Harbor Area Management Plan

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FINAL

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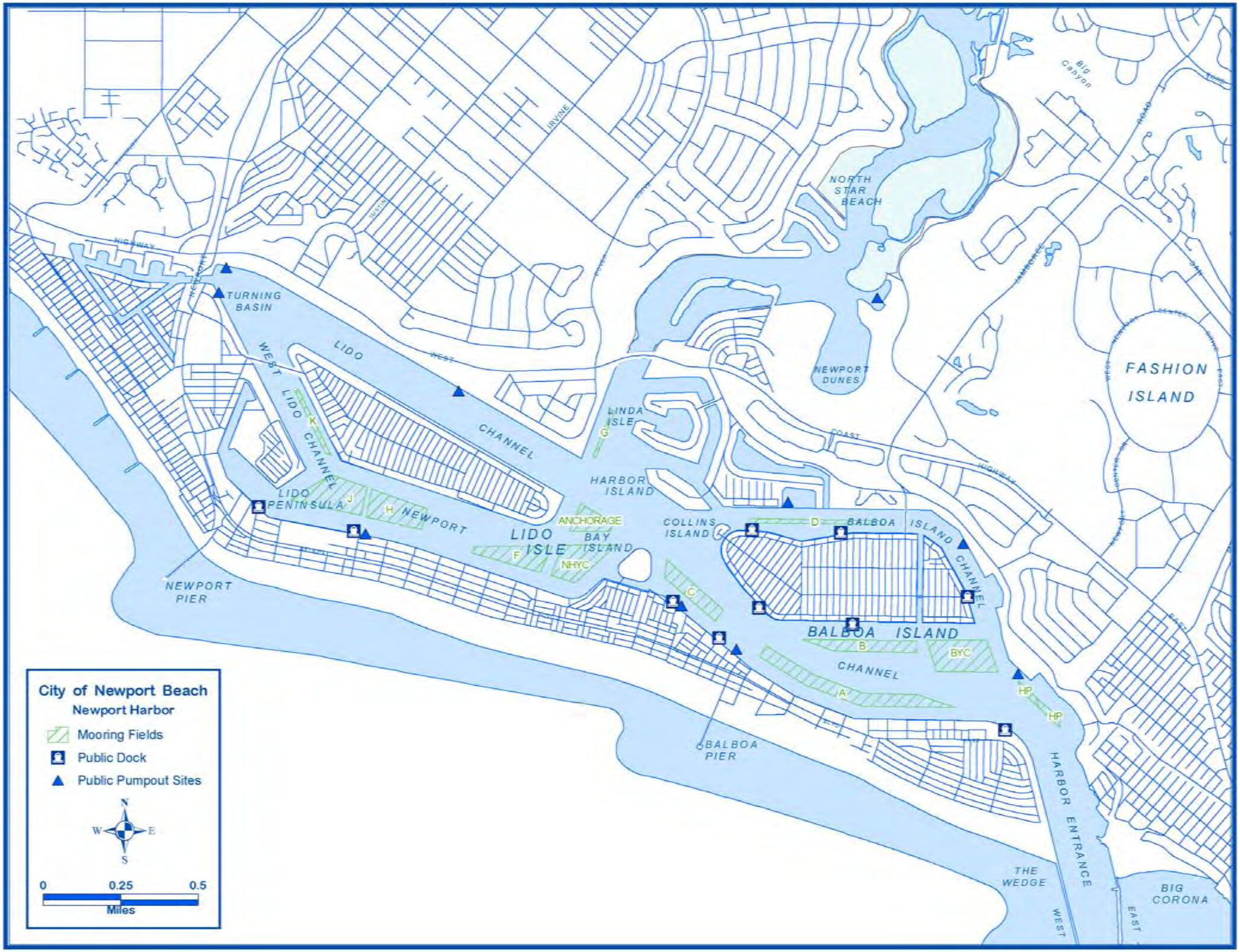
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ANCHORAGE
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THE WEDGE
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NEWPORT DUNES
FASHION ISLAND
Big Canyon
IRVINE
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Vision

"The management and preservation of Newport Bay in a sustainable manner by balancing the community, economical and environmental beneficial uses of this keystone estuary ecosystem and community asset"

Harbor Area Management Plan Workgroup

Mission

"To protect and improve the resources of Newport Harbor, Upper Newport Bay, and the ocean beaches to ensure their proper use and enjoyment by all things that derive life, recreation, or commerce from our City's most important asset"

City of Newport Beach Harbor Commission

Elements

The Harbor Area Management Plan (HAMP) uses an integrated approach. Integrating these HAMP elements results in multiple benefits. These colored symbols appear throughout the document and indicate a link to another element. These symbols are hyper linked in the PDF document to the beginning of the corresponding element's section.

- Dredging Requirements and Contaminated Sediment Management
- Eelgrass Capacity and Management Tools
- Beach Replenishment Strategy
- Water Quality
- Harbor Channel and Pierhead Lines
- Hydrodynamic and Water Quality Numerical Modeling Requirements
- Regional General Permit
- Sea Level Rise and Flood Control Management
- Upper Bay Sediment Control
- Upper Bay Restoration and Management

Document Structure

This document includes first an Executive Summary-style presentation of the HAMP. This beginning summary document provides an overview of the Plan's objectives, the elements listed above, challenges, element goals, suggested steps forward, and the level of benefits achieved. This summary document is then followed by more detailed reports on each element, provided in the appendices.

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Funding ◇ 94

Appendices

Purpose of the HAMP

The purpose of this Harbor Area Management Plan (HAMP) is to develop a resource management tool for the City of Newport Beach (City) to move forward with key sediment management, water quality, restoration, and public use projects critical in meeting the following overall goals:

- Maintain the beneficial uses of the Upper and Lower Newport Bay and economic value of the Bay;
- Provide a practical framework to meet regulatory requirements in the current and anticipated municipal discharge permits, sediment management permits, total maximum daily loads (TMDLs), and other regulatory programs for Newport Bay; and,
- Support a sustainable estuary ecosystem able to be integrated with upstream sustainable watersheds and adjacent coastal area systems.

Purpose of the HAMP

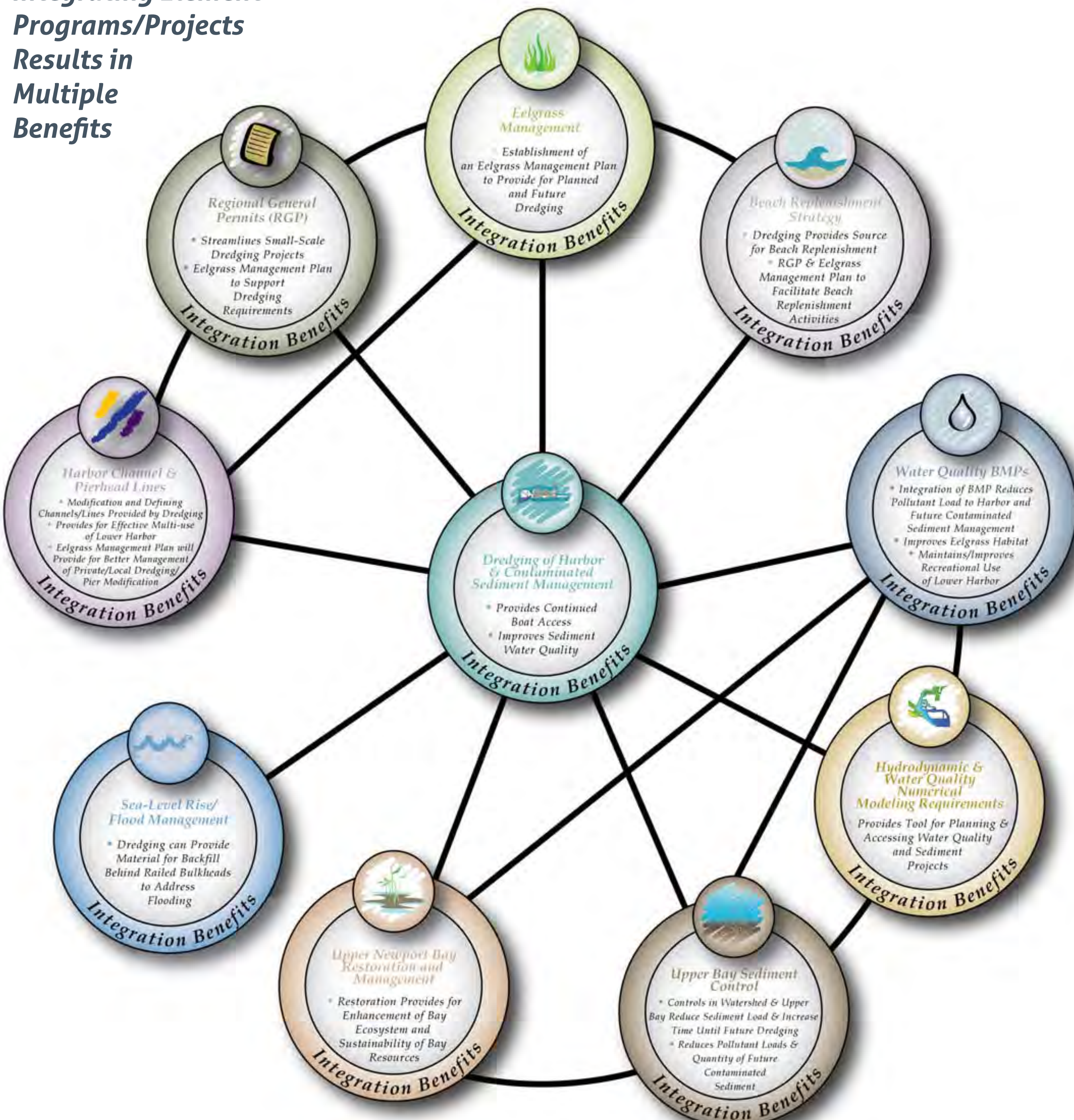
The benefit of this plan is the integration of these various projects where previous plans have focused only on a single or a smaller set of projects. This plan presents the linkages of these projects and highlights the inter-connection of the City's efforts. This plan also provides the City an assessment of these multiple projects using equally-weighted end goals of benefits. Previous plans have targeted only certain benefits, and therefore have not considered these projects in a more holistic manner.

This plan is not a recipe for project implementation, rather a framework that the City can use as a guide to planning and developing more project specific plans. Without the demonstration of the integration of the various projects provided in the HAMP, the full benefits and cost-effective solutions can not be fully realized. This plan also provides a prioritization tool for the City in considering how best to use available resources. By comparing projects to an equally weighted set of benefits, project can be better prioritized based on cost and final benefits realized.

This plan also provides the City with a management framework to provide as the basis for future state and federal grant applications to augment City resources for the implementation of projects in the Bay. State grant programs require jurisdictions to have a planning document in place and approved by management that supports the proposed projects for which grant funds are being requested.

HAMP Integrated Approach

Integrating Element Programs/Projects Results in Multiple Benefits



Introduction

Newport Bay is a vital asset to the City of Newport Beach (City) that includes some of the state's largest marinas, vibrant beach communities, and a keystone estuary ecosystem linking a diverse watershed with critical coastal habitat. Recognizing that the Lower Newport Bay serves a variety of important uses and users, including recreation, navigation, wildlife, and business and that multiple stakeholders have an interest in the management of this resource, the City has undertaken this effort to develop a Harbor Area Management Plan (HAMP) to integrate and balance everyone's efforts and goals.

The 13.2 square mile Newport Bay Watershed drains into the Santa Ana Delhi Channel and San Diego Creek that discharges into Upper Newport Bay. Upper Newport Bay is characterized by mudflat, salt marsh, freshwater marsh, riparian, and upland habitats that are protected within the 752-acre Upper Newport Bay Ecological Reserve and the 140-acre County of Orange Regional Park. The Lower Newport Bay is characterized by diverse beach communities and world class marinas. Both the Upper and Lower Bays are linked as an integrated estuary ecosystem that begins with the mixing of fresh and salt water in the mud flats and tidal marshes of the Upper Newport Bay Ecological Reserve, continues into the eelgrass beds of the Lower Newport Bay, and finally reaches the coastal marine intertidal and subtidal habitats of the Newport Coast. Adjacent to the Bay entrance are the Newport and Irvine Areas of Special Biological Significance (ASBS). These coastal areas have been designated for their importance to the California coastal habitat. These natural resources attract visitors from around the world and provide recreational opportunities to Newport residences. The Newport Bay is vital to the economic health and growth of the region through its renowned residential, recreational, and commercial opportunities. The economical success of the region depends on the sustainable management of the Newport Bay.

One of the most critical outcomes of the HAMP will allow the City to move forward with key sediment management, water quality, restoration, and public use projects. The HAMP focuses primarily on the Lower Newport Bay. Restoration activities in the Upper Newport Bay Ecological Reserve are under a separate initiative that includes the planning, design, and implementation of restoration projects in cooperation with the California Department of Fish and Game which is responsible for the management of the 752-acre reserve. Linkages to the restoration projects underway and proposed in the Upper Newport Bay will be discussed.

As a Resource Management Tool, this plan provides integrated solutions that result in cost savings and positive return on investment paid to the triple bottom line of economic, community, and environmental benefits. The suggested actions in this plan provide the steps forward to meet the challenges in a cost-effective manner through the integration of projects. For example, unit costs for management of dredged material from the Harbor's channels can be significantly reduced through integration with beneficial uses for bulk head upgrades to address flooding, beach replenishment, and eelgrass management. This plan is based on the understanding that the "no action alternative" would lead to inaccessible channels, loss of property values, and regulatory action. Management measures are needed to maintain the vitality of the Harbor's assets that balance the beneficial uses cost-effectively.

The foundation for the Harbor Area Management Plan is the Harbor and Bay Element of the City's General Plan. The management measures that are developed and presented in this plan are evaluated using the beneficial uses developed in the Harbor and Bay Element. The goals of the Harbor and Bay Element therefore are consistent with those of the HAMP. This overall vision of the HAMP also mirrors the mission statement for the Harbor Commission:

> ***"To protect and improve the resources of Newport Harbor, Upper Newport Bay, and the ocean beaches to ensure their proper use and enjoyment by all things that derive life, recreation, or commerce from our City's most important asset"***

The HAMP is therefore built on the foundation of the Harbor and Bay Element and provides the framework to build an integrated and sustainable program that most cost-effectively addresses the beneficial uses. It is the integration of the measures that this HAMP provides in order to best meet the long-term goals and vision. The integration of elements that include dredging of the channels, eelgrass management, and water quality has not been fully integrated in previous documents. This plan therefore provides this needed function to best achieve the beneficial use goals in a cost-effective manner.

The Harbor Commission has been the guiding light to moving this process forward from the foundation of the Harbor and Bay Element to the development of the HAMP. The Harbor Commission was instrumental in obtaining the grant funding from the state for the completion of the HAMP.

The HAMP provides management and planning tools for the "water side" of Lower Newport Bay. The Local Coastal Program (LCP) provides the management plan for the "land side "of the Harbor Area. The LCP consists of the Coastal Land Use Plan approved by the California Coastal Commission and adopted by the City in 2005. There have been subsequent amendments to this plan to make it consistent with the General Plan approved by the voters in 2006. The land use plan indicates the kind, location, and intensity of land uses; the applicable resource protection and development policies; and where necessary, a listing of implementing actions. The implementation plan consists of the zoning ordinances, zoning district maps, and other legal instruments necessary to implement the land use plan.

Objectives and Goals to Achieve a Sustainable Newport Bay

The sustainability of the social, economic, and environmental values of this treasured estuary ecosystem and its beach communities depends on successfully managing the Newport Bay to achieve the following broad objectives:

- **Protect the recreational values** ***(social)***
- **Recognize the economic value of the Harbor and its channels to the local community** ***(economic)***
- **Assure a sustainable estuary system linked to watershed and coastal habitats** ***(environmental)***

These broad objectives are more clearly defined and measured through a more specific set of goals as follows:

Objectives	Goals
Protect the recreational values *(social)*	*Community/Public Access* *Recreational Opportunities*
Recognize the economic value of the Harbor and its channels to the local community *(economic)*	*Channel Maintenance* *Flood Control* *Berthing Management*
Assure a sustainable estuary system linked to watershed and coastal habitats *(environmental)*	*Water Quality* *Marine Resource Protection (ASBS)* *Habitat Protection/Improvement* *Sustainability*

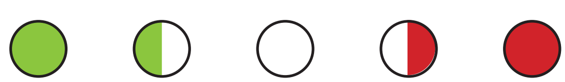
The following guiding principles have been identified as programs and activities that are being developed and coordinated:

- **Maintain the beneficial uses of the Upper and Lower Newport Bay and economic value of the Bay,**
- **Achieve regulatory requirements within a practical framework that meet the specified target in the current and anticipated municipal permits, sediment management permits, total maximum daily loads (TMDLs), and other regulatory programs for Newport Bay,**
- **Work toward a sustainable estuary ecosystem integrated with sustainable watershed and coastal area systems.**

Recommended Goals

The suggested priority projects and activities developed and presented for each Harbor challenge are integrated into the HAMP Management Tools section and assessed using a set of more specific beneficial use goals, consistent with the broad objectives defined earlier. These criteria include each of the beneficial uses defined in the Harbor and Bay Element and additional elements to achieve the long-term sustainability of the Bay. The table on the following page presents the goals used for the evaluation of the recommendations. Further description of the goals is also provided with the origin of the criteria. Several criteria have been added to achieve a more holistic and integrated approach with other regional plans, including the Central Orange County Integrated Regional and Coastal Watershed Management Plan, the Newport Coast Watershed Management Plan, and the Upper Newport Bay Restoration Plan. Several of these criteria also apply to state grant program as listed in the table. This evaluation provides an additional tool to demonstrate the importance of an integrated approach to achieve the overall goals.

The priority projects and activities for each HAMP challenge/element are evaluated using a scale of 1 to 5. A score of 1 indicates that the activities proposed for that element are the most effective at meeting the listed beneficial use goal and a score of 5 indicates those activities are the least effective at meeting the listed beneficial use goal. Scores 1 though 5 are indicated using the symbols in the legend below. On page 92, all of the scores for each element are averaged together to show that when integrated, these combined HAMP element activities result in a beneficial outcome. Therefore, although one element may have little or no benefit in a single criteria, when integrated and implemented as an overall program, the combined outcome achieves the stated goals.



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Beneficial Use Criteria Table

Beneficial Use Goals	Descriptions	Origins
Water Quality	Create and maintain a sustainable watershed through protection, preservation, and improvement of water quality.	• Harbor & Bay Element Goals 8 & 10 • Proposition 50 • Proposition 84
Marine Resource Protection (ASBS)	Protect, preserve, and enhance marine resources, including marine plants, invertebrates, fishes, seabirds, marine mammals, and their habitats.	• Harbor & Bay Element Goals 7, 8, & 10 • Proposition 50 • Ocean Plan
Habitat Protection/ Improvement	Protect, preserve, and restore sustainable upland, wetland, and marine habitats, focused on Upper Newport Bay.	• Harbor & Bay Element Goals 7 & 10 • Proposition 50
Community/ Public Access	Maintain and improve public access to the shoreline, beach, coastal parks, trails, and bays through waterfront and infrastructure improvement projects.	• Harbor & Bay Element Goals 5 & 6 • Proposition 50
Water Conservation/ Urban Runoff Management	Reduce non-stormwater runoff and conserve water through education and the implementation of a watershed-based runoff reduction program to increase groundwater recharge and limit pollution to the Bay and its waters.	• Harbor and Bay Element 8 • Proposition 84
Channel Maintenance	Enhance and maintain deep-water channels through dredging and sediment management to ensure and improve navigation.	• Harbor & Bay Element Goals 13
Flood Control	Reduce the potential for catastrophic floods through identification of at-risk areas, maintenance of flood control facilities, and design of flood control projects.	• Proposition 50 • Proposition 84
Berthing Management	Ensure a variety of vessel berthing and storage opportunities at marinas, moorings, anchorages, and piers.	• Harbor & Bay Element Goal 5
Recreational Opportunities	Preserve and enhance water-dependent and water-related recreational activities.	• Harbor & Bay Element 1, 2, & 4 • Proposition 50
Sustainability	Integrate and maintain the balance of beneficial uses in the Bay by considering economic, recreational, and commercial interests.	• Harbor and Bay Element

The development of this management tool for the Lower Newport Bay requires coordination between multiple programs and requires addressing multiple challenges to achieving the overall goals. These programs and challenges that have been identified through the regulatory agencies, stakeholder groups and the City include:

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Dredging Requirements and Contaminated Sediment

In recent years, sedimentation in Lower Newport Bay has resulted in the narrowing and shoaling of the federal channels and adjacent non-federal channels that act as the main conduits to marina and harbor traffic. Although sediment catch basins constructed in Upper Newport Bay were somewhat effective in helping to reduce sedimentation, the Lower Bay has remained subject to heavy amounts of silt and sedimentation via tidal activity and storm events. By dredging the Lower Bay, the United States Army Corps of Engineers (USACE) and City of Newport Beach (City) hope to re-establish adequate water depths along the federal channels and to improve navigation for the high volume of sea-going vessels entering and leaving Newport Bay. The dredging of contaminated sediments may have a long-term positive effect on the environment due to the ongoing source of contaminants released to the environment if left in place. However, the handling and management of these sediments reduces the options for beneficial uses and placement of dredged material. Based on the June 2008 bathymetry survey conducted by the USACE, approximately 1 million cubic meters (1.3 million cubic yards) of sediment has accumulated above the authorized Operations and Maintenance depths within actively maintained Federal areas of responsibility (USACE). Based on the results of recent chemical and biological testing data of the accumulated sediments, conservative projections indicate approximately 60 percent of these sediment are suitable for ocean disposal (exact number to be determined during the dredging process), with the balance not likely to pass suitability for this management option. These remaining sediments will instead require some form of treatment or alterative disposal. Assuming sedimentation rates stay the same or diminish, an additional 650,000 cy will need to be dredged over the next 30 years to maintain harbor depths.

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Eelgrass Capacity and Management

While eelgrass serves an important ecological resource within Lower Newport Harbor, it often conflicts with other beneficial harbor uses, particularly those related to guest and residential boating and navigation. Dredging and maintenance of navigational channels; construction and maintenance of bulkheads, piers, and docks; and nourishment of beaches directly impacts eelgrass through burial or removal of vegetation and a loss of eelgrass function as a wildlife habitat. The eelgrass is a protected habitat that needs to be balanced with other beneficial uses and economic value of recreational and personal use of the Harbor. The City has an adopted Coastal Commission-approved Land Use Plan (LUP) that acknowledges the need for a balance between harbor maintenance and recreational activities and preservation of this important habitat. To mitigate the potential impacts to eelgrass of dredging and development, the LUP requires avoidance where possible and restoration where avoidance is not practical. The challenge is therefore to develop an Eelgrass Management Plan that balances existing harbor uses with maintaining a high value and sustainable eelgrass habitat.

Beach Replenishment Strategy

There are over 30 beaches located in Lower Newport Bay. The beach uses and needs vary. Several issues have prevented efficient management of beach replenishment projects. No formal system is in place to manage and prioritize beach replenishment projects and the beneficial

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uses of dredged material that can be used for these projects. Components of the Regional General Permit (RGP) restrict the placement of dredged material on beaches if eelgrass beds are within 15 feet. Under the RGP, only small volumes (<1000cy) of dredged material from the Lower Bay can be beneficially used to nourish compatible beaches. A more comprehensive management and priority system is needed to address these challenges.

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Water Quality Best Management Practices

Key water quality challenges include understanding the extent and sources of water quality impacts to the Lower Newport Bay, and the development of a strategy to cost-effectively implement best management practices (BMPs) to meet the anticipated requirements of TMDLs. The TMDLs under implementation for the Lower Newport Bay include nutrients, pathogens, and sediment. TMDLs in the technical phase include organochlorine compounds and metals for the Rhine Channel. The water quality issues in the Lower Newport Bay are linked to the Upper Bay and watershed as they contribute to the constituent loading to the Lower Bay. This is highlighted by the dual listing of the San Diego Creek watershed and the Newport Bay on most of the TDMLs. Located just outside the Harbor are two areas designated by the state as ASBS that are subject to special protections under the California Ocean Plan (COP). Preliminary constituent transport modeling indicates a likely connection between the Bay and the ASBS. The strategy for BMP implementation therefore needs to integrate with watershed, Upper Newport Bay, and coastal plans and projects; and allow for effectiveness assessment of the program.

Harbor Channel and Pierhead Lines

After construction of the portion of Newport Bay below Pacific Coast Highway (Lower Bay), the federal government, through the USACE, established harbor lines (project lines, pierhead lines, and bulkhead lines). These lines define the federal navigation channel dredging limits, and the limits on how far piers, wharfs, bulkheads,

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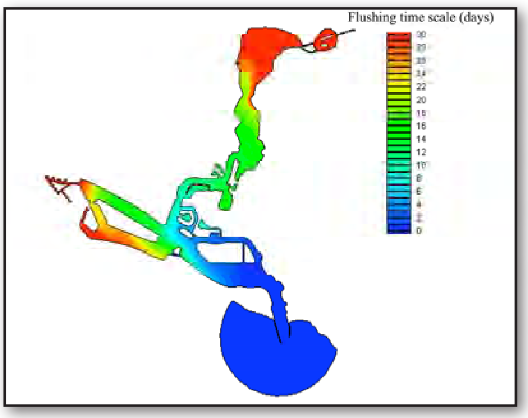
and other solid fills can extend into Lower Bay waters. These lines are important for maintaining safe navigation conditions throughout the Lower Bay. The harbor lines have not been systematically adjusted since their original development in 1936 even though the Lower Bay has been altered extensively since this time, and there have been changes in uses as well. As part of the HAMP, this section identifies and addresses issues related to the harbor lines throughout the Lower Bay and provides recommendations to update these lines which will impact dredging needs, eelgrass management, and areas defined under the RGP. Specific changes have been suggested, and methods for implementing those changes have been provided.



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Hydrodynamic Model

Numerical models are widely used as a management decision-making tool in addressing sediment and water quality problems, including several numerical modeling efforts specifically for Newport Bay. Numerical models are used to simulate hydrodynamic conditions (e.g., flows, water surface elevations, and velocities) and water quality transport (e.g., sediment or salinity) within a river, estuary, or Bay. Changes to hydrodynamic and water quality conditions are used to evaluate alternatives or management decisions, such as dredging strategies or storm drain diversions to improve water quality. Numerical models are also used to understand the physical environment of the Bay and to aid in decision making to address water quality issues. Development of a hydrodynamic and water quality numerical model for Newport Bay can be used to evaluate many of the proposed strategies and BMPs developed for the HAMP. Accurate models are needed to assess future dredging and beach replenishment needs, effectiveness of water quality, and sediment control BMPs.

Regional General Permits

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In Lower Newport Bay, in-water maintenance activities are carried out under a variety of federal, state, and regional permits, the principal one being the federal Regional General Permit 54 (RGP 54), issued by USACE and managed by the City of Newport Beach Harbor Resources Division. The RGP, which is valid for a term of five years, governs maintenance dredging and disposal of sediments and the repair and replacement of docks, piers, and seawalls. The current RGP contains a number of special conditions. Several issues have hampered the efficient administration of the RGP and resulted in significant delays and additional costs for necessary harbor maintenance. These include the long and costly permit renewal process, sampling plan approval, restricted range of activities covered by the permit, no consistent disposal options for impacted sediment, and Special Conditions that prevent many minor maintenance dredging operations within 15 feet of eelgrass beds.

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Sea Level Change and Potential Shoreline Flooding

Historical measurements indicate a steady increase in global sea levels. Continued sea level rise will increase the risk of nearshore flooding during storm surges that correspond to high tide events. The potential for flooding in the Lower Harbor has not been evaluated with regard to this documented rise in sea levels. Flood modeling is needed to evaluate this potential and to develop recommendations regarding the modification of existing bulkheads and other flood control structures and municipal infrastructure.

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Upper Bay Sediment Control Plan

The Upper Newport Bay Sediment Control includes the management of sediment loading occurring from the watershed. Current restoration and dredging activities in the Upper Newport Bay include the establishment of sediment control basins to control sedimentation to the Bay. Further sediment transport modeling is needed to assess the efficiency of these basins and the effects of the current dredging regime. Long-term management of sedimentation patterns and sediment types will also need to be coordinated with TMDLs and other regulatory drivers. Dredge material management in the Lower Bay is dependent on aggressively addressing fine-grained sediments transported from San Diego Creek through the Upper Bay.

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Upper Bay Restoration Management Plan

The Management Plan for the Upper Newport Bay Ecological Reserve is the framework for the implementation and management of the restoration activities and long-term sustainability of this Critical Coastal Area. The Ecological Reserve is managed by the California Department of Fish and Game. Due to funding constraints, this Management Plan is currently in a preliminary phase. However, the City and County are aggressively moving forward with several restoration projects. The challenges for the Upper Bay Restoration include securing funding for the restoration projects and the development of the Management Plan and coordination of the dredging activities with the restoration projects and water quality projects.

The intent of the development of the HAMP is to guide the City and the Harbor stakeholders in the implementation of activities that balance the beneficial uses with the long-term sustainability of the Bay. The Newport Bay stakeholders include the Newport Harbor Commission; Community Support Groups; Newport Beach Chamber of Commerce; Orange County Coastkeeper; County of Orange Watershed and Coastal Resources Division; Regional Water Quality Control Board; other environmental conservation groups, non-governmental organizations, industry professionals and private citizens that live, work and recreate in and around the Bay.

Integral in the development of this plan is the input provided by the stakeholders. The development approach to the HAMP includes feedback from the Harbor stakeholders as well as coordination with regional and coastal watershed plans, TMDL programs, and channel maintenance programs. Stakeholder input was provided at several phases of the plan development. These phases included the preliminary draft, draft, and final plan development. The content and format of the documents at each of these phases has been planned to allow for incorporation of stakeholder feedback.

The HAMP is composed of two sets of documents consisting of the main report and supporting appendices. The main report includes the Technical Report Summaries and HAMP Management Tools. The Technical Summaries are developed from the Technical Reports that are presented in the appendices. This plan incorporates comments from the stakeholder groups from previous drafts.

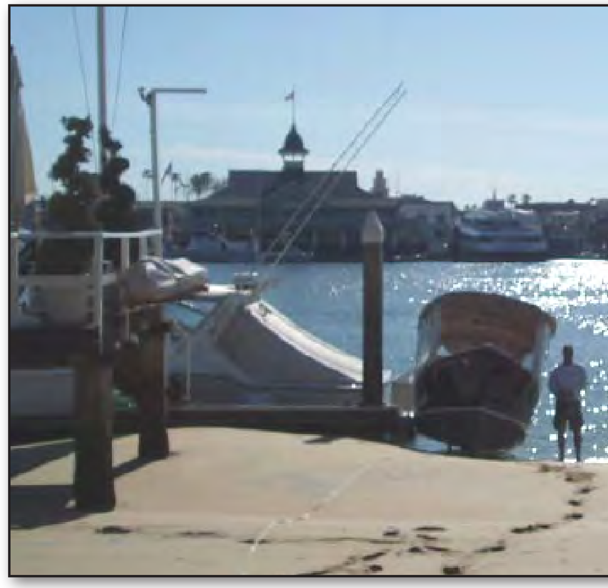
The HAMP integrates the potential steps forward presented in the individual Technical Summaries into an overall strategy with possible project prioritizations, potential funding sources and linkages to other projects. This overall strategy is presented following the Technical Summaries, and consists of a set of HAMP Management Tools. These tools include an implementation schedule that provides the suggested priorities, linkages, estimated costs, and potential funding sources for activities in the Lower Newport Bay to achieve the overall program goals. The suggested priority projects and activities are assessed using a set of evaluation criteria based on the goals of the program. These criteria include each of the beneficial uses defined in the Harbor and Bay Element and additional elements to achieve the long-term sustainability of the Bay. This evaluation provides an additional tool to demonstrate the importance of an integrated approach to achieve the overall goals. These criteria are further defined in the following subsection.

The development of this HAMP is funded by a State Water Resources Control Board (SWRCB) Grant to the City of Newport Beach. The City and community of Newport Beach appreciates this support from the state for the preparation of this plan toward the goal of a sustainable Newport Bay that is integrated into a sustainable watershed and coastal area. It should be noted that the contents of this document do not necessarily reflect the views and policies of the SWRCB, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Dredging Requirements & Contaminated Sediment Management

Beneficial Use Criteria/Rating	
Water Quality	◐
Marine Resource Protection (ASBS)	◐
Habitat Protection/ Enhancement	◑
Community/ Public Access	◐
Water Conservation	○
Channel Maintenance	●
Flood Control	◐
Berthing Management	●
Recreational Opportunities	◐
Sustainability	●

Dredging Requirement Study



Problem Statement: In recent years, sedimentation in Lower Newport Bay has resulted in the narrowing and shoaling of the federal channels and adjacent non-federal channels that act as the main passageway for marina and Harbor traffic. Therefore, there is a need for a plan to maintain the channels and berthing areas necessary for safe navigation of the Lower Newport Bay in an economically and environmentally sound manner. Sediment catch basins constructed in Upper Newport Bay were somewhat effective in helping to reduce sedimentation ; however, the Lower Bay has remained subject to heavy amounts of silt and sedimentation via tidal activity and storm events. The United States Army Corps of Engineers (USACE) and City of Newport Beach (City) plan to re-establish sufficient water depths along the federal channels and to improve navigation safety for the large quantity of sea-going vessels entering and leaving Newport Bay. Since 1929, there has been a long history of dredging within Newport Bay. This has served a dual purpose by addressing critical dredging needs such as improving navigation safety for sea-going vessels, and also by considering beneficial use alternatives.

Benefits of Dredging: By dredging the Lower Bay, USACE and the City of Newport Beach (City) hope to re-establish adequate water depths along the federal channels and to improve navigation safety for the high volume of sea-going vessels entering and leaving Newport Bay. The dredging of contaminated sediments may have a long-term positive effect on the environment due to the removal of contaminants that could potentially become exposed to marine life if left in place.

Overview of Dredging Requirements

Current Dredging Needs:

Based on the June 2008 bathymetry survey conducted by the USACE, approximately 1 million cubic meters (1.3 million cubic yards) of sediment has accumulated above the authorized Operations and Maintenance (O&M) depths within actively maintained Federal areas of responsibility (USACE). Based on the results of recent chemical and biological testing data of the accumulated sediments, conservative projections indicate approximately 60 percent of these sediment are suitable for ocean disposal exact number to be determined during the dredging approval process), with the balance not likely to pass suitability for this management option. These remaining sediments will instead require some form of treatment or alternative disposal. These totals are summarized below:

Summary of Operation and Maintenance Dredge Volumes by USACE Channel Reach[1]

Federal Channel Segment	Estimated O&M Volume (Cubic Meters)
Entrance Channel	40,580
Corona Del Mar Bend	2,150
Balboa Beach	79,370
Harbor Island Reach	74,570
Lido Island Reach	157,500
Turning Basin	63,740
West Lido Area A	51,710
West Lido Area B	38,020
Newport Channel	187,050
Yacht Anchorage	359,220
Bay Island Anchorage	14,690
Upper Channel	37,050
North Anchorage Area	5,720
South Anchorage Area	9,800
Balboa Island Channel	40,520

1-Lower Newport Bay CAD Site Feasibility Study, Anchor QEA,L.P., 2009

In addition to the contaminated material from the federal O&M channel, there are several other areas of contaminated sediment in the Lower Newport Bay that also require some form of management. Not all of these areas are the responsibility of the City.

Non-Operations and Maintenance Sources of Contaminated Sediments from Lower Newport Bay[1]		
Source	**Estimated Volume of Contaminated Sediment (cubic meters)**	**Responsibility**
Rhine Channel	100,584	City and Various Shoreline Tenants
Private/Commercial Facilities	10,000+	Various

1-Lower Newport Bay CAD Site Feasibility Study, Anchor QEA,L.P., 2009

Future Dredging Needs:

Based on models developed by USACE in the late 1990s and historic depositional records, approximately 1 to 1.5 million cubic yards of sediment will be transported through, with a significant volume settling in the Lower Newport Bay in a 15-year cycle. However, these models do not account for hydrological changes that will be implemented with the most recent designs for the Upper Newport Bay Restoration Project. In addition, these models do not assess the impact of current dredging operations in Upper Newport Bay, which remove only the coarse grain size fraction. This model does not account for volumes by grain size fractions; therefore, sedimentation patterns cannot be predicted and are confounded by the current dredging operations in Upper Newport Bay. A model that incorporates grain size fraction information is needed. Additional data would need to be established to determine sedimentation rates and future dredging needs.

The City has a Regional General Permit (RGP) ■ , which is a 5 year renewable permit that allows property owners to apply to the City for permission to dredge within their dock area. This permit allows for up to 20,000 cubic yards of sediment to be dredged each year. In the past 30 years, about 357,000 cubic yards of sediment was dredged under the RGP. About 170,000 cubic yards was disposed of at LA-3, and about 187,000 cubic yards was used for beach replenishment.

Based on recent bathymetry, the removal of approximately 1.3 million cubic yards (1 million cubic meters) is required to increase Harbor depths to design depths. Based on historic dredging efforts over the last 30 years, approximately 360,000 cubic yards were dredged under the RGP and 289,000 cubic yards were dredged by the USACE in the federal channels. Assuming sedimentation rates stay the same or diminish, additional dredging is needed over the next 30 years to maintain Harbor depths.

Options for Management of Sediment

Ocean Disposal

Suitability of dredged material for ocean disposal is based on MPRSA Tier III analysis as described in the Ocean Testing Manual. Tier III analysis includes sediment chemistry, solid phase toxicity tests, suspended particulate phase toxicity tests, and bioaccumulation tests. Dredged material from Newport Bay for ocean disposal will be placed in the USEPA designated LA-2 or LA-3 disposal sites. LA-2 is located within Los Angeles County, approximately six nautical miles from the entrance of Los Angeles Harbor. LA-3 is located within Orange County, approximately 4.5 nautical miles from the entrance of Newport Harbor.

Sustainable Sediment Management Alternatives

Dredging requires processing and handling of sediments, which are typically removed from a system and placed in nearshore ocean disposal sites or in confined disposal facilities (CDF). Often this is done without considering alternative beneficial uses of the sediment. For some dredging projects, disposal issues can be problematic resulting in postponements or even cancellation of dredging at harbors. However, sediments which do not exceed predetermined criteria may be a viable source for beneficial use projects where some type of soil or fill is needed.

Beneficial use includes a wide variety of options that utilize dredged material for a productive purpose. Beneficial uses of dredged material may make traditional placement of dredged material unnecessary or at least reduce the level of disposal. The broad categories of beneficial uses, based on the functional use of the dredged material or site, defined by the USACE (1987) are as follows:

- *Beach nourishment-* the strategic placement of large quantities of beach quality sand on an existing beach to provide a source of nourishment for littoral movement or restoration of a recreational beach

- *Shoreline stabilization-* the use of material to create berms or embankments at an orientation to the shoreline that will either modify the local wave climate in order to improve shoreline stability, or alter the wave direction to modify the rate or direction of local sediment transport

- *Landfill cover for solid waste management-* the use of material at landfills as daily or final cover, and as capping material for abandoned contaminated industrial sites known as "brownfields"

- *Material transfer-* the use of dewatered dredged material as construction fill for roads, construction projects dikes, levees

Management of Materials Not Suitable for Ocean Disposal

The long history of commercial and recreational boating uses, as well as the urbanization of the watershed, has contributed to sediment toxicity and chemical contamination of Newport Bay. Contaminant chemicals and metals have accumulated within the Bay's sediments, reaching levels that exceed sediment quality standards in specific portions of the Bay, such as the Rhine Channel. As a consequence, sediment management and treatment strategies are necessary to control and remediate sediment contamination in order to comply with state regulations and enhance the environmental conditions within the Bay. In doing so, sediment management has the potential to contribute to the goals set forth in the Newport Beach Harbor and Bay Element.

Options for contaminated sediment management in Southern California are documented in the Los Angles Contaminated Sediment Task Force (CFTS) Long-Term Management Strategy (LTMS), and the Los Angeles Regional Dredged Material Management Plan (DMMP). These documents were used as the basis to develop potential management options for evaluation relative to Lower Newport Bay sediments. The options being considered by the City include:

•Future Port Fill in the Ports of Los Angeles or Long Beach

•On-site (On-shore) Treatment Facility

•Upland Disposal to a Landfill

•Long Beach Confined Aquatic Disposal (CAD) site

•Newport Harbor Confined Aquatic Disposal (CAD) site

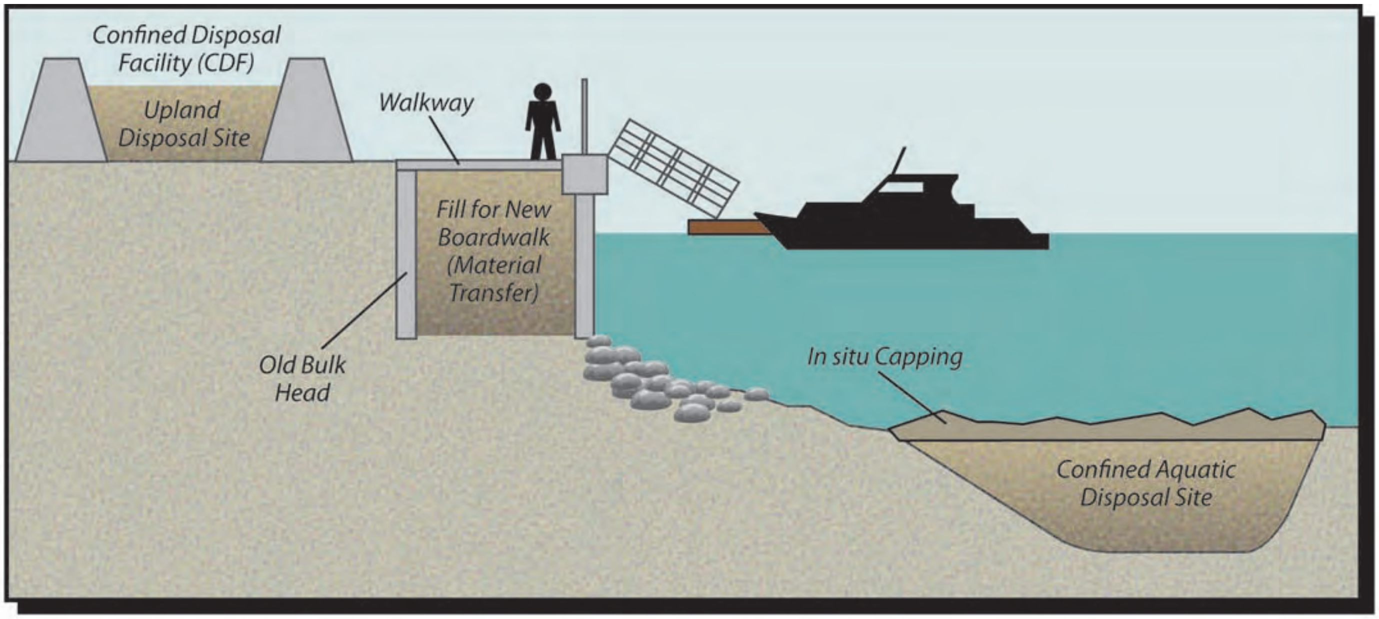
In order to address an ongoing goal of the Council, the Newport Beach Harbor Commission and the community, the City is working with USACE to take the necessary steps in planning for a Lower Bay dredging project. Before materials may be dredged, there needs to be disposal solutions for contaminated sediments. The City is currently studying these options and evaluating the most cost effective alternative.

Benefits of Managing Contaminated Sediment: Effective management of contaminated sediments within the Bay will have several environmental, social, and economic impacts. Upper Newport Bay is a State Ecological Reserve and one of the last large undeveloped wetlands in southern California. It is a home to a variety of threatened species. Removal and treatment of contaminated sediments can enhance the floral and faunal communities of the Bay, benefiting not only those organisms that inhabit the sediments, but also fish and invertebrates that feed on the benthic infauna. Lower Newport Bay is a major recreational destination for tourists and locals. Reducing sediment contamination will improve water quality, which has the potential to increase the level of recreational uses within the Bay, such as swimming, fishing, and sailing.

Potential management alternatives for contaminated sediment include:

•shoreline stabilization (fill behind bulkheads)

•landfill cover for solid waste management, and



Potential Management Options for Sediment

• material transfer (all discussed above)

as well as:

• ***Monitored Natural Recovery-*** the use of naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment. It is necessary that contaminants are at relatively low concentrations throughout the area and the area does not require dredging to meet the City's needs. Given specific site characteristics, this remediation option is most appropriate if the expected risk of exposure to humans and aquatic organisms is relatively low and when the site is a sensitive habitat that may be permanently damaged by dredging or capping, such as eelgrass habitat.

• ***In situ Capping-*** the covering or capping the contaminated sediment in place with a clean material. In situ capping may be more appropriate than dredging/excavation when there is risk of contaminant exposure during removal activities, or residual contamination at a site.

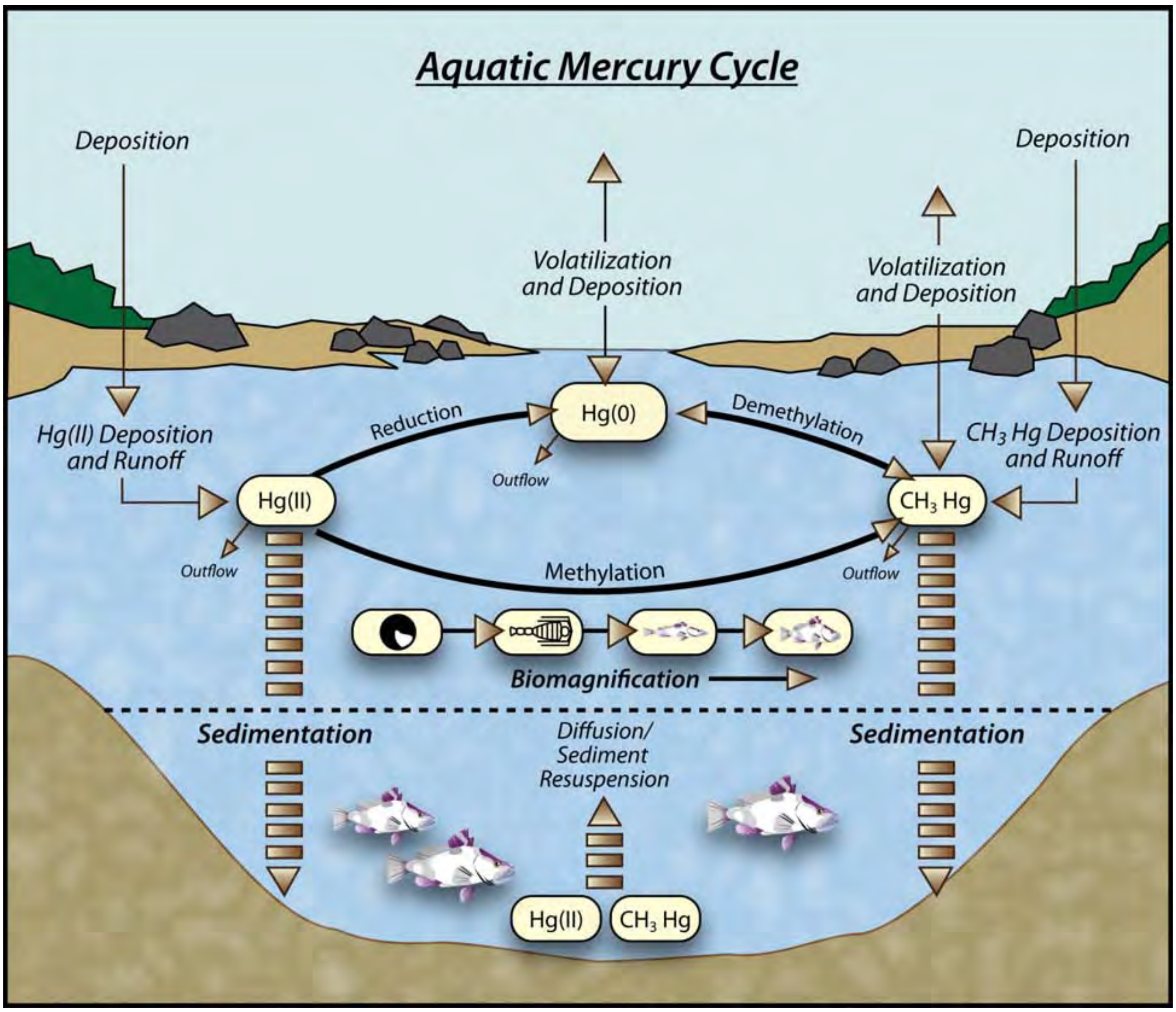
• ***Confined disposal facility (CDF)-*** an engineered structure bound by confinement dikes for containment of dredged material. CDFs serve as a dewatering facility and can be used as a processing, rehandling and/or treatment area for beneficial use of dredged material. Dredged material may be placed temporarily or permanently in the CDF.

• ***Confined aquatic disposal (CAD)-*** a process where dredged material is disposed at the bottom of a body of water, usually within a natural or constructed depression (i.e. created specifically for the disposal) or a relic borrow-pit created during previous construction activities. A CAD facility is under evaluation for the Lower Newport Bay. This option may also include the use of the CAD facility in Long Beach.

• *On-site Treatment-* Certain treatment technologies may be applied to the dredged material to reduce contaminant exposures to acceptable levels. Treatments involve reducing, separating, immobilizing and/or detoxifying contaminants, and could be applicable either as stand alone units or combined as part of a treatment train.

• *Upland Landfill Disposal –* Contaminated sediments are dewatered then transported to a permitted landfill for disposal. This requires an area for temporary storage and dewatering of the dredge material prior to transport off-site.

• *Fill Material for Future Port Expansion -* Expansions are planned for the Ports of Los Angeles and Long Beach. If dredging of the Lower Bay could be timed with these expansions, this options provides a very cost effective alternative since dredged materials can



be loaded on to barges and transported to the Ports. The challenge for this option is the coordination of schedules between the projects.

An evaluation of the alternatives favoring the use of a CAD site in Lower Newport Bay is presented in the Lower Newport Bay CAD Site Feasibility Study, Anchor QEA, L.P., April 2009.

Contaminants of Concern within Sediment

Agricultural activities, commercial and recreational boating uses, and urbanization of the watershed, has resulted in widespread contamination in Upper and Lower Newport Bay sediments. The primary contaminants of concern include DDTs, mercury, copper, and pyrethroids.

DDTs

Widespread DDT contamination in the Bay is the result of historical agricultural activities in the watershed. Organochlorine pesticides, such as DDT, were widely used as pesticides from the mid-1940s to the 1970s. San Diego Creek meanders through historical agricultural farmland that are impacted with DDT, and its breakdown products DDE and DDD. The soils are transported to the Bay by runoff.

Mercury

Possible sources of mercury in the Bay include historical antifouling boat paints, historical shipyard activities, the natural locally occurring geological material known as cinnabar, and mercury mining in the watershed. Mercury mining occurred at Red Hill mine between 1880 and 1939, and the San Diego Creek may have transported sediment containing mercury into the Bay. Natural processes can change the mercury from one form to another. In specific forms (methyl mercury), mercury can accumulate in living organisms and reach high levels in fish and marine mammals via a process called biomagnification (i.e. concentrations increase in the food chain). The figure below illustrates the complex chemical cycle in which mercury changes forms in the aquatic environment.

Copper

Sources of copper include antifouling paints, hull cleaning, cooling water, NPDES discharges, industrial processes, stormwater runoff, mining and point source runoff. Copper, in a variety of formulated fungicides, herbicides and algaecides, is widely used in antifouling paints to control the growth of bacteria and fungus. Copper has a lithic biogeochemical cycle, therefore, it has a strong propensity for sediments and soils.

Pyrethroids

A possible source of pyrethroids is historic agricultural uses and residential uses. Pyrethroids are used residentially in insecticides that previously had organophosphates as the active ingredients. Pyrethroids, which consist of 40% of all pesticide products, display high toxicity to a wide range of aquatic organisms including invertebrates. Many of these compounds are extremely toxic to fish. They are usually not sprayed directly onto water, but they can enter lakes, ponds, rivers, and streams from rainfall or runoff from agricultural fields and eventually find their way to coastal areas.

Potential Steps Forward

Related Potential Steps Forward for near- or long-term management of dredging programs and sediment management programs include:

Phase 1 – Near-Term Solution for Management of Dredged Materials and Maintenance of Navigational Depths

1. Sediment Management Plan – This Plan is currently under development. A Conceptual Development Plan focusing on the Lower Newport Bay CAD Site was completed in April 2009 (Anchor QEA, L.P.).
    a. Management of Materials Meeting Ocean Disposal Suitability Requirements
    b. Management of Materials for Beneficial Use
        i. Review of alternatives using logistical, technical, and economic feasibility evaluation criteria.
        ii. Geotechnical evaluation for construction or bulkhead restoration suitability.
    c. Management of Materials Unsuitable for Either Ocean Disposal or Beneficial Use
        i. Identification of sediment rehandling facility.
        ii. Identification and evaluation of Confined Aquatic Disposal (CAD) facilities/ alternatives.
2. MPRSA Tier III Evaluation – 6 months
3. Master Dredging Plan and Schedule – 6 months
    a. Design and Dredging Requirements
    b. Schedule Including Consideration of Environmental Windows
    c. Identification and Mitigation of Potential Impacts: Habitat, Water Quality, Harbor Activities, Navigation and Public Access, Noise, Aesthetics, Air Quality
    d. Equipment and BMPs

Phase 2 – Long-Term Solution Management of Dredged Materials and Maintenance of Navigational Depths

1. Sediment Transport Study – 9 months
    a. Data Collection, Analysis and Modeling
    b. Forecasted Sediment Budget for Lower Newport Bay and Estimate of Future Dredging Needs
2. Sustainability Plan for Maintenance of Harbor Channels – 6 months
    a. Identification and Discussion of Significant Load Sources (Contaminants and Sediments)
    b. Identification and Discussion of Relevant BMPs for Reduction of Source Loadings
    c. Identification and Discussion of Potential Future Development Impacts
    d. Long-term Management Plan for Future Dredging Needs

Eelgrass Capacity and Management Tools

Beneficial Use Criteria/Rating
Water Quality
Marine Resource Protection (ASBS)
Habitat Protection/ Enhancement
Community/ Public Access
Water Conservation
Channel Maintenance
Flood Control
Berthing Management
Recreational Opportunities
Sustainability

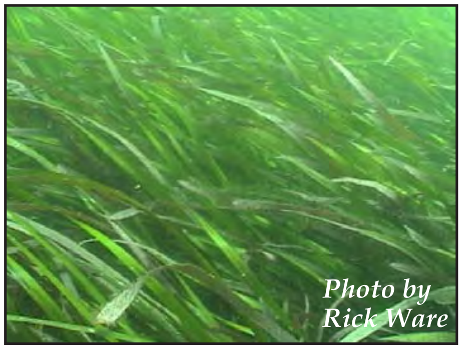


Photo by Rick Ware

Introduction

The marine resources of Newport Harbor are diverse and rich, and are extremely important to the health and maintenance of nearshore coastal resources. The City is committed to achieving a sustainable Newport Harbor Area through the protection and improvement of harbor marine resources, balanced with the economic value of recreational uses of the Harbor.

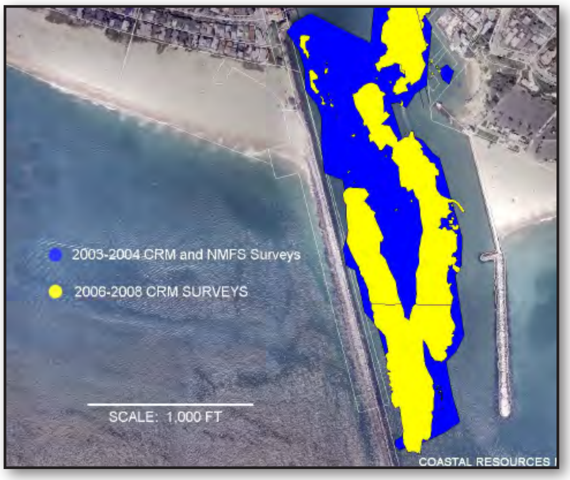
One of the most important biological resources within Newport Harbor is eelgrass (Zostera marina). Eelgrass meadows (and sub units called "beds" and "patches") are important habitat for invertebrates as a source of food, substrate for attachment, and protection for numerous fish and invertebrate species. The vegetation provides protection while it serves as a nursery for many juvenile fishes, including species of commercial and/or sports fish value (i.e., California halibut and barred sand bass).

Key Issues: While eelgrass serves an important ecological resource within Lower Newport Harbor, it often conflicts with other beneficial harbor uses, particularly those related to tourist and residential boating and navigation. Dredging and maintenance of navigational channels, construction and maintenance of bulkheads, piers and docks, and nourishment of beaches directly impact eelgrass through burial or removal of vegetation, shading impacts, and a loss of eelgrass function as a wildlife habitat. Thus, eelgrass is a protected habitat that must be safeguarded and balanced with other beneficial uses.

- *Eelgrass habitat is considered wetland habitat by State of California and federal wetland definitions and is protected by a no-net loss wetlands policy.*
- *Eelgrass is considered Essential Fish Habitat under the Magnuson-Stevens Fishery Management and Conservation Act*
- *Eelgrass is protected under NEPA and CEQA*

The City has an adopted, Coastal Commission-approved land use plan (LUP). The LUP acknowledges that the need to maintain and develop coastal-dependent uses may result in impacts to eelgrass. To mitigate the potential impacts to eelgrass of dredging and development, the LUP requires avoidance where possible and restoration where avoidance is not practical. Development of an Eelgrass Management Plan for Newport Harbor will protect eelgrass to ensure a sustainable population while maintaining all of the Harbor's beneficial uses.

Figure 1: Harbor Entrance Channel



Current Eelgrass Distribution

The distribution of eelgrass increased from about 3 acres in 1993 to over 100 acres in 2003-2004, and then decreased to 70.7 acres in 2006-2008. Areas of greatest eelgrass abundance in Newport Bay during 2003-2004 included the harbor entrance channel (Figure 1), and the shorelines of Corona del Mar (Figure 2), Balboa Island (Figure 3), Harbor Island/Beacon Bay, Balboa Channel yacht and marina basins, and the channels that surrounded Linda Isle (Figure 4). Upper Newport Bay (Figure 5) had a significant eelgrass meadow around the southern one-half of the DeAnza/Bayside marsh peninsula and nearby the Castaways site on the west side of the Channel. Recent mapping in 2006-2007 documented an eelgrass acreage decline of 24%. Declines occurred primarily in Upper Bay (Figure 6), in the channels surrounding Linda Isle and Harbor Island, and along the north shoreline of Balboa Island (Figure 3).

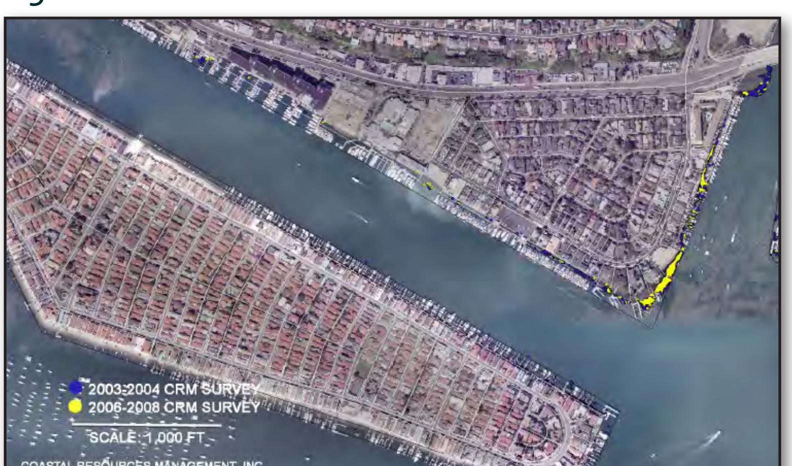
Figure 2: Corona del Mar Reach

Figure 3: Balboa Island

Figure 4: North Harbor, around Linda Isle

Figure 5: Upper Newport Bay

Figure 6: Lido Isle Ranch



Though variable on a biannual basis, the eelgrass population has increased in abundance over the last 15 years likely due to several factors:

- Improvement in water clarity;
- Highly favorable growing conditions during low rainfall years where the concentration of suspended sediments is decreased;
- Better management of dredge and fill projects;
- Increased environmental awareness of the importance of eelgrass; and
- More systematic, repetitive methods of mapping eelgrass vegetation

Current Challenges to Establish Sustainable Eelgrass Populations in Newport Harbor

The most critical challenges to eelgrass populations and their establishment are (1) the presence of availability of suitable intertidal and subtidal soft-bottom habitat (2) maintaining adequate water quality and underwater light conditions to promote eelgrass growth and health and (3) maintaining a balance between the natural resources within Newport Harbor with the uses of Newport Harbor as a viable recreational boat harbor so that the areal cover and health of eelgrass vegetation continues to serve an important function as a habitat for marine life.

These challenges are particularly important because eelgrass mitigation projects cannot be successful unless specific habitat requirements are met for the establishment and growth of eelgrass. Based on water and habitat quality, ecological zones of eelgrass population health are apparent. Eelgrass distribution in Newport Harbor can be divided into three zones: (1) a Stable Eelgrass Zone (green) that includes areas where tidal flushing is between approximately 0 and 6 days, (2) a Transitional Zone (yellow) where eelgrass acreage is susceptible to large-scale variability and tidal flushing is about 7 to 14 days; and (3) an Unvegetated eelgrass zone (red) where tidal flushing ranges between 14 days and 30 days and the amount of eelgrass present is insignificant.

Figure 7: Eelgrass Distribution Zones

Developing an Eelgrass Management Plan

Current and future Harbor infrastructural improvement projects such as maintaining safe navigable waters; the renovation and construction of piers, docks, and seawalls; and replenishing the Harbor's beaches will affect the distribution and abundance of eelgrass and will require programs to compensate for eelgrass habitat losses. Thus, understanding governing regulations, the constraints for eelgrass success in various regions of the Bay, and identifying specific mitigation options for eelgrass losses are important to consider.

Ensuring a Healthy Population

While eelgrass occurs throughout many regions of Newport Bay, its structure and function varies widely from region-to-region and from year-to-year. Mitigation for losses of eelgrass habitat must be focused in areas where suitable habitat requirements are met for size of the habitat, sediment types, depth, and light intensity, and where eelgrass will survive and flourish over the long term. Based on the historical changes of eelgrass distribution, on the results of eelgrass mitigation successes and failures, and on the limited suitable water and habitat quality that is needed to support a healthy eelgrass population, high priority should be given to maintaining and creating a sustainable eelgrass population in the Stable Eelgrass Zone (Figure 7).

Implementation of an Eelgrass Management Plan

The City of Newport Beach would be responsible for developing, overseeing, and enforcing compliance with the Eelgrass Management Plan. The City would be responsible for eelgrass surveying, implementing programs to establish eelgrass populations, monitoring the success of the programs, and conducting periodic, bay-wide eelgrass surveys. Under such a concept, the City would protect and promote a shallow water eelgrass population. As long as the sustainable eelgrass population remains above a determined quantity then a certain small amount may be impacted per year. Should the shallow water eelgrass population drop below the approved quantity, increased mitigation measures and decreased allowable annual impacts will be implemented in a phased manner.

Best Management Practices for Eelgrass

1. Avoid and minimize damage to existing eelgrass bed resources.
2. Educate boat owners and property owners as to the importance of eelgrass within Newport Harbor so that they take "ownership" in their project and view eelgrass as a positive outcome of their project.
3. Create and maintain a sustainable eelgrass population in the Stable Eelgrass Zone should the threshold value of eelgrass populations in Newport Harbor fall below the minimum amount.

Close coordination will be needed between the City of Newport Beach, the Department of Fish and Game, and the National Marine Fisheries Service in order to develop special conditions that will be effective in making the Newport Beach Long-term Eelgrass Management Plan a success, and at the same time, responsive to agency concerns.

The Eelgrass Management Plan would develop guidance to (1) maintaining a base amount of eelgrass based upon identified eelgrass threshold capacity measurements and using BMPs to ensure this threshold capacity is maintained, (2) implementing programs to maintain and establish sustainable eelgrass populations in areas affected by disturbances, or into the created habitat using innovative and cost-efficient methods if necessary to maintain a determined sustainable eelgrass population, and (3) monitoring the success of the sustainable eelgrass population over the long term.

Building a Sustainable Eelgrass Population

Establish a sustainable eelgrass population in the Stable Eelgrass Zone. The deeper channel waters beneath Mooring Area B seaward of the southern perimeter of Balboa Island encompass a maximum of about 28 acres of bay floor that could potentially be modified to support a sustainable eelgrass population. Selected site (or sites) could be engineered to provide for (1) long-term stability from the effects of sediment scour and/or sediment deposition, (2) appropriate depth ranges to support a sustainable eelgrass population, and (3) adequate depths to maintain safe navigation and boating. The creation of new shallow-water habitat in the Harbor would also present an opportunity to establish both a confined disposal site to manage contaminated, dredge sediments from Newport Bay dredging projects as well as maintain a sustainable eelgrass population.

Additional actions that can be taken to provide a healthy eelgrass population:

- Improving water quality by the reduction of nutrients from San Diego Creek.
- Decreasing sediment loading, specifically finer sediments, from San Diego Creek.
- Reducing shade associated with docks and piers to increase light penetration.

Potential Steps Forward

1. Identify appropriate needs relative to future watershed and harbor activities to gauge the extent of required sustainable eelgrass management. Develop an ecosystem approach Eelgrass Management Plan (EMP) rather than managing eelgrass project on an incremental basis.

2. Meet with stakeholders and identify concerns, constraints, and permitting issues based on what will be required for future dredging and infrastructure improvements in Newport Harbor. *It will be critical to assess the environmental permitting and fiscal constraints of the program early on to assess the ability of the City to implement an Eelgrass Management Plan. Early agency involvement with the Coastal Commission, U.S. Army Corps of Engineers, State Lands Commission, State Water Resources Control Board, and resource agencies (NMFS, USFWS, and CDFG) is critical to ensure that there is sufficient agency understanding and support for such a critical undertaking.*

3. The EMP will promote a system-based approach; the key metric of eelgrass protection is the maintenance of a sustainable shallow water eelgrass population of at least 20 acres. *The focus of the City's management will be to protect and promote shallow water eelgrass populations and as long as the sustainable eelgrass population is above 20 acres, no more than 2 acres of eelgrass impacts will be permitted per year conditioned on compliance with best management practices for avoiding eelgrass disturbance where possible. Should the shallow water eelgrass population fall below 20 acres, increased mitigation measures and decreased allowable annual impact will be implemented in a phased manner.*

4. The City of Newport Beach will assume lead responsibility for the preparation and implementation of the Eelgrass Management Plan. *The City will enforce compliance with the plan, subject to agency oversight. Consistent with its management role, the City, rather than individual residents, will be responsible for surveying and data gathering, while relieving individual property owners of a burden they generally lack the expertise to effectively carry.*

5. The City will of Newport Beach will identify primary and alternative locations in the Stable Eelgrass Zone capable of supporting the maximum amount of sustainable eelgrass required for future projects should it be necessary to create additional Stable Eelgrass Zone eelgrass populations. *Conduct coastal engineering and marine biological surveys to identify those areas with the Stable Eelgrass Zone that have a potential to be utilized for mitigation bank sites. Conduct side scan sonar mapping surveys, physical modeling, and field studies in potential sustainable eelgrass areas to evaluate erosion, sedimentation, and other process that will be required to refine site selection.*

6. The City will prepare a draft Eelgrass Management Plan (DEMP) and negotiate a Final Stable Eelgrass Zone Management Plan (FEMP) with the National Marine Fisheries Service, the California Department of Fish and Game, the U.S., Army Corps of Engineers, and the California Coastal Commission. *Upon completion of the FEMP, the City shall commence review of the plan for consistency with provisions of the City of Newport Beach Local Coastal Plan and the Regional General Dredging Permit (RGP).*

7. Once in place, the City will implement and manage the FEMP. Following implementation, the City will review the success of the EMP at five-year intervals to determine the effectiveness of the program, identify any required changes to the program, and implement if necessary, adaptive management to ensure the key program metrics are being met.

8. Establish an Eelgrass Management Plan web site. *Lastly, the City should consider establishing a web site that will track project implementation and achievement of key metrics for public review. This will also assist the City in providing suggested public educational outreach for the project.*

Beach Replenishment Strategy

Beneficial Use Criteria/Rating	
Water Quality	○
Marine Resource Protection (ASBS)	○
Habitat Protection/ Enhancement	○
Community/ Public Access	●
Water Conservation	○
Channel Maintenance	◐
Flood Control	◐
Berthing Management	◐
Recreational Opportunities	●
Sustainability	◐

Introduction

Natural beaches are dynamic landforms altered by wind and waves in a continual process of creation and erosion. River sediments are the source of 80 to 90% of beach sand; some beaches are built to great widths by sediments washed to the sea by large storm events and then gradually erode through wave and other process. After the construction of the Lower Bay, beaches are modified through human processes.

Definition: Beach replenishment or nourishment refers to the strategic placement of beach-quality sand on an existing beach to provide a source of nourishment for littoral movement or restoration of a recreational beach. Generally, beach nourishment projects are carried out along beaches where a persistent erosional trend exists. To carry out a beach nourishment project, sediment with physical characteristics similar to the native beach material is mechanically or hydraulically placed. Beach replenishment has proven to be cost-effective and environmentally acceptable method of maintaining the recreational, aesthetic, and shore protection aspects of beaches within the Lower Bay.

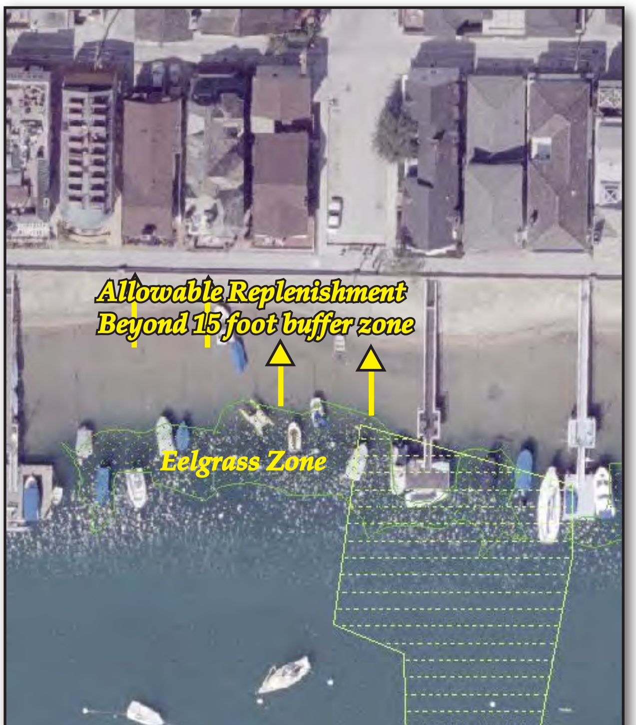
Key Issues: There are over 30 beaches located in Lower Newport Bay. The beach uses and needs vary. Several issues have prevented efficient management of beach replenishment projects. A formal system is not in place to manage and prioritize beach replenishment projects. Components of the RGP restrict the application of dredged material on beaches.

1. No management system in place to prioritize selection of beaches for replenishment.
2. No management system is in place to characterize and prioritize dredged material for beneficial uses.
3. Eelgrass habitat restrictions: The proximity of eelgrass beds can limit the opportunities to replenish the beaches. Currently, beach replenishment can-

not be conducted in areas where eelgrass is found within 15 feet of the replenishment footprint. If eelgrass is found within 15 to 30 feet of the replenishment footprint, pre-and post-monitoring surveys are required.

4. Under the RGP, only small volumes (<1000cy) of dredged material from the Lower Bay can be beneficially used to nourish compatible beaches.

5. Maintenance of sands on replenished beaches



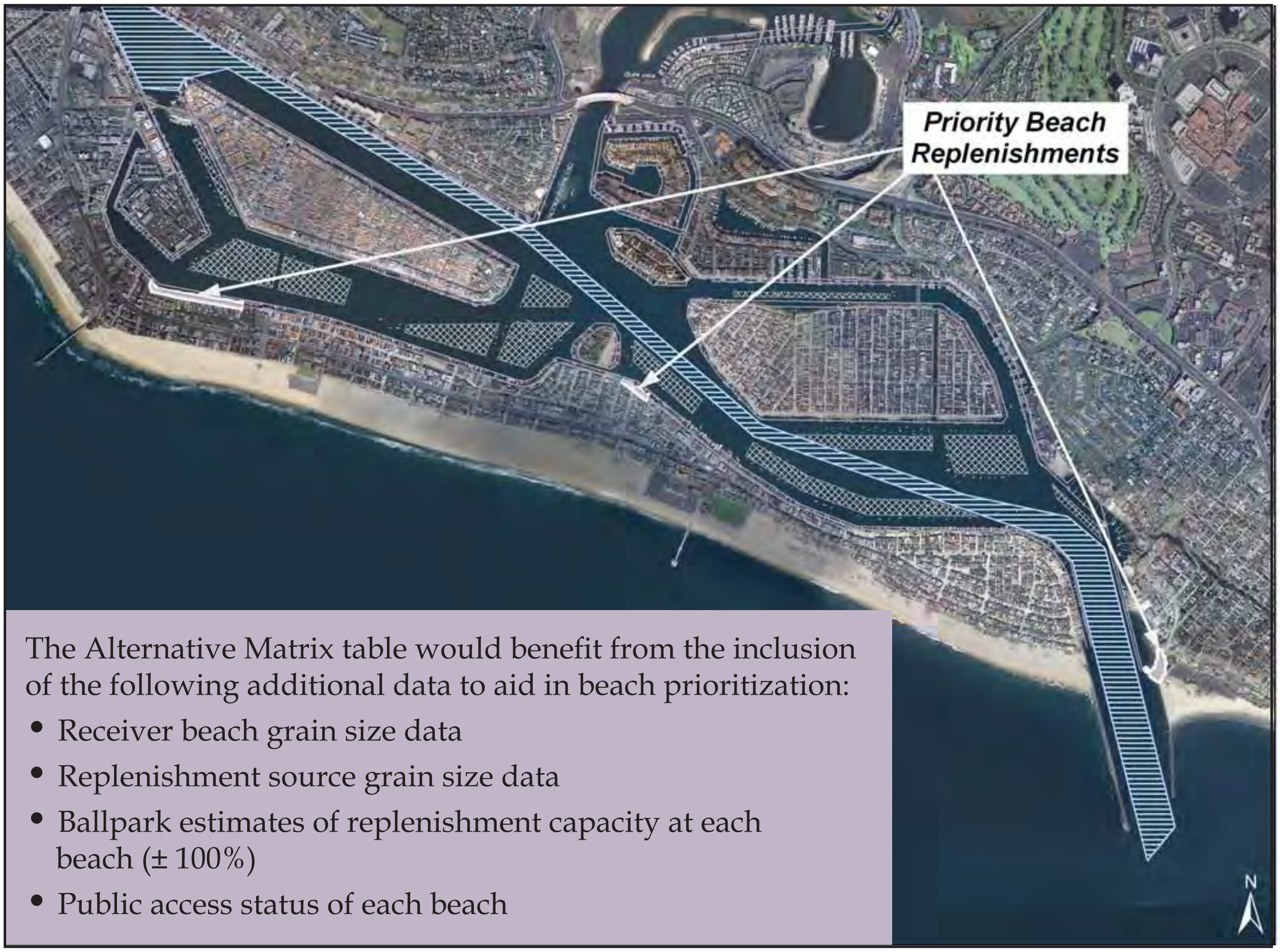
Development of a Beach Replenishment Program

The City will benefit from developing a centralized management program to be run by the Harbor Resources division. An Alternative Matrix has been developed as part of this program that can be used to develop a long-term analysis tool as data become available. This interactive table can be modified as priorities and opportunities change. The Alternative Matrix is a tool to qualitatively rank beaches for their replenishment capacity and need. All beaches are evaluated by their access and popularity, sand capacity, constructability, and proximity to eelgrass. Values for each criteria range from 1 to 3 with 1 being poor performance and 3 being good performance within that criteria. Also, the criteria are weighted from 1 to 3 based on their level of importance, with 3 being most important. For example, access & popularity is very important so that criteria receives a weight of 3, while constructability is least important, receiving a weight of 1. Each beach and criteria combination has a subtotal calculated as the criteria value times the importance weighting. The beaches that would benefit the most from replenishment have the highest total and the lowest rank.

Based on existing available data, the Alternative Matrix shows that Marina Park, Edgewater/Montero, and China Cove all rank very high for beach replenishment since these beaches all have a recreational need, can accept significant quantities of sand, are easily constructed, and are far enough from eelgrass to be permitted. Pirate's Cove, Lake St., 10th St., and M St. also rank well for beach replenishment.

Beach at Marina Park

Beach at Edgewater and Montero Avenues



The Alternative Matrix table would benefit from the inclusion of the following additional data to aid in beach prioritization:

- Receiver beach grain size data
- Replenishment source grain size data
- Ballpark estimates of replenishment capacity at each beach (± 100%)
- Public access status of each beach

As material is dredged, grain size compatibility information should be collected to determine the best location for placement options. Grain size data for the many receiver beaches is not yet organized in one report. Many of the beaches have been maintained by individual homeowners or homeowners associations and sampling data may be available from those individuals or groups. While it is beyond the scope of this study, development of an evolving database of all replenishment sources and receiver beaches would be useful for grain size compatibility analysis to support the Beach Replenishment Alternative Matrix. General rules for grain size compatibility are that the replenishment source material must be either greater than 80% sand or at least 75% sand and no more than 10% difference in sand content between the source and receiver beach.

■ Increase volume of material to be beneficially used for beach replenishment in the RGP

■ Include beach replenishment projects in the Eelgrass Management Plan

A sand study was begun in 2007 to assess sand management and beach improvement options for Balboa Island. The study is to focus on quantifying existing conditions of sediment transport and effects from natural and man-induced changes. Other studies can be conducted in areas with known sand erosion problems.

Potential Steps Forward:

The following steps are made for improving the effectiveness of the Beach Replenishment Program:

1) Include the following additional data in the current Alternative Matrix table: a) cost/benefit analysis; b) source and receiving beach compatibility; and c) quantification of how long beach sand will stay on each beach. Data needs include: receiver beach grain size data, replenishment source grain size data, estimates of replenishment capacity at each beach, and public access status of each beach. Based on the Alternative Matrix, Marina Park, Edgewater/Montero, and China Cove have a recreational need, can accept significant quantities of sand, are easily constructed, and are far enough from eelgrass to be permitted. Pirate's Cove, Lake St., 10th St., and M St. also rank well for beach replenishment.

2) Develop Eelgrass Management Plan ■ and determine if these banks can be used for beach replenishment mitigation. This would significantly reduce restrictions on beach replenishment placement locations .

3) Modify the RGP ■ to simplify and streamline the special conditions and increase the 1,000 cubic yard quantity limit. This would allow the resumption of maintenance dredging and beach replenishment by individual homeowners and homeowners associations.

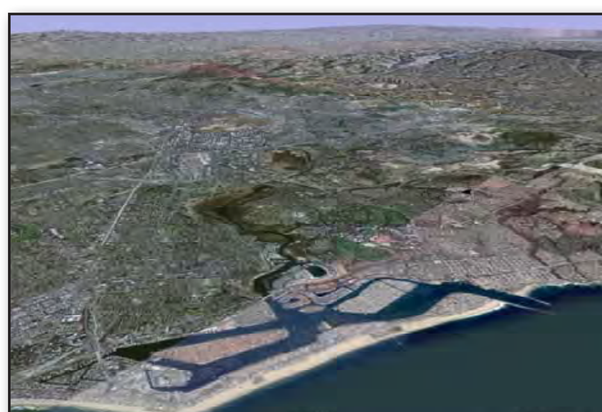
4) Expand sand movement studies along Balboa Island to other areas within Lower Newport Bay to develop a better understanding of sand movement at other beaches in Lower Newport Bay.

Water Quality

Beneficial Use Criteria/Rating	
Water Quality	●
Marine Resource Protection (ASBS)	◐
Habitat Protection/ Enhancement	◐
Community/ Public Access	○
Water Conservation	◐
Channel Maintenance	○
Flood Control	○
Berthing Management	○
Recreational Opportuni-ties	◐
Sustainabil-ity	◐

Introduction

The City of Newport Beach (City) is committed to achieving a sustainable Newport Harbor Area (Harbor Area) through protection and improvement of water quality. Water quality is a key link in addressing community needs, regulatory requirements, and the health and diversity of the surrounding ecosystems to the Harbor Area. The City's strategy toward achieving this vision begins with an evaluation of the current health and water quality of the Harbor Area and identifying the sources of impacts to it. Based on this understanding, strategies will be developed to protect water quality in the Harbor Area through the implementation of best management practices (BMPs) supplemented by coordination with other regional water quality protection measures, community outreach, and education. The end goal is to create a Strategic BMP Implementation Plan (BMP Plan)



	Agricultural Supply	Groundwater	Water Contact Recreation	Non-water contact recreation	Commercial and Sportfishing	Warm Freshwater Habitat	Limited Warm Freshwater Habitat	Biological Habitats of Special Significance	Wildlife Habitat	Rare, Threatened, or Endangered Species	Spawning, Reproduction, and Development	Marine Habitat	Shelfish Harvesting	Estuarine Habitat
Bays, Estuaries, and Tidal Prisms														
Lower Newport Bay			●	●	●				●	●	●	●	●	
Upper Newport Bay			●	●	●			●	●	●	●	●	●	●
Channels Discharging to Coastal or Bay Waters			●	●	●				●			●		
Ocean Waters														
SWQPA (formerly ASBS)			●	●				●				●		
Newport Bay			●	●	●								●	
Inland Surface Streams														
Buck Gully	●	●				●	●							
Morning Canyon						●	●							
San Diego Creek														
Reach 1 - Below Jeffries Road			●	●					●					

Table 1: Beneficial Uses for Waters in the Newport Harbor Area

to strategically implement water quality BMPs that is coordinated with Harbor Area beneficial uses and addresses current and future pollutants entering and discharging from the Upper and Lower Newport Bay. The strategic plan will also coordinate with the watershed, Upper Newport Bay, and coastal plans and projects to create a sustainable water quality improvement plan maintained through iterative effectiveness assessment of the implanted water quality protection, preservation, and improvement measures.

Overview of Water Quality Issues

The Newport Harbor Area faces significant water quality challenges as identified through regulatory action and a number of special studies recently undertaken by the City of Newport Beach and other watershed stakeholders. The Harbor Area, located in the Lower Bay, is the nexus between the highly urbanized upstream watershed, the ecologically sensitive Upper Newport Bay and the receiving waters of the Pacific Ocean. The Harbor Area is also functioning small boat harbor surrounded by small businesses, private residences, and municipal facilities and has over 9,000 boats berthed in the Lower Bay. The Lower Bay also serves as a major Southern California recreational destination, attracting both visitors and locals to take advantage of a variety of water-related activities.

The Upper Newport Bay in addition to supporting high value habitat serves a number of recreational uses that include a small boat marina for approximately 670 slips and 620 dry storage spaces (data from Newport Dunes and DeAnza), public boat launch ramp, and an aquatic recreational facility. Potential sources of pollutant inputs therefore also exists in the Upper Bay that need to be addressed as part of a watershed management program for which this HAMP provides a key element along with the Central Orange County Integrated Regional and Coastal Watershed Management Plan (San Diego Creek, Delhi Channel and Coastal Canyon Creeks Watersheds) and the Newport Coast Watershed Management Plan (ASBS).

Key water quality challenges in the Harbor Area include understanding constituent loadings from regional upstream sources in the San Diego Creek Watershed, contributions of constituents from local sources within the Harbor Area, potential cross-contamination from sources outside the Bay, and Bay discharges of degraded water quality to sensitive marine areas outside the Harbor. The Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) lists Newport Bay as a tributary to the Pacific Ocean and also serves as the receiving waters for San Diego Creek. Located just outside the Harbor are two areas designated by the State as Areas of Special Biological Significance (ASBS) that are subject to special protections under the California Ocean Plan (COP). Table 1 summarizes the Basin Plan beneficial uses for the waters in and adjacent to the Harbor Area.

	Buck Gully Creek	Lower Newport Bay	Upper Newport Bay	Rhine Channel	San Diego Creek - Reach 1
TMDLs					
Nutrients		●	●		●
Pathogens		●	●		
Pesticides		●	●		●
Sedimentation			●		●
303(d) Listings					
Chlordane		●	●		
Copper		●	●	●	
DDT		●	●		
Fecal Coliform	●				●
Lead				●	
Mercury				●	
Metals			●		
PCBs		●	●	●	
Sediment Toxicity		●	●	●	
Selenium					●
Total Coliform	●				
Toxaphene					●
Zinc				●	

Table 2: Impaired Water Bodies and Pollutants of Concern in the Newport Harbor Area

Based on the Basin Plan beneficial use designations and the COP, water bodies within and near the Harbor Area are subject to regulatory action from the USEPA, the State Water Resources Control Board (SWRCB) and the Santa Ana Regional Water Quality Control Board (RWQCB). The EPA and the RWQCB have implemented total maximum daily loads (TMDLs) for various constituents in San Diego Creek and the Upper and Lower Newport Bay. Buck Gully Creek, the Upper and Lower Newport Bay, Rhine Channel, and San Diego Creek all are listed as impaired on EPA's 303(d) list (Table 2).

The development of a cost-effective strategy to implement (BMPs) to meet current and anticipated TMDLs, other regulatory drivers, and existing City planning documents and ordinances is a key component in effectively addressing water quality issues in the Upper and Lower Bay.

Key Questions and Coordination with Current Programs

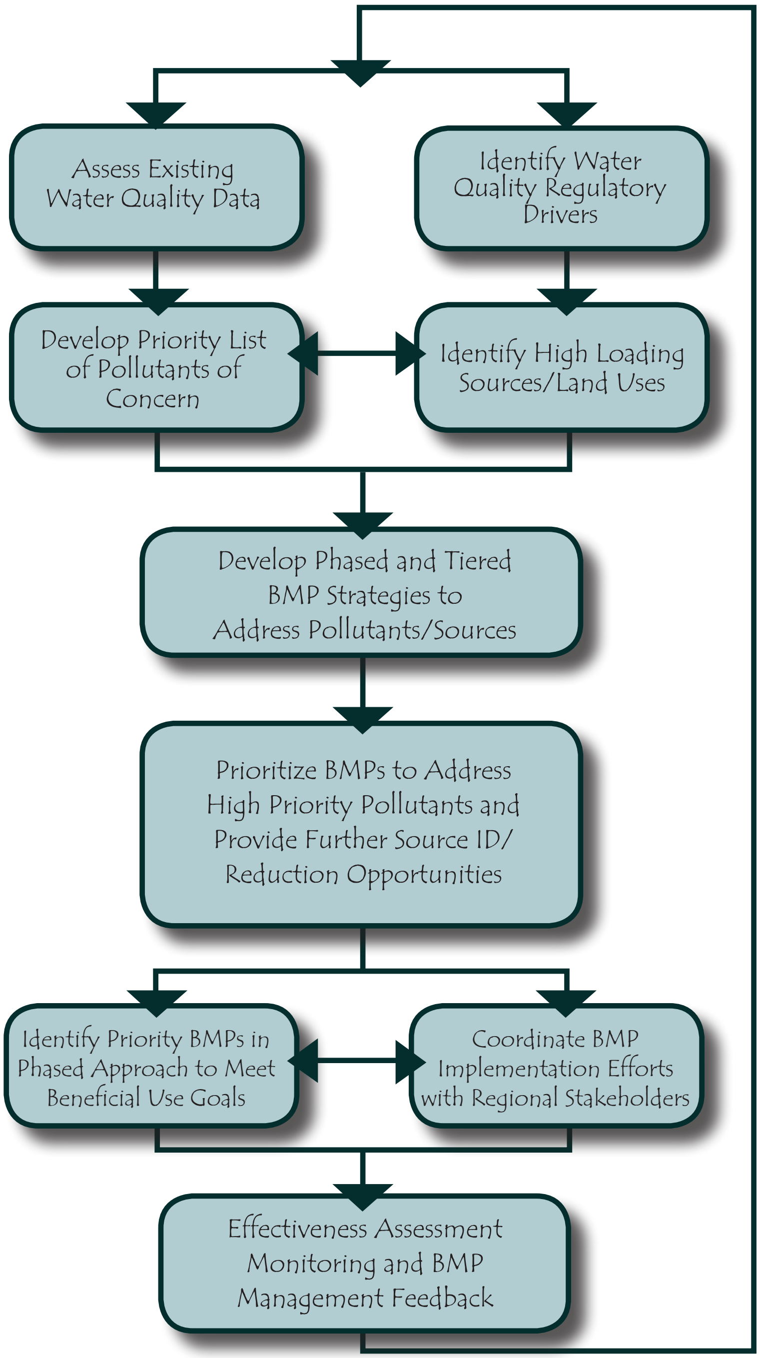
Water quality is a key component to bring together diverse water resource and land use agencies, environmental groups, and other stakeholders within the region to develop management strategies. The objective of the BMP Plan is to coordinate regional and local water quality protection and improvement efforts to meet both Harbor Area beneficial use criteria and regulatory drivers within and outside the Lower Bay. Many of the issues in the Harbor Area involve aquatic resources and/or the presence or transport of pollutants in water; therefore, water quality protection and improvement is a key aspect of successful Harbor Area Management. The water quality BMP implementation strategy will include ongoing effectiveness assessment to evaluate the performance of water quality improvement programs in meeting the water quality goals and integration with watershed, Newport Bay and coastal plans, and BMP projects.

Regionally, the Central Orange County Integrated Regional and Coastal Watershed Management Plan (IRCWM Plan) addresses overall water resources management needs for the Newport Bay and Newport Coast Watersheds (County of Orange, 2007). The IRCWM Plan has been submitted to the SWRCB to qualify for state and other grant funding to support numerous projects to improve water quality within and adjacent to the Harbor Area.

The City has been moving toward improving water quality in the Harbor through its partnering with other watershed leads on meeting the requirements of current TMDLs and requirements under its current NPDES Storm water Permit. The City has developed a Master Plan for the communities around the Harbor to include needed upgrades to storm drain systems to address flooding and water quality issues.

Other water quality-related programs under the jurisdiction of USACE, RWQCB, County of Orange Watershed & Coastal Resources Division, and local environmental and restoration groups are currently being conducted in Newport Bay and the San Diego Creek and Coastal Watersheds. Harbor Area stakeholder coordination with these groups is key to the success of water quality improvement projects in Newport Bay.

