Appendix A

GOALS AND OBJECTIVES

Prepared by

Wallace Roberts & Todd

GOAL STATEMENT

The following text forms a goal statement to guide the future development of Mission Bay Park as an aquatic park, planned and designed to serve citizens of and visitors to San Diego.

Goals for Land Use

Mission Bay Park is a truly unique public coastal resource. The world's largest urban water-recreation park, its 2,100-acre land area supports a diversity of land and water uses including water-oriented public recreation, commercial and resort enterprises, and wildlife habitat.

The public recreational use of land in Mission Bay Park has traditionally been focussed on passive parkland that supports the enjoyment of the waterfront setting as well as access to the water for wading and a variety of boating activities. The strip of land immediately adjacent to the water is, of course, especially valuable as a recreation resource along with the bicycle and pedestrian paths that provide access to it.

Commercial recreation amenities in Mission Bay Park form a vital constituent of the Park's extensive use and include a marine theme Park, and a number of resort hotels and marinas. Many people enjoy the Bay through the use of these facilities, which also provide revenue for the park's operations and maintenance.

Once a huge marsh with a dramatic diversity and richness of natural and wildlife resources, Mission Bay has been gradually dredged to form the current bodies of land and water. Remaining natural resources in Mission Bay have tended to be valued primarily for their biological function. In recent years, however, as public awareness of environmental issues has grown, there has been a rise in the perception of natural areas also as key recreational and aesthetic amenities.

In the light of these issues, Mission Bay Park should be:

Land Use Goal 1

An aquatic-oriented park which provides a diversity of public, commercial and natural land uses for the enjoyment and benefit of all the citizens of San Diego and visitors from outside communities.

1.1 *A park in which all public recreation land use areas are designed and managed to maximize uses that benefit from the bay's unique environment.*

1.2 *A park where the waterfront is designed and managed for public access to the greatest extent possible.*

1.3 *A park which supports commercial and non-profit lease areas, with priority given to water-oriented leases, on up to 25 percent of the total land area of the Park.*

1.4 *A park which provides certain natural areas for passive recreation, with limited public access to certain natural areas for passive recreation, aesthetic enjoyment, and education, while enhancing, and protecting from public access if necessary, other more sensitive natural areas to maximize their biological value.*

1.5 *A park which provides a continuous, safe, and enjoyable network of recreational pathways for pedestrians, joggers, cyclists, roller skaters, and other approve non-motorized recreational users to enjoy and access the park's recreation environments.*

Mission Bay serves the recreation needs of adjacent neighborhoods as well as city and regional constituencies. For this reason, the park functions, in effect, as a system of different parks, or "parks within a park," serving the various user groups, including biotic conservation interests. Accordingly, Mission Bay park should be:

Land Use Goal 2

A park in which land uses are located so as to avoid negative impacts on adjacent areas, providing for ease of access, and according to the particular qualities of different parts of the Bay.

2.1 *A park which provides aquatic-oriented neighborhood recreational amenities to serve adjoining neighborhoods.*

2.2 *A park which provides easily accessible regional recreation areas serving various user groups while minimizing conflicts between them.*

2.3 *A park which integrates the various park areas into a coherent whole, principally through paths, shore access and landscape management & certain unified design elements.*

Mission Bay Park has a defined boundary, but is nevertheless connected to a number of other important open space resources which link throughout San Diego. There is an opportunity for the Park to function as a hub uniting citywide recreational, aesthetic, and environmental areas. Accordingly, Mission Bay should be:

Land Use Goal 3

A park which enhances the viability and use of other connected open space areas so as to promote the creation of a comprehensive, integrated open space system.

3.1 *A park which is connected by recreational trails and pathways to the San Diego River, Tecolote Creek and Canyon, Rose Creek and Canyon, San Clemente Canyon, and the ocean beaches.*

3.2 *A park in which biological values are enhanced through the integration of the Bay's natural resources with those of Famosa Slough, the San Diego River, Tecolote Creek and Rose Creek.*

Goals for Water Use

Mission Bay's development as a park has, from the beginning, held the provision of water recreation as a primary goal. Accordingly, Mission Bay Park should be:

Water Use Goal 1

A park in which the water areas are allocated and maintained to support the diverse aquatic interests of those visiting Mission Bay.

1.1 A park in which provision is made for the interests of all users including power boaters, sail boaters, competition and recreational waterskiing, boardsailors, rowers, jet skiers, personal watercraft users, swimmers, bird watchers, persons fishing and future unidentified users.

Water Use Goal 2

A park which provides adequate and safe access to the waters of Mission Bay.

2.1 A park in which shoreline design and maintenance are managed to maximize water access within the context of shoreline stabilization needs, land use designations, environmental resources and regulations, aesthetic concerns, and public safety.

Water Use Goal 3

A park in which the water areas are maintained to assure the maximum enjoyment of aquatic activities consistent with safety, aesthetic, and environmental concerns.

3.1 A park in which the highest water quality is maintained, and in which water access facilities and water recreation designations are appropriately designed and located with respect to aesthetic and environmental goals, and consistent with the maintaining public safety.

Water Use Goal 4

A park in which water areas are maintained to assure continued navigability for designated uses, and in which adequate shoreline access for water use is maintained.

4.1 A park in which the consistent utilization of appropriate methods to maintain usability of water recreation designated areas is a primary goal of park planners and managers.

Goals for Circulation and Access

Circulation, transportation and access to and around the park plays a key role in how the park is used and enjoyed. Transportation policy and design with regards to the park also affects adjacent neighborhoods, particularly through congestion and parking impacts, and the surrounding region with regards to air quality. Circulation and access should be addressed and planed to comprehensively meet the needs of activities within the park, and to avoid as far as possible conflicts between park user groups and neighboring communities. Special consideration should be given to transportation systems which provide for park access and which promote enjoyable use of the park, support ongoing business concerns, minimize adverse environmental and residential impacts, maximize public safety, and provide motivations for use of transportation modes other than the private automobiles. Accordingly, Mission Bay should be:

<u>Circulation and Access Goal 1</u>

A park which promotes and ensures safe and enjoyable access for all park users and minimizes negative transportation-related impacts on surrounding neighborhoods.

1.1 *A park which provides maximum public pathway access to the waterfront.*

1.2 *A park which utilizes strategies to eliminate congestion on major roads so that pubic access is not impeded or significantly discouraged.*

1.3 *A park which minimizes conflicts between through traffic and park-related traffic.*

1.4 *A park which provides and encourages the use of alternative forms of transit for access to and circulation within the park, including but not be limited to shuttle bus and water taxi service to key recreational areas during the peak season and bike access to the park.*

1.5 *A park which ensures priority access to emergency vehicles to all areas during all seasons.*

1.6 *A park in which groups sponsoring major special events are required to provide alternative modes of transportation including, but not limited to, remote parking lots which can be used by shuttle busses.*

<u>Circulation and Access Goal 2</u>

A park that addresses the competing parking needs of area residents, employees, and visitors to Mission Beach, Pacific Beach, and Mission Bay Park, provides necessary parking for park users, and utilizes strategies for protecting neighboring areas from adverse parking impacts.

2.1 *A park in which the approach to parking is compatible with regional management plans and goals.*

2.2 *A park in which peak season and special event parking needs are addressed in a cost effective manner that does not compromise surrounding neighborhood and recreational uses.*

Circulation and Access Goal 3

A park which provides a complete, clearly defined and safe (Class 1) bike path that ties in with the existing bicycle network for adjoining neighborhoods.

3.1 A park which is served by public transit which provides racks for transporting bicycles.

Circulation and Access Goal 4

A park which provides a path system designed and managed so as to safely accommodate both pedestrian and non-motorized wheeled circulation.

4.1 A park which is connected to surrounding neighborhoods by safe pedestrian and bicycle path and routes.

4.2 A park which provides complete accessibility for persons with disabilities throughout Mission Bay.

4.3 A park which includes separate paths for pedestrians and non-motorized, wheeled circulation where possible and necessary to maximize safety and enjoyment of the path network.

Goals for Economics

Mission Bay Park is an economic entity as well as a public park. It hosts a variety of commercial enterprises which serve tourists and residents and generate income for businesses, investors, and the City of San Diego. There is a symbiotic relationship between the City and Mission Bay Park businesses. As Mission Bay Park private enterprises prosper, the City and Park benefit financially, through lease revenue, taxes, and fees. These revenues help fund public improvements and maintenance made to the park, and in turn, the Park business benefit from these improvements. As an important economic resource, Mission Bay Park should be:

Economic Goal 1

A park where private enterprise within appropriate designated areas can prosper in order to support and enhance public use, access, and enjoyment of the Mission Bay Park.

1.1 A park which encourages land-lease tenants to maintain and upgrade their facilities in order to remain competitive, attract visitors, and generate revenue, within the context of the master plan's design and land use guidelines.

1.2 A park which is cooperatively marketed to promote business activity related to recreation, particularly during the non-peak times of the year.

1.3 A park which is safe, well-maintained, and has adequate public and private infrastructure to serve visitors.

1.4 A park which does not place incompatible uses next to each other, potentially diminishing the value of each use.

Economic Goal 2

A park which generates sufficient revenue to the City to cover public operations and maintenance costs associated with the park, and helps finance and maintain public improvements within the park.

2.1 A park where land and water lease rates reflect the market value for the particular use unless the use meets other public objectives deemed important to the City.

2.2 A park which generates additional fiscal revenue from increased business activity.

2.3 A park in which commercial land leases are strategically placed to enhance commercial tenants' ability to earn revenue, thereby increasing the City's land value and fiscal revenue, unless other public uses at such locations better serve the public good.

2.4 A park which is managed so that fiscal revenue and costs associated with the park can be monitored on an annual basis.

2.5 A park where all land and water lease revenue generated in the park are spend on needed park maintenance, operations and capital improvements.

Economic Goal 3

A park which uses economic approaches to efficiently manage use of public areas.

3.1 A park in which permits and user fees, at rates consistent with the park's public service function, may be used for certain areas during peak periods to control overcrowding, maintain public safety, and encourage use during less crowed periods.

3.2 A park which has designated improved areas for organized events and parties which can be reserved from the City for a fee.

3.3 A park which provides opportunities during non-peak periods for the City to generate additional revenue from special events, organized programs, and public recreation targeting specific user groups.

3.4 A park in which user fees are structured to differentiate between public gatherings or events and commercial or business gatherings or events.

Economic Goal 4

A park which fairly attributes funding responsibility to those who benefit from the facility or services that is funded.

