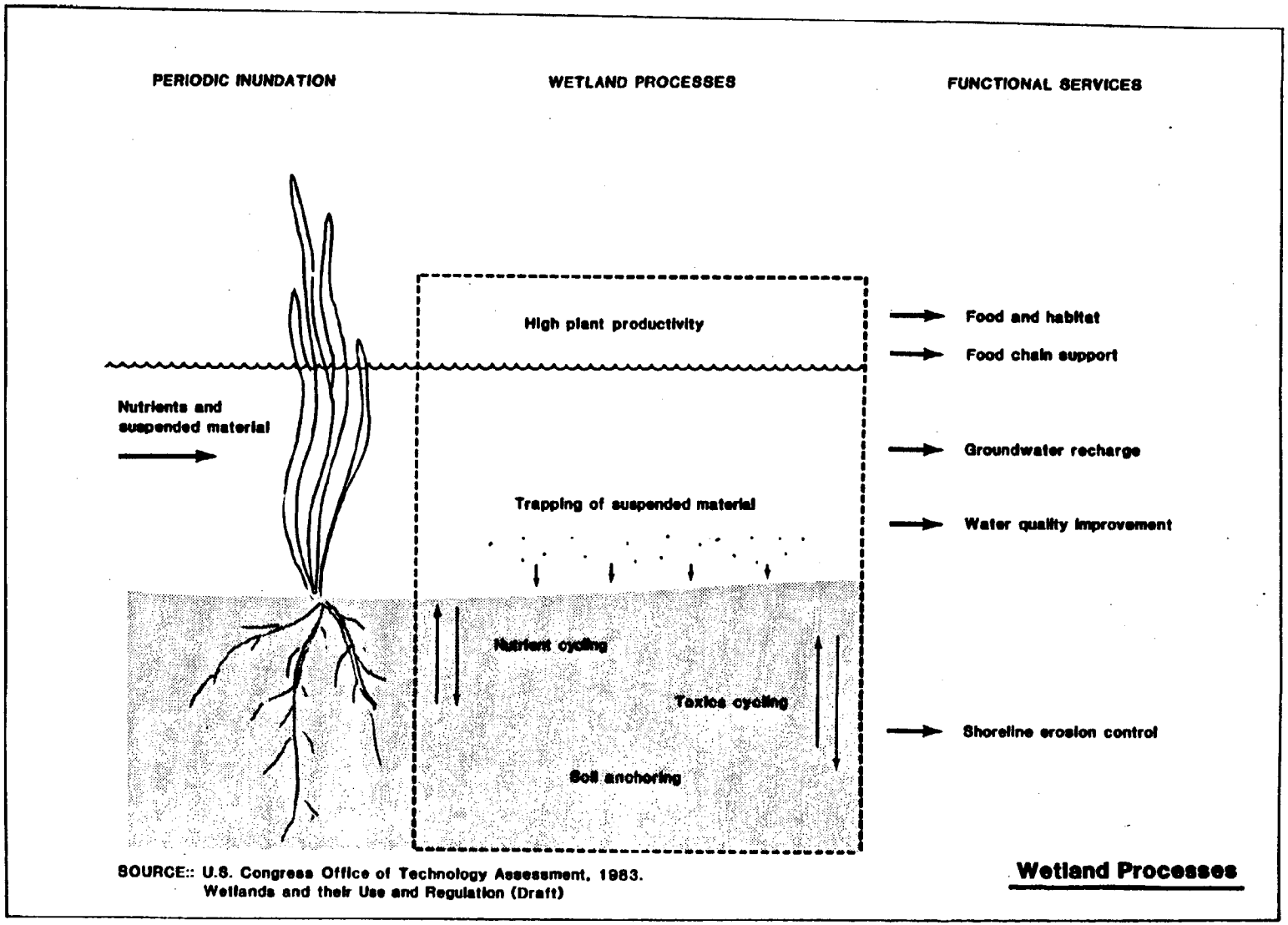

PERIODIC INUNDATION
WETLAND PROCESSES
FUNCTIONAL SERVICES
High plant productivity
Food and habitat
Food chain support
Nutrients and suspended material
Groundwater recharge
Trapping of suspended material
Water quality improvement
Nutrient cycling
Toxics cycling
Shoreline erosion control
Soil anchoring
SOURCE:: U.S. Congress Office of Technology Assessment, 1983. Wetlands and their Use and Regulation (Draft)
Wetland Processes

FIG. 2

The net movement of plant detritus (decomposed plant material) and nutrients between salt marshes and adjacent estuaries in California is unknown. Detritus produced in the marsh is used by invertebrates and fish which inhabit muds and sloughs. These filter feeders sieve fine material from the tidewater, and thus represent the "secondary productivity" level of the marsh and contribute to further decomposition and nutrient cycling. These consumers, in turn, are eaten by shorebirds and other animals, who, in their migrations and movements, "export" the nutrients of the marsh to other areas (see Figure 2).

While the productivity of brackish and freshwater marshes in California has not been investigated in detail except in relation to waterfowl food values, limited measurements of biomass (plant material) of brackish marsh plants indicate a higher annual productivity than salt marshes but yield little information as to the movement (export vs. import) of nutrients and utilization by animals other than waterfowl (Atwater, 1979). Overall, the salt, brackish, and freshwater marshes in California produce large amounts of plant and algal material and provide a rich food base, as evidenced in their wildlife populations.

Wildlife Habitat

Decades of observations and reports document the function of California wetlands as habitat for wildlife. Southern California coastal wetlands had some of the finest duck hunting in the state. Although the numbers of animals inhabiting wetlands have dramatically decreased, migratory birds and resident species still depend on remaining habitat.

With the exception of the plants, the wetland food base for wildlife is relatively inconspicuous. Dense communities of invertebrates (worms, clams, crabs, shrimp, amphipods and insects), inhabit the shallow depths of mudflats and sloughs of tidal and brackish marshes, each species adapted to a part of the substrate (sediments). Some invertebrates, such as barnacles and crabs, undergo their yearly larval stages in tidal sloughs and sheltered shallow water areas (Ricketts, 1948). Seasonal wetlands support large numbers of invertebrates but lack diversity in the types of species present. Freshwater wetlands support a different array of invertebrate species, dragonfly and damselfly nymphs, insect larvae, aquatic insects, worms and snails cover stems and roots of submerged plants, and many invertebrates inhabit the substrate (Good, 1978).

Most wetlands that contain tidal sloughs or other permanent open water support fish populations. Staghorn sculpin, three-spine stickleback, California killifish, topsmelt and others are common in tidal estuarine marshes. The arrow goby shares a mud burrow with worms and crabs (Moyle, 1976). Seasonally, fishes such as surfperch, anchovies, flatfish, and rockfish from nearshore waters move into estuaries and marshes to feed or have their young.

Although the precise contribution of salt marshes in reproduction and growth of fishes is largely unknown, evidence suggests a chain of dependency of fishes on salt marshes. Small resident fish species of sloughs feed on invertebrates in channels and mudflats; these smaller fish are prey to larger, often commercially important species that move out of the estuary into the Pacific

Ocean. Highly modified estuaries and lagoons which lack marsh and mudflats have demonstrated significantly lower habitat value for fish (Zedler, 1982). At least indirectly, and probably directly, wetlands contribute to the habitat needs of both commercial and game fish species.

Birds are the most conspicuous form of wildlife in California wetlands. The Pacific Flyway, the major western migratory route for waterfowl, shorebirds and small passerines, connects the nesting grounds of Alaska and western Canada with wintering grounds in California and Central and South America. Each fall millions of waterfowl and shorebirds migrate to the wetlands of California to spend the winter months or feed prior to moving south. U.S. Fish and Wildlife Service states that, "the single most important function of remaining United States wetlands is to provide wintering rather than breeding habitat for waterfowl" (U.S. Fish and Wildlife Service, 1978).

A low tide in coastal wetlands brings flocks of shorebirds poking up and down in the mudflats or scooping their bills through the surface, searching for invertebrates. Salt marshes are less used than mudflats for feeding, but birds seek refuge amongst the marsh plants to wait out high tides and storms. When extreme high tides submerge all of the marsh, adjoining lands - transition and buffer zones - provide essential "back-up" shelter for both waterfowl and shorebirds. One of the most striking features of California coastal and bay salt marshes, both tidal and nontidal, is their seasonality. Even a summer-dry seasonal "wetland" comes to life when it is wetted by winter rains; flocks of migratory birds exploit these seasonal resources.

Generally migrants will go to those areas where food is abundant and move to another as food levels decrease, visiting many different sites along the coast in one season. The coastal chain of wetlands thus provides a series of geographically dispersed habitat areas for these migratory species, many of which continue their travel to Central and South America.

Mammals, both large and small, forage in or are residents of wetlands. Raccoon, muskrat, mink, and deer hunt or graze in salt, brackish and freshwater wetlands. Shrews, harvest mice and pocket mice live in the thick marsh vegetation. Larger mammals live in upland areas but travel to nearby riparian forest and marshland to feed on fish, invertebrates, and other small prey.

Rare and Endangered Species

The loss of wetland habitats on the coast has dramatically reduced the populations of at least 10 animal and 9 plant species that are now listed by state and/or federal governments as endangered or rare. The populations of animals such as the Aleutian Canada Goose, California Clapper Rail, California Least Tern or Belding's Savannah Sparrow have been diminished by reduction of available habitat (U.S. Fish and Wildlife Service, 1980). Others, such as the salt-marsh harvest mouse, or salt marsh bird's beak (plant) have evolved specialized adaptions to the habitat conditions of marshes. Their narrow adaptability compounds the problem of loss of their habitat. It is not surprising that 20% of federally listed endangered species depend on some type of wetlands. In almost all cases, populations have declined because their habitats have been destroyed or reduced to a size too small to sustain viable

populations.

Shoreline and Bank Protection

By interrupting and absorbing the energy in waves, marsh and riparian vegetation in many locations is effective in reducing bank erosion and protecting shoreline structures. This useful function of wetlands is less evident in California than in other coastal locations for two reasons. First, along the high energy Pacific Coast, marshes have developed only in locations already protected within bays and river estuaries. The sites of greatest erosion - coastal bluffs and beaches - are fully exposed to wind and waves and thus are not conducive to marsh establishment. However, large bays and estuaries, where the fetch of wind over shallow water may reach large distances, tidal marsh vegetation effectively buffers the shoreline from wave erosion.

Water Purification

Through a variety of mechanisms, both natural and artificially created wetlands have demonstrated their ability to enter into the treatment of municipal wastewater and urban stormwater. Conceptually, the wetland approximates a combination of waste stabilization pond and trickling filter.

The broad, flat surface of wetlands and their saturated condition encourages a number of physical, chemical, and biological transformations to take place. For example, sediments and other suspended material carried into the marsh from storm drains will settle out, and forces of adhesion can bind heavy metals, bacteria, hydrocarbons, and other constituents to the sediments. Micro-organisms in shallow sediment will degrade and recycle organic and other compounds. Across the surface, oxidation and photochemical reactions can participate in removal of such pollutants as the pesticides- 2,4-D, malathion, methoxychlor, and DDT (Chan, 1981; Demgen, 1977). Marsh plants can remove pollutants directly by taking up nutrients and heavy metals (cadmium, copper, lead, zinc, and iron) and indirectly by creating the proper conditions for breakdown of pollutant compounds such as hydrocarbons and other organics.

The Association of San Francisco Bay Area Governments (ABAG) reviewed 14 marsh systems across the nation that treated urban stormwater runoff and municipal wastewater (Chan, 1981). Wetland systems removed from urban storm water: nutrients; 85-99% of suspended solids; and up to 50% of Biological Oxygen Demand (BOD is the concentration of organic particles which require oxygen from the water for biodegradation). Data from several California wetlands - Mt. View Sanitary District's Martinez Marsh, Palo Alto Marsh/Flood Water Basin and Lake Tahoe Meadowlands also demonstrated the potential for wetlands to serve as water purification systems for municipal stormwater and wastewater.

The relative effectiveness of each marsh type, species, and location in waste treatment must be investigated individually, but the collective data demonstrate that waste treatment is a functional service of many wetlands. Certain potential problems such as heavy metals, pesticides and other potentially toxic compounds concentrating in marshes used by wildlife will

warrant further study.

SUMMARY-WETLAND VALUES

Wetlands provide essential wildlife habitat to migratory and resident birds, estuarine and marine fish and rare and endangered species. When functioning as tidal systems, coastal wetlands provide nutrients to the nearshore ocean environment and increase productivity of the nearshore waters. Certain wetlands may also provide shoreline protection and purification of wastewater and stormwater. In enhancing a wetland the first two values, wildlife habitat and primary productivity are usually the factors whose value is increased. Many wetlands, especially those in urban areas, have intrinsic values related to their aesthetic features and open space qualities.

BATIQUITOS LAGOON ENHANCEMENT PLAN

Batiquitos Lagoon is amongst those coastal wetlands which still survive and serve as valuable wildlife habitat and as open space for the surrounding community. Although a unique natural system, Batiquitos Lagoon is exemplary of many of the problems facing our coastal wetlands. It was a tidal lagoon less than 150 years ago, nourished by daily infusions of ocean water. Archaeological evidence shows the lagoon had shellfish which the local indians harvested in abundance. It probably held great numbers of fish and coastal birds and perhaps even seals and sea lions which feed on these creatures.

While our understanding of this natural wetland system is limited, our ability to change the lagoon is not. Since settlement of the area, the lagoon has changed significantly. Roads and railroads crisscross the lagoon restricting water flow; vast amounts of sediment, washed down from plowed and graded lands in the watershed, has filled in the lagoon. Portions of the original eastern lagoon have been filled; water flow from the upper watershed has been caught behind a dam and diverted to other uses. All these alterations, perceived and carried forth as isolated actions, have combined to drastically change Batiquitos Lagoon. The lagoon is now filled with water only seasonally when tributary streams flow; tidal inflows have largely stopped.

But despite all these changes, Batiquitos Lagoon is still a seasonal wetland and large numbers of migratory birds stop here every year on their annual journey. It contains many acres of marsh and provides habitat for several endangered species. While diminished in its capacity as a tidal system, the lagoon is a rare and valuable habitat worth preserving and enhancing. Without some human intervention to benefit the lagoon environment, it will continue to degrade and lose many of its wetland values. Present estimates predict the entire lagoon will be filled in to +4.0 ft. MSL in 30-50 years with continued sedimentation and no enhancement.

What is Enhancement?

The following plan sets forth a blueprint for the enhancement of Batiquitos Lagoon. We use the words "habitat enhancement" rather than "habitat restoration" because restoration implies we have chosen a former state of the lagoon to return the area to. Enhancement is a different concept involving a

rejuvenation and improvement of the natural system to increase the values it presently has and to add new values.

Because the wetlands of the coast serve as a migratory route for birds and many have been lost, the decision on how to enhance a particular wetland must be made in the larger context of the entire region and state resource. In order to set forth a valid enhancement concept for Batiquitos Lagoon, the plan documents a number of things.

1) We have examined present patterns of wildlife use of the lagoon, how the lagoon has changed from the historic condition, what problems it has and other important features of the existing system.

2) We identified what physical, economic and social issues constrain our enhancement efforts.

3) Then with the help of many interested agencies, landowners and residents, we have established enhancement goals for the lagoon and formulated several enhancement alternatives.

4) We have outlined how the plan could be funded and implemented and how the lagoon will be maintained so that our efforts are preserved into the future.

5) We have identified a public access trail and other public facilities to allow residents and visitors to observe lagoon wildlife and enjoy the area.

Lagoon Study Area Boundary

The enhancement plan recognizes two boundaries for the lagoon system. The first boundary defines the upland edge of the existing lagoon wetlands (see Figure A. Figures with letters are bound in the back of the plan.) This boundary defines the areas of the lagoon to be enhanced. The boundary was determined by the staff of the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and California Department of Fish and Game. These agencies used the Corps' three parameter approach to defining wetland boundaries. This approach relies on the presence of wetland indicator plant species and hydric soils (showing signs of periodic inundation) and the hydrology of the area. This boundary was surveyed and all acreage figures in the lagoon plan are based upon this wetland boundary. All the lagoon area below this boundary is wetland of a vegetated or non-vegetated type. The Corps' definition of wetlands was therefore adopted for use in the enhancement plan.

The second boundary used in the plan defines the 52 square mile watershed of Batiquitos Lagoon (see Figure B). The watershed boundary was used in all the sedimentation studies completed for the lagoon plan. The watershed boundary determines the land area which has the greatest effect upon the lagoon, and from a land-use planning perspective must be considered to assure the long-term viability of the lagoon.

Lagoon History

For many thousands of years, the only human residents of the Batiquitos Lagoon

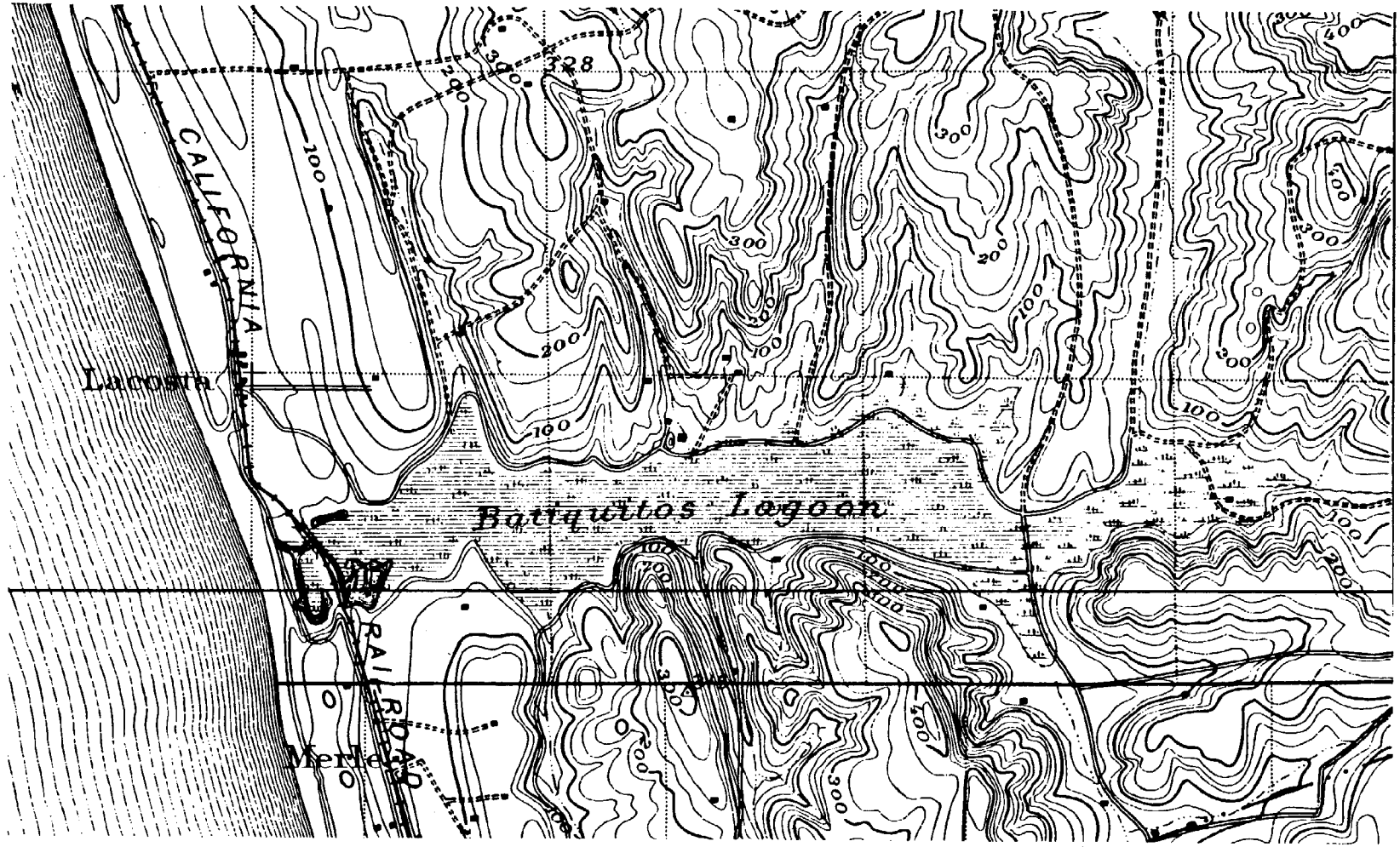


FIG. 3 **U.S. Topographic Survey Map Batiquitos Lagoon, 1898**

TABLE 1

HISTORY OF BATIQUITOS LAGOON

I. Prehistoric - Various California Paleo-Indian cultures, dating to 9,500 Before Present (B.P.).

Lagoon Continuously Tidal

San Diequito Complex (9,500 B.P.) - Paleo-Indian complex living near the lagoon and primarily living on collected shellfish from the lagoon's waters.

La Jolla Complex (7,500 B.P.) - An early milling complex that supplemented collecting shellfish with the crude milling of flour. The La Jolla Complex form the most numerous archaeological sites near the lagoon. Most sites are within 1,000 feet of the lagoon and are concentrated on the flatter north shore. Some sites indicate a history of habitation from 7,500 B.P. to 1,270 B.P. (approx.).

Late Prehistoric Cultures (950 B.P.) - Characterized by advanced milling techniques and a reduced dependency on marine foods.

II. Hispanic Era - Early exploration of the area. Includes the Mission Era and Ranch Era 1760's to 1848.

Exploration/Mission Era (1769-1833) - Portola-Crespi Expedition explored north San Diego County around 1769. Their route is believed to follow the approximate alignment of El Camino Real. San Luis Rey Mission was established in 1798. Mission livestock probably grazed the land adjacent to the lagoon and the local Indians continued to exploit the lagoon resources.

Mexican Rancho Era (1830's-1848) - In 1842 Marron was granted Aqua Hedionda Rancho north of the lagoon and Ybarra was granted Las Encinitas Rancho, located south of the lagoon. Livestock from these ranchos probably grazed the lagoon area.

III. Americanization Era (1849-1900) - The American takeover in 1848 of Mexican Ranchos opened the area for homesteading in the 1870's.

TABLE 1 (continued)

HISTORY OF BATIQUITOS LAGOON

Circa 1880-	The Johnson homestead (located along San Marcos Creek in present-day La Costa).	Lagoon Tidal on Intermittent Basis
	The Stewarts' homestead.	
	A major roadway extended south from the lagoon through Green Valley (El Camino Real).	
1881-	California Southern Railroad built across the lagoon's mouth. Shipping points were established at La Costa (present Ponto) and Merle (present Leucadia).	
1880-1900-	Homesteading began in Green Valley. Batiquitos Gun Club established. La Costa (Ponto) filed for incorporation.	
IV.	Modern Period (1901-Present)	
1901-1910-	California Salt Company operated 25 acres of evaporative ponds in the lagoon's eastern basin.	
1912-	Pacific Coast Highway constructed.	
1917-	The avocado was introduced and irrigated orchards became a prevalent land use around the lagoon.	
1920-	Green Valley was the most extensively farmed section of the entire north coastal area.	
1927-	Pacific Coast Highway was reconstructed across Batiquitos Lagoon after storms destroyed it.	
1934-	Santa Fe Railroad constructed across the lagoon.	
1952-	San Marcos Dam constructed, decreasing the volume and scouring potential of floods.	Lagoon Infrequently Tidal

TABLE 1 (continued)

HISTORY OF BATIQUITOS LAGOON

1963-	Plans for a small craft marina in the west end of the lagoon were prepared.
1965-	Interstate 5 was constructed across the lagoon.
1966-	La Costa Resort built upon eastern portion of lagoon wetland.
1967-74-	Secondary treated wastewater discharged into lagoon.
1971-74-	Plans prepared for Nemo's Secret Harbor (an amusement park located in and around the lagoon).
1975-	World Cultural Center (including a Hilton Hotel) proposed by Excel Foundation to occupy same north shore site as Nemo's Secret Harbor.
1976-	San Diego County prepared Master Plan for Batiquitos Lagoon Regional Park.
1977-	Batiquitos Lagoon included in Carlsbad's Sphere of Influence by LAFCO.
1983-	Batiquitos Lagoon Foundation formed.
1984-	Carlsbad annexed Batiquitos Lagoon. Lagoon Rarely Tidal

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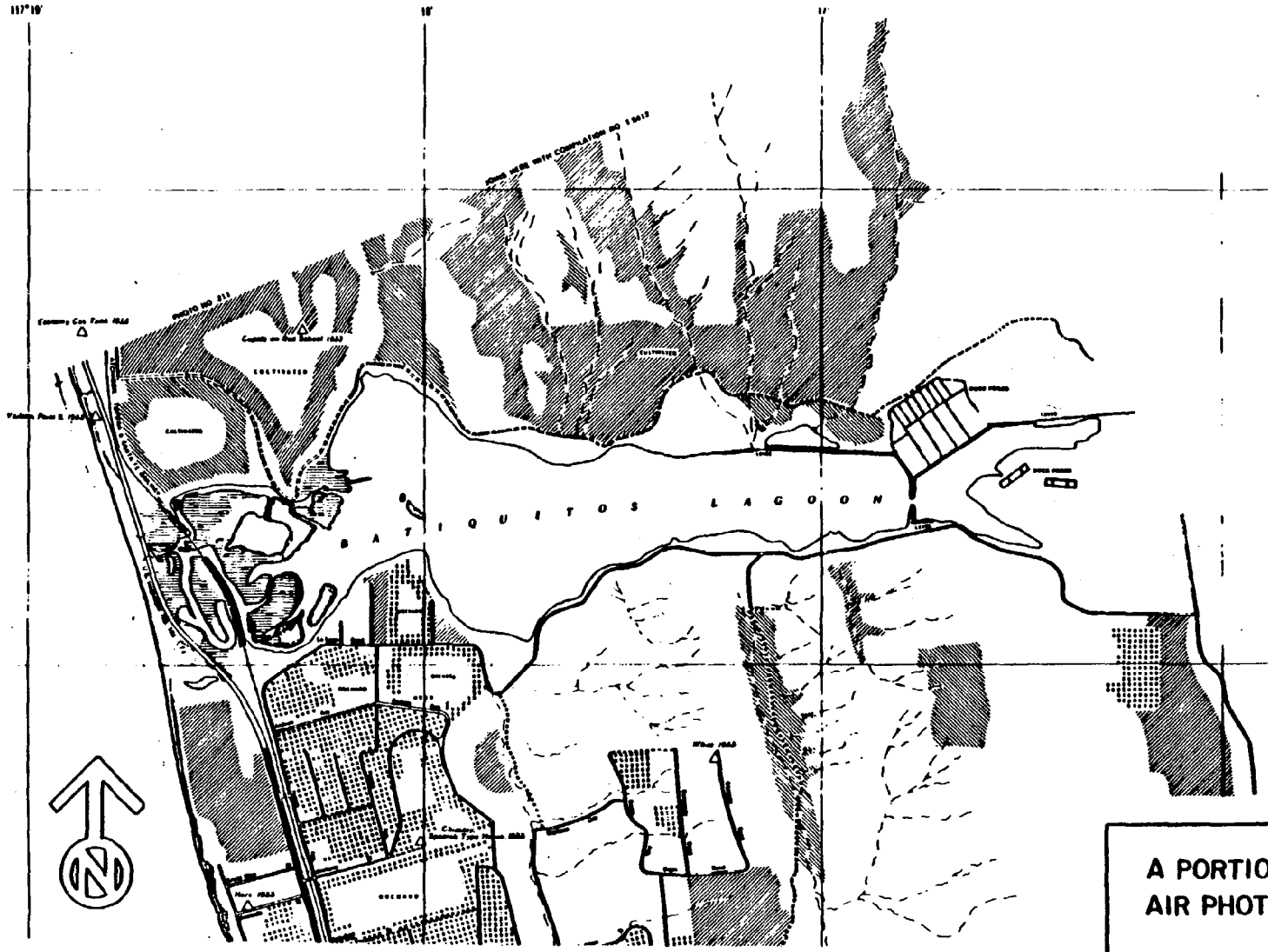
Adapted from City of Carlsbad Draft Batiquitos Lagoon Management Plan 1984, University of San Diego, Environmental Studies Laboratory, 1978. Tidal Aspects of Batiquitos Lagoon, 1850 to present, K.K. Bertine and D. Schug, 1981. Man and the historical sedimentary record in two semi-arid estuaries in River Input to Ocean Systems, Proceedings of a Review Workshop, United Nations, New York.

area were Native Americans. Various cultures inhabited the lagoon area continuously from about 8,000 B.C. to 1890 A.D. and largely depended on the marine animals of the lagoon for food. The first Europeans to visit this area, the Portola expedition, crossed the lagoon's eastern edge in 1769. This expedition left no detailed descriptions. However, they are credited by some for giving the lagoon its name "Batiquitos", meaning little water holes. The Spanish later established a mission at San Luis Rey and cattle grazing began in the vicinity of the lagoon and in its watershed. The local indians continued their tradition of harvesting shellfish from the lagoon.

Following independence from Spain in 1830, the Mexican government granted much of the land surrounding the lagoon and its watershed to several owners. The new landowners used the grasslands for grazing and settled in the area permanently. Americans took over many of the California ranchos in 1849 and after California became a state in 1850. During the 1880's an influx of American settlers brought intensive agriculture to the lands immediately surrounding the lagoon and to the lagoon watershed. Figure 3 is a topographic map of the area in 1898. The small black squares indicate the buildings which were scattered around the lagoon borders. With the advent of American settlement and agriculture, a need for roads and railways developed. The lagoon was filled to support a railroad, two roads and eventually an interstate freeway. The late nineteenth century and twentieth century saw ever increasing development of the lagoon and its watershed lands with a consequent loss of marine character in the lagoon (see Figure 4). Table 1 outlines the human history of the lagoon area.

Researchers at the University of San Diego reviewed historic surveys, archaeological information, sediment and pollen studies and have established a history of tidal inundation for the lagoon (Phillips et al, 1978). Researchers at San Diego State University have also dated sediment cores and obtained similar results (Bertine and Schug, 1981). These studies show Batiquitos Lagoon was continuously tidal for at least several thousand years until about 1870-1880. Following 1880 the lagoon underwent intermittent tidal conditions for the next 45 years or so but experienced more frequent tidal flooding than presently occurs. The amount of tidal flooding decreased even more through the 1920's to the infrequent and rare tidal inundation in recent years. Therefore the lagoon was completely tidal when Americans first settled in the area but the combination of agriculture and its associated soil erosion; upstream water impoundments; filling for roads and railways and blockage of tidal flows acted to greatly reduce tidal inflows to the lagoon.

In recent years the lagoon mouth only opens when large winter storms bring enough water to break through the beach berm and empty the lagoon. The La Costa Resort also has a permit to open the lagoon mouth should water begin to threaten their lands. In either case, it is presently a rare occurrence that the mouth opens and any tidal water enters the lagoon.



A PORTION OF USC & GS
AIR PHOTO COMPILATION

1934
Scale 1"=2000'

FIG. 4

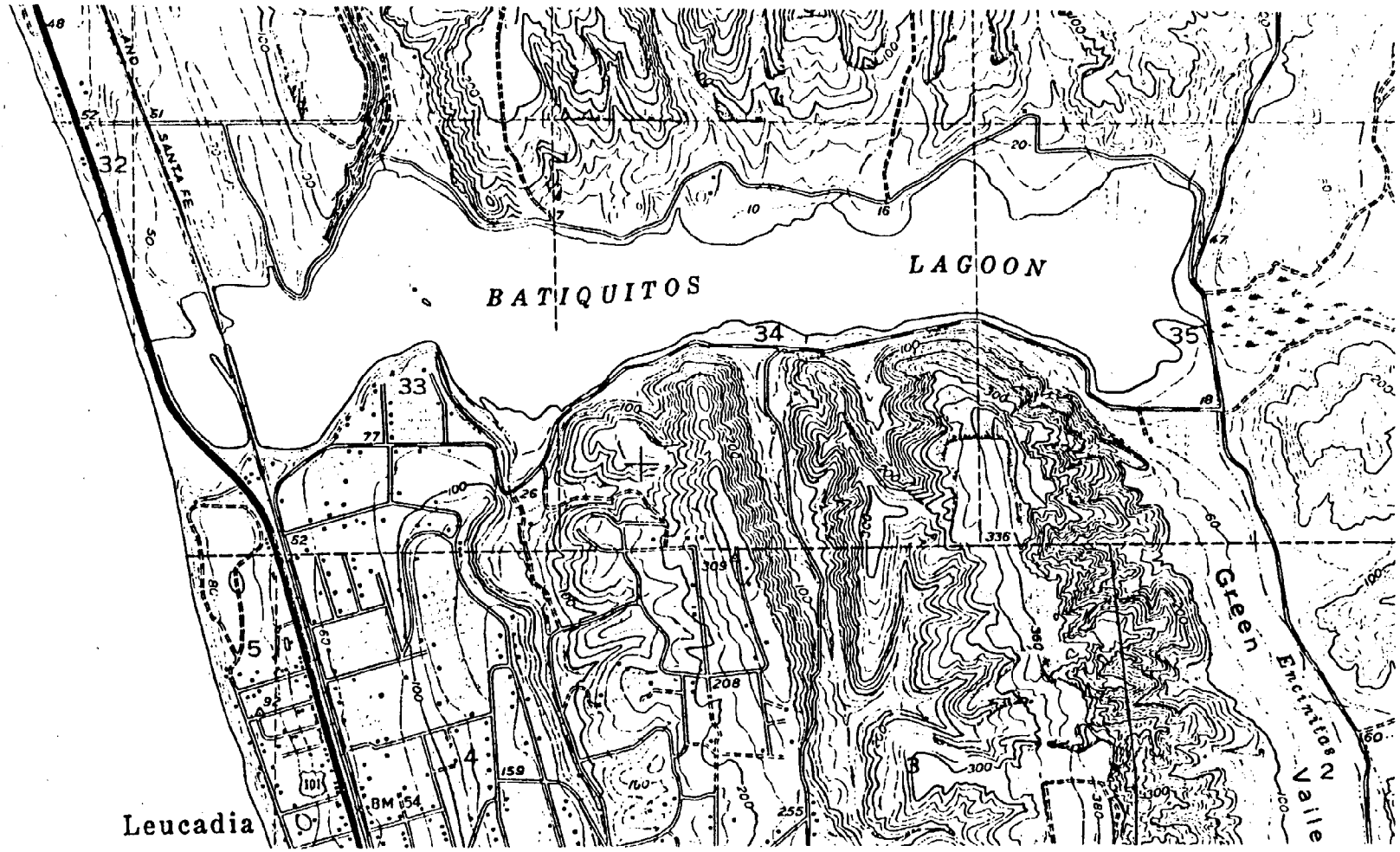


FIG. 5 **U.S. Coast and Geodetic Survey Map Batiquitos Lagoon, 1948**

DEFINITIONS

The following terms appear often in this document, but readers may not understand the technical meaning or the distinction between different terms.

Wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. (U.S. Army Corps of Engineers, 1977.)

A marsh is one form of wetland, either freshwater or salt, which is dominated by nonwoody plants (especially grasses and sedges) often developing in a shallow depression, river margins, tidal areas, and estuaries.

An estuary is a semi-enclosed coastal body of water which has a free connection with ocean, is tidally influenced, and experiences mixing of seawater with freshwater from inland drainages. Estuaries often contain marshes along their edges.

A lagoon is a shallow lake or sheet of water connected by a narrow inlet with a river or the sea.

Mean diurnal tidal prism is defined as the volume of water that flows into a lagoon or estuary between the lower low tide and the higher high tide or that flows out of the lagoon between the higher high tide and the lower low tide.

Tidal cycle is defined as the period between two consecutive high tides or two consecutive low tides. The semidiurnal tide has a cycle of approximately one half a tidal day, about 12.4 hours, whereas a diurnal tide has a cycle of a full day, about 24.8 hours.

Perigean spring tide - Tides of increased size which occur when moon is in perigee or at its closest point in its monthly orbit around the earth.

Subtidal Habitat is the tidal area below mean lower low water (MLLW) which is covered by water most of the time.

Intertidal habitat is the tidal area between the mean lower low water and mean higher high water which is exposed twice daily and covered by water twice daily.

Fluvial - of, found in or produced by a river or creek.

Alluvial - of or having to do with the process of deposition of sediments by flowing water.

Pluvial - of or having to do with rain.

TABLE 2
Tidal Elevations

Datum	Definition	Elevation (ft/NGVD)
MHHW Mean higher high water	Average height of the higher of the daily high tides	+2.52
MHW Mean high water	Average height of all tides	+1.77
MSL Mean sea level	Average height of the water surface for all stages of the tide, determined from hourly readings	-0-
MLW Mean low water	Average height of all low tides	-1.93
MLLW Mean lower low water	Average height of the lower of the daily low tides. Adopted as a plane of reference for hydrographic surveys and nautical charts of the west coast of the U.S.	-2.88

Throughout this document elevations are measured in feet in reference to Mean Sea Level. In the case of the Batiquitos Lagoon, it is equivalent to an elevation of zero on the National Geodesic Verticle Datum (NGVD). The table shows the range in tide levels observed at the mouth of the lagoon.

II. EXISTING ENVIRONMENT

SOILS, WATER & STREAMS

INTRODUCTION

The purpose of this section is to document the present and historic hydrologic conditions of the lagoon including a discussion of the tidal aspects of the lagoon and the changes the lagoon system has experienced in the past 150 years. The Batiquitos Lagoon watershed is described as are the current land uses and sedimentation processes of the watershed and their effects upon the lagoon. This section discusses the results of measurements of water quality in the lagoon and identifies the primary water quality problems and hydrologic constraints to returning the lagoon to a tidal system.

Batiquitos Lagoon is the result of gradual sea level rise after the last ice age, which submerged a canyon incised into highly erodible marine sedimentary rocks. Like other coastal lagoons in San Diego County, Batiquitos Lagoon has been severely altered by human activity. Bridges traverse the lagoon at three locations, and create significant flow constrictions. Land disturbance and development in the watershed have greatly accelerated the rate of sediment inflow, increased peak stream flows in some tributaries, and degraded water quality in the lagoon. The watershed of the lagoon comprises 52.3 square miles, most of which is drained by San Marcos Creek (38 square miles) and Encinitas Creek (7.4 square miles, See Figure B.)

Before the arrival of Europeans, the mouth of Batiquitos Lagoon was open to tidal action most of the time (Phillips et al, 1978; Bertine and Schug, 1981). The volume of tidal exchange was sufficient to keep the mouth open against beach sand thrown up by all but the most violent storms, and daily tidal flushing swept fine sediment out of the lagoon. By the 1920s, however, accelerated sedimentation had reduced the tidal prism enough that the lagoon mouth began to close more frequently. This closure in turn accelerates the accumulation of sediment in the lagoon. Today, the lagoon mouth is closed most of the time and almost all sediment reaching the lagoon is returned there. The lack of tidal exchange has had severe impacts on water quality in the lagoon, causing salinity and temperature increases in late summer.

Information Sources

The physical environment and biological characteristics of Batiquitos Lagoon have been the subject of numerous studies. Both Bertine and Schug (1981) and Phillips et al. (1978) studied the sedimentation in the lagoon and drew inferences on the historic frequency of closure of the lagoon mouth. The California Department of Fish and Game described the natural resources of Batiquitos Lagoon (Mudie et al., 1976). Several studies have been done pursuant to proposals for development around the lagoon. MacDonald and Feldmeth (1985) described the physical environment of the lagoon, and the ecological relationships and values of the wetland habitat around the margins of the lagoon. Jenkins and Skelley (1985) estimated the tidal prism and size of opening for various closure frequencies, given the site-specific wave environment at Batiquitos Lagoon. Woodward-Clyde Consultants (1985) developed

soil test boring logs and grain size distribution data for the lagoon, and Shepardson Engineering took additional cores at the mouth of Encinitas Creek and at the I-5 bridge.

Although the physical and biological characteristics of the lagoon have been studied in some detail, the characteristics of the watershed area have not been well studied. No streamflow records are available for streams entering the lagoon, although the Army Corps of Engineers estimated the 100-year, 50-year, and 10-year flood discharge and the corresponding water elevations for the 100-year and "standard project flood" for San Marcos Creek (Corps of Engineers, 1971). The annual and seasonal runoff from San Marcos and Encinitas Creeks have never been measured, and there are no monitoring data for sediment in streams entering the lagoon.

GEOMORPHIC HISTORY

Batiquitos Lagoon is, geologically speaking, quite young. About 18,000 years ago, sea level was 120 meters (394 feet) lower than it is today. With sea level lower, San Marcos Creek cut a deep valley in the marine coastal terraces. Between 18,000 years and 6,000 years B.P. (Before Present), sea level rose relatively rapidly (about one meter (3.2 feet) per century), drowning the river valley. For the last 6,000 years, the rate of rise has been about 0.15 meters (6 inches) per century. As the sea level rose over many thousands of years, Batiquitos Lagoon gradually filled with sediment from the San Marcos Creek watershed; geomorphic and paleontological evidence indicate that the lagoon has been relatively shallow for at least 200 years (Phillips, et al., 1978). The depth of the lagoon prior to the arrival of Europeans and the advent of grazing and agriculture represented a balance between the sediment supply, the rate of sea level rise, and the wave energy available to keep lagoon bottom sediments in suspension.

Since the late 1800s, human development has had profound effects on the sedimentation rate in the lagoon. The fill and bridge for the railroad were built in 1880 and the first Highway 101 bridge was built across the mouth in about 1912. A new highway 101 bridge stabilized the inlet channel on the north side of the lagoon. Construction of the I-5 bridge in the late 1960s created an additional constriction to tidal movements in the lagoon.

From the mid 1800s to the 1960s, agriculture and grazing played an important role in accelerating the sediment supply to the lagoon. During the mid-1960s, urban development in the watershed rapidly replaced agricultural activities. The marsh east of El Camino Real which once absorbed much of the sediment from San Marcos Creek was filled and developed in the 1960s (see Figure 5). The soil disturbance from urban development and agriculture, combined with large floods in the winter of 1977-78, 79-80 and 82-83, resulted in large inputs of sediment to the lagoon and a reduction in tidal prism. Table 3 summarizes the loss of tidal prism from 1887 to 1978.

As the tidal prism of the lagoon decreased, the frequency of closure has increased. Phillips et al, (1978) surveyed the available historic evidence and examined fossil pollen and invertebrates in sediment cores from the lagoon in an effort to determine the history of lagoon closure. They concluded that the

Table 3 Tidal Prism of Batiquitos Lagoon (in million cubic feet)

Potential Tidal Prism	1850	1887	1985
Mean	55-61		13.2
Mean diurnal	83-91		20
Perigean spring		153	43

Table 4 Tidal elevations at Scripps Wharf (in feet)

	DATUM	
	MLLW	NGVD
MHHW	5.4	2.5
MHW	4.55	1.65
MTL	2.7	-0.2
MLW	0.85	-2.5
MLLW	0	-2.9

lagoon was continuously tidal in 1849 and for 20 to 25 years thereafter. A study by Bertine and Schug (1981) corroborates this conclusion. The lagoon was closed at least temporarily in 1874, 1877, 1891, and 1898. Between 1898 and 1928, the lagoon was intermittently tidal. From 1928 to 1982 it was rarely open to tidal action. Presently, if the lagoon mouth opens at all, it is during large winter storms. A berm of cobbles blocks the mouth allowing water levels in the lagoon to gain depth during winter storms. The La Costa Resort has a permit to enable them to open the lagoon mouth when water levels reach +8.0 ft. MSL. At this level San Marcos Creek backs up and threatens to flood the golf course and other properties. In its current condition the lagoon rarely experiences tidal inflows and has a greatly reduced tidal range. Table 4 shows the tidal elevations for the Scripps Wharf, 16 miles south of the lagoon. The NGVD (National Geodetic Vertical Datum 1929 MSL, see Definitions page 17 for details) elevation of MLLW at the Scripps Wharf is -2.88 ft; maximum perigeal tidal range is from -4.5 ft. to +4.5 ft. NGVD in the ocean adjacent to the lagoon (S. Jenkins, personal communication). These values are based on the current sea level. During the sporadic periods when the lagoon mouth is open, the constriction and sediment sills at the bridges, and the frictional effect of the lagoon bottom severely dampen tidal movements into the lagoon.

Tidal measurements recorded in February and March, 1978, a period when the mouth was open, showed that high tide levels at the eastern end of the lagoon lagged 2.0 to 2.5 hours behind the high tide in the ocean, and the maximum tidal range was only about 1.2 ft. compared to the 6.6 ft. maximum tidal range in the open ocean during the same period. The maximum tidal range in the western end of the lagoon exceeded 3.0 ft. (Phillips et al., 1978). Additional tidal measurements in 1980 showed essentially the same pattern. Jenkins and Skelley (1985) cited the importance of the sediment sill at the I-5 bridge in restricting outflow on a low tide and reducing the actual tidal prism.

TIDAL HYDRAULICS AND ENTRANCE CHANNEL CLOSURE CONDITIONS

In its natural state, the inlet to a coastal lagoon such as Batiquitos remains open provided that tidal currents moving through the entrance channel are powerful enough to remove sand deposited by the action of ocean waves. The relative magnitude of the tidal scouring and the amount of littoral sand transport by wave action dictates the susceptibility of the entrance channel to closure. Through estimates of the interactions of these two factors -- tidal scouring and littoral sand transport, the closure conditions for the Batiquitos Lagoon channel can be described.

Littoral Sand Transport

Sand is deposited in the lagoon entrance channel by wave action during the inflowing or flood tide. The most intensive sand movement occurs during large storms when the nearshore wave energy is high. It has also been suggested that during heavy storms the dominant mechanism for depositing sand in the entrance channel is wave action moving the offshore bar onshore (O'Brien, 1980). The average nearshore wave power at a particular location can be used as an index of the wave climate for that location.

Tidal Scouring

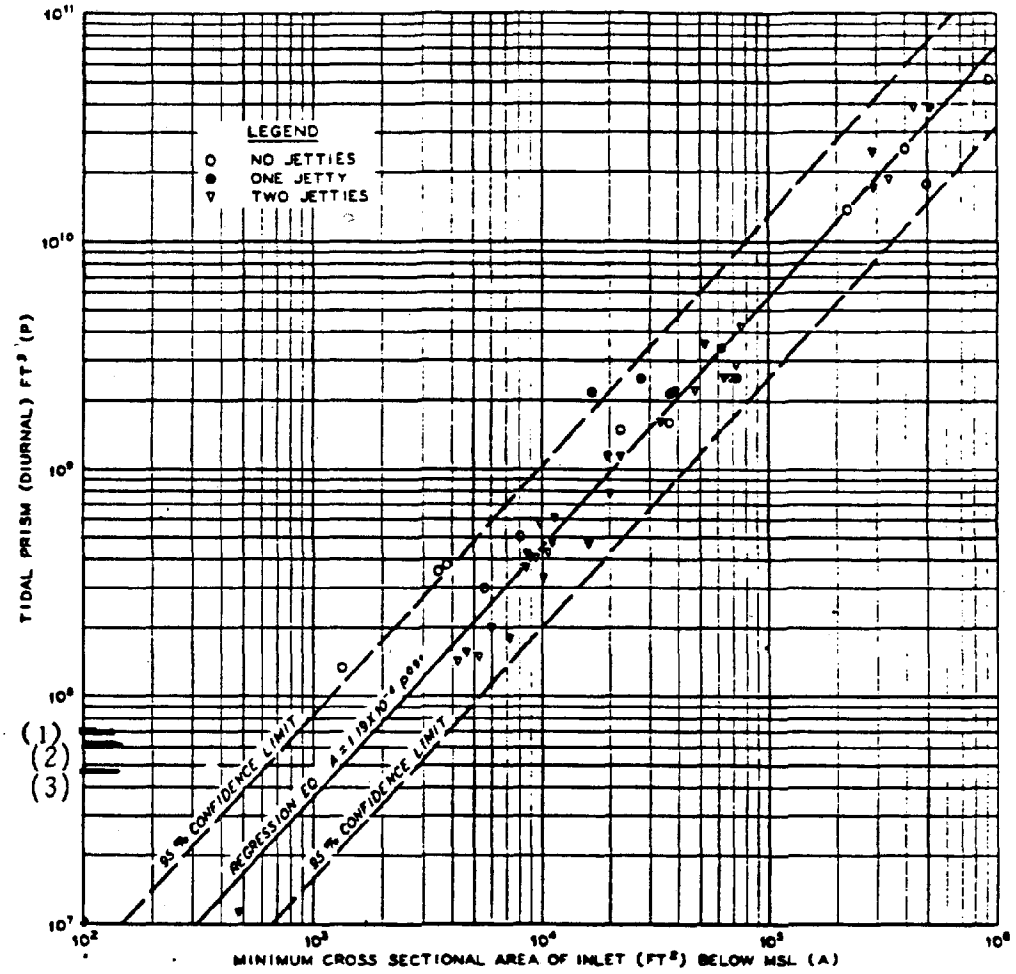
A combination of factors determine the amount of tidal scouring. These include: 1) the velocity of the ebb flow through the channel; 2) the duration of the ebb; 3) the grain size of the beach sand; and 4) the geometry of the entrance channel. The first two factors, the velocity and duration of the ebb flow, can be roughly approximated by the tidal prism, that is, the volume of water flowing out of the lagoon on the ebb tide. Factor four, the geometry of the lagoon entrance channel through the sand beach, is determined by the power of the tidal scouring and hence the tidal prism. Most Pacific Coast beaches have similar sized sands and factor three can be estimated. Therefore it is possible to develop an empirical correlation between tidal prism and the cross sectional area of the entrance channel (Jarrett, 1976). This correlation can be done for natural entrances and for artificial entrances stabilized by jetties (such as the one at Agua Hedionda). As can be seen in Figure 6, an entrance stabilized by jetties is more hydraulically efficient and allows scouring of a larger cross section than a natural channel.

It is therefore possible to describe closure frequency of a lagoon by an empirical correlation of wave power and tidal prism (Johnson, 1973). Unfortunately, because nearshore wave power data are not available for many locations, deep water wave power data has to be used. A refinement of Johnson's correlation for Pacific Coast lagoons is shown as Figure 7. As Figure 7 illustrates, Batiquitos Lagoon in 1850 had a sufficient sized tidal prism to remain below the dividing line and thus never closed. The lagoon's tidal prism in 1986 is much smaller and falls in the frequent closure area of the graph.

In comparing data with other lagoons it is important to maintain a consistent definition of tidal prism. The most significant tidal range for determining inlet closure conditions has not been identified. Most researchers use either the potential mean tidal range (Mean High Water to Mean Low Water) or potential mean diurnal range (Mean Higher High Water to Mean Lower Low Water). Jenkins and Skelley (1985) have used the perigean spring tidal range (the maximum tidal range) in their studies. In this plan we will use the potential mean diurnal tidal range. In addition it is sometimes important to distinguish between the "potential" tidal prism of a lagoon or the physical volume measured by survey between high and low water datum, and the "actual" tidal prism or the volume of water discharged during the ebb tide. In many instances, the actual tidal prism can be considerably less than the potential tidal prism. This difference occurs due to physical constrictions in tidal movements, such as bridges, and the frictional losses of the water flowing over the bottom of the lagoon.

Batiquitos Lagoon Inlet

Since the first mapping of Batiquitos Lagoon in 1856, the tidal prism has been significantly reduced due to sedimentation. As is shown in Figure 7, the potential mean diurnal tidal prism has been reduced from about 83 or 91 to 20 million cubic feet. The actual mean diurnal tidal prism has been reduced more, primarily due to the constricting effects of the Highway 101 bridge and formation of a mud sill at the I-5 bridge. Consequently the lagoon entrance has changed from one that was always open in 1850 (Phillips et al, 1978;



(1) Alternative 1

(2) Alternative 2
(3) Alternative 3

NOTE REGRESSION CURVE WITH 95 PERCENT CONFIDENCE LIMITS

TIDAL PRISM VS CROSS-SECTIONAL AREA
ALL INLETS ON PACIFIC COAST

FIG. 6

From Jarrett 1976

FIG. 7

Closure Conditions of Natural Lagoons of California

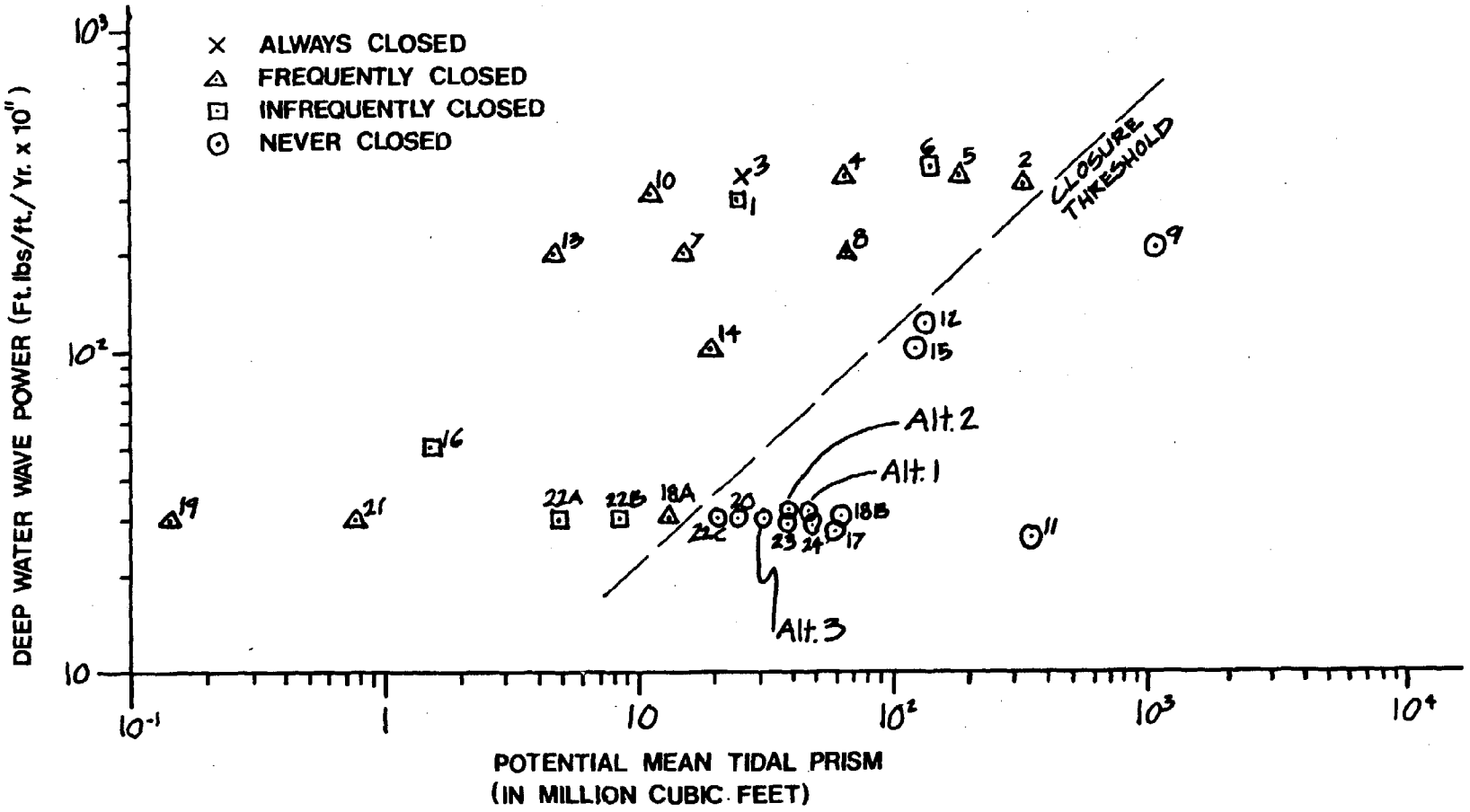


Figure 7

Summary of Tidal Inlet Characteristics

for Selected California Coast Estuaries and Lagoons

No.	Name	Potential Tidal Prism		Annual Deep Water Wave Power ft lbs/ft/yr x 10"	Closure Conditions	Remarks
		Diurnal	Mean			
1	Smith River Estuary	35	24	303	Infrequent	
2	Lake Earl	430	320	329	Frequent	
3	Freshwater Lagoon	35	25	348	Always	
4	Stone Lagoon	86	64	348	Frequent	
5	Big Lagoon	240	180	348	Frequent	
6	Eel River Delta	200	140	371	Infrequent	
7	Estero Americano	22	15	(200)	Frequent	
8	Estero San Antonio	11	65	(200)	Frequent	
9	Tomales Bay	1580	1070	209	Never	
10	Abbotts Lagoon	17	11	307	Frequent	
11	Drakes Estero	490	340	26	Never	
12	Bolinas Lagoon	200	130*	117	Never	Good Data
13	Pescadero Marsh	6.8	4.6	(200)	Frequent	
14	Mugu Lagoon 1976	27	19	(100)	Frequent	
15	Mugu Lagoon 1857	170	120	(100)	Never	
16	Carpinteria Marsh	4.8*	1.5	(50)	Infrequent	Good Data, Entrance Lined
17	Aqua Hedionda Lagoon 1976	80	55*	28	Never	Entrance Lined
18a	Batiquitos Lagoon 1985	20	13	(30)	Frequent	
18b	Batiquitos Lagoon 1850	90	60	(30)	Never	
19	San Dieguito Lagoon 1976	0.2	0.14	(30)	Frequent	
20	San Dieguito Lagoon 1889	37	24	(30)	Never	
21	Los Penasquitos Lagoon 1976	2	0.75	(30)	Frequent	
22a	Tijuana River Estuary 1986	12.6*	4.8*	(30)	Infrequent	

Figure 7 (continued)

Summary of Tidal Inlet Characteristics

for Selected California Coast Estuaries and Lagoons (continued)

No.	Name	Potential Tidal Prism Diurnal	Mean	Annual Deep Water Wave Power ft lbs/ft/yr x 10"	Closure Conditions	Remarks
22b	Tijuana River Estuary 1977	14.8	8.3	(30)	Infrequent	
22c	Tijuana River Estuary 1928	34.4	20.0	(30)	Never	
22d	Tijuana River Estuary 1852	67.5	47.9	(30)	Never	
23	Bolsa Bay	---	38	29	Never	
24	Anaheim Bay	---	47	29	Never	

* Indicates tidal prism data based on a large-scale topographic map
( ) Indicates an estimate of deep water wave power

Adapted from Johnson, 1973, by Philip Williams and Associates

Bertine and Schug, 1981) to one that is now most frequently closed.

When closure of the entrance channel occurs due to intensive wave action, the lagoon is cut off from tidal action until sufficient fresh water inflow occurs to raise the lagoon water level to overtop and scour a new channel through the sand of the barrier beach. Runoff in the Batiquitos watershed is extremely variable from year to year. This situation means that the winter runoff in many years is insufficient to fill the lagoon or may be excessive and fill it to an eight foot depth.

The closure conditions of the lagoon are complicated by the presence of cobbles in the barrier beach. These cobbles require high velocities to scour them -- higher velocities than normally occur in the entrance channel during the ebb tide or freshwater runoff. In the natural state, these cobbles may have accumulated as a bar in the channel, causing the entrance channel to migrate and break through a new area of the beach. Eventually wave action would break up the concentration of cobbles and redistribute them on the beach.

Now that the entrance channel is fixed by the Highway 101 bridge, the channel can no longer migrate. It appears that there is now a sufficient accumulation of cobbles to create a sill that limits the depth of tidal scouring. This sill would reduce the actual tidal prism in the lagoon.

Jenkins and Skelly (1985) have quantified the closure frequency of the lagoon by correlating the statistics of the waves and tides at the mouth of the entrance channel using a relationship for the "minimum tidal prism". Although the definitions and derivation of this relationship are unclear, the calculated frequency curve appears to be consistent with the conditions for 1850 and the present day.

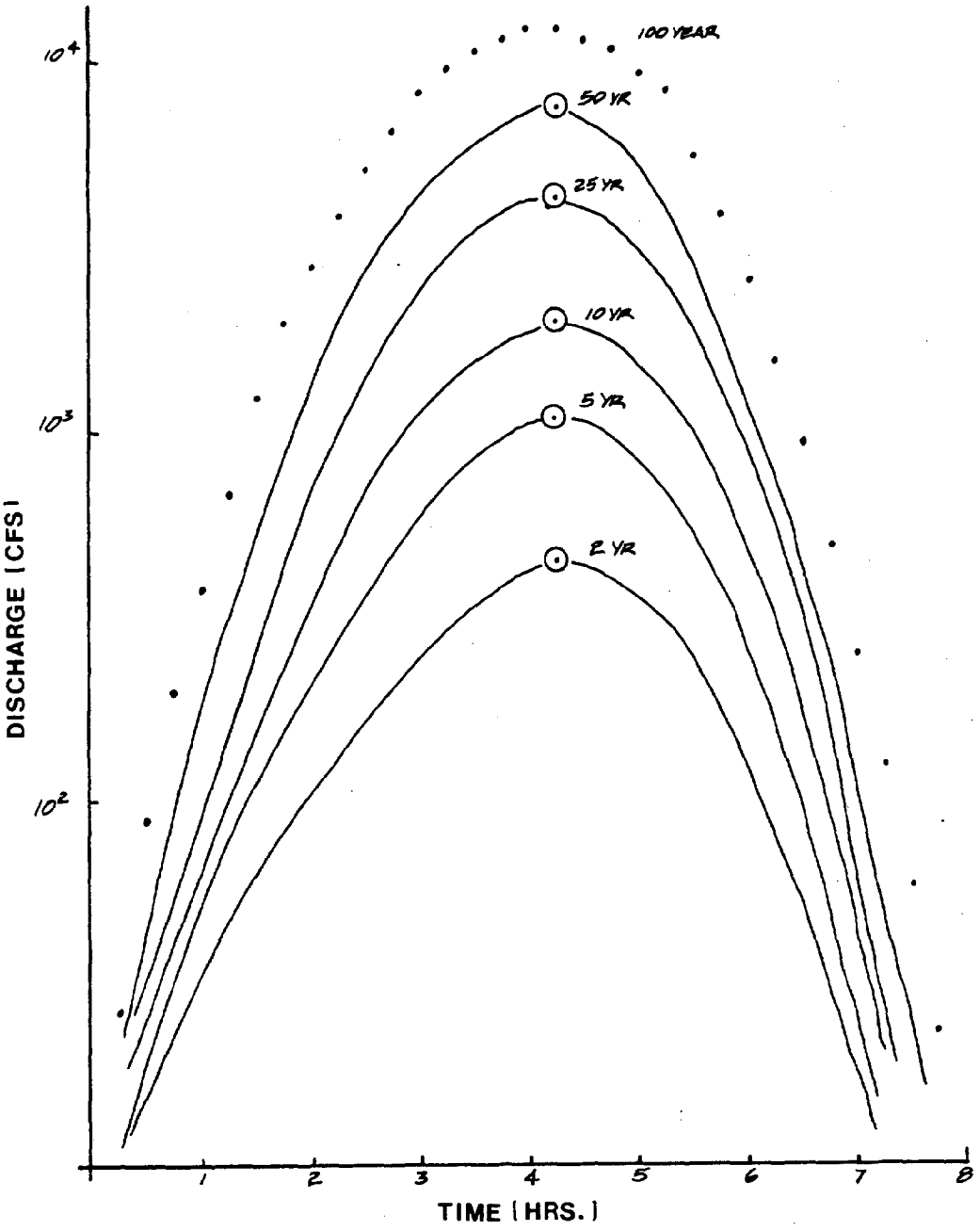
In summary a number of factors affect the lagoon channel and its ability to remain open. The primary constraints include:

1) insufficient tidal prism to adequately clear the lagoon entrance channel of cobbles and sand thrown up on the beach by storm waves.
2) hydraulic constrictions to tidal flows at the Highway 101 & 5 bridges and the railroad bridge.

HYDROLOGY OF THE WATERSHED

The Batiquitos Lagoon drainage basin has an area of 52.3 square miles. Figures B-1 to B-4 depicts the condition of streams and variety of land uses in the watershed.

Average annual rainfall in the basin ranges from about 10 in. near the coast to 16 in. in upland areas. No streamflow records are available for San Marcos Creek, but the Corps of Engineers (1971) has estimated a flood frequency curve from San Marcos Creek, based on streamflow records for De Luz Creek near Fallbrook in northern San Diego County. Figure 8b is the derived curve. The Corps' report includes floodplain maps, cross-sections, and flood profiles.



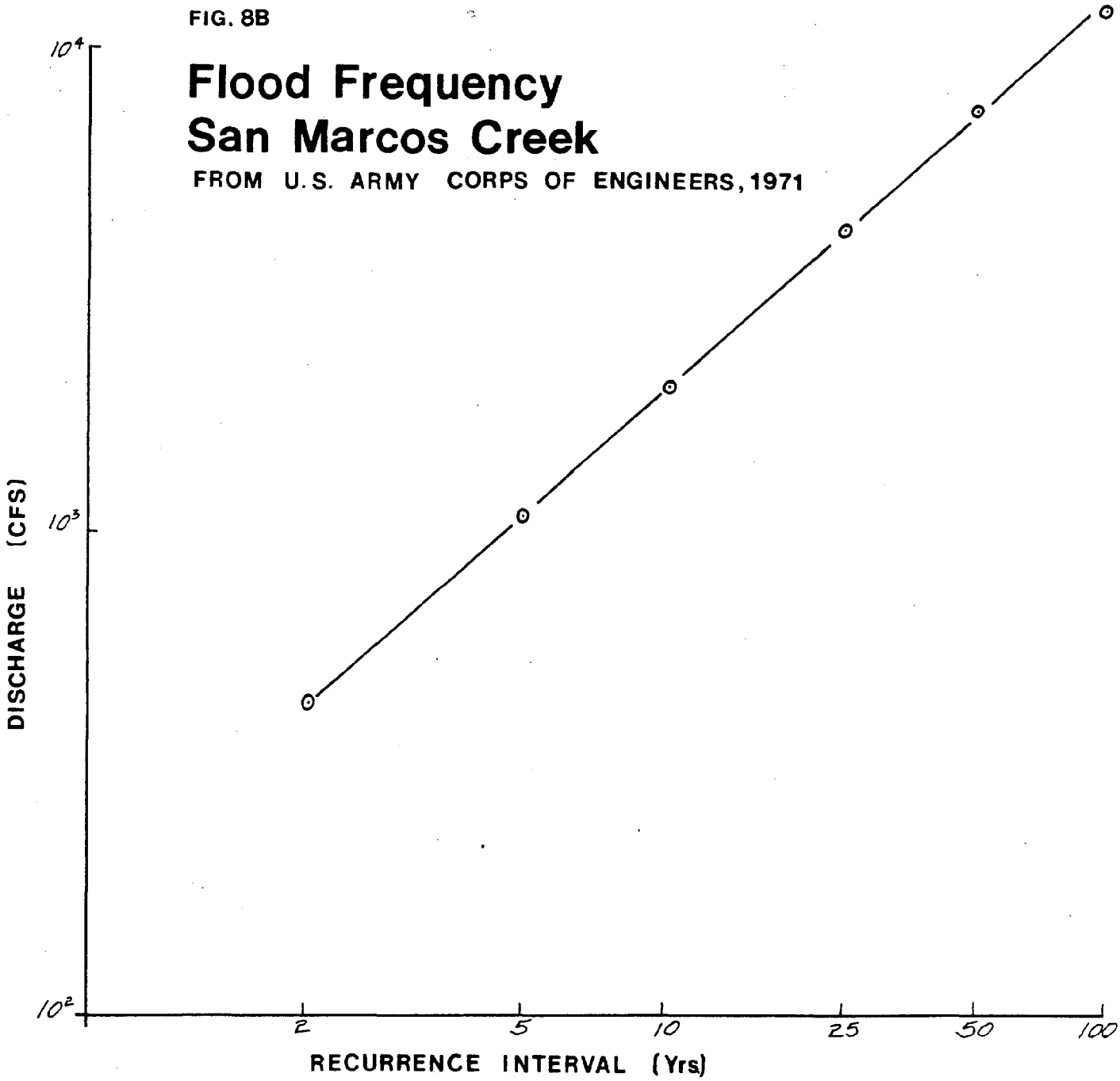
Flood Hydrographs, San Marcos Crk.

FIG. 8

FIG. 8B

Flood Frequency
San Marcos Creek

FROM U.S. ARMY CORPS OF ENGINEERS, 1971



The largest single tributary to the lagoon is San Marcos Creek, which drains a basin of about 38.3 square miles. Flooding on San Marcos Creek is somewhat reduced by the presence of the San Marcos Dam and Lake, 5.12 miles above the El Camino Real bridge at the head of Batiquitos Lagoon. The drainage area above the lake is 27.5 square miles. The lake was created for recreational purposes in 1952. Below San Marcos Lake, San Marcos Creek crosses Rancho Santa Fe Road before entering a steep narrow canyon. There is a large riparian forest at this road crossing. The stream gradient in the canyon is as high as 10% in some reaches. Above the La Costa Golf Course the stream debouches from the canyon onto an alluvial floodplain; the stream gradient through the lower part of the golf course is less than 1%. The land surrounding San Marcos Creek canyon is both urbanized and undeveloped. Several large quarries are located in this area. The section of the creek flowing through the golf course has been modified significantly; a small area of riparian vegetation occupies the mouth of the canyon above the golf course.