Within the Harbor Area, the City and other stakeholders have already implemented



some programs that align with other city-wide water quality improvement goals such as residential and construction BMPs and numerous clean water outreach efforts. However, water quality improvement efforts in the Lower Bay require special consideration given the sensitive habitats of the Upper and Lower Bay, current and future harbor maintenance requirements, and federal, state and local regulatory actions.

Harbor Area Water Quality BMP Identification and Prioritization

The BMP Plan is a strategic plan that builds on the projects identified in the IRCWM Plan and other planning documents. The BMP Plan provides guidance for water quality BMP efforts within the Harbor Area for issues specific to harbor stakeholders. The BMP Plan establishes an iterative activity prioritization process and implementation strategy for the identification of priority pollutants in the Harbor Area. The BMP Plan prioritization strategy is a process to implement BMPs in a cost-effective manner that considers current and future water quality issues so that BMPs are designed to accommodate future reduction requirements without expensive retrofits. The strategy also implements BMPs in a phased approach in order to both assess the effectiveness of the projects as they are implemented and to continually refine the prioritization process using all available data. The BMP Plan provides a road map for watershed activities within the Harbor Area that coordinates with the IRCWM and other watershed protection efforts.

Linkages to Other Programs

The BMP Plan has been developed in this HAMP to coordinate with existing planning documents for watershed and coastal areas. Specifically, the Phase I projects developed in the BMP Plan are consistent with projects proposed in the IRCWP for the Newport Bay Watershed for the Lower Newport Bay. Several of these projects have been included in recent grant funding applications under Proposition 84 and federal grant opportunities. These Lower Newport Bay projects are linked to water quality issues in the watershed and coastal areas that include the ASBS. Preliminary pollutant transport modeling has indicated a likely connection between the Lower Newport Bay and the ASBS; therefore, projects that improve the water quality of the Lower Bay will benefit the coastal habitats. These projects are further coordinated with the Phase I projects developed in the Newport Coast Watershed Management Plan for the seven coastal watersheds along the Newport Coast and the Upper Bay Restoration Planning. For example, the City is planning to expand the runoff reduction program to all the watersheds within its jurisdiction in order to reduce urban flows and associated pollutant loads into the Upper and Lower Newport Bay, and to the ASBS. Metals reductions projects in the Coastal Watersheds will be implemented on schedules similar to the copper reduction programs in the Lower Newport Bay.

As presented in the BMP plan, water quality improvement efforts will also need to coordinate with sediment control and dredge management projects. Siltation issues in the watershed and Upper Newport Bay have resulted in the migration of fine sediments and associated metals and pesticide pollutant loading to Lower Newport Bay. Siltation can also impact vital eelgrass beds and impact the quality of sediments and benthic communities. These issues can only be successfully addressed through an integrated program that reduces the siltation loading from the watershed, maintains the inline basins in the Upper Bay, and removes impacted sediments from the Lower Bay. Projects planned and underway in the watershed to reduce siltation include channel stabilization, agricultural BMPs, construction site BMPs, sediment monitoring, natural treatment basins and installation of inline channel basins in San Diego Creek. The inline basins in the Upper Newport Bay are undergoing maintenance to provide additional sediment removal. As discussed in the Upper Newport Bay Sediment Control section ■, the effectiveness of these basins to remove the fine-grained materials requires further assessment. The Big Canyon Restoration project includes water quality ponds for sediment and other constituent reduction before discharge into the Upper Bay. These projects, along with the implementation of BMPs during dredging activities and bulkhead maintenance and upgrades, will reduce the siltation to meet overall TMDL goals.

As outlined in the BMP Plan, a tiered and phased approach is suggested to meet water quality improvement and TMDL goals. The BMPs proposed in the first phase of the Lower Newport Bay program focus on source control and pollution prevention and runoff reduction while also providing for the collection of effectiveness assessment data that may also be used to identify additional water quality improvement program opportunities. These activities are consistent with the coastal watershed strategy.

Potential Steps Forward

The purpose of the BMP Plan is to develop a comprehensive Harbor Area activity strategy that addresses current and anticipated pollutants and associated regulatory drivers, community needs, and ecosystem health and sustainability. The iterative prioritization and implementation strategy developed for the Harbor Area provides the framework for stakeholder participation and coordination in the protection and improvement of water quality in Newport Bay. Ongoing effectiveness assessment of implemented strategies will assure the coordinated and efficient use of available resources in achieving a sustainable Harbor Area plan to protect and improve water quality.

Phase I of the BMP strategic plan involves using the iterative activity prioritization process to define the following water quality improvement projects.

Pollution Prevention/Runoff Reduction -
Copper Source Identification and Pilot Reduction Program

Controlling potential impacts from copper-based paints requires first further assessment of the specific activities/mechanisms in which copper is migrating to the sediments. Collaboration with ongoing studies is a potential step forward to assure the proper reduction BMPs are implemented. An initial pilot program may include implementation of a copper reduction program focused on the use of alternatives to copper-based boat paints and a BMP pilot project for boat maintenance to address potential cross-contamination impacts to the ASBS from Newport Harbor. The program will also implement an outreach program to further educate the boating community regarding the environmental effects of using copper-based antifouling paints.

Pollution Prevention/Runoff Reduction - Water Quality Enforcement Cross Training Program

Municipal inter-departmental coordination program designed to control non-point source discharges to the Lower Bay. The program will train Harbor Area oversight departments (Harbor Patrol, Lifeguards, Coast Guard, California Department of Fish and Game) in identifying potential sources of water quality degradation and increase communication to City Code Enforcement officers to report potential violations.

Green Marine Initiative

The Green Marina Initiative promotes and celebrates voluntary adoption of measures to reduce waste and prevent pollution from marinas, boatyards, and recreational boats. Designated “Green Marinas” are recognized as environmentally responsible businesses. The Newport Beach Harbor Commission is participating in the Green Marina Initiative program and is identifying opportunities to implement practices to control pollution associated with vessel maintenance and repair, petroleum storage and transfer, sewage disposal, hazardous and non-hazardous waste, storm water runoff, and facilities management.

Pollution Prevention/Runoff Reduction - Washing Activities

A Water Quality Education Program designed to provide brochures and posters for Harbor Area boat users informing them of the need to reduce pollutants entering the Bay as a result of boat and dock washing activities.

Pollution Prevention/Runoff Reduction- Water Quality Education for Short-term Slip Rentals

A municipal inter-departmental coordination program designed to educate harbor users and visitors on the importance of water quality protection. The program will provide literature to help short-term slip tenants and mooring renters identify and reduce potential sources of water quality pollution from their vessels.

Pollution Prevention/Runoff Reduction- Water Quality Inspections as part of Slip Transferability Permitting

A municipal inter-departmental coordination program designed to educate and enforce water quality improvement efforts as part of the Slip Transferability Program. The City could implement an inspection process linked to slip transfers so that harbor users are educated and potentially polluting vessels are identified prior to the slip transfer process.

Pollution Prevention/Runoff Reduction- Municipal Low Impact Development (LID) Assessments

A pilot assessment program to incorporate additional LID designs into municipal facilities within the Harbor Area and the Marina Park Conceptual Plan. Currently, the Marina Park Conceptual Plan indicates a Bio-Swale Filtration Area to be built adjacent to the Community Center.

Harbor Channel and Pierhead Lines

Beneficial Use Criteria/Rating	
Water Quality	○
Marine Resource Protection (ASBS)	○
Habitat Protection/ Enhancement	◐ (half red)
Community/ Public Access	◐ (half green)
Water Conservation	◐ (half red)
Channel Maintenance	◐ (half green)
Flood Control	○
Berthing Management	● (green)
Recreational Opportunities	● (green)
Sustainability	◐ (half green)

Channel and Pierhead Lines Study

Definition: During and immediately following initial construction of Newport Bay, USACE established harbor lines (project, pierhead, and bulkhead lines). These lines define the federal navigation channel dredging limits, limits on how far piers and wharfs can extend into Bay waters, and the bayward extent of bulkheads and other solid fills into Bay waters. These lines are important for maintaining safe navigation conditions throughout Newport Bay.

Key Issues: The design and use of Newport Bay has been altered extensively, however the harbor lines have not been systematically adjusted since their original development in 1936.

1. Numerous basins and islands have been constructed since initial construction.
2. The type, size, and distribution of vessels within Newport Bay have changed over time to reflect changes in the market and the desires of boat owners and operators.
3. Changes in policy and regulations at the federal, state, and local levels have resulted in a different regulatory condition from that considered at the time the lines were initially established.

Harbor Lines: Rules and Regulations

Updating harbor lines is a multi-phase process beginning with the recommendations provided in this HAMP. After review and public input, the Harbor Commission would make recommendations to the City Council. City Council could formalize a request to the federal government to proceed with enacting changes to the harbor lines. The California Coastal Act does not regulate harbor lines, but it does regulate any construction taking place in the coastal zone. The harbor lines can be modified without a California Coastal Commission permit, but any subsequent construction dependent on those harbor lines would still be regulated by the California Coastal Commission. While there is no explicit requirement, the public should also be informed and consulted on the harbor line changes early in the process.

DEFINITIONS

harbor line n. **1.** the line set by the federal government, delineating the area in which no obstructions to navigation are allowed. **2.** In Newport Harbor, harbor lines include the project line, pierhead line, and bulkhead line.

project line n. **1.** the boundary of the federal project and limit of certain federal responsibilities.

pierhead line n. **1.** a boundary set by USACE beyond which a pier may not extend.

bulkhead line n. **1.** a boundary set by USACE beyond which solid fill may not be extended.

Specific Conflicts

- *Throughout the Harbor, many beaches extend beyond the bulkhead line. This practice has evolved over time and is likely in conflict with a strict interpretation of the bulkhead line definition.*
- *Promontory Bay and the Grand Canal (Balboa Island) lack bulkhead lines.*
- *Promontory Bay, Balboa Yacht Basin, Linda Isle, from Harbor Patrol through Pirate's Cove, and Balboa Coves have bulkhead lines crossing existing navigable waters and channels.*
- *There do not seem to be any locations where existing pierhead lines intrude excessively into the navigable channels.*
- *Pierhead lines are noticeably absent from Promontory Bay. Also, pierhead lines for Newport Island exist only in the Harbor Permit Policy.*
- *Existing structures extend beyond pierhead lines at numerous locations. This situation has developed over the decades and is one of the main reasons for performing this study.*
- *No project line exists around Newport Island, the Rhine Channel, Promontory Bay, or Linda Isle. These areas are not federal projects, however, and do not require project lines.*
- *Existing structures extend beyond project lines at numerous locations.*

Changing the Lines: Benefits, Constraints, and Solutions

Benefits

- Improving clarity and consistency of the harbor lines;
- Allow pier owners access to deeper, more navigable waters that are further offshore; and
- Updating the harbor lines allows the opportunity of bringing nearly all harbor structures into compliance.

Constraints

- The change should minimize pierhead encroachment into navigable waterways.
- Any change in the harbor lines require USACE approval.
- A navigation study should be performed to verify that changing the harbor lines to match existing conditions would not impact navigation beyond allowable standards. If the impacts are beyond allowable standards, the realignment should be modified.
- Any channelward realignment of the project line would transfer maintenance (e.g. dredging) requirements from the federal government to the City and/or County. In addition, the expansion of pierhead lines would allow increases in dock lengths which may extend over eelgrass beds.
- Widening of Federal Navigation Channel (reduction in pierhead lines) have a potential to reduce eelgrass habitat through the expansion of navigation channel lines into shallow existing eelgrass habitat .

Solutions

- Realign pierhead lines to bring potential structures into compliance. In other words, move pierhead lines channelward, connecting existing pierheads;
- Where necessary, move the project lines channelward to include the new pierhead lines. This is necessary to maintain project lines channelward of pierhead lines;
- To simplify and clarify bulkhead lines, move bulkhead lines landward to the existing bulkhead or property lines;
- Since no structures should cross navigation channels, remove bulkhead and pierhead lines that cross navigation channels;
- To improve consistency throughout the Lower Bay, add bulkhead and pierhead lines where they do not currently exist; and
- Update harbor lines to reflect the Harbor Permit Policy and then streamline the Harbor Permit Policy by removing area specific exceptions.

Potential Steps Forward

Based on existing and potential future harbor uses and considering the probable opportunities and constraints, the following items are suggested:

1. Develop a comprehensive plan for adjusting channel and pierhead lines to meet current and future harbor beneficial uses, including the following tasks (6 months):
   a. Realign pierhead lines to eliminate exceptions. In other words, move pierhead lines to where they make sense, given the varied bathymetry along the shore;
   b. Where necessary, move the project lines channelward to account for the new pierhead lines;
   c. Perform a navigation study to confirm appropriateness of proposed new pierhead lines;
   d. Move bulkhead lines landward to the existing bulkhead or property lines;
   e. Remove bulkhead and pierhead lines that cross navigation channels;
   f. Add bulkhead and pierhead lines where they do not currently exist; and
   g. Update harbor lines to reflect the Harbor Permit Policy and then streamline the Harbor Permit Policy by removing area specific exceptions.

Note: These suggestions may have an impact on properties and their values, so any plans that recommend modification to the lines will require review and approval by the City Council as well as possible approval by the federal government.

2. Coordinate channel and pierhead line adjustment plan with other beneficial use needs such as eelgrass habitat protection/restoration .

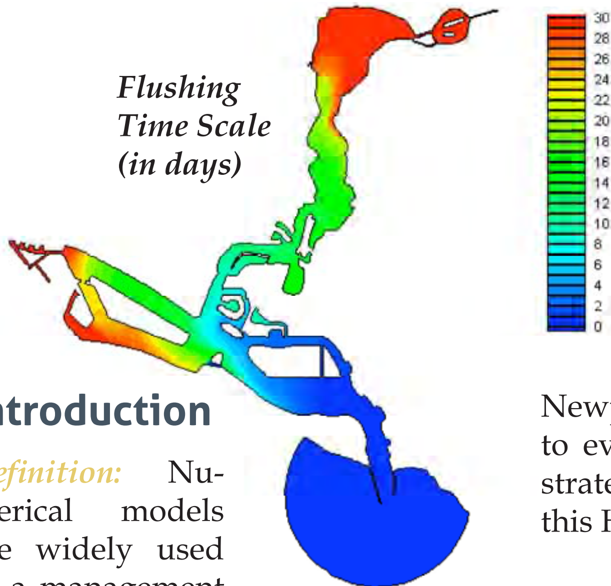
3. Phase line adjustment implementation to coordinate with other dredge requirements and potential eelgrass strategies .

4. Develop enforcement strategies to reduce future violations and minimize encroachment into navigable waters.

5. Perform similar evaluation for mooring area boundaries.

Hydrodynamic and Water Quality Numerical Modeling Requirements

Beneficial Use Criteria/Rating	
Water Quality	●
Marine Resource Protection (ASBS)	◐
Habitat Protection/ Enhancement	○
Community/ Public Access	○
Water Conservation	○
Channel Maintenance	○
Flood Control	◐
Berthing Management	○
Recreational Opportunities	○
Sustainability	◐



Introduction

Definition: Numerical models are widely used as a management decision-making tool in addressing sediment and water quality problems, including several numerical modeling efforts specifically for Newport Bay. Numerical models can be used to simulate hydrodynamic conditions (e.g., flows, water surface elevations, and velocities) and water quality transport (e.g., sediment or contaminants) to evaluate management decisions. In the past, two-dimensional (2D) models have been used to assess the effectiveness of sediment traps in Upper Newport Bay, to strategize the implementation of a storm drain diversion program to improve water quality in Newport Bay, as well as to study the potential transport of pollutants from Lower Newport Bay to the ASBS.

Key Issues: Based on past modeling efforts, it is concluded that a 3D hydrodynamic and water quality model would be required to fully capture the complex flow and transport of the Newport Harbor and Bay. A calibrated 3D model for Newport Bay and Harbor is needed to evaluate many of the proposed strategies and BMPs developed for this HAMP.

Numerical Model Evaluation

The most appropriate numerical model for Newport Bay was evaluated using the following objectives:

- Review existing water quality reports based on numerical modeling of Newport Bay.
- Identify the most compatible and efficient models that can address water quality issues and sediment transport throughout Upper and Lower Newport Bay.
- Provide recommendations for modeling enhancements of an existing model or the development of a new model.
- Provide a list of information or data requirements for the use of a numerical model for Newport Bay.

Overview of Hydrodynamic and Water Quality Numerical Modeling Requirements

The primary purpose of a numerical model for Newport Bay is a management decision-making tool to address water quality issues, and in particular, sediment deposition in the Bay. In determining the most compatible and efficient model for Newport Bay, model selection criteria were established, then the models were compared. Criteria were based on suitability of simulating the hydrodynamics and transport characteristics of Newport Bay, as well as the capability of anticipated applications of the model. Each model was evaluated in terms of the following aspects:

- Mathematical formulation for an estuarine system
- Numerical methods
- Water quality application
- Watershed model interface
- User-friendliness
- Prior application within Newport Bay and/or at similar locations

MODEL	*Mathematical formulation for an estuarine system*	*Numerical Methods*	*Water Quality Application*	*Watershed Model Interface*	*Prior Application within Newport Bay and/or at similar locations*	*User-Friendliness*
EFDC	+	+	+	+	+ *(TMDL use in So. Cal)*	+
RMA10 and RMA11	+	+	+	+	+ *(use in UNB)*	_
CH3D and CE-QUAL-ICM	-	-	+	-	-	_

Suggested Model

The simulation of hydrodynamics, water quality, and sediment transport can be accomplished using one or more of the available models: RMA10 and RMA11, CH3D and CE-QUAL-ICM, or EFDC. These models or combination of models were evaluated based on the evaluation criteria listed above. On the basis of the mathematical formulation and numerical method, EFDC and RMA10/RMA11 appear better suited to modeling Newport Bay than CH3D. Although CH3D is capable of simulating estuarine systems, it is better suited for channel flows as opposed to intertidal areas as is the case in Upper Newport Bay. All three models have similar water quality application capabilities. In terms of interfacing with a watershed model, EFDC and RMA10/RMA11 have greater flexibility.

There are no compelling reasons to select RMA10/RMA11 over EFDC or vice versa on the basis of the mathematical formulation, numerical methods, or water quality applications. However, there are some other advantages and disadvantages of each model. RMA10 and RMA11 have the advantage of being successfully applied in UNB for hydrodynamics and sediment transport. However, EFDC is becoming popular for TMDL applications, particularly in Southern California. RMA10 and RMA11 have an associated graphical user interface (GUI) to pre- and post-process model results, but require purchasing software, which can limit the use by other stakeholders. On the other hand, EFDC does not have an associated GUI, but can be modified to accommodate other GUI software. EFDC also has the advantage of using one model for hydrodynamics and water quality compared to two separate models. In addition, EFDC has the advantage of having the source code available for the public, making it easier for the development of the Newport Bay.

Model Data Requirements

Model data requirements include physical properties, inflows into the Bay, hydrodynamic conditions, and water quality conditions. Physical properties of the bay include bathymetry, creek and storm drain locations, and sediment bed properties. Inflows define the flow and pollutant loadings from creeks and storm drains into the Bay. Field data of hydrodynamic conditions (e.g., water levels and velocity) and water quality (e.g., salinity, temperature, or sediment) are required to calibrate the model. The calibration data should cover various locations throughout the Bay and concurrent periods of the time (hydrodynamic and water quality data) long enough to capture seasonal variations as well as dry and wet weather conditions. The accuracy of the model will depend primarily on the quantity and quality of data for inflows, and hydrodynamic and water quality conditions.

Potential Steps Forward

1. Develop a calibrated 3D hydrodynamic and water quality model for Newport Bay and Harbor using either RMA10/RMA11 or EFDC. (Development of such a model will take about 12 months and about $250,000.)

2. Implement a field data collection program to collect hydrodynamic and water quality data for the calibration of the 3D model. The field program will involve the collection of water elevations, velocity profiles and CTD data at three to four fixed locations throughout Newport Bay and Harbor for a period of about four months (to cover a range of dry and wet weather conditions), supplemented by a data collection with a boat for one dry and one wet weather events. These data will be used for the calibration of the hydrodynamic model. For the calibration of the water quality model, water samples will need to be collected throughout the Bay for one to two dry and wet weather events. The collected samples will be analyzed for sediment contents and contaminates of concern. (Takes about 8 to 12 months, about $500,000)

3. Use the developed 3D model for the evaluation and development of the various proposed strategies and BMPs developed in this HAMP. These may include:

- Evaluate the impact of fine sediments from Upper Bay to Lower Bay and ASBS.

- Evaluate the effectiveness of any proposed sediment control BMPs in reducing the source of fine sediments to Lower Bay.

- Help to select an optimal location for maintenance of an eelgrass population with the optimum hydrodynamic and water quality conditions.

- Help to evaluate the impacts of different proposed strategies for dredging of both clean and contaminated sediments .

- Evaluate the effectiveness of proposed water quality improvement strategies .

Regional General Permit

Beneficial Use Criteria/Rating	
Water Quality	○
Marine Resource Protection (ASBS)	○
Habitat Protection/ Enhancement	○
Community/ Public Access	○
Water Conservation	○
Channel Maintenance	◐
Flood Control	◐
Berthing Management	●
Recreational Opportunities	○
Sustainability	◐

Introduction

Definition: In Lower Newport Bay, in-water maintenance activities are carried out under a variety of federal, state, and regional permits, the principal one being the federal Regional General Permit 54 (RGP 54), issued by USACE and managed by the City of Newport Beach Harbor Resources Division. The RGP, which is valid for a term of 5 years, governs maintenance dredging and disposal of sediments and the repair and replacement of docks, piers, and seawalls. The current RGP contains a number of special conditions that set out the terms under which in-water maintenance activities can be performed, in particular the limits on quantities, permit administration, application and renewal procedures, eelgrass protection, structural work, and dredging and disposal.

Key Issues: Several issues have hampered the efficient administration of the RGP and resulted in significant delays and additional costs for necessary harbor maintenance.

1. Unduly long and costly permit renewal process every 5 years, including the difficulty reconciling the various agencies' agendas into acceptable permit language;

2. The need to revise portions of the RGP for the next renewal will make achieving acceptance by all agencies a challenge;

3. Difficulties and delays in sampling plan approval by all stakeholders;

4. The restricted range of activities and areas covered by the permit (Harbor Resources would like the permit to include areas with known contamination);

5. Numerous overly restrictive Special Conditions that prevent many minor dredging operations due to the presence of eelgrass or make them financially infeasible for private entities;

6. No consistent disposal opportunities for contaminated sediment, as previously detailed; and

7. Eelgrass *(Zostera marina)* beds constitute sensitive habitat under several programs. Losses of eelgrass, therefore, must be avoided and minimized to the extent practicable, and unavoidable losses must be mitigated. The RGP's special conditions prohibit dredging or disposal within 15 feet of established eelgrass plants unless mitigation can be provided. Given the widespread coverage of eelgrass under and adjacent to docks in Newport Bay, these restrictions have severely curtailed maintenance in some areas of the Bay.

Improvement of the RGP Process

The City's strategy for achieving the necessary balance between environmental protection and beneficial uses includes obtaining regulatory permits that recognize the particular circumstances of Newport Harbor, and administering those permits for the benefit of both the boating community and the natural environment. To that end, the implementation strategy will emphasize establishing sound relationships with the regulatory agencies, articulating clear goals and objectives for future permits, and developing a sound, cost-effective strategy for the permit renewal process. Coordination with other management programs and with the renewal process for the Coastal Development Permit (CDP) should minimize the delays and expense compared to the previous renewal effort. The goal is to obtain permits that have clear, flexible, effective conditions that allow the City to protect its natural resources while safeguarding its beneficial uses.

Permit Duration

A permit duration of 10 years would facilitate permit administration and reduce the financial and administrative burden on the City and the regulatory agencies and has the support of USEPA Region 9 headquarters. Nevertheless, USACE Los Angeles District apparently has no authority to grant a 10-year permit. Furthermore, the sediment test results would not be valid for a 10-year period, and the City would still have to go through a 5-year renewal cycle for the Coastal Development Permit. Accordingly, pursuing a 10-year RGP may be most productive at the level of USACE regulatory headquarters in Washington, D.C.

Streamline Sampling Plan Approval

A template for a Sampling and Analysis plan that specifically details all possible outcomes can be created with input from all involved agencies to ensure acceptance prior to sampling. The Sampling and Analysis Plan may include recommendations for phased testing to target specific disposal activities.

Geographical Coverage

It would be possible to extend RGP 54 to the currently excluded areas if the City could commit to placing the sediments in a previously-approved disposal site. As a disposal site outside the city is financially and logistically infeasible, identifying and developing an in-bay confined disposal site for contaminated sediments is a suggested course of action. The permit would have to incorporate appropriate restrictions on dredging, disposal, and other in-water work for contaminated areas. The potential benefits to the City and to the regulators from extending the permit's coverage make the effort worthwhile.

Streamlining Special Conditions

There is a need to (1) streamline the special conditions by simplifying the language and removing redundancies, (2) develop a system for monitoring the dredging and disposal activities , and (3) develop an Eelgrass Management Plan .

Contaminated Sediment

Handling of Contaminated Sediment Options: There is a need to include management options for contaminated dredge materials. Currently many of the RGP users do not have the financial resources to handle management of contaminated sediments;

guidance and options should be included in the RGP.

Eelgrass Management

The RGP could be modified to incorporate a comprehensive, bay-wide eelgrass management program in such a way as to achieve the twin goals of eelgrass protection and the facilitation of maintenance dredging and structural work. The Eelgrass Management Plan will describe a strategy for a concerted future effort that would incorporate sediment management while maintaining an eelgrass population. Close coordination would be needed with the Department of Fish and Game and National Marine Fisheries Service (NMFS) eelgrass management programs in order to develop modifications of the RGP's special conditions that would be effective and at the same time responsive to agency imperatives.

Beach Replenishment

Currently the RGP allows dredging projects of less than 1,000 cy to be used for beach replenishment, assuming the material is physically and chemically suitable. Increasing the volume of dredged material that can be beneficially used for beach replenishment under the RGP may increase opportunities to use the dredged material.

A Path Forward

The RGP renewal strategy should be based on an early, comprehensive effort to identify the key issues with the various stakeholders, provide necessary information, and conduct negotiations. The renewal effort needs to be undertaken with clear objectives in view and a strong sense of what can be negotiated and what cannot. This effort is best accomplished by preparation of a written renewal strategy that will guide the efforts of the City and its consultants. The strategy will describe how the various components will fit together and will provide guidance on negotiation strategies and desired outcomes.

Potential Steps Forward

Specific recommendations for future RGP renewals and for the administration of the RGP are put forward in the accompanying technical report. In general, however, the following six basic steps are suggested for the renewal process:

1) Eelgrass management
a. Negotiate modified eelgrass conditions to one of three possible models; and
b. Negotiate the Coastal Development Permit to allow more flexibility with respect to eelgrass conditions.

2) Negotiate the RGP conditions through a structured series of meetings with the stakeholders.
a. Establish agency information needs in order to improve the project approval process in the permit administration phase;
b. Gain early approval of the Sampling and Analysis Plan (SAP), using the SAP for the current RGP renewal as a template, with some changes (2 months, $15K);
c. Conduct sediment testing promptly in order to leave time to resolve anomalous results; and
d. Increase volume of material to be beneficially used for beach replenishment.

Sea Level Rise and Flood Control Management

Beneficial Use Criteria/Rating	
Water Quality	○
Marine Resource Protection (ASBS)	○
Habitat Protection/ Enhancement	○
Community/ Public Access	○
Water Conservation	○
Channel Maintenance	◐
Flood Control	●
Berthing Management	○
Recreational Opportunities	○
Sustainability	◐

Introduction

The extreme high tides in California threaten flooding of low-lying terrain and result from the coincidence of extreme astronomical tides and storm-induced sea level changes.

In Newport Harbor, these extreme conditions have occurred as recently as 1983 and also in 2005, and resulted in damage to 175 homes and businesses on Balboa Peninsula. Analysis of recent topographic survey shows that most shorelines in Lower Newport Bay fall below the height of present-day extreme high tides.

Sea levels have been rising for decades, but higher rates are forecasted for the coming century. This will impact not only mean sea level (MSL), but high water levels as well. Data reported for Los Angeles and La Jolla indicate faster rise over the past 50 years. Estimates of future sea level rise at Newport Harbor fall in the range of 1-3 ft/100 years range for Newport Harbor.

There is also evidence that North Pacific cyclones, which bring storm weather to Southern California in Winter, have intensified over the past 50 years. This has contributed to higher high tides and is thought to be a consequence of warmer ocean water. Future extreme tides constitute the most immediate flooding threat to low-lying coastal communities such as the Newport Harbor area, and are likely to be amplified by increasing sea levels.

The challenge for the City of Newport Beach is to assess its flood vulnerability using predictive models and evaluation of existing flood protection. Based on this vulnerability assessment management measures can be developed that are integrated into the overall HAMP program.

The final report of the assessment of flood vulnerability of the Newport Harbor Area caused by present and future extreme high tides and to identify those areas of the Harbor most vulnerable to flooding has been completed and is provided in Appendix H (Flow Simulation, 2008).

Overview of Flooding Issues

Ocean tides are predominantly controlled by the gravitational attraction of the moon and sun and therefore can be modeled by a number of astronomical harmonic constituents corresponding to different periods. Extreme high tides occur when these constituents are aligned (or "in phase") so their effect is cumulative. In California, extreme high tides occur in Winter and occasionally in Summer, but never in Fall or Spring (Zetler and Flick 1985, Flick 1986). The height of tides can be further amplified by storms associated with low atmospheric pressure, wind, and waves, as well as inter-annual phenomena such as El Niño (Flick 1986). The worst-case scenario for coastal flooding is a Pacific storm that approaches the California coastline from the Gulf of Alaska during an El Niño winter, and arrives coincident with the annual maximum astronomical high tide. Such a scenario occurred in late January, 1983, causing widespread damage all along the California coastline.

Coastal communities are in a position to plan for extreme tides. Their occurrence is predictable based on semi-annual and inter-annual cycles. In fact, there are only a few multi-day periods each Winter when extreme tides threaten the California coast. Only the most extreme cases are likely to cause flooding in the near future and the severity of extreme tides will hinge on atmospheric conditions.

Surface flooding is most likely to occur in low lying areas around the Harbor, and analysis of topographic data allows these areas to be identified. Parts of the Harbor such as Balboa Island are encircled by elevated bulk heads, or sea walls, that are designed to obstruct flooding by ocean water during episodes of high sea levels. Hence, land may not necessarily flood simply because of its elevation. Rather, it is necessary to consider the combined effects of sea levels, sea defenses, terrain heights, and flood control infrastructure, as well as hydraulic principles to identify those areas vulnerable to flooding.

Analysis of a 2006 Light Detection and Ranging (LiDAR) topographic survey shows that Balboa Island, Little Balboa Island, Newport Island, and nearly the full length of Balboa Peninsula along its bay-ward side fall below the height of present-day extreme high tides. A review of site conditions shows that flood control systems are in place to guard these areas against flooding. This includes a combination of public and private infrastructure (e.g. bulks heads and valves or plugs at storm drain outlets) and operational practices (e.g. City staff monitoring of tides, closure of storm drain outlets, sand berms, and cooperation with occupants to implement flood control measures).

A review of historical data shows that in January 1983 and January 2005 a tide height of nearly 8 ft. above Mean Lower Low Water (MLLW) was attained. Flooding was observed in the Harbor area in both cases (Figures 1 and 2). Several lines of evidence suggest that the onset of flooding on Balboa Peninsula and Balboa Island, when all tide gates are closed, occurs at a tide height above 7.0 ft. above MLLW.

Figure 1: Photographs of the January 10, 2005 high tide that reached the 7.8 ft (MLLW) level.

Figure 2: Photographs of the January 10, 2005 high tide that reached the 7.8 ft (MLLW) level.

The height of the bulk heads around Balboa and Little Balboa Islands were estimated to be between 7.9 to 9.2 ft (MLLW) and 8.7 to 9.8 ft (MLLW), respectively, based on LiDAR data and field measurements. Seepage cracks in these bulkheads have been observed and could cause flooding at lower tide heights.

As stated above, there are predictable and unpredictable aspects to the height attained by extreme high tides that need to be considered for short and long-term planning. The effect of astronomical factors (position of the moon and earth) is predictable. The effects of inter-annual phenomena such as El Niño/La Niña, weather conditions, and global warming on tide heights are more difficult to predict.

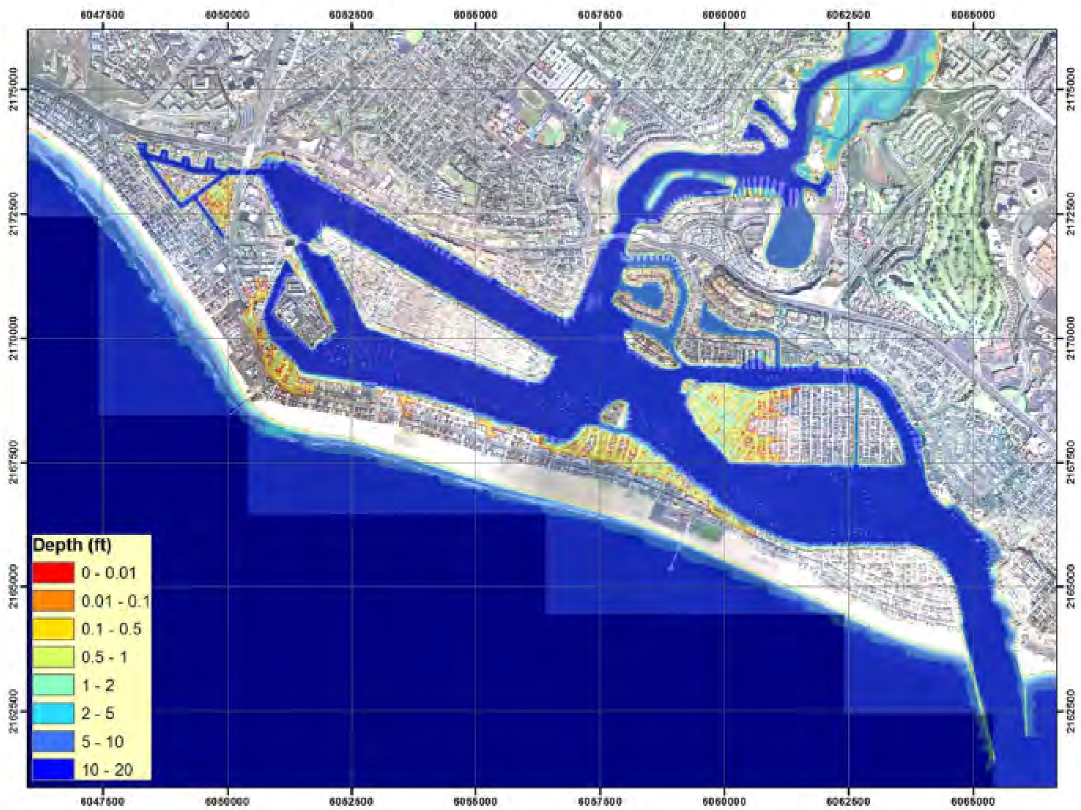


Figure 3:
Model simulations of the 8 ft tide show localized flooding along Balboa Peninsula and widespread flooding across the western half of Balboa Island

To identify and map the vulnerability of the Newport Harbor area to future flooding by extreme high tides, a flood inundation model was developed and applied. A total of nine model simulations were completed corresponding to three tide scenarios (tide heights of 8, 9, and 10 ft), two infrastructure scenarios (an "as is" scenario and an "improved" scenario corresponding to bulk head improvements presently planned or in progress), and two stream flow scenarios. These scenarios represent a range of tide heights that could occur through 2100 from the combined influence of astronomical tides, sea level rise, and environmental conditions such as storms.

Model simulations of the 8 ft tide show localized flooding along Balboa Peninsula and widespread flooding across the western half of Balboa Island as shown on Figure 3. This is largely consistent with historical observations. As shown on Figure 4, model simulations of the 9ft tide show widespread flooding along the bay side of Balboa Peninsula and near complete flooding of Balboa Island, Little Balboa Island and Newport Island. Model simulations of the 10 ft tide show near complete flooding of the developed areas of the Lower Harbor.

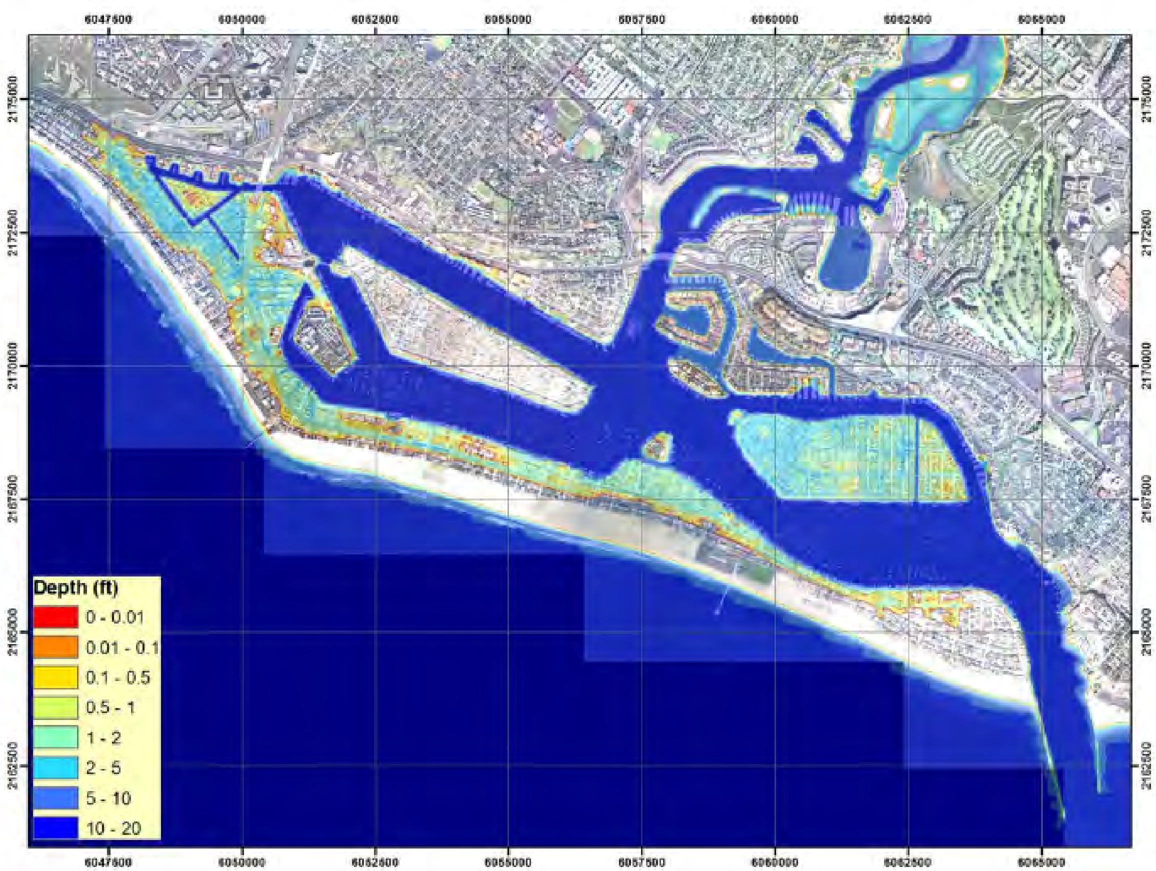


Figure 4:
Model simulations of the 9ft tide show widespread flooding along the bay side of Balboa Peninsula and near complete flooding of Balboa Island, Little Balboa Island and Newport Island.

Linkages to Other Programs

The results of the flood vulnerability assessment will be the basis for the development of management measures to reduce the potential for future impact to property from the coincidence of extreme astronomical tides and storm-induced sea level changes that are predicted to increase in the future. Linkages to other programs include the dredging of the channels and use of dredged material for backfill behind sea walls and bulkheads that may require raising to meet new elevation requirements. The beneficial use of the dredged material will lower both the unit cost for the channel dredging and management, and the cost of the bulkhead upgrades. Integration of these programs can therefore result in cost savings. In addition, the beach replenishment management program is linked to the flooding potential as beach sand provides a buffer from storm surges.

Potential Steps Forward

The purpose of the assessment is to address the City's challenge of flood vulnerability using predictive models and evaluation of existing flood protection. Based on this vulnerability assessment, management potential measures can be implemented to better prepare for future extreme high tides that are integrated into the overall HAMP program. The potential steps forward include:

Coastal Flooding Condition Monitoring Program Implementation

A potential step forward is creating a monitoring system for environmental conditions that effect coastal flooding. This system could improve the City's emergency response to flooding and help staff to prioritize and guide infrastructure improvement efforts (e.g. sand replenishment).

Database of Public and Private Flood Controls

The City should consider creating and maintaining a database, which is integrated into the City GIS, of public and private flood control infrastructure, and implementing a monitoring system to track key factors that bear on flood control. This data can then be used to update the flood models to be used to evaluate the benefit of the proposed flood control measures. The City should also consider obtaining through a registered surveyor the precise elevations of the bulkheads.

Legal and Policy Framework for Bulkhead Improvements

An additional potential step forward is exploring the legal and policy framework that would allow for more systematic improvement of the condition and continuity of the bulkheads (both public and private) in the future.

Flood Risk Management Plan

The City should consider developing and adopting a flood risk management plan for the Harbor before moving forward with any major efforts to improve flood control infrastructure (e.g. raise bulk heads). This plan would consider the economic, environmental and social consequences of flooding to identify the most optimal structural and non-structural measures for implementation.

Impact of Waves on Flooding

A final potential step forward is the examination of the impact of waves on flooding. Based on preliminary assessment data, it is not clear that there is adequate protection against the combined effects of an extreme high tide and ocean waves typical of storm conditions. Such a study could be used to guide future sand replenishment efforts.

Upper Bay Sediment Control

Beneficial Use Criteria/Rating	
Water Quality	●
Marine Resource Protection (ASBS)	◐
Habitat Protection/ Enhancement	●
Community/ Public Access	○
Water Conservation	○
Channel Maintenance	●
Flood Control	◐
Berthing Management	◐
Recreational Opportunities	○
Sustainability	◐

Introduction

The Upper Newport Bay contains the 752 acre Upper Newport Bay Ecological Reserve and the 140 acre County of Orange Regional Park. Within the Reserve are two in-bay sedimentation basins that have been constructed with the goal of capturing sediment loads from the San Diego Creek watershed, and reducing the siltation of the Upper and Lower Newport Bays. In 1999, a TMDL for sediment was implemented for the San Diego Creek watershed and Newport Bay. Continued sediment loading to the Bay has resulted in increased sediment accumulation and the need for maintenance dredging in the Upper and Lower Newport Bays. Maintenance of the Lower Bay channels will require more frequent dredging without the implementation of an effective comprehensive sediment source control and prevention program in the watershed. A comprehensive sediment control program to meet the goals of the TMDL is being implemented in the watershed of which the two in-bay basins are key elements. The elements of this program also include in-channel basins along San Diego Creek, channel stabilization projects, agricultural BMPs, construction site monitoring and BMPs, and foothill retarding basins (see Figure 1 on following page).

Dredging of the Upper Newport Bay is underway to remove accumulated sediments and provide adequate capacity for the in-bay basins. The current dredging activities in the Upper Newport Bay are enhancing habitats through improved circulation and creation of islands that protect nesting areas from predators.

Figure 1

Key Elements of the Sediment Control Plan

Agricultural BMPs

Land use in the San Diego Creek Watershed has significantly changed over the last 30 years, from primarily agricultural use to greater urbanization. Despite these changes, agricultural land has the potential to be a major contributor of sedimentation. An advanced BMP program has been implemented in the San Diego Creek Watershed.

Construction BMPs

Local governments are currently enforcing grading and erosion control at construction sites, especially during the winter when heavy rains have the potential to transport large amounts of sediment. The Orange County National Pollution Discharge Elimination System (NPDES) and Drainage Area Management Plan (DAMP) require construction BMPs. The RWQCB enforces the State General Construction NPDES which requires construction sites develop a Storm Water Pollution Prevention Plan (SWPPP; Tettemer 1993).

Channel Stabilization

Erosion from channels within the watershed is a source of sediment in Upper Newport Bay. Lining the channel with non-erodible material and controlling the flow of water can help stabilize the channel and reduce erosion. Several channel stabilization projects have been conducted in the San Diego Creek Watershed including sections of San Diego Creek, Peters Canyon Channel, Marshburn Channel, Trabuco Channel, Borrego Channel, and Bee Canyon Channel (Tettemer 1993). Channel stabilization is also part of the BMP program for agricultural land. A priority project proposed for the IRCWM Plan is the Serrano Creak Bank Stabilization and Sediment/Pollution Reduction Project (County of Orange RDMD Watershed and Coastal Resources 2007). This project involves stabilizing 1.2 miles of Serrano Creek to reduce erosion. Stream erosion in Serrano Creek threatens homes, has damaged the Los Alisos Water District sewer line, and cut channel banks in the storm season (ACOE 1998).

Foothill Retention Basins

To reduce sediment load to Upper Newport Bay from the Lomas de Santiago foothills, several retarding basins were constructed.

Retention In-channel Basins

In-channel basins are used to catch sediment in the San Diego Creek before they reach Upper Newport Bay. They are effective at catching coarser sediment particles, however they are less effective at removing fines (Sediment Control Plan 1982). Regular maintenance is necessary to ensure efficiency. Currently, there are 3 in-channel basins in the San Diego Creek. The design capacity of Basin 1, 2, and 3 is 210,000 cy, 73,000 cy, and 78,000 cy (Tettemer 1993). Removal of sediment from in-channel basins is more economical and has a smaller impact on the environment than dredging the in-bay basins. It is suggested that in-channel basins be maintained at 75% design capacity (Tettemer 1994).

In-bay Basins

There are two in-bay basins in Upper Newport Bay (Unit I/III and Unit II). The in-bay basins are effective at catching finer sediment that is not caught by the in-channel basins, however regular clean outs are necessary to ensure efficiency. Fine-grained suspended particles are difficult to remove through these techniques. These particles consist of clay and organic matter that attract and transport pollutants to the Bay. Pollutant loading to the Bay needs to be addressed through upstream measures and further transport modeling to improve removal effectiveness.

Overview of Upper Bay Sediment Management Issues

Upper Newport Bay Sediment Control includes the management of sediment loading occurring from the San Diego Creek watershed that migrates through the Upper Bay to the Lower Bay. Current restoration and dredging activities in Upper Newport Bay include the establishment of in-bay sediment basins to control sedimentation of the Lower Bay. The effectiveness of these basins to reduce sediment loads, particularly fine grained sediment needs further evaluation. These basins are only effective with regular clean outs. They have been designed to reduce sediment loading; however, the greatest reduction may be for coarse-grained sediments. Most sedimentation into Newport Bay is associated with major rainfall runoff when large amounts of fine-grained sediment enter Upper Newport Bay. The key issue with the efficacy of these basins is the reduction in fine-grained sediment loading that has resulted in reduction of channel depth and migration of impacted sediments to the Lower Newport Bay. Fine-grained sediments remain in suspension longer and require greater retention times. Fine-grained sediment also contained a greater fraction of organic and charge particles (clay) that attract and adsorb contaminants. These contaminants include metals, pesticides and nutrients. Loading of fine-grained particles to the Lower Bay at current rates will continue to negatively impact sediment quality and channel maintenance. Another issue that needs to be assessed is the potential contribution to fine-grained sediment loading to the Lower Bay from the ongoing dredging in the Upper Bay. This is a temporary issue, but understanding this component will allow for better assessment of the basin effectiveness.

Defining the effectiveness of the in-bay basins and watershed sediment control projects is vital to the long-term management of the Lower Bay. Data gaps exist to conduct this assessment. In addition sediment transport modeling is required as part of this process. In the 1990's, the USACE developed the RMA2 finite element hydrodynamic and RMA11 sediment transport model. In Phase II of development the models were reconfigured and calibrated to observed depositional patterns in Upper Newport Bay from 1985 to 1997 (USACE 1998). The model predicted sediment deposition in Upper Newport Bay within 2 percent, however the model was not calibrated for Lower Newport Bay. According to these models, over the next 50 years approximately 3.75 million cy of sediment will be deposited in Lower Newport Bay and approximately 3 million cy of sediment will be deposited in Upper Newport Bay. However, these models have several shortcomings. Sediment density values used in models are only estimates, the accuracy of the data are difficult to determine. In addition, the models do not include the effects of marsh plants in calculating sedimentation. An increase in marsh plant cover will increase sediment deposition. To more accurately simulate sediment deposition rates and patterns, the inclusion of marsh plants needs to be reflected in the model. Furthermore, to adequately manage sediments, sediment modeling needs to include information on grain size fractions in order to predict sedimentation patterns and future dredging needs. Finally, these models do not allow for an evaluation of the efficiency of the current sediment basins in the Upper Bay.

Long term management of sedimentation patterns and sediment types will also need to be coordinated with TMDLs and other regulatory drivers. Dredge material management in the Lower Bay is dependent on aggressively addressing fine-grained sediments transported from San Diego Creek through the Upper Bay.

Coordination with Current Programs

The sediment control efforts in the Upper Newport Bay need to be coordinated with sediment control projects in the watershed to address the TMDL, and with the dredging requirements and contaminated sediment management in the Lower Newport Bay. In addition to the sediment source control projects presented above, a series of approximately 30 natural treatment systems are planned throughout the watershed. These natural treatment systems will be managed by Irvine Ranch Water District. The City has participated and supported these projects through the Proposition 50 grant application under the Integrated Regional Watershed Management Plan. The City has supported these projects due to the importance of sediment control in the long-term maintenance of the Lower Bay and impact to sediments. Contaminants transported by sediment to the Lower Bay may impact the benthic communities and limit the options for reuse of dredged material removed from navigable channels. The TMDL for sediments includes both the San Diego Creek watershed and the

Newport Bay. The linkage of the watershed to the Bay is defined by the TMDL. In order to meet the goals of the TMDL the City is conducting dredging of the in-bay basins in the Upper Newport Bay. The efficacy of these basins and the source control efforts in the watershed needs to be more fully assessed to determine what additional measures are needed. This effectiveness assessment will require additional modeling efforts using a 3D hydrodynamic and water quality model. The selection and recommendation on the development of the 3D model are discussed in detail in the Hydrodynamic and Water Quality Modeling section .

Sediment migration to the Lower Bay from sources in watershed may also result in impacts to the coastal ecosystems that include the ASBS. Preliminary contaminant transport modeling has indicated a potential connection between the Lower Bay and the ASBS depending on wet weather condition and tidal regimes. Studies in the ASBS have indicated that sediment from Lower Bay may be impacting the ASBS. The City has included in the Proposition 50 grant application erosion control projects in the coastal canyons to reduce the sediment loading to the ASBS. These measures need to be coordinated with sediment control measures for the Bay and watershed to achieve the overall goal of reducing impacts to the ASBS.

Upper Newport Bay Ecosystem Restoration Project

The Upper Newport Bay Ecosystem Restoration is a $38 million multiyear project which includes restoring the capacity of the in-bay sediment storage basins, restoration of channels, restoration of wetlands, and creation/improvement of Least Tern Island. Approximately 70,000 cy of clean material dredged from Upper Bay will be placed nearshore to serve as nourishment for the beach. Dredging of the sediment storage basins in Upper Bay (Basins I/III and Basin II) is a major component of this project which coincides with the sediment control plan. Maintenance of these basins is critical to ensure they are effective at capturing sediment. When dredging is completed, approximately 950,000 cy will be dredged from Unit I/III Basin, and approximately 866,000 cy will be dredged from Unit II Basin. Open water area will be increased to about 19 acres at both locations. The access channel to Unit II Basin was dredged in April 2006. Dredging of Unit II Basin was finalized in December 2007. A portion of Unit I/III Basin was dredged in March 2007. Dredging of Unit I/III Basin was finalized in March 2008. The sediment basins were dredged to approximately -17 ft mean lower low water (MLLW). The access channels were dredged to approximately -11 ft MLLW and 100 ft wide. This project is a significant part of the restoration and management plan for Upper Newport Bay. It will also have a major affect on reducing frequency of dredging in Lower Newport Bay by increasing the effectiveness of the in-bay sediment catch basins.

Potential Steps Forward

The overall goals of the Sediment Control Management program should include:

- Reduce the sediment load to the Upper and Lower Bay through effective sediment control measures in the watershed
- Effectively manage the inline sediment basins in the Upper Bay and assess their effectiveness in reducing the load of sediment, particularly fine-grained sediments that can transport contaminant to the Lower Bay
- Address the data gaps and conduct sediment transport modeling to assess the effectiveness of the inline basins
- Coordinate sediment removal in the basins with restoration/beach replenishment/sustainable sediment management

In order to achieve these goals, the suggested priority activities should include:

- Coordinate ongoing dredging in the Upper Newport Bay to increase the capacity of the inline basins (ongoing – through 2010)
- Continue to support the Integrated Regional Watershed Management framework and process through coordinated grant applications for projects that reduce sediment loading from the watershed to the Bay and ASBS
- Address data gaps in current sediment loading and sedimentation rate patterns (start Nov. 2008-Dec 2009)
- Conduct sediment modeling using current restoration design options (start June 2009-Dec 2009)

Upper Newport Bay Restoration and Management

Beneficial Use Criteria/Rating	
Water Quality	◐
Marine Resource Protection (ASBS)	●
Habitat Protection/ Enhancement	●
Community/ Public Access	◐
Water Conservation	○
Channel Maintenance	◐
Flood Control	◐
Berthing Management	○
Recreational Opportunities	●
Sustainability	◐

Introduction

The Upper Newport Bay is characterized by functioning and intact mudflat, salt marsh, freshwater marsh, riparian and upland habitats that are protected within the 752-acre Upper Newport Bay Ecological Reserve and the 140-acre Orange County Regional Park. The area has been designated a Critical Coastal Area (CCA) under the CCA Program, a part of the State's Non-Point Source Plan (NPS Plan). The NPS Plan is a non-regulatory planning tool to coordinate the efforts of multiple agencies and stakeholders, and direct resources to CCAs. The program's goal is to ensure that effective NPS management measures are implemented to protect or restore coastal water quality in CCAs.

The California Department of Fish and Game (DFG) is tasked with managing the Upper Newport Bay Ecological Reserve (Reserve) and has developed a Preliminary Management Plan (Management Plan) for the Reserve. The Management Plan document is of primary importance in guiding the DFG, the City, and other stakeholders in the long-term management of one of the most important ecological habitats in southern California. The Management Plan for the Upper Newport Bay Ecological Reserve will be the framework for the implementation and management of the restoration activities and long-term sustainability of this CCA.

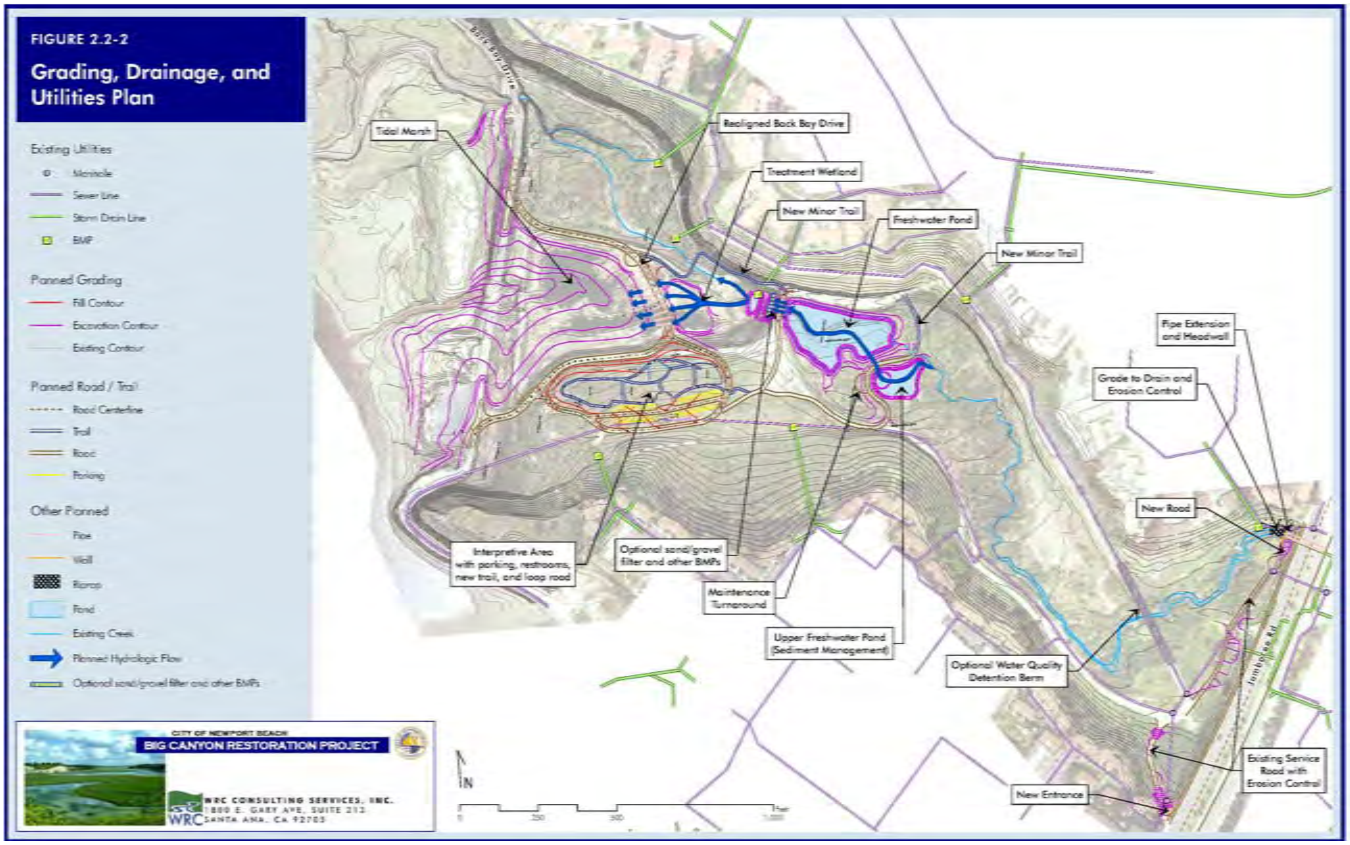
Upper Newport Bay in Newport Beach is an estuary - a place where fresh and salt water meet and mix. It is one of only a few remaining estuaries in southern California and is the home of nearly 200 species of birds, including several endangered species, as well as numerous species of mammals, fish, other critters and native plants. The Upper Bay is an important stopover for migrating birds on the Pacific Flyway and up to 30,000 birds can be seen here on any day during the winter months. Its proximity to urban Orange and Los Angeles counties makes the Upper Bay easily accessible to both local and regional visitors. Every year, thousands of people come here to hike, cycle, canoe, kayak, fish or simply enjoy nature.

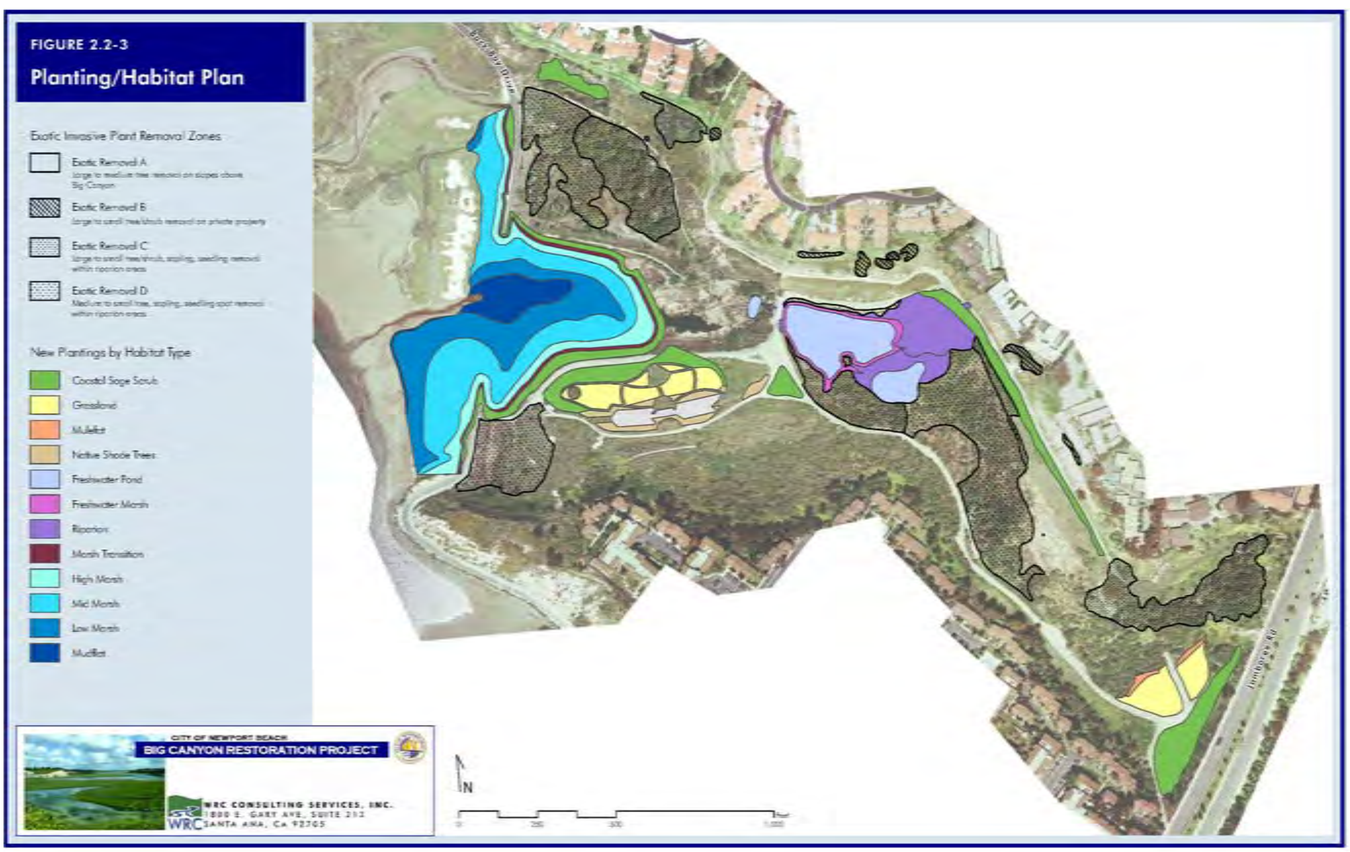
The Upper Newport Bay Ecological Reserve was created in 1975 as result of the purchase of 527 acres of land in and around the Bay from the Irvine Company and the transfer of 214 acres of tidal wetlands from Orange County to the State of California. An additional 11 acres of land in Big Canyon was added to the area in 1982 increasing the total acreage of the Reserve to 752 acres. In 1990 Orange County acquired 140 acres of bluffs on the north and north-west sides of the Bay and created a Regional Park. The Regional Park was rededicated as the Upper Newport Bay Nature Preserve in 2000.

Source:
Newport Bay Naturalists and Friends Web Site
www.newportbay.org

Overview of Upper Bay Restoration Issues

The Reserve was first purchased by the state in 1975 and is currently managed by the DFG. Due to State funding constraints, however, little preservation work has been completed to date, including completion of the Upper Bay Management Plan. Despite the absence of a comprehensive restoration and management plan for the area, the City of Newport Beach and County of Orange are currently moving forward with several restoration projects in the Upper Bay. These projects include a salt marsh demonstration project at Shellmaker Island for the Back Bay Science Center, the Upper Newport Bay Restoration Dredging Project, and the ongoing design and permitting phase of the Big Canyon Restoration Project (See Figures 1 and 2).





Figures 1 and 2: Conceptual plans for Phase II of the Big Canyon Creek Restoration Plan

The Upper Bay is also widely enjoyed by members of the general public. Several non-profit organizations provide valuable stakeholder input towards management efforts in the Upper Bay. The lack of a consistently funded governmental agency tasked with leading comprehensive and integrated management efforts may lead to a disjointed implementation of independently well-intended restoration efforts, and that way, ultimately fail to produce a healthy, fully-functioning estuary habitat.

Current dredging activities in the Upper Newport Bay are also enhancing habitats through improved circulation and creation of islands that protect nesting areas from predators. Challenges central to the integration of current and future Upper Bay restoration activities into an overall Harbor Area strategic plan include securing funding and development of a comprehensive Management Plan for ongoing and planned restoration projects, coordinating dredging and other Lower Bay maintenance activities with the restoration projects, and integrating local and regional water quality improvement projects to meet current and anticipated regulatory drivers in the San Diego Creek and adjacent watersheds.

Goals:

The goals of the Upper Newport Bay stakeholders are to:

- Identify opportunities and implement priority restoration projects for the Upper Newport Bay Ecological Reserve and
- Complete an integrated and comprehensive Upper Bay Management Plan

Coordination with Current Programs

DFG is the lead agency tasked with providing a comprehensive Upper Bay Restoration Management Plan. Due to funding constraints, however, the Management Plan is still in a preliminary format. A regional Integrated Coastal Watershed Management Plan (ICWMP) was submitted by the County of Orange in January 2008. The ICWMP proposes to implement an integrated suite of projects through a regional planning effort that has been prioritized to address watershed management challenges within highly urbanized Central Orange County.

The IRCWM Plan notes that, "The CCAs and ASBS may be directly impacted by urban activities within the planning area, including fresh water drainage carrying pollutants of concern from the upper watershed and coastal canyons, creek bed erosion due to the increase of impervious surfaces, legacy pesticides from former agricultural operations, contaminants from boat maintenance in Newport Harbor, and high levels of naturally occurring selenium and nitrogen in the groundwater that may rise to the surface and move downstream. These fragile coastal ecosystems are further impacted by heavy recreational use within the coastal zone."

The project bundles proposed in the ICWMP are summarized in the following table.

Receiving Waters of Upper Newport Bay (CCA 69)	
Serrano Creek Bank Stabilization, Sediment/ Pollution Reduction (Project A 02)	Constructing erosion control and bank stabilization measures in Serrano Creek Reach 2 will reduce sediment transport and related contaminant loads (including sediments from the Santiago Fire burn area in the creek's headwaters) to Upper Newport Bay. This supports the Upper Newport Bay Ecosystem Restoration Project (A10) by reducing a primary sediment source that has reduced in-bay sediment storage basins, impacted habitat, and reduced water quality.
Newport Bay Watershed Natural Treatment System – 2 sites (Project A 07)	Constructing two additional NTS sites within the planned regional system will improve water quality within Upper Newport Bay, the receiving water for nearly all of the drainage from the Newport Bay Watershed. This supports the Upper Newport Bay Ecosystem Restoration Project (A10) by reducing contaminant loads in the freshwater that is needed to maintain the estuarine habitat for threatened and endangered species.
Upper Newport Bay Ecosystem Restoration (Project A10)	By restoring the capacity of in-bay sediment storage basins, improving estuarine habitat for threatened and endangered species as well as other marine species, and improving tidal flows, this project will maintain the quality ecosystem needed to provide critical habitat along the Pacific Flyway and for other aquatic species. This project complements other water quality and habitat projects locally and statewide.

In addition, the Big Canyon Creek Restoration Project is a program designed to restore the 55-acre Big Canyon Nature Park between Jamboree Road and Upper Newport Bay. The Big Canyon project exemplifies an integrated approach to habitat restoration designed to provide multiple benefits across beneficial use goals. The project will increase valuable salt marsh habitat by re-routing the existing Back Bay Drive and increasing the area subject to Bay tidal flow. Design elements of the Restoration Plan will also improve water quality in Big Canyon Creek by reducing flows to allow for sediment and other potential pollutant removal. Additional habitat benefits will include removal of non-native vegetation and planting of native plants throughout the Nature Park area. Recreational use opportunities of the Nature Park area will also be enhanced through creation of additional trails and public access points into the Nature Park and posting of interpretive signage to assist the public in understanding the importance of the restored native habitat. The Big Canyon Creek Restoration Project will provide a valuable connection between urban development, restored coastal sage scrub, riparian, Upper Bay saltwater marsh habitat and the Lower Bay. The project will also provide a linkage to overall water quality improvement goals for the Upper and Lower Newport Bays ■.

The Big Canyon Creek Restoration Project is in the final engineering and design phase. A Phase II Feasibility Study was completed in June 2007 and has undergone several stakeholder review sessions. Final project plans are in the approval stages.

Potential Steps Forward

As stated above, DFG is in the preliminary stages of preparing the Upper Newport Bay Management Plan, but to date has been hindered by a lack of funds in fully completing this task. It is suggested that, barring a comprehensive Upper Bay Management Plan, proposed restoration projects be designed to be inline with anticipated mandates within the Management Plan. This can be accomplished by developing an integrated project development approach that includes the following attributes:

- Solicit and incorporate Upper Bay stakeholder input in the early stages of project development.
- Assemble multi-disciplinary project teams to identify restoration project opportunities and constraints.
- Adopt and commit to provide commonly accepted regional and State project planning, permitting and performance criteria throughout project development.
- Develop potential funding opportunities early in project lifecycle.
- Identify opportunities to relate proposed restoration project objectives to other local, regional, state and federal restoration and habitat improvement efforts.

A secondary recommendation for the Upper Bay Restoration portion of the Harbor Area Management Plan is to lobby state legislators to provide more comprehensive funding to the DFG or provide alternate funding sources for the completion of the final Management Plan. When funding is secured to accomplish this task, it is suggested DFG finalize the Management Plan in the following steps:

- Complete field studies and synthesize existing data identified by the DFG to allow the completion of the Management Plan.
- Prepare Upper Newport Bay Management Plan.
- Solicit review and comments from stakeholders.
- Integrate Management Plan and Long-term Restoration of Upper Bay into the Newport Harbor Area Management Plan.

Harbor Area Management Tools

The purpose of this HAMP is to develop a resource management tool for the City to move forward with key sediment management, water quality, restoration and public use projects critical in meeting the following overall goals:

- Maintain the beneficial uses of the Upper and Lower Newport Bay and economic value of the Bay.
- Provide a practical framework to meet regulatory requirements in the current and anticipated municipal discharge permits, sediment management permits, TMDLs, and other regulatory programs for Newport Bay.
- Support a sustainable estuary ecosystem able to be integrated with upstream sustainable watersheds and adjacent coastal area systems.

The aim of the development of the HAMP is to guide the City and the Harbor stakeholders in the prioritization and implementation of activities that balance beneficial uses with the long-term sustainability of Newport Bay.

The resource management tools presented in this section assist in balancing the economic, social, and environmental issues in the Lower Newport Bay (Newport Harbor). This includes balancing the environmental needs of the Bay with the day-to-day operation, maintenance and recreational activities. Throughout the development of this Plan we have recognized that the Bay is not only one of the most significant economic assets of our community, it is also a unique and vitally important ecosystem which includes the Harbor, Lower Bay, Upper Bay and upstream watershed.

Purpose of Harbor Area Management Plan:

To provide the City with a Resource Management Tool to assist in balancing environmental issues with the day-to-day operation, long-term maintenance and recreational use activities in Newport Bay.

The development of this management tool for the Lower Bay requires addressing multiple challenges across often dissimilar or even contrasting beneficial use interests to achieve the overall goals. These challenges, identified through regulatory agencies, stakeholder groups and the City include:

- Dredging Requirements & Contaminated Sediment Management
- Eelgrass Capacity Management & Tools
- Beach Replenishment Strategy
- Water Quality
- Harbor Channel and Pierhead Lines
- Hydrodynamic & Water Quality Numerical Modeling Requirements
- Regional General Permit
- Sea Level Rise & Flood Control Management
- Upper Bay Sediment Control
- Upper Bay Restoration & Management

Each of these different challenges has been evaluated and potential steps forward have been presented in Technical Report Summaries in previous sections. The Summaries have been developed from the Technical Reports that are presented in the Appendices.

This Harbor Area Resource Management Tool section presents the potential steps forward given in the individual Technical Summaries and integrated into an overall strategy with preliminary project prioritizations, potential funding sources and linkages to other projects. For each of the program elements above, this section first presents a summary of the issues/challenges and the overall goals. Based on the assessment of these challenges and the steps forward presented in the Technical Summaries, an implementation schedule is presented. This implementation strategy provides the suggested priorities, linkages to other program challenges, and estimated costs to achieve the overall program goals.

The suggested priority projects and activities are then assessed using evaluation criteria that are based on the goals of the overall integrated program. These criteria include each of the beneficial uses defined in the Harbor and Bay Element and additional elements designed to support long-term sustainability of the Bay. This evaluation provides an additional tool to demonstrate the importance of an integrated approach to achieve the overall program goals. The scoring for these criteria uses a five-point scale with a full red circle representing the least effective in meeting the criteria and a full green circle representing the most effective in meeting the criteria. A full description of the criteria is presented on page 7. Although one element may have little or no benefit in a single criteria, when integrated and implemented as an overall program, the combined outcome achieves the stated goals.

Following the presentation of each of the suggested priority projects and activities for each challenge, an integrated implementation schedule is presented for the entire Harbor Area Management program. The linkages of each priority project and activity to other elements are identified as dashed lines connecting the activities in the schedule. This overall implementation strategy provides the City with a management tool to identify the timeline for implementing the activities, the critical path linkages and the estimated costs. Potential funding sources are also identified in this strategic implementation tool. Following the implementation schedule is the overall assessment of the priority activities with regard to an integrated score for the program criteria. The results of this evaluation demonstrate the need for the integrated program set forth by the HAMP in order to effectively address the overall goal of balancing environmental issues with the day-to-day operation, long-term maintenance and recreational use activities in Newport Bay.

Harbor Area Management Tools:

Technical Summaries – Presents the challenges and goals for each element based on the Technical Report Summaries presented in the previous sections and the full Technical Reports in the Appendices.

I*mplementation Strategy Schedule –* Provide an integration of the suggested priority activities/elements for each of the HAMP challenges, the estimate timelines and the critical path linkages with other activities.

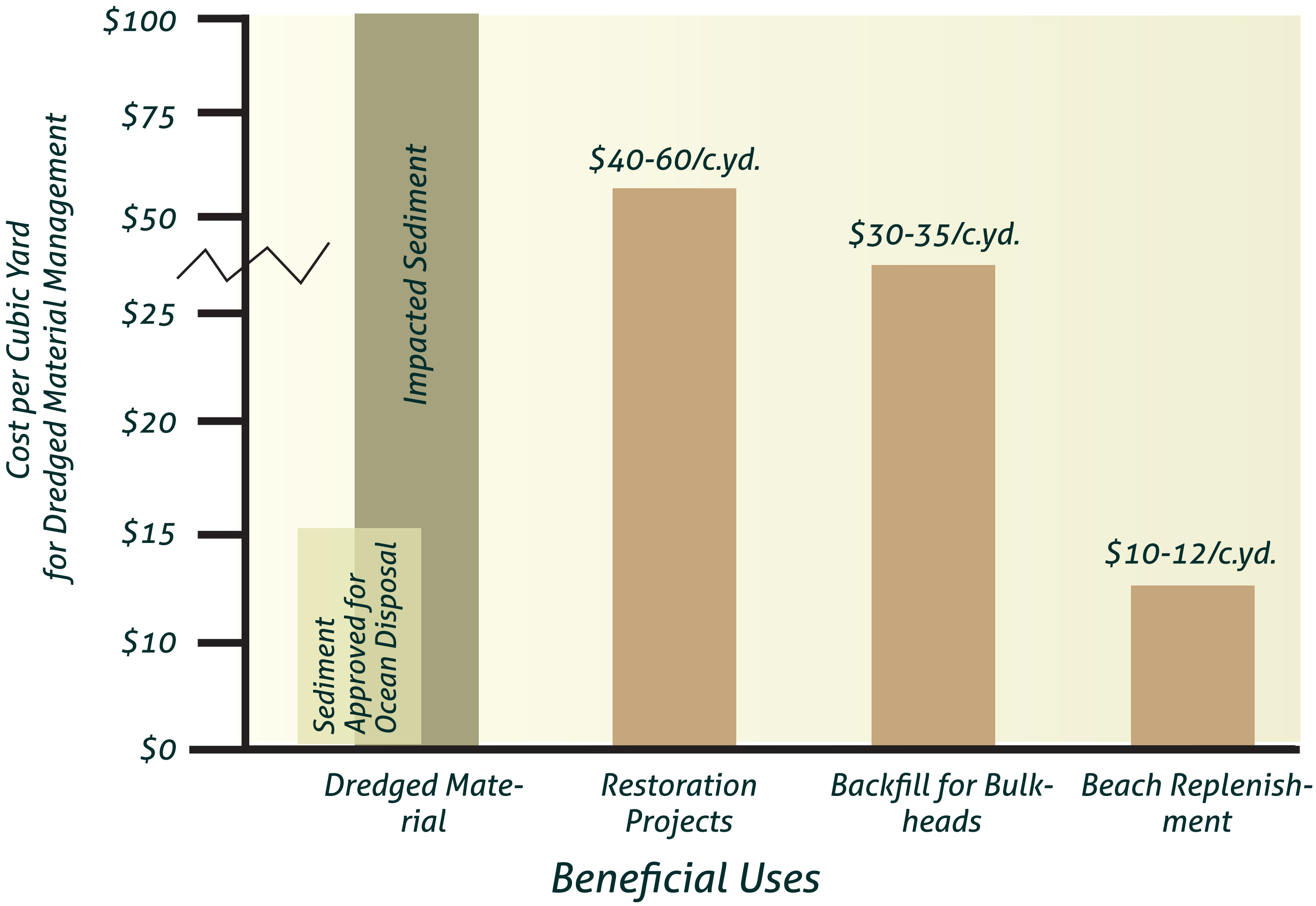
Cost Estimates – The Implementation Schedule also presents estimated costs and potential funding for planning purposes.

Integrated Project Scoring – Program elements are scored using the beneficial use criteria and the scores combined demonstrating the need for an integrated Harbor Area Management program.

Funding – The final discussion under these management tools covers potential funding strategies and options of the suggested projects.

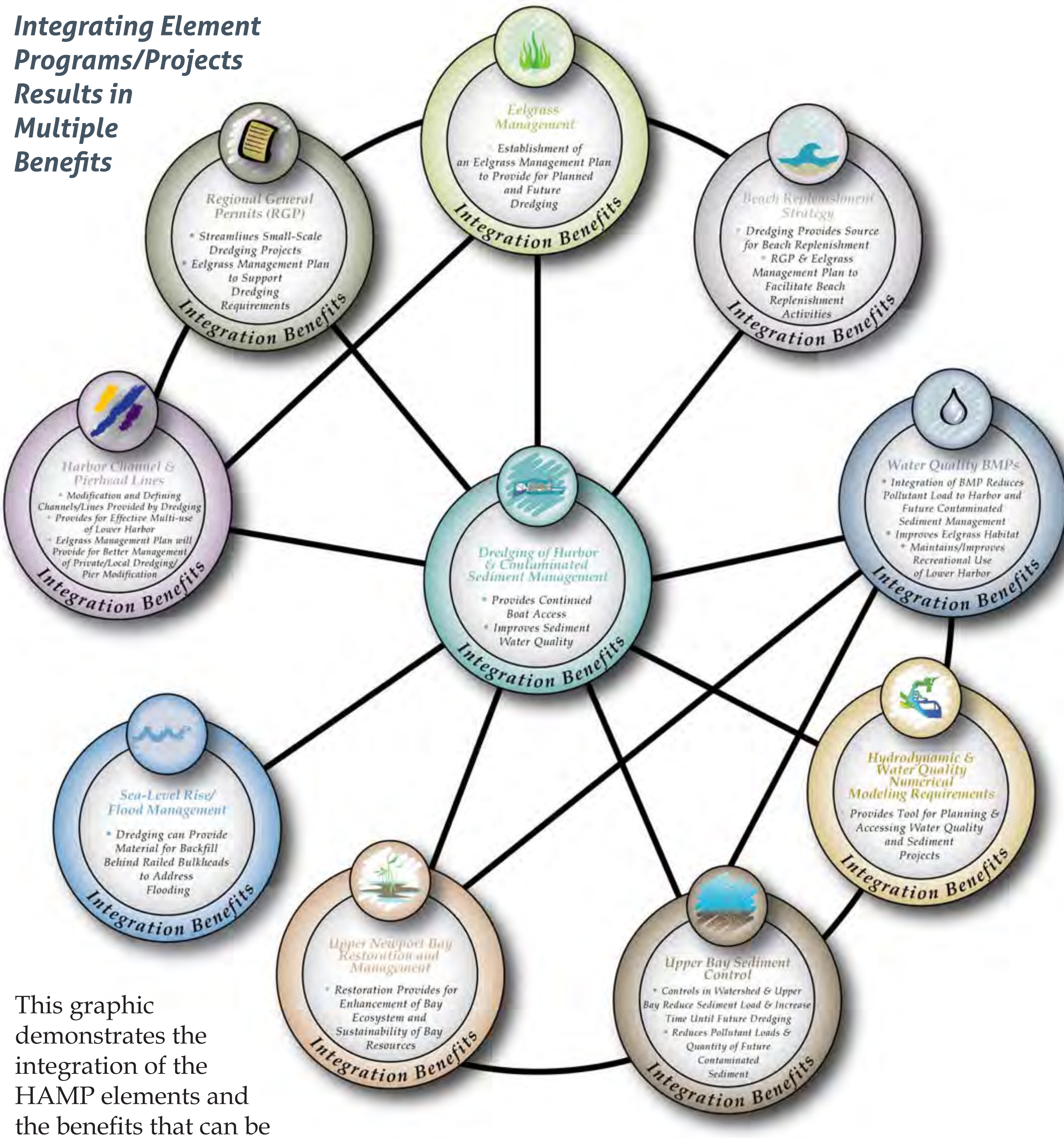
The HAMP is built on the foundation of the Harbor and Bay Element and provides the framework to build an integrated and sustainable program that most cost-effectively addresses the beneficial uses. The following management tools present the integration of the suggested projects to best meet the long-term goals and vision. The integration of elements that include dredging of the channels, eelgrass management, and water quality has not been fully integrated in previous documents. This plan therefore provides this needed function to best achieve the beneficial use goals in a cost-effective manner.

As shown in the graphic on the following page, the integrated approach of the HAMP results in benefits to the individual projects. For example, the integration of the dredging of the harbor with eelgrass management, beach replenishment and flood vulnerability provides for potential beneficial use opportunities that will lower the unit cost of dredged material management. This is illustrated in the bar graph of the unit costs for dredged material handling and placement. There is also a benefit to the other projects in the lower cost of materials for use in restoration projects by increasing the elevation of existing deeper areas, in replacing sandy material on Harbor beaches and backfilling behind modified sea walls to address future flooding.



HAMP Integrated Approach

Integrating Element Programs/Projects Results in Multiple Benefits



This graphic demonstrates the integration of the HAMP elements and the benefits that can be achieved through this integration.