4.1 A park whose management policy assigns the cost of expenditures for private benefit to *those private entities or individuals who benefit.*

4.2 *A park whose management policy assigns the cost of expenditures for public benefit to the public group who benefits.*

4.3 *A park whose management policy calls for sharing the cost of expenditures which benefit both private and public groups.*

4.4 *A park whose financing policy attempts to spread the cost burden over time when the facility financed will serve several generations.*

The way in which the environment is planned, designed, and managed has economic, as well as environmental implications. It should be recognized that, in some cases, the use of ecologically sustainable construction, operation and maintenance practices can have positive long term economic benefits through the avoidance of future health and pollution problems and through the reduction of energy consumption. Accordingly, Mission Bay Park should be:

Economic Goal 5

A park in which information regarding ecologically sustainable design and management practices are assessed and used as appropriate.

5.1 *A park which incorporates energy and water efficient design measures, thereby reducing operations and maintenance costs for both public and private entities.*

5.2 *A park in which management practice seeks to minimize the use of toxic materials, to minimize the use of imported potable water, and to maximize the use of recycling.*

Goals for the Environment

Mission Bay was until recently a huge marsh area with a dramatic diversity of natural and wildlife resources. In its conversion to a water recreation playground, Mission Bay has lost much of its original biological diversity. In recent years there has been a growth in public awareness and concern over the need for man to better conserve the natural environment and to learn to coexist in a more symbiotic manner with wildlife.

With the rise of environmental consciousness, people have begun to appreciate - and demand - the opportunity to interact with nature as a recreational activity. While natural habitat park areas may once have been seen as a wasted resource, natural habitat areas in parkland are often now viewed as aesthetically pleasing, and recreationally and educationally significant. Accordingly, Mission Bay should be:

Environmental Goal 1

A park in which aquatic wildlife and natural resources are a major recreational attraction for park users.

1.1 *A park in which aquatic biological ecosystems are identified and managed to improve their recreational and aesthetic resource value.*

1.2 *A park in which public access to wildlife and natural habitats is optimized within the constraints of maintaining habitat viability and protection of wildlife.*

1.3 *A park in which interpretive information is provided to allow visitors to develop an understanding of the importance and fragile nature of the Bay's natural resources.*

Since much of the original biodiversity of the Bay has been lost due to its conversion to an active water recreation playground, Mission Bay should be:

Environmental Goal 2

A park in which biodiversity is sustained and enhanced through the protection of natural resources and the expansion of habitat areas for sensitive species.

2.1 *A park in which habitat restoration projects focus on re-creating ecosystems which were historically present in the Bay and on enhancing biodiversity.*

2.2 *A park in which habitat restoration projects include habitat for appropriate species which are afforded regulatory protection as well as other sensitive species.*

2.3 *A park in which adequate buffers exist to protect sensitive environmental resources from incompatible land uses.*

2.4 *A park which plays an increasingly important role as part of the Pacific Flyway and the California halibut fishery.*

As the need to manage and restore coastal habitats increases, Mission Bay has the potential to play an important role in understanding how nature "works." The Bay's remnants of natural habitat will serve as models for future restoration projects both within the Bay and throughout Southern California. The Bay is one of only six fully tidal coastal embayments in the region; hence, studies of the Bay's resources would yield important information about species that require access to the ocean such as the California halibut. The Bay provides unique learning opportunities for the public and students of all ages. Thus, Mission Bay should be:

Environmental Goal 3

A park which supports ongoing education and research related to the Bay's natural resources.

3.1 *A park where users can study a variety of environmental issues, including long term issues such as the effects of global warming, and the relationship of these issues to park planning, design and, management.*

3.2 *A park where users can study the functional equivalency of restored and natural habitats to see if they work as intended.*

3.3 *A park which teaches how native species are linked to the Bay's habitats.*

3.4 *A park which allows research by students of all ages to interpret nature and generally educates the public.*

Mission Bay Park has had problems in the past with water pollution leading to closure of parts of the water body to prevent bodily contact. The contamination of water in the Bay has negative effects on environmental resources, on recreation, and on public perception regarding the desirability of Mission Bay as a recreational and leisure destination. Potential sources of contaminants are vehicle/boat exhaust, fueling activities, bottom paint, cleansers/solvents, bilge pumping, sewage, pesticides/herbicides/fertilizer in runoff, automotive-related chemicals in runoff, dry-flow contaminants, and fireworks. Accordingly, Mission Bay should be:

Environmental Goal 4

A park in which achieving the highest possible water quality is a planning, design, and management priority.

4.1 *A park in which water quality is regularly monitored to assure maintenance of acceptable standards.*

4.2 *A park in which water quality is protected by upgraded sewer mains and storm drains in surrounding areas and by a complete interceptor system to eliminate surface contaminants from entering the Bay.*

4.3 *A park which provides adequate restroom, marina, water-based, and land-based waste-handling facilities so as to minimize illegal recreation-user contamination of water.*

4.4 *A park in which septic tank flushing by private boats is carefully regulated and in which flushing regulations are strictly enforced.*

4.5 *A park in which educational information is provided to boat and recreational vehicle users regarding impacts to water quality of illegal flushing/dumping and regarding regulations and locations available for legal sewage disposal.*

4.6 *A park in which the ability of the water body to carry various pollutants is compared to the cumulative pollutant loading of existing and future park uses prior to the approval of future uses.*

4.7 *A park in which water quality is enhanced through a watershed and water use plan that identifies the pollutants that typically contaminate the Bay and includes regulations and public education programs to minimize such contaminants.*

The physical environment in Mission Bay incorporates a number of components in addition to biological and water resources. Traffic and noise impacts affect users within the Park as well as adjacent residential areas. As a regional tourist and recreation destination, Mission Bay Park generates a substantial level of transportation demand. The heavy use of private automobiles to reach the Park forms part of a regional cumulative negative impact on air quality. Accordingly, Mission Bay should be:

Environmental Goal 5

A park in which traffic, noise, and air pollution sources, particularly those that are not directly related to the aquatic resources of the park, are reduced to the greatest extent possible.

5.1 *A park which provides adequate public services, and in which rules and regulations are enforced, so as to protect human health and public safety.*

5.2 *A park in which land and water uses which are not dependent on a water-oriented setting and which degrade the natural resource or recreational values of the Bay are excluded.*

5.3 *A park in which users are protected through the enforcement of rules, ordinances, and laws.*

Goals for Aesthetics and Design

The natural and recreational histories of Mission Bay Park are water-bound, from the former and extant marshes and tidal flats to the current water bodes, island fills and shoreline configurations. The park represents first and foremost the adaptation of an aquatic environment for recreational purposes. As a unique and limited coastal resource, Mission Bay Park should be:

Aesthetics and Design Goal 1

A park whose image, as defined by its landscape architecture, and public works manifests and magnifies its unique and distinctive aquatic nature.

1.1 *A park in which views to the water and/or aquatic environments are maximized, particularly from entrance and perimeter roads and gateways.*

1.2 *A park where public's exposure to the water from land recreation areas is enhanced through grading, planting, the placement of structures, and the location of paths and recreational facilities.*

1.3 *A park in which a substantial portion of the vegetation is recognized as belonging to the waterfront environment, including native vegetation associated with marsh and aquatic communities, and plantings on the land which are aesthetically associated with water.*

1.4 *A park in which the architecture can be identified as appropriate to the southwestern United States marine environment and which is supportive of the context of Mission Bay Park's landscape.*

1.5 *A park in which the architecture avoids extreme or exaggerated thematic designs.*

Within the "aquatic" identity umbrella, Mission Bay Park contains a variety of environments. For example, five distinctive types of water bodies have been identified, each with a unique spatial characteristic: channel, lake, cove, basin, and lagoon. Likewise, the parkland alternates from narrow strips in close proximity to the water to wide areas more removed from the shore. This diversity of environments enables the park to satisfy many different recreation needs. For this reason, Mission Bay Park should be:

<u>Aesthetics and Design Goal 2</u>

A park comprising an interconnected system of diverse recreational environments, or "parks within a park."

2.1 *A park in which the waterfront and circulation pathways have common design elements which serve to aesthetically unify the various recreation and open space areas.*

2.2 *A park in which each discrete recreation area manifests a coherent and uniquely appropriate aquatic-oriented image according to its function and context.*

2.3 *A park in which a comprehensive art program reveals the special qualities, physical and/or historical, environmental and/or cultural of each recreation area.*

2.4 *A park in which a comprehensive and coordinated signage and lighting system informs and directs the public to the various public and commercial recreation areas, their facilities and recreation programs.*

2.5 *A park in which an interpretive signage program informs visitors about the significance and historical narrative of the landscape of the Bay.*

With its unique water setting, its significant expanse, its location close to downtown and adjacent to major freeways, and its dual role as a local and regional park as well as a premier tourist destination, Mission Bay plays a unique role in defining San Diego's image. This role is fulfilled both by experiencing the park up close and from afar -- from within the park;s boundary and from distant vantage points outside the park. The preceding goals address the near view. Of equal importance, however, are the images gathered from roadways, bluffs, hilltops, and airplane and the manner in which the long view yields to the near view along the park's entrance roads and gateways. Accordingly, Mission Bay Park should be:

<u>Aesthetics and Design Goal 3</u>

A park that extends beyond its boundaries by offering "image bytes" or encapsulated views of its open waters and landscape to surrounding roadways, neighboring streets and distant viewing points.

3.1 *A park that maximizes its exposure to the freeways, particularly in the vicinity of the De Anza Cove, where the bay waters are within 300 feet of Interstate 5.*

3.2 *A parks that preserves water view corridors and maximizes its exposure from surrounding neighborhood streets and hillside vantage points.*

3.3 *A park whose buildings and landscape enhance the enjoyment of city, ocean, and sky views from the surrounding neighborhoods.*

3.4 *A park whose entrances clearly mark the passage from the far to the near view through a comprehensive system of gateways that guide and direct visitors to the various recreation areas.*

3.5 *A park where adjacent neighborhoods which have strong visual connections to the water also have easy and direct physical access for pedestrians, bicycles, and other non-vehicular means of reaching the bay.*

Goals for South Shores

Comprising 152 acres, South Shores is one of the two key remaining unimproved areas of Mission Bay Park. South Shores is located contiguous to an intensively developed area of the Park which includes Sea World, Dana Landing, Dana Inn, and the various uses around Quivera Basin. South Shores has a hard rip-rapped edge, as opposed to the beach which provides for the best passive recreational amenity, and has a north-facing shoreline which is less suitable for passive waterfront uses such as picnicking.

South Shores enjoys convenient access to and from regional freeways (I-5, I-8) and major city arterials (Friars Road, Sea World Drive, Pacific Highway). Due to the high traffic volume on these roadways, the area is also highly visible.

When combined, these factors make South Shores uniquely suitable to a high intensity of recreation use, both public and commercial; it also places on the area the burden of encapsulating the park's aquatic identity for the benefit of people who may rarely or never actually use the Park as a recreational amenity. Accordingly, South Shores should be:

South Shores Goal 1

An intensively used park area that attracts visitors to a variety of public and commercial recreation venues yielding, in aggregate, a summary view of the park's grand aquatic identity.