A tributary of San Marcos Creek drains lands to the north and joins the main stem of San Marcos Creek on the La Costa Golf Course. This tributary drains mostly agricultural and undeveloped lands. Agricultural land fills the streambed in several locations and the stream is diverted into a ditch. In other areas the stream contains large areas of riparian habitat. The lower end of the stream has been developed as a golf course; the creek is diverted into a drainage ditch through the golf course. As part of urban development, the upper end of this tributary bordering Palomar Airport Road has been channelized with a concrete lining. A great deal of grading for development projects is also occurring in this area and the creek channel has been filled or disturbed in several locations (see Figure B-3).

Overall, most of San Marcos Creek is unlined and contains some substantial riparian forest. Development of the floodplain and significant land alteration have not yet occurred.

Encinitas Creek drains an area of 7.4 square miles south of the San Marcos Creek basin. In the upper reaches of Encinitas Creek along Rancho Santa Fe Road the stream channel has been extremely disturbed. The entire area is undergoing grading for urban development and sections of the stream channel have been graded over and other sections of the channel containing riparian vegetation remain (see Figure B-1). There is no buffer between the natural channel vegetation and the graded slope. This development represents a substantial disturbance to the Encinitas Creek floodplain. The floodplain of one tributary of Encinitas Creek is in agricultural use. Encinitas Creek below the crossing of Rancho Santa Fe Road is filled with riparian trees and marsh. Near the crossing of El Camino Real and the tributary from the south, the creek has been modified into an earthen channel. The upper section of this tributary flows through a pipe.

Most of Encinitas Creek and its tributaries are relatively low gradient alluvial streams with well-developed riparian vegetation (see Figures B-1 and B-3). These alluvial reaches are important sediment storage sites. The thick root systems of the willows along the creek slow water and act as a sieve in catching sediment. Without proper management, changes in any portion of the stream channel could cause these riparian areas to become significant sources

of sediment to the lagoon. For example, if the upper portions of the creek are paved and the creek channel lined, the speed of this water would substantially increase and cause downcutting in the lower riparian channel. Therefore preservation and management of the entire natural floodway is essential to reducing sediment inflows into the lagoon.

Several smaller tributary streams also flow into the lagoon. These include several streams along the northshore which flow through agricultural lands and some urban areas and several streams on the southern lagoon shore (see Figure B-4). The creek along Saxony Road has a large riparian corridor and some disturbance in its upper reaches. The stream that flows along Pireaus Road has been diverted into culverts and channels in many areas and drains through a ditch adjacent to I-5. On the west side of the highway a similar drainage system serves the creek along Eolus Drive. Both these drainage ditches collect sediment and require frequent cleaning by CalTrans.

SOILS OF THE WATERSHED

The watershed of the lagoon can be subdivided into four different geomorphic zones, each with characteristic soil associations (USDA Soil Conservation Service, 1973). The zones are:

1) Heavily dissected marine terraces (beach sands and weakly consolidated sandstone) near the lagoon. These uplands comprise the Marina-Chesterton Soil Associations of somewhat excessively drained to moderately well-drained loamy coarse sands and fine sandy loams with a subsoil of clay over a handpan. Erodability of these soils is severe.

2) Alluvial fans in valley bottoms along San Marcos Creek and Encinitas Creek. This unit comprises the Salinas-Corralitos Association of moderately well-drained to somewhat excessively-drained clays, clay loams and loamy sands, on slopes .0 - 9 percent. The Salinas series, formed on clay loam, is slightly to moderately erodible; the Corralitos series (formed on sandy alluvium) is severely erodible.

3) Uplands in the coastal plains area. These soils are moderately well-drained, moderately sloping to very steep loamy fine sands to clays. Three associations have been mapped by SCS. These are:

a) The Diablo Altamount Association; consisting of well-drained clays, on 5 - 15 percent slopes.
b) The Diablo-Las Flores Association, consisting of well-drained clay and moderately well-drained loamy fine sands with a subsoil of sandy clay or clay, on 9 - 30 percent slopes.
c) The Las Flores-Huerhuero Association, eroded phase, consisting of moderately well-drained loamy fine sands to loams with a subsoil of sandy clay or clay.

The Las Flores and Huerhuero series are derived from marine sandstone and are severely erodible; the Diablo and Altamount are derived from calcareous sandstone and shale; their erodability varies from slight to severe, depending on slope.

4) Uplands in the foothill areas. These areas area comprised of the Exchequer-San Miguel Association, rocky phases. These are well-drained silt loams derived from metasedimentary (the Exchequer) and metavolcanic (the San Miguel) parent materials. Slopes are relatively steep (30 -70 percent) and erodability is severe due to both slope steepness and poor internal drainage.

THE SEDIMENT SYSTEM

Pluvial erosion is the primary source of sediment for transport to the lagoon. This process occurs when relatively intense short-duration bursts of rainfall during the wet season carry away loose soil from graded and agricultural sites, gullies and open lands. This loose soil is carried by the stream and redeposited downstream or in the lagoon. Along the coast, 1.15 inches of rainfall in one hour can be expected once in 20 years; the storm intensity in the mountainous areas of the lagoon watershed can be greater. As described previously the soils bordering the lagoon are derived from sandy, highly erodible parent material.

Landslides play a relatively minor role as sediment sources. The coastal bluffs near the lagoon are prone to landsliding on steep slopes; a significant landslide occurred last year along the southside of the lagoon just west of I-5.

Detached or eroded sediment is not a problem until it has been transported through the stream system to the lagoon. On Encinitas Creek, low-gradient alluvial reaches dominated by marsh and riparian vegetation are important sites for trapping and storing sediment (see Figures B-1). With accelerated land development upstream, these reaches are currently aggrading, that is, the volume of stored sediment is increasing. On San Marcos Creek, the reach of the stream between El Camino Real and the steep canyon above the La Costa Golf Course, contains a large volume of stored sediment. This reach is currently a source of sediment for the lagoon, when high flows erode stream banks. The northern tributary of San Marcos Creek is also a source of sediment to the lagoon due to poor agricultural and land development practices. The management of these alluvial reaches will play a key role in the longevity of the lagoon.

Since the mid-1800s, land use has played an important role in accelerating sediment input to the lagoon. The historic sedimentation record reconstructed by Phillips et al. (1978) indicates that agricultural activities prior to the 1920s resulted in a major input of sediment to the lagoon, perhaps exceeding in importance the recent contribution from suburban development. Even today, steeply sloping fields in the Encinitas Creek watershed are plowed perpendicular to the contour, a practice that invites accelerated erosion and sedimentation.

Since the 1960s, construction of roads and subdivisions has provided a major source of sediment. Exposed building pads and unvegetated cut-and-fill slopes, especially in sandy soils, are highly erodible. The increased area of paved surfaces and creation of a storm drain network increase the efficiency of stormwater runoff, and thus increase the downstream peak flows. Replacement of riparian corridors with efficient trapezoidal ditches further increases the capacity of the streams to transport sediment to the lagoon.

SEDIMENT YIELD AND TRANSPORT ESTIMATES

No sediment concentration data are available for streams flowing into the Batiquitos Lagoon. Estimates were completed for four tributaries San Marcos Creek, Encinitas Creek, and the drainage ditches along Highway 5 at Piraeus and Eolus. The remaining tributary streams either have sediment basins or will have as proposed in developments (see Figure I). Estimates of sediment yield and deposition in the lagoon must be based on: 1) sediment transport equations, which calculate the sediment transport capacity of the stream rather than actual sediment transport; or 2) average deposition rate in the lagoon over some known time period. In both of these approaches, there are many sources of uncertainty. Sediment transport equations assume an unlimited supply of sediment and can only be applied to alluvial reaches. Estimates based on average sediment rates may not reflect site-specific problems on highly erodible soils or effects of future development practices or the implementation of erosion control practices or Best Management Practices.

Philips et al. (1978) estimated the mean sediment deposition (1888-1978) at 1-2 cm/yr. Deposited over the 480 acres below an elevation of 4.0 ft. MSL, this amounts to 2.54×10^4 to 5.1×10^4 cubic yards/year or 1076 to 2152 cubic yards/square mile/year.

Estimates based on the recent loss of tidal prism in the lagoon (Jenkins and Skelley, 1985) are somewhat higher; average rates are 576 cubic yards/square miles/year (1916-1965) and 11,780 cubic yards/square miles/year (1965-1978). The latter figure, however, is based on an abnormally restricted actual tidal prism, and may be unrealistically high. The City of Carlsbad's Master Drainage Plan used a figure of 5642 cubic yards/square miles/year in planning sediment basins. For average yield rates, we will use estimates comparable to those of the City's Master Drainage Plan of 2152 cubic yards/square miles/year with Best Management Practices, (BMPs) and 5700 cubic yards/square miles/year without implementation of BMPs.

Some idea of the size distribution of material entering the lagoon can be gained from 18 borings taken in the delta at the mouth of San Marcos and Encinitas Creeks. (Shepardson Engineering Associates, Inc., 1985). From the sieve data for these borings, a volume-weighted average size distribution was calculated; Figure 9 is the average curve. It indicates, for example, that 50 percent of the sediment is finer than 0.032 mm., and 94.5 percent is finer than 0.25 mm. This curve was used in calculating total sediment transport capacity in San Marcos Creek, as well as for estimating the percentage of sand in the sediment load.

Since the main source of sediment in San Marcos Creek is the lower alluvial reach of the stream through the golf course, the average sediment yield rate for the lagoon is not very useful for estimating the sediment yield of San Marcos Creek. Instead, the long-term average sediment transport capacity of lower San Marcos Creek was estimated using the equation of England-Hansen. This calculation was done in the following steps:

1) The synthesized 100-year, 50-year and 10-year flood peaks (from the Corps of Engineers 1971 Floodplain Study) were plotted, and the 2-, 5- and 10-year

floods were estimated by interpolation and extrapolation.

2) The Corps' 100-year flood hydrograph was plotted, and the 2-, 5-, 10-, 25- and 50-year hydrographs were drawn to pass through the appropriate peaks.

3) Using the Corps of Engineers cross section number 2 at the La Costa Golf Course, the relationship between discharge and width for an equivalent rectangular cross section was calculated.

4) Using a computer program, the total sediment transport capacity at cross section 2 was calculated. Results are shown in Figure 10.

5) Combining the sediment transport curve and the estimated flood hydrographs, the total sediment transport for the 2-, 5-, 10-, 25-, 50- and 100-year events was calculated. The resulting sediment transport-frequency curve was used to calculate the long-term mean annual sediment transport, by taking the area under the curve.

The resulting estimate of mean annual sediment transport from San Marcos Creek is 13,200 cubic yards/year. From the size distribution curve, 30 percent of this is fine sand to coarse sand. If all of the sand (and only sand) were trapped, then 4,000 cubic yards/year would have to be removed. If the estimate were based on the average yield per square mile, it would amount to 3,500 to 7,000 cubic yards/year of sand from lower San Marcos Creek.

For Encinitas Creek and the two small tributaries near I-5, the average sedimentation rates are used to estimate debris basin requirements. Since the soils near the west end of the lagoon are fine sandy loams and loamy coarse sands, a higher proportion of the total sediment yield (about 75 percent) must be removed from debris basins.

Table 5 shows the estimated average annual yield of sand from San Marcos Creek, Encinitas Creek, and the ditches at Piraeus and Eolus in Leucadia.

To reduce the sedimentation impacts of land uses, three approaches are necessary: 1) implementing Best Management Practices (erosion control practices) on construction sites; 2) maintaining and managing alluvial riparian corridors; and 3) implementing Resource Management Practices on agricultural lands (see Watershed Plan).

A third approach to sediment management -- construction and operation of debris basins -- provides supplemental protection, but is not a substitute for good land management practices. Debris basins are in place on the Sammis Property, along the Batiquitos Drive (Lagoon Lane) drainage and on the tributary at the most northeastern corner of the lagoon. There is also a basin on the tributary bordering Saxony Road on the southshore of the lagoon (see Figure I). Additional basins are planned for several other tributaries, especially on the north side of the lagoon (VTN Engineers, 1980). If they are properly designed and maintained, debris basins can help provide an important degree of protection. It is not practical to catch all of the incoming sediment in debris basins, since silt and clay will remain in suspension for many hours to days and require extremely large catchment basins. If the lagoon is restored

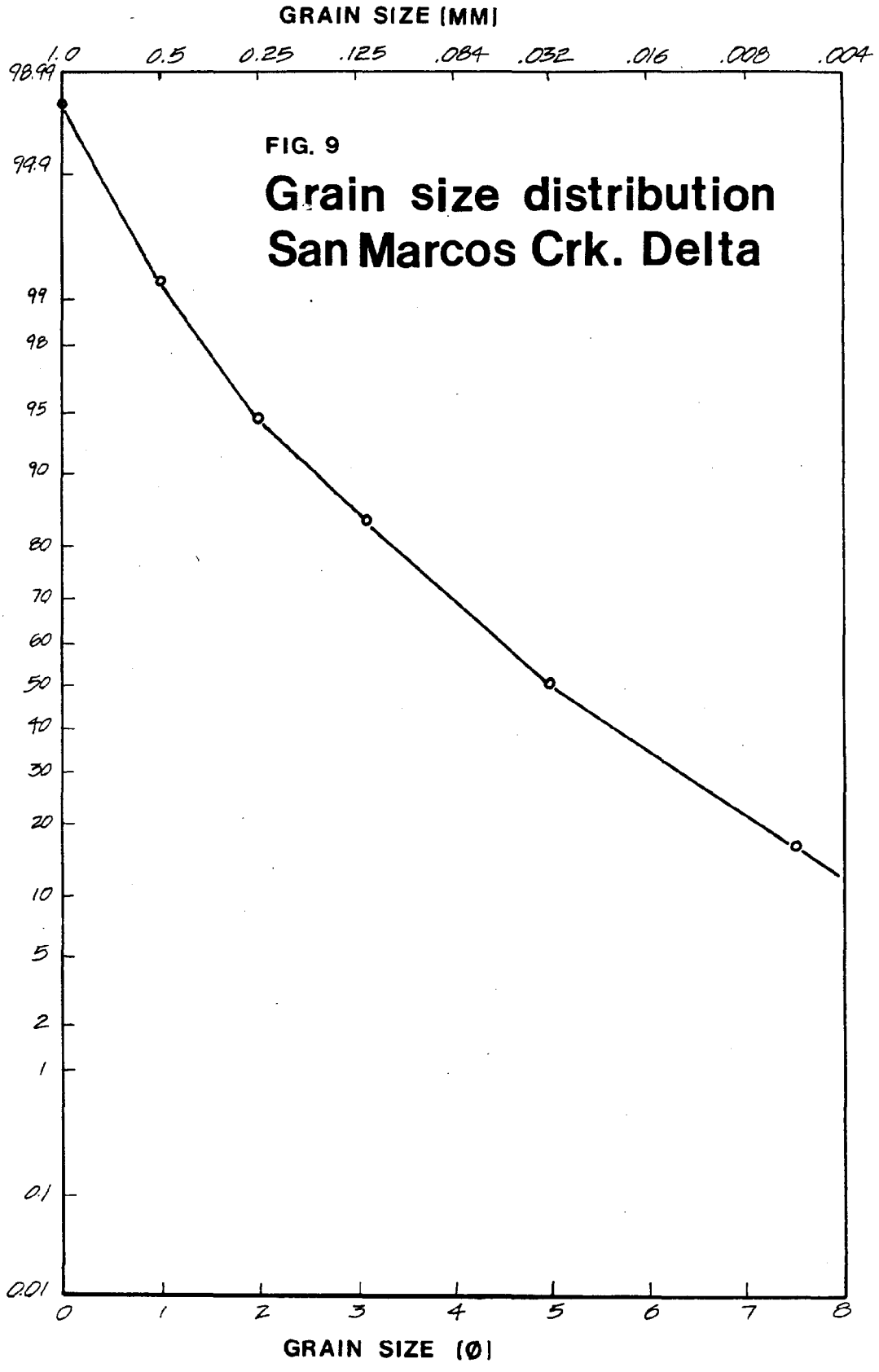


FIG. 9

Grain size distribution San Marcos Crk. Delta

to a tidal system, these fine sediments will be carried out with the ebbing tide. At least one debris basin (along Saxony Road) appears to be trapping silt and clay as well as sand. If a debris basin is too efficient, the outflowing water may by "hungry" for sediment, and begin attacking the bed and banks of the channel as it flows downstream.

San Marcos Lake is the largest debris basin in the Batiquitos watershed. It probably traps virtually all of the incoming sediment. San Marcos Creek at the Rancho Santa Fe Bridge shows virtually no recent overbank deposition of sediment. Below the alluvial golf course reach, however, the stream carries appreciable sediment. Therefore any facilities for additional sediment reduction on San Marcos Creek must be located below the golf course.

A fourth issue to address is the continuing urbanization of the watershed and paving of currently open land. Once land is paved, storm water flows off the pavement and into storm drains rather than percolating into the soil and eventually into stream channels. When the storm runoff from the paved areas enters the natural stream corridor it is flowing faster than the former natural drainage. At a certain point in the urbanization of the watershed the volume and speed of the water will increase enough to begin to downcut into the natural channel and erode the sediments stored in the riparian corridors. These sediments will be transported to the lagoon. This process occurs in the Buena Vista Lagoon watershed and required a large dredging project to clean out the lagoon.

One way to alleviate this problem is to require developments in the watershed to not produce an increase in the flow leaving the site. This goal can be accommodated by decreasing the slope of roofs, downsizing parking and drainage channels, planting of landscaping rather than paving, use of storm water detention ponds as water amenity features. At the point where the storm drain releases water into the natural channel drop structures or retention structures and energy dissipators should be placed. Road crossings can be designed to slow creek water flows. However, if this issue is not addressed, the likelihood of the downcutting in the lower reaches of Encinitas and San Marcos Creeks and transport of a great deal of sediment into the lagoon is very great.

LAGOON WATER QUALITY

The San Diego Regional Water Quality Control Board has collected water quality data for Batiquitos Lagoon for the past five years (California Regional Water Quality Control Board, 1985). Parameters measured include conductivity (salinity), total phosphate, orthophosphate, nitrate, nitrite, ammonia, total organic nitrogen, total dissolved residue, turbidity, total suspended solids, volatile suspended sediment and settleable residue. Samples were taken monthly at three locations in Batiquitos Lagoon (see Figure 11). Additional water quality tests were performed in July, 1984 by MacDonald & Feldmeth (1985). Zedler et al (1987) reviewed nutrient loading in San Diego coastal lagoons and predicted existing levels of nitrogen loading and recommended methods to reduce these loads.

Table 5 Annual Sand Sediment Yield

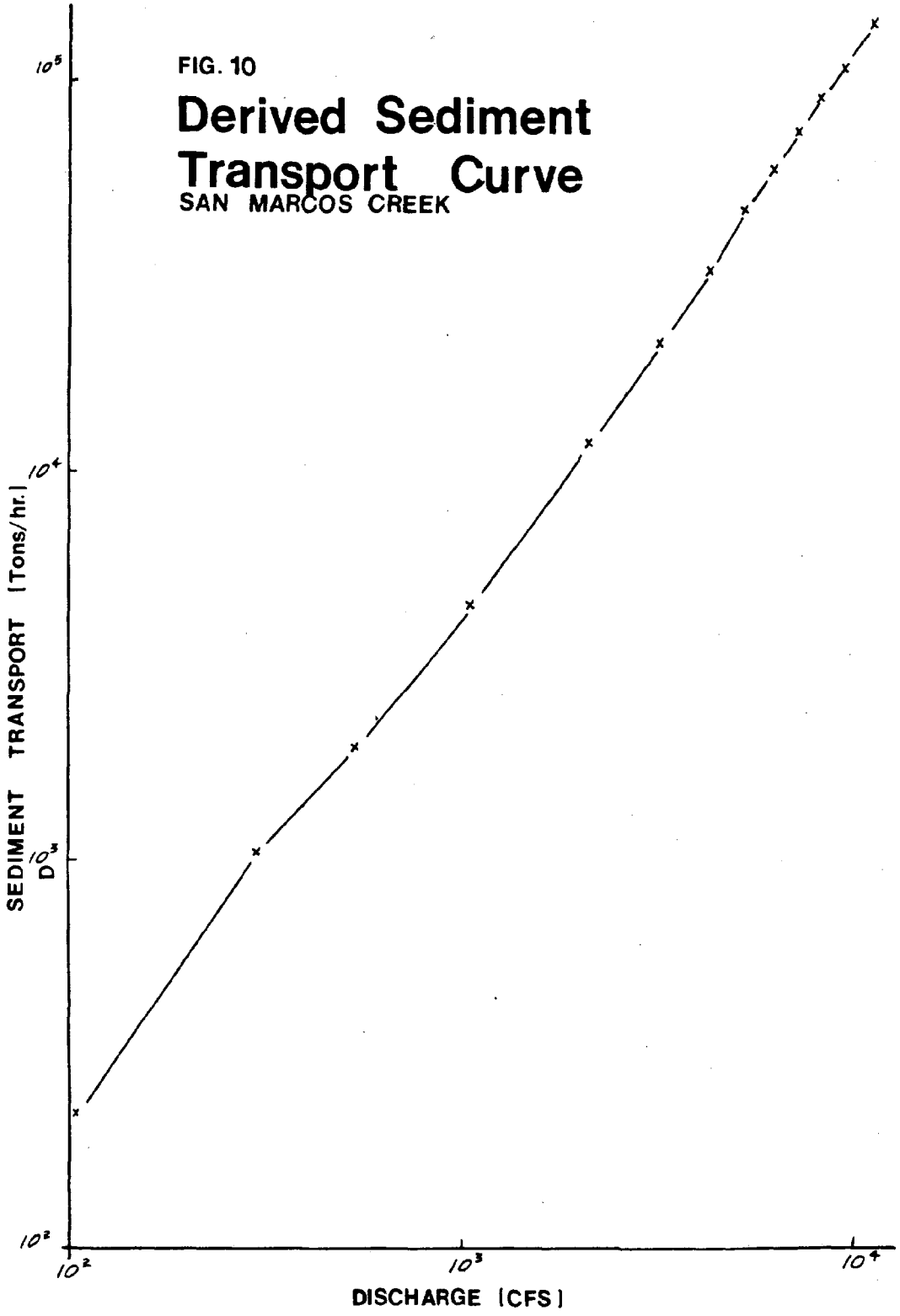
Basin	Drainage Square Mile Area	Sand Yield with BMP's* cubic yds/yr	Sand Yield without BMP's cubic yds/yr
Piraeus	0.60	480 to 660	1750
Eolus	0.3	240 to 480	1272
Encinitas	5.50	1775 to 3550	9407
San Marcos	10.8	3333 to 4750	4750
		5303 9440	17,179

*Best Management Practices

FIG. 10

Derived Sediment Transport Curve

SAN MARCOS CREEK



Water quality measurements reflect the overall condition of an aquatic system and determine its suitability as habitat to many aquatic organisms. Odor and color problems are often reflective of certain water quality conditions. We shall briefly review the monitoring results for several of the more important parameters measured.

Conductivity

Conductivity, or specific conductance, is a measure of the capacity of a water sample to conduct or convey an electrical current. The property of conductance is directly related to the concentration of ionized substances in the water and the temperature at which the measurement is made and can thus be related to the salinity of a water sample. As the various dissolved substances in water are concentrated by evaporation, the specific conductance increases. Distilled water has a specific conductance ranging from 0.5 to 2 micro-milliohms (umohs/cm), while most freshwater streams and lakes would have a conductivity ranging from 50 to 1000 umohs/cm. Sea water has a conductance of 34,000 umohs/cm (MacDonald and Feldmeth, 1985).

As demonstrated in Figures 12 A, B, and C, the conductivity of Batiquitos Lagoon, water varies both seasonally and at the different sampling locations in the lagoon.

During the winter months conductivity measurements are low, a reflection of the large quantities of freshwater entering the lagoon. As expected, Station A next to San Marcos Creek exhibits the lowest conductivity measurements with winter readings of 40 to 1200 umohs/cm. Stations B and C are considerably higher (note different scale on graph). Station B shows winter readings of 2,000 to 12,000 umohs/cm and Station C, closest to the ocean with winter measurements of 12,000 to 16,000 umohs/cm.

During the summer as lagoon water evaporates, salinity levels rise and conductivity measurements increase. Station A exhibited a summer maximum measurement of 5,200 to 6,800 umohs/cm. Measurements at Station B were 76,000 to 84,000 umohs/cm by late fall, a six to seven fold increase over winter levels. Station C has the highest summer levels with peak measurements of 108,000 to 128,000 umohs/cm, over a ten fold increase from winter levels.

The data show that Batiquitos Lagoon has salt concentrations far in excess of ocean water for a major portion of the year. Both Stations B and C exhibit levels two and four times the salinity concentration of sea water. In addition these data show a great annual variance in salinity levels related to the inflow of freshwater in winter and gradual evaporation of water over the summer.

Nitrogen Compounds

Four separate measurements of dissolved nitrogen compounds were made for the lagoon waters: nitrite, nitrate, ammonia and total organic nitrogen. In most marine bays, lagoons and salt marshes, levels of these compounds are very low. Ammonia comes from the breakdown of the protein of decomposing organisms or from effluents which may enter a body of water such as inorganic fertilizers or

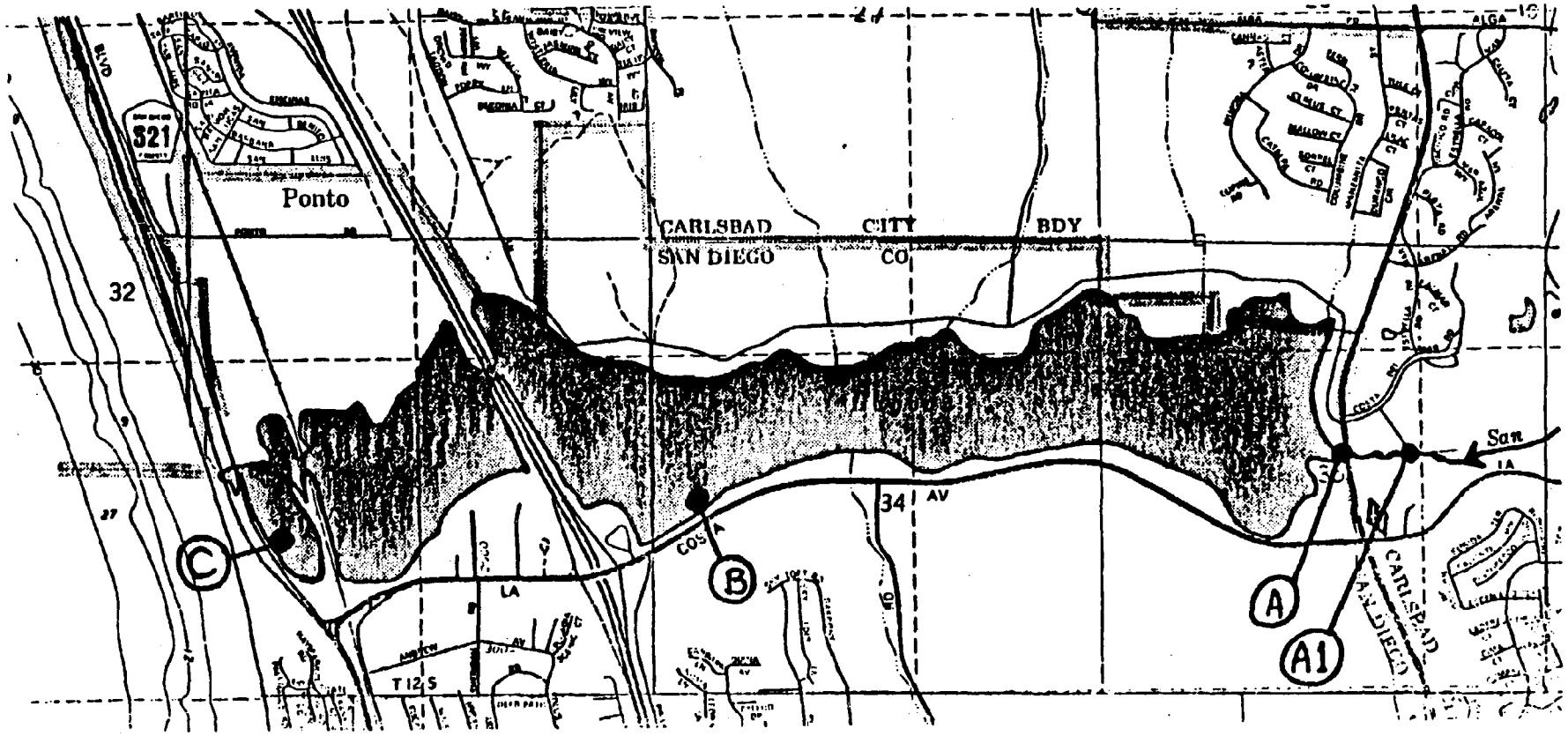


FIG. 11 Location of San Diego Water Quality Control Board Sampling Sites.

domestic wastewater. Normally bacteria convert ammonia (NH_3) or ammonium ion (NH_4^+) into nitrite (NO_2^-) and then into nitrate (NO_3^-). The cycle of conversion from ammonia to nitrate occurs as organisms die and decompose and the nitrogen that was tied up in their bodies is recycled (see Figure 13). Nitrate is a critical nutrient for plants and essential for primary production. Nitrate levels in any aquatic system are usually very low (about 0.5 ppm in sea water) because plants continually utilize this nutrient as it is released by bacterial action. High levels of nitrogen compounds will stimulate algae blooms and aquatic plant growth.

Figures 14 A and B depict ammonia concentrations measured at each sampling station. Station A on San Marcos Creek shows concentrations ranging from very low, .02 parts per million (ppm), to a high of 1.5 ppm. These peak concentrations are generally found during winter months and are probably associated with the runoff from heavily fertilized areas such as La Costa Golf Course and lawns and gardens upstream. Ammonium sulfate and other ammonia compounds are typically used in commercial fertilizers.

Station B shows higher levels (3.0ppm) of ammonia occurring at various times of the year. These high concentrations could be the result of inflows of fertilized runoff. This runoff will stimulate blooms of algae and other aquatic plants during spring and early summer.

As these plants die off in summer from high salinities and temperatures they are covered with a film of bacteria and begin to decompose. This decomposition releases ammonia into surrounding water and could account for high concentrations recorded in late summer.

Station C exhibited much the same pattern as Station B. High concentrations of ammonia (3.0 ppm) may be attributed to the decomposition of algae and to inflow of water carrying nitrogen fertilizer residues.

Accidental release of wastewater from the pump station near the mouth of the lagoon has added large amounts of nutrients to lagoon water. One spill in the summer of 1985 caused large algae blooms on the lagoon.

A recent study (Zedler et al, 1987) concluded that nitrogen levels are the primary controlling nutrient to algae growth in San Diego coastal lagoons. This study described Batiquitos Lagoon as having a "high incidence of algae blooms at all seasons".

Phosphate

In addition to nitrate, phosphate and orthophosphate are also important nutrient substances for primary productivity and hence plant growth. In most aquatic systems, levels of phosphate and nitrogen are the major limiting factors to plant growth (see Figure 13). Phosphate levels at Station A were highest during winter months and could be associated with urban and agricultural runoff levels for both stations. Levels then decline in the summer (see Figure 15). This pattern undoubtedly occurs because vascular plants such as ditch grass (Ruppia maritima) and various species of algae, take up phosphate in the spring and summer months when temperatures and light levels

allow rapid growth. Thus plant growth lowers the existing levels of phosphate in the lagoon as the season progresses.

Chlorophyll a

Chlorophyll a levels were also monitored for the lagoon. Chlorophyll a is a measure of the concentrations of photosynthetic material in the water column and approximates aquatic productivity levels.

Figure 16 shows the mean chlorophyll a concentrations at various lagoons and the trophic state classifications associated with these concentrations. Batiquitos Lagoon (c) has a high chlorophyll a concentration and falls under the classification of eutrophic. This trophic classification indicates a high level of organic material and can be associated with high nutrient environments.

Groundwater

An important feature of the water quality picture at Batiquitos Lagoon is the seepage of freshwater around the fringes of the lagoon. Macdonald and Feldmeth (1985) found that this water table was independent of the water level in the lagoon. The seepage apparently originates in the drainage area above the lagoon and percolates downward until it reaches the more dense saline groundwater associated with the lagoon. This seepage provides a measure of freshwater inflow during dry summer months.

Summary - Water Quality

Monthly water quality data are available from the Regional Water Quality Control Board for the years 1979 - 1983. The results show that water quality in the lagoon is controlled by the frequency of opening of the lagoon mouth, by evaporative concentration of salts, and by the inflow of fresh nutrient-rich water from San Marcos and Encinitas Creeks. Midsummer salinity in the lagoon exceeds that of seawater, ranging from 2.5 times the salinity of seawater in the upper lagoon to almost four times higher in the lower lagoon. The inflow of water rich in ammonium, nitrate and phosphorous from San Marcos Creek and probably other tributary streams stimulates blooms of ditch grass (Ruppia maritima) and filamentous green algae. Higher salinity and temperature levels later in the summer cause the aquatic plants to die off. Decomposition of the dead plants depletes the supply of dissolved oxygen in lagoon water and further increases nutrient levels. With no tidal exchange and little summer inflow from San Marcos Creek, water temperatures in the lagoon increase, further reducing the dissolved oxygen. In summary, the lack of tidal inflows and limited seasonal freshwater inflows results in stagnant summer water quality conditions. Water quality conditions fluctuate widely over one year's time with extremely harsh conditions prevailing during mid to late summer.

SUMMARY

Batiquitos Lagoon has undergone significant geomorphic change in the past 150 years. For thousands of years prior to European settlement the lagoon mouth was open on a continuous basis. The channel was able to remain open because

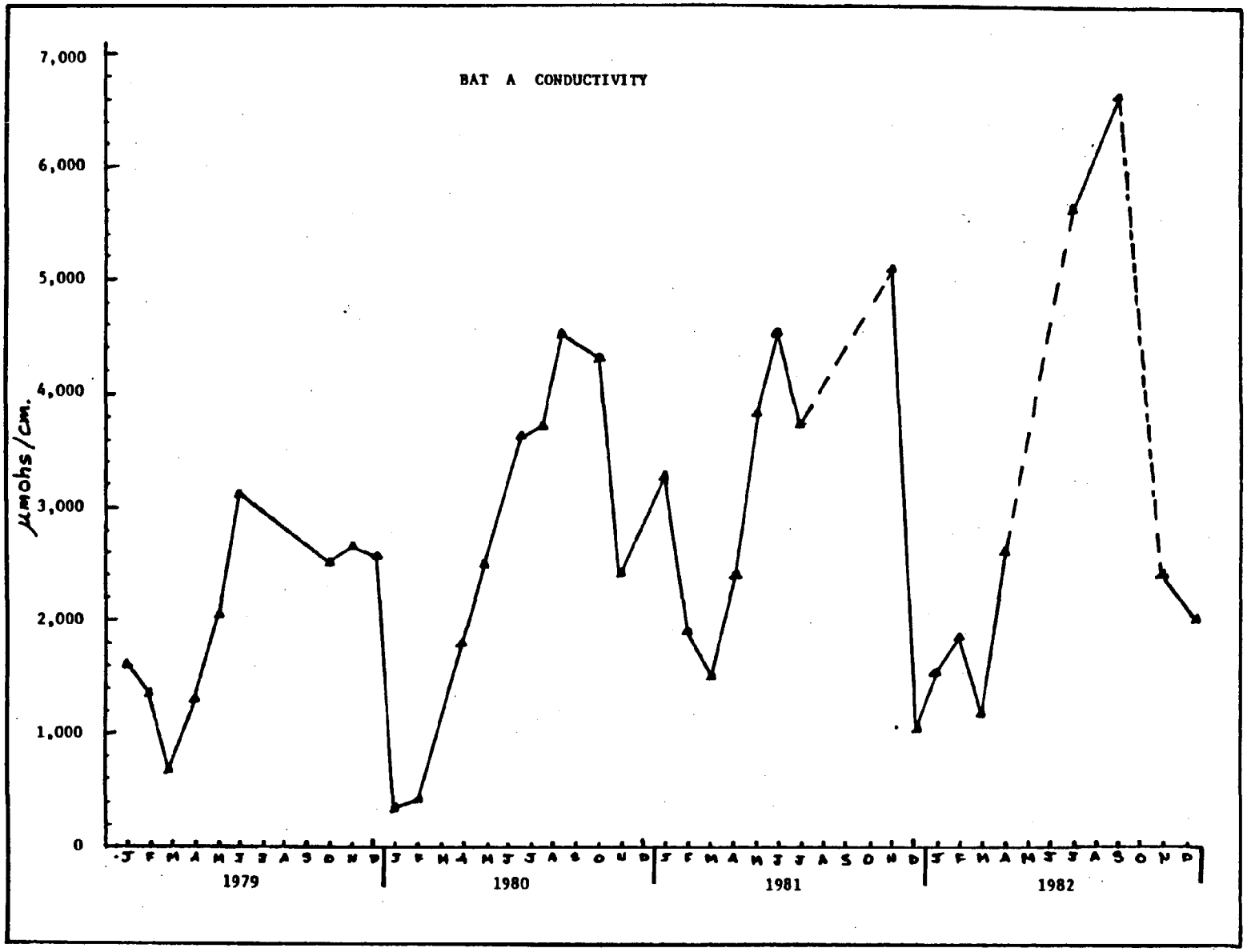


FIG. 12A

Batiquitos Lagoon; Conductivity data from Station A/A1.

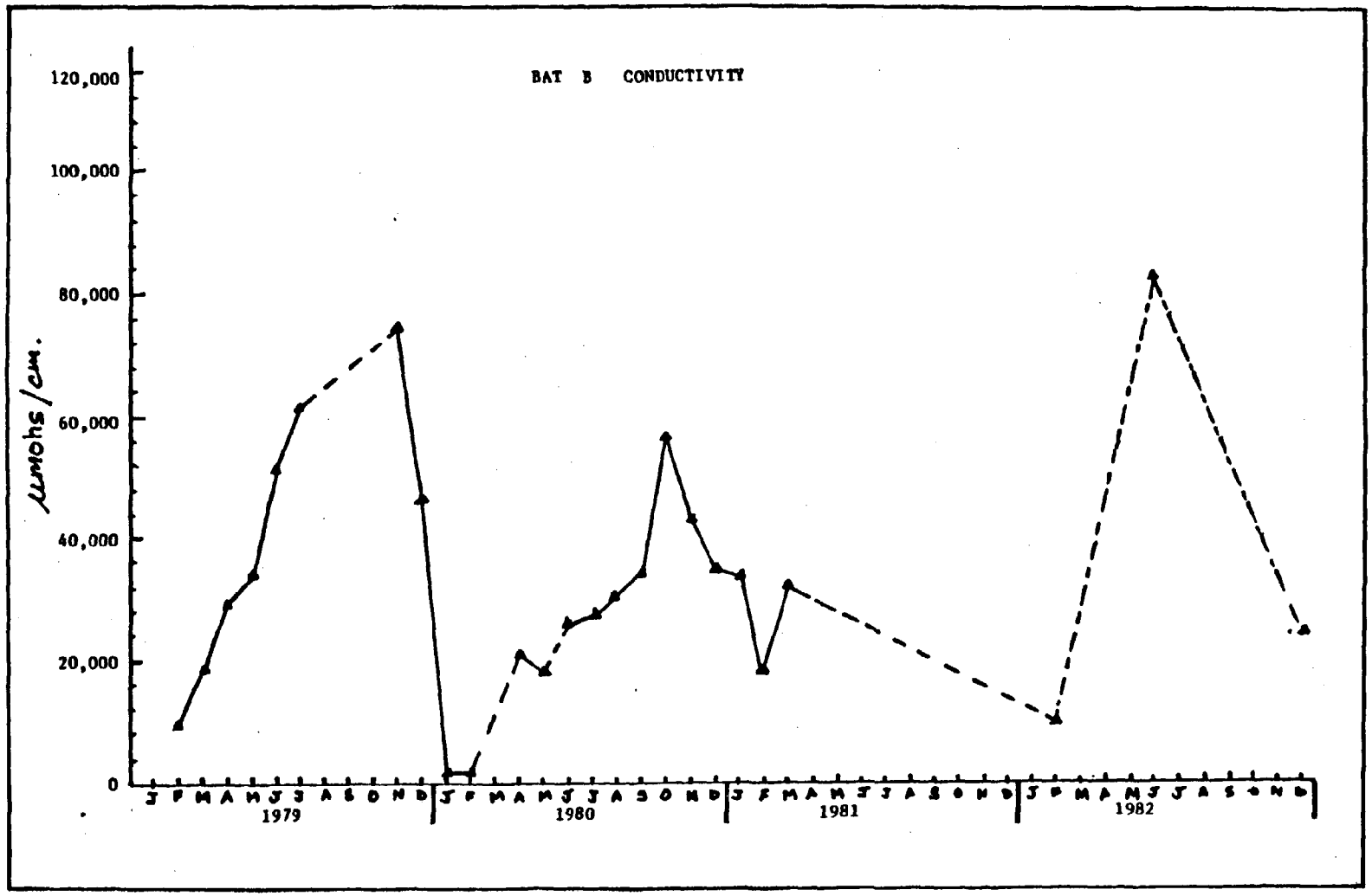


FIG.12B Batiquitos Lagoon; Conductivity data from Station B.

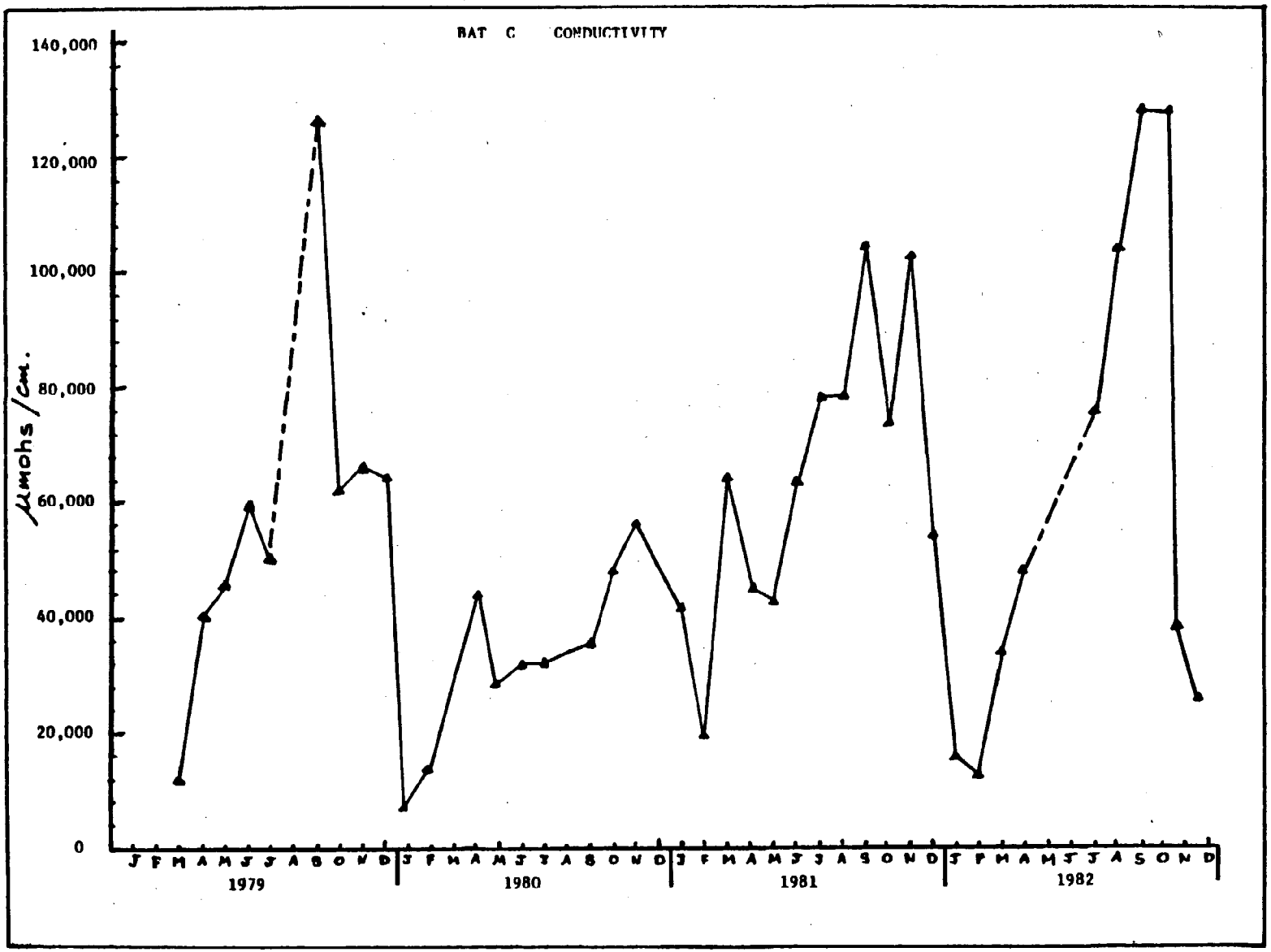
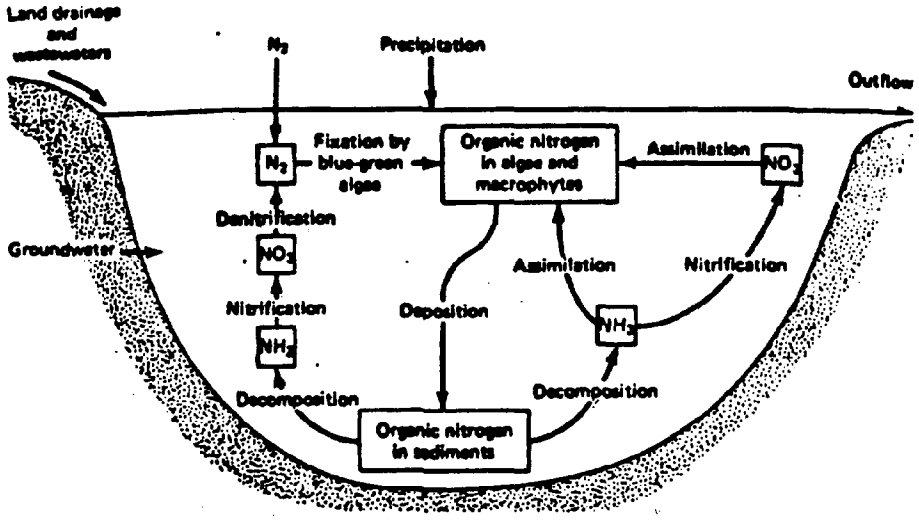
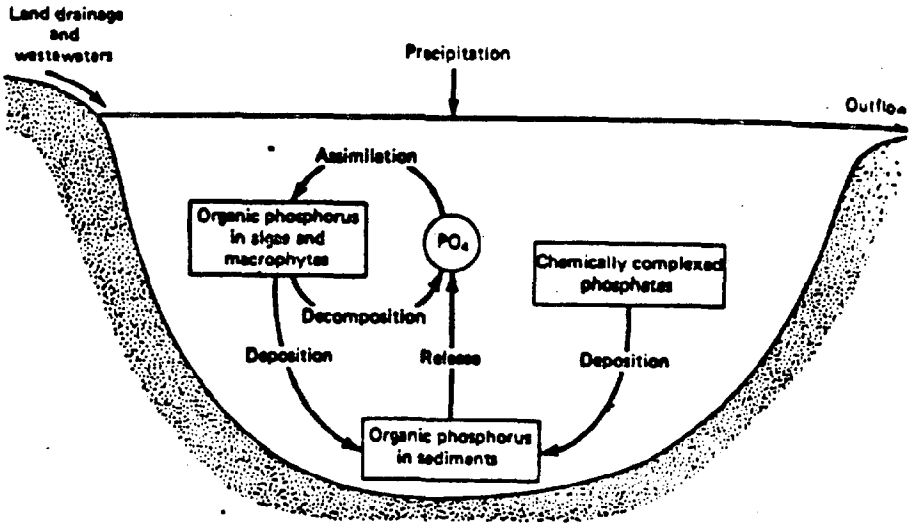


FIG. 12C Batiquitos Lagoon; Conductivity data from Station C.



NITROGEN CYCLING



PHOSPHORUS CYCLING

FIG.13

NITROGEN AND PHOSPHORUS CYCLES IN AN AQUATIC ENVIRONMENT (FROM HAMMER AND MACKICHAN, 1981)

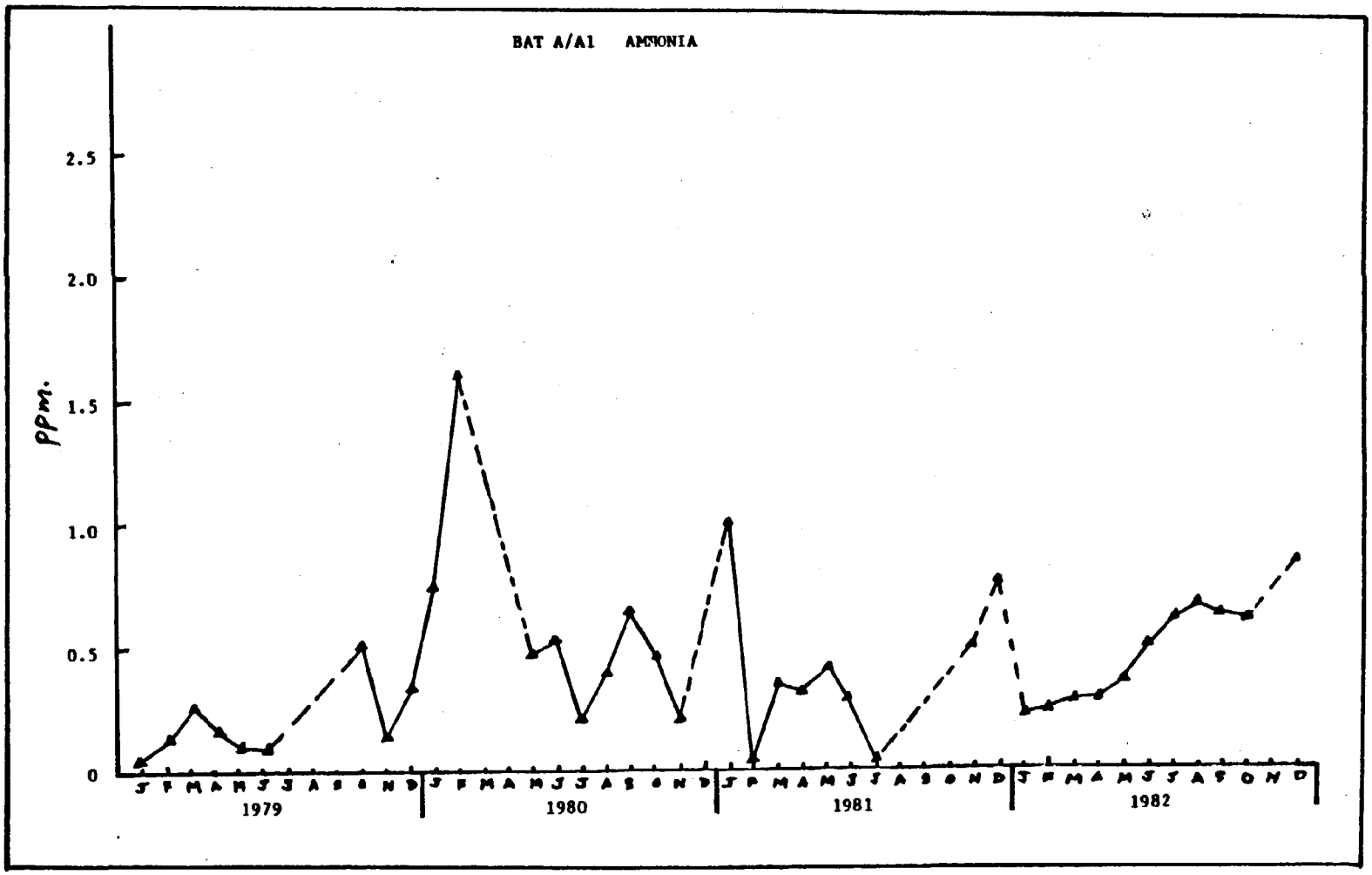


FIG. 11A Bataquitos Lagoon - Ammonia data from Station A/A1

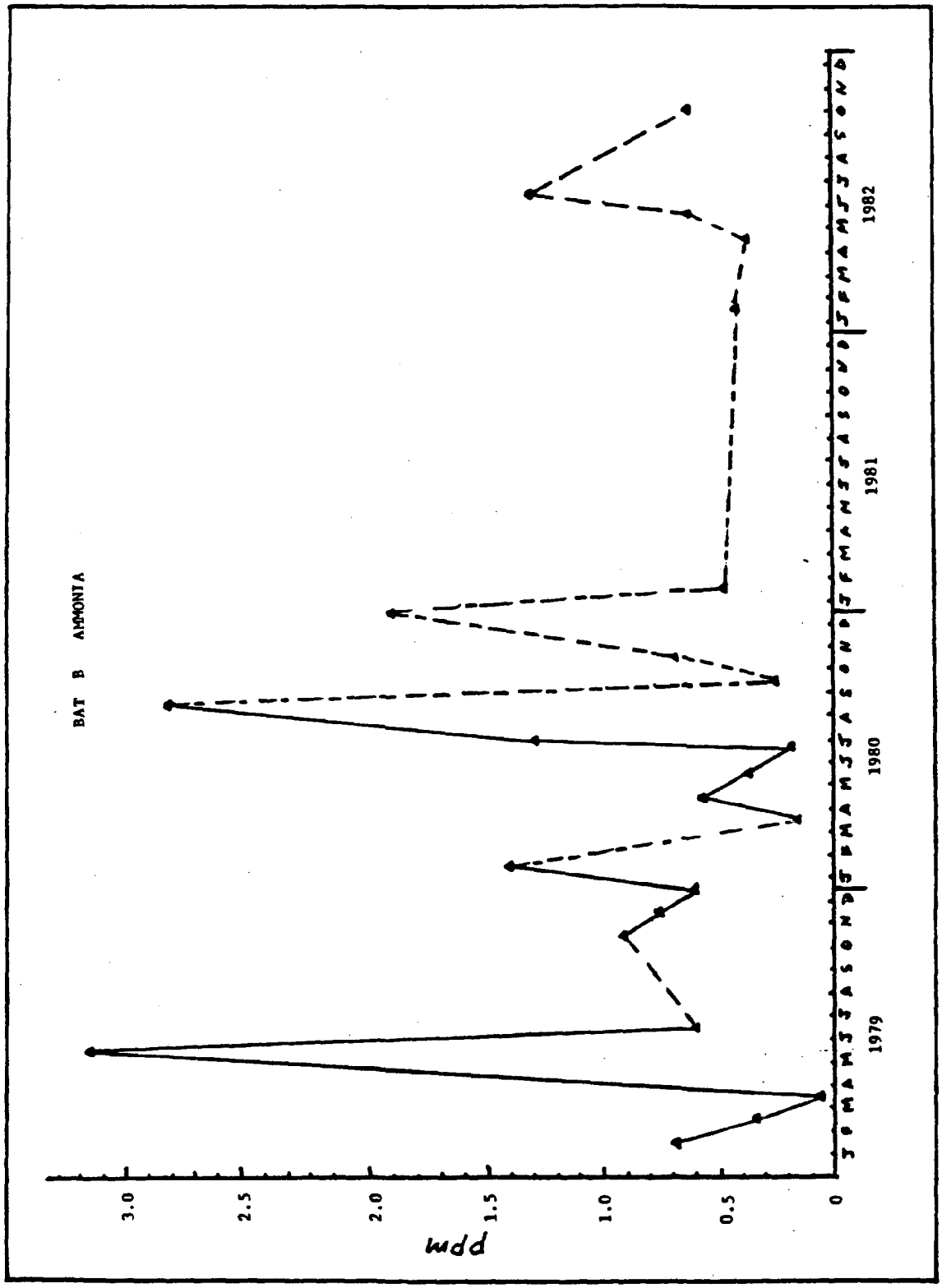


FIG 14B

Batiquitos Lagoon; Ammonia data from Station B.

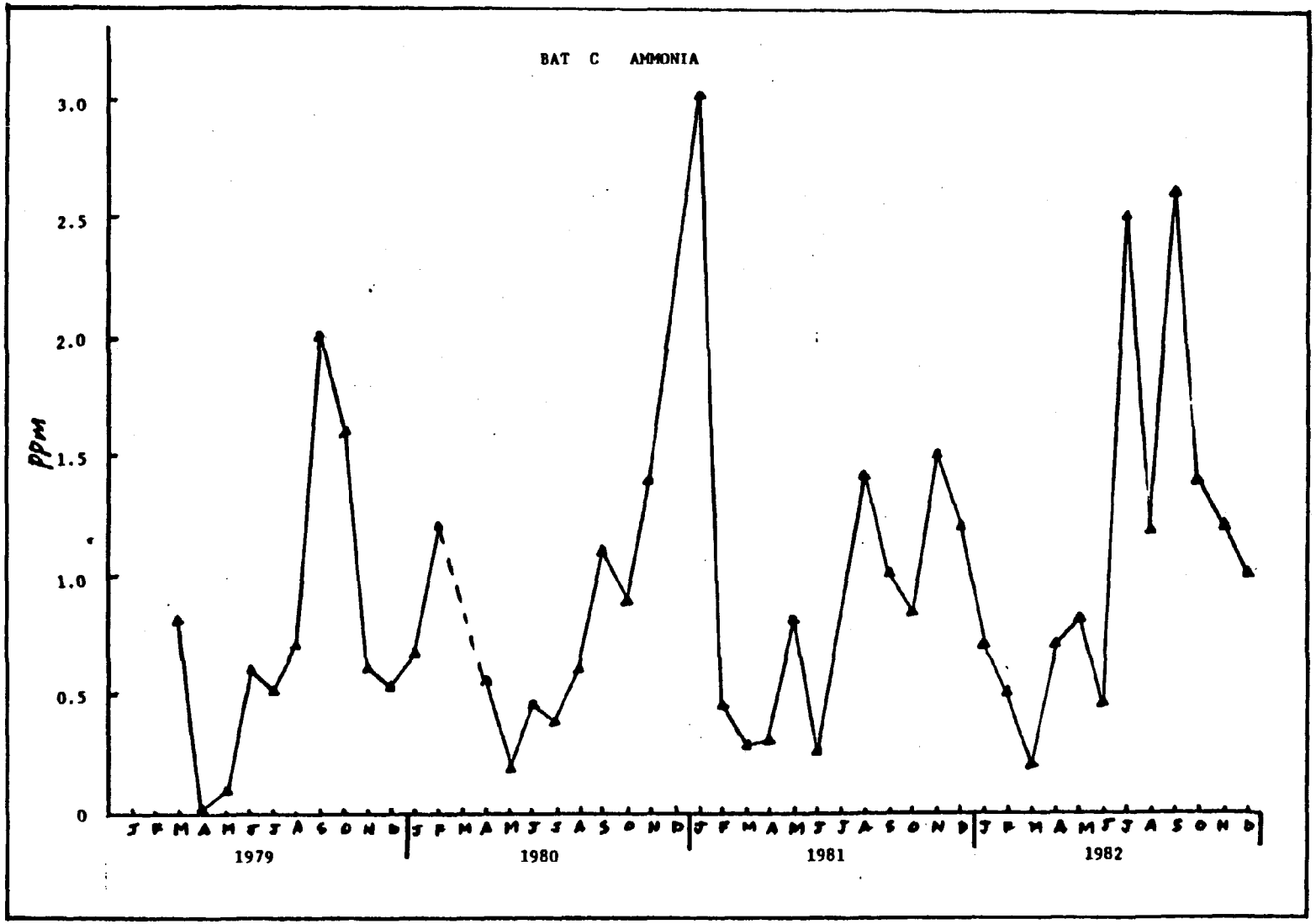


FIG. 14C Batiquitos Lagoon; Ammonia data from Station C.

the actual tidal prism of the lagoon had adequate capacity on the ebb flow to scour a channel through the beach and offset the effect of sand build-up in the channel from storm waves. However, since settlement of the area, the lagoon has experienced significant filling from sedimentation and constriction of water flows from the fills and bridges for Highways 101 & 5 and the railroad. These bridges now represent choke points to tidal inflows. Sedimentation has reduced the tidal prism of the lagoon to the point where the mouth rarely opens and not enough tidewater is able to enter and leave the lagoon to keep the mouth open. When the mouth does open due to high freshwater levels, tidal inflows now stop after a maximum of several days.

The Batiquitos Lagoon watershed consists of 52 square miles with the primary tributary being San Marcos Creek. A dam on San Marcos Creek impounds water into San Marcos Lake which acts as a silt basin for the upper portion of the creek. The remaining area below the dam is incised in a canyon until it spills out onto an alluvial plain which has been filled and developed for the La Costa Golf Course. Encinitas Creek is the other major tributary. Most of the floodplain of Encinitas Creek is covered with riparian forest and marsh which traps most of the heavy sediment carried by the creek.

Estimates of the average annual sedimentation rate into the lagoon show accumulation of 1-2 cm/year. Estimates of the sedimentation rates for San Marcos and Encinitas Creeks as well as the drainage ditches along I-5 at Piraeus and Eolus are given. Other tributaries around the lagoon either have sediment basins or are planned to have them. The primary sources of this sedimentation is erosion of graded development sites, agricultural areas, open, unvegetated land and creek channel erosion. Implementation of erosion control measures or Best Management Practices (BMPs) throughout the watershed could significantly decrease sediment entering the lagoon. Installation of sediment basins and preservation of the natural floodplain are also effective in lowering sediment input into the lagoon. New developments in the watershed should be designed such that peak stormflows leaving the site will not be increased.

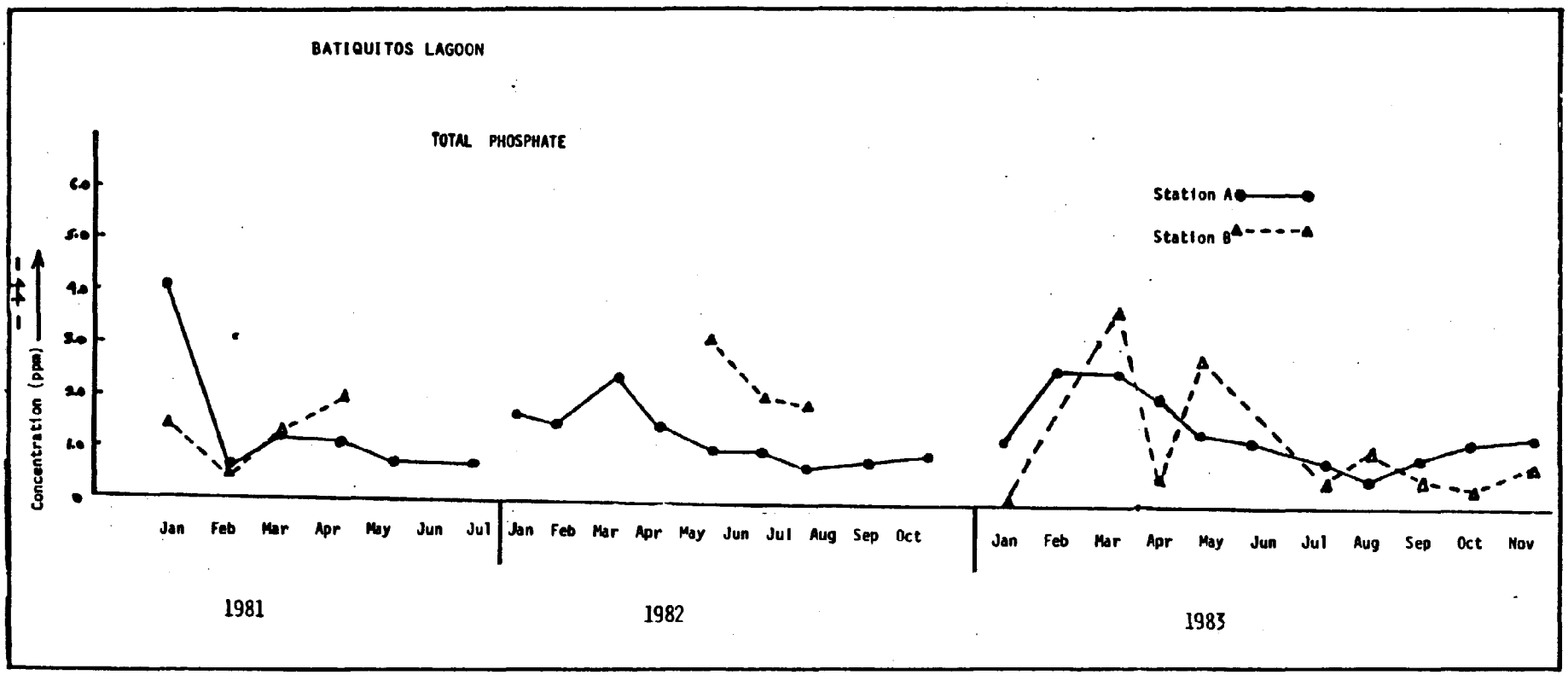


FIG. 15 Batiquitos Lagoon; Total Phosphate data.

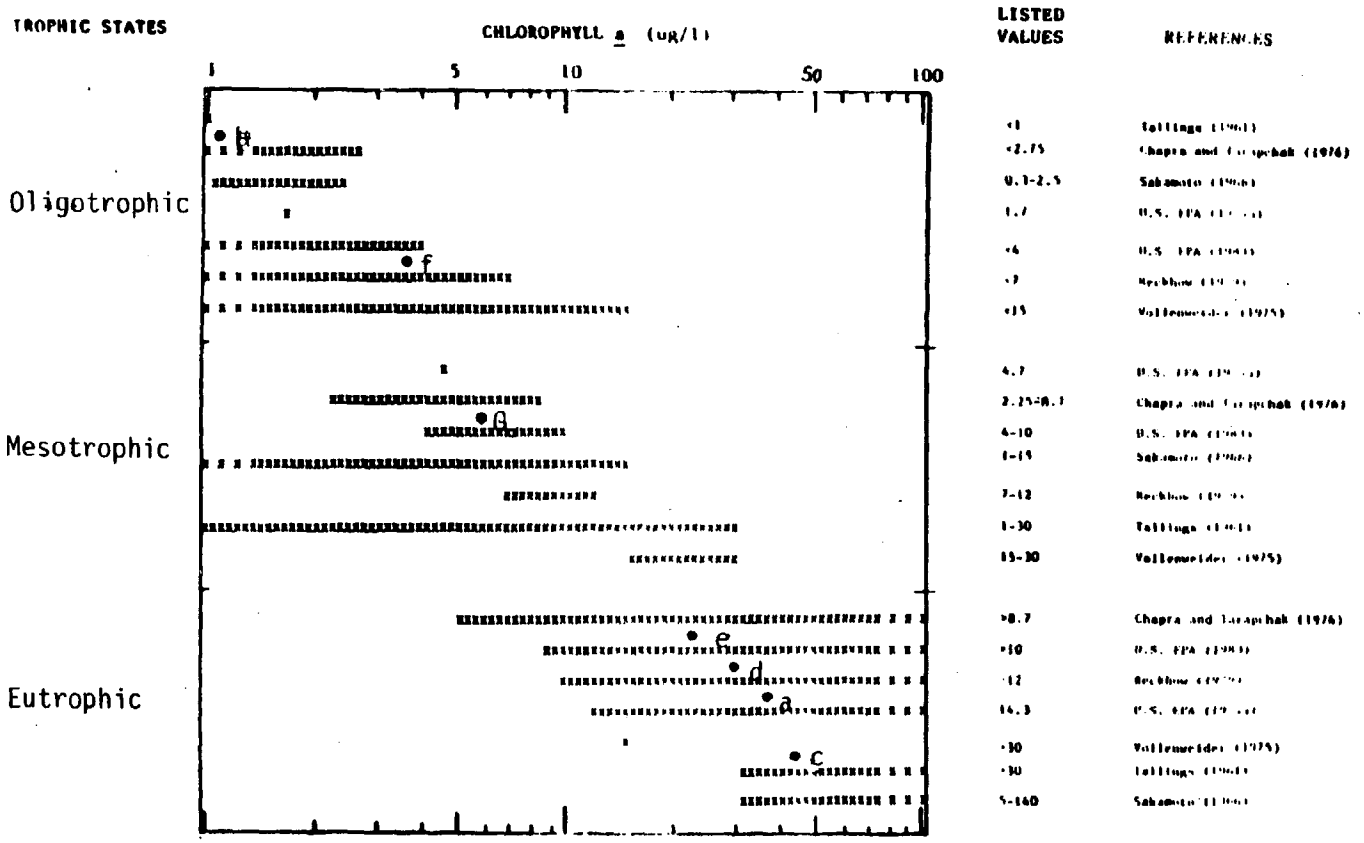


FIG. 16 **MAJOR TROPHIC STATE CLASSIFICATIONS BASED ON MEAN CHLOROPHYLL a CONCENTRATIONS. FOR COMPARISON, MEAN VALUES FOUND WITHIN SIX COASTAL LAGOONS[a/] ARE SHOWN.**

a/ The coastal lagoons are identified as: (a) = Buena Vista (BUV-C); (b) = Agua Hedionda (AGH-C); (c) = Batiquitos (BAT-C); (d) = San Elijo, western basin (SEL-B); (e) = San Elijo, eastern basin (SEL-A1); (f) = San Dieguito (SDI-B); and (g) = Los Penasquitos (PEN-B).