Dredging Requirements & Contaminated Sediment Management

Challenges: *In recent years, sedimentation in Lower Newport Bay has resulted in the narrowing and shoaling of the federal channels and adjacent non-federal channels that act as the main conduits to marina and harbor traffic. The Lower Bay has remained subject to heavy amounts of silt and sedimentation via tidal activity and storm events.*

Goals: *Obtain dedicated federal funding and support for current phase of dredging of federal navigable channels to ensure safe and navigable waterways.*

Short-Term	*Mid-Term*	*Long-Term*	*Est. Cost*
Dredge Material Mgt. Plan	Rhine Channel Remediation		Ongoing Variable at this time
Ocean Disposal Evaluation			Ongoing
Sediment Sustainability Plan			Ongoing
	Dredging of federal channels		Variable at this time
	Dredging of non-federal channels		Variable at this time

Beneficial Use Criteria/Rating
Water Quality
Marine Resource Protection (ASBS)
Habitat Protection/ Enhancement
Community/ Public Access
Water Conservation
Channel Maintenance
Flood Control
Berthing Management
Recreational Opportunities
Sustainability

Eelgrass Capacity & Management

Challenges: *While eelgrass serves as an important ecological resource within Lower Newport Harbor, it often conflicts with other beneficial harbor uses, particularly those related to guest and residential boating and navigation.*

Goals: *Provide information to aid the City in developing and implementing an Eelgrass Management Plan for Newport Harbor. The plan will ensure eelgrass is being sustained while the City maintains all the beneficial uses of Newport Harbor.*

Short-Term	Mid-Term	Long-Term	Est. Cost
Habitat Value Assessment			$60K
Eelgrass Capacity Assessment			Funded
Eelgrass Management Plan Development			$150K
	Management Plan - Agency Review and Approval		$50K
	Management Plan Implementation		$3-5M
	Assessment		$75K

Beneficial Use Criteria/Rating	
Water Quality	
Marine Resource Protection (ASBS)	
Habitat Protection/ Enhancement	
Community/ Public Access	
Water Conservation	
Channel Maintenance	
Flood Control	
Berthing Management	
Recreational Opportunities	
Sustainability	

Beach Replenishment Strategy

Challenges: *A formal system is not in place to manage and prioritize beach replenishment projects. Components of the RGP restrict the application of dredged material on beaches.*

Goals: *Develop a centralized system for efficiently tracking and utilizing compatible dredge material for beach replenishment. Increase volume of materials for beach replenishment under the RGP process.*

Short-Term	*Mid-Term*	*Long-Term*	*Est. Cost*
Enhance and Utilize Beach Replenishment Priority Matrix			Covered under existing budget
Beach Erosion Studies			$150K
	Beach Erosion Control		$500K-$4M
Priority Beach Replenishment			$80K

Beneficial Use Criteria/Rating	
Water Quality	○
Marine Resource Protection (ASBS)	○
Habitat Protection/ Enhancement	○
Community/ Public Access	●
Water Conservation	○
Channel Maintenance	◐
Flood Control	◐
Berthing Management	◑ (red)
Recreational Opportunities	●
Sustainability	◐

Water Quality

Challenges: *Understanding the extent and source(s) of water quality impacts to the Lower Newport Bay, and the development of a strategy to cost-effectively implement BMPs to meet the anticipated requirements of TMDLs.*

Goals: *To develop an implementation strategy for water quality BMPs that is coordinated with regional and local water quality protection and improvement efforts to meet both regulatory drivers and Harbor Area beneficial uses.*

Short-Term	Mid-Term	Long-Term	Est. Cost
BMP Strategic Plan; Phase I BMP Implementation	Phase I BMP Implementation; Phase II BMP Implementation	Phase II BMP Implementation	Variable (1)(2)
Implementation with IRCWMP Projects	Implementation with IRCWMP Projects	Implementation with IRCWMP Projects	$26M (1)(2)
TMDL Implementation & Monitoring of Newport Bay/San Diego Creek Watershed	TMDL Implementation & Monitoring of Newport Bay/San Diego Creek Watershed	TMDL Implementation & Monitoring of Newport Bay/San Diego Creek Watershed	Variable (1)(2)

Beneficial Use Criteria/Rating	
Water Quality	●
Marine Resource Protection (ASBS)	◐
Habitat Protection/ Enhancement	◐
Community/ Public Access	○
Water Conservation	◐
Channel Maintenance	○
Flood Control	○
Berthing Management	○
Recreational Opportunities	◐
Sustainability	◐

(1) Prop 50 IRWM Funding (Variable sources but requires partial City match)
(2) Potential State and Federal Grant Funding (Variable sources but requires partial City match)

Harbor Channel & Pierhead Lines

Challenges: *The design and use of Newport Bay has been altered extensively; however, the harbor lines have not been systematically adjusted since their original development in 1936.*

Goals: *Update harbor lines to reflect current uses.*

Short-Term	*Mid-Term*	*Long-Term*	*Est. Cost*
Line Adjustment Plan			$60K
Line Adjustment - Agency Review			$50K
	Line Adjustment - Implementation		$50K

Beneficial Use Criteria/Rating

- *Water Quality*
- *Marine Resource Protection (ASBS)*
- *Habitat Protection/ Enhancement*
- *Community/ Public Access*
- *Water Conservation*
- *Channel Maintenance*
- *Flood Control*
- *Berthing Management*
- *Recreational Opportunities*
- *Sustainability*

Hydrodynamic Models

Challenges: *Based on past modeling efforts, it is concluded that a 3D hydrodynamic and water quality model would be required to fully capture the complex flow and transport of the Newport Harbor and Bay. A calibrated 3D model for Newport Bay and Harbor can be used to evaluate many of the proposed strategies and BMPs developed for this HAMP.*

Goals: *To develop, calibrate, and use a 3D model for the evaluation and development of the various proposed strategies and BMPs developed in this HAMP.*

Short-Term	Mid-Term	Long-Term	Est. Cost
	Develop 3D Hydrodynamic Model		$250K
	Calibrate Hydrodynamic Model		$500K
	Implement Hydrodynamic Model		Covered Under Related Projects

Beneficial Use Criteria/Rating
Water Quality
Marine Resource Protection (ASBS)
Habitat Protection/ Enhancement
Community/ Public Access
Water Conservation
Channel Maintenance
Flood Control
Berthing Management
Recreational Opportunities
Sustainability

Regional General Permit

Challenges: *The permit renewal process is long and costly, and the permit needs revisions. Approval of the plan by all stakeholders is difficult to attain. The permit restricts the range of activities and does not allow for consistent disposal opportunities. The result is a loss of eelgrass.*

Goals: *Streamline the RGP process. Include Eelgrass Management Plan opportunities under the RGP.*

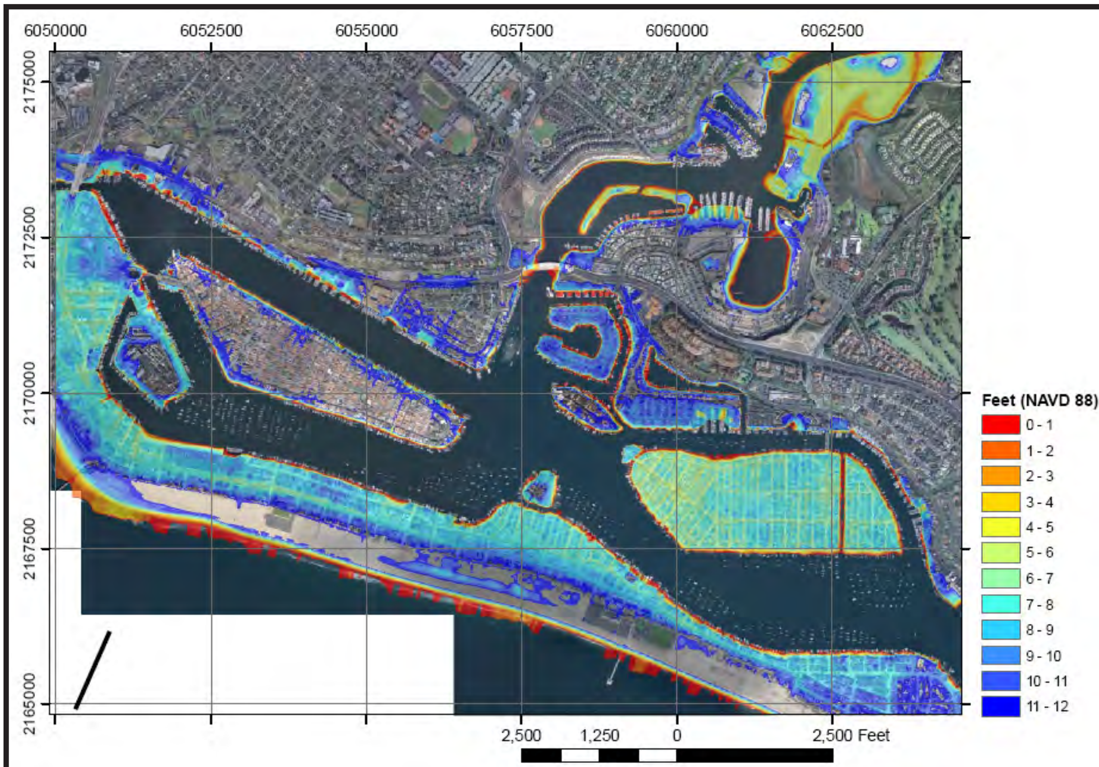
Short-Term	*Mid-Term*	*Long-Term*	*Est. Cost*
Revise RGP			$150K
Sampling Plan Template			$15K

Beneficial Use Criteria/Rating	
Water Quality	○
Marine Resource Protection (ASBS)	○
Habitat Protection/ Enhancement	○
Community/ Public Access	○
Water Conservation	○
Channel Maintenance	◐
Flood Control	◐
Berthing Management	●
Recreational Opportunities	○
Sustainability	◐

Sea Level Rise and Flood Control Management

Challenges: *The extreme high tides in California threaten flooding of low-lying terrain and result from the coincidence of extreme astronomical tides and storm-induced sea level changes. Estimates of future sea level rise at Newport Harbor fall in the range of 1-3 ft/100 years range.*

Goals: *Assess long-term flood vulnerability to the Harbor Area using predictive models and evaluation of existing flood protection. Based on this vulnerability assessment, develop management measures that are integrated into the overall HAMP program. These measures may include revisions to the required elevation of new bulkheads.*



Short-Term	Mid-Term	Long-Term	Est. Cost
Flood Vulnerability Assessment			Not Assessed
Develop Flood Management Measures			
Implement Revised Bulkhead Elev. Code	Implement Revised Bulkhead Elev. Code		
	Implement Flood Protection Measures	Implement Flood Protection Measures	

Beneficial Use Criteria/Rating	
Water Quality	○
Marine Resource Protection (ASBS)	○
Habitat Protection/ Enhancement	○
Community/ Public Access	○
Water Conservation	○
Channel Maintenance	◐
Flood Control	●
Berthing Management	○
Recreational Opportunities	○
Sustainability	◐

Upper Bay Sediment Control

Challenges: *Current restoration and dredging activities include the establishment of sediment control basins to control sedimentation of the Lower Bay. The effectiveness of these basins to reduce sediment loads of fine grained sediments needs further evaluation. Data gaps exist to conduct this assessment.*

Goals:
- *Long-term goal is to reduce the sediment load to the Upper and Lower Bay.*
- *Effectively manage sediment basins.*
- *Coordinate sediment removal with restoration / beach replenishment / sustainable sediment management.*

Short-Term / Mid-Term / Long-Term	Est. Cost
Upper Bay Dredging of Inline Basins & Channels	$13M(3), $25M(4)
Sedimentation Data Gaps	$60K
Sediment Transport Modeling	$60K
IRCWMP Watershed Sediment Control Projects	Variable (1)
TMDL Implementation & Monitoring - Upper Bay/San Diego Creek Watershed	Variable (1)

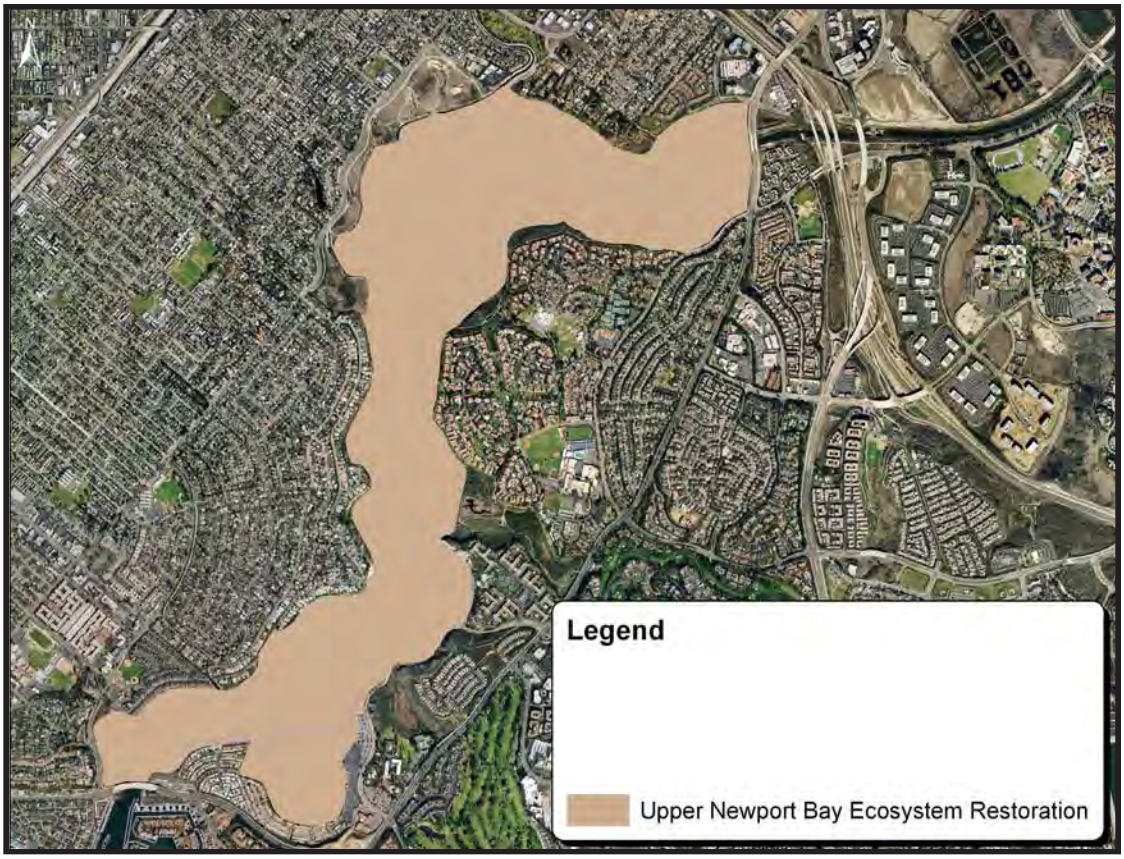
Beneficial Use Criteria/Rating	
Water Quality	●
Marine Resource Protection (ASBS)	◐
Habitat Protection/ Enhancement	●
Community/ Public Access	○
Water Conservation	○
Channel Maintenance	●
Flood Control	◐
Berthing Management	◐
Recreational Opportunities	○
Sustainability	◐

(3) Local Share
(4) Federal Funds

Upper Newport Bay Restoration & Management

Challenges: *The challenges for the Upper Bay Restoration includes securing funding for the restoration projects and the development of the Management Plan and coordination of the dredging activities with the restoration projects and water quality and Lower Bay dredging projects.*

Goals: *Implement the restoration projects for the Ecological Reserve and complete the Upper Bay Management Plan.*

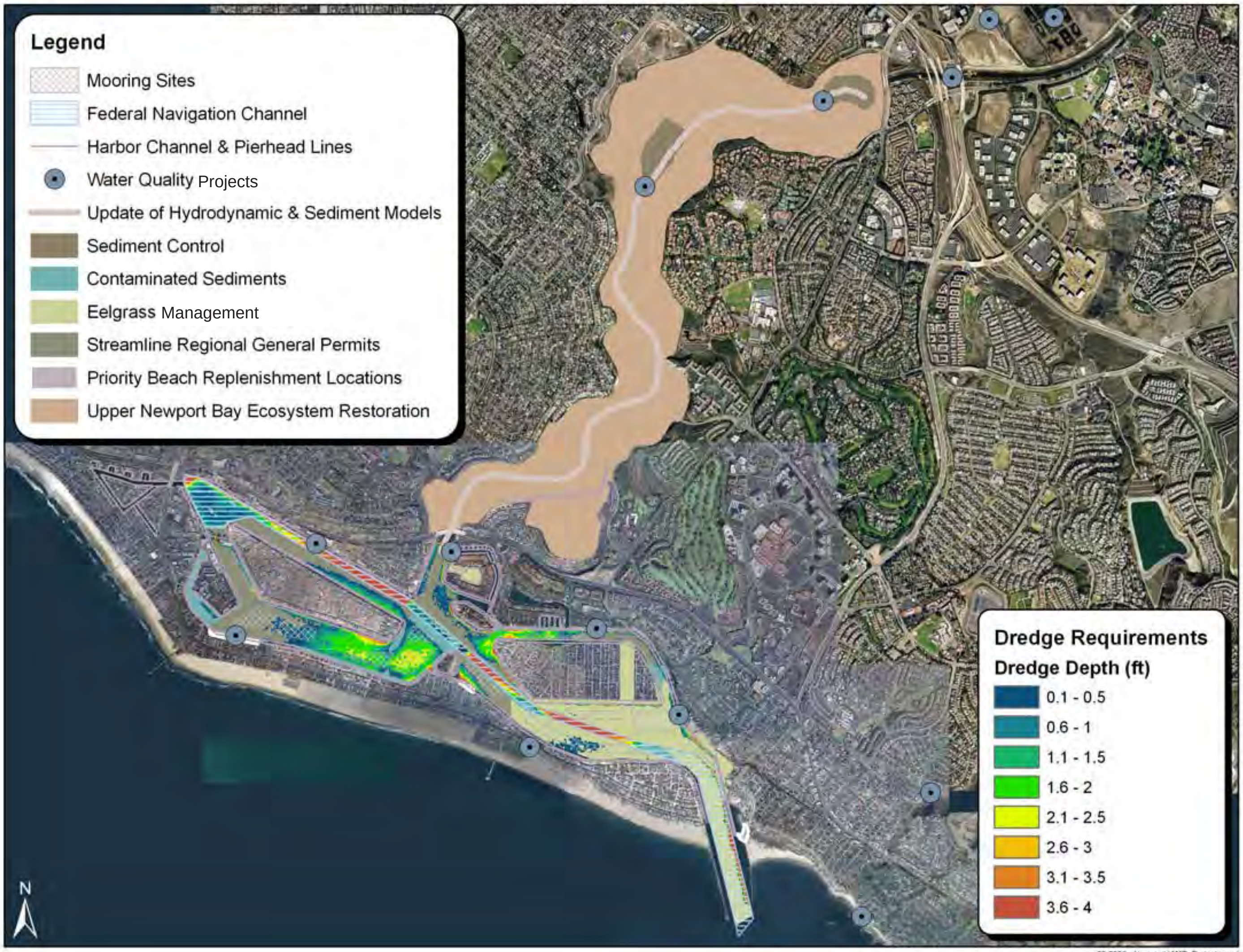


Short-Term	*Mid-Term*	*Long-Term*	*Est. Cost*
IRWMP Application Submitted	IRWMP Restoration Projects		$45M(1)
IRWMP Funding Approval; Draft Upper Bay Management Plan	Final Upper Bay Management Plan		$150K
Big Canyon Design & Implement	Big Canyon Restoration Project - Implementation		$5M(2)

(1) Prop 50 IRWM Funding (Variable sources but requires partial City match)
(2) Potential State and Federal Grant Funding (Variable sources but requires partial City match)

Beneficial Use Criteria/Rating	
Water Quality	◐
Marine Resource Protection (ASBS)	●
Habitat Protection/ Enhancement	●
Community/ Public Access	◐
Water Conservation	○
Channel Maintenance	◐
Flood Control	◐
Berthing Management	○
Recreational Opportunities	●
Sustainability	◐

Map of Integrated Projects



This map represents the integration of the suggested projects to meet the stated goals and achieve the greatest balance of beneficial uses.

Implementation Strategy Schedule and Cost Estimates

The following Implementation Strategy Schedule presents the integration of the suggested projects/management measures that address the goals of each of the HAMP challenges. This tool provides a prioritization of the projects based on the timeline presented and the integration of the projects represented by the dash-line linkages. These linkages represent a critical path to complete the integrated projects cost-effectively and achieve the greatest balance of beneficial uses. Prioritization of projects is therefore based on required starting dates to fully implement the project and the linkages to the other integrated projects. For example, dredging of the non-federal channels in the Lower Bay needs to be coordinated with the completion of the Eelgrass

Management Plan, the streamlined RGP process, and the harbor and pier line activities to successfully meet the goals of each challenge cost-effectively with the greatest balance of beneficial uses. Prioritization of the projects will also depend on the availability of resources to complete the projects. Funding strategies and options are discussed in the final section and are listed as footnotes on the Implementation Schedule.

The Implementation Strategy Schedule and Cost Estimates represent the overall framework of the HAMP. As a Resource Management Tool, this Implementation Schedule provides integrated solutions that result in cost savings and positive return on investment paid to the triple bottom line of economic, community, and environmental benefits. The suggested actions in this plan provide the potential steps forward to meet the challenges in a cost-effective manner through the integration of projects. This plan is based on the understanding that the "no action alternative" would lead to inaccessible channels, loss of property values, and regulatory action. Management measures are needed to maintain the vitality of the Harbor's assets that balance the beneficial uses cost-effectively.

Integrated Project Scoring

The assessment of the suggested projects is presented in the table that lists the HAMP elements and the evaluation criteria. The HAMP elements listed represent the suggested projects presented in the summaries and listed in the Implementation Schedule. This table therefore represents the assessment of the suggested priority projects using the evaluation criteria that are based on the goals of the overall integrated program. These criteria include each of the beneficial uses defined in the Harbor and Bay Element and additional criteria to support the long-term sustainability of the Harbor.

This evaluation provides an additional tool that demonstrates the combined benefits achieved through the integration of the projects. As shown on the table, there are a number of negative scores for the projects under the single HAMP elements represented by red half circles. However, when the suggested projects are integrated, the overall scores result in a positive score for each of the beneficial use criteria.

Integration of the HAMP element projects results in a combined score that is positive to all the criteria based on beneficial uses. The integrated HAMP strategy therefore results in an overall balance of beneficial uses in accordance with the mission statement.

The overall outcome of the HAMP is illustrated by the figures on the following page.

These figures provide the framework for current and future planning to meet beneficial use goals.

p. 92 *Integrated Project Scoring Table*

p. 93 *Implementation Strategy Schedule and Cost Estimates*

The HAMP provides a framework for the development and integration of specific project plans and designs that address the challenges outlined and linked in this document. The HAMP will therefore be updated through these project plans that will include more recent data, polices and regulatory requirements. It was the Harbor Commission's intent to use the HAMP as a launching pad for the specific projects that address the outlined challenges, and to use available resources on the implementation of these projects rather than focusing on continual updates to specific issues in this document.

Integrated Project Scoring Table: Project Assessment and Integrated Benefit

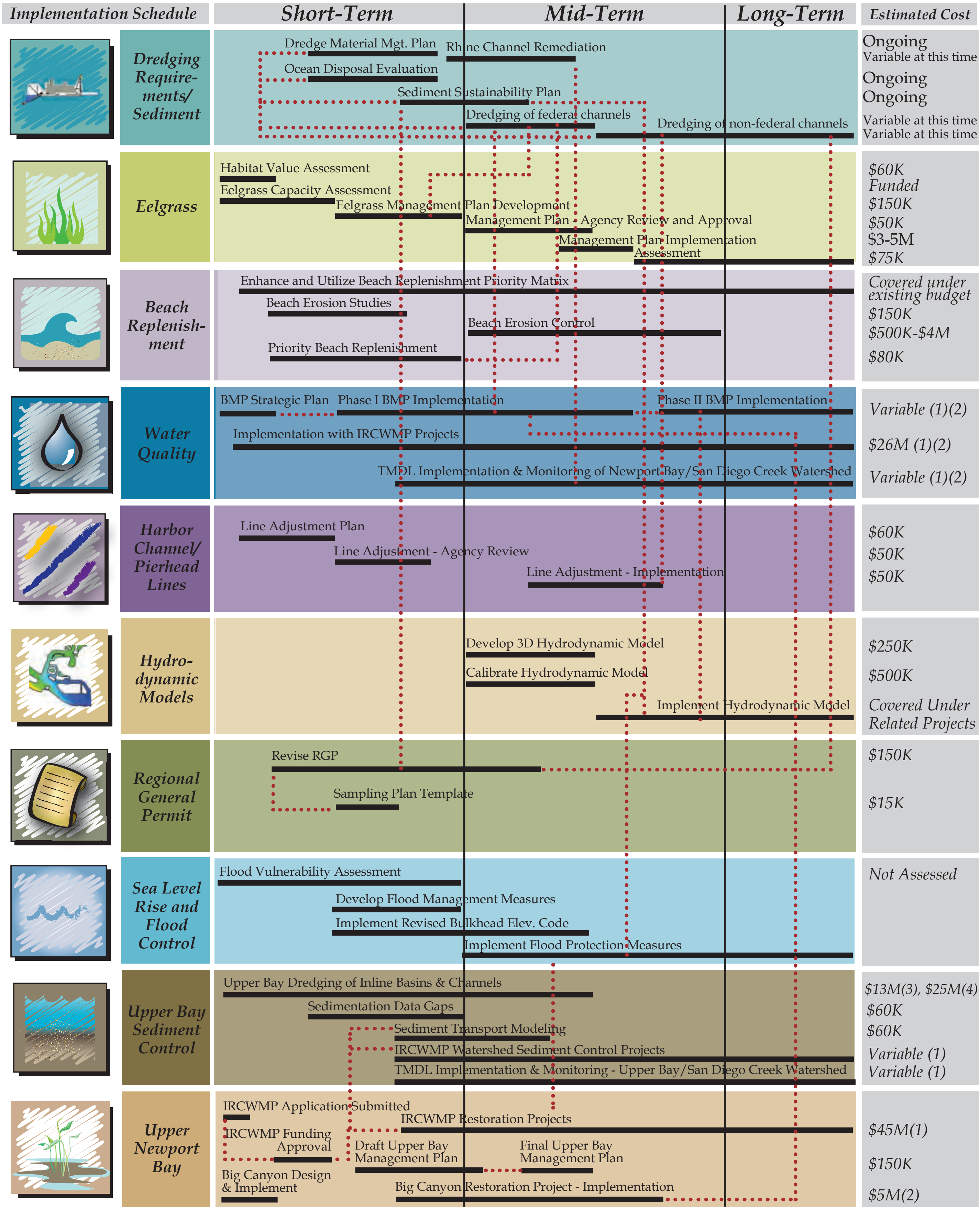
Scores for each element are averaged together for each beneficial use

Suggested Projects by Element	Water Quality	Marine Resource Protection (ASBS)	Habitat Protection/ Enhancement	Community/ Public Access	Water Conservation	Channel Maintenance	Flood Control	Berthing Management	Recreational Opportunities	Sustainability
	Beneficial Use Criteria									
Dredging Requirements/ Sediment	2	2	4	2	3	1	2	1	2	1
Eelgrass	2	1	1	3	3	4	4	4	2	2
Beach Replenishment	3	3	3	1	3	2	2	4	1	2
Water Quality	1	2	2	3	2	3	3	3	2	2
Harbor Channel/ Pierhead Lines	3	3	4	2	4	2	3	1	1	2
Hydrodynamic Models	1	2	3	3	3	3	2	3	3	2
Regional General Permit	3	3	3	3	3	2	2	1	3	2
Sea Level Rise and Flood Control	3	3	3	3	3	2	1	3	3	2
Upper Bay Sediment Control	1	2	1	3	3	1	2	2	3	2
Upper Newport Bay	2	1	1	2	3	2	2	3	1	2
Combined Benefit of Integrated Approach	(2)	(2)	(2)	(2)	(3)	(2)	(2)	(2)	(2)	(2)

1 = Activities proposed for the element are the MOST effective at meeting the beneficial use goal

1 2 3 4 5

5 = Activities proposed for the element are the LEAST effective at meeting the beneficial use goal



(1) Prop 50 IRWM Funding (Variable sources but requires partial City match)
(2) Potential State and Federal Grant Funding (Variable sources but requires partial City match)
(3) Local Share
(4) Federal Funds

Introduction

An important part of any management plan is the issue of funding. Many projects and programs have been identified in this plan and are at various stages of implementation. This section is intended to begin the process of describing existing funding sources to implement these activities, to point out the potential cost savings of implementing integrated projects and activities rather than single-purpose projects, and to identify next steps and a strategy for creating and attracting additional funding needed to complete these tasks.

Significant financial resources will be needed to implement the HAMP, and there are currently limited fund sources for this purpose. As discussed in this section, conceptual cost estimates have been developed for the priority elements/projects which suggest over $100 million would be required to complete these projects. Additionally, there are currently no estimates for additional projects that will need to be implemented to fully achieve the objectives and goals identified in the HAMP. A future task will be to identify measurable metrics that define success for each of these goals, and then a set of projects that will achieve these metrics, and cost estimates for these projects.

It is clear that existing local revenue sources will not be sufficient to fund either the priority projects or the expected future projects that need to be achieved. The local stakeholders have acknowledged that additional funding sources are needed, and these will likely be a combination of local, state, and federal sources. Following is a table summarizing the existing funding sources expected for the priority projects as well as discussion of the major activities needed to assure a comprehensive funding plan is developed and implemented in support of future funding.

Local Funding Strategy

The Harbor Commission has indicated that local funding measures (e.g. harbor use fee and local sales tax) should be considered as a part of their overall strategy to develop the appropriate revenue to implement priority elements and projects identified in this plan. This potential funding source may be used toward non-federally funded dredging costs.

Possible next steps in developing the local funding plan may include:

- Evaluate current federal, state and local sources of funding for Channel Maintenance, Flood Control, Berthing Management , Water Quality, Marine Resource Protection (ASBS), and Habitat Protection/ Improvement, and determine funding gaps.

Potential Funding Sources

	Sources	Expected Contribution	Targeted Beneficiaries
Local	• Harbor use fee • Local sales tax • Utility fee or benefit assessment based on use of the property • Utility fee or benefit assessment based on total area and impervious area • Gasoline fee • Water sales • Parcel fee • General Obligation Bond	High (50%-100%)	Region's residents, environment, and economy.
State	• Competitive grants • Appropriations • State-wide assessments	Moderate (10-50%)	Statewide environment and economy.
Federal	• Appropriations • Competitive grants • Stimulus Block or Resource Grants	Moderate-High (10-80+%)	Navigable waterway under federal jurisdiction – ranks high in priority for federal funding. Areas of national environmental or economic significance.
Others	• Individual and corporate donors • Conservancy/Foundations and other non-profit organizations	Low-Moderate (<10%)	Particular communities or targeted interests in the region.

- Evaluate feasibility of implementing a local funding measure.
- Evaluate potential for state and federal partners and grant funding opportunities so that an estimate of the required local share of funding can be developed.
- Identify and rank potential local funding alternatives.
- Prepare draft local funding plan.
- Identify key local stakeholders.
- Meet with stakeholders to promote funding plan and partnerships.
- Compile feedback from stakeholders and revise funding plan based on stakeholders' input.
- Develop education and outreach campaign to educate the public on the HAMP targets, the need for infrastructure to achieve the targets, the need for additional local revenue, etc.
- Implement Local Funding Plan.
- Refine Local Funding Plan as needed.

State Funding Strategy

Voters of the State of California have passed a number of statewide water and watershed funding measures in the past several years, including propositions 12, 13, 40, and 50. Proposition 84 was approved in November 2006 and also provides opportunities to fund specific HAMP projects. Approximately $114 million is dedicated to the Santa Ana Funding Area, which includes Newport Bay. The HAMP is an integral component of the Central Orange County Integrated Regional and Coastal Watershed Management Plan (IRCWMP), and projects within the HAMP are therefore consistent with that plan and eligible for Proposition 84 funds. The local stakeholders have acknowledged that future statewide funding may play a significant role in implementing priority projects identified in this HAMP.

The following actions have been implemented within a state funding strategy:

- The Round 2 Proposition 50 application was submitted in December 2007 for the Orange County Central Watershed Management Area (which includes Newport Bay and the City of Newport). Unfortunately the application was scored just below the applications that were requested to submit Round 2 applications. The next steps should include meeting with the state selection board and obtaining feedback on the application.

- An application under Proposition 84 grant funding specific to ASBS was submitted in August 2008. The application was ranked number 3 and is positioned to receive grant funding pending available state resources. The projects included in this application include water quality projects in the Harbor.

Possible next steps in developing the state funding plan may include:

- Evaluate and apply for existing state funding opportunities under Proposition 84.

- Follow up on existing grant application submitted for Proposition 50, and find out what is needed to obtain a higher score to compete with available funds.

- Consider other chapters of Proposition 50 and their applicability to HAMP implementation.

- Evaluate other statewide funding opportunities, including Bay–Delta watershed program grants.

- Coordinate with other regional stakeholders who are implementing the IRCWMP and an integrated strategy for implementing Proposition 84 funds within the Orange County Central Watershed Management Area.

- Participate in crafting and/or providing leadership of future statewide funding measures.

- Participate in statewide discussions regarding the scope and projects to be funded in Proposition 84, as well as the appropriate distribution of funds statewide.

- Identify appropriate representatives to participate in discussions within the IRCWMP on development and interpretation of the language in any draft or final funding measures.

- Identify key statewide stakeholders.

- Meet with stakeholders to promote state funding plan and partnerships.

- Compile feedback from stakeholders and revise funding plan based on stakeholders' input.

- Implement Funding Plan.
- Refine Funding Plan as needed.

Federal Funding Strategy

The ability of USACE to dredge the federal channels has been limited by federal funding. Currently, efforts are underway to seek funding to bring all federal channels to design depths. To incentivise USACE, the City has taken an active role in pursuing federal appropriations.

Possible next steps in developing the federal funding plan may include:

- Develop a list of opportunities to leverage local funding for the design and construction of HAMP projects through partnerships with federal agencies.
- Identify specific existing federal programs with the ability to share funding for the design and/or construction of single/multi-purpose facilities to achieve progress with HAMP objectives and IRCWMP objectives.
- Identify ongoing joint local and federal investigations that could accelerate the future commitment of federal funds.
- Redefine existing federal investigations that would provide federal funding for continuing stages of watershed planning in 2009 and beyond.
- Summarize the various federal opportunities enumerating their pros and cons and recommending those best suited to the HAMP objectives.
- Describe the actions/timelines under existing programs to initiate new local partnerships to secure federal contributions for the design and/or construction of new facilities.
- Determine appropriate agencies that could act as the local cost-sharing sponsor for new federal studies/projects.

Current Funding Activities

- An application under a NOAA Restoration grant program was submitted in April 2009. These are monies provided under the federal stimulus package. The projects under this application include restoration projects in the upper and lower Harbor and along the coast, as shown in Figure 1.

Funding to Further the HAMP Program

In addition to the funding of capital projects and improvements described above, it is clear that additional planning is needed to refine projects that have been identified in the HAMP. Additional planning is also needed to develop fully integrated sets of projects and a comprehensive vision for the Harbor and the watershed over the next 20 years which will ultimately achieve (yet to be defined) measurable watershed planning targets.

To fund additional detailed HAMP projects, several funding options may be possible:

- Contribution from local sources (e.g., local stakeholders with a vested interest in the HAMP objectives).
- Grant from state funds (e.g., planning funding from Proposition 50 and/or Proposition 84, or future water quality funding measures).
- Legislative appropriation.
- Federal funds (e.g., via USACE participation or through stimulus monies).

Figure 1: Map of restoration projects in the upper and lower Harbor and along the coast, as submitted with the NOAA Restoration grant application

APPENDIX A

Dredging Requirements and Contaminated Sediment Management

"The following technical report reflects the findings and data available at the time the report was prepared and may not represent the current conclusions and steps forward in the main text of the HAMP, which has been updated after the completion of these reports. These more detailed technical reports provided in the appendices represent the foundation for the overall approach to the HAMP, but are not "living" documents that reflect updated steps forward, costing, quantities, etc. presented in the main text of the HAMP. The main text of the HAMP represents more current information and recommendations based on updated information, new studies, changes in conditions, new funding sources, and/or new regulations."

HARBOR AREA MANAGEMENT PLAN

DREDGING REQUIREMENTS & CONTAMINATED SEDIMENT MANAGEMENT

Technical Report

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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
CAD	confined aquatic disposal
CDF	confined disposal facility
City	City of Newport Beach
DDT	dichlorodiphenyltrichloroethane
EC_{50}	median effect concentration
ER-L	effect range-low
ER-M	effect range-median
FDA	U.S. Food and Drug Administration
FEMA	Federal Emergency Management Agency
ITM	Inland Testing Manual
LPC	limiting permissible concentration
MEC	MEC Analytical Systems, Inc.
MLLW	Mean Lower Low Water
MNR	monitored natural recovery
MPRSA	Marine Protection, Research, and Sanctuaries Act Title I
NAS	National Academy of Sciences
NSI	National Sediment Inventory
OTM	Ocean Testing Manual
O&M	operation and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
pH	hydrogen ion concentration
RGP	Regional General Permit
SCCWRP	Southern California Coastal Water Research Project
SP	solid phase
SPP	suspended particulate phase
STFATE	short term fate
TBT	tributyltin
TIE	toxicity identification evaluation
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
Weston	Weston Solutions Inc.

UNITS OF MEASURE

cm	centimeter
cy	cubic yards
^{o}C	centigrade
ft	feet or foot
°F	Fahrenheit
km	kilometer
M	million
mi	miles
mg/kg	milligram per kilogram
µg/kg	microgram per kilogram
%	percent

1.0 DREDGING REQUIREMENTS AND SEDIMENT MANAGEMENT

1.1 Introduction

In recent years, sedimentation in Lower Newport Bay has resulted in the narrowing and shoaling of the Federal Channels and adjacent non-federal channels that act as the main passageway for marina and harbor traffic. Therefore, there is a need for a plan to maintain the channels and berthing areas necessary for navigation of Lower Newport Bay in an economically and environmentally sound manner. Sediment catch basins constructed in Upper Newport Bay were somewhat effective in helping to reduce sedimentation; however, the Lower Bay has remained subject to heavy amounts of silt and sedimentation via tidal activity and storm events. The United States Army Corps of Engineers (USACE) and City of Newport Beach (City) plan to re-establish sufficient water depths along the Federal Channels and to improve navigation for the large quantity of sea-going vessels entering and leaving Newport Bay. Since 1929, there has been a long history of dredging within Newport Bay. This has served a dual purpose by addressing critical dredging needs such as improving navigation for sea-going vessels, and also by considering beneficial use alternatives.

1.2 Benefits of Dredging

By dredging the Lower Bay, the USACE and City hope to re-establish adequate water depths along the Federal Channels and to improve navigation for the high volume of sea-going vessels entering and leaving Newport Bay. The dredging of contaminated sediments may have a long-term positive effect on the environment due to the ongoing source of contaminants released to the environment if left in place.

1.2.1 Support of City of Newport Beach Harbor and Bay Element Goals

There has been a long history of dredging within Newport Bay, beginning in 1929. Dredging has served an important role in shaping this small boat harbor, while also enhancing beneficial uses of the bay through direct and indirect causes. For example, dredging directly improves safe access for vessels, while also indirectly reducing contamination within the bay through the removal of pollutants within sediments, potentially benefiting recreational activities, as well as the bay's flora and fauna. Furthermore, dredging activities are responsible for the maintenance and restoration of tidally-dependent ecosystems, and dredged materials have been used for beach replenishment. Thus, dredging and the use of dredged materials provide benefits to the environment, the local community, and society.

The City of Newport Beach has defined 13 goals in the Harbor and Bay Element that pertain to harbor issues (2001). These goals are intended to guide the regulation of development and use of its harbor, waterfronts, and bays. In accordance, direct and indirect effects of proposed dredging activities and management of contaminated sediment are analyzed in the context of enhancement of the City's Harbor and Bay Element goals, which are enumerated in the table below (Table 1).

Table 1. Contribution of Dredging and Management of Contaminated Sediment to the Harbor and Bay Element Goals

Harbor and Bay Element Goals	Dredging Effects[1]	Sediment Management Effects[1]
HB-1 Preservation of the diverse uses of the Harbor and waterfront that contribute to the charm and character of Newport Bay, and that provide needed support for recreational boaters, visitors, and residents.	○	○
HB-2 Retention of water-dependent and water-related uses and recreational activities as primary uses of properties fronting on the Harbor.	○	○
HB-3 Enhanced and updated waterfront commercial areas.		
HB-4 Preservation of existing commercial uses in the Harbor to maintain and enhance the charm and character of the Harbor and to provide support services for visitors, recreational boaters, and other water-dependent uses.	○	
HB-5 A variety of vessel berthing and storage opportunities.	○	
HB-6 Provision and maintenance of public access for recreational purposes to the City's coastal resources.		
HB-7 Protection and management of Upper Newport Bay commensurate with the standards applicable to our nation's most valuable natural resources.	○	●
HB-8 Enhancement and protection of water quality of all natural water bodies, including coastal waters, creeks, bays, harbors, and wetlands.	○	○
HB-9 A variety of beach/bulkhead profiles that characterize its recreational, residential, and commercial waterfronts.		
HB-10 Coordination between the City, county, state, and federal agencies having regulatory authority in the Harbor and Bay.		
HB-11 Adequate harbor access for coastal-dependent harbor maintenance equipment and facilities.	●	
HB-12 Balance between harbor revenues and expenses.		
HB-13 Maintain and enhance deep water channels and ensure they remain navigable by boats.	●	

[1] Open circles (○) indicate indirect effects.
Closed circles (●) indicate direct effects.

Through the maintenance and improvement of channels and proper depths of marinas, dredging and the use of dredge materials have the potential to contribute to the preservation of the diverse uses of the Harbor and the waterfront by enhancing support for local boaters (HB-1), retention of water-dependent and water-related uses (HB-2), preservation of the existing commercial uses in the harbor (HB-4), increase in the variety of vessel berthing opportunities (HB-5), maintenance and enhancement of harbor access for harbor maintenance equipment(HB-11), and maintenance and enhancement of deep water channels to ensure navigability by boats (HB-13). Dredging of sediment traps is an essential component of the management of Upper Newport Bay (HB-7), since high levels of sedimentation threaten to reduce intertidal mudflat and estuarine habitats due to reduced tidal flows as upland habitats become more prevalent. Therefore, certain types dredging can be seen as beneficial to the bay's native biota. However, given the prevalence of eel grass beds within the harbor, dredging activities can result in the disturbance of this protected habitat through direct removal. Lastly, although dredging can temporarily adversely impact water quality due to the resuspension of sediments during operations, the dredging of contaminated sediments may have a long-term positive effect on water quality due to the removal of contaminants that could otherwise be continually released into the water column if left in place (HB-8). Therefore, environmental, economic, and social benefits can be derived from the productive use of dredging and dredged material within Newport Bay and adjacent beaches, and in so doing contribute to the City's Harbor and Bay Element goals.

Effective management of contaminated sediments within the bay will also have several environmental, social, and economic impacts. Some of these impacts contribute to the City's Harbor and Bay Element goals. Management of contaminated sediment has the potential to directly contribute to the protection and management of Upper Newport Bay (HB-7). Upper Newport Bay is a State Ecological Reserve and one of the last large undeveloped wetlands in southern California. It is home to a variety of threatened species. Removal and treatment of contaminated sediments can enhance the floral and faunal communities of the bay, benefiting not only those organisms that inhabit the sediments, but also fishes and invertebrates that feed on the benthic infauna, crustaceans, worms, and mollusks. In addition, sediment management activities can indirectly contribute to the preservation of the diverse uses of the harbor (HB-1), the retention of water-dependent dependent uses of the bay (HB-2), and the enhancement and protection of water quality (HB-8). Lower Newport Bay is a major recreational destination for tourists and locals. By reducing sediment contamination, the overall environmental conditions of the bay are improved, such as water quality, which has the potential to increase the level of recreational uses within the bay, such as swimming, fishing, and sailing. Furthermore, treatment and/or removal of contaminated sediments from the bay have the potential to improve long-term water quality, although such activities would likely have short-term adverse effects on localized water quality. Lastly, sediment treatment may also provide a source of sufficiently clean sand that can be used in beach replenishment and habitat enhancement activities. Therefore, environmental, economic, and social benefits can be derived from the effective treatment of contaminated sediments in conjunction with the productive use of materials within Newport Bay and adjacent beaches, thereby, contributing to the City's Harbor and Bay Element goals.

1.3 Overview of Dredging Requirements

1.3.1 Current Dredging Needs

The volume of material to be dredged in Lower Newport Harbor, based on harbor design depth (-20 ft mean lower low water [MLLW] inside federal channels and -10 ft MLLW outside of federal channels) and projected bathymetry, is approximately 425,000 cy inside federal channels and 300,000 cy outside federal channels, with an estimated 175,000 cy for over dredge volume. Total estimated volume of material required for management is 905,000 cy (Table 2).

Table 2. Current Dredging Needs Inside and Outside Federal Channels

Volume of Dredged Material (cy)			
Inside Federal Channel	Outside Federal Channel	Over dredge	Grand Total
425,000	300,000	175,000	900,000

1.3.2 Future Dredging Needs

Based on models developed by the USACE in the late 1990's and historic depositional records, approximately 1 to 1.5 M cy of sediment will be transported to Lower Newport Bay in a 15 year cycle. However, these models do not account for hydrological changes that will be implemented with the most recent designs for the Upper Newport Bay Restoration Project. In addition, these models do not access the impact of current dredging operations in Upper Newport Bay, which remove only the coarse grain size fraction. This model doesn't account for volumes by grain size fractions; therefore, sedimentation patterns cannot be predicted and are confounded by the current dredging operations in Upper Newport Bay. A model that incorporates grain size fraction information is needed. Additional data would need to be established to determine sedimentation rates and future dredging needs.

The City has a Regional General Permit (RGP), which is a 5 year renewable permit that allows property owners to apply to the City for permission to dredge within their dock area. This permit allows for up to 20,000 cy of sediment to be dredged each year. In the past 30 years, about 357,000 cy of sediment was dredged under the RGP. About 170,000 cy was disposed of at LA-3, and about 187,000 cy was used for beach replenishment.

Based on recent bathymetry, the removal of approximately 725,000 cy (without over dredge) is required to reduce harbor depths to design depths (Figure 1). Based on historic dredging efforts over the last 30 years, approximately 360,000 cy were dredged under the RGP and 289,000 cy were dredged by the USACE in the federal channels. Assuming sedimentation rates stay the same or diminish, an additional 650,000 cy will need to be dredged over the next 30 years to maintain harbor depths.

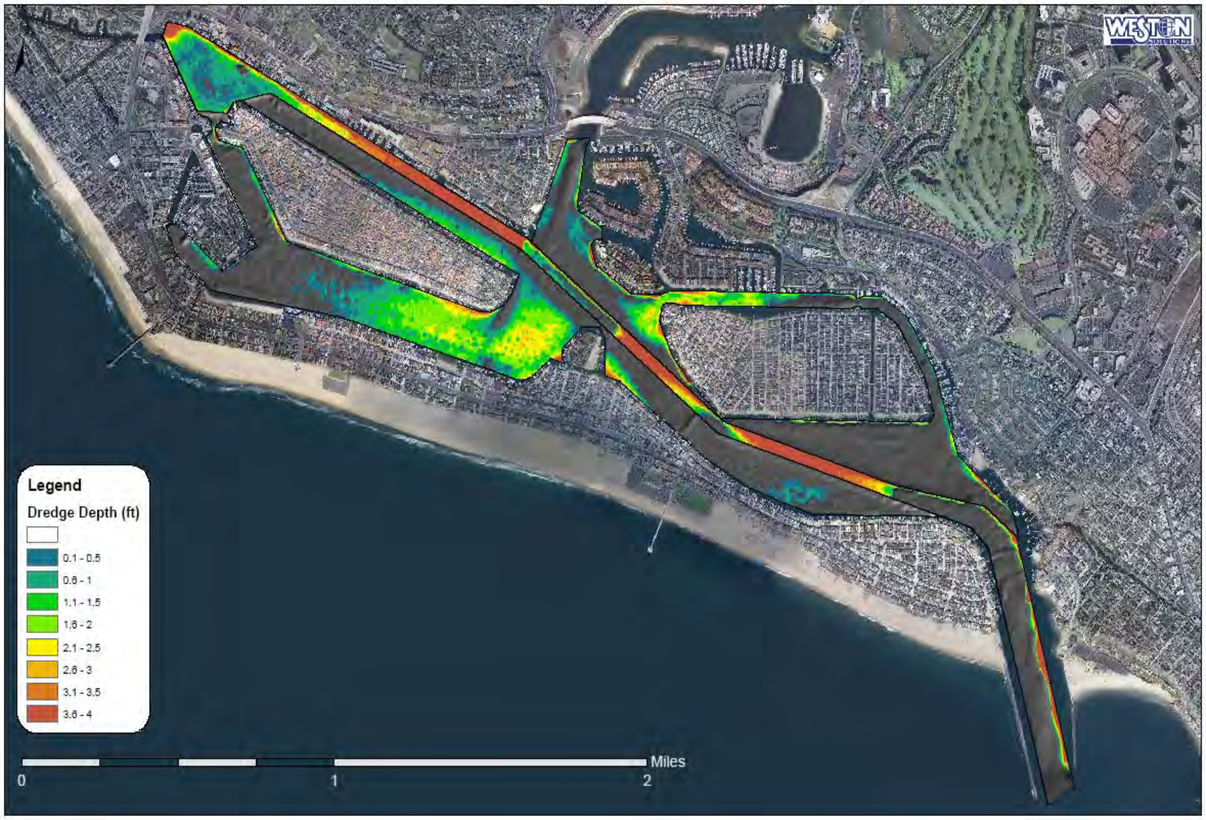

Figure 1. Dredging Needs in Lower Newport Bay

The ability of USACE to dredge the federal channels has been limited by federal funding. Current efforts are underway to seek funding for a "final federal dredge program" that will bring all federal channels to design depths. To incentivize the USACE, the City would agree to release the USACE of all future dredging and maintenance of waterways responsibilities. The advantages and disadvantages of releasing the USACE of their federal responsibilities are provided in Table 3.

Table 3. Advantages and Disadvantages of Releasing USACE from its Federal Responsibilities

Advantages of removing USACE responsibilities in Lower Newport Bay	Disadvantages of removing USACE responsibilities in Lower Newport Bay
• Once dredged, it is believed that the proposed sediment management plans will be designed to intercept 20 years of sediment from watershed, therefore, reducing dredging needs in the future. • The Harbor would still qualify for Federal Emergency Management Agency (FEMA) funding for natural disasters such as major El Nino storms resulting in emergency declarations and possible. • Federal funding for maintenance of recreational harbors will continue to be difficult to obtain • Federal harbor lines could be eliminated.	• Future dredging will not be a Upper Bay project, when completed would protect Lower Bay from significant impacts. • Loss of federal maintenance would most likely include loss of maintenance funds for breakwater • The City will need to develop a plan to fund future dredging projects.

1.4 Options for the Management of Sediment

1.4.1 Sustainable Sediment Management Alternatives

Dredging requires processing and handling of sediments, which are typically removed from a system and placed in confined disposal facilities (CDF) or in nearshore ocean disposal sites. Often this is done without considering alternative beneficial uses of the sediment. For some dredging projects, disposal issues can be problematic resulting in postponements or even cancellation of dredging at harbors. However, sediments which do not exceed predetermined criteria may be a viable source for beneficial use projects where some type of soil or fill is needed.

Beneficial use includes a wide variety of options that utilize dredged material for a productive purpose. Beneficial uses of dredged material may make traditional placement of dredged material unnecessary or at least reduce the level of disposal. The broad categories of beneficial uses, based on the functional use of the dredged material or site, defined by the USACE (1987) are as follows:

- Beach nourishment;
- Shoreline stabilization;
- Landfill cover for solid waste management;
- Material transfer (fill, dikes, roads, etc.);

Below is a discussion of the beneficial uses of dredged material that are most relevant to sediment from Newport Bay.

1.4.1.1 Beach Nourishment

Beach nourishment refers to the strategic placement of large quantities of beach quality sand on an existing beach to provide a source of nourishment for littoral movement or restoration of a recreational beach (Figure 2). Generally, beach nourishment projects are carried out along a beach where a moderate and persistent erosional trend exists. Sediment with physical characteristics similar to the native beach material used is mechanically or hydraulically placed. Please refer to the Beach Replenishment Appendix for further discussion on beach nourishment within Newport Bay; including key issues, development of a beach replenishment program, and recommendations.

Source: Carteret Count Shore Protection Office 2005.

Figure 2. Beach Nourishment Using Dredged Material from Inlet Realignment Project, Emerald Isle, NC

1.4.1.2 Shoreline Stabilization

Beneficial use of dredged material for shoreline stabilization includes the creation of berms or embankments at an orientation to the shoreline that will either modify the local wave climate in order to improve shoreline stability, or alter the wave direction to modify the rate or direction of local sediment transport. Berms may be constructed of a wide variety of dredged material, including rock or coarse gravel, sands, and clays (Figure 3). Stabilization and enhancement of eroding shorelines with dredged materials may also help reduce the volume and frequency of future maintenance dredging. Shoreline stabilization has the potential to improve recreational opportunities for surfing, swimming, sailing, and other activities.

Source: Miratech 2005

Figure 3. Dredging Material Hydraulically Placed in Geotubes for Shoreline Protection in Atlantic City, NJ

1.4.1.3 Landfill Cover

Dewatered dredged material may be used beneficially at landfills as daily or final cover, and as capping material for abandoned contaminated industrial sites known as "brownfields." Solid waste landfills require a minimum of 6 inches cover daily to prevent unsightly appearance, pest control, odor control, and prevent surface water infiltration. In addition, the closure of a landfill or brownfield requires a cap of clean material to isolate the solid waste from the surrounding environment. Dredged material typically possesses important cover material characteristics such as workability, moderate cohesion, and low permeability. Landfill cover is a viable beneficial use for consolidated clay, and silt/clay. Final cover and capping is applicable for virtually all sediment types, although amendments to the material may be required to achieve the required physical properties for the intended end use. In order for dredged material to be economically feasible for daily cover, the landfill should be located less than 50 mi (80 km) from the dredged material supply.

1.4.1.4 Material Transfer

The use of dewatered dredged material as construction fill for roads, construction projects dikes, levees, or CDF expansion is a practical beneficial use for sands/gravel, consolidated clay, and silt/ clay, although fine-grained dredged material may require amendment to provide the physical properties required for light load engineering uses. Material may be used as backfill to build or refurbish / reinforce existing bulkheads to accommodate possible sea level rise. These processes have been used in Holland to produce construction materials suitable for reinforcement of dykes and docks, sealant materials for CDF construction, noise barriers, and road embankments (Rijkswaterstaat, 2004). The applicability of dredged material to a particular construction project depends on the physical and engineering properties of the material and the specific requirements of the project. However, if the material has poor foundation qualities, a suitable additive such as cement may be added to increase shear strength and bearing capacity. The type, combination, and amount of amendment material depends on the moisture content, the amount of fines (clays and silts), and organic content of the dredged material. Such amendments can also be used to stabilize contaminants, making this a potential use for contaminated dredged material.

Industrial and commercial development near waterways can be aided by the availability of fill material from nearby dredging activities. The direct placement of hydraulically placed fill requires specific engineering, environmental, and feasibility considerations, and is only viable if project sites are located within a few miles of dredging areas. Additionally, dewatered dredged material can also be used as construction fill to build port facilities, which may be a viable beneficial use alternative because dredged material is typically in surplus from routine maintenance dredging near proposed sites for port facilities.

1.4.2 Management of Materials Meeting Ocean Disposal Suitability Requirements

1.4.2.1 Ocean Disposal

Suitability of dredged material for ocean disposal is based on the Marine Protection, Research, and Sanctuaries Act Title I (MPRSA) Tier III analysis as described in the Ocean Testing Manual (OTM; United States Environmental Protection Agency [USEPA]/USACE, 1991) and the Inland Testing Manual (ITM; USEPA/USACE, 1998). Tier III analysis includes sediment chemistry, solid phase toxicity tests, suspended particulate phase toxicity tests, and bioaccumulation tests. If found suitable for ocean disposal; dredged material from Newport Bay will be placed in the USEPA designated LA-2 or LA-3 disposal sites. LA-2 is located within Los Angeles County, approximately six nautical miles from the entrance of Los Angeles Harbor (USACE, 2002). LA-3 is located within Orange County, approximately 4.5 nautical miles from the entrance of Newport Harbor (USEPA/USACE, 2005).

Dredged material is placed in open-water by means of a release from a hopper dredge or barge. The discharged material settles through the water column and deposits on the bottom of the placement site. The physical behavior of open-water placement, and thus its potential environmental impact, depends on the type of dredging and discharge operation used, physical characteristics of the material, and the hydrodynamics of the placement site. Several specialized practices have been developed to minimize environmental effects of open-water placement and include submerged discharge, lateral containment, thin-layer placement, capping and modifications of time, location, and volume (USEPA, 1992). Open-water placement has the potential for the management of large volumes of dredged material.

The cost associated with open-water placement is a function of the type of dredging equipment, the capacity of the dredge, the nature of the material, and the distance to the placement site.

1.4.2.2 Beach Nourishment

Please refer to section 1.4.1.1 for a detailed description of this management alternative.

1.4.3 Management of Materials Not Suitable for Ocean Disposal

The long history of commercial and recreational boating uses, as well as the urbanization of the watershed, has contributed to sediment toxicity and chemical contamination of Newport Bay. Contaminant chemicals and metals have accumulated within the bay’s sediments, reaching levels that exceed sediment quality standards in specific portions of the bay, such as the Rhine Channel (Bay and Brown, 2003). As a consequence, sediment management and treatment strategies are necessary to control and remediate sediment contamination in order to comply with state regulations and enhance the environmental conditions within the bay. In doing so, sediment management has the potential to contribute to the goals set forth in the Newport Beach Harbor and Bay Element (2001).

1.4.3.1 Confined Disposal Facility

A CDF is an engineered structure bound by confinement dikes for containment of dredged material. CDFs serve as a dewatering facility and can be used as a processing, rehandling and/or treatment area for beneficial use of dredged material. Dredged material may be placed temporarily or permanently in the CDF.

CDFs may be used for coarse and fine-grained material. The material is placed into the CDF either hydraulically or mechanically. Placing the material directly into the CDF from the dredging site through pipelines is the most economical method. The dredged material consists of a certain percentage of slurry when it is pumped into the facility. Depending on the placement method, slurry material initially deposited in the CDF may occupy from 1.2 times (mechanical placement) to 5 – 10 times (hydraulic placement) its original volume due to water content. Design of the CDF must account for this additional volume during the drying phase. Following placement, the finer sediments are allowed to consolidate, settle, and dewater. Water evaporates or percolates through the dike walls or into the ground. CDFs that use weirs to enable surface water to exit the facility must be designed with sufficient retention times to ensure adequate sediment settling will occur.

Dredged material placement within a CDF has several benefits. CDFs can prevent or substantially reduce the amount of dredged material re-entering the environment when properly designed, operated, and maintained. CDFs can provide either a temporary or permanent storage location for dredged material that will naturally vegetate if left undisturbed. Finally, CDFs can be used as processing and/or blending areas for beneficial use activities.

The size, design, and cost of a CDF are site-specific. Factors considered in the design of a CDF include: the location, physical nature of sediments to be placed (e.g., grain size, organic content, etc.), physical nature of project footprint, chemical nature of sediments (contaminated vs. clean), volume of sediments to be stored, placement method, and the length of time material will be stored at the facility. Depending on the design, operation and maintenance (O&M) costs of the CDF will vary.

1.4.3.2 Confined Aquatic Disposal

Confined aquatic disposal (CAD) is a process where dredged material is disposed at the bottom of a body of water, usually within a natural or constructed depression (i.e. created specifically for the disposal) or a relic borrow-pit created during previous construction activities. As with open-water placement, a CAD has the potential to store large volumes of dredged material. The difference between CAD and open-water placement is that the deposited material is confined to the designated area preventing lateral movement. Once the dredged material is placed within the CAD facility, the material could be left exposed to the surrounding water to be covered by natural sedimentation or capped with a layer of suitable clean material to prevent re-suspension.

The feasible use of a CAD facility depends on the capacity of the CAD and the availability of suitable locations in reasonable proximity to the dredging operations. Development of a CAD within Lower Newport Harbor could be used to increase bottom elevation and create an eelgrass habitat.

1.4.3.3 Shoreline Stabilization

Please refer to section 1.4.1.2 for a detailed description of this management alternative.

1.4.3.4 Landfill Cover

Please refer to section 1.4.1.3 for a detailed description of this management alternative.

1.4.3.5 Material Transfer

Please refer to section 1.4.1.4 for a detailed description of this management alternative.

1.4.3.6 In situ Treatment

Monitored Natural Recovery
Monitored natural recovery (MNR) is a remediation alternative that uses naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment. This process is dependent on a relatively consistent rate of sediment deposition to cover the existing contaminated sediment in an aquatic environment, and deposited sediment should be resistant to resuspension. If using MNR to remediate contaminated sediment, it is necessary that contaminants are at relatively low concentrations throughout the area (i.e., significantly below hazardous waste concentrations), and are those that may be degraded to less toxic forms. In addition, significant anthropogenic disturbances are not permitted in areas where MNR is implemented. Therefore, it is necessary that the area does not need dredging to meet the City's needs. Given specific site characteristics, this remediation option is most appropriate if the expected risk of exposure to humans and aquatic organisms is relatively low and when the site is a sensitive habitat that may be permanently damaged by dredging or capping, such as eelgrass habitat.

In situ capping
In situ capping is used to remediate contaminated sediment in place by covering or capping the contaminated sediment with clean material. A variety of materials may be used as caps including clean granular sediment, sand, or gravel. Caps can also be engineered to meet specific project requirements. Such engineering controls may include treatments to attenuate contaminant flux (e.g., organic carbon, impermeable liners to reduce mixing between the clean material and contaminated sediment, and bio-barriers to prevent penetration by deep burrowing organisms [i.e., ghost shrimp]). As a result of *in situ* capping, contaminated sediment is isolated from benthic organisms that bioturbate and release contaminants in sediment through resuspension or biological transfer through the food chain. The primary site characteristics that are important for successful implementation of capping include hydrodynamic conditions that are not likely to disturb the cap, adequate sediment strength to support a cap, sufficient water depth to support future uses once the cap is in place, and compatibility with existing or planned infrastructure and associated activities (i.e. piers, pilings) within the capping area. Significant anthropogenic disturbances are not permitted in areas where the cap is implemented. Therefore, it is necessary that the area does not need dredging to meet the City's needs. An *in situ* capping alternative may

be more appropriate than MNR when the long-term risk reduction associated with contaminant exposure is more important than potential alterations of habitat resulting from the capping process. Similarly, *in situ* capping may be more appropriate than dredging when there is risk of contaminant exposure during removal activities, or residual contamination at a site.

1.4.3.7 Upland Treatment

Certain treatment technologies may be applied to the dredged material to reduce contaminant exposures to acceptable levels. Treatments involve reducing, separating, immobilizing and/or detoxifying contaminants, and could be applicable either as stand alone units or combined as part of a treatment train.

Dewatered dredged material has been manufacture into various construction materials, using the treatment methods listed below. It has been proven as a valuable resource in the production of riprap or blocks for erosion protection (rock), concrete aggregates (gravel/sand), production of bituminous mixtures and mortar (sand), raw material for brick manufacturing (clay), and ceramics and tile (clay).

Physical/Chemical Treatment Processes

Soil Washing/Particle Sorting Technologies

A valuable overview of washing/sorting technologies is presented by Olin et al (1999), and step-wise evaluation procedures in Olin-Estes and Palermo (2000). During sediment washing, contaminated dredged material is slurried and subjected to physical collision, shearing, and abrasive actions and aeration, cavitation, and oxidation processes, and in some cases while reacting with chemical additives. Soil washing involves separating sediment particles based on differences in size, density, or surface chemistry. Since contaminants tend to associate with produced water, fine-grained and organic materials, removal of these fractions may render the remainder of the material suitable for a broader range of beneficial uses.

Washing technologies span a wide range of sophistication, including simple sluicing processes to a hydrocyclone concentrator. In general, screened material is slurried and fed into mechanical equipment such as hydrocyclones and settling tanks, designed to remove silts and clays from granular particles. After separation, silts and clays may be either dewatered mechanically or pumped into a CDF for settling, and the coarser sand fraction (which is generally less contaminated) can be stockpiled for confirmatory testing and subsequent beneficial use.

Solidification

Solidification has a long track record in the treatment of dredged materials (GLC, 2004). Sediment solidification reduces the availability of contaminants by the addition of Portland cement, coal fly ash, cement kiln dust, lime, asphalt and/or other stabilizing chemicals to create soil aggregates. As a result, these treatments bind the small dredged material particles into larger aggregates with improved physical and chemical properties that enable the treated sediment to be used as aggregate in some types of construction processes. In the process, these stabilization techniques may reduce the accessibility of associated contaminants, thus reducing their availability to the environment. The end product can be used in landfill closure and brownfield remediation projects.

Chemical extraction and stabilization
Chemical extraction increases the solubility of contaminants, thereby mobilizing them from the sediment phase into the aqueous phase, where they may be removed by further processes. Extraction options include the addition of surfactants, acids, bases or chelators, and may be enhanced by temperature elevations of 99 to 140 °F (37 to 60 °C). Removal efficiency depends on the porosity of the material and the treatment time. Extraction processes can be further optimized by incorporation with separation processes, which tend to reduce the total volume of material and increase the concentration of the most contaminated, finer or less dense material. In addition, the water used in the washing process may be treated to remove metals and organics, and recycled to the treatment plant for use. Soil washing technologies using a blend of biodegradable detergents, chelating and oxidizing agents, and high pressure water jets to remove both organic and inorganic contaminants have been developed by BioGenesis, Inc. and Weston Solutions Inc. (Weston). This combination of mechanical and chemical processes has been shown to reduce organic compounds by approximately 90 percent and the inorganic compounds by approximately 70 percent. The process produces an end material that is suitable for use as a base for manufactured topsoils.

Chemical binding processes reduce the solubility of contaminants, thereby reducing their availability to pore water leaching and bioavailability. While these processes have been used in effluent and drinking water treatment for decades, their application to the stabilization of contaminants in solid materials is recent.

Thermal Treatment Processes
Vitrification
Vitrification is the process of converting sediment into glass aggregate, a process that destroys organic contaminants at 99.99 percent efficiencies and immobilizes metals within a glass matrix using a high-temperature plasma torch. The plasma torch is an effective method for heating sediments to temperatures that are higher than can be achieved in rotary kilns (see thermal desorption below). Plasma temperatures can reach 5430 °F (3000 °C) at which the sediment is melted using fluxes to produce a glass product. The molten glass can be quenched to produce a glass aggregate or directly fed to glass manufacturing equipment to produce a salable product.

Thermal desorption
Thermal desorption requires the application of very high temperatures to break down organic compounds, and has been applied to both moderately and highly contaminated dredged material. In this process, dredged materials are tumbled in a rotary kiln while applying temperatures around 930 – 2550 °F (500-1400 °C). Depending on the temperature and duration of the digest, this technique has been shown to eliminate some metal and organic compounds, Thermal desorption at the lower temperature results in a waste stream of hazardous material as a side product that may still require disposal at a hazardous waste treatment facility. Temperatures around 2550 °F (1400 °C) have been shown to completely destroy all organic compounds, and vitrify metals into a melted matrix. However, at these high temperatures some metals can be volatilized, therefore requiring comprehensive air permits. Higher temperature treatment can lock metals into a solid, melted matrix. The higher temperature demonstration has been conducted in existing cement plants with an associated "Cement-Lock" technology. Cement-Lock technology, developed by the Gas Technology Institute, can utilize any type of dredged

material. The ability of existing cement plants to handle large volumes of dredged material may reduce overall costs. The end result is construction-grade cement.

Biological Treatment Processes

A variety of technologies exist that may be characterized as bioremediation technologies, or processes that use organisms to reduce contaminant concentrations in materials. However, only some of these technologies have been tested for their use in the decontamination of sediment. Potential for bioremediation of contaminated sediments is discussed in the following references: (Price and Lee, 1999; Fredrickson et al., 1999; Price et al., 1999; Myers and Williford, 2000).

Composting

Composting involves mixing dredged material with organic matter and wood chips to accelerate the degradation of some contaminants (particularly polychlorinated biphenyls [PCBs] and polycyclic aromatic hydrocarbons [PAHs]; GLC 2004). The organic matter 'biosolids' (e.g., sewage sludge or manure) provide nutrients and microbes and the wood chips provide moisture and a substrate for microbial action. There are numerous types of composting technologies including windrow, static pile, vessel, and vermi-composting; however, not all of these technologies have been fully tested for use with dewatered dredged material. A pilot study using composting technology is being conducted by the USACE-Detroit District in the Great Lakes basin at the Milwaukee and Green Bay CDFs in an attempt to create marketable topsoil. Composting dredged material also has been used to create topsoil at the Toledo Harbor CDF. The resulting topsoil has been used for landfill capping and landscaping throughout the city of Toledo.

Land Farming

Land farming involves encouraging microorganisms to degrade contaminants within an enclosed area, such as a lined bed with leachate and aeration procedures in place. In this process, water and nutrients are often added to facilitate a successful microbial community. This technology has been primarily applied to soil, though small-scale studies and one pilot study have demonstrated its applicability to large-scale projects.

Phytoremediation

Phytoremediation uses living plants to facilitate the breakdown or immobilization of certain contaminants in dredged material. This technology has been used extensively to decontaminate soils and groundwater. Full scale studies have also been performed to demonstrate the usefulness of phytoremediation to decontaminate sediment; however, fewer studies have been completed on sediment as compared to soil or groundwater, using this technology (Belt Collins, 2002).

Fungal Remediation

Fungal remediation (also called mycoremediation) has been evaluated as a bioremediation treatment for certain organic contaminants in dredged material. This treatment involves the use of select fungal strains as "keystone" species along with the diverse array of naturally occurring organisms commonly present in soils and sediments, and uses these combinations of species to initiate a cascade of biological processes (Jack Word, personal communication; Belt Collins, 2002). Unlike conventional bioremediation applications, this fungal-centric biological consortium is capable of degrading complex organic contaminants including a variety of aromatic compounds. This occurs when fungal enzymes weaken the typically resilient carbon bonds of the aromatic rings, allowing naturally occurring microbes to further degrade sediment contaminants until the compounds are reduced to basic chemical elements (i.e. carbon dioxide and water). Preliminary investigations have demonstrated the potential to reduce complex organic contaminant concentrations (PAHs, PCBs, and dichlorodiphenyltrichloroethane [DDT]) by up to 97 percent in soils and sediments.

1.5 Overview of Contaminated Sediment Issues

Agricultural activities, commercial and recreational boating uses, and urbanization of the watershed, has resulted in widespread contamination in Upper and Lower Newport Bay. The primary contaminants of concern include DDTs, mercury, copper, and pyrethroids. A discussion of the possible sources of contaminants is presented in Section 1.5.1. A discussion of the distribution of contaminants is presented in Sections 1.5.2.1 and 1.5.2.2. A discussion of sediment toxicity data is presented in Sections 1.5.3.1 and 1.5.3.2 .

1.5.1 Contaminants of Concern

1.5.1.1 DDTs

Widespread DDT contamination in the bay is the result of historical agricultural activities in the surrounding areas. Organochlorine pesticides, such as DDT, were widely used as pesticides from the mid-1940s to the 1970’s. It has been estimated that the use of DDT reached peak levels in the mid-1960’s. Because of lenient sewage treatment and waste disposal laws and scientific ignorance about the detrimental effects of DDT, the Palos Verdes Shelf became one of the largest DDT-contaminated sites in the country. Today, an estimated 100 tons of DDT are scattered cover a 17 square mile superfund site up to 200 feet below the ocean surface. An end to continued domestic usage of DDT was decreed on June 14, 1972. Rivers that meander through historical agricultural farmland are impacted with DDT, and its breakdown products DDE and DDD. At least 40 years after their use was prohibited, their presence is still observed in sediment and biota. Levels of DDT have been declining since the late 1960s, yet it continues to enter rivers and streams from atmospheric deposition and the erosion of agricultural soils. Since these pesticides generally have moderate-to-low water solubility and moderate-to-high environmental persistence, they have the strong potential for accumulation in sediment and aquatic biota.

1.5.1.2 Mercury

Possible sources of mercury in the bay include historical antifouling boat paints, historical shipyard activities, the natural locally occurring geological material known as cinnabar, and mercury mining. Mercury mining occurred at Red Hill mine between 1880 and 1939, and the San Diego Creek may have transported sediment containing mercury into the bay. Potential pathways have been identified based on media, and include direct contact, flux / leaching to surface waters / runoff, resuspension and transport of sediment, leaching to groundwater, volatilizations, and fugitive dust from sediment / soil surface. The most common being metallic mercury, mercuric sulphide, mercuric chloride, and methylmercury. Natural processes can change the mercury from one form to another. For instance, chemical reactions in the atmosphere can transform elemental mercury into inorganic mercury. Some micro-organisms can produce organic mercury, particularly methylmercury, from other mercury forms. Methylmercury can accumulate in living organisms and reach high levels in fish and marine mammals via a process called biomagnification (i.e. concentrations increase in the food chain) (Figure 4).

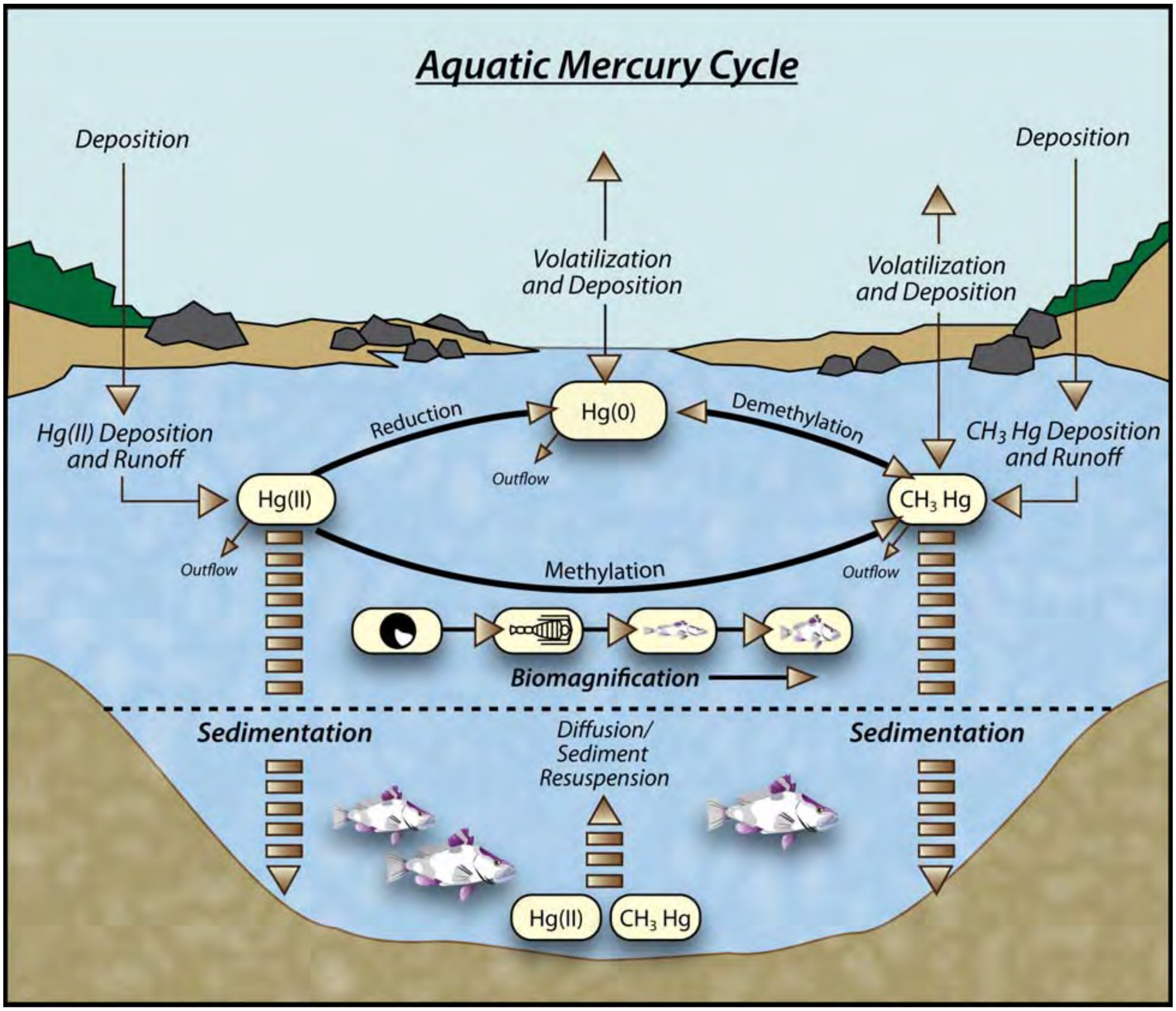

Figure 4. Aquatic Mercury Cycle

1.5.1.3 Copper

Sources of copper include antifouling paints, hull cleaning, cooling water, NPDES discharges, industrial processes, stormwater, mining and point source runoff. Copper, in a variety of formulated fungicides, herbicides and algaecides, is widely used in antifouling paints to control the growth of bacteria and fungus. Copper has a lithic biogeochemical cycle; therefore, it has a strong propensity for sediments and soils. Because it adsorb so strongly to sediments and soil, copper usually does not leach into groundwater, and does not contaminate drinking water supplies. Elemental copper does not break down in the environment and may be found in plants and animals, and at elevated concentrations in filter feeders such as mussels and oysters. Two forms of copper, Cu^{+1} (cuprous) and Cu^{+2} (cupric) can occur in aqueous environments, however, their relative stabilities depend on factors such as hardness, alkalinity, temperature, hydrogen ion concentration (pH), ionic strength and dissolved organic carbon.

1.5.1.4 Pyrethroids

A possible source of pyrethroids is historic agricultural uses and residential uses. Pyrethroids are used residentially in insecticides that previously had organophosphates as the active ingredients (California Department of Pesticide Regulation, 2004). Pyrethroids, which consist of 40% of all pesticide products, display high toxicity to a wide range of aquatic organisms including invertebrates, but also have a strong affinity towards sediment and soil particles. Therefore, pyrethroids may not be bioavailable to organisms. Most pyrethroids are broken down or degraded rapidly by sunlight or other compounds found in the atmosphere, therefore often lasting 1 or 2 days before being degraded. Since many of these compounds are extremely toxic to fish, they are usually not sprayed directly onto water, but they can enter lakes, ponds, rivers, and streams from rainfall or runoff from agricultural fields and eventually find their way to coastal areas. Pyrethroids are not easily taken up by the roots of plants and vegetation because their affinity to soil. Because these compounds adsorb so strongly to soil pyrethroids usually do not leach into groundwater, do not contaminate drinking water supplies, and volatilize from soil surfaces slowly. Microorganisms in water and soil degrade these compounds. However, some of the more recently developed pyrethroids can persist in sediment and soil for several months or years before they are degraded.

1.5.2 Review of Existing Sediment Chemistry Data

In preparation of sediment management activities in support of maintaining navigable waterways, docks, and bulkheads in Newport Bay, an understanding of the potential for sediment contamination is necessary. Information on contaminated sediment within the bay will be used to help determine quantity of material that may not be suitable for ocean disposal, determine the distribution of contaminants, and help develop sediment management alternatives. Therefore, a review of existing sediment chemistry data was performed for Newport Bay. Existing sediment conditions in Upper Newport Bay has a direct effect on the sediment quality in Lower Newport Bay due to sedimentation via tidal activity and storm events. Therefore, a review of contaminated sediment in Upper Newport Bay was also necessary. Elevated levels of contaminants of concern in Upper and Lower Newport Bay are discussed in the following sections.

1.5.2.1 Distribution of Contaminants in Upper Newport Bay

<u>DDTs</u>
In November 2000, MEC Analytical Systems, Inc. (MEC) collected sediment cores from 5 sites in Upper Newport Bay (including offshore of Newport Dunes, Dover Shores, and the Upper Newport Bay boat launch facility) for Tier III analysis (MEC, 2001). Chemical analyses on the composite sample indicated elevated levels DDT congeners. The concentration of 4,4’-DDE (59 µg/kg) exceeded the corresponding effects range-median (ER-M; 27 µg/kg). A refined analysis of each station of Area 3 was performed to see if there were differences in sediment contamination among the different stations. Elevated concentrations of DDE were evenly distributed among the stations with concentrations ranging from 28 to 58 µg/kg. All concentrations of DDE exceeded the corresponding ER-M.

In March 2002, MEC collected sediment cores from Upper Newport Bay for Tier III analysis (MEC, 2003a). Samples were collected from 5 stations within Area A (Unit II Basin), 2 stations within Area N (New Island East Side Channel), and 1 station within Area HD (Hot Dog Island

Channel). Due to stratification in Area A sediment, samples were split into tops and bottoms. The top sample represented the top 2.29 to 2.44 ft of sediment. Chemical analyses of composite samples from Areas A Top, N, and HD indicated elevated levels of DDT congeners. The concentration of 4,4'-DDE in Area A Top (35.2 µg/kg) and Area N (46.6 µg/kg) exceeded the corresponding ER-M. Likewise, the concentration of 4,4'-DDT in Area HD (10.8 µg/kg) exceeded the corresponding ER-M (7 µg/kg).

In May 2005, Weston collected sediment from Newport Bay for Tier III analysis (Weston, 2005). Samples were collected from the channel and marina immediately north of Galaxie View Park (Area 3a) and the area around Bayside Village Marina (Area 3b). Chemical analyses of the composite samples indicated elevated levels of DDT congeners. The concentration of 4,4'-DDE at Area 3a (42 µg/kg) and Area 3b (30 µg/kg) exceeded the corresponding ER-M. Total detectable DDTs in area 3a (48.4 µg/kg) also exceeded the corresponding ER-M (46.1 µg/kg). In bioaccumulation testing with *Macoma nasuta* and *Nephtys caecoides*, DDT congeners were detected is tissue chemistry. Total DDT concentration in each treatment was well below Food and Drug Administration guidance of 5.0 mg/kg wet weight. Total DDT was also below the concentration shown to cause effects in marine biota.

In 2006, stormwater from San Diego Creek and Santa Ana-Delhi watersheds was sampled to link contamination in Upper Newport Bay to stormwater runoff and identify possible sources of contamination (Peng et al., 2007). Stormwater particulate concentrations of DDTs were an order of magnitude greater at agricultural land use sites when compared to other land uses. Concentrations of DDTs from stormwater particulates were greater than or equal to concentrations in sediment collected from Upper Newport Bay, indicating that stormwater is contributing to DDT contamination in the bay.

Mercury

In May 2005, Weston collected sediment from 3 stations near Bayside Village Marina for Tier III analysis (Weston, 2005). Chemical analyses of the composite of all three stations did not indicate elevated levels of mercury; however, the concentration (0.82 mg/kg) at one station (3-2) exceeded the corresponding ER-M.

1.5.2.2 Distribution of Contaminants in Lower Newport Bay

Copper

In September 2000 and May 2001, Southern California Coastal Water Research Project (SCCWRP) conducted an assessment of sediment toxicity in Newport Bay (Bay et al., 2004). Samples were collected using a Van Veen grab, and the top 2 cm of multiple grabs were composited together for chemical analyses. Concentrations of copper in Rhine Channel sediment (634 and 607 mg/kg) exceeded the corresponding ER-M (270 mg/kg).

In 2002, SCCWRP conducted an assessment of contamination in Rhine Channel (Bay and Brown, 2003). Samples were collected from 15 stations using a Van Veen grab, and the top 2 cm of multiple grabs were composited together for chemical analyses. Copper concentrations exceeded ER-M at 14 stations with concentrations ranging 225 to 957 mg/kg. Highest concentrations were detected in the upper channel between 29th Street drain and the cannery area, and also the central part of the channel between Balboa Boatyard and South Coast Shipyard. However, the lowest concentrations were detected near the entrance to Rhine Channel.

In November 2004, Anchor Environmental conducted a sediment remediation feasibility study on the Rhine Channel (Anchor, 2006). Samples were collected with a piston corer at 16 stations (15 of the same locations sampled in the 2002 SCCWRP survey). Cores were split at distinct geologic layers and analyzed to characterize the vertical extent of contamination. Chemical analyses of the Rhine Channel sediment indicated elevated levels of copper. Surficial sediment exceeded corresponding effects range-low (ER-L) or ER-M at every station ranging from 88.9 to 635 mg/kg. Elevated concentrations were also consistently measured in subsurface sediment.

<u>DDTs</u>
In November 2000, MEC collected sediment cores from 6 sites near Linda Isle including the shoreline west of the main Upper Newport Bay Channel south of the Pacific Coast Highway bridge for Tier III analysis (MEC, 2001). Chemical analyses of the composite sample indicated elevated levels of the chemical analogues of DDT.   The concentration of 4,4'-DDE (39 µg/kg) exceeded the corresponding ER-M (27 µg/kg). A refined analysis of each station was performed to see if there were differences in sediment contamination within the area. Concentrations of 4,4'-DDE were undetectable at stations 2-1, 2-3, and 2-4. However, concentrations at stations 2-2, 2-5, and 2-6 ranged from 8 to 22 µg/kg, which exceeded corresponding ER-L of 4,4'-DDE, but were below ER-M. Bioaccumulation testing with clams and polychaetes resulted in elevated concentrations of DDTs in tissue; however, concentrations were lower than the concentration established by National Academy of Sciences (NAS) or National Sediment Inventory (NSI) as standards for maximum prey concentrations that are protective of wildlife. This indicates that the elevated concentrations of DDTs, while measurable are not sufficiently high enough to have adverse effects on wildlife. After full Tier III analysis, dredged material from the Linda Isle area was determined acceptable for ocean disposal at LA-3.

In May 2001, SCCWRP conducted an assessment of sediment contamination in Newport Bay (Bay et al., 2004). Samples were collected using a Van Veen grab, and the top 2 cm of multiple grabs were composited together for chemical analyses. Elevated levels of DDT congeners were detected in the Turning Basin station (NB4). Concentrations of 4,4'-DDD (25.6 µg/kg) and 4,4'-DDE (30.4 µg/kg) exceeded corresponding ER-M values. Total detectable DDTs (56.0 µg/kg) also exceeded corresponding ER-M.

In September and October 2002, MEC collected sediment cores from the Federal Channels in Lower Newport Bay for Tier III analysis (MEC, 2003b). Samples were collected from Balboa Reach (Area 1), Lido Isle Reach (Area 2), Harbor Island Reach (Area 3), and Newport Channel (Area 4). Chemical analyses of composite samples from all areas except Balboa Reach indicated elevated levels of DDT congeners. The concentration of 4,4'-DDE at Area 2 (51 µg/kg), Area 3 (31.8 µg/kg), and Area 4 (89.5 µg/kg) exceeded the corresponding ER-M. In Area 4, concentrations of 2,4'-DDE (30 µg/kg), 2,4'-DDT (9.2 µg/kg) and 4,4'-DDD (21.3 µg/kg), also exceeded the corresponding ER-M values. Total detectable DDTs in Area 2 (67.3 µg/kg) and Area 3 (161.9 µg/kg) exceeded the corresponding ER-M (46.1 µg/kg). Sediment chemistry was also performed on the individual cores to look at the differences in sediment contamination within the area. Individual core location analyses detected the highest concentrations of DDT congeners near the confluence of the different channels (Area 4), while the lowest concentrations were found along Balboa Channel (Area 3) and at the locations near the harbor entrance (southeastern portion of Area 1). Failure of the refrigeration unit may have compromised sample integrity; therefore areas were re-sampled in November 2002. Individual cores were analyzed for pesticides. There was a fair amount of variability between the two sampling events, suggesting that total DDT is somewhat patchy in its spatial distribution within Newport Harbor. A second sampling and analysis effort was conducted in May 2003 to assess the vertical distribution of DDT contamination (MEC, 2003b). Nineteen of the original 28 stations and two new stations in the vicinity of Harbor Island Reach were sampled. Results indicated fairly widespread contamination of DDT congeners. ER-M values were exceeded at nearly every depth in each location with the exception of station 5 and 30. Highest concentrations were found at three feet or more below the surface (Figure 5). This indicates that it may be possible to dredge and ocean dispose the cleaner material within the top few feet of the surface, provided they pass the OTM suitability determination.

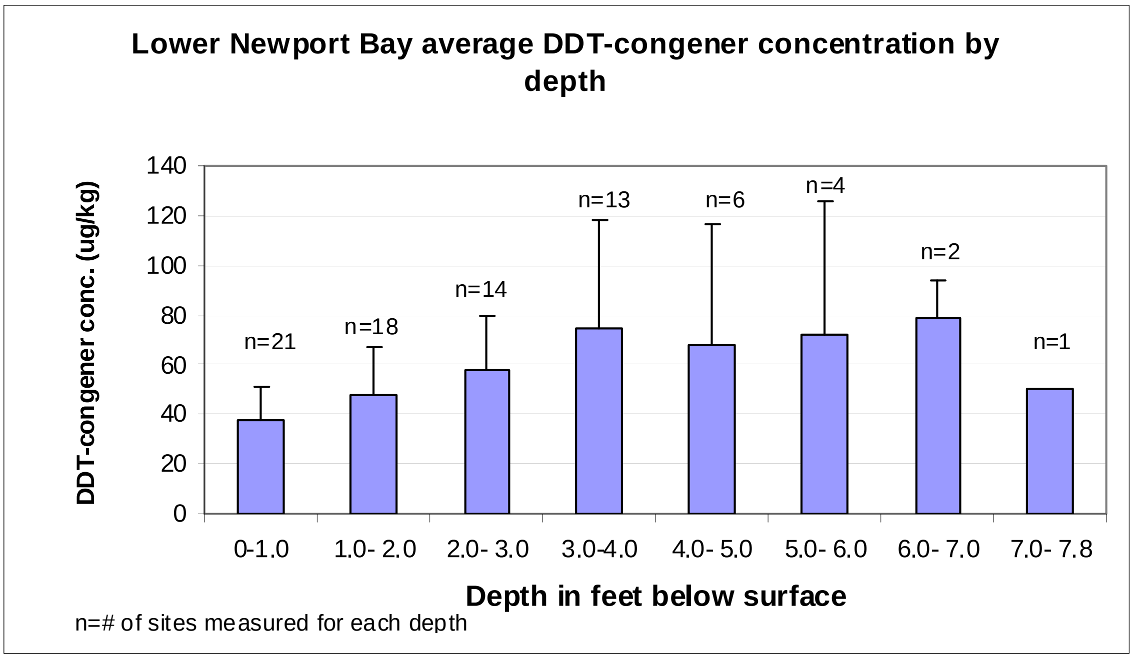

Figure 5. Average DDT-congener concentrations (µg/kg) in Lower Newport Bay along one foot depth increment (MEC 2003b).

In 2002, SCCWRP conducted an assessment of contamination in Rhine Channel (Bay and Brown, 2003). Samples were collected from 15 stations using a Van Veen grab, and the top 2 cm of multiple grabs were composited together for chemical analysis. Elevated levels total DDTs were detected at concentrations ranging 30 to 98 µg/kg, some which exceeded corresponding ER-M. Highest concentrations were detected near the entrance to Rhine Channel.

In November 2004, Anchor Environmental conducted a sediment remediation feasibility study on the Rhine Channel (Anchor, 2006). Samples were collected with a piston corer at 16 stations (15 of the same locations sampled in the 2002 SCCWRP survey). Cores were split at distinct geologic layers and analyzed to characterize the vertical extent of contamination. Chemical analyses of the station RS04-01 indicated elevated levels of 4,4'-DDE in subsurface sediments, which exceeded corresponding ER-M.

In May 2005, Weston collected sediment from Lower Newport Bay for Tier III analysis (Weston, 2005). Samples were collected from two areas. Area 1 included the area near Lido Island and the north shore of Balboa Peninsula. Area 2 included the area south of the Pacific Coast Highway Bridge, north of Harbor Island Reach, and the shorelines of Linda Isle and Harbor Island. Chemical analyses of the composite samples indicated elevated levels of DDT congeners. The concentrations of 4,4'-DDE at Area 1 (28 µg/kg) and Area 2 (30 µg/kg) exceeded the corresponding ER-M. The concentrations of DDT congeners were also elevated in tissue chemistry of *M. nasuta* and *N. caecoides* after bioaccumulation testing. However, total DDT concentrations were well below U.S. Food and Drug Administration (FDA) guidance of 5.0 mg/kg wet weight. Total DDT concentrations were also below the concentration shown to cause effects in marine biota.

Mercury

In August 1998, MEC performed a Tier II investigation on Lower Newport Bay Harbor (MEC 1998). Sediment from the Main Channel and three areas surrounding the Main Channel were sampled for chemical and physical analyses to support ocean disposal of the dredged material at the LA-3 USEPA designated ocean disposal site. Chemical analyses of project sediments indicated relatively low concentrations of all analytes measured with the exception of mercury. The concentration of mercury (1.16 mg/kg) at station A3-10 (south of Harbor Island surrounding Main Channel) exceeded the corresponding ER-M (0.71 mg/kg).

In September and October 2002, MEC collected sediment cores from the Federal Channels in Lower Newport Bay for Tier III (MEC, 2003b). Samples were collected from 5 sites within Lido Isle Reach (Area 2). Chemical analyses of the composite sample indicated elevated levels of mercury (0.72 mg/kg), which exceeded the corresponding ER-M.

In September 2000 and May 2001, SCCWRP conducted an assessment of sediment contamination in Newport Bay (Bay et al., 2004). Samples were collected using a Van Veen grab, and the top 2 cm of multiple grabs were composited together for chemical analyses. Concentrations of mercury in Rhine Channel sediment (5.3 and 5.8 mg/kg) and Turning Basin sediment (1 and 0.73 mg/kg) exceeded the corresponding ER-M. As described in *Newport Bay Toxics TMDLs*, mercury concentrations in Rhine Channel have historically exceeded the ER-M. Sediment TMDL target for mercury has been developed for Rhine Channel (0.13 mg/kg).

In 2002, SCCWRP conducted an assessment of contamination in Rhine Channel (Bay and Brown, 2003). Samples were collected from 15 stations using a Van Veen grab, and the top 2 cm of multiple grabs were composited together for chemical analyses. Elevated levels of mercury were detected at every station. Concentrations ranged from 2.4 to 14.3 mg/kg and exceeded corresponding ER-M. Highest concentrations were detected in the upper channel between 29th Street drain and the cannery area. Lowest concentrations were detected near the entrance to Rhine Channel.

In November 2004, Anchor Environmental conducted a sediment remediation feasibility study on the Rhine Channel (Anchor, 2006). Samples were collected with a piston corer at 16 stations (15 of the same locations sampled in the 2002 SCCWRP survey). Cores were split at distinct geologic layers and analyzed to characterize the vertical extent of contamination. Chemical analysis of the Rhine Channel sediment indicated elevated levels of mercury. Surficial sediment exceeded corresponding ER-M at every station ranging from 1.12 to 3.68 mg/kg. Elevated concentrations were also consistently measured down to the interface between native and recent sediments.

In May 2005, Weston collected sediment from 10 sites around Lido Island including the north shore of Balboa Peninsula for Tier III analysis (Weston, 2005). Chemical analyses of the composite sample indicated elevated levels of mercury. The concentration of mercury (0.82 mg/kg) exceeded the corresponding ER-M.

Other Contaminants
Besides copper, DDTs, and mercury, several other contaminants of concern were detected in Rhine Channel sediment. In 2002, total PCBs and zinc were detected at concentrations greater than ER-M (Bay and Brown, 2003). Highest concentrations of total PCBs were detected in the upper channel between 29^{th} Street drain and the cannery area. In 2004, lead, zinc, total PAHs, and total PCBs were all detected at concentrations greater than corresponding ER-M values (Anchor, 2006). Elevated concentrations of arsenic, cadmium, nickel, and tributyltin (TBT) were also detected in surface and subsurface samples throughout the channel.

1.5.3 Review of Existing Sediment Toxicity Data

Extensive toxicity testing has been performed in Newport Bay over the last several years. Many of these tests resulted in measurable or significant toxicity to test organisms. Toxicity testing conducted within the last 3 years has identified specific areas that were not suitable for ocean disposal. Based on these evaluations, approximately 561,280 cy of this material is not suitable for ocean disposal and is recommended for beneficial use or treatment. A summary of toxicity in Newport Bay sediment is discussed in the following sections.

1.5.3.1 Sediment Toxicity in Upper Newport Bay

In November 2000, MEC collected sediment cores from 5 sites in Upper Newport Bay (including offshore of Newport Dunes, Dover Shores, and the Upper Newport Bay boat launch facility) for Tier III analysis (MEC, 2001). Measurable toxicity was observed in solid phase (SP) testing of the composite sample with *Eohaustorius estuarius* and *Mysidopsis bahia*. Biological significant toxicity was only observed with the amphipod. Measurable effects were also observed with suspended particulate phase (SPP) testing with *Mytilus galloprovincialis* (median effect concentration [EC_{50}] = 75%). As a composite sample, project material from Upper Newport Bay was determined unacceptable for ocean disposal at LA-3. It is possible contamination and associated toxicity is not distributed evenly throughout the area; therefore, additional testing was conducted on each station. A second sampling episode was conducted in March 2001 to collect additional material for toxicity analysis. Stations 3-1, 3-3, and 3-4 resulted in measurable toxicity on mussel larvae exposed to sediment elutriates; however, a short term fate (STFATE) model was run and samples met limiting permissible concentration (LPC) requirements for ocean disposal. SP testing with *E. estuarius* at station 3-1 resulted in significant toxicity relative to the reference sediment. Therefore, this sample was not acceptable for ocean disposal at LA-3.

In March 2002, MEC collected sediment cores from Upper Newport Bay for Tier III analysis (MEC, 2003a). Sediment elutriate testing with *Strongylocentrotus. purpuratus* (EC_{50} = 15.5 to 66.7%) resulted in measurable toxicity to Areas A Top and Bottom (Unit II Basin), B Bottom

(Unit I/III Basin), D Upper Channel (access channel from Unit I/III Basin to Unit II Basin), D Lower Channel (access channel from Unit II Basin to Pacific Coast Highway bridge), HD (Hot Dog Island Channel), N (New Island East Side Channel), and SA (Santa Ana-Delhi Channel). Sediment elutriate testing with *Menidia beryllina* (LC_{50} = 57.4 to 86.0%) resulted in measurable toxicity to Areas A Top, B Top, HD, and N. Therefore, a STFATE model was performed and all samples met LPC requirements for ocean disposal.