1.1 *A destination which balances intensive water-oriented recreation uses with the provision of public access to the shore for passive recreation purposes, such as a pedestrian and bicycle pathway.*

1.2 *The area where the view from the roadway confluence at the eastern end of South Shores greet visitors as a primary gateway capturing near and long views of the aquatic environment, natural marsh areas, and adjacent recreation areas.*

1.3 *An area which provides bicycle and pedestrian paths allowing for recreational use and connecting to other park destinations.*

1.4 An area which includes safe access to a path along the San Diego River floodway providing access to its rim for passive recreation purposes and viewing of the river and its resources.

The level of recreation intensity envisioned for South Shores may be compromised by the existing landfill in terms of suitability for foundations and toxic hazards. The costs required to mitigate its impact on development should be weighed against the potential fiscal and recreation benefits of such development. Regardless of the its level of development intensity, South Shores should be:

South Shores Goal 2

A toxic-free recreation area posing no hazard to the health and safety of current and future park users.

Goals for Fiesta Island

Comprising 465 acres, Fiesta Island is one of the two key remaining unimproved areas of Mission Bay Park. The shores of Fiesta Island face three very different water bodies and recreational zones of Mission Bay Park. The eastern shore faces a collection of lagoons, especially suited for non-motorized boating use and wading, and forms a complementary land mass to the East Shores area of the Park. In addition, the east shore of the Island is a critical area in terms of the Park's image to the City because of its exposure to views from the east including from the I-5 freeway. The west shore of Fiesta Island faces Fiesta Bay, the Park's largest water body, which is dominated by motorized boat use and special aquatic events. The west shore of the Island is also highly visible from Ingraham Street, Ski Beach, and the Crown Shores area. The south shore faces across South Pacific Passage to South Shores and Sea World. This diversity of contexts provides a basis for the use of the Island as a multifaceted recreation area.

It should also be noted that Fiesta Island does not abut any residential neighborhoods and can be freely accessed by road from the southeast corner of the Park which in turn in readily accessible to the regional serving freeways. In these regards Fiesta Island is well suited to accommodate significant portions of the regional passive recreational demand.

As one of the few remaining unimproved areas in the Park, Fiesta Island also offers a particular opportunity for natural resource management and enhancement uses. The Mission Bay Park Natural Resource Management Plan recognizes that opportunity through the identification of the southwestern portion of the Island as a potential future resource enhancement preserve area.

Based on these issues, Fiesta Island should be:

Fiesta Island Goal 1

An area which supports a diversity of regional-serving public and nonprofit recreation and natural resource management and enhancement uses.

1.1 An Island whose east side provides for citywide and regional-serving passive recreation uses, forming a unit with North Pacific Passage and the East Shores area of the Park.

1.2 *An Island whose west side focuses on the wide beach and its relationship to the water uses on Fiesta Bay, allowing for informal public use of the beach and permitting temporary use as a controlled access special-event view area.*

1.3 *An Island where the landscape design of the east and west sides respects their significance in terms of defining the Park's image to passing and through traffic as well as to Park users.*

1.4 *An Island which provides for the operation of special events both on land and on adjacent water bodies.*

1.5 *An Island whose southern side provides for public recreational uses complementary to the water use in South Pacific Passage and Hidden Anchorage, and the land use at the South Shores area of the Park.*

1.6 *An Island which includes a substantial new resource enhancement area, located to the southwest facing across the water to Sea World, displacing the current sludge drying beds.*

1.7 *An Island which provides for bicycles, other non-motorized forms of circulation, pedestrian circulation, and connection to other park areas.*

1.8 *An Island on which pedestrian and other non-motorized circulation is prioritized over automobile circulation.*

1.9 *An Island on which special emphasis is placed on using natural landscapes within recreation areas.*

1.10 *An Island on which the land is graded to increase the area with strong visual connection to the water.*

1.11 *An Island to which the access bridge(s) and/or causeway(s) form an appropriate gateway and aesthetic statement.*

Appendix B-1

HYDROLOGY - Feasibility of A Constructed Wetland at the Mouth of Rose Creek

Prepared by

Philip Williams & Associates,Ltd.

I. INTRODUCTION

The 1990 Natural Resources Management Plan (NRMP) for Mission Bay Park included creation of 110 acres of wetland habitat on the Fiesta Island sludge beds. Wallace, Roberts and Todd (WRT) is recommending that this proposed habitat be relocated to the mouth of Rose Creek to take advantage of water quality improvements that could be provided by wetlands in this vicinity, and to maximize habitat values. A number of questions were raised by this proposal. This investigation was requested to provide a brief feasibility check on three principal elements of the wetlands restoration effort:

1) Flooding: Will the marsh increase flood hazards on the Rose Creek floodplain?

2) Viability: Can a wetland created at the mouth of Rose Creek survive high velocity flood flows and sediment deposition?

3) Water Quality: What water quality improvement benefits could be provided by a constructed wetland at this location?

II. FLOOD HAZARDS

Local flood control agencies are concerned that the creation of a marsh at the mouth of Rose Creek would increase the backwater effect of Mission Bay on flood elevations in Rose Creek. The marsh would be created by excavating surrounding uplands to elevations appropriate for marsh development. The final wetland design would incorporate some means of diverting and treating the lower flow events on the marsh plain, while allowing flood flows to pass through the marsh in a main distributary channel. In addition, the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) flood profile (Figure 1) for Rose Creek shows a starting water surface elevation, representing backwater at Mission Bay, of approximately 4.1 feet NGVD. The marsh would be constructed at an elevation of approximately 3 ft NGVD, approximately Mean Higher High Water. The elevation of the marsh would, therefore, be below the current assumed backwater elevation, and so would not increase upstream water surface elevations. In addition, the marsh should be designed to be "off-line". A high-flow channel would convey flows greater than the marsh treatment design flow directly to Mission Bay with a minimum of disturbance to the marsh, or impact on flood elevations upstream (Figure 2 and Figure 3). Therefore, the marsh will not be subject to high sediment loads which would raise its elevation and increase flood risk.

This is discussed further in the section on Marsh Viability.

III. MARSH VIABILITY

There has been some concern that a marsh created at the mouth of Rose Creek would be damaged or destroyed by high velocity flows in the creek during flood events, or would be buried by the sediment carried in Rose Creek. In California, marshes typically form at the mouth of coastal streams subject to flood flows and sedimentation. Virtually all of the southwest streams have developed with a salt marsh located at the mouth of the channel. The marsh evolves on the stream delta, in dynamic equilibrium with the flow of sediment and freshwater from the creek, and the tidal regime and coastal sediment dynamics of the area.

The predicted 100-year flow velocity at the mouth of Rose Creek is approximately 9-11 feet per second (fps) (USACOE 1966). Rick Engineers has suggested that this velocity is high enough to cause erosion of vegetated cohesive soils and would require some form of channel bank protection. This would be true in a situation which required a stable channel. However, erosion of the main distributary channel is part of the natural dynamics of the marsh and stabilization of the channel is not desirable. PWA has developed enhancement plans for many of the local San Diego fluvial systems which include wetlands at their confluence with the ocean or San Diego Bay. These include the Tijuana River, Otay River, Sweetwater River, Los Penasquitos Creek, and the San Dieguito River. These marshes are adapted to a wide range of flow regimes and are able to recover from sedimentation and erosion during extreme events.

Sediment yield from the Rose Creek watershed has been estimated to be approximately 14,300 cubic yards per year (WCC 1986). This volume of sediment is consistent with sediment yields of other coastal systems. Coarse sediments appear to be deposited upstream between Highway 5 and Garnet Ave where the flow regime changes from supercritical to subcritical and the velocity drops. The sediment reaching the inlet of Rose Creek would be finer sediments which were not trapped upstream. The delivery of sediment is episodic, corresponding to larger rainstorms and runoff events. Large volumes of sediment associated with infrequent floods would be carried through the marsh in the major distributary channel, while some fine sediment will be deposited on the marsh, a natural phenomenon and one that is not detrimental to the health of the marsh ecosystem.

IV. WATER QUALITY

The primary water quality problem in Mission Bay is bacterial contamination which results in closure of parts of the Bay to water contact. While it is evident that flow in Rose Creek contributes to the problem, the exact source of the contamination has not been identified

(Karen Henry, per comm). The construction of a marsh at the mouth of Rose Creek will not solve the water quality problems in Mission Bay. Rather, the marsh should be viewed as an important component of an overall watershed management program that identifies the sources of pollution, reduces pollution discharge to Rose Creek, and maximizes pollutant removal along the flow path.

Two projects, constructed and planned, are designed to prevent contaminated water from discharging into Mission Bay. The East Mission Bay Peak Interceptor Peak Period Storage and Pumping Facility, constructed in 1989, has reduced sewage spills into the bay. Phase I of The Mission Bay Dry Weather Interceptor System is diverting dry weather runoff from the west side of Rose Creek into the sanitary sewer system (up to approximately 50 gallons per minute), and Phase V, scheduled for construction in the Spring of 1993 will divert dry weather flows from the east side. These projects are not designed to handle the larger runoff volumes generated during winter storm events.

San Diego County is currently involved in the Municipal Stormwater Discharge permitting process under the National Pollution Discharge Elimination System (NPDES) requirements of the Clean Water Act. The Regional Water Quality Control Board (RWQCB) recommends a comprehensive approach to pollution abatement, including retrofitting of existing stormwater facilities to improve stormwater quality (Thomas Mumley, per comm). A constructed wetland at the mouth of Rose Creek can be an important component of an integrated watershed management approach to pollution reduction.

Wetlands provide water quality improvements through a combination of physical, chemical, and biological processes. Constructed marshes can be designed to enhance these processes to provide more treatment than would be available in a "natural" wetland. Most constructed wetlands for water quality improvement are freshwater marshes. While saltmarsh vegetation is being used to treat wastewater, we are not aware of examples saltmarsh wetlands specifically designed to treat freshwater urban runoff. There is no biological reason such marshes would not be as effective as freshwater marshes (Gersberg 1992). The Palo Alto Flood Basin is a subsided tidal saltmarsh used for floodwater storage. Its value for water quality improvement is currently being evaluated. The natural estuarine environment is one where freshwater mixes with salt water. The climate of Southern California produces many marsh systems where intermittent flow of fresh water inundate tidal salt marsh systems.