Taken from California Regional Water Quality Control Board , 1985. Draft A Review of Nutrient Standards for the Coastal Lagoons in the San Diego Region

NATURAL RESOURCES

INTRODUCTION

Batiquitos Lagoon is one of a series of coastal wetlands that dot the southern California coastline. These coastal wetlands are relatively small discrete units confined to the mouths of narrow river valleys and bays. Each lagoon or wetland has distinct characters and varied types and acreages of wetland habitats. Each of these wetlands has undergone changes due to human activities either around or in the wetland. No pristine examples of wetland systems remain in southern California.

This section reviews the natural resource information which currently exists for Batiquitos Lagoon. This existing information is relatively general in nature but does describe the habitat types at the lagoon and the level of wildlife use of these habitats. No additional monitoring of wildlife species was completed as part of this plan. This analysis is not intended to represent a comprehensive review and documentation of the current habitat values at the lagoon. Instead, it is a compilation of all the existing field data. Vegetation and habitat types were mapped using recent aerial photographs and maps were field checked. This section also includes a review of the regional significance of Batiquitos Lagoon in comparison to other San Diego County wetlands and their habitats.

Information Sources

The following discussion of the existing biological resources of Batiquitos Lagoon uses information taken from several sources including published documents (Mudie et al. 1976; Pacific Southwest Biological Services, Inc. 1982; Westec Services, Inc. 1983; MacDonald and Feldmeth 1985; Leucadia County Water District, 1985), unpublished accounts (Christmas bird counts, Least Tern and Belding's Savannah Sparrow nesting surveys, unpublished bird surveys), discussions with individuals familiar with lagoon resources (K. MacDonald, D. King, E. Copper, J. Oldenettle), and personal observations by the author, Ted Winfield.

BATIQUITOS LAGOON

Habitat Types

Batiquitos Lagoon contains six types of habitats: mud/sand/shallow water, emergent coastal salt marsh, brackish marsh, willow-dominated riparian forest, deep water and transitional border areas. Presently, large areas of mud/sand/shallow water dominate Batiquitos Lagoon. Based upon photo interpretation of an October, 1984 aerial photograph and field reconnaissance during August, 1985, the mud/sand/shallow water areas cover approximately 393 acres. During rare episodes of tidal flushing, a portion of this habitat type becomes intertidal and covered by shallow water for varying periods of time on a daily basis. During winter months and following storms, freshwater covers these flats. Depending upon the amount and timing of winter rains, water covers the mud/sand flat areas to various depths. As these waters evaporate, the mud/sand flat areas become exposed. The depth of water covering these mud/sand

flat areas varies greatly from year to year. In 1985, the lagoon had a few inches to one foot of water covering these flats in the winter and then dried out completely in summer. In contrast, during the winter of 1987, the lagoon ad 4 to 8 feet of water covering these flats and did not dry out in the summer.

Natural seeps are present along the edges of the lagoon especially in the east basin, and these seeps provide an additional source of water for the lagoon. During the summer and fall months, the combined waters of these seeps may form a shallow water area in the middle of the east basin. The extent and depth of the shallow water area is probably controlled by the rate of seepage and evaporation.

Marsh is present around the entire lagoon edge (Figure C) and comprises approximately 179 acres (Table 6). This acreage includes coastal salt marsh, brackish marsh, and riparian (willow)/brackish marsh areas. Most of the willow thickets are at the mouth of Encinitas Creek and several other north shore locations. Brackish marsh is found throughout the lagoon in areas of higher freshwater occurrence. Coastal salt marsh is found over most of the lagoon and is the most prevalent type of marsh habitat.

Open water areas account for approximately 29 acres of the lagoon (Table 6). The open water areas occur primarily in the middle and western end of the lagoon with small open water areas occurring along the San Marcos Creek channel. The open water area beneath Interstate 5 has probably resulted from scouring during flood flows. In general, the open water areas are coincident with the main channels in the western and middle areas of the lagoon.

The western basin (between the railroad causeway and Pacific Coast Highway) is a mixture of emergent marsh, primarily coastal salt marsh, shallow water or mud/sand flats, and open water. The western basin covers an area of approximately 25 acres. Of those 25 acres, open water comprises nearly 7 acres, marsh approximately 7 acres and shallow water or mud/sand flats about 11 acres (Table 6).

The middle basin (between Interstate 5 and the railroad causeway) is also dominated by shallow water or mud/sand flats (Figure C; Table 6) comprising approximately 69 percent of the total area of the middle basin. The remaining area in this basin is divided approximately equally between emergent marsh and open water. The open water area in the middle lagoon accounts for approximately 58 percent of the total open water area for Batiquitos Lagoon. Together the western and middle basin constitute the west lagoon.

The eastern basin (east lagoon) is by far the largest basin area, comprising nearly 78 percent of the total acreage of Batiquitos Lagoon. This basin is dominated by shallow water or mud/sand flats which cover over 308 acres or 66 percent of the east basin. The emergent marsh, totaling nearly 156 acres, is located primarily in the eastern third of the east basin and represents 87 percent of the total emergent marsh found in Batiquitos Lagoon. Deep water areas (Figure C), lie along the course of the San Marcos Creek and near the Interstate 5 bridge, and represent 1 percent of the total area of the east basin.

Table 6. ACRES OF EMERGENT MARSH, SAND/MUD/SHALLOW WATER (<12") AND OPEN WATER (>12") IN THE THREE BASINS OF BATIQUITOS LAGOON

	Basin			
Physical Habitat Type	West	Middle	East	Total
Emergent Marsh*	7	16	155*	178
Sand/Mud/Shallow Water (<12")	11	75	307	393
Open Water (>12")	7	18	4	29
TOTAL	25	109	466	600

*includes scattered riparian areas

Upland areas occur around the margins of the lagoon but have not been inventoried as part of this project. Roads and development occur along much of the lagoon periphery and serve to partially isolate the lagoon proper from surrounding upland areas and the wildlife that inhabits these upland areas.

Vegetation

The vegetation of Batiquitos Lagoon has been described in a number of papers or reports dating back to an initial paper by Purer (1942). Mudie et al. (1976) produced a report on the natural resources of Batiquitos Lagoon wherein they describe its vegetation communities. Pacific Southwest Biological Services (1982) mapped and briefly described the wetland and riparian vegetation of the eastern end of Batiquitos Lagoon. During a recent wetland boundary study performed in the east basin, MacDonald and Feldmeth (1985) described the wetland vegetation. Their observations were in close agreement with the descriptions presented by Pacific Southwest Biological Services. The following description of the vegetation was developed during a reconnaissance survey of the lagoon on August 1, 1985, supplemented by existing literature on Batiquitos Lagoon.

The marsh vegetation in the western basin is more or less restricted to the edges of the lagoon (Figure C) and is dominated by coastal salt marsh species, primarily common pickleweed (Salicornia virginica). Other salt marsh species are present and may be locally abundant. These species include alkali heath (Frankenia grandifolia), salt grass (Distichlis spicata), jaumea (Jaumea carnosa), alkali weed (Cressa truxillensis), two species of salt bush (Atriplex semibaccata, A. patula ssp hastata), and scattered hummocks of spiny rush (Juncus acutus). The introduced iceplant (Mesembryanthemum chilense) is also present, especially near the Coast Highway. Salt grass is particularly common as the primary invader of exposed sand flats and dunes. These two species and several others (sea rocket, sand verbena, see Appendix F) occur on sandier soils in the upper marsh and are typically associated with sand dunes.

Along the northern and southern boundary where the marsh is adjacent to the foot of the coastal bluffs, the presence of freshwater seeps has resulted in the growth of brackish marsh species such as cattails (Typha sp) and bulrush (Scirpus californicus, S. robustus) in conjunction with the characteristic coastal salt marsh species. Common pickleweed, alkali heath, and jaumea are robust in these areas, forming extensive and dense patches. The presence of freshwater appears to enhance the productivity of these typically salt marsh species.

The vegetation in the middle basin is more limited in distribution, being primarily confined to a narrow fringe around the middle basin (Figure C). The vegetative structure is similar to that observed in the western basin in that common pickleweed is the dominant vegetation with pockets of brackish marsh being present along the outer edge of the marsh near areas of seep.

Species characteristic of coastal salt marshes and, in particular, common pickleweed, dominate the marsh vegetation in the eastern basin of Batiquitos Lagoon. Locally other salt marsh species such as alkali heath, salt grass, and

jaumea may form nearly monotypic stands. Other species include glasswort (Salicornia subterminalis), Australian salt bush (Atriplex semibaccata), fat-hen (Atriplex patula ssp hastata), salt cedar (Monanthochloe littoralis), salt marsh daisy (Lasthenia glabrata), alkali weed, and spiny rush. In the vicinity of the seeps around Batiquitos Lagoon, and in the vicinity of the San Marcos and Encinitas creek channels, brackish marsh species such as cattail, and bulrush are common as are the coastal salt marsh species, especially common pickleweed. Curly dock (Rumex crispus) is common near the mouth of Encinitas Creek. In several areas such as the northeast corner of the lagoon the cover of salt marsh is sparse having been disturbed by off-road vehicles and other factors.

Stands of willows (Salix lasiolepis) are found at the mouth of Encinitas Creek in the east basin (Figure C), mixed with brackish marsh species. Smaller isolated stands of willows are also present around the northern margin of the east basin. Riparian habitat dominated by willows lines most of the floodplain of Encinitas Creek and its tributaries as well as certain areas of San Marcos Creek above the La Costa Golf Course and near the Rancho Santa Fe Road crossing. Willows also line the northern tributary of San Marcos Creek and the stream along Saxony Road. The extent of this riparian vegetation is depicted in Figures B-1 to B-4.

Wildlife

The abundance and variety of wildlife in the lagoon is a response to the extent, type and quality of habitat types. Batiquitos Lagoon has a variable water regime which has changed significantly in the past 50 years. The lagoon has lost its tidal characteristics. A shallow water lagoon some winters, the lagoon may attract hundreds of migratory birds. The following year, the lagoon may fill to a depth of eight feet and provide little feeding habitat for the same species seen the year before. As these yearly changes affect the types of animals visiting the lagoon, seasonal changes in water temperatures and water quality determine what aquatic species will inhabit the lagoon water. Since both annual and seasonal variations are not well studied at the lagoon, no single profile of wildlife values readily emerges from the existing information. The following discussion summarizes the data collected on animal use at the lagoon and discusses how these variations in aquatic conditions affect wildlife use.

Mammals and Reptiles.

As indicated in Mudie et al. (1976), the studies on mammals and reptiles in Batiquitos Lagoon are scarce; those that are available are primarily restricted to field observations of tracks, scat, burrows, and direct sightings. The common species of mammals listed by Mudie et al. (1976) include black-tailed jackrabbit, desert cottontail, beechy ground squirrel, house mouse, coyote, striped skunk, raccoon, and feral dogs. The gopher snake was the only reptile recorded for the lagoon area although the western fence lizard, side-blotched lizard, and southern alligator lizard are probably also present. The mule deer and long-tailed weasel are listed as occasional visitors to the lagoon proper.

Fish and Invertebrates

Data on the fish and invertebrate fauna of Batiquitos Lagoon are limited. The available data for Batiquitos Lagoon (and other similar lagoons in San Diego County), indicate that on the average, a limited number of species of fish and invertebrates exist in the lagoon environment. The diversity and abundance of fish in Batiquitos Lagoon is directly related to the occurrence of open tidal circulation. Marine species can only enter the lagoon when the mouth naturally opens during large floods or is manually opened. Then they are trapped within the lagoon once the mouth closes. As water levels drop and water temperature increases, most marine species are unable to survive. The continued existence of these species during summer months is directly dependent upon the quality of the water (salinity, dissolved oxygen, temperature).

Observations presented in Mudie et al. (1976) indicate that mosquito fish, mullet, mudsuckers, and bay topsmelt are common and California killifish abundant in Batiquitos Lagoon. This species list probably represents the fish found in the lagoon during periods of no tidal exchange. Recently, MacDonald and Feldmeth (1985) surveyed the fish at four stations in Batiquitos Lagoon during July, 1984. Since the lagoon has been closed to tidal circulation for the two years previous to this survey, the species observed represent resident species. In the west lagoon, just east of the Pacific Coast Highway, they found the California killifish, topsmelt, arrow goby, and mudsucker to be present. In addition, they observed several large stripped mullet and a large California halibut. Further east, in the open water area in the middle basin, they found the same four species. At both stations, the California killifish was most abundant, but the mudsucker showed an appreciable increase in abundance at the second station. In the east lagoon, near the Interstate 5 bridge, MacDonald and Feldmeth (1985) found the mudsucker to be most abundant. Topsmelt and arrow goby were not caught and the California killifish was far less abundant than at the two western stations. They also caught several mosquito fish. Discussion with a commercial bait fisherman indicated that the staghorn sculpin had been present sometime prior to the 1984 study. The fourth station was located in the freshwater portion of San Marcos Creek just downstream from the El Camino Real Bridge. This station yielded juvenile blue gill in addition to bullhead, mosquito fish, and largemouth bass.

During this survey, MacDonald and Feldmeth (1985) found the lagoon water to be highly saline, with the lowest salinities occurring at the westernmost station (40 to 43 parts per thousand-[ppt]) and the highest salinities at the station just east of the Interstate 5 bridge (54 ppt). The water temperature also increased west to east, ranging from 27^{0} C (west) to 32^{0} C (east). The easternmost station was essentially freshwater (1 to 2 ppt) but had a high range of temperatures (17^{0} to 30^{0} C). Low levels of dissolved oxygen in summer months also create harsh conditions for fish survival. These extreme water quality conditions limit the diversity and numbers of fish species able to survive in the lagoon.

The presence and abundance of marine crustaceans (e.g. crabs) and benthic invertebrates (e.g. worms, clams or other animals which inhabit the bottom muds of the lagoon) as well as phytoplankton and zooplankton (algae and small animals which live in the water column) is related to tidal flow. During

periods of closure, especially for extended periods, there will be a die-off of benthic invertebrates as suggested in the work of Miller (1966), Bradshaw (1968), and others in nearby Los Penasquitos Lagoon. Once the lagoon is open, the benthic invertebrates will reestablish themselves. However, at Batiquitos Lagoon, the extended periods of closure limits the occurrence of benthic invertebrates. Mudie et al. (1976) reported populations of ghost shrimp and two species of polychaete worms in the western basin near the entrance of the lagoon. The striped shore crab was also reported to be common near the mouth of the lagoon. Insects--primarily water boatman and midge larvae--were common in the east basin. Large blooms of aquatic insects in the lagoon during winter months provide the food base which attracts migratory birds.

During their July 1984 survey of the lagoon, MacDonald and Feldmeth (1985) recorded observations on the invertebrates observed at their fish collection stations. Aquatic invertebrates were sampled using dip nets, but they collected no bottom cores and sampled no benthic organisms. The salt water boatman (Corixa reticulata) was found in large numbers at the three western stations where the waters were hypersaline. At the freshwater station in San Marcos Creek, they collected a more diverse fauna which included hemipterans (families Corixidae and Notenectidae), midges (Chironomidae), dragonfly nymphs (Suborder Anisoptera), damselfly nymphs (Suborder Zygoptera), and a species of freshwater snail (Physa sp). Abundant and seasonal variation in aquatic insects is undoubtedly related to seasonal changes in water depth, salinity and quality.

Phytoplankton and zooplankton also exhibit patterns of abundance related to the presence of tidal circulation in coastal lagoons. Neither of these aquatic components have been censused at Batiquitos Lagoon. During the rare periods of open tidal circulation at Batiquitos Lagoon, plankton species composition in the western part of the lagoon is probably similar to that of the nearby coastal marine waters. Species composition in more interior waters would be more variable depending upon salinity, temperature, and rate of exchange with ocean water. During periods of closure (no tidal circulation), there is probably a shift in species composition and production. Phytoplankton blooms may occur at Batiquitos Lagoon when the mouth is closed as has been documented in unpublished data by J. Boland for Los Penasquitos Lagoon. Data are also lacking for zooplankton populations in Batiquitos Lagoon, but in nearby Los Penasquitos Lagoon, Sertig (personal communication) found that Pseudodiaptomus euryhalinus became the dominant form during periods of lagoon closure. During periods of open tidal circulation, the estuarine species Acartia californica was common and P. euryhalinus was a minor component (Bradshaw, 1968).

The lack of regular tidal flushing in Batiquitos Lagoon limits the export of nutrients from the lagoon to the nearshore waters. Much of the primary productivity in the lagoon remains within the lagoon system excepting the occasional release of water from the lagoon to the ocean. Birds, mammals and other large animals indirectly export a portion of the lagoons productive base through their consumption of insect, invertebrate and plant materials and movements out of the lagoon area. Overall, in its present condition, the lagoon is a closed system and does not substantially contribute to the primary productivity of nearshore waters.

Birds

The most obvious wildlife component in Batiquitos Lagoon is the bird fauna, particularly shorebirds and waterfowl. A number of surveys have been performed at Batiquitos Lagoon recording bird use of the lagoon, but few of the data have been summarized or published. The following discussion is based upon several unpublished data sets which were supplied by Mr. David King, Ms. Anne Olmsted, and Mr. Jerry Oldenettle. These data sets include the following: Christmas Count Data for Batiquitos Lagoon, Buena Vista Lagoon, Aqua Hedionda Lagoon, 1975-1984; survey of shorebirds along the beach section of Batiquitos Lagoon for the years 1969-70, 1970-71, 1971-72; monthly survey of birds at Batiquitos Lagoon, undated but probably 1970 (D. King, pers. comm.); periodic survey of birds at Batiquitos Lagoon, October 1976 - February 1979.

The seasonal use pattern of Batiquitos Lagoon by shorebirds and waterfowl is generally similar to the pattern reported for other southern California coastal lagoons. During the late summer and early fall, migrant shorebirds on their way south begin to arrive and use exposed sand/mud flats for roosting and feeding. During the late fall and winter months, when the coastal lagoons generally contain more water due to rainfall and runoff, waterfowl species dominate the lagoon fauna. During the spring, shorebird numbers usually increase as the migrants return to the north. This general pattern for Batiquitos Lagoon is shown in Figures 17 and 18. Figure 18 is especially informative since it covers the last part of a dry year (1976) and a wet year (1977) and demonstrates the effect that the aerial extent of water in Batiquitos Lagoon has on the local bird fauna. The high shorebird count for October, 1976 is due primarily to the presence of large numbers of wintering Northern Phalaropes (Table 7). Water levels during this period were not high and the east lagoon was essentially dry. Because of 1976-1977 winter rains, the lagoon was full of water during the winter and remained relatively full through the remainder of 1977. Waterfowl numbers were high during the spring of 1977 and again in the fall and winter of 1977. The fall peak of shorebirds is evident and most of the shorebirds occurred in the east lagoon (Table 7). The lagoon was again full in June, 1978 and waterfowl species were most abundant. The increased shorebird numbers in February 1979 were due primarily to the occurrence of large numbers of American Avocets in the west lagoon (Table 7).

The use of the east lagoon by shorebirds and waterfowl is generally greater than use of the west lagoon (Figure 19; Table 7). The exception usually results from the occurrence of a large number of a single species, such as the occurrence of large numbers of Southern Phalaropes in the west lagoon during the fall of 1976 and early winter of 1977 (Table 7). The 11 species of waterfowl and 15 species of shorebirds listed in Table 7 generally account for over 95 percent of the total number of individuals of each group observed in Batiquitos Lagoon during the field surveys assessed.

Waterfowl

The most common waterfowl species in terms of number of individuals include the Pintail, Green-winged Teal, Northern Shoveler, and Ruddy Duck. The Pintail is an abundant migrant and winter visitor to San Diego County and is the county's

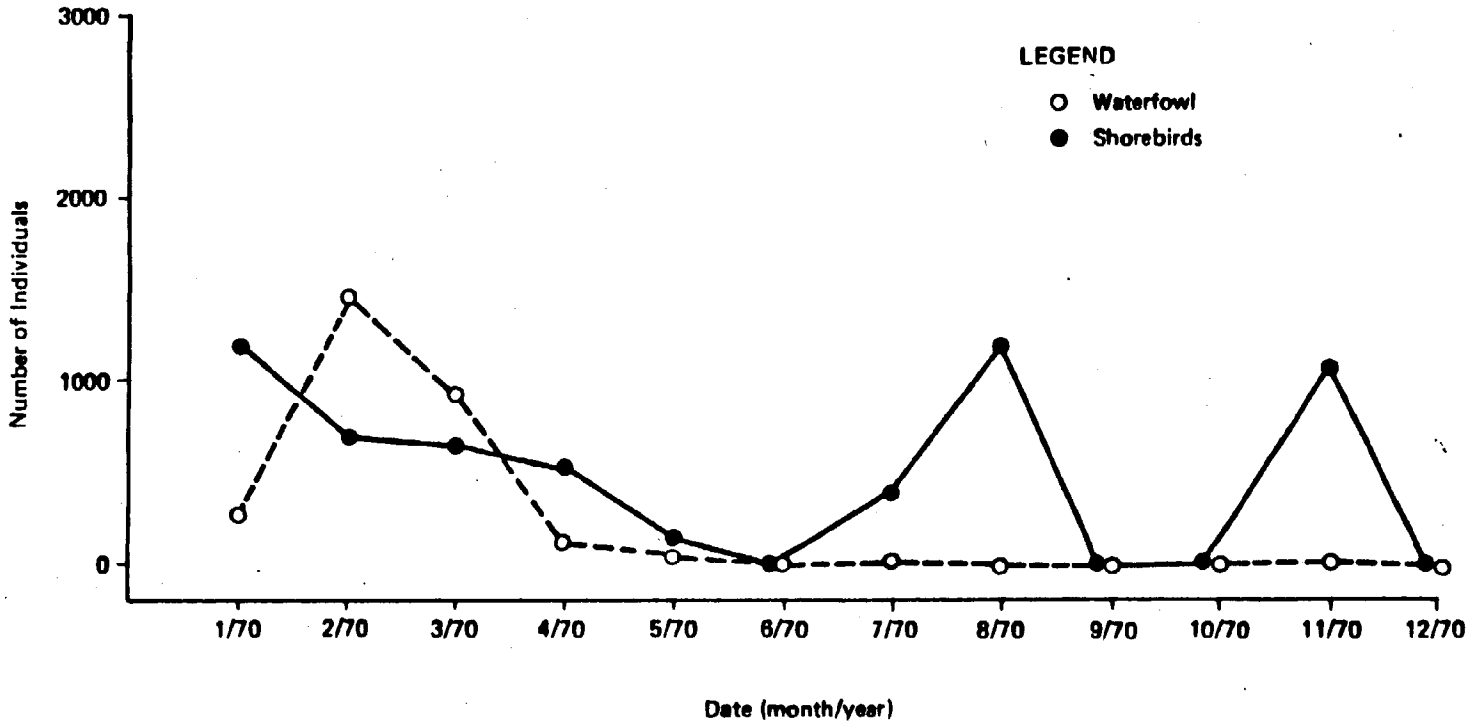


FIG. 17

TOTAL NUMBER OF INDIVIDUALS OF SHOREBIRDS AND WATERFOWL AT BATIQUITOS LAGOON, 1970(?)

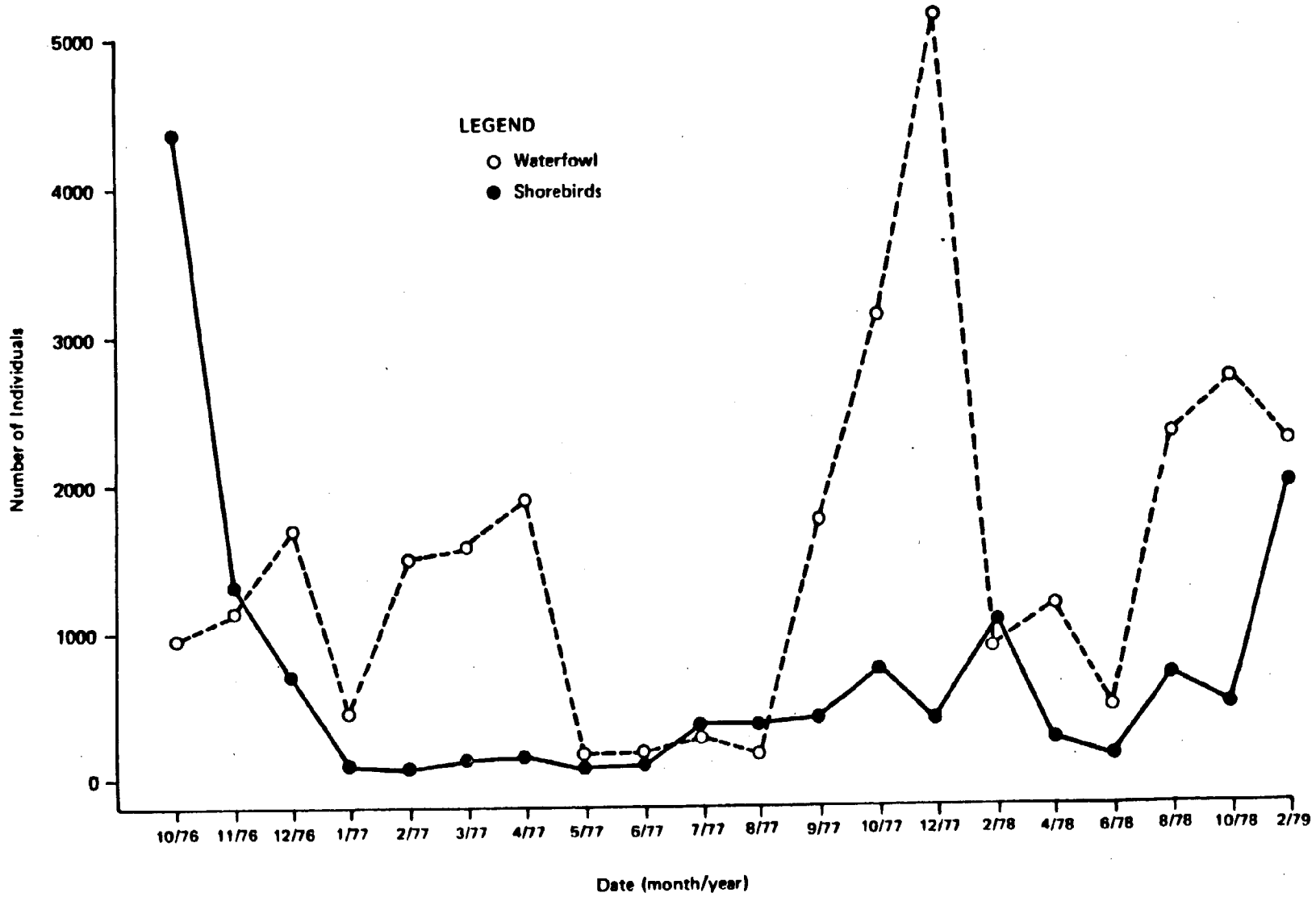


FIG. 18

TOTAL NUMBER OF INDIVIDUALS OF SHOREBIRDS AND WATERFOWL OBSERVED AT BATIQUITOS LAGOON BETWEEN OCTOBER 1976 AND FEBRUARY 1979

Table 7 RESULTS OF BIRD SURVEYS OF BATIQUITOS LAGOON BETWEEN OCTOBER 1976 AND FEBRUARY 1979[a]

Species	Location[b]	Oct. 1976			Nov. 1976			Dec. 1976			Jan. 1977			Feb. 1977			Mar. 1977			Apr. 1977		
		E	W	T	E	W	T	E	W	T	E	W	T	E	W	T	E	W	T			
Mallard		9	1	10	3	5	8	0	0	0	4	0	4	4	1	5	0	13	13	15	15	27
Gadwall		6	0	6	12	0	12	0	3	3	22	2	24	4	2	6	7	4	11	22	0	22
Pintail		408	346	754	521	181	702	471	258	719	61	4	65	70	58	128	44	44	88	13	1	14
Green-winged Teal		116	10	126	292	0	292	257	2	259	26	4	30	20	5	25	10	4	14	47	1	48
Cinnamon Teal		4	10	14	9	0	9	5	0	5	3	8	11	57	12	69	47	54	101	135	97	232
American Wigeon		0	6	6	0	0	0	0	0	0	12	8	20	24	12	36	14	24	38	4	60	64
Northern Shoveler		5	21	26	12	2	14	636	6	642	200	34	234	620	109	729	405	422	827	885	69	954
Redhead		0	0	0	0	0	0	0	0	0	0	0	0	35	0	35	8	7	15	30	13	43
Lesser Scaup		0	0	0	0	43	43	0	30	30	1	1	1	7	8	15	80	0	80	52	0	52
Bufflehead		0	0	0	0	6	6	0	5	5	3	0	3	9	0	9	28	25	53	4	50	54
Ruddy Duck		0	17	17	0	21	21	2	13	15	10	13	23	435	0	435	305	39	344	355	24	379
TOTAL		548	411	959	849	258	1107	1371	317	1688	341	73	414	1285	207	1492	948	636	1584	1562	27	1889
Semipalmated Plover		27	9	36	15	5	20	12	1	13	0	0	0	3	0	3	2	0	2	2	0	2
Snowy Plover		5	0	5	10	0	10	3	1	4	0	0	0	0	0	0	2	0	2	6	0	6
Killdeer		32	14	46	30	11	41	32	3	35	5	4	9	14	1	15	25	0	25	13	1	14
Black-bellied Plover		12	8	20	4	4	8	0	0	0	0	0	0	0	0	0	22	0	22	6	0	6
Willet		12	20	32	4	9	13	7	7	14	12	0	12	0	1	1	2	2	4	2	3	5
Least Sandpiper		6	34	40	50	51	101	15	13	28	0	2	2	3	0	3	2	9	11	12	0	12
Dowitcher sp.		25	5	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-billed Dowitcher		0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	9	0	9	0	0	0
Long-billed Dowitcher		0	0	0	34	0	34	7	0	7	0	0	0	0	0	0	0	0	0	10	0	10
Western Sandpiper		39	176	215	580	37	617	60	12	72	8	3	11	7	0	7	7	0	7	27	0	27
Marbled Godwit		0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	2	0	2
Sanderling		0	16	16	22	96	118	18	70	88	0	3	3	18	5	23	11	23	34	0	9	9
American Avocet		22	10	32	4	0	4	9	0	9	11	0	11	4	0	4	8	4	12	9	0	9
Black-necked Stilt		30	29	59	64	26	90	40	11	51	3	0	3	0	0	0	1	2	3	24	20	44
Wilson Phalarope		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6
North Phalarope		62	3793	3855	7	220	227	0	330	330	0	20	20	0	0	0	0	0	0	0	0	0
TOTAL		272	4114	4386	824	462	1286	203	448	651	39	35	74	49	7	56	91	40	131	113	39	152
Peeps		290	0	290	900	0	900	420	0	420	5	0	5									

Table 7 RESULTS OF BIRD SURVEYS OF BATIQUITOS LAGOON BETWEEN OCTOBER 1976 AND FEBRUARY 1979[a] (continued)

Species	Location[b]	May 1977			June 1977			July 1977			Aug. 1977			Sept. 1977			Oct. 1977			Dec. 1977		
		E	W	T	E	W	T	E	W	T	E	W	T	E	W	T	E	W	T			
Mallard		19	10	29	21	5	26	39	45	84	46	10	56	19	5	24	3	0	3	6	0	6
Gadwall		18	2	20	5	0	5	0	0	0	0	16	16	12	0	12	2	0	2	6	0	6
Pintail		1	5	6	0	3	3	15	0	15	2	0	2	1000	0	1000	2150	303	2453	3732	29	3761
Green-winged Teal		3	0	3	0	0	0	0	0	0	0	0	0	62	0	62	41	0	41	46	2	48
Cinnamon Teal		19	6	25	10	0	10	0	0	0	2	0	2	60	0	60	1	2	3	5	1	6
American Wigeon		0	2	2	0	0	0	0	0	0	0	0	0	30	0	30	92	0	92	43	11	54
Northern Shoveler		3	0	3	2	0	2	0	0	0	3	0	3	467	0	467	185	0	185	881	147	1028
Redhead		0	4	4	45	8	53	13	0	13	16	6	22	16	0	16	0	0	0	30	0	30
Lesser Scaup		0	0	0	2	0	2	3	0	3	0	0	0	0	0	0	0	3	3	30	0	30
Bufflehead		2	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruddy Duck		29	30	59	61	30	91	56	90	146	18	54	72	61	48	109	111	224	335	130	35	165
TOTAL		94	59	153	147	46	193	126	135	261	87	86	173	1727	53	1780	2585	532	3117	4909	225	5134
Semipalmated Plover		1	0	1	2	0	2	0	0	0	11	0	11	12	1	13	31	15	46	10	0	10
Snowy Plover		6	0	6	24	0	24	24	7	31	11	0	11	0	0	0	8	0	8	0	0	0
Killdeer		11	1	12	20	4	24	13	5	18	30	3	33	8	12	20	44	25	69	50	1	51
Black-bellied Plover		3	0	3	0	0	0	0	0	0	1	0	1	0	6	6	0	61	61	0	1	1
Willet		0	0	0	0	6	6	0	0	0	0	0	0	0	26	26	0	0	0	2	0	2
Least Sandpiper		0	0	0	0	0	0	41	0	41	0	0	0	46	23	69	1	25	26	3	15	18
Dowitcher sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	0	46	16	11	27
Short-billed Dowitcher		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	22	0	0	0
Long-billed Dowitcher		0	0	0	0	0	0	25	0	25	2	0	2	24	15	39	30	12	42	6	0	6
Western Sandpiper		2	0	2	0	0	0	82	0	82	76	0	76	74	5	79	282	20	302	230	3	233
Marbled Godwit		0	0	0	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Sanderling		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	2	0	2
American Avocet		18	0	18	18	2	20	11	11	22	12	0	12	38	0	38	34	0	34	30	0	30
Black-necked Stilt		10	2	12	13	34	47	26	70	96	116	28	144	56	20	76	18	20	38	5	0	5
Wilson Phalarope		0	0	0	2	0	2	2	0	2	45	12	57	0	0	0	0	0	0	0	0	0
North Phalarope		0	0	0	0	0	0	1	0	1	0	0	0	0	29	29	0	0	0	0	0	0
TOTAL		51	3	54	79	46	125	230	93	323	304	43	347	258	137	395	516	198	714	354	31	385
Peeps								20	0	20							340	0	340			

Table 7 RESULTS OF BIRD SURVEYS OF BATIQUITOS LAGOON BETWEEN OCTOBER 1976 AND FEBRUARY 1979[a] (concluded)

Species	Location[b]	Feb. 1978			Apr. 1978			June 1978			Aug. 1978			Oct. 1978			Jan. 1979			Feb. 1979		
		E	W	T	E	W	T	E	W	T	E	W	T	E	W	T	E	W	T	E	W	T
Mallard		7	1	8	8	51	59	58	3	61	22	16	38	1	9	10		10	2	5	7
Gadwall		0	0	0	5	1	6	15	3	18	0	0	0	4	0	4		6	10	0	10
Pintail		150	74	224	2	2	4	0	0	0	2200	0	2200	900	156	1056		60	17	50	70
Green-winged Teal		10	14	24	13	0	13	0	0	0	2	0	2	15	2	17		35	238	28	266
Cinnamon Teal		65	30	95	60	6	66	37	0	37	12	0	12	3	18	21		10	57	19	76
American Wigeon		0	1	1	0	0	0	0	0	0	0	0	0	124	0	124		50	0	0	0
Northern Shoveler		336	2	338	635	57	682	3	0	3	15	0	15	600	68	668		900	1326	128	1454
Redhead		6	26	32	4	59	63	27	27	54	3	5	8	22	3	25		4	0	0	0
Lesser Scaup		20	41	61	5	0	5	0	0	0	0	0	0	0	0	0		6	0	15	15
Bufflehead		0	41	41	3	0	3	0	0	0	0	0	0	0	0	0		15	0	0	0
Ruddy Duck		2	40	42	233	43	276	194	61	255	20	48	68	400	360	760		700	196	150	346
TOTAL		596	270	866	968	219	1187	334	94	428	2274	69	2343	2069	616	2685		1796	1846	395	2241
Semipalmated Plover		16	27	43	9	0	9	0	0	0	0	3	3	6	7	13		2	20	7	27
Snowy Plover		4	0	4	8	0	8	5	0	5	0	0	0	0	0	0		0	15	0	15
Killdeer		25	24	49	11	0	11	22	3	25	11	15	26	43	19	62		20	101	10	111
Black-bellied Plover		0	33	33	2	0	2	0	0	0	0	0	0	0	2	2		2	42	5	47
Willet		0	7	7	0	2	2	0	0	0	0	24	24	0	64	64		0	0	8	8
Least Sandpiper		27	2	29	0	0	0	0	0	0	36	12	48	8	12	20		0	67	2	69
Dowitcher sp.		43	0	43	0	0	0	0	0	0	12	18	30	0	9	9		0	0	0	0
Short-billed Dowitcher		30	162	192	2	0	2	0	0	0	15	0	15	0	8	8		0	1	0	1
Long-billed Dowitcher		0	0	0	5	0	5	0	0	0	2	0	2	48	4	52		3	269	207	476
Western Sandpiper		200	0	200	96	0	96	0	0	0	88	4	92	24	20	44		0	397	48	445
Marbled Godwit		0	10	10	0	0	0	0	0	0	0	2	2	3	0	3		1	0	22	22
Sanderling		25	0	25	10	0	10	0	0	0	0	0	0	50	1	51		0	28	96	124
American Avocet		97	239	336	19	0	19	35	3	38	52	0	52	79	2	81		0	249	341	590
Black-necked Stilt		42	24	66	21	39	60	27	44	71	191	25	216	8	6	14		15	18	40	58
Wilson Phalarope		0	0	0	0	0	0	0	0	0	50	95	145	0	0	0		0	0	0	0
North Phalarope		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
TOTAL		509	528	1037	183	41	224	89	50	139	457	198	655	269	154	423		43	1207	786	1993
Peeps		745	300	1045										200	0	200			1350	50	1400

[a] Source: unpublished survey data from Mr. David King, Solana Beach, California.

[b] Location: E = eastern lagoon (east of I-5), W = western lagoon (west of I-5), T = total lagoon

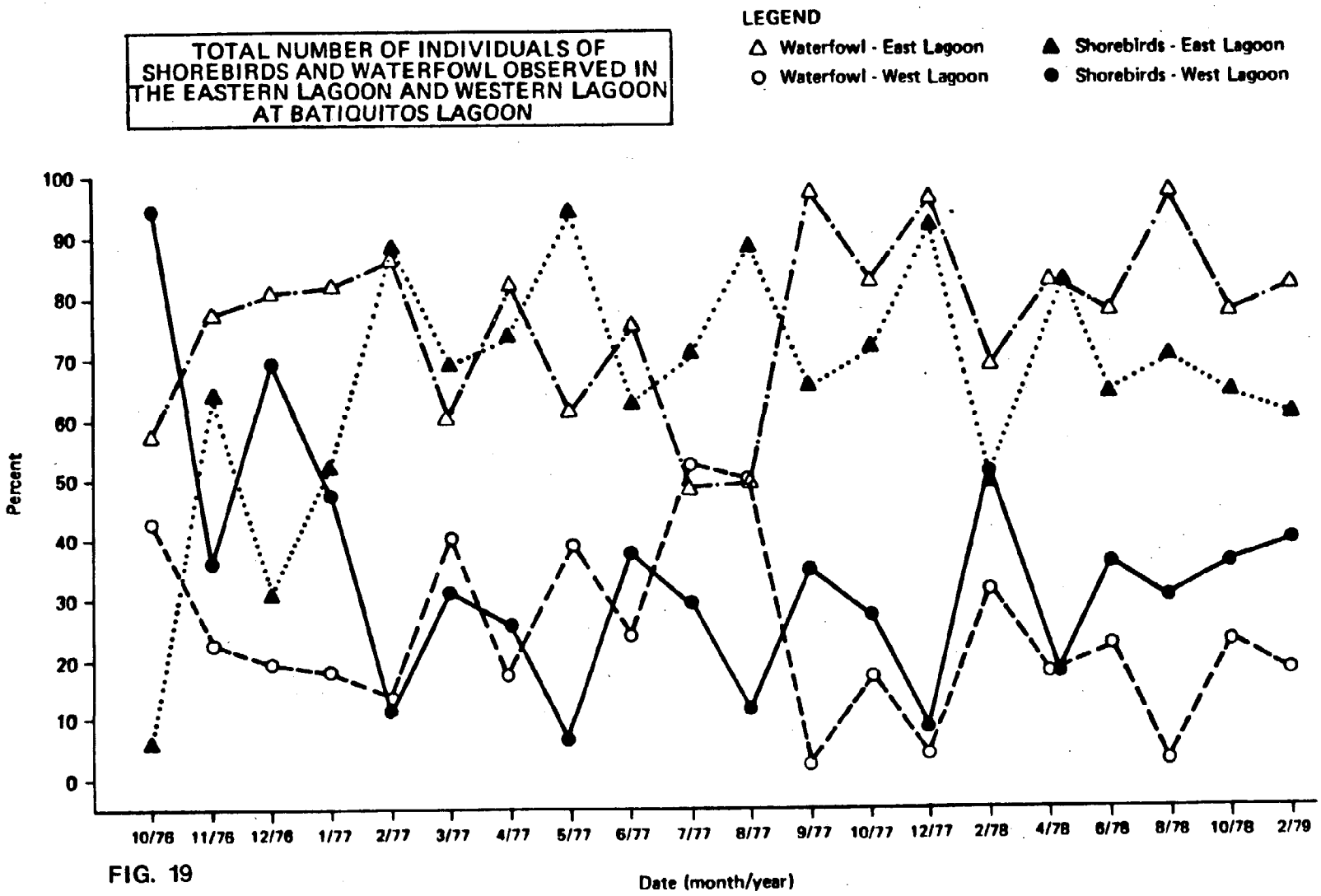

TOTAL NUMBER OF INDIVIDUALS OF SHOREBIRDS AND WATERFOWL OBSERVED IN THE EASTERN LAGOON AND WESTERN LAGOON AT BATIQUITOS LAGOON
LEGEND
Waterfowl - East Lagoon
Waterfowl - West Lagoon
Shorebirds - East Lagoon
Shorebirds - West Lagoon
Percent
100
90
80
70
60
50
40
30
20
10
0
10/76
11/76
12/76
1/77
2/77
3/77
4/77
5/77
6/77
7/77
8/77
9/77
10/77
12/77
2/78
4/78
6/78
8/78
10/78
2/79
Date (month/year)

FIG. 19

most widespread and abundant dabbling duck (Unitt, 1984). Pintails occur in both ends of the lagoon during the fall, winter, and early spring but appear to prefer the east lagoon. The Green-winged Teal is numerous in the fall and winter months (Table 7) and is widespread in San Diego County in fresh and brackish water areas (Unitt, 1984). This species shows a definite preference for the east lagoon.

The Northern Shoveler is present at Batiquitos Lagoon in large numbers during the fall, winter, and early spring and also shows a preference for the east lagoon (Table 7). The Ruddy Duck is generally present year-round and occurs regularly throughout Batiquitos Lagoon (Table 7). The Ruddy Duck prefers diving more than the other species, which may explain its regular occurrence in the west lagoon.

Shorebirds

The shorebird fauna of Batiquitos Lagoon is generally dominated (in terms of number of individuals) by the Semipalmated Plover, Killdeer, Willet, Least and Western Sandpiper, Long-billed Dowitcher, Sanderling, Black-necked Stilt and American Avocet (Table 7). The Northern Phalarope can be very abundant when present but is apparently not a regular visitor to Batiquitos Lagoon. The category of shorebirds known as peeps (a general term for small sized shorebirds) consists of birds such as Sanderlings, Dunlin, Turnstones, Knots, Surf Birds, and sandpipers, that are difficult to identify to species. Peeps are a common component of the shorebird fauna at Batiquitos Lagoon and show a preference for the shallower water of the east lagoon.

Shorebirds are generally more abundant during the late summer and fall months (Figures 18 and 19). The Semipalmated Plover, Killdeer, Western Sandpiper, Long-billed Dowitcher, and American Avocet are more abundant in the east lagoon. The Willet and Sanderling show a preference for the west lagoon while the Least Sandpiper and Black-necked Stilt do not show a definite preference for either basin.

The use of the westernmost section of the west lagoon by shorebirds was studied between 1969 and 1972 (Figure 20, Table 8). The number of shorebird individuals tended to be higher during the spring (Figure 20). The species of shorebirds observed during this period (Table 8) are species common to Batiquitos Lagoon. Several of these species appear to prefer the west lagoon (Willet, Sanderling) while others are usually more common in the east lagoon (Semipalmated Plover, Killdeer) or found throughout the lagoon.

Regional Comparison

The Christmas count data from 1975 through 1984 from Batiquitos Lagoon (Table 9), Buena Vista Lagoon (Table 10), and Aqua Hedionda Lagoon (Table 11) provide some insight to the relative importance of these lagoons for wintering waterfowl and shorebirds. Pintails, Green-winged Teals, Northern Shovelers, and Ruddy Ducks are the most common and abundant species of waterfowl at Batiquitos Lagoon (Table 9). At Buena Vista Lagoon, Northern Shovelers and Ruddy Ducks are the most common species; the occurrence and abundance of Pintails and Green-winged Teals is not as consistent as at Batiquitos Lagoon

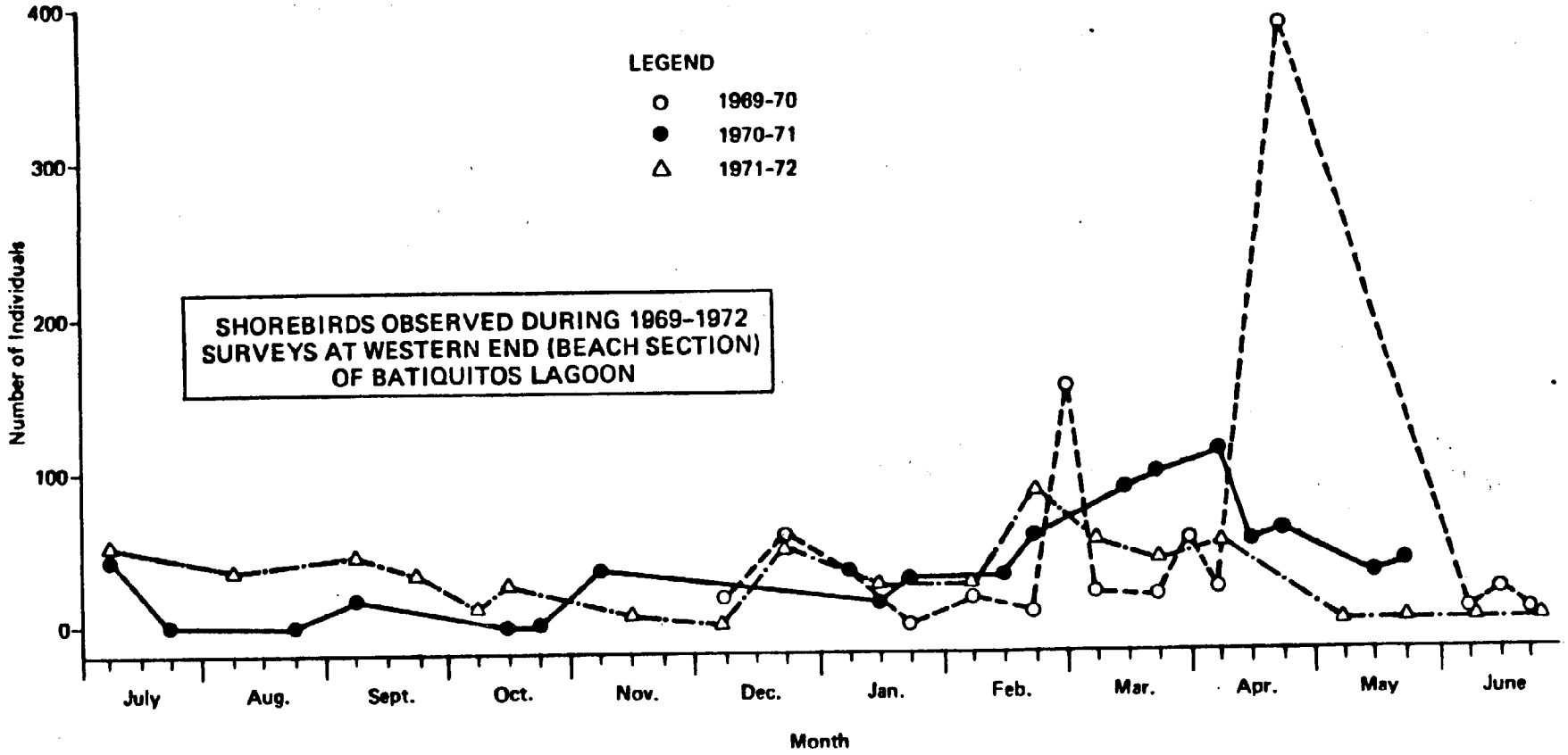

LEGEND
1969-70
1970-71
1971-72
SHOREBIRDS OBSERVED DURING 1969-1972
SURVEYS AT WESTERN END (BEACH SECTION)
OF BATIQUITOS LAGOON
Number of Individuals
400
300
200
100
0
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
June
Month

FIG. 20

Table 8 · SHOREBIRDS OBSERVED DURING 1971-1972 SURVEYS AT THE WESTERN END (BEACH SECTION) OF BATIQUITOS LAGOON[a]

	1969		1970												
	12/5	12/18	1/1	1/22	2/4	2/18	2/28	3/4	3/18	3/31	4/17	4/23	6/5	6/15	6/27
Semipalmated Plover	3						15		2		11	100			
Snowy Plover							1			1		8	3	12	7
Killdeer													4	3	
Black-bellied Plover		1	3		3	2	24	4	1	8					
Willet	4	3	2		7	4	31	1	5	9					
Least Sandpiper												75			
Dunlin	12		25		6		67		2			200			
Sandpiper sp.		55							4	36	10				
Marbled Godwit			1		3		10	15	4						
American Avocet														5	

	1970							1971												
	7/7	7/20	8/30	9/3	10/12	10/15	11/7	1/18	1/27	2/12	2/23	3/21	3/29	4/9	4/15	4/16	5/11	5/19	5/27
Semipalmated Plover											13	2	1	6					
Snowy Plover	10			2							12	10	11		6	6	10		2
Killdeer	8						1	2				2	3		1		1		2
Black-bellied Plover	2						12				5	4	2	2	5	3	3		
Willet				15			1	10		1	9	10	55	48	50	30	4	5	15
Dowitcher sp.												1		2					
Western Sandpiper													4			8			
Sandpiper sp.												40		10					
Marbled Godwit				1			4	2		2	10	5	2	2	5		2		
Sanderling							16	2	12	25	6	10	18	35	2	4	36	25	15
American Avocet	2													1					
Black-necked Stilt	25													4	1		1		3

	1971									1972								
	7/9	8/5	9/8	9/21	10/6	10/18	11/15	12/6	12/31	1/17	2/7	2/21	3/6	3/20	4/10	5/8[b]	5/22[b]	6/5	6/26
Semipalmated Plover				1								9							
Snowy Plover	2											6							
Killdeer	2		2	1										2					
Black-bellied Plover			1						2		8	40		1					
Willet	9	4	5	6		11	4		11	9	8	3	4	12	7				
Western Sandpiper					8									20					
Sandpiper sp.	6	20			4				2				50						
Marbled Godwit	9	3		10					1	2		2		6	2				
Sanderling			35	17		14	2		29	14	8	20			44				
Black-necked Stilt	6																		

[a] Source: unpublished survey data from Mr. David King, Solana Beach, California.
[b] Human activity in study area during survey.

(Table 10). Buffleheads and Ruddy Ducks appear to be the most consistently abundant species of waterfowl at Aqua Hedionda (Table 11). Large numbers of Pintails, Green-winged Teals, and Northern Shovelers occasionally occur at Aqua Hedionda Lagoon.

Using Christmas bird count data for the years 1975 to 1984, the difference in waterfowl and shorebird abundance at Batiquitos Lagoon compared to Buena Vista and Aqua Hedionda Lagoons is shown in Figure 21. The highest number of waterfowl individuals observed during the Christmas count surveys since 1977 was at Batiquitos Lagoon, followed by Buena Vista Lagoon. We assumed that during the winter the mud/sand flat areas are part of the open water habitat (covered by flood waters), and then calculated the average number of individuals per acre for the more common species of dabbling ducks using the 10 year Christmas bird counts for Batiquitos Lagoon, Buena Vista Lagoon, and Aqua Hedionda Lagoon. We found Batiquitos and Buena Vista Lagoons supported the larger number and density of waterfowl (primarily dabbling ducks) (Table 12). The waters at Batiquitos Lagoon and Buena Vista Lagoon are generally shallower and less saline than the waters at Aqua Hedionda Lagoon, and thus hold larger feeding areas for the dabbling ducks. Additionally in dry years with low rainfall and runoff, lagoons such as Buena Vista (with a more constant open water area) probably support a larger waterfowl population than lagoons such as Batiquitos Lagoon, which is more dependent on rainfall for shallow open water areas.

The patterns of shorebird use in the three lagoons is less obvious (Figure 22). Shorebirds are generally less abundant than waterfowl during the winter months and their use of lagoons is controlled by the availability of sand/mud flat habitat for feeding. Many species of short legged shorebirds are restricted to very shallow water feeding areas; therefore seasonal water levels determine the abundance of shorebirds at certain lagoons. The only consistent pattern the data present is Buena Vista Lagoon generally has the lowest count of shorebirds. Buena Vista is non-tidal and relatively deep water and consequently has no sand/mud flat areas. Aqua Hedionda Lagoon, on the other hand, is a tidal lagoon, and as such has some tidal flats exposed daily for use by shorebirds. In wet years when water levels in Batiquitos Lagoon are high, Aqua Hedionda supports a great number of shorebirds. When water levels at Batiquitos are moderate to low and shallow water conditions prevail then shorebird numbers appear to increase.

Resident birds which use Batiquitos Lagoon include those which inhabit the brackish and salt marshes in the lagoon and those which live in adjoining uplands and feed or roost in the lagoon. Long-legged wading birds such as the Great Blue Heron, Great Egret and Snowy Egret may be seen in the lagoon hunting for fish. Belted Kingfishers dive into the lagoon water from perches on trees or electrical wire. Small passerines such as the Song Sparrow, House Finch, Wrentit, Lesser Goldfinch and Bushtit live in adjoining upland and brushy areas and may feed along the lagoon borders. Some species, such as Long-billed Marsh Wren or Red-winged Blackbirds nest in dense brackish and freshwater marsh vegetation.

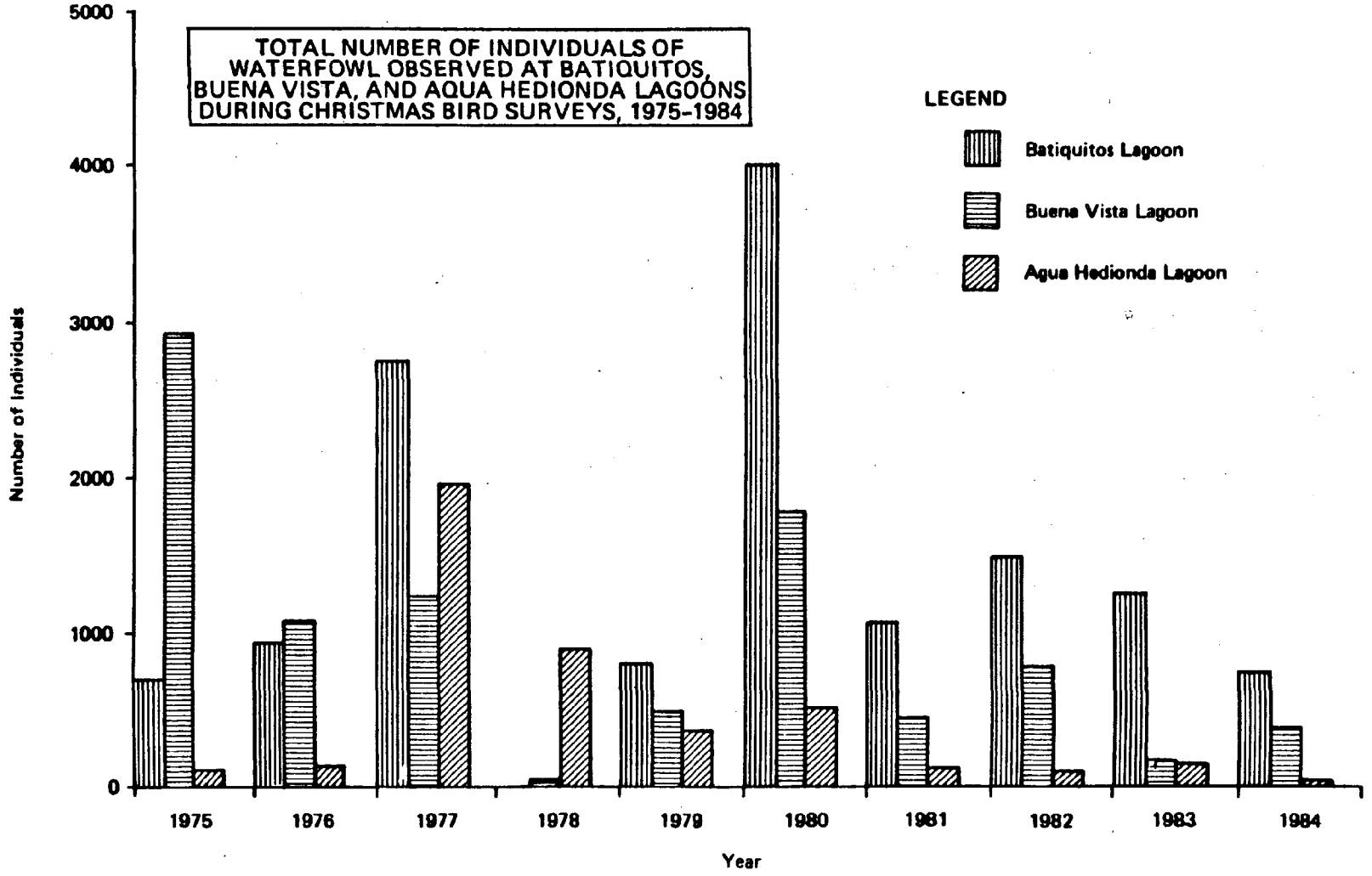

TOTAL NUMBER OF INDIVIDUALS OF WATERFOWL OBSERVED AT BATIQUITOS, BUENA VISTA, AND AQUA HEDIONDA LAGOONS DURING CHRISTMAS BIRD SURVEYS, 1975-1984
LEGEND
Batiquitos Lagoon
Buena Vista Lagoon
Agua Hedionda Lagoon
Number of Individuals
5000
4000
3000
2000
1000
0
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
Year

FIG. 21

Table 9 CHRISTMAS BIRD COUNTS AT BATIQUITOS LAGOON, 1975-1984[a]

	YEAR								
	1975	1976	1977	1979	1980	1981	1982	1983	1984
Mallard	12	12	24	0	5	8	6	20	71
Gadwall	47	5	30	4	21	15	43	15	22
Pintail	356	178	497	185	132	68	83	110	295
Green-winged Teal	228	80	223	167	61	88	9	35	28
Cinnamon Teal	5	0	3	4	6	11	11	25	2
American Wigeon	37	0	18	6	63	27	93	3	53
Northern Shoveler	28	570	1321	436	3054	828	891	600	76
Redhead	0	0	208	0	16	7	26	22	17
Lesser Scaup	0	0	102	0	14	10	3	35	25
Bufflehead	0	0	6	0	1	7	20	15	0
Ruddy Duck	20	89	320	1	630	10	273	360	166
TOTAL	733	934	2752	803	4003	1079	1458	1240	755
Semipalmated Plover	36	1	0	49	15	10	3	0	4
Snowy Plover	0	10	0	9	16	0	0	0	0
Killdeer	30	10	20	20	20	18	12	8	33
Black-bellied Plover	3	0	13	1	5	61	0	2	10
Willet	0	30	1	4	13	10	2	0	9
Least Sandpiper	40	0	4	26	21	17	3	0	0
Dunlin	15	11	0	52	7	5	0	0	0
Dowitcher sp.	0	0	3	0	0	0	2	0	0
Short-billed Dowitcher	0	0	0	20	0	0	0	0	0
Long-billed Dowitcher	0	0	0	0	14	8	0	20	0
Western Sandpiper	100	486	3	259	20	252	8	1	3
Marbled Godwit	0	1	5	0	0	3	0	15	21
Sanderling	0	1	13	12	14	10	2	8	4
American Avocet	22	78	40	186	40	100	0	0	0
Black-necked Stilt	34	28	11	46	16	36	5	15	15
TOTAL	280	656	113	684	201	530	37	69	99

[a] Source: data from Mr. Jerry Oldenettel, San Diego, California.

Table 10 CHRISTMAS BIRD COUNTS AT BUENA VISTA LAGOON, 1975-1984[a]

	YEAR									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Mallard	20	0	34	0	9	83	6	4	27	65
Gadwall	0	5	20	0	0	0	0	5	23	10
Pintail	9	10	262	5	15	39	8	0	0	18
Green-winged Teal	24	8	134	0	67	86	30	11	4	0
Cinnamon Teal	13	14	10	0	4	10	14	2	4	0
American Wigeon	0	0	4	0	1	12	154	0	0	0
Northern Shoveler	2400	726	506	6	210	1500	190	228	81	12
Redhead	6	6	0	0	0	0	0	72	0	0
Lesser Scaup	54	8	6	0	0	0	0	95	15	3
Bufflehead	94	16	24	1	0	28	1	0	0	0
Ruddy Duck	340	275	235	6	155	35	18	349	36	270
TOTAL	2960	1068	1235	18	461	1793	421	766	190	378
Semipalmated Plover	3	0	0	0	0	0	0	0	0	0
Snowy Plover	0	0	15	0	0	0	0	0	0	0
Killdeer	15	26	30	0	6	20	9	18	3	25
Black-bellied Plover	9	8	12	12	5	1	0	13	9	30
Willet	1	3	6	12	0	0	0	2	0	0
Least Sandpiper	5	0	8	0	6	0	0	9	0	0
Dunlin	0	0	0	0	1	0	0	0	0	0
Dowitcher sp.	0	0	0	0	0	0	0	88	4	0
Short-billed Dowitcher	0	0	1	0	0	0	0	0	0	0
Long-billed Dowitcher	11	0	30	0	40	0	0	0	0	15
Western Sandpiper	7	0	40	4	20	0	0	21	1	6
Marbled Godwit	10	0	9	10	0	0	0	0	0	0
Sanderling	7	1	55	35	0	0	0	6	0	4
American Avocet	15	2	7	0	40	0	4	19	0	5
Black-necked Stilt	8	0	10	1	30	5	0	12	5	4
TOTAL	91	40	223	74	148	26	13	188	22	89

[a] Source: data from Mr. Jerry Oldenettel, San Diego, California.

Table 11. CHRISTMAS BIRD COUNTS AT AQUA HEDIONDA LAGOON, 1975-1984[a]

	YEAR									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Mallard	8	6	1	6	10	10	9	8	10	0
Gadwall	0	0	0	4	5	22	8	6	0	0
Pintail	0	14	21	4	12	250	0	0	0	0
Green-winged Teal	0	80	21	11	20	35	6	12	100	0
Cinnamon Teal	0	0	57	14	0	1	0	0	0	0
American Wigeon	0	2	5	0	0	40	0	0	0	0
Northern Shoveler	0	2	1058	383	2	20	0	2	0	0
Redhead	0	0	23	3	0	0	0	0	0	0
Lesser Scaup	1	1	61	36	220	0	50	8	0	0
Bufflehead	50	2	49	15	90	32	40	27	21	10
Ruddy Duck	10	10	632	373	26	100	0	8	15	4
TOTAL	69	117	1928	849	385	510	113	71	146	14
Semipalmated Plover	6	1	0	0	5	0	3	5	0	7
Snowy Plover	0	50	0	0	2	0	0	0	5	0
Killdeer	14	58	153	5	30	14	36	24	2	4
Black-bellied Plover	12	9	1	2	15	12	40	12	20	1
Willet	15	12	10	3	20	30	57	14	17	1
Least Sandpiper	0	6	0	5	10	0	200	83	47	3
Dunlin	0	0	0	0	15	2	30	2	40	0
Dowitcher sp.	0	0	1	0	0	0	0	15	10	0
Short-billed Dowitcher	0	0	13	0	0	0	0	0	0	0
Long-billed Dowitcher	10	0	0	5	25	10	25	3	0	4
Western Sandpiper	30	9	15	0	100	30	30	53	80	3
Marbled Godwit	17	4	6	0	10	8	125	27	20	1
Sanderling	3	2	46	5	12	50	22	11	40	21
American Avocet	0	0	0	12	2	1	15	6	2	0
Black-necked Stilt	0	0	0	15	1	0	14	4	0	3
TOTAL	107	151	245	52	247	157	597	259	283	48

[a] Source: data from Mr. Jerry Oldenettel, San Diego, California.

Table 12. AVERAGE NUMBER OF INDIVIDUALS PER LAGOON AND AVERAGE NUMBER OF INDIVIDUALS PER ACRE PER LAGOON FOR COMMON SPECIES OF DABBLING DUCKS. DATA FROM CHRISTMAS BIRD COUNTS, 1976-1984[a].

Common Species	Average Number of Individuals/Lagoon			Average Number of Individual/Acre/Lagoon		
	Batiquitos L.	Buena Vista L.	Aqua Hedionda L.	Batiquitos L.	Buena Vista L.	Aqua Hedionda L.
Green-winged Teal	102.11	36.40	28.50	0.25	0.18	0.09
Mallard	17.56	24.80	6.80	0.04	0.12	0.02
N. Pintail	211.56	36.60	30.10	0.51	0.18	0.10
N. Shoveler	867.11	585.90	146.70	2.11	2.93	0.46
Gadwall	22.44	6.30	4.50	0.05	0.03	0.01
American Widgeon	33.33	17.10	4.70	0.08	0.09	0.01

[a]Christmas Bird Count Data provided by J. Oldenettel, San Diego.

Marine birds, including the California Gull, Western Grebe, and Eared Grebe spend the winter at Batiquitos Lagoon whereas, other marine species, such as Forester's Tern, Western Gull, and Double Crested Cormorant may be seen all year round.

Predatory birds or raptors such as Red-tail Hawks, White-tailed Kites, Kestrel and various owls hunt for small birds and rodents along the lagoon edge and in the marshes.

The riparian trees of Encinitas Creek and scattered groves around the lagoon offers habitat to migrating warblers, kinglets and other small birds as well as resident species such as vireos, flycatchers and finches. Riparian vegetation is a dense, well protected environment with numerous insects and larvae. Many species of birds nest and feed in these areas.

Rare and Endangered Species

Batiquitos Lagoon provides critical nesting habitat for the federal and state listed endangered California Least Tern, state listed endangered Belding's Savannah Sparrow, and the Snowy Plover (candidate species for federal listing). Adjacent floodplain areas are habitat for federal and state listed Least Bell's Vireo.

The California Least Tern formerly nested in large colonies on the dunes and beaches of southern California. They characteristically established colonies along the coast in open areas composed of light-colored substrate material with sparse vegetation. Nesting colonies were usually located near lagoons, bays or estauries where food could be procured (Craig, 1971; Swickard, 1971; Massey, 1974). Within individual colonies, the density of nests is usually less than other terns which makes the individual nests difficult to discover and helps reduce losses by predation (Unitt, 1984). Since its nesting habitat has nearly disappeared in the past 100 years, the Least Tern has been forced to nest in fill sites, abandoned airport landing strips, salt flats and other locations. Generally the Least Tern prefers sandy, relatively large nesting sites where the birds may clearly view the entire area around them, and sites which are located close to water so a feeding area is available close to the nest.

Disturbance by dogs and people and predation of nesting colonies by coyotes, dogs and raptors are continual problems to the reproductive success of the tern. The Least Tern has used the open salt flats, which are common in Batiquitos Lagoon, and has nested in several locations in the lagoon (Figure D). Typically, the terns have utilized only one to three nesting sites during a season. Recent nesting has occurred primarily at three locations in the lagoon (Figure D) and the success of Least Tern nesting in the lagoon since 1969 is summarized in Table 13. The fluctuating water levels in the lagoon affect the location and timing of nesting at Batiquitos Lagoon. In high water years, only one site may be uncovered and dry enough to allow nesting. Least Terns begin to arrive in the San Diego region during early April. During May, the terns select their colony sites and initiate courtship behavior and egg-laying (Unitt, 1984). As the young terns fledge, the adults and recently fledged juveniles leave the nesting colonies and form post breeding flocks near favorable feeding areas.