In September 2000 and May 2001, SCCWRP conducted an assessment of sediment toxicity in Newport Bay (Bay et al., 2004). One goal of this study was to determine if toxicity is persistent year-round. Samples were collected using a Van Veen grab for the September survey and diver cores for the May survey. The top 2 cm were composited together for SP testing using *E. estuarius*. Five samples were collected from Upper Newport Bay. Results indicated the same spatial pattern of toxicity between both sampling events, with 60% of samples toxic. Toxicity was present year round and not influenced by seasonal factors. Samples collected from the entrance of Dune Lagoon (NB6), from Unit II Basin (NB8), and from the mouth of San Diego Creek (NB10) demonstrated measurable toxicity. The mouth of San Diego Creek station demonstrated significant and persistent toxicity. Therefore, toxicity identification evaluations (TIE) were conducted with sediment from this station to identify the contaminants of concern. TIE results indicated that multiple toxicants of concern were present. Toxicity was most likely not due to metals or naturally occurring factors (i.e. grain size, ammonia). Nonpolar organic constituents were the dominant toxicant; however, a review of chemistry indicated that DDTs, PCBs, and PAHs were not likely responsible for toxicity. Toxicity at this site is most likely due to runoff of an unmeasured contaminant such as an organic pesticide (i.e., pyrethroids).

In May 2005, Weston collected sediment from 6 stations immediately above the Pacific Coast Highway bridge for Tier III analysis (Weston, 2005). Two composite samples were created. Area 3a consists of sediment from 3 stations in the channel and marina immediately north of Galaxie View Park. Area 3b consists of sediment from 3 stations near Bayside Village Marina. Sediment elutriate testing with sediment from Areas 3a and 3b resulted in measurable toxicity to *Mytilus sp*. (EC_{50} = 67 and 91%, respectively). A STFATE model was performed and all samples met LPC requirements for ocean disposal.

1.5.3.2 Sediment Toxicity in Lower Newport Bay

In September/October and November 2002, MEC collected sediment cores from the Federal Channels in Lower Newport Bay for Tier III analysis (MEC, 2003b). Samples were collected from 5 sites within each area (Balboa Reach, Lido Isle Reach, Harbor Island Reach, and Newport Channel). SPP testing of Area 4 (Newport Channel) resulted in measurable toxicity (EC_{50} = 79.8%) to mussel larvae. A STFATE model was run and the sample met LPC requirements for ocean disposal. SP testing of all samples resulted in measurable toxicity to the amphipod *E. estuarius*. Survival was significantly lower and 20% less than survival of animals exposed to the reference. Therefore, samples did not meet LPC requirements for ocean disposal. A second sampling and analysis effort was conducted in July 2003 (MEC, 2003b). It was thought that further sampling and analysis might lead to the delineation of cleaner sub-areas for which ocean disposal would be acceptable. SP testing of Area 8 (Upper Yacht Anchorage off of the southeastern end of Lido Isle) and Area 14 (south of Harbor Island at the intersection of Main Channel and Balboa Channel) resulted in significant toxicity to *E. estuarius*. Therefore, these samples were also determined to not be suitable for ocean disposal.

In September 2000 and May 2001, SCCWRP conducted an assessment of sediment toxicity in Newport Bay (Bay et al., 2004). One goal of this study was to determine if toxicity is persistent year-round. Samples were collected using a Van Veen grab, and the top 2 cm of multiple grabs were composited together for SP testing using *E. estuarius*. Five samples were collected from Lower Newport Bay. Results indicated the same spatial pattern of toxicity between both sampling events, with 80% of samples toxic. Toxicity was present year round and not influence by seasonal factors. Samples collected at north side of Bay Island (NB2), Rhine Channel (NB3), Turning Basin (NB4), and Lido Isle Reach (NB5) demonstrated measurable toxicity. Rhine Channel station demonstrated significant and persistent toxicity. Therefore, TIEs were conducted with sediment from Rhine Channel to identify the contaminants of concern. TIE results indicated that multiple toxicants of concern were present and metals may have contributed to toxicity. Copper and mercury were detected at this site at concentrations greater than the corresponding ER-M. Toxicity was not due to naturally occurring factors (i.e. grain size, ammonia). The TIE did not characterize the contaminant most likely responsible for toxicity.

In 2002, SCCWRP conducted an assessment of contamination in Rhine Channel (Bay and Brown, 2003). Samples were collected from 15 stations using a Van Veen grab, and the top 2 cm of multiple grabs were composited together for SP testing with *E. estuarius*. Eleven sites were toxic (significantly different and less then 80% of control survival) to amphipods. The most toxic sites were at the entrance of the Rhine Channel and near Lido Shipyard. However, most sites in the upper portion of Rhine Channel were not toxic to *E. estuarius*.

1.5.3.3 Confounding Factors

Specific areas of Newport Bay found unsuitable for ocean disposal were the result of significant toxicity to *E. estuarius*. Current investigations suggest that some toxicity observed to *E. estuarius* may be the result of confounding factors (i.e. grain size) and not the result of contamination (NewFields, 2007, currently under review). The indigenous habitat of *E. estuarius* typically is sandy sediment. While these organisms are tolerant of a wide variety of grain sizes, extremely fine sediments may not be suitable. Studies have shown that survival of many organisms may be affected by grain size distribution (DeWitt et al., 1989). In addition, previous studies conducted by Weston (formerly MEC Analytical) have demonstrated that survival of *E. estuarius* is affected by grain size extremes (i.e., >75% sand or >75% clay). Specifically, increased mortality associated with increased proportions of sand or clays in sediment. To determine whether toxicity measured in Newport Bay was confounded by grain size, additional testing with multiple amphipod species is recommended in conjunction with pore water testing.

1.6 Recommendations

1.6.1 Phase 1 – Near-Term Solution for Management of Dredged Materials and Maintenance of Navigational Depths

1. Sediment Management Plan – 1 year / $350,000
    a. Management of Materials meeting Ocean Disposal Suitability Requirements
    b. Management of Materials for Beneficial Use
        i. Review of alternatives with logistical, technical, and economic feasibility evaluation
        ii. Geotechnical evaluation for construction or bulkhead restoration suitability
    c. Management of Materials Unsuitable for Either Ocean Disposal or Beneficial Use
        i. Identification of sediment rehandling facility
        ii. Identification and evaluation of CAD facilities/alternatives
2. MPRSA Tier III evaluation - 6 months / $400,000
3. Master Dredging Plan and Schedule – 6 months / $90,000
    a. Design and Dredging Requirements
    b. Schedule including consideration of environmental windows
    c. Identification and Mitigation of Potential Impacts: Habitat, Water Quality, Harbor Activities, Navigation and Public Access, Noise, Aesthetics, Air Quality
    d. Equipment and Best Management Practices (BMPs)

1.6.2 Phase 2 – Long-Term Solution Management of Dredged Materials and Maintenance of Navigational Depths

1. Sediment Transport Study – 9 months / $100,000
    a. Data Collection, Analysis and Modeling
    b. Forecasted Sediment Budget for Lower Newport Bay and Estimate of Future Dredging Needs
2. Sustainability Plan for Maintenance of Harbor Channels – 6 months / $175,000
    a. Identification and Discussion of significant load sources (contaminants and sediments)
    b. Identification and Discussion of relevant BMPs for reduction of source loadings
    c. Identification and Discussion of Potential Future Development Impacts
    d. Long-term Management Plan for Future Dredging Needs

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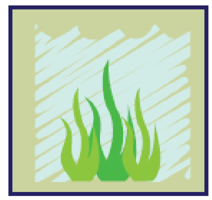
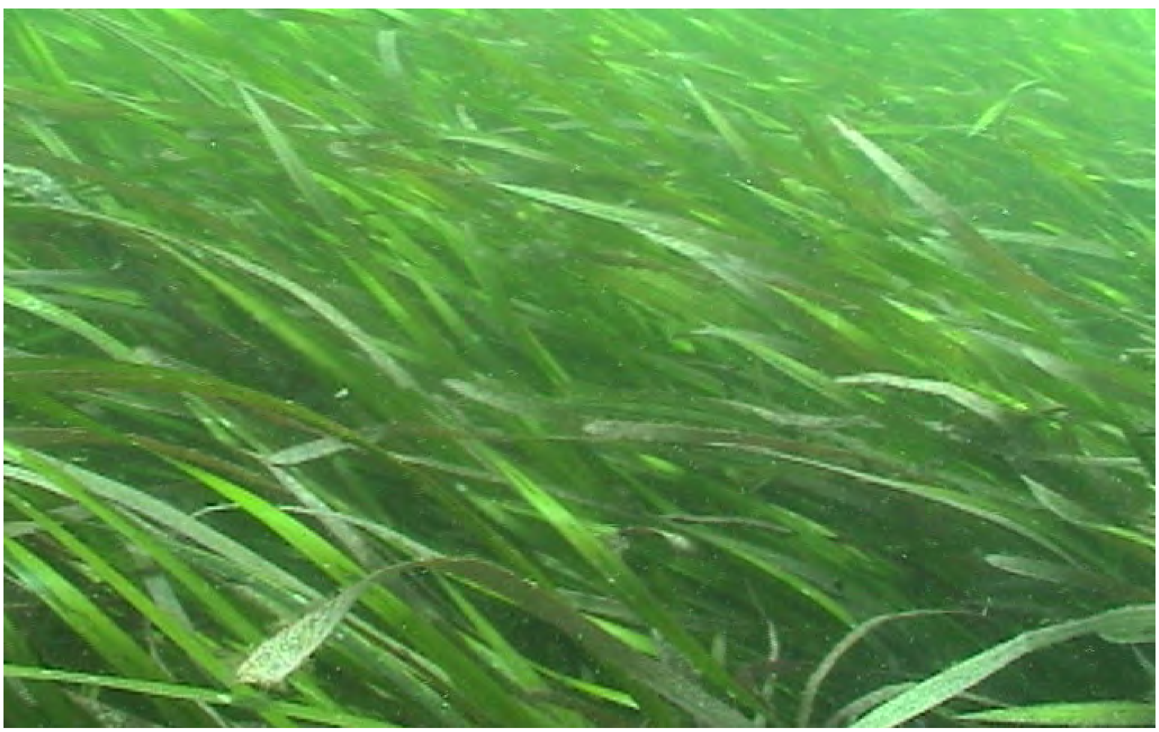
APPENDIX B

Eelgrass Capacity and Management Tools





"The following technical report reflects the findings and data available at the time the report was prepared and may not represent the current conclusions and steps forward in the main text of the HAMP, which has been updated after the completion of these reports. These more detailed technical reports provided in the appendices represent the foundation for the overall approach to the HAMP, but are not "living" documents that reflect updated steps forward, costing, quantities, etc. presented in the main text of the HAMP. The main text of the HAMP represents more current information and recommendations based on updated information, new studies, changes in conditions, new funding sources, and/or new regulations."

HARBOR AREA MANAGEMENT PLAN

EELGRASS CAPACITY AND MANAGEMENT TOOLS

Technical Report

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April 2008; Revised June 2009

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1.0 EELGRASS CAPACITY AND MANAGEMENT TOOLS

1.1 Introduction

The marine resources of Newport Harbor are extremely diverse and rich and are extremely important to the health and maintenance of nearshore coastal resources. The City of Newport Beach is committed to achieving a sustainable Newport Harbor area through the projection and improvement of harbor marine resources, including marine plants, invertebrates, fishes, seabirds, marine mammals, and the habitats that they are associated with.

One of the most important biological resources within Newport Harbor is eelgrass (*Zostera marina*). It is considered wetland habitat by state of California and federal wetland definitions and is protected by a no net loss wetlands policy. Any development that has a potential to adversely affect eelgrass must include provisions to avoid, reduce the level of impacts, or compensate for losses of eelgrass habitat values.

1.2 Objectives

The objectives of this technical report are as follows:

- Identify historical and current eelgrass distributions in Newport Bay.
- Identify key issues related to resource management conflicts between eelgrass and the management goals of Newport Harbor.
- Provide recommendations for developing and implementing an Eelgrass Management Plan for Newport Harbor.
- Provide information and data requirements needed to develop a long-term management program of eelgrass bed resources in Newport Bay.

1.3 Organization

This technical report provides a detailed review of eelgrass biology and its distribution and abundance in Newport Bay. Data are then presented to determine the regions within the Bay where the potential for future eelgrass sustainability sites are the highest. A plan for the long-term mitigation requirements related to harbor infrastructure projects impacts on eelgrass bed resources is presented. The report concludes with data requirements to implement a long-term mitigation program.

2.0 EELGRASS BIOLOGY AND DISTRIBUTION IN NEWPORT BAY

2.1 Importance of Eelgrass

Eelgrass (Figure 1) is a marine flowering plant that grows in soft sediments in coastal bays and estuaries and occasionally offshore to depths of 50 ft. Eelgrass forms meadows on mudflats and subtidal sediment in bays and estuaries. The presence of eelgrass in Newport Harbor is a biologically important feature because of the high biological productivity associated with eelgrass beds. Eelgrass meadows form a basis of primary production that supports ecologically and economically important species (Orth et al., 1984; Thayer et al., 1984).

Source: CRM, Inc.

Figure 1. Eelgrass (*Zostera marina*)

As a primary producer, eelgrass fixes carbon at rates that are equivalent to or exceed the rates of the most intensively farmed agricultural crops (Thayer et al., 1984). Epiphytes such as diatoms and green algae that attach to eelgrass blades add to this high level of productivity (Thayer et al., 1984; Phillips and Menez, 1988). The organic matter in the form of shoots, blades, and roots is transferred to both invertebrate and vertebrate secondary consumers that feed on the particulate matter through the detrital feeding pathway. In addition, invertebrate and fish predators forage upon the diverse types of detrital feeding invertebrates which congregate within eelgrass habitat.

Eelgrass meadows (and subunits called “beds” and “patches”) are important habitat for invertebrates as a source of food and attachment and for marine fishes that seek the shelter of the beds for protection and forage on invertebrates that colonize the eelgrass blades and sediments in and around eelgrass vegetation.

Eelgrass canopy (consisting of shoots and leaves approximately 2–3 ft long) attracts many marine invertebrates and fishes, and the added vegetation and the vertical relief it provides enhances the abundance and the diversity of the marine life compared to areas where the sediments are barren. Juvenile California halibut (*Paralichthys californicus*) and California spiny lobsters (*Panulirus interruptus*)—which are of sports fish and commercial value as adults—use eelgrass beds as a nursery habitat. The vegetation also serves a nursery function for many juvenile fishes, including species of commercial and/or sports fish value (e.g., California halibut and barred sand bass) and federal Fishery Management Plan (FMP) groundfish species (e.g., lingcod, and Boccaccio rock fish).

A diverse community of bottom-dwelling invertebrates (e.g.., clams, crabs, and worms) live within the soft sediments that cover the root and rhizome mass system. Eelgrass is an important contributor to the detrital (decaying organic) food web of bays because the decaying plant material is consumed by many benthic invertebrates (e.g., polychaete worms) and reduced to primary nutrients by bacteria. This carbon is then transported offshore and becomes important sources of nutrients for coastal food webs.

Eelgrass coexists and competes for bottom habitat and sunlight with benthic algae. For example, eelgrass meadows in Newport Bay often co-occur in the low intertidal or shallow subtidal zone with green algae (*Enteromorpha spp)* and in deeper parts of the meadow, with brown algae (*Ectocarpus*), and red algae (*Acrosorium* and *Gracilaria)*. Eelgrass in Newport Bay and other Southern California bays also support unusual or rare species, including Pacific seahorse (*Hippocampus ingens*) that became established as a result of warm water intrusions into Southern California produced by El Nino conditions and the juvenile broad-eared pecten (*Leptopecten latiauratus*) which attaches to eelgrass shoots and blades.

Eelgrass meadows are also foraging centers for endangered seabirds, such as the California least tern (*Sterna albifrons browni*) and California brown pelican (*Pelecanus occidentalis*), that feed on topsmelt and anchovy that congregate within eelgrass meadows.

From a recreational standpoint, eelgrass meadows in Newport Bay provide fishing opportunities for boat and kayak fishermen; this translates into a consistent economic base for businesses within Newport Beach, including the recreational fishing industry, boat and kayak rental/retail stores, and food concessions. Detailed fishing charts of Newport Harbor were recently produced that include the Coastal Resources Management, Inc. (CRM, Inc.) 2003–2004 eelgrass habitat maps produced for the Harbor Resources Division (http://www.bajadirections.com).

2.2 Key Issues

From a resource management perspective, the presence of eelgrass within Newport Harbor often conflicts with the development and the maintenance of federal, state, city, and residential infrastructure. From a geological perspective, eelgrass beds dampen wave and current action, trap suspended particulates, and reduce erosion by stabilizing the sediment (National Marine Fisheries Service (NMFS) 1991, as amended). Once established, eelgrass colonization will promote additional shoaling that can be a navigational hazard. Dredging of these shoals; maintenance of navigational channels, bulkhead, pier and dock construction and/or maintenance; and beach nourishment along the shoreline of Newport Harbor directly affects eelgrass through burial or removal of vegetation and a loss of eelgrass function as a wildlife habitat. Other activities may also indirectly affect the distribution and abundance of eelgrass. Dredging activity, pile driving activity, and stormwater flows via street-end storm drains and Upper Newport Bay that discharge into Newport Harbor increase water turbidity and decrease the amount of underwater irradiation that reaches the bayfloor. Secondary effects from boat dock and pier construction will permanently shade soft bottom habitat. Because eelgrass is considered wetland habitat by state of California and federal wetland definitions, it is protected by a no net loss wetlands policy. Any development that has a potential to adversely affect eelgrass must include provisions to avoid, reduce the level of impacts, or compensate for losses of eelgrass habitat values.

These projects are undertaken as federal, state, local agency projects, or individual resident's projects which do not qualify under the City's Regional General Dredging Permit (RGP 54) due to the presence of eelgrass within 15 ft of their docks, bulkhead, piers, or beach nourishment projects. More detailed and, to the homeowners, more costly analyses are required under these circumstances if they do not qualify for inclusion in the RGP.

The City of Newport Beach has an adopted a Coastal Commission-approved land use plan (LUP). The LUP acknowledges that the need to maintain and develop coastal-dependent uses may result in impacts to eelgrass. To mitigate the potential impacts to eelgrass of dredging and development, the LUP requires the avoidance where possible and restoration where avoidance is not practical:

The City and all the stakeholders need to develop an eelgrass mitigation program to allow the City to go forward with dredging and construction activities that are necessary and will impact eelgrass.

2.3 Eelgrass Distribution and Abundance

Many factors, both abiotic and biotic, have an influence on eelgrass distribution and abundance. These factors are discussed below.

2.3.1 Sediments

Eelgrass colonizes a range of sediments varying from firm sand with moderate wave action to soft muds in quiet bays (Phillips, 1974). In Newport Bay, eelgrass colonizes in sediments that range from fine sands to silt/clay (Coastal Resources Management, Inc., in progress). Eelgrass grows in predominantly fine sand sediments between the entrance channel to Harbor Island. In most other areas of the Bay, eelgrass colonizes siltier, less compact sediments. Results of sediment grain-size analysis in eelgrass beds and in sediments where eelgrass is not found in Newport Bay (CRM, Inc. in progress) indicate that on the average, eelgrass can grow in a wide range of sediment types with as little as 4% sand (Linda Isle Inlet) and as much as 97% sand (near the harbor entrance). On average however, sediments tended to consist of approximately 10% more sands in eelgrass beds than in unvegetated sediments, although the proportions of sand and silt/clay can be highly variable. Typically, sediments exhibit a decreasing grain size with increasing depth in Newport Bay (Ware, 1993; Chambers Group Inc. and Coastal Resources Management, 1998; Chambers Group Inc. and Coastal Resources Management, 1999) as well as lower velocity current regimes.

2.3.2 Depth Distribution

The upper elevational range limit of eelgrass on naturally sloped shorelines is primarily regulated by desiccation, sediment stability, and wave shock (Phillips, 1974). In Newport Bay, this limit appears to be approximately at the mean lower low water (MLLW) mark (0.0 ft), although it can occur as high as +1 ft MLLW. However, in many areas of Newport Bay and other modified Southern California embayments, its upper range limit is also affected by dredging and bulkheading activity that eliminates natural intertidal slopes and eelgrass meadows. Within Newport Bay, eelgrass is found at depths as great as -25 ft MLLW in the entrance channel, although it more typically occurs in other areas of Newport Bay at depths from 0.0 ft and -8.0 ft (Ware, 1993; NMFS, 2003; CRM, Inc., 2005 and 2008; CRM in progress; Chambers Consultants Inc. and Coastal Resources Management, 1998 and 1999).

2.3.3 Wave/Current Energy

Some water motion is needed to supply nutrients to the plants, cool the flats, and prevent the buildup of floating organic matter that can smother eelgrass (Thom et al., 2003). Strong waves and currents will erode the sediment in an eelgrass bed (Phillips, 1984).

Light, temperature, and salinity also control growth and productivity of seagrasses (Thayer et al., 1984; Backman and Barilotti, 1976; Zimmerman et al., 1991). Of these, light is the factor which often controls the depth, distribution, density, and productivity of seagrass meadows (Backman and Barilotti, 1976; Zimmerman et al., 1991).

2.3.4 Light Penetration

In Newport Bay, as in other shallow-water embayments, light penetration is affected by parameters, such as time of day and year, tidal condition, suspended organics and sediment input into the bay from dry-season runoff, winter storms, plankton blooms, shading from docks and boats, and in-bay activities such as dredging and boating activity (ACOE, 1998; 1996; MBC Applied Environmental Sciences and SCCWRP, 1980; CRM, Inc. in progress).

Light penetration is better during the incoming tides compared to outgoing tides which carry higher levels of suspended organics and sediments out of Newport Bay. Zimmerman et al. (1991) estimated that eelgrass in San Francisco Bay required between three and five hours a day of irradiance to maintain carbon balance and growth and suggested that eelgrass is adapted to extremely low light availability.

Higher water turbidity in coastal embayments limits eelgrass depth distribution to intertidal and shallow subtidal environments (Zimmerman et al., 1991). This is reflected in Newport Bay with eelgrass exhibiting a greater depth range nearer the harbor entrance compared with eelgrass beds located near Harbor Island, Balboa Island, Linda Isle, and Upper Newport Bay where water clarity is poorer and sediments are much finer (CRM, Inc., 2005). Generally, the compensation depth for seagrasses is approximately 11% of the available surface irradiance (Duarte, 1991).

Eelgrass growth and distribution is also affected by a decrease in solar radiation resulting from seafloor shading from docks, piers, and vessels. Studies indicate that shoot densities of seagrasses decrease near docks and pilings and that the construction of docks and piers can lead to a permanent loss of seagrass vegetation (Beal and Schmit, 2000). In addition, the height of pier structures will affect how much light can penetrate beneath the piers. In locations such as Corona del Mar where piers are elevated several feet off of the sediments, eelgrass will grow underneath the piers. In other areas, structures (e.g., along Balboa and Harbor Island piers and gangways) are not as elevated and allow less light penetration beneath. Consequently, eelgrass may not grow as well or may be absent altogether underneath these structures (Coastal Resources Management, Inc., 2005).

2.3.5 Temperature

Eelgrass is a eurythermal species (Phillips, 1984). Its optimal temperature distribution is between 10^{o} Celsius (C) and 20^{o} C ($50–68^{o}$ F). Its extreme temperature ranges may vary from -6^{o} C in Alaska to 40.5^{o}C ($21.2^{-}104.9^{o}$ F). Therefore, water temperatures in Newport Bay are generally not a limiting factor for eelgrass growth and distribution. During late summer, water temperatures in Newport Bay can exceed 21^{o} C for sustained periods of time (CRM, Inc., in progress) that promote seasonal biofouling of the blades. The heavy blades then bend and come in contact with the sediments that lead to eventual burial and loss of eelgrass above-ground biomass.

Eelgrass may display some genetic and/or environmentally associated variations in response to water temperature and/or light requirements. For example, wider-bladed meadows of eelgrass occur primarily in the deeper, cooler entrance channel waters of Newport Bay, whereas a narrower-bladed variant is found throughout the other regions of Newport Bay in shallower, warmer conditions (Figures 2 and 3). Recently, wide-blade eelgrass in the Channel Islands was identified as a different species (*Zostera pacifica*) (Coyer et al., 2007), whereas before it was considered either a subspecies (Z. *marina var latifolia*) or a separate species (*Z. asiatica*) (Phillips and Wyllie-Echeverria, 1990). Currently, it is not known if the wide-blade variant form in the entrance channel is the subspecies *Z. marina var latifolia* or if it is considered to be *Z. pacifica*. The genetic differences and the relative differences in depth and geographical distribution of the two forms within Newport Bay suggest that future mitigation efforts need to take into account the morphological and genetic differences when collecting donor material for specific projects and the selection of the eelgrass mitigation site.

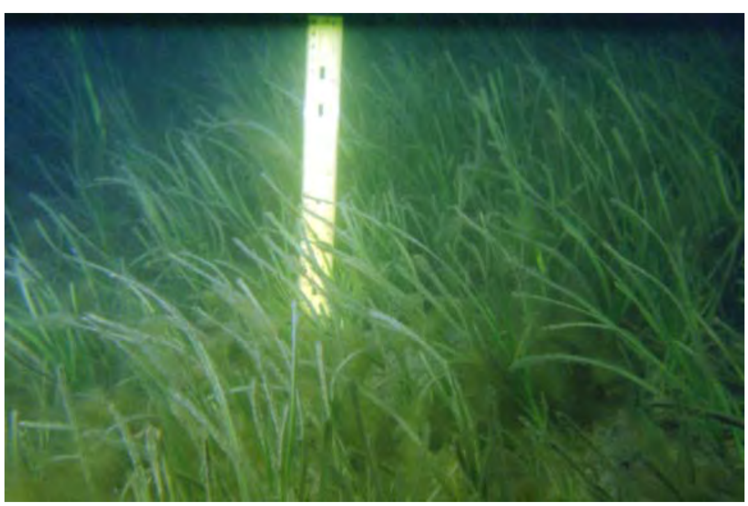


Figure 2. Narrow-Bladed Eelgrass

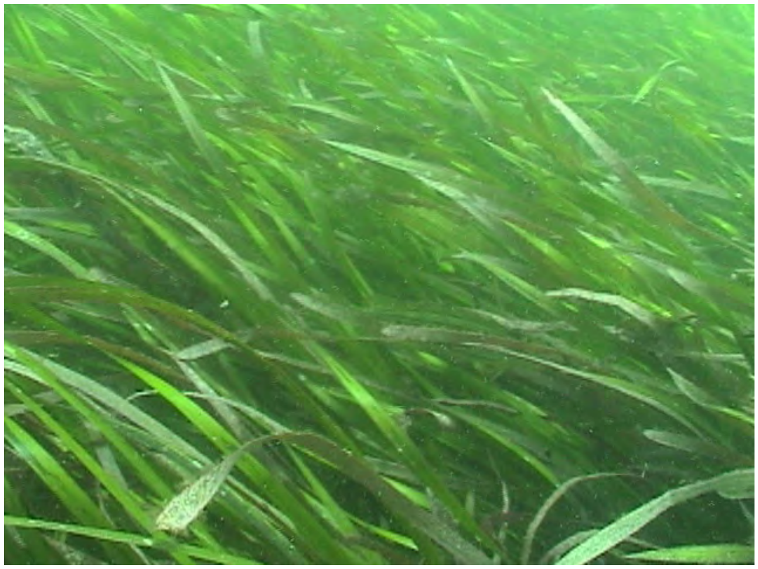


Figure 3. Wide-Bladed Eelgrass

2.3.6 Salinity

Eelgrass is also a eurysaline species, tolerating a wide range of water salinities, including the range of salinities that Newport Harbor experiences. It has been documented to grow at stream mouths when the water is fresh at low tide (Phillips, 1984) but does not grow in persistent freshwater. At the other extreme, eelgrass can grow in waters of extreme salinity (42 ppt). In Puget Sound, eelgrass grows best in a salinity of 20 to 32 ppt. Phillips (1972) found that most (70%) eelgrass seed germination occurred at 5 to 10 ppt at all temperatures, although at 10 ppt, seed germination often doubled from 10° C to 15° C but did not do so in full strength seawater (30 ppt). Newport Bay salinity, on the average range between approximately 30 to 33 ppt, although during wet periods, surface salinity may decrease to below 25 ppt for short periods of time. In addition, salinity is typically lower in the Upper Bay due to runoff from the Newport Bay Watershed.

2.3.7 Oxygen

Under normal growing conditions, oxygen is not a limiting factor for eelgrass. However, during periods of high turbidity which may result in significant light limitation and decrease in photosynthesis and oxygen production, eelgrass root and rhizome tissue may experience periods of anoxia. While eelgrass tissue apparently can withstand periods of 24 hrs of anoxia (Smith, 1989), the long-term cumulative effects of prolonged anoxia are not known, but it is possible that eelgrass distribution, particularly at its deeper limit, may be negatively affected (Zimmerman et al., 1991).

2.3.8 Nutrients

Eutrophication is one of the main causes for decreased light availability that can lead to a decline of eelgrass populations. As excess nutrients stimulate phytoplankton growth, light penetration to the plants growing at depth is reduced. Increased epiphytic (and benthic) macroalgae growth from excessive nutrient loading can shade and suffocate eelgrass plants. As light diminishes, the plants develop thinner blades, leading to lower rates of productivity and a decrease in biomass and lower shoot densities (Denison, 1987).

2.3.9 Synergistic Effects

There is a lack of available data that compare submarine light levels, turbidity levels, eelgrass compensation depths, and temperature variations within vegetated and unvegetated regions of Newport Harbor. These data are required to understand the observed differences in eelgrass cover and density among the various regions of the bay, and to identify areas that may or may not be suitable for future eelgrass transplants. Consequently, studies are currently being conducted that will address these parameters and how they influence eelgrass distribution in Newport Bay (CRM, Inc., in progress).

2.3.10 Summary of Other Relevant Scientific Information Regarding Eelgrass Structure and Function

Few studies have directly approached the biological diversity and habitat value of eelgrass within Newport Bay. These studies are critical to understand the relative habitat importance and value of eelgrass habitat within the various regions of Newport Bay, and to be able to make informed management decisions relative to eelgrass mitigation. For example, do sparse, low-density, and patchy eelgrass beds along Mariner's Mile provide the same habitat value for marine life as eelgrass beds near the Harbor Entrance Channel, and should all eelgrass areas of Newport Harbor be treated the same from a harbor management perspective?

While not comprehensive or quantitative, a list of organisms observed during the 2003–2004 bay wide eelgrass habitat surveys included 63 species. Of these, one was a sulphur bacterium, nine were algae species, two were seagrasses, 31 were invertebrates, and 20 were fishes. Data were not analyzed by region with the harbor. During eelgrass surveys conducted in July 1999, 28 species of macro invertebrates were observed living on eelgrass or in sediments of eelgrass beds. The most common forms were speckled scallops (*Argopecten aequisulcatus)*, anemones (*Pachycerianthus fimbriatus*), snails and sea slugs (*Bulla gouldiana and Navanax inermis*) and nudibranchs (*Anisodoris nobilis*). During both the 2003–2004 and 1999 surveys, commonly encountered fish included topsmelt (*Atherinops affinis*), spotted sand bass (*Paralabrax maculatofasciatus*), barred sand bass (*P. nebulifer*) and round string ray (*Urolophus halleri*). Fourteen of 16 species of fish observed during July 1999 eelgrass bed surveys were associated with eelgrass habitat (Chambers Group Inc. and Coastal Resources Management, 1999).

Directed research in other Southern California embayments concerning the value of eelgrass beds as a nursery or wildlife habitat not received high priority, although several studies (MBC, 1986; Hoffman, 1986; Hoffman, 1990; Hoffman, 1991) suggest the marine life of eelgrass meadows is enhanced in numbers, species, and standing crop compared to unvegetated soft bottom habitat. Infaunal and epifaunal invertebrate studies conducted in Mission Bay, Sunset Bay and Huntington Harbour eelgrass meadows suggest vegetated bay sediments support a higher diversity of invertebrates compared to unvegetated bay sediments because of the added structure and habitat (MBC Applied Environmental Sciences, 1986). Ninety-seven species of epifauna (plants and invertebrates living on the blades and shoots of eelgrass) were collected from in Mission Bay, Sunset Bay, and Huntington Harbour. Community composition and abundances were dominated by crustaceans (39 species), polychaete worms (23 species) and mollusks (13 species). Other common epifaunal invertebrates included nemertean worms, ectoprocts, hydrozoans, nematodes, and ascidians. The benthic community living amongst the root-rhizome mass included 216 species of invertebrates, dominated in richness and abundance by 87 species of polychaete worms, 63 species of crustaceans, 28 species of clams, and 17 species of snails. Dominant organisms in both the epifauna and infaunal communities were species that occur commonly throughout embayments of Southern California.

2.3.11 Nutrients and Macroalgae

Relationships between nutrients and macroalgae abundances and species compositions have been examined in Upper Newport Bay (SCCWRP, 2003; County of Orange, 2003; County of Orange, 2004; County of Orange, 2005). Findings of these studies indicate that nitrate, rather than organic nitrogen is the most common and most bioavailable nitrogen source. Between 1996 and 2003, the incidence of nuisance algal blooms in the Upper Bay diminished (County of Orange, 2003). In addition, algal biomass decreased along a gradient between San Diego Creek and the Pacific Coast Highway Bridge. The decline in nuisance seaweeds in Upper Newport Bay was similar to those found for all kinds of algae when the limiting nutrient(s) are reduced. The most obvious explanation for the reductions in seaweeds in Newport Bay was the reduction in nitrate entering from San Diego Creek.

Eelgrass competes with macroalgae for space and sunlight, and seasonal blooms of green algae can blanket eelgrass beds (R. Ware, pers. observation). Such events can contribute to year-to-year variations in eelgrass abundance throughout Newport Bay. In areas of poor water circulation where tidal residence times are high, green algae is abundant; in other areas, the red algae (*Acrosorium*), particularly in mid-bay (Harbor Island) and Mariner’s Mile areas compete with eelgrass for space and light. The combination of poor water circulation, warm water temperatures, and high algal productivity in areas like Newport Shores and West Newport Bay likely affect the ability of eelgrass to colonize these areas. However, observed water quality improvements in the Newport Bay watershed, like the reduction in nitrates (County of Orange, 2003) over the long term, will benefit eelgrass by reducing competition and shading.

2.3.12 Invasive Algae

Invasive algae (Figure 4) has a potential to cause ecosystem-level impacts in Newport Bay and nearshore systems due to its extreme ability to out-compete other algae and seagrasses. *Caulerpa taxifolia* grows as a dense smothering blanket, covering and killing all native aquatic vegetation in its path when introduced in a non-native marine habitat. Fish, invertebrates, marine mammals, and sea birds that are dependent on native marine vegetation are displaced or die off from the areas where they once thrived. It is a tropical/subtropical species that is used in aquariums. It was introduced into Southern California in 2000 (Agua Hedionda Lagoon) and (Huntington Harbour) by way of individuals likely dumping their aquaria waters into storm drains, or directly into the lagoons. While outbreaks have been contained, the Water Resources Board, through the National Marine Fisheries Service and the California Department of Fish and Game require that when projects that have potential to spread this species through dredging, and bottom-disturbing activities preconstruction surveys must be conducted to determine if this species is presence using standard agency-approved protocols and by National Marine Fisheries Service / California Department of Fish and Game Certified Field Surveyors.

Source: NMFS
Figure 4. Invasive Algae, *Caulerpa taxifolia*

2.3.13 Effects of Bottom Disturbances on Eelgrass

Eelgrass is susceptible to physical damage from activities that disturb the seafloor. Dredging will remove all vegetation and change bottom depth and sediment characteristics. Deployment of anchors and anchor chains will remove eelgrass vegetation and create furrows within eelgrass beds, as will damage from vessel propellers. Single-point mooring anchor systems can “crop and thin” eelgrass within a defined radius around the anchor chain as ebb and flood tides change the position of the mooring. Some bottom disturbances are temporary while others will result in a sustained, long-term loss of eelgrass, particularly where depth and light requirements for eelgrass are permanently altered.

2.3.14 Historical Range of Eelgrass in Newport Bay

Pre-1900s – It is difficult to asses whether eelgrass was present in Newport Bay prior to the time of the development of Newport Harbor. However, there are indications that eelgrass was present in the vicinity of Newport Bay dating back to at least 600 A.D. (Weide, 1981) as evidenced by the presence of eelgrass in local midden (refuse areas) remains along the shoreline of what is now Upper Newport Bay (Attachment 1). Prior to the mid 1800s, “Newport Harbor”, or “Lower Newport Bay” did not exist and the coastline was an open coastal sandy beach and rocky shoreline. Eelgrass was only present in what is now referred to as “Upper Newport Bay”. Following the formation of a sand spit that formed the Balboa Peninsula in the mid to late 1800s, quiet water conditions in Newport Lagoon were likely conducive for eelgrass growth and establishment.

Recent History – In Upper Newport Bay, eelgrass was reported to be present in the 1950s and 1960s, although not abundantly, from the Coast Highway Bridge to the southern tip of Upper Island near Big Canyon (Barnard and Reish, 1959; State Water Quality Control Board, 1965; Stevenson and Emery, 1958; Posjepal, 1969; Hardy, 1970; Allen, 1976). The bulk of eelgrass was located in the main channel on the west side of the Bayside (DeAnza) Peninsula to the entrance to the Dunes Aquatic Park. The estimated amount of eelgrass in the Upper Bay was estimated to be approximately 8 acres (Posjepal, 1969). See Attachment 1 which illustrates where eelgrass was located in the Upper Bay. Comparatively, in 2003/2004, the mapped area of eelgrass in the same vicinity was 1.2 acres and in 2006/2007, the mapped area of eelgrass diminished to 0.001 acre (CRM Inc., 2005 and 2008).

Stephenson and Emery's work, conducted in 1950, indicated that eelgrass was "confined to rather deep, -4 ft channels with mud bottoms and to narrow fringelike patches along the main channel. In Newport Lagoon (the future Newport Harbor), almost continuous expanses of this eelgrass line the deepened channels. In the main channel, with high velocity, the bottom is swept clean of mud, leaving coarse sand and shell. Sparse colonies are found where mud is either beneath the shelly bottom or in small hollows of the channel." Stephenson and Emory (1958, page 35). A California Department of Fish and Game survey of Lower Newport Bay, conducted in 1951 (CDFG, 1953) found eelgrass fragments in several locations: the south side of Balboa Island, the southeast corner of Balboa Island, within the Balboa Channel, the northwest side of Balboa Channel near Harbor Island, two locations along Mariner's Mile, off of the Kerckhoff Marine Laboratory in the entrance channel, and on the east Balboa Peninsula. Allen (1976) found dense eelgrass beds in Newport Harbor off of Bayside Drive and in the entrance channel during 1974 and 1975 while conducting fish studies throughout Newport Bay. Locations of all of the sites where eelgrass was reported present pre-1976 are shown in Attachment 1.

Eelgrass beds all but disappeared in Newport Bay between the late 1960s and the mid 1970s. Although the reason for its disappearance was never conclusively determined, increased siltation, higher turbidity, dredging, and the effects of destructive floods in 1969 likely contributed to the disappearance of eelgrass.

Eelgrass transplants conducted along the DeAnza Peninsula did not survive in 1984 (Ware, 1993). A small subtidal eelgrass bed however, was located near the Castaways Site at a depth of -5 ft MLLW in 1990 and 1992 (Ware, pers. obs). Eelgrass surveys conducted in Upper Newport Bay channels between Coast Highway Bridge and Jamboree Road during December 1997 and January 1998 immediately prior to Upper Bay dredging failed to locate any surviving eelgrass beds (Coastal Resources Management, 1998). Eelgrass acreage in Newport Bay was roughly estimated to be 3 acres in 1993 (Hoffman, pers. comm. in Ware, 1993). In 1999, eelgrass was estimated to cover over 18 acres of shallow underwater habitat (CRM, 2002).

Small patches of eelgrass were located in the Dunes Marina facing Shellmaker Island during predredge surveys in December 2004 (Chambers Group, Inc., 2005). No eelgrass was observed in Upper Bay during extensive surveys conducted prior to the Upper Newport Bay Restoration Project (MBC Applied Environmental Sciences, 2004) or within the Dunes Marina or Aquatic Park in October 2007 (Chambers Group, 2007; CRM, Inc., 2007).

Bay-wide mapping surveys were conducted in 2003–2004 and again in 2006–2008 (CRM Inc., 2005, CRM Inc., 2008; CRM in progress) using diving biologists and GPS technology to map the distribution of shallow water eelgrass between bulkhead-to-pierhead lines at depths to -10 ft MLLW. During 2003, the National Marine Fisheries Service mapped eelgrass in the deeper portions of the entrance channel and Corona del Mar Reach using a single beam acoustic sonar unit. In 2008, CRM, Inc. mapped eelgrass in the deeper portions of the same areas at depths between -10 and -25 ft MLLW using sidescan sonar technology. The distribution of eelgrass in the Bay during these surveys is summarized on Figure 5, and presented by region on Figures 6–13. These results suggest that eelgrass acreage increased from approximately 3 acres in 1993 to over 100 acres in 2003–2004, and then decreased to 70.7 acres in 2006–2008. Variation can be high over the short term (two to three years) depending on storm events and other extrinsic factors.

Areas of greatest eelgrass abundance in Newport Bay during 2003–2004 included the harbor entrance channel, and the shorelines of Corona del Mar, Balboa Island, Harbor Island / Beacon Bay, Balboa Channel yacht and marina basins, and the channels that surrounded Linda Isle (Areas 1-4). Upper Newport Bay (Area 8) had a significant eelgrass meadow around the southern one-half of the DeAnza/Bayside marsh peninsula and nearby the Castaways Site on the west side of the Channel. Eelgrass was substantially less abundant in West Newport Bay (Areas 5, 6, and 7) along the shoreline of Mariner's Mile, Lido Isle, the Balboa Peninsula shoreline west of Bay Island.

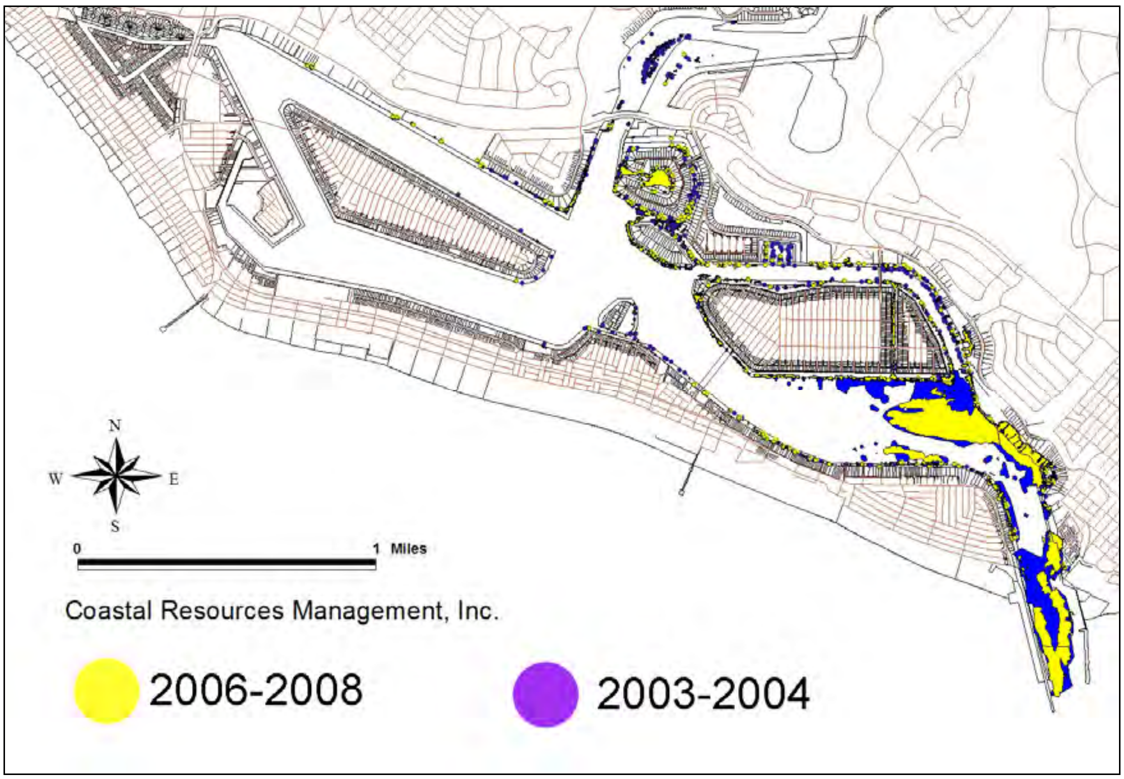


Figure 5. Newport Bay Eelgrass Distribution 2003–2004 and 2006–2007 Surveys Maximum Distribution

Figure 6. Area 1, Eelgrass Habitat, Entrance Channel

Figure 7. Area 2, Eelgrass Habitat, Corona Del Mar Reach

Figure 8. Area 3, Eelgrass Habitat, Balboa Island

Figure 9. Area 4, Eelgrass Habitat, North Harbor

Figure 10. Area 5, Eelgrass Habitat, Northwest Harbor

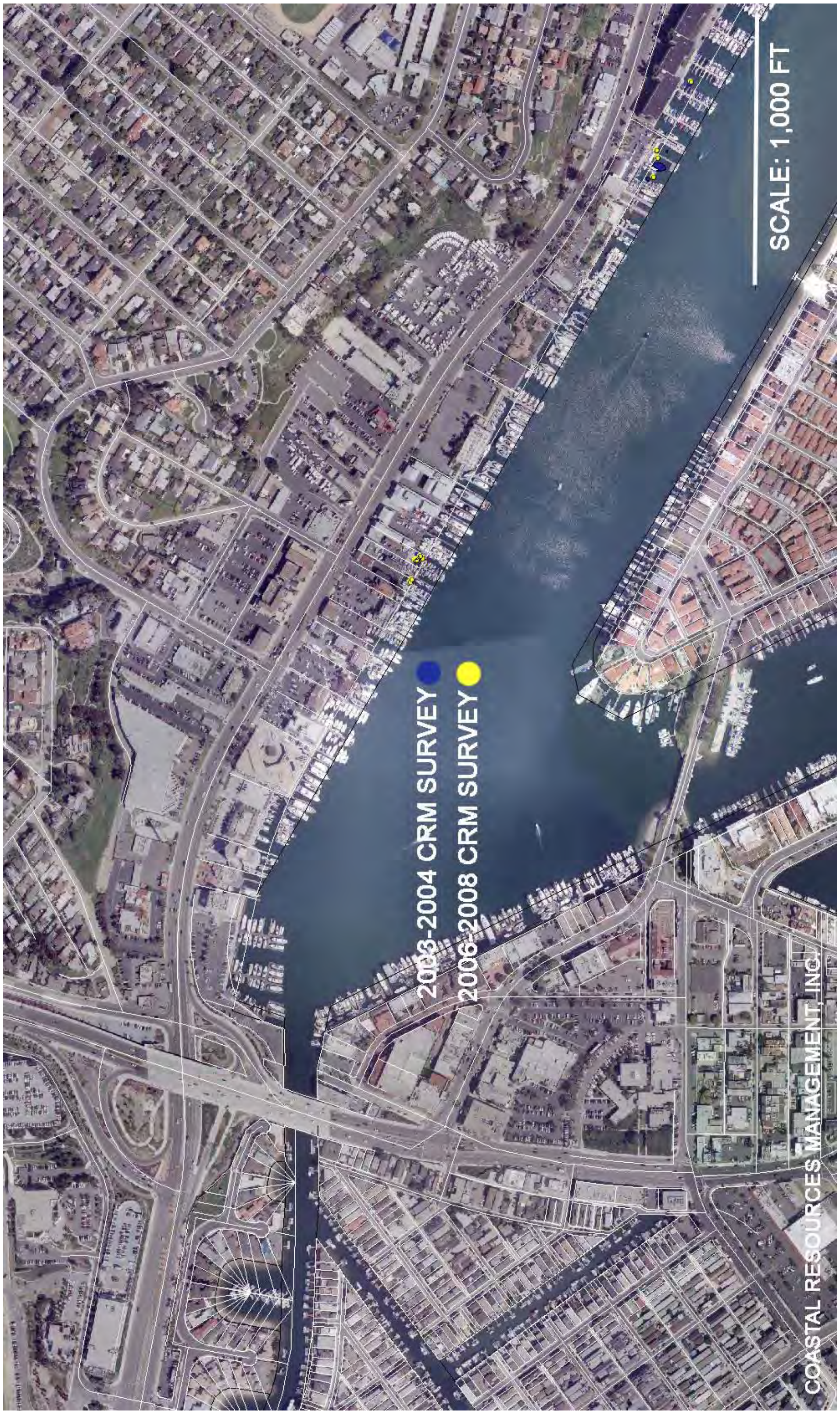


Figure 11. Area 6, Eelgrass Habitat, Northwest Newport Harbor

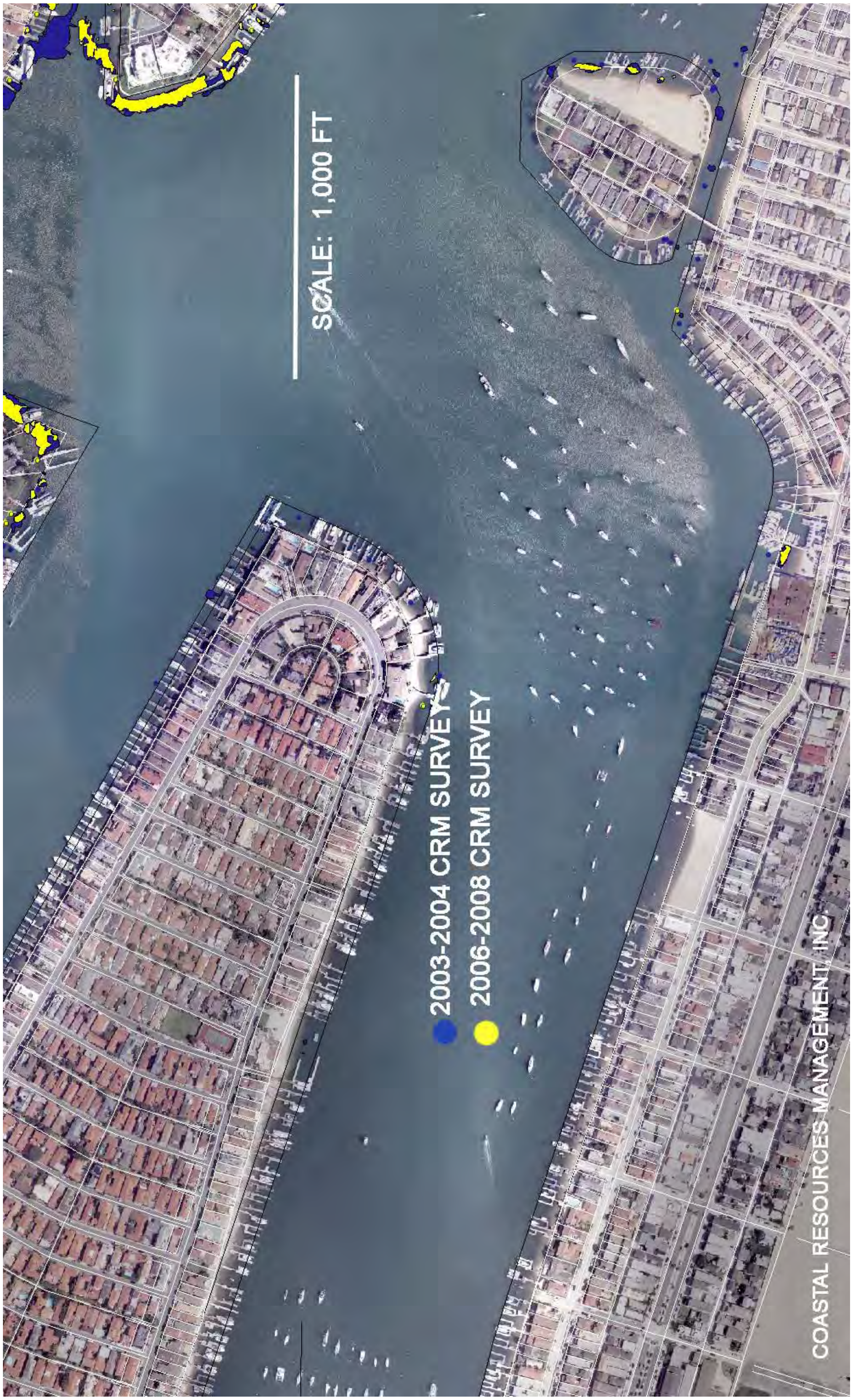


Figure 12. Area 7, Eelgrass Habitat, Soutwest Newport Harbor

Figure 13. Area 8, Eelgrass Habitat, Upper Newport Bay. Note: Eelgrass Patches in the Newport Dunes Marina were mapped by Chambers Consultants (2005)

In 2003–2004, 30.4 acres of shallow water eelgrass were mapped within the bulkhead-to-pier head lines (CRM, Inc., 2005) and 93 acres in the deeper navigational channels between Corona del Mar and Balboa Island (NMFS unpublished data). Some of the CRM and NMFS mapping areas overlapped in the main channel, so the total amount in the bay was less than the 124 acres when the data for the two surveys were summed.

The increase in eelgrass acreage in Newport Bay since 1993 may be the result of several factors: an improvement in water clarity, highly favorable growing conditions during prolonged dry weather years (i.e., La Niña years of low rainfall and low concentration of suspended sediments), better management of dredge and fill projects in the last decade, increased environmental awareness of the importance of eelgrass, and more systematic, repetitive methods of mapping eelgrass vegetation (CRM, Inc., 2005).

CRM conducted shallow water eelgrass surveys again in 2006–2007 (CRM, Inc., 2008) and mapped 23.1 acres-a decline of 7.4 acres within a three-year period (Table 1). Losses occurred primarily in Upper Bay (Area 8), in the channels surrounding Linda Isle and Harbor Island, and along the north shoreline of Balboa Island (Area 4). While the overall loss in Newport Harbor was 24% compared to 2003–2004, losses in these particular regions ranged from 31% and 100% compared to 2003–2004. Exceptions to the eelgrass loss patterns included both the inlet of Linda Isle and the Grand Canal, both of which exhibited increases rather than losses. Both of these areas are shallow, with relatively narrow openings.

CRM, Inc., using sidescan sonar methods, surveyed the deeper navigational channels originally surveyed by NMFS (2003) and mapped 47.6 acres of eelgrass at depths between -10 and -25 ft MLLW in Areas 1-3 (Figures 6, 7, and 8). This represents a decrease of 46.1 acres compared to the NMFS 2003 survey results. This may be reflective of differences in survey methods used and data interpretation (single beam sonar vs sidescan sonar) or an actual loss of eelgrass. Two large sections of the navigation channel contained eelgrass: the harbor entrance channel and the main channel between Corona del Mar and Balboa Island. However, the recent CRM surveys, using sidescan sonar technology, were ground-truthed by divers and remote video methods that provided a high degree of confidence in the data and the interpretation of the sidescan sonar records.

The distribution of eelgrass appears to be heavily influenced by the amount of time it takes to fully flush the bay based upon tidal flushing rates (Figures 14, 15a and 15b, and 16). Longer periods between complete tidal flushing reduces water quality by increasing water temperatures, lowering dissolved oxygen, and increasing the length of time that suspended sediments prevent light from illuminating the seafloor. The reduction in eelgrass area observed during the 2006–2007 survey was likely related to overlapping factors: tidal flushing rates combined with region-wide rainfall and runoff events that occurred during late 2004 and Winter 2005 period, which was one of the wettest rainfall years on record. In addition, heavy plankton blooms were present in the harbor during Spring and Summer 2005 (R. Ware, pers. observations). Eelgrass losses were associated with increased suspended material that remained in the harbor for long periods following extremely heavy rainfall in areas where tidal flushing rates exceeded six to eight days (Figure 16) and secondly, prolonged reduced light levels due to heavy plankton blooms.

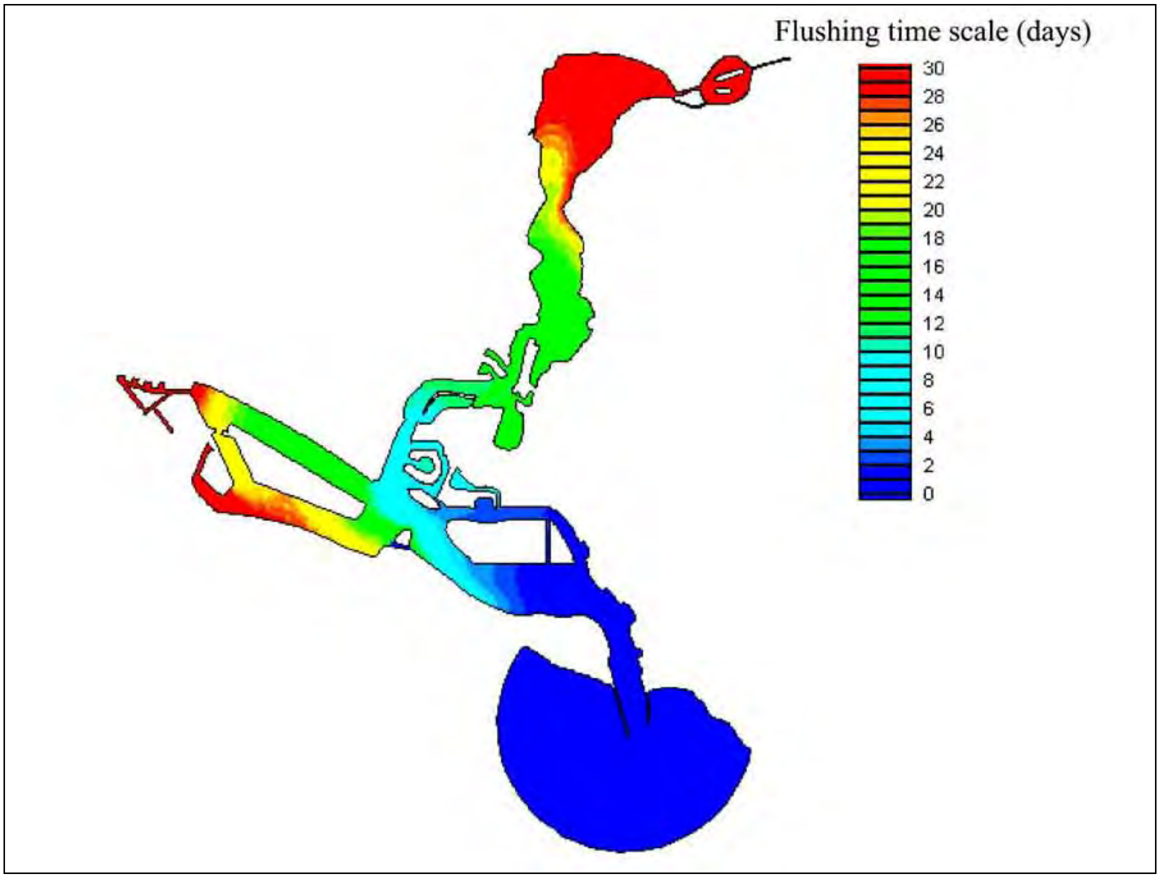
The pattern of eelgrass habitat loss around Linda Isle and Harbor Island may also suggest that events related to Upper Bay restoration activities such as dredge-scow and tug movement through Newport Harbor may have created higher than normal suspended sediment loads in areas of low tidal flushing rates over the last few years (Figure 14). While in the long run, Upper Newport Bay restoration activities will benefit eelgrass. In the short term however, secondary effects related to dredging have a potential for limiting eelgrass recovery in Lower Bay and near the PCH Bridge in Upper Newport Bay.

The one exception where eelgrass has not receded is Linda Isle basin where eelgrass has actually increased in acreage compared to 2003. This area may have been excluded from effects of rainfall events and higher turbidity in 2004–2005, and increased turbidity from dredge scow movement because of the physiographic setting of the area; the entrance to the basin is relatively narrow, it has a single entrance opening, and the tidal current flows from Upper Newport Bay pass perpendicular to the opening to the basin. It is atypical compared to other areas of high eelgrass abundance because the tidal residence time in Linda Isle basin is more typical of areas that do not support extensive eelgrass beds, and sediments are extremely high in silt (96%) compared to other areas that support eelgrass.

Table 1. Eelgrass Abundance in Newport Bay, 2003–2004 and 2006–2007 Surveys

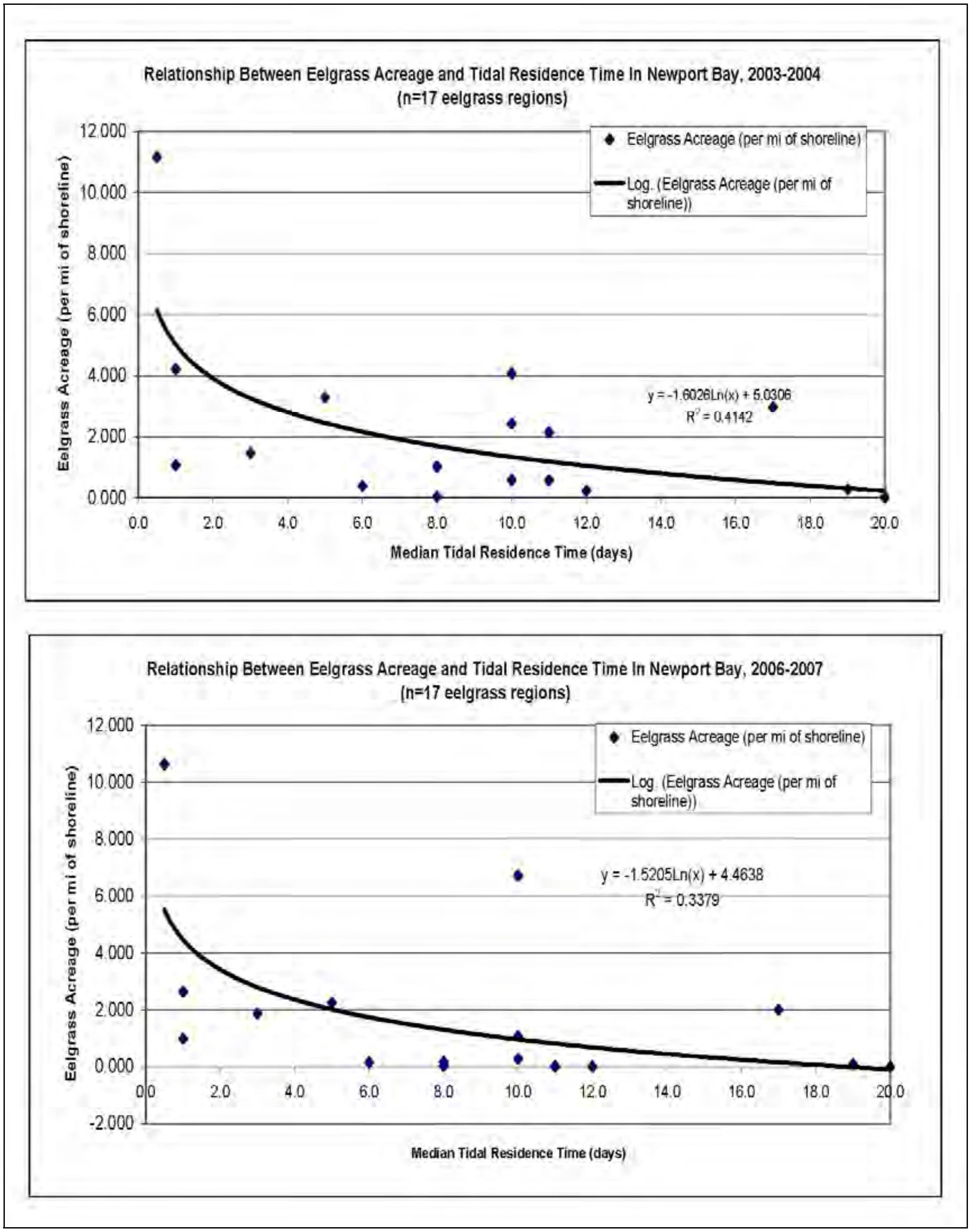
Section of Newport Bay	2003-2004 (acres)	2006-2007 (acres)	Mean (acres)	Difference (acres)	% Difference	Shoreline Length (Miles)	Mean Acres/Linear Mile
Corona del Mar/Bayside Drive to OCHD	9.521	9.075	9.298	-0.446	-4.7	0.85	10.90
Balboa Channel Yacht Basins	2.469	1.539	2.004	-0.93	-37.7	0.58	1.02
Balboa Peninsula-East of Bay Island	1.672	1.557	1.615	-0.115	-6.9	1.58	0.03
Grand Canal	0.898	1.143	1.021	0.245	27.3	0.61	0.59
Balboa and Collins Islands	6.686	4.554	5.620	-2.132	-31.9	2.03	3.43
Bay Island	0.132	0.051	0.092	-0.081	-61.4	0.34	0.12
Balboa Peninsula-West of Bay Island	0.034	0.03	0.032	-0.004	-11.8	1.09	0.18
North Balboa Channel and Yacht Basins	0.698	0.115	0.407	-0.583	-83.5	0.69	1.35
Harbor Island	2.721	0.712	1.717	-2.009	-73.8	0.67	2.77
Linda Isle (outer channels)	2.916	0.328	1.622	-2.588	-88.8	1.20	0.27
Linda Isle (Inner basin)	0.281	3.218	1.750	2.937	1045.2	0.48	1.67
DeAnza/Bayside Peninsula (inner side)	0.209	0.009	0.109	-0.2	-95.7	0.37	1.07
DeAnza/Bayside Peninsula (Outer)	0.792	0	0.396	-0.792	-100.0	0.37	3.64
Castaways to Dover Shores	0.132	0	0.066	-0.132	-100.0	0.56	2.48
Bayshores	0.991	0.664	0.828	-0.327	-33.0	0.33	2.58
Mariner's Mile	0.234	0.066	0.150	-0.168	-71.8	0.84	0.30
Lido Isle	0.025	0.004	0.015	-0.021	-84.0	2.23	0.01
All Regions	30.411	23.065	26.738	-7.346	-24.2	14.82	1.80

Source: CRM, Inc.



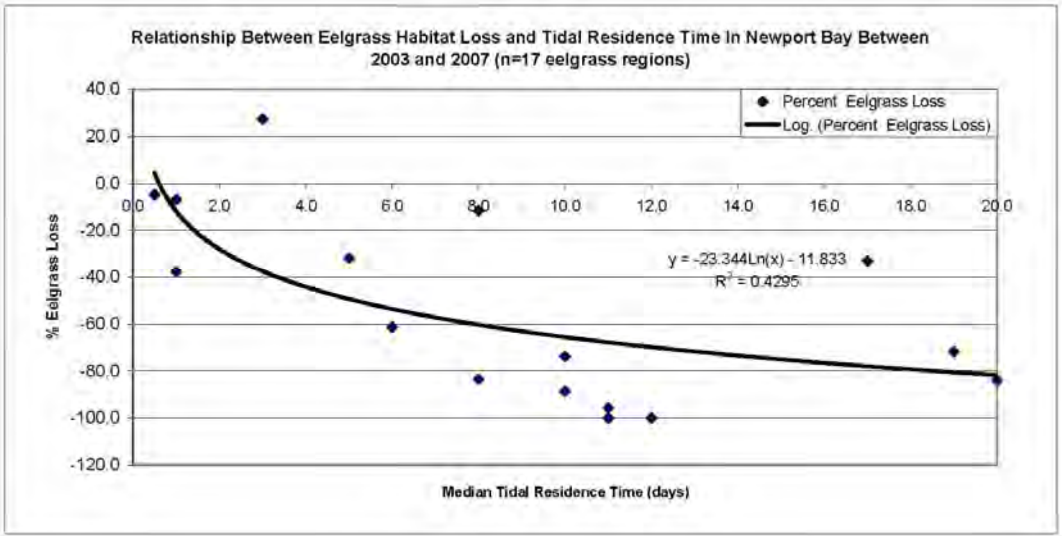
Source: Ying Poon, Everest International Consultants

Figure 14. Tidal Flushing Rates in Newport Bay



Source: CRM, Inc., 2008

Figure 15. Relationships between Eelgrass Acreage and Tidal Residence Times in Newport Bay, 2003–2004 and 2006–2007



Source: CRM, Inc., 2008

Figure 16. Relationships between Eelgrass Habitat Loss and Tidal Residence Times in Newport Bay, 2003–2007

Based upon these studies, eelgrass distribution in Newport Harbor can be divided into three zones: a Stable Eelgrass Zone that includes areas where tidal flushing is between approximately zero and six days; a Transitional Zone where eelgrass acreage is susceptible to large-scale variability and tidal flushing is approximately seven to 14 days; and an Unvegetated Eelgrass Zone where tidal flushing ranges between 14 days and 30 days and the amount of eelgrass present is either insignificant or lacking.

Eelgrass within the Stable Eelgrass Zone provides longer-term critical habitat for more organisms than within the Transitional Eelgrass Zone, where organisms are highly susceptible to short-term and long-term losses of vegetation. Stable Eelgrass Zone shallow water acreage based on the average of the two bay-wide eelgrass habitat mapping surveys is approximately 20 acres and 47 acres of deeper channel eelgrass (based on the 2008 deeper channel surveys. Shallow water Transitional Eelgrass Zone habitat, on the other hand, accounts for approximately 10 acres of eelgrass and no deeper channel eelgrass habitat exists in the Transitional Eelgrass Zone.

Eelgrass Turion Density – A turion is an above ground unit of eelgrass growth that consists of an eelgrass shoot and associated eelgrass blades. Eelgrass density refers to the number of turion units per area of bayfloor. Turion density can be highly variable as a result of water temperature, water currents and tidal exchange rates, sediment characteristics, light availability, and water depth. A combination of low and high density canopy, and open patches of unvegetated sediment may contribute to a greater diversity of organisms and a more complex ecological system.

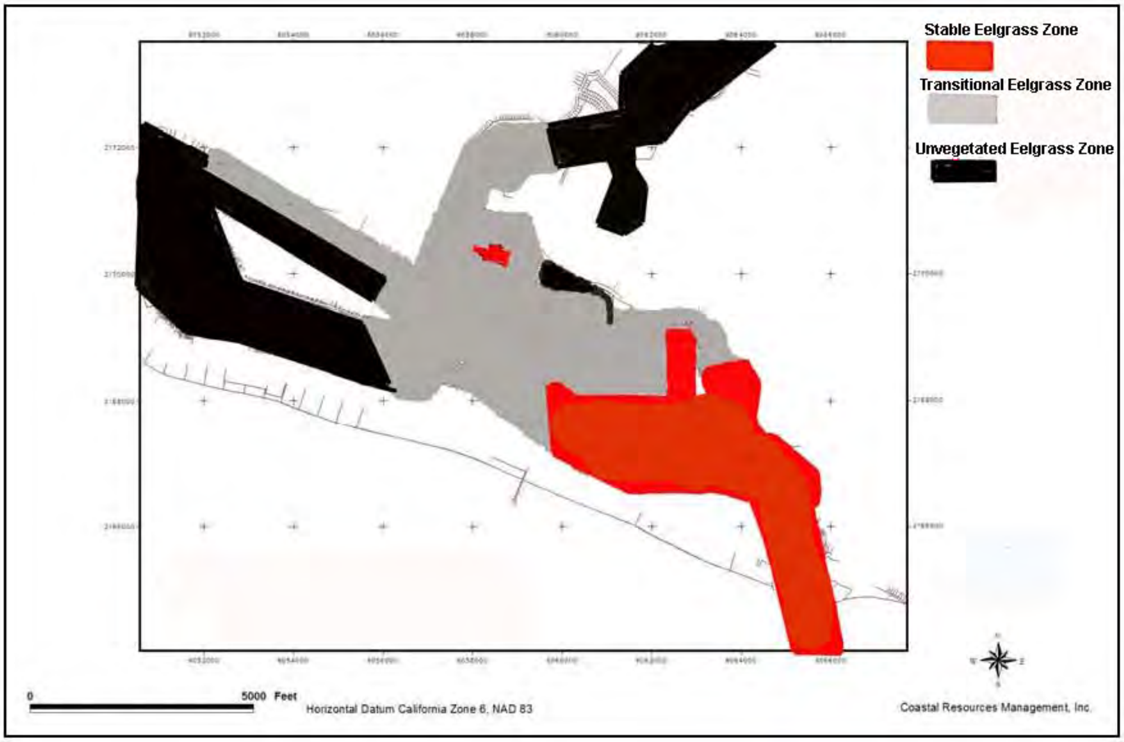


Figure 17. Eelgrass Habitat Zones in Newport Bay

For example, open, unvegetated areas in eelgrass beds are frequented by demersal (bottom) fishes such as sand bass, staghorn sculpin, turbot, California halibut, and round stingray. Some disrupt the bottom sediments (bioturbation) and create their own open habitat in eelgrass beds as they forage in the muds (Merkel, 1990). Dense, long-bladed canopy will provide a greater degree of protection and shelter for cryptic, resident species (canopy-associated pipefish and kelpfish), and shelter or foraging habitat for transients (surfperch and topsmelt).

Mean turion density in Newport Bay eelgrass meadows during late Spring to Summer 2004 period was 231.2 turions per sq m (n=600 replicates) (CRM Inc., 2005). By sampling area, turion density ranged between 102.3 (Orange Coast College Boat Basin) to 323.4 per sq m (Outer DeAnza Peninsula). In most areas of Newport Bay, eelgrass turion density exhibited a significant negative correlation to sampling depth (t=2.8, 12 deg freedom, $r^2 = 0.72$). While this is true for most areas, deeper areas with better water clarity near the ocean entrance channel support higher density eelgrass beds than regions farther back in the harbor at similar depths (i.e., Lido Yacht Club and the Orange Coast College Boat Basin).

In 2008, Newport Bay eelgrass turion density was 136.1 turions per sq m (n=415 replicates; CRM Inc., in progress), which is 60% of the average density observed in Newport Bay in 2004 and ranged between no eelgrass (where it previously was present) to 234.8 turions per sq m along Corona del Mar shoreline. Substantial density decreases occurred at stations in the Transitional Eelgrass Zone; five of the sampling stations in 2004 lacked eelgrass in 2008 (two in Upper Newport Bay, at Lido Yacht Club, and within the Orange Coast College boat basin).

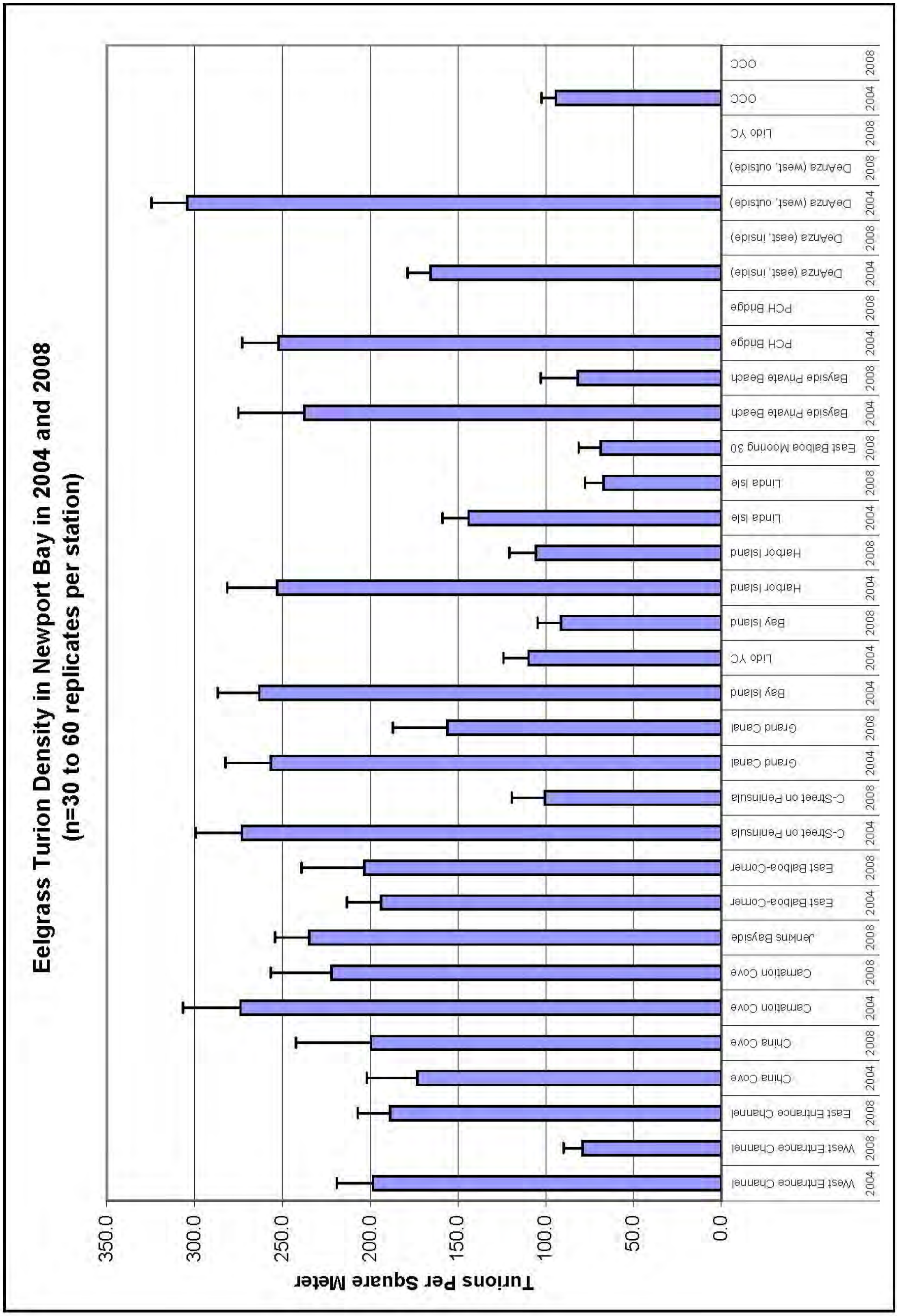


Figure 18. Eelgrass Turion Density in Newport Bay, 2004–2008

2.4 Eelgrass Regulatory Overview

Environmental legislation under the National Environmental Policy Act (NEPA) and State of California Environmental Quality Act (CEQA) dictates that project designs for coastal projects (1) make all possible attempts to avoid impacts to eelgrass, (2) minimize the degree or magnitude of impacts, (3) rectify, or compensate for unavoidable eelgrass habitat losses by restoring soft bottom habitat with eelgrass using transplant techniques, and (4) reduce or eliminate impacts to eelgrass over time by preservation and maintaining eelgrass over the life of the project. Eelgrass is considered a protected resource by California Department of Fish and Game, U.S. Fish and Wildlife Service, and the National Marine Fisheries Service although it does not have a formal listing as a state or federal rare, sensitive, endangered, or candidate species.

2.4.1 Clean Water Act

Eelgrass, as a vegetated shallow water habitat, is protected under the Clean Water Act, 1972 (as amended), section 404(b)(1), "Guidelines for Specification of Disposal Sites for Dredged or Fill Material", subpart E, "Potential Impacts on Special Aquatic Sites." This area includes sanctuaries and refuges, wetlands, mudflats, vegetated shallows, coral reefs, riffle, and pool complexes.

2.4.2 Magnuson–Stevens Fishery Management and Conservation Act (FR 62, 244, December 19, 1997 – Essential Fish Habitat and Habitats of Particular Concern

Newport Harbor and Upper Newport Bay are estuarine and eelgrass habitats, which are considered habitat areas of particular concern (HAPC) for various federally managed fish species within Coastal Pelagic (i.e., northern anchovy) and Pacific Groundfish Fisheries Management Plans (FMP), (i.e., rockfishes) under Essential Fish Habitat (EFH) provisions of the 1996 amendments to the Magnuson–Stevens Fishery Management and Conservation Act (FR 62, 244, December 19, 1997).

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". An adverse effect is "any impact which reduces the quality and/or quantity of EFH." Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to benthic organisms, prey species, and their habitat, and other ecosystem components. Adverse effects may be sites specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.910(a)).

HAPC are described in the regulations as subsets of EFH which are rare, particularly susceptible to human induced degradation, especially ecologically important, or located in an environmentally stressed area. Designated HAPC, including eelgrass, are not afforded any additional regulatory protection under the Magnuson–Stevens Fishery Conservation and Management Act (1997). However, federally permitted projects with potential adverse impacts to HAPC are more carefully scrutinized during the consultation process (National Marine Fisheries Service, 2008).

2.4.3 Southern California Eelgrass Mitigation Policy

Mitigation for impacts to eelgrass bed vegetation and potential eelgrass habitat is addressed in the *Southern California Eelgrass Mitigation Policy* (NMFS, 1991 as amended, Revision 11). This document provides the current standards for all mitigation projects and includes information regarding habitat replacement ratios, timing and methods for eelgrass habitat mapping surveys, eelgrass transplants, monitoring and maintenance, and success criteria. Eelgrass management is on a project-by-project basis, so that individual homeowners and applicants are responsible for implementing surveys, assessing project impacts, conducting transplants, and monitoring transplants for a five-year period. This policy is described in more detail in Section 4.1.1.

2.4.4 California Department of Fish and Game Regulations. 2008 Department of Fish and Game Ocean Fishing Regulations. Section 4 Ocean Fishing

30.00. Kelp General – (a) Except as provided in this section and in Section 30.10 there is no closed season, closed hours or minimum size limit for any species of marine aquatic plant. The daily bag limit on all marine aquatic plants for which the take is authorized, except as provided in Section 28.60, is 10 pounds wet weight in the aggregate. (b) Marine aquatic plants may not be cut or harvested in state marine reserves. Regulations within state marine conservation areas and state marine parks may prohibit cutting or harvesting of marine aquatic plants per subsection 632(b). 30.10. Prohibited Species. No eelgrass (*Zostera)*, surf grass *(Phyllospadix*), or sea palm (*Postelsia*) may be cut or disturbed.

2.4.5 California Code of Regulations, Title 14, 650. Natural Resources. Division 1. Fish and Game Commission – Department of Fish and Game. Subdivision 3, General Regulations. Chapter 1. Collecting Permits

(a) General – Except as otherwise provided, it is unlawful to take or possess marine plants, live or dead birds, mammals, fishes, amphibians, or reptiles for scientific, educational, or propagation purposes except as authorized by a permit issued by the department.

2.4.6 City of Newport Beach Local Coastal Plan

The City of Newport Beach has an adopted, Coastal Commission-approved land use plan (LUP). The LUP acknowledges that the need to maintain and develop coastal-dependent uses may result in impacts to eelgrass:

"Dredging and dock and bulkhead construction projects have a potential to impact eelgrass resources within several areas of Newport Bay through direct habitat loss or secondary effects of turbidity or vessel anchor scarring. However, ongoing maintenance of harbor structures and periodic dredging is essential to protect Newport Harbor's value as a commercial and recreational resource. A comprehensive and balanced management plan is necessary to maintain the recreational and commercial uses of the harbor while protecting its natural marine resources…" LUP at 4-40.

To mitigate the potential impacts to eelgrass of dredging and development, the LUP requires the avoidance where possible and restoration where avoidance is not practical:

"Avoid impacts to eelgrass (*Zostera marina*) to the greatest extent possible. Mitigate losses of eelgrass at 1.2 to 1 mitigation ratio and in accordance with the Southern California Eelgrass Mitigation Policy. Encourage the restoration of eelgrass throughout Newport Harbor where feasible." LUP Policy 4.2.5-1.

3.0 CURRENT CHALLENGES TO ESTABLISHING SUSTAINABLE EELGRASS POPULATIONS IN NEWPORT HARBOR

The most critical challenges to eelgrass populations and their establishment are (1) the presence of availability of suitable intertidal and subtidal soft-bottom habitat (2) maintaining adequate water quality and underwater light conditions to promote eelgrass growth and health and (3) maintaining a balance between the natural resources within Newport Harbor with the uses of Newport Harbor as a viable recreational boat harbor so that the areal cover and health of eelgrass vegetation continues to serve an important function as a habitat for marine life.

These challenges are particularly important because eelgrass mitigation projects cannot be successful unless specific habitat requirements are met for the establishment and growth of eelgrass. In addition, biodiversity associated with eelgrass beds is directly influenced by the conditions that govern eelgrass growth and habitat characteristics. Dredging, bulkheading, and other waterside infrastructure projects affect the abundance and distribution of eelgrass through direct losses (i.e., removal or burial) and secondarily, light-limitations through sediment resuspension and construction of structures that impede light from reaching the bayfloor. Infrastructure projects are undertaken as federal, state, local agency projects, or individual resident's projects that don't qualify under the City's Regional General Permit (RGP) 54 due to the presence of eelgrass within 15 ft of their docks, bulkhead, piers, or beach nourishment projects. If residents do not quality for inclusion in the RGP, they are responsible for individually obtaining the necessary state and federal permits from the regulatory agencies.

4.0 DEVELOPING AN EELGRASS MANAGEMENT PLAN

Current and future harbor infrastructural improvement projects such as maintaining safe navigable waters, the renovation and construction of piers, docks, seawalls, and replenishing the harbor's beaches will affect the distribution and abundance of eelgrass and will require programs to compensate for eelgrass habitat losses. Thus, understanding governing regulations, the constraints for eelgrass success in various regions of the bay, and identifying specific mitigation options for eelgrass losses are important to review.

4.1 Current Guidelines for Conducting Eelgrass Transplants

The Southern California Eelgrass Mitigation Policy (SCEMP) (NMFS, 1991 as amended) is the basis for current eelgrass mitigation throughout the Southern California region.

Eelgrass transplants "shall be considered only after the normal provisions and policies regarding avoidance and minimization, as addressed in the Section 404 Mitigation Memorandum of Agreement between the Corps of Engineers and Environmental Protection Agency, have been pursued to the fullest extent possible prior to the development of any mitigation program. Mitigation will be required for the loss of existing vegetated areas, loss of potential eelgrass habitat, and/or degradation of existing/potential eelgrass habitat as well as for boat docks and/or related work" (NMFS, 1991 as amended).

The policy requires that eelgrass habitat losses be successfully mitigated at a 1.2:1 mitigation-to-impact ratio (i.e., successful mitigation over a period of five years requires an additional 20% more eelgrass habitat than the amount originally impacted by the project). Also, the policy defines the methods by which eelgrass transplants will be conducted, despite the possibility that other, more cost-effective and efficient methods have been developed since the inception of the SCEMP.

The SCEMP does recognize that "There may be circumstances (e.g., climatic events) where flexibility in the application of this Policy is warranted. As a consequence, deviations from the stated Policy may be allowed on a case-by-case basis.

4.1.1 Current Specific Mitigation Success Criteria from the Policy (NMFS 1991 as amended)

Criteria for determination of transplant success shall be based upon a comparison of vegetation coverage (area) and density (turions per square meter) between the **adjusted project impact area** (i.e., original impact area multiplied by 1.2) and **mitigation site(s)**. Extent of vegetated cover is defined as that area where eelgrass is present and where gaps in coverage are less than one meter between individual turion clusters. Density of shoots is defined by the number of turions per area present in representative samples within the original impact area, control or transplant bed. Specific criteria are as follows:

a) The mitigation site shall achieve a minimum of 70% area of eelgrass and 30% density as compared to the adjusted project impact area after the first year.

b) The mitigation site shall achieve a minimum of 85% area of eelgrass and 70% density as compared to the adjusted project impact area after the second year.

c) The mitigation site shall achieve a sustained 100% area of eelgrass bed and at least 85% density as compared to the adjusted project impact area for the third, fourth and fifth years.

Should the required eelgrass transplant fail to meet any of the established criteria, then a Supplementary Transplant Area (STA) shall be constructed, if necessary, and planted. The size of this STA shall be determined by the following formula:

$STA = MTA \times (|A_t + D_t| - |A_c + D_c|)$
MTA = mitigation transplant area.
A_t = transplant deficiency or excess in area of coverage criterion (%).
D_t = transplant deficiency in density criterion (%).
A_c = natural decline in area of control (%).
D_c = natural decline in density of control (%).

The STA formula shall be applied to actions that result in the degradation of habitat (i.e., either loss of areal extent or reduction in density).

Five conditions apply:

1) For years 2–5, an excess of only up to 30% in area of coverage over the stated criterion with a density of at least 60% as compared to the project area may be used to offset any deficiencies in the density criterion.

2) Only excesses in area criterion equal to or less than the deficiencies in density shall be entered into the STA formula.

3) Densities which exceed any of the stated criteria shall not be used to offset any deficiencies in area of coverage.

4) Any required STA must be initiated within 120 days following the monitoring event that identifies a deficiency in meeting the success criteria. Any delays beyond 120 days in the implementation of the STA shall be subject to the penalties as described in Section 8.

5) Annual monitoring will be required of the STA for five years following the implementation and all performance standards apply to the STA.

Eelgrass transplant programs cannot be conducted within areas where eelgrass has occurred in the past or where it currently is present since the transplant would only be considered “habitat enhancement” by National Marine Fisheries Service (Bryant Chesney, NMFS per. com to R. Ware, April, 2007). Therefore, eelgrass transplants for mitigation purposes must be conducted at sites where eelgrass has historically not been present or in areas “created” within Newport Bay by dredging or in-filling of bay habitat to depth ranges and with sediment types that are known to support eelgrass vegetation.

4.1.2 Eelgrass Mitigation Success in Newport Bay

Eelgrass mitigation was initiated in the late 1970s and early 1980s in Newport Bay. These have taken place in the Harbor Entrance Channel for U.S. Army Corps of Engineers dredging projects (Noel Davis, Chambers Consultants, pers. com. with R. Ware, January 2008); on De Anza (Bayside) Peninsula in Upper Newport Bay as mitigation for eelgrass losses in Huntington Harbour (MBC Applied Environmental Sciences, 1987) and for the 2004 U.S. Army Corps of Engineers Harbor Entrance Channel / Balboa Channel Dredge Project (MBC Applied Environmental Sciences, 2004); for a pier and dock project at a private residence on Bayside Drive (Mike Curtis, MBC Applied Environmental Sciences, pers. com. with R. Ware, 1998); and in the Grand Canal on Balboa Island for losses associated with dredging and seawall protection in 1999 (CRM, Inc., 2000). In addition, under a joint program conducted by the City of Newport Beach, the U.S. Army Corps of Engineers, and the County of Orange, a Newport Harbor Eelgrass Pilot Restoration Project was undertaken by Chambers Group, Inc. and CRM, Inc. in August and September 2004 under Section 206 of the Water Resources Development Act (1996). Six sites in Lower and Upper Newport Bay were experimentally transplanted to determine if these sites could be used as eelgrass mitigation banking sites for future federal, city, and county eelgrass mitigation projects. These were undertaken in Transitional Eelgrass Zones of the harbor.