The area of marsh needed to treat urban runoff varies with the degree of water quality improvement desired. The "hydraulic residence time" is the factor most directly associated with the potential for improvement. The residence time is the average time that the inflowing water is retained on the marsh. This is the time available for sunlight penetration, settling of suspended sediment, and chemical and biological processes to take place. The residence time is defined by the following relationship between area, depth, and flow:

$$\text{Residence Time} = \frac{\text{Area} \times \text{Depth}}{\text{Flow Rate}}$$

Dr. Gersberg has indicated that a 20-hour residence time would provide 90% removal of suspended solids and coliform, but that a 6-hour residence time (a tidal cycle) could still provide significant benefits. One acre of marsh, ponded to a depth of 1 foot, for 24 hours would provide a high level of treatment for a peak flow of 0.5 cubic feet per second (cfs). At the other end of the scale, one acre of marsh ponded 1.5 feet deep for 6 hours would provide some level of treatment for a peak flow of 3 cfs. Thus, a 100 acre marsh could provide treatment for between 50 and 300 cfs.

Detailed information on frequent, low flow events in Rose Creek is not currently available. Based on an analysis of rainfall data (WCC 1989), the average storm in San Diego is 0.51 inches, or 0.052 inches/hour. The "first flush" from a rainstorm which can carry up to 90% of the pollutant load is generally associated with up to the first 1 inch of rainfall and 0.5 inches of runoff. Rick Engineers has estimated that the first inch of rainfall would produce 0.5 inch of runoff and a peak flow of 3,000 cfs on Rose Creek. This is greater than the 10-year peak flow of 2,700 cfs estimated for the FEMA study. For the average storm in San Diego, the peak flow on Rose Creek would be on the order of 600 cfs. Therefore, 100 acres of marsh could provide some water quality benefits for up to the peak flow from the average storm. More information on the shape of the low-flow hydrograph for Rose Creek, and how the pollutant load is distributed in the hydrograph could provide much needed information to assess the level of water quality improvement potentially available.

IV. DESIGN CONSIDERATIONS

As the purpose of this review is to provide a "reality check" on the feasibility of marsh creation, specific design factors are beyond the present scope of study. However, a few observations are appropriate. Most wetland treatment marshes are designed as freshwater systems with enclosing levees to control water flow. While it is widely recognized that salt marshes provide many of the same benefits, data to quantify these benefits is sparse.

Providing sufficient detention time on the marsh may require constructing levees around the marsh perimeter to pond the runoff water. These levees will need water control structures, such as bladder dams or culverts with tide gates, which can be closed to provide retention time, and opened to release impounded water and to allow full tidal action when there is no runoff. The levees may be designed to provide upland habitat in lieu of islands on the marsh plain as originally proposed.

If the saltmarsh is bermed, it would be an "off-line" facility. This means that the low flows which would normally pass down the main distributary channel without flowing onto the marsh plain would need to be conveyed to the marshplain by a secondary distributary channel system. Ideally, low flows would be diverted from Rose Creek at a location where the channel invert is above the marsh plain elevation and the water can flow by gravity though a vegetated swale to the marsh. This would provide a buffer area to increase the residence time and treatment available, and potentially reduce the frequency of freshwater flows onto the saltmarsh (very low flows would be evapotranspired and infiltrated into the soil). This may be difficult on Rose Creek as the channel gradient is very flat at the downstream end. Based on the FEMA profile (Fig. 1), the channel invert does not reach 4 feet NGVD until approximately 300 feet downstream of Balboa Ave, and it may be difficult to construct a low flow bypass from this location to the Park. An alternative would be to construct an inflatable "bladder dam" across the Rose Creek channel in the vicinity of Grand Ave to raise the water surface elevation sufficiently to divert flow to a pipe which would then daylight upstream of the golf course, and flow in a swale through the golf course to the marsh.

VI. OTHER ISSUES

There will be some tradeoffs to balance between the "naturalness" of the constructed wetland and its water quality improvement function. These will include the need for water control structures, management of the tidal regime, and the availability of the wetland for recreational uses, and the type and quality of the recreational experience. In addition, the regulatory agencies may have concerns regarding the mitigation value of a wetland that is designed primarily for water quality improvement.

The construction of a saltwater wetland to provide treatment of freshwater runoff will require the construction of control structures and the development of an operation, maintenance, and monitoring plan. Proper management of the system may include automatic gates which can be controlled remotely, and a system for manual backup should the automatic system not function properly. Important issues will be keeping sufficient volume available on the marsh for fresh water treatment, the ability to drain the water so that the marsh does not drown in freshwater, the ability to open the gates if the runoff is lower than expected and the ponding depth is not necessary. Monitoring of the water and sediment quality on the marsh will be needed to determine the impact of the water quality improvement function of the marsh on its habitat values.

VII. FURTHER STUDIES AND ISSUES

If the City wishes to pursue the concept of a wetland at the mouth of Rose Creek, the next step would be the development of a conceptual plan for the facility. This would include refinement of the design, and a cost/benefit analysis for the project. The conceptual design would cover biological, hydrologic, engineering, water quality, land-use planning and economic issues. The specific conceptual plan topics might include:

1. Existing Conditions: Detailed site mapping (100 scale with 1 ft contour interval), hydrology, soils, topography, vegetation, wildlife use, land-use, transportation, water quality, etc.

2. Opportunities and Constraints Analysis

3. Goals and Objectives

4. Design Alternatives

5. Preferred Conceptual Plan

6. Implementation (costs, permits, phasing, responsibilities, etc.)

Some of the specific topics of concern would include the following:

A. HYDROLOGY

There is not currently available sufficient information on the low flows in Rose Creek to evaluate the frequency of flows that can be treated to an acceptable extent by the area of marsh available. The ALERT system gage on Rose Creek is not designed to monitor low flows (Carey Stevenson, per comm). A new gage at Grand Ave may provide more useful information on low flows near the mouth, and would include the urbanized area of Pacific Beach within the watershed. An analysis of rainfall records for the watershed to determine the frequency and depth of precipitation associated with pollutant loads is an important element of the management plan.

B. POLLUTANT SOURCE AND LOADING

Some information on the pollutant loads in Rose Creek is available, but this information is not well correlated with flows or rainfall. A monitoring program to measure pollutant loads at several locations along the creek would help to identify the pollutant source and indicate the best solutions to the source problem. Correlation of rainfall data with pollutant loading will aid in design of the marsh treatment system to achieve the necessary balance between water quality improvement and habitat functions.

C. INTEGRATION INTO THE NPDES PERMIT PROCESS

The treatment marsh should be integrated into a basin-wide plan to control the source of pollutants and reduce pollutant loads at various locations along the stream. The basin-wide plan should be part of the County of San Diego municipal and construction permits for NPDES.

D. MANAGEMENT PLAN

A Management Plan is needed to assure that the marsh functions properly to provide the multiple benefits of water quality improvement and wildlife habitat. The plan should include regulation of the water control structures, backup and emergency plans for water level control, and maintenance of water control structures, including levees, dams and gates. Any maintenance activities, such as dredging or sediment removal need to be justified based on criteria established in the management plan.

E. MONITORING PLAN

A monitoring plan is needed to evaluate the effectiveness of the marsh at meeting its water quality improvement function and to evaluate the effect of this function on wildlife habitat values. Monitoring of the evolution of the biological values of the habitat is also needed.

F. REGULATORY ISSUES

The concerns of the regulatory agencies regarding the use of a water quality marsh for habitat mitigation must be determined by close communication with representatives of those agencies.

REFERENCES

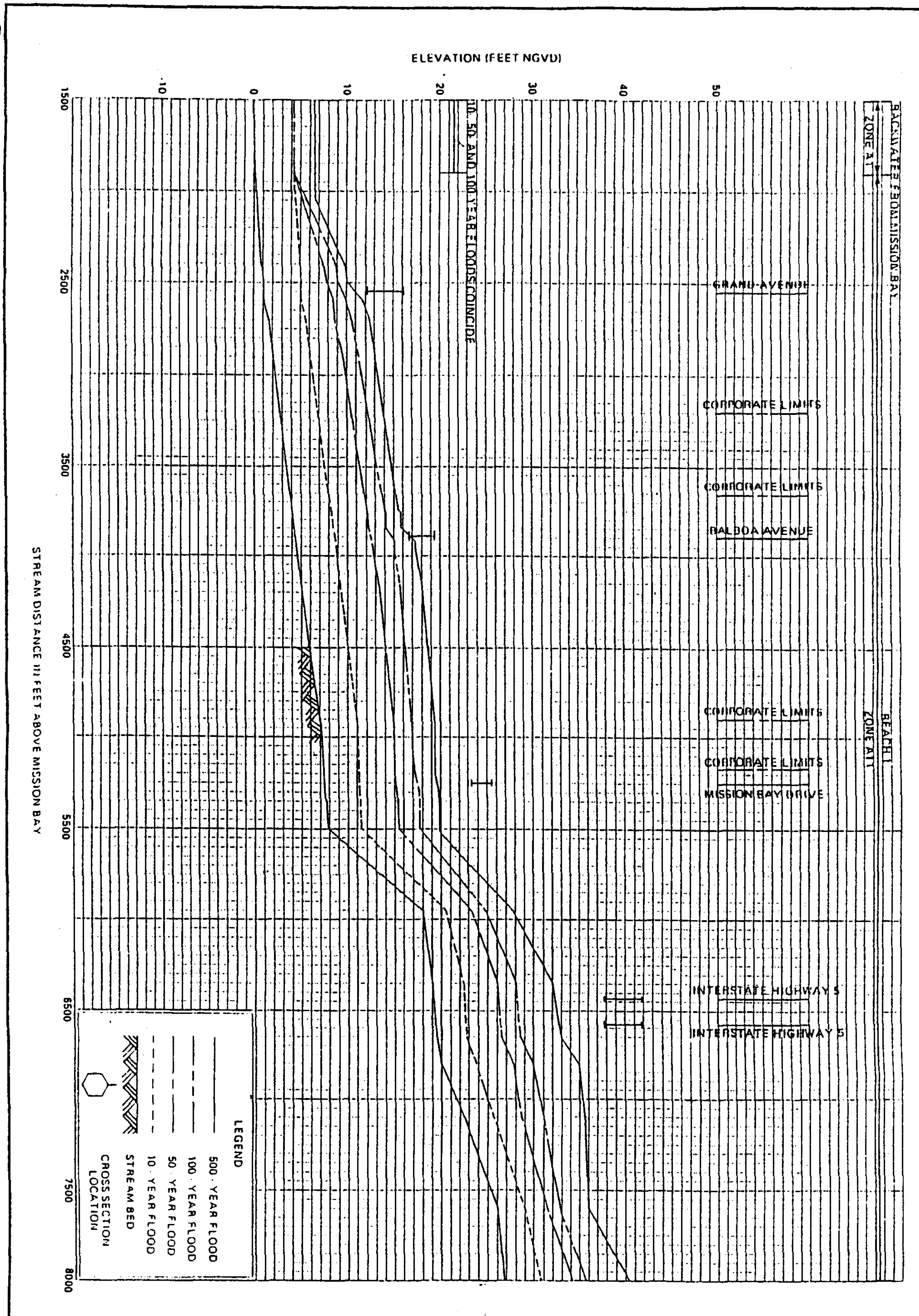
U.S. Army Corps of Engineers. 1966. Detailed Project Report for Rose Creek Channel Improvements, San Diego, California, Los Angeles, CA .