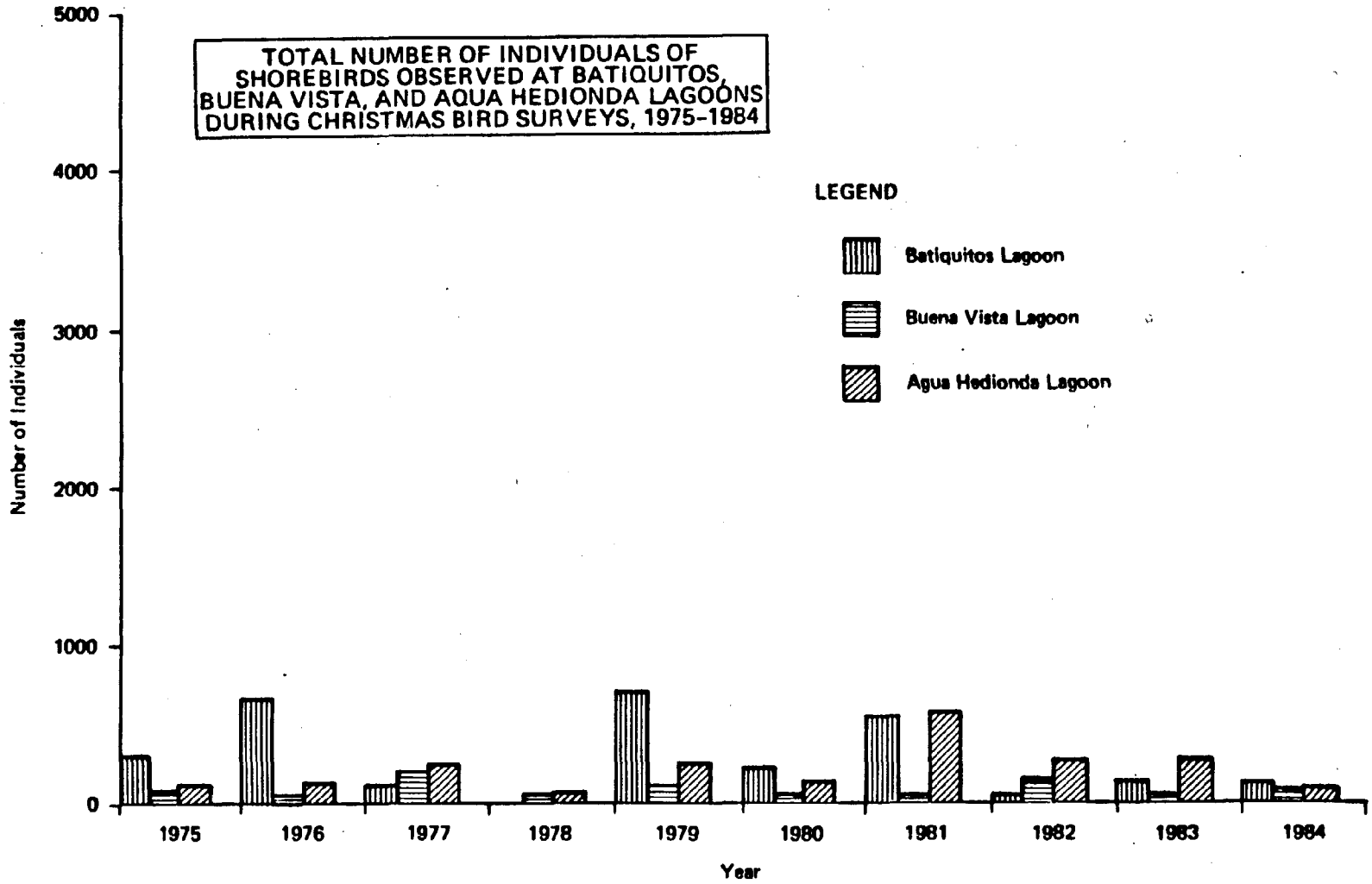

TOTAL NUMBER OF INDIVIDUALS OF SHOREBIRDS OBSERVED AT BATIQUITOS, BUENA VISTA, AND AQUA HEDIONDA LAGOONS DURING CHRISTMAS BIRD SURVEYS, 1975-1984
LEGEND
Batiquitos Lagoon
Buena Vista Lagoon
Agua Hedionda Lagoon
Number of Individuals
5000
4000
3000
2000
1000
0
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
Year

FIG. 22

Table 13. SUMMARY OF LEAST TERN NESTING AT BATIQUITOS LAGOON

Year	Area*	Estimated No. Pairs	Est. No. Fledged
1985	mouth	9-14	11+
	Park & Ride	5-18	12-14
	east end levee	3	0
1984	Park & Ride	3	6
1983	northeast**	1	2
1982	mouth	8 -13	0
	Park & Ride	7 -19	6+
	east end	7	0
1981	mouth	36	25+
	Park & Ride	36	
	east end	7	0
1980	east end	12 -15	8 -10
1979	mouth	9	25 -40 for
	east end	38	both sites
1978	northeast	22	0
	southeast	8	0 - 4
1977	east end	11	"several"
1976	east end	9	"good"
1975	northeast	9	2
1974	between RR & I-5 on north shore	50 -60	"good"
	east end	6 -10	unknown
1973	between RR & I-5 on north shore	30+	"good"
	east end	2	unknown
1969	east end	3+	unknown

*See Figure D for location of Least Tern nest sites in Batiquitos Lagoon.

**Park and Ride and mouth underwater during most of the season.

The location of areas of post breeding concentrations vary somewhat from year to year but certain areas appear to be used more-or-less regularly (Unitt 1984). The San Luis Rey River mouth, Buena Vista Lagoon and the mouth of the Tijuana River are used regularly and in some years large post breeding concentrations have been observed at Batiquitos Lagoon and the mouth of the San Dieguito River (Unitt, 1984). By the middle of September most of the Least Terns have left San Diego County.

Least Terns tend to return to colony sites where they had initial success (Unitt, 1984). They will abandon sites as the former sites become overgrown with vegetation, flooded by high tides or flood water, if too many eggs, chicks, or adults are killed by predators, or if nesting sites are lost to development. Reduction in the size of a nesting site is also detrimental because it results in an increase in nesting density which increases the vulnerability of the colony to predation. As a result, the activity of a few predators can cause the failure of a colony supporting a large number of birds.

The U.S. Fish and Wildlife Service (FWS, 1980) prepared a recovery plan for the Least Tern which identifies present nesting locations and suggests measures to protect existing areas and create new ones. This plan contains several policies that directly relate to Batiquitos Lagoon such as "Preserve adequate nesting habitat in Batiquitos Lagoon." It also directs FWS to "investigate and implement actions needed to increase populations of fish eaten by terns in degraded or potential tern feeding areas including Batiquitos Lagoon." Some of the more general policies include:

> "Develop or refine management techniques for providing adequate nesting sites and implement techniques where needed."
>
> "Protect breeding colonies annually by minimizing disturbance and mortality."

The Brown Pelican, a federal and state listed endangered species, rests and feeds at Batiquitos Lagoon. This species nests on offshore islands.

The Snowy Plover is a candidate species for federal endangered status. This species also nests on beaches and alkali flats and, like the tern, has seen a reduction in the area of its nesting habitat in southern California. They are often found in association with Least Terns. The Snowy Plover has nested on the salt flats of Batiquitos Lagoon in approximately the same locations as the Least Tern. Like the Least Tern the fluctuating water levels in the lagoon affect the timing and location of nesting.

The state listed Belding's Savannah Sparrow is a resident of the high marsh pickleweed areas. It requires thick pickleweed cover above the reach of high tides or high water. The sparrows also forage in the upland transition zone bordering high marsh as well as salt flats and beach areas. Nesting has occurred in the east end near the mouth of San Marcos Creek and in the western basin near the Coast Highway (E. Copper, personal communication). In 1977 some 20 pairs nested at the lagoon with fifteen in the eastern basin and five in the western basin. A recent survey (April 1986) conducted by the Fish and Wildlife Service found 47 pairs of sparrows in the pickleweed fringes of the eastern

lagoon. Most were found along the north shore of the eastern lagoon. The western lagoon was not censused (M. Elpers, pers. comm.) However, due to the limited area of habitat available for nesting, the population of Belding's Savannah Sparrows in Batiquitos Lagoon is limited relative to other coastal wetlands such as Los Penasquitos Lagoon.

Least Bell's Vireo nests in thick riparian woodland and has been found in the willows along Encinitas Creek bordering the lagoon. This species is state and federal listed as endangered and requires older, well-developed willow riparian forest for nesting. Loss of habitat and nest parasitism by the brown-headed cowbird are major causes for its population decline.

Another endangered species, the Light-Footed Clapper Rail could potentially inhabit Batiquitos Lagoon but has not been observed there nor are they expected to be found in the lagoon currently. They may have previously inhabited the lagoon marshes. The Light-Footed Clapper Rail nests and lives in cordgrass and pickleweed marshes. The Light-footed Clapper Rail Recovery Plan suggests restoration of tidal flow to Batiquitos Lagoon and possible reintroduction of this species.

Several other bird species, while not listed as endangered, threatened, or rare, are considered sensitive and undergoing population declines (Pacific Southwest Biological Services, Inc., 1982). These include the Willow Flycatcher, Warbling Vireo and Yellow Warbler; all are riparian species who suffer from habitat losses.

Cooper's Hawks breed in riparian woodlands and utilize oak woodlands for hunting. Loss of riparian habitat statewide has caused a decline in this species.

The Least Bittern is a wading bird of freshwater marshes and has nested in the brackish marsh of Batiquitos Lagoon. Its population is declining in San Diego County due to loss of freshwater habitat.

The Short-eared Owl and Northern Harrier or Marsh Hawk both hunt in marsh areas and have been observed in the Batiquitos lagoon marshes. Both are declining in numbers due to reduction in marsh habitat.

REGIONAL PERSPECTIVE

Batiquitos Lagoon is one of a series of coastal wetlands in San Diego County. Each of these wetlands contains a varied mix of habitat types. These habitats consist of intertidal mud/sand flats, seasonally flooded mud/sand/salt flats, deep water, coastal salt marsh, brackish marsh, willow dominated riparian forest, uplands and transitional areas between habitats. Figure 23 illustrates the relative concentration of these habitat types at various coastal wetlands. Seasonally flooded mud/sand flat areas dominate the lower Santa Margarita River Estuary and Batiquitos Lagoon but are essentially absent at Buena Vista and Los Penasquitos Lagoons. Marsh areas are present at all areas but form the dominant landscape at San Dieguito and Los Penasquitos Lagoons and Tijuana River Estuary. Open water dominates San Elijo, Buena Vista and Aqua Hedionda Lagoons.

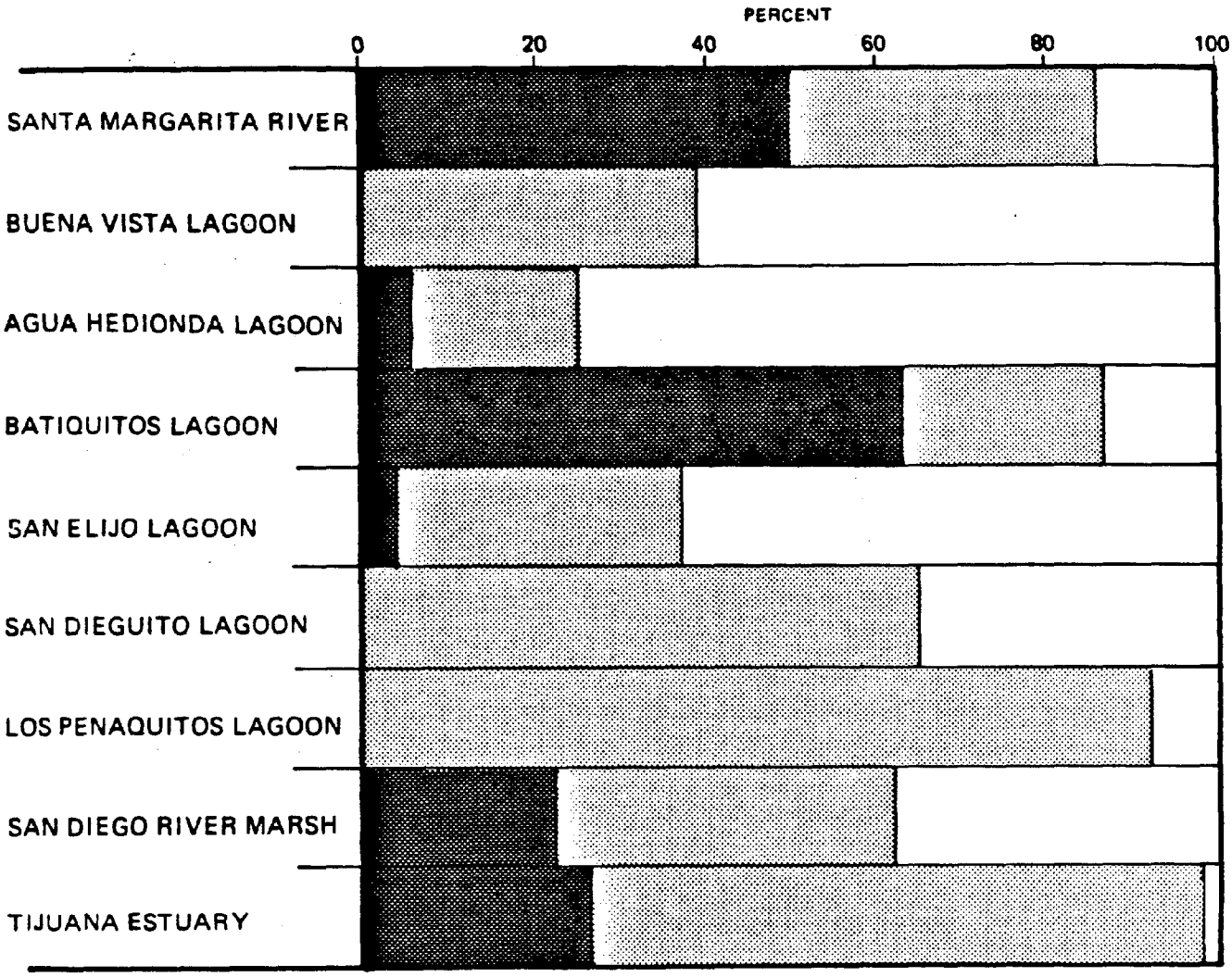


FIG. 23

COMPARISON OF MAJOR HABITAT TYPES FOR NINE COASTAL WETLANDS IN SAN DIEGO COUNTY

The type of habitat and extent of a particular habitat type are major factors determining a given wetland's overall value as a habitat. For example, a lagoon which has limited tidal flushing or small areas of open water, such as Batiquitos Lagoon, will be less valuable for providing fishery habitat than a system such as Aqua Hedionda Lagoon with its continuous tidal flushing. Wetlands with large emergent salt marsh, such as Los Penasquitos Lagoon provide greater habitat value for species such as Belding's Savannah Sparrow. Intertidal mud/sand flats and shallow water are more valuable for shorebirds and dabbling ducks, whereas deeper open water areas are preferred by diving ducks.

Figure 23 and Table 14 generally summarize the habitat types and characteristics of fourteen coastal wetlands in San Diego County. The values presented in Table 14 were developed by Dr. J. Zedler, Mr. C. Nordby, and Ted Winfield through interaction with local agency personnel, researchers with experience working in the various lagoons, published literature, and from the experience of the three authors. Additional field survey data on these wetland systems is necessary to allow a thorough comparison of the habitat values at each wetland and the regional relationship of these systems to migratory birds and other species. The following discussion generally outlines the habitat values at these wetlands as based on currently available data.

Those lagoon or wetland systems which are considered to have high values for shorebirds possess either large areas of tidal flats (Mission Bay, San Diego Bay), contain large areas of emergent marsh (Tijuana River Estuary, Los Penasquitos Lagoon) or are only periodically flooded or essentially non-tidal (containing large areas of exposed mud and sand flats). Buena Vista Lagoon is the one exception and its importance as a shorebird habitat is probably inflated, especially when compared to other lagoons.

The value of Batiquitos Lagoon as a waterfowl habitat (Table 14) is closely related to the large areas of open water present during the winter and early spring. The shallow nature of the open water areas in Batiquitos Lagoon, especially in the east lagoon, along with the fresh to brackish nature of the water in the east lagoon, appears to make Batiquitos Lagoon a favorable habitat to dabbling ducks. Dabbling duck species dominate the waterfowl present at Batiquitos Lagoon during the winter and spring months (Table 7) and are usually present in greater abundance than at other nearby lagoons (Tables 9, 10, and 11; Figure 21).

Batiquitos Lagoon is considered to have a moderate value as a habitat for wading birds, other water-associated birds (not including the endangered California Least Tern), and terrestrial species.

The overall value of Batiquitos Lagoon as a fishery habitat is low relative to other lagoon and wetland systems. The lack of regular tidal exchange with the oceanic waters and small area of freshwater limit its fishery value. Most of the lagoons with moderate or high fishery values all have a more-or-less regular occurrence of tidal exchange with oceanic waters. The low value for recreational fishery arises from the freshwater areas near San Marcos Creek.

TABLE 14

San Diego County Wetland Matrix - Part I: Inventory

I. INVENTORY	Santa Margarita River Estuary	San Luis Rey River Marsh	Loma Alta Lagoon	Buena Vista Lagoon	Agua Hedionda Lagoon	Batiquitos Lagoon	San Elijo Lagoon	San Dieguito Lagoon	Los Penasquitos Lagoon	Mission Bay	San Diego River Marsh	Famosa Slough and Channel	San Diego Bay	Tijuana Estuary
A. Habitats (acres)(% total)														
Openwater- total	35		6	200	296	70		66	33	1500	90	21	11,000	197
Tidal Channels	35(13)		6(75)	200(57)	296(54)	70(12)		66(16)	33(5)	1500	90(14)	21(58)	11000(82)	197(14)
Sewage Ponds														
Salt Ponds													1900(10)	
Eelgrass					70									
Tidal Flats - total	132				76	341	30				50		619	16
Rock					4(<1)									
Sand/Silt	125(47)				2(<1)	341(57)							38(<1)	16(1.5)
Mud	7(2.5)				70(13)		30(7)						576(3)	
Salt Marsh - total	92	remnant	1(12.6)		16	16	150	135	350	21	50(24)	4	359	410
Low														67(6)
Middle	92(35)						150(38)		350(55)	21		4(11)	359(3)	133(12.5)
Upper					16(3)			125(31)						210(20)
Brackish/Fresh Marsh - total	4(1)	40	1(12.5)	130(37)	5(1)	111(18)	110(28)		7(1)		45(22)	10(28)		2(<1)
Transition/Upland - total				20	149	64	100	218	246		20	<1		494
Sand Dunes								216(53)	7(1)		20(10)			494(96)
Maritime					19(3)		100(26)					<1(3)		
Riparian	2(<1)			20(6)				3(<1)	212(34)					
Other					130(29)				27(4)					
Watershed Area - total	740 mi²	565 mi²	10acres	22 mi²	29 mi²	46 mi²	77 mi²	390 mi²	98 mi²		935/152 mi²	<100acres		1731 mi²
B. Biological Resources														
[presence (+) or absence (-)]														
Threatened/Endangered Species														
Flora	-	+	-	-	-	-	-	-	-	-	-	-	-	+
Invertebrates	+	-	-	-	-	-	-	-	-	-	-	-	-	+
Birds														
Shorebirds	-	-	-	-	+	+	+	+	+	-	-	-	+	+
Waders	+	-	-	+	+	-	+	-	+	+	+	-	+	+
Other Water-Associated	+	+	-	+	+	+	+	+	+	+	+	-	+	+
Terrestrial	+	+	-	+	+	+	+	+	+	+	+	-	+	+
Species of Regional Significance														
Flora	-	-	-	-	-	+	-	+	+	-	-	-	-	-
Fauna	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. Tidal Flushing Characteristics														
O=open C= closed O/C=primarily open C/O=primarily closed	O/C	C/O	C	C	O	C/O	C/O	C/O	C/O	O	O	C	O	O
stabilized mouth	-	-	-	-	-	+	-	-	-	+	-	+/-	+	-

TABLE 14

San Diego County Wetland Matrix - Part 2: Functional Values

II. FUNCTIONAL VALUES (0 = no; 1 = low; 2 = moderate; 3 = high)	Santa Margarita River Estuary	San Luis Rey River Marsh	Loma Alta Lagoon	Buena Vista Lagoon	Agua Hedionda Lagoon	Batiquitos Lagoon	San Elijo Lagoon	San Dieguito Lagoon	Los Penasquitos Lagoon	Mission Bay	San Diego River Marsh	Famosa Slough and Channel	San Diego Bay	Tijuana Estuary
A. Habitat Values														
Birds														
Shorebirds	3	1	1	3	3	3	1	2	3	3	2-1	2	3	3
Waders	3	1	2	2	2	2	2	1	3	1	2	2	3	3
Waterfowl	3	2	2	3	2-3	2-3	3	3	3	2-1	3	2	3	2
Other Water-Associated	3	2	1	2	3	2	3	2	2-3	3	3	1	3	3
Terrestrial	3	1	1	2	2	2	2	2	3	1	2	1	3	3
Fish														
Spawning/Nursery area	2	1	1	1	3	1	1	1	1-2	3	2	1	3	3
Recreational Fishery	1	1	1	2	3	1	1	1	1	3	2	1	3	2
Bait Fishery	2	1	1	1	1	1	1	1-2	1-2	1	2	2	3	3
Other Wildlife Species	3	2	2	2	3	1	2	2	3	1	1	1	2	2
Linkage with Watershed Wildlife	3	3	1	2	2	2	2	2	3	1	2	1	2	3
B. Harvest and Heritage Values														
Threatened/Endangered Spp.	3	1	1	2	3	2	3	2	3	2	2-1	1	3	3
Species of Regional Significance	2	1	1	1	1	3	1	3	3	1	1	1	2	3
Passive Recreation	1	2	1	3	3	3	3	3	3	3	3	2	3	3
Active Recreation	1	1	1	2	3	1	2	2	2	3	1	1	3	2
Education/Research	3	1	1	2	3	2	2	2	3	3	3	2	3	3
Unique Biological Features	3	1	1	2	3	3	3	1	3	1	3-2	3	3	3
Aesthetic/Visual	2.	2	2	3	3	2	3	2	3	3	2	2	3	3
Aquaculture Potential	2	1	1	1-2	1-2	1-2	1-2	1-2	1-2	3	1	1	3	2
Water Quality	3	1	1	1	3	1	1	1-2	2	2-3	2-3	1	2-3	2-3

TABLE 14

San Diego County Wetland Matrix - Part 3: Impacts

III. IMPACTS [presence (+) or absence (-)]	Santa Margarita River Estuary	San Luis Rey River Marsh	Loma Alta Lagoon	Buena Vista Lagoon	Agua Hedionda Lagoon	Batiquitos Lagoon	San Elijo Lagoon	San Dieguito Lagoon	Los Penasquitos Lagoon	Mission Bay	San Diego River Marsh	Famosa Slough and Channel	San Diego Bay	Tijuana Estuary
A. Historic														
Impacts within Lagoon														
Dredge (acres)	+(153)	+	+	-	+	-	+	-	-	+	+	-	+	+
Fill (acres lost)	+	+	+(32)	+(115-140)	+	+(1.5)	+(36)	+(197)	+	+	+	+(20)	+	+
Salt Extraction	-	-	-	-	-	+	-	-	-	-	-	-	+	-
Sewage Influx	+	+	-	+	-	+	+	+	+	+	+	-	+	+
Military	+	+	-	-	-	-	-	-	-	+	-	-	+	+
Vehicular	+	-	-	-	+	-	-	-	+	+	-	+	+	+
Introduced spp	+	+	+	+	+	-	+	+	+	+	+	+	+	+
Watershed Impacts														
Pollutants														
Urban/Industrial	-	-	-	-	-	-	-	-	-	+	+	+	+	+
Agricultural	+	+	+	+	+	-	-	-	+	+	+	+	+	+
B. Current														
Impacts within Lagoon														
Dredge	+	-	-	+	+	-	-	+	-	+	-	-	+	+
Fill (acres lost)	+	-	-	-	-	-	-	+	+	+	-	-	+	+
Salt Extraction	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Sewage Influx	+	+	-	-	-	-	-	-	+	+	+	-	+	+
Military	+	-	-	-	-	-	-	-	-	-	-	-	+	+
Vehicular	+	+	-	-	-	-	-	+	+	-	+	+	+	+
Domestic Pets	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Reduced Tidal Flushing	-	+	+	+	-	+	+	+	+	-	-	+	-	+
Watershed Impacts														
Pollutants														
Urban/Industrial	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Agricultural	+	+	-	+	+	+	+	+	+	-	+	-	+	+
Reduced Freshwater Influx	-	+	+	-	+	+	+	+	+	+	+	+	+	+
Increased Freshwater Influx	+	+	-	-	-	-	-	+	-	-	+	-	-	+
Sedimentation	-	+	-	+	+	+	+	+	+	+	+	-	+	+
Sand Extraction	-	+	-	-	-	-	-	-	-	-	+	-	-	+

The moderate value for linkage with watershed wildlife results from the presence of undeveloped canyons immediately surrounding Batiquitos Lagoon. However, the presence of human disturbance along the north side of the east lagoon, and the presence of roads along the east and south sides, limits access to the lagoon by wildlife species living in the watershed.

The lagoon has a high habitat value for threatened or endangered species. California Least Terns and Snowy Plovers nest at the lagoon as does a small resident population of Belding's Savannah Sparrow. Nesting by Least Terns and Snowy Plovers is variable and directly related to water levels in the lagoon. The variable number of nesting pairs of Least Terns since 1969 is evident in the data presented in Table 13. These three species are also present in other lagoons in San Diego County where their numbers are also somewhat controlled by water levels. The large areas of salt flats at Batiquitos Lagoon present one of the larger areas of preferred nesting habitat for the Least Tern and Snowy Plover in the county. At the same time, the lack of extensive emergent marsh, such as occurs at Los Penasquitos Lagoon, probably restricts the population of Belding's Savannah Sparrow.

SUMMARY

Batiquitos Lagoon contains four habitat types: emergent marsh (including both brackish and salt marsh), sand/mud flats which are seasonally covered by water, open water, and riparian forest dominated by willows. The values of these habitats to wildlife largely vary with the amount of water the lagoon contains.

Several species of mammal such as jackrabbits, ground squirrels and raccoons use the lagoon and live along its edges as do several reptilian species. Fish species are limited in diversity due to the lack of tidal inflows and the drastic fluctuations in water quality and temperature which occur annually in the lagoon. Likewise benthic invertebrates (worms, clams and other creatures which inhabit the lagoon bottom) and zooplankton species have difficulty surviving the water quality conditions at the lagoon.

Birds, both migratory and resident, are the most conspicuous members of the lagoon fauna. Batiquitos Lagoon supports a seasonal influx of migratory waterfowl and shorebirds. Both shorebirds and waterfowl use the eastern basin of the lagoon more than the western basin. Eleven species of waterfowl and fifteen species of shorebirds account for 95 percent of the total number of individuals observed in Batiquitos Lagoon.

Shorebirds typically use the lagoon in late fall and spring when water levels are shallow and allow feeding by short-legged bird species. Some years, when water levels are shallow, Batiquitos Lagoon supports greater numbers of shorebirds than either Aqua Hedionda or Buena Vista Lagoons. However in high water years when the Batiquitos Lagoon water levels are deep, shorebird populations are higher at Aqua Hedionda Lagoon. Many of the occurrences of large numbers of shorebirds at Batiquitos Lagoon are due to the influx of a flock of one species.

Waterfowl tend to use Batiquitos Lagoon during winter months when water levels are higher. Batiquitos usually has higher numbers of waterfowl than either

Aqua Hediónda or Buena Vista Lagoons. In drier years when Batiquitos water levels are low, Buena Vista Lagoon hosts larger waterfowl populations.

Other resident bird species include small passerine birds such as Long-billed Marsh Wrens, Red-winged Blackbirds, House Finches and Song Sparrows which reside in the marsh or adjacent uplands. Wading birds such as Great Blue Herons and Great Egrets feed in the lagoon as do marine species like Double Crested Cormorant, Forster's Tern and California Gulls.

Several state and federally listed endangered species nest or feed in the lagoon. These include the California Least Tern, Belding's Savannah Sparrow, and Brown Pelican. A candidate species, the Snowy Plover also nests in the lagoon. The riparian forest along Encinitas Creek provides habitat for the Least Bell's Vireo.

In comparison to some of the other San Diego County wetlands, Batiquitos Lagoon has high habitat values for waterfowl and shorebird habitats. It has a low value for fishery habitat due to the lack of tidal inflows or stable water levels. The lagoon also has a high value for endangered species due to the number of different species nesting and feeding in the area.

AESTHETIC VALUES

One of the most immediately noticeable qualities of Batiquitos Lagoon is its high aesthetic value. The diversity of the landscape, the beauty of such a large water feature, and the large expansive open space of the lagoon set it apart from other surrounding lands. Steep bluffs ring the lagoon, striking a contrast with the flat, often water-filled basin. The constant changes in the water level of the lagoon, as well as the seasonal movements of birds into the lagoon, create visual variety for local residents. The lagoon also provides a wide swath of open space unrestricted by urban developments. Only the roads and railways break up the continuous line of sight along the lagoon.

Most local residents and many visitors to the area view the lagoon from La Costa Boulevard, Highways 5 and 101, and El Camino Real as they travel to work or other destinations. Since most of the lagoon borders are presently undeveloped, only three sites afford a place to stop and view the lagoon. These include the CalTrans Park and Ride lot, South Carlsbad State Beach and the end of Lagoon Lane. Some people may also use the dirt road along the north shore for viewing the lagoon and bluff tops on the south shore. Figure E indicates the locations of prime viewpoints around the lagoon.

Depending upon who you ask, there are various opinions about problems with the aesthetic features of the lagoon, the wet and dry cycles of the lagoon in particular. For some, water level in the lagoon is of great importance, judging whether the lagoon is a pleasing site or an unsightly mess. For others, the seasonal change from wet to dry is acceptable. Perhaps generally more important than water level to many residents, is odor, algae blooms and sewage spills in the lagoon. Given the right conditions, bright green algae blooms may cover the lagoon, then die and create a strong, pungent odor. In addition, accidental spills of sewage into the lagoon can create similar noxious odors. Unlike the variety of opinions about visual aspects, there are few people who do not complain about the lagoon's odor problems. Overall, the aesthetic values of Batiquitos Lagoon are relatively high, but suffer some loss due to seasonal water fluctuations and odor problems.

PLANS AND POLICIES

This section documents land ownership and use in the lagoon area, the various roads and utility lines which cross the lagoon and the local plans which affect land uses in the lagoon and watershed area. In addition the state and federal agencies with jurisdiction over particular activities in the lagoon area are discussed. This mosaic of existing and planned land uses, proposed developments and government regulations poses a complex number of constraints upon enhancement of the lagoon.

LAGOON LAND USE AND OWNERSHIP

A number of different property owners claim title to various portions of the lagoon area. Figure F illustrates property boundaries and owners. Figure G outlines the land uses surrounding and including the lagoon. Both of these maps are current as of June, 1986. These two figures represent the human environment of the lagoon. In discussing ownership, we have noted where land owners are proposing a change in land use.

In general, the land surrounding Batiquitos Lagoon is undergoing a change from agricultural use to urban development. Expansion of Carlsbad from the north and development of unincorporated lands to the south have left a swath of open and agricultural land along the lagoon's north shore and tributary streams. However, for the most part the lagoon is surrounded by residential and commercial lands and its watershed is rapidly becoming more urbanized.

California Department of Fish and Game (DFG) owns approximately 135 acres in the western and eastern lagoon. DFG is the only lagoon landowner who actively manages their lagoon lands as wildlife habitat. The lands in Batiquitos lagoon were made a State Ecological Reserve in 1983. The primary purpose of the reserve program is to protect examples of native lands as wildlife habitat. There is no boating, swimming, hunting, commercial fishing, collecting of specimens, or feeding of wildlife allowed on the reserve. Sport fishing is allowed from the shore only and passive recreation such as bird watching and nature study are permissable from identified access sites such as the CalTrans Park and Ride Lot. Overall the DFG manages the reserve for conservation of wildlife habitat and protection of endangered species.

Sammis Properties Inc. owns about 5 acres in the western lagoon as part of their holdings along the northwest shore of the lagoon. Sammis Properties recently (November, 1985) received a Coastal Development Permit and City of Carlsbad approval for a mixed use development on the bluff top property above the lagoon. As conditions of this permit, Sammis Properties dedicated the title to most of their lagoon land holdings to the State Land Commission. The permit also requires a 45-50 foot setback from the edge of the bluff, erosion control measures during property development and maintenance of sediment catchment basins on two tributary streams to the lagoon. Should final designs for the enhancement project show a need for the 5 acre fill area in the north west corner of the lagoon, Sammis Properties would be required to dedicate a portion of this land under their permit conditions. Construction for the project began in June, 1986 and is limited to April 1 to September 30 to ensure erosion control during the rainy season.

Hunt Properties Inc. (HPI) is the major property owner in the east basin of the lagoon. Their lagoon lands of 360 acres are part of a larger 1730 acre holding which is concentrated along the north shore of the lagoon but also includes Green Valley and the lower portion of Encinitas Creek. Much of the HPI property was in agricultural use until a few months ago when the owners ended farming operations on most of the property. The land is now open and generally unused.

Off-road vehicles are a major problem on both the upland and lagoon areas of the HPI property. Dirt bikes tear up the lagoon shoreline and adjacent slopes and during the dry season can be seen driving over the lagoon bottom. Efforts by the owners to restrict access have been unsuccessful. Helicopters have also used the flat eastern basin of the lagoon for landing practice. HPI does not actively manage the lagoon wetlands in its holdings. Nor do they manage or maintain the riparian corridor along Encinitas Creek.

HPI recently submitted a master plan to the City of Carlsbad for development of portions of their holdings. The master plan outlines a mixture of resort and residential uses for much of the property. For the most part this proposed development lies outside the lagoon wetlands. However HPI does designate a 2.5 acre site on the southeast corner of the lagoon wetland as a development site, but no specific site plans have been proposed. Development of this site would require filling about two acres of lagoon wetlands. HPI has not submitted any specific plans for their Green Valley property either. The City of Carlsbad released an Environmental Impact Report on the HPI master plan in May, 1986.

The master plan designates open space for the HPI portion of the lagoon and wetlands. A 100 ft. buffer is outlined and would separate the north shore wetlands from the proposed development. The HPI master plan also proposed sediment control basins for several creeks on their property.

William Savage owns a small section of the western lagoon and larger portion of the eastern lagoon adjacent to Interstate 5. This property is open and vacant. Mr. Savage currently has no plans for his properties being considered by the City of Carlsbad or other agencies.

The State Lands Commission has accepted a boundary agreement with Mr. Savage which would resolve state title claims on those portions of his property above the 6.0 ft. (MSL) contour. The title to the portion of his property below the 6.0 ft. contour was conveyed to the State Lands Commission.

Batiquitos Drive (Lagoon Lane) ends on the Savage property and provides direct access to Carlsbad. Many residents use the end of this road as a site for painting, photographing, birdwatching or just sitting and watching the lagoon.

Mitsuuchi owns a parcel of the northern lagoon shoreline which contains both wetlands and uplands. A nursery operation is active on the upland portion of the property.

Murphy holds another north shore parcel which is primarily uplands and contains a residence.

Community Bank owns a large parcel along the southeastern shore of the lagoon. One small section of this parcel north of La Costa Avenue includes lagoon wetlands. The property is not used and no development plans are currently in process.

Leucadia County Water District (LCWD) has several small holdings on the lagoon where their pump stations are located (see Figure F). These pump stations are connected to sewer mains which transport wastewater to the Encinitas Water Pollution Control Facility for processing.

California Department of Parks and Recreation owns and operates South Carlsbad State Beach at the lagoon mouth. The Department of Parks and Recreation owns and operates four miles of beaches within Carlsbad and most of the public shoreline within California.

The South Carlsbad State Beach presently has no facilities in the vicinity of Batiquitos Lagoon. A campground lies several miles to the north. There is limited parking along the Pacific Coast Highway for beach users.

County of San Diego owns a 2.4 acre parcel of the beach at the lagoon mouth.

Rancho La Costa/Newport Shores owns a ten acre parcel at the northeast corner of the lagoon. This parcel has an open space easement recorded over it which the Conservancy manages.

State Lands Commission holds title to 17 acres of wetland along the north shore in the western and middle basin. They received this land through a dedication as part of a permit condition for the Sammis Properties development.

There are a number of casual users of the lagoon such as joggers and bird watchers as well as high school and college classes. Classes use both the north shore and the CalTrans Park and Ride lot and other access points to study lagoon biology and complete class projects. Individual users may use the north shore, south shore and beach/lagoon mouth area. Although we have no records of individuals and classes using the lagoon, several local residents estimate several thousand people use the lagoon per year.

Regional Transportation Corridors

A number of transportation routes cross or border Batiquitos Lagoon. Figure G outlines these corridors. Starting at the eastern edge of the lagoon, El Camino Real is a four lane north/south arterial for regional traffic and access to commercial and residential areas. Similarly La Costa Avenue is an important east-west route for local traffic circulation between the La Costa area and Interstate 5. The City of Carlsbad is currently constructing an expansion of La Costa Boulevard. Parts of both La Costa Boulevard and El Camino Real cover former lagoon wetlands.

Interstate 5 is the major north/south freeway in northern San Diego County. The California State Department of Transportation or CalTrans owns, operates, and maintains the freeway and the Park and Ride lot at the La Costa Avenue exit. CalTrans has no plans for widening the freeway in the lagoon vicinity.

Any freeway widening would require filling of the lagoon as the highway currently covers former lagoon wetlands.

The Atchison, Topeka and Santa Fe Railroad tracks span the western lagoon. A wooden bridge crosses the lagoon. There is considerable rail traffic on this line with freight trains and passenger trains crossing the lagoon daily.

The Pacific Coast Highway, called Carlsbad Boulevard in the lagoon area, crosses the mouth of lagoon. This roadway was the primary north/south highway in the region prior to the construction of Interstate 5. It now serves as a scenic route and local arterial, and is maintained by the City of Carlsbad.

A pedestrian access to the north shore of the lagoon is provided by the dirt road, termed Batiquitos Drive or Lagoon Lane on various maps. This road which begins at El Camino Real once ran to the lagoon mouth along the lagoon shoreline. Crossed by I-5, it now acts as a pedestrian/jogger route between El Camino Real and Lagoon Lane. Portions of the old route are still usable west of I-5 but do not provide a complete shoreline route.

Utilities

Several types of utility lines cross the lagoon or run along its edges (see Figure G). San Diego Gas and Electric (SDG&E) has two electrical lines which cross the lagoon on the eastern edge of the lagoon. A 230 KV transmission line traverses the northeast section of lagoon wetlands; no transmission towers stand within the lagoon area. A smaller 69 KV transmission line crosses the western basin.

Two sewer mains border the lagoon. A City of Carlsbad line runs parallel to the dirt Batiquitos Lane along the north shore of the eastern portion of the lagoon. A second sewer main operated by the Leucadia County Water District (LCWD) parallels La Costa Boulevard to the pumping station at the lagoon's western edge and then runs north to the Encinitas Water Pollution Control Plant. LCWD has proposed to expand the pump station at the lagoon mouth. This expansion would have a minor effect on lagoon wetlands.

A natural gas line operated by Southern Cities Gas Company crosses the lagoon near the railroad. This 12 inch pipe carries natural gas to City of San Diego customers.

Summary

At present the lagoon lands primarily serve as a wildlife habitat both officially under the ownership of the Department of Fish and Game and State Lands Commission and unofficially under the ownerships of HPI, Mitsuuchi and Community Bank. The lagoon is bordered and crossed by several transportation corridors and utility lines of various types. None of these uses conflicts with the lagoons function as a wildlife area.
The agricultural uplands along the north shore of the lagoon are slated for mixed use development on the western end and proposed for residential and resort development along most of the eastern end. Residential development covers the steep bluffs on the lagoon's southern shores and the La Costa Resort

and various commercial lands border the floodplain of San Marcos Creek to the immediate east of the lagoon. Green Valley and Encinitas Creek still support some agricultural use but much of this area is planned for development. In sum, the lands surrounding the lagoon and comprising its immediate watershed are either already developed as urban areas or are proposed for development within the next ten years. The lagoon itself remains an important open space area and wildlife habitat/reserve.

PLANS AND JURISDICTIONS

Several government agencies have jurisdiction over activities within Batiquitos Lagoon and its watershed. This jurisdiction is based upon certain geographic boundaries and the type of activity proposed. Table 15 outlines the federal, state and local agencies and their authority in the lagoon. Figure H depicts the boundaries of several regulatory bodies whose jurisdiction is based upon geographic divisions. This section generally describes each agency, its statutory authority and its plans or policies pertaining to Batiquitos Lagoon. This matrix of government regulation defines in large part the enhancement and development activities allowed in the lagoon area and its watershed.

Local

Batiquitos Lagoon and its north shore drainage lies almost entirely within the City of Carlsbad. The lower sections of San Marcos Creek and Encinitas Creek are also within the City. The lands and drainage area to the south of the lagoon and a portion of Encinitas Creek lie within the newly incorporated City of Encinitas. The upper portion of Encinitas Creek lies within the City of Carlsbad. Upper San Marcos Creek is largely within the City of San Marcos. County of San Diego has jurisdiction over many scattered areas in the watershed. Thus the Batiquitos watershed is split between four jurisdictions while the lagoon itself is within a single jurisdiction.

City of Carlsbad

The City of Carlsbad annexed Batiquitos Lagoon into their jurisdiction along with most of the north shore lands and parts of Encinitas Creek in 1984. The City has jurisdiction over the lagoon area and a portion of the watershed for decisions regarding land use and development.

Guiding the City's land use in this area is the City General Plan, Open Space and Conservation Element and the Batiquitos Lagoon Management Plan. The City also has a Local Coastal Program Land Use Plan which pertains to the western portion of the lagoon and its surrounding uplands.

TABLE 15

Regulatory Jurisdictions in Batiquitos Lagoon and Watershed

Government Agency	Legal Authority	Primary Responsibility
Federal		
U.S. Army Corps Engineers	Rivers and Harbors Act of 1899, Section 10; Clean Water Act Section 404	Regulation of dredge and fill in "Waters of the United States" including their adjacent wetland areas
U.S. Fish and Wildlife Service	Fish and Wildlife Coordination Act; Endangered Species Act; Marine Mammal Protection Act	Advisory comments to Corps regarding biological impacts of project including migratory birds and endangered species habitat
National Marine Fisheries Service	Fish and Wildlife Coordination Act; Marine Mammal Protection Act	Advisory comments to Corps regarding impacts of projects on marine species
U.S. Environmental Protection Agency	Section 404(b) Clean Water Act	Comment to Corps on whether project is acceptable under 404(b) guidelines
	Sections 404(c), 402 Clean Water Act	Veto of Corps action on permit
State		
California Coastal Commission	California Coastal Act of 1976	Regulation of development within Coastal Zone; particular concern with protection and, where feasible, restoration of coastal wetlands
State Lands Commission	California State Constitution; Public Trust Doctrine	Regulation of activities in California's tidelands and submerged lands and lands subject to tidal influence in 1850

TABLE 15 (continued)

Regulatory Jurisdictions in Batiquitos Lagoon and Watershed

Government Agency	Legal Authority	Primary Responsibility
California Department of Fish and Game	Fish and Wildlife Coordination Act; Public Resources Code, Section 1600-1603, Fish and Game Code; California Endangered Species Act	Advisory comments to Corps regarding biological impacts of projects; issuance of Streambed Alteration Agreements for development in any stream channel; endangered species consultation for State projects; regulation and management of game species and their taking; management of State Ecological Reserves
San Diego Regional Water Quality Control Board	Section 401 Clean Water Act; Porter-Cologne Water Quality Act	Protection of water quality; certification of federally-permitted activities which involve discharge of fill; preparation of regional water quality plans and standards; issuance of waste discharge permits
Local		
City of Carlsbad	Local police power Municipal Code; zoning law; Subdivision Map Act	Regulation of development within city limits, including north and south shores of Batiquitos Lagoon, portions of San Marcos and Encinitas Creeks
City of Encinitas	Local police power; zoning law; Subdivision Map Act	Regulation of development within city boundaries including southern bluffs of Batiquitos Lagoon, portions of Encinitas Creeks
County Environmental Health Department		Reviews and comments on vector control (mosquitos) through CEQA process; has power to enter public and private land for pest control

TABLE 15 (continued)

Regulatory Jurisdictions in Batiquitos Lagoon and Watershed

Government Agency	Legal Authority	Primary Responsibility
City of San Marcos	Local police power; Municipal Code; zoning law; Subdivision Map Act	Regulation of development within city limits including upper San Marcos Creek drainage
County of San Diego	Local police power; Municipal Code; zoning law; Subdivision Map Act	Regulation of development within the County area scattered throughout the watershed

General Plan

The General Plan has several goals and policies which pertain directly to Batiquitos Lagoon. One goal of the General Plan directs the City to:

> "Protect and conserve natural resources, fragile ecological areas, unique natural assets and historically significant features of the community."

The General Plan indicates Batiquitos Lagoon as a Special-Resource Area due to its regional significance. The plan sets forth several guidelines to govern City decisions on land use in the lagoon until a specific lagoon plan is approved. One guideline applicable to Batiquitos Lagoon is:

> "Limiting future development adjacent to the lagoons and beach in such a manner to provide maximum physical and visual accessibility to these resources for public use and enjoyment."

Under the General Plan, Batiquitos Lagoon for the most part is designated for open space. The plan indicates a ten acre area in the southeast corner for travel services. The lands along the north shore of the lagoon are indicated for residential uses at various densities.

The portion of Encinitas Creek within the City of Carlsbad and just south of the lagoon boundaries is indicated for community commercial, professional and related, and residential uses. The portion of Encinitas Creek within the City east of El Camino Real is indicated for open space. The San Marcos Creek floodplain within the City is also designated open space. (see Figure G)

The Open Space and Conservation Element of the City's General Plan sets several goals which are applicable to Batiquitos Lagoon and its watershed creeks.

> "To preserve optimum sustainable environmental quality levels with respect to air, water and sound levels, and plant and animal life.
>
> "To preserve an adequate amount and variety of open space for outdoor recreation which shall include, but not be limited to, parks, beaches, areas for organized sports, connecting corridors with trails, water recreation areas (beaches, lagoons, lakes) unique conservation areas for nature study, and semi-development areas for camping.
>
> "To protect select wildlife through the preservation of feeding, nesting, and breeding areas.
>
> "To conserve and encourage the use of all forms of vegetation needed to (a) prevent erosion, siltation and flooding, (b) protect air and water resources, and (c) protect and enhance visual resources."

Specific policies to obtain these goals include:

> "Greenbelts: To establish greenbelts to preserve and/or create open space areas as a means of maintaining community scale and identity, separating conflicting land uses, and achieving a sense of natural openness as an

integral part of urban surroundings.

Preservation of Natural Resources: To preserve natural resources by: protecting fish, wildlife, and vegetation habitats; retaining the natural character of waterways, shoreline features, hillsides, and scenic areas; safeguarding areas for scientific and educational research; respecting the limitations of our air and water resources to absorb pollution; encouraging legislation that will assist logically in preserving these resources."

The Open Space Element defines several categories of open space lands. The lagoon and its creeks best fit into the floodplain category and this element outlines the following guidelines for these lands.

"Water resources in the City of Carlsbad should be maintained in as natural and beneficial a state a possible by (a) conserving or improving the appearance and ecology of those which are in a relatively untouched condition, (b) restoring, in accordance with recognized ecological principles and insofar as it is possible, those water areas which have been significantly altered, to a condition which is most beneficial to the public, and (c) simulating a natural condition in areas which are to be altered in the future for purposes of safety engineering, water conservation, or recreation.

"Alteration of waterways that would cause significant adverse impacts on the environment should be prohibited."

These guidelines also apply to the tributary creeks of the Batiquitos Lagoon watershed. The Open Space element identifies the north shore tributaries and San Marcos Creek as prime open space. These guidelines support the restoration of the lagoon and prohibition of the alteration of waterways which would adversely affect the environment. These guidelines should have specific application to Encinitas and San Marcos Creeks where any change in the existing riparian corridor or stream channel could have a great effect on sedimentation in the lagoon.

In summary, the City of Carlsbad General Plan and Open Space Element recognize Batiquitos Lagoon as a Special Resources Area and as Open Space and sets forth guidelines and policies to protect the area.

Zoning

The western portion of the lagoon is zoned for Open Space (O-S) (see Figures G and H). This zoning ordinance allows several uses such as public shoreline recreation, public parks, horse, bike and pedestrian trails, certain recreational uses, scenic and open space easements.

The eastern basin is partially zoned Open Space and partially zoned Planned Community (P-C). The portion of Encinitas Creek just south of the lagoon within the City is also zoned P-C. The Planned Community zone is intended to provide an orderly method for development of residential, commercial or industrial uses. This zone requires a master plan outlining planned uses, open space areas (a minimum of 15% of the total master planned area is required as

open space), public facilities, major roads and water and sewer supply lines. The City of Carlsbad is processing a master plan for the eastern lagoon and a portion of the north shore. No plan is in progress for this area of Encinitas Creek. The portion of Encinitas Creek east of El Camino Real which lies in the City of Carlsbad is zoned open space and planned community (see Figure H).

Prior to annexation of Batiquitos Lagoon in 1984 the City has indicated several areas in their boundaries which lie in the 100 year floodplain of San Marcos Creek. These are indicated on Figure H as a Floodplain Overlay Zone. The City has not extended this zone over the newly annexed lands of the lagoon or Encinitas Creek even though both are floodplain areas. Therefore, we must assume this zone only applies to the areas indicated on Figure H. The Floodplain Overlay Zone (F-P) is intended to supplement the other zoning on floodplain areas to provide additional development regulations to protect the public health and welfare. A special use permit is required for development in this zone which the City Engineer and Planning Commission must review and approve.

Batiquitos Lagoon Management Plan

The City of Carlsbad has another plan, the Batiquitos Lagoon Management Plan which it uses in evaluating developments in the lagoon area. This plan has never been adopted by the City Council and therefore serves only as a guideline for city staff preparing reports and comments on specific projects. The plan discusses the problems the lagoon experiences and recommends goals and policies for development in the lagoon area. The City staff use the goals of the plan when reviewing development projects but do not necessarily use the standards and criteria outlined in the plan to achieve these goals. These goals include:

"-Activities in the drainage basin should not increase the sedimentation rate of the lagoon.

-Activities in the drainage basin should not degrade the lagoon's water quality.

-Minimize impacts on wildlife habitats that are functionally related to the lagoon resource.

-Minimize the impact of development on the visual character of the area.
-Provide a coordinated mix of land uses that are compatible with the preservation of significant lagoon resources.

-Provide passive recreational opportunities around the lagoon.

-Protect, preserve, and if possible, restore the biological productivity of Batiquitos Lagoon."

These goals reinforce many of the goals expressed in the City's General Plan.

City of Carlsbad Local Coastal Program

In November, 1985, the Coastal Commission certified a Local Coastal Program (LCP) amendment for the Sammis Properties lands and Fish and Game lands in the western lagoon. The West Batiquitos Lagoon/Sammis Properties LCP amendment sets forth a number of development uses for the bluff tops and other uses for portions of the western lagoon and adjoining north shore bluffs. This LCP designates the lagoon property and the bluff face as open-space and restricts uses to passive recreation, habitat enhancement and educational and scientific nature study. The LCP also states that the Batiquitos Lagoon Enhancement Plan will determine the ultimate uses in the lagoon.

<u>San Diego County/City of Encinitas</u>

San Diego County Local Coastal Program

Prior to 1984 the lagoon was under the jurisdiction of the County of San Diego. As part of its Local Coastal Program, the County completed the San Dieguito Land Use Plan (LUP) which the Coastal Commission certified. However, for those lands the City of Carlsbad has annexed in Batiquitos Lagoon, Encinitas Creek and the north shore, the policies in the San Dieguito LUP serve only as a guideline until the City of Carlsbad submits and the Coastal Commission certifies its own LUP for this area.

The San Dieguito LUP outlines land uses for the south shore bluffs and portions of Encinitas Creek which were recently incorporated by the City of Encinitas. The San Dieguito Community Plan outlined land uses for those portions of the watershed formerly within the County east of El Camino Real. The new City of Encinitas will be formulating its own Local Coastal Program and community plans; therefore the policies in these documents are only guidelines.

The San Dieguito LUP includes a number of policies regarding Batiquitos Lagoon. These include:

"Policy 41 Prevent Further Degradation of Wetlands

"The County will preserve the function of Batiquitos Lagoon and its immediately adjacent uplands as a viable wetland ecosystem and habitat for resident and migratory wildlife by prohibiting actions which:

1. Involve wetland fill or increase sedimentation into wetlands
2. Adversely decrease stream flow into the wetlands
3. Reduce tidal interchange
4. Reduce internal water circulation, or
5. Adversely affect existing wildlife habitats

"And by encouraging public acquisition of privately held portions of the lagoons and surrounding recreation-suitable areas.

"Policy 42 Reduce Sedimentation

"The County will reduce the rate of sedimentation of the lagoons by formulating procedures for controlling runoff and erosion associated with upland grading and development.

"Policy 43 Restore Biological Productivity and Quality of the Lagoon

"The County will encourage and cooperate with other responsible agencies to plan and implement an integrated management plan for the long-term conservation and restoration of wetlands resources at Batiquitos Lagoon according to the following guidelines:

"1. Plans for the west, central, and eastern basins should be treated as integral parts of the whole.

"2. The plan should be implemented in phases so that discreet physical alterations can be performed as funds become available, and so that the effects of changes can be evaluated at each stage, and recognizing the experimental basis of wetland manipulations.

"3. Wildlife corridors between the wetland shoreline and important uplands areas and upstream riparian areas should be maintained and enhanced where feasible.

"4. Management plans should implement, where possible, adopted State and Federal Wildlife Management Plans (i.e., California Least Tern Recovery Plan, etc.

"5. Human uses of the wetland and adjacent areas should be compatible with the primary use of the wetland as a natural habitat of national value.

"6. Passive recreational activity at the lagoons should be compatible with the primary use of the wetland as a natural habitat of national value.

"7. Passive recreational activity at the lagoons should be encouraged to the extent there are no substantial adverse impacts to wildlife.

"8. Public visual access to the lagoon shoreline from public streets should not be excluded by new uses or structures except where access could substantially affect wildlife adversely.

"9. There should be limited human access to the wetland shoreline since the immediate wetland shoreline and adjacent shallows are the most important sensitive wildlife habitat.

"10. Boating and other water surface activities should be restricted in significant wildlife habitat areas, particularly in the central and east basin and parts of the west basin supporting significant water-bird populations.

"11. The plan should include a provision for sediment catch basins or other sediment control devices outside the wetland area and should periodically remove recently accumulated sediment from the lagoon until a long-range sediment control plan is operational.

"12. Plans should attempt to optimize the habitat for species already known to use the wetlands, as well as certain "featured" species recognized as depleted, rare, or endangered (California Least Tern, Belding's Savannah Sparrow, Snowy Plover, and other species recommended by wildlife management agencies), to the extent feasible.

"13. The integrity of the existing natural system (in particular, topography, hydrology, and vegative cover) should not be disturbed.

"14. Adequate monitoring of chemical, physical and biological changes should be carried out for periodic re-evaluation of the management plan and maintenance of optimal conditions.

"15. Rare and significant habitats such as coastal strand (dunes), salt flats and freshwater ponds existing in and around the lagoons should not be reduced or substantially degraded.

"16. High priority shall be given to actions which serve to remove impediments of internal lagoon water circulation (except where such areas are significant wildlife habitats in their own right) and improve tidal flow with the ocean.

"17. It shall be a long-range goal to remove the flow blockage caused by existing fills for transportation facilities and by existing dikes to the extent necessary to create an adequate internal water circulation system.

"18. Aquaculture uses shall be allowed on adjacent uplands of lagoons, as well as within lagoons themselves, which do not have significant adverse effect on natural processes or visual quality and which would be compatible with other land uses in the vicinity."

To accomplish these policies, the San Dieguito LUP designates both the lagoon and Encinitas Creek as an Ecological Resource Area. The uses allowed under this designation are limited to habitat enhancement, educational and scientific nature study, passive recreational and aquaculture if it imposes no significant adverse effect.

The LUP also outlines a special coastal resource protection area (see Figure H). This area encompasses much of the south shore of the lagoon and watershed of Encinitas Creek (within the coastal zone). The following policies apply to development within this zone and many are designed to protect the lagoon.

"Policy 124 Coastal Resource Protection Overlay

"The county shall adopt and apply a "Coastal Resource Protection Overlay" category in order to assure that development, use, or alteration of land within major areas of environmental sensitivity, steep slopes, major drainageways, and of outstanding scenic quality is reviewed and approved in accordance with criteria, standards and limitation that will protect coastal resources.

"1. Effect of Category - any grading, construction, or removal of natural vegetation that does not now require a permit, or only requires an administrative permit, will require a special permit which will only be issued in accordance with the standards and criteria of this category; and any activity which now requires a discretionary permit or action shall conform to the standards and criteria of this category.

"2. Standards and Criteria - All development and other activities otherwise permitted shall conform to the following:

Board of Supervisors' Policy I-73, Hillside Development, shall apply to development of property containing steep slopes. Slopes remaining undisturbed as a result of Policy I-73 shall be placed in a permanent Open Space Easement as a condition of development approval.

The PD planned development area regulation of the zoning ordinance shall be applied to development of any properties of 10 acres or greater in any size and may also be applied to smaller properties when appropriate.

Drainage and run-off shall be controlled so as not to exceed, at any time, the rate associated with a property in its present state, and appropriate measures shall be taken on and/or off-site to prevent siltation of lagoons and other environmental sensitive areas.

The grading activity be prohibited during the rainy season from October 1 to April 1 of each year.

That all graded areas shall be landscaped prior to October 1 with either temporary or permanent landscape materials in order to reduce erosion potential. Said landscaping shall be maintained and replanted if not established by December 1."

Much of the steep bluffs and bluff tops to the south of the lagoon are designated for residential use at one unit/acre and 2.9 units/acre (See Figure H).

The section of Encinitas Creek now in the jurisdiction of the City of Encinitas is included in two different County plans. The section of creek west of El Camino Real and south of the City of Carlsbad boundary is under the San Dieguito LUP and is designated as an Ecological Resource Area.

The San Dieguito LUP includes several policies which apply to this portion of Encinitas Creek. These include:

"Policy 34 Riparian Habitat

"The County will prohibit any development or other significant disruption of the Encinitas Creek Riparian Habitat.

"Policy 31 Habitat Protection

"The County will preserve the integrity, function, productivity and long term viability of environmentally sensitive habitat areas within the coastal zone, including lagoons, riparian areas, coastal strand areas, coastal sage scrub and coastal mixed chaparral habitat."

San Dieguito Community Plan

The creek section east of El Camino Real is not in the coastal zone and thus is included under the San Dieguito Community Plan. This plan designated the creek as an impact sensitive area. This designation allows for one dwelling unit per 4, 8 or 20 acres or a very low density development. Under County Zoning consistent use regulations allow rural residential use, limited agricultural, open space, utility or transportation corridors, general rural uses and once a specific plan is completed and adopted, the uses the plan designates. The San Dieguito Community Plan contains several goals and objectives which apply generally to this area of Encinitas Creek.

"Encourage types and patterns of development which minimize water pollution, air pollution, fire hazard, soil erosion, silting, slide damage, flooding and severe hillside cutting and scarring.

"Encourage the preservation of the floodplains for recreation, open space, and agriculture and avoid the necessity of constructing concrete channels.

"Encourage the use of natural channels and streambeds, discourage the need for artificial drainage structures, and encourage the use of runoff and drainage for groundwater recharging."

The Batiquitos Lagoon Enhancement Plan incorporates most of the LUP policies for the lagoon and its watershed into its enhancement design, public access plan and watershed plan.

The new City of Encinitas in formulation of their plans could incorporate these County policies or significantly change them. Appendix D contains a set of Best Management Practices (BMPs) to guide erosion control and stream alteration policies in the lagoon watershed. Many of these BMPs reflect and expand upon the policies in the County's LCP and Community Plan

San Diego County Department of Public Health

The Department of Public Health is responsible for vector control in areas such as Batiquitos Lagoon. This Department attempts to control mosquito production

through various techniques one of which is avoiding creating mosquito producing habitat. This Department reviews projects which might involve mosquito areas and comments through the CEQA process.

City of San Marcos

Much of the upper reaches of San Marcos Creek lie within the City of San Marcos. The San Marcos Dam impounds most of the water and sediment from this area and essentially removes this area from the functioning lagoon watershed (see Figure B-2). However several miles of creek below the dam lie within the City of San Marcos and do contribute to the lagoon watershed system.

General Plan

The City of San Marcos is in the process of redrafting and updating its general plan. The draft plan indicates the San Marcos Creek channel for open space. The creek channel is very rocky and steep in this section and alteration for flood control or land development is unlikely. The plan designates the land surrounding the San Marcos creek channel for rural residential use.

Summary-Local Government

Four local governments have jurisdiction over Batiquitos Lagoon and its watershed.

The lagoon and its north shore, most of the San Marcos Creek floodplain and two separate portions of the Encinitas Creek floodplain lie within the City of Carlsbad. The City's General Plan Open Space and Conservation element and West Batiquitos Land Use Plan contain goals and policies which support preservation and restoration of the lagoon as open space, protection of wildlife and retention of public recreation and visual access to the lagoon. The City policies also outline retention of the natural character of waterways. The City's Batiquitos Lagoon Management Plan, although not adopted, contains many goals which guide evaluation of development proposals.

City zoning for the lagoon is different for the western basins and eastern basin. While the western basin zoning is open space much of the eastern basin in zoned planned community. Likewise the San Marcos Creek floodplain is zoned open space as is the eastern portion of Encinitas Creek (within the City of Carlsbad) while the lower area of Encinitas Creek is zoned planned community.

There is a certified Local Coastal Program Land Use Plan which includes the bluffs along the southern margin of the lagoon and a small area of Encinitas Creek. These areas have since been incorporated into the City of Encinitas. This LUP when written also included the lagoon prior to Carlsbad annexation of the area in 1984. It contains many policies to guide land use in the lagoon which are used in this plan. The LUP places a special coastal resource protection overlay zone on the southern watershed within the coastal zone boundary. The San Dieguito Community Plan designates the portion of Encinitas Creek east of the coastal zone boundary (El Camino Real) as an impact sensitive area and for open space. The City of Encinitas will be formulating a plan for

these former county lands and the present LUP and Community Plan may serve as a guide.

Within the City of San Marcos lies much of the upper watershed of San Marcos Creek. San Marcos Dam impounds most of this drainage and separates it functionally from the lagoon watershed. The small area of the creek downstream from the dam in the City of San Marcos is zoned for open space use.

State of California

California Environmental Quality Act (CEQA)

All state and local agencies are required to comply with CEQA prior to approving or denying a project within their jurisdiction or for which they provide funding. Compliance usually requires producing an Environmental Impact Report or Negative Declaration which identifies the effects of the project on the environment and outlines mitigation measures to offset the effects. CEQA allows certain time periods for public and agency review of documents, submission of comments and response to comments by the lead agency.

A number of different State agencies have jurisdiction and interest in Batiquitos Lagoon. These include the Coastal Commission, whose jurisdictional boundary ends at El Camino Real (see Figure H); the State Lands Commission, whose jurisdiction rests on the question of public trust lands in the lagoon; and the Department of Fish and Game, whose authority over the lagoon comes as a primary landowner and as a responsible agency for federal, state and local agency permit actions, and as the issuing agency of Stream Alteration Agreements in the watershed.

California Coastal Commission

In 1972, 55% of the state's voters approved Proposition 20 and created the California Coastal Zone Conservation Commission. By 1975, the regional and state commissions had issued a 443-page California Coastal Plan designating a coastal zone and containing findings and policies concerning topics from natural habitats and wetlands to energy facility siting criteria along the 1,100 mile California coast. During the past ten years the regional commissions and their successors, the State Commission under the California Coastal Act of 1976, have processed more than 50,000 permit applications for development projects within the coastal zone, following detailed statutory, regulatory and judicial guidelines. California communities have been preparing Local Coastal Programs (LCPs) which apply coastal zone management policies at the local level.

The Coastal Act is concerned with protecting agricultural lands, developing coastal access for the public, siting critical energy facilities appropriately, protecting sensitive habitats, identifying hazard areas, expanding commercial fishing and recreational boating, and protecting wetlands from diking and filling. The Coastal Act identifies Batiquitos Lagoon as one of nineteen high priority wetlands for public acquisition.

The terms "wetlands, "biological productivity, "marine resources"; "environmentally sensitive habitats," are cited and defined in a number of sections in the statute, along with policies for development activities such as dredging and filling. The Commission adopted Interpretive Guidelines for Wetlands and Other Wet Environmentally Sensitive Habitat Areas early in 1981 after two years of study and public input. The guidelines were designed to assist local governments in protection, restoration and mitigation efforts in wetlands and adjacent areas undergoing development.

The guidelines contain three important sections: technical definitions for environmentally sensitive habitats, including wetlands and riparian habitats among others; permitted development and conditions in these areas; means of restoration and maintenance of wetland areas. The guidelines elaborated on the statutory definition of wetlands in the Coastal Act, drawing on hydric soils and wetland plant species criteria developed by U.S. Fish and Wildlife Service to provide a more precise basis for identifying wetlands.

The guidelines also establish standards for siting development adjacent to wetlands, and suggest appropriate mitigation measures, such as setbacks, buffer areas, landscaping, erosion control, and drainage control.

The Coastal Commission jurisdiction in the lagoon area extends to El Camino Real (See Figure H) and encompasses both the wetland area and northern and southern uplands west of El Camino Real.

The San Dieguito Local Coastal Program Land Use Plan completed by the County and certified by the Commission included the lagoon area. However since the City of Carlsbad annexed the area in 1984 they have submitted and the Commission certified an LUP for only the western portion of the lagoon. The City has the option of submitting the Batiquitos Lagoon Enhancement Plan as the LUP for the lagoon. Once an LCP is certified by the Commission for Batiquitos Lagoon the Commission still retains primary permit authority within the wetlands area.

State Lands Division and Commission: Public Trust Doctrine

On admission to the Union September 9, 1850, California acquired nearly 4 million acres of sovereign land underlying the state's tidelands, submerged lands, and navigable lakes and rivers. In 1938, the State Lands Commission (consisting of the Lieutenant Governor, Controller, and Director of Finance) was created by the legislature to manage these lands and hold exclusive jurisdiction over them (Public resources Code, Sections 6301 and 6216). These sovereign or "Public Trust" lands are held in trust by the state on behalf of the public for certain limited water dependent or water oriented uses. In certain locations, the legislature has, by statute, transferred trust lands to a local governmental entity (city, county, harbor district) for specified trust uses.

In the 19th century, the state sold extensive areas of tidelands to private interests. These lands, with few exceptions, remain subject to the Public Trust Easement.

California also acquired, by grant from the United States, several million acres of "swamp and overflowed lands" which were to be sold, reclaimed, and put into agriculturally productive status. Often, the ability or desire of surveyors to properly segregate swamp and overflowed lands from tide and submerged lands was lacking. True swamp and overflowed lands lie above the ordinary high water mark while tide and submerged lands, which are subject to the Public Trust Easement, lie below (Civil Code, Section 830). The lack of precision in early surveys results in the necessity today of requiring careful study to resolve disputes over the true physical character of these lands in 1850. Even after intensive research, often the evidence is meager or conflicting as to the true nature of the lands.

As to all the public trust lands within the state (whether sold or unsold), the California courts have assiduously protected the public's rights. In Marks v. Whitney (1971), 6 C.3d 251, a unanimous California Supreme Court reaffirmed that even in instances where tidelands have been sold to private parties and filled, those facts do not extinguish the public easement for commerce, navigation, fisheries, recreation and "preservation of the lands in their natural state, so that they may serve as ecological units for scientific study, as open space, and as environments which provide food and habitat for birds and marine life, and which favorably affect the scenery and climate of the area."

The State Lands Commission, in its management of trust lands, reviews development plans in areas subject to the Public Trust Easement for their consistency with the state's public trust interest in the subject property. In instances where the state owns the fee interest, as well as the easement, a lease may be issued for trust consistent uses. The State Lands Commission has been involved in settling boundary disputes in nearly every San Diego County lagoon, including Batiquitos Lagoon (and hundreds of sites elsewhere). Many of the sites confirmed in state ownership pursuant to settlement agreement have become part of the statewide system of Ecological Reserves maintained by the California State Department of Fish and Game (i.e., San Elijo Lagoon, Bolsa Chica, Upper Newport Bay).

The State Lands Commission also monitors certain activities of legislative grantees (i.e., City of Los Angeles) for compliance with terms and conditions of their trust grant. It is also not uncommon for the California Coastal Commission to condition development permits for projects involving public trust lands upon review and approval of the State Lands Commission.

California Department of Fish and Game (DFG)

DFG has a number of responsibilities and authorities which directly and indirectly influence projects and activities in wetlands and riparian areas. The broad charge of the department, expressed in the California Fish and Wildlife Plan (1966, in revision), states the department's overall objective: "to maintain all species of fish and wildlife for their intrinsic and ecological values, and for their direct benefits to man, such as diversified recreational use, economic contributions and scientific and educational use".