Of the major eelgrass transplant projects conducted in Newport Bay since 1982 only three were successful; all were conducted within the Stable Eelgrass Zone (Figure 16). These included the 1982 entrance channel transplant, the 1998 Bayside Drive (Corona del Mar) transplant, and the 1999 Grand Canal eelgrass transplant. The remaining transplants were successful for less than one year. Because there were no concurrent studies abiotic parameters at the successful or unsuccessful transplant sites, there are no clear indications of the physical, chemical, or biological conditions that were responsible for either success or failure. However, the failure of the City of Newport / County of Orange / ACOE pilot eelgrass transplants was likely attributable to heavy rains in the months following the transplants, extremely warm temperatures during the late-season planting period, and the long tidal residence times that diminish water quality in the areas that were transplanted.

Eelgrass is capable of recovering from habitat disturbances without mitigation measures being implemented. For example, following a dredging project in the Grand Canal during the mid-1980s, eelgrass successfully recolonized the area (R. Ware, pers. com with Robert Hoffman). After dredging the Balboa Channel in 2004, eelgrass was reported to have naturally grown back on the dredged slope (R. Ware, pers. com. with Tom Rossmiller, City of Newport Beach Harbor Resources Department). Alternatively, it is possible that patches of eelgrass were left untouched during the dredging operation.

4.2 Eelgrass Threshold Capacity

Eelgrass threshold capacity can be defined as the acreage of eelgrass within Newport Bay that is sustainable over time taking into account short-term and long-term temporal and spatial variability. The goal of identifying eelgrass threshold capacity is to provide harbor resource managers a tool by which to evaluate appropriate long-term eelgrass mitigation options relative to future maintenance of harbor infrastructure.

Projects such as maintenance dredging, beach nourishment, dock and bulkhead renovation projects that are within bulkhead and pierhead lines are generally accomplished on an incremental basis, account for the majority of harbor infrastructure projects, and have a high potential to affect eelgrass habitat stability on a year-to-year basis in Newport Bay.Based upon the results of bay-wide shallow water habitat mapping surveys between 2003 and 2007 (CRM Inc., 2005 and CRM, Inc.,2008) the "average threshold capacity" (the average amount of eelgrass mapped in the 2003/2004 and 2006/2007 surveys) in Stable Eelgrass Zones was approximately 20.4 acres. This zone exhibited very little variation between surveys (20 acres in 2003/2004 and 21 acres in 2006/2007). Transitional Eelgrass Zones, where eelgrass habitat is more susceptible to temporal and environmental disturbances than Stable Eelgrass Zones, accounted for an average eelgrass threshold capacity of approximately 6.3 acres, with a range between 2.2 (2006/2007) and 10.4 acres (2003/2004).

Eelgrass in the deeper channels of Newport Harbor are susceptible to less frequent episodic dredging impacts but when dredging occurs, the potential for wide-scale damage to dense and large eelgrass meadows is high. Based on the most recent 2008 survey data set, the threshold capacity of eelgrass in the federal navigational channel is approximately 47 acres

These estimates of eelgrass threshold capacity can be refined, over time, with additional data acquired from bay-wide eelgrass distributional studies.

4.3 Recommended Areas in Newport Bay to Create A Sustainable Eelgrass Population (SEP)

While eelgrass occurs throughout many regions of Newport Bay, its structure and function varies widely from region-to-region and from year to year. Mitigation for losses of eelgrass habitat must be focused in areas where suitable habitat requirements are met for size of the habitat, sediment types, depth, and light intensity) and where eelgrass will survive and flourish over the long term.

Based on the historical distribution changes of eelgrass in Newport Bay, on the results of eelgrass mitigation successes and failures, and the realization that the amount of habitat that meet eelgrass establishment and growth criteria in Newport Bay is extremely limited, high priority should be given to maintaining and creating a sustainable eelgrass population (SEP) in the Stable Eelgrass Zone (Figure 17) . The long-term potential for successful eelgrass population sustainability is highest in this zone, where tidal residence times are less relatively short (less than six days), tidal currents are moderate to high, and there is a history of long-term eelgrass sustainability with minimal year-to-year natural variation

Conversely, maintaining sustainable eelgrass populations in the Transitional Zone is difficult. Creating eelgrass populations in this zone increases the risk of failure because this zone is susceptible to large-scale natural variability due to episodic events such as El Nino and the effects of extremely heavy rainfall and runoff (which occurred in 2004 and 2005). And, in these areas where tidal residence times are already decreased, events such as plankton blooms can push the light threshold limits below that which can sustain eelgrass reproduction, growth, and survival. The potential for the highest risk of mitigation failure is within the Unvegetated

Eelgrass Zone where tidal flushing ranges between 14 days and 30 days and where virtually no eelgrass is currently found.

4.4 Development and Implementation of a Long-Term Eelgrass Management Plan

Eelgrass within both the Stable Eelgrass Zone and the Transitional Eelgrass Zone will be continually susceptible to infrastructure improvements within Newport Harbor. Consequently, it is in the interest of the City to develop and implement a long-term Eelgrass Management Plan to maintain and create a sustainable eelgrass population (SEP) where eelgrass populations have the highest potential for long-term survival.

The City of Newport Beach would be responsible for developing, overseeing, and enforcing compliance with the Eelgrass Management Plan, and be responsible for eelgrass surveying, implementing programs to establish eelgrass populations, monitoring the success of the programs, and conducting periodic, baywide eelgrass surveys. Under such a concept, the City would protect and promote a shallow water eelgrass population and as long as the sustainable eelgrass population is above 20 acres, no more than 2 acres of eelgrass impacts would be permitted per year conditioned on compliance with best management practices (BMPs) for avoiding eelgrass disturbance where possible. Should the shallow water eelgrass population drop below 20 acres, increased mitigation measures and decreased allowable annual impacts will be implemented in a phased manner.

The purpose of the BMPs would be three-fold: (1) To avoid and minimize damage to existing eelgrass bed resources. Such BMPs would include reviewing the need for beach nourishment, dredging and dock projects, identifying alternatives that would minimize impacts on eelgrass; using Best Available Technology (BAT) to minimize dredging and dock construction effects; using materials on docks and piers that could promote eelgrass growth beneath these structures; (2) Educate boat owners and property owners as to the importance of eelgrass within Newport Harbor so that they take "ownership" in their project and view eelgrass as a positive outcome of their project; and (3) Maintaining and creating a sustainable eelgrass population in the Stable Eelgrass Zone should the threshold value of eelgrass populations in Newport Harbor fall below the minimum amount of 20 acres.

Close coordination will be needed between the City of Newport Beach, the Department of Fish and Game, and the National Marine Fisheries Service to develop special conditions that will be effective in making the Newport Beach Long-Term Eelgrass Management Plan a success, and at the same time, responsive to agency concerns.

To achieve this goal, eelgrass sustainability populations should be maintained and if needed, eelgrass sustainability areas created for future public and private sector projects in Newport Harbor. The concept would involve (1) maintaining a base amount of eelgrass based upon identified eelgrass threshold capacity measurements and using BMPs to ensure this threshold capacity is maintained, (2) implementing programs to maintain and establish sustainable eelgrass populations in areas affected by disturbances, or into the created habitat using innovative and cost-efficient methods if necessary to maintain a critical eelgrass mass (20 acres), and (3) monitoring over the long term, the success of the sustainable eelgrass population.

Traditionally, eelgrass transplants for small to medium-sized projects have been conducted by using an anchor-bundle method by which eelgrass is collected from donor sites, bundled into units, and then replanted by divers in predetermined planting grids (Fonseca et al., 1982). However, for large-scale mitigation and restoration projects (on the order of small to large projects it may be necessary to utilize alternative transplant methodologies using eelgrass seed banks and seed dispersal methods (Granger et al., 2002) that will have less environmental impacts than collecting large amounts of eelgrass donor material. Safety concerns for deploying teams of divers to conduct eelgrass transplant using the anchor/bundle method may also require the implementation of alternative transplant methodologies such as the remote deployment of prefabricated eelgrass structural units (Short et al., 2002). Labor costs can potentially be reduced. Such experimental programs have been initially established for San Francisco Bay (Michael Josselyn, Wetland Research Associates, Inc. pers. com with R. Ware, March 2008). Due to the expected large size of the mitigation site, transplant methodologies should be evaluated and tested within Newport Bay prior to the creation of the shallow water habitat to determine the most effective and cost-efficient methods to employ for large-scale eelgrass transplants.

If needed, sustainable eelgrass population could be established in the Stable Eelgrass Zone (Figures 17 and 19). For example, the deeper channel waters beneath Mooring Area B seaward of the southern perimeter of Balboa Island encompass a maximum of approximately 28 acres of bayfloor that could be modified to support a sustainable eelgrass population(Figure 19) although several sites within the Stable Eelgrass Zone could be utilized for this purpose. Being within the Stable Eelgrass Zone, this site exhibits good water circulation, and the nearby shoreline along South Bay Front is colonized by high eelgrass cover. While depths within this area are currently too deep to support eelgrass, a selected site(s) could be engineered to provide for (1) long-term stability from the effects of sediment scour and/or sediment deposition, (2) appropriate depth ranges to support a sustainable eelgrass population, and (3) adequate depths to maintain safe navigation and boating. The creation of new shallow-water habitat in the harbor would also present an opportunity to establish both a confined disposal site to manage contaminated, dredge sediments from Newport Bay dredging projects as well as maintain a sustainable eelgrass population. Similar sites have been created in San Diego Bay near North Island Naval Air Station (Pondella et al., 2006). A 40+ acre shallow water eelgrass mitigation site is proposed within Outer Los Angeles Harbor as mitigation for loss of shallow water habitat associated with the Port of Los Angeles Pier 300 project.

Figure 19. Potential Eelgrass Sustainability Locations in the Stable Eelgrass Zone

4.5 Steps Forward

1. **Identify appropriate needs relative to future watershed and harbor activities to gauge the extent of required sustainable eelgrass management. Develop an ecosystem approach Eelgrass Management Plan (EMP) rather than managing eelgrass project on an incremental basis.**

2. **Meet with stakeholders and identify concerns, constraints, and permitting issues based on what will be required for future dredging and infrastructure improvements in Newport Harbor.** It will be critical to assess the environmental permitting and fiscal constraints of the program early on to assess the ability of the City to implement an Eelgrass Management Plan. Early agency involvement with the Coastal Commission, U.S Army Corps of Engineers, State Lands Commission, State Water Resources Control Board, and resource agencies (NMFS, USFWS, and CDFG) is critical to ensure that there is sufficient agency understanding and support for such a critical undertaking.

3. **The EMP will promote a system-based approach; the key metric of eelgrass protection is the maintenance of a sustainable shallow water eelgrass population of at least 20 acres.** The focus of the City’s management will be to protect and promote shallow water eelgrass populations and as long as the sustainable eelgrass population is above 20 acres, no more than 2 acres of eelgrass impacts will be permitted per year conditioned on compliance with best management practices for avoiding eelgrass disturbance where possible. Should the shallow water eelgrass population fall below 20

acres, increased mitigation measures and decreased allowable annual impact will be implemented in a phased manner.

4. **The City of Newport Beach will assume lead responsibility for the preparation and implementation of the Eelgrass Management Plan.** The City will enforce compliance with the plan, subject to agency oversight. Consistent with its management role, the City, rather than individual residents, will be responsible for surveying and data gathering, while relieving individual property owners of a burden they generally lack the expertise to effectively carry.

5. **The City will of Newport Beach will identify primary and alternative locations in the Stable Eelgrass Zone capable of supporting the maximum amount of sustainable eelgrass required for future projects should it be necessary to create additional Stable Eelgrass Zone eelgrass populations.** Conduct coastal engineering and marine biological surveys to identify those areas with the Stable Eelgrass Zone that have a potential to be utilized for mitigation bank sites. Conduct side scan sonar mapping surveys, physical modeling, and field studies in potential sustainable eelgrass areas to evaluate erosion, sedimentation, and other process that will be required to refine site selection.

6. **The City will prepare a draft Eelgrass Management Plan (DEMP) and negotiate a Final Stable Eelgrass Zone Management Plan (FEMP) with the National Marine Fisheries Service, the California Department of Fish and Game, the U.S. Army Corps of Engineers, and the California Coastal Commission.** Upon completion of the FEMP, the City shall commence review of the plan for consistency with provisions of the City of Newport Beach Local Coastal Plan and the Regional General Dredging Permit (RGP).

7. **Once in place, the City will implement and manage the FEMP. Following implementation, the City will review the success of the EMP at five-year intervals to determine the effectiveness of the program, identify any required changes to the program, and implement if necessary, adaptive management to ensure the key program metrics are being met.**

8. **Establish an Eelgrass Management Plan Website.** Lastly, the City should consider establishing a website that will track project implementation and achievement of key metrics for public review. This will also assist the City in providing suggested public educational outreach for the project

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ATTACHMENT 1

SITE LOCATION MAP WHERE EELGRASS WAS RECORDED PRIOR TO 1976
Source: CRM, Inc.

APPENDIX C

Beach Replenishment Strategy

"The following technical report reflects the findings and data available at the time the report was prepared and may not represent the current conclusions and steps forward in the main text of the HAMP, which has been updated after the completion of these reports. These more detailed technical reports provided in the appendices represent the foundation for the overall approach to the HAMP, but are not "living" documents that reflect updated steps forward, costing, quantities, etc. presented in the main text of the HAMP. The main text of the HAMP represents more current information and recommendations based on updated information, new studies, changes in conditions, new funding sources, and/or new regulations."

HARBOR AREA MANAGEMENT PLAN

IN-HARBOR BEACH REPLENISHMENT STRATEGY

Technical Report

Prepared For:

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1.0 INTRODUCTION

1.1 Background

Beach replenishment or nourishment refers to the strategic placement of beach quality sand on an existing beach to provide a source of nourishment for littoral movement or restoration of an eroded beach. Generally, beach nourishment projects are carried out along beaches where a persistent erosional trend exists. To carry out a beach replenishment, sediment with physical characteristics similar to the native beach material is mechanically (bucket) or hydraulically (pipeline) placed. Beach replenishment has proven to be cost effective and environmentally acceptable method of maintaining the recreational, aesthetic, and shore protection aspects of beaches within the Lower Bay.

Current beach replenishment related programs that are ongoing within the Lower Bay include:

Balboa Island Beach Sand Study was begun in 2007 to assess sand management and beach improvement options for Balboa Island. The study is to focus on quantifying existing conditions of sediment transport and effects from natural and man-induced changes. The majority of the effort will be in the South Bay Front of Balboa Island.

There are ongoing beach replenishment projects performed by individual homeowners and homeowners associations throughout the Lower Bay. For example, in 2007, 15 small projects applied for permits under the Regional General Permit #54 (RGP) held by the City of Newport Beach Harbor Resources Division (Harbor Resources Division, no date; USACE, no date). In the past, many of the projects have been maintenance dredging under docks with both ocean and beach disposal. Recent work has been primarily beach disposal due to a shortage of ocean going construction equipment.

1.2 Purpose

At present, there is no management system in place to prioritize selection of beaches in Lower Bay for replenishment or to prioritize the use of dredged material for beneficial reuse. As part of the Harbor Area Management Plan (HAMP), the purpose of this report is to recommend a framework towards coordinating the ongoing and future beach replenishment efforts throughout the Lower Bay.

1.3 Report Organization

This report organizes relevant beach replenishment issue into one document. In the next section, a list of existing beaches in the Lower Bay and their replenishment needs is provided. Constraints on beach replenishment are reviewed and summarized in Section 3. These needs and constraints feed into the development of the use of a weighted alternative matrix to qualitatively rank the beaches to determine which beach would benefit most from replenishment. The alternative matrix and another more quantitative benefit-cost ration analysis for evaluating priority beaches are presented in Section 4. Lastly, findings and recommendations are provided in Section 5.

2.0 BEACH REPLENISHMENT NEEDS

The first step in determining beach replenishment needs is to define the beaches and identify their locations. From there, the need for beach replenishment is typically driven by two factors: how much the beach is used and how much beach area is available. Beach usage is usually determined with beach attendance counts and depends on factors such as available parking, amenities, and beach quality. The amount of beach area required at specific beaches is subjective, with a significant emphasis on how much area existed in the past and what beach goers are accustomed to.

Beach use data is very limited in the Lower Bay. The only source available was a study based on local lifeguard estimates. Beach width and changes in beach width can be determined by direct and indirect measurements from data sources such as:

- Aerial photos;
- Beach profiles or monitoring data;
- Past dredging and replenishment projects (location, quantity, sediment source); and
- Site visits, visual observation, photographs.

For this report, the beach conditions were evaluated based on two days of site visits, aerial photos, as well as beach profiles dredging records provided to us by the City of Newport Beach Harbor Resources Division, the City of Newport Beach GIS group, the USACE Los Angeles District, and the County of Orange Watershed and Coastal Resources Division.

2.1 Existing Conditions

An inventory of beaches in the Lower Bay was developed as a first step in identifying beach replenishment needs. Figures 1 and 2 show maps of all the beaches within the Lower Bay. Table 1 lists these beaches from west to east of Lower Bay and the essential information for each beach including location, public access, boat launch, boat slip, proximity to eelgrass and potential erosion problem. This is followed by a brief description and photographs of each beach.

Figure 1. Beaches of West Lower Bay

Figure 2. Beaches of East Lower Bay

Table 1. Lower Bay Beaches (Listed West to East)

Number	Beach Name	Location	Public Access	Boat slips	Boat Launch	Erosion Problem	’01-’06 SL Change	Distance to Eelgrass
1	Channel Place Park	Channel Pl. & River Ave.	Yes	yes	No		ND	>30’
2	Balboa Coves	Near PCH	No	Yes	No		ND	>30’
3	Lake St.	38th St.	Yes	No	No		ND	>30’
4	Newport Island Park	Newport Island	Yes	Yes	No		ND	>30’
5	Lido Park	Via Lido Bridge	Yes	Yes	No		ND	>30’
6	Lido Peninsula/Beach Dr.	East end of Lido Peninsula	Yes	Yes	No		ND	>30’
7	Marina Park	Balboa Peninsula	Yes	No	Yes		ND	>30’
8	15th St.	Balboa Peninsula	Yes	Yes	Yes		ND	>30’
9	Via Lido Nord	Lido Isle	Yes	No	No		ND	>30’
10	Via Lido Soud	Lido Isle	No	No	No		ND	>30’
11	10th St	West Bay, Balboa Peninsula	Yes	Yes	No		ND	>30’
12	Crestview	Bayshores	No	Yes	No		ND	>30’
13	Bayshore	Bayshores	No	Yes	No		ND	<15’
14	Bay Island West	Bay Island	No	Yes	No		ND	>30’
15	Edgewater/Montero	Balboa Peninsula	Yes	Yes	No		ND	>30’
16	Bay Island East	Bay Island	No	Yes	No		ND	Varies
17	PCH Bridge	South of PCH Bridge	No	No	No		ND	>30’
18	Linda Isle	Linda Isle	No	Yes	No		ND	>30’
19	Beacon Bay	Harbor Island Blvd.	No	No	No		ND	15’-30’
20	North Bay Front	Balboa Island	Yes	Yes	Yes	Anecdotal	ND	Varies
21	South Bay Front	Balboa Island	Yes	Yes	Yes	Anecdotal	ND	Varies
22	E. Bay Ave	NE Side of Balboa Peninsula A – N St.	Yes	Yes	Yes		ND	Varies
23	Promontory Bay	Bayside Dr.	No	No	No		ND	>30’
24	Bayside Cove		No	No	No		ND	>30’
25	East Bay Front	Balboa Island	Yes	Yes	Yes		ND	Varies
26	Harbor Patrol	Corona del Mar	Yes	No	Yes		ND	<15’
27	M St.	Channel Rd., Balboa Peninsula	Yes	Yes	No		ND	>30’
28	Carnation Cove	Corona del Mar	No	Yes	No	Anecdotal	+10’	>30’
29	China Cove	Corona del Mar	Yes	No	No	Anecdotal	-20’	>30’

Table 1. Lower Bay Beaches (Listed West to East)

Number	Beach Name	Location	Public Access	Boat slips	Boat Launch	Erosion Problem	'01-'06 SL Change	Distance to Eelgrass
30	Pirate's Cove	Corona del Mar	Yes	No	No		ND	>30'

Notes:

Public Access is an indication of the public's ability to get to and use the beaches. If the beach cannot be accessed by the public, then economic benefits to the public are minimal and the current status of beach width cannot be assessed for this report. Access was determined during the site visits of the current study.

Boat Slips column indicates that boat slips are nearby and would be the primary limit on additional sand capacity.

Boat Launch indicates whether a beach allows launching of hand carried water craft (Newport Beach, 2001).

Erosion. Most evidence of shoreline erosion within the Lower Bay is limited to personal accounts and photographs. Nevertheless, this has been sufficient to initiate beach replenishment projects in the past.

'01-'06 SL Change indicates the amount of shoreline change observed between the 2001 and 2006 aerial photographs provided by Newport GIS. ND = shoreline change was "not detectable" or less than the detectable limit. Of the beaches reviewed, Carnation Cove stands out as the only beach with a significant increase in shoreline position. In 2001, there was not beach, and by 2006 there was approximately 10 feet of dry beach.

Distance to Eelgrass The distances were measured from the 2006 aerial photograph provided by the City of Newport Beach GIS department. <15' = there was no possible footprint within the beach that would be greater than 15 feet from eelgrass boundaries. 15'-30' = eelgrass was found between 15 to 30 feet from any possible replenishment boundary. >30' = there are replenishment boundaries that are farther than 30 feet from eelgrass boundaries. Varies = eelgrass was found from <15' to >30' from possible replenishment boundaries. In many instances the only location that would be greater than 30' from eelgrass was on the intertidal region of the beach.

All of the beaches within the Lower Bay are described in greater detail below. Ground level photos, where available, were taken during site visits of October 2 and October 6, 2007. Ground level photos were only taken at beaches that have public land access.

Channel Place Park

Channel Place Park is a public beach with a playground and other amenities. Additional sand capacity on the beach is limited by sand retention groins at either end, which function to separate the sandy beach from nearby boat slips. Currently, the beach could accept on the order of tens of cubic yards without overflowing beyond the end groins.

Figure 3. Channel Place Park

Balboa Coves

The four beaches at Balboa Coves are not publicly accessible via land. The beaches were relatively stable between the 2001 and 2006 as determined from aerial photographs. From the aerial photographs, it seems that any replenishment would cause a negative impact on the many boat slips within the coves.

Figure 4. Balboa Coves

Lake Street

The beach at Lake Street and 38th Street is bound on either end by the 38th Street Bridge and an impermeable patio, shown in the photo below. Additional sand capacity is available at this beach on the order of tens of cubic yards.

Figure 5. Beach at Lake Street

Newport Island Park

This public park is located on the south shore of Newport Island near the intersection of Marcus Avenue and 38th Street. All beaches on Newport Island are excluded from replenishment under the RGP. Replenishment can be permitted with additional sediment testing and acquisition of an amendment to the RGP. Due to the nearby boat slips, the beach has a small capacity for additional sand on the order of tens of cubic yards.

Figure 6. Beach at Newport Island Park

Lido Park

The beach at Lido Park is located on the north-west side of the Via Lido Bridge. It is bounded by a groin on the west and the bridge to the east. The current beach is at capacity. Any additional sand would likely slip around the groin into the nearby boat slips.

Figure 7. Beach at Lido Park

Lido Peninsula/Beach Dr.

This beach is located on the south east tip of the Lido Peninsula. Based on visual inspection, the sand ranged from very fine at the water line to very coarse at the beach berm. Sand retention groins are located at both ends of this pocket beach to prohibit sand migration out of the beach and into the nearby boat slips. The current beach is at capacity.

Figure 8. Beach at Lido Peninsula

Marina Park

The beach at Marina Park is located between 16th Street and 19th Street on the north shore of the Balboa Peninsula. This beach can accommodate a relatively large quantity of replenishment sand on the order of hundreds of cubic yards.

Figure 9. Beach at Marina Park

15th Street

No beach replenishment is permittable within 1,000 feet of the 15th Street public pier under the RGP. If beach replenishment is desired, additional sediment testing and an amendment to the RGP would be required. The current beach width appears adequate. Any beach replenishment would likely impact the 15th St. Pier docks and nearby boat slips.

Figure 10. Beach at 15th Street

Via Lido Nord

The photo below shows the beach at Via Lido Nord at Koron Street. Additional sand capacity on the beach is limited by sand retention groins, which function to separate the sandy beach from nearby boat slips. The current distance between the high tide water line and the end of the east groin is approximately 5 feet. Any additional sand should be placed in the middle of the beach, far from boat slips at either end.

Figure 11. Beach at Via Lido Nord

Via Lido Soud

Additional sand capacity on the beach at Via Lido Soud is limited by the size and placement of sand retention structures. The boat launch ramp in the photo below is protected on the edges by small groins which serve to keep sand from migrating onto the ramp surface. The vertical distance from the beach surface to the top of the groin is a few inches. Public land access to this beach is difficult. Visual inspection of the beach sand yielded grain sizes from medium to coarse sand.

Figure 12. Beach at Via Lido Soud

10th Street

There is a public beach at 10th Street and West Bay Avenue. It is bound on either end by structures functioning as sand retention groins. The beach is wide, but still has capacity to accept on the order of tens of cubic yards of additional sand without impacting the nearby boat slips.

Figure 13. Beach at 10th Street

Crestview and Bayshore

Crestview Beach is located at the intersection of Crestview Drive and Bayshore Drive. Bayshore Beach is located on the south east corner of the Bayshore development. These beaches are inaccessible to the public by land. They appear stable, near to eelgrass beds, and bound by boat slips. Any replenishment would have to be small, on the order of tens of cubic yards.

Figure 14. Crestview and Bayshore Beaches

Bay Island West

There is a small beach on the west shore of Bay Island. In 2007, a sand retention wall was proposed for this beach to hold sand up onto the beach and keep it from migrating into the boat slips (Rossmiller, 2007). The beach has no public access, is small, and bound by boat slips, so replenishment capacity is small, on the order of tens of cubic yards.

Figure 15. Beach at Bay Island West

Edgewater/Montero

The beach near the junction of Edgewater Avenue and Montero Avenue is bound on either end by boat slips and offshore by eelgrass. Nevertheless, there are long stretches between boat slips (hundreds of feet) and the eelgrass beds are located more than 30 feet from possible replenishment locations. Therefore, this could receive hundreds of cubic yards of replenishment sand.

Figure 16. Beach at Edgewater and Montero Avenues

Bay Island East

The beach on the east side of Bay Island is inaccessible to the public by land. This beach has boat slips along the majority of its length, with one open area at the north end. The beach is relatively wide compared to other beaches within the Lower Bay and would likely have a low attendance due to it being located on a private island. It could accept on the order of tens of cubic yards without impacting navigation.

Figure 17. Beach at Bay Island East

PCH Bridge

The beach just south of the Pacific Coast Highway Bridge is inaccessible to the public by land. It is currently fenced off and occupied by numerous sculling boats (not shown).

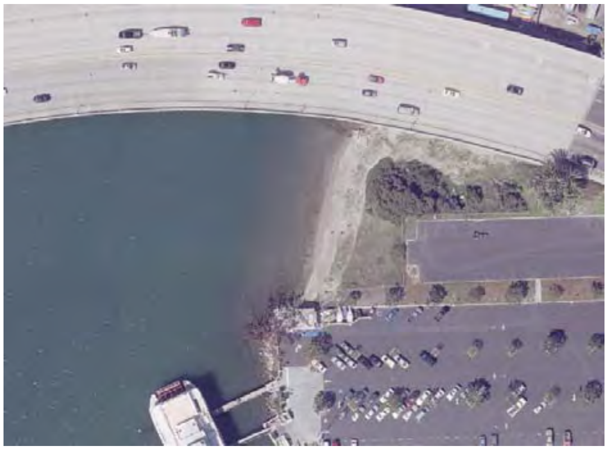

Figure 18. Beach at PCH Bridge

Linda Isle

This beach is inaccessible to the public by land. From aerial photographs it appears that no additional sand could be placed without impacting navigation in nearby boat slips.

Figure 19. Beach at Linda Isle

Beacon Bay

This beach is inaccessible to the public by land. This beach could accept hundreds of cubic yards of sand without negatively impacting navigation or boat slips.

Figure 20. Beach at Beacon Bay

North Bay Front

1,500 cubic yards was replenished on Ruby Beach on the North Bay Front as part of a 2007 dredging effort that removed a total of 7,000 cubic yards from Channel Reef docks. This beach could receive additional sand at specific locations.

Figure 21. Beach at Ruby Street, North Bay Front, St. Looking West

South Bay Front

South Bay Front stretch along the south and west sides of Balboa Island. A 2002 economic study concluded that if beach widths were doubled to an average of thirty feet, the average increase in attendance would be between 7% and 9% (King & Symes, 2002). Also, any significant increase in beach width would cause a negative impact to navigation in the boat slips. There are however erosion hot spots, such as west of Ruby St. that would benefit from replenishment.

Figure 22. Beach at Ruby Street, South Bay Front, Looking East and West

E. Bay Avenue

The beaches along E. Bay Avenue consist of mainly street ends as shown in Figure 23 below and beaches fronting private homes. The street ends are bound on both sides by sand retention groins which serve to separate sand from the nearby boat slips. Most of the beaches along E. Bay Ave. are at capacity. Minor replenishment projects of tens of cubic yards may be acceptable.

Figure 23. Typical Street End Beach Along E. Bay Avenue

Promontory Bay

The beach at Promontory Bay is just south of Bayside Drive and east of Harbor Island Road. There is a sign indicating that it is a private beach. This beach is excluded from replenishment under the RGP. Replenishment can be permitted with additional sediment testing and acquisition of an amendment to the RGP. The beach currently is at capacity. Sand replenishment beyond a few cubic yards would likely overspill the sand retention groin shown in Figure 24.

Figure 24. Beach at Promontory Bay

Bayside Cove

The beach at Bayside Cove is inaccessible to the public by land or water. From the aerial photographs it appears that additional sand could be placed without impacting boat slips.

Figure 25. Beach at Bayside Cove

East Bay Front

The beach along East Bay Front is variable in width and underlies many boat dock ramps. Any beach replenishment would have to be of small quantities at specific locations. The proximity of boat slips would be a limiting factor to replenishment.

Figure 26. East Bay Front

Harbor Patrol

The beach near the Harbor Patrol office in Corona del Mar is sometimes called Interceptor Beach. This name describes its function, which is to intercept, or trap, migrating sand, keeping it from penetrating farther into the harbor and boat slips (Brodeur, 2007). By design, this beach would not be a receiver of replenishment sand, rather a source.

Figure 27. Harbor Patrol Beach

M Street

A public beach is located at M Street and Channel Road on the tip of the Balboa Peninsula. This beach has a flat sandy platform maintained by a concrete, shore parallel retaining wall. On the bay side of the wall is a low sandy beach accessed by concrete steps. The bay side beach is submerged at high tide as shown in the figure below. Some capacity for additional sand exists, but is limited by the nearby boat slips and eelgrass.

Figure 28. Beach at M Street

Carnation Cove

Carnation Cove has an erosive beach (Miller, 2007). The beach is inaccessible to the public by land. Comparing the 2001 and 2006 aerial photographs showed the beach increased from no beach in 2001 to a 10 foot wide dry beach in 2006.

Figure 29. Carnation Cove

China Cove

The beach at China Cove is erosive (Miller, 2007). Between the 2001 and 2006 aerial photographs, the beach width eroded by approximately 20 feet. Since then, this beach received about 985 cubic yards of replenishment in the summer of 2007 under the RGP. The purpose of the replenishment project was to provide additional dry beach for recreation and to help protect the bulkhead and exposed piles within China Cove. The replenishment source was 500 feet north of China Cove. The beach has since returned to a narrow, eroded condition as shown in the photos below.

Figure 30. China Cove

Pirate's Cove

Pirate's cove has a popular beach due to the easy access and plentiful parking. Of all the beaches in the Lower Bay, this beach is the most exposed to open ocean swell. The beach is consistently narrow as observed in the 2001 and 2006 photos as well as the recent site visit. It is likely that any replenishment to this beach would erode quickly, migrating further into the bay.

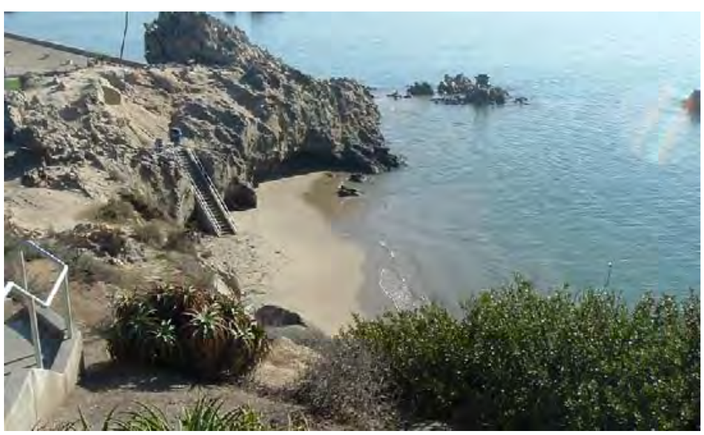

Figure 31. Pirate's Cove

2.2 Beach Usage

Little information is available on beach usage. The only beach attendance estimates available within the Lower Bay were for the south shore of Balboa Island with annual attendance of between 10,000 and 15,000 people (King & Symes, 2002). The study finds that Balboa Island's beaches were less crowded in 2002 than in the 1960s and 1970s. The study concluded that if the beach width along Balboa Island's South Bay Front were doubled to an average of thirty feet, attendance would increase by 7% to 9%.

Since there is only one public boat launch ramp at Newport Dunes in Newport Bay, many of the beaches in the Lower Bay allow hand launching of kayaks and other human powered boats to relieve the demand. These boat launch areas are in high demand and should be maintained as sandy beaches.

2.3 Beach Replenishment and Erosion Rate

No quantitative studies of shoreline erosion rates were available within the Lower Bay. There are however anecdotal observations of significant erosion at China Cove, Carnation Cove, and Balboa Island. Observations of a replenishment project with subsequent erosion at Balboa Island are reproduced here:

"In 1970-1971, 4,210 cubic yards of sand were removed from an area near Promontory Bay and placed on Balboa Island from the north side of the island starting at Sapphire Street and extending around the east end of the island to the south side ending at Coral Street. The southwest side of the island between Emerald Avenue and Turquoise Avenue also received sand. City employees familiar with this project report that the sand did not remain on the beach very long. They felt the slope on which sand was placed was too steep. Wave action flattened the slope and caused sand to fill underneath the boat slips (Moffatt & Nichol, Engineers, 1982)."

Aerial photographs taken in 2001 and 2006 were available from the City of Newport Beach. Shoreline positions were evaluated from these photographs to determine changes in beach width during this time. In most cases no significant change in beach width was observed. This does not necessarily mean that beaches in the Lower Bay are stable, only accretion or erosion was too small to be observed in the photos. This type of analysis is typically useful for large shoreline changes greater than 50 feet, whereas changes in the Lower Bay are on the order of less than ten feet. Due to the small changes observed, additional shoreline change analysis is not warranted.

3.0 BEACH REPLENISHMENT CONSTRAINTS

There are many constraints on how, when, what, and where replenishment is allowed. This section provides an overview of relevant government regulations and practical implementation of those regulations on beach replenishment projects for Newport Bay. In addition, others environmental and practical constraints such as impacts to docks, navigation, and constructability are also discussed.

3.1 Regulatory Environment

Successful implementation of a beach replenishment project requires knowledge of the regulatory environment as well as an understanding of the physical, biological, and chemical characteristics of the receiver and borrow sites. The California Coastal Sediment Management Workgroup has been working on simplifying and summarizing beach replenishment regulations over the past few years. They have developed the following key references to assist in understanding the process:

> *California Coastal Sediment Master Plan Status Report*, California Coastal Sediment Management Workgroup. 2006.
>
> *Sand Compatibility and Opportunistic Use Program*. (Moffatt & Nichol. 2006). Prepared for SANDAG and the California Coastal Sediments Management Workgroup.
>
> California Coastal Sediment Master Plan Policies, Procedures, and Regulations Analysis, Beach Restoration Regulatory Guide, Final. (Everest. 2006). Prepared for California State Coastal Conservancy and Coastal Sediment Management Workgroup.

The following summary of beach replenishment regulations is paraphrased from Everest (2006). Depending on the specific nature of the project, implementing a beach replenishment project requires compliance with various regulations at the federal, state, and local levels of government. The most relevant federal, state and local regulations are summarized in Table 2, along with corresponding regulatory requirements and agencies responsible for administering each regulation.

Table 2. Relevant Regulations Affecting Beach Replenishment Projects

Policy/Regulation	Requirement	Permitting/Approval/ Responsible Agency
Federal		
National Environmental Policy Act	Compliance	Lead Federal Agency
Coastal Zone Management Act	Coastal Consistency Determination (CCD)	California Coastal Commission
Rivers and Harbors Act	Section 10 Permit	US Army Corps of Engineers
Clean Air Act	Title V Operating Permit	California Air Resources Board (see below under State)
Clean Water Act (CWA)	Section 401 Certification or Waiver (401 Permit)	Regional Water Quality Control Boards+
Clean Water Act	Section 402 National Pollution Discharge Elimination System (NPDES) Permit	Regional Water Quality Control Boards+
Clean Water Act	Section 404 Permit (404 Permit)	US Army Corps of Engineers
Endangered Species Act*	Section 7 Consultation	U.S. Fish and Wildlife Service
National Historic Preservation Act*	Section 106 Approval	State Historic Preservation Officer
Fish and Wildlife Coordination Act*	Coordination Act Report (CAR)	US Army Corps of Engineers
Magnuson-Stevens Fishery Conservation & Management Act*	Assessment of Impacts to Essential Fish Habitat	National Marine Fisheries Service
State		
California Environmental Quality Act (CEQA)	Compliance	Lead CEQA Agency
California Coastal Act	Coastal Development Permit (CDP)	California Coastal Commission
Porter-Cologne Water Quality Control Act	Compliance Permits under Clean Water Act Sections 401, 402, and 404	State Water Resources Control Board Regional Water Quality Control Boards
California State Lands Public Resources Code	Lease Agreement for Utilization of Sovereign Lands	California State Lands Commission
California Public Resources Code Section 1600	Streambed Alteration Agreement (SAA)	California Department of Fish and Game
California Endangered Species Act	Section 2081(b) Incidental Take Permit (State) Section 2081.1 Consistency Determination (State and Federal)	California Department of Fish and Game
Water Quality Control Plans California Ocean Plan	Consistency Compliance	Regional Water Quality Control Boards+

Table 2. Relevant Regulations Affecting Beach Replenishment Projects

Policy/Regulation	Requirement	Permitting/Approval/ Responsible Agency
Clean Air Act	Title V Operating Permit	Air Pollution Control Districts and Air Quality Management Districts
Local		
City Municipal Code, Title 17	Title 17, 17.55 Dredging Permit	Newport Beach Harbor Resources Division
Harbor Permit Policy	RGP Permit	Newport Beach Harbor Resources Division

* Review and compliance is usually triggered through the initial Clean Water Act Section 404 permitting process by the USACE.
\+ The SWRCB has lead responsibility when a project involves jurisdiction by more than one RWQCB.

In general, the regulatory compliance process consists of three phases: (i) environmental review; (ii) permitting; and (iii) compliance review. Environmental review is typically done first since the information contained in the environmental review documentation is used by the regulatory and resource agencies to process permits and agreements. Once the environmental review process is complete, or in some cases near completion, then the permitting phase begins.

The environmental review process consists of NEPA and CEQA compliance, including other environmental laws. To streamline the environmental review process and as encouraged by CEQA, NEPA and CEQA documents should be prepared concurrently. The major differences between NEPA and CEQA are summarized in Everest (2006).

Upon completion of the environmental review process, the project applicant will submit the necessary permit and agreement applications to the appropriate agencies. In order to improve coordination and consistency in resource protection and management, the federal regulatory agencies (USACE) and State (California Coastal Commission, or CCC) typically do not approve their permits until they have seen the final draft responses from the other agencies and worked out any response differences. USACE and the State Water Resources Control Board recently issued Regional General Permit Number 67, designed to streamline the beach replenishment permitting process under the USACE, Los Angeles District (USACE, 2006). This standing permit expired September 25, 2011. Newport Harbor falls under the jurisdiction of the Los Angeles District of the USACE.

Most beach replenishment projects involve the placement of material (i.e., fill) in waters of the U.S; therefore, a Clean Water Act (CWA) Section 404 Permit and RHA Section 10 Permit from the USACE are usually required. A CWA Section 401 Certification from the appropriate Regional or State Water Board is needed for the 404 Permit. The CCC (and possibly a Local Coastal Program) will require either a Coastal Consistency Determination (if it's a federal project) or a Coastal Development Permit. The CDFG and State Land Commission must also issue a Streambed Alteration Agreement and Sovereign Lands Utilization Lease, respectively. Triggers and corresponding processes for each regulation are described in Everest (2006).

Successful processing of all required environmental review documentation and permit information requires close coordination with representatives from the relevant regulatory and resource agencies. Contact information (as of December 2006) for federal, state, and local regulatory and resource agencies is provided in Table 3. Each agency should be contacted early in the regulatory compliance phase to identify the agency staff member(s) that will be responsible for the project.

The permitting process can be an expensive and time consuming portion of any replenishment project. For replenishment projects less than 1000 cubic yards (plus other conditions), the Newport Beach Harbor Resources Division maintains a Regional General Permit #54 (RGP). This greatly simplifies the permitting process, condensing the documentation into a four page Dredging Application (with supporting documents) submitted to the Harbor Resources Division. General information such as locations, project description, quantities, depths, grain sizes, and environmental habitat information are required. The RGP is valid for five years, with the current permit ending on October 4, 2011.

Table 3. Regulatory and Resource Agency Contact Information for Beach Replenishment Projects

Agency	Region/District	Office/Area	Contact	Telephone	E-Mail Address
USCAE	Los Angeles District	Orange County	Cori Farrar	(213) 452-3296	Corice.J.Farrar@usace.army.mil
State Water Resources Control Board	California	State	Bill Orme	(916) 341-5464	BOrme@waterboards.ca.gov
Regional Water Quality Control Board	Region 8, Santa Ana		Jun Martirez	(951) 782-3258	jmartirez@waterboards.ca.gov
California Coastal Commission	South Coast District	Counties: Los Angeles and Orange	Teresa Henry	(562) 590-5071	thenry@coastal.ca.gov
California Department of Fish and Game	South Coast Region	Santa Barbara, Ventura, Los Angeles, Orange and San Diego Counties	SAA Contact	(858) 636-3160	
County	Orange	Watershed & Coastal Resources Division	Susan Brodeur	(714) 834-5486	Susan.brodeur@rdmd.ocgov.com
City	Newport Beach	Harbor Resources Division	Chris Miller	(949) 644-3043	cmiller@city.newport-beach.ca.us

Acronyms:
CWA = Clean Water Act of 1972
NEPA = National Environmental Policy Act of 1969
CZMA = Coastal Zone Management Act of 1972
CCA = California Coastal Act of 1976
CDFG = California Department of Fish and Game
ESA = Endangered Species Act of 1973
RHA = River and Harbor Act of 1899
FWCA = Fish and Wildlife Coordination Act of 1956
MSFCMA = Magnuson-Stevens Fishery Conservation and Management Act of 1996
SAA = Streambed Alteration Agreement

Environmental

Simple rules regulating impacts to eelgrass communities within the Lower Bay have been incorporated into the RGP (Harbor Resources Division). An eelgrass survey of the replenishment area is required as part of the permitting process. If it is found that eelgrass is present within 15 feet of the replenishment footprint, the project will not be permitted. If it is present within 15 to 30 feet of the replenishment footprint, then pre-and post-monitoring is required by a certified eelgrass diver. Further than 30 feet requires no additional permitting or monitoring.

An example application of this eelgrass distance rule is shown in Figure 32. This image shows the extent of eelgrass beds (marked in green) overlaid on the beach at South Bay Front, Balboa Island. The eelgrass drawing was provided by the Newport Beach GIS Department. It can be seen that eelgrass has existed right up to the low tide line at this beach. Nevertheless, sand replenishment could still take place on the dry beach as long as the footprint is greater than 15 feet away.

To date, there is no mitigation flexibility in these rules. There has been discussion of developing eelgrass management plan to offset dredging and beach replenishment losses to eelgrass habitats. The eelgrass management plan is currently in the conceptual stage, but would likely ease placement restrictions for beach replenishment if adopted.

A survey for caulerpa taxifolia must be performed covering an area within 30 feet of the replenishment site by a certified caulerpa diver (National Marine Fisheries Service, 2004). Results must be reported to the Harbor Resources Division. While the eelgrass and caulerpa rules have been developed over time for the RGP, it is likely that they would also apply for replenishment projects within the Lower Bay that are not covered under the RGP.

Beach replenishment should not be placed during least tern and snowy plover foraging and nesting seasons, grunion runs, and high beach usage times, which can all differ according to site.

Replenishment rates are restricted to control turbidity levels. Restrictions are also placed on the number of trips per day allowed for transporting source sediment to minimize air quality, noise, public safety, and traffic impacts.

Figure 32. Eelgrass Overlay and Replenishment Footprint on South Bay Front

Sediment Compatibility

In addition to the environmental interpretations of the regulations, rules pertaining to the compatibility of replenishment sources and receiver beaches have been developed specifically for Newport Bay. These rules cover issues associated with grain size compatibility, color, shape, debris, and in place hardness.

The general rule for beach replenishment is that sources must have grain sizes compatible with the receiving beaches. Since beaches in the Lower Bay have sand sized grains a simple rule was developed for use under the RGP. It states that the replenishment source material must be either greater than 80% sand or at least 75% sand and no more than 10% difference in sand content between source and receiver beach. In addition, one soil sample must be collected at each disposal site and at least one sample per quarter acre must be collected.

The 80% rule may also be applicable for larger projects not covered under the RGP. For projects not covered under the RGP and having replenishment sources with 80% sand or less, the source may still be beach suitable if it falls within the grain size envelope of the receiver beach (Moffatt & Nichol, 2006).

It is necessary to know grain sizes of the replenishment sources and receiver beaches for determining grain size compatibility. In support of the most recent (2005) RGP application, 33 sediment samples were collected at potential replenishment sources within Newport Bay (Weston Solutions, Inc., 2005). These locations included both subtidal and intertidal sites near Lido Peninsula, Lido Isle, Bayshore, Linda Isle, Harbor Isle, Balboa Island, Bay Island, and the Balboa Peninsula. It was found that subtidal samples (further from shore) had high percentages of silt and clay and intertidal samples (close to shore) had much higher percentages of ranging from 90.4 to 98.3%. The sediment sample data can be useful for a preliminary analysis if the grain size envelope approach is required.

Grain size data for the many receiver beaches is not yet organized under one report. Many of the beaches have been maintained by individual homeowners or homeowners associations and sampling data may be available from those individuals or groups. While it is beyond the scope of this study, an evolving database of all replenishment sources and receiver beaches would be useful for grain size compatibility analysis within the HAMP.

Similar sediment color is required for aesthetic reasons. Most dredged material is typically suitable for beach replenishment. The darker color of dredged material normally begins to resemble the beach material after exposure to the sun.

Source sediment should have sub-rounded particles, rather than angular or sharp particles. Most dredged material meets this requirement since it is common for naturally transported fluvial material to have rounded particles.

Source sediment should be free of trash and debris. Debris should not pose health or safety hazards, bad odor, or poor visual aspects.

Source sediment should not harden when compacted during beach placement or when exposed to wetting and drying conditions. If this is of concern, then the source material should be placed in the surf zone (Moffatt & Nichol, 2006)

3.2 Impact on Boat Slips

One of the key findings of a 1982 study of beach replenishment on Balboa Island was that locally dredged material when placed on the Balboa Island beaches would quickly result in sedimentation of the nearby boat slips (Moffatt & Nichol, Engineers, 1982). This would result in a hazard to navigation and impact the utility of the slips. Succinctly stated, “A wide beach and boat slips are incompatible uses” (Moffatt & Nichol, Engineers, 1982).

The combined desire for relatively wide beaches and functional boat slips has resulted in the need for near constant beach maintenance. In many cases the maintenance is essentially pushing sand from below the boat slips, uphill to the beach and repeating on a regular basis. In addition, sand retaining groins are prevalent throughout the Lower Bay. Two examples are shown in Figures 33 and 34 below. The groins function to separate the sandy beach from boat slips, reducing the maintenance frequency.

Figure 33. Groin Separating Sandy Beach from Boat Slips at Via Lido Nord

Figure 34. Groin Separating Sandy Beach from Boat Slips on Lido Peninsula

3.3 Construction

Beach replenishment construction within the Lower Bay has been limited to two companies within the past few years. Shellmaker Inc. has been capable of dredging in and around docks as needed with both ocean and beach disposal. Recently, their ocean scow has become disabled so little to no ocean disposal is taking place from the Lower Bay. The second company, Intracoastal Dredging has a small, 6 inch hydraulic dredge operating on a floating platform. The majority of their dewatering and beach shaping has been performed with bobcats and front end loaders. This allows for easy maneuvering between the many docks and structures within the Lower Bay. For the majority of projects within the Lower Bay, construction is limited to these two companies and their equipment. They have an economic advantage over other companies since their mobilization and demobilization costs will be minimal.

There is larger dredging equipment currently operating in the Upper Bay. When that project finishes in 2008, it will likely move out of Newport Bay to other large-scale projects. Re-mobilizing back to Newport Bay would likely be cost prohibitive for future use.

4.0 PRIORITIZING BEACH REPLENISHMENT

The numerous factors both for and against replenishment at the many possible beaches within the Lower Bay make choosing which beach receives sand replenishment difficult. To date, no systematic decision making method is available. To assist in this, two possible decision making tools are presented: 1) a benefit to cost (B/C) ratio analysis which provides one relatively objective dollar value to each possible scenario; and 2) the use of an Alternative Matrix to provide more subjective qualitative rating between different alternatives.

4.1 Benefit Cost Ratio Approach

To help with large scale sand replenishment project decision making, economists and policy-makers typically perform a B/C analysis. This approach has been pursued by the US Army Corps of Engineers with their automated GIS based regional sediment management computer programs for the Ventura and San Diego regions (Everest, 2006 and 2008). Also, the California Department of Boating and Waterways used this approach on a state wide level (King and Douglas, 2003) and the San Diego Association of Governments (SANDAG) used B/C analysis for the San Diego region (SANDAG, 2007).

A B/C analysis examines the ratio of benefits to costs. For example if a replenishment project yields an increase in total economic benefit of $800,000 and costs $200,000, then the B/C ratio is 4 ($800,000/$200,000). If the B/C ratio is greater than one, then the project makes sense in terms of California State policy. As a practical matter, many agencies require a somewhat higher ratio, for example, a B/C ratio greater than two is sometimes required to ensure that the project makes sense given the uncertainties involved. When resources are limited, it is useful to choose projects with the highest B/C ratio.

The approach normally taken to perform a B/C analysis involves 1) development of alternatives, 2) estimates of construction and lifetime costs, 3) estimates of the potential benefits, and 4) review of the B/C ratios for each alternative.

Costs that are typically considered include: studies, engineering, environmental review, permitting, construction, mitigation, maintenance, and monitoring. The evaluation of economic benefits will typically consider the following factors: weather (sunny or cloudy); water quality (recreation experience); beach width and quality (existing beach widths, future widths, sustainability, sand quality), overcrowding (attendance, carrying capacity), beach facilities and services, availability of substitutes and parking (accessibility); storm protection (some agencies do not include this); and environmental benefit (in most cases replenishment is a detriment).

If the B/C approach were pursued for sand replenishment in the Lower Bay, significant gaps in available data would need to be filled such as: receiver beach grain sizes, replenishment source grain sizes, existing beach widths, erosion rates, attendance/popularity, public access status, and amenities of each beach.

The B/C analysis, while providing objective information, is also very data intensive and likely over burdensome for small scale sand replenishment projects such as proposed for the Lower Bay. A more effort-appropriate approach is the less data intensive, more qualitative “Alternative Matrix”.

4.2 Alternative Matrix

An Alternative Matrix was developed for this report (Table 4) to qualitatively rank beaches for their replenishment capacity and need. To do this, the beach names were listed on the left column with each beach having qualitative values for various criteria. The criteria include: access & popularity, sand capacity, constructability, and eelgrass. Values for each criteria range from 1 to 3 with 1 being poor performance and 3 being good performance within that criteria. Also, each criteria are weighted from 1 to 3 based on their level of importance, with 3 being most important. For example, access & popularity is very important so that criteria receives a weight of 3, while constructability is least important receiving a weight of 1. Each beach and criteria combination has a subtotal calculated as the criteria value times the importance weighting. On the right hand side of the table the sub-totals are added together and ranked. The beaches that would benefit the most from replenishment have the highest total and the best rank (1 being best).

The best ranking beaches in the Alternative Matrix are (from west to east): Marina Park, Edgewater/Montero, and China Cove, all having an equal rank of 1. The next best ranked beaches are Pirate's Cove (ranked 2), Lake St, 10^{th} St, and M St. (ranked 3).

The Alternative Matrix could be improved by refinement and/or addition of the following data: estimates of replenishment capacity at each beach (± 100%), public access status of each beach, a database of grain sizes and their compatibility to potential sediment sources.

Table 4. Beach Replenishment Alternative Matrix

Number	Beach Name	Access & Popularity	Importance x 3	Sand Capacity & Erosion	Importance x 3	Constructability	Importance x 1	Eelgrass	Importance x 2	Total	Rank
		value	subtotal	value	subtotal	value	subtotal	value	subtotal		
1	Channel Place Park	3	9	1	3	2	2	3	6	20	6
2	Balboa Coves	1	3	1	3	1	1	3	6	13	12
3	Lake St.	3	9	2	6	2	2	3	6	23	3
4	Newport Island Park	3	9	1	3	2	2	3	6	20	6
5	Lido Park	2	6	1	3	1	1	3	6	16	9
6	Lido Peninsula	2	6	1	3	2	2	3	6	17	8
7	Marina Park	3	9	3	9	2	2	3	6	26	1
8	15th St	3	9	1	3	2	2	3	6	20	6
9	Via Lido Nord	2	6	3	9	1	1	3	6	22	4
10	Via Lido Soud	1	3	1	3	1	1	3	6	13	12
11	10th St	3	9	2	6	2	2	3	6	23	3
12	Crestview	1	3	1	3	2	2	3	6	14	11
13	Bayshore	1	3	1	3	2	2	1	2	10	13
14	Bay Island West	1	3	1	3	1	1	3	6	13	12
15	Edgewater/Montero	3	9	3	9	2	2	3	6	26	1
16	Bay Island East	1	3	2	6	1	1	2	4	14	11
17	PCH Bridge	1	3	2	6	2	2	3	6	17	8
18	Linda Isle	1	3	1	3	1	1	3	6	13	12
19	Beacon Bay	1	3	2	6	2	2	2	4	15	10
20	North Bay Front	3	9	2	6	2	2	2	4	21	5
21	South Bay Front	3	9	2	6	2	2	2	4	21	5
22	E Bay Ave	3	9	1	3	2	2	2	4	18	7
23	Promontory Bay	1	3	1	3	2	2	3	6	14	11
24	Bayside Cove	1	3	2	6	1	1	3	6	16	9
25	East Bay Front	3	9	2	6	2	2	2	4	21	5
26	Harbor Patrol	3	9	1	3	2	2	1	2	16	9

Table 4. Beach Replenishment Alternative Matrix

Number	Beach Name	Access & Popularity	Importance x 3	Sand Capacity & Erosion	Importance x 3	Constructability	Importance x 1	Eelgrass	Importance x 2	Total	Rank
		value	subtotal	value	subtotal	value	subtotal	value	subtotal		
27	M St	3	9	2	6	2	2	3	6	23	3
28	Carnation Cove	1	3	3	9	2	2	3	6	20	6
29	China Cove	3	9	3	9	2	2	3	6	26	1
30	Pirate's Cove	3	9	3	9	1	1	3	6	25	2

Notes on the Alternative Matrix:

Access & Popularity indicate the recreational need of each beach. This includes public access by land to the beach, recreation on the dry beach (such as lounging and exercise), in the water (such as swimming), and boat launching of hand carried craft. Beaches that are not accessible by the public would receive a criteria value of 1. Beaches that are popular and easy to access would receive a value of 3.

Sand Capacity & Erosion indicate the need of each beach for additional sand. Many beaches are already at capacity, not requiring additional sand. These would receive a criteria value of 1. Others are highly erosive and require significant replenishment. Beaches that require the most replenishment would receive a criteria value of 3.

Constructability This category describes how difficult it would be to construct beach replenishment. The criteria values range from 1 to 3, with 3 being the easiest, and 1 being most difficult. Easy constructability would be a beach easily accessed by land and water. Difficult constructability would be a beach with narrow streets and blocked beach access making land transport of sand difficult to impossible. All but one of the beaches are accessible by water.

Eelgrass This criteria generally reflects the ease of permitting. Of the permitting issues, eelgrass proximity is the most constraining. Beaches are rated with a scale from 1 to 3 with 3 being easy and 1 being difficult permitting. An easy permitting means that eelgrass is greater than 30 feet away and the replenishment could be applied for under the RGP. Difficult permitting means eelgrass is within 15 feet and the replenishment could not use the RGP. Other regulatory and environmental considerations include temporary impact to water quality and grain size compatibility requirements. These other considerations, however, are approximately equal for all beaches being considered and are not reflected in the 1 to 3 scale.

Total Beaches with the highest total are most promising for replenishment.

Rank Beaches are ranked from 1 to 13 with 1 being the most promising and 13 being the least favorable beach for replenishment. Some beaches are tied for rank.

5.0 FINDINGS AND RECOMMENDATIONS

There are over 30 beaches within Lower Newport Bay with varying uses and needs. Several issues have prevented efficient management of beach replenishment projects.

- There is no management system in place to characterize and prioritize dredged material for beneficial uses such as beach replenishment.

- There is no management system is in place to prioritize selection of beaches for replenishment.

- Eelgrass habitat restrictions: The proximity of eelgrass beds can limit the opportunities to replenish the beaches. Currently, beach replenishment cannot be conducted in areas where eelgrass is found within 15 feet of the replenishment footprint. If eelgrass is found within 15 to 30 feet of the replenishment footprint, then pre-and post-monitoring surveys are required.

- Components of the RGP restrict the application of dredged material on beaches. Under the RGP, only small volumes (<1000cy) of dredged material from the Lower Bay can be beneficially used to nourish compatible beaches. Larger replenishments require a separate and costly permit.

The City will benefit from developing a centralized management program to manage future dredging and beach replenishment projects. An Alternative Matrix has been developed that the City can use in the future to rank the varying uses, needs, and constraints of the beaches to decide on which beach would most benefit from replenishment. It is recommended that the City to fill the data gaps listed earlier to improve the Alternative Matrix which can easily be modified as more information becomes available or when priorities and opportunities change.

Based on existing available data, the Alternative Matrix shows that Marina Park, Edgewater/Montero, and China Cove (Figure 35) all rank very high for beach replenishment since these beaches all have a recreational need, can accept significant quantities of sand, are easily constructed, and are far enough from eelgrass to be permitted. Pirate’s Cove, Lake St, 10th St., and M St. also rank well for beach replenishment.

Figure 35. Priority Beach Replenishment Locations

In addition to continue to improve the Alternative Matrix, the following recommendations are made for improving the effectiveness of future beach replenishment program:

- Develop eelgrass management plan and determine if these banks can be used for beach replenishment. This would significantly reduce restrictions on beach replenishment placement locations.

- Modify the RGP to simplify and streamline the special conditions and increase the 1,000 cubic yard quantity limit. This would allow the resumption of maintenance dredging and beach replenishment by individual homeowners and homeowners associations.

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APPENDIX D

Water Quality

"The following technical report reflects the findings and data available at the time the report was prepared and may not represent the current conclusions and steps forward in the main text of the HAMP, which has been updated after the completion of these reports. These more detailed technical reports provided in the appendices represent the foundation for the overall approach to the HAMP, but are not "living" documents that reflect updated steps forward, costing, quantities, etc. presented in the main text of the HAMP. The main text of the HAMP represents more current information and recommendations based on updated information, new studies, changes in conditions, new funding sources, and/or new regulations."

HARBOR AREA MANAGEMENT PLAN

Strategic BMP Implementation Plan

Technical Report

Prepared For:

Harbor Resources Division

City of Newport Beach

829 Harbor Island Drive

Newport Beach, CA 92660

Prepared By:

WESTON SOLUTIONS, INC.

2433 Impala Drive

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June 2009

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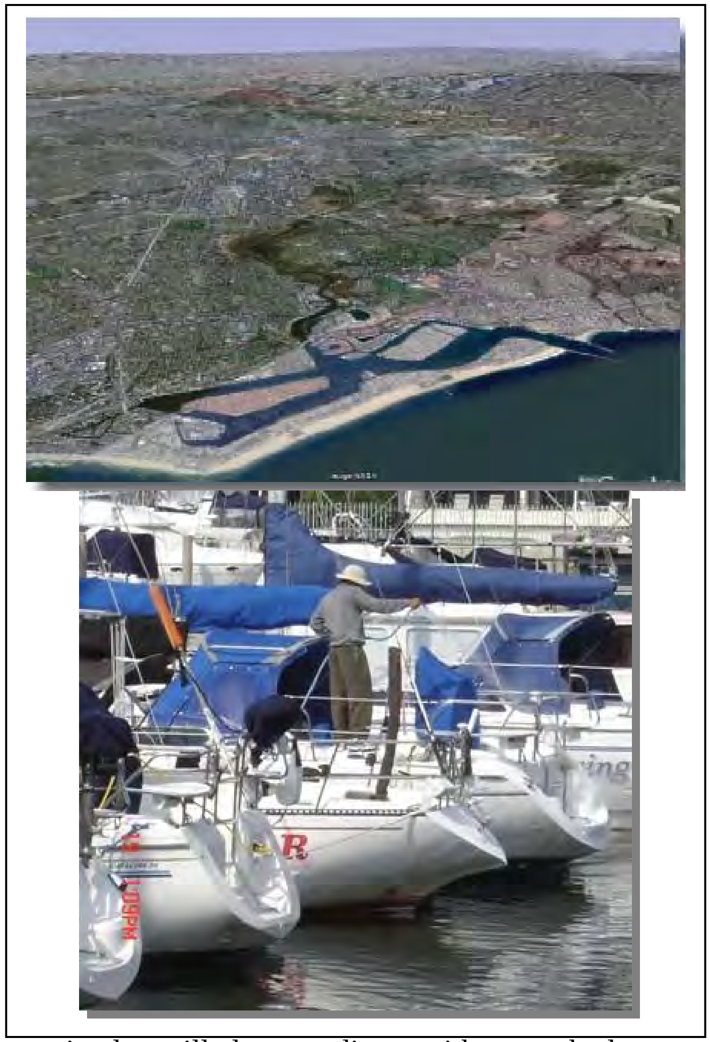
1.1 Introduction



The City of Newport Beach (City) is committed to achieving a sustainable Newport Harbor Area (Harbor Area) through protection and improvement of water quality. Water quality is a key link in addressing community needs, regulatory requirements, and the health and diversity of the surrounding ecosystems to the Harbor Area. The City's strategy toward achieving this vision begins with an evaluation of the current health and water quality of the Harbor Area and identifying the sources of impacts to it. Based on this understanding, strategies will be developed to protect water quality in the Harbor Area through the implementation of best management practices (BMP) supplemented by coordination with other regional water quality protection measures, community outreach, and education. The end goal is to create a Strategic BMP Implementation Plan (Strategic BMP Plan) to strategically implement water quality BMP that is coordinated with Harbor Area beneficial uses and addresses current and future pollutants entering and discharging from the Upper and Lower Newport Bay. The strategic plan will also coordinate with watershed, Upper Newport Bay and coastal plans and projects to create a sustainable water quality improvement plan maintained through iterative effectiveness assessment of the implanted water quality protection, preservation, and improvement measures.

1.2 Purpose of the Strategic BMP Plan

The purpose of the Strategic BMP Plan is to first identify the priority water quality issues and the management measures to address them. Based on the applicable management measures developed in this plan, the strategy for the implementation of these measures is then presented. Therefore, this Strategic BMP Plan provides the City with a management tool to identify the BMP to be implemented to address the water quality issues of the Newport Harbor.

These BMP will be implemented in coordination with the other components of the HAMP to achieve the following overall goals:

- Maintaining the beneficial uses of the Upper and Lower Newport Bay and economic value of the Bay;
- Providing a practical framework to meet regulatory requirements in the current and anticipated municipal discharge permits, sediment management permits, total maximum daily loads (TMDL), and other regulatory programs for Newport Bay; and,
- Supporting a sustainable estuary ecosystem to integrated with upstream sustainable watersheds and adjacent coastal area systems.

This Strategic BMP Plan focuses on addressing the water quality issues of the Newport Bay. BMP recommended for implementation in this Plan are to be coordinated with the management measures and priorities presented in the following management plans for the upper watershed and the coastal canyon watersheds:

- Central Orange County Integrated Regional and Coastal Watershed Management Plan (County of Orange Resources and Development Management Department, Watershed and Coastal Resource Division, August 2007)

- City of Newport Beach Coastal Watershed Management Plan (Weston, November 2007)

Each of these plans presents the goals, challenges and recommended solutions for the respective watersheds. Solutions that address water quality issues are linked to measures recommended in this plan by the connectivity of the upper watershed and coastal areas to the Harbor. Several of the projects presented in these plans are included in the BMP presented in this plan where there directly address water quality in the Harbor.

1.3 Plan Outline and Contents

The Strategic BMP Plan first presents in Section 2 an evaluation of the water quality issues of the Harbor Area based on available data. The outcome of the evaluation is the identification of priority constituents of concern (COC). These priority COC are then used to develop the key questions and coordination with other program presented in Section 3. The identification of applicable BMP to address the priority COC and prioritization strategy for the implementation of the BMP are presented in Section 4. The recommend implementation strategy is an integrated, tiered and phased BMP implementation approach. Recommended prioritized BMP are then presented in Section 5.

2.0 EVALUATION OF WATER QUALITY ISSUES IN THE HARBOR AREA

2.1 Overview of Water Quality Issues and Regulatory Drivers

Upper Newport Bay is approximately 1,000 acres in size and 2 miles long. The Upper Newport Bay State Ecological Reserve is one of only a few remaining estuaries in Southern California and is the home to numerous species of mammals, fish, invertebrates, and native plants, including several endangered species (Newport Bay Naturalists and Friends, 2007). The lower portion of the Upper Newport Bay includes the Upper Newport Bay State Marine Park. Lower Newport is approximately 752 acres in size, and consists of Newport Harbor and recreational and navigational channels.

The primary tributary to Newport Bay is San Diego Creek. This sub-watershed covers approximately 122 square miles and includes numerous tributary drainages such as Peters Canyon Wash, Serrano Creek, Borrego Canyon Wash, Bee Canyon Wash, El Modena-Irvine Channel, and Sand Canyon Wash. The Santa Ana-Delhi Channel is the second major tributary, draining approximately 17 square miles of densely developed area within the City of Santa Ana.

The Newport Harbor Area faces water quality challenges as identified through regulatory action and a number of special studies recently undertaken by the City of Newport Beach and other watershed stakeholders. The Harbor Area, located in the Lower Newport Bay, is the nexus between the highly urbanized San Diego Creek and Santa Ana-Delhi Channel upstream sub-watersheds, the ecologically sensitive Upper Newport Bay and the receiving waters of the Pacific Ocean (Figure 2-1). The Harbor Area is also functioning small boat harbor surrounded by small businesses, private residences, and municipal facilities. The Lower Bay has over 9000 boats berthed in its marinas and private boat slips. The Lower Bay also serves as a major Southern California recreational destination, attracting both visitors and locals to take advantage of a variety of water-related activities.

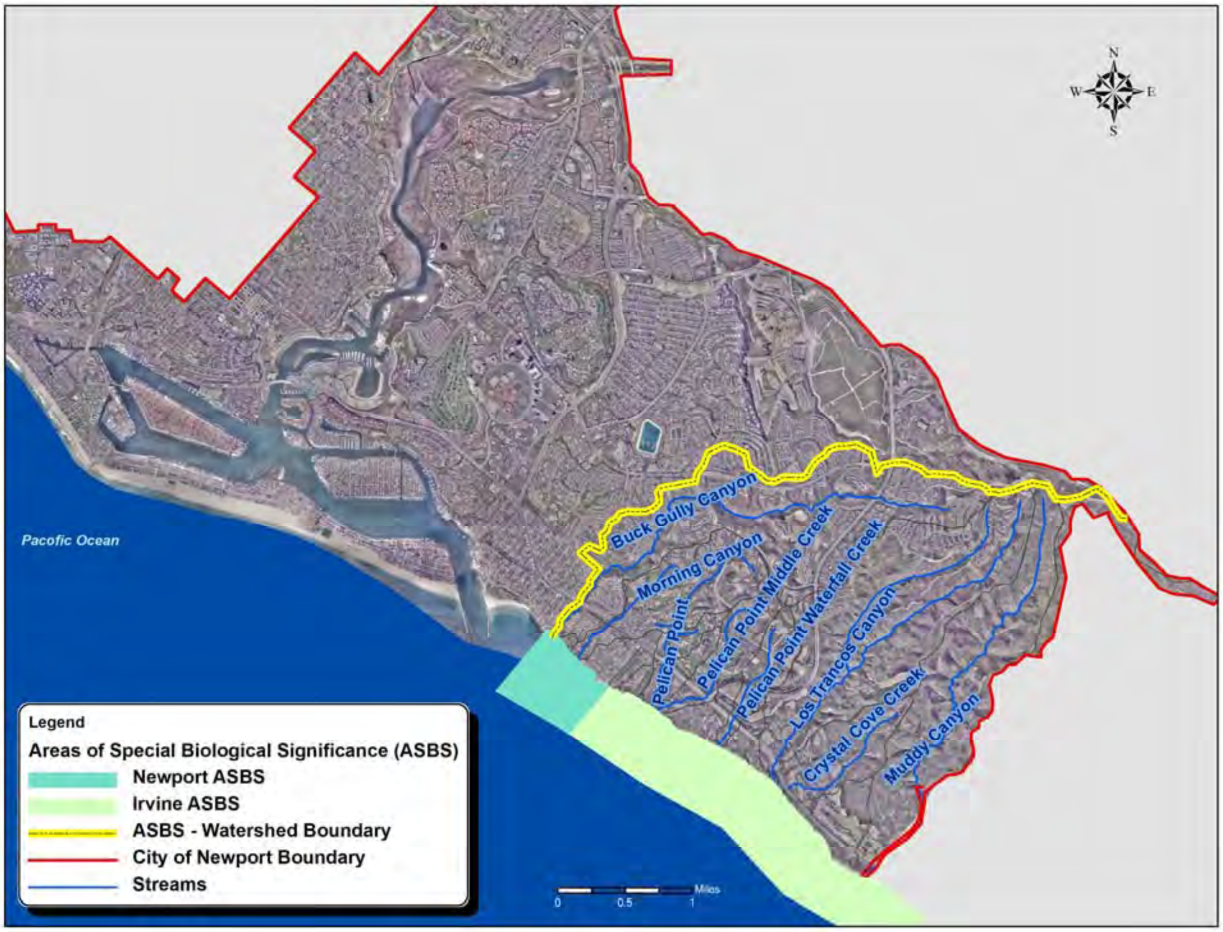


Figure 2-1: Newport Beach Coastal Watershed

Key water quality challenges in the Harbor Area include: understanding constituent loadings from regional upstream sources in the San Diego Creek Watershed, contributions of constituents from local sources within the Harbor Area, potential cross-contamination from sources outside of the Bay, and Bay discharges of degraded water quality to sensitive marine areas outside of the harbor. The Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) lists Newport Bay as tributary to the Pacific Ocean and also serves as the receiving waters for San Diego Creek. Located just outside the Harbor are two areas designated by the State as Areas of Special Biological Significance (ASBS) that are subject to special protections under the California Ocean Plan (COP). Table 2-1 summarizes the Basin Plan beneficial uses for the waters in and adjacent to the Harbor Area.

Table 2-1. Beneficial Uses for Waters in the Newport Harbor Area.

	Agricultural Supply	Groundwater	Water Contact Recreation	Non-water contact recreation	Commercial and Sportfishing	Warm Freshwater Habitat	Limited Warm Freshwater Habitat	Biological Habitats of Special Significance	Wildlife Habitat	Rare, Threatened, or Endangered Species	Spawning, Reproduction, and Development	Marine Habitat	Shellfish Harvesting	Estuarine Habitat
Bays, Estuaries, and Tidal Prisms														
Lower Newport Bay			●	●	●				●	●	●	●	●	
Upper Newport Bay			●	●	●			●	●	●	●	●	●	●
Channels Discharging to Coastal or Bay Waters			●	●	●				●			●		
Ocean Waters														
SWQPA (formerly ASBS)			●	●				●				●		
Newport Bay			●	●	●								●	
Inland Surface Streams														
Buck Gully	●	●				●	●							
Morning Canyon						●	●							
San Diego Creek														
Reach 1 - Below Jeffries Road			●	●					●					

* Beneficial use definitions can be found in the Santa Ana Basin Plan (RWQCB, 2000)

Table 2-2. Impaired Water Bodies and Pollutants of Concern in the Newport Harbor Area.

	Buck Gully Creek	Lower Newport Bay	Upper Newport Bay	Rhine Channel	San Diego Creek - Reach 1
TMDLs					
Nutrients		●	●		●
Pathogens		●	●		
Pesticides		●	●		●
Sedimentation			●		●
303(d) Listings					
Chlordane		●	●		
Copper		●	●	●	
DDT		●	●		
Fecal Coliform	●				●
Lead				●	
Mercury				●	
Metals			●		
PCBs		●	●	●	
Sediment Toxicity		●	●	●	
Selenium					●
Total Coliform	●				
Toxaphene					●
Zinc				●	

Based on the Basin Plan beneficial use designations and the COP, water bodies within and near the Harbor Area are subject to regulatory action from the USEPA, the State Water Resources Control Board (SWRCB) and the Santa Ana Regional Water Quality Control Board (RWQCB). The EPA and the RWQCB have implemented Total Maximum Daily Loads (TMDL) for various constituents in San Diego Creek and the Upper and Lower Newport Bay. Buck Gully Creek, the Upper and Lower Newport Bay, Rhine Channel, and San Diego Creek all are listed on the EPA's 303(d) list as impaired (Table 2-2).

The development of a cost-effective strategy to implement BMP to meet current and anticipated TMDL, other regulatory drivers, and existing City planning documents and ordinances is a key component in effectively addressing water quality issues in the Upper and Lower Bay.

2.2 Newport Bay Watershed History and Water Quality Issues (IRWMP, County of Orange, 2007)

Newport Bay Watershed History and Water Quality Issues

"The resources of Newport Bay have been long and extensively studied. Gilbert (in 1889) described the main channel of the Bay as muddy, soft in places—quote: '. . . but with many banks of native oysters, which reach a large size'. He also noted a small but constant flow of freshwater from springs at the head of the Bay. Another early contribution (MacGinitie, 1939) documented freshwater storm flows as causing high mortality among benthic organisms in Newport Bay. Historical changes in Bay ecology that reflect the shifting course of the Santa Ana River (and later the San Diego Creek) have also been documented (Stevenson and Emery, 1958; Macdonald, 1991).

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After the eastward extension of Balboa Peninsula in the 1860s, the Upper Bay was protected from direct ocean waves providing a quiet environment subject only to tidal action and local runoff. The result was the accretion of silt over the previously sandy platform. By the 1950s, silt was 18 to 50 inches deep throughout the Bay (Stevenson and Emery, 1958).

As the Bay became shallower, marsh vegetation spread and further enhanced deposition. Major sources for the initial 18-50 inches of silt were the roughly 32 square miles of natural local drainage area surrounding Newport Bay and, until 1920 when the Santa Ana River was re-routed directly to the sea, fine sediments from floods could be brought into the Bay through that source. Sediment from the larger drainage of San Diego Creek was not a factor until that stream was gradually routed into Upper Newport Bay in this century.

San Diego Creek did not have integrated drainage nor regular drainage to the sea at the time of European settlement. Sediment-laden streams from both Loma Ridge and the San Joaquin Hills flowed through steep valleys to the Tustin plain where the slope suddenly decreased. The resulting decrease in stream velocity plus rapid infiltration of water caused the deposition of the coarser sediment creating alluvial fans at the base of the hills. The flow of water moved about on these fans causing them to spread laterally and coalesce along the foot of the hills.

The higher stormflows were ponded in an ephemeral lake located between Upper Newport Bay and the present site of the Santa Ana River. The ephemeral lake bed and the area to its north and east was usually swampy and marshy and was known as the "Swamp of the Frogs" (Cienega de las Ranas). The swamp extended to areas near the 100 feet elevation mark and included areas with slopes up to perhaps 1.5 percent.

To improve agricultural drainage for those areas on either side of Peters Canyon Wash, a channel was dug towards Upper Newport Bay and the ridge which had historically dammed water in the Tustin Basin was breached (1901 and 1915). However, the water was only being conducted to the 600 or so acres of peat and swampland lying one to three miles above the Bay, where it was simply allowed to spread into that wetland and make its way to the Bay the best it could (Trimble, 1998).

To contain increasing flood flows and sediment loads, and to protect a salt works, the Irvine Company in 1946 built a 3,000 acre-feet floodwater retention pond upstream of present University Avenue. Finally, the wide, efficient San Diego Creek channel was built in the 1960s so that peak floods and sediment could be efficiently routed to the Bay itself.

The uppermost portion of Upper Newport Bay contained salt evaporation ponds and was separated from the rest of the Bay by an earthen dike. Heavy storm runoff destroyed the salt ponds and breached the dike in 1969. Subsequent storm season sedimentation events in 1978 and 1980 caused shallowing of the Upper Bay; while intertidal saltmarsh vegetation became established and expanded rapidly (ACOE, 1993).

In 1985, 85 acres of the Upper Bay were dredged out to create the Unit I Sediment Control Basin (depths –3 to –7 feet MSL). A second dredging project in 1988 created the 37-acre Unit II Sediment Control Basin, just south of the Main Dike (depth –14 feet MSL). Both basins have worked well, collecting large volumes of coarser grained sediment from periodic flood runoff, principally down San Diego Creek. These then require extensive maintenance dredging, as is on-going at present.

Open water estuary/marine aquatic habitats still predominate in Newport Bay. The present shoreline includes scattered bare and disturbed areas, extensive intertidal saltmarsh with cordgrass, less common pickleweed, rare eelgrass, and small fringing areas of willow/mulefat scrub wetland. Algae and other forms of plankton are seasonally dominant.

Studies of physical conditions in Upper Newport Bay confirm a picture of significant tidal, seasonal, and annual variability. During peak storms the upper part of Upper Newport Bay was characterized by a well mixed, freshwater column. In lesser flows, salinity stratification is noted in the lower part of Upper Newport Bay, with freshwater overlying slightly diluted seawater." (California Coastal Conservancy, 1998)

Changes in land use from ranching and grazing to farmland resulted in the discharge of pesticides and nutrients into San Diego Creek and Upper Newport Bay. Since the 1960s, commercial, residential, and light industrial development has replaced open space and agricultural lands. Development and the related increase in impervious surfaces have increased runoff and altered drainage patterns. Several drainages were channelized for flood control as the amount of runoff necessitated increasing the size and number of channels that drain into San Diego Creek and Upper Newport Bay. As a result, basins were constructed to control sedimentation (ACOE 1999). Additional erosion control structures were installed in the channels. Channel erosion is most evident along Serrano Creek, where recent estimates of flow velocities are about 30 feet per second (Watershed and Coastal Resources Division 2007).

These changes in land use and the location of the former military bases within the San Diego Creek subwatershed have resulted in the discharge of toxic substances, including metals and pesticides, into San Diego Creek and Upper Newport Bay.

Lower Newport Bay, which includes Newport Harbor, has additional water quality issues associated with metals used in boat paints. Rhine Channel, located in the western end of Lower Newport Bay, has been surrounded by industrial uses such as canneries, metal plating companies, and shipyards since the 1920s (Anchor Environmental 2006). Rhine Channel is a dead-end channel in which toxic pollutants have accumulated in the sediment. Sediment accumulation in the bay due to erosion from San Diego Creek and its tributaries has created adverse effects on habitat in the bay and on use of the Lower Newport Bay channels for navigation.

San Diego Creek, Peters Canyon Channel, Upper and Lower Newport Bay, and the Rhine Channel are listed on the EPA's 303(d) list (SWRCB, 2006) as impaired with fecal coliform, organochlorine pesticides, polychlorinated biphenyls (PCBs), metals, and sediment toxicity. The EPA and the Santa Ana RWQCB have implemented TMDLs for the San Diego Creek and Newport Bay for toxicity (including pesticides and metals), sediment, and nutrients. Additionally, a TMDL for fecal coliform has been established for Newport Bay. The TMDLs have been established to restore the beneficial uses of and improve water quality in the Newport Bay Watershed, including Upper Newport Bay State Ecological Reserve.

Surface Water

The two main tributaries to Newport Bay are San Diego Creek and the Santa Ana-Delhi Channel (*See Figure 2.1*). San Diego Creek accounts for approximately 80 percent of freshwater flows into Upper Newport Bay, and the Santa Ana-Delhi Channel accounts for approximately 15 percent of the freshwater flows (ACOE 2000). Newport Bay also receives flows from Santa Isabel Channel, Bonita Creek, Costa Mesa Channel, Big Canyon Wash and smaller storm drains (EPA 1998).

Two important tributaries to San Diego Creek are Serrano Creek and Borrego Wash. These tributaries have experienced significant erosion and have created a life and property hazard for nearby residents. Unfortunately, neither of these tributaries are gauged, so no historical flow data is available.

San Diego Creek extends approximately 14 miles from the Newport Bay to its headwaters and is differentiated into two reaches for the purpose of defining specific beneficial uses and corresponding water quality objectives. Reach 1 extends from the mouth of San Diego Creek at Upper Newport Bay to Jeffrey Road. Reach 2 is upstream of Reach 1 and extends from Jeffrey Road to the headwaters of San Diego Creek. Stream flow in Reach 2 is intermittent (Basin Plan).

Mean daily flow rates in Reach 1 of the San Diego Creek (at Campus Drive) from July 2003 to June 2004 varied from a low of 6.51 cubic feet per second (cfs) in July 2003 to a high of 167 cfs in February 2004 (County of Orange 2004). The average daily flow rates from San Diego Creek at Campus Drive are presented in *Table 2.3, Stream Flow for San Diego Creek Reach 1 – Mouth of San Diego Creek at Upper Newport Bay to Jeffrey Road.*

Stream-flow data for San Diego Creek at Campus Drive were also obtained from the U.S. Geological Survey for the years 1977 through 1984 (there is no data for October 1979 to September 1982). Average monthly flow rates for that time period are also presented in *Table 2.3*. Average monthly flow rates for San Diego Creek Reach 2 are presented in *Table 2.4, Stream Flow for San Diego Creek Reach 2 – Jeffrey Road to Headwaters*.

Table 2.3
Stream Flow for San Diego Creek Reach 1 –Mouth of San Diego Creek at Upper Newport Bay to Jeffrey Road(measured at Campus Drive)

AVG Q (cfs)	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
2003-2004	6.51	8.76	7.45	7.52	14.4	29.0	13.7	167	27.1	19.7	7.47	7.37
1977-1984	26.5	27.5	32.1	31.9	53.9	57.1	110.7	106.9	184.5	45.5	28.2	26.6

Source: County of Orange, RDMD, Hydrologic Data Report, 2003-2004 Season, Station 226; USGS Water Resources Historical Data for San Diego Creek at Campus Drive.

AVG Q = Average Daily Flow Rate
cfs = cubic feet per second

Table 2.4
Stream Flow for San Diego Creek Reach 2 – At Culver Drive and Jeffrey Road to Headwaters
(measured at Lane Road)

AVG Q (cfs)	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
2003-2004	2.4	1.3	1.1	1.4	2.3	10.8	4.3	76.0	12.8	5.3	1.0	0.8
1972-1977	15.3	15.5	13.3	12.3	20.3	17.7	32.4	30.9	31.2	19.7	12.5	13.3

Source: County of Orange, RDMD, Hydrologic Data Report, 2003-2004 Season, Station 231, USGS Water Resources.

AVG Q = Average Daily Flow Rate
cfs = cubic feet per second

The Santa Ana Delhi Channel contributes about 15 percent of the total flow into Newport Bay. During water year 2003-2004 the momentary peak flow from the channel was about 2,000 cfs with an average daily flow of about 5.1 cfs. Average daily flow rates for 2003-2004 are shown in *Table 2.5, Stream Flow for Santa Ana-Delhi Channel at Irvine Avenue*

Table 2.5
Stream Flow for Santa Ana Delhi Channel at Irvine Avenue

Avg Q (cfs)	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
2003-2004	2.36	1.09	1.88	1.10	4.09	7.09	3.63	29.6	3.80	4.07	1.57	2.08

Source: County of Orange, RDMD, Hydrologic Data Report, 2003-2004 Season, Station 220

Avg Q = Average Daily Flow Rate
cfs = cubic feet per second

Peters Canyon Wash originates in Peters Canyon Regional Park and drains into San Diego Creek approximately 14 miles upstream from the Newport Bay. Average monthly flow rates for Peters Canyon Wash are presented in *Table 2.6, Stream Flow for Peters Canyon Wash.*

Table 2.6
Stream Flow for Peters Canyon Wash
(at Barranca Parkway)

AVG Q (cfs)	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
2003-2004	7.54	5.22	4.44	3.36	3.78	7.94	4.79	64.0	8.83	6.66	4.20	3.98
1982-1985	17.8	17.0	20.5	22.0	33.6	27.5	26.0	33.1	59.0	24.1	17.9	18.2

Source: County of Orange, RDMD, Hydrologic Data Report, 2003-2004 Season, Station 230, USGS Water Resources.

AVG Q = Average Daily Flow Rate
cfs = cubic feet per second

Beneficial uses for surface waters have been designated within the Newport Bay Watershed by the Santa Ana RWQCB (see *Table 2.1*). At this time, native surface waters from the Newport Bay Watershed are not used as a potable water supply.

Surface Water Quality

San Diego Creek, Peters Canyon Channel, Upper and Lower Newport Bay, and the Rhine Channel are listed on the 303(d) list as impaired with fecal coliform, organochlorine pesticides, PCBs, metals, and sediment toxicity. The EPA and the Santa Ana RWQCB have implemented TMDLs for the San Diego Creek and Newport Bay for toxicity (including pesticides and metals), sediment, and nutrients. Additionally, a TMDL for fecal coliform has been established for Newport Bay. Monitoring locations are shown in *Figure 2.10, Newport Bay Monitoring Locations*.

Coliform

Bacterial contamination of the waters of Newport Bay can directly affect two designated beneficial uses: water-contact recreation and shellfish harvesting. The Orange County Health Care Agency (OCHCA) conducts routine bacteriological monitoring and more detailed sanitary surveys as necessary, and is responsible for closure of areas to recreational and shellfish harvesting uses if warranted by the results.

Because of consistently high levels of total coliform bacteria, the upper portion of Upper Newport Bay (Upper Bay) has been closed to these uses since 1974. In 1978, the shellfish harvesting prohibition area was expanded to include all of the Upper Bay, and the OCHCA

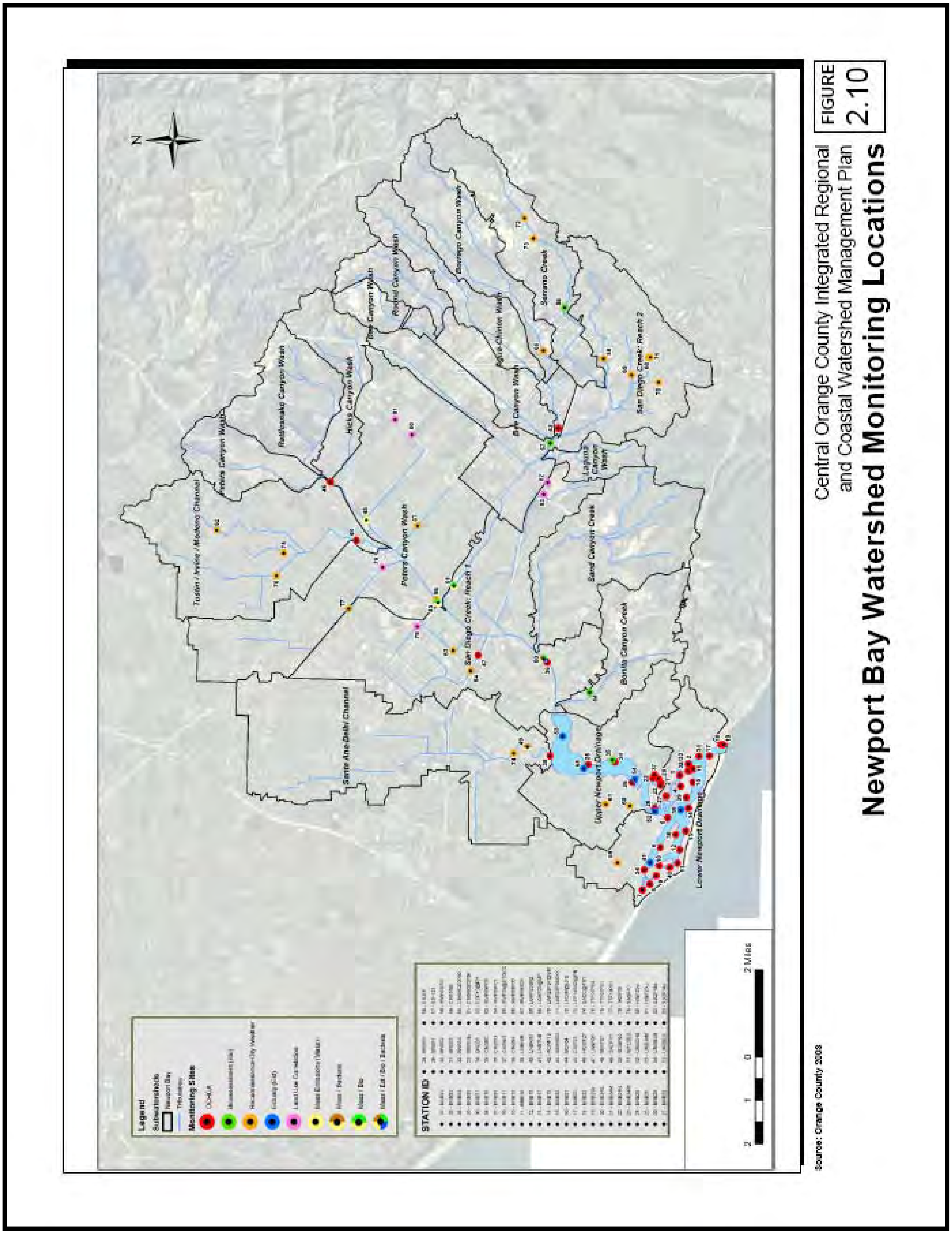
FIGURE
2.10
Central Orange County Integrated Regional
and Coastal Watershed Management Plan
Newport Bay Watershed Monitoring Locations
Source: Orange County 2008
Legend
Monitoring Sites
STATION ID
2 Miles
San Diego Creek: Reach 1
San Diego Creek: Reach 2
Peters Canyon Wash
Santa Ana-Delhi Channel
Sand Canyon Creek
Bonita Canyon Creek
Upper Newport Drainage
Lower Newport Drainage
Serrano Creek
Borrego Canyon Wash
Hicks Canyon Wash
Rattlesnake Canyon Wash
Laguna Canyon Wash
Bee Canyon Wash

generally advises against the consumption of shellfish harvested anywhere in the Bay. Bacterial objectives established to protect shellfish harvesting activities are rarely met in the Bay. Certain areas in the lower parts of the Upper Bay and in Lower Newport Bay (Lower Bay) are also closed to water-contact recreation on a temporary basis, generally in response to storms. In these areas, there is generally good compliance with water-contact recreation bacterial objectives in the summer.