Woodward-Clyde Consultants. 1986. Rose and San Clemente Canyon Watershed Erosion/Sedimentation Study - Phase I, San Diego, California, San Diego, CA.

Gersberg, Richard M. 1992. Use of Created Wetlands for Stormwater Treatment in Mission Bay, California, San Diego, CA.

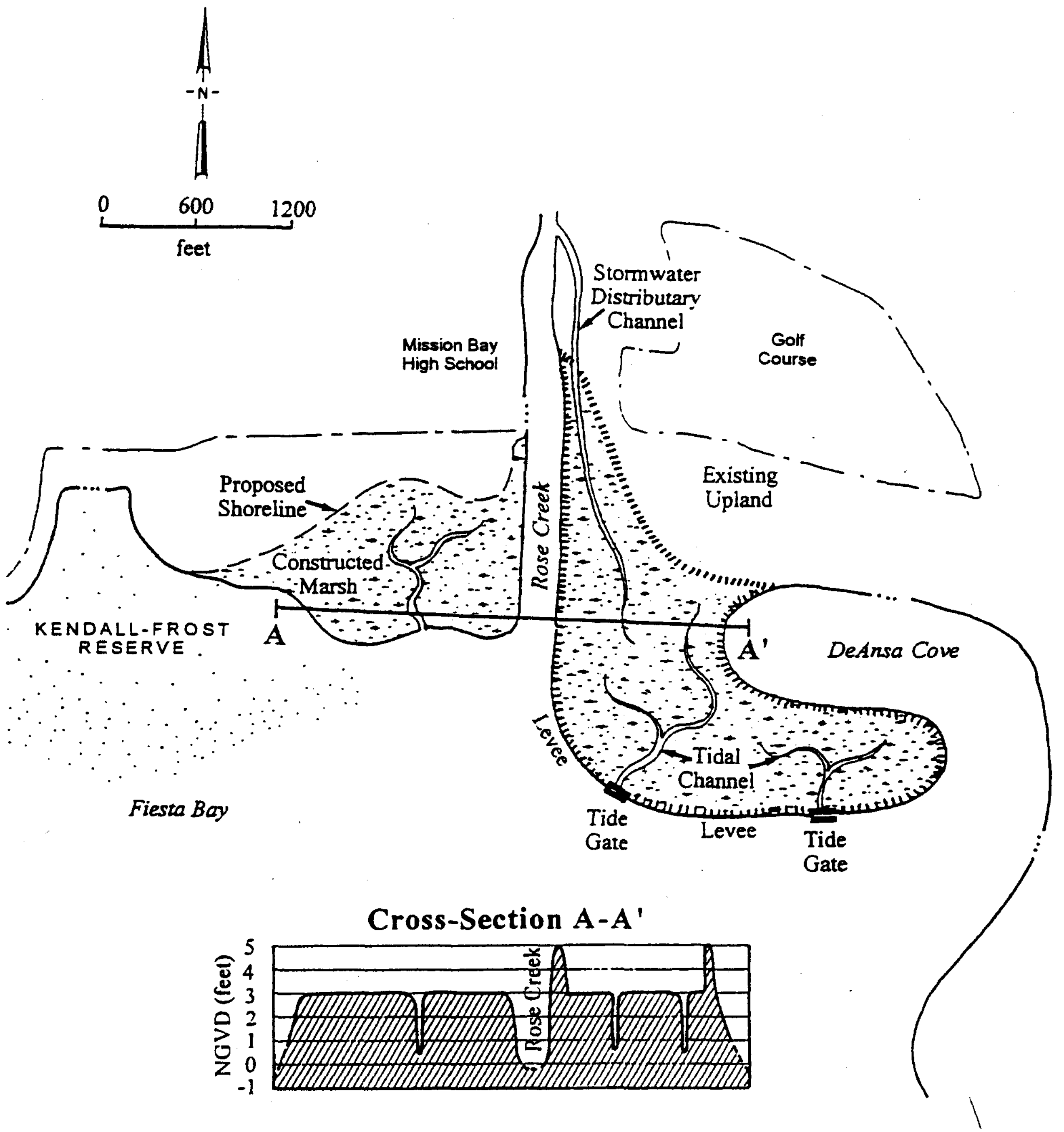
Woodward-Clyde Consultants. 1989. Analysis of Storm Event Characteristics for Selected Rainfall Gages Throughout the United States, Oakland, CA.

Philip Williams & Associates, Ltd.



FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF SAN DIEGO, CA (SAN DIEGO CO.)	FLOOD PROFILES ROSE CANYON CREEK

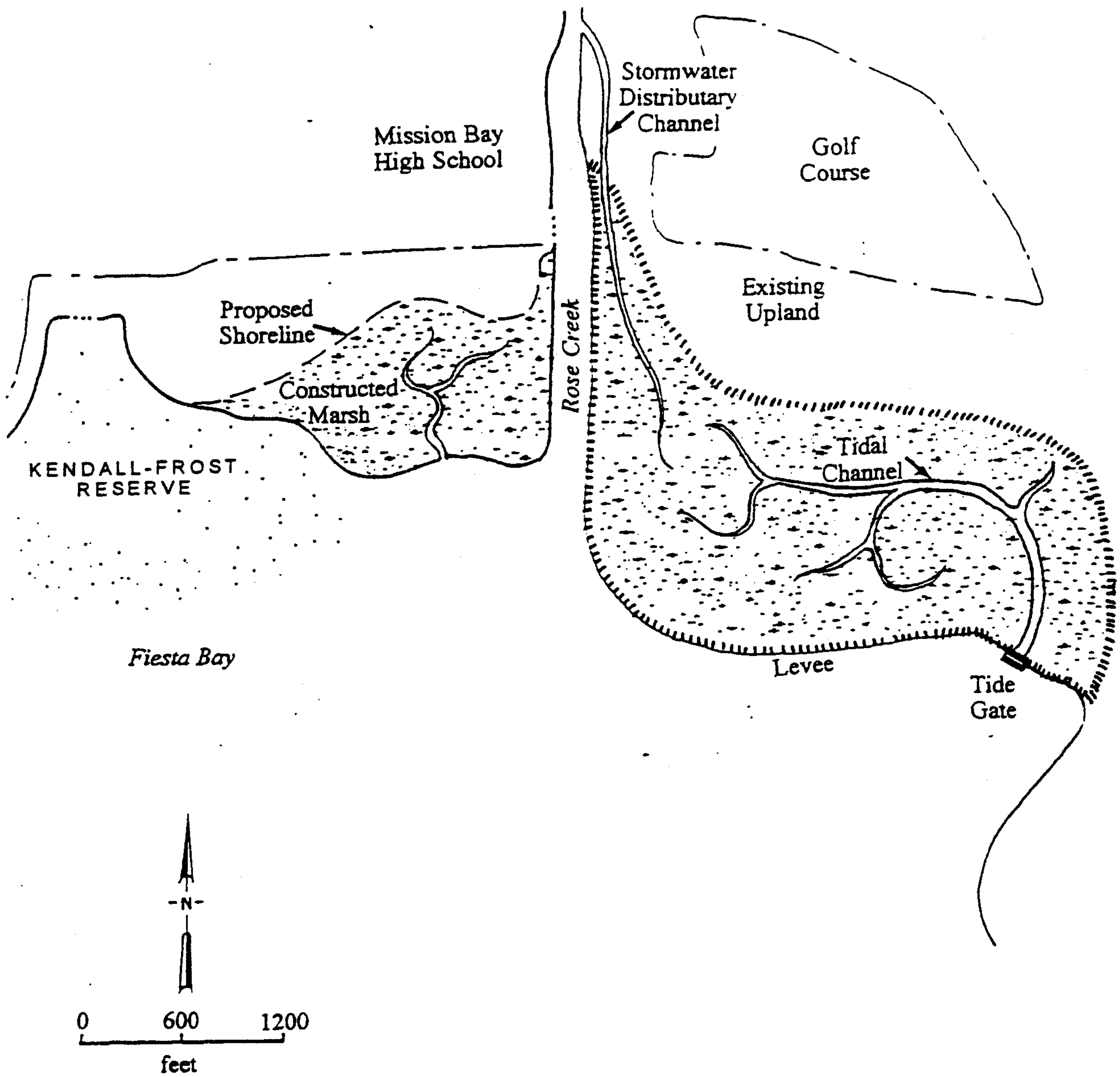
Figure 1



Philip Williams & Associates, Ltd.
Consultants in Hydrology

San Diego Mission Bay Park
Conceptual Design I

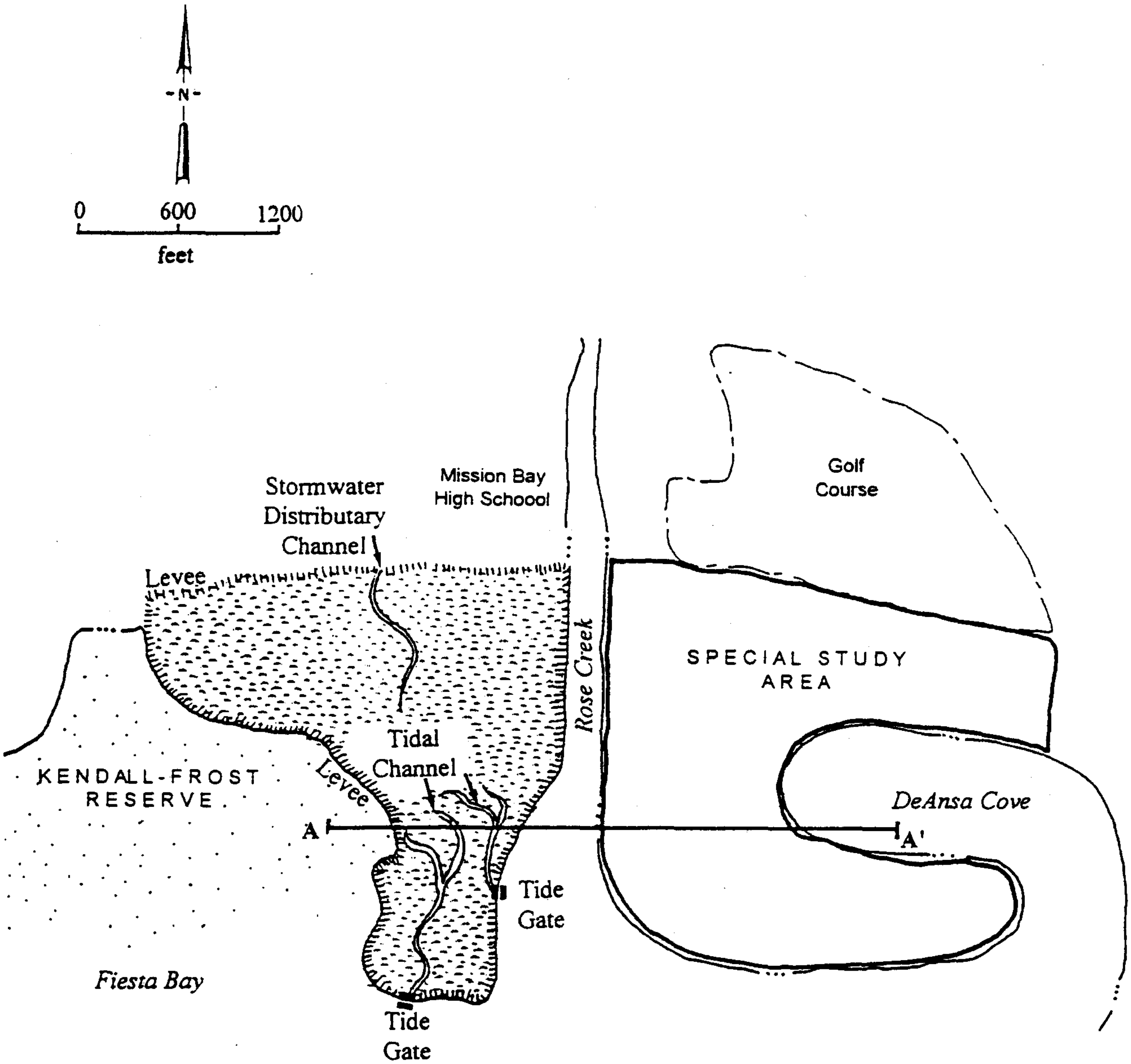
Figure 2



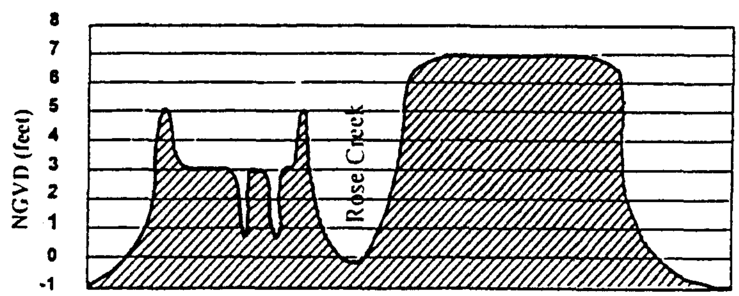
Philip Williams & Associates, Ltd.
Consultants in Hydrology

San Diego Mission Bay Park
Conceptual Design II

Figure 3



Cross-Section A-A'



Philip Williams & Associates, Ltd.
Consultants in Hydrology

San Diego Mission Bay Park
Conceptual Design III

Figure
4

Appendix B-2

HYDROLOGY - Use of Created Wetlands for Stormwater Treatment in Mission Bay

Prepared by

Richard M. Gersberg, Ph.D
San Diego State University

USE OF CREATED WETLANDS FOR STORMWATER TREATMENT IN MISSION BAY, CA

Richard M. Gersberg, Ph.D
San Diego State University

INTRODUCTION

Wetlands are an essential part of nature's stormwater management system. Important wetland functions include conveyance and storage of stormwater, which dampens the effect of flooding; reduction of velocity of stormwater, which increases sedimentation; and modification and removal of pollutants carried in stormwater. Accordingly, there is a great amount of interest in the incorporation of natural or constructed wetlands into stormwater management systems. This concept provides an opportunity to use one of nature's systems to mitigate the effects of runoff associated with urbanization. In addition, by using wetlands for stormwater management, wetlands can be restored and revitalized, and opportunities for wildlife enhancement and esthetic enjoyment can be maximized.

DESIGN CONSIDERATIONS

Relations between hydrology and wetland ecosystem characteristics must be included in the design to ensure long-term effectiveness. The source of water and it's quality, velocity and volume, hydraulic retention time, and frequency of inundation all influence the chemical and physical properties of wetland substrates which, in turn, influence species diversity and abundance, pollutant removal rates, and nutrient cycling. Hydrology ultimately influences sedimentation, biological transformation, and soil adsorption processes. Critical factors which must be evaluated include velocity and flow rate, water depth and fluctuation, hydraulic retention time, circulation and distribution patterns, seasonal, climatic, and tidal influences, and soil permeability.

POLLUTANT REMOVAL IN WETLANDS

Reducing the loading of pollutants into Mission Bay requires an innovative solution. Created wetlands serving the drainage area of the Rose Creek basin can be relied upon to mitigate a major source of contamination. In Mission Bay, microbial contamination (as reflected in elevated counts of both total and fecal coliform bacteria) resulting from stormwater runoff, poses a major public health problem. During the 1991-92 rainy season, the waters of Mission Bay had to be posted (by the San Diego County Department of Health) on a number of occasions, and both the perception and the reality of degraded water quality in Mission Bay is now affecting the recreating public, Mission Bay leaseholders, and other concerned parties alike.

Regional stormwater systems using created wetlands have been constructed in Tallahassee, FL (Livingston, 1986), and Fremont, CA (Silverman, 1989). These systems have been shown to significantly reduce pollutant loads including suspended solids, total nitrogen and total phosphorus, and BOD. Created wetlands have also been shown to have the capability to reduce bacterial and viral levels by 90-99% (Gersberg et al.,1989), and also have a high capacity for the retention of toxic heavy metals (Sinicrope et al., in press).

POLLUTANT REMOVAL BY SALTMARSHES

Natural tidal saltmarshes have been shown to have use in wastewater purification applications. The U.S. Environmental Protection Agency investigated BOD and suspended solids removal in a salt marsh treating food processing wastewater (U.S. EPA, 1986). Guida and Kugelman (1989) investigated saltmarsh polishing of effluent from activated sludge treatment of shrimp processing wastewater. They found BOD removal ranged from 29-100%; total suspended solids removal , 58-108%, total N removal; 69-98%; and total P removal, 30-73%. These investigators also found that a short residence time(6 hr) of wastewater in the saltmarsh due to tidal hydrology did not preclude effective treatment in the tidal marsh system, even at near-freezing temperatures. The pollutant removal in these tidal saltmarshes was comparable with the performance of other freshwater marsh polishing systems. This similarity of treatment effectiveness is not surprising since the mechanisms of pollutant removal whether in a freshwater or saltwater wetlands are remarkably similar. For example, suspended solids are removed mostly by physical processes (filtration and sedimentation), heavy metals are mainly removed via chemical adsorption and precipitation reactions, while bacteria and viruses are removed through a combination of physico-chemical and biological processes, including adsorption, sedimentation, ultra-violet radiation inactivation, filtration, predation (by zooplankton), chemical antagonism, and antibiosis. It is important to note here that all of these processes proceed independently of the vegetation type (saltwater versus freshwater), and are more dependent on hydrology than the actual marsh type or salinity levels.

AREAL REQUIREMENTS FOR WETLAND TREATMENT

Most water quality effects from stormwater result from the "first flush." In the early stages of a storm, accumulated pollutants in the watershed, especially on impervious surfaces such as streets and parking lots, are flushed clean by rainfall and resulting runoff. The first flush typically equates to the fist inch or so of precipitation which carries 90% of the pollution load of a storm event. Treatment of this fraction of the runoff will help mimimize the water quality effects of stormwater runoff.

In order to attain efficient treatment performance by stormwater treatment wetlands, sufficient hydraulic retention time is required. If we assume that 200 acres of wetlands are available for treatment in Mission Bay, and these wetlands can be designed to hold a water depth of 0.5m during a rain event, then the storage volume equals about 400,000 cubic meters. Assuming a 200 cfs (cubic feet per second) flow in Rose Creek, then the hydraulic retention time would be nearly 20 hours, a value which should be sufficient for good suspended solids and coliform removal efficiencies (90%). Storm events involving much larger flows than those above would receive lessor treatment due to the shortened residence times.

BENEFITS OF CREATED WETLANDS

A wetlands developed in Fremont, CA as part of the Coyote Hills Regional Park serves as a prototype for a created stormwater treatment wetlands (Silverman, 1989). Before development into the urban runoff treatment wetlands, the site contained an abandoned agricultural field, a dense willow grove, an area of pickleweed (Salicornia virginica), and a meandering slough with no surface outlet, which drained a small agricultural area. Water was diverted onto the site from Crandall Creek, draining a 12-km^2 area characterized by 75% suburban/residential development and 25% agrucultural and open space.

Three distinct systems were incorporated into the wetlands to test performance of different designs. Influent is diverted fairly equally into two initial systems. One is a long, narrow pond containing a long island. Considerable area was devoted to shallow edges to encourage growth of rooted aquatic vegetation (mainly cattails, Typha latifolia). The other system is more complex, using a spreading pond draining into an overland flow sytem (innundated only during storms), followed by a pond with berms supporting rooted aquatic vegetation. This system allows testing of water quality effects of overland flow characterized by different vegetation and flow patterns than those of the pond and effects of "combing" water through cattail strands.

These systems drain into a common third system, which provides an area of shallow, meandering channels, maximizing contact with various types of wetlands vegetation. The discharge is into another section of Coyote Hills Regional Park and flows back into the channel that Crandall Creek discharged into before diversion. Hydraulic considerations included sizing the diversion structure and channels to accommodate the 10-yr, 6-hr storm, with greater flows causing diversion structure failure with most of the flow remaining in Crandall Creek.

Development of stormwater wetlands has a number of benefits. Attractive wetlands may be created in an urbanized region needing additional "natural" areas, and a facility to research the potential and future designs for urban runoff treatment systems can be provided. Another important benefit is the practical demonstration for implementation of other wetlands development projects.

A created wetlands in Mission Bay provides an outstanding opportunity to improve Bay water quality while providing a multitude of other benefits to the recreational, esthetic and ecological environment of the urban Mission Bay.

REFERENCES

Gersberg, R.M. et al. 1989. Pathogen Removal in Constructed Wetlands. In Constructed Wetlands for Wastewater Treatment (D.A. Hammer, ed.), Lewis Publishers, Chelsea, MI.

Guida, V.G. and I.J.. Kugelman. 1989. Experiments in Wastewater Polishing in Constructed Tidal Marshes. In Constructed Wetlands for Wastewater Treatment (D.A. Hammer, ed.), Lewis Publishers, Chelsea, MI.