The Department of Fish and Game has authorities under specific sections of the Public Resources Code, Fish and Game Code, federal Fish and Wildlife

Coordination Act, and administrative regulations and procedures to directly regulate or comment on activities in wetlands and riparian areas. DFG is empowered to negotiate agreements for streambed alterations. It has some limited responsibilities with respect to native plant protection, and enforcement of state law concerning endangered and rare animal species. DFG comments on all projects under consideration by other local state and federal agencies which may affect fish and wildlife resources and enforces state fish and game laws, including those that regulate waterfowl hunting. It administers and/or manages state-owned ecological reserves, and it is charged with carrying out specific programs authorized by the legislature.

Streambed Alteration Agreements (Fish and Game Code Section 1601-1603)

In general, this law requires that any proposed project that will divert or obstruct the natural flow or change the bed, channel or bank of any river, stream or lake or use any streambed materials, must be reviewed for its effects on fish and wildlife resources. If DFG finds that the project will adversely affect fish or wildlife, they propose modifications necessary to protect fish and wildlife and negotiate with the applicant to have them incorporated into the project. This law applies to the tributary streams of Batiquitos Lagoon and agreements are required prior to any changes in the streambed.

Threatened and Endangered Plants and Animals

For all projects carried out or permitted by state agencies, state agencies are required to consult with DFG regarding the projects effects on threatened and endangered species (state-listed only). This consultation is required as part of the CEQA process. The agency must obtain a written statement from DFG as to whether the project would jeopardize the continued existence of a threatened or endangered species. If a jeopardy opinion is received, the state agency must adopt alternatives to the project to avoid the impact. DFG encourages agencies to consult with them early in the project planning.

As part of this protection effort, DFG conducts monitoring and field studies of endangered species populations. DFG also comments on federal permit activities and their effects upon threatened and endangered species.

Commenting Policies and Resource Planning

Department of Fish and Game personnel are regularly involved in review and comment on all forms of development-related processes in wetlands: State Lands permits and leases; EIRs and other CEQA documents, EISs; Corps of Engineers Section 10 and 404 permits; Regional Water Quality Control Board (RWQCB) Section 401 (NPDES) permits.

DFG consistently advocates the maintenance of existing fish and wildlife resources. If this goal cannot be satisfactorily accomplished, either project denial or approval with mitigative measures is recommended.

Land Management

DFG is a major land owner in the lagoon and manager of the Batiquitos Lagoon

Ecological Reserve. The primary goal of the reserve is to preserve the wetland habitat for migratory birds, endangered species and other wildlife.

State Water Resources Control Board and the Regional Water Quality Control Boards (RWQCB)

The State Board and nine Regional Boards were designated in 1973 as the state agency responsible to exercise powers set forth in Section 401 of the Clean Water Act. The Boards are also responsible for exercising powers in the state Porter-Cologne Water Quality Control Act, amended 1969. The primary responsibility of the Boards is to protect water quality.

Section 401 of the Clean Water Act empowers the state to require certification that federally permitted activities involving discharge of fill into navigable waterways will meet state water quality objectives, set forth in basin plans. The Regional Boards, acting as agent to the State Board, may issue certificates or place conditions on certification of a Section 404 permit application to ensure that the project will comply with effluent limitations and standards in the Clean Water Act, EPA regulations, and with state standards.

The Regional Boards also issue National Pollution Discharge Elimination System (NPDES) waste discharge permits under Section 402 of the Clean Water Act. The program is administered by the Regional Boards in conjunction with state waste discharge requirements established by the Porter-Cologne Act. The National Pollution Discharge Elimination System applies to point-source discharge of such materials as solid waste, sewage, heat, industrial, municipal and agricultural waste. The NPDES permit program applies to waters of the United States as defined by Corps and EPA regulations, including adjacent wetlands.

The State and Regional Boards have independent authority over water quality, including discharges of dredge and fill material in wetlands. The Porter-Cologne Water Quality Control Act has broader authority than the federal law. The Porter-Cologne Act established the State and Regional Boards and granted the State Board power to formulate state policy on water quality, administer technical research, and enforce waste discharge requirements. The Regional Boards also administer self-monitoring systems for waste dischargers.

The San Diego County Regional Board reviews all waste discharge systems in the lagoon vicinity and is responsible for enforcing restrictions against sewage spills into the lagoon. The Regional Board will review and must certify the Corps 404 permit for the lagoon enhancement.

The Regional Board has completed many years of water quality monitoring at Batiquitos and the north county lagoons. The RWQCB recently released a staff report "A Review of Nutrient Standards for the Coastal Lagoons in the San Diego Region." This report summarizes and analyzes the water quality monitoring data and promulgates a set of nutrient objectives which are site specific for each lagoon. These objectives outline values for total inorganic nitrogen, total nitrogen, orthophosphate phosphorous, total phosphate phosphorous. The Regional Board is expected to review and vote on these revised standards before the end of 1986.

Department of Parks and Recreation (DPR)

The State Department of Parks and Recreation owns and operates South Carlsbad State Beach at the lagoon's mouth. They have adopted a plan for this beach which outlines several proposed activities in Area 3, the lagoon mouth portion of the beach. This plan proposes a day use parking lot for 400 cars on the very southern section of the beach, installation of interpretive signs and access walks and acquisition of the 2.5 acre parcel of County property at the lagoon mouth. Presently the Department of Parks and Recreation does not have funding for these activities.

Any enhancement activities at the lagoon requiring use of State park property will require a special use permit from the Department of Parks and Recreation.

Federal

National Environmental Protection Act (NEPA)

All federal agencies who either propose a project, permit a project or fund a project must conform to NEPA. NEPA requires the preparation of an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI) which outline the effects of the proposal and the measures required to mitigate these effects. NEPA includes provisions for several additional analyses over that which CEQA requires; generally, however, the two laws are very similar.

There are four federal agencies who hold either permit or review powers over Batiquitos Lagoon.

U.S. Army Corps of Engineers (Corps)

The Army Corps of Engineers has permit powers related to Batiquitos Lagoon and its watershed under two authorities:

> Section 10 of the Rivers and Harbors Act of 1899 which regulates the diking, filling, and placement of structures in navigable waterways.
>
> Section 404, Clean Water Act which regulates disposal of dredge and fill materials in the "waters of the United States." This phrase has been judicially and administratively interpreted to include all streams to their headwaters (5 cubic feet per second, average annual water flow; and contiguous wetlands, including those above the ordinary high water mark in nontidal waters and mean high tide in tidal waters).

The Corps uses a three-parameter approach to determine the boundaries of regulatory jurisdiction in a wetland area. Wetland plant species, hydric soils and hydrologic elements must all be present in an area for it to be wetland. The wetland boundary outlined on Figure A was determined by Corps personnel using this approach. Corps regulatory jurisdiction may also extend over San Marcos and Encinitas Creeks and their adjacent riparian vegetation.

The Corps' practice is to issue public notices on proposed projects and invite comments from all interested parties. The Corps can deny a permit to those applicants whose projects are determined not to be in the public interest. Generally, Corps permits will not be issued in those instances where required state or local authorizations have been denied.

The Corps also applies a criteria of water dependent use to developments in wetlands. Non-water dependent projects receive less favorable review for permits.

Any projects (including the lagoon enhancement) within the lagoon wetland boundary (see Figure A) and possibly within Encinitas and San Marcos Creeks will require individual Section 404 permits from the Los Angeles District of the Corps of Engineers.

Environmental Protection Agency (EPA)

EPA's oversees the Corps 404 permit program. The role is more closely defined in a memorandum of agreement between EPA and the Department of the Army and in EPA's 404 regulatory guidelines. The principal areas of EPA's responsibility are in promulgating 404(b) guidelines and criteria for review of permits, review of Congressionally authorized or other federal projects which claim exemption from 404, specific review of proposed discharge sites, and comment on 404 permits. EPA, in effect, can veto Corps permit actions if found not to be in conformance with the 404(b) guidelines. EPA can then take over processing of the permit. EPA may also complete wetland jurisdictional boundary determinations for Corps permits.

U.S. Fish and Wildlife Service (USFWS)

The Fish and Wildlife Service operates under a number of statutory and administrative authorities but does not have direct permit authority in wetlands. Among these are the Fish and Wildlife Coordination Act, Estuary Protection Act, Migratory Bird Act, Land and Water Conservation Fund Act, Marine Mammal Protection Act, and Endangered Species Act. Under these authorities, the agency's basic responsibilities concern migratory birds, fish, waterfowl, and endangered species. The Service shares interest in anadromous fish with National Marine Fisheries Service, whose primary responsibilities lie in marine and estuarine resources.

In conjunction with the Corps' Section 10 and Section 404 permit program, the Service reviews, comments and provides technical assistance to applicants for 404 and other federal permits and other developments in or affecting navigable waters. Under the Fish and Wildlife Coordination Act, the USFWS reviews federally permitted, funded, or constructed projects with the goal of protecting and where possible restoring the fish, wildlife, and natural values of waters and related wetlands. The Coordination Act, which plays an important role in the Corps' denial or conditioning of permits, mandates that any department or agency of the United States, or any public or private agency under federal permit, license, or funding, proposing to modify any stream or other body of water, shall first consult with the Fish and Wildlife Service to determine the effects of the proposed projects on fish and wildlife resources.

The USFWS in their review of 404 permits and projects which would affect wetlands attempt to advise applicants to redesign projects or to design mitigation such that no net loss of fish and wildlife values will occur. Both the Department of Fish and Game and National Marine Fisheries Service use this criteria in their permit evaluations.

The Endangered Species Act, recently reauthorized in 1982, requires all federal agencies to consult with Fish and Wildlife Service when any federally funded, authorized, or approved projects or actions might affect the habitat of an endangered or threatened species. The USFWS is directed to identify and list these species and develop plans for their protection and recovery, principally through management of critical habitat. The Act sets forth a formal consultation process (Section 7) that requires first a biological assessment, where the presence of an endangered species is suspected, and a mitigation plan in the event of project approval. Since the California Least Tern nests at Batiquitos Lagoon, a Section 7 consultation was completed for the lagoon enhancement. Additional review may be necessary for other species.

National Marine Fisheries Service (NMFS)

A part of the National Oceanic and Atmospheric Administration in the U.S. Department of Commerce, the National Marine Fisheries Service like USFWS, has no direct permitting authority. Under the Fish and Wildlife Coordination act, NMFS reviews federally initiated, licensed, or permitted projects which have the potential of altering aquatic environments and biological resources. Existing or potentially restorable spawning, rearing, food-producing, or other habitats necessary for the survival of marine, estuarine, or anadromous resources are of particular concern. The NMFS also has mandated authority under the Marine Mammal Protection Act and Endangered Species Act.

While the Corps must consult with both USFWS and NMFS in their permit procedures, the final decision for denial, conditions, or acceptance of a permit rests with the Corps. However, should either resource agency disagree with the permit decision made by the local district, they may request elevation of the decision to the national offices in Washington D.C.

Summary - State and Federal Agencies

Two agencies - the California Coastal Commission and the Army Corps of Engineers, have the primary permit authority over the lagoon area. Advisory to the Corps on permit applications is the U.S. Fish and Wildlife Service, National Marine Fisheries Service and Department of Fish and Game. These "resource" agencies have policies which require a project to cause no net loss of fish and wildlife values either through permit denial, redesign of the project or mitigation of project impacts. The Corps must weigh many factors in its permit decision including the "public interest" and makes the final permit decision. In addition to its authority over Batiquitos Lagoon, the Corps may also have authority over the riparian resources and streambeds of San Marcos and Encinitas Creeks.

The Coastal Commission has extensive policies and guidelines regarding protection and restoration of wetland habitats. The Coastal Commission has identified Batiquitos Lagoon as one of the nineteen most important coastal wetlands in the state.

The State Lands Commission and Department of Fish and Game have additional authority over the lagoon for each to protect the public trust and fish and wildlife resources respectively. Department of Fish and Game must issue stream alteration permits for any changes in the tributaries to the lagoon.

SUMMARY OF EXISTING ENVIRONMENTAL FEATURES

Our review of the biological, physical, social and regulatory aspects of Batiquitos Lagoon and its watershed has revealed a number of resource problems. These are summarized below.

Soils, Water and Streams

-Road fills and bridges for Highways 101 & 5 and the railroad restrict water movements and act as choke points to water flows.

-Sedimentation from agriculture and suburban development has filled in the lagoon significantly reducing the tidal prism. Tidal inflows are now rare since the size of the lagoon's tidal prism is not sufficient to sustain a channel through the beach against the power of nearshore storm waves and the sand they deposit in the lagoon channel.

-Batiquitos Lagoon watershed experiences high erosion rates with the lagoon as a recipient of much of the eroded sediment. San Marcos Creek is impounded 5 miles upstream from its confluence with the lagoon. Below this point sediment sources are stream channel erosion and agricultural and urban grading on the creek's northern tributary. Sediment carried by Encinitas Creek is trapped in the extensive riparian forest along its floodplain. Sedimentation rates into the lagoon are approximately 1-2 cm/year. Agricultural and land development activities continue to cause high sedimentation rates with the lagoon acting as a settling basin for most incoming sediment. At present sedimentation rates, the lagoon will fill in completely to the +4.0 ft MSL elevation in 30-50 years.

-The lagoon primarily receives water from winter storm flows filling it to +7.0 to +8.0 feet MSL and creating a fresh to brackish water lagoon which may dry out completely in the summer. Water levels fluctuate greatly both annually and over wet and dry years.

-Water quality in the lagoon has been monitored for several years by the Regional Water Quality Control Board. The results of these tests show several trends:

-Salinity levels undergo enormous variation over a year with summer levels reaching 2.5 - 4.0 times the salt level of seawater and winter levels being nearly fresh to brackish. Water temperatures vary greatly over the year.

-Nutrient levels for nitrogen and phosphate, normally low in a marine or estuarine system, were present in higher concentrations than other tidal coastal lagoon systems. Levels of these nutrients increase in summer and cause blooms of algae. However with increasing salinities and temperatures much of the algae dies increasing nutrient levels and lowering dissolved oxygen.

-Overall Batiquitos Lagoon experiences extreme variations in seasonal water quality and for many months of the year has conditions of high salinity, water temperature and nutrient levels beyond the tolerance of most aquatic animals.

Natural Resources

-Due to the extreme variation in water levels, salinity, temperature and water quality, the lagoon presently supports only a small number of species of fish, benthic and aquatic organisms.

-Variation in water levels in the lagoon yearly may create shallow water or deep water over much of the lagoon. Depth of water dictates the types of migratory shorebirds and waterfowl able to use the lagoon as a feeding site. Therefore the type of water year (wet vs. dry) and seasonality of rainfall determine the amount of feeding habitat available to various bird species.

-In comparison to other San Diego County wetlands, Batiquitos Lagoon's most unique attribute is its large areas of seasonally flooded mud/sand flats used as migratory bird feeding areas. Batiquitos Lagoon also contains coastal salt marsh, brackish marsh and small open deep water areas.

-The abundance of Belding's Savannah sparrow, a state-listed endangered species, around the lagoon has not been completely documented. Forty-seven pairs were recorded in the east basin in 1986 but the western basin was not censused.

-Both state and federal endangered California Least Tern and candidate endangered species, Snowy Plover, have nested successfully on the dry salt flats at Batiquitos Lagoon. Variation in lagoon water levels determines the location and size of nesting areas for both species.

-Due to the lack of regular tidal exchange the lagoon does not contribute to the primary productivity of nearshore coastal waters.

Aesthetic Values

-Variation in seasonal water levels combined with water quality problems create noxious odors and a seasonally dry lagoon which many local residents consider to have a lower aesthetic value than a water-filled lagoon.

Plans and Policies

-Major portions of the lagoon are in private ownership. These lands are not actively managed as wildlife preserves as is the portion of the lagoon which is a Fish and Game Ecological Reserve.

-Local City of Carlsbad general plan policies and land use designations support preservation of the lagoon as "open space". The zoning for most of the east basin of the lagoon is "planned community" while the zoning for the remainder of the lagoon is "open space".

-A 2.5 acre fill is proposed for the wetlands on the southeast corner of the lagoon. This site is designated for travel services and zoned for planned community.

-A 16 inch gas line crosses the western lagoon as do several utility lines and transportation corridors.

-The lagoon watershed lies in the jurisdiction of four local governments - City of Carlsbad, County of San Diego, City of San Marcos and the newly incorporated City of Encinitas. Each has different zoning and policies for their portion of the watershed streams.

-State and federal agencies with jurisdiction over the lagoon area have a number of policies regarding preservation of wetland values. These policies serve to direct the type of enhancement planned for Batiquitos Lagoon and generally dictate that no net loss of habitat values occur.

III. THE ENHANCEMENT PLAN

THE ENHANCEMENT PLAN PROCESS AND PUBLIC INVOLVEMENT

In January, 1985 the Coastal Conservancy brought together a number of different people and agencies who were interested in Batiquitos Lagoon. This group, with the later addition of some other people, formed the Batiquitos Lagoon Enhancement Group. The purpose of the group was to set goals for the enhancement of the lagoon and guide the decisions for the direction of the enhancement effort. The group has met monthly since this time, held numerous public meetings and one public workshop and had a large effect on the enhancement design contained in this plan. This group included representatives from Sammis Properties, Hunt Properties, Inc., Department of Fish and Game, City of Carlsbad, Leucadia County Water District, Coastal Commission, Batiquitos Lagoon Foundation, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Army Corps of Engineers.

When the group began, the possibilities for enhancing the lagoon were considerably different than presently envisioned. In January, 1985 the two landowners most interested in the lagoon, Sammis Properties and HPI, were both preparing different studies and enhancement concepts for their section of the lagoon. HPI was studying the idea of filling the eastern lagoon with pumped seawater and impounding it by placing a weir at I-5. Their primary concern was to create an aesthetically pleasing, water-filled lagoon which also served as wildlife habitat. Sammis Properties hired Scripps Institute of La Jolla to calculate the tidal prism necessary to create a tidal lagoon in the western basin or even the entire lagoon. Although these two concepts were not in conflict, they were not necessarily appropriate for the same lagoon. The Conservancy hoped to complete an enhancement plan which would contain a single enhancement concept for the lagoon.

In June, 1985, while the tidal studies were still in progress, the enhancement group held a public workshop and established a set of enhancement goals for the lagoon. Table 16 lists these goals.

In June, 1985, the Conservancy Board approved the expenditure of $40,000 for a consultant to prepare an enhancement plan for Batiquitos Lagoon. The entire enhancement group supported this action. The first activity of the consultant was to identify the existing habitat types at the lagoon, hydrologic characters and problems, land use constraints and to review other studies and field data. The findings of this work is contained in the Existing Environment Section II of this plan.

As this work was progressing, the Conservancy, along with several other agencies, became involved in discussions with the Port of Los Angeles regarding the need for mitigation of the proposed Pacific Texas Pipeline landfill at the Port. The Pacific Texas Pipeline Company proposed to construct a 115 acre landfill in the outer harbor of the Port of Los Angeles. This landfill would serve as the Pacific terminus of a pipeline which would convey oil from Alaska to refineries in Texas. Construction of the project required dredging and filling of subtidal habitat in the Port of Los Angeles.

TABLE 16

BATIQUITOS LAGOON ENHANCEMENT GOALS

Habitat Types

- The overall goal is to enhance the lagoon environment for wildlife habitat.
- Open the lagoon to tidal action while retaining migratory bird habitats to the greatest degree feasible.
- Protect endangered species habitat and create additional habitat where possible.
- Maintain existing areas of wetland and create additional marsh.
- Maintain existing riparian habitat.
- Maintain natural buffer (e.g. bluffs) where possible and adequate lateral buffer (e.g. 100 ft.) in other areas.

Hydrology

- Restore tidal action.
- Provide for a fluctuation of water level.
- Maintain good water quality.
- Keep the lagoon wet as much of the year as is possible.

Public Access

- Create a north shore trail.
- Establish viewing points around the lagoon with interpretive signs.
- Recommend the City of Carlsbad include a bike trail in any expansion of La Costa Blvd.
- No water sports, boats or fishing should be allowed in the lagoon.

Visual Qualities

- Minimize the use of man-made structures.
- Retain a natural look.
- Biological viability takes precedence over aesthetic values should the two ever conflict.

Sedimentation

- Reduce sedimentation into the lagoon using the most cost effective remedies.
- A mixture of public and private funding should be used to operate and maintain lagoon improvements.

The Resource Agencies (DFG, NMFS, USFWS) informed the Port that mitigation for the fill would be required as part of the Corps' 404 permit. The Port has very little area left within its boundaries in which to replace the subtidal habitat they propose to fill. Therefore, a group of agencies (USFWS,DFG, NMFS and the Conservancy) and the Port reviewed a number of sites from Los Angeles to San Diego County for off-site mitigation of the Port's fill.

The three final sites chosen were the Los Cerritos wetlands in Los Angeles County, Tijuana River Estuarine Sanctuary and Batiquitos Lagoon. After further discussions, the Port and agencies identified Batiquitos Lagoon as their primary choice as a mitigation site. This decision was based upon the large area available in the lagoon, the apparent willingness of the landowners to cooperate, and the fact that the enhancement plan process was started and organized. In addition, the Port needed to create subtidal habitat as compensation and the mitigation site needed to be readily accessible to the ocean and ready to proceed in the very near future.

So, in July, 1985, a very different situation faced the enhancement group than had the previous month. The Port of L.A. could provide funding for enhancement of Batiquitos Lagoon to a tidal system. The Port needed to re-create intertidal and subtidal areas and this goal appeared compatible with our enhancement goal for restoring tidal action to Batiquitos Lagoon. Given this general compatibility of the two programs, the enhancement group and the Conservancy's consultants set out to review several alternatives for tidal restoration and agree upon a conceptual enhancement design.

The primary enhancement decisions which needed to be made were:

1) How many acres and what kind of habitats were needed to preserve the existing habitat values at the lagoon for endangered species and migratory birds? How would these habitats be arranged to protect existing marshland and allow the lagoon to function in an hydraulically efficient manner?

2) What size tidal prism was needed to create a "self-maintaining" lagoon mouth which would not require constant re-dredging and maintenance?

3) What type of watershed erosion and sediment control system was needed to protect the enhanced lagoon from filling up with sediment again?

4) How much would the project cost to construct, to operate and to maintain, and how would the project be implemented?

5) How would the dredge spoils be disposed of? How much was suitable for beach replenishment and how should it best be placed on the beaches?

6) Where should the public access trail be located?

7) How would the lagoon lands be managed and owned after the enhancement project is completed?

Following the guidance of the resource agencies and the enhancement group, the Conservancy completed three preliminary enhancement alternatives with different

amounts of dredging. These were presented in a public meeting in October, 1985. The consultants modelled the tidal cycle of each alternative plan with computers to simulate tidal heights and calculate the acreage of habitat types which would be created. The Conservancy then received comments upon all three alternatives. Several groups requested we review a fourth intermittent tidal alternative. A discussion of this alternative was added.

There were two competing factors in the lagoon plan: a desire to create a large tidal prism to assure adequate water movement to keep the mouth open, and a need to create both intertidal and shallow freshwater habitats needed by migratory birds and sandy nesting habitat for Least Terns. In order to determine the acreage of intertidal and shallow water habitat required to conserve existing habitat, the Resource Agencies performed a modified Habitat Evaluation Procedure (HEP) on the lagoon in its present state. They also evaluated each of the three alternatives for the habitat values they would create and determined which would conserve existing values. From these analyses the resource agencies determined the minimum acceptable acreages of intertidal and shallow freshwater marsh which the plan must incorporate to conserve existing habitat values. These acreage figures were given to the Conservancy and are incorporated in Plan Alternative Number One. The analyses completed to determine these minimum acreages were not given to the Conservancy.

Scripps Institute and Nolte & Associates, consultants to the lagoon property owners, had completed separate studies of the tidal dynamics and ocean characteristics in the Batiquitos area. They had defined a tidal prism of such large proportion that little intertidal or wetland habitat would remain in the lagoon should their proposal be implemented. This alternative was rejected by the enhancement group due to its deleterious effects on existing habitat values at the lagoon.

In January, 1986, Plan Alternative Number One was presented for public comment and was endorsed as the "Preferred Alternative" by the Resource Agencies landowners, City of Carlsbad, Port of Los Angeles, and others. This alternative incorporated the results of numerous meetings, field studies, and negotiations between various members of the enhancement group. Two other enhancement alternatives were also presented at this January, 1986 meeting. The fourth alternative has not been reviewed extensively or presented for public comment.

The details of controlling sedimentation, the costs for operation and maintenance and the legal arrangements for implementing the project took further negotiation and study. The conclusions of these studies and resolution of several of these issues are contained in this plan. The Draft Batiquitos Lagoon Enhancement Plan was released in October, 1986. The Conservancy held a public hearing January 15, 1987 to receive public comment. This revised document incorporates as many of these comments as possible. Due to the level of public comment regarding the biological effects of the "Preferred Alternative" (Alternative One) contained in the Draft Plan, the Conservancy no longer endorses any of the three alternatives as a preferred plan. Some of the issues raised require additional research and will be addressed as part of the preliminary engineering and the EIR/EIS. This Revised Draft Plan is separated

into two sections - one volume dealing with the lagoon and its immediate surroundings and the other containing the plan for the lagoon watershed.

The Conservancy has sought public input throughout the enhancement plan process and incorporated the comments we received at each step into the draft plan. The next steps in the process, preliminary engineering studies and the preparation of the two environmental documents (EIR and EIS) will not be directed by the Conservancy. The EIR will be prepared by the City of Carlsbad with the assistance of the Port of Los Angeles. The EIS will be prepared by the Army Corps of Engineers, Los Angeles District. These two documents allow for additional public input and will consider a wide range of alternative plans. The findings contained in these two documents will identify the preferred alternative.

Once these environmental documents are completed and certified, the Conservancy will revise the Draft Enhancement Plan into a Final Plan. This final plan may then be adopted by the Conservancy Board and those elements not funded by the Port (public access, watershed erosion control) could be funded and implemented by the Conservancy.

THE ENHANCEMENT PLAN

The enhancement of coastal wetlands is still an uncertain process. Despite ten years of enhancement efforts in California wetlands, there are still many unknowns and always the possibility that what is planned in an enhancement project will not be realized in the final result. Consequently, there is a degree of risk involved in undertaking any enhancement effort at Batiquitos Lagoon. But there is a more certain risk in leaving Batiquitos Lagoon in its present condition. Sedimentation levels into the lagoon far exceed natural levels and the lagoon is quickly filling in. The lagoon mouth rarely opens except in large floods, and nearly all the sediment entering the lagoon remains there, progressively building up bottom elevations and transforming the lagoon into an upland. Calculations using current sedimentation rates and lagoon bottom elevations found that Batiquitos Lagoon will be filled in its entirety to the +4.0 ft MSL elevation in 30-50 years. As such an event occurs, the shallow water habitat so valuable to migratory bird species will disappear, replaced by marsh and eventually riparian forest and upland. The progressive expansion of the San Marcos and Encinitas Creek deltas into the lagoon demonstrates not only the existance of this problem but the speed at which the filling is progressing.

The primary goals of the enhancement program (see Table 16) are to: "enhance Batiquitos Lagoon for wildlife habitat" and to "open the lagoon to tidal action while retaining migratory bird habitats to the greatest degree feasible." Turning these goals into plan alternatives necessitates looking at the entire lagoon system, not just a single component of the system. The hydrology, water quality, sediment mechanics, each floral and faunal component as well as economic and engineering factors, have to be considered. Achieving these goals requires evaluating each of these components and the overall ecology and function of the lagoon system.

Most of the lagoon's habitat values are directly related to its varied hydrologic regime. Batiquitos Lagoon currently functions as a seasonally flooded wetland subject to varied water depths. The lagoon undergoes yearly and seasonal extremes in water quality and supports few resident aquatic species. Emergent marsh rings the lagoon varying in species composition due to differences in salinity levels around the lagoon. The lagoon's value to migratory shorebirds and waterfowl fluctuates with its water depths and cannot be determined at a consistent yearly value. Likewise, the availability of nesting areas for endangered Least Terns and Snowy Plovers varies with water levels. Unfortunately, the bird counts and data which exist for the Batiquitos Lagoon are not comprehensive enough in scope to relate bird populations and water levels over a long period of time. For example, there is very little data on the lagoon during the dry period which occured in San Diego from 1965 - 1978. The bird data which does exist and is included in Section II, is general in nature. Therefore, any evaluation of the value of the lagoon habitat for migratory birds is a judgement made by trained experts after review of what data is

available. These experts, drawn from both the Resources Agencies and conservation organizations, do not agree on the lagoon's existing habitat values nor do they agree on how to translate these existing habitat values of seasonal wetland into habitat values for intertidal mudflats. The intertidal system provides a different food base for bird species and can be considered a more "stable" system of predictably fluctuating water levels and habitat acreages. There are no previous models to review where a seasonal wetland and a tidal wetland have been compared for value to migratory birds.

The other evaluation inherent in a plan for a tidal system is an analysis of the hydraulic function of the lagoon under different sized tidal prisms. Road fills now constrict water flows through the lagoon and the mouth is confined to a small opening which is blocked by sand and cobbles. The ability of the lagoon to maintain a clear channel can be evaluated using different computer models and approaches, but this evaluation also falls within the category of expert opinion. Scientific expertise in predicting coastal processes is not yet well developed.

For both the tidal system studies and habitat value evaluations there is no easy solution or definitive answers; instead best guesses and expert opinions must be used.

This Revised Draft Enhancement Plan reviews three fully tidal alternatives and one intermittent tidal alternative. The determination of what alternative is the environmentally preferred plan will be made through the EIR/EIS process following preliminary engineering studies. This Revised Draft Plan sets forth a number of conceptual plans for evaluation.

TIDAL ALTERNATIVES

This section reviews three fully tidal alternatives involving different amounts of dredging and various size tidal prisms.

Tidal Prism and Lagoon Channel Closure Conditions

Table 17 lists the physical characteristics of the three tidal alternatives. Alternative One contains the largest mean diurnal tidal prism of 67 million cubic feet. Alternative Two is slightly smaller with a mean diurnal tidal prism of 60 million cubic feet. Alternative Three contains a mean diurnal tidal prism of 46 million cubic feet. Dredging volumes, the size of the entrance channel and the costs of each alternative vary according to the size of the tidal prism involved.

The single most important hydraulic design constraint for Batiquitos Lagoon is to ensure that there is a sufficiently large tidal prism to keep the entrance channel open. The lagoon channel can only retain an

Table 17

SUMMARY OF ALTERNATIVES - BATIQUITOS LAGOON ENHANCEMENT PLAN

	1	2	3	4
Intertidal Area (acres) (+2.5′ to -2.5′ NGVD*)	170	217	317	338 - 348
Subtidal area (acres) (below -2.5′ NGVD)	220	171	71	35 - 45
Area of salt/brackish marsh (acres) (above +2.5′ NGVD)	139	141	141	141
Area of Least Tern habitat (acres)	34	34	34	34
Area of freshwater marsh (acres)	33	33	33	33
Potential mean diurnal tidal prism (million cubic feet)	67	60	46	40
Potential mean tidal prism (million cubic feet)	44.4	40	30.5	30
Potential perigean spring tidal prism (million cubic feet)	99	89	68	----
Approximate volume of dredge material (million cubic yards)	3.0	2.1	1.3	----
Entrance channel area (below 0′ NGVD) (square feet)	1700	1500	1200	----
Total Capital Costs (includes dredging @ $4.00/yd, drag bucket system, beach groins, levee, in million dollars)	12.4	8.8	5.6	----

*NGVD = National Geodetic Vertical Datum - approximately equal to Mean Sea Level

TABLE 18

Summary of Tidal Inlet Characteristics

for Selected California Coast Estuaries and Lagoons

No.	Name	Potential Tidal Prism		Annual Deep Water Wave Power ft lbs/ft/yr x 10"	Closure Conditions	Remarks
		Diurnal	Mean			
1	Smith River Estuary	35	24	303	Infrequent	
2	Lake Earl	430	320	329	Frequent	
3	Freshwater Lagoon	35	25	348	Always	
4	Stone Lagoon	86	64	348	Frequent	
5	Big Lagoon	240	180	348	Frequent	
6	Eel River Delta	200	140	371	Infrequent	
7	Estero Americano	22	15	(200)	Frequent	
8	Estero San Antonio	11	65	(200)	Frequent	
9	Tomales Bay	1580	1070	209	Never	
10	Abbotts Lagoon	17	11	307	Frequent	
11	Drakes Estero	490	340	26	Never	
12	Bolinas Lagoon	200	130*	117	Never	Good Data
13	Pescadero Marsh	6.8	4.6	(200)	Frequent	
14	Mugu Lagoon 1976	27	19	(100)	Frequent	
15	Mugu Lagoon 1857	170	120	(100)	Never	
16	Carpinteria Marsh	4.8*	1.5	(50)	Infrequent	Good Data, Entrance Lined
17	Aqua Hedionda Lagoon 1976	80	55*	28	Never	Entrance Lined
18a	Batiquitos Lagoon 1985	20	13	(30)	Frequent	
18b	Batiquitos Lagoon 1850	90	60	(30)	Never	
19	San Dieguito Lagoon 1976	0.2	0.14	(30)	Frequent	
20	San Dieguito Lagoon 1889	37	24	(30)	Never	
21	Los Penasquitos Lagoon 1976	2	0.75	(30)	Frequent	
22a	Tijuana River Estuary 1986	12.6*	4.8*	(30)	Infrequent	

TABLE 18 (continued)

Summary of Tidal Inlet Characteristics

for Selected California Coast Estuaries and Lagoons (continued)

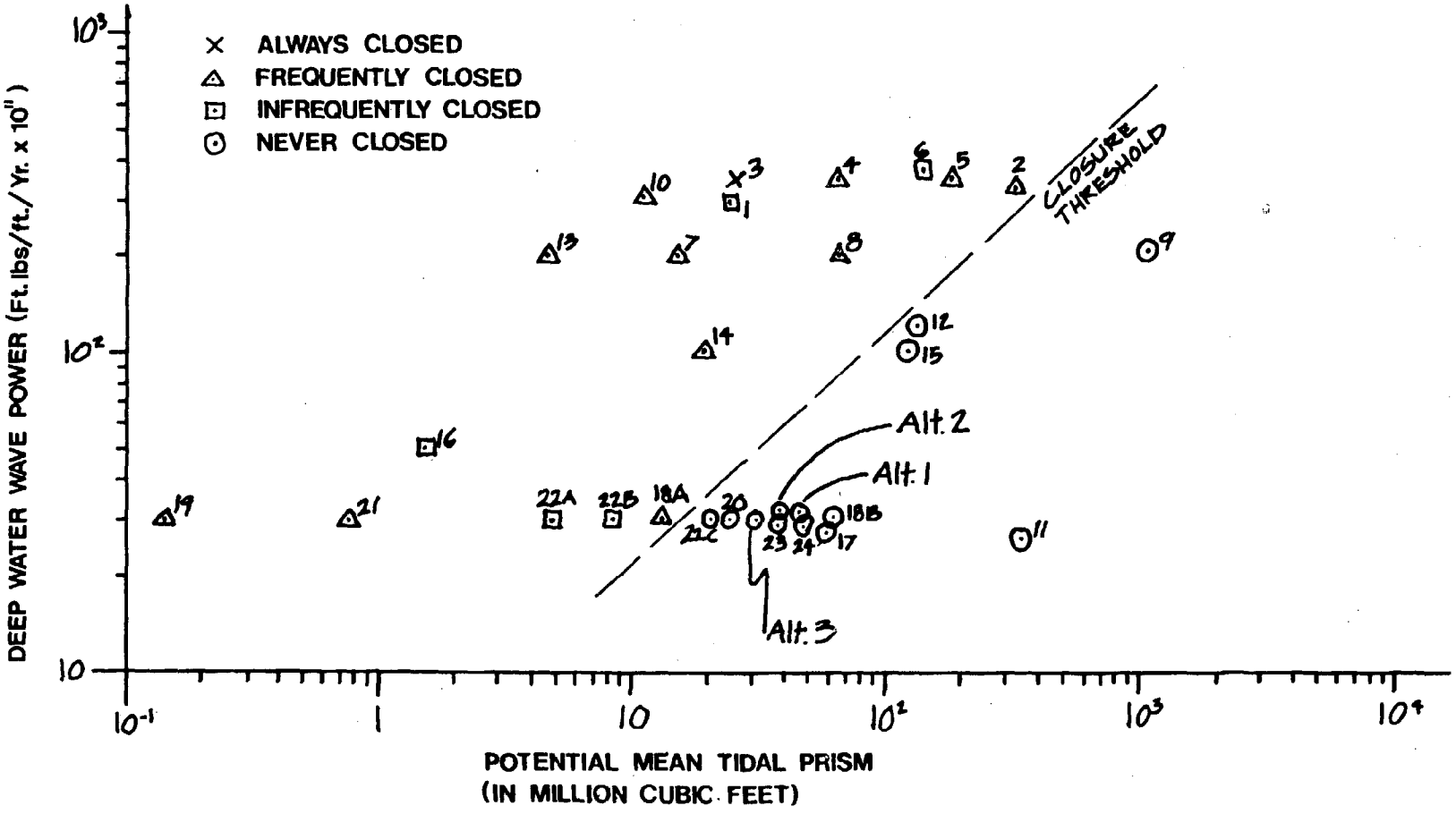
No.	Name	Potential Tidal Prism Diurnal	Mean	Annual Deep Water Wave Power ft lbs/ft/yr x 10"	Closure Conditions	Remarks
22b	Tijuana River Estuary 1977	14.8	8.3	(30)	Infrequent	
22c	Tijuana River Estuary 1928	34.4	20.0	(30)	Never	
22d	Tijuana River Estuary 1852	67.5	47.9	(30)	Never	
23	Bolsa Bay	---	38	29	Never	
24	Anaheim Bay	---	47	29	Never	

* Indicates tidal prism data based on a large-scale topographic map
( ) Indicates an estimate of deep water wave power

Adapted from Johnson, 1973, by Philip Williams and Associates

FIG. 7

Closure Conditions of Natural Lagoons of California



"always open" state if the scouring power of the ebb tidal prism is greter than the wave power along the beach to move sand into the channel. This wave power reaches a peak during storms. The complexity of these hydrodynamic processes, and the difficulty in their measurement, make it difficult to predict a "critical" value for the tidal prism, above which we can be assured the entrance channel will always stay open. This plan takes an empirical approach to this problem. Based upon studies by Johnson (1973) and updated by Philip Williams and Associates, the potential mean tidal prism and closure conditions for 22 coastal lagoons in California were determined, and plotted against deep water wave power. The plotted points are shown in Figure 7, along with three alternatives for Batiquitos Lagoon. The plotted points show a clear separation between lagoons that are "always open" and those that are "sometimes closed". This separation is indicated by a dotted line in Figure 7. The position of the line, however, is only approximate; the minimum tidal prism needed to keep a coastal lagoon "always open" can only be estimated within a factor of two.

If this separation line is shifted downward by a factor of two, both Alternative One and Two remain below the line in the "never closed" portion of the graph. Alternative Three would fall on the dividing line between "never closed" and "infrequently to frequently closed". Alternative Three represents a minimum dredging alternative for maintaining continuous tidal action in the lagoon. Plans which involve less dredging would create an intermittent tidal system.

Jenkins and Skelley (1985) used a different analysis to predict the closure frequency of Batiquitos Lagoon under various tidal prisms. Their study showed a closure frequency of less than once in 30 years for Alternatives One and Two and once every nine years for Alternative Three. The details of this analysis are contained in their report listed in Appendix B.

The reconfigurations of the lagoon under each alternative are presented in Figures I, N and O. The eastern basin would be excavated from the approximate +2.5 foot MSL contour down to the -6.0 foot contour. The western basins would be excavated down to the -8.0 foot contour (see lagoon cross-sections Figures J and K). The hydrodynamic program analyzed tidal heights in the entire lagoon for an average tidal cycle. In order to decrease the amount of friction between the lagoon bottom and tidal flows, to create subtidal habitat and to overdredge the lagoon slightly, the bottom dredging elevations of -6.0 foot for the eastern basin and -8.0 foot for the western basin were decided upon. The hydrodynamic program showed that deeper dredging in either basin provided no additional benefits to tidal flows. Another feature of the dredging contours is a defined bottom channel to help transport fine sediment through the lagoon and out to the ocean. This channel extends from the mouth of San Marcos Creek through the subtidal area to the lagoon entrance channel. This channel will also serve to facilitate flows of freshwater through the marsh to the lagoon and improve current flood problems along lower San Marcos Creek.

For the most part, the dredging area under each alternative is confined to the presently unvegetated portions of the lagoon. The dredging was designed in this way to avoid loss of existing marshland. The exception to this design criteria is the far western basin between the railroad and Highway 101. As previously mentioned, modelling completed for this plan does not conclude the

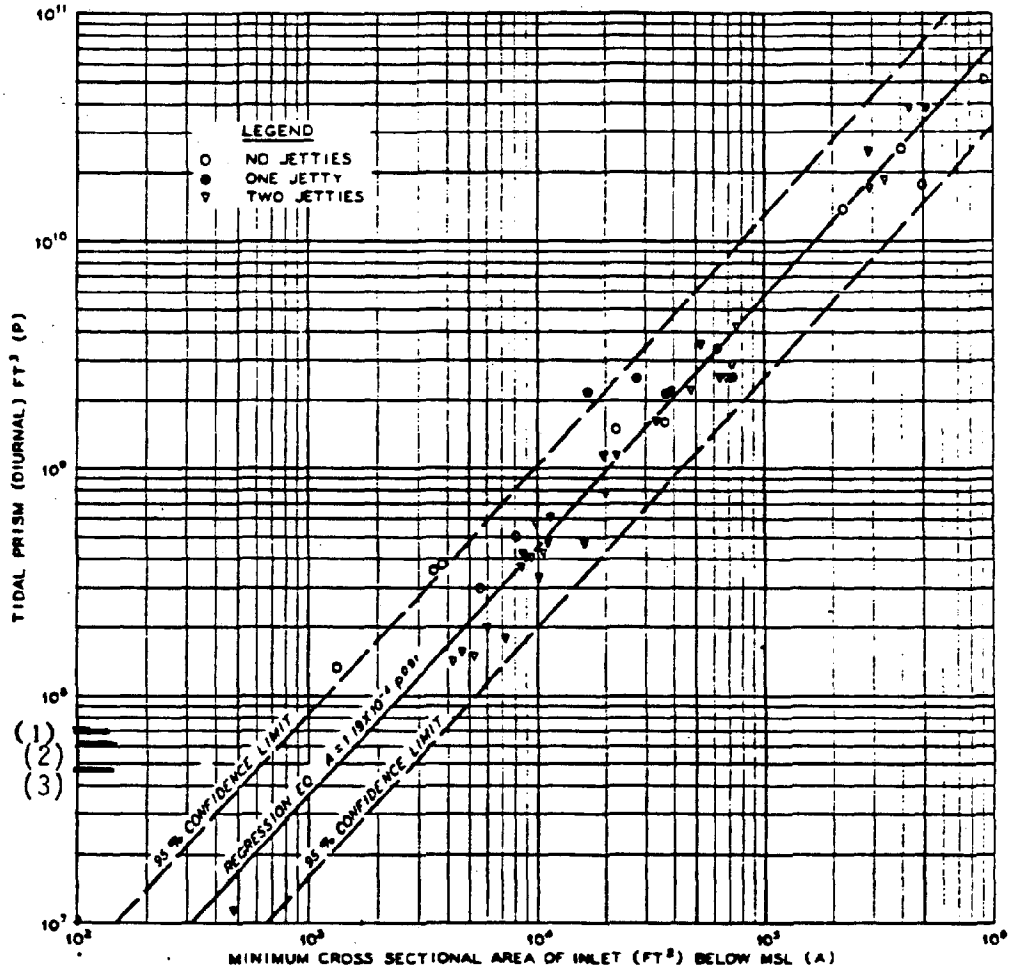
same dredging requirements as the Jenkins and Skelly (1986) report. It was the decision of members of the enhancement group to provide for dredging of the western basin under Alternative One and the design of the dredging incorporates these results. In addition, small areas of marsh in the east and west basins are below the +2.5 ft. contour. These would not be able to survive the inundation once the lagoon is open to tidal action and could not be preserved.

Another way of looking at the size of the tidal prism created under each alternative is to compare them to the historic lagoon tidal prism which existed in 1850. In 1850, Batiquitos Lagoon had an estimated mean diurnal tidal prism of 90 million cubic feet (Jenkins and Skelley, 1985). Alternative One would re-create a mean dirunal tidal prism 75% of the original size. Alternative Two creates a mean dirunal tidal prism which is 66% of the original size and Alternative Three creates a mean dirunal tidal prism which is 51% of the original level.

To determine whether the actual tidal prism will not be significantly less than the potential tidal prism, a tidal hydrodynamic model was used to simulate friction losses (for details see Appendix C). The model found that the difference between the actual and potential diurnal tidal prism was small, approximately 5% for all three alternatives. Ebb flows through the entrance channel are slowed by energy losses and the MLLW level in the main part of the lagoon is increased by 0.4 ft. Most of this tidal dampening is due to the constrictions of the entrance channel through the beach and the Highway 101 bridge. Once the channel is deepened, the I-5 and railroad bridge no longer have much effect on the tidal range.

During the peak ebb flow, the maximum difference in water level between the ocean and the lagoon is about one foot for the mean diurnal tide for the most constricted channel alignment which assumes no dredging of the western basin except for the channel (Alternatives Two and Three). Jenkins & Skelly (1986) have carried out a two-dimensional model simulation that indicated for similar conditions the maximum water level difference to be approximately 1.5 ft. for the perigean spring tide. However, it should be noted that this water level difference does not translate directly into a loss of tidal prism. Instead, it causes a lag and steepening of the tidal wave form as it moves into the lagoon. The actual dampening of the tidal range is considerably less. Therefore, dredging the western basin may not be particularly important to minimize tidal dampening. However, deepening the western basin does add 1 million cubic feet or 1.6 percent to the tidal prism.

A hydrodynamic computer program predicted tidal heights for the lagoon over an average tidal cycle under all three alternatives. Table 19 contains the results of this analysis. Under this tidal regime the proposed dredging contours were designed to create an intertidal zone below existing vegetated wetlands. This intertidal band will encircle each basin and vary from a maximum 10 percent slope to a nearly flat gradient of less than 1 percent slope. At the -2.5 foot contour, the lagoon bottom will drop off at a six percent slope to the subtidal bottom elevation of -6.0 or -8.0 ft MSL.



(1) Alternative 1

(2) Alternative 2
(3) Alternative 3

NOTE REGRESSION CURVE WITH 95 PERCENT CONFIDENCE LIMITS

TIDAL PRISM VS CROSS-SECTIONAL AREA
ALL INLETS ON PACIFIC COAST

FIG. 6

From Jarrett 1976

Table 19

Modeled and Measured Tide Heights, Batiquitos Lagoon, NGVD (ft.)

	Scripps Wharf	West Basin			Middle Basin			East Basin		
		Alt. 1	Alt. 2	Alt.3	Alt. 1	Alt.2	Alt.3	Alt. 1	Alt.2	Alt.3
MHHW	+2.52	+2.5	+2.5	+2.5	+2.5	+2.5	+2.5	+2.5	+2.5	+2.5
MLLW	-2.88	-2.8	-2.8	-2.9	-2.5	-2.8	-2.9	-2.5	-2.5	-2.5

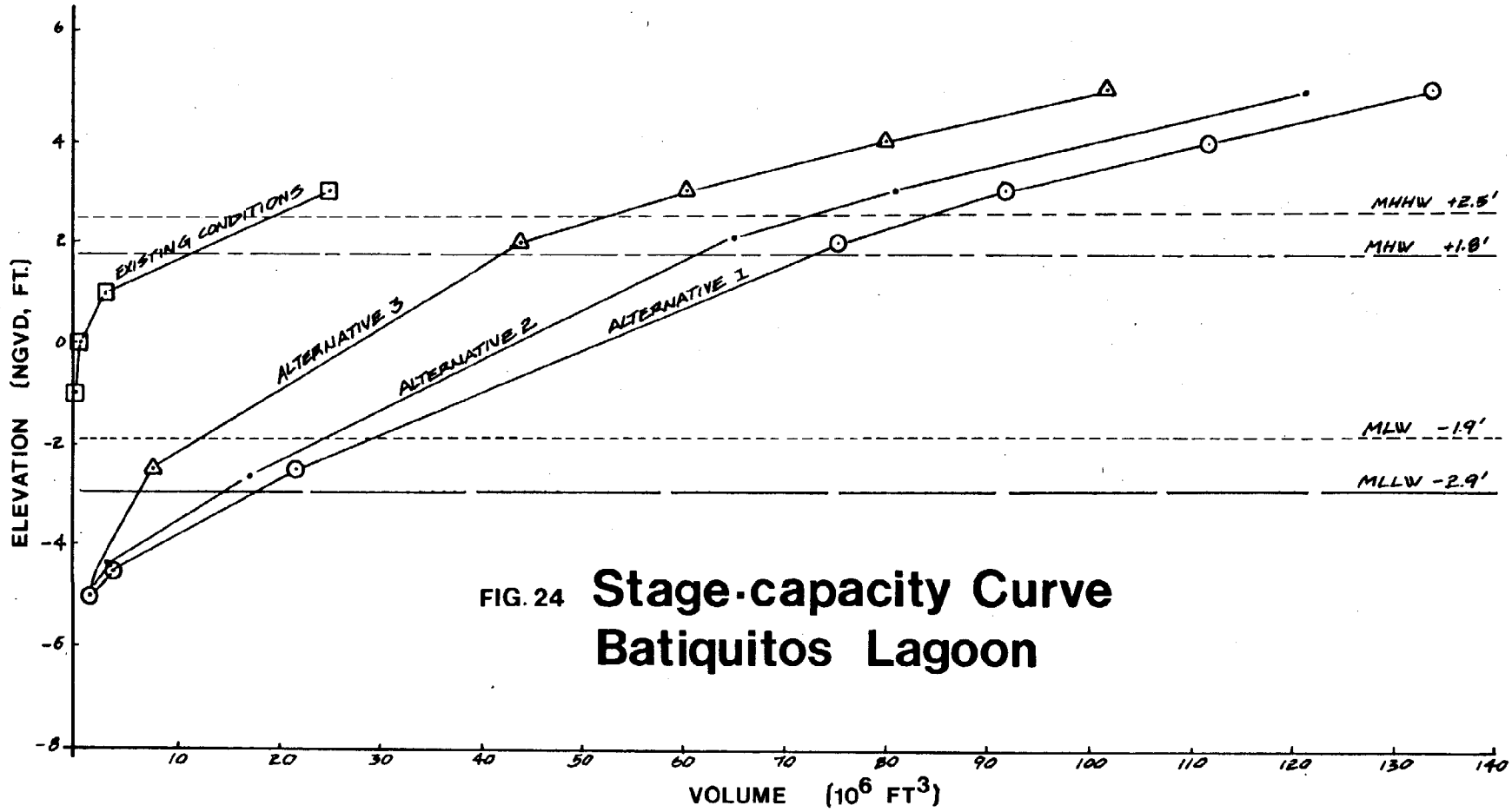


FIG. 24 **Stage-capacity Curve Batiquitos Lagoon**

The cross-sectional area of the lagoon entrance channel will vary with each alternative. Calculation of this cross-section uses the Jarrett relationship (see Figure 6). The cross-sectional area of the channel for Alternative One is 1700 square feet below MSL, 1500 square feet below MSL for Alternative Two and 1200 square feet below MSL for Alternative Three. For example, the width of the channel under the bridge (from headwell to headwell) for Alternative One would be about 160 feet with riprap side slopes at 3:1. This channel would be about 15 feet deep MSL and 10 feet wide across the bottom. For all three alternatives, the entrance channel would require riprap and 3:1 side slopes but would vary in width. The Highway 101 bridge has at least three sets of piers on the southbound lane and seven sets on the northbound lane, therefore engineering specifications for the channel will require provisions for fortification and protection of these piers from undercutting. The lagoon channel would be lined with riprap through the beach to the mean lower low water (MLLW) line. A fence would be erected along the riprap to restrict access to the channel.

Habitat Acreages

The acreages and types of habitat which are expected to occur after the construction of the Batiquitos project are based upon the elevations to which the lagoon will be dredged, predicted tide levels and the occurance of similar habitat types in nearby wetlands.

The three alternatives contain different acreages of subtidal and intertidal habitats. These habitat areas constitute the dredging area within the lagoon. The majority of this dredging will take place below the level of existing vegetated marsh. Table 17 estimates the acreages of each habitat type to be created and conserved under each alternative. Figures I, N and O illustrate the distribution of these habitats for each alternative.

Subtidal Habitat

The subtidal area stretches from -2.5 ft to -8.0 ft MSL and would be covered by tidewater during most stages of the tidal cycle. Several times during the month when low tide levels are at their extremes, portions of the lagoon bottom in the subtidal area will be exposed. However for the most part this is a shallow marine aquatic habitat covered by 5 to 6 feet of water.

Certain fish and invertebrate species would be expected to colonize the lagoon once it is dredged and opened to the ocean. We propose no stocking of the area or introduction of shellfish into the lagoon. Therefore, the abundance of these animals would be dependent upon natural colonization rates and be expected to increase following the initial opening of the lagoon. The types of invertebrates and their abundance will also depend upon substrate types in the lagoon bottom, water quality and nutrient levels and soil chemistry. These factors will change in the first few years following the project.

For example, after the lagoon is dredged the bottom sediments will be made up primarily of sand with little silt or clay. As fine sediments continue to come into the lagoon from the watershed, some probably will settle on the sand and form a mud layer. The thickness of this layer and the mixing of the sand and

mud by bottom currents will change the type of substrate in the lagoon and thus the habitat for benthic organisms.

A similar enhancement project in San Dieguito Lagoon has been monitored for several years following completion of dredging of a tidal basin (Christopher, 1984). The substrate is largely sand and varies from subtidal to intertidal zones. These studies found a number of benthic organisms, the most common being: bubble shell (Haminoea vesicula), wavy chione (Chione undatella), dish clam (Mactra nasuta), California jacknife clam (Tagelus californicus) violet ray jacknife clam, (Tagelus subtores) and marine polychaete worms (Capitella capitata, Polydora paucibranchiata, Scolelepis accuta and Mediomastos californiensis) and various species of oligochaete worms. In addition, other species which could colonize this area include: snails (Ceratostoma nuttalli), moon snail (Polinices lewisi), rough piddock (Zirfaea pilsbryi), ghostshrimp (Callinassa gigas), blue-mud shrimp (Upogebia pugettensis), spenculid worm (Sipunculus nudus), segmented worm (Chaetopterus variopedatus), rough skinned lugworm (Arenicola brasiliensis) and ribbon worms (Nereis spp.).

In general, invertebrate species select their habitats according to the grain sizes of the substrate (sand vs. mud), the amount of wave action or current and the salinity and water quality. As noted earlier, in the first few years after the lagoon is dredged, sediment layers will move and sort according to tidal and storm currents. Soil chemistry and water quality will change as well. The system will not reach an equilibrium condition for several years at least and the invertebrate fauna would be expected to respond to these changes.

The subtidal area will also provide habitat for marine and estuarine fish species such as California halibut, white, spot-fin and yellow-fin croaker, topsmelt, deep-body anchovy, barred and spotted sand bass, long jaw mudsucker, Pacific staghorn sculpin, California killifish, arrow goby and several species of surfperch. Many of these species enter shallow bays and estuaries to spawn. Juvenile fish born both in the open ocean and in the lagoon may spend several months feeding and maturing in the shallow water prior to their migration into the ocean. The abundance of zooplankton and benthic animals will support both juvenile and adult fish. The San Dieguito Lagoon, since its enhancement, supports many of these species.

Juvenile fish and invertebrates provide food for diving ducks, diving ocean birds, gulls and terns including the endangered Least Tern. Presently the lagoon does not provide any subtidal habitat and only very limited fish habitat due to the seasonally poor water quality conditions.

Eelgrass (Zostera marina) is a subtidal flowering plant which provides a rich feeding area and shelter for many juvenile fish species and invertebrates. Eelgrass is rooted in the mud and forms thick beds in subtidal and low intertidal zones. This plant could be planted in the areas of the lagoon of appropriate depth with low velocity water currents. Aqua Hedionda Lagoon contains eelgrass beds.

Alternative One contains the largest subtidal area (220 acres) and would create the largest open water area of the three plans. Alternative Two would create 171 acres of subtidal habitat and Alternative Three would create the smallest

subtidal area of 71 acres.

In all three plans, a greater percentage of the subtidal area would be dredged in the middle and western basins. This design is necessary to facilitate maintaining an open lagoon mouth.

Intertidal Habitat

The intertidal zone is the area which average tidal flows cover and expose twice daily. As with the subtidal habitat, the intertidal zone will be in a state of flux for the first few years following the dredging. Colonization by benthic animals would occur over time and would change as the bottom substrate evolves.

In most lagoons and estuaries, the intertidal zone is habitat to numerous benthic animals which burrow into the mudflats or live on its surface. The infusion of ocean water twice daily provides a source of food for the benthic animals who sieve bits of detritus and food from the water. Worms, clams, amphipods and other creatures inhabit this area. Monitoring studies from an enhancement project at San Dieguito Lagoon found such animals as; polychaete worms such as Capitella capitata, Polydora sp., Scolelepis acuta and various oligochaete worms as well as clam or mollusc species, violet ray jacknife clam (Tagelus subtores) eggshell cockle (Laevicardium substraitum) dish clam (Mactra nasuta); Macoma yoldiformis; razor clam (Solen rosaceus), and striped mussel (Ischadium demissum) in the intertidal area one year after dredging. Other animals which were found in this zone are echinoderms such as Leptosynapta albians, gastropods (Acteocina harpa) and various amphipod species including Caprella equilibra (Christopher, 1984).

Some of the other species which could typically inhabit intertidal sand and mud flats and could colonize the intertidal zone of the lagoon include: sand dollars (Dendraster excentricus), sea pansies (Renilla kollikeri), sea stars (Aspropecten armatus), horn shell snail (Cerithidea californica), moon snails (Polinices recluzianus), ghost shrimp (Callianassa californiensis), burrowing anemone (Cerianthus aestuari, Harenactis attenuata), brittle stars (Amphiodria barbarae) and segmented worms (Mesochaetopterus taylori) and joint worm (Axiothella rubrocincta). Crab species (Portunis xantusi, Heterocrypta occidentalis) may forage in this area as well.

These invertebrate animals provide the productive food base associated with bird use of intertidal areas. The depth of water and productivity of the habitat will largely determine the species and number of shorebirds using different areas of the lagoon. Approximately the same shorebirds species would be expected to use the enhanced lagoon as do presently (see Appendix E). Wading birds, diving ducks, terns, gulls and others would be expected to use the intertidal zone at various tidal stages as well. However, the value of the intertidal area to the dabbling ducks which currently use the lagoon is less certain. Shallow freshwater or brackish water habitats are most valuable to these species. The shallowest areas of intertidal habitat should provide some duck feeding habitat as will the managed freshwater marsh.

The three alternatives vary in the size of the intertidal habitat each creates.

For the most part, this habitat is concentrated in the eastern basin under each alternative. Alternative One contains 170 acres of intertidal habitat, Alternative Two contains 215 acres and Alternative Three contains 315 acres of intertidal habitat.

The interdidal habitat created by these plans would replace the seasonally flooded mud/sand flat habitat which currently exists in Batiquitos Lagoon and supports migratory bird populations. It is difficult to equate the value of the existing seasonal habitat with the re-created intertidal habitat to determine an acreage figure agreeable amongst all involved parties. As part of the enhancement plan process, the Department of Fish and Game and U.S. Fish and Wildilfe Service evaluated this habitat type trade-off through the use of a modified Habiatat Evaluation Procedure (HEP). The HEP system was devised by the Fish and Wildlife Service to determine habitat values as units based upon an evaluation of the quality of the habitat for several evaluation species. It is our understanding this analysis will be released with the EIR/EIS. Therefore, at this time, the Conservancy has not determined which of the plan alternatives best sustains and enhances the habitat values at Batiquitos Lagoon for migratory birds.

However, several nearby enhancement projects may shed some light on the habitat values for bird species created with intertidal habitats. Unfortunately, these areas did not contain the same type of habitats as Batiqutos Lagoon prior to dredging and no direct comparison of value trade-offs can be made.

Upper Newport Bay, located in Orange County, is a 750 acre State Ecological Reserve. The lower bay is a developed harbor and residendtial area with a stabilized entrance. The large watershed of Newport Bay was rapidly developed in the in the 1970's and the primary tributary, San Diego Creek, was channelized in 1968. These actions led to a great increase in sediment transport to the upper bay with filling of many areas. In addition, the upper bay held a large area of abandoned salt ponds which lay above the highest tide levels. These ponds received occasional freshwater from rainstorms but usually were dry salt flats with very low value to wildlife.

Three enhancement projects have been completed in the reserve. The first two enhancement projects involved removing the old salt ponds and dredging this approximately 100 acre area into a subtidal and intertidal area. The total enhancement area as a result of the project was 200 acres. The third project, which is currently underway, involves dredging to remove accumulated sediment in the tidal channel located in the middle of the reserve. This project directly affects 75 acres but will enhance almost 150 acres due to the increase in tidal flushing.

The wildlife of Upper Newport Bay has been monitored since the late 1960's including bird censuses both before and after the enhancement projects. The upper bay has seen an increase in migratory bird numbers after the projects were completed. The restored salt pond area was used by a greater number and diversity of species of shorebirds several years following restoration rather than immediately after. This observation is probably related to the development of a varied benthic community, a process which requires several years (Wilcox, 1986). Bird populations in the enhancement area include large

numbers of puddle ducks which feed in the high intertidal zone. Although freshwater marshes occur nearby, the ducks primarily feed in the saltwater system. Fish populations have also increased and both juvenile and adults of many species are found. While the enhancement projects at Upper Newport Bay differ somewhat from the circumstances at Batiquitos Lagoon, there are some similarities and it does provide an example of a successful project.

San Dieguito Lagoon in San Diego County has also had an enhancement project completed which restored tidal action to a portion of the lagoon. The southern fish hook area of the lagoon had partially filled in from erosion in the adjacent Crest Canyon. The lagoon had not been tidal for many years. The project area consisted of seasonally flooded channels surrounded by salt marsh and upland. The area was highly affected by sediment from Crest Canyon. The enhancement project dredged a new tidal channel and restored Crest Canyon with the dredge spoils and an underground pipe system. The lagoon mouth was also opened with a large bulldozer after construction and has remained open for several years. The 100 acre enhanced lagoon area now contains subtidal, intertidal and salt marsh habitats.

Monitoring studies of the enhancement area have found successful recolonization by benthic animals and estuarine fish species (Christopher et al, 1985). Prior to the enhancement, migratory bird use was low. Following the dredging, monitoring studies found a high diversity of migratory species but relatively low numbers (Mack, 1987). Diving birds, such as the Least Tern, have used the tidal areas for feeding. Overall, the San Dieguito project has proved successful.

Salt/Brackish Marsh

The salt/brackish marsh acreage is composed of existing marsh which occurs above the dredge zone (+2.5 ft MSL). This marsh would experience tidal inundation as a result of the lagoon enhancement but would not be mechanically manipulated or changed.

The introduction of tidal inflows to the lagoon could cause the composition of plant species in the marsh to change. The present distribution of plant species is a response to a hydrologic regime in which the lagoon seasonally floods with freshwater and then dries out and has hypersaline conditions. The present marsh vegetation extends from approximately +2.0 ft. to over +7.0 ft. in several areas. This marsh is a mixture of brackish and salt marsh species.

Studies in other salt marshes in San Diego County have found that a number of physical factors affect marsh plant distribution. These factors include: tidal inundation, elevation, slope, soil salinity, wave force and nutrients. The plan would introduce tidal inflows and create tidal zones in the marsh. The enhanced lagoon would have a mean higher high tide level at +2.5 ft. (MSL) and a spring high tide level at about +4.5 ft. (MSL). Extreme storm tide levels could reach +6.0 ft. (MSL). Figure 25 depicts the elevational occurrence of certain species of marsh plants in relation to tidal influence. The range for each species is a maximum zone and the areal extent of each species in the enhanced lagoon may differ significantly. In the far eastern end of the lagoon the inflow of freshwater could affect the distribution of

plant species and the brackish, less salt-tolerant plant species (e.g. Scirpus robustus, Scirpus Olneyi, Typha domingensis) may occur there. Likewise areas of freshwater seeps may retain their brackish water species. However, for the most part, the re-introduction of tidal flows should create conditions which favor the growth of salt marsh plants (e.g. Salicornia virginica, Frankenia grandifolia, Jaumea carnosa) and increase the vigor of those salt marsh plants already in the lagoon. Many salt marsh species are active colonizers of areas with suitable conditions. Cordgrass (Spartina foliosa) occupies the lowest zone of vegetation in a tidal marsh and does not presently occur in Batiquitos Lagoon. It could be planted in expermential areas once the project has been functioning for several years and sediments and water levels have stabilized. Other marsh plant species including the endangered salt-marsh birds beak (Cordylanthus maritimus) could be introduced to the lagoon wetlands.

Overall it is difficult to predict how the species composition and extent of the marsh will change once the lagoon is enhanced. For the most part the existing areas of marsh are conserved and changes in the acreage of marsh will be monitored.

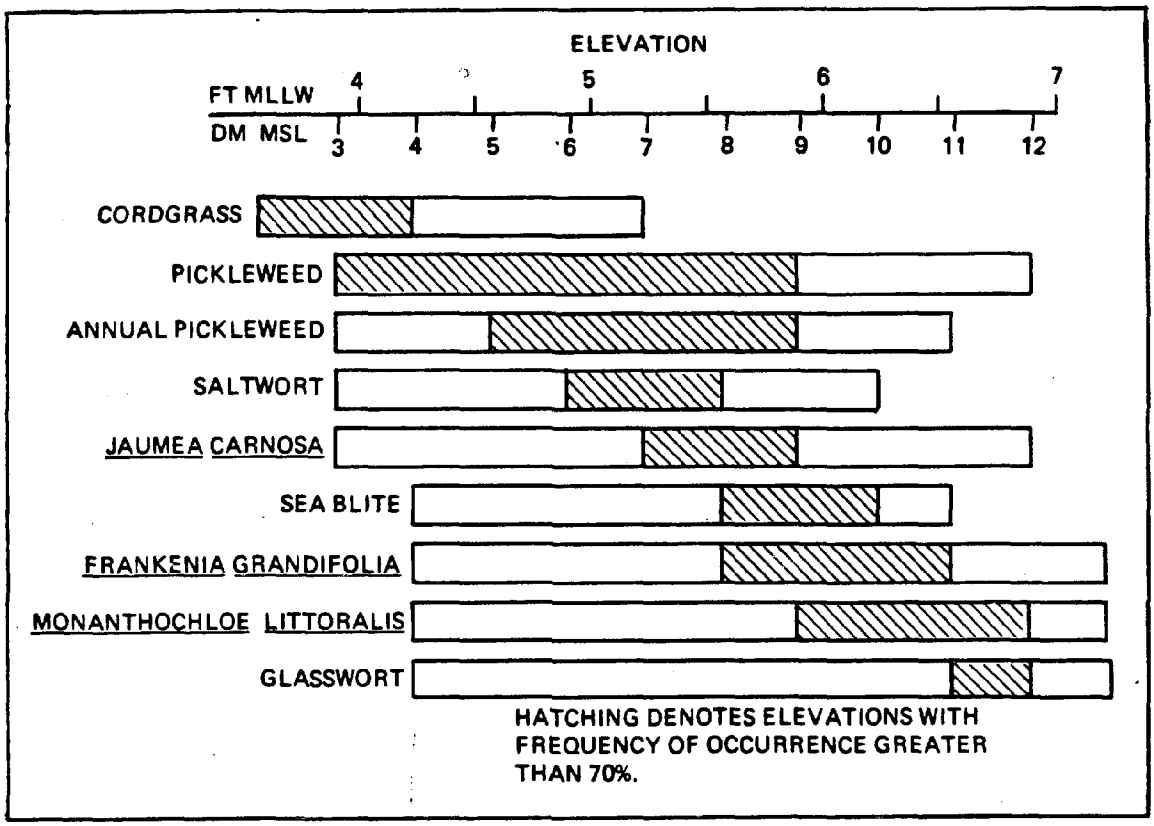
Shorebirds are expected to regularly use the marsh both to forage for invertebrates in tidal sloughs and to roost during high tides. Wading birds and some ducks may also roost and feed in the marsh. Bird species use will depend largely upon the type of plants that predominate. For example, a greater extent of pickleweed marsh could support more breeding pairs of Belding's Savannah Sparrows. More brackish marsh could support long-billed marsh wrens and other small birds.

Alternative One would conserve a total of 139 acres of salt/brackish marsh whereas both Alternatives Two and Three would conserve a total of 143 acres. The four acre difference is due to the dredging of the western basin proposed only under Alternative One.

Freshwater Marsh

All three plans include a managed freshwater marsh enclosed by an earthen levee. The primary reason for creation of a freshwater marsh is to assure the continuance of the existing habitat values at Batiquitos Lagoon. While the intertidal mudflats and subtidal areas proposed in the plans would create habitat for migratory shorebirds, wading birds and some waterfowl, one component of the present fauna - the dabbling ducks - require a freshwater component.