Data collected by the OCHCA demonstrate that tributary inflows, composed of urban and agricultural runoff, including stormwater, are the principal sources of coliform input to the Bay. As expected, there are more violations of bacterial standards in the Bay during wet weather, when tributary flows are higher, than in dry weather. There are few data on the exact sources of the coliform in this runoff. Coliform has diverse origins, including: manure fertilizers which may be applied to agricultural crops and to commercial and residential landscaping; the fecal wastes of humans, household pets and wildlife; and other sources.

Another source of bacterial input to the Bay is the discharge of vessel sanitary wastes. Newport Bay has been designated a no-discharge harbor for vessel sanitary wastes since 1976. Despite this prohibition, discharges of these wastes have continued to occur. Since these wastes are of human origin, they pose a potentially significant public health threat.

As noted, the fecal waste of wildlife, including waterfowl that inhabit the Bay and its environs, is a source of coliform input. The fecal coliform from these natural sources may contribute to the violations of water quality objectives and the loss of beneficial uses, but it is currently unknown to what extent these natural sources contribute to, or cause, the violations of bacterial quality objectives in Newport Bay.

Implementation of the TMDL is expected to address these bacterial quality problems and to assure attainment of water quality standards, that is, compliance with water quality objectives and protection of beneficial uses.

Sediment

Sediment control has been a key water quality issue for decades. Increased surface water flow due to urbanization and channelization has increased the quantity of sediment transported through the watershed to Upper Newport Bay. For example, an estimated 400,000 cubic yards of sediment were deposited in Upper Newport Bay during the 1969 storm season (ACOE 1998). Issues related to increased surface water flow and sedimentation are: increased stream erosion, which has threatened homes, utilities, and other structures; impacts to estuarine species and habitats in Upper Newport Bay; and loss of navigation channels in Newport Bay (ACOE 1998).

Stream erosion has recently been most notable in Serrano Creek, upstream of Serrano Creek Community Park. In Serrano Creek, stream erosion threatens to undercut homes, has damaged and threatened a Los Alisos Water District sewer line and a Southern California Edison utility pole, and has cut hundreds of thousands of cubic yards of channel banks in a storm season, which has resulted in the loss of riparian habitat (ACOE 1998). In addition, Borrego Wash has also shown severe erosion. Historically, there are other channels that have had erosion issues.

Sedimentation in Upper Newport Bay has altered the depth of the bay, which in turn has altered tidal exchange and the type and availability of aquatic and wildlife habitat (ACOE 1998). These conditions are of concern to natural resource groups and regulatory agencies as Upper Newport Bay is one of only a few remaining estuaries in Southern California, is one of the only remaining coastal Mediterranean habitats and is used as a stopover point on the Pacific flyway, and is the home to numerous species of mammals, fish, invertebrates, and native plants, including several endangered species (Newport Bay Naturalists and Friends 2007).

The implementation of BMPs (i.e. foothill retarding basins, in-channel and in-bay sediment trapping basins, etc.) and the TMDL have improved these conditions of concern; however, tens of thousands of tons of sediment are still being deposited in the bay each year, as shown in *Table 2.7, Sediment Discharge from San Diego Creek to Newport Bay*.

Table 2.7
Sediment Discharge from San Diego Creek to Newport Bay as Measured at the San Diego Creek at Campus Drive Station

Year	Annual Flow in Acre-Feet	Annual Sediment Discharge in Tons
1983	58,952	534,035
1984	29,425	64,455
1985	26,987	32,236
1986	29,746	37,760
1987	21,423	20,060
1988	22,089	34,186
1989	17,359	19,810
1990	19,154	24,855
1991	28,935	83,924
1992	37,186	173,212
1993	62,510	355,208
1994	20,000	33,027
1995	61,182	347,579
1996	23,501	49,438
1997	33,946	92,181
1998	92,345	618,006
1999	17,334	16,439
2000	17,780	28,864
2001	27,320	75,686
2002	10,610	5,640
2003	30,090	64,740

Table 2.7
Sediment Discharge from San Diego Creek to Newport Bay as Measured at the San Diego Creek at Campus Drive Station

Year	Annual Flow in Acre-Feet	Annual Sediment Discharge in Tons
2004	18,690	30,464
2005	75,860	165,810
2006	20,150	9,291

Source: URS 2003 and County of Orange, RDMD Upper Newport Bay/ San Diego Creek Watershed Sediment TMDL Annual Reports

The Sediment TMDL monitoring program includes a monitoring element for Newport Bay. The Newport Bay monitoring element includes bathymetric surveys, vegetation surveys, and sediment removal.

Nutrients

Changes in land use from ranching and grazing to farmland in the watershed resulted in the discharge of nutrients into San Diego Creek and Upper Newport Bay. Nutrients are also discharged from landscaped areas of residential and commercial developments. The increased nutrient loading to the San Diego Creek and Upper Newport Bay has resulted in algal growth. Algal blooms in Newport Bay have been responsible for aesthetic nuisances and interfered with recreational activities, and decomposing algae has resulted in fish kills due to the creation of anoxic conditions (EPA 1998). Additionally, the nutrient impairment has resulted in non-compliance with the narrative water quality objectives of the Santa Ana River Basin Plan regarding algae and dissolved oxygen (EPA 1998).

Nutrient loading from San Diego Creek to Upper Newport Bay peaked in the mid-1980s at 7 million pounds of nitrate in the 1985-1986 seasons (EPA 1998). Nutrient loading decreased in the 1990s due to increased controls and BMPs; however, total inorganic nitrogen (TIN) data continued to be greater than the water quality goals in the 1990s, and algal blooms continued in Upper Newport Bay (EPA 1998).

San Diego Creek and Newport Bay were placed on the EPA Section 303(d) list of impaired waters. Based on that listing, TMDLs of nutrients entering waters of the creek and bay were established. In accordance with the nutrient TMDL, a Regional Monitoring Program was initiated in 2000.

Data from the Quarterly Data Report, Newport Bay Watershed, Nutrient TMDL, October - December 2006 are presented in *Table 2.8, Summary of Second Quarter 2006-2007 Concentrations in San Diego Creek at Campus Drive* and *Table 2.9, Summary of Second Quarter 2006-2007, Concentrations in Santa Ana-Delhi Channel at Irvine Avenue*.

Table 2.8
Summary of Second Quarter 2006-2007
Concentrations in San Diego Creek at Campus Drive

	NH3	NO3 + NO2 as N	TKN	TIN	TP as PO4	TP	OrthoPO4 as P	TSS	VSS	TN
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Max	0.8	8.8	9.6	9.0	1.71	0.56	0.23	40	14	1776.82
Min	0.1	2.6	4.2	3.2	0.25	0.08	<0.02	14	2	89.57
Median	0.2	4.9	6.4	5.1	0.59	0.19	0.08	27	7	281.61
Mean	0.3	5.0	6.6	5.2	0.71	0.23	0.08	27	7	400.40
St Dev	0.2	1.6	1.4	1.6	0.37	0.12	0.07	8	3	390.10

Source: Quarterly Data Report, Newport Bay Watershed, Nutrient TMDL, October - December 2006

Table 2.9
Summary of Second Quarter 2006-2007
Concentrations in Santa Ana-Delhi Channel at Irvine Ave

	NH3	NO3 + NO2 as N	TKN	TN	TIN	TP as PO4	TP	OrthoPO4 as P	TSS	VSS
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Max	1.9	8.7	8.4	12.3	8.8	5.85	1.91	0.14	630	180
Min	<0.1	3.4	0.6	5.9	4.0	0.11	0.04	< 0.02	<5	< 1
Median	0.2	6.6	1.1	8.4	6.7	0.48	0.16	0.07	19	5
Mean	0.4	6.3	2.4	8.7	6.7	1.26	0.41	0.06	116	32
St Dev	0.5	1.9	2.8	2.0	1.6	1.76	0.58	0.04	204	56

Source: Quarterly Data Report, Newport Bay Watershed, Nutrient TMDL, October - December 2006

A Nitrogen and Selenium Management Program (NSMP) was created in 2005 in response to a general NPDES permit (Order No. R8-2004-0021) issued for the Newport Bay watershed. The NSMP is a collaborative effort of 18 stakeholders, including various State, county, and local agencies, water districts, and private entities with the goal of developing management strategies and treatment technologies for groundwater dewatering discharges of both selenium and nitrogen for the watershed. A work plan has been developed by the NSMP and approved by the Santa Ana Regional Water Quality Control Board. The work plan will focus on the development of treatment technologies, BMPs, and an offset, trading or mitigation program. Additionally, if necessary, the NSMP will develop and recommend a site specific objective for selenium. The County of Orange is the Chair of the NSMP, providing program leadership and ensuring implementation of the work plan and compliance with the terms of the permit.

The key elements of the work plan include, (1) collecting additional data to fill knowledge gaps regarding the movement and impacts and selenium and nitrogen in the watershed, (2) examining Best Management

Practices (BMPs) and treatment technologies that can reasonably and effectively be applied in the watershed, (3) developing an offset, trading, or mitigation program for both selenium and nitrogen, (4) using the increased knowledge and treatment opportunities developed in previous tasks to evaluate the Nutrient TMDL, and (5) if appropriate, develop a site specific objective for selenium.

Toxic Pollutants

Changes in land use from ranching, grazing, and farming to residential and industrial development result in the discharge of metals (cadmium, cooper, lead, selenium, and zinc) and organic compounds into San Diego Creek, Upper Newport Bay, and Lower Newport Bay. Historical farming, military bases, and urban development all introduce sources of toxic substances into the watersheds. Land use activities that cause erosion increase the delivery of toxic substances to the watersheds.

On June 14, 2002, the U.S. Environmental Protection Agency (EPA) established the Toxics TMDL for San Diego Creek/Newport Bay. The EPA promulgated TMDL covers 14 different constituents – chlorpyrifos and diazinon (organophosphate pesticides); chlordane, dieldrin, DDT, PCBs, and toxaphene (organochlorinated compounds); cadmium, copper, lead and zinc (metals); selenium; chromium and mercury (metals, specific to Rhine Channel only).

Table 2.10 Waterbodies and Pollutants below lists the pollutants and the geographical areas to which the TMDL applies within the San Diego Creek/Newport Bay watersheds:

Table 2.10
Waterbodies and Pollutants

Waterbody	Element/Metal	Organic Compounds						
San Diego Creek (freshwater)	Cd, Cu, Pb, Se, Zn	Chlorpyrifos	Diazinon	Chlordane	Dieldrin	DDT	PCBs	Toxaphene
Upper Newport Bay (saltwater)	Cd, Cu, Pb, Se, Zn	Chlorpyrifos		Chlordane		DDT	PCBs	
Lower Newport Bay (saltwater)	Cu, Pb, Se, Zn			Chlordane	Dieldrin	DDT	PCBs	
Rhine Channel (saltwater)	Cd, Cu, Pb, Se, Zn, Cr, Hg			Chlordane	Dieldrin	DDT	PCBs	

The Santa Ana Regional Water Quality Control Board is in the process of reviewing the EPA promulgated Toxics TMDL and has decided to break it down into five separate constituent and geographically specific TMDLs. The five resulting TMDLs include:

1. Organophosphate Pesticides (diazinon and chlorpyrifos);
2. Selenium;
3. Organochlorinated Compounds (chlordane, dieldrin, DDT, PCBs, toxaphene);
4. Metals (cadmium, copper, lead, zinc); and
5. Rhine Channel (copper, lead, selenium, zinc, chromium, mercury).

The organophosphate pesticides TMDL has been amended into the Basin Plan. The other individual TMDLs must proceed through the full State approval process before they are officially adopted.

An investigation of stormwater runoff in tributaries to Newport Bay in 1992 and 1993 demonstrated the existence of aquatic life toxicity. A toxicity identification evaluation (TIE) performed on several of the samples collected during the study, indicated that one or more pesticides were responsible for the observed toxicity, and that diazinon was likely one of these pesticides. Separate sampling programs, the Toxic Substances Monitoring Program (TSMP), and the State Mussel Watch (SMW), demonstrated that chlorpyrifos and diazinon were present in fish and mussel tissue. The TSMP and SMW were conducted in upper and lower Newport Bay as well as in the drainage channels in the Newport Bay watershed, with diazinon and chlorpyrifos data available from 1983 onwards.

As a result of these investigations, upper and lower Newport Bay and Reach 1 of San Diego Creek were included on California's 1998 Clean Water Act Section 303d list for pesticides. Reach 2 of San Diego Creek was listed for unknown toxicity. Supplemental studies to determine the sources of the toxicity observed during the 1992-93 investigation were carried out from 1996 to 2000. These studies further documented the occurrence of aquatic life toxicity in the Newport Bay watershed, and concluded that diazinon and chlorpyrifos were causing a large portion of the observed toxicity in San Diego Creek. An investigation of Upper Newport Bay indicated the presence of toxicity attributable to chlorpyrifos in stormwater runoff entering the upper bay from San Diego Creek. No samples were collected from lower Newport Bay. Based on these findings, TMDL development for diazinon and chlorpyrifos in San Diego Creek, and chlorpyrifos in upper Newport Bay was initiated (Santa Ana Regional Water Quality Control Board [SARWQCB] 2001). Diazinon and chlorpyrifos are widely used organophosphate pesticides, and are among the pesticides detected most frequently in urban waterways.

Selenium, a primary metal of concern in the watershed, is discharged into the San Diego Creek and eventually to Newport Bay through erosion, runoff, and discharges of shallow groundwater from dewatering activities and pump-and-treat groundwater remediation activities (EPA 2002).

Hibbs and Lee (2000) investigated sources of selenium in the Newport Bay/San Diego Creek watershed. The study presents convincing evidence that groundwater is a significant source of selenium to San Diego Creek and Newport Bay. At the watershed scale, the study shows that selenium concentrations exceed the numeric target in most of the surface and groundwater samples collected, and that they exhibit spatial heterogeneity. Concentrations in groundwater range from below 4 µg/L (method detection limit) to 478 µg/L. A statistical analysis shows that selenium concentrations in groundwater samples were generally found to be higher within the boundaries of a historical marsh ("Swamp of the Frogs" or "La Cienega de las Ranas") than in other areas. Radioisotope analysis on the water samples suggest that high selenium concentrations in groundwater result from oxidation and leaching of subsurface soils in the saturated zone underlying the old marsh area. Monitoring of nursery discharge shows selenium concentrations in most runoff samples (6 out of 7) were below detection limits (*i.e.*, < 4 µg/L). One sample was detected at 7 µg/L from Bordiers Nursery. Surface water monitoring shows that discharges containing less than 10 µg/L selenium were mostly urban and agricultural runoff. Surface channels and drains with particularly high concentrations coincide with areas where high selenium groundwater samples were collected. Those channels include Como Channel (38 to 42 µg/L), Valencia Drain at Moffett Drive (25 to 40 µg/L), Warner Drain (24 to 33 µg/L), and the circular drains at Irvine Center Drive (141 to 162 µg/L) and at Barranca Parkway (107 µg/L). Channel inspection and chemical composition analysis indicate that those drainage channels collect considerable amounts of groundwater

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In November 2006, the Santa Ana RWQCB presented a staff report for TMDLs for organochlorine pesticides and PCBs. The RWQCB TMDLs report summarizes the information presented in the EPA TMDL and presents some new information and modifications to reflect the 2006 proposed 303(d) list and revised loading information.

Lower Newport Bay has additional water quality issues associated with metals used in boat paints. Rhine Channel, located in the western end of Lower Newport Bay, has been surrounded by industrial uses, such as canneries, metal plating companies, and shipyards, since the 1920s (Anchor Environmental 2006). Rhine Channel is a dead-end channel in which toxic pollutants have accumulated in the sediment. Consequently, the Santa Ana Regional Board has designated Rhine Channel as toxic hotspot. The land use history in the area immediately adjacent to Rhine Channel suggests that local pollutant source may be significantly different from the pollutant sources that have discharged to the rest of the watershed. Given the different levels of sediment contamination observed in Rhine Channel as compared to other areas of Newport Bay and the likely association of toxic hotspots in Rhine Channel with local pollutant sources, EPA has determined that is appropriate to develop separate TMDLs for that specific reach of Lower Newport Bay.

Table 2.11, Toxic Pollutant TMDLs and Newport Bay Concentrations, presents the TMDLs and the concentrations of pesticides and metals contained in samples collected from San Diego Creek, Upper and Lower Newport Bay, and the Rhine Channel.

Table 2.11
Toxic Pollutant TMDLs and Newport Bay Watershed Concentrations

			Criteria			2002 Concentrations			
Pollutant	Type of Compound	Location	Status	Fresh-water (ug/l)	Saltwater (ug/l)	San Diego Creek (ug/l)	Upper Newport Bay (ug/l)	Lower Newport Bay (ug/l)	Rhine Channel (ug/l)
Diazinon	Organophosphate Pesticide	San Diego Creek	Chronic	0.05		0.2	0.202		
			Acute	0.08					
Chlorphyrifos	Organophosphate Pesticide	San Diego Creek	Chronic	0.014	0.009	0.111	0.0433		
			Acute	0.02	0.02				
Selenium	Metal	San Diego Creek	Chronic	5		22.1			
			Acute	20	71 (dissolved)				
Cadmium	Metal	San Diego Creek	Acute	8.9 to 19.1 for large flows to baseflows	42	0.13-0.27	0.095-0.22	-	-

Table 2.11
Toxic Pollutant TMDLs and Newport Bay Watershed Concentrations

			Criteria			2002 Concentrations			
Pollutant	Type of Compound	Location	Status	Fresh-water (ug/l)	Saltwater (ug/l)	San Diego Creek (ug/l)	Upper Newport Bay (ug/l)	Lower Newport Bay (ug/l)	Rhine Channel (ug/l)
			Chronic	4.2 to 6.2 for medium flows to baseflows	9.3				
Copper	Metal	San Diego Creek	Acute	25.5 to 50 for large flows to baseflows	4.8	2.4-5.5	3.4-29.0	8.2-26.3	-
			Chronic	18.7 to 29.3 for medium flows to baseflows	3.1				
Lead	Metal	San Diego Creek	Acute	134 to 281 for large flows to baseflows	210	0.05-0.35	0.023-0.96	0.03-0.89	-
			Chronic	6.3 to 10.9 for medium flows to baseflows	8.1				
Zinc	Metal	San Diego Creek	Acute	208 to 379 for large flows to baseflows	90	2.6-23.1	10-100	2.5-11.5	-
			Chronic	244 to 382 for medium flows to baseflows	81				
PCBs	Organochlorine Pesticides	San Diego Creek	Chronic	0.014		ND			ND
DDT	Organochlorine Pesticides	San Diego Creek	Acute	1.1		ND			ND
			Chronic	0.001					
Chlordane	Organochlorine Pesticides	San Diego Creek	Acute	2.4		ND			ND
			Chronic	0.0043					
Dieldrin	Organochlorine Pesticides	San Diego Creek	Acute	0.24		ND			ND
			Chronic	0.056					

Table 2.11
Toxic Pollutant TMDLs and Newport Bay Watershed Concentrations

			Criteria			2002 Concentrations			
Pollutant	Type of Compound	Location	Status	Fresh-water (ug/l)	Saltwater (ug/l)	San Diego Creek (ug/l)	Upper Newport Bay (ug/l)	Lower Newport Bay (ug/l)	Rhine Channel (ug/l)
Toxaphene	Organochlorine Pesticides	San Diego Creek	Acute	0.73		ND			ND
			Chronic	0.0002					

Notes
Source: EPA 2002;metal data from Newport Bay Toxics TMDL Part E.
NA – not analyzed, DNQ – detected but not quantified, ND – not detected

Water Quality Projects

Major efforts being conducted within the Newport Bay Watershed to reduce non-point source releases and improve water quality as identified in the June 2006 *State of the CCAs Report for Upper Newport Bay* are listed in *Table 2.12, Water Quality Projects Defined in the State of the CCAs Report*.

Table 2.12
Water Quality Projects Defined in the State of the CCAs Report

1	Serrano Creek Stabilization and Restoration Project	Restore about 1.2 miles of Serrano Creek in the City of Lake Forest through installation of several creek stabilization features coupled with riparian restoration; designed to balance flood management, habitat, and recreation objectives. http://www.willdan.com/Services_Flood.asp?ProjectID=41
2	Newport Bay Watershed Management Plan	Framework for how to achieve effective watershed management, leading to a sustainable urban environment; includes wetland protection, education, water conservation, regulation, ad stormwater management, economics. http://www.ocwatersheds.com/watersheds/pdfs/Newport_Bay_Watershed_Plan_04-12-15.pdf
3	Special Area Management Plan for San Diego Creek Watershed	Plan will describe an approach and set of actions to preserve, enhance, and restore aquatic resources, while allowing reasonable economic development and construction and maintenance of public infrastructure facilities. http://www.spl.usace.army.mil/samp/sandiegocreeksamp.htm
4	Selenium Removal Pilot Project	Tested an anoxic biofiltration process using laboratory cylinders and "mesocosms" to remove selenium from surface water in San Diego Creek; now constructing a full-scale in situ version to treat water from Peters Canyon Wash. http://www.irwd.com/
5	Upper Newport Bay Ecosystem Restoration Project	The project will deepen two sediment basins in the upper bay; includes an ongoing maintenance-dredging program and enhancements to several existing wetlands and tidal channels and the creation of a least tern nesting island.

Table 2.12
Water Quality Projects Defined in the State of the CCAs Report

		http://www.spl.usace.army.mil/newportbay/uppernewportbay.htm
6	Newport Bay Naturalists and Friends	Mission is to restore and preserve the native habitat of the bay and surroundings; educate the public about the ecological value of the bay; achieve good water quality, healthy native flora and fauna, and compatible public use. www.newportbay.org
7	Orange County CoastKeepers	Mission is to protect and preserve Orange County's marine habitats and watersheds through education, advocacy, restoration, and enforcement. www.coastkeeper.org
8	Dry Weather Diversions, Storm Drain Inlet Modifications, and Circulation Study	Clean Beaches Initiative grant study at Newport Bay to divert or treat urban runoff. http://www.city.newport-beach.ca.us/Pubworks/pwmain.htm
9	Divert Urban Runoff at Newport Bay Beaches an Newport Beach and Ocean Beach	Grant for storm drain to sewer diversions. http://www.city.newport-beach.ca.us/Pubworks/pwmain.htm
10	Working At the Watershed Level Science & Stewardship Program & ERF High School Clubs	Modules on understanding importance of a healthy watershed, urban refuse collection, data collection, source identification, and bioassessment. Program enhances the teachers' opportunity to involve students in science. http://earthresource.org/
11	Big Canyon Creek Restoration Project	Improving the water quality of Big Canyon Creek as it enters Upper Newport Bay; remove exotic species and replace with native, non-invasive species; create effective riparian, wetlands, coastal sage scrub, and other habitat. http://www.city.newport-beach.ca.us/Pubworks/pwmain.htm
12	Newport Bay Fecal Coliform Source Identification and Management Plan	Activities to determine extent that urban and natural sources of fecal coliform contribute to bacterial quality problems throughout the bay; and development of a source management plan to address source inputs. http://www.ocwatersheds.com/
13	Newport Bay Nutrient Total Maximum Daily Load (TMDL) Dissolved Oxygen and Algae Distribution Study	Two investigations of the Newport Bay Nutrient TMDL Regional Monitoring Program: (1) monitor dissolved oxygen levels continuously; and (2) collect remote sensing data of bay to document extent of algae growth. http://www.ocwatersheds.com/
14	Assessment of Food Web Transfer of Organochlorine Compounds and Metals in Fishes Newport Bay, California	Identify fish species that could be used as surrogates for assessing ambient water quality relative to wildlife protection and human health concerns; examine food-web interactions of DDTs, PCBs, and trace metals in fish. http://www.sccwrp.org/
15	Storm Drain Inlet Modifications and Implement Circulation Measures	Source abatement at Newport Bay. http://www.city.newport-beach.ca.us/Pubworks/pwmain.htm

Groundwater Supply

The Orange County Groundwater Basin (the Basin) is located throughout the majority of the San Diego Creek subwatershed (see *Figure 2.2*). Resolution No. R8-2004-0001, which was adopted by the Santa Ana RWQCB and amended the Water Quality Control Plan, contains several revisions that affect waters within the region. Specifically, the Irvine Forebay I, Irvine Forebay II, and Irvine Pressure groundwater basins were amalgamated into one groundwater management zone called the Irvine Management Zone for groundwater quality purposes. Within OCWD's Groundwater Management Plan, the area is called the Irvine Subbasin.

The Irvine Subbasin is bounded by the San Joaquin Hills to the south and the foothills of the Santa Ana Mountains to the northeast (Wildermuth 2000). The boundary with the Main Basin is approximately aligned along Interstate Highway 55 and Newport Boulevard. The Irvine Subbasin and Main Basin, while hydraulically continuous, are distinct in that they have separate recharge zones; the thickness of the water-bearing alluvium increases substantially from Irvine to the central portion of the main basin; and the permeability of the water-bearing alluvium increases substantially from Irvine to the central portion of the main basin. The percentage of clay and silt is much higher in the Irvine Subbasin than in the main basin (USGS 2002).

Groundwater in the Irvine Subbasin flows westward from the forebay areas into the pressure area. The pressure area, in a general sense, is defined as the area where surface waters and near-surface groundwater are impeded from percolating in large quantities into the major productive aquifers by clay and silt layers at shallow depths (upper 50 feet). Most of the central and coastal portions of the basin fall within the pressure area (OCWD 2004). Groundwater flow direction can vary locally due to variations in climate and groundwater production patterns; however, the prevailing flow direction remains westward (Wildermuth 2000). The depth to groundwater in the basin is known to vary based on the permeability characteristics of the subsurface soils, irrigation, groundwater pumping, and groundwater recharge.

The Irvine Subbasin is divided into three groundwater aquifers referred to as the shallow, principal, and deep aquifers (OCWD 2004). The shallow aquifer is unconfined, is of poor quality, and is generally not used for municipal supply. Details regarding each of these aquifers are presented in *Table 2.13, Irvine Groundwater Aquifers*.

Table 2.13
Irvine Groundwater Aquifers

Aquifer	Description	Thickness
Shallow	System of unconfined semi-perched aquifers in Pleistocene marine terrace deposits that is generally not used for domestic or agricultural supply. Consists mostly of fine sands, silts, and clays. In the vicinity of the Upper Newport Bay, the shallow aquifer discharges to Upper Newport Bay.	1 to 180 feet
Principal	The principal aquifer is where the majority of the water is produced. It includes an alluvial sequence of interbedded sands and gravels with silts and clays.	400 to 1,000 feet
Deep	The deep aquifer consists of fine- to coarse-grained sands. It is rarely used for supply due to economical constraints and slight brownish tint. IRWD began pumping and treating approximately 7,400 acre-feet per year in 2002. Water in the deep aquifer contains fewer minerals than in other areas of the basin.	1,000 to 3,000 feet

Source: USGS 2005.

Table 2.12 is an overall generalization of a fairly complex aquifer system, and the depths of the three aquifer units described above vary based on location. For instance, the units thin and converge at the basin margins, and the principal aquifer is located at much shallower depths in these areas.

Based on the studies and modeling conducted by OCWD, the Orange County Groundwater Basin stores approximately 66 million acre-feet of water, although only a fraction can be removed without causing physical damage, such as seawater intrusion or land subsidence (OCWD 2004). The Basin is not operated on an annual safe-yield basis, and it has historically been overdrafted. OCWD has developed a hydrologic budget (with inflows and outflows balanced) to evaluate Basin production capacity and recharge requirements. The budget factors in recharge, groundwater production, and flows along the coast and across the Los Angeles/Orange County line. The budget shown in *Table 2.14, Representative Basin Water Budget,* is based on the following assumptions: (1) average precipitation; (2) accumulated overdraft (400,000 acre-feet from full); (3) recharge at Forebay facilities equal to current maximum capacity of 250,000 acre-feet per year; and (4) adjusted groundwater production to balance inflows and outflows (OCWD 2004).

Table 2.14
Representative Basin Water Budget

INFLOW	Acre Feet
Measured Recharge	
1. Forebay spreading facilities, current maximum, including imported water	250,000
2. Talbert Barrier injection, current maximum	12,000
3. Alamitos Barrier injection, Orange County only	2,500
Unmeasured Recharge (average precipitation)	
1. Inflow from La Habra Basin	3,000
2. Santa Ana Mountain recharge into Irvine subbasin	13,500
3. San Joaquin Hills recharge into Irvine subbasin	500
4. A real recharge from rainfall/irrigation (Forebay area)	13,000
5. A real recharge from rainfall/irrigation (Pressure area)	4,500
6. Chino Hills recharge into Yorba Linda subbasin	6,000
7. Subsurface inflow at Imperial Highway beneath SAR	4,000
8. SAR recharge between Imperial Highway and Rubber Dam	4,000
9. Subsurface inflow beneath Santiago Creek	10,000
10. Peralta Hills recharge into Anaheim/Orange	4,000
11. Tustin Hills recharge into City of Tustin	6,000
12. Seawater inflow through coastal gaps	2,000
Subtotal:	*70,500*
TOTAL INFLOW	**335,000**
OUTFLOW	
1. Groundwater Production	327,000
2. Flow across Orange/Los Angeles County line, est. at 400,000 acre-feet accumulated overdraft	8,000
TOTAL OUTFLOW	**335,000**
CHANGE IN STORAGE: 0	**0**

Note: The representative water budget has equal (balanced) total inflow and total outflow and does not represent data for any given year.

Source: OCWD 2004.

OCWD replenishes the Basin through the use of recharge basins located outside of the study area for this IRCWM Plan. In November 2007, the Groundwater Replenishment System will begin operating, which will use advance treated wastewater from OCSD's reclamation plant for groundwater recharge and seawater barrier. The first phase of the Groundwater Replenishment System will provide an estimated 70,000 acre-feet per year for recharge, with a maximum project size of 110,000 acre-feet year. One of the key factors for future phases is the availability of sufficient secondary treated wastewater flows from OCSD.

Recharge to the Irvine Subbasin occurs through infiltration of flow within the unlined stream channels, underflow from the saturated alluvium and fractures within the bordering bedrock, and from precipitation and irrigation (Wildermuth 2000). As groundwater production increases in the subbasin to where it exceeds recharge, groundwater will flow from the main basin into the subbasin. As noted in *Table 2.13*, unmeasured recharge to the Irvine Subbasin based on average precipitation is approximately 20,000 acre-feet per year.

There are approximately 500 active wells within OCWD's boundaries, with an estimated 300 wells producing less than 25 acre-feet per year (OCWD 2004). All large-capacity wells are metered, and individual well production is documented monthly. OCWD manages groundwater production from the groundwater basin through setting an annual basin pumping percentage (BPP) based on net water available for pumping divided by net total water demands from the previous year. The BPP is directly related to hydrologic conditions and recent groundwater production. Water available for future basin pumping is estimated at approximately 357,000 acre-feet in 2007-2008, increasing to 367,104 acre-feet in 2010-2011 (OCWD 2006). Producers pay a Replenishment Assessment for groundwater production up to the BPP; production that exceeds the BPP is assessed an additional higher-cost Basin Equity Assessment charge to cover the cost of replenishing that groundwater. Through this methodology, OCWD is able to manage the basin resources and provide financial incentive for producers to work cooperatively in reducing any overdraft.

Groundwater production has doubled since 1954, and increasing use is anticipated as agencies seek to reduce dependence on imported water. OCWD has developed a draft Long-Term Facilities Plan that identifies and evaluates projects that could increase the sustainable yield of the basin in a cost-effective manner to the highest possible amount. The Plan also identifies projects to protect and enhance groundwater quality and protect the coastal portion of the basin.

Groundwater Quality

The Orange County Groundwater Basin is currently recharged by streambed percolation, recycling programs, and imported water purchases. OCWD monitors the quality of the Groundwater Basin extensively, testing for over 190 constituents, including nitrate, salts, selenium, trichloroethylene, volatile organic compounds, and radon to ensure potable quality. OCWD and OCSD are also implementing the new Groundwater Replenishment System, scheduled to be on-line in 2007, which will take highly treated wastewater from the OCSD Water Reclamation Plant and purify it using micro-filtration, reverse osmosis, and ultraviolet light and hydrogen peroxide before percolating it into the basin. Water produced by this system is expected to be so pure it will actually help to reduce the growing mineral content in the basin and will exceed all state and federal drinking water standards (OCWD 2005).

Individual water districts, such as IRWD, also test their domestic groundwater sources. IRWD, which serves the majority of the planning area, obtains domestic groundwater from two sources: the Irvine Subbasin, which is located within the Orange County Groundwater Basin, and Lake Forest, which does not overlie the Orange County Groundwater Basin. The Irvine Subbasin is mainly used for non-potable water, as the groundwater is high in TDS, nitrates, and has color. Additionally, the groundwater obtained from the six Lake Forest wells have poor quality and are used as non-potable water to supplement IRWD's recycled water production. Water quality for groundwater from these two areas is presented in *Table 2.15, Select Groundwater Concentrations in 2005*.

Table 2.15
Select Groundwater Concentrations in 2005

Analyte	Dyer Road Well Field (Irvine Subbasin)		Lake Forest Wells		
	Concentration Range	Average Concentration	Concentration Range	Average Concentration	Concentration Limit (MCL)
Nitrate and Nitrite as Nitrogen	ND-1.9 mg/l	<0.4 mg/l	ND-1.3 mg/l	0.6 mg/l	10 mg/l
Nitrate as Nitrate	ND-8.2 mg/l	<2 mg/l	ND-5.7 mg/l	2.6 mg/l	45 mg/l
Arsenic	ND-9.0 ug/l	<2 ug/l	3.3-5.7 ug/l	4.3 ug/l	0.004 ug/l
PCE	ND-0.9 ug/l	<0.5 ug/l	ND	<5 ug/l	5 ug/l
Color	ND-500	41	5-10	8	15
Iron	ND-172 ug/l	<100 ug/l	170-490 ug/l	300 ug/l	300 mg/l
Manganese	ND-22 ug/l	<20 ug/l	ND-75 ug/l	44 ug/l	50 ug/l
TDS	208-394 mg/l	263 mg/l	450-850 mg/l	670 mg/l	1,000 mg/l
Perchlorate	ND-6.1 ug/l	<4 ug/l	ND	<4 mg/l	N/A

Source: IRWD 2006 Water Quality Annual Report, Dyer Road Wellfield Data.

As shown in *Table 2.15*, color is a water quality issue in portions of the Groundwater Basin, including areas where groundwater is produced for the City of Costa Mesa. Colored water is generally a problem in the deeper aquifer.

High TDS in portions of the Irvine Subbasin present a water quality issue. High TDS in other areas of the Groundwater Basin are due to seawater intrusion.

Nitrogen concentrations in the study area groundwater, especially shallow groundwater, have been high. Several studies have indicated that the high nitrogen concentrations are a result of the historical agricultural practices in the area.

Selenium is an issue in shallow groundwater throughout the watershed High selenium concentrations are mainly found in the Peters Canyon Wash sub-watershed; however, high concentrations are also found in the vicinity of MCAS–Tustin. Selenium concentrations in groundwater sources in the main subbasins of the San Diego Creek Watershed from 1999-2005 are presented in *Table 2.16, Selenium Concentrations in Groundwater Sources*.

Table 2.16
Selenium Concentrations in Groundwater Sources

Sub-watershed	Range of Selenium Concentrations (ug/l)	Concentration Limits (ug/l)
San Diego Creek, Reach 1	3.15-187	2-5
San Diego Creek, Reach 2	1.87-12.8	2-5
Peters Canyon Wash	2.6-270	2-5
Santa Ana-Delhi Channel	7.69-106	2-5

Source: Sources and Loads and Identification of Data Gaps for Selenium – Nitrogen and Selenium Management Program.

OCWD and local water districts have implemented water quality projects in the study area to treat the groundwater. These projects include the Irvine desalter project to remove nitrates, TDS, and volatile organic compounds (VOCs); the Tustin desalter and nitrate projects to remove TDS and nitrates; the IRWD Deep Aquifer Treatment to remove color and organics; and the MCWD colored water program.

The Irvine desalter program focuses on groundwater in central Irvine, specifically in the vicinity of the former MCAS–El Toro facility. In addition to high TDS and nitrate concentrations, groundwater in this area was found to contain concentrations of VOCs due to former use and disposal of solvents related to aerospace use. A 1 mile-by-3 mile plume of VOC contamination extends off of the former MCAS–El Toro. The Tustin desalter program is a similar program located in the northern portion of Tustin.

2.5.2 Newport Coast Watershed

The Newport Coast Watershed is shared by several jurisdictions. Most of this watershed was annexed by the City of Newport Beach in 2002, although the southernmost portion, beginning at Morro Canyon, is within the County of Orange's jurisdiction. The northern portion of the watershed is within the Santa Ana RWQCB boundary, and the southern portion is within the San

Diego region. Only the portion of the watershed within the jurisdiction of the Santa Ana RWQCB is included in this IRCWM Plan.

Surface Water

Eight coastal canyon drainage areas, defined by their canyon creeks, are included in the Newport Coast Watershed for this IRCWM Plan, including:

- Buck Gully: Reaches 1, 2, and 3
- Morning Canyon: Reaches 1 and 2
- Pelican Point, Pelican Point Middle Creek, Pelican Point Waterfall Creek
- Los Trancos Creek (and Crystal Cove Creek)
- Muddy Creek
- Morro Creek.

Most of the canyon creeks in the upper portions of the drainage areas are steep natural channels. Several are developed in both the upper and lower portions and contain concrete storm drain outlets. Unpaved access roadways and hiking trails exist in several canyons but are generally not maintained. The lower portions of the steep canyon creek channels have been subject to erosion impacts caused by increased and longer sustained peak flows. These flows are a result of increased impervious surfaces, introduction of invasive/exotic species of vegetation, and greater number of channelized/piped flows into the canyons. Flow data from the Newport Coast Flow and Water Quality Assessment study completed in 2006 are shown in *Table 2.17, Wet Weather Flow Data,* and *Table 2.18, Dry Weather Flows Per Unit Area* (Weston 2006).

Table 2.17
Wet Weather Flow Data

Station ID	Unit Modeled Flow (cfs)
Buck Gully	
BG1	1.18
BG2	1.08
BG3	1.03
BG4	0.89
BG5	0.69
BG6	0.46
BG7	0.29
Morning Canyon	
MCD	0.36
Pelican Point	
PP1	0.02
PPM	0.22
PPW	0.13

Table 2.17
Wet Weather Flow Data

Station ID	Unit Modeled Flow (cfs)
Los Trancos Canyon	
LTD*	1.10
Muddy Canyon	
MCC	0.93
El Morro Canyon	
EMD*	2.00

*Dry weather flows are diverted at these sites

Table 2.18
Dry Weather Flows Per Unit Area

Station ID	Unit Modeled Flow (cfs)
Buck Gully	
BG1	0.43
BG2	0.39
BG3	0.37
BG4	0.32
BG5	0.25
BG6	0.17
BG7	0.10
Morning Canyon	
MCD	0.13
Pelican Point	
PP1	0.01
PPM	0.08
PPW	DRY
Los Trancos Canyon	
LTD*	
Muddy Canyon	
MCC*	
El Morro Canyon	
EMD	0.72

*Dry weather flows are diverted at these sites

Surface Water Quality

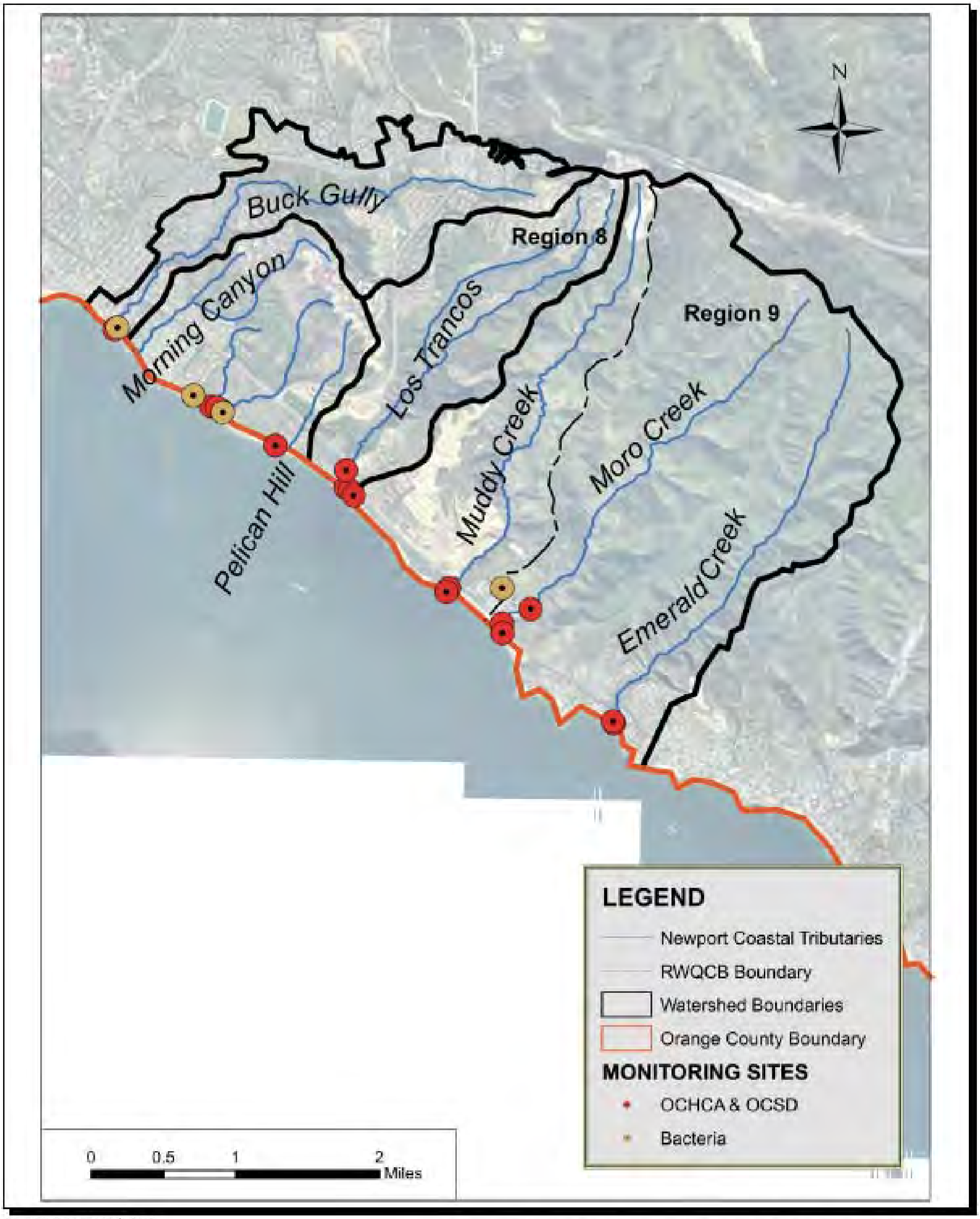
In recent years, the Newport Coast Watershed, like much of Orange County, has faced watershed problems involving streambed instability as exhibited by head-cutting and slope failures, the arrival of invasive plant species, and the loss of native wetland and riparian habitat. Seven of the canyon streams now flow year-round due to over-irrigation in the upstream developments. It is suspected that the dry-weather flows carry bacteria, fertilizer, and pesticides through the canyon reaches and into the ocean. These problems have become progressively worse and pose a threat to residences, the two ASBSs, Crystal Cove State Park, and the ecological function of the riparian corridors within the watershed. A piecemeal approach to dealing with these problems has been ineffective due to the technical, jurisdictional, and financial hurdles that must be simultaneously addressed.

Over the past 40 years, the Orange County Health Care Agency has been testing the coastal waters in Orange County for bacteria. As of 1999, new requirements for frequent testing of surf zone waters and stringent criteria for beach water closures went into effect as part of Assembly Bill 411. Samples from the watershed are collected weekly by the Health Care Agency from 10 ocean, bay, and drainage locations (County of Orange 2003). The Irvine Company, IRWD, Surfrider Foundation, and Orange County Coastkeeper have performed limited water quality sampling as well. The results of these sampling programs are currently being reviewed. Monitoring programs are specifically geared toward providing information that can be used to develop programs to protect the two ASBSs (Newport Coast Watershed Program 2004). Monitoring locations are shown in *Figure 2.11, Newport Coastal Watershed Monitoring Stations*.

In accordance with the Clean Water Act, the Santa Ana Regional Board in 2006 placed Buck Gully Creek and Los Trancos Creek on the draft 303(d) list for total coliform and fecal coliform (see *Figure 2.1*). The Orange County coastline, which runs along over 5 miles of the Newport Coast Watershed, is also listed on the draft 303(d) list for trash.

A confluence of separate investigations and projects are being carried out in the Newport Coast Watershed by the City of Newport Beach, the Irvine Company, the County of Orange, IRWD, Orange County Coastkeeper, and the Surfrider Foundation. In order to address the destabilization and degradation of the watershed's coastal canyons in a systematic and effective manner, the City of Newport Beach is developing a watershed program for the Newport Coast as an organizing tool for future activities in the watershed.

As part of this program, a flow and water quality assessment has been performed for the watershed to assess the extent and magnitude of the current or potential problems in the eight Newport Coast canyons and the two ASBSs where these creeks flow into. The most frequently exceeded and widely detected exceedances of the water quality objectives were observed for bacteriological indicators, followed by dissolved cadmium. Specific finding include:



Source: Orange County 2003

Central Orange County Integrated Regional and Coastal Watershed Management Plan

FIGURE 2.11

Newport Coastal Watershed Monitoring Stations

- The exceedances for fecal indicator bacteria were observed for all coastal canyons for multiple storm events (see *Exhibit 2.E*). Comparison of the observed Enterococcus and total coliform concentrations to water quality objectives for ocean samples for indicate exceedances in the mixing zone samples at Buck Gully and El Morro (Enterococcus only).

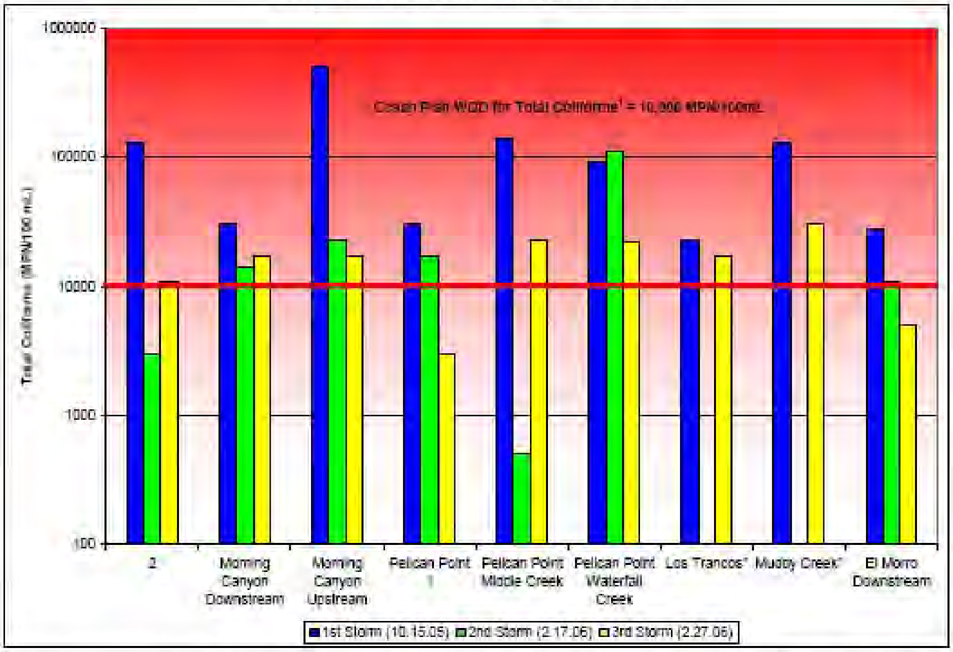
- Exceedances of water quality objectives for fecal coliform bacteria concentrations were limited to dry weather samples to Pelican Point, Upper Los Trancos and Muddy Creek. Of these, Los Trancos and Muddy Creek are diverted to the sewer system during weather.

- The findings from the development of load duration curves for Buck Gully indicate that predicted exceedances of the fecal indicator bacteria load allocation for Buck Gully would occur during wet weather events in the absence of measures to reduce the overall current loads. Dry weather flows would not exceed the load allocation.

- In addition to bacteriological indicators, dissolved cadmium concentrations exceeded water quality objectives in wet and dry weather flows in Pelican Point Middle Creek and Morning Canyon Downstream (see *Table 2.19*). The highest concentrations for wet weather events were Pelican Point Waterfall Creek and Morning Canyon (see *Exhibit 2.F*), and for dry weather samples at Pelican Point Middle Creek, which was an order of magnitude greater than the concentration detected at Buck Gully. An evaluation of total loads for dissolved cadmium using modeled annual flows showed the highest annual loads from Morning Canyon and Pelican Point Middle Creek, even though these are much smaller watersheds.

- Exceedances of dissolved copper concentrations were found in two canyons during storm flows (see *Exhibit 2.G*)

Exhibit 2.E
Total Coliform Results during Wet Weather



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.

[1] The Ocean Plan WQO is applicable to ocean samples only and is presented as a reference

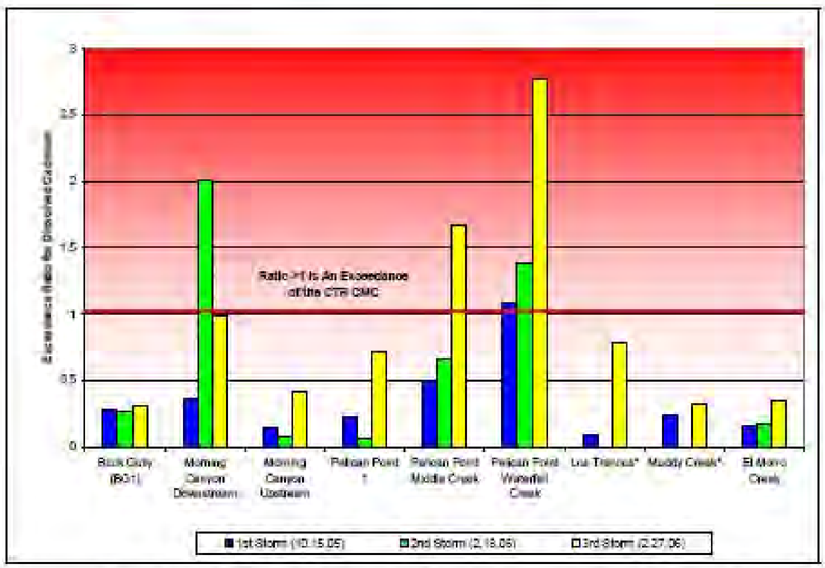
The relative urban runoff contribution to the problems in the eight coastal canyons and the ASBSs are assessed as follows.

1. Dry weather flows deliver the preponderance heavy metal loads to the ocean that exceed water quality objectives.
2. An opposite conclusion was found for dissolved metals where the largest loadings are due to storm flows.
3. The results of the analysis of contributions to the total estimated annual load for bacteriological indicators found that wet weather flows contribute the greatest portion of total load.
4. The bacterial load contribution from wet weather flows was an order of magnitude higher than those from the dry weather flows for both fecal coliform and Enterococcus.
5. Substantial nitrate and phosphate concentrations found in the canyon watershed.

Based on the Groundwater Seepage Study prepared by Todd Engineers (2006), the use of imported water for irrigation has resulted in a groundwater mound in the Buck Gully, Morning Canyon and Pelican Point watersheds. The Groundwater Seepage Study also suggested that the quality of the dry weather flows is significantly influenced by the quality of the infiltration waters and the groundwater seeps. Analysis of groundwater seeps by Todd Engineers for chloride and sulfate indicated higher concentrations of these constituents downgradient of potential sources compared to upstream samples. The Draft Groundwater Seepage Report indicated that the golf course at Pelican Point may increase concentrations of these constituents through the use of soil amendments and provide a migration pathway through irrigation.

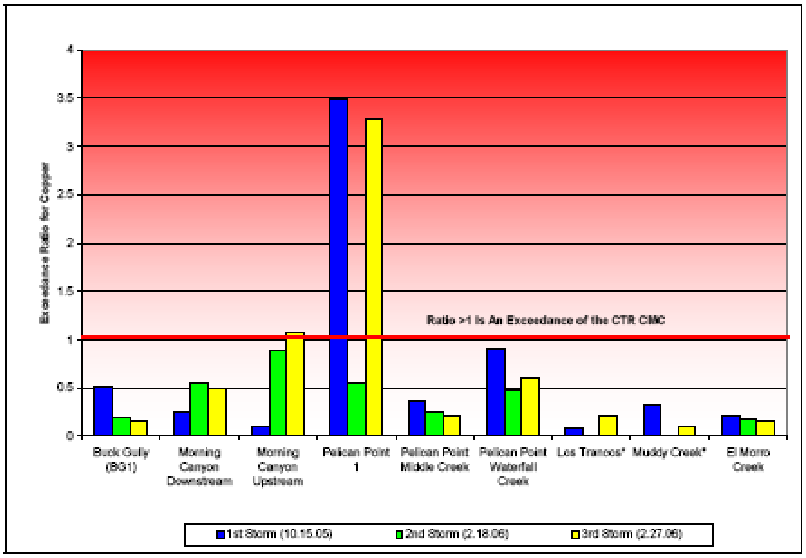
Exhibit 2.F

Exceedance Ratio for Wet Weather Dissolved Cadmium Results



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.

Exhibit 2.G
Exceedance Ratio for Wet Weather Dissolved Copper Results



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.

Table 2.19
Newport Coast Dry Weather Exceedances

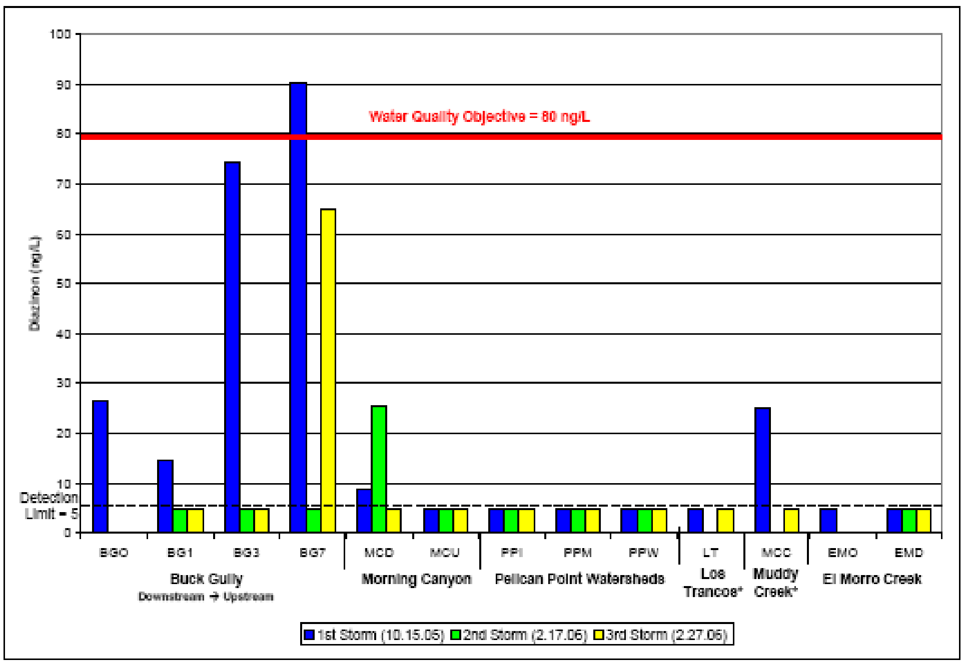
Constituent		Copper Dissolved	Copper Total		Cadmium Dissolved	Cadmium Total		Total Coliforms	Fecal Coliforms	Enterococcus
Units		µg/L	µg/L		µg/L	µg/L		MPN/100mL	MPN/100mL	MPN/100mL
WQO		29.28	12	30.5	6.22	4	7.31	10,000	400	105
WQO Source		CTR CCC[1] (Hardness > 400)	Ocean Plan Daily Max	CTR CCC[1] (Hardness > 400)	CTR CCC[1] (Hardness>400)	Ocean Plan Daily Max	CTR CCC[1] (Hardness>400)	Ocean Plan[2]	Ocean Plan[2]/ Basin Plan[3]	Ocean Plan[2]
BGO	(9.27.05)	0.754		2.85	<0.005		4.58	300	<20	228
BG1	(9.27.05)	9.06		1.09	1.12		3.36	3000	230	213
	(2.13.06)	11.1		11	6.39		9.01	170	40	121
EMO	(9.27.05)	0.475		1.54	<0.005		0.045	<20	<20	<10
EMD	(9.27.05)	5.26		0.199	0.87		1.48	500	300	<10
	(2.13.06)	6.08		5.64	2.67		3.34	500	40	30
BG2	(9.27.05)	8.91		9.52	2.07		3.58	5000	210	327
BG3	(9.27.05)	8.5		9.48	2.13		3.92	1700	220	121
	(2.13.06)	11		11.4	6.23		7.96	500	40	52
BG4	(9.27.05)	7.75		7.47	2.52		5.47	800	130	52
	(2.13.06)	9.4		10.5	4.85		8.01	220	20	20
BG5	(9.27.05)	3.97		5.69	0.95		0.96	500	40	20
BG6	(9.27.05)	2.09		3.41	0.48		0.34	1700	300	63
BG7	(9.27.05)	2.9		3.62	0.51		0.61	800	130	84
	(2.13.06)	5.14		3.59	3.04		3.35	170	70	63
MCD	(9.27.05)	15		17.2	26.2		36.7	2300	40	480
MCU	(9.27.05)	6.7		7.6	2.26		2.44	1700	300	279
PP1	(9.27.05)	6.55		9.58	2.82		3.75	30000	1400	798
PPM	(9.27.05)	35.1		12.8	100		105	270	<20	73
LTU	(9.27.05)	10.3		11.8	3.51		12.3	3000	2300	613
MCC	(9.27.05)	7.16		5.88	1.11		1.34	5000	800	132

[1] CTR CCC = The California Toxic's Rule Criterion Continuous Concentration (chronic criterion) defined as a four-day average concentration limit (EPA 65 FR 31682).
[2] The Ocean Plan WQOs for total coliforms, fecal coliforms, and Enterococcus are single sample objectives for samples collected in the ocean and do not apply to freshwater samples.
[3] The Basin Plan WQO for fecal coliforms states, "the log mean [must be] less than 200MPN/100mL based on five or more samples/30 day period, and not more than 10% of the samples exceed 400 MPN/100mL for any 30-day period." Therefore, as a conservative approach, the WQO presented here assumes that one samples would equal 10% of the monthly samples, and a result greater than 400MPN/100mL would exceed the WQO.

A monitoring program will specify biological indicators and metrics to assess and monitor ecosystem health relative to watershed function. Examples of applicable indicators include biomass of native riparian wetland vegetation, habitat use by declining or sensitive species, attached fresh-water algae, aquatic macro-invertebrate diversity and distribution, and the health and diversity of intertidal and subtidal communities in the marine life refuges. Additional indicators will be selected in consultation with the Santa Ana RWQCB and the County of Orange. In addition, the watershed program will include a program for mapping the areas of *Arundo* and instituting a removal program.

Diazinon was found in several stormwater samples in Buck Gully and Morning Canyon (see *Exhibit 2.H*).

Exhibit 2.H
Diazinon Results During Wet Weather Events



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by The Irvine Company.

Six objectives have been put forth by the Newport Coast Watershed Program (Newport Coast Watershed Program 2004), several of which are already being implemented:

- Complete the technical studies and prepare the watershed assessment report for the watershed management area (this has been completed);
- Implement a monitoring program for baseline data and ongoing monitoring to track changes in the watershed (in process);
- Prepare a Watershed Management Plan that provides specific restoration recommendations for each of the coastal streams with attendant ecological benefits for the intertidal and subtidal communities in the ASBSs (an internal draft has been prepared);
- Implement specific stabilization and restoration projects in Buck Gully and Morning Canyon within the framework of the Watershed Management Plan;
- Provide educational opportunities for city staff, community members, and stakeholders in watershed science and management skills and enlist community support in monitoring and restoring the health of the watersheds and marine life refuges (in process); and
- Expand the scope of the watershed management program, including researching funding opportunities for subsequent restoration projects as outlined by the Watershed Management Plan.

Major efforts being conducted within the watershed to reduce non-point source releases and improve water quality as identified in the June 2006 *State of the CCAs Report for Upper Newport Bay* include:

1	**Working At the Watershed Level Science & Stewardship Program & Earth Resources Foundation High School Clubs**	Modules on understanding importance of a healthy watershed, urban refuse collection, data collection, source identification, and bioassessment. Program enhances the teachers' opportunity to involve students in science. http://earthresource.org/
2	**Newport Coast Watershed Program: Assessment, Management and Restoration**	Complete watershed assessments (survey, hydrologic/hydraulic, biological/ecological, water quality, and sedimentation), prepare restoration recommendations, and implement stabilization and restoration projects. http://www.city.newport-beach.ca.us/Pubworks/pwmain.htm
3	**Orange County CoastKeeper**	Mission is to protect and preserve Orange County's marine habitats and watersheds through education, advocacy, restoration, and enforcement. www.coastkeeper.org

Streamflow and surface water quality data are lacking due to limited dry weather flows in the past. A program has been developed by the City of Newport Beach to monitor dry weather flows and water quality in Buck Gully (City of Newport Beach 2007). Additionally, a program is being developed by the City of Newport Beach to evaluate pollutant loads in the drainages in the Newport Coast Watershed.

Groundwater

While a groundwater basin has not been identified in the Santa Ana RWQCB Basin Plan for the Newport Coast Watershed, groundwater is present in the watershed (City of Newport Beach 2007). According to the City of Newport Beach, groundwater seepage occurs in Buck Gully and Crystal Cove State Park, located at the exit of Los Trancos Creek at the Pacific Ocean. A pumping experiment in Buck Gully in 1999 indicated that groundwater exfiltration provides a significant amount of water to dry-weather flows in the canyon. A groundwater seepage study is now underway to begin to identify sources, quantities, and quality.

2.3 Priority Constituent of Concern for Harbor Area

Based on the existing water and sediment quality data, 303d listings and TMDL discussed in the previous subsections, the priority constituents of concern (COC) for the harbor area are identified in Table 2-3. The priority constituents are considered in BMP development and implementation. As discussed further in Section 3, an integrated approach is recommended for BMP implementation. An integrated approach considers both current and future priority constituents to insure a long-term cost effective water quality program. An integrated approach is more cost effective as it addresses potential future BMP retrofits in order to address additional constituents in the future.

The priority constituents listed in Table 2-3 have been identified for consideration in the development and prioritization of BMP. As will be discussed in Section 3, BMP implementation is to be conducted in a tiered and phased approach. Initial phases will include further investigations of the impact to the beneficial uses and the sources of constituents. These activities shall be conducted for priority constituents before a second phase of BMP are implemented.

Table 2-3. Priority Constituents of Concern Lower Newport Bay

Priority Constituent of Concern	Reason for Listing	Potential Sources	Further Data Needs
Nutrients	TMDL	Upper Watershed runoff from agricultural areas and runoff from residential area upstream and within the Harbor Area. Groundwater seepage into the San Diego Creek also is a source of nitrates. Air Deposition of nitrogen compounds	Source Identification Studies and Modeling of the contributions from upstream and local sources. Investigations of the impact of the nutrients in the Lower Bay
Pathogens – Bacteria Indicators – Fecal Coliform	TMDL	Non-point anthropogenic and natural sources from the upstream watershed and drainage areas within the Harbor. Sources within the Harbor may include boat washing and prohibited vessel sanitary waste discharges, water fowl, sea lions, sewer leaks, pet wastes, dry weather flows that provide transport mechanism for bacteria, and commercial poor house keeping, poor solid waste management, improper washing, and illicit discharges.	Source Identification Study in the Harbor Area to assess the primary and largest bacteria loading and contribution from natural sources (birds, sea lions, etc.)
Chlordane and Dieldrin	Toxics TMDL	Chlordane and Dieldrin have been phased out due to these pesticides' toxicity to aquatic organisms. Licensed businesses no longer use these pesticides, but small quantities may still be used by residences. Additional chlordane and dieldrin loading may be from impacted sediment in the upper watershed and	Continued monitoring of the storm flows and water quality in the Lower Bay to asses the long-term trend.

Table 2-3. Priority Constituents of Concern Lower Newport Bay

Priority Constituent of Concern	Reason for Listing	Potential Sources	Further Data Needs
		Upper Newport Bay that is transported during significant storm events.	
Synthetic Pyrethroids	These pesticides have replaced the chlorinated pesticides and only recently have been shown to result in toxic effect to aquatic organisms. Sediment toxicity testing of sediments in the Harbor have indicated that these pesticides may be the primary cause of the toxicity observed.	Synthetic pyrethroids are regulated pesticides that are used by licensed commercial pest control businesses and also sold for public use to control household pests such as ants.	Further toxicity testing and extent and nature of these constituents to define the issue
DDT	TMDL	This is a legacy constituent that is transported to the Lower Bay via impacted sediments and soils from the upper watershed and Upper Bay during storm events.	Continued monitoring of the storm flows and water quality in the Lower Bay to asses the long-term trend
PCBs	303d listing	This is a legacy constituent that is transported to the Lower Bay via impacted sediments and soils from the upper watershed and Upper Bay during storm events.	Continued monitoring of the storm flows and water quality in the Lower Bay to asses the long-term trend
Sediment	TMDL for Upper Bay – although Lower Bay not listed, the Harbor receives significant sediment loading that has impact sediments (sediment toxicity) and navigation channels	Sediment is transported from the upper watershed due to erosion of channels due to hydro-modification and agricultural activities. The sediment basins in the Upper Bay function to remove much of the coarse grained sediments. Fine-grained sediments that may consist of clay and organic matter are carried to the Lower Bay. These particles have a greater affinity to attract and absorbed pollutants that have results in toxicity of sediments in areas of the Harbor. Dredging of the basins and channels of the Lower Bay will remove impacted sediments.	Sediment transport modeling to assess the loading contribution to the Lower Bay and the associated loading of legacy constituents such as PCB, DDT, and chlordane.
Copper	Toxics TMDL	Copper based boat paints – studies have shown that both maintenance and leaching are source of copper. Air Deposition – Studies in Los Angeles and San Diego have indicated that air deposition from traffic can contribute a significant portion of the load of copper to storm water in urban areas.	Evaluation and possible further study of the contribution of leaching compared to maintenance and assessment of the effectiveness of better maintenance practices. Air deposition studies
Lead Zinc	Toxics TMDL	Air Deposition – Studies in Los Angeles and San Diego have indicated that air deposition from traffic can contribute to the load of lead and zinc to storm water in urban areas.	Source Identification Studies

Table 2-3. Priority Constituents of Concern Lower Newport Bay

Priority Constituent of Concern	Reason for Listing	Potential Sources	Further Data Needs
		Lead and zinc may also be transported from industrial areas of former DOD facilities in the watershed.	
Selenium	Toxics TMDL	Natural sources of selenium have been identified in the watershed. The mobilization of Se to groundwater has occurred due to the changes in land use in the watershed. Impacted groundwater then discharges into the San Diego Creek and Bay.	Water quality and source studies to identify additional natural sources of Se that have been mobilized by land use changes in the drainage areas/canyon surrounding the Harbor

The Rhine Channel is part of the Lower Newport Bay, but is considered a separate unit based on its designation. Rhine Channel is a dead-end channel in which toxic pollutants have accumulated in the sediments. Consequently, the Santa Ana Regional Board has designated Rhine Channel as a toxic hotspot. Due to the different historical land uses, sources of pollutants and level of contamination in the sediment, EPA has determined that a separate TMDL is appropriate for this specific reach of Lower Newport Bay. Water quality issues will therefore be address through the source control and sediment management activities under this regulatory program for Rhine Channel. The priority constituents of concern for Rhine Channel are consistent with those listed in Table 2-3 for the Lower Newport Bay with the exception of addition of the metals Cadmium, Chromium, and Mercury.

3.0 LINKAGES WITH OTHER PROGRAMS

The BMP Plan has been developed in this HAMP to coordinate with existing planning documents for watershed and coastal areas. Specifically, the Phase I projects developed in the BMP Plan are consistent with projects proposed in the Integrated Regional Watershed Management Plan (IRWMP) for the Newport Bay Watershed for the Lower Newport Bay. These Lower Newport Bay projects are linked to water quality issues in the watershed and coastal areas that include the ASBS. Preliminary pollutant transport modeling has indicated a likely connection between the Lower Newport Bay and the ASBS. Therefore, projects that improve the water quality of the Lower Bay will benefit the coastal habitats. These projects are further coordinated with the Phase I projects developed in the Integrated Coastal Watershed Management Plan (Weston, 2007) for the seven coastal watersheds along the Newport Coast and the Upper Bay Restoration Planning. For example, the City is planning to expand the runoff reduction program to all the watersheds within its jurisdiction in order to reduce urban flows and associated pollutant loads into the Upper and Lower Newport Bay, and to the ASBS. Metals reductions projects in the Coastal Watersheds will be implemented on similar schedules to the copper reduction programs in the Lower Newport Bay.

As presented in the BMP plan, water quality improvement efforts will also need to coordinated with the sediment control and dredge management projects. Siltation issues in the watershed and Upper Newport Bay have resulted in the migration of fine sediments and associated metals and pesticide pollutant loading to the Lower Newport Bay. Siltation can also impact vital eel grass beds and impact the quality of sediments and benthic communities. These issues can only be successfully addressed through an integrated program that reduces the siltation loading from the watershed, maintenance of inline basins in the Upper Bay and removal of impacted sediments in the Lower Bay. Projects planned and underway in the watershed to reduce siltation include channel stabilization, agricultural BMPs, construction site BMPs, sediment monitoring, natural treatment basins and inline channel basins in San Diego Creek. The inline basins in the Upper Newport Bay are undergoing maintenance to provide additional sediment removal. As discussed in the Upper Newport Bay Sediment Control section, the effectiveness of these basins to remove the fine-grained materials requires further assessment.

The Big Canyon Restoration project includes water quality ponds for sediment and other constituent reduction before discharge into the Upper Bay. These projects along with the implementation of BMPs during dredging activities and bulkhead maintenance and upgrades will reduce the siltation to meet overall TMDL goals.

As outlined in the following section of this Plan, a tiered and phased approach is recommended to meet water quality improvement and TMDL goals. The BMP proposed in the first phase of the Lower Newport Bay program focus on source control and pollution prevention and runoff reduction while also collecting effectiveness assessment data that may also be used to identify additional water quality improvement program opportunities. This is consistent with the coastal watershed strategy as presented in the Integrated Coastal Watershed Management Plan (Weston, 2007).

Water quality is a key component to bring together diverse water resource and land use agencies, environmental groups, and other stakeholders within the region to develop management strategies. The objective of the Strategic BMP Plan is to coordinate regional and local water quality protection and improvement efforts to meet both Harbor Area beneficial use criteria as well as regulatory drivers within and outside the Lower Bay. Many of the issues in the Harbor Area involve aquatic resources and/or the presence or transport of pollutants in water and water quality protection and improvement is a key link to successful Harbor Area Management. The water quality BMP implementation strategy will include ongoing effectiveness assessment to evaluate the performance of water quality improvement programs in meeting the water quality goals and integration with watershed, Bay and coastal plans and BMP projects.

Regionally, the Central Orange County Integrated Regional and Coastal Watershed Management Plan (IRCWM Plan) addresses overall water resources management needs for the Newport Bay and Newport Coast Watersheds (County of Orange, 2007). The IRCWM Plan has been submitted to the SWRCB to qualify for Proposition 50 funding to support numerous projects to improve water quality within and adjacent to the Harbor Area. Other water quality-related programs under the jurisdiction of the US Army Corps of Engineers, RWQCB, County of Orange Watershed & Coastal Resources Division, and local environmental and restoration groups are currently being conducted in Newport Bay and the San Diego Creek and Coastal Watersheds. Harbor Area stakeholder coordination with these groups is key to the success of water quality improvement projects in the Newport Bay.

Within the Harbor Area, the City and other stakeholders have already implemented some programs that align with other city-wide water quality improvement goals such as residential and construction BMP and numerous clean water outreach efforts. However, water quality improvement efforts in the Lower Bay require special consideration given the sensitive habitats of the Upper and Lower Bay, current and future harbor maintenance requirements, and federal, state and local regulatory actions.

4.0 HARBOR AREA WQ BMP PRIORITIZATION

The Strategic BMP Implementation Plan provides guidance for water quality BMP efforts within the Harbor Area for issues specific to harbor stakeholders. This plan establishes an iterative activity prioritization process and implementation strategy for the identification of priority pollutants in the Harbor Area. The prioritization strategy for BMP implementation considers current and future water quality issues such that BMP are designed to accommodate future reduction requirements without expensive retrofits. The strategy also implements BMP in a phased approach in order to both assess the effectiveness of the projects as they are implemented and to continually refine the prioritization process using all available data. The BMP Plan provides a road map for BMP implementation within the Harbor Area that coordinates with the regional watershed plan (IRCWM) and the coastal watershed and ASBS plan (ICWMP).

This section describes the approach to BMP identification and planning based on the assessment of water quality issues and regulatory drivers. BMP are identified in this section that area applicable to prevent, control, or treat constituents in urban runoff and discharges from recreational activities in the Lower Bay in order to lessen overall water quality degradation and environmental impacts.

Project Identification Process

Reduction of pollutant loads to receiving waters can be accomplished using three main project types, non-structural BMP, structural BMP and treatment systems. A non-structural BMP approach can include source control, runoff reduction and pollution prevention measures that can be used to reduce pollutant sources and prevent pollutant pathways to receiving waters. Source control can be accomplished through activities such as legislative restrictions on the manufacture and use of potential pollutants and education of community stakeholders to become aware of, and change behaviors that potentially lead to pollution. This may include the use of copper-based boat paints or modifications to boat maintenance practices. Runoff reduction non-structural BMPs include activities that reduce the runoff volumes and peak flows for both dry and wet weather flows such as education of responsible irrigation practices. It may also include reduction of discharges from boat washing practices and sanitary discharges. Together, non-structural source control and runoff reduction are accomplished through public participation efforts such as outreach, education and enforcement programs that all aim to educate Harbor stakeholders and users to practice techniques to prevent pollutants from entering the Bay. This approach has the added benefit of integrating water management strategies, such as responsible boat maintenance practices, water conservation and water quality protections and improvement.

A phased implementation of non-structural and structural BMPs in the Lower Newport Bay is recommended to establish the actual effectiveness in reducing constituent concentrations to the Bay. This phased approach will allow the effectiveness of non-structural and lower-impact BMPs implemented in early phases to be assessed as well as allow design parameters required to implement more complex treatment systems to be measured. Effectiveness assessment activities of the early phases of the BMP implementation program will therefore accomplish two objectives: assess the effectiveness of lower impact BMPs in reducing pollutant loads and assess the runoff volume and volume of storm water requiring more complex treatment to be developed.

Published data indicates that the effectiveness of non-structural source control and runoff reduction measures can range widely from 30-70% pollutant reduction. The effectiveness of these non-structural BMP will vary depending on the level of implementation and enforcement, drainage area hydrological characteristics, and constituent type. However, the effectiveness of non-structural BMP in a particular watershed can not be accurately assessed without effectiveness data that compares drainage areas in which these measures are fully implemented compared to a drainage-area where little or no measures are established. In addition, initial pilot studies are recommended for innovative approaches such as use of non-copper based boat paint in order to assess the effectiveness of measures to reduce pollutant loads and to develop community and stakeholder support before implementing the BMP on a broader scale.

Source control and pollution prevention measures can be more effective when targeted at sources and activities that have the greatest loading potential for the constituents of concern. Therefore assessment of individual projects and assessment of the overall impact of project implementation on the water quality of the Lower Bay are integral components of the strategy of this Plan.

Nonstructural BMP techniques can be combined with structural BMP to both control sources and reduce runoff volume to prevent pollution. Structural BMP include source control and runoff reduction strategies that require infrastructure for implementation. Examples of structural BMP include street sweeping, Low Impact Development (LID) structures, infiltration basins, and other techniques (Figure 4-1). Published data indicates that the effectiveness of structural BMP in reducing pollutants varies from 50-90%. The effectiveness of different structural BMP also varies depending on the level of implementation and enforcement, drainage area hydrological characteristics, and constituent type. Effectiveness assessment of structural BMP in the context of local conditions is imperative to evaluating individual project pollutant reduction efforts.

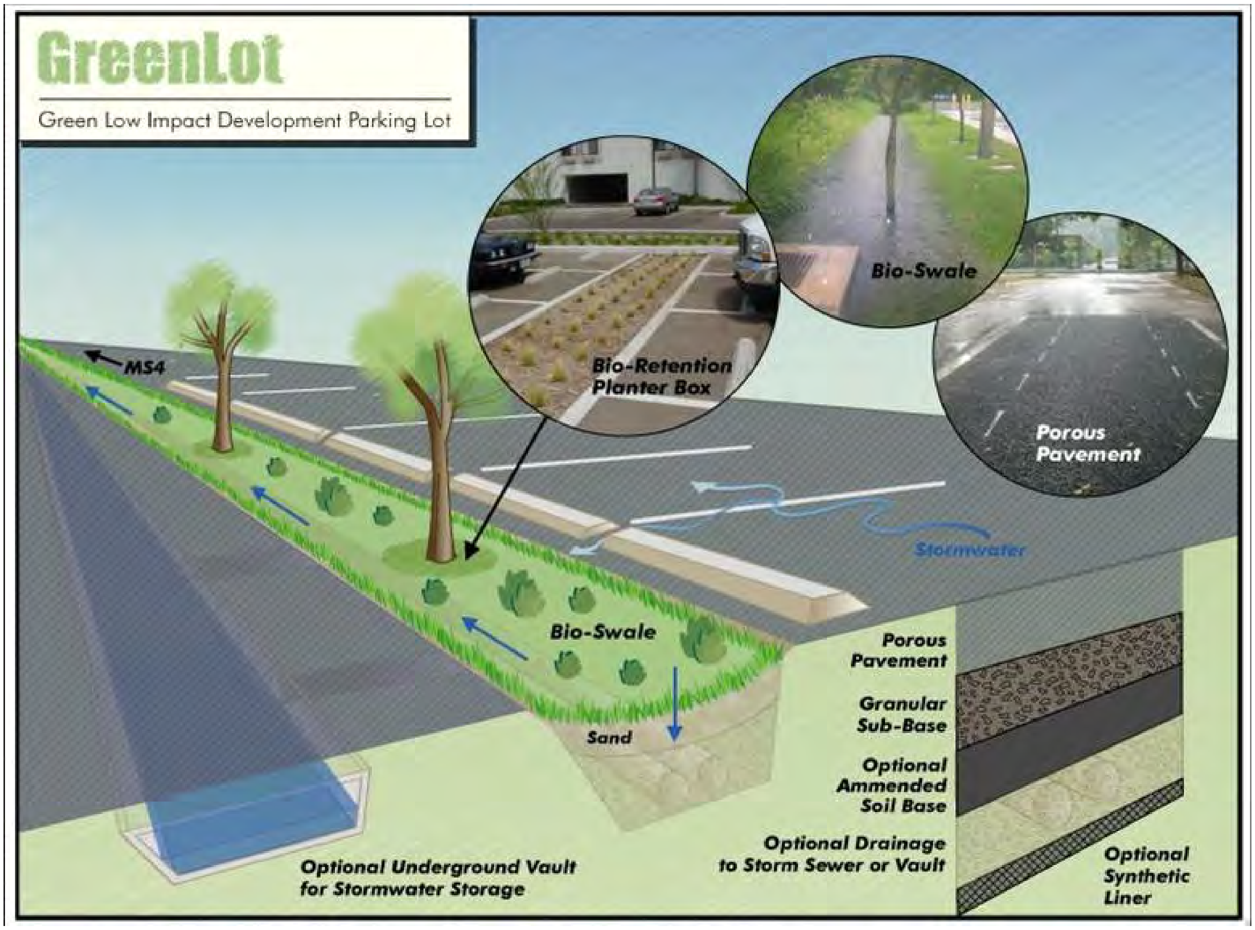


Figure 4-1. Example LID- Green Lot BMP schematic

A final method of pollutant load reduction can be accomplished through treatment BMP technologies that treat constituent concentrations. Published data indicates that pollutant reduction effectiveness of treatment BMPs can vary from 50-90+%. The effectiveness of treatment BMPs have been evaluated based on information presented in the Treatment BMP Technology Report (Caltrans, April 2006), USACE/USEPA BMP Database (USACE, 2006), and other technical publications. Based on the data presented in these referenced studies, it is likely that relatively complex treatment systems ("treatment trains") are required to collect and treat the complete design storm events to meet the required water quality objectives and load allocations for the multiple pollutants that have been identified as priority constituents of concern for the Lower Bay. These treatment train technologies often require relatively large areas and capital expenditure to design and install depending on the design storm volume required to meet pollutant reduction goals. Therefore, a phased approach, discussed in the following section, is recommended that implements source control pollution prevention and runoff reduction BMP in the first phase (Phase I). Reductions in runoff volume from infiltration BMP and pollution reductions through source control and pollution prevention measures may significantly reduce the need for more infrastructure-intensive treatment train BMP.

BMP Integrated and Tiered Approach

The development of management measures to address the goals of the HAMP and this BMP Implementation Plan is based on an integrated and tiered approach. The integrated approach addresses all priority constituents in the BMP development. A tiered project selection process then addresses constituents with the greatest impacts to beneficial uses through the effective use of resources and is then used to rank potential BMP. In the integrated and tiered process, each BMP is then classified according to the relative efficiency of constituent removal from the system, level of infrastructure required for implementation, and cost.

Three tiers of BMP classifications are defined. Tier I BMP focus on non-structural source control and pollution prevention measures that are designed to reduce the amount and understand the effect of pollutants entering runoff though education, enforcement and behavioral modification programs.

Tier I – Non-structural BMP and Activities
- Product Substitution through Education/Pilot Program or through Legislation
- Source Control Measures and Pollution Prevention BMP
- Effectiveness Monitoring of BMP
- Integrate Efforts through Information Management
- Public Participation and Community Involvement through a Bay Protection Program that includes safe and green boating practices

Tier II includes structural BMP such as smart irrigation controllers, infiltration basins, bioretention and LID techniques to reduce wet and dry weather runoff volumes (including water conservation efforts) and further reduce pollutant entry into the Lower Bay. Additionally, Tier II includes source identification and design studies that will fill data gaps and aid in the further identification of pollutant sources and provide design parameters for construction of effective in-line treatment systems as part of Tier III.

Tier II – Structural BMP and Activities
- Hydrologic Studies, Source Studies and Determination of Design Storm
- Aggressive Pollutant Source Control in Targeted Areas (e.g. Street Sweeping)
- Implementation of Urban Runoff Reduction Techniques (irrigation controllers, progressive water rates, LID)
- Dry weather Flow Diversions
- Effectiveness Monitoring of BMP

Tier III BMPs are infrastructure-intensive structural pollution reduction treatment measures that typically require significant capital investment and/or have impacts on surrounding communities.

Tier III – Treatment BMP and Activities
- Pilot Treatment Projects to Assess Effectiveness
- Property Acquisition and Easements (where necessary)
- Implementation of Treatment BMP in Targeted Areas where Tier I and Tier II BMP have been shown not to meet full reduction goals
- Effectiveness Monitoring of BMP

Effectiveness assessment, monitoring, and data incorporation into the overall information management program are components common to all three tiers. Within each tier, the effectiveness of each BMP program must be monitored in order to assess whether the program is meeting pollution reduction goals. A secondary benefit of effectiveness monitoring is that oftentimes BMP techniques can be modified or pollutant sources can be identified in order to further reduce pollutant loads as time series data becomes available.

Project Prioritization Process

The development of an implementation strategy to reduce pollution within the Lower Newport Bay and impacts to the beneficial uses of the Harbor requires that potential management measures be prioritized. Criteria for the prioritization process include:

- Meets the Plan objectives
- Meets multiple regulatory objectives
- Integrates water management strategies
- Reduces priority COC inputs to the Bay
- Follows the tiered approach to urban runoff management
- Leads to understanding of Bay ecosystem impacts
- Fills critical data gaps
- Contributes to Newport Watershed and ASBS information management
- Increases Harbor Protection stewardship and Safe and Green Boating Practices
- Implements the most feasible and cost effective measures first
- Assesses management measure effectiveness

The prioritization process begins with current knowledge of water quality issues that was summarized in the previous sections. A three-phased implementation approach is then developed based on the prioritization criteria listed above. Central to the prioritization process is the iterative nature of the process where priority management actions concurrently address identified project goals, priority pollutants and identify emergent issues. This process occurs in parallel with ongoing source identification, water quality and BMP assessment projects and the development of an overall assessment data management strategy that integrates specific pollutant reductions with beneficial use goals. This process allows for effective management decisions for BMP implementation to be coordinated with long-term assessment of ASBS performance. The overall goal of the phased and integrated approach is to address individual constituents of concern, address multiple water management strategies, and meet pollution reduction goals in a prioritized cost-efficient manner.

Management Measures: Short-term Implementation Program- Phase I

The prioritization process implements management measures defined by the tier system in a phased approach. Phase I of this approach consists of implementing a range of Tier I and II, and pilot Tier III projects, including pollution prevention and source control measures to address priority constituents of concern and loading identified in the water quality issues discussion. Several of the Phase I projects are designed to fill data gaps needed for more effective design of future projects. In Phase I, Tier III projects will only be implemented on a pilot basis where a specific pollutant source and treatment system has been identified and the implementation of a Tier III BMP will provide a clear benefit to overall pollutant reduction. These pilot BMPs are also located in small isolated drainage areas where the storage volume required is limited and the effectiveness of the BMP can be readily assessed. Specific Tier I and II source control and pollution prevention projects included as part of Phase I include public outreach and education, increased inspection of identified sources, increased targeted street sweeping, and runoff reduction and diversion programs that best meet the prioritization criteria presented above.

Phase I also incorporates effectiveness assessment to measure the performance of specific BMP. Specific BMP effectiveness assessments verify the efficiency of implemented BMP by measuring load reductions and/or water quality improvements and determine whether Tier I and Tier II BMP need to be modified or can be expanded to other areas of the Harbor.

Overall, Phase I aims to implement a range of BMP projects designed to address identified priority constituents of concern from a range of community, structural and ecosystem-level activities. Phase I is also designed to understand the efficiency of specific pollutant reduction efforts and to identify existing pollutant source or BMP design data gaps through the integration of data into an information management system. The goal is to maximize the effectiveness of Tier I and II projects in Phase I to address pollutant reduction goals and guide the BMP priority rankings and implementation strategies in Phases II and III. Figure 4-2 shows the emphasis on Tier I and II projects during Phase I and also shows the planned timing for implementation.

Management Measures: Long-term BMP Implementation- Phase II

Information gathered during Phase I will then used to prioritize management measures in Phase II. The information management system developed as part of this Plan will combine effectiveness assessment data of programs conducted in Phase I, specific health of the Harbor studies, and other data to prioritize specific pollutant reduction BMPs in Phase II, characterize design parameters for Phase II structural BMPs, and re-evaluate or verify constituents of concern and data gaps. Phase II will consist of continued implementation of a range of Tier I and II projects, and some pilot Tier III projects, including pollution prevention and source control measures to address high priority pollutant and loading areas originally identified in the water quality assessment and modified as a result of effectiveness assessments conducted in Phase I. Some Tier I and Tier II projects may also be modified or expanded through this analysis process. Since Tier III BMPs are often infrastructure-intensive and costly, this integrated and tiered strategy has the potential to reduce overall project costs and community impacts and will focus Tier III efforts on pollutants with the highest impact to beneficial uses and in locations where pollutants can be most effectively reduced.

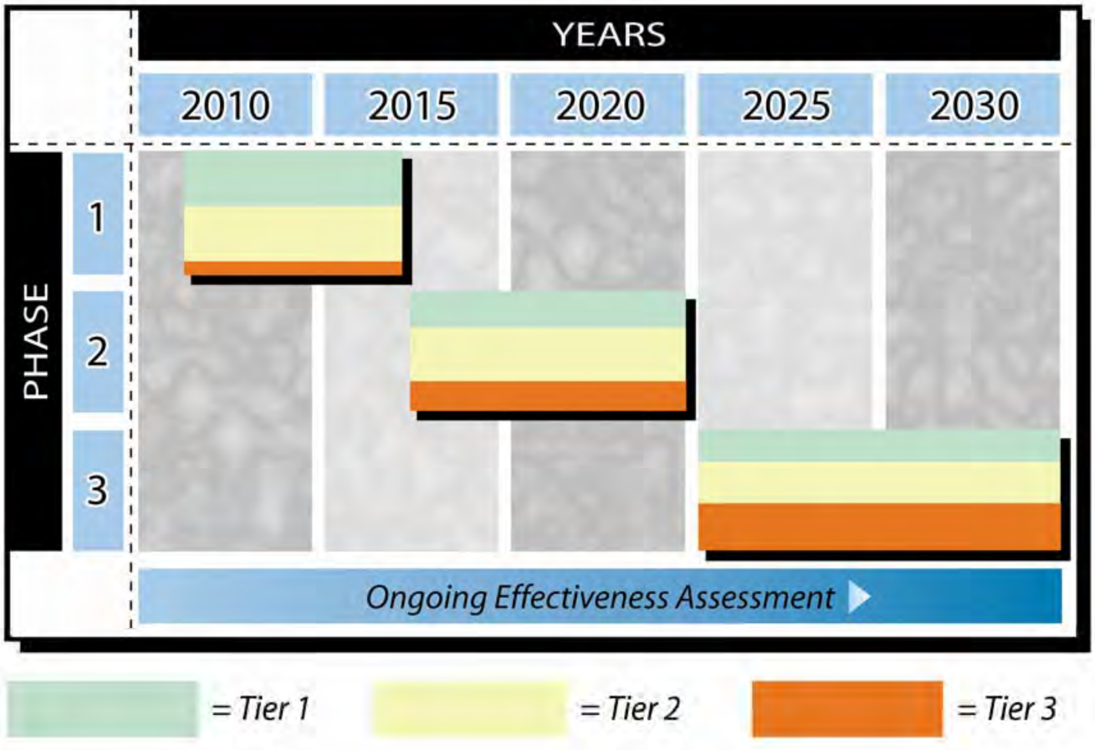


Figure 4-2. BMP Phased Approach.