Livingston, E.H. 1986. Stormwater Regulatory Program in Florida. In Urban Runoff Quality-Impact and Quality Enhancement Technology, Proceedings of an Engineering Foundation Conference, Henniker, NH, June 23-27, 1986.

Silverman, G.S. 1989. Treatment of Nonpoint Source Pollutants-Urban Runoff and Agricultural Wastes- Development of an Urban Runoff Treatment Wetlands in Fremont, CA. In Constructed Wetlands for Wastewater Treatment (D.A. Hammer, ed.), Lewis Publishers, Chelsea, MI.

Sinicrope, T.L. et al. In Press. Metal Removal by Wetland Mesocosms Subjected to Different Hydroperiods. Ecological Engineering. In Press.

Appendix B-3

HYDROLOGY - Mission Bay Physical Model

Prepared by

Clive E. Dorman,Ph.D, Russel Johnson, Robert Zimdar
San Diego State University

Mission Bay Physical Model

Clive E. Dorman
Russell Johnson
Robert Zimdar

Dept of Geological Sciences
San Diego State University

Abstract

A scale physical model of Mission Bay is used to test changes in circulation patterns on the east side of Fiesta Island and DeAnza Cove. The horizontal scale is 1/2000 and the vertical scale is 1/100. Water is cycled in and out scaled to the tides. Removing the Fiesta Island causeway combined with one-way flapper valves are found to significantly improve the circulation in the east end. These changes with a cut in the DeAnza Cove peninsula will improve circulation in DeAnza Cove.

1. Introduction

The water exchange in Mission Bay is very poor on the east side of Fiesta Island and in DeAnza Cove. In order to improve this situation, proposals have been made to alter the circulation through structural and engineering solutions. A physical model was constructed and operated to test efficacy of proposed changes. The results are describe in this report.

Mission Bay is a tidally flushed lagoon which means that there is little fresh water input and the salinity in the Bay is near that of the coastal ocean. Tidal forces along the coast cause the water level to have a spring tide range of 1.2 m. The area is about 4 km on a side. Most of the bay away from the mouth has a rather uniform depth of around 2.1 m.

The shape of the bay sets the stage for the circulation. At the mouth, the maximum spring tide ebb and flood currents is 2.3 km/hour (McNabe, Holmes and Dorman, 1978). Currents are slower in the larger bays, but the circulation is persistent and the water is moving. On the other hand, the currents are very weak in the narrow channels in the east end and the circulation is extremely poor. The worst circulation is on the east side of Fiesta Island to the north of the causeway.

2. Physical Theory

The essential dynamics of the model is governed by Froude theory (Fisher, et al, 1979; Von Arx, 1962). Shallow water gravity waves dominate the circulation in the Bay and in the model. The time for a shallow water gravity wave to traverse from the front to the back of the bay is proportional to time for a shallow water gravity wave to traverse from the front to the back of the model. Once the vertical and horizontal scales of the model are chosen, other model factors are set by Froude theory. Since the model used here has a horizontal scale of 1/2000 and the vertical scale of 1/100, the scale of speed is 1/10 and the scale of time in the model is 1/200. Thus, the time between two high tides in the model is 3.725 minutes instead of 12 hours and 25 minutes in the Bay.

The interpretations of the results of a Froude model is related to the scale distortion. The scale distortion is the ratio between the vertical and the horizontal scales. It is generally accepted that circulation patterns are faithfully replicated in models with scale distortions up to 1/20 which is the value for the model used here. Therefore, this model may be used to study the effect of changes in the geometry on the circulation pattern in the Bay.

3. Model Construction and Operation

The model is constructed in styrofoam. The scaled shape of the Bay was cut out of 4X8 foot sheets that were sandwiched together and then glued side by side so that the finished model is 8X8X0.5 feet. The styrofoam was sealed and painted.

Tidal variations are generated by the raising and lowering of a reservoir over a 3.725 minute cycle. Water is exchanged between the model and the reservoir by a syphon. The effect of this system is to cycle water in and out of the mouth of the model duplicating the effect of the spring tidal range.

Tests show that the model comes to equilibrium after three tidal cycles. After any changes in the model configuration or exchanging of water, the model was cycled at least three times before any measurements were taken.

4. About One-Way Gates

It was the suggestion of one of us (Johnson) that one-way gates would be more effective in forcing circulation through the weak exchange areas. In the model, this is a "flapper valve" formed from a 1/4 inch screen with a plastic film hanging down loosely on one side, so that water moving one direction flows through and pushes the film back. Water moving the opposite direction pushes the film against the screen, closing the "valve" and preventing flow. There are six different geographical positions for flapper valves in the model that are designated by a "Gate" number. Gate 2, extending between Vacation Island and Fiesta Island, was tried with the flapper covering 100%, 75%, 50% and 25% of the opening, extending from the eastern side. Except for the 100% covering, the remaining portion was open so that water could move freely in either direction.

The full scale flapper valve gate in the Bay has not been designed nor is there a working model as far as we know. This would have to be developed by engineers and prototypes tested. We envision this device to possibly be a window shade type, with vertical strips that rotate open or closed depending upon the water direction. Another possibility is down hanging doors are pushed open or closed by the current against a fixed vertical structure. A solid structure such as a bridge or pier would support the one way valve structure(s). If there is insufficient velocity to open and close the valves, a low power motor could open and close them as they would not be moving against the current.

The auto bridge to Fiesta Island could located over the flapper valve at gate 4 or 6 so as to provide the structural support. For gates off the east and south sides of Fiesta Island, provisions could be made to allow small boats to pass. One example would be to have a shallow draft channel opening on one side covering less than 10 % of the total channel area so that shallow draft boats could pass through at any time.

Between Fiesta Island and Vacation Island, a pier could extend partway out into the channel that would be the structural support for the flapper valve. As it will be shown later, a flapper valve extending across 50 % of this channel from the east side would improve the circulation on the east side of Fiesta Island. Navigation across the western half of the channel would be unimpeded and wide enough to handle the traffic. The pier would support navigational markings, provide access for maintenance of the flapper valve system and might be used for recreational purposes. Configurations 7 and 9, which have a partial gate between Fiesta Island and Vacation Island and a gate at the present causeway site, would allow the same navigation as is in the present Bay configuration.

Gates in Configuration 12, that included flapper valves across the two main channels on the east and west side of Vacation island, was not considered realistic because they would interfere with navigation and other configurations would do the job. This was included to show an extreme case that would generate very rapped flow around Fiesta Island.

5. Data Collection

To test the circulation in the model, dye was injected only at one point for a particular run. Three dye spots were used, two on the east side of Fiesta Island and one in De Anza Cove (Fig. 1). The dye path movement was recorded by video and still photo. For consistency, die was injected at maximum ebb, and recorded on video for at least three tidal cycles. Still photos were taken at least at every maximum ebb.

Velocity measurements were made for selected cases for quantitative comparison. This was done by measuring the distance a small paper dot floating on top of the water and in the center of the channel would travel in 10 and 20 seconds. Velocities were measured at two sites on the east side of Fiesta Island simultaneously. These sites corresponded with the two dye spots on the east side of Fiesta Island.

Sixteen different model configurations were tested. The first 11 concentrated on the circulation on the east side of Fiesta Island. Of these, the first 4 were passive in nature, and any changes were cuts. Number one was the present configuration with the solid Fiesta Island Causeway in place. The causeway was removed for configuration Number 2. Configuration 3 was # 2 with a proposed cut through the northern third of Fiesta Island. Configuration 4 was # 3 with an additional proposed cut through the southern third of Fiesta Island.

The next series of modifications included one-way flapper valves. Configuration 5 was with no causeway, a north opening flapper valve (gate 6) and a southwest opening flapper valve covering 100 % the narrows between Fiesta Island and Vacation Island (gate 2), the sum of which forced a counterclockwise circulation around Fiesta Island. Configuration 6 was as 5 except that the flapper valve at gate 2 covered 75% of the narrows while the remaining 25% on the western end was open. Configuration 7 was as 5 except that the flapper valve covered 50% of the narrows while the remaining 50 % on the western end was open. Configuration 8 was as 5 except that the flapper valve covered 25 % of the narrows while the remaining 75% on the western end was open. Configuration 9 was as 7 except that the flapper valves were reversed, being south opening on gate 2 and north opening on gate 3 which forced a clockwise circulation around Fiesta Island. Configuration 10 is with no causeway but two Fiesta Island flapper valves opening east (gate 4) and north (gate 5) between Fiesta Island, forcing a counterclockwise flow around Fiesta Island. Configuration 11 is the same as configuration 10 except that the flapper gates are reversed so as to force a clockwise flow around Fiesta Island. Finally, configuration 12 consisted of gate 1 with flapper valve south opening was across the channel to the west of Vacation Island, gate 2 flapper valve south opening between Vacation Island and Fiesta Island, and gate 3 flapper valve east opening between Fiesta Island and the mainland which forced a strong counterclockwise flow around Fiesta Island on the flood tide.

The remaining configurations concentrated on the De Anza cove area. Configuration 13 was the present configuration with the Fiesta Island causeway but there was a cut across the De Anza Cove peninsula. Configuration 14 was as 11 (no causeway and two flapper valves causing counterclockwise flow around Fiesta Island) plus the De Anza cut. Configuration 15 was as 14 except the valves were reversed causing clockwise flow around Fiesta Island.

6. Observations.

Run 1. Set up: Configuration 1 - present configuration.
Dye Injection: Site 1
Results: Little dye movement, very stagnet.

Run 2. Set up: Configuration 1
Dye Injection: Site 2
Results: Dye is difused south into Enchanted Cove and toward the causway. Most dye remains on the east side of Fiesta Island. A little moves around the north end of Fiesta Island.

Run 3. Set up: Configuration 1
Dye Injection: Site 1

Results: Little dye movement, very stagnet.

Run 4. Set up: Configuration 2 - no causeway
Dye Injection: Site 1
Results: Dye is moved around the south end of Fiesta Island. Removing the causeway improves the circulation at this spot.

Run 5. Set up: Configuration 2 - no causeway
Dye Injection: Site 2
Results: Dye is moved a little to the south, into Enchanted Cove, but not to Site 1. A new stagnet null point is set up inbetween site 1 and 2.

Run 6. Set up: Configuration 2 - no causeway
Dye Injection: Site 1
Results: Similar to run 4.

Run 7. Set up: Configuration 2 - no causeway
Dye Injection: Site 2
Results: Similar to run 5.

Run 8. Set up: Configuration 3 - N.F.I. cut, no causeway
Dye Injection: Site 1
Results:

Run 9. Set up: Configuration 3 - N.F.I. cut, no causeway
Dye Injection: Site 2
Results:

Run 10. Set up: Configuration 4 - N.&S. F.I. cut, no causeway
Dye Injection: Site 1
Results: Results compromised by dye at room temperature, not comparable with other runs.