The levee is designed with an approximate 80 foot toe and an 8 to 1 slope on the outer side and a 3 to 1 slope on the inner side (see Figure L). The gentle slope on the outer side would allow for tidal water to inundate the lower portion of the levee and create marsh and mudflat. The 8:1 slope is flat enough to avoid wave erosion and the need for rip rap. The bottom toe of the levee would be constructed at the approximate elevation +2.5 ft. (MSL) and the top of the levee would reach +8.0 ft. (MSL). The top elevation would preclude yearly high tides from overtopping the levee. The interior of the marsh would be recontoured to an elevation of +2.5 to +3.0 ft. (MSL) and would provide deep areas and exposed plant areas to increase diversity. Water depths would be



Distribution of the most common halophytes by elevation, at Tijuana Estuary (Zedler 1977). Data from Anaheim Bay (Massey and Zembal 1979) were used to extend the ranges of species beyond the 3- to 12-dm MSL range observed at Tijuana Estuary.

From Zedler,1982

FIG. 25

controlled at six inches to one foot. The dredging would allow for the portion of the marsh closest to the upland to be higher than the area near the levee so that the marsh can be drained completely.

The water source for the marsh will be San Marcos Creek. A weir would be placed in the creek at the El Camino Real bridge at the +5.0 ft MSL level. This weir would detain water and the water would flow by gravity through pipes into the marsh. Given a maximum evaporation rate of 25 acre feet per month in the summer, it is estimated that the marsh will require 1/2 cubic feet per second (cfs) of inflow during the summer. Summer waterflows in the channel could fill this need. In the winter the need for water in the marsh may be minor since a small tributary enters the marsh area. The weir in San Marcos Creek would be designed such that no upstream flood problems would be created.

Additionally, dual slide/flap gates would be placed at several locations in the levee to allow for release of freshwater when levels are in excess of the six inch to one foot marsh depth and to allow the flooding of the marsh with salt water. All culverts, frames and gates would be coated with replacable zinc anodes and be made of eight gauge bituminous-coated asbestos-bonded galvanized steel for long wear and low maintenance. Salt water flooding in the summer could create a year round habitat should a drought occur and could be used to control tules and other unwanted vegetation. Use of salt water should remain a management option for the marsh, not necessarily a mandate since it could adversely affect certain brackish to freshwater marsh plants needed for waterfowl. When viewed from the adjoining hills the marsh will look like a shallow water pond with small collections of bulrush or other marsh plants. The freshwater marsh would replace salt marsh and salt pan on the site.

The water management scheme and finished bottom elevations of the freshwater marsh will largely determine what plant species inhabit the area. At present, there are not plans to plant marsh species, but instead, the plants would colonize by seed. Cattail, bulrush, three-square rush, pondweed and other aquatic plants would be expected to invade the shallow areas. Because soils may remain brackish for the first years following construction, some plant species may be limited. However, if the marsh is left strictly as a freshwater area, the soils will leach and salts should be reduced. The management of the marsh water levels and annual drying wil largely determine the plants which colonize and thrive there.

Least Tern Nest Sites

The U.S. Fish and Wildlife Service in conjunction with the Department of Fish and Game determined that a minimum of four least tern nesting sites should be created in the lagoon totalling approximately 32 acres. All three plans provide for four sites - one 16 acre site near the Park and Ride lot, one 12 acre site on the north shore, one 4 acre site contained in the levee of the freshwater marsh and one 2 acre site near the lagoon mouth. All these sites occupy locations of previously used nest sites. When tidal influence is returned to the lagoon, the previous nest sites on the salt pan will be flooded. Therefore to provide sufficient area for the terns to nest, new nesting sites have to be created. These sites would be created out of sandy dredge spoils from the lagoon and raised up to +8.0 ft. MSL. A layer of clean

white imported sand with broken shells would cap the dredge spoils.

The Least Terns previously have used a greater number of sites in the lagoon but the availability of most of these sites is limited by high water levels. Since 1969, the Least Terns have never used more than three sites in one season and have more typically used one or two sites (see Table 13). All existing sites are prone to disturbance and flooding.

Maintenance of the nesting sites will be required; removal of all vegetation must be performed yearly. In order to gain access to the nesting sites they are located close to the edges of the lagoon. In order to protect the sites against predators six foot cyclone fencing will border the lagoon edge in the vicinity of the least tern sites and be located a minimum of 100 feet from the site. Both ends of the freshwater marsh levee would be fenced. The fencing will restrict domestic animals and other terrestrial predators from entering the nest sites. The fence is located at a distance from the site so that avian predators are not able to use the fence posts as hunting roosts.

An additional nesting area could be gained if the levee surrounding the freshwater marsh were kept free of vegetation and covered with white sand. Least Terns in the San Francisco Bay area nest on similar levees surrounding salt ponds.

All four sites are designed to provide relatively isolated, dry sandy locations with clear views for the terns. A number of different sites are provided to allow for various locations over the entire lagoon for the terns to choose from. A total of 34 acres of nesting sites are provided.

Construction Methods and Schedules

All three alternatives would require dredging and disposal of large amounts of sand and silt material from the lagoon. Before exact construction methods can be outlined and a reliable schedule drawn up, a number of tests must be completed. The only available studies on the lagoon sediments are a limited number of corings of the lagoon bottom in the eastern basin and a larger number in the western basin (Woodward-Clyde Consultants, 1985; Shepardson Engineering Associates Inc., 1985). These corings reveal information regarding the grain size of the material and thus the thickness of clay and silt layers and sand layers over the lagoon bottom. These coring studies did not include any chemical analysis of the materials. The City of Carlsbad and Port of Los Angeles have hired a consultant to complete sediment cores and chemical and physical studies of the lagoon sediment.

The available coring studies give gross estimates of the quantities of two classes of sediment on the lagoon bottom. The upper layers of the lagoon bottom are primarily fine silts, clays and fine sands with grain sizes smaller than .125 mm. The silt and clay layer in the east basin is much thicker than the west basin and could compose 60 to 70% of the dredge volume from the east basin.

The sand fraction in the lagoon lies below the clay and silt layers and represents a larger proportion of the dredge volume in the western lagoon than

the eastern basin. The median grain diameter of the sandy sediments in the western lagoon is .18 mm while the median grain diameter for the same layers in the east basin is .15 mm. These sandy sediments are coarse enough to be used for beach nourishment should bioassay and toxin testing prove negative (Jenkins and Skelley, 1986).

These two sediment layers must both be tested for the concentration of toxic chemicals, nutrient levels and other substances. The results of these tests will determine where the dredge spoils can be disposed of and could have a great effect on the cost of the project. Detailed soils engineering studies, which are currently underway, will determine exact quantities and conditions of spoils. There are a number of possible options for dredge disposal and construction methods.

The most inexpensive method of dredging the lagoon is to use dry land techniques. Construction would begin in the east basin and progress to the west. In the early spring (February-March) the lagoon mouth would be opened and the lagoon drained. Inflowing streams would be diverted by pipe to the ocean, stormdrains or other appropriate outlet. Groundwater would be pumped out of the basin and the lagoon bottom dried out. Rubber tired scrapers or comparable equipment would remove the silt and clay layers and spoils would be disposed of in one or several ways. The silt-clay spoils must be dried prior to disposal and, if possible, the adjacent north shore uplands owned by Sammis and HPI could be used.

Once dried and depending upon the test results, the spoils could be:

1) trucked to a sanitary landfill for disposal;
2) mixed with fine sands and sold or given away as structural fill;
3) used as landscaping fill on adjacent properties; or
4) disposed of in the ocean at a site approved by the Environmental Protection Agency.

The preferable option would be to place the spoils on adjacent properties for landscaping fill should they pass all needed tests for this use. Sammis Properties has offered to accept approximately one half million cubic yards to fill a canyon on their property (Jon Briggs, pers comm). A site is still needed for the remaining matrial. Placement of the spoils on adjacent properties would avoid the use of public roads. If the spoils are transported to other sites for disposal, additional equipment will be needed as the rubber tire scrapers can not travel public roads. A fleet of dump trucks would be used and could be loaded at the end of Lagoon Lane or other appropriate access points.

Both the landfill and ocean disposal options are prohibitively expensive and nearby landfills may not have the capacity for such a large disposal project. Remixing the spoils for use as structural fill will require some additional space but could possibly be feasible.

The levee for the freshwater marsh would be constructed from on site dredge spoils and is the only feature of the lagoon project which could utilize the clay-silt spoils. The interior of the marsh also needs to be dredged to create

a bottom elevation (+2.5 ft. MSL) such that water impounded in San Marcos Creek could flow by gravity into the marsh. A suggestion for using the marsh as a recipient site for silt-clay spoils to raise the base level would require pumping water into the marsh, and thus increase yearly operating costs and is not recommended.

The method for disposal of the silt-clay layers will be determined after elutriate, bioassay and soil engineering tests are completed during the environmental review, preliminary engineering and permit processes.

The sand layers will also require certain toxicity tests but they are of suitable size for disposal on local beaches. Elutriate tests and bulk sediment analysis test must be completed. The lagoon dredging could produce as much as 1.8 to 2.0 million cubic yards of sandy material under Alternative One or as little as 800,000 cubic yards of sand under Alternative Three. Alternative Two would proudce approximately 1.3 million cubic yards of sandy material. Again dry land methods would be employed if possible as they are less costly than dredging. The majority of sandy spoils lie in the middle and western basins. Once silting spoils are removed, these sandy layers would be scraped up and transported to the lagoon mouth for placement on the beach. Depending on the type of construction used (dry land vs. hydraluic dredging) the method for placement of the spoils on the beach may differ. If dry land methods are used and scraping equipment can fit through the three bridges, the scrapers could deposit sand directly on the beach. A dirt haul road may be needed along the beach. If the scrapers can't transport sand directly they would load it into dump trucks at the end of Lagoon Lane for the east basin and Highway 101 for the west basin or other appropriate access points. Dump trucks would use public roads to transport the sand to the beach for disposal. Some sandy spoils would be used to construct the least tern sites in the lagoon and cap the freshwater marsh levee.

Disposal of sandy dredge spoils on Carlsbad beaches is not only convenient to the lagoon project but allows for nourishment of a badly eroded coastline. Sand movement in this area has been interupted by the construction of Oceanside harbor which traps southward moving sand. In addition, the sand supply has been depleted by the damming of most rivers and streams and year round closure of many lagoons such that sandy sediments deposit in the closed lagoon or behind the dam rather than being carried out to the coast. The littoral cell supplying sand to the Carlsbad area begins about San Clemente and ends about La Jolla. Generally sand volumes are deposited onto the beach by ocean waves in spring and summer and eroded off the beach during winter. Depending upon the amount of sand in the cell and the storm sizes, the width of sandy beaches in this region varies.

The profile of the Carlsbad beaches was measured in 1983 and 1984 (Flick et al, Seymour et al). The winter of 1982-83 saw extreme wave heights associated with El Nino. During the winter the large storm waves removed 200 cubic meters of sand per meter of beach. This erosion quantity is associated with extreme storm waves. The following year winter storms removed 20-35 cubic meters of sand per meter of beach. These erosion losses represent more average winter storms.

As can be witnessed during a trip to the South Carlsbad Beach, sand is in short supply and the beach is often made up only of cobbles. The dredging of Batiquitos Lagoon has as a by product the placement of sandy spoils into this littoral cell. While deposition of this amount just below Oceanside harbor progessing southward would be favorable, the cost to truck this much material exceeds the costs of dredging it from the lagoon (V. Hall, pers. comm.) Therefore, the placement of the material on the beaches likely will begin at the mouth of Batiquitos Lagoon and progress northward. One likely beach nourishment method would be the creation of large sand piles or dunes at the landward edge of the beach. These dunes could be progressively pushed onto the beach to nourish the intertidal area. Numerous other methods are possible as are various management options to increase the longevity of the sand on the Carlsbad beaches.

The precise method for placement of the sand spoils on the beach and the miles of beaches covered will be determined through the environmental review, preliminary engineering and permit processes. Since State Department of Parks and Recreation owns and operates most of these beaches, their concerns and suggestions will help to determine what methods are used. Their primary concerns have been: sand stockpiling should not seriously constrain recreational activities on the beach, and dredging and spoils disposal should not negatively affect benthic animals in the surf zone and grunion spawning. All cost estimates for the lagoon project assume that the sand spoils will be placed on the beach in the most cost-effective manner.

Several constraints must be placed on the construction activities to protect existing resources of the lagoon. In order to minimize disturbance to the lagoon wetlands, heavy equipment should enter and leave the construction area at one or two points where little or no vegetation is present. Several locations on the north shore of the eastern basin are appropriate. Access to the western basins will be more difficult and may need to be done under the Highway 101 bridge or from the fill site in the northwestern corner of the western basin.

The beginning of project construction largely will depend upon the timing of permit approvals and CEQA compliance. However the beginning of construction must be scheduled either prior to the beginning of the nesting season of the Least Tern or following fledging of all chicks. The nesting time period stretches from April or May to August or September. If construction begins anytime during this period it would disturb the terns and cause a loss of a nesting season. Therefore construction may begin in March or October. Since it is more difficult and expensive to construct during the wet season, a March date would be preferable. By timing the construction of the project to protect the tern, the construction should not affect any other endangered species. However, during the de-watering and construction period, the lagoon would not function as a bird feeding habitat.

Maintenance of the Lagoon Channel

Waves such as occurred during the extreme storms of 1982-83 will no doubt occur again. These waves have enough energy to fill the lagoon channel inlet with sand and cobbles and overcome the scouring energy of the tidal prism flowing

out of the lagoon. There are no reliable predictions for how often such extreme storms would occur; there are also no foolproof predictions of how well the lagoon channel will maintain itself under normal winter storm waves. In addition, the large concentration of cobbles presently blocking the lagoon mouth is a major concern in the self maintenance of the lagoon mouth. It is not entirely clear that the proposed tidal prism will be able to consistently push these cobbles from the lagoon channel. The City of Carlsbad and Port of Los Angeles have hired consultants to review these problems in detail and complete a detailed engineering design for the lagoon mouth. Under all three alternatives, some type of back-up system is required to open the lagoon channel should it become clogged.

A number of different methods are possible. The Highway 101 bridge and its supporting piers create a narrow constricted channel which does not allow for certain types of equipment to operate easily. Bulldozers and some dredging equipment will not be able to operate well to clear the channel. The recommended method would be the use of a drag bucket which could scoop sand and cobbles out of the channel and redeposit them offshore. There are two alternative ways to set up a drag bucket system.

The recommended alternative is discussed in Jenkins & Skelley (1986). The following excerpt describes the system,

> "Drag buckets have been used successfully in both inlet maintenance and beach nourishment from offshore deposits. The best design has been the Sauerman drag-scraper. It is a bottomless bucket with three vertical sides, a lid, with a front side open to the scraping direction and a backside that is closed. The bucket is dragged seaward through the inlet by a shore mounted winch operating an endless loop drag-cable system to a block and tackle moored offshore to the bottom. As the bucket is dragged seaward, it fills with sediment until reaching capacity. On the return haul to shore, the contents of the bucket are deposited out the open end at the point of reversal.
>
> "Considering the inlet dimensions at Batiquitos, as well as the volume of sand that had to be excavated to reopen the lagoon in September 1985, it is estimated that an inlet bar would typically comprise about 300 cubic yards. Practical experience has shown that 300 round trips of the bucket are feasible per day. Therefore a 3 cubic yard capacity bucket would allow clearing of the inlet in about 1/2 day. This would require a 260 horsepower winch to drag a bucket of this size. The block and tackle should be anchored seaward of the mean shoreline by about 850 feet in order to avoid seasonal burial by bar formations. A 350 pound Danforth anchor would provide a 7 kip mooring with a 2:1 safety factor for the block and tackle. The block and tackle is secured to the anchor using a length of pig-tail sufficiently long to reach the surface at the mooring point. A marker float is attached to the block and tackle at the pig- tail. The endless loop drag cable must be recovered upon completion of the scraping operation. This involves a small boat recovering the marker float, raising the block and tackle to the surface and disconnecting it from the pig-tail. The drag cable and block and tackle are then retrieved by using the shore mounted winch. The pig-tail and anchor are left on the bottom with the marker float

attached for future relocation. To initiate scraping operations, a polypropylene rope must be brought out from the shore to the marker float. There a small service boat is anchored. Using the propylene line, a winch on the service boat will haul the drag cable and block and tackle assembly out to the mooring site. The marker float line is used to retrieve the pig-tail and reattach the block and tackle. This procedure requires relatively calm seas to initiate. Furthermore, recreational swimming must be prohibited 100 feet to either side of the drag cable during scraping operations."

This system would only be set up when needed and is relatively inexpensive to operate. The shore mounted winch would be located on the fill site at the northwestern corner of the western lagoon basin. The drag bucket system would be able to remove both sand and cobbles from the channel. The drawback to this system is the hazard it poses to swimmers when the cable is in use and its limitations for use in heavy seas.

The second alternative involves construction of a pier for use as a base for a drag bucket system. This alternative involves:

"This approach would build a short pier, 400 feet in length and parallel to the axis of the inlet channel. The pier should extend 300 feet seaward and 100 feet into the lagoon channel. The deck of this pier would be at the elevation of the Highway 101 bridge, +19 feet MSL, and should provide access to the highway for a mobile crane. The mobile crane is operated on the deck of the pier and is used to drag the Sauerman bucket seaward to perform the scraping operations in the inlet channel. The scraping operation could be performed from the pier in higher sea states than could the drag cable method, and would not involve the potential hazard to the swimmers associated with the drag cable. The pier could be used as a recreational fishing pier when scraping operations are not being performed. The estimated cost in building such a pier is $2,000 per foot, or a total of $800,000."

The disadvantages of this system are its high construction costs, high maintenance costs and the need for a public agency to operate the pier and accept ownership and liability. The Department of Parks and Recreation, which must approve of the maintenance system, favors the drag bucket system. DPR also requires a safety risk assessment, operating procedures and contingency plan developed for the system. For these reasons this plan recommends the use of the first alternative, a drag bucket system using an offshore bottom moored block and tackle.

Sediment Control System

This plan proposes a number of facilities for controlling sedimentation into the lagoon. A review of present watershed conditions identified four tributaries for which no sediment control facilities were proposed or presently in place. Estimates of sediment from these four tributaries were made for various storm levels. The details of this analysis are contained in Section II. Table 20 summarizes the results of this analysis. These facilities are proposed to control estimated annual loads of heavy sediments; large storms (100 year) may create sediment loads beyond the capacity of these facilities.

It is not practical to construct sediment control facilities which will capture the fine sediments entering the lagoon as these basins must be extremely large and detain stormwater for up to several days to settle out fine particles. Therefore, it is assumed that the lagoon, once dredged and returned to a tidal system, will transport the majority of fine sediment out with tidal flows into the ocean. If the lagoon mouth closes frequently or remains closed during large storms, much of the fine sediments (approximately 80% of the total sediment inflow) would be retained and deposited in the lagoon. Therefore, keeping the lagoon mouth open during storms is important to controlling sediment deposition and filling of the lagoon.

An equally important factor in controlling sediment inflows is controlling the erosion of soil in the watershed, the source of lagoon sedimentation. The Batiquitos Lagoon Watershed Sediment Control Plan, bound as a separate volume, outlines in detail both structural and non-structural regulatory and design approaches to erosion and sediment control.

Structural Control Facilities

This portion of the plan reviews structural control measures for several tributaries to the lagoon.

Encinitas Creek The riparian corridor on lower Encinitas Creek is presently functioning as a very effective sand trap. Continued deposition of sediment in the valley floor will gradually increase the slope of the stream and increase the stream's sediment transport capacity. Eventually, the stream may reach some threshold and begin a cycle of downcutting and lateral migration, delivering stored sand to the lagoon. Rather than constructing a large debris basin, however, it makes better sense to manage the riparian corridor downstream of the intersection of Olivenhain and El Camino to enhance and maintain its ability to trap sand. This can be done by constructing a low dam across the channel with several culvert outlets. All the culverts should be set at the same elevation in the dam in order to disperse flow across the riparian corridor. Sand can be removed from parts of the trap on a rotating basis, so that some willow cover will be maintained. The purpose of maintaining some vegetation is to enhance the sedimennt trapping ability. It would not be necessary to maintain a large "freeboard" below the dam elevation for the trap to work, but only to maintain a low gradient in the reach above the dam. The area available for this sediment trap will depend on landowner cooperation. The average annual sand yield of Encinitas Creek is estimated to be about 1-2 acre feet; a layer of sand 1-2 feet thick would need to be removed

Table 20

Batiquitos Lagoon Sediment Control

Basin	Drainage Area (square miles)	Sand Yield with BMPs* (cubic yds/yr)			Sand Yield without BMPs* (cubic yds/yr)
Piraeus	0.60	480	to	660	1750
Eolus	0.3	240	to	480	1272
Encinitas	5.50	1775	to	3550	9407
San Marcos	10.8	3333	to	4750	4750
		5303		9440	17179
Annual Maintenance Cost at $4.00/yard		$21,212		$37,760	$68,716

*Best Management Practices

Table 21

Percent Efficiency of a Sediment Trap on San Marcos Creek

		Size fraction				
	Total	Coarse sand	Fine and very fine sand	Medium and coarse silt	Fine and very fine silt	clay
2-year flood	46	98	92	46	4.7	0.0
100-year flood	32	96	78	20	1.2	0.0

FIG. 26

Sediment inflow and retention

SAN MARCOS CREEK SEDIMENT BASIN

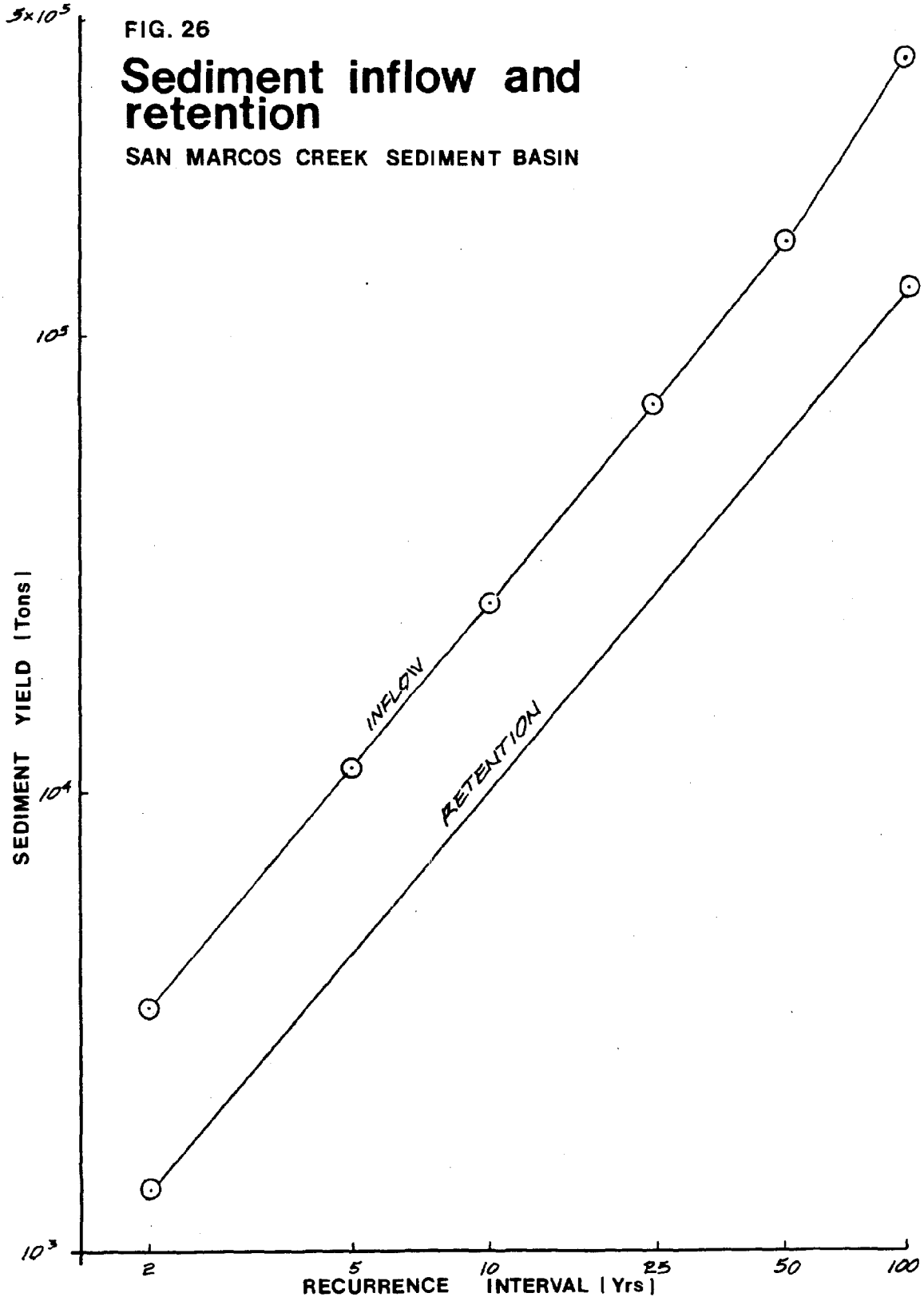


Table 22

Sediment Basins or Traps Required to Protect Batiquitos Lagoon

Location	Vol. (cubic yards)	Estimated Construction Cost
Piraeus[1]	3300	$33,000
Eolus[1]	2400	$28,600
Encinitas[1]	17,750	$30,000
San Marcos Creek[2]	15,130	$160,000

1) volume based on 5 years accumulation at mean annual rate

2) volume of pond at +5.0 ft. NGVD; annual maintenance will be required.

from a 5-acre trap every five years on the average. In the 300 foot wide riparian corridor, a 5-acre trap would be 726 feet long. The riparian forest downstream of the trap should be preserved as a natural floodplain to further assure adequate sediment trapping.

It will also be necessary to install a concrete sill or apron in the bed of Encinitas Creek at the La Costa Bridge. This sill will prevent the initiation of channel incision in response to the lowering of the base level in the lagoon from dredging and the progressive aggradation upstream.

San Marcos Creek Two alternatives for sediment control were considered: 1) dredging a basin above the El Camino Real Bridge to enhance deposition of sediment; 2) dredging a pool below the bridge in the wetlands at the head of the lagoon. Sand could be dredged from the basin by a dragline but the pool in the wetland would require a hydraulic dredge and an area dedicated to storage and dewatering of dredged sediment. Because a pond at the head of the lagoon dedicated to sediment control would be detrimental to wildlife habitat and aesthetics and would be more costly to maintain, the preferred control measure is a basin above the bridge.

The channel of San Marcos Creek between the El Camino Real Bridge and the golf course is a natural area for sediment deposition. By dredging out a pond 300 feet wide and 500 feet long just above the bridge, and deepening the channel upstream, the sediment trapping ability at this area can be enhanced. In order to evaluate the feasibility and annual maintenance costs, a sediment transport and deposition model was used. The model is based on the Bagnold sheer velocity limit and the settling rate for five ranges of particle sizes.

The model was run for the 2- and 100-year, 8-hour flood hydrographs, with a pond outlet at +2.0 and +4.0 feet NGVD, against both mean low and mean high tides. The mass of sediment trapped for the 2- and 100-year events was then plotted, and the mean annual load trapped was calculated. The results indicate that:

1) Tide height has little effect on sediment deposition above the bridge during major storms.

2) A low weir at +2.0 feet NGVD combined with a higher weir at +5.0 feet (the lower weir would appear as a slot in the higher weir) would effectively trap sand during the 100-year flood, but virtually all of the sediment from a 2-year flood would pass through the low two foot slot and enter the lagoon. Therefore, this design proved ineffective.

3) By combining a 20-foot wide control structure (such as a weir) at +4.0 feet (NGVD) with a 140 foot wide weir at +5.0 feet, most of the sand in both the 2- and 100-year storms could be trapped. Table 21 and Figure 26 show the trap efficiency for five size classes of material, for the 100-year and 2-year events. The mean annual trap efficiency is 36 percent, or about 4740 cubic yards. There are, no doubt, other weir widths and elevations that would work as well as those tested in the model. This design is the preferred plan.

Before the San Marcos Creek sediment trap can be designed and built, however, two problems must be faced. First, the effect of a control structure in the bed at +4.0 feet (NGVD) on upstream flood elevations must be evaluated. This could be done fairly easily, with recent cross sections across the channel and the floodplain above the bridge. Second, the property must be acquired in fee title or an easement dedicated to a public agency from its present owner, the La Costa Resort.

It will be necessary to install a concrete sill or weir in the bed of San Marcos Creek at the El Camino Real Bridge to prevent downcutting into the upstream alluvium as a result of the lagoon dredging. The sill should be placed no lower than the present bed elevation of about +2.0 feet (NGVD).

Piraeus and Eolus Ditches Drainage ditches adjacent to I-5 on the south side of the lagoon contribute sand directly to the lagoon. At the intersection of Piraeus and La Costa Boulevard, there is a natural site for a debris basin. The trapezoidal channel there is presently filled with sand. It is cleared periodically by CalTrans, but there is no dam or weir to enhance sediment accumulation. Construction of a 3300 cubic yard debris basin for Piraeus and 2400 cubic year for Eolus is recommended.

Non-Structural Control Measures

Revision and adoption of erosion control ordinances (Best Management Practices) in the Cities of Carlsbad, San Marcos and Encinitas and the County of San Diego. The watershed plan reviews the City of Carslbad's erosion control ordinance and suggests adoption of this ordinance (with several additions), in the other jurisdictions. Throughout the watershed, the sediment yield estimates used in this plan are based on long-term average rates. Certain grading practices, replacement of riparian corridors with concrete ditches, road-building on steep slopes and other kinds of intensive site disturbance could negate any downstream sediment control efforts. Implementation of this ordinance as well as the following measures are essential to reducing sediment inputs to the lagoon.

Changing agricultural practices in the watershed to reflect Resource Management Practices as suggested by the Soil Conservation Service.

Adoption of floodplain management criteria for stream channels in the Cities of Carlsbad, San Marcos and Encinitas and the County of San Diego. The watershed plan reviews the sediment retention features of natural floodplains and offers two options to retain these features through the development process.

Adoption of stormwater management criteria in the Batiquitos watershed by the Cities of Carlsbad, San Marcos and Encinitas and the County of San Diego. These criteria should reduce the amount of peak runoff produced by new developments in the watershed and decrease the problem of streambed erosion and sedimentation into the lagoon.

Public Access

The plan outlines a number of public access facilities. The facilities include

a north shore trail with interpretive facilities and trailhead parking and interpretive facilities at a few other locations around the lagoon.

The original goal of the enhancement group was to provide a continuous public access trail from El Camino Real to the ocean along the north shore of the lagoon. There are a number of major impediments to this goal including the Interstate 5, the railroad and the Highway 101 bridges. In all three instances crossing under or over these bridges presents construction difficulties and does not necessarily increase the recreational value of the trail. We have attempted to solve this problem in several ways outlined in the proposed alignment for this trail (Figure M).

Beginning in the east, the trailhead will occupy a portion of a 10 acre parcel in the far northeast corner of the lagoon. This property is owned by Rancho La Costa/Newport Shores, but the Conservancy presently holds an open space easement over it which was dedicated as a condition of development. Contained within this open space easement is also a public access easement. This trailhead will be accessible from Arenal Road and interpretive signs explaining the natural resources of the lagoon would be located there.

From this trailhead, the trail will follow the existing dirt road west. This road has been used by the public for over 100 years and continues to be used today. The California State Attorney General's office has informed the Conservancy that they have determined that prescriptive rights apply to this road and that it is therefore public (Greg Taylor, State Attorney General's Office, pers. comm.). In this first section the road borders the lagoon wetlands but does not cross through wetlands.

The proposed trail will begin to divert from the dirt road on the HPI property. Following a trail alignment reviewed and tentatively agreed to by HPI and staff of the Coastal Commission, Department of Fish and Game, City of Carlsbad, and the Conservancy, the trail moves to border the lagoon wetlands and will be located within the outer 50 feet of the 100 foot wetland buffer. The trail moves from the lagoon border to the dirt road and back along the shoreline in this section.

The Department of Fish and Game has recommended that the trail be placed on the outer 50 feet of the 100 foot wetland buffer so that a minimum of wildlife disturbance is created. Our trail proposal incorporates this recommendation in most locations, particularly when the trail diverges from the dirt road. However in several sections the dirt road directly borders the wetlands and therefore the creation of a new trail would create a larger land disturbance than use of the existing road. Staff for the Department of Fish and Game have reviewed the trail alignment and agreed with using the dirt road in certain areas designated on Figure M, despite its close proximity to the lagoon wetlands.

As proposed, the trail will follow the lagoon edge and then the dirt road as it crosses off the HPI property and onto the Savage property to intersect with Lagoon Lane (Batiquitos Drive). The plan proposes that the end of Lagoon Lane be another trailhead for this section of the trail. Lagoon Lane is a public road and trail users can park along the street. Interpretive signs would also

be placed at this trailhead.

Continuing the trail around the wetland and under Interstate 5 is extremely costly and could also create a disturbance to wildlife. We have indicated this portion of the trail as a possible future access trail but do not recommend it be built at this time. The trail would have to be constructed as a wooden boardwalk over the marsh and along both sides of the I-5 road berm. The crossing under the bridge could be placed on the road fill. The estimated cost for this boardwalk is over one million dollars and could involve substantial disturbance of the marsh during construction. There is also possible public safety issues involved with placement of a trail so close to moving tidal water.

The plan therefore recommends that the eastern section of the trail have a trailhead at Lagoon Lane and a trailhead at the northeastern end of the lagoon. Hikers wishing to proceed further on to the ocean can walk up Lagoon Lane to Poinsettia Lane, cross I-5 and proceed back toward the lagoon on Avenida Encinas into the proposed Sammis Development. Once this development is constructed, hikers can proceed along Windrose Circle and reach the access trail for the western portion of the lagoon. Access signs proposed for the public streets would direct hikers to trailheads.

The access trail along the western shoreline of the lagoon will have several access points and a number of interpretive stations. The primary access point for the trail will be on Windrose Circle in the Sammis Development. From this point, hikers can proceed to the bluff edge and proceed down to the lagoon shoreline and east along the lagoon to a wildlife observation platform.

Alternately, from the same access point on Windrose Circle, hikers can proceed west along one of two tentative routes. This section of the trail has a number of impediments which make its design more difficult. The railroad line is a significant obstacle to pedestrian access due to the speed and volume of rail traffic on this section of track. The proposed alignment would create a trail along the bluff top with a bridge over the railroad to the western bluff. The Conservancy has received a letter from the Atchison, Topeka and Santa Fe Railway Company expressing their willingness to enter into an agreement with a public agency for a grade-separated overpass to provide pedestrian access across the railroad. The design of this bridge crossing must include:

1. Vertical clearance from top-of-rail to underside of structure of 23 feet or more.

2. Horizontal clearance to accommodate two tracks plus a maintenance road.

3. A location suitably beyond the end of Santa Fe's track bridge to allow Santa Fe's bridge maintenance equipment, including cranes and pile drivers, to work and maneuver.

4. Fencing or mesh screens along both sides of the overpass structure, curved inward at the top to prevent users from throwing rocks or missiles at the trains.

5. Fencing or walls along both sides of Santa Fe's right-of-way for a sufficient distance to discourage "short-cutting" across the track at-grade rather than using the overpass.

6. The use of concrete and/or steel for the structure, not wood.

7. Approval of construction plans and specifications by Santa Fe.

8. Approval by the State Public Uitlities Commission for a public crossing.

This crossing would provide continuous public access along the western basin shoreline as required under the Coastal Development permit for Sammis Properties and is therefore the preferred alignment.

As an alternative, should the bridge crossing not be approved, a trail alignment at the base of the bluff is shown. The trail would have to be placed between the bluff face and the wetlands and would have to be constructed as a boardwalk. The trail would be in very close proximity to both the wetland and the water area. This trail alignment would result in adverse effects on the lagoon wetlands and public safety problems with easy access to the lagoon water and the difficulty of patrolling an uncontrolled access to this area of the lagoon. For these reasons, the blufftop alignment is preferable to the trail along the base of the bluff.

The final leg of the trail would cross the top of the bluff on the far western portion of the lagoon and end at Highway 101. Limited parking is available on Highway 101. A number of viewpoints and interpretive stations are located in the western section of the trail. In addition, several lateral access trails provide connections between the roads in the Sammis Development and the shoreline trail.

Another tentative alignment for a trail under the Highway 101 bridge to the beach is shown. It is not clear at this time whether there will be room for an access trail in this location or whether there will be public safety problems due to the depth of the adjacent water channel.

A final design will be needed once the alignment of the trail is decided upon. As presently envisioned, the trail will be approximately 10 feet in width and, for those areas not following the dirt road, would consist of crushed granite or some other all weather surface. Interpretive stations would be wooden kiosks with signs and displays explaining various features of the natural and archaeological resources of the lagoon. Benches or wildlife viewing platforms may also constitute interpretive facilities. No large interpretive center building is currently planned for the lagoon area.

Along the south shore of the lagoon the plan proposes interpretive and wildlife observation facilities for the CalTrans Park and Ride lot. These would consist of kiosk signs and binocular viewers to gain a close-up view of lagoon wildlife. Due to the proximity of this site to the Least Tern nesting site and mudflats, interpretive facilities would concentrate on Least Terns and migratory shorebirds.

The Batiquitos Lagoon Foundation has proposed managing a docent program for the lagoon. The final design of the trail facilities will be completed in conjunction with the Foundation, the City of Carlsbad, the Coastal Commission, and affected landowners.

The plan also recommends that the City of Carlsbad include a bike lane along La Costa Avenue in their current road widening project. The north shore trail would be for pedestrian use only and a bike lane along La Costa Avenue would allow for a continuous bicycle access along the lagoon.

In summary, the plan proposes a north shore pedestrain trail in two segments - one bordering the eastern basin of the lagoon and one bordering the western basin. Both segments would be connected by public streets, making possible a continuous hike from one end of the lagoon to the other. The plan also suggests a number of interpretive facilities around the lagoon and a bike path along the south shore of the lagoon.

Land Ownership and Land Management

Presently the lagoon area up to the wetland boundary is held in several different ownerships, both public and private (see Figure F). This ownership pattern makes for inconsistent management or lack of management of the lagoon. In order to carry out the goals of this plan and implement the enhancement program, the lagoon will need to be held under one ownership.

Since the Department of Fish and Game owns a large area of the lagoon, the plan recommends they manage the entire enhanced lagoon as an Ecological Reserve. DFG would have a part-time lagoon manager who would oversee the lagoon and operate and maintain the improvements. The primary management objective for Batiquitos Lagoon would be preservation in perpetuity of the fish and wildlife habitat values created and conserved through the enhancement project.

As explained in detail in the Plan Implementation section, the private lands in the lagoon must be transferred to the State Lands Commission before the dredging project can begin. The State Lands Commission will then lease the property to DFG and the entire area would be managed as an Ecological Reserve. Ecological Reserves are created to preserve wildlife habitat and very few uses are allowed. Nature study, hiking along access trails, sportfishing from designated shoreline areas, and passive recreation are allowable. Boating, swimming, hunting or commercial fishing are not permitted. This category of protection seems most consistent with the enhancement goals for the lagoon and affords the best long-term protection and management for the lagoon and its resources.

The lands needed for the sediment basins on San Marcos Creek and Encinitas Creek will require dedication of fee title or a conservation easement. Because the riparian corridor on lower Encinitas Creek in Green Valley is an integral part of the proposed sediment control facilities, a conservation easement should also be recorded for it. The property at the lagoon mouth, owned by the County of San Diego will also require a transfer of title or conservation easement.

Operation and Maintenance

Many features of the lagoon enhancement program will require on-going operation and maintenance. Funding and responsibility for operation and maintenance is discussed in detail in the Plan Implementation section.

The primary plan elements requiring operation and maintenance are:

1. general oversight of lagoon use and condition
2. lagoon channel inlet
3. managed freshwater marsh
4. Least Tern sites
5. sedimentation control basins
6. public access trail

The costs for maintenance for these features are outlined in Table 23.

1. A lagoon manager who works part-time under the Director of the Department of Fish and Game will oversee the operation and maintenance activities for the lagoon. The manager will oversee or, when possible, perform maintenance activities and monitoring. A specific manager for Batiquitos Lagoon is needed due to the large number of maintenance activities, the need for an on-site and readily available person to clear the lagoon channel and sediment control facilties and the need to formulate and carry out the operating plan for the freshwater marsh each year. Along with a manager, a number of other facilities will require funding each year to cover replacement and operation costs.

The lagoon manager will also need to oversee the general operation and maintenance of the lagoon. This task includes partolling the lagoon area and assuring that no one is swimming or boating in the lagoon or harassing or feeding wildlife. If feasible, a DFG warden may be responsible for the task.

2. The preferred method for opening the lagoon channel inlet is the drag bucket system using an offshore anchored block and tackle. Large storms could close the lagoon mouth at any time and closure could occur several years in a row under certain weather patterns. Therefore, it is likely that the lagoon channel will require periodic maintenance. The equipment needed should be available to the lagoon manager so that the mouth may be opened soon after closure.

3. The freshwater marsh is designed to require a minimum of maintenance. However, pipes and gates will need periodic repair and replacement. The levee should require little maintenance outside of vegetation removal along its top.

The lagoon manager will need to operate the marsh by overseeing the function of the water diversion and monitoring of freshwater levels and performance of flapgates. The lagoon manager will need to decide when the freshwater marsh requires draining or flooding with salt water to control plant growth or achieve habitat management goals. In any case, the manager representing DFG will set the management goals for the freshwater marsh and carry them out by manipulating the system of tidegates and water intakes.

Table 23
Operation and Maintenance Costs

Plan Element	Task	Cost	Frequency
Overall management of lagoon	Oversight and maintenance of fencing, freshwater marsh, Least Tern nesting sites, sediment facilities, monitoring of lagoon, patrolling reserve	$60,000/yearly for full time manager; only a part-time manager may be required	Continuous oversight; performance and oversight of maintenance activities as needed
Lagoon Channel	Clearance of cobbles and sand	$1000/Clearance	Possibly once in thirty years or more often; no estimates are available
Freshwater Marsh	Management of water levels and vegetation; maintenance of tidegates, water diversion structures, etc.	not available at this time	Yearly management; replacement of gates, culverts, etc., as needed
Least Tern sites	Removal of vegetation, maintenance of sandy surface	$300-500/acre/year	Yearly management
Sediment Control Facilties (see Table 20 for more details)	Cleaning and disposal of sediment	Approximate - $68,700	Average annual cost may vary each year
Public Access Trail	Repair and replacement of signs, interpretive facilites, water bars, resurfacing of trail	Unknown, until designs are completed, estimate-approximately 2% of construction costs per year	Unknown, trail will be designed with low maintenance criteria

Table 23 (continued)
Operation and Maintenance Costs

Plan Element	Task	Cost	Frequency
Monitoring	Measurement of physical, chemical and biological parameters of enhanced lagoon	$30,000-$50,000	Yearly program

4. The lagoon manager will also be responsible for maintaining the Least Tern nesting sites. Annual or semi-annual removal of weedy vegetation will be needed to keep the nesting sites available for terns. This maintenance activity requires a work crew and other sites in San Diego County have averaged $300 to $500 per acre per year to maintain (DFG, pers comm). The fencing which protects the nest sites will also require periodic maintenance and replacement.

5. The sediment control facilities outlined in Table 20 will require maintenance. The annual cost for this maintenance will largely depend upon the size of the storms each winter and whether erosion control practices are used in the watershed. The cost estimates in Table 20 are based upon mean annual sedimentation rates and give a range of maintenance cost figures. There are some uncertainties in the estimation of mean annual sedimentation rates (see discussion in Section II) and actual rates could vary considerably from estimates. Since there is no reason to believe that sedimentation rates will drop due to the implementation of BMPs, we recommend the use of the highest figure of $68,700/year. The cost for cleaning the sediment traps and disposal of the sediment used is $4.00/cubic yard and reflects current 1986 costs. Future costs will rise with inflation. A factor of 3-5 percent per year or higher should be applied to predict future maintenance costs. The $4.00/cubic yard disposal figure also assumes that none of the sediment could be sold for beach replenishment or other uses.

6. The public access trail will be designed to require a minimum of maintenance. Since the final design for the trail is not yet complete, it is not possible to predict maintenance costs. But a general estimated based on other areas is about 2% of the construction costs per year for maintenance. For the east basin, the path will consist of a crushed stone trail and the existing dirt road as well as several interpretive stations. Occasionally, some repair of the trail and replacement of stone, water bars, culverts, railings or signs could be needed. Gates, interpretive signs and any restroom facilities would need to be maintained. The western portion of the trail could require greater maintenance due to the need for boardwalks and/or bridges. Planks and railings could need to be replaced and wood boardwalks would need occasional painting or weatherproofing. No estimates for these tasks is available at this time. The landowners or homeowners associations owning the trails could be responsible for their maintenance. However, the local jurisdiction or a public agency or non-profit foundation could decide to take over this task (see Section V for further discussion).

Monitoring Program

Monitoring of the physical, chemical, and biological conditions in the lagoon is mandatory to determine the effect of the enhancement and provide insight for future enhancement projects. A monitoring program would periodically review the physical contours of the lagoon, record the chemical condition of the water and census the benthic organisms, fish and bird species in the lagoon. The overall purpose of the program is to review changes in these characters of the lagoon and record the condition of the various floral and faunal components of the lagoon over time. Very specific questions should be posed and answered by the monitoring program to evaluate the enhancement project in depth. These questions could include:

-Recording bottom contours of the lagoon and their changes for evaluation of siltation, tidal erosion and movement of sediments;

-Installation of stream flow and sediment gauges on San Marcos and Encinitas Creek to assess sediment transport rates and possible relative increases or decreases to particular changes in channel morphology or land developments;

-Measuring of basic water quality parameters to set a background chemical picture and evaluate lagoon water quality changes and the relationship to any changes observed in particular floral or faunal elements;

-Analysis of marsh plant species composition and its changes in time following project construction;

-Evaluation of the rates of re-colonization of intertidal and subtidal zones by benthic organisms and measurements of the change in species diversity and numbers over time;

-Analysis of fish species diversity and numbers and the use of the lagoon as a nursery ground area, a feeding area for adult fish and other functions;

-Census of bird species, both migratory and resident, to record changes in use over time. The census of migratory species should be coordinated with similar studies at other coastal wetlands to allow for a regional comparison;

-Surveys of nesting endangered species and use of the lagoon by endangered species.

There are numerous other questions which could be asked and answered by a monitoring program as well.

It is our recommendation that wetland scientists, such as those involved in the Pacific Estuarine Research Laboratory at Tijuana Estuary, and biologists from the Corps, Department of Fish and Game, U.S. Fish and Wildlife Service, and National Marine Fisheries Service evaluate the specific features of the lagoon requiring monitoring.

INTERMITTENT TIDAL ALTERNATIVE

Under this alternative, the lagoon would receive tidal flows on an intermittent rather than a continuous basis. The plan for this alternative would employ a greater amount of maintenance of the lagoon channel and less initial dredging than the three fully tidal alternatives. The management of tidal flows into the lagoon would be based on maximizing migratory bird habitat.

The Conservancy received several requests to include this additional alternative in the Enhancement Plan. We have described the concept of an intermittent tidal system. However, this alternative has not received the detailed analysis of the other three tidal alternatives.

Alternative Four Limited Dredging Plan

Under this alternative, the lagoon would be dredged but to a lesser degree than under Alternative Three. The middle and western basins would be similar to Alternative Three in their composition of subtidal and intertidal habitats. Dredging of the eastern basin would maximize the intertidal area. Only enough dredging would be completed to deepen the lagoon to create intertidal elevations below the vegetated marsh area and a narrow subtidal/flood control channel. This channel would extend from the mouth of San Marcos Creek to the I-5 bridge and could be as narrow as 50-100 feet. The channel would be dredged to -6.0 feet MSL and would have side slopes of 1:6. The remaining area of the dredging zone, about 250-260 acres, would be dredged at a nearly flat contour to an intertidal zone with elevations of -2.5 feet to +2.5 feet MSL. This configuration represents a minimum dredging plan for the lagoon.

The habitat acreages would total:

Salt marsh	141 acres
Freshwater marsh	33 acres
Least Tern sites	34 acres
Subtidal/deep water (-2.5 ft to -8.0 ft)	35-45 acres
Intertidal/shallow water (-2.5 ft to +2.5 ft)	338-348 acres

The potential mean tidal prism created by this alternative would be 30 million cubic feet and the potential mean diurnal tidal prism would be 40 million cubic feet. The hydrologic function of the lagoon under this system would differ from a continuously tidal system. Due to the smaller tidal prism, the lagoon mouth would close periodically as the channel filled with sand from ocean waves. There is no assured method to predict how often the channel would close; however, this alternative would lie within the "frequently closed" area of Figure 7. The modeling results indicate that with a smaller tidal prism, the low water elevation in the lagoon would not alter significantly from the level outside the lagoon. This feature is due to the smaller tidal prism which would drain out at low tide.

Once the mouth was closed, the drag bucket channel maintenenace system could be used to clear the lagoon mouth. This system can only be operated during calm seas so a series of winter storms could prevent the lagoon mouth from being re-opened for several weeks. During the time the lagoon mouth was closed, freshwater from storms could fill the lagoon as it presently does. Very large storms would probably cause the mouth to open due to the large volume of water in the lagoon. If the mouth did not open naturally or was not opened mechanically, rising lagoon water levels could pose flood problems along San Marcos Creek.

It is difficult to predict how the lagoon would function under this system. When the mouth remains open, a tidal system would be created. The intertidal mudflats and subtidal channel would be colonized by marine invertebrates and fish species as described for the tidal alternatives. These invertebrates and fish provide a consistent food base for migratory birds using the lagoon. However, when the mouth closes, the water quality in the lagoon would change depending upon how long the mouth remains closed and in what season. During

winter storms of moderate size, it is probable the mouth could close due to strong wave action, but freshwater inflows to the lagoon would not be great enough to scour the channel. The lagoon would then change from a marine system to a brackish to nearly freshwater system. The marine invertebrates and fish which had colonized the lagoon would be killed by this shift in salinity levels. Depending upon how long the lagoon remains closed, a brackish water fauna of invertebrates could develop over a period of months. More likely, however, the lagoon would be reopened to a tidal system before a true brackish system could develop. In addition to a change in salinity and water quality, water depths in the lagoon could be variable. The lagoon could fill with freshwater to create water depths of 8-12 feet over the lower intertidal and subtidal area. A closure of the lagoon mouth during summer months could result in hypersaline conditions. Closure during summer and fall would result in a drying out of the upper intertidal and salt marsh areas. If salinity levels become too extreme (50 ppt.) the marine invertebrates and fish could die or greatly decrease in numbers.

During mouth closure, all the fine sediments which enter the lagoon during a storm would be deposited in the lagoon. The proposed sediment management system can only catch heavy sediment in basins; fine sediment can be carried out to sea on the tide. However, the combination of mouth closure with freshwater and sediment inflow could result in substantial filling of the lagoon over time.

There are two local examples of these types of changes in a lagoon system. Los Penasquitos Lagoon in the City of San Diego has been closed to continuous tidal action for many years. This lagoon has a large watershed and it often floods during winter storms and the mouth may open naturally. The mouth rarely stays open more than a few days. As part of an enhancement project, the lagoon mouth periodically was opened with a bulldozer and a year-long monitoring program measuring water quality, benthic invertebrates, fish and bird populations was conducted (Greenwald and Britton, 1987). This monitoring program found that following the intermittent mouth openings in the winter and spring, the lagoon was rapidly colonized by marine invertebrates and fish. During summer and fall, once the mouth closed, the water gradually became more hypersaline resulting in a drastic lowering of fish and invertebrates species diversity and numbers. The greatest change in the system came following a fall rainstorm when the lagoon flooded with freshwater. This sudden drop in salinity killed most of the marine invertebrates and fish which had colonized the lagoon. The overall effect of this die-off on the birds using the lagoon was unclear. The recommendation of this monitoring study was to prolong the tidal inflows to the lagoon to create a more stable and diverse system.

A second, more intensively studied example comes from Tijuana Estuary. Tijuana Estuary is a National Estuarine Research Reserve on the California/Mexico border. Scientists from San Diego State University have monitored various components of the estuary for many years (Nordby, 1987). This estuary has been open to continuous tidal action for a number of years and closes infrequently. However, in January, 1983, high tides and surf closed the estuary mouth. The mouth was subsequently dredged and closed again in April, 1984. Monitoring of benthic invertebrates, fish and water quality over this entire period found that, following closure, water salinities elevated to greater than 100 ppt.

Nearly all the intertidal invertebrates were killed and several fish species were no longer found. Over several years, fish populations were shown to be affected by the mouth closure with low relative abundance of some species. The invertebrate populations showed the effects of the die-off 18-24 months after the closure and reopening and had not recovered to the density and size classes of pre-closure conditions (Nordby, 1987). The overall recommendations of this study were to "maintain tidal flushing while minimizing the frequency of maintenance dredge operations" and to maintain an open estuary mouth to insure the health of the system.

If Alternative Four is implemented, maintaining an open channel mouth may be difficult. The drag bucket system requires mobilization of equipment and personnel and up to several days operation to clear the channel. It can not be operated under even moderately heavy seas and when in operation is a safety hazard to ocean swimmers. Therefore, the beach area would have to be closed or continuously patrolled during operation. Despite these constraints, it may be possible to re-open the lagoon channel promptly following closure if all conditions are right.

As with the other tidal alternatives, the features of the operation and maintenance program would remain the same, land ownership, sediment control, monitoring and construction methods would be similar to the previous discussion.

No Project Alternative

The No Project Alternative would leave the lagoon in its present state with no enhancement. The lagoon would continue to function as a seasonal wetland and be dependent upon freshwater inflows for its primary water source. The water quality problems which currently exist would continue. Probably the greatest change which would occur, barring any other enhancement proposals, would be the slow filling of the lagoon with sediment. Given present sedimentation rates, our estimates show the entire lagoon will fill to the +4.0 foot MSL elevation in 30-50 years. Any increases in sedimentation due to watershed development would shorten the lagoon's lifespan. During the time the lagoon is filling in, it will change from a salt marsh/salt flat dominated basin to a shallower water area with a larger marsh area. This trend is demonstrated by the continued growth of the vegetated delta at the mouth of San Marcos and Encinitas Creeks. As the elevation of the marsh increases with the deposition of new sediment, riparian trees and upland will become prominent. Eventually, the shallow water areas will be completely filled in. Any activities in the watershed to lower sedimentation rates would prolong the life of the lagoon.

IV. IMPLEMENTATION PROGRAM

INTRODUCTION

Once constructed, the Batiquitos Lagoon Enhancement project will be one of the largest and most costly habitat enhancement projects ever undertaken. It will require a number of permits, agency agreements, landowner agreements and the establishment of several funding mechanisms. This section outlines and discusses the steps which must occur before construction may begin on the project, the steps which will follow and what alternative funding mechanisms are available. The general implementation strategy is summarized below and the remainder of this section discusses each feature in detail.

Overview

All three of the tidal alternatives are estimated to cost between eight and fifteen million dollars to design, construct and provide for an operation and maintenance fund. It is only possible to implement a project of this magnitude because the lagoon is able to serve a dual purpose. Implementation of this plan would provide mitigation credits to the Port of Los Angeles and the Pacific-Texas Pipeline Company (PacTex). These two entities have proposed a landfill project in the Port of Los Angeles to create a terminal for an oil pipeline. The site they plan to fill is presently a subtidal habitat with certain values to fish, benthic animals and birds. Under the permit processes for Section 404 of the Clean Water Act and the California Coastal Act, the Port and PacTex must re-create or mitigate for the habitat they plan to fill. The ratio at which they compensate for the fill is determined by the Corps of Engineers, the three Resource Agencies (Department of Fish and Game [DFG], National Marine Fisheries Service [NMFS], and U.S Fish and Wildlife Service [FWS]), and the Coastal Commission through the permit review process. These same agencies also determine where the mitigation may take place and what types of habitats the Port and PacTex may create and receive mitigation credits.

As discussed in Section III (Enhancement Plan Process), the three Resource Agencies identified Batiquitos Lagoon as an appropriate site for Port and PacTex mitigation and determined the acreages of habitat types needed to conserve the current habitat values at the lagoon. Additional habitat values which could be created by an enhancement project could become credits for the Port and PacTex to use in mitigating for landfills in the Port area. The habitat values and credit system are numerically determined through the use of the Habitat Evaluation Procedure, or HEP process, and are usually determined by the three Resource Agencies.

The main agreement to implement both the PacTex fill project and the Batiquitos Lagoon Enhancement project is a Mitigation Agreement (MA) among the various government agencies who must approve the project. The agencies who must sign the MA are the U.S. Fish and Wildlife Service, Department of Fish and Game, State Lands Commission, City of Carlsbad, Port of Los Angeles, and National Marine Fisheries Service. This agreement is a required attachment to both the Corps' 404 Permit and the Coastal Development Permit for the PacTex landfill project. These two permitting agencies must approve the conditions of the MA.

In addition to the MA, a number of other agreements and actions must occur before the enhancement project can go forward. These include: transfer of private lands in the lagoon enhancement area to the State Lands Commission; conservation easements over the sediment basin sites on Encinitas and San Marcos Creek; a conservation easement over the riparian corridor on Green Valley; an agreement with the State Department of Parks and Recreation allowing for construction and maintenance of a permanent open channel through the beach and for disposal of sand spoils on state property; an agreement with the County of San Diego to allow construction of the lagoon channel on their property; review of utility easements crossing the lagoon and relocation or protection of utilities as necessary; encroachment permits from CalTrans; any agreements necessary to implement the spoils disposal methods once they are determined; and certification of a final EIR/EIS for the project.

The Port and PacTex will not be involved in funding or constructing any public access improvements at the lagoon nor will they be involved in implementing the non-structural erosion control measures. These two plan features are also discussed herein.

The following discussion outlines the steps necessary to implement an enhancement project and the agencies responsible for various actions and the funding sources. This information is outlined in Table 24.

PROJECT DESIGN AND CONSTRUCTION

The enhancement plan contains several a conceptual plans for the lagoon. It is based on the best data currently available but several design issues are still unresolved. Additional studies are needed to complete engineering plans for construction of the lagoon project. An Environemental Impact Report (EIR) must also be prepared on the enhancement project before it can go forward.

Institutional Arrangements

While the Port of Los Angeles has recognized its responsibility to fund these preliminary studies and project construction, they have stated their unwillingness to be the primary implementing agency for the project. They prefer that another state or local agency take on this responsibility to oversee and carry out the necessary studies and construct the project.

After several rounds of negotiations, a system of responsibility has been worked out. The City of Carlsbad has agreed to serve as the implementing agency for the lagoon project. In this capacity it will: 1) hire consultants; 2) oversee completion of the needed studies; 3) prepare engineering plans; 4) gain the necessary permits, approval, agreements and easements; 5) award the construction bids; 6) oversee construction of the project; and 7) assure that the final constructed product is consistent with the enhancement plan and any amendments to the Enhancement Plan agreed to by all parties. The City began the needed engineering and environmental studies in June, 1987.

The Corps of Engineers will complete a seperate EIS to fulfill its requirements under NEPA, the National Environmental Policy Act. The Corps will prepare, circulate, take public comments and certify the EIS.

Preliminary Studies

As discussed in Section III, there are a number of additional studies and tests required before the project can proceed to the construction phase. These include:

1) Environmental Impact Report (EIR)/Environmental Impact Statement (EIS)
An EIR/EIS must be done to determine the effects of the project, including the short-term effects of construction, and to identify needed mitigation measures. The findings of the EIR/EIS will determine the preferred environmental alternative for enhancement of the lagoon. The City of Carlsbad will act as lead agency for the EIR and the Corps of Engineers will act as lead agency for the EIS.

2) Soils Testing, Preliminary Engineering and Determination of Construction Methods.
A very preliminary review of construction methods for an enhancement project are outlined in this plan. Before these methods can be definately determined, the sediments in the lagoon bottom which are to be dredged must be tested. Elutriate, bioassay, grain size coring (east basin only) and soil engineering tests are needed. These tests will determine the exact amounts of the various size materials (sand vs. clay and silt) to be disposed of and whether any toxins or heavy metals occur in significant quantities in the spoils. This information is necessary to identify a spoils disposal scheme.

   Preliminary engineering studies are needed to identify the costs and schedule for various methods of construction and the various alternatives. The findings of these studies will then be evaluated as part of the EIR/EIS and a preferred alternative chosen. Preliminary engineering studies are also needed to determine what type of protective measures are necessary for the Highway 101 bridge, railroad bridge and I-5 bridge. There is a large natural gas line which crosses the western lagoon (see Figure G) which must either be relocated or protected during construction. Engineering studies should address these isssues and determine if there are any other impediments to project construction. These preliminary studies are currently underway (July, 1987).

3) Permits and Agreements
Once the City of Carlsbad certifies the final EIR, they may apply for a Section 404 Permit from the Corps and a Coastal Development Permit from the Coastal Commission. The permitting agencies will review these applications, evaluate them against their policies, issue public notices, take comments, hold public hearings (mandatory by the Coastal Commission, upon request by the Corps) and render a decision.

   A permit from the Air Resources Control Board may be required in order to construct the project. The need for this permit will be determined by the construction methods used and mitigation measured will be outlined in the EIR/EIS.

The City must also apply for an operating permit to construct the project on state property. Since both the State Lands Commission and the Department of Fish and Game (who will become the major owners of the lagoon) are parties to the MA, no special operating agreements will be necessary for these two agencies. However, the Department of Parks and Recreation must grant the City permission to:

1) dispose of any dredge spoils on their beaches or use the beach for a haul road or other construction use;

2) cut a lagoon channel through any part of the State Park property, line it with riprap and fence it. This channel will separate the beach into two sections and separate access from Highway 101 must be available to each side to allow for lifeguard and maintenance patrols. Resolution of this specific issue will be evaluated in the EIR/EIS. The channel will also change water velocities and currents in the ocean immediately adjacent to the lagoon mouth. A restriction on swimming in this area may be required;

3) install the proposed offshore block and tackle and drag-bucket system and to operate this system. When operating, this system poses a safety hazard for swimmers. There is also a need to be able to set up and operate this system as soon as possible after the lagoon mouth closes. The City and Department of Fish and Game, as part of the operating agreement, must negotiate a method of installing and using this system which is agreeable to the Parks Department.

The County of San Diego presently owns a 2.4 acre parcel at the mouth of the lagoon. The City will need to secure an agreement from it allowing for permanent use of the land as a constructed lagoon opening. For liability and other reasons, the best solution would be for the County to transfer the title of this parcel to the State Lands Commission for inclusion in the Batiquitos Lagoon Ecological Reserve and management by the Department of Fish and Game. If this transfer cannot be accomplished, the Department of Fish and Game will need a long-term agreement with the County to allow for maintenance of the lagoon channel and the City will need an agreement to allow construction.

The spoils disposal program outlined in the preliminary engineering studies and EIR/EIS could require a number of permits depending upon its features. Some possibilities are: 1) temporary spreading of the silt and clay spoils on adjacent private lands which will require license agreements with each landowner specifying allowable uses of land, liability, schedule of removal, etc.; 2) agreements with local landfill operators to accept a certain amount of spoils; 3) a permit from the Environmental Protection Agency for ocean disposal; and 4) an agreement with private landowners to permanently accept spoils as non-structural or landscape fill. As part of the preliminary engineering, the City of Carlsbad must secure the proper type of agreement(s) to

allow for the specific method of disposal to be used.

Depending upon final engineering drawings and construction methods, an Encroachment Permit from CalTrans may be needed. This permit allows for passage through and construction in a CalTrans right-of-way. For example, any fortification of the I-5 or Highway 101 bridges would require an Encroachment Permit.

Construction of the sediment basins at Pireaus and Eolus at I-5 definitely will require Encroachment Permits from CalTrans, both for construction and maintenance.

The City must obtain either a conservation easement or fee title to the areas proposed for sediment basins on San Marcos Creek, and Encinitas Creek. Due to the level of construction and maintenance, a license agreement with these landowners will not be adequate. Once a conservation easement or fee title is gained, it should be transfered either to the State Lands Commission or the Department of Fish and Game. In addition, a conservation easement should be recorded, in favor of the City, for the riparian corridor on Encinitas Creek in Green Valley to permanently protect this portion of the stream and retain its sediment holding function.

A stream alteration permit from the Department of Fish and Game will be required prior to construction of the sediment basins on Encinitas and San Marcos Creek.

The City, as implementing agency, would be responsible for gaining all these approvals and agreements. In any instance where maintenence is involved, the Department of Fish and Game should be party to the agreement as well.

4) Engineering Plans

The City's engineering consultants will prepare very detailed engineering plans to guide the construction of the project. These plans will outline exact dredging contours; fortification measures for bridges and pipelines; diagrams for the freshwater marsh levee, sediment basins, and lagoon channel, and a spoils disposal program. The three Resources Agencies will review and comment on these plans when they are completed. Because these plans are the working drawings for construction of the enhanced lagoon, their accuracy and conformance to the enhancement plan are essential to a successful project.

5) Construction

The City will evaluate contractor bids for the dredging project once the engineering plans are completed. Construction of the project will involve dredging of the lagoon, construction of the freshwater marsh, construction of the sediment basins and weir, creation of the Least Tern islands, the lagoon channel, and other features.

Once construction is completed, the Resource Agencies, Port of L.A., Corps and Coastal Commission must certify the project is complete and

in conformance with permit requirements. Differences between the final project and the permitted project must be rectified between the City and these parties or corrected.

TRANSFER OF LAGOON LAND OWNERSHIP

There are a number of issues and events which must take place regarding the transfer of lands within the lagoon from private parties to the State of California.

One of the functions of the State Lands Commission is to oversee the use of the tide and submerged lands of the state. They have made a determination that because the Port of Los Angeles derives its funds from use of state tide and submerged lands granted to the Port by the Legislature, that these funds can only be spent upon state lands. Therefore, the lands within the lagoon must be transfered to the State Lands Commission before any Port funds can be expended on the project. The lands in question are owned by Hunt Properties Inc. and Mitsuuchi (see Figure F).

The State Lands Commission has determined that the transfer of these lands may take several forms:

1) Transfer the fee title of the property. Landowners who are not required by any permit to dedicate their property may receive substantial tax benefits for a contribution;

2) Dedication of a broad conservation easement which restricts all uses of the land to those consistent with resource enhancement and which allows for construction and maintenance of a lagoon enhancement project, followed by dedication of the fee title upon final action on the owners' development permit application;

3) Placement of the land title in an escrow account jointly established by the landowner and State Lands Commission with transfer of the title to the state occuring at such time as either:

    a) the owners' development application for adjacent lands receives final action; or

    b) the permits for the enhancment project are received;

    Whichever action occurs first would trigger the transfer.

At the present time, neither of the other landowners, HPI or Mitsuuchi, have fulfilled any of the three alternatives listed above. A fourth alternative, condemnation of the property by the local government, City of Carlsbad, is a last resort possibility and has not been reviewed fully or approved by the State Lands Commission.

Once transferred into escrow, the State Lands Commission must vote to accept the land dedications. These lands then become sovereign lands of the State of California. Unlike other categories of state-owned property, sovereign lands

cannot be deemed surplus by the Legislature and sold. The lagoon lands would be held in state ownership permanently.

OPERATION AND MAINTENANCE

As currently proposed, the Department of Fish and Game would operate and maintain the completed lagoon project. Since the State Lands Commission would own the lagoon lands, they will lease the property to the Department of Fish and Game for a period of 49 years at a time. The lagoon would be managed by DFG as an Ecological Reserve for the explicit purpose of preserving in perpetuity the fish and wildlife habitat values created by the enhancement project.

The three Resource Agencies have stated that it is the Port/PacTex's responsibility to fund operation and maintenance of the lagoon for the life of the landfill project. In other terms, since the enhanced lagoon will serve as mitigation for the complete and permanent loss of habitat within the Port, the lagoon must be kept in its enhanced state for the same amount of time that the landfill remains in place. The life of the landfill project is estimated in the hundred year or greater range. For our purposes, this time frame represents a "permanent" status.

Operation and maintenance activities are outlined in Section III and preliminary cost estimates are given. The responsibility for funding and method of funding operation and maintenance activities is outlined in the MA.

Briefly, there are two accounts which would be established:

1. At the completion of construction, an annuity would be purchased by the Port/PacTex which will provide $200,000 a year to DFG for maintenance of the lagoon. This sum would be deposited in an escrow account accessible to DFG and available only for maintenance of Batiquitos Lagoon. All the costs for lagoon maintenance listed in Section III are average annual costs and in the case of sediment control costs, can vary greatly depending upon the size of storms and conditions in the watershed. Whatever portion of the $200,000 remains each year would be retained by DFG to be used in years when maintenance costs are higher. The annuity would have a life of 30 years and its initial cost will take inflation into account.

2. At the completion of construction an investment account would be created by Port/PacTex. An initial sum would be placed in this investment account and allowed to compound interest during the 30 year period in which the annuity is used. At the end of the 30 year period, the total amount of the investment account would be transferred to the escrow account. This escrow, which would then hold any remaining funds from the annuity and the entire amount of the investment account, should provide enough funds for on-going lagoon maintenance. The cost of the initial investment fund must take into account inflation adjusted future costs.

Monitoring

The Department of Fish and Game would monitor the lagoon for a period of 5

years following construction as part of the operation and maintenance program. Monitoring is essential in a project this size to provide an objective information base for decision makers on future mitigation and enhancement projects.