Management Measures: Long-term BMP Implementation- Phase III

Information gathered during Phases I and II will then used to prioritize management measures in Phase III. Similar to Phase II, Phase III will incorporate data and knowledge acquired as part of previous phases to prioritize specific pollutant reduction BMP, characterize design parameters for structural BMP, and identify emergent constituents of concern and data gaps. Although Phase III will continue the implementation of a range of Tier I and II, and some Tier III, pollution prevention and source control measures to address high priority pollutant and loading areas, it is assumed that Phase III may prioritize a larger proportion of specific Tier III BMP to be implemented through the analysis of Phase I and II efforts. As in Phase II, some Tier I and Tier II programs may also be modified or expanded through this analysis process.

As a result of the iterative process and the nature of the phased BMP approach, specific projects to be included in Phase III of the BMP approach are not well defined. As defined above, specific management decisions and allocation of projects in subsequent phases will be driven by an integrated information analysis of identified priority pollutants, BMP effectiveness assessments, and public participation and Bay Protection Program activities.

Adaptive Management Strategy

As the Phased BMP Implementation process proceeds, data gathered from Phase I activities will be integrated into the information management system and used to evaluate the prioritization and implementation schedule for Phase II and III. Accordingly, Phase I contains the most well defined set of Tier I, II and III projects. As new pollutants emerge or strategies to address pollutants are developed, results of effectiveness assessments of Phase I activities become available, assessment data is gathered from special studies, and more funding sources become available, the list of projects in Phases II and III will increase. Inherent in this strategy, therefore, is the need to continuously assess and manage each phase of the project implementation. This iterative process is depicted in Figure 4-3.

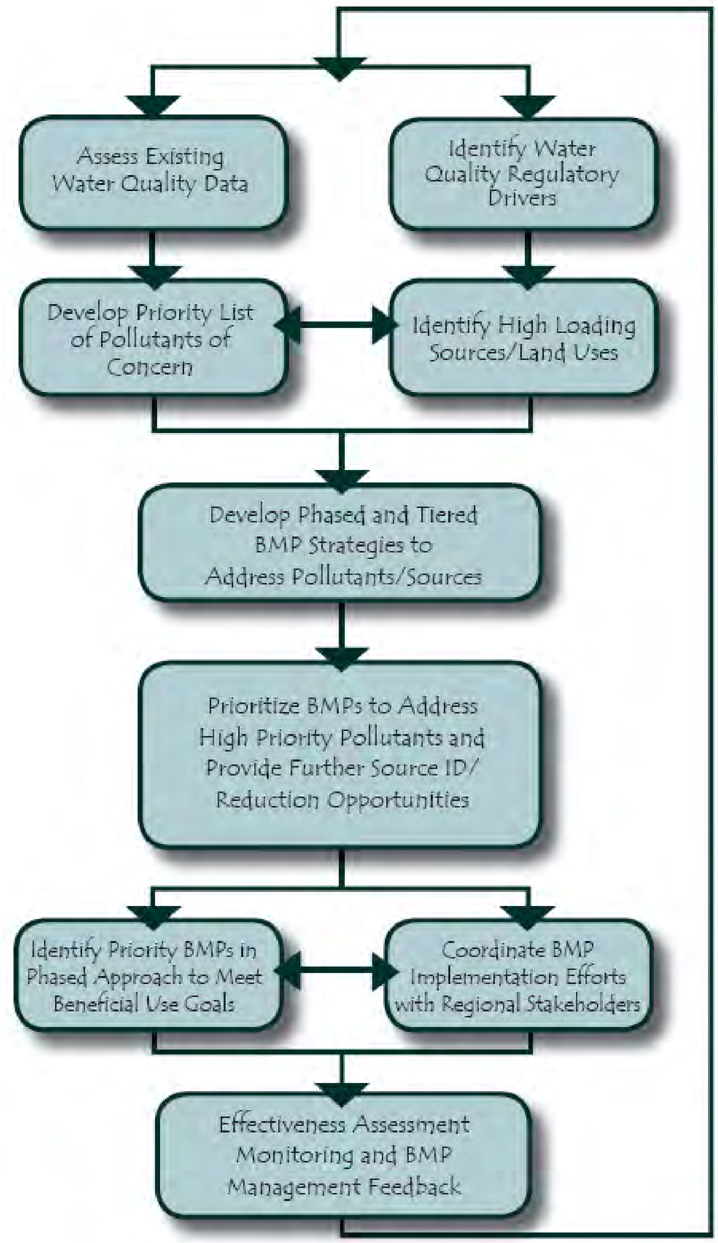


Figure 4-3. Adaptive management strategy for pollutant reduction process.

Public Participation and Bay Protection Program

In order to effectively implement the Strategic BMP Implementation Plan, public participation and education is critical. Failure to implement public outreach and promote a program of Bay protection will prevent the success of source control BMPs and run-off reduction. Public participation and Outreach must continue and expand. Phase I of the Plan includes implementation of education and outreach programs to reduce copper loading through the use of alternative paints and boat maintenance practices, boat washing and proper disposal of sanitary boat waste. A behavior-based approach to outreach programs should be used to engage the public and create positive behaviors that impact pollution prevention. This approach involves: identifying barriers to a sustainable behavior, designing a strategy that utilizes behavior change tools, piloting the strategy with a small segment of a community, and finally, evaluating the impact of the program once it has been implemented across a community. This approach is similar to the iterative approach of the BMP implementation strategy presented above. Education and outreach activities should be coordinated with local stakeholder groups such as Coastkeeper and Surf Rider. 4

Implementation Schedule

The implementation schedule for management measures within the Lower Newport Bay is based on results of the water quality issue assessment and the integrated and tiered process. Figure 4-2 illustrates the general implementation schedule and estimated maximum pollutant reduction goals for recommended projects in the La Jolla Shores Coastal Watershed. In general, Phase I projects are to be implemented within the first 3 – 5 years of the Program. Several of these projects have been initiated such as the copper-based boat paints outreach program and the runoff reduction program in the watershed. Phase II projects are to be implemented in 5 – 10 years and Phase III beyond 10 years. Recommended Phase I BMP projects are presented in Section 4.

BMP Effectiveness Monitoring

In conjunction with BMP implementation efforts, effectiveness assessment and monitoring efforts will be conducted in order to further refine identified or emerging pollutants and/or sources, BMP effectiveness, and address any data gaps. Effectiveness monitoring is vital for accurate adaptive management and will be tailored to specific BMPs. For instance, effectiveness monitoring of outreach activities should include surveys, community dialogue and polls. Structural BMP effectiveness should include assessments of baseline conditions, calculated flows, assessment of concentrations of contaminants of concern and assessment of overall efficacy.

The effectiveness of each BMP program must be monitored in order to assess whether the program is meeting pollution reduction goals. Effectiveness assessment activities can sometimes be combined to allow multiple BMP efforts to be assessed concurrently A secondary benefit of effectiveness monitoring is that oftentimes BMP techniques can be modified or pollutant sources can be identified in order to further reduce pollutant loads as time series data becomes available.

5.0 BMP PRIORITY (PHASE I) PROJECTS AND IMPLEMENTATION

The purpose of the BMP Plan is to develop a comprehensive Harbor Area activity strategy that addresses current and anticipated pollutants and associated regulatory drivers, community needs, and ecosystem health and sustainability. The iterative prioritization and implementation strategy developed for the Harbor Area provides the framework for stakeholder participation and coordination in the protection and improvement of water quality in Newport Bay. Ongoing effectiveness assessment of implemented strategies will assure coordinated and efficient use of available resources in achieving a sustainable Harbor Area plan to protect and improve water quality.

Based on the process outlined in the previous sections, the following are the recommended Phase I water quality improvement projects for the Lower Newport Bay:

Pollution Prevention/Runoff Reduction- Copper Reduction Program

Several COCs are listed in the Toxics TMDL for lower Newport Bay, including lead, zinc, selenium, and copper. There are several potential on-point sources of these contaminants in Newport Bay. Copper-based anti-fouling boat paints have been shown to be a significant source of copper in harbor environments, including Lower Newport Bay. Other sources, such as break pad wear introduced to the receiving waters via urban runoff are also a concern. Preliminary cross contamination study results have identified a connection between Lower Newport Bay and the Newport ASBS. Because of this association, bioaccumulation studies are being conducted to determine the extent to which copper may be influencing ASBS biota.

To address these concerns, a primary focus of the copper reduction program in Lower Newport Bay will address the use of alternatives to copper-based boat paints. An important constituent of the study will be to implement a BMP pilot project for boat maintenance to address potential cross-contamination impacts to the ASBS from Newport Harbor. The program will also implement an outreach program to further educate the boating community regarding the environmental effects of using copper-based antifouling paints.

Other regional programs will be incorporated into the copper reduction program. For instance, the City of Newport Beach in conjunction with Orange County Coastkeeper (a local NGO) and Trace Marine Services is conducting a 3-year public campaign to encourage boaters to switch from copper-based boat paints to less toxic alternatives. The goal of the study is to reduce dissolved copper levels in a designated area of Lower Newport Bay (the Balboa Yacht Basin Marina) to below California Toxics Rule (CTR) criteria. In addition to reducing copper levels in the receiving waters, it is hoped that the study will elevate the use of non-toxic bottom paints to the preferred application for boaters in the harbor area.

The Shelter Island Yacht Basin TMDL for dissolved copper will also be used as an important resource for the Lower Newport Bay copper reduction program. Because of the similarities between Shelter Island and Upper Newport Bay with respect to sources of copper, harbor configuration, and abatement alternatives, the implementation plan for the Shelter Island TMDL provides meaningful alternatives to a copper reduction plan in Newport Bay. In addition to a transition to non-toxic hull coatings, other recommendations from the Shelter Island TMDL for reducing copper levels in the harbor receiving waters include management practices designed to reduce the effects of copper-based paints, financial incentives to boat owners and marinas, effective fate and transport modeling, and other alternative anti-fouling strategies. Assessing the most effective reduction measures from other studies conducted in the region will allow for the most of efficient management plan for reducing copper levels in Lower Newport Bay.

Pollution Prevention/Runoff Reduction- Water Quality Enforcement Cross Training Program

The primary path through which nearly all of the priority COC listed for Newport Bay enter the receiving waters is through non-point sources. These COC are common to urbanized environments, but source identification and abatement is often complicated by numerous inputs, intermittent sources, and the co-mingling of COC, particularly in a complicated harbor environment. A focused, efficient program is required to address these issues.

The Water Quality Enforcement Cross Training Program is a Municipal inter-departmental coordination initiative designed to control non-point source discharges to the Lower Bay. The Program will train Harbor Area oversight departments (Harbor Patrol, Lifeguards, Coast Guard, Cal Fish and Game) in identifying potential sources of water quality degradation. In addition, the Program will increase communication among these Departments and City Code Enforcement officers to report potential violations.

These efforts will be conducted in conjunction with Sea Grant projects related to the Coastal Zone Management Act that are being conducted in the region. The Nonpoint Source Pollution Program is an education and outreach program for boaters, marinas, and the marine industry on pollution prevention, non-point pollution, marine debris, and other related topics. The program provides education for recreational boaters on ways they can prevent water pollution and help protect marine species and habitats.

Pollution Prevention/Runoff Reduction- Boating Activities

Nutrients and bacteria are listed as priority COCs for Upper Newport Bay. In addition to natural sources, there are numerous non-point anthropogenic sources of these constituents that can impact water quality in the Bay, including animal waste, groundwater seepage, a diffuse storm drain network. In harbor areas, source identification studies of these constituents are complicated by the presence of numerous boats and boating activities, such as illicit discharge of holding tanks, dock maintenance, and boat washing.

To address these latter concerns a Water Quality Education Program has been designed to provide brochures and posters for Harbor Area boat users to reduce pollutants entering the Bay as a result of boat and dock washing activities. The Program is designed to mesh with the Boating Clean and Green Campaign, a statewide boater education assistance program conducted by the California Department of Boating and Waterways and the California Coastal Commission. The Campaign promotes environmentally sound boating practices to marine businesses and boaters throughout California. The Campaign focuses on boater education in promoting environmentally friendly boating practices while assisting marinas and local governments in identifying and installing pollution prevention services for boaters.

In addition, other programs have been initiated to education boat owners about the environmental impacts of certain boating activities. The Water Quality Education Program for Short-term Slip Rentals is a Municipal, inter-departmental coordination initiative designed to educate Harbor users and visitors of the importance of water quality protection. The Program will provide literature to help short-term slip tenants identify and reduce potential sources of water quality pollution from their vessels. Similarly, the City could implement inspection process linked to slip transfers so that Harbor users are educated and potentially polluting vessels are identified prior to the slip transfer process.

Pollution Prevention/Runoff Reduction- Nutrient Load – Cross Contamination Study

Nutrients are listed as a Priority COC for Lower Newport Bay and there is currently a Nutrient TMDL for the water body. Excessive nutrients in an urbanized water body, particularly in a semi-enclosed harbor area, can lead to limited circulation and a nutrient build-up that can result in algal blooms. Assessing the sources of these nutrients and their fate and transport in the Harbor and surrounding area are important factors for maintaining water quality in the Bay as well as the adjacent Newport ASBS. The transport of nutrients and algae from Newport Bay to the area is determined by coastal circulation and volume of the water outflow from the Newport Bay. Because of the large tidal exchange in the Bay, it has been hypothesized that nutrients and algae originating in the Bay may have a larger impact on the adjacent Newport Coast ASBS than runoff from its local watershed.

The Cross-Contamination Project is designed to reduced fertilizer and pesticide use that impact the Bay the Bay via urban runoff and assess nutrient loads in urban runoff and their potential for causing algal blooms. Community outreach will be targeted towards chemical suppliers (such as garden centers, etc.), commercial landscaping operations, and residents. In addition, the project will incorporate the Newport Bay outlet plume modeling project to understand the impact of nutrient loading and algal blooms on the Newport Coast ASBS.

Pollution Prevention/Runoff Reduction- Municipal Low Impact Development (LID) Assessments

As part of the Phase I BMP projects, Tier II runoff reduction BMP are recommended that will address multiple pollutant loading to the Lower Bay. This first phase of Tier II project includes a pilot assessment program to incorporate additional LID designs into municipal facilities within the Harbor Area and the Marina Park Conceptual Plan. Currently, the Marina Park Conceptual Plan indicates a Bio-Swale Filtration Area adjacent to the Community Center. Additional LID techniques as shown on Figure 5-1 and Figure 5-2 may be incorporated into the Marina Park projects and well as other municipal projects schedule in the next 5-years. This pilot assessment program include first identifying the municipal projects where LID techniques can be incorporated into the design. The City will then coordinate with the team’s that are designing and implementing the project to incorporate infiltration and runoff disconnect features as part of the project. The LID features will then we assessed for their effectiveness in reducing runoff and pollutant loadings. The results of this Phase I will be used to expand on this program where effective and feasible.

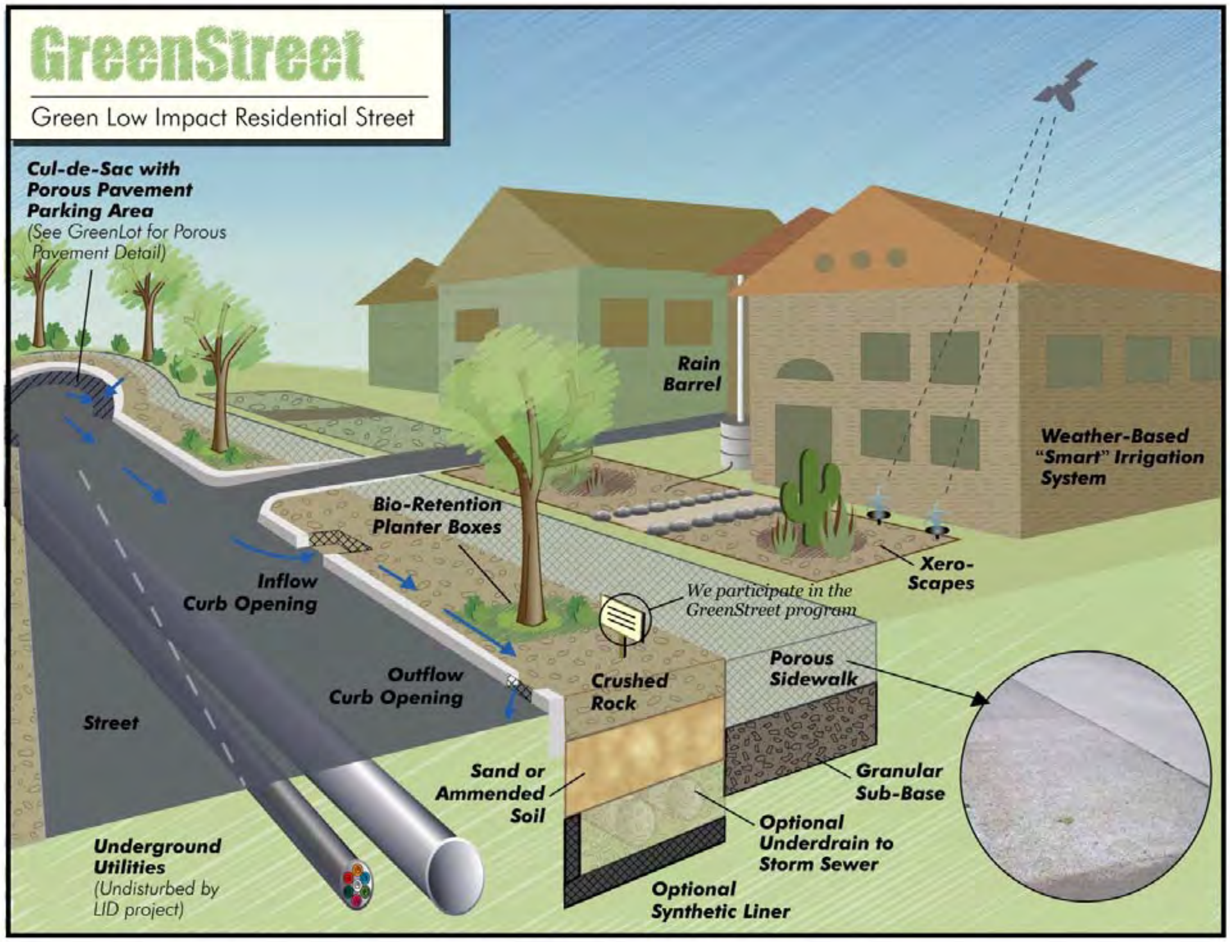


Figure 5-1. GreenStreet

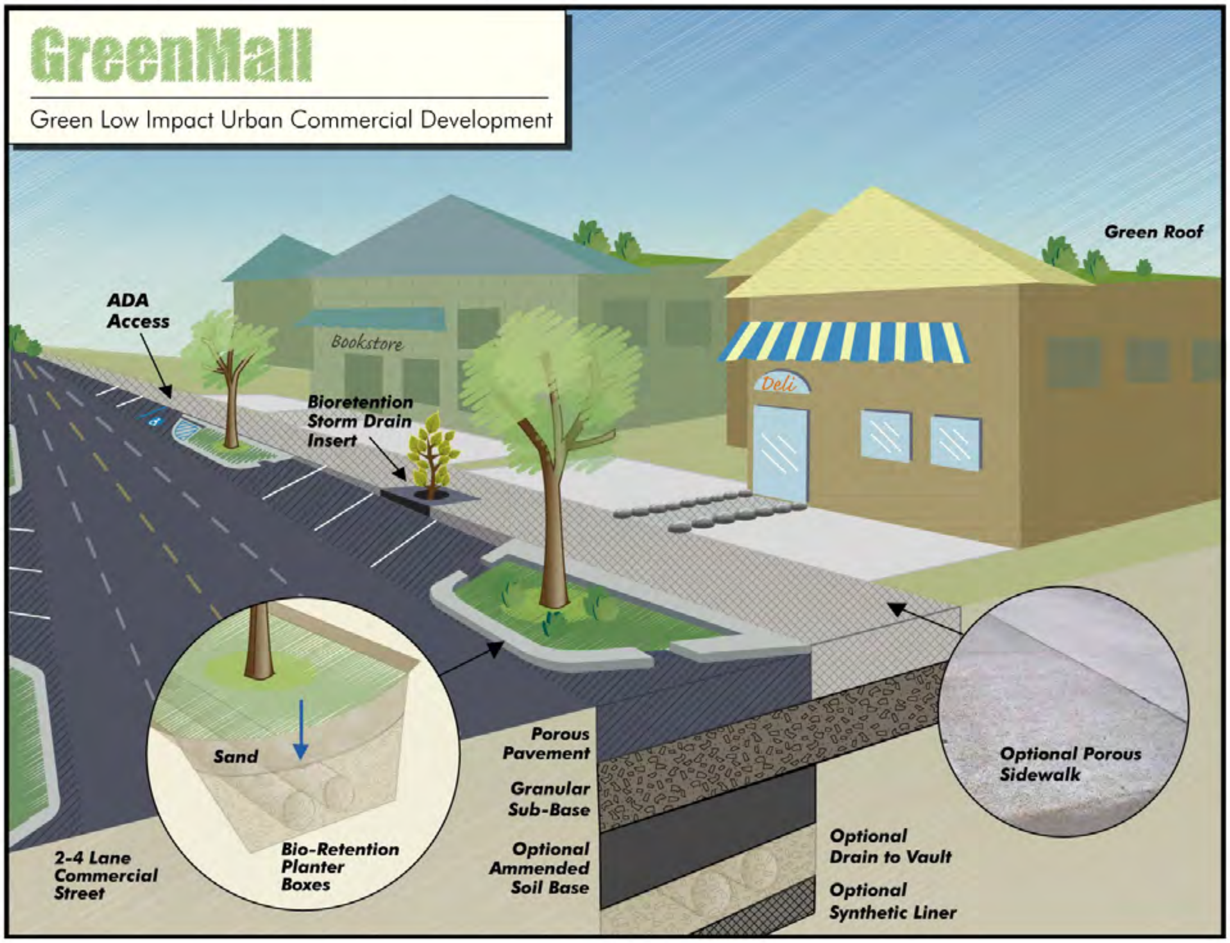


Figure 5-2. GreenMall

APPENDIX E

Harbor Channel and Pierhead Lines

"The following technical report reflects the findings and data available at the time the report was prepared and may not represent the current conclusions and steps forward in the main text of the HAMP, which has been updated after the completion of these reports. These more detailed technical reports provided in the appendices represent the foundation for the overall approach to the HAMP, but are not "living" documents that reflect updated steps forward, costing, quantities, etc. presented in the main text of the HAMP. The main text of the HAMP represents more current information and recommendations based on updated information, new studies, changes in conditions, new funding sources, and/or new regulations."

HARBOR AREA MANAGEMENT PLAN

HARBOR LINES REVIEW

Technical Report

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June 2009

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1.0 INTRODUCTION

1.1 Background

After construction of the portion of Newport Bay below the Pacific Coast Highway (Lower Bay), the federal government, through the U.S. Army Corps of Engineers (USACE), established harbor lines (project lines, pierhead lines and bulkhead lines). These lines define the federal navigation channel dredging limits, and the limits on how far piers, wharfs, bulkheads and other solid fills can extend into Lower Bay waters. These lines are important for maintaining safe navigation conditions throughout the Lower Bay.

The harbor lines have not been systematically adjusted since their original development in 1936 even though the Lower Bay has been altered extensively since this time and there have been changes in uses as well. For example, numerous basins and islands have been constructed after the initial construction. The types, sizes, and distributions of vessels within the Lower Bay have also been changing over time following market demands. In addition, changes in policy and regulations at the federal, state, and local levels have resulted in a different regulatory condition from that considered at the time the lines were initially established.

1.2 Purpose and Objectives

As part of the Harbor Area Management Plan (HAMP) for Newport Bay, this task identifies and addresses issues related to the harbor lines throughout the Lower Bay and provides recommendations to update these lines.

Specific objectives developed to satisfy the purpose of this task include:

- Identify existing harbor lines including project lines, pierhead lines, and bulkhead lines.
- Review the development of these lines with respect to relevant policies, regulations, guidelines, and procedures.
- Prepare a map showing the existing harbor lines and summarizing the relevant policies.
- Develop a matrix of goals and constraints to evaluate current harbor line positions based on existing uses.
- Prepare a draft and final report on work performed for the above objectives as well as recommendations, and a road map for implementation of the recommendations.

2.0 EXISTING CONDITIONS

2.1 Definitions

A harbor line is the line set by the federal government, delineating the area in which no obstructions to navigation are allowed (United States of America, Sec. 403). In the Lower Bay, harbor lines include the project line, pierhead line, and bulkhead line (United States of America, Sec. 424).

A harbor project line, federal project line, or project line is the boundary of the federal project and limit of certain federal responsibilities. Pierhead and bulkhead lines are typically between the project line and land.

A pierhead line is a boundary set by the USACE beyond which a pier may not extend (Committee on Standardization and Special Research, 1940). This is typically located between the project line and the bulkhead line.

A bulkhead line is a boundary set by the USACE beyond which solid fill may not be extended (Committee on Standardization and Special Research, 1940).

2.2 Rules and Regulations

There are several rules and regulations pertaining to the harbor lines that must be accommodated in any potential update or realignment of harbor lines.

The City of Newport Beach Municipal Code (Title 17) has the following regulations concerning harbor lines:

All channels, turning basins, anchorage areas, and pierhead and bulkhead lines in Newport Harbor shall be as established by the Federal Government or by the City Council upon recommendation of the Harbor Commission. A map thereof shall be kept on file in the offices of the City Clerk and the Public Works Director for public inspection (Newport Beach, 2002a).

And:

Prior approval of the U.S. Corps of Engineers will be required when:

A. Work extends beyond the U.S. pierhead line; B. Solid filling of a solid structure is constructed beyond the U.S. bulkhead line; C. Harbor lines have not been established in the area by the U.S. Corps of Engineers. (Newport Beach, 2002b).

The Harbor Permit Policy was developed by the City of Newport Beach to regulate bulkheads, cantilevered patio decks, bulkhead lines, piers, floats, pierhead lines, and other water front structures (Harbor Resources Division, 2004). The rules are extensive and hence not repeated here.

The following are federal regulations (Title 33 – Navigation and Navigable Waters) pertaining to harbor lines in Newport Harbor:

The Secretary of the Army is authorized and directed to fix and establish pierhead and bulkhead lines, either or both, at Newport Harbor, California, in accordance with plan dated United States Engineer Office, Los Angeles, California, March 25, 1913, and entitled "Newport Bay, California", showing harbor lines, beyond which no piers, wharfs, bulkheads, or other works shall be extended or deposit made, except under such regulations as shall be prescribed from time to time by the Secretary of the Army (United States of America, Sec. 424).

And:

The Secretary of the Army is authorized to modify from time to time, the harbor lines at Newport Harbor, California, established in pursuance of section 424 of this title: *Provided*, That in his opinion such modification will not injuriously affect the interests of navigation (United States of America, Sec. 424a).

At the time of publishing this report, the City of Newport Beach is in the process of approving a Local Coastal Program. Until it is approved, the California Coastal Act is enforced directly by the California Coastal Commission. The California Coastal Act does not specifically mention any of the harbor lines.

2.3 Evolution of the Lower Bay and Harbor Lines

Physical features and harbor lines of the Lower Bay have evolved over the years. The evolution of the Lower Bay and associated harbor lines is summarized here to help understand how the harbor lines arrived at where they are.

The first record of Newport Bay occurs in Title 33 of the U.S. code, which refers to a 1913 map of Newport Bay, California. This map however, could not be located for inclusion in this report, so the 1913 extent of Newport Bay is unknown.

Work for Newport Bay started in December 1934 and opening celebrations were held on May 26, 1936 (OCParks.com, 2008). A 1934 map of Newport Bay showed a similar layout as today, but without Linda Isle, Promontory Bay, Balboa Yacht Basin, Balboa Coves, Newport Island or the Grand Canal splitting Balboa Island. On this map, the northern extent of Newport Harbor ended at PCH Bridge and the western extent was at Newport Blvd (U.S. Engineer Office, 1934).

In 1936, "Newport Bay Harbor" had the same features and extents as in 1934. By 1936 the pierhead, bulkhead, and project lines were available, with pierhead lines set at distances varying between zero to 96 feet from bulkhead lines depending on the locations. The project lines were usually 10 to 20 feet channelward from the pierhead lines. This was intentional to allow a buffer so that dredging would not undermine or interfere with the pier piles. The most common spacing had the pierhead line 80 feet from the bulkhead line and the project line 20 feet from the pierhead line (U.S. Engineer Office, 1936).

By 1950 Balboa Coves, Newport Isle, the Grand Canal, Balboa Yacht Basin, and an incomplete Linda Isle had been added (Office of the District Engineer, 1950). Since 1936, a few areas have shown a 10 foot increase in the distance between bulkhead and pierhead lines with a corresponding decrease in the distance between pierhead and project lines. Bulkhead lines near the Harbor Patrol were moved bayward.

By 2008, a bay had been added to the middle of Linda Isle and Promontory Bay had been added. Figures 1A through 1C shows the harbor lines as of 2008. In these figures, bulkhead lines, Pierhead lines and harbor project lines are shown as yellow, green, and red lines, respectively, while Harbor Permit Policy exceptions and special permits are shown as dashed lines. The circled location markers in these figures are addressed in Section 3 of this report. Changes in the harbor lines that occurred between 1950 and 2008 include: new bulkhead lines in Balboa Yacht Basin, new bulkhead lines in Balboa Coves and Newport Island, new pierhead and bulkhead lines in and around Linda Isle, removed project (channel) lines in Newport Channel, and development of a Harbor Permit Policy regulating variances and exceptions to the original harbor lines at specific locations throughout the Lower Bay.

Figure 1A. Harbor Lines Review

Figure 1B. Harbor Lines Review

Figure 1C. Harbor Lines Review

3.0 HARBOR LINES REVIEW

Existing harbor lines were overlaid on photos of existing Lower Bay features as shown in Figures 1A through 1C. This map, in combination with location specific rules from the Harbor Permit Policy, was used to identify locations where potential conflict and inconsistencies exist between the harbor lines, Harbor Permit Policy, and existing features. At these locations, outstanding issues can be summarized as follows:

Throughout the Lower Bay, many beaches extend beyond the bulkhead line. In no instance does any beach extend beyond the project line. This practice has evolved over time and is likely in conflict with a strict interpretation of the bulkhead line definition.

Promontory Bay and the Grand Canal (Balboa Island) do not have bulkhead lines.

Some locations have bulkhead lines crossing existing navigable waters and channels. This occurs at Promontory Bay, Balboa Yacht Basin, Linda Isle, from Harbor Patrol through Pirate's Cove, and Balboa Coves.

Pierhead lines are noticeably absent from Promontory Bay and Newport Harbor. There is however guidance in the Harbor Permit Policy for pierhead lines around Newport Island.

No project line exists around Newport Island, The Rhine Channel, Promontory Bay, or Linda Isle. These areas are not federal projects however and may not require project lines.

There are numerous locations where existing structures extend beyond pierhead and project lines. This situation has developed over the decades and is one of the main reasons for performing this study.

These locations were shown to the Harbor Resources Agency and the outstanding issues were discussed. During this meeting, a list of general goals and constraints were developed to address these outstanding issues. The goals included:

- Improving clarity and consistency of the harbor lines and Harbor Permit Policy;
- Allowing pier owners access to deeper, more navigable waters that are further offshore, while reducing impacts to eelgrass; and
- Bringing nearly all Lower Bay structures into compliance through modification of the harbor lines and Harbor Permit Policy.

The constraints on harbor line and Harbor Permit Policy modifications included:

- The changes should minimize pierhead encroachment into navigable waterways;
- Any change in the harbor lines requires USACE approval;
- A navigation study should be performed to verify that changing the harbor lines to match existing conditions would not impact navigation beyond allowable standards. If the impacts are beyond allowable standards, the realignment should be modified.

Any channelward realignment of the project line would transfer maintenance (e.g., dredging) requirements of that new area from the federal government to the City and/or County.

Solutions to the outstanding issues were then developed which attempt to satisfy the goals and constraints. The most common solutions are:

- Realign pierhead lines to bring potential violators into compliance. In other words, move pierhead lines channelward, connecting existing pierheads;
- Where necessary, move the project lines channelward to include the new pierhead lines. This is necessary to maintain project lines channelward of pierhead lines;
- To simplify and clarify bulkhead lines, move bulkhead lines landward to the existing bulkhead or property lines;
- Since no structures should cross navigation channels, remove bulkhead and pierhead lines that cross navigation channels;
- To improve consistency throughout the Lower Bay, add bulkhead and pierhead lines where they do not currently exist; and
- Update harbor lines to reflect the Harbor Permit Policy and then streamline the Harbor Permit Policy by removing area specific exceptions.

Location specific solutions are described in Table 1 and graphically located in Figures 1A through 1C. The different waterfront regions within the Lower Bay have been identified by alpha-numeric labels originally designated in the Harbor Permit Policy. These circled location labels were copied into figures 1A through 1C and supplemented where additional detail was needed. Each column in Table 1 specifies the change recommended to the bulkhead line, pierhead line, project line, or Harbor Permit Policy. In addition, the goals and constraints applicable to each location are also given in the last two columns of Table 1.

An example will clarify the connection between Table 1 and Figures 1A through 1C. Location A in Figure 1C is found on the north-east corner of the Balboa Peninsula. The recommended solution at this location involves moving the pierhead line channel-ward to bring piers into compliance and improve harbor-wide consistency of the rules. While this solution moves the pierhead line into the waterway, no increase in physical encroachment occurs, so encroachment is minimized.

Table 1. Recommended Harbor Line Changes

Location	Bulkhead Line Changes	Pierhead Line Changes	Project Line Changes	Harbor Permit Policy Changes	Goals	Constraints
A	No change	Realign to end of existing pierheads	No change	No change	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
B	No change	Realign channelward to the project line	No change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
C	No change	No change	No change	No change		
D	No change	No change	No change	No change		
E	Realign landward to existing bulkheads or property boundaries	Replace with Special Permit Line	No change	No change	Improve harbor-wide consistency. Bring into compliance.	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
F	No change	No change	No change	No change		
G	No change	Realign to end of existing pierheads	Realign channelward to accommodate pierhead line change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
H	No change	Realign to end of existing pierheads	Realign channelward to accommodate pierhead line change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
I	No change	Realign to end of existing pierheads	No change	No change	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
J1	No change	Realign to end of existing pierheads	Realign channelward to accommodate pierhead line change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
J2	Realign along bridge embankments	Realign channelward to the project line	No change	No change	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Requires USACE approval.
J3	No change	Realign channelward to the project line	No change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.

Table 1. Recommended Harbor Line Changes

Location	Bulkhead Line Changes	Pierhead Line Changes	Project Line Changes	Harbor Permit Policy Changes	Goals	Constraints
K	Eliminate lines that cross navigable waters	Add pierhead lines to map	No change	Entirely re-write Harbor Permit Policy for this area.	Improve harbor-wide consistency.	Requires USACE approval.
L	Realign landward to existing bulkheads or property boundaries	Realign to end of existing pierheads	Realign channelward to accommodate pierhead line change	No change	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
M	Realign landward to existing bulkheads or property boundaries	Realign to end of existing pierheads	Realign channelward to accommodate pierhead line change	Piers or slips currently permitted to bulkhead line. Eliminate special condition from future policy.	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
N	No change	No change	No change	No change		
O	No change	Realign channelward to the project line	No change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
P	No change	No change	No change	No change		
Q	Realign landward to existing bulkheads or property boundaries. Eliminate lines that cross navigable waters	Eliminate lines that cross navigable waters	No change	Ownership issues to be resolved between City, County, and Irvine Company	Improve harbor-wide consistency.	Requires USACE approval. Ownership issues to be resolved between City, County, and Irvine Company.
R	Realign landward to existing bulkheads or property boundaries. Eliminate lines that cross navigable waters	Realign channelward to the project line	No change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
S1	Realign landward to existing bulkheads or property boundaries. Eliminate lines that cross navigable waters	Realign to end of existing pierheads	No change	No change	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
S2	Realign landward to existing bulkheads or property boundaries. Eliminate lines that cross navigable waters	Realign channelward to the project line	No change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
T1	No change	Realign to end of existing pierheads	Realign channelward to accommodate pierhead line change	No change	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.

Table 1. Recommended Harbor Line Changes

Location	Bulkhead Line Changes	Pierhead Line Changes	Project Line Changes	Harbor Permit Policy Changes	Goals	Constraints
T2	Realign landward to existing bulkheads or property boundaries	Replace with Special Permit Line	No change	No change	Improve harbor-wide consistency. Reduce future construction of longer piers that encroach into waterway.	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
U	No change	Realign to end of existing pierheads	No change	No change	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
V1	No change	Realign channelward to the project line	No change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
V2	No change	Realign channelward to the project line	No change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
V3	No change	No change	No change	No change		
V4	Realign landward to existing bulkheads or property boundaries	Co-relocate with bulkhead line by maintaining 80' distance between two lines. Where piers extend greater than 80', realign to end of existing pierheads.	No change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
V5	No change	Realign to end of existing pierheads	No change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
V6	Eliminate lines that cross navigable waters. Add to existing bulkheads or property boundaries	Realign to end of existing pierheads	No change	No change	Improve harbor-wide consistency.	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
W	Realign landward to existing bulkheads or property boundaries	No change	No change	No change	Improve harbor-wide consistency. Bring into compliance.	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
X	No change	Realign to end of existing pierheads	No change	No change		

Table 1. Recommended Harbor Line Changes

Location	Bulkhead Line Changes	Pierhead Line Changes	Project Line Changes	Harbor Permit Policy Changes	Goals	Constraints
Y1	Realign landward to existing bulkheads or property boundaries	Replace with Special Permit Line	No change	No change	Improve harbor-wide consistency.	Requires USACE approval.
Y2	No change	Replace with Special Permit Line	No change	No change	Improve harbor-wide consistency.	Requires USACE approval.
Y3	No change	Realign to end of existing pierheads	No change	No change	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
Y4	No change	Realign to end of existing pierheads	Realign channelward to accommodate pierhead line change	Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
Y5	Realign landward to existing bulkheads or property boundaries	Realign to end of existing pierheads	Realign channelward to accommodate pierhead line change	No change	Improve harbor-wide consistency. Bring into compliance. Improve docking navigation while reducing impact to eelgrass	Minimize encroachment into waterway. Requires USACE approval. Requires navigation study to verify existing conditions adequate.
Z	Realign landward to existing bulkheads or property boundaries. Eliminate lines that cross navigable waters	Eliminate lines that cross navigable waters	No change	Ownership issues to be resolved between City, County, and Irvine Company	Improve harbor-wide consistency.	Requires USACE approval, Ownership issues to be resolved between City, County, and Irvine Company.

<u>Bulkhead changes</u>
1. No change
2. Realign landward to existing bulkheads or property boundaries
3. Eliminate lines that cross navigable waters
4. Realign along bridge embankments

<u>Pierhead changes</u>
1. No change
2. Realign to end of existing pier heads
3. Eliminate lines that cross navigable waters
4. Realign seaward to the project line
5. Replace with Special Permit Line
6. Co-relocate with bulkhead line by maintaining 80' distance between two lines. Where piers extend greater than 80', realign to end of existing pierheads.
7. Realign 20' beyond existing
8. Add pierhead lines to map

<u>Project Line Change</u>
1. No change
2. Realign seaward to accommodate pierhead line change

<u>Harbor Permit Policies</u>
1. No change
2. Piers or slips currently permitted a specified distance beyond pierhead line. Eliminate extension from future policy
3. Piers or slips currently permitted to <u>bulkhead</u> line. Eliminate special condition from future policy.
4. Ownership issues to be resolved between City, County, and Irvine Company
5. Entirely re-write Harbor Permit Policy for this area.

<u>Goals</u>
1. Improve harbor-wide consistency.
2. Bring into compliance.
3. Reduce future construction of longer piers that encroach into waterway.
4. Improve docking navigation while reducing impact to eelgrass

<u>Constraints</u>
1. Minimize encroachment into waterway.
2. Required USACE approval
3. Requires navigation study to verify existing condition adequate.
4. Ownership issues to be resolved between City, County, and Irvine Company.

<u>General Recommendations/Considerations</u>
A
B
C
D
E

4.0 RECOMMENDATIONS

4.1 Action Items

Based on the results of reviewing existing harbor lines, the following action items are recommended:

A new harbor lines map should be developed incorporating project line, pierhead line, and bulkhead line solutions as detailed in Table 1 and Figures 1A through 1C. To increase accuracy, ground truth surveying should be included as part of re-drawing the harbor lines map.

The Harbor Permit Policy should be updated and simplified according to the changes detailed in Table 1 and Figures 1A through 1C.

Pierhead lines should be replaced with special permit lines where applicable. The special permit line is a graphical marker indicating that reference to the Harbor Permit Policy would be necessary at these locations.

Navigation studies should be performed based on the updated harbor lines map to assess the navigation impacts from the recommended changes.

Since there are locations where beaches cross bulkhead lines, guidelines should be codified to regulate beaches with respect to harbor lines. Suggested language for the Harbor Permit Policy is: "dry beach areas may extend beyond bulkhead and pierhead lines, but may not extend beyond project lines at the Mean Lower Low Water elevation."

Since no review has taken place since initial implementation, and many physical changes have taken place, navigation channel lines should be analyzed in a manner similar to the work performed for the harbor lines.

Mooring area boundaries should be analyzed in a manner similar to the work performed for the harbor lines for the same reasons.

The new harbor lines should be enforced in the future to reduce the likelihood of violations and minimize encroachment into navigable waters.

4.2 Roadmap to Implement Harbor Line Changes

Updating harbor lines is a multi-phase processes requiring coordination between different agencies. The first step to start the process is the preparation of a proposed updated harbor lines map based on the recommendation of this report. It is also recommended that any proposed updates of the mooring boundaries and navigation channels should occur concurrently with any update of the harbor lines. A navigation study may be required to evaluate potential impact of the proposed mooring boundaries, navigation channels, and harbor lines map, and the results of the navigation study may lead to further modifications to the proposed map. The Harbor Permit Policy should also be updated at the same time to reflect on the proposed changes to the mooring boundaries, navigation channels, and harbor lines. Any proposed changes to the map shall be verified with ground truth surveying before preparing the final proposed harbor lines map.

After review and finalization of the proposed recommendations to the harbor lines map, the Harbor Commission would make recommendations to the City Council (Newport Beach, 2002a) who could codify the changes. Both the Harbor Commission and City Council may require further changes to the map. After passing through the City Council, a letter request or recommendation would be made to the Los Angeles District of the USACE who ultimately have jurisdiction to change harbor lines. However, if the federal government de-authorizes the harbor and the City takes responsibility, then the City Council would not be required to request or recommend harbor line changes to the USACE. The California Coastal Act does not regulate harbor lines, but it does regulate any construction taking place in the coastal zone. The harbor lines can be modified without a California Coastal Commission permit, but any subsequent construction dependent on those harbor lines would still be regulated by the California Coastal Commission or a Local Coastal Program. While there is no explicit requirement, the public should also be informed and consulted on the harbor line changes early in the process.

5.0 REFERENCES

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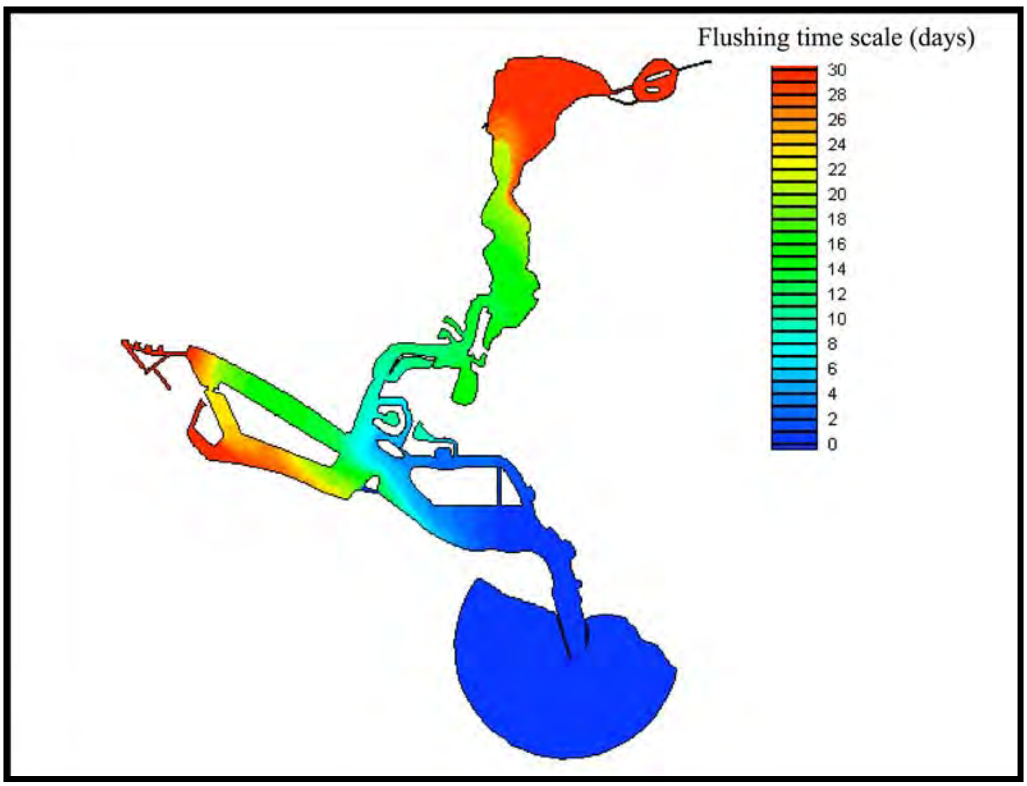
APPENDIX F

Hydrodynamic and Water Quality Numerical Modeling Requirements



"The following technical report reflects the findings and data available at the time the report was prepared and may not represent the current conclusions and steps forward in the main text of the HAMP, which has been updated after the completion of these reports. These more detailed technical reports provided in the appendices represent the foundation for the overall approach to the HAMP, but are not "living" documents that reflect updated steps forward, costing, quantities, etc. presented in the main text of the HAMP. The main text of the HAMP represents more current information and recommendations based on updated information, new studies, changes in conditions, new funding sources, and/or new regulations."

HARBOR AREA MANAGEMENT PLAN

Hydrodynamic and Water Quality Numerical Modeling Requirements

Technical Report

Prepared For:

Harbor Resources Division

City of Newport Beach

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June 2009

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1.0 INTRODUCTION

1.1 Background

Numerical models are widely used as a management decision making tool in addressing sediment and water quality problems, including several numerical modeling efforts specifically for Newport Bay. Numerical models are used to simulate hydrodynamic conditions (e.g., flows, water surface elevations, and velocities) and water quality transport (e.g., sediment or salinity) within a river, estuary, or bay. Changes to hydrodynamic and water quality conditions are used to evaluate alternatives or management decisions such as dredging strategies or storm drain diversions to improve water quality. Numerical models are also used to understand the physical environment of the bay to aid in decision making to address water quality issues. For example, the tidal flushing of pollutants (i.e., rate at which pollutants locally dissipate due to tidal mixing) varies significantly by location in the bay, as illustrated in Figure 1. Pollutant discharges to the back ends of the bay (indicated in red) do not disperse as easily as discharges to the main channel. As such, appropriate management strategies to improve water quality such as source reductions or circulation improvement may differ based on where the pollutant source is located.

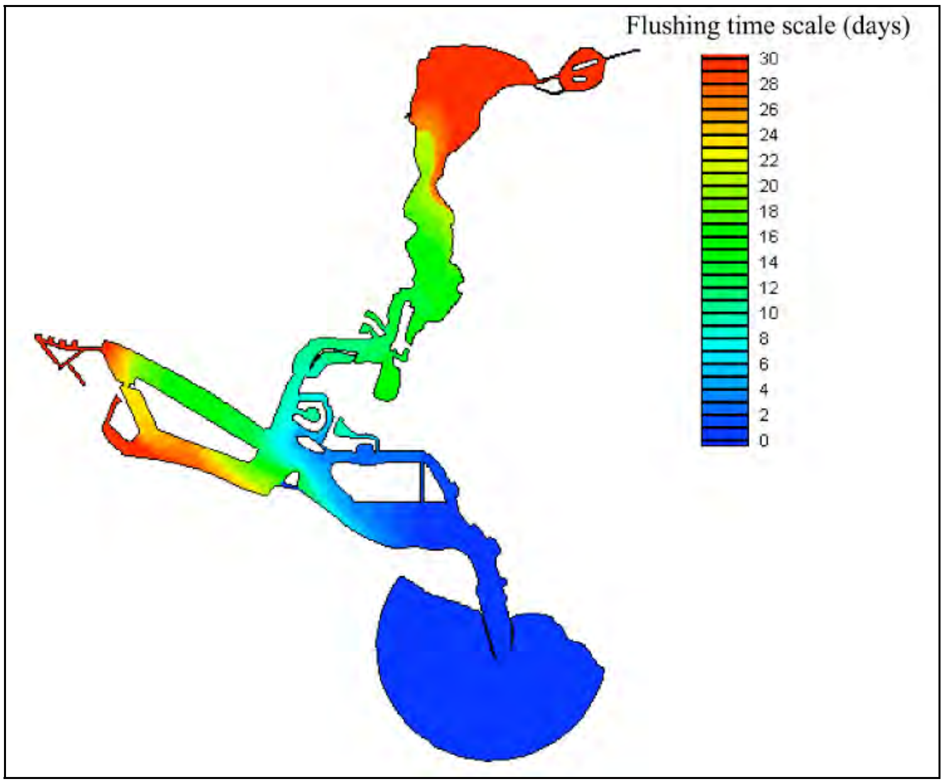

Figure 1. Tidal Flushing of Newport Bay

1.2 Objectives

Development of a hydrodynamic and water quality numerical model for Newport Bay can be used to evaluate many of the proposed strategies and BMPs developed for the Harbor Area Management Plan (HAMP). Selection of the most appropriate numerical model for Newport Bay was evaluated using the following objectives:

- Review existing water quality reports based on numerical modeling of Newport Bay
- Identify the most compatible and efficient models that can address water quality issues, as well as predicting sediment depositions throughout Upper and Lower Newport Bay
- Provide recommendations for model enhancements of an existing model or development of a new model for Newport Bay
- Provide a list of information or data requirements needed to develop a numerical model for Newport Bay

1.3 Organization

This technical report supports recommendations in the HAMP relating to developing a numerical model tool for Newport Bay. Numerical models were identified based on a review of previous models developed for Newport Bay and other available models. Models were then evaluated based on model selection criteria developed to select the most appropriate model. The report is concluded with data requirements necessary to develop a model.

1.4 Previous Numerical Models for Newport Bay

Prior modeling studies of Newport Bay or portions of Newport Bay have been primarily conducted by three agencies: U.S. Army Corps of Engineers (USACE), Los Angeles District, State Water Resources Control Board (SWRCB), and the City of Newport Beach.

USACE has developed a 2D hydrodynamic and sediment transport model (RMA2 and RMA11) of Newport Bay in support of the UNB Ecosystem Restoration Feasibility Study (USACE, 2000). The USACE model was used to evaluate sediment deposition impacts of four dredging alternatives representing different sediment management measures (USACE, 1999). The evaluation of the alternatives was based on the sediment trapping efficiencies of sediment basins within UNB relative to a no project condition. The USACE model was developed in several phases between 1993 and 1999. The hydrodynamic model was calibrated to water surface elevation and velocity measurements made in 1992 (USACE, 1993). The sediment transport model was calibrated to bathymetry changes between October 1985 and February 1997 (USACE, 1997 and 1998). The model was also used to simulate salinity fluctuations during dry and wet weather conditions (USACE, 1998).

The SWRCB funded the RWQCB Upper Newport Bay Water Quality Model Development Study to further develop the USACE model to develop and calibrate a 3D hydrodynamic and water quality model (RMA10 and RMA11) to simulate stratified flows (SWRCB, 2003). A 3D model was determined to be necessary to simulate low flow, neap tide and wet weather conditions. The numerical grid was developed as a combination of 2D and 3D areas to minimize computation times. The SWRCB model was used to evaluate transport conditions in Newport Bay by analyzing mass distributions of conservative and settleable constituents (i.e., tracer) under low flow and three storm flow conditions. The conservative tracer represents a dissolved constituent with no settling velocity, while a settleable tracer represents sediment with no resuspension. The model was calibrated to salinity measurements (SARWQCB 2001).

The City of Newport Beach has also developed several 2D hydrodynamic and water quality models (RMA2 and RMA4) to analyze circulation and mixing in different areas of Newport Bay. Several circulation improvement projects were analyzed for Newport Dunes and Newport Island Channels. Storm drain discharges into LNB were evaluated for relative impacts to the bay as part of a storm drain diversion project. A model of the entire bay was also developed and calibrated to water level and velocity data. The City model is also currently being used to evaluated discharges from the bay to areas of biological significance (ASBS) located downcoast from the bay.

These prior modeling studies are summarized in Table 1. The first three columns of the table show the agency responsible for the study, the year the study was completed and the study area, respectively. The next three columns show the model and model type used for the study and the constituents being simulated. A brief summary for each of the model study is also provided in the last column of the table.

Table 1. Prior Hydrodynamic and Water Quality Model Studies for Newport Bay

REFERENCE	YEAR	FOCUS AREA	MODEL USED	MODEL TYPE	SIMULATED CONSTITUENTS	SUMMARY
USACE	1993	UNB[1]	RMA2 RMA4	2D	Dye	Assessment of suitable models for circulation and water quality modeling and initial model development.
	1997	UNB	RMA2 RMA11	2D	Sediment	Phase 1 to develop sediment transport model including model calibration and 50-year without project simulations.
	1998	UNB	RMA2 RMA11	2D	Sediment	Phase 2 in development of sediment transport model including final model calibration, extreme flow condition, and 50-year without project simulations.
	1998	UNB	RMA2 RMA4	2D	Salinity	Salinity fluctuations attributed to dry and wet weather freshwater inflows between 1995 and 1998.
	1999	UNB	RMA2 RMA11	2D	Sediment	Phase 3 for Alternative evaluation of sediment deposition impacts using calibrated sediment transport model for no project and 4 dredging alternatives.
SWRCB	2003	UNB	RMA2/11 RMA10/11	2D and 3D	Conservative tracer, settable tracer, and sediment	Phase 1 of the UNB Water Quality Model to simulate 3D stratified flow under dry and wet weather conditions.
City of Newport Beach	2002	Newport Dunes and NIC[2]	RMA2 RMA4	2D	Tracer	Feasibility study to evaluate using mechanical devices to improve water circulation and mixing.
	2003	NIC	RMA2 RMA4	2D	Tracer	Feasibility study to evaluate using submerged pumps to improve water circulation and mixing.
	2004	LNB	RMA2 RMA4	2D	Tracer	Evaluation of storm drains for dry weather flow diversion program to reduce bacteria levels.
	2005	Bay	RMA2	2D	N/A	Hydrodynamic model calibration
	2007	Bay entrance	RMA2 RMA4	2D	Tracer	Evaluation of impacts of discharges from Newport Bay to ASBS.

[1] Upper Newport Bay
[2] Newport Island Channels

2.0 AVAILABLE NUMERICAL MODELS

The hydrodynamics and sediment transport in Newport Bay and Harbor are highly complex as a result of the complex geometry of the network of channels and beaches in the Lower Newport Bay and the inter-tidal areas in the Upper Newport Bay. Hence, only 3D hydrodynamic and water quality models capable of simulating both water quality constituents and sediment deposition in a complex estuarine system are considered for the development of a Newport Bay hydrodynamic and sediment transport model. The following 3D models were selected for evaluation:

- RMA10 – Multi-dimensional hydrodynamic, salinity, and sediment transport model
- RMA11 – Multi-dimensional water quality and sediment transport model
- CH3D – Multi-dimensional hydrodynamic, salinity, temperature, and non-cohesive sediment transport model
- CE-QUAL-ICM – Multi-dimensional water quality model
- EFDC – Multi-dimensional hydrodynamic, water quality, and sediment transport model

A brief description of the model capabilities are provided below, while details of the technical capabilities are provided in Section 3.0.

2.1 RMA10

RMA10 is a multi-dimensional finite element numerical model written in FORTRAN-77. It is capable of steady or dynamic simulation of three dimensional hydrodynamics, salinity, and sediment transport. The primary features of RMA10 are as follows:

- Coupling of advection and diffusion of temperature, salinity and sediment to the hydrodynamics
- Multi-dimensional – 1D, 2D depth-averaged or laterally-averaged and 3D elements within a single mesh
- Depth-averaged elements can be made wet and dry during a simulation

RMA10 was originally developed by Dr. Ian King of Resource Management Associates, Inc. with funding provided by USACE WES. Similar to CH3D, WES has made modifications to the original model and integrated the model into the TABS Series since its development. The FORTRAN model code is proprietary; however, the executable and source code are available for purchase. USACE WES also distributes the model, but provides technical support only to USACE users. This model requires purchasing pre- and post-processing software.

2.2 RMA11

RMA11 is a finite element water quality model for simulation of three-dimensional estuaries, bays, lakes and rivers. RMA11 can model temperature with a full atmospheric heat budget at the water surface, BOD/COD, dissolved oxygen, nitrogen cycle (including organic nitrogen, ammonia, nitrite and nitrates), phosphorous cycle (including organic phosphorous and phosphates), Algae growth and decay, cohesive suspended sediment, non-cohesive suspended sediment, and other constituents such as tracers or E-coli. The primary features of RMA11 include the following:

- Shares the same capabilities of the RMA2/RMA10 hydrodynamics models including irregular boundary configurations, variable element size, one-dimensional elements, and the wetting and drying of shallow portions of the modeled region
- Velocities supplied may be constant or interpolated from an input file from another hydrodynamic model (e.g., RMA2 or RMA10 velocity and depth output)
- Source pollutants loads may be input to the system either at discrete points, over elements, or as fixed boundary values
- In formulating the element equations, the element coordinate system is realigned with the local flow direction. This permits the longitudinal and transverse diffusion terms to be separated, with the net effect being to limit excessive constituent dispersion in the direction transverse to flow
- For increased computational efficiency, up to fifteen constituents may be modeled at one time, each with separately defined loading, decay and initial conditions
- A multi-layer bed model for the cohesive sediment transport constituent keeps track of thickness and consolidation of each layer.

Similar to RMA10, RMA11 was originally developed by Dr. Ian King of Resource Management Associates, Inc. with modifications done by USACE WES. The FORTRAN model code is proprietary; however, the executable and source code are available for purchase. USACE WES also distributes the model, but provides technical support only to USACE users. This model requires purchasing pre- and post-processing software.

2.3 CH3D

CH3D (Curvilinear Hydrodynamics in Three Dimensions) is the newly developed CH3D-SED, a mobile bed version combined with CH3D-WES, a time-varying three-dimensional numerical hydrodynamic, salinity, and temperature model. CH3D-WES simulates physical processes impacting circulation and vertical mixing that are modeled include tides, wind, density effects (temperature and salinity), freshwater inflows, turbulence, and the effect of earth rotation. CH3D-SED functions as a 2D or 3D hydrodynamic and sediment transport model that can also be linked to the water quality model, CE-QUAL-ICM. CH3D-SED can simulate cohesive and non-cohesive sediment and account for settling, deposition, and resuspension. Additional features of the model include user-specified multiple-grain-size distribution and independently tracking of each grain size specification.

CH3D was originally developed by Dr. Peter Sheng (1986) for USACE WES. Since then WES has made substantial upgrades for the Chesapeake Bay Program. This model is not freely available and no support is available to users outside of USACE. However, model development and application is possible through a cooperative agreement with USACE.

2.4 CE-QUAL-ICM/TOXI

CE-QUAL-ICM/TOXI is a water quality model that includes a eutrophication model (ICM) and an organic chemical model (ICM/TOXI). The release version of the eutrophication model computes 22 state variables including physical properties; multiple forms of algae, carbon, nitrogen, phosphorus, and silica; and dissolved oxygen. ICM/TOXI includes physical processes such as sorption to DOC and three solid classes, volatilization, and sedimentation; and chemical processes such as ionization, hydrolysis, photolysis, oxidation, and biodegradation. The model computes constituent concentrations resulting from transport and transformations in well-mixed cells that can be arranged in arbitrary one-, two-, or three-dimensional configurations. The model does not compute hydrodynamics and requires hydrodynamic inputs such as the CH3D-WES model. Other features of CE-QUAL-ICM/TOXI are:

- Operational in one-, two-, or three-dimensional configurations
- Unstructured, finite volume structure of the model facilitates linkage to a variety of hydrodynamic models
- Features to aid debugging include the ability to activate or deactivate model features, diagnostic output, and volumetric and mass balances
- Each state variable may be individually activated or deactivated
- Includes diagenetic sediment sub-model the interactively predicts sediment-water oxygen and nutrient fluxes
- Simulates temperature, salinity, three solids classes, and three chemicals (total chemical for organic chemicals and trace metals). Each species can exist in five phases (water, DOC-sorbed, and sorbed to three solids types) via local equilibrium partitioning.

CE-QUAL-ICM water quality model was initially developed by USACE WES CHL as part of the Chesapeake Bay Program. The ICM/TOXI model resulted from incorporating the toxic chemical routines from EPA's WASP (Water Analysis Simulation Program) model into the transport code for ICM, incorporating a more detailed benthic sediment model, and enhancing linkages to sediment transport models. The model FORTRAN code is not proprietary, but is only available to USACE users.

2.5 EFDC

The EFDC (Environmental Fluid Dynamics Code) is a 2D or 3D hydrodynamic and water quality model. EFDC transports salinity, temperature, simple constituents (e.g., tracer), cohesive or noncohesive sediments, and toxic contaminants (e.g., metals or organics). The water quality model HEM-3D (Hydrodynamic-Eutrophication Model) with twenty-one state variables has been integrated with EFDC. This water quality component simulates the spatial and temporal distributions of dissolved oxygen, suspended algae (three groups), various components of carbon, nitrogen, phosphorus and silica cycles, and fecal coliform bacteria. Other features of EFDC include:

- Simulates wetting and drying
- Hydraulic structures for controlled flow systems
- Vegetation resistance for wetlands
- High frequency surface wave radiation stresses in nearshore zones
- Optional bottom boundary layer submodel allows for wave-current boundary layer interaction
- Equilibrium partitioning between the aqueous and solid phases of toxic constituents
- Sediment process model with twenty-seven state variables that simulates POM diagenesis and the resulting fluxes of inorganic substances (ammonium, nitrate, phosphate, and silica) and sediment oxygen demand back to the water column
- Coupling of the sediment process model with the water quality model enhances the predictive capability of water quality parameters and enables it to simulate the long-term changes in water quality conditions in response to changes in nutrient loading.

EFDC was originally developed by Dr. John Hamrick of the Virginia Institute of Marine Science at the College of William and Mary and is currently supported by Tetra Tech, Inc for USEPA. The FORTRAN model code is not proprietary. EFDC model execution file (without GUI) can be freely downloaded from EPA website.

3.0 NUMERICAL MODEL EVALUATION

The primary purpose of a numerical model for Newport Bay is a management decision-making tool to address water quality issues and in particular, sediment deposition in the bay. In determining the most compatible and efficient model for Newport Bay, model selection criteria were established, then the models described above were compared based on the established selection criteria. In the next section, a brief discussion of the fundamentals of numerical modeling is first presented to provide some background on numerical modeling basics, followed by the model selection criteria in Section 3.2.

3.1 Fundamentals of Numerical Modeling

Simulation of fluid motion in the environment (i.e., hydrodynamic modeling) is the basis for simulating contaminant transport (i.e., water quality modeling). The fundamentals of numerical modeling are summarized in the following three types: mathematical modeling, numerical modeling, and water quality modeling.

Mathematical Modeling is the process by which the physical world (e.g., water motion in the bay) is represented by a set of mathematical equations. Prediction of fluid motion in estuaries requires solving the following mathematical equations.

Mass and momentum conservation equations – For an incompressible fluid such as water, mass and momentum (three equations that balance forces in each of the three spatial dimensions) are conserved.

Transport equations for scalars that affect fluid density – One of the key features of estuarine water is that its density depends on salinity, temperature, and, in some cases, suspended particulate matter (i.e., scalars). Therefore, mathematical models for estuarine flow typically include *transport equations* which describe the spatiotemporal distribution of these scalars.

Equation of state – The *equation of state* relates the transported scalars (e.g., salinity, temperature, or suspended particulate matter) to the fluid density.

Turbulence model equations – Another key feature of estuarine water is that it is in a state of turbulence, which consists of seemingly random motions superimposed upon fairly coherent motion known as the *mean flow*. While there has been success in recent years simulating turbulent fluid motions, including the seemingly random component, it is not presently practical to do so at the scale of a river or harbor. Mathematical models of turbulent fluid motion predict only the mean flow. Therefore, *turbulence models* and associated algebraic and transport equations must also be used to account for the effect of random motions on the mean flow.

Numerical Modeling is the process by which the algebraic and differential equations that constitute the mathematical model are solved to give the water surface elevation, water pressure, three components of velocity, and scalars such as salinity, temperature, and sediment concentration. This process is broken down below, along with a summary of each step in the process.

Model Domain Discretization – All numerical methods predict flow variables at a finite set of discrete points and time levels. The discrete points are organized as a computational grid made up of cells or elements, which can be either structured or unstructured. A checkerboard is an example of a structured grid, for there is a repeating pattern: every red square is surrounded by four black squares and vice-versa. Structured grids may be either rectilinear (all cells are rectangles) or curvilinear (all cells are simply quadrilateral and therefore may be distorted so the mesh conforms to the boundary of the study area). Curvilinear, structured grids may be either orthogonal or non-orthogonal. An orthogonal grid is one where four 90 degree angles can be observed at each cell vertex. Structured grids are more difficult to set up for domains characterized by islands and branching channels and does not support localized grid refinement, but require less computational overhead. In addition, global refinement of structured grids is quite simple (each cell can be divided into two or four smaller cells), but this may add grid resolution where it is not needed. However, globalized grid refinement is sometimes preferred over localized grid refinement because the latter may promote unphysical reflections where the resolution suddenly changes. With unstructured grids, there is no repeating pattern. Unstructured grids are generally easiest to set up and refine and facilitate localized grid refinement, but require the most computational overhead.

Numerical Methods – Finite difference, finite element, and finite volume methods represent three different numerical modeling methods. Finite difference schemes use only structured grids. Finite element schemes typically use unstructured grids, but may also use structured grids. Finite volume schemes, which are closely related to finite difference schemes, may be designed for either structured or unstructured grids.

Spatial and Temporal Limitations – Recognizing that typical horizontal grid resolutions in harbor simulations are on the order of 10m, and that a minimum of 5 to 8 cells are necessary to resolve a particular flow feature, it becomes clear that under ideal circumstances the smallest resolvable flow features will be on the order of 100m in length. Moreover, with a time step on the order of a minute, the highest frequency fluctuations that could possibly be predicted will have periods on the order of 5-10 minutes.

Numerical Modeling Errors – Limitations of model predictions are driven by both the mathematical model and the numerical solution method. For example, a common mathematical approximation is to assume that fluid pressure is hydrostatic, (i.e., pressure is only a function of the fluid density and distance below the surface). This approximation limits the applicability of estuarine models to slowly varying flows, such as those driven by tides, and excludes flow scenarios involving shorter period waves such as ocean swell and ship wakes. A common numerical approximation is to assume that spatial derivatives of an arbitrary dependent variable q are given by the difference in q between neighboring grid points, divided by the distance between these points. However, there are *truncation errors* associated with this approach which increase as the grid points get farther apart. Moreover, the truncation errors may be either diffusive or dispersive depending upon the numerical model. Diffusive errors will tend to smear out an otherwise sharp front, which can lead to problems when trying to sharply resolve stratified flow. Dispersive errors introduce physically meaningless oscillations near sharp fronts that may grow with time causing a numerical model to “crash” (i.e., stop running).

Water Quality Modeling is based on the following mathematical equations that describe the spatial and temporal variability of constituents such as salinity, heat, suspended solids, nutrients, dissolved oxygen, and metals. Water quality models essentially consist of a set of transport equations that are coupled to each other by mass balance equations that account for gains and losses.

Transport equations – In estuarine systems, the spatial and temporal distribution of estuarine currents predicted by the hydrodynamic model is used to account for advection and turbulent diffusion of constituents which is the basis for the linkage between water quality models and hydrodynamic models. Advection is the transport of constituents by the mean flow and turbulent diffusion is the mixing of constituents by turbulent fluid motions. Additional transport equations are used to account for the transport of constituents sorbed to mobile sediment.

Mass balance equations – Simulates gains and losses of constituents due to physical, chemical, and/or biological processes and gains and losses due to exchanges at fluid boundaries (e.g., free surface and bed). Additional mass balance equations are used to account for changes in constituent concentrations in sediments.

Hydrodynamic coupling – While the transport of some constituents has no bearing on the hydrodynamic state of the estuary, others affect the fluid density which, in turn, affects the flow. Hence, in some cases there is a one-way coupling between the hydrodynamics and water quality (e.g., trace contaminants), while in others there exists a two-way coupling (previously mentioned as *scalars that affect fluid density*). For hydrodynamic and water quality models that are designed as two separate codes, it is important and logical for the hydrodynamic code to account for all two-way coupling of constituents; while the water quality code should account for all one-way coupled constituents.

3.2 Model Selection Criteria

The model selection criteria were established based on suitability of simulating the hydrodynamics and transport characteristics of Newport Bay, as well as the capability of anticipated applications of the model. Each model was evaluated in terms of the following aspects:

- Mathematical formulation for an estuarine system
- Numerical methods
- Water quality applications
- Watershed model interfacing
- User-friendly adaptations
- Prior applications within Newport Bay and/or at other similar locations.

4.0 NUMERICAL MODEL COMPARISONS

The simulation of hydrodynamics, water quality, and sediment transport can be accomplished using one or more of the available 3-D models. The following models or combination of models were compared and evaluated based on the model selection criteria to determine which is best suited to support hydrodynamic and water quality modeling of Newport Bay.

- RMA10 and RMA11
- CH3D and CE-QUAL-ICM
- EFDC

Salient features of the mathematical formulation and numerical solution method of CH3D, EFDC, and RMA10, as well as water quality applications, data input features, and prior applications are summarized below. The technical strengths and weaknesses of the mathematical formulation and numerical methods of these models are examined in Sections 4.1 and 4.2. Water quality applications of each model are compared in Section 4.3. Data input structures which govern the ease of interfacing with a watershed model and user-friendly adaptability are also compared between the models in Sections 4.4 and 4.5. Finally, prior applications of the three models in Newport Bay are discussed in Section 4.6.

Limited documentation creates some level of ambiguity regarding details of RMA10. In addition, there are several versions of CH3D (some supported by WES and others by Dr. Peter Sheng), each with different features. Comments below mainly apply to CH3D-WES, though in some cases additional references made to other versions of CH3D.

4.1 Comparison of Mathematical Formulation

A comparison of the mathematical formulation for each model is summarized in Table 2. The mathematical formulation of these models is far more similar than different. However, differences do exist in the turbulence model and Equation of State for density, which may bear on the applicability of these models to Newport Bay. First, CH3D uses a k-e (k-epsilon) turbulence model, which has been widely used in channel flows particularly pressure driven flows. Whereas, most ocean and estuary models including EFDC and RMA10/RMA11, use the Mellor-Yamada Level 2.5 turbulence model. However, a recent study found that both models similarly predict the shape, concentration, and position of turbidity maxima in an estuarine test problem. Second, CH3D and EFDC compute density as a function of salinity and temperature, and solve dynamically coupled equations for these scalars. RMA10 appears to include an option to also dynamically couple sediment transport predictions, allowing density to also be computed in terms of suspended particulate matter. If suspended sediment concentrations control the vertical density structure in Newport Bay (in general this is applicable when suspended sediment concentrations exceed 10,000 mg/L), dynamically coupled sediment transport equations would be advantageous. However, with access to the model source code it is likely that both EFDC and CH3D can be modified to support this functionality.

Table 2. Comparison of Mathematical Formulations

Mathematical Formulation of Equations	CH3D and CE-QUAL-ICM	EFDC	RMA10 and RMA11
Flow Equations	Reynold-Averaged Navier-Stokes (RANS) equations. Assumes incompressible flow and a hydrostatic pressure distribution. Turbulent closure via horizontal and vertical eddy viscosities. Incorporates Boussinesq approximation for density variations.	Reynold-Averaged Navier-Stokes (RANS) equations. Assumes incompressible flow and a hydrostatic pressure distribution. Turbulent closure via horizontal and vertical eddy viscosities. Incorporates Boussinesq approximation for density variations.	Reynold-Averaged Navier-Stokes (RANS) equations. Assumes incompressible flow and a hydrostatic pressure distribution. Turbulent closure via horizontal and vertical eddy viscosities. Incorporates Boussinesq approximation for density variations.
Air-Water Interface	Free surface boundary.	Rigid lid or free surface boundary.	Free surface boundary.
Bed-Water Interface	Law of the wall, roughness height.	Law of the wall, roughness height.	Law of the wall, roughness height.
Equation of State for Density	Based on salinity and temperature.	Based on salinity and temperature.	Based on salinity, temperature, and suspended sediment.
Turbulence Model	Algebraic/Smagarinsky model for horizontal eddy viscosity, k-e model for vertical eddy viscosity. The version of CH3D supported by Sheng includes several other options for turbulence closure.	Algebraic/Smagarinsky model for horizontal eddy viscosity, Mellor and Yamada level 2.5 for vertical eddy viscosity.	Algebraic/Smagarinsky model for horizontal eddy viscosity, several options for vertical eddy viscosity including Mellor and Yamada level 2.5 for vertical eddy viscosity.
Boundary Conditions	Slip and no-slip shoreline-water interfaces; inflow boundaries for rivers and storm drains; distributed inflow boundaries for precipitation; heat inflows, evaporation, precipitation input, tidal boundaries.	Slip partial-slip, and no-slip shoreline-water interfaces; inflow boundaries for rivers and storm drains; groundwater inflow possible through bed, distributed inflow boundaries for precipitation; salt and heat inflows, evaporation, precipitation input, tidal boundaries.	Slip, partial-slip, and no-slip shoreline-water interfaces; inflow boundaries for rivers and storm drains; distributed inflow boundaries for precipitation; salt and heat inflows, evaporation, precipitation input, tidal boundaries.

4.2 Comparison of Numerical Methods

The comparison of numerical methods is presented in Table 3. The numerical methods adopted by CH3D and EFDC are nearly identical, but far different from the approach adopted by RMA10/11. Therefore, on numerical grounds there is little basis for the numerical performance of CH3D and EFDC to differ. A well-known deficiency of the Galerkin finite element method used by RMA10/11 is the required artificial dissipation to avoid stability problems. The use of an unrealistically large eddy viscosity to stabilize the hydrodynamic predictions will lead to over-prediction of contaminant mixing by turbulent diffusion unless unphysically large values of the turbulent Schmidt number (ratio of momentum diffusion to scalar diffusion) are also used. In addition, the Galerkin finite element method is not well-suited to channel flows with fast currents and is only suitable for subcritical (slow) flows.

Table 3. Comparison of Numerical Methods

NUMERICAL METHOD	CH3D AND CE-QUAL-ICM	EFDC	RMA10 AND RMA11
Computational Grid	Structured, curvilinear, non-orthogonal grid of quadrilateral cells	Structured, curvilinear, orthogonal grid of quadrilateral cells including cut cells at model boundaries	Unstructured grid
Vertical Grid Scheme	Sigma coordinate or z coordinate	Sigma coordinate	Sigma coordinate
Spatial Discretization and Time-Stepping Scheme	Semi-Implicit Finite Difference (External-Internal Mode Splitting)	Semi-Implicit Finite Difference (External-Internal Mode Splitting)	Galerkin Finite Element (Theta time-stepping)
Wetting and Drying	Not supported based on existing documentation. Versions of CH3D supported by Dr. Peter Sheng appear to support this feature	Supported – using element elimination method	Supported – using element elimination method or Marsh Porosity method
Random Walk Particle Tracking	Not supported based on existing documentation. Versions of CH3D supported by Dr. Peter Sheng appear to support this feature	Supported	Unclear whether it is supported

4.3 Comparison of Water Quality Applications

Water quality applications are similar between the models. All three models can directly or indirectly simulate a full range of water quality constituents (Table 4) including simple constituents (e.g., tracer or bacteria), cohesive and non-cohesive sediment, metals, organics, eutrophication (including nitrogen cycle, phosphorus cycle, biological oxygen demand, chemical oxygen demand, and dissolved oxygen). The only major difference is the linkage between the hydrodynamic and water quality components in which EFDC utilizes one combined model, while the other models use two separate components (one hydrodynamic and one water quality model).

Table 4. Comparison of Water Quality Applications

CONSTITUENT	CH3D AND CE-QUAL-ICM	EFDC	RMA10 AND RMA11
Salinity	Dynamically coupled with hydrodynamics	Dynamically coupled with hydrodynamics	Dynamically coupled with hydrodynamics
Temperature	Dynamically coupled with hydrodynamics	Dynamically coupled with hydrodynamics	Dynamically coupled with hydrodynamics
Sediment Transport	Suspended load, bed load, deposition, and resuspension	Suspended load, bed load, deposition, and resuspension including wave induced resuspension	Dynamically coupled with hydrodynamics, suspended load, bed load, deposition, and resuspension
Cohesive Sediment	Supported	Supported	Supported
Non-cohesive sediment	Up to three sediment classes	Multi-classes with variable settling velocity and grain size	Supported
Simple Constituent	Up to three constituents	Arbitrary number with decay	Up to 15 constituents
Metals or Organics	Up to three constituents and sorption to three sediment classes and dissolved organic carbon	Arbitrary number with varying partitioning coefficients and sorption to sediment classes, particulate organic carbon, and dissolved organic carbon	Supported
Eutrophication	22-state variable eutrophication model with diagenic sediment sub-model	21-state variable eutrophication model with 27-state variable sediment biogeochemical process model or simplified 9-state variable eutrophication model	BOD, COD, DO, nitrogen cycle, phosphorus cycle, algae growth and decay

4.4 Comparison of Watershed Model Interfacing

As a management-decision making tool, it is important that the 3D hydrodynamic and water quality model developed for Newport Bay can be easily interfaced with other watershed models. Linking the 3D model with a watershed model provides a tool to evaluate the effectiveness of source control measures within the watershed in reducing pollutant levels within the bay,

Current programs or activities to reduce pollutants within the Newport Bay include the Upper Sediment Control Plan, dredging of LNB, implementation of BMPs throughout the watershed, and the Nitrogen and Selenium Management Program (NSMP). These programs or activities on transport of pollutants can be incorporated into a 3D model to determine the effect on transport of pollutants in the bay. For example, dredging strategies have previously been evaluated using numerical models to select sediment management controls in UNB as discussed previously in Section 1.4. Likewise, management strategies to reduce the pollutant sources can also be reflected in a 3D model to estimate corresponding reductions in pollutant levels within the bay.

For example, the NSMP includes the development of explicit conceptual models for selenium and nitrogen for the Newport Bay watershed to describe the movement of selenium/nitrogen through the watershed (i.e., identify sources, fate, and transport). This model would also be used as a management decision tool. Linkages of the selenium/nitrogen sources entering the bay with a 3D hydrodynamic and water quality model would allow a greater accuracy of predicting where these pollutants are transported upon entering the bay.

In general, a 3D hydrodynamic and water quality model can be linked to a watershed model via specifications of input flows and pollutant loads. Ideally, the watershed model interfacing capabilities would include flexible inputs to allow specifying 3D stratification of flow (i.e., apply input flows and pollutant loads at varying water depths). Watershed model interfacing capabilities of each model are described in Table 5. EFDC provides the most flexible interfacing with a watershed model since inflow, temperature, salinity and suspended sediments can all be applied to different water layers of the model (i.e. can be applied at different water depth). The current version of CH3D only allows inflow to be averaged over the water depth even though different temperatures can be assigned to different water layers. It is not clear whether inflow, temperature, salinity can be applied to different water layers for RMA10.

Table 5. Comparison of Watershed Model Interfacing

MODEL INPUT	CH3D AND CE-QUAL-ICM	EFDC	RMA10 AND RMA11
Inflow	Constant or time-varying flow averaged over water depth (cannot input flow at different water depths)	Constant or time-varying flow applied at any given layer	Constant or time-varying flow or velocity – unknown whether can be applied to different water depth
Temperature	Input at any layer at inflow boundary	Assigned with inflow	Assigned with inflow
Salinity	Can only input fresh water at inflow boundary	Assigned with inflow	Assigned with inflow
Suspended Sediment	Only available with certain version of the model	Assigned with inflow	Assigned with inflow

4.5 Comparison of User-Friendly Adaptations

In addition to interfacing with other watershed models, user-friendly adaptations to site-specific conditions or user-defined applications would allow greater applications as a management-decision making tool. User-friendly adaptations refer to the flexibility to accommodate user-desired capabilities in the future such as a graphical user interface (GUI) to create, simulate, or view model results or to expand model capabilities to simulate a site specific unique situation that the model is currently not set up for.. Expansion of model capabilities would require the use of a non-proprietary model with publicly available model source code. As such, the model source code could be revised to add model capabilities that may be needed in the future. Use of a non-proprietary model allows easier integration with future models, access for other stakeholders to utilize the model, and use in future grant funded studies since some state funded grants require providing all model executable and source codes.

All models evaluated are non-proprietary models, but only the source code for EFDC is publicly available. RMA10 and RMA11 have an associated GUI to pre- and post-process model inputs and results, but require purchasing of the necessary software. This can limit the use of the model by the various stakeholders. On the other hand, EFDC does not have an associated GUI, but since the source code is available, it can be modified to accommodate other GUI software, hence provided greater flexibility for the user to pre- and post-process the data and results.

4.6 Comparison of Model Applications in Newport Bay and Southern California

Prior model applications in Newport Bay are summarized in Table 6. The RMA10 and RMA11 models have been extensively used to simulate tidal circulation and sediment transport in UNB. This provides an obvious advantage over CH3D or EFDC since the past model calibration efforts has proved that the model can be applied to Newport Bay. In addition, a model grid has already been setup for the bay that can be easily modified and calibrated for LNB. Although CH3D and EFDC have not been used for Newport Bay, both models have been used in other similar estuarine applications in Southern California and can be used for Newport Bay. Recently, EFDC is becoming popular for TMDL applications, particular in Southern California.

Table 6. Comparison of Model Application in Newport Bay

CH3D AND CE-QUAL-ICM	EFDC	RM10 AND RMA11
CH3D has not applied to Newport Bay. However, the model has been used extensively for the Los Angeles/Long Beach Harbor. The applications in the Los Angeles/Long Beach Harbor included hydrodynamic calibration for tidal and wind-driven circulation and water quality simulations with CE-QUAL-ICM for the Cabrillo Beach Basin.	EFDC has not been applied to Newport Bay. However, the model has been applied to the Los Angeles/Long Beach Harbor. The applications in the Los Angeles/Long Beach Harbor included hydrodynamic and water quality calibration for salinity, TSS, and metal for Dominguez Channel Estuary. EFDC has been used or is being developed for several TMDL applications in Southern California.	RMA10 and RMA11 have been extensively used in Newport Bay. USACE has developed a 2D hydrodynamic and sediment transport model (RMA2 and RMA11) in support of the UNB Ecosystem Restoration Feasibility Study (USACE 2000). The USACE model was used to evaluate sediment deposition impacts of four dredging alternatives representing different sediment management measures. The evaluation of the alternatives was based on the sediment trapping efficiencies of sediment basins within UNB relative to a no project condition.

5.0 MODEL RECOMMENDATIONS

An overview of the model evaluation is summarized in Table 7. On the basis of the mathematical formulation and numerical method, EFDC and RMA10/RMA11 appear better suited for modeling Newport Bay than CH3D. Although CH3D is capable of simulating estuarine systems, it is better suited for channel flows as opposed to intertidal areas as is the case in UNB. All three models have similar water quality application capabilities. In terms of interfacing with a watershed model, EFDC and RMA10/RMA11 have greater flexibility.

Table 7. Model Evaluation for Estuarine System Summary

Model	Mathematical Formulation	Numerical Methods	Water Quality Applications	Watershed Model Interfacing	User-Friendly	Prior Applications
EFDC	+	+	+	+	+	+ (TMDL use in So. Cal)
RMA10/11	+	+	+	+	-	+ (Use in UNB)
CH3D and CE-QUAL-ICM	-	-	+	-	-	-

+ indicates a model better meets the evaluation criteria.

There are no compelling reasons to select RMA10/RMA11 over EFDC or vice versa on the basis of the mathematical formulation, numerical methods, or water quality applications. However, there are some other advantages and disadvantages of each model. RMA10 and RMA11 have the advantage of being successfully applied in UNB for hydrodynamics and sediment transport. However, EFDC is becoming popular for TMDL applications, particularly in Southern California. RMA10 and RMA11 have an associated graphical user interface (GUI) to pre- and post-process model results, but require purchasing software, which can limit the use by other stakeholders. On the other hand, EFDC does not have an associated GUI, but can be modified to accommodate other GUI software. EFDC also has the advantage of using one model for hydrodynamics and water quality compared to two separate models. In addition, EFDC has the advantage of having the source code available for the public, making it easier for the development of the Newport Bay.

6.0 DATA REQUIREMENTS

Development of a numerical model grid for Newport Bay requires bathymetry data of the Bay and coastline that includes at least one-feet accuracy within the intertidal portions of the Bay and inflow (e.g., creeks and storm drains) characteristics such as locations, size, and drainage area. Initial conditions of the model domain can include water depth, spatially-varying (horizontally and vertically) salinity or temperature conditions.

Basic model inputs include time-varying water surface elevations (tide), volumetric flows, salinity, and temperature at the ocean entrance and freshwater inflows. Time- and spatially-varying wind and surface heat exchange (i.e., atmospheric thermodynamic conditions) may also be needed.

For hydrodynamic model calibration, additional field data are required to compare with model-predicted values. Calibration data can include time-varying water surface elevations at multiple locations, time- and depth-varying velocities, temperature and salinities at multiple locations,. Calibration data should cover concurrent periods of time and include varying hydrodynamic conditions to capture seasonal variations and both dry and wet weather conditions.

Sediment transport modeling requires inputs for sediment loading associated with the inflows and sediment properties within the bay. As part of the numerical model grid setup, the sediment bed properties include spatially-varying bed thickness (total bed or individual bed layers for vertically-varying bed properties), spatially- and vertically-varying bed bulk density, porosity, and sediment fractions (e.g., cohesive and noncohesive). In addition, spatially-varying (horizontally and vertically) initial sediment concentrations of each sediment class in the water column are needed. Sediment input data includes sediment loading associated with each inflow and sediment fractions at all boundaries (e.g., ocean and inflows). Additional sediment data for each sediment class include critical shear stress for erosion, critical shear stress for deposition, settling velocity and grain size.

For sediment transport model calibration, additional data are required for the water column and sediment bed. Sediment calibration data should correspond to the hydrodynamic data (i.e., concurrent hydrodynamic and sediment data) and can include time- and spatially varying sediment concentrations for each sediment class, bathymetry data, and depositional or dredge volumes.

Similarly to sediment transport modeling, model calibration for other water quality constituents requires defining pollutant properties and data for the water column and sediment bed. For example, calibration for copper requires inputs of copper loadings associated with inflows, spatially varying initial concentrations, and corresponding copper levels within the bay. Simulation of a sediment-associated pollutant like copper also requires determination of the partition coefficient for simulating dissolved and particulate fractions. The partition coefficient varies for each pollutant and can vary with other factors like salinity. Likewise, spatially-varying initial concentrations of both dissolved and particulate fractions within the sediment bed are also necessary.

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APPENDIX G

Regional General Permits

"The following technical report reflects the findings and data available at the time the report was prepared and may not represent the current conclusions and steps forward in the main text of the HAMP, which has been updated after the completion of these reports. These more detailed technical reports provided in the appendices represent the foundation for the overall approach to the HAMP, but are not "living" documents that reflect updated steps forward, costing, quantities, etc. presented in the main text of the HAMP. The main text of the HAMP represents more current information and recommendations based on updated information, new studies, changes in conditions, new funding sources, and/or new regulations."

HARBOR AREA MANAGEMENT PLAN

REGIONAL GENERAL PERMIT

Technical Report

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1.0 INTRODUCTION

Currently, most maintenance and improvement activities on docks, seawalls, basins, and channels in lower Newport Bay (south of North Star Beach) are carried out under a variety of federal, state, and regional permits. The principal permits are the US Army Corps of Engineers (USACE) Regional General Permit (RGP) 54 (USACE, 2005), the California Coastal Commission's (CCC) coastal development permit CDP5-06-117, and waste water discharge requirements from the Santa Ana Regional Water Quality Control Board (RWQCB; see section 2 for more detail on the regulatory setting of the RGP and CDP). The RGP is the controlling document as, typically, the CDP renewal process follows on and conforms to the RGP process, and the CDP and the RWQCB permit reflect the RGP's conditions; accordingly, this analysis considers only the RGP.

A number of activities and several areas of the lower bay are not covered by the RGP; for example, sediment toxicity issues have placed several areas such as the Rhine Channel, Promontory Bay, and the West Newport channels (Figure 1) outside the permit coverage. The RGP allows dredged sediments deemed suitable for unconfined aquatic disposal to be disposed of either for beach nourishment inside the bay, if the grain size profile is appropriate, or at the LA-3 ocean disposal site for fine material.

The City of Newport Beach (CONB) Harbor Resources Division administers the RGP, serving as a clearinghouse for private work and undertaking bay-wide and/or expensive activities such as sediment testing, eelgrass surveys and management, and most regulatory interactions. In fact, for the current RGP CONB has developed a streamlined process that includes a consolidated permit application form, standardized screening of permit applications, computer-based permit tracking, and an efficient system for handling the multiple agency notifications and information requests. CONB's permit administration system has proven to be effective for managing a complex set of permits, and could serve as a model for other coastal cities with similar regulatory issues.