Run 11. Set up: Configuration 4 - N.&S. F.I. cut, no causeway
Dye Injection: Site 1
Results: Dye tended to remain near release site. A little was swepted around the southern end of Fiesta Island. This configuration does not significantly improve all circulation in the east end.

Run 12. Set up: Configuration 4 - N.&S. F.I. cut, no causeway
Dye Injection: Site 2
Results: Most dye is spread between release points 1 and 2 and stagnates around the new null point on the east side of Enchanted Island. This configuration does not significantly improve all circulation in the east end.

Run 13. Set up: Configuration 5 - causeway gate (6), north opening; gate 2, 100%, south opening

Dye Injection: Site 1
Results: Dye is moved northward and into the northern end of Fiesta Bay. At the end of the first cycle, dye had reached the northern end of Fiesta Island. At the end of the second cycle, weak concentrations of dye had reached the little islands in the northern portion of Fiesta Bay. By the end of the third cycle, most of the dye had been cleared out of the east side of Fiesta Island. A substantial improvement in circulation on the east side of Fiesta Island.

Run 14. Set up: Configuration 5 - causeway gate (6), north opening; gate 2, 100%, south opening
Dye Injection: Site 2
Results: Similar to Run 13 except no significant amount of dye is moved south of the injection point, and the dye is more quickly spread throughout Fiesta Bay. Little dye remains in the Fiesta Island channel after the 3rd cycle. A substantial improvement in circulation on the east side of Fiesta Island.

Run 15. Set up: Configuration 6 - causeway gate (6), north opening; gate 2, 75%, south opening
Dye Injection: Site 1
Results: Similar to Run 13 in general details. Perhaps a little weaker in circulation on the east side.

Run 16. Set up: Configuration 6 - causeway gate (6), north opening; gate 2, 75%, south opening
Dye Injection: Site 2
Results: Similar to Run 14. Hard to tell the difference.

Run 17. Set up: Configuration 7 - causeway gate (6), north opening; gate 2, 50%, south opening
Dye Injection: Site 1
Results: Similar to 13 and 15, except the dye in not distributed quite as far. A leaky gate 6 allowed some faint dye to move to the south. At the end of the 3rd cycle a significant portion of the dye is in the east side of Fiesta Island channel two-thirds of the distance from the release point to the northern tip of Fiesta Island.

Run 18. Set up: Configuration 7 - causeway gate (6), north opening; gate 2, 50%, south opening
Dye Injection: Site 2
Results: Similar to 14 and 16, except the dye is not

distributed quite as far into Fiesta Bay. Dye concentration is greatly reduced in the Fiesta Island channel on the east side of the Island.

Run 19. Set up: Configuration 8 - causeway gate (6), north opening; gate 2, 25%, south opening
Dye Injection: Site 1
Results: Similar to 17 in general pattern. However, the dye is not quite spread as far. At the end of the 3rd cycle a significant portion of the dye is in the east side of Fiesta Island channel one-third of the distance from the release point to the northern tip of Fiesta Island.

Run 20. Set up: Configuration 8 - causeway gate (6), north opening; gate 2, 25%, south opening
Dye Injection: Site 2
Results: Similar to 18.

Run 21. Set up: Configuration 10 - gate 4, east opening; gate 5, north opening, gate edges not sealed
Dye Injection: Site 1
Results: Dye is rapidly mixed and spread into the northern end of Fiesta Bay south of the little islands. Dye left on east side of Fiesta Island significantly diluted with some streaks remaining. A substantial improvement in circulation on the east side of Fiesta Island.

Run 22. Set up: Configuration 10 - gate 4, east opening; gate 5, north opening
Dye Injection: Site 2
Results: Dye is mixed and spreads further initially into Fiesta Bay. Dye remaining on east side of Fiesta Island significantly diluted with some streaks remaining. A substantial improvement in circulation on the east side of Fiesta Island.

Run 23. Set up: Configuration 11 - gate 4, east opening; gate 5, north opening
Dye Injection: Site 1
Results: Similar to 21

Run 24. Set up: Configuration 11 - gate 4, west opening; gate 5, south opening
Dye Injection: Site 2
Results: Dye is quickly moved south and some reaches Vacation Island by the end of the first ebb cycle. Successive cycles carry dye out the mouth. This set up has about the same dye disperison as configuration 10 in the east side

but the dye is mostly carried out the mouth rather than first going into the northern portion of Fiesta Bay.

Run 25. Set up: Configuration 12 - gate 1, south opening; gate 2, south opening; gate 3, east opening
Dye Injection: Site 1
Results: Dye is quickly moved around north around Fiesta Island and through out all of Fiesta Bay by the end of the first cycle. Little dye is left in the east channel by the end of the third cycle. This set up is a forceful method of causing rapid exchange of the water and very high velocities in the east end of the bay.

Run 26. Set up: Configuration 11 - gate 4, west opening; gate 5, south opening;
Dye Injection: Site 2
Results: Similar to run 24.

Run 27. Set up: Configuration 9 - causeway gate (6), south opening; gate 2, 50%, north opening
Dye Injection: Site 2
Results: Dye is moved south and some is carried to the mouth of the bay by the end of the third cycle. Remaining dye east of Fiesta Island is being rapidly diluted. This configuration causes significant improvement in the circulation in the east bay with the additional advantage that flushed water goes more directly to the mouth.

Run 28. Set up: Configuration 7 - causeway gate (6), north opening; gate 2, 50%, south opening
Dye Injection: Site 1
Results: Problem with causeway gate not functioning properly, result compromised.

Run 29. Set up: Configuration 7 - causeway gate (6), north opening; gate 2, 50%, south opening
Dye Injection: Site 1
Results: Similar to run 17.

Run 30. Set up: Configuration 7 - causeway gate (6), north opening; gate 2, 50%, south opening
Dye Injection: Site 2
Results: Similar to run 18.

Run 31. Set up: Configuration 1 - present
Dye Injection: Site 3
Results: Dye stays in DeAnza cove with little dilution and exhange with rest of bay.

Run 32. Set up: Configuration 13 - DeAnza cut and causeway

Dye Injection: Site 3
Results: Null point remains in DeAnza Cove behind new "island" where most of the dye stagnates. Not much improvement in DeAnza Cove circulation over present configuration.

Run 33. Set up: Configuration 14 - DeAnza cut, no causeway, gate 4, west opening; gate 5, south opening, clockwise flow around Fiesta Island.
Dye Injection: Site 3
Results: Pulses of dye out of DeAnza Cove on west entrance or counterclockwise sence around the DeAnza island. This is caused by gates forcing increased eastbound flow around the northern end of Fiesta Island. This configuration improves the exchange in the DeAnza Cove area.

Run 34. Set up: Configuration 14 - no DeAnza cut, no causeway, gate 4, west opening; gate 5, south opening, clockwise flow around Fiesta Island.
Dye Injection: Site 3
Results: Most of the dye stays in DeAnza Cove with only weak improvement.

Run 35. Set up: Configuration 11 - no DeAnza cut, no causeway, gate 4, east opening; gate 5, north opening; counterclockwise flow around Fiesta Island.
Dye Injection: Site 3
Results: Similar to run 34.

Run 36. Set up: Configuration 15 - DeAnza cut, no causway, gate 4 east opening; gate 5 north opening; counterclockwise flow around Fiesta Island.
Dye Injection: Site 3
Results: Similar to run 33. Dye pulses out of DeAnza Cove on west entrance or counterclockwise sence around the DeAnza island. This is caused by gates forcing increased westbound flow around the northern end of Fiesta Island. This configuration improves the exchange in the DeAnza Cove area.

7. Conclusions.

Consider first the circulation on the east side of Fiesta Island. Passive changes such as cuts in Fiesta Island does not eliminate the null point where the water stagnates, but just relocates it. Removing the Fiesta Island causeway moves the null point a little north to the Hilton hotel area. Cuts in Fiesta Island shift the null point to be east of the Enchanted Cove area. None of these changes would significantly improve the total circulation on the east side of Fiesta Island although it may be imporved in some specific areas.

The one-way gates will eliminate the null point by forcing a continuous circulation around the Island. Configurations with gates 4 and 5 or gates 2 and 3 can be oriented to cause flows oriented in either direction. A clockwise flow will move the east Fiesta Island water out into the main channel, whence it is quickly mixed and carried out the mouth. A counterclockwise flow will carry the Fiesta Island water into the northern end of Sail Bay, where it would take longer to be ultimately removed from Mission Bay. The gate 4 & 5 combination results in somewhat greater circulation and more control of the velocities in the east end than gates 2 & 3. However, both configurations and directions will significantly improve the total circulation of the east end of the bay.

Configuration 12 with the three one-way gates is an extreme case. Although providing rapid refreshment of the water, the greatly increased velocities on the east side of Fiesta Island would be so great as to be sure to cause severe erosional problems in this area.

Turning to the DeAnza Cove area, the model studies show that the DeAnza cut by itself would not significantly improve circulation in this area. However, the DeAnza cut with the flapper gates 4 and 5 oriented in either direction will significantly improve the water exchange in the DeAnza Cove. Although not directly tested, any other flapper gate configuration that causes increased flow around Northern Fiesta Island with the DeAnza cut (such as the 50 % gate 2 with the causeway gate) should cause a similar improvement in the DeAnza Cove.

8. Recommendations:

We recommend that configurations 7, 10 and 11 with the flapper valves be considered for improving the circulation on the east side of Fiesta Island. Additional large scale (1/1000 or greater) physical modelling should be done of the eastern side of the bay when design plans are narrowed to test refinements and make quantitative measurements of the flow velocities induced by these changes. This in turn could be used to estimate the areas most sensitive to scouring and erosion. Estimates on the erosion caused by wave action and currents should be examined through a combination of large scale physical modelling with scale distortions (the ratio of the vertical scale to the horizontal scale, which is 1/20 in this model) of 1/3 to 1/5 combined with field studies.

A cut in the DeAnza cove peninsula should be considered for improving the circulation in the cove. On the other hand, if this area is to be made into a marsh habitat, then this would be unnecessary.

Acknowledgments:

This project was supported by Wallace Roberts & Todd of San Diego.

References:

Fischer, H.B., E. J. List, R.C.Y.Koh, J. Imberger and N.H. Brooks, 1979: Mixing in Inland and Coastal Waters. Academic Press. New York. 483pp.

McNaboe, G.J., L.C.Homes and C.E. Dorman, 1978: Mission Bay Tidal Currents. Center for Marine Studies, San Diego State University, San Diego, CA 92182

Von Arx, W.S., 1962: An Introduction to Physical Oceanography. Addison-Wesley, Reading MA, 422pp.