Under the Coastal Development Permit for the PacTex fill (Special Conditions 2B), Port/PacTex is required to complete a monitoring program for the lagoon. The exact parameters of this program are not outlined. Both the Commission and Corps staff have stated that the program should monitor biological and chemical changes at the lagoon as well as the physical changes. The Coastal Development Permit also requires "a mechanism to ensure that restoration efforts are successful." According to the Commission staff, "success" is meant to apply to the biological habitat values created by the project, not just the creation of certain dredged contours. Therefore, to fulfill these conditions and determine whether the restoration effort is successful or not will require implementation of a monitoring program by the Port/PacTex. Once monitoring data are compiled, an estimation of success may be made and if the project is not functioning as expected, the "mechanism" to ensure its success can be formulated. Without a thorough monitoring program, there will be no basis upon which to establish "success" and fulfill these specific conditions. These requirements will be further reviewed when the Coastal Commission considers the Mitigation Agreement and Enhancement Plan prior to releasing the PacTex fill permit.

SEDIMENT CONTROL FACILITIES

The plan proposes two types of measures for controlling sediment entering the lagoon -- structural and non-structural measures. The implementation of each of these measures requires distinctly different actions

Structural Control Measures

Section III of the plan outlines the need for four sediment basins and protection of the Encinitas Creek riparian corridor.

The four sediment basins described in the structural control measures section of the plan will be funded by the Port of Los Angeles/PacTex as part of the lagoon enhancement project. These basins will be maintained by the Department of Fish and Game as part of the Ecological Reserve. In their implementation of the project, the City of Carlsbad will have to gain a conservation easement over the private lands at the site of the Encinitas and San Marcos Creek basins. The City must gain CalTrans approval for the installation of facilities on the drainage ditches at Eolus and Piraeus bordering I-5. The City will need to record a conservation easement over the riparian corridor on Encinitas Creek in Green Valley and condition adjacent development accordingly to fully protect its sediment retention function.

The other basins pictured in Figure I are either already built or are proposed as part of another development project. The Sammis Properties development which includes one new basin has received its tentative map approval and all needed permits and will begin construction this year. The HPI development project, which proposes three new basins, has just begun the environmental review process. Should this project not go forward, the enhancement plan

should be amended to allow construction of these basins as part of the enhancement project. All the basins which are currently in place appear to be functioning properly with the exception of the basin on Saxony Road. This basin is oversized and is causing downstream bank erosion and gullying. The inlets and outlets of the basin should be changed or other measures taken by the owner to correct this problem.

Non-Structural Control Measures

Joint Powers Committee

Presently, there is no single jurisdiction or government agency which has control over the lagoon watershed. In order to create a forum for discussion of watershed issues and cooperative action between the four jurisdictions, a Joint Powers Committee should form. The Committee would be advisory in nature and two council members/supervisors from each city and the county would sit on the Committee. A staff member from the planning and engineering departments of each city would attend meetings as well as representatives from the Department of Fish and Game, Army Corps of Engineers, and other interested parties. The Committee would work toward implementing erosion control measures in the Batiquitos Lagoon watershed.

This concept has worked successfully in the Buena Vista Lagoon watershed where a Joint Powers Committee has advised the three cities in that watershed on erosion issues. The Conservancy helped to form this committee and would assist in forming one for the Batiquitos Lagoon watershed.

The next action needed to implement better erosion control in the watershed is the revision of existing erosion control ordinances in the cities of Encinitas/Carlsbad and San Marcos and San Diego County as outlined in the watershed plan. Additional changes in administrative procedures to require better erosion control measures should be implemented by the local jurisdiction. These are discussed in the Watershed Plan

Agricultural Resource Management Practices

Typically, the Resource Management Practices (RMPs) outlined in this plan would be implemented on agricultural lands by the voluntary actions of landowners. These RMPs have been promulgated to farmers by the Soil Conservation Service for at least the last thirty years. While some farmers may be utilizing some of these practices, it is our observation that this is generally unheeded advice. Therefore, in the absence of voluntary use of such practices, it is up to the local jurisdictions to decide if an ordinance is needed to implement Resource Management Practices on agricultural lands in the watershed. It seems particularly unfair to require erosion control practices for developing land while equally bad erosion problems go unregulated on agricultural lands.

If such an ordinance is deemed desirable by local jurisdictions, the ordinance should contain provisions requiring the following actions:

1) Each landowner should file a soil erosion plan designed by either the Soil Conservation Service or a registered civil engineer. The plan should outline the locations of erosion control measures to be implemented on the site and a description of how the specific agricultural use will be practiced in conformance with these measures (conservation tillage, cover crops, etc.). This plan shall be filed with the local engineering department and revised to meet their comments.

2) The City Engineer or staff should periodically inspect the site to assure the plan is being enforced. Landowners found in violation of their plans shall be notified and appropriate actions taken. Penalties for non-compliance should be set by the local jurisdiction.

Floodplain Management

The criteria outlined in the watershed plan can be implemented by the drafting of an ordinance which would regulate the manner in which stream channels can be modified. The process for adoption of a new ordinance does not vary considerably from the process for revising an ordinance outlined above.

The implementation of these criteria through an ordinance is much preferred to implementation by simple adoption of the watershed plan. The plan only serves as a guideline to review of a development project by city staff. An ordinance is a regulatory measure which requires compliance through the land development process.

Stormwater Management

The criteria set for stormwater management would be implemented in the same way as the floodplain management criteria (see Watershed Plan for details).

PUBLIC ACCESS

The public access program of the plan includes facilities along both the north and south shores of the lagoon. Implementation of this program will require actions by both public and private parties.

North Shore Trail

Beginning in the east at the trailhead, the Conservancy holds an open space easement over the ten acre parcel owned by Rancho La Costa/Newport Shores. This open space easement has provisions for a public access easement. A public agency must accept and record the public access easement.

There are two likely candidates for acceptance of the public open space easements in the lagoon: The City of Carlsbad or the Batiquitos Lagoon Foundation. Once either of these entities records the easement, the trail may be improved and other facilities installed. We suggest that whichever entity decides to accept the trail easement, it work with the Conservancy regarding funding for needed access improvements.

The next section of the trail follows the existing dirt road through private property held by Mitsuuchi and Murphy. The plan proposes no improvements in this section. It is our understanding however, that the public has a prescriptive right to use this road without a recorded public access easement.

The next section of the trail follows the road and the shoreline through the HPI development. Depending upon the outcome of the City of Carlsbad and Coastal Commission permit actions on this development, HPI may be required to dedicate a public access easement following this alignment. HPI may also be required to construct and improve the trail and provide for its maintenance. Once again, either the City of Carlsbad or the Batiquitos Lagoon Foundation may accept the access easement and, if HPI is not required to construct the trail, either entity may apply for Conservancy funds to complete needed construction. Review and approval by the Conservancy Board is required to obtain funding for access improvements. Should the City or the Foundation install the access improvements on the trail it would have to maintain the improvements.

The trail then follows the road onto the Savage property to Lagoon Lane. Once again, the outcome of the Savage development proposal will largely determine what type of action is required by public agencies to develop public access facilities on this property.

The next section of the trail is located in the western lagoon and stretches from the trailhead in the Sammis development to the corner of the lagoon bordering I-5. Sammis Properties, under their coastal permit, is required to dedicate a public access easement and to construct this trail. An encroachment permit from CalTrans may be needed to construct the viewing platform in the eastern corner of this trail. Again, either the City of Carlsbad or the Batiquitos Lagoon Foundation may accept the public access easement but, in this case, Sammis Properties is required to construct the trail and provide for its maintenance unless a public agency agrees to accept the maintenance responsibility.

The final section of the trail stretches from the trailhead to Highway 101, crossing over the railroad with a pedestrian bridge. The trail will follow the blufftop and, under their coastal permit, Sammis Properties is required to dedicate a public access easement and construct and maintain the trail. The City of Carlsbad or Lagoon Foundation should accept the access easement for the trail and may consider taking over the management as well. The bridge over the railroad will be an expensive construction project, costing between $300,000 - $500,000. Due to its large expense, it is possible that the Conserevancy Board could consider funding for a portion of the bridge. However, Sammis Properties would be required to construct all of the blufftop trail. They should also pay for a portion or all of the bridge, as well as any interpretive stations, benches, or other ammenities included in their plans. A permit from the Public Utilities Commission and an agreement with Santa Fe Railway Company will be needed prior to construction of the railroad bridge.

The two tentative trail alignments under I-5 and under Highway 101 are not proposed for implementation at this time. However, either the City of Carlsbad or the Lagoon Foundation may investigate the costs and requirements for these trails and begin the implementation process.

South Shore Facilities

The two access improvements suggested by the plan for the south shore of the lagoon are: 1) a bike lane be provided during the widening of La Costa Avenue; 2) interpretive facilities be constructed at the CalTrans Park and Ride lot.

The City of Carlsbad is currently building a road widening project for La Costa Boulevard which would include a bike lane and a sidewalk.

Interpretive facilities at the CalTrans lot could be installed through a Conservancy grant to either the Batiquitos Lagoon Foundation or the City of Carlsbad. An encroachment permit from CalTrans would be needed prior to construction.

In summary, the Conservancy proposes that either the City of Carlsbad or the Batiquitos Lagoon Foundation accept the offers to dedicate public access easements on the Rancho La Costa/Newport Shores property and the Sammis Property and, if required, those offered on the HPI and Savage property. Depending upon permit requirements, public funds could be expended to build access improvements where developers are not required to build them. The one proposed exception is the railroad bridge on the Sammis Property where the high cost of the bridge could be borne by both the developer and public funding upon approval by the Conservancy Board.

Negotiations between various landowners, the Conservancy, the City of Carlsbad, CalTrans, Santa Fe Railway Company, and the Batiquitos Lagoon Foundation will be forthcoming to implement the public access plan.

Table 24

Implementation Program
Batiquitos Lagoon Enhancement Program

Implementation Element	Responsible Agency	Funding Source	Actions Required
LAGOON CONSTRUCTION			
Signing of mitigation agreement by all parties	Port of L.A., City of Carlsbad, U.S. Fish and Wildlife Service National Marine Fisheries Service, Department of Fish and Game, State Lands Commission	N/A	
Approval of Mitigation Agreement by Coastal Commission and the Corps and release of Pac/Tex permits	Coastal Commission Corps of Engineers	N/A	1. The Coastal Commission final permit approval will be held during a public meeting; a public meeting is not necessary for the Corps permit
Transfer of lagoon land from private owners to State of California	State Lands Commission	N/A	1. Owners may execute one of three different types of agreements to begin transfer process
Establishment of special accounts for Batiquitos project	Port of L.A./PacTex City of Carlsbad	N/A	1. Use of these accounts is outlined in the Mitigation Agreement
Completion of EIR, preliminary studies and preliminary engineering study	City of Carlsbad	Port of LA/PacTex	1. EIR and studies must evaluate condition and constituents of lagoon bottom sediments, various construction methods, spoils disposal methods, channel safety issues, short-term construction impacts and beach access issues amongst others

Table 24 (continued)

Implementation Program
Batiquitos Lagoon Enhancement Program

Implementation Element	Responsible Agency	Funding Source	Actions Required
LAGOON CONSTRUCTION (continued)			
			2. Preliminary engineering studies will determine the need for bridge fortifications, need for relocation of gas pipeline which crosses lagoon and cost estimates for project construction 3. Following CEQA procedures, the City of Carlsbad will certify the final EIR
	Coastal Conservancy	N/A	4. Lagoon enhancement plan will be amended if needed to incorporate changes in project resulting from EIR/EIS
Completion of EIS	Corps of Engineers	Port of LA/PacTex	
Permit applications and agreements required for Quality project	City of Carlsbad	Port of LA/PacTex	1. City will apply for Coastal Development Permit and Army Corps of Engineers permit, Air permit and any additional permits required for disposal of dredge spoils 2. City must negotiate: a) operating agreement wit Dept. of Parks and Recreation b) long-term operating agreement or transfer of fee title for land at lagoon mouth held by County of San Diego c) encroachment permit from CalTrans d) agreements for disposal of clay/silt dredge spoils on private lands e) 1601 stream alteration

Table 24 (continued)

Implementation Program
Batiquitos Lagoon Enhancement Program

Implementation Element	Responsible Agency	Funding Source	Actions Required
LAGOON CONSTRUCTION (continued)			
			agreement with DFG for construction of sediment basins f) conservation easements or title title to land for sediment basins on San Marcos and Encinitas Creek and over the riparian corridor in Green Valley on Encinitas Creek
Preparation of final engineering specifications and bid documents	City of Carlsbad	Port of LA/PacTex	1. The three Resource Agencies must review and approve engineering design
Construction bids and letting of contracts	City of Carlsbad	Port of LA/PacTex	
Construction of lagoon project	City of Carlsbad,	Port of LA/PacTex	1. The three Resource Agencies, Coastal Commission, and Corps must certify the project complete and in accordance with permit requirements
Deptartment of Fish and Game becomes operations and maintenance agency for Batiquitos Lagoon	Deptartment of Fish and Game State Lands Commission	Port of LA/PacTex Operation and Maintenance Account	1. Dept of Fish and Game and State Lands Commission and must sign a 49 year 2. Yearly maintenance activities carried out

Table 24 (continued)

Implementation Program
Batiquitos Lagoon Enhancement Program

Implementation Element	Responsible Agency	Funding Source	Actions Required
LAGOON CONSTRUCTION (continued)			
Monitoring Program begins	Deptartment of Fish and Game Scientific researchers interested in conducting additional studies	Port of LA/PacTex Operation and Maintenance Account	1. A monitoring program is required as part of the Coastal Development Permit and Corps Permit
STRUCTURAL SEDIMENT CONTROL MEASURES			
Construction of sediment basins outlined in enhancement plan	City of Carlsbad	Port of LA/PacTex	1. Land donation or easement for basins on San Marcos and Encinitas Creek 2. Agreement with CalTrans to modify cement channel t create Eolus and Piraeus basins 3. Environmental review and construction for basins to be completed under contracts for lagoon enhancement project 4. Maintenance will be performed by DFG with Port of LA/PacTex funding
Construction of sediment basins on private land along north shore of lagoon	City of Carlsbad Coastal Commission	Sammis Properties HPI	1. Basin is already a condition of Sammis permit approval 2. Basins on HPI Propertie should be made condition o Project approval 3. Maintenance of private basins is responsibility of owner(s)
Modification of Saxony Road sediment basin to stop downstream	City of Encinitas Coastal Commission	Owner	1. Request owner to modify basin to be consistent with permit requirements under which basin was

Table 24 (continued)

Implementation Program
Batiquitos Lagoon Enhancement Program

Implementation Element	Responsible Agency	Funding Source	Actions Required
NON-STRUCTURAL EROSION CONTROL MEASURES (continued)			
erosion it currently causes			constructed
Adoption of Batiquitos Lagoon Watershed Sediment Control Plan	City of Carlsbad City of San Marcos City of Encinitas County of San Diego	N/A	1. Review of plan and staf analysis 2. City Council/Board of Supervisors vote on plan adoption
Adoption of Excavation and Grading ordinance contain provisions of Carlsbad existing ordinance	City of San Marcos City of Encinitas County of San Diego	N/A	1. Review of ordinanace revisions and processing as a zone code amendment 2. City Council/Board of Supervisors vote on adoption of ordinance
Revision of ordinance to include three additional land develolpment erosion control measures recommended by Watershed Plan	City of Carlsbad City of San Marcos City of Encinitas County of San Diego	N/A	1. Cities of Encinitas, Sa Marcos and County of San Diego should consider revisions at same time as adoption of new ordinance
Adoption of standard conditions for grading plans which include erosion control measures recommended by Watershed Plan	City of Carlsbad City of San Marcos City of Encinitas County of San Diego	N/A	1. May be accomplished by resolution from City Council/Board of Supervisors or by directive from City Engineer or City Manager to staff

Table 24 (continued)

Implementation Program
Batiquitos Lagoon Enhancement Program

Implementation Element	Responsible Agency	Funding Source	Actions Required
NONSTRUCTURAL EROSION CONTROL MEASURES (continued)			
Adoption of a Hillside Development Ordinance similar to that of City of Carlsbad or adoption of Special Conditions for grading plans affecting steep lands	City of Encinitas City of San Marcos County of San Diego City of Carlsbad	N/A	1. Review of ordinance 2. City Council/Board of Supervisors vote 3. Adoption of Special Conditions may be accomplished by directive to staff from City Manager or City Engineer or resolution by City Council/Board of Supervisors
Enforcement of grading ordinances	City of Carlsbad City of Encinitas City of San Marcos County of San Diego	Unknown	1. City Council/Board of Supervisors should budget adequate funding for enforcement ment staff and direct staff to regularly inspect grading sites
Possible adoption of ordinance for Resource Management Practices	City of Carlsbad City of San Marcos City of Encinitas County of San Diego	N/A	1. Review of agricultural land erosion issues 2. Drafting of agricultura resource managment practices ordinance 3. Ordinance review proces City Council/Board of Supervisors vote on ordinance
Adoption of floodplain management criteria for stream channels and an ordinance implementing these criteria	City of Carlsbad City of San Marcos City of Encinitas County of San Diego	N/A	1. Review of criteria and staff analysis 2. Drafting of floodplain management ordinance to implement criteria through the development permit process 3. City Council/Board of Supervisors vote on ordinance

Table 24 (continued)

Implementation Program
Batiquitos Lagoon Enhancement Program

Implementation Element	Responsible Agency	Funding Source	Actions Required
NONSTRUCTURAL EROSION CONTROL MEASURES (continued)			
5. Adoption of stormwater management criteria for new developments in the watershed and an ordinance implementing these criteria	City of Carlsbad City of San Marcos City of Encinitas County of San Diego	N/A	1. Same as floodplain management above
PUBLIC ACCESS PROGRAM			
Dedication of accessways and construction and maintenance of improvements as parts of private developments around the lagoon	Coastal Commission Sammis Properties	Private Funding	1. Requirements for dedication of a public access easement and construction of access improvements are a part of Sammis Properties coastal permit 2. Similar requirements ma possibly be placed on permits for the HPI and Savage properties
Adoption of the Final Enhancement Plan (following Final EIR/EIS Certification) by Conservancy Board and consideration of possible funding of public access projects	Coastal Conservancy City of Carlsbad Batiquitos Lagoon Foundation	Conservancy Fund	1. Potential applicants to implement necessary portions of the program include City of Carlsbad and the Batiquitos Lagoon Foundation

ALTERNATIVE IMPLEMENTATION PROGRAM

Under the proposed Mitigation Agreement, the Port of L.A./PacTex may withdraw from the Batiquitos project for two reasons:

1) The costs of the Batiquitos project as specified in the preliminary engineering studies or construction bids are deemed "excessive" by the Port/PacTex; or

2) The permits or land interests required for the Batiquitos project are not granted.

The Port/PacTex would be required to identify another mitigation site. Although withdrawal of the Port from the Batiquitos project does not appear imminent, the possibility does exist and alternative sources of funding would be required.

Without Batiquitos Lagoon serving as a mitigation site, different types of funding would be needed. A degree of public funds from the Wildlife Conservation Board or the Conservancy could be applied to an enhancment project. However, the level of funding available would most likely not exceed $2-3 million dollars.

Another potential source of funds could come from the landowners adjacent to the lagoon. As part of their coastal permit requirements, Sammis Properties must pay a $5,000/acre mitigation fee to convert agricultural land to urban development. An amendment to the Coastal Act in January, 1985 created Section 30171.5 and allowed for this provision which applies to portions of the Sammis Property and portions of the HPI property. Section 30171.5 specifically states:

"(a) The amount of the mitigation fee for development on nonprime agricultural lands in the coastal zone in the City of Carlsbad that lie outside of the areas described in subdivision (f) of Section 30170 and subdivision (d) of Section 30171 shall be determined in the applicable segment of the local coastal program of the City of Carlsbad, but shall be not less than five thousand dollars ($5,000), nor more than ten thousand dollars ($10,000) per acre. All mitigation fees collected under this section shall be deposited in the State Coastal Conservancy Fund.

"(b) All mitigation fees collected pursuant to this section are hereby appropriated to, and shall be expended by, the State Coastal Conservancy in the following order of priority:

(1) Restoration of natural resources and wildlife habitat in Batiquitos Lagoon.

(2) Development of an interpretive center at Buena Vista Lagoon.

(3) Restoration of beaches managed for public use in the coastal zone in the City of Carlsbad.

(4) Any other project or activity benefiting natural resources in the coastal zone in the City of Carlsbad that is provided for in the local coastal program of the City of Carlsbad."

Under this section, funds from these Agricultural Mitigation fees could be applied to restoration of Batiquitos Lagoon. The maximum amount of funds available from this source will not be known until the coastal development permit for the HPI project is acted upon and the acres of mitigation area determined. The Carlsbad City Council may then determine the price per acre for the mitigation fee. The funds are then paid into the Conservancy Fund for expenditure by the Conservancy Board in conformance with Section 30171.5.

The combination of public funds and agricultural mitigation fees is unlikely to exceed $5-6 million dollars. The costs for Alternatives Three and Four are about $5-6 million dollars and this alternative could possibly be implemented. At such time as the Port/PacTex withdraws from the project or permits are not issued, the Conservancy, in conjunction with the Enhancement Group, will review the options for funding an enhancement project.

APPENDIX A
List of Abbreviations Used in Batiquitos Lagoon Enhancement Plan

CORPS-	U.S. Army Corps of Engineers
NMFS-	National Marine Fisheries Service
FWS-	United States Fish and Wildlife Service
EPA-	U.S. Environmental Protection Agency
DFG-	California Department of Fish and Game
SCC-	State Coastal Conservancy
CCC-	California Coastal Commission
SLC-	California State Lands Commission
DPR-	California Department of Parks and Recreation
POLA-	Port of Los Angeles
RWQCB-	San Diego Regional Water Quality Control Board
LCWD-	Leucadia County Water District
HEP-	Habitat Evaluation Procedure
MHHW-	Mean Higher High Water
MHW-	Mean High Water
MSL-	Mean Sea Level
MLW-	Mean Lower Water
MLLW-	Mean Lower Low Water
NGVD-	National Geodesic Vertical Datum
PacTex-	Pacific Texas Pipeline Company

APPENDIX B

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APPENDIX C LAGOON MODEL

To analyze the effect of various dredging alternatives on tidal fluctuations in Batiquitos Lagoon, a tidal hydrodynamic model developed by the late Hugo Fisher was used. This model was originally developed for modelling tidal flows in Suisun Marsh. To apply the model to Batiquitos, the lagoon was divided into ten segments, with "nodes" located above and below constrictions. The model uses the method of characteristics, which requires solving a set of simultaneous linear equations in each time step.

For computations within a segment the use of the method of characteristics is straightforward, and is described in detail in Hydraulic Transients, by U.L. Streeter and E. Wylie (New York, Mcgraw Hill, 1967) and in an earlier paper "A Method for Predicting Pollutant Transport in Tidal Waters", by H.B. Fishcer, (WRC Contribution 132, Hydraulic Engineering Laboratory, University of California, Berkeley, 1970, 132pp.) An upstream and a downstream characteristic line are established. On the upstream line the quantity $E = U + gY/C$ is constant, and on the downstream line $F = U - gY/C$ is constant. In these equations, U is velocity, Y is mean depth, and C is the wave velocity, $(gY^{/2})$. E and F are determined from quantities calculated in the previous time step, and U and Y are obtained by solution of two simultaneous equations.

The solution at the nodes requires the equation of continuity and one characteristic equation from each segment. In the most general case the program allows three upstream segments, two downstream segments, and an additional discharge which might represent supplementary flow. The node is the coincident location of the end grid point of each segment connected to the node, so the tidal elevation at each of these grid points must be the same. The solution involves eleven unkowns, the tidal elevation above datum, the total depth in each of the five connected segments, and the velocity in each of the five connected segments. Let subscripts 1, 2, and 3 indicate the upstream segments, 4 and 5 indicate the downstream segments, A_1 the cross sectional area of the ith segment, D_i the mean depth of the channel bottom, below datum of the i^{th} segment, Z the tidal elevation above datum, and Q the supplementary discharge. The following eleven equations are to be solved simultaneously:

$$E_1 = U_1 + gY_1/C_1 \qquad (1)$$

$$E_2 = U_2 + gY_2/C_2 \qquad (2)$$

$$E_3 = U_3 + gY_3/C_3 \qquad (3)$$

$$F_4 = U_4 - gY_4/C_4 \qquad (4)$$

$$F_5 = U_5 - gY_5/C_5 \qquad (5)$$

$$Y_1 = D_1 + Z \qquad (6)$$

$$Y_2 = D_2 + Z \tag{7}$$

$$Y_3 = D_3 + Z \tag{8}$$

$$Y_4 = D_4 + Z \tag{9}$$

$$Y_5 = D_5 + Z \tag{10}$$

$$U_1A_1 + U_2A_2 + U_3A_3 + Q = U_4A_4 + U_5A_5 \tag{11}$$

The solution gives

$$Z = \left[E_1A_1 + E_2A_2 + E_3A_3 - F_4A_4 - F_5A_5 + Q - g\left(\frac{D_1A_1}{C_1} + \frac{D_2A_2}{C_2} + \frac{D_3A_3}{C_3} + \frac{D_4A_4}{C_4} + \frac{D_5A_5}{C_5}\right)\right] \Bigg/ g\left(\frac{A_1}{C_1} + \frac{A_2}{C_2} + \frac{A_3}{C_3} + \frac{A_4}{C_4} + \frac{A_5}{C_5}\right) \tag{12}$$

Values of U and Y for each segment can then be found by substituting Z into the previous equations.

In the program each node is given a type number. The tidal elevation at each node is found in Equation 12, setting terms equal to zero where connecting segments are missing. At the boundary node, where the tide is specified, values of E and Y are known and the velocity is determined by Equation 1. At terminal upstream nodes, where discharge is given, values of F and U are known and elevation is found by Equation 4.

Since segments across bridges were relatively short, it was necessary to use a time step of 15 seconds to achieve stability. The output summaries, however, are printed for hourly increments. The first 13 hours of the simulation are used to develop a stable initial condition, and results are printed only for the second 13-hour period of the 26 hour simulation.

Additional information and computer printouts are available from the Conservancy.

APPENDIX D
LIST OF FLOWERING PLANTS IN BATIQUITOS LAGOON*

Family	Specific Name	Common Name
EMERGENT MARSH VEGETATION		
Brackish/Freshwater Marsh		
Cyperaceae	Cyperus sp.	Sedge
	Scirpus californicus	California bulrush
	Scirpus cf. fluviatilis	Bulrush
	Scirpus olneyi	Olney's bulrush
	Scirpus robustus	Alkali bulrush
Gramineae	Distichlis spicata	Saltgrass
	Polypogon monospeliensis	Rabbit's-footgrass
	Sporobolus cf. poiretii	Dropseed
Juncaceae	Juncus acutus ssp. sphaerocarpus	rush
Typhaceae	Typha domingensis	Southern cattail
	Typha latifolia	cattail
Chenopodiaceae	Atriplex patula ssp. hastata	Fat-hen
	Salicornia virginica	Pickleweed
Compositae	Ambrosia psilostachya	Western ragweed
	Aster exilis	Alkali aster
	Cotula coronopifolia	Brass buttons
	Jaumea carnosa	Jaumea
	Pluchea purpurascens	Salt marsh fleabane
Frankeniaceae	Frankenia grandifolia	Alkali heath
Polygonaceae	Rumex crispus	Curly dock
Salicaceae	Salix lasiolepis	Arroyo willow
Sauruaceae	Anemopsis californica	Yerba mansa
Umbelliferae	Apium graveolens	Wild celery
Salt Marsh - Low Marsh		
Cyperaceae	Scirpus robustus	Alkali bulrush
Gramineae	Distichlis spicata	Saltgrass
	Monanthochloe littoralis	Salt cedar

*From Mudie et al. (1976), Westec Services, Inc. (1983)

APPENDIX F (continued)
LIST OF FLOWERING PLANTS IN BATIQUITOS LAGOON*

Family	Specific Name	Common Name
EMERGENT MARSH VEGETATION		
Juncaceae	Juncus acutus	Spiny rush
Chenopodiaceae	Salicornia virginica	Pickleweed
Compositae	Jaumea carnosa	Jaumea
	Pluchea purpurascens	Salt marsh fleabane
Frankeniaceae	Frankenia grandifolia	Alkali health
Salt Marsh - High Marsh		
Gramineae	Bromus mollis	Soft chess
	Distichlis spicata	Saltgrass
	Mononanthochloe littoralis	Salt cedar
	Parafolis incurva	Rattail grass
Aizoaceae	Mesembryanthemum nodiflorum	Little ice plant
Boraginaceae	Heliotropium curassavicum	Chinese parsley
Caryophyllaceae	Spergularia marina	Salt marsh sand spurrey
Chenopodiaceae	Atriplex semibaccata	Australian salt bush
	Salicornia europaea	Annual pickleweed
	Salicornia subterminalis	Glasswort
	Salicornia virginica	Pickleweed
Compositae	Cotula coronopifolia	Brass buttons
	Lasthenia glabrata ssp. coulteri	Salt marsh daisy
Convolvulaceae	Cressa truxillensis	Alkali weed
Plumbaginaceae	Limonium californicum ssp. mexicanum	Marsh lavender
SAND DUNE VEGETATION FOUND IN SOME LAGOON SALT MARSH AREAS		
Gramineae	Distichlis spicata	Saltgrass
Aizoaceae	Mesembryanthemum chilense	Wild ice plant
Chenopodiaceae	Atriplex leucophylla	Beach saltbush
Cruciferae	Cakile maritima	Sea rocket

APPENDIX F (continued)
LIST OF FLOWERING PLANTS IN BATIQUITOS LAGOON*

Family	Specific Name	Common Name
EMERGENT MARSH VEGETATION		
	Matthiola incana	Wild stock
Nyctaginaceae	Abronia maritima	Beach sand verbena
	Abronia umbellata	Sand verbena
RIPARIAN VEGETATION		
Compositae	Artemisia douglasiana	Wormwood
Juncaceae	Juncus mexicanus	Mexican rush
Salicaceae	Salix lasiolepis	Arroyo willow
Platanaceae	Platanus racemosa	California sycamore
Umbelliferae	Conium maculatum	Hemlock

APPENDIX E

BIRDS OF BATIQUITOS LAGOON

Species	Status
Red-throated Loon (Gavia stellata)	WV
Horned Grebe (Podiceps auritus)	WV
Eared Grebe (Podiceps caspicus)	WV
Western Grebe (Aechmophorus occidentalis)	WV
Pied-billed Grebe (Podilymbus podiceps)	R
California Brown Pelican (Pelecanus occidentalis)	R
Double-crested Cormorant (Phalacrocorax auritus)	R
Brandt's Cormorant (Phalacrocorax penicillatus)	R
Pelagic Cormorant (Phalacrocorax pelagicus)	R
Great Blue Heron (Ardea herodias)	R
Green Heron (Butorides virescens)	R,B?
Great Egret (Casmerodius albus)	R
Snowy Egret (Egretta thula)	R
Black-crowned Night Heron (Nycticorax nycticorax)	R
Least Bittern (Ixobrychus exilis)	B
White-faced Ibis (Plegadis chihi)	S
Flamingo (Phoenicopterus sp.)	I
Canada Goose (Branta canadensis)	WV
Mallard (Anas platyrhynchos)	R
Gadwell (Anas strepera)	WV,S
Pintail (Anas acuta)	WV
Green-winged Teal (Anas carolinensis)	WV
Blue-winged Teal (Anas discors)	WV
Cinnamon Teal (Anas cyanoptera)	R
American Widgeon (Mareca americana)	WV
Northern Shoveler (Spatula clypeata)	WV
Redhead (Aythya americana)	WV
Lesser Scaup (Aythya affinis)	WV
Common Goldeneye (Bucephala clangula)	WV
Bufflehead (Bucephala albeola)	WV
White-winged Soter (Melanitta deglandi)	WV
Surf Scoter (Melanitta perspicillata)	WV
Ruddy Duck (Oxyura jamaicensis)	R
Common Merganser (Mergus merganser)	WV
Red-breasted Merganser (Mergus serrator)	WV
White-tailed Kite (Elanus leucurus)	R,B
Sharp-shinned Hawk (Accipiter striatus)	WV
Cooper's Hawk (Accipiter cooperii)	R,B?
Red-tailed Hawk (Buteo jamaicensis)	R&WV,B
Red-shouldered Hawk (Buteo lineatus)	R,B?

Taken from "A Biological Survey of Rancho La Costa Properties" (Batiquitos Lagoon) prepared by Pacific Southwest Biological Services, Inc.

Some bird species listed may frequent upland habitats adjacent to lagoon wetlands

APPENDIX E

BIRDS OF BATIQUITOS LAGOON (continued)

Species	Status
Marsh Hawk (Circus cyaneus)	R&WV
Osprey (Pandion haliaetus)	WV
California Quail (Lophortyx californicus)	R&B
Virginia Rail (Rallus limicola)	R,B?
Sora Rail (Porzana carolina)	R
Common Gallinule (Gallinula chloropus)	R
American Coot (Fulica americana)	R,B
Semipalmated Plover (Charadrius semipalmatus)	WV
Snowy Plover (Charadrius alexandrinus)	R,B
Killdeer (Charadrius vociferus)	R,B
Black-bellied Plover (Squatarola squatarola)	WV
Ruddy Turnstone (Arenaria interpres)	WV
Common Snipe (Capella gallinago)	WV
Long-billed Curlew (Numenius americanus)	WV
Whimbrel (Numenius phaeopus)	WV
Spotted Sandpiper (Actitis macularia)	WV
Willet (Catoptrophorus semipalmatus)	WV
Greater Yellowlegs (Totanus melanolecus)	WV
Lesser Yellowlegs (Totanus flavipes)	WV
Least Sandpiper (Erolia minutilla)	WV
Dunlin (Erolia alpina)	WV
Short-billed Dowitcher (Linnodromus griseus)	WV
Long-billed Dowitcher (Linnodromus scolopaceus)	WV
Western Sandpiper (Ereunetes mauri)	WV
Marbled Godwit (Limosa fedoa)	WV
Sanderling (Crocethia alba)	WV
American Avocet (Recurvirostra americana)	R,B?
Black-necked Stilt (Himantopus mexicanus)	R,B?
Wilson's Phalarope (Phalaropus tricolor)	WV
Northern Phalarope (Phalaropus lobatus)	WV
Western Gull (Larus occidentalis)	R
Herring Gull (Larus argentatus)	WV
California Gull (Larus californicus)	WV
Ring-billed Gull (Larus delawarensis)	R
Heerman's Gull (Larus heermanni)	S
Forster's Tern (Sterna forsteri)	R
Common Tern (Sterna hirundo)	R
Least Tern (Sterna albifrons)	S,B
Royal Tern (Thalasseus maximus)	WV
Elegant Tern (Thalasseus elegans)	WV
Caspian Tern (Hydroprogne caspia)	S
Band-tailed Pigeon (Columbia fasciata)	R
Mourning Dove (Zenaidura macroura)	R,B
Greater Roadrunner (Geococcyx californianus)	R,B
Burrowing Owl (Speotyto cunicularia)	R,B?

APPENDIX E

BIRDS OF BATIQUITOS LAGOON (continued)

Species	Status
Short-eared Owl (Asio flammeus)	WV
Anna's Hummingbird (Calypte anna)	R,B
Costa's Hummingbird (Calypte costae)	S
Belted Kingfisher (Megaceryle alcyon)	R
Common Flicker (Colaptes auratus)	R,B
Nuttall's Woodpecker (Dendrocopos nuttallii)	R
Western Kingbird (Tyrannus verticalis)	S
Ash-throated Flycatcher (Myiarchus cinerascens)	S
Black Phoebe (Sayornis nigricans)	R,B?
Say's Phoebe (Sayornis saya)	WV
Western Flycatcher (Empidonax difficilis)	S
Western Wood Pewee (Contopus sordidulus)	S
Olive-sided Flycatcher (Nuttallornis borealis)	S,B?
Cliff Swallow (Petrochelidon pyrrhonota)	S
Rough-winged Swallow (Stelgidopteryx ruficollis)	S
Scrub Jay (Alphelocoma coerulescens)	R,B
Common Raven (Corvus Corax)	R,B?
Bushtit (Psaltriparus minimus)	R,B
Wrentit (Chamaea fasciata)	R,B
House Wren (Troglodytes aedon)	R,B
Bewick's Wren (Thryomanes bewickii)	R,B
Long-billed Marsh Wren (Telmatodytes palustris)	R,B
Mockingbird (Mimus polyglottos)	R,B
California Thrasher (Toxostoma redivivum)	R,B
Swainson's Thrush (Hylocichla ustulata)	S,B
Blue-gray Gnatcatcher (Polioptila caerulea)	R&WV
Black-tailed Gnatcatcher (Polioptila melanura)	R,B
Ruby-crowned Kinglet (Regulus calendula)	WV
Phainopepla (Phainopepla nitens)	S,B
Loggerhead Shrike (Lanius ludovicianus)	R,B
Starling (Sturnus vulgaris)	R,B,I
Least Bell's Vireo (Vireo belli)	B
Warbling Vireo (Vireo gilvus)	B
Yellow Warbler (Dendroica petechia)	S,B
Yellow-rumped Warbler (Dendroica coronata audubonì)	WV
Townsend's Warbler (Dendroica townsendii)	S
Wilson's Warbler (Wilsonia pusilla)	S
Common Yellowthroat (Geothlypis trichas)	R,B
Orange-crowned Warbler (Vermivora celata)	S,B
Western Meadowlark (Sturnella neglecta)	R,B
Red-Winged Blackbird (Agelaius phoeniceus)	R,B
Northern Oriole (Icterus galbula)	S,B
Black-headed Grosbeak (Pheucticus melanocephalus)	S,B
House Finch (Carpodacus mexicanus)	R,B
Lesser Goldfinch (Spinus psaltria)	R
American Goldfinch (Spinus tristis)	R

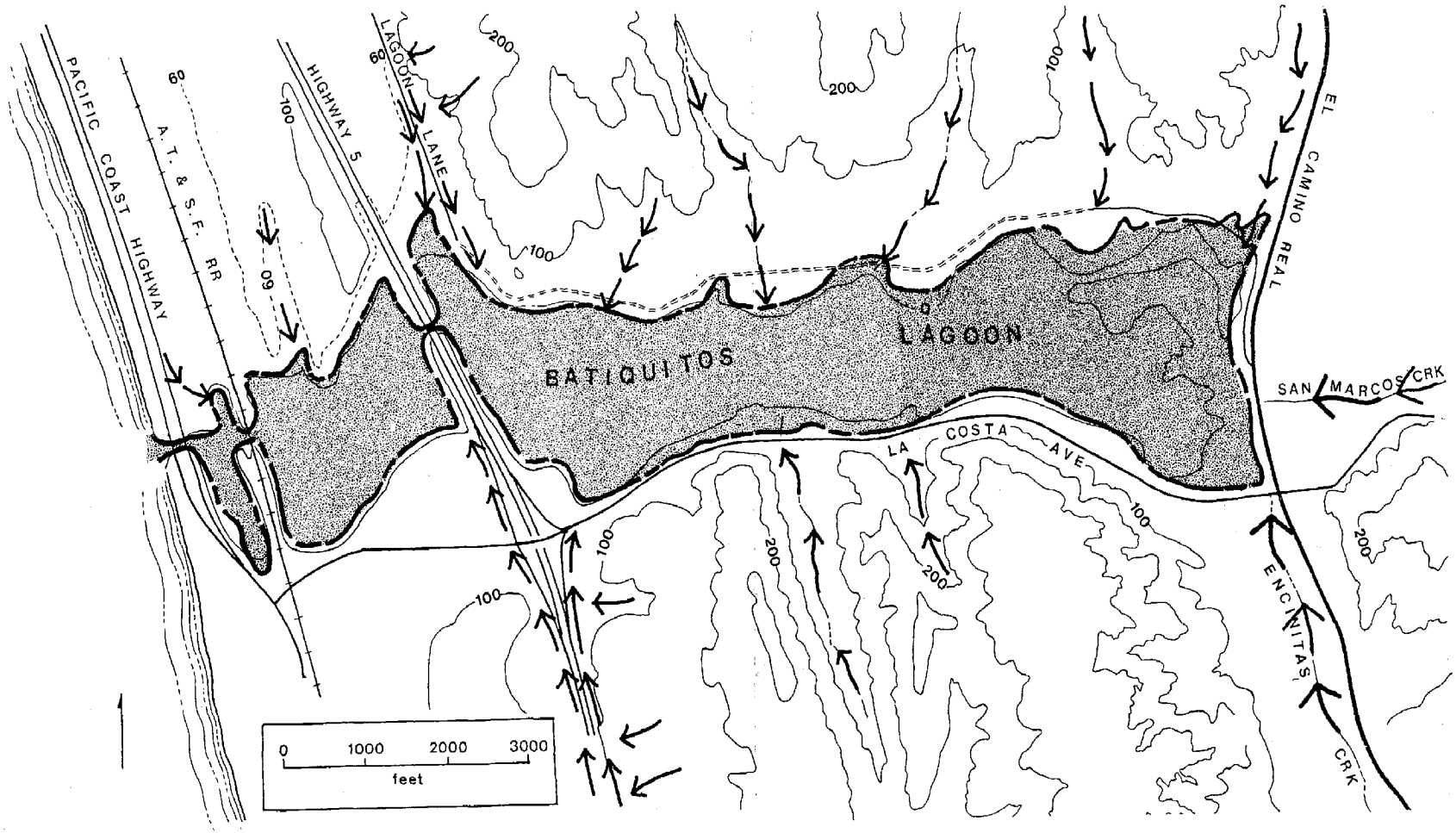
APPENDIX E

BIRDS OF BATIQUITOS LAGOON (continued)

Species	Status
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	R,B
Brown Towhee (*Pipilo fuscus*)	R,B
Savannah Sparrow (*Passerculus sandwichensis beldingi*)	R,B
White-crowned Sparrow (*Zonotrichia leucophrys*)	WV
Rufous-Crowned Sparrow (*Aimophila ruficeps*)	R,B
Song Sparrow (*Melospiza melodia*)	R,B

WV - Winter Visitor
R - Resident
S - Spring Migrant or Summer Resident

I - Introduced
B - Breeds in Batiquitos Lagoon
B? - May breed in Batiquitos Lagoon



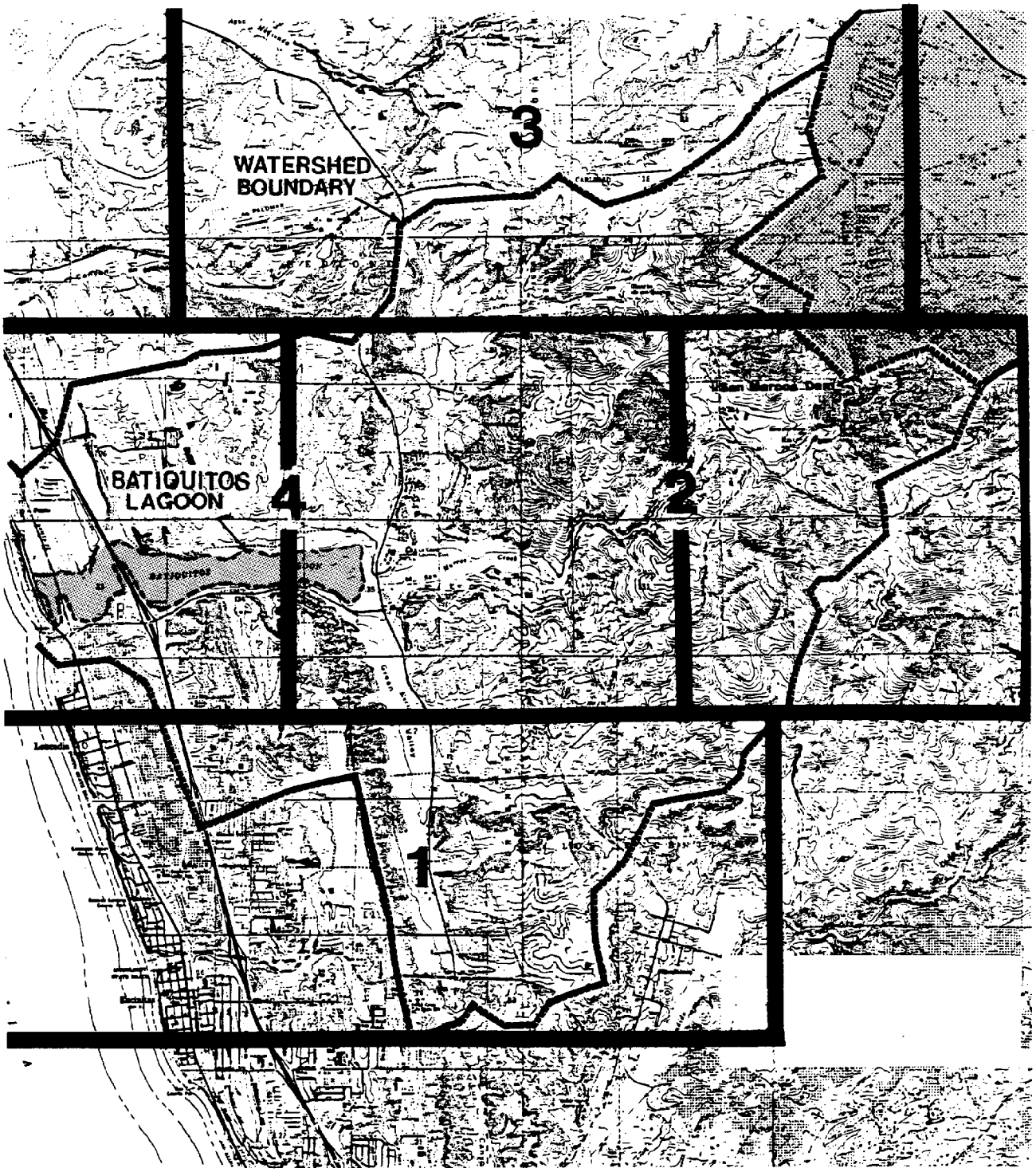
BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. A LAGOON HYDROLOGY AND WETLAND BOUNDARY

SURFACE WATER FLOW

WETLAND BOUNDARY

The California State Coastal CONSERVANCY

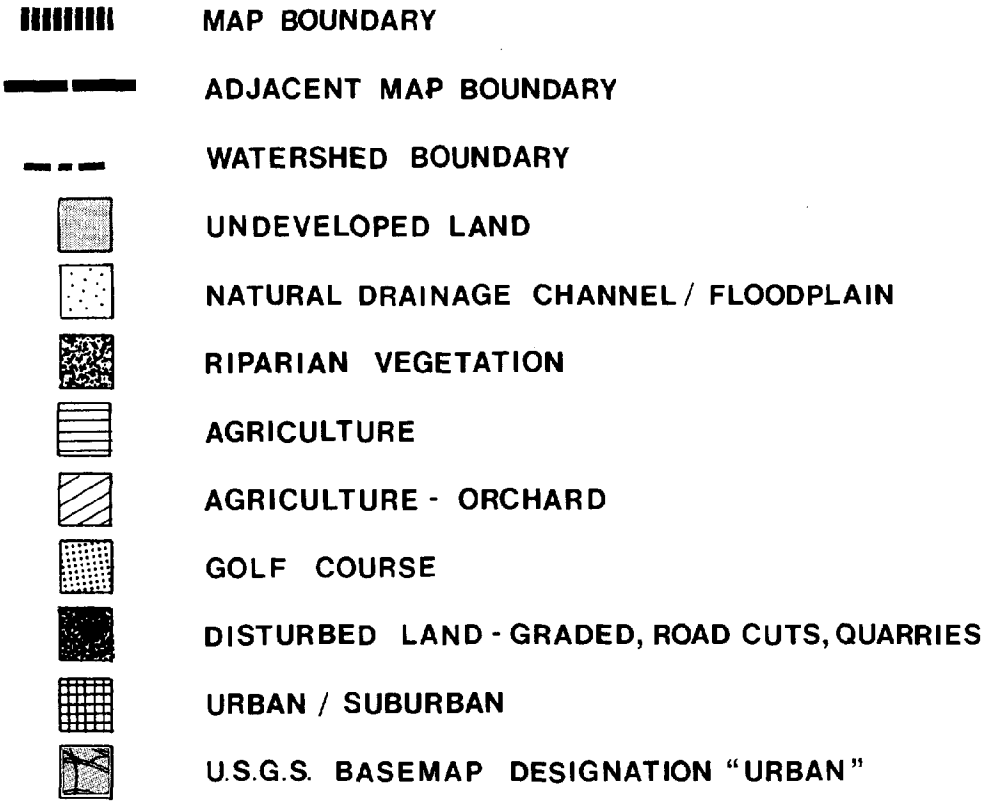


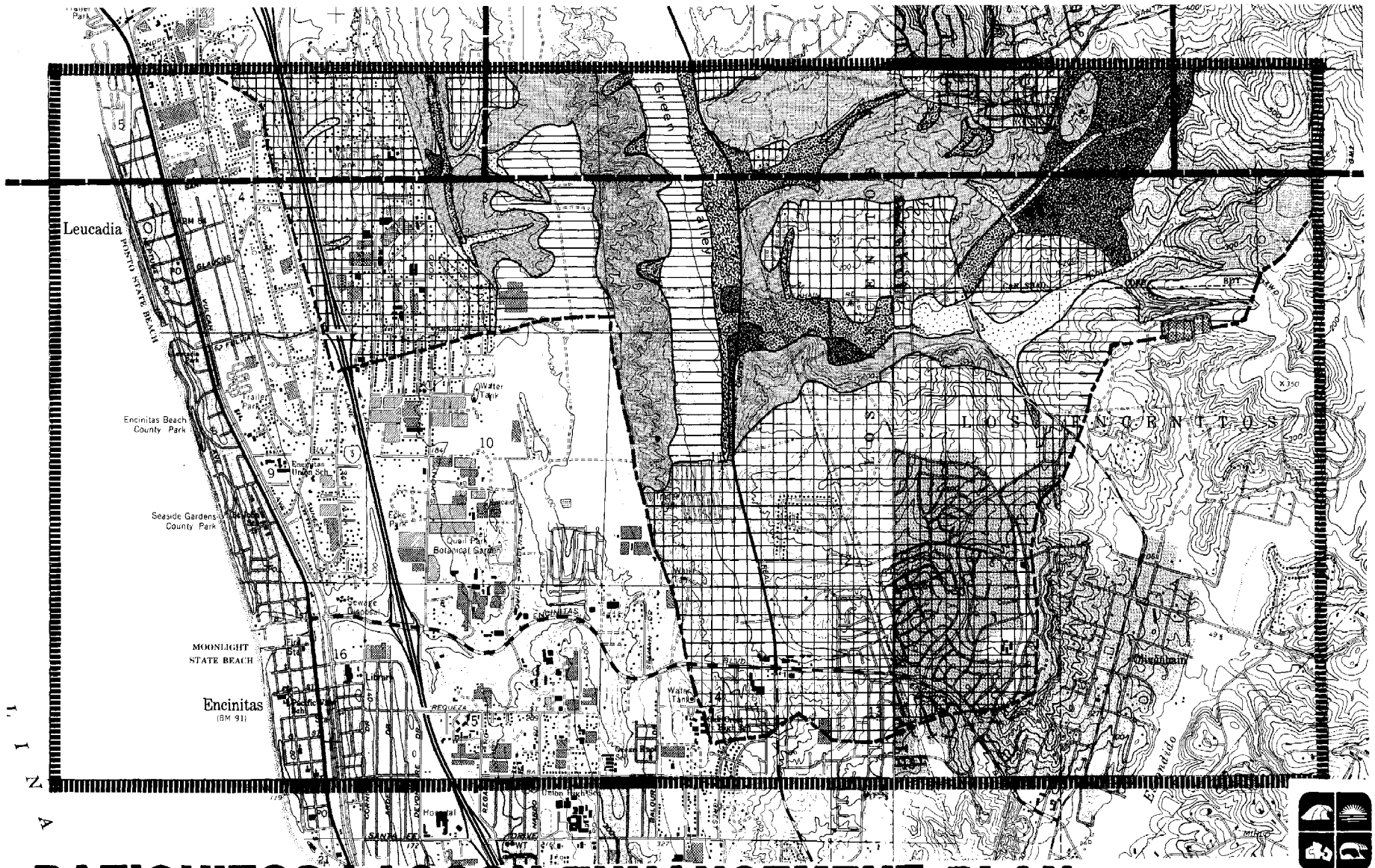
WATERSHED MAPS INDEX

FIG. B

LEGEND
WATERSHED MAPS 1-4

FIGS. B-1-4





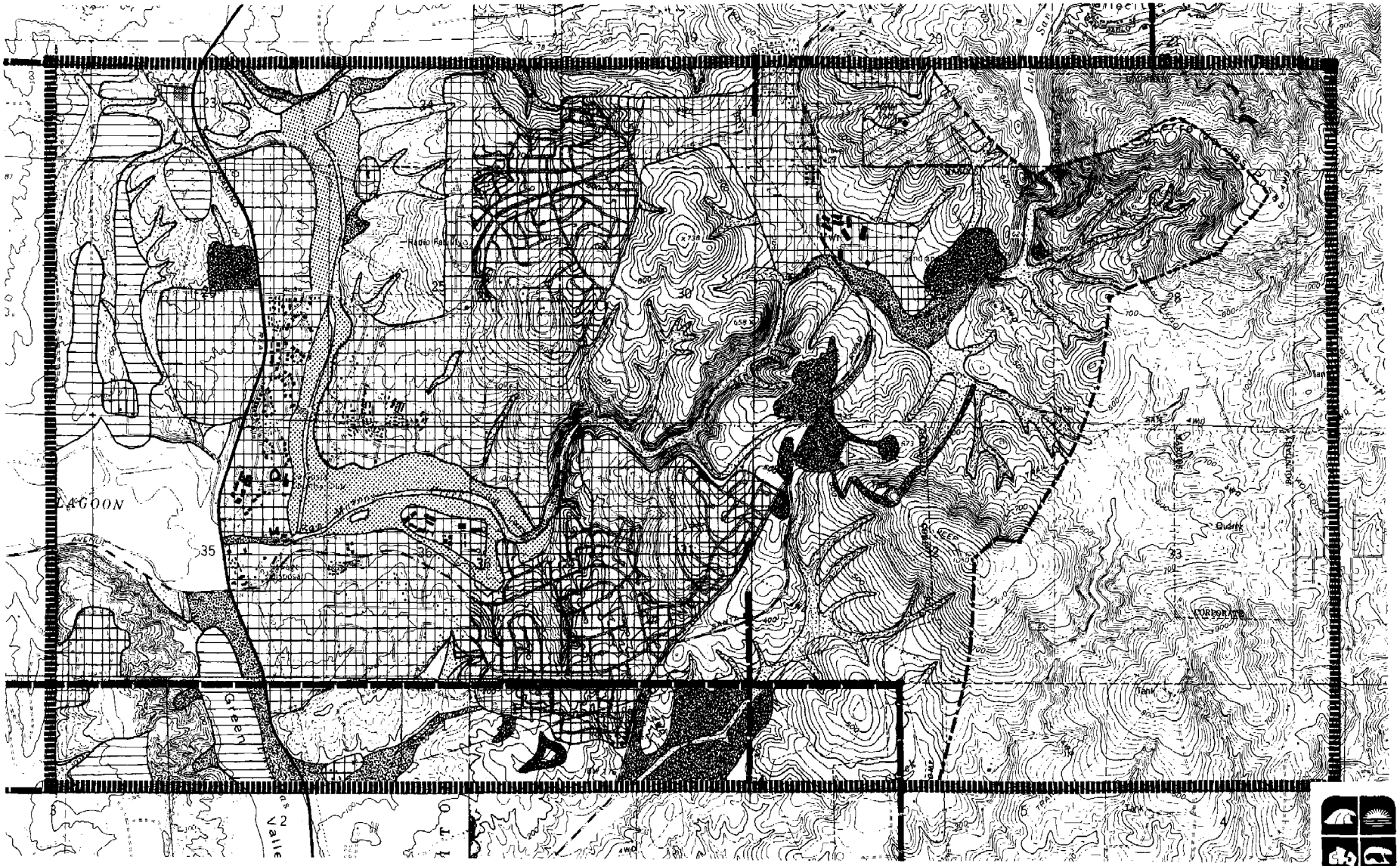
BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. B1 WATERSHED MAP NO.1

SEE PG. FOR LEGEND

0 2000 feet

The California State Coastal CONSERVANCY

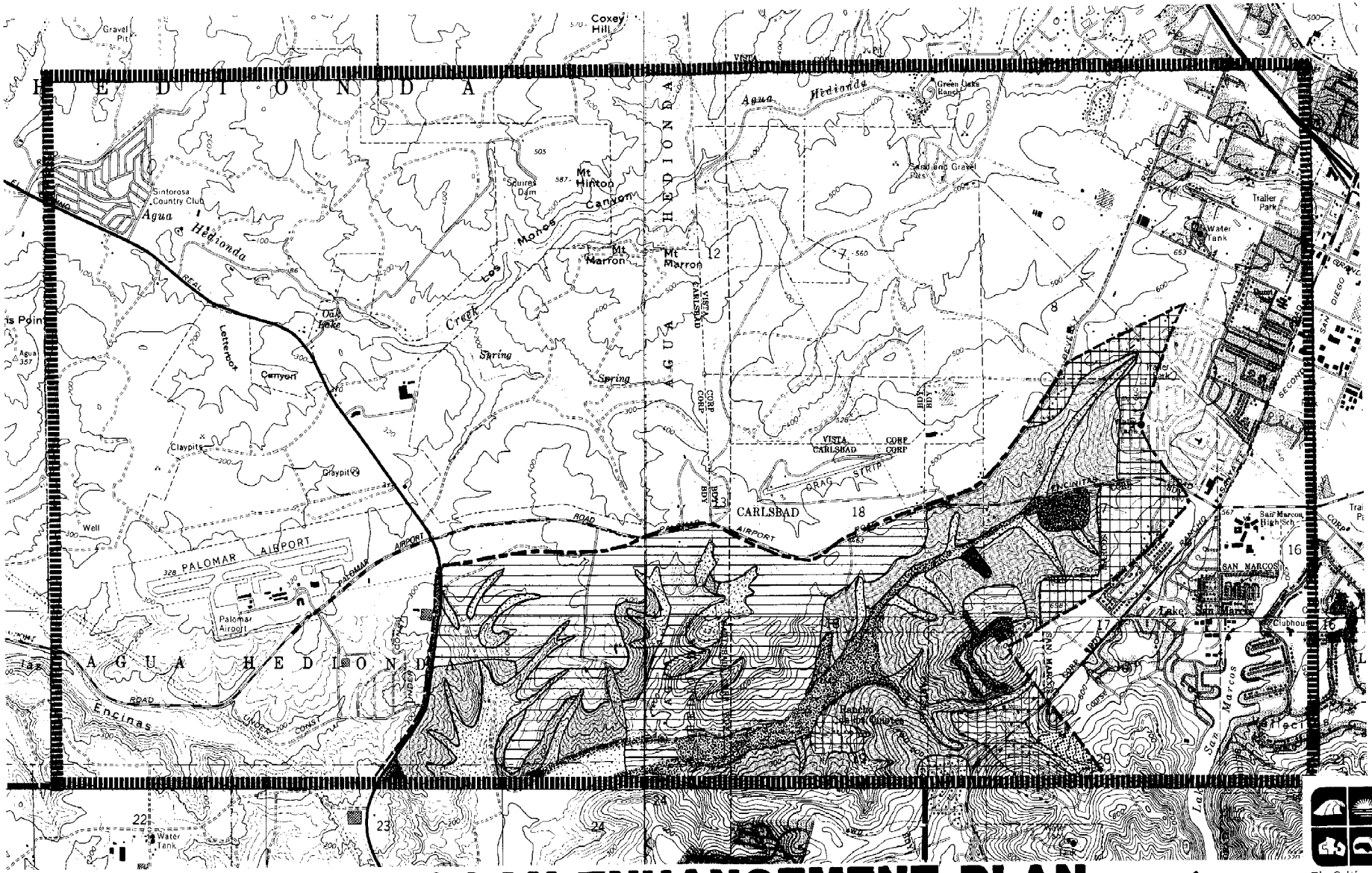


BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. B2 **WATERSHED MAP NO. 2** SEE PG. FOR LEGEND

0 2000 feet

The California State Coastal CONSERVANCY



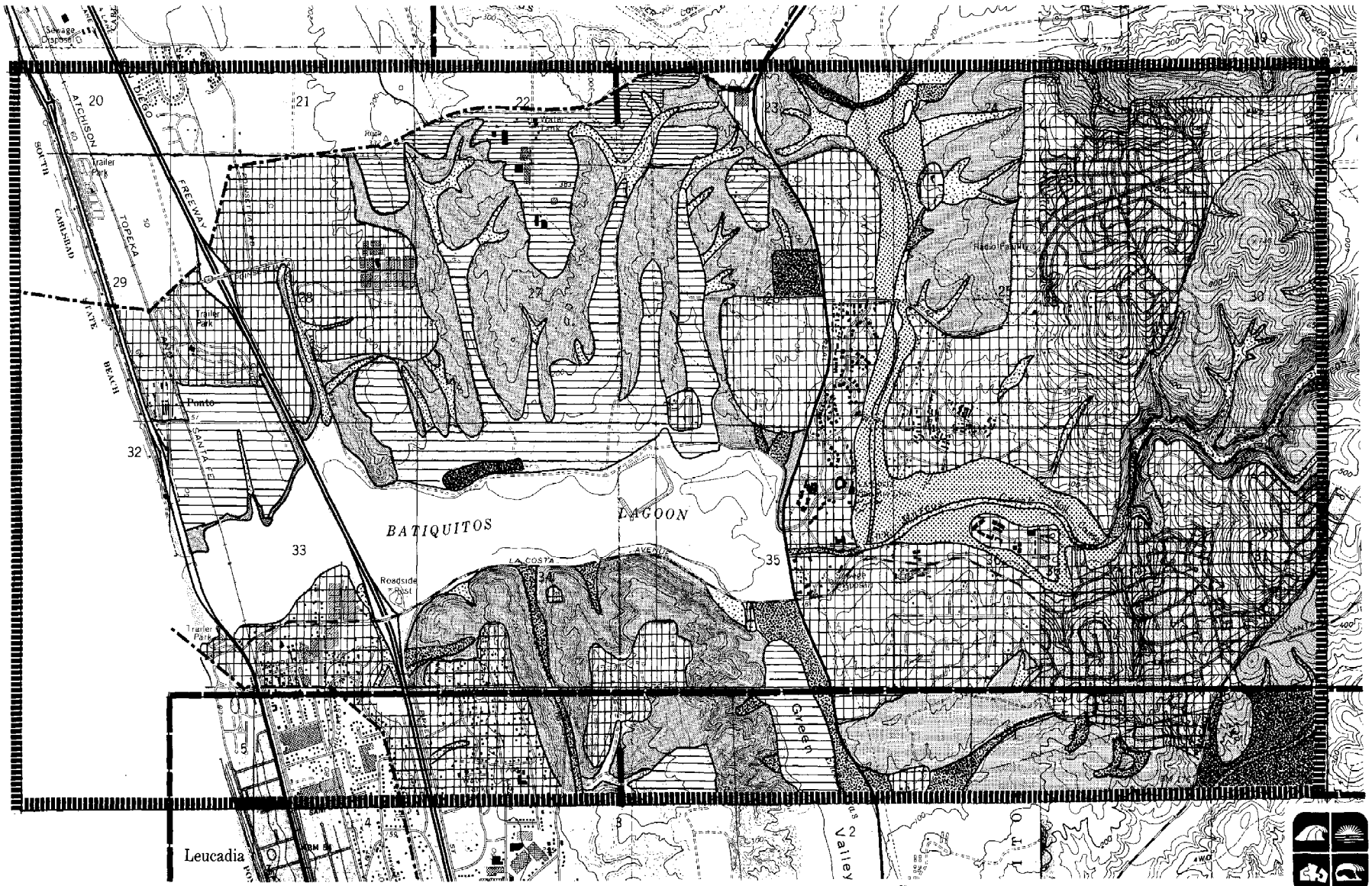
BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. B3 WATERSHED MAP NO. 3

SEE PG. FOR LEGEND

0 2000 feet

The California State Coastal CONSERVANCY



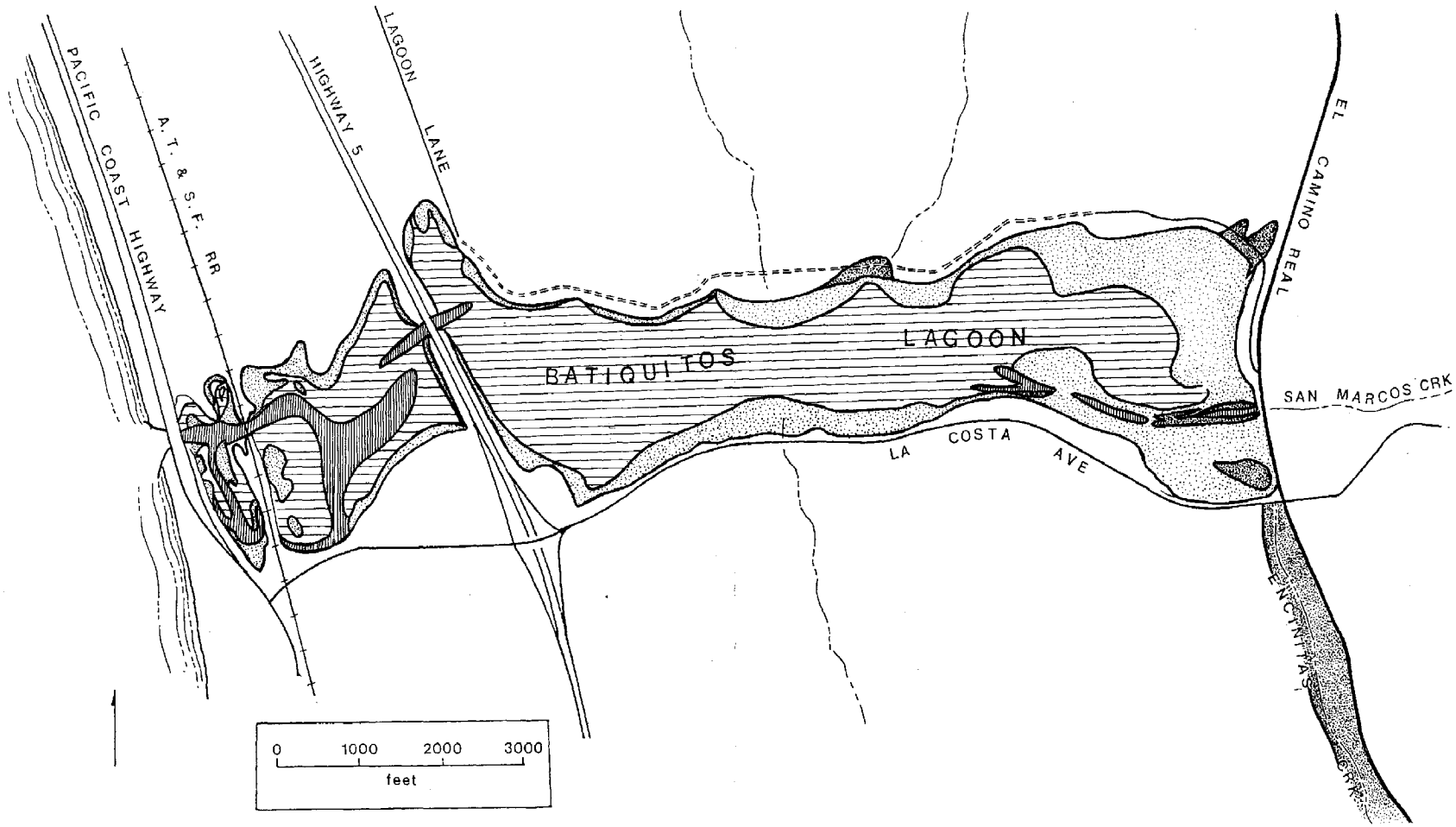
BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. B4 WATERSHED MAP NO. 4

SEE PG. FOR LEGEND

0 2000 feet

The California State Coastal CONSERVANCY

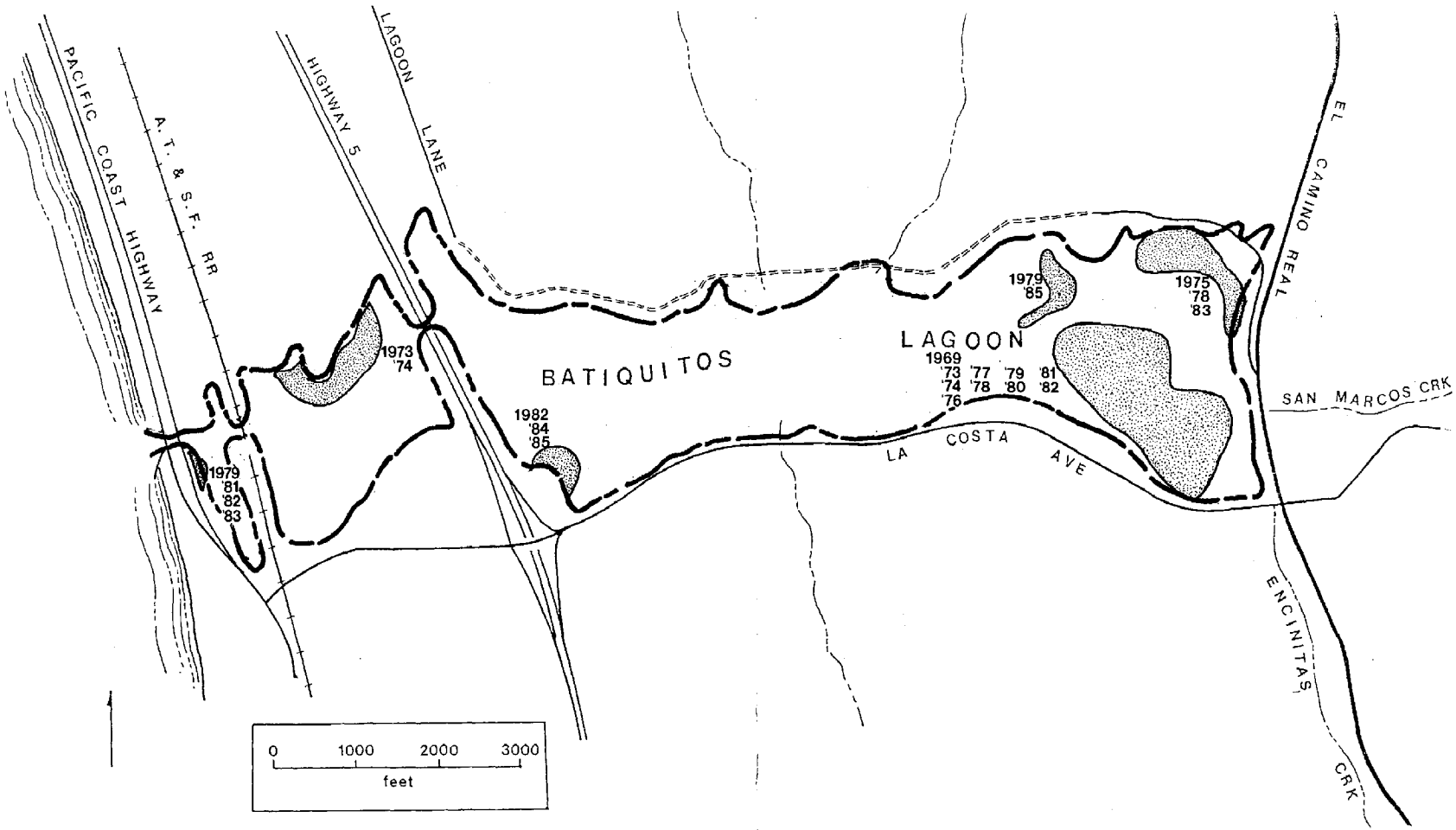


BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG.C LAGOON VEGETATION

- EMERGENT MARSH
- RIPARIAN(WILLOWS)/BRACKISH MARSH
- SAND/MUD/SHALLOW WATER(<12")
- OPEN WATER (>12")

The California State Coastal CONSERVANCY



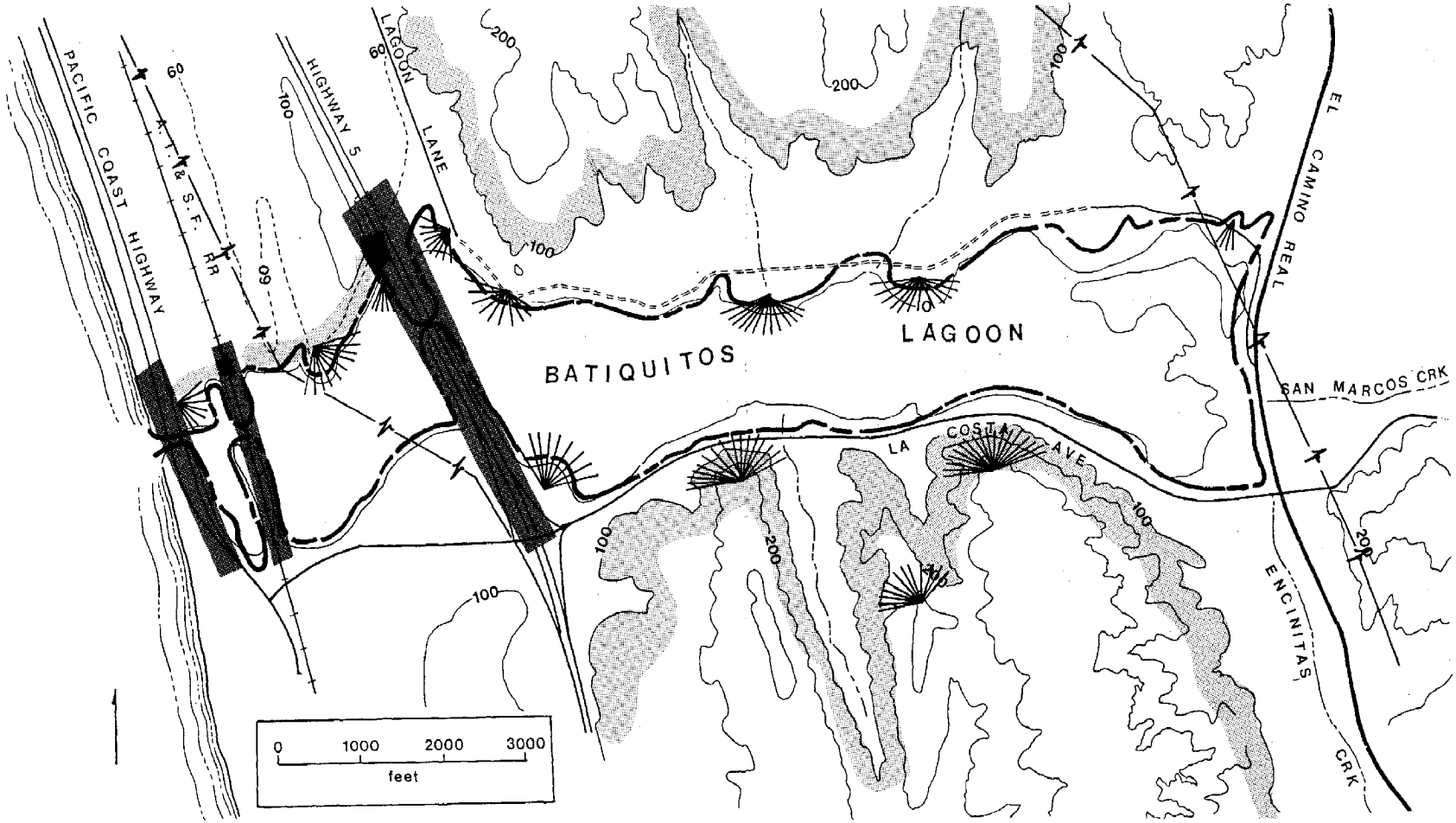
BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. D LEAST TERN NESTING SITES

NESTING SITE WITH DATE OF OBSERVATION

WETLAND BOUNDARY

The California State Coastal CONSERVANCY



BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. E LAGOON VIEWSHED

PROMINENT BLUFFS

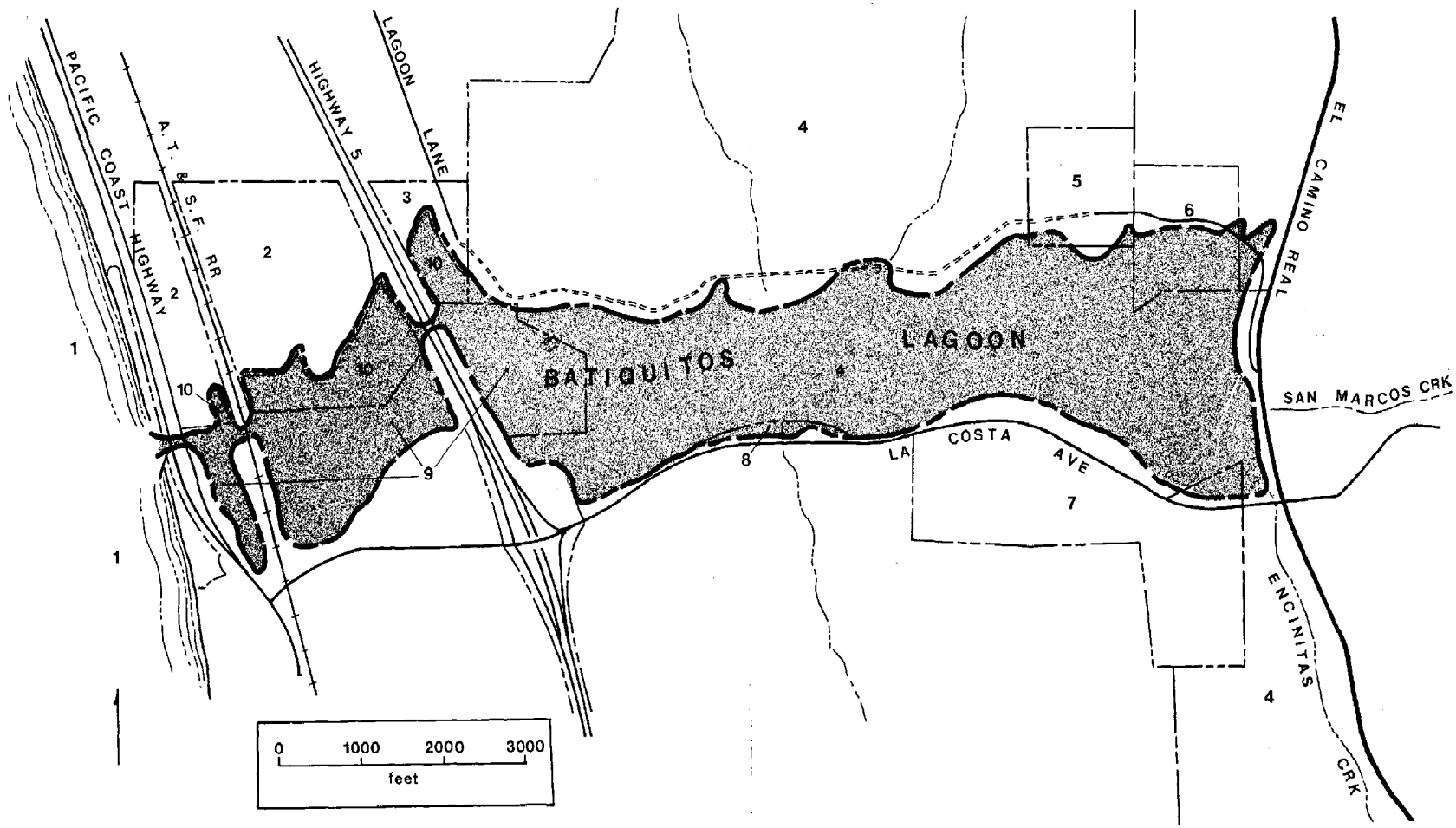
ELECTRICAL TRANSMISSION LINES

MAJOR VIEWPOINTS

MAN-MADE INTRUSIONS

WETLAND BOUNDARY

The California State Coastal CONSERVANCY



BATIQUITOS LAGOON ENHANCEMENT PLAN

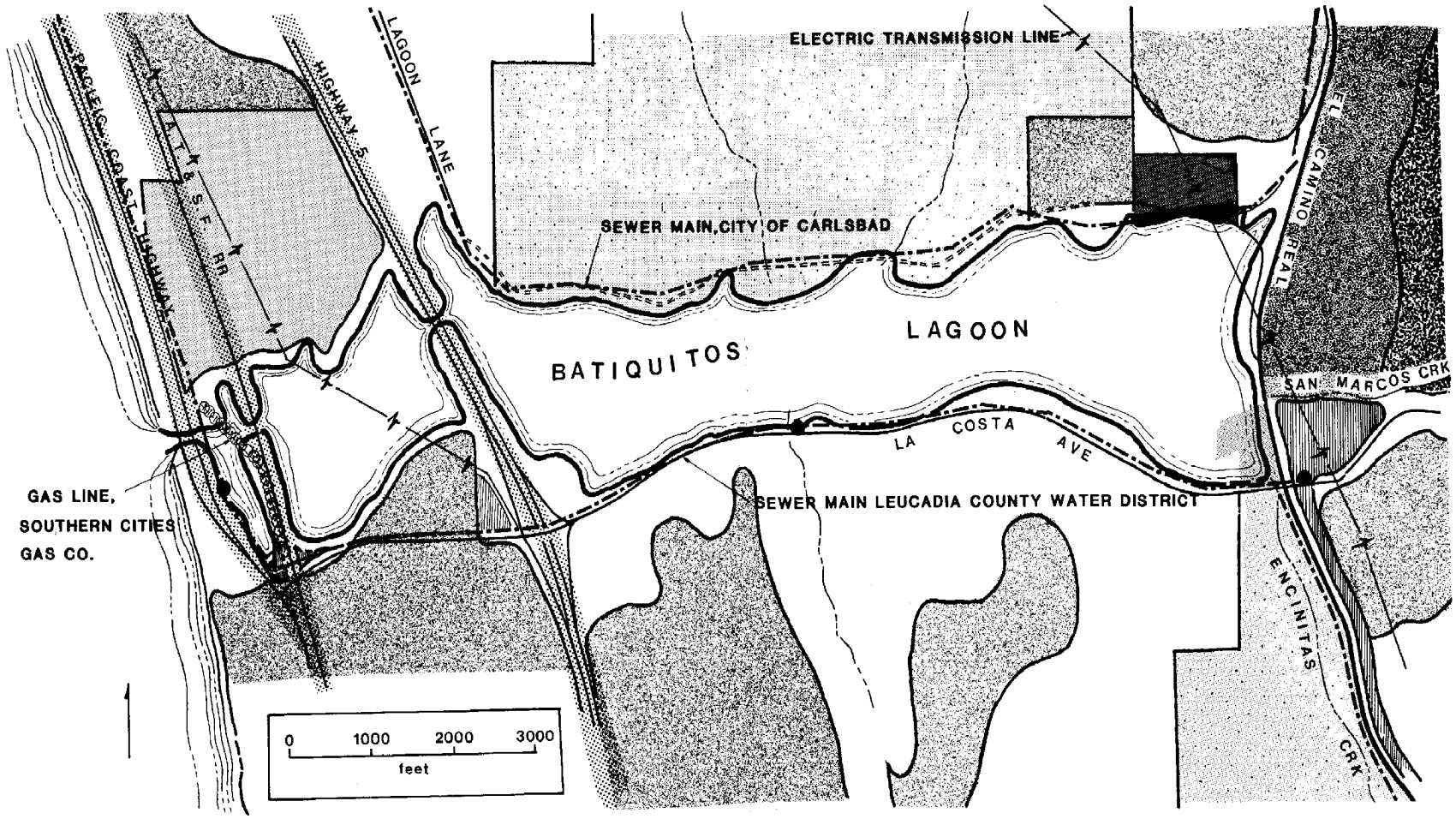
FIG. F LAND OWNERSHIP

PROPERTY LINE

WETLAND BOUNDARY

1. CA. STATE DEPT., PARKS & RECREATION
2. SAMMIS PROPS.
3. SAVAGE
4. HUNT PROPS., INC.
5. MURPHY
6. MITSUCHI
7. COMMUNITY BANK
8. LEUCADIA CO. WATER DISTRICT
9. CA. STATE DEPT., FISH & GAME
10. STATE LANDS COMMISSION

The California State Coastal CONSERVANCY

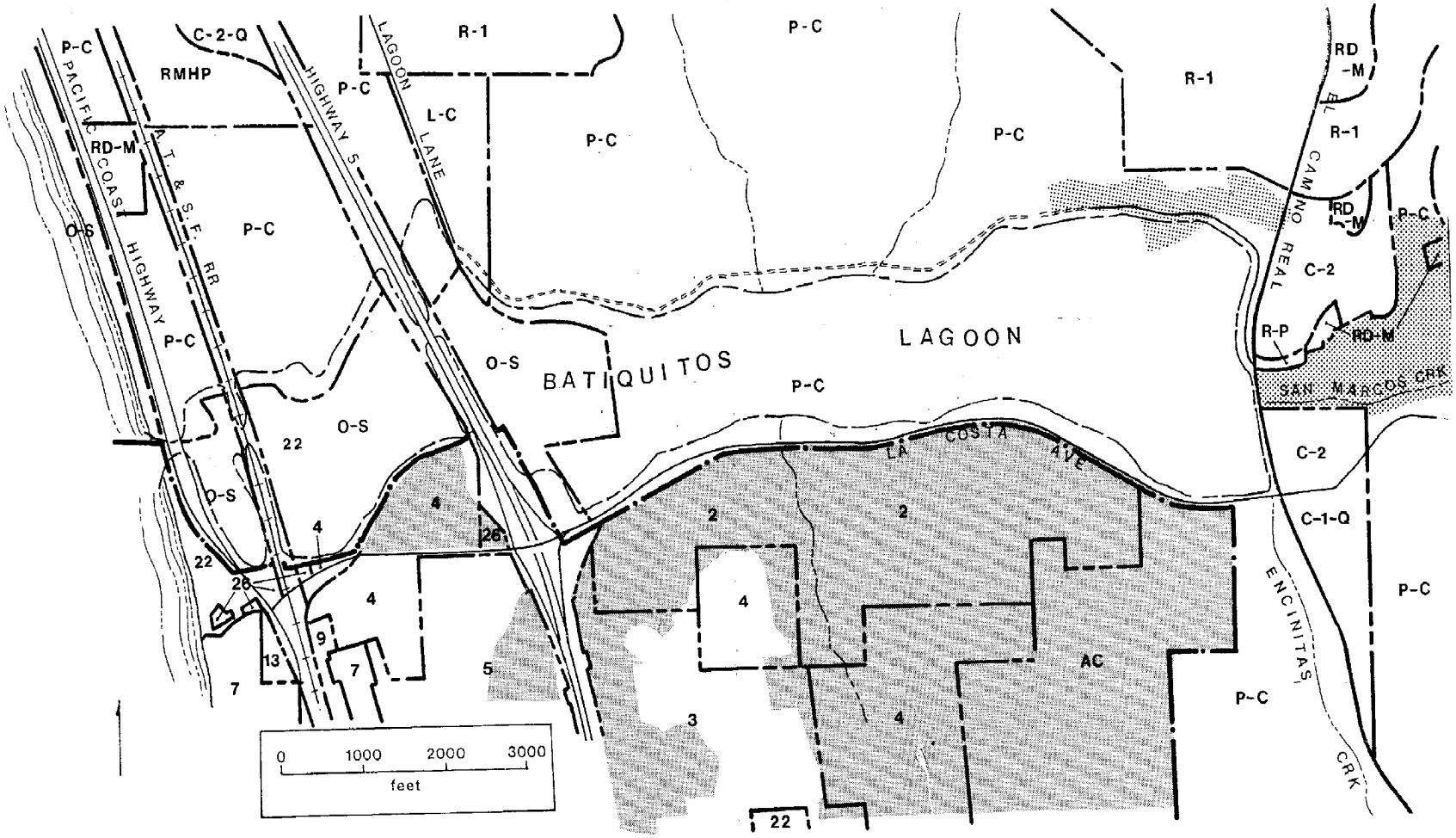


BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. G LAND USE AND UTILITIES

- RESIDENTIAL / RESORT
- RESIDENTIAL/MIXED USE
- PLANNED MIXED USE/ RESIDENTIAL/INSTITUTIONAL/VISITOR SERVING
- GOLF COURSE
- COMMERCIAL
- AGRICULTURE
- REGIONAL TRANSPORTATION ROUTES
- PROPOSED MIXED USE DEVELOPMENT
- PUMP STATION

The California State Coastal CONSERVANCY



BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. H ZONING AND JURISDICTIONAL BOUNDARIES

CITY OF CARLSBAD/CITY OF ENCINITAS LINE

ZONE LINE

APPLICABLE COASTAL RESOURCE PROTECTION ZONE [SEE ZONING LEGEND]

FLOODPLAIN OVERLAY ZONE

The California State Coastal CONSERVANCY

ZONING LEGEND FIG. H

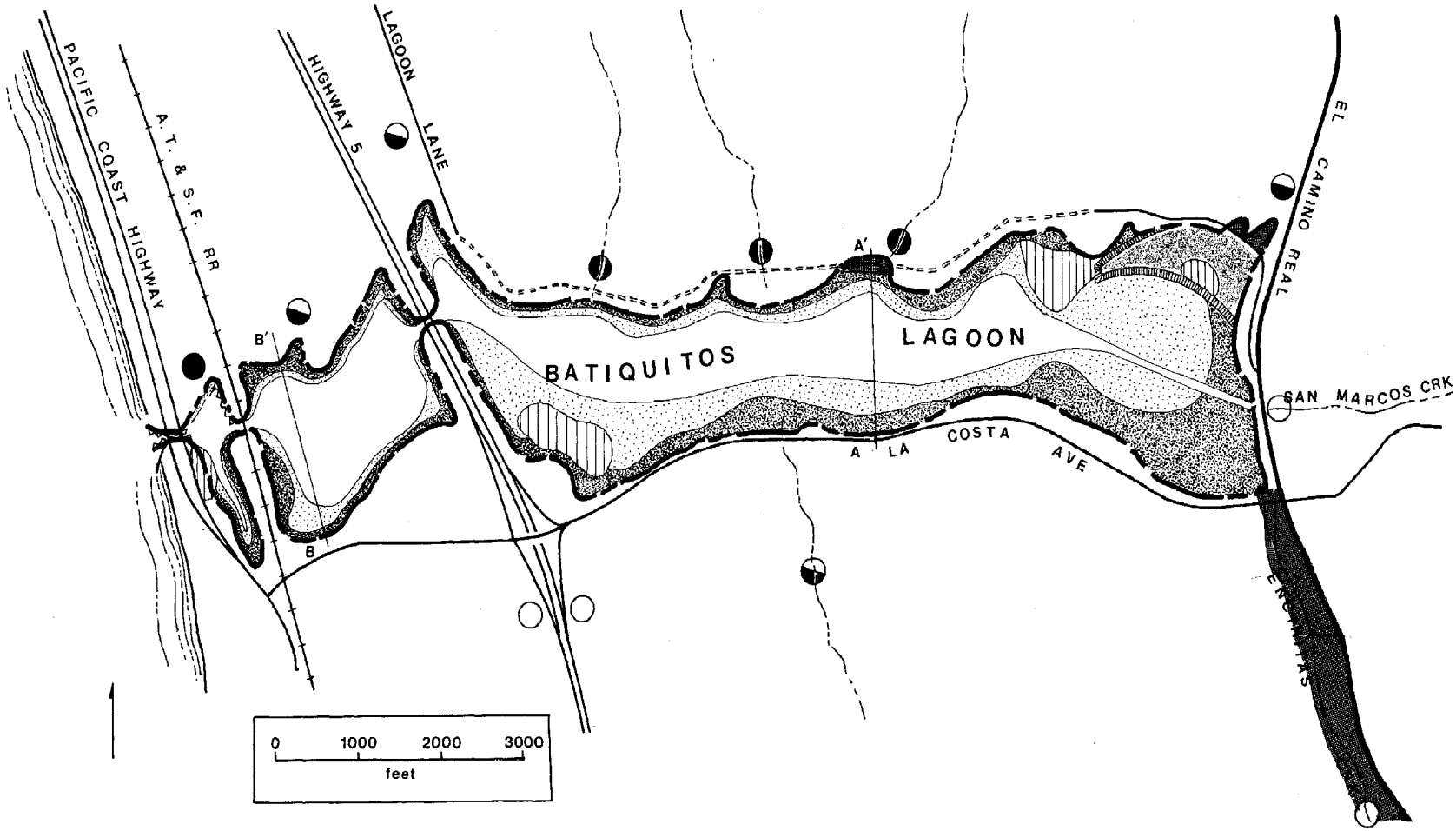
City of Carlsbad

C-1	NEIGHBORHOOD COMMERCIAL
C-2	GENERAL COMMERCIAL
L-C	LIMITED CONTROL
O-S	OPEN SPACE
Q	QUALIFIED DEVELOPMENT OVERLAY ZONE
R-1	ONE-FAMILY RESIDENTIAL
R-P	RESIDENTIAL PROFESSIONAL
RD-M	RESIDENTIAL DENSITY-MULTIPLE
RMHP	RESIDENTIAL MOBILE HOME PARK
P-C	PLANNED COMMUNITY

San Diego County

2	RESIDENTIAL,1 d.u./a.
3	RESIDENTIAL,2 d.u./a.
4	RESIDENTIAL, 2.9 d.u./a.
5	RESIDENTIAL,4.3 d.u./a.
7	RESIDENTIAL,10.9 d.u./a.
9	RESIDENTIAL,29 d.u./a.
13	GENERAL COMMERCIAL
22	PUBLIC/SEMI-PUBLIC
26	VISITOR-SERVING COMMERCIAL
AC	AGRICULTURE-CROPLAND

* Since the incorporation of the City of Encinitas, the new city will adopt a zoning code for the lands indicated under San Diego County.



BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. 1 ALTERNATIVE NO. 1

- EXISTING SEDIMENT BASIN
- SEDIMENT BASIN PROPOSED IN THIS PLAN
- SEDIMENT BASIN PROPOSED BY OTHER DEVELOPMENTS

- SUBTIDAL ZONE(-8.0 ft.-2.5 ft.,NGVD)
- INTERTIDAL ZONE(-2.5 ft.-2.0 ft.,NGVD)
- SALT MARSH
- BRACKISH/FRESHWATER MARSH
- RIPARIAN

- LEVEE
- RIP-RAP
- LEAST TERN SITES
- WETLAND BOUNDARY

The California State Coastal CONSERVANCY

FIGURE J1

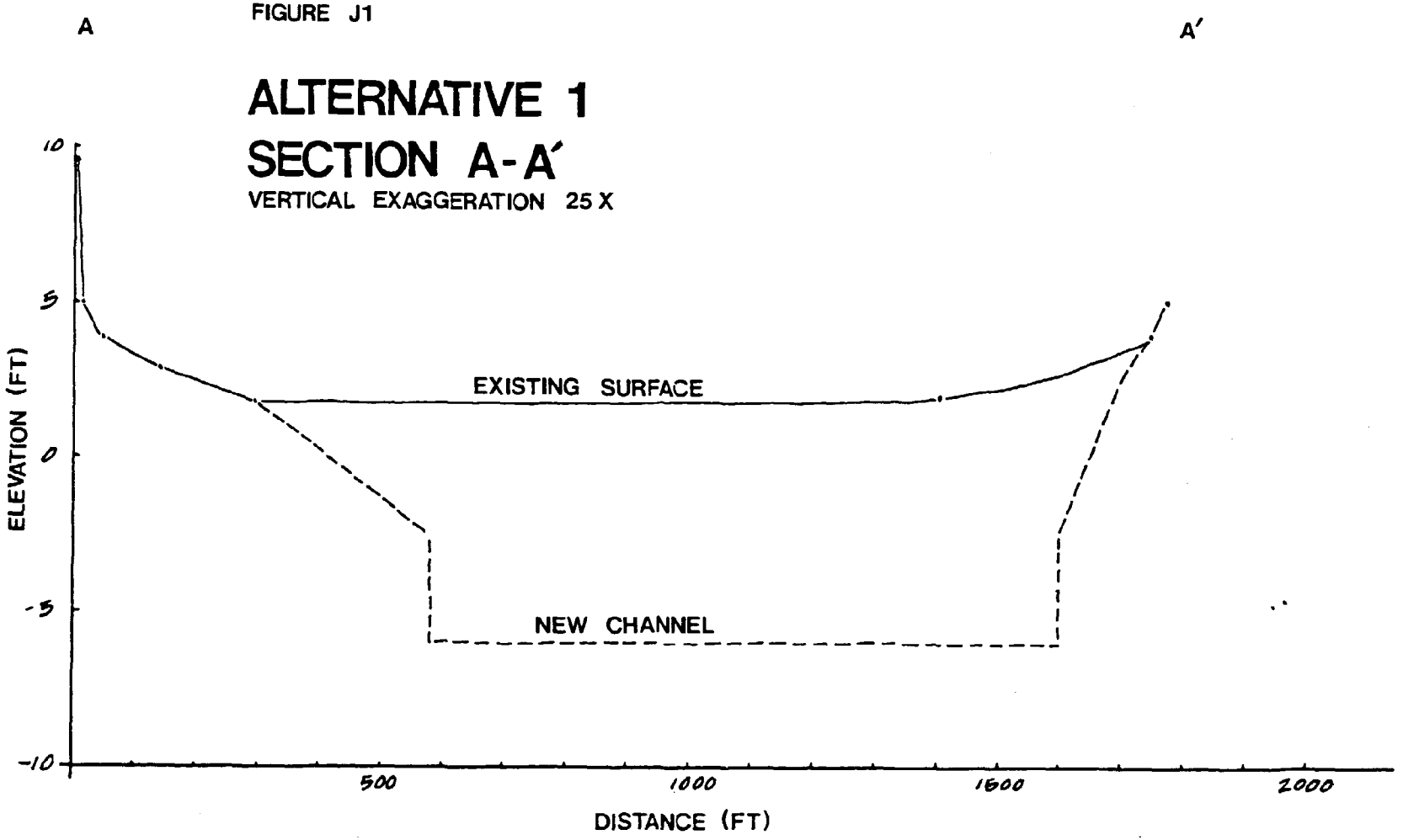

A
A'
ALTERNATIVE 1
SECTION A-A'
VERTICAL EXAGGERATION 25 X
10
5
0
-5
-10
ELEVATION (FT)
EXISTING SURFACE
NEW CHANNEL
500
1000
1500
2000
DISTANCE (FT)

FIGURE J2

A

A'

ALTERNATIVE 2
SECTION A-A'

VERTICAL EXAGGERATION 25 X

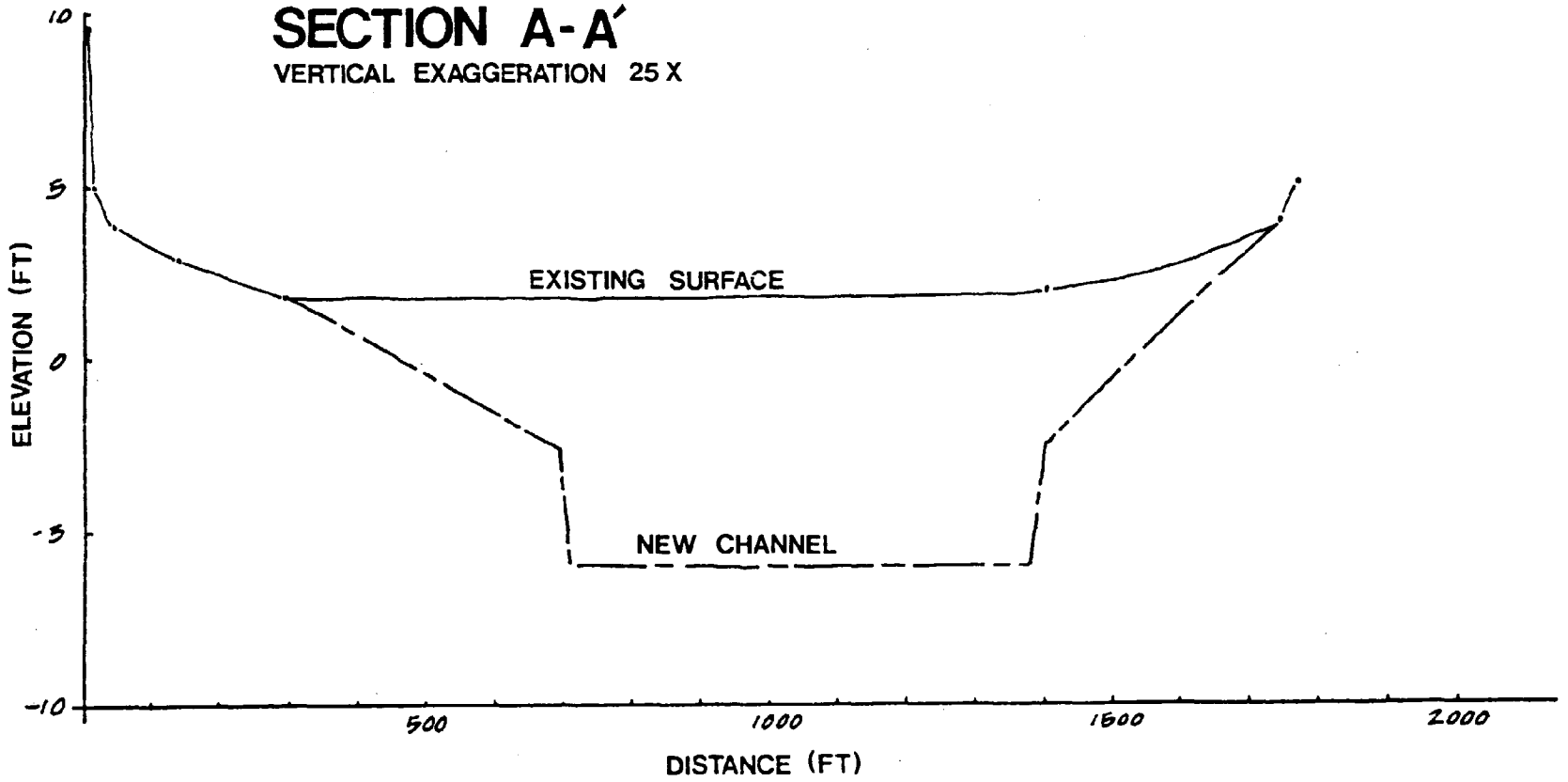


FIGURE J3

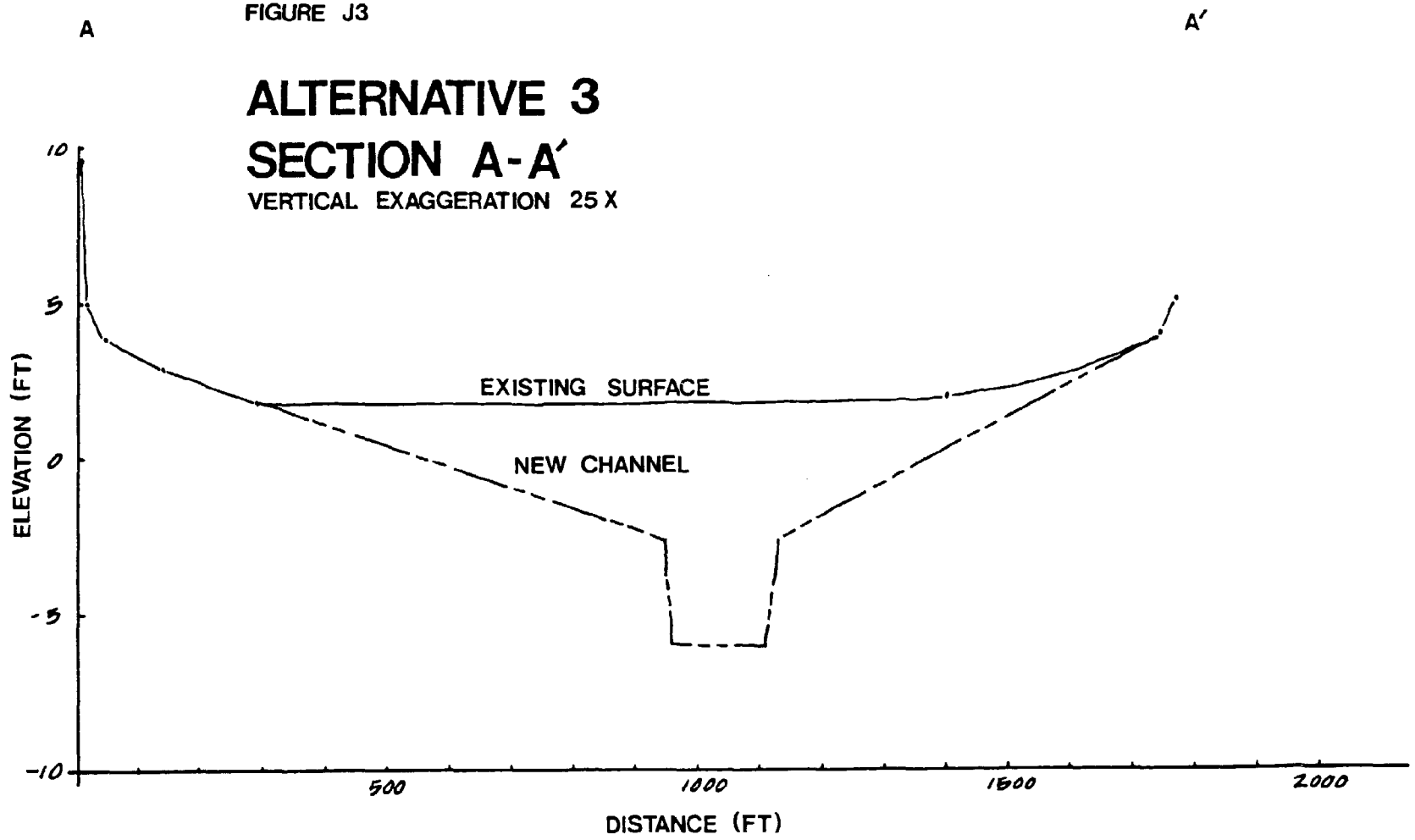

A
A'
ALTERNATIVE 3
SECTION A-A'
VERTICAL EXAGGERATION 25 X
10
5
0
-5
-10
ELEVATION (FT)
EXISTING SURFACE
NEW CHANNEL
500
1000
1500
2000
DISTANCE (FT)

FIGURE K1

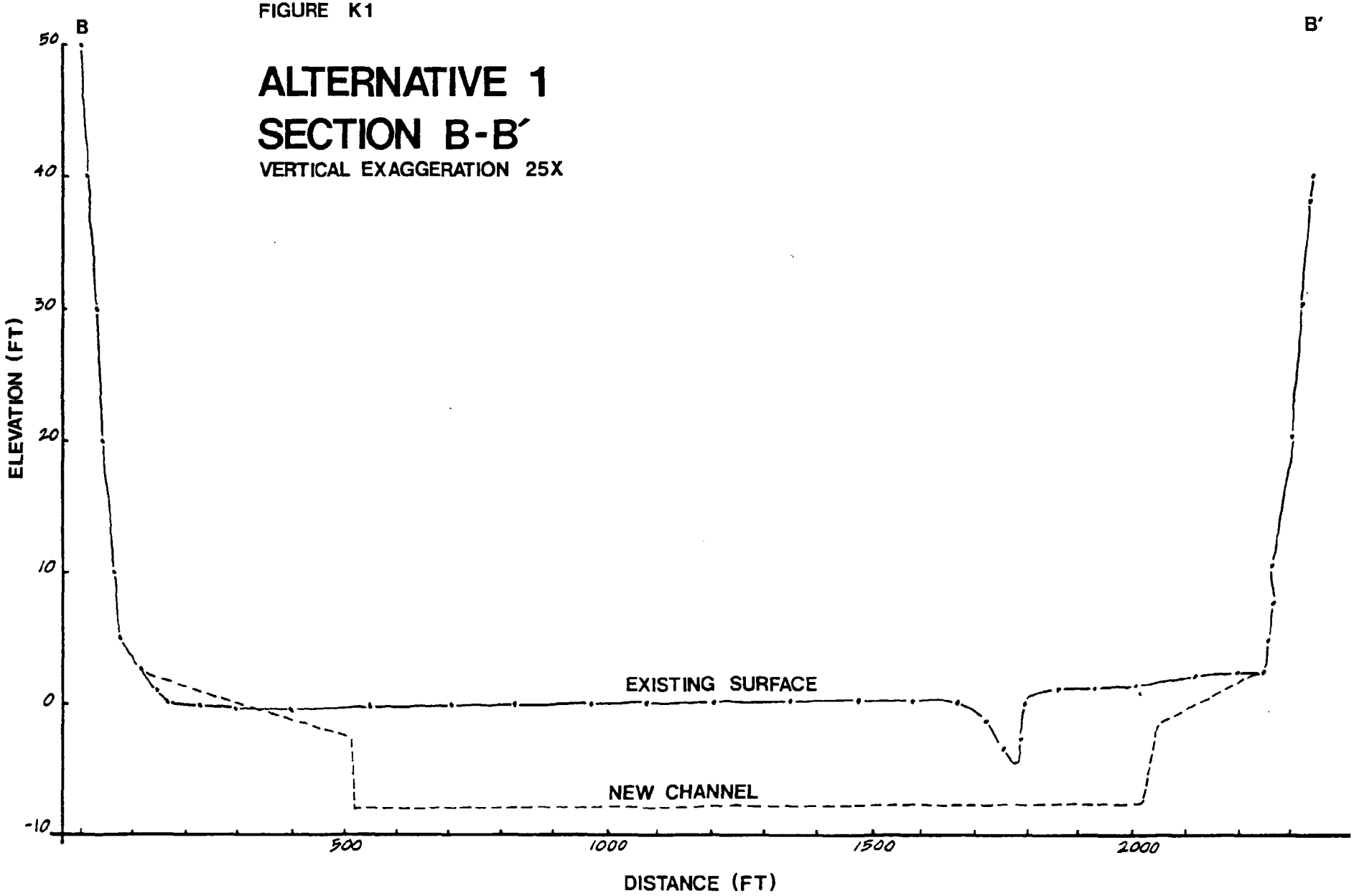

B
B'
ALTERNATIVE 1
SECTION B-B'
VERTICAL EXAGGERATION 25X
50
40
30
20
10
0
-10
ELEVATION (FT)
EXISTING SURFACE
NEW CHANNEL
500
1000
1500
2000
DISTANCE (FT)

FIGURE K2

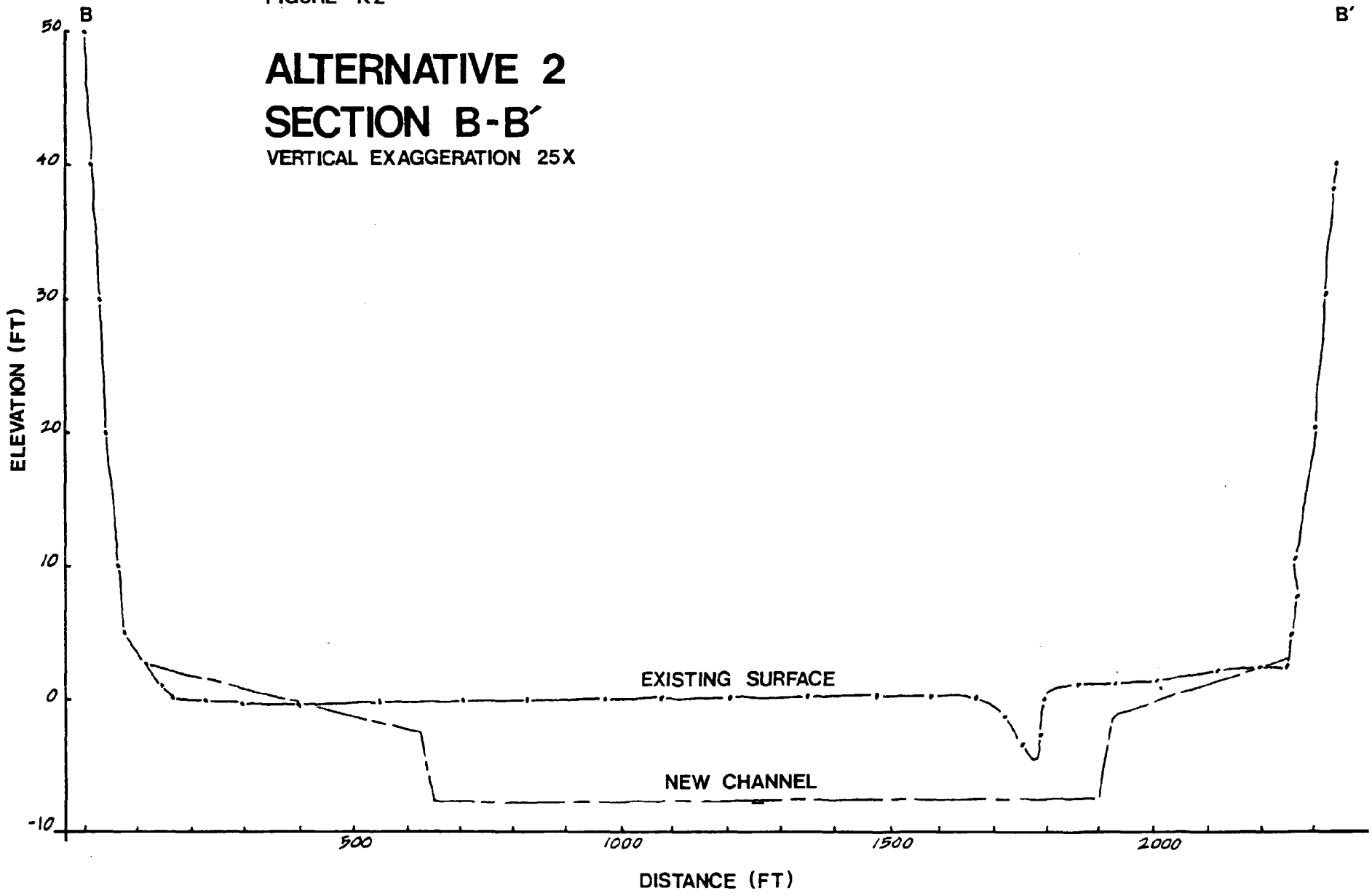
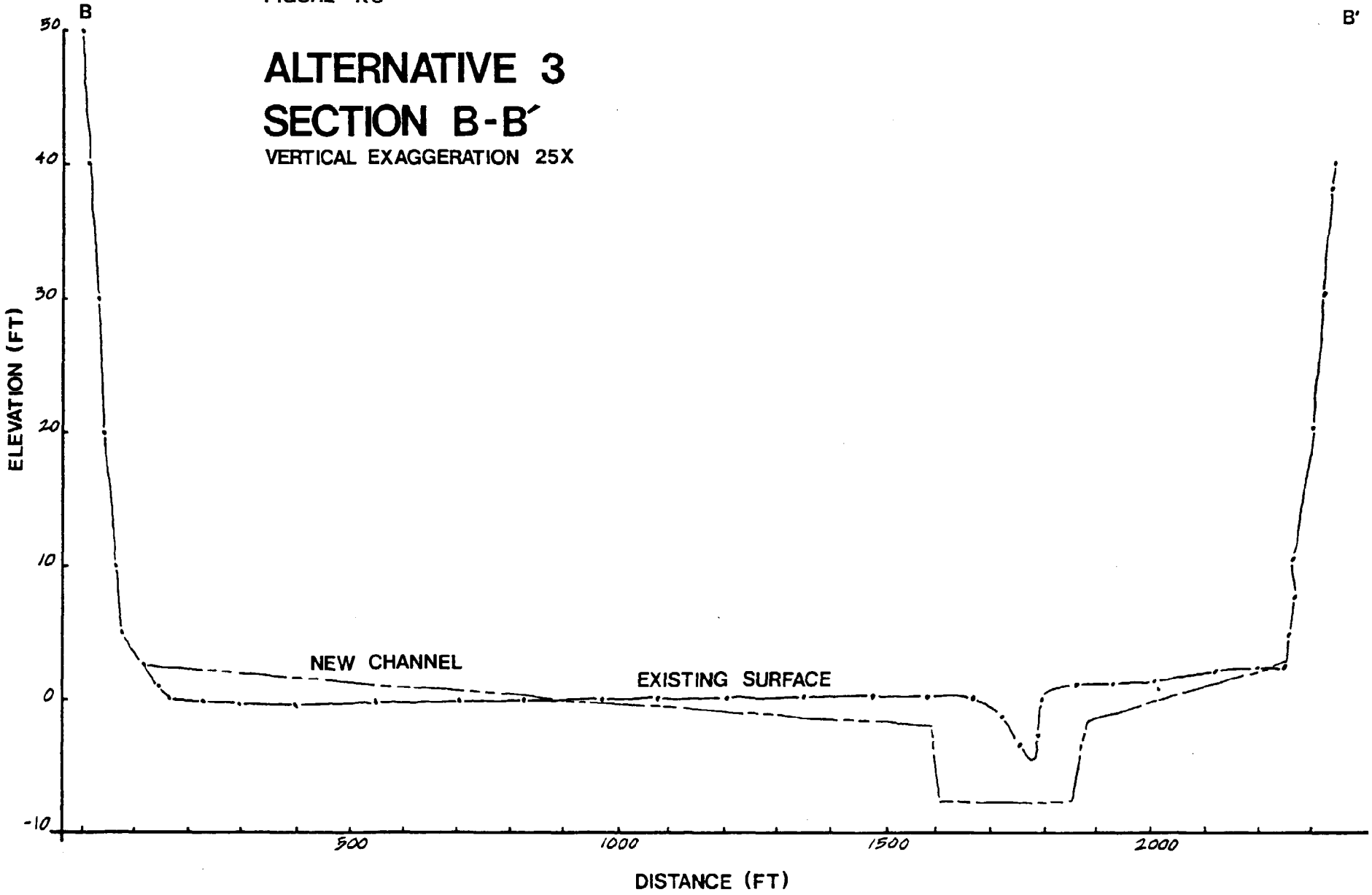

B
B'
ALTERNATIVE 2
SECTION B-B'
VERTICAL EXAGGERATION 25X
50
40
30
20
10
0
-10
ELEVATION (FT)
EXISTING SURFACE
NEW CHANNEL
500
1000
1500
2000
DISTANCE (FT)

FIGURE K3

ALTERNATIVE 3
SECTION B-B´
VERTICAL EXAGGERATION 25X



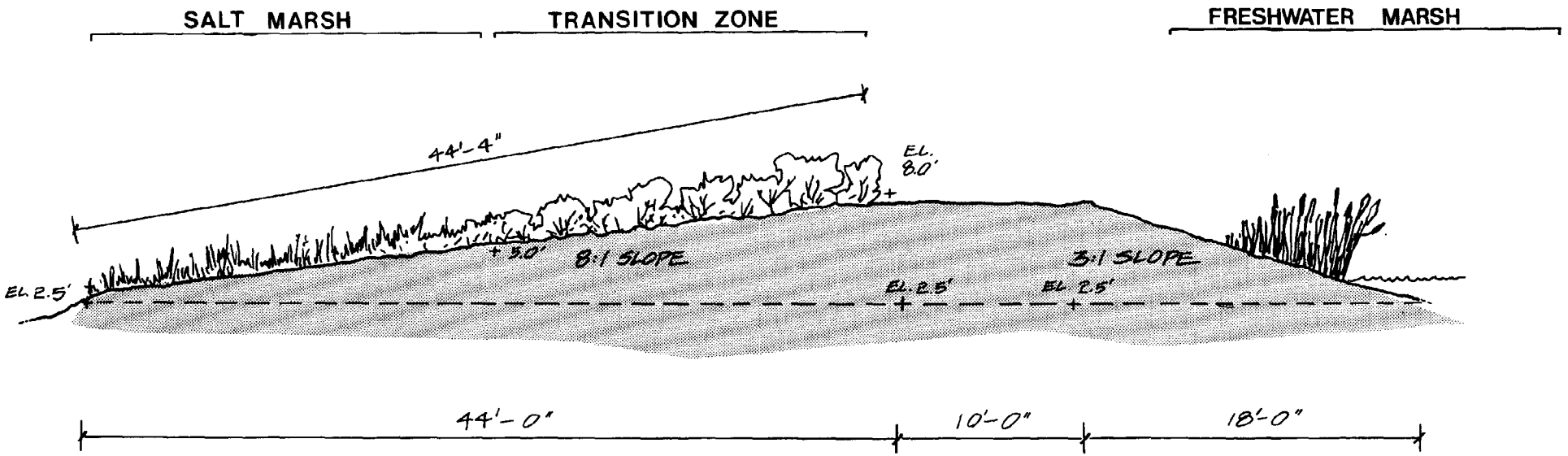
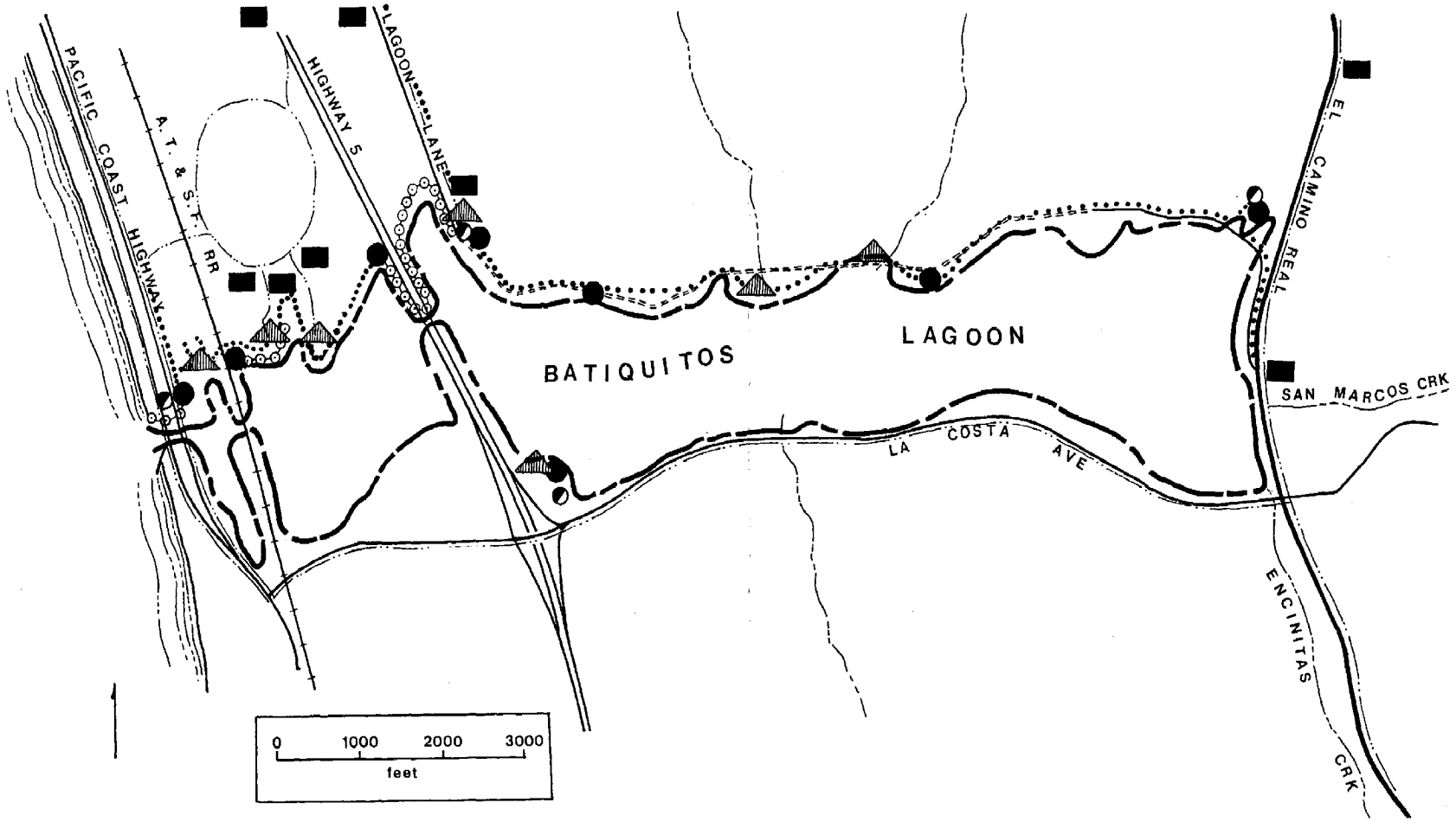


FIG. L **Typical Cross-section, Freshwater marsh Levee**



BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. M PUBLIC ACCESS

- PUBLC ACCESS SIGNS
- PARKING/TRAILHEAD
- PEDESTRIAN ACCESS TRAIL
- INTERPRETIVE FACILITIES
- LAGOON VIEWPOINT
- POSSIBLE FUTURE ACCESS TRAIL
- BICYCLE PATH OR BICYCLE LANE ON ROADWAY

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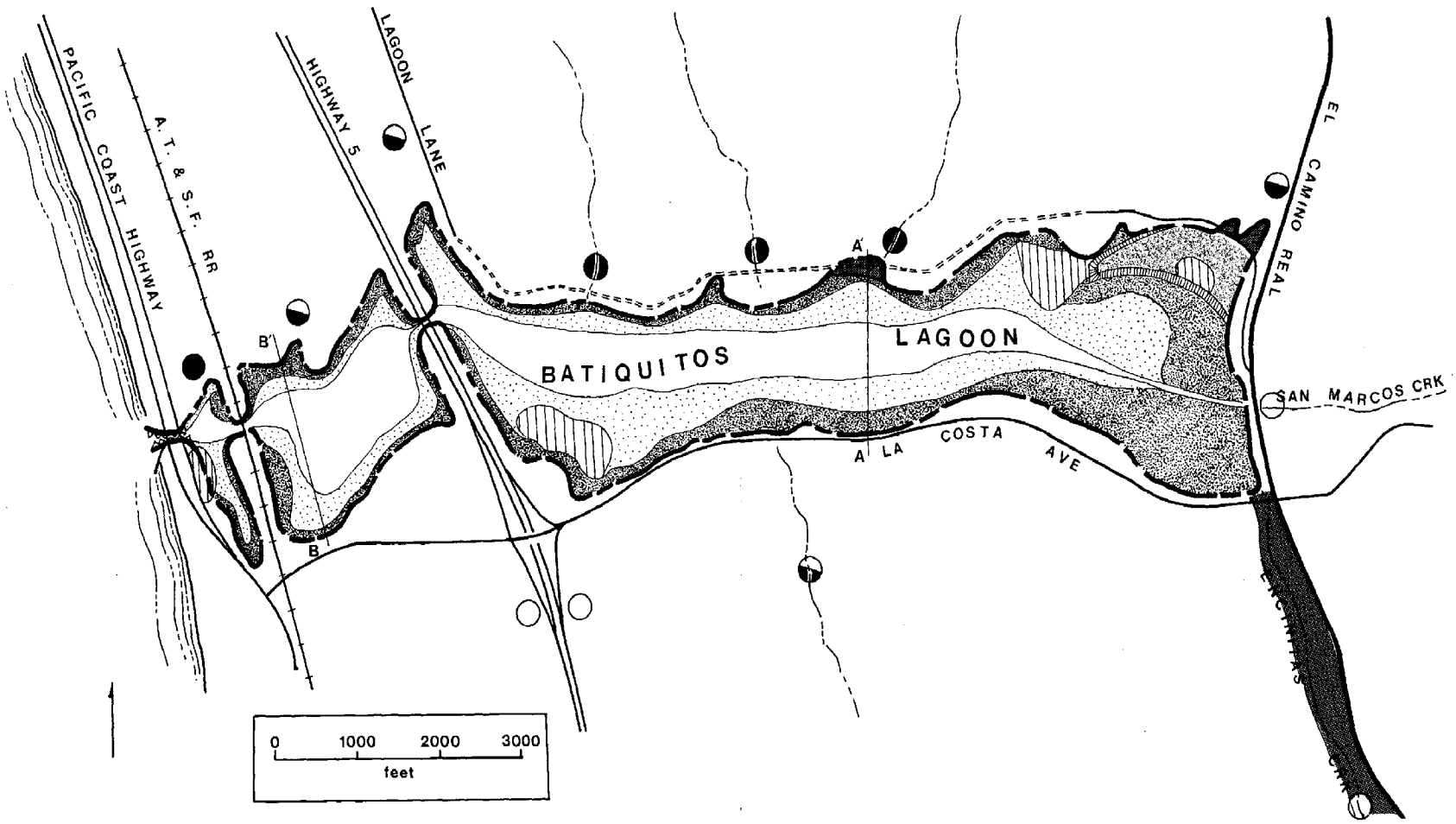


BATIQUITOS LAGOON ENHANCEMENT PLAN

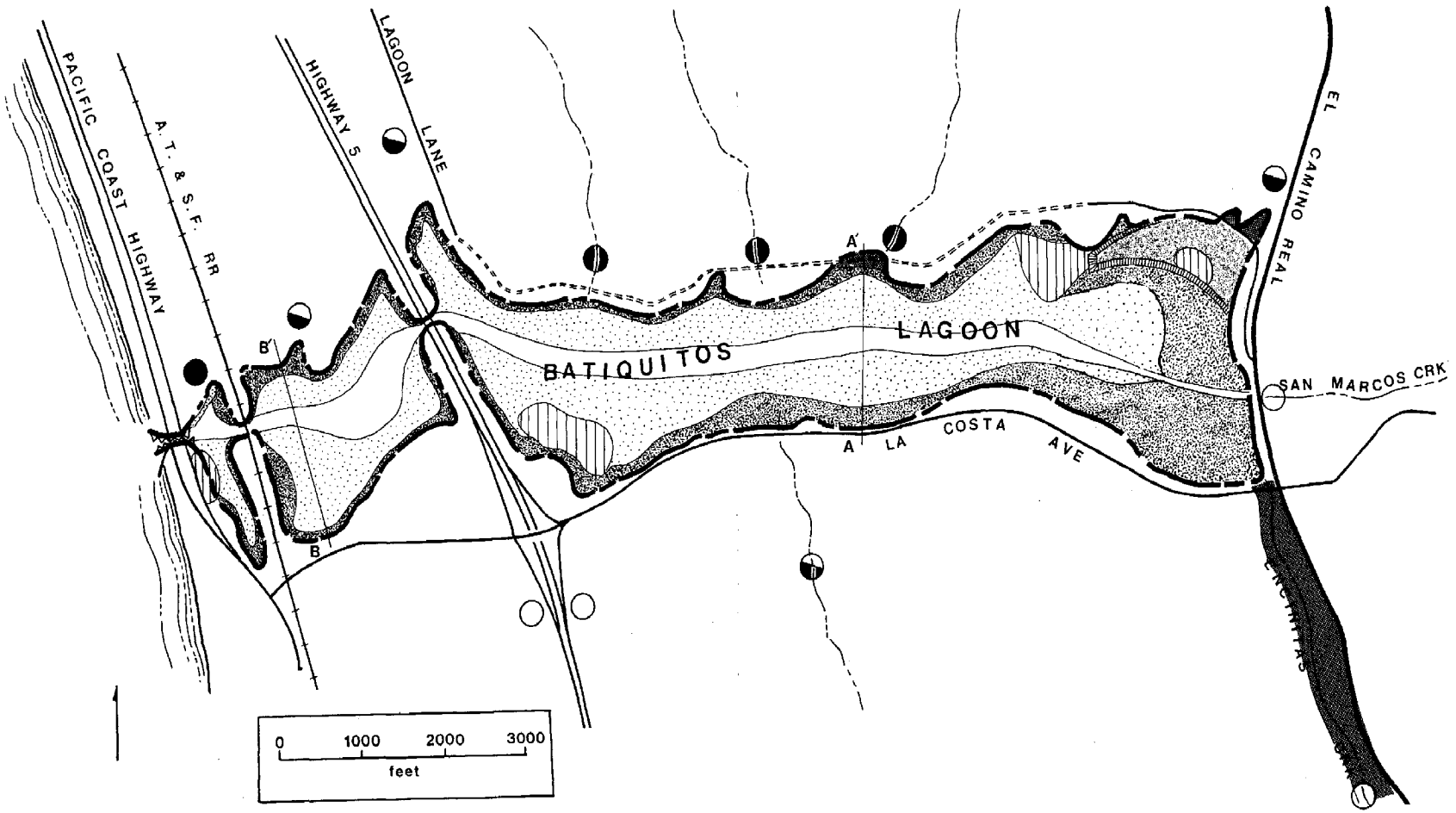
FIG. N PLAN ALTERNATIVE NO. 2

- EXISTING SEDIMENT BASIN
- SEDIMENT BASIN PROPOSED IN THIS PLAN
- SEDIMENT BASIN PROPOSED BY OTHER DEVELOPMENTS

- SUBTIDAL ZONE(-8.0 ft.-2.5 ft.,NGVD)
- INTERTIDAL ZONE(-2.5 ft.-2.0 ft.,NGVD)
- SALT MARSH
- BRACKISH/FRESHWATER MARSH
- RIPARIAN

- LEVEE
- RIP-RAP
- LEAST TERN SITES
- WETLAND BOUNDARY

The California State Coastal CONSERVANCY



BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. O PLAN ALTERNATIVE NO. 3

- EXISTING SEDIMENT BASIN
- SEDIMENT BASIN PROPOSED IN THIS PLAN
- SEDIMENT BASIN PROPOSED BY OTHER DEVELOPMENTS

- SUBTIDAL ZONE(-8.0 ft.-2.5 ft.,NGVD)
- INTERTIDAL ZONE(-2.5 ft.-2.0 ft.,NGVD)
- SALT MARSH
- BRACKISH/FRESHWATER MARSH
- RIPARIAN

- LEVEE
- RIP-RAP
- LEAST TERN SITES
- WETLAND BOUNDARY

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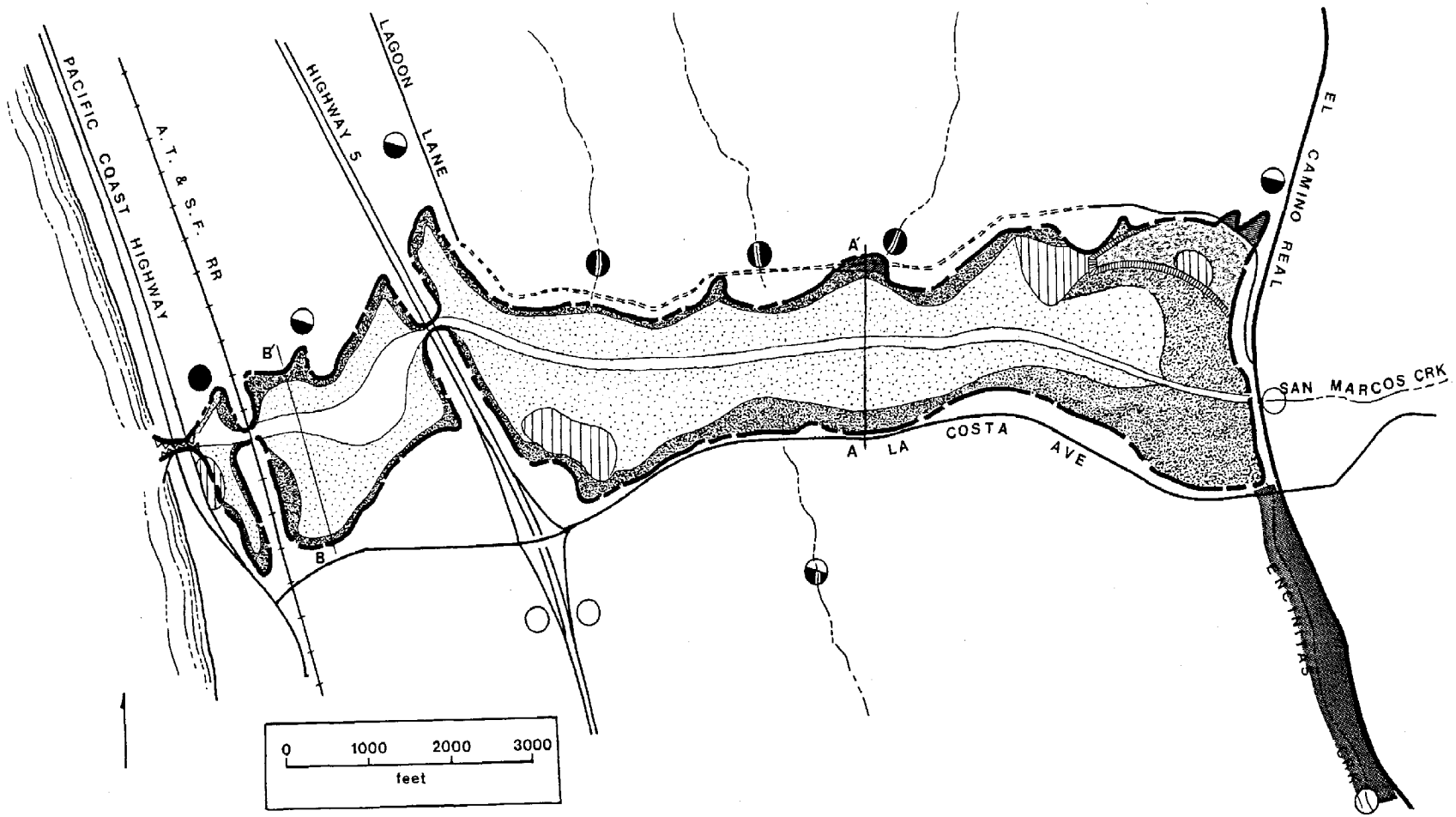

BATIQUITOS LAGOON ENHANCEMENT PLAN

FIG. 0 PLAN ALTERNATIVE NO. 4

- EXISTING SEDIMENT BASIN
- SEDIMENT BASIN PROPOSED IN THIS PLAN
- SEDIMENT BASIN PROPOSED BY OTHER DEVELOPMENTS

- SUBTIDAL ZONE(-8.0 ft.-2.5 ft.,NGVD)
- INTERTIDAL ZONE(-2.5 ft.-2.0 ft.,NGVD)
- SALT MARSH
- BRACKISH/FRESHWATER MARSH
- RIPARIAN

- LEVEE
- RIP-RAP
- LEAST TERN SITES
- WETLAND BOUNDARY

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