In accordance with USACE policy, the RGP has a five-year duration, meaning that it must be renewed every five years. The CONB has experienced significant delays and incurred considerable costs in obtaining and renewing the RGP, and is seeking to streamline the process by identifying both the stumbling blocks and possible resolutions.

2.0 KEY ISSUES

The CONB has identified several issues that are currently hampering the efficient administration of the permits and that have resulted in significant delays and additional costs for necessary harbor maintenance and improvement. These are, generally, the lengthy, complex permit renewal process; the restricted coverage and extensive special conditions of the permits; sediment contamination, which in several areas is not addressed by the permits and for which CONB has no disposal site; and the current policies with respect to management of eelgrass in lower Newport Bay, which have virtually prohibited dredging and beach nourishment in some areas.

Figure 1. RGP 54 Coverage

2.1 Permit Renewal Process

Based on their experience with the most recent renewal process, CONB is concerned that it could take as long as three years (and $500,000) to renew the five-year permit. They view this delay as being due to a number of factors, including the difficulty of getting the sediment Sampling and

Analysis Plan (SAP) approved, the length of time the sediment testing can take, and the difficulty of resolving the various agency agendas into appropriate permit language.

USACE South Coast staff do not perceive a problem with the process. They believe that the current permit is a sound template for future renewals (unless CONB should want to change the permit). In USACE's view there is a template SAP that will be easy to approve, so that the sediment testing should be straightforward. The existing permit is acceptable to the agencies, and once sediment testing is completed per the SAP the renewal should take a matter of four months (per Special Condition I(g)). The history of sediment contamination and testing and the current strategy for developing and implementing the SAP for future testing are discussed in the Dredging Requirements and Contaminated Sediment Technical Report.

2.2 Restricted Coverage

As mentioned above, RGP 54 does not cover dredging in several key areas of Newport Bay because those areas have histories of sediment contamination. The RGP covers disposal of clean sediments only (as beach nourishment material or at the LA-3 ocean disposal site); the RGP does not contain provisions for management of contaminated sediment, so that it is not possible to allow dredging and disposal of such sediments under the RGP. As a result, many activities in those areas must go through the normal permitting process rather than the expedited RGP process. CONB would like to see the excluded areas included in the RGP with appropriate restrictions on dredging, disposal, and other in-water work.

2.3 Special Conditions

The current RGP has 18 pages of special conditions. Many of these are standard USACE/EPA conditions related to notifications, reporting, and limits, and much of the length of the conditions is attributable to several pages of redundancy with respect to excluded areas and activities. CONB believes that many of the conditions related to dredge and disposal tracking and monitoring are so conservative as to unnecessarily constrain small projects. Of special concern to CONB, however, are the conditions related to eelgrass protection, monitoring, and mitigation, and to ocean disposal. CONB views many of these as overly restrictive, given the limited nature of the activities conducted under the RGP. The result of the restrictions is that many minor dredging operations either are precluded entirely by the presence of eelgrass or are rendered financially infeasible for private entities because of the cost of providing the information and complying with the restrictions associated with eelgrass and ocean disposal.

2.4 Sediment Contamination

As mentioned above and described in the Dredging Requirements and Contaminated Sediment Technical Report, several areas of Newport Bay are not covered by the RGP because of sediment contamination. This issue is problematic largely because of the lack of an approved disposal site for contaminated sediments, which prevents dredging projects that involve contaminated sediments from being approved through the streamlined RGP process. Instead, CONB has to wait until a disposal opportunity arises and then conduct additional sediment testing to be covered under RGP 54 (Special Condition III(d and e)).

2.5 Eelgrass

NOAA Fisheries has determined at the national level that eelgrass (*Zostera marina*) beds constitute sensitive habitat under several programs, including the Essential Fish Habitat provision of the Magnuson-Stevens Act (eelgrass is designated as a Habitat Area of Particular Concern in the Pacific Groundfish EFH designation [PFMC 2005], affording the resource EFH protection). Losses of eelgrass, therefore, must be avoided and minimized to the extent practicable, and unavoidable losses must be mitigated.

As described in the Eelgrass Technical Report, eelgrass coverage in Newport Bay varies from year to year, and according to both CONB and NMFS personnel (personal communication, 2007) it is currently in a high-coverage phase (70% of the historic maximum). NMFS believes that at the moment eelgrass is growing nearly everywhere it can, and tentatively attributes the current lush growth to improved water quality (that, in turn, suggests that high coverage will continue and the issue will not abate of its own accord). In NMFS's view, the best growth is in the area between the eastern end of Balboa Island and the Lido peninsula, as well as the entrance channel – those areas are what might be termed the "core" of eelgrass in Newport Bay. CONB, on the other hand, indicates that eelgrass is widespread throughout the bay; for example, there is a persistent bed in the embayment of Linda Isle. In general, it would appear that eelgrass persists in the core area but is ephemeral in other areas of the bay.

Eelgrass is an especially important issue because the RGP's special conditions prohibit dredging or disposal within 15' of established eelgrass plants unless mitigation, in the form of replanting elsewhere nearby, can be provided. The guidelines that form the special conditions were developed by the NMFS as standard best management practices for Southern California coastal areas and are not specific to Newport Bay. Given the widespread coverage of eelgrass under and adjacent to docks in Newport Bay, these restrictions have severely curtailed maintenance in some areas of the bay. NMFS staff recognize the dilemma but are committed to giving eelgrass the protection they believe it warrants and that the law and agency guidelines mandate, particularly given their position that the eelgrass was there first and thus, arguably, has priority over recreational boating.

3.0 IMPROVEMENT OF THE RGP PROCESS

Recognizing these issues, the City's goal is to make its implementation of the RGP achieve the necessary balance between environmental protection and beneficial uses. To achieve that goal the City must obtain regulatory permits that recognize the particular circumstances of Newport Harbor, and administer those permits for the benefit of both the boating community and the natural environment. To that end, the RGP implementation strategy should emphasize establishing sound relationships with the regulatory agencies, articulating clear goals and objectives for future permits, and developing a sound, cost-effective strategy for the permit renewal process. Coordination with other management programs and with the renewal process for the Coastal Development Permit (CDP) should minimize the delays and expense compared to the previous renewal effort. The goal is to obtain permits that have clear, flexible, effective conditions that allow the City to protect its natural resources while safeguarding its beneficial uses.

There are several specific issues that should be addressed during the RGP renewal process in order to improve the City's ability to implement the RGP: extending the duration of the permit, streamlining the formulation and approval of the sampling and analysis plan, extending the geographic coverage of the permit, streamlining and clarifying permit conditions, improving management of eelgrass in order to be able to negotiate more favorable permit conditions, and increasing the scope of beach nourishment under the RGP.

The RGP renewal strategy should be based on an early, comprehensive effort to identify the key issues with the various stakeholders, provide necessary information, and conduct negotiations. The renewal effort needs to be undertaken with clear objectives in view and a strong sense of what can be negotiated and what cannot. This effort is best accomplished by preparation of a written renewal strategy that will guide the efforts of the City and its consultants. The strategy will describe how the various components will fit together and will provide guidance on negotiation strategies and desired outcomes.

3.1 Permit Duration

A permit duration of 10 years would facilitate permit administration and reduce the financial and administrative burden on the City and the regulatory agencies, and has the support of USEPA Region 9 headquarters. Nevertheless, USACE Los Angeles District apparently has no authority to grant a 10-year permit. Furthermore, the sediment test results would not be valid for a 10-year period, and the City would still have to go through a 5-year renewal cycle for the Coastal Development Permit. Accordingly, pursuing a 10-year RGP may be most productive at the level of USACE regulatory headquarters in Washington, D.C.

3.2 Streamline Sampling Plan Approval

A template for a Sampling and Analysis plan that specifically details all possible outcomes could be created with input from all involved agencies to ensure acceptance prior to sampling. The Sampling and Analysis Plan may include recommendations for phased testing to target specific disposal activities, including dredging in currently restricted areas such as the Rhine Channel, Promontory Bay, and the West Newport Channels. The RGP renewal process should be coordinated with the efforts of the Dredging Requirements and Contaminated Sediment component of the HAMP.

3.3 Geographical Coverage

It would be possible to extend RGP 54 to the currently excluded areas if the City could commit to placing the sediments in a previously-approved disposal site. As a long-term disposal site outside the city is financially and logistically infeasible, identifying and developing an in-bay confined disposal site for contaminated sediments is a recommended course of action. Development of such a site would be a substantial undertaking that would require coordination of several HAMP elements (at a minimum, the Dredging Requirements and Contaminated Sediment, Eelgrass Capacity, and Hydrodynamic and Water Quality elements), intensive coordination with the resource and regulatory agencies, and a public education and environmental documentation (EIS/EIR) effort. Weston believes, however, that the potential benefits to the City and to the regulators from extending the permit's coverage would make the effort worthwhile.

3.4 Streamlining Special Conditions

The RGP's special conditions could be streamlined by (1) simplifying the language and removing redundancies, (2) developing a more straightforward system for monitoring the dredging and disposal activities, and (3) developing an eelgrass management plan that would be protective of eelgrass resources while not being unnecessarily burdensome to dredgers.

Currently many of the RGP users do not have the financial resources to manage contaminated sediments, to comply with the eelgrass requirements, or to comply with the ocean disposal monitoring requirements. The RGP could be revised to incorporate guidance and options for these issues that would make more small dredging projects feasible. Specific areas of the RGP that could be revised are addressed in the detailed recommendations (Section 4).

3.5 Eelgrass Management

The RGP could be modified to incorporate a comprehensive, bay-wide eelgrass management plan in such a way as to achieve the twin goals of eelgrass protection and the facilitation of maintenance dredging and structural work. As described in the Eelgrass Capacity Management Technical Report, there are two possible models for the eelgrass component of the permit. Option 1 would recognize that boating has priority in some areas, eelgrass in others (this option would be consistent with the goals of the Harbor Area Management Plan, which would balance various uses in the bay). Option 2 would establish a baseline eelgrass population for a portion of the bay, and the RGP would acknowledge this area.

Close coordination would be needed with the Department of Fish and Game and National Marine Fisheries Service (NMFS) eelgrass management plan in order to develop modifications of the

RGP's special conditions that would be effective and at the same time responsive to agency imperatives. See Appendix B for more detail.

3.6 Beach Replenishment

Currently the RGP allows dredging projects of less than 1,000 cy to be used for beach replenishment, assuming the material is physically and chemically suitable. Increasing the volume of dredged material that can be beneficially used for beach replenishment under the RGP may increase opportunities to use the dredged material. The specific details of beach nourishment opportunities and needs are described in the Beach Replenishment Technical Report; the RGP renewal negotiations would use that report to support modified permit language.

4.0 RECOMMENDATIONS

Weston has developed recommendations that address specific Special Conditions of the current version of RGP 54 (Table 1). The recommendations are based upon discussions with Harbor Resources personnel, USACE Regulatory Branch personnel, and NOAA Fisheries personnel. Only those conditions for which changes are recommended or have been suggested are included.

Harbor Resources personnel have also suggested that two conditions of the Coastal Development Permit should be changed. Neither of these conditions is on the RGP, and both make administration of the CDP more difficult without adding environmental protection. Condition I(i) establishes the permit duration as three years; Weston concurs that the CDP should have the same duration as the RGP. Condition II(d) requires implementation of "Clean and Green" measures in the harbor. Harbor Resources points out that the program is voluntary and that there is no basis for making them mandatory. Weston concurs with Harbor Resources' suggestion that the language be changed to "The City shall continue to promote its "Clean and Green" program throughout the harbor district."

TABLE 1. SPECIFIC RECOMMENDATIONS FOR CHANGING SPECIFIC SPECIAL CONDITIONS OF THE RGP

CONDITION	RECOMMENDATION
I(c)iv	Because many of the beaches are too small for five photographs to be reasonable, Weston recommends changing the sentence to read "As many photos as are necessary to portray the beach area…"
I(e)i	CONB has suggested that it is vulnerable to the requirement that an independent eelgrass expert has to conduct the surveys. Currently, CONB contracts with the expert, but if that arrangement were to be challenged, CONB has no written agreement that it is authorized to administer that function. Weston does not recommend pursuing this issue. The current informal arrangement is in everyone's interests, but if the issue is raised the agencies could feel obligated to take a less permissive stance.
I(e)ii	CONB would like this condition to permit precision dredging within 15 ft of eelgrass and to eliminate the prohibition on in-kind replacement and repair, in order to facilitate small-scale berth maintenance. In addition, above-water work should be exempted entirely so long as the shaded area does not increase. Weston concurs that this is a reasonable goal, and recommends that in order to achieve that goal in the next renewal process CONB proactively offer construction best management practices that would provide NOAA Fisheries with assurances that eelgrass would be protected. Measures should include mandatory silt curtains for dredging and pile removal/placement, photographic before/after verification that the work does not increase shading of eelgrass, and an on-site construction inspector authorized to shut down work if necessary.
I(e)iv(2)	According to CONB staff, the approval of individual permit applications takes so long that the survey required by this condition often expires before approval is granted, because the surveys are submitted with the applications.

TABLE 1. SPECIFIC RECOMMENDATIONS FOR CHANGING SPECIFIC SPECIAL CONDITIONS OF THE RGP

CONDITION	RECOMMENDATION
	Weston concurs with CONB's suggestion that the permit application merely indicate whether or not eelgrass is present at the project site, and that the survey be conducted within 60 days of the start of work. Note that this condition (reiterated in I(e)vi) does not actually require that the survey be submitted with the application. Therefore, Weston recommends that CONB raise this issue with USACE to determine whether that agency is willing to accept a presence/absence indication with the application and allow CONB to ensure that the survey is conducted before the start of work in compliance with this condition. The permit management system currently in place could easily be adapted to ensure USACE receives the survey in a timely manner.
I(f)	CONB would like to see the survey timing restrictions for *Caulerpa* parallel those of eelgrass, so that both surveys can be done at the same time and have the same "shelf life". Weston recommends that this issue be raised with NOAA Fisheries, but notes that the timing is standard wording representing regional agency policy, so that altering it may involve extensive negotiations.
I(g)	This condition, although it does not expressly so state, could be interpreted as requiring full Green Book testing throughout the harbor in order to renew the RGP. CONB points out that testing has been going on for the past 30 years and that the constituents of concern are well known. CONB would like to ensure that future testing is focused on those constituents at the Tier I level. Weston recommends that this issue not be addressed through changes in the wording of the RGP, but rather through the SAP for the renewal process (i.e., the Dredging Requirements and Contaminated Sediments element). The SAP should be formulated and approved in consultation with EPA, which has expressed support for focused testing. The current wording of the RGP would not contradict such an approach. It would be especially helpful to have EPA present at SAP negotiations with CCC, possibly including testimony at a Commission hearing for the consistency certification of the new RGP.
II(b)	CONB has expressed a desire to have this condition specify that bulkhead replacement landward of an existing bulkhead is permitted. Given, however, that this permit is for maintenance of existing structures and explicitly prohibits new work, Weston recommends that the CONB not pursue this issue. RGP 54 should remain focused on maintenance: repairs, minor modifications, and removal of accumulated material to previously authorized depths.
II(j), III(l)	These conditions are standard in USACE dredging permits. For this situation, however, notifications to USCG XI District and Coast Guard Marine Safety Office in San Pedro would appear to be superfluous, since the Coast Guard has told CONB it has no interest in or use for the information. NOAA (condition II(n)) is a similar case: the survey information from minor maintenance dredging is not used in NOAA mapping and survey activities. Weston recommends that for the next RGP renewal process CONB request that the notification language be changed to omit NOAA entirely and to require CONB to notify

TABLE 1. SPECIFIC RECOMMENDATIONS FOR CHANGING SPECIFIC SPECIAL CONDITIONS OF THE RGP

CONDITION	RECOMMENDATION
	the Newport Harbor Coast Guard unit of upcoming dredging activities. This request could be justified in terms of the paperwork and personnel savings to USCG, NOAA, and CONB.
III(b)	This condition restricts maintenance dredging to -7 ft MLLW, but the USACE authorized depth for most of the harbor is -10 ft MLLW. Weston recommends that the RGP renewal request -10 as the maximum dredge depth. The SAP, of course, would need to test appropriately, and such testing would not, at depths below -7' MLLW, be restricted to focused Tier 1 testing. The USACE, EPA, and CCC would undoubtedly require full testing of material that has not been tested in previous years, as would be the case with most of the material below -7' MLLW. CONB should be prepared, however, for the counter argument that the USACE authorized depth is irrelevant, that the definition of maintenance dredging is restoring previously dredged, not authorized, depths.
IV(l), (m)	These conditions are standard language for USACE dredging permits, and they were designed with large-scale projects in mind. They are not really practicable for the single-load, small-contractor projects characteristic of Newport Bay, since most of the contractors do not have the capability of real-time tracking and web posting. Dredgers have indicated that they will not undertake small projects if they have to comply with the language. Weston recommends that the RGP renewal process explore the possibility of deleting these two conditions and replacing them with a condition that requires trip and dump logging on the basis of GPS positioning, and post-trip submission of the track plot. Weston expects the USACE to be amenable to such a proposal.

5.0 REGULATORY ENVIRONMENT

The activities authorized by the RGP and the CDP are governed by several federal and state laws and by the regulations promulgated under those laws. The principal federal laws are: Clean Water Act (CWA), Marine Protection, Research, and Sanctuaries Act (MPRSA), Endangered Species Act (ESA), Magnuson-Stevens Fisheries Conservation and Management Act, the Coastal Zone Management Act (CZMA), and the River and Harbor Act. The principal state laws are the California Coastal Act, which implements the federal CZMA; the California Endangered Species Act (CESA); and the Porter-Cologne Act, which implements the federal CWA.

RGP 54 is a federal permit issued by the USACE, with the concurrence of the US EPA, and is the only permit needed for maintenance activities in waters of the United States. The USACE issues its permit pursuant to the Section 404 of the CWA, Section 10 of the River and Harbor Act, and Section 103 of the MPRSA. However, Corps regulations prohibit permit issuance until the Corps is assured that the permitted activities will comply with all other applicable state and federal laws and regulations. This it does by obtaining concurrence from other agencies in the form of certifications or consultations.

The approvals needed for RGP issuance (and renewal) include a certification from the Regional Water Quality Control Board (RWQCB) that the activities comply with Section 401 of the CWA (and, therefore, with the Porter-Cologne Act), a certification from the Coastal Commission that the activities comply with the California Coastal Act (and, therefore, with the CZMA), and concurrence from the federal and state wildlife resources agencies (US Fish and Wildlife Service, NOAA Fisheries, and California Department of Fish and Game) that the activities will comply with the ESA, the CESA, and the Magnuson-Stevens Fisheries Act. These other approvals typically result in additional special conditions on the RGP.

The Coastal Commission exercises its mandate through the coastal development permit and the coastal consistency certification process. In early 2006 the Commission granted CONB CDP 5-06-117, whose conditions closely parallel those of the RGP, and Federal Consistency CC-031-06.

6.0 REFERENCES

Pacific Fishery Management Council. 2005. Amendment 18 (Bycatch Mitigation Program)/Amendment 19 (Essential Fish Habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. http://www.pcouncil.org/groundfish/gffmp/gfa19/A18-19Final.pdf

United States Army Corps of Engineers (USACE). 2005. Regional General Permit 54 (File No. 200501233-DPS). http://www.spl.usace.army.mil/regulatory/RGP54.pdf

APPENDIX H

Sea Level Rise and Flood Control Management

"The following technical report reflects the findings and data available at the time the report was prepared and may not represent the current conclusions and steps forward in the main text of the HAMP, which has been updated after the completion of these reports. These more detailed technical reports provided in the appendices represent the foundation for the overall approach to the HAMP, but are not "living" documents that reflect updated steps forward, costing, quantities, etc. presented in the main text of the HAMP. The main text of the HAMP represents more current information and recommendations based on updated information, new studies, changes in conditions, new funding sources, and/or new regulations."

HARBOR AREA MANAGEMENT PLAN

SEA LEVEL RISE AND FLOOD CONTROL MANAGEMENT

Technical Report

Prepared For:

Harbor Resources Division

City of Newport Beach

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FlowSimulation, LLC

With HAMP Team:

November 2008

Vulnerability of the Newport Harbor Area to Flooding by Extreme Tides

Draft Final Report

Prepared for:

City of Newport Beach, California

Prepared by:

FlowSimulation, LLC

November 20, 2008

Executive Summary

This study addresses the vulnerability of the Newport Harbor area in Newport Beach, California to flooding by extreme high tides. Extreme high tides represent the highest high tides of each year with the potential to rise above bulk heads and inundate low-lying topography. Rainfall and ocean waves represent another threat to flooding but were not the focus of this study.

Analysis of a 2006 Light Detection And Ranging (LiDAR) topographic survey shows that Balboa Island, Little Balboa Island, Newport Island, and nearly the full length of Balboa Peninsula along its bay-ward side fall below the height of present-day extreme high tides.

A review of site conditions shows that flood control systems are in place to guard these areas against tidal flooding. This includes a combination of public and private infrastructure and operational practices. Infrastructure includes bulk heads (i.e., retaining walls or sea walls) and valves or plugs at the outlets of storm drains and storm sewers that prevent back-flooding. Operational practices include City General Services staff efforts to monitor tide conditions, close storm drain outlets in anticipation of high tides, construct sand berms at bay-side beaches, interface with occupants to ensure that drains on private land are plugged, interface with occupants to encourage sand bagging of low bulkheads, and operation of pumps to drain flooded areas. These efforts are particularly challenging on Balboa Peninsula because the vast majority of shoreline is privately owned, many parcels require that drains be plugged or low bulkheads be sandbagged, yet there appears to be no formal process for occupant cooperation. In contrast, a City owned bulk head encircles both Balboa Island and Little Balboa Island so occupant cooperation is not required.

A review of historical data shows that two times a tide height of nearly 8 ft above Mean Lower Low Water (MLLW) was attained: January 28, 1983 (7.8 ft) and January 10, 2005 (7.8 ft). There were reports of flooding in the Harbor area in both cases. Several lines of evidence suggest that the onset of flooding on Balboa Peninsula and Balboa Island, when all tide valves are closed, occurs when the tide rises above the 7.0 foot level relative to Mean Lower Low Water (MLLW). This includes first-hand observation of flooding from a 7.5 ft tide, photographs of historical tides nearly even with the top of the Balboa Island bulk head, and LiDAR ground elevation data. On Balboa Peninsula, flooding commences as a consequence of low and leaky bulk heads. On Balboa Island, flooding commences with overtopping of the Balboa Island Ferry ramp. Topographic survey data shows that the west side of Balboa Island (location of the Ferry ramp) slumps in comparison to the east side, perhaps as a consequence of differential settling.

The height of the bulk heads around Balboa and Little Balboa islands were estimated by a combination of LiDAR ground elevation data and field measurements of wall heights. These data indicate that the bulk head varies in height between 7.9 and 9.2 ft (MLLW) around Balboa Island and 8.7 and 9.8 ft around Little Balboa Island. However, seepage through cracks in Balboa and Little Balboa island bulk heads has been reported by

General Services staff and this could cause flooding at lower tide heights. Also, waves in the harbor could promote overtopping and subsequent flooding at lower tide heights. The southeast corner of Little Balboa Island, in particular, faces the harbor entrance and therefore may be exposed to greater wave energy than other parts of the harbor.

There are predictable and unpredictable aspects to the height attained by extreme high tides that should be recognized for effective short and long-term planning purposes. The effect of astronomical factors is predictable. This causes the highest extreme high tides to occur in Winter and Summer but never in Fall or Spring. In addition, there is a cycle lasting several years that causes tide heights to vary by approximately 0.5 ft. This causes tides to be higher one year versus another. This cycle is peaking at present (2007- 2008 time frame) and will peak again in 2011-2012. *Through 2020, the highest extreme tide is predicted for December, 2008.*

The effects of inter-annual phenomena such as El Nino/La Nina, weather conditions, and global warming on tide heights are more difficult to predict. These effects can be characterized by studying historical differences between actual and predicted tides or the Non-Tide Residual (NTR). A review of data for Los Angeles shows that NTRs exceeding 0.5 ft have persisted for days at a time, and 1.0 ft for hours at a time, during Winter. NTRs exceeding 1.0 ft have occurred during strong El-Nino conditions as well as neutral El Nino/La Nina conditions, but never during weak or strong La Nina conditions. Hence, climatic conditions give some indication of flooding risk. Global warming is expected to heighten sea levels further and current projections call for a 1-3 ft rise by 2100. There are also indications that global warming has intensified Winter storms. Therefore, global warming could cause larger NTRs than in recent history as well as more wind and wave energy and more intense rainfall. The worst case scenario for coastal flooding is a strong winter storm that approaches the California coastline from the Gulf of Alaska during an El Nino winter, arriving simultaneously with a high astronomical tide. By monitoring climatic conditions seasonally, and weather conditions daily, it should be possible to forecast a worse-case scenario on a 24-48 hour basis and have a good indication of its severity.

To identify and map the vulnerability of the Newport Harbor area to future flooding by extreme high tides, a flood inundation model was developed and applied. A total of nine model simulations were completed corresponding to three tide scenarios (tide heights of 8, 9 and 10 ft), two infrastructure scenarios (an "as-is" scenario and an "improved" scenario corresponding to bulk head improvements presently planned or in progress by the City) and two stream flow scenarios. The 8, 9 and 10 ft tide scenarios represent a range of tide heights that could occur through 2100 from the combined influence of astronomical tides, sea level rise, and environmental conditions such as storms. The probability of these events decreases with tide height, and increases with time due to sea level rise.

Model simulations of the 8 ft tide show localized flooding along Balboa Peninsula and widespread flooding across the western half of Balboa Island. This is largely consistent with historical observations of flooding from extreme high tides, particularly considering that the largest historical tide only reached the 7.8 ft level. Model simulations of the 9 ft tide show widespread flooding along the bay side of Balboa Peninsula and near complete flooding of Balboa Island, Little Balboa Island and Newport Island. Model simulations of the 10 ft tide show near complete flooding of developed parts of Balboa Peninsula, Balboa Island, Little Balboa Island, Newport Island, and parts of Bay Island and Linda Island. Model predictions suggest that planned bulk head improvements will reduce flooding from future tides with heights of 8 ft, but do little to reduce the impact of 9 ft or higher tides. Further, model predictions suggest that a high rate of stream flow into Upper Bay will exacerbate flooding by an 8 ft tide but have relatively little impact on flooding caused by a 9 or 10 ft tide. That is, tidal effects will overwhelm stream flow effects.

To be better prepared for future extreme high tides, the following is recommended:

1) The City should consider creating or formalizing a monitoring system for environmental conditions that affect coastal flooding. This would include not only high astronomical tides but also climatic and weather conditions that contribute to damaging high tides (large NTRs). On a short term basis (24-48 hours), the system could be used to improve the City's emergency preparedness. On a seasonal or inter-annual basis, the system could help staff to prioritize and guide infrastructure improvement efforts (e.g., sand replenishment).
2) The City should consider creating and maintaining a database of public and private flood control infrastructure, and implementing a monitoring system to track key factors that bear on flood control. For example, the database could provide an inventory of the location, height and condition of bulkheads encircling the harbor, the height and thickness of beach sand along the coastline, and other important data such as tide valves and plugs. This data would logically be integrated into the City GIS, and could be coupled to the flood model developed here to maintain up-to-date maps of flood-vulnerable areas. The model could also be used to evaluate the benefit of proposed flood control measures.
3) In support of item (2) above, the City should consider hiring or employing a qualified surveyor to precisely measure the height of bulk heads around the harbor.
4) The City should consider exploring the legal or policy framework that would allow for more systematic improvement of the condition and continuity of bulkheads around the bay in the future, particularly considering that most bulk heads appear to be privately owned.
5) The City should consider developing and adopting a flood risk management plan for the Harbor area before moving forward with any major efforts to improve flood control infrastructure (e.g., raising bulk heads). Flood risk management plans consider the economic, environmental and social consequences of flooding to identify the optimal structural (e.g., bulk heads, pump stations) and non-structural (e.g., zoning, insurance) measures for implementation.
6) The City should examine the impact of waves on flooding in a future study. Based on a cursory review of LiDAR data characterizing the height of beach sand along Balboa Peninsula, it is not clear that there is adequate protection against the

combined effects of an extreme high tide and ocean waves typical of storm conditions. Such a study could be used to guide future sand replenishment efforts.

Table of Contents

Chapter 1: Introduction

The highest high tides in Newport Beach threaten flooding of low-lying terrain. Historically, the highest high tides have reached approximately 7.8 ft above Mean Lower Low Water (MLLW). This has occurred twice: January 28, 1983 and January 10, 2005. In both instances, flooding of Balboa Peninsula and Balboa Island was reported.

The highest high tides of each month are called “extreme high tides,” and to some extent are predictable. Based on astronomical factors, the height of future tides can be predicted many years in advance. However, such predictions do not account for factors such as El Nino or La Nina, changes in atmospheric pressure, and weather effects. These effects can cause significant deviations from predicted tides, i.e., greater than one foot in southern California.

While sea levels have been rising for decades, higher rates of rise are forecast for the coming century as a consequence of climate change. Increases can be attributed to warmer temperatures, which cause water to expand, as well more liquid mass caused by the melting of ice caps. Current estimates of future sea level rise generally fall in the range of 1-3 ft for the year 2100 (IPCC 2007). A United States Environmental Protection Agency (USEPA) study put these figures in a probabilistic perspective, suggesting there was a 50% chance that sea level rise would exceed 0.4, 0.7 and 1.5 ft by 2025, 2050 and 2100, respectively, and a 10% chance that sea level rise would exceed 0.6, 1.1 and 2.9 ft by 2025, 2050 and 2100, respectively (Titus and Narayanan 1995). A California Coastal Commission report has suggested that a 1 ft increase in sea level is very likely by 2050, and a 3 ft increase is very likely by 2100 (California Coastal Commission 2001). Global warming may impact flooding in other ways as well. Warmer water could intensify North Pacific storms, bringing greater wind and wave energy to the shoreline in Winter and higher intensity precipitation.

In support of the Harbor Area Management Plan (HAMP), this report presents a study addressing the vulnerability of the Newport Harbor area to flooding by extreme high tides. To limit the scope and budget of the project, this project focuses on tidal effects and stream flow only. That is, we consider what flooding is likely to occur as the rising tide and stream flow into the bay cause water levels to rise above bulk heads and spill into the developed portions of Newport Harbor. The study does not consider the impact of wind and waves on coastal flooding, although a subsequent study along these lines is recommended, or the effect of local precipitation and flow into storm drains. The study includes the following tasks which are each addressed in subsequent chapters of this report:

<u>Task 1: Review and synthesize terrain data sources.</u> Accurate terrain data are crucial for flood inundation modeling. Therefore, this study will begin with a review and synthesis of terrain elevation data likely to be useful for this study including: (1) Bay bathymetry data (land below water) collected by the US Army Corps of Engineers (2002, 2005), (2) City of Newport Beach LiDAR terrain data (2006), (3) Upper Newport Bay LiDAR terrain data collected by the US Army Corps of Engineers (2002), (4) Offshore

bathymetry data distributed by the NOAA Geophysical Data Center (NOAA/GDC) bathymetry data and (5) coastline LiDAR data distributed by NOAA Coastal Services Center (NOAA/CSC).

These data are likely to adopt different datums and/or projections. In addition, the coverage of these data sources is not presently clear. In this task, we will convert all data to the California State Plane Coordinate System (Zone VI) using NAVD88 for vertical control. Furthermore, we will review the coverage and accuracy of all data sources and identify the most accurate data sources for the proposed modeling. This is expected to include the recent City LiDAR survey for above-water areas around the Bay and Corps bathymetry data for the below-water areas of the Bay. A map will be prepared showing the coverage and quality of relevant data sources.

Deliverable: Interim Report 1 describing the coverage, accessibility and quality of terrain data for flood inundation modeling. ***This appears as Chapter 2 of this report.***

<u>Task 2: Develop hypothetical design tides.</u> Records and reports on extreme tides in California will be reviewed first, focusing on information relevant to Newport Harbor. A set of design tides will then be developed to reflect a range of likelihoods based on a 25, 50 and 100 year planning horizon. The specifics of this have yet to be determined, but one possibility is to take the tide record from January 28, 1983 tide as a base case, and to add an uniform offset consistent with EPA sea level rise projections. By running the flood inundation model several times using increasingly larger offsets, a range of flooding scenarios will be depicted corresponding to decreasing probability.

Deliverable: Interim Report 2 presenting a set of design tides for subsequent flood inundation modeling. ***This appears as Chapter 3 of this report.***

<u>Task 3: Review of sea defense infrastructure.</u> Bulk heads protect several parts of Newport Bay from high Bay levels. Knowledge of the extent of this infrastructure, as well as its exact height, is essential for an accurate depiction of ocean flooding. In addition, a review of drainage infrastructure will be needed to ascertain routes by which ocean water may bypass sea defenses (e.g., through storm drain system) and cause flooding. This task will require support from City staff and involve a site visit around the perimeter of Newport Harbor.

Deliverable: Interim Report 3 presenting an overview of sea defense infrastructure in the Newport Harbor area. ***This appears as Chapter 4 of this report.***

<u>Task 4a: Prepare a computational grid for model simulations.</u> A model grid will be prepared to support flood inundation modeling. The grid will adopt a variable resolution that balances the demands for accuracy and computational efficiency. Large computational cells will be used in deep water that is always flooded, and small computational cells will be used in areas where inundation of normally dry land is predicted. In addition, the model grid will be aligned with bulk heads and new modeling techniques will be used to realistically simulate overtopping. The resolution of the grid

will be sufficient resolve surface flow along streets. Quality control checks will be made to ensure that model predictions of flood zones are not grid dependent.

Task 4b: Perform flood simulations. A 2D numerical model developed by Professor Sanders, BreZo, will be applied to simulate flooding. The model has previously been applied in a number of coastal and inland flow simulation applications, and there are a number of published papers that validate its use. Electronic versions of Professor Sanders' papers can be accessed from his university web page http://gram.eng.uci.edu/~bfs/sanders2.html or a hard copy can be provided upon request. In each simulation, flow conditions will be forced by two factors: the design tide and storm water inputs from major tributaries that drain to the Bay. The model will assume that all terrain is impermeable, implying no infiltration or drainage of flooding ocean water into storm sewers. In addition, the model will not consider precipitation directly. This approach will allow the model to isolate the impact of ocean levels on flooding. At a future time, BreZo could be coupled to a City drainage model to see how readily ocean water flooding can be mitigated with existing infrastructure, or to design improvements to the sewer infrastructure to better cope with ocean water flooding. However, these tasks are outside the scope of the present study. An executable version of the flood model used for this study will be provided to the City upon completion of the study to support additional modeling if the need arises (e.g., simulations could be repeated with higher bulk-head heights or a different design tide).

Task 4c: Prepare flood inundation maps corresponding to extreme tides. The results of model simulations will be processed and distilled into a set of flood inundation maps. These maps will depict regions of inundation corresponding to design tides of various heights.

Deliverable: A Project Report incorporating the previous reports and presenting the flood modeling methodology, flood modeling results, a discussion of the vulnerability of the Newport harbor area to flooding, and recommendations for flood hazard mitigation. ***Flood predictions are presented in Chapter 5 of this report, and recommendations appear in the Executive Summary and in Chapter 6 (Conclusions and Recommendations).***

Chapter 2: Review and Synthesis of Terrain Data

This chapter describes topographic and bathymetric data which have been synthesized for flooding analysis. Surface flooding is most likely to occur in low lying areas around the harbor, and analysis of topographic data allows these areas to be identified. Parts of the harbor such as Balboa Island are encircled by elevated bulk heads, or sea walls, that are designed to obstruct flooding by ocean water during episodes of high sea levels. Hence, land may not necessarily flood simply because of its elevation.

2.1 Data Sources

Several sources of data were obtained and organized to provide a seamless map of terrain height that synthesizes available topographic (above sea level) and bathymetric (below sea level) ground elevation data in the vicinity of Newport Harbor. We will use *terrain data* to indicate both of these data types. The data sources include the following and are summarized in Table 2.1:

1) Light Detection and Ranging (LiDAR) topography data collected by Merrick for the City of Newport Beach.
2) Upper Bay bathymetry data resulting from a multi-beam survey by an unknown contractor for the U.S. Army Corps of Engineers, Los Angeles District.
3) Lower Bay bathymetry data resulting from a multi-beam survey by an unknown contractor for the U.S. Army Corps of Engineers, Los Angeles District.
4) Offshore bathymetry data from the National Geophysical Data Center (NGDC) 3 arc-second coastal relief model access from the Southern California Coastal Ocean Observing System (SCCOOS) website.

Table 2.1: Summary of Terrain Data

Dataset	Data Provider	Date	Resolution	Datum	Vertical Accuracy
LiDAR	Merrick	2006	10 feet	NAVD88	< 0.6 ft
Lower Bay Bathymetry	Corps Contractor	2005	10 feet	NAVD88	0.1-0.3 ft
Upper Bay Bathymetry	Corps Contractor	2002-2003	~3 feet	NAVD88	0.1-0.3 ft
Offshore Bathymetry	National Ocean Service (NOS)		~300 feet	MLLW	1 ft

Figure 2.1 illustrates the coverage of these data. Note that recently collected LiDAR data is most important relative to flooding analysis because it covers all of the developed land around the harbor.

Aerial photography of the Newport Harbor area collected by Merrick for the City of Newport Beach was also obtained and used to support organization and analysis of terrain data. This consisted of 56.4 square miles of 3 inch photography divided into 262 tiles, each covering an area of 3000 x 2000 feet. In addition, we obtained a 1 foot re-sampled version of the same photography from City of Newport Beach GIS personnel for faster processing. The spatial extent of the LiDAR data was the same as the aerial imagery and included over 53.5 million surface samples. These were extracted at an average spacing of 10 feet with vertical accuracy better than 0.6 feet at 95% confidence level to comply with National Standard for Spatial Data Accuracy (NSSDA) requirements for 1 foot contours. Imagery and LiDAR were processed by Merrick to use the NAD 1983 California State Plane Zone VI (feet) coordinate system and the NAVD 1988 vertical datum. NAD83 and NAVD88 were also adopted for subsequent processing.

Of the 262 available tiles, a subset of 112 tiles covering an area of 24.1 square miles was identified for further analysis. The discarded tiles included terrain on Newport Mesa and in San Joaquin Hills where coastal flooding is not a threat. Figure 1.2 shows 1 ft aerial imagery of the selected tiles.

2.2 Data Processing

LiDAR survey data obtained in this study consisted of point clouds corresponding to remotely sensed samples of the land surface height. In addition, the provided data had been processed by Merrick to include only ground elevation points. Hence, points corresponding to non-terrain features including tree tops and building roof tops were not included. The dataset included over 10 million points.

Whereas the LiDAR sensor adopted by Merrick passed over Newport Bay, it has no capability to penetrate water and measure the underlying ground height. The LiDAR point cloud therefore includes many points that correspond to water heights which must be removed for flooding analysis. In addition, the obtained bathymetric datasets provide a number of points that correspond to bottom elevation of the bay and coastal ocean that can be combined with the topography. A strategy was to filter and merge these topographic and bathymetric datasets was devised and applied.

Topographic and upper and lower bay bathymetric data were loaded into ArcGIS (ESRI, Redlands, Calif.) in a point format to facilitate data filtering and merging. First, to eliminate LiDAR points over water a proximity search was performed whereby all LiDAR points overlapping bathymetric points were identified and removed. Second, LiDAR points were manually removed from areas corresponding to shallow water where bathymetric data were sparse or completely absent. Third, in a few areas where no bathymetric data was available (e.g., Newport Island Channels), LiDAR points over water were manually selected and the elevation was set to the nearest available bathymetric reading.

To include offshore bathymetry in the Harbor terrain dataset, data from the National Ocean Service (NOS) three second coastal bathymetry model were obtained and converted using ArcGIS (ESRI, Redlands, Calif.) from geodetic coordinates to NAD 1983 California State Plane Zone VI (feet) projection. These data points are spaced roughly 300 ft apart, relatively coarse in comparison to the LiDAR data. NOS data heights were specified relative to Mean Lower-Low Water (MLLW) which differs from the NAVD 1988 datum used for the overland LiDAR survey by 0.18 feet. Given that these data correspond to offshore depths that are not essential for flooding analysis, this difference was considered to be insignificant and therefore ignored.

Along the offshore perimeter of Balboa Peninsula and around the harbor mouth, a number of LiDAR points were located in areas corresponding to water and these were identified based on aerial imagery and removed manually to preference the NOS data.

Once the four datasets were filtered and synthesized into a single point file, a 10 ft digital terrain model (DTM) was created using an inverse distance interpolation (IDW) scheme that utilizes eight neighboring points. The DTM provides continuous description of terrain elevations from -1,245 feet to 594 ft and will be used in modeling studies presented in Chapter 5 to parameterize ground elevation in a mesh used for flow simulation.

The DTM that results from synthesizing the available topographic and bathymetric data is illustrated as a hill shade plot in Figure 2.3 and a contour plot in Figure 2.4. Figure 2.5 shows a contour plot of terrain elevation in the vicinity of lower bay where land elevations are closest to sea level.

2.3 DTM Accuracy

Horizontal accuracies of the original LiDAR and bathymetric RMSEs are stated to better than 0.5 feet and no significant loss of accuracy resulted from re-projection of the bathymetry data, so an RMSE of 0.5 ft applies to the DTM as well.

Vertical RMSEs differ across the modeling domain as LiDAR and bathymetry sensors feature unequal accuracies. LiDAR elevations were collected to conform to NSSDA requirements of better than 0.6 feet, while bathymetry sensors usually capture depth at accuracies between 0.1-0.3 feet. However, sedimentation is a notorious problem in Newport Bay and dredging has taken place since the time of the last bathymetric data, so measurement precision of the bathymetric sensor is not a good indicator of the DTM vertical accuracy. Based on professional judgment, we suspect the vertical accuracy of bathymetric data may be as poor as 3 ft in upper bay and closer to 1 ft in lower bay. To evaluate DTM accuracy over land, a comparison was made to the original point data and a RMSE of 0.7 ft was measured. Therefore, based on the RMSE of the measurement and resampling errors we estimate the vertical accuracy of the DTM to be 0.9 ft over land.

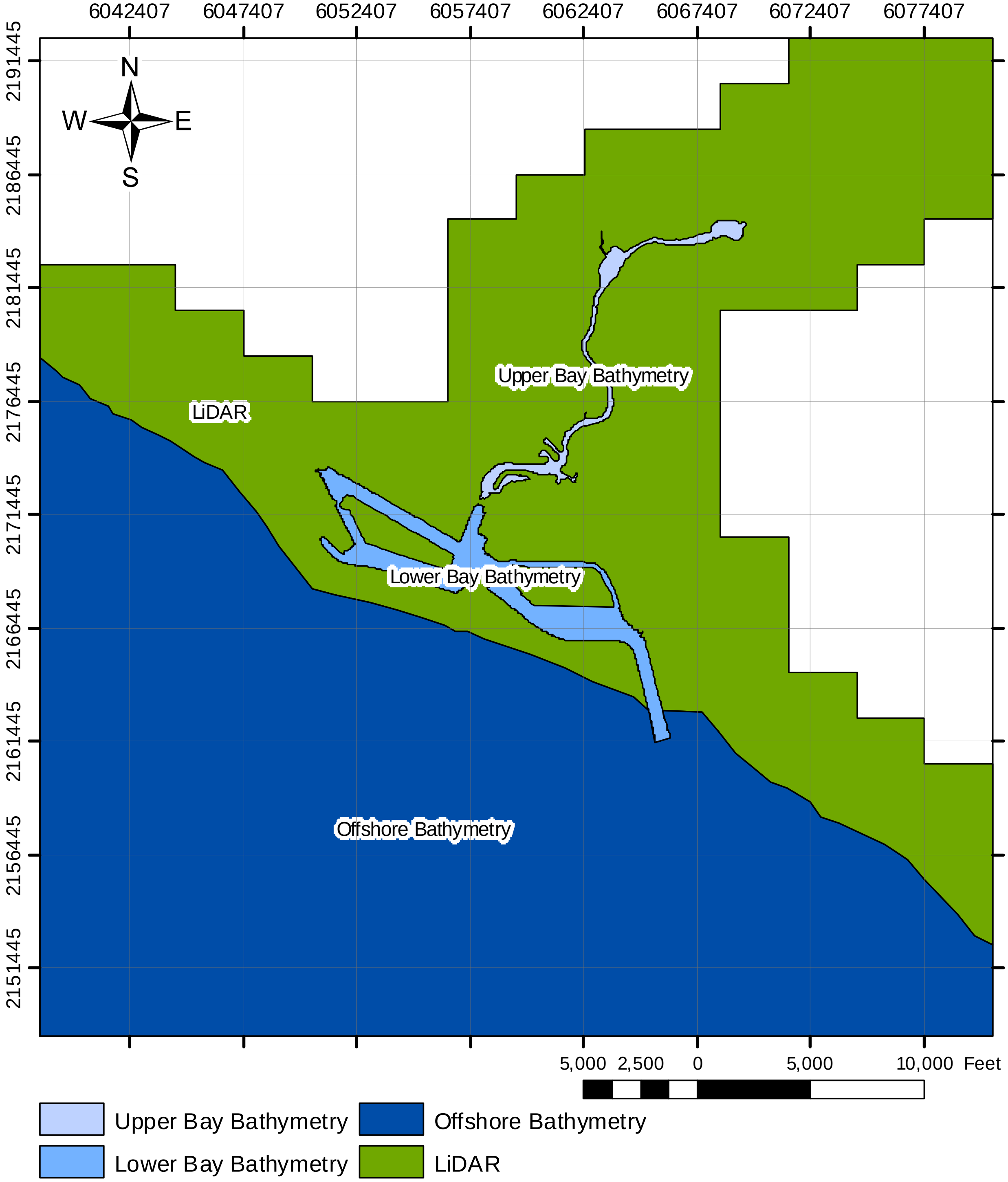

Figure 2.1: Coverage of data sources that were merged to create a Digital Terrain Model (DTM) of the Newport Harbor area.

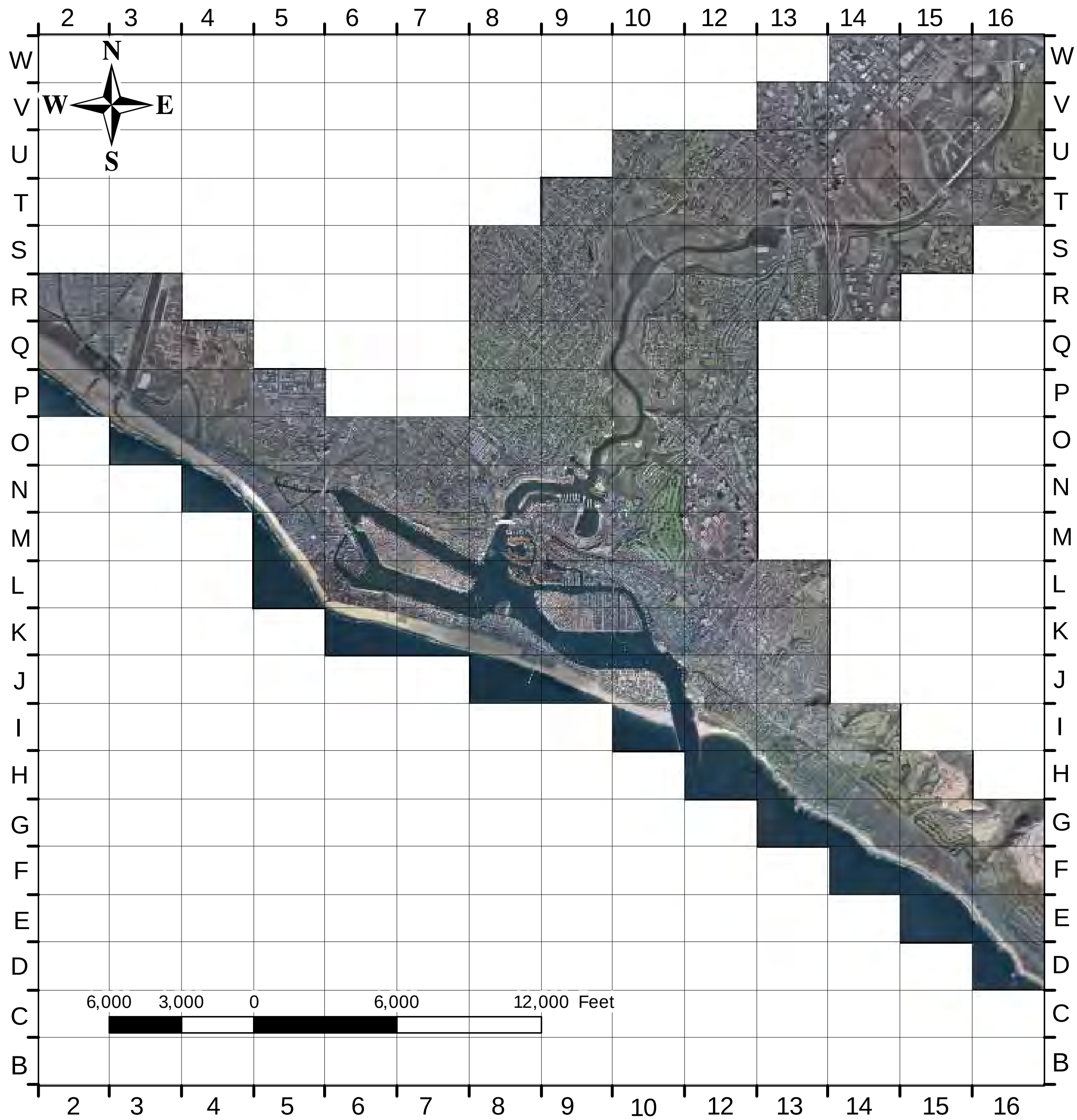

Figure 2.2: Tiles corresponding to imagery and LiDAR data selected for inclusion in Digital Terrain Model (DTM)

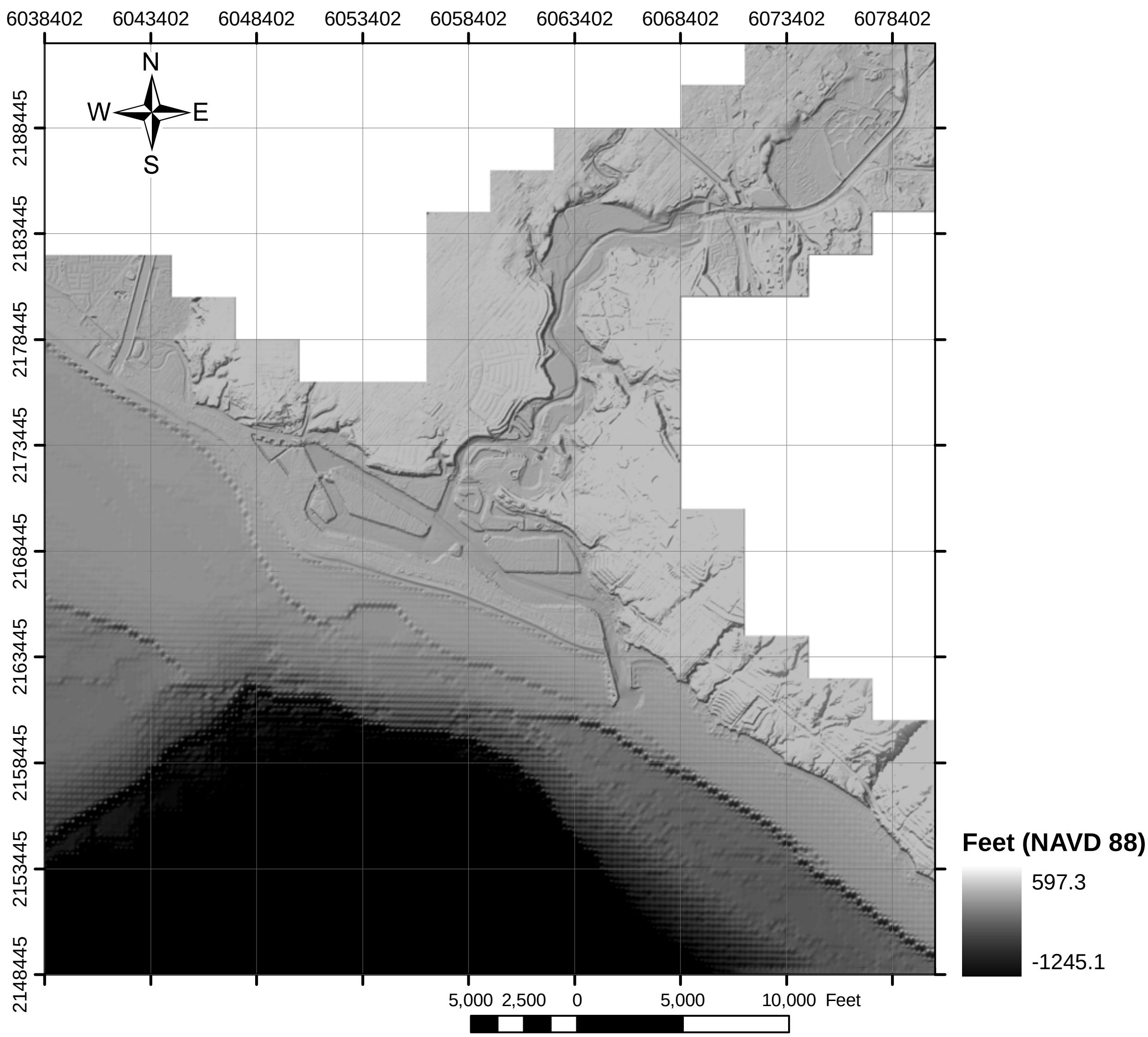

Figure 2.3: Hill shade plot of digital terrain model (DTM).

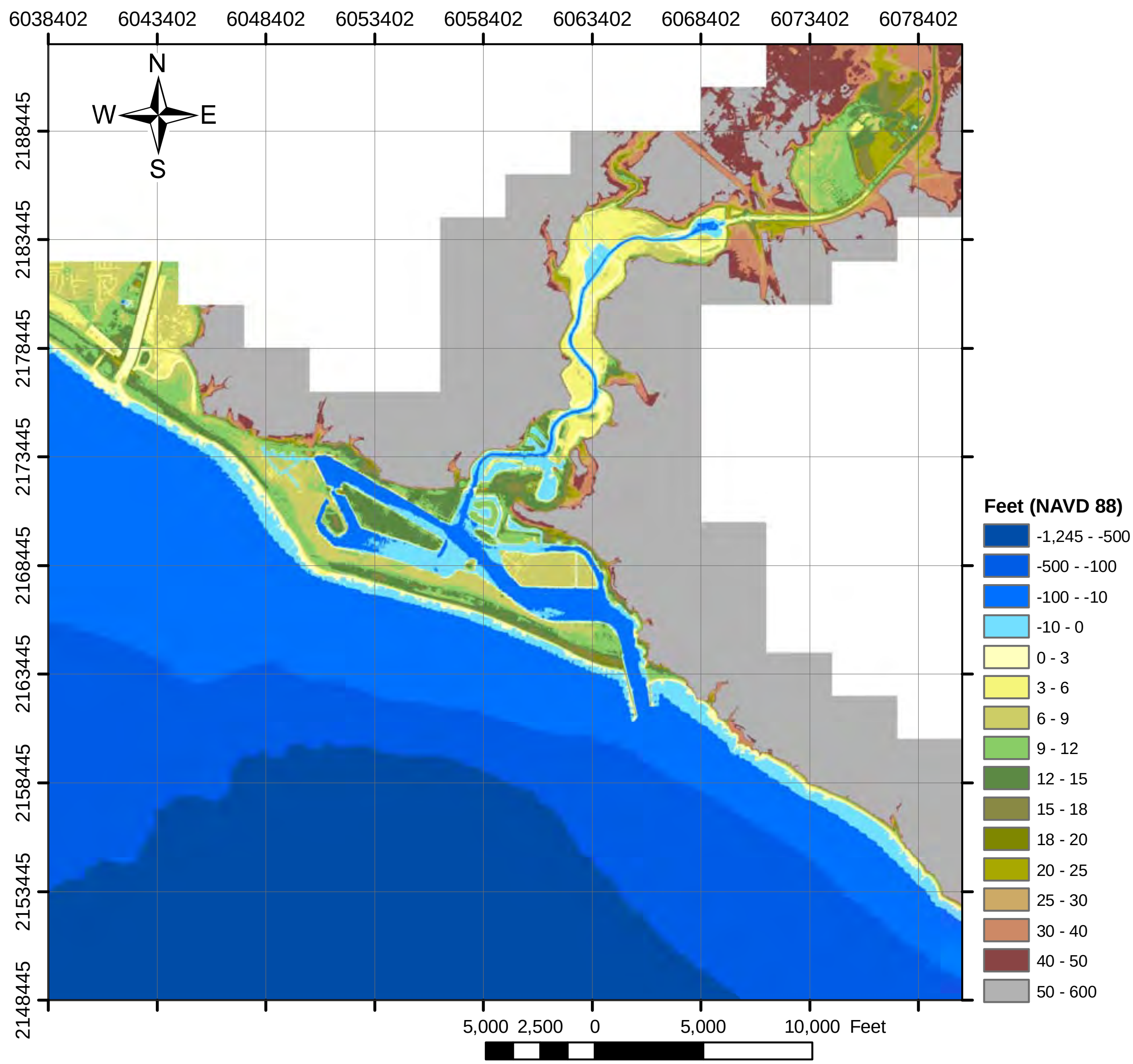

Figure 2.4: Contour plot of terrain height depicted by digital terrain model (DTM).

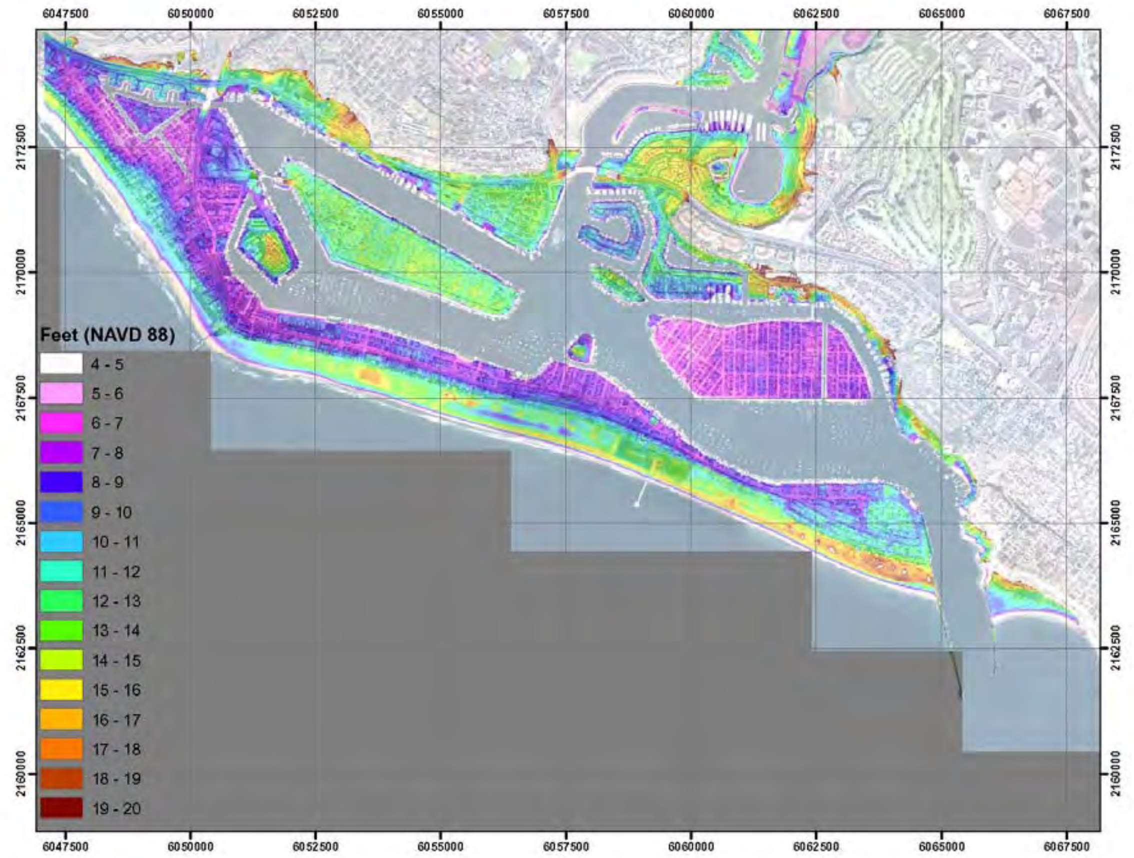

Figure 2.5: Contour plot of terrain height depicted by digital terrain model (DTM) overlain upon aerial imagery.

Chapter 3: Review of Historical Tides and Development of Design Tides

This chapter begins by reviewing historical tides to elucidate the salient features that bear on coastal flooding risk. This includes the seasonal and inter-annual variability of the high tides due to astronomical factors as well as anomalies associated with ENSO events and winter storms which we will call Non-Tidal Residuals (NTRs). We also look to the future to identify those years when extreme tides are expected to be maximum according to astronomical factors, and we consider trends in sea level rise. Finally, the range of tides heights that could result from the combined effects of high astronomical tides, NTRs and sea level rise are identified and used to identify a set of tide scenarios for flood inundation modeling. The results of subsequent model simulations are expected to provide insight into the vulnerability of the Newport Harbor area to flooding and likely patterns of inundation.

An important caveat to note is that the modeling aspect of this study is focused on extreme tides which are most important relative to flooding of Newport Harbor; we are not considering ocean waves in our modeling which could contribute to flooding via overtopping of the beach dunes and temporary sand berms along the open coast. This is outside the scope of the present study but should be considered in a future study.

3.1 Data Sources

To review historical tides, tide height data were obtained from the NOAA Center for Operational Oceanographic Products and Services (CO-OPS) “Tides and Currents” website, http://co-ops.nos.noaa.gov/ (Data accessed April, 2008). Year-long records of hourly tide predictions and measurements for Station ID: 9410660 (Los Angeles) were accessed for 1982-2007. In addition, year-long records of hourly tide predictions were accessed for 2008-2020. All tide heights were saved in units of feet relative to Mean Lower Low Water (MLLW) and relative to Greenwich Mean Time (GMT). Los Angeles was chosen because it is the nearest NOAA tide station with tide measurement data. A review of benchmark data for Los Angeles versus Newport Harbor shows that tide heights typically differ by less than an inch. For example, NOAA benchmark data reports that the mean tide range at Newport Harbor is 3.76 ft versus 3.81 ft at Los Angeles, a difference of 0.05 ft or 0.6 inches.

In order to examine sea level heights in relation to climatic conditions of the Pacific Ocean, the monthly Oceanic Nino Index (ONI) was obtained for the period 1950-2007 from the NOAA, National Weather Service (NWS) Climate Prediction Center http://www.cpc.noaa.gov/index.php (Data Accessed April, 2008). The ONI represents the sea surface temperature anomaly (^{o}C) for the equatorial Pacific region defined by 5^{o} N-5^{o} S and 120^{o}-170^{o} W, averaged over a three month period. El Nino (warm) and La Nina (cool) events are defined by 5 consecutive months above +0.5 ^{o}C or below -0.5 ^{o}C, respectively.

Sea level rise projections associated with global climate change were also reviewed. For example, an Intergovernmental Panel on Climate Change (IPCC) 2007 report calls for a global mean sea level rise of 0.6 to 1.9 ft by 2100 (IPCC 2007), a USEPA report suggests there is a 10% chance sea level will rise 2.9 ft by 2100, and a California Coastal Commission report suggests that 3 ft of sea level rise is "very likely" by 2100. The California Coastal Commission report cites the USEPA study in arriving at the 3 ft figure, so it appears that "very likely" implies a 10% chance. A more recent study based on satellite observations indicates that, globally, sea levels are rising at a rate of approximately 0.01 ft per year (Colorado Center for Astrodynamics Research, http://sealevel.colorado.edu/). Were this rate extrapolated to 2100, the increase in sea level would be approximately 1 ft. However, climate models indicate that this rate is likely to increase over time, pointing to a higher cumulative rise by 2100 (IPCC 2007). In addition, sea level will not rise uniformly over the earth so the rate in Newport Beach could be higher or lower. Furthermore, these numbers do not reflect the considerable uncertainty in future sea levels related to the stability of the Greenland and West Antarctic ice sheets. There is enough water in the Greenland ice sheet to raise mean sea level 23 ft, and the West Antarctic ice sheet could raise sea levels by 17-20 ft. However, there is no consensus regarding the time scale over which these ice caps could melt. The preceding information points to considerable uncertainty in the magnitude of sea level rise, but a clear indication that a rise in the range of 1-3 ft by 2100 is likely.

3.2 Data Analysis Methods

Hourly Non-Tide Residuals (NTRs) were computed for years 1982-2007 by subtracting the predicted tide height from the measured tide height. Positive NTR corresponds to higher tides than predicted and negative NTR correspond to lower tides than predicted.

To characterize the magnitude and frequency of historical NTRs during the winter season when maximum astronomical tides occur, hourly NTRs for the months of December, January and February were compiled for each year between 1982/83 and 2006/07 and rank ordered. From this ranking the 98th percentile NTRs were extracted; this corresponds to a 2% exceedance probability.

To examine possible linkages between NTRs and climatic conditions (e.g., El Nino), annual NTR were plotted versus ONI for January of each year and analyzed for trends.

Lastly, hourly tide forecasts for the years 2000-2020 were reviewed to identify future instances of extreme high tides according to astronomical factors alone. Maximum monthly tide heights were tabulated to help readily identify the years and months with the highest expected tides, and a plot of monthly maximum tide heights was prepared.

3.3 Results

Appendix I shows plots of measured hourly tides (top panels) and NTR (bottom panels) during January, February and December of each year from 1982 to 2007 (26 years). A review of the measured tides shows that the highest tide on record nearly reached the 8 ft mark (relative to MLLW) on January 28, 1983, and a tide of nearly the same magnitude occurred on January 10, 2005.

Widespread flooding and storm damage occurred all along the California coastline as a consequence of the 1983 event (Zetler and Flick 1985). Reports of widespread flooding along Balboa Peninsula appeared in the Orange County Register. The 2005 event appeared to have far less state-wide impact, probably because of less wind and wave energy. A prominent spike in NTR lasting several hours and coincident with the 1983 event (Appendix I) reflects the strength of storm conditions; the spike is relatively small in the case of the 2005 event. However, City staff photo-documented flooding at several sites on Balboa Peninsula and Balboa Island in 2005. Hence, it is clear that a tide of 7.8 ft (MLLW) or higher causes considerable flooding.

Further inspection of the NTR time series from December of 1982 through February of 1983 (Appendix I) shows that sea levels can rise 0.5 ft or more above predicted tides and persist for a week or more at a time, even reaching heights over 1.0 ft above predicted tides. In January and February of 1992, and December of 1997 through February of 1998, elevated NTR are observed and these episodes all correspond to strong El Nino conditions. There are also many instances of NTR greater than 0.5 ft lasting less than a week and as short as a few hours. For example, in February 2002 an NTR of nearly 1 ft lasted only about a day.

Appendix II shows the NTR probability distribution for each winter season based on the rank-ordering of hourly NTR levels over three months (Dec-Jan-Feb). A review of these plots shows that in many years NTR is less than 0.5 ft 100% of the time, but in other years NTR values exceed 1.0 ft. For example, during the strong El Nino winter of 1982-83, NTR exceeded 1 ft roughly 1% of the time and exceeded 0.5 ft about 30% of the time. Large NTR values also occurred during the 1997-98 winter; NTR exceeded 1.0 ft 3% of the time and exceeded 0.5 ft about 40% of the time.

To further explore the association between NTR and strong El Nino conditions, the 98th percentile NTR for each winter (2% exceedance probability) was plotted versus ONI as shown in Figure 3.1 and a positive correlation was identified (R^2=0.72, $p<0.05$). The implication for coastal flooding is not only that the probability of coastal flooding, or flood risk, varies from year to year depending on climatic conditions in addition to astronomical factors (Zetler and Flick 1985, Flick 1986), but that the stronger the El Nino the greater the coastal flood risk. There are important exceptions to this trend, however. Figure 3.1 shows two instances where NTR exceeded 0.5 ft even though ONI values were between 0 and 1 ^{o}C corresponding to El Nino neutral or weak El Nino conditions. On the other hand, Figure 3.1 also shows that 2% exceedance probability NTR values never exceeded 0.5 ft when ONI values were less than zero (i.e., during La Nina conditions). This suggests that coastal flood risk is minimized during La Nina conditions.

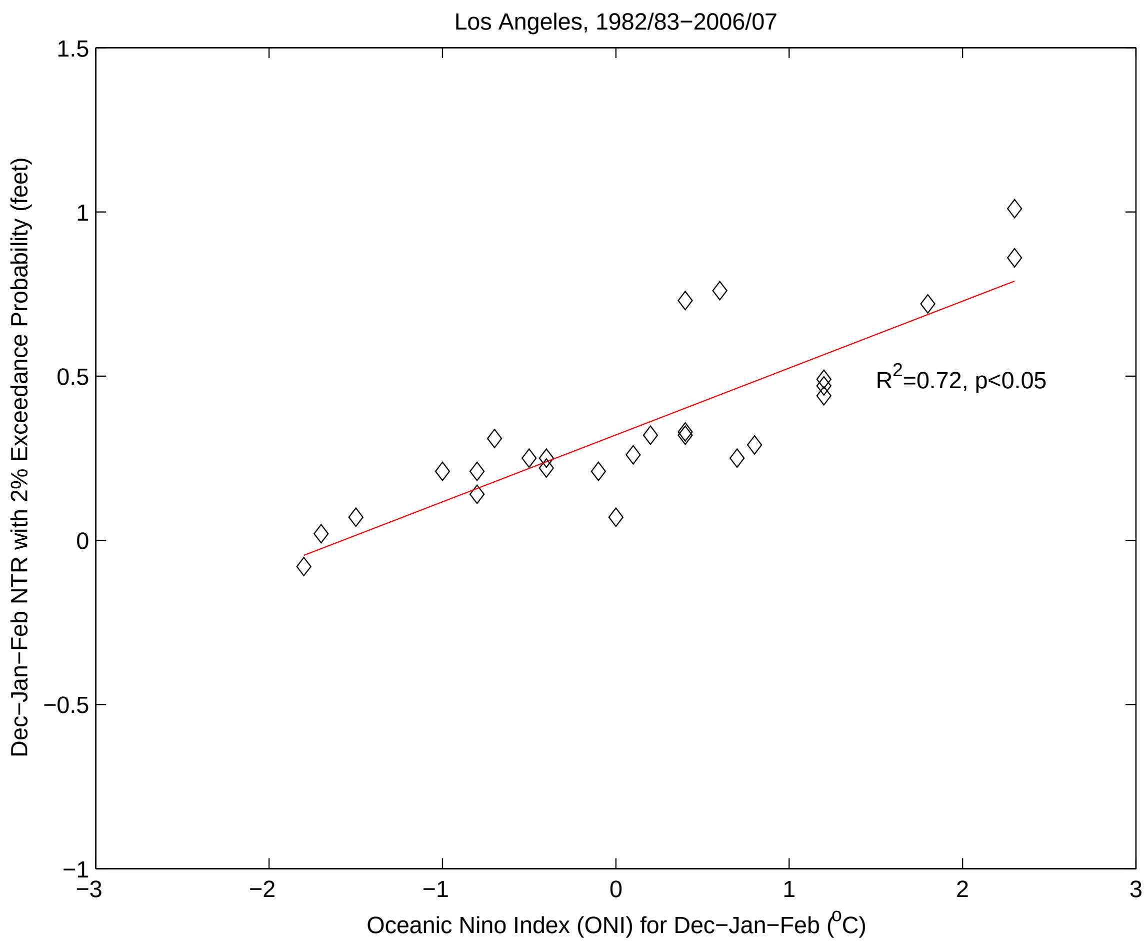

Figure 3.1. A plot of 2% exceedance probability NTR versus ONI shows significant correlation (R^2=0.72, $p<0.05$), but note that NTR exceeding 0.5 ft have also occurred during weak El Nino and El Nino neutral winters (0<ONI<1).

Given the strong association between ONI and NTR, coastal communities in Southern California such as Newport Beach should consider monitoring ONI on a monthly basis (particularly in Fall and Winter) in addition to predicted tide heights to gage the risk of coastal flooding. Positive ONI should be taken as a signal that the risk of coastal flooding will be heightened during the winter storm season, particularly during times when astronomical tide heights are maximum.

Figure 3.2 shows the height of monthly maximum high tides through 2020 based on astronomical factors. In addition, Appendix III shows tide predictions for January, February and December of each year from 2008-2020. Note that the highest high tide over this period (7.3 ft above MLLW) is predicted to occur *this coming winter* at approximately 08:00 local standard time on December 12, 2008. Over the next five years, winter high tides exceeding 7 feet will also occur in December 2009, 2011 and 2012.

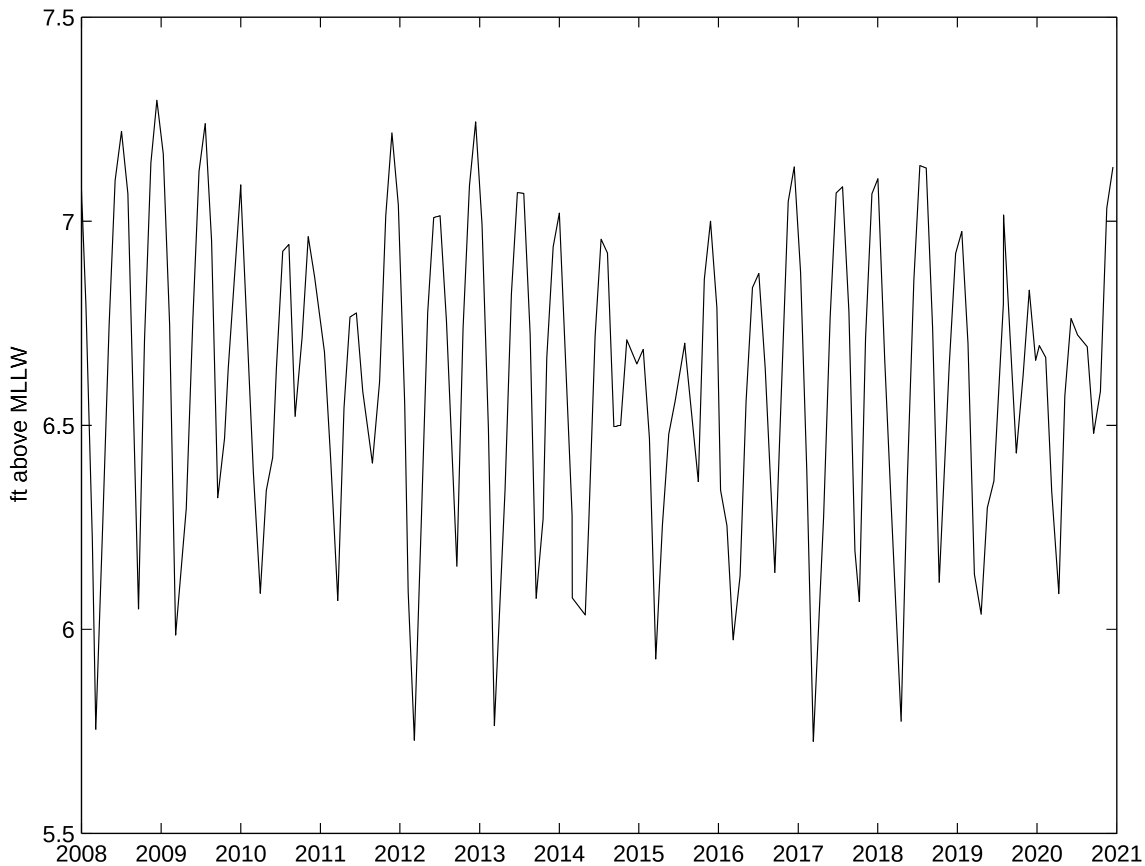

Figure 3.2. Monthly maximum high tides for Los Angeles between 2008 and 2020. There are two peaks per year corresponding to maximum high tides in summer and winter. Note also the 4.4 year cycle reported by Zetler and Flick (1985) and Flick (1986).

3.4 Hypothetical Tide Scenarios

Flood inundation resulting from hypothetical extreme tide scenarios will be modeled in this study to identify regions of Newport Harbor vulnerable to flooding. The preceding analysis highlights the primary factors that should be considered in designing a flooding scenario including astronomical components, NTRs and global climate change. Here we aim to identify a set of tide scenarios that qualitatively reflect a reasonable range of present day and future flood risk. A quantitative approach of identifying risk is not recommended at this stage given the complexity of factors affecting tide levels and the associated trends (e.g., global sea level rise).

Given that historical tides have nearly reached the 8 foot level (above MLLW) twice since 1982, that NTRs can add another foot of height to sea levels, and between 1 and 3 ft of sea level rise has been forecast for the year 2100 as a consequence of global climate change, we propose three tide scenarios with peak heights that are 8, 9 and 10 ft above MLLW. These scenarios were chosen for a number of reasons. First, whole numbers are simple to remember and given that tides are commonly tabulated in feet relative to MLLW, these scenarios should be easy to grasp, conceptually. Second, these scenarios represent a range of heights that could occur by 2100 from the combined effects of high astronomical tides, NTR effects, and sea level rise. Third, a set of three tide scenarios should enable the basic trends in flooding such as the flood extent and depth of inundation to be identified.

A trigonometric formula is proposed to model the tide scenarios as follows,

$$h(t) = H_0 + A_1 \cos\left(2\pi \frac{t - t_1}{t_2}\right) + A_2 \operatorname{sech}^2\left(\frac{t - t_3}{t_4}\right) \tag{3.1}$$

where H_0 represents a baseline sea level (similar to but not precisely equal to mean sea level), A_1 represents the amplitude of the harmonic component of the tide described by the cosine function with period t_2 and phase t_1, and A_2 represents the amplitude of a unimodal surge in sea level described by the hyperbolic secant function (squared) with a peak time t_3 and a duration parameter t_4. The value of these parameters for each of the three tidal scenarios is shown in Table 3.1, and Figure 3.3 graphically illustrates the three tide scenarios as well as the hyperbolic secant function.

	8 foot tide	**9 foot tide**	**10 foot tide**
H_0	3.18 ft	3.18 ft	3.18 ft
A_1	3.82 ft	3.82 ft	3.82 ft
A_2	1.00 ft	2.00 ft	3.00 ft
t_1	0 hrs	0 hrs	0 hrs
t_2	12 hrs	12 hrs	12 hrs
t_3	12 hrs	12 hrs	12 hrs
t_4	2 hrs	2 hrs	2 hrs

Table 3.1. Parameters proposed for tide scenarios. Note use of identical parameters in each case except for A_2, which is used to adjust the magnitude of each scenario.

It is not possible at this time to assign a probability to these flooding scenarios due to the uncertainty in sea level rise predictions, the intermittency of NTR, and the unknown likelihood that large NTR would be coincident with high astronomical tides. Further, it is not possible to rule out that an extreme tide even larger than 10 ft might occur before 2100. If mean sea levels do increase by 3 ft by 2100, such a tide would in fact be likely.

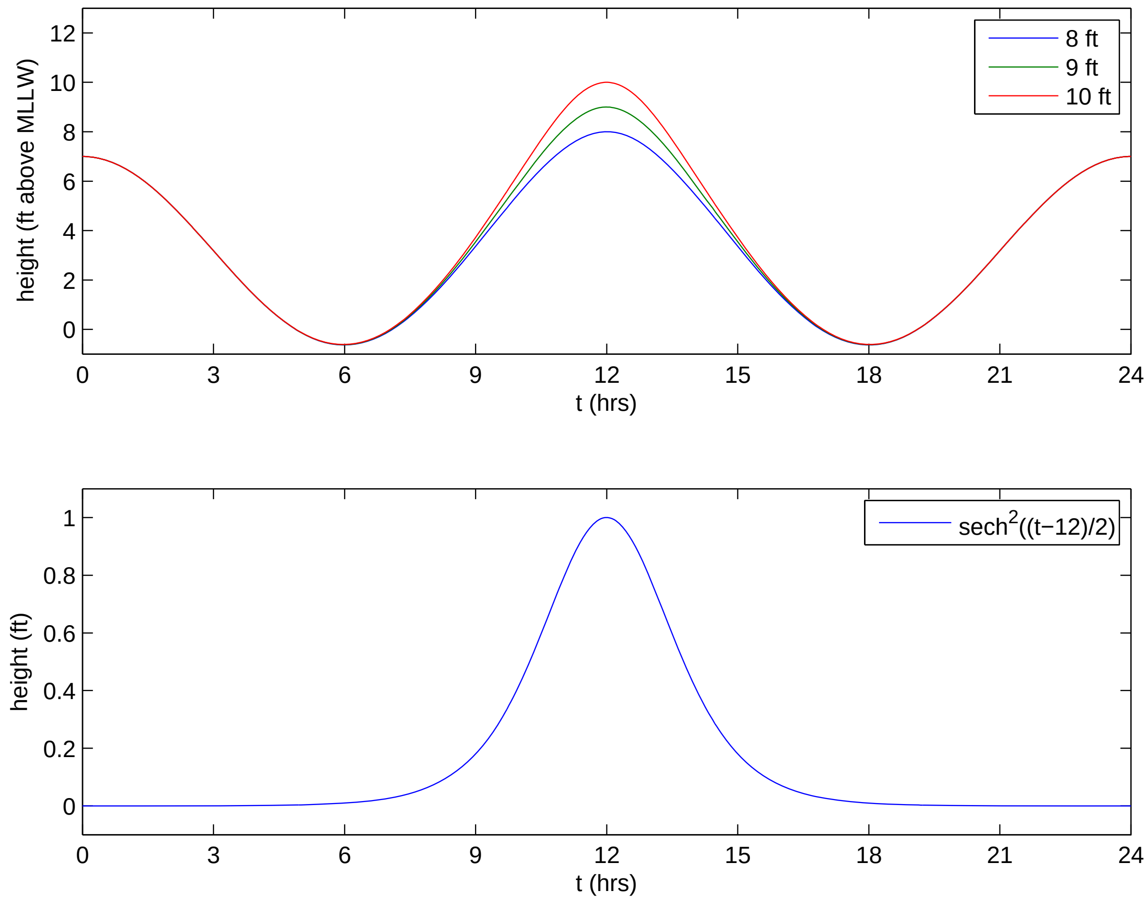

Figure 3.3. Top panel shows tide scenarios recommended for flooding analysis including 8 ft, 9 ft, and 10 ft cases. Bottom panel shows the hyperbolic secant function used to scale the magnitude of the tide.

Chapter 4: Review of Tidal Flood Control Infrastructure

This chapter provides an overview of infrastructure and operating practices that are presently in use to protect the harbor area from flooding by extreme high tides. Further, based on a combination of limited first-hand observations, analysis of aerial imagery and Light Detection and Ranging (LiDAR) topographic data, and information supplied City staff, we report on the potential for this infrastructure to provide protection from future extreme tides. The first three sections of this chapter describe observational data in the order it was collected. Section 4.1 describes observations from a first survey of bulk heads, Section 4.2 describes observations during a ride-along with Mr. Thomas Miller of the City's General Services Department, who closed tide valves in anticipation of an extreme high tide. Section 4.3 describes observations from a second survey of bulk heads, those around Balboa and Little Balboa islands.

4.1 First Survey of Bulk Heads

The digital terrain model (DTM) presented in Chapter 2 (Figs. 2.3-2.5) depicts ground heights in and around Newport Harbor. Many regions fall below the height of extreme high tides, but these do not necessarily flood because elevated bulk heads or sea walls are in place to provide protection. On March 25, 2008, Dr. Sanders visited the site to become familiar with site conditions and estimate the elevation of several bulk heads above a reference datum (NAVD 88). This information was collected to characterize the threshold of tidal flooding (i.e., overtopping) which is required for accurate flood modeling. A few sites without sea walls were also observed, in which case the ground height represents the threshold for flooding. Note that the efforts described here do not represent a comprehensive, high-precision survey of bulk heads. This would require a qualified surveyor which was not part of this study design. The efforts described here provide a representative sample of bulk head heights with a vertical accuracy of approximately 0.6 ft, which is reasonable for the purpose of this study which is to identify the flood vulnerable areas of the harbor related to extreme high tides.

To guide the first bulk head survey, the DTM shown in Fig. 4.1 was manually inspected to identify the lowest regions of developed land around the bay. Recognizing that annual maximum high tides typically reach about 7 ft (MLLW) or 6.8 ft (NAVD 88), Fig. 4.1 shows that there are essentially two built areas vulnerable to flooding by present-day tides. The first is Balboa and Little Balboa Islands, particularly the western half of Balboa Island. The second is the bay side of Balboa Peninsula, along nearly its full length, including the region surrounding Newport Island Channels and the western side of the Rhine Channel. Consequently, bulk heads in both of these areas were examined.

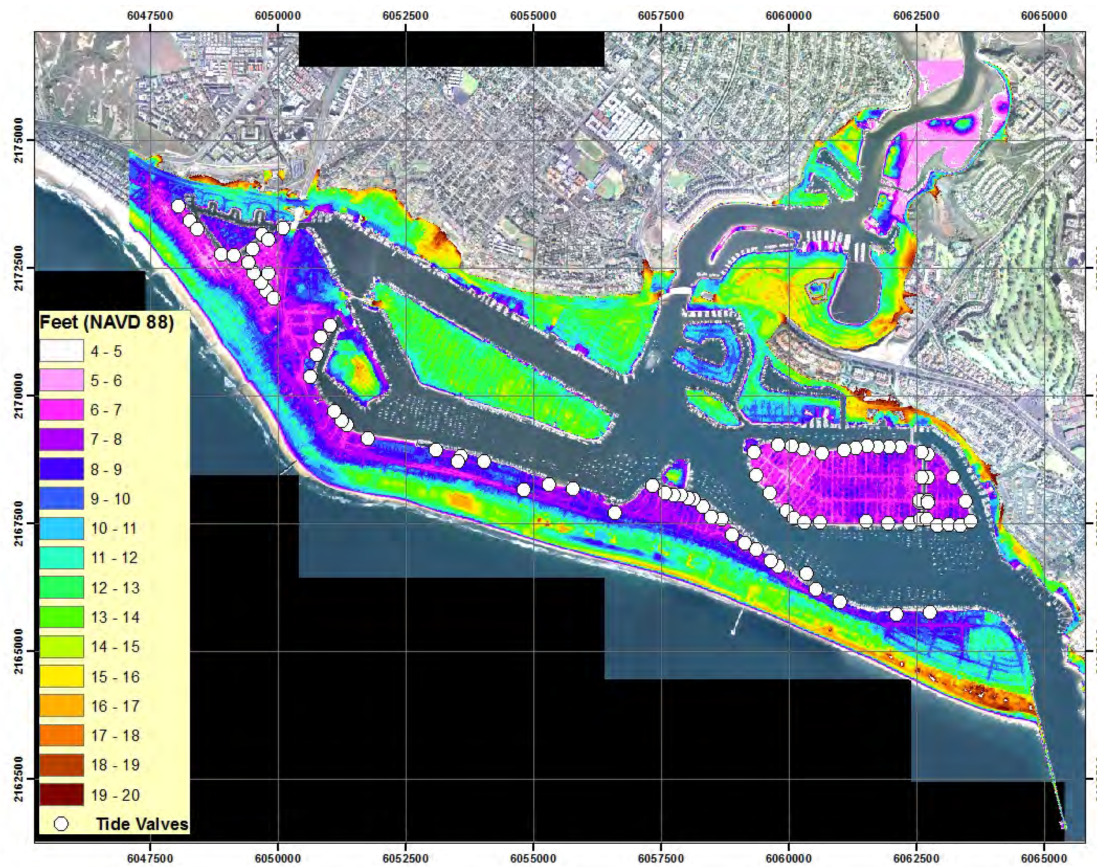

Figure 4.1. Contours of ground elevation in the Newport Harbor area depicted by a DTM based on a 2006 LiDAR survey, and location of tide valves that prevent back-flooding through storm sewers. Note that annual maximum high tides typically exceed 7 ft but fall short of 8 ft relative to NAVD 88. Heights between 6 and 7 ft appear pink.

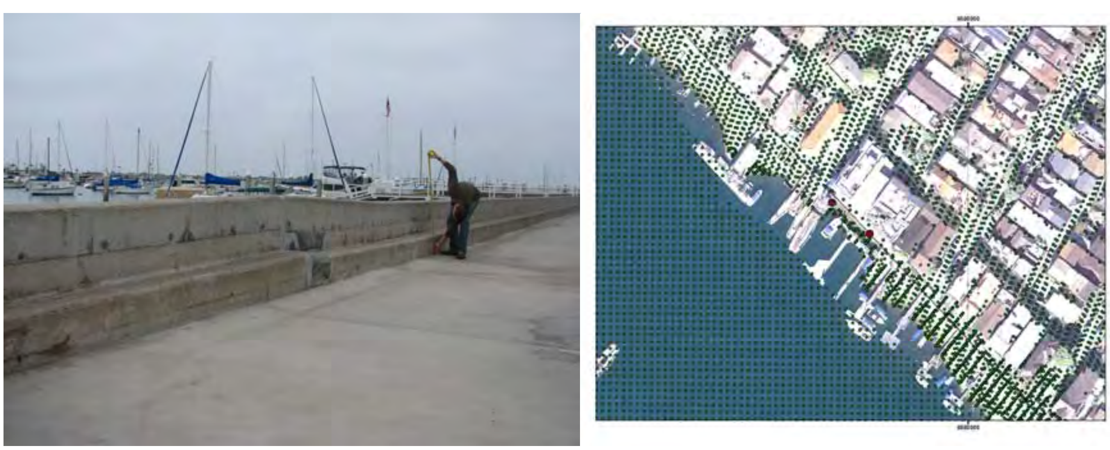

Figure 4.2. The elevation of sea walls was estimated at selected locations by adding measurements of wall height (left) to LiDAR-based estimates of ground elevation (right) which appear as green dots.

The height of elevated bulk heads or sea walls was measured with a tape-measure, as shown in Fig. 4.2, and added to LiDAR-based estimates of ground elevation to obtain the bulk head elevation. LiDAR point measurements of ground elevation, which appear as green dots in the image on the right in Fig. 4.2, were used to indicate the ground elevation. In each case, the nearest available LiDAR survey point representative of the surface next to the bulk head (e.g., sidewalk) was used. Recall the vertical accuracy of LiDAR point measurements is less than 0.6 ft, and we estimate the vertical accuracy of the tape measurement to be less than 0.1 ft, so we estimate the vertical accuracy of bulk head heights to be less than 0.6 ft. At some of the examined sites, the bulk head was not elevated as in a wall so the height is based on LiDAR point measurements only. Fig. 4.3 shows sites around the harbor where the preceding method was applied, and results are shown in Table 4.1. Note that elevations are listed relative to NAVD 88 and MLLW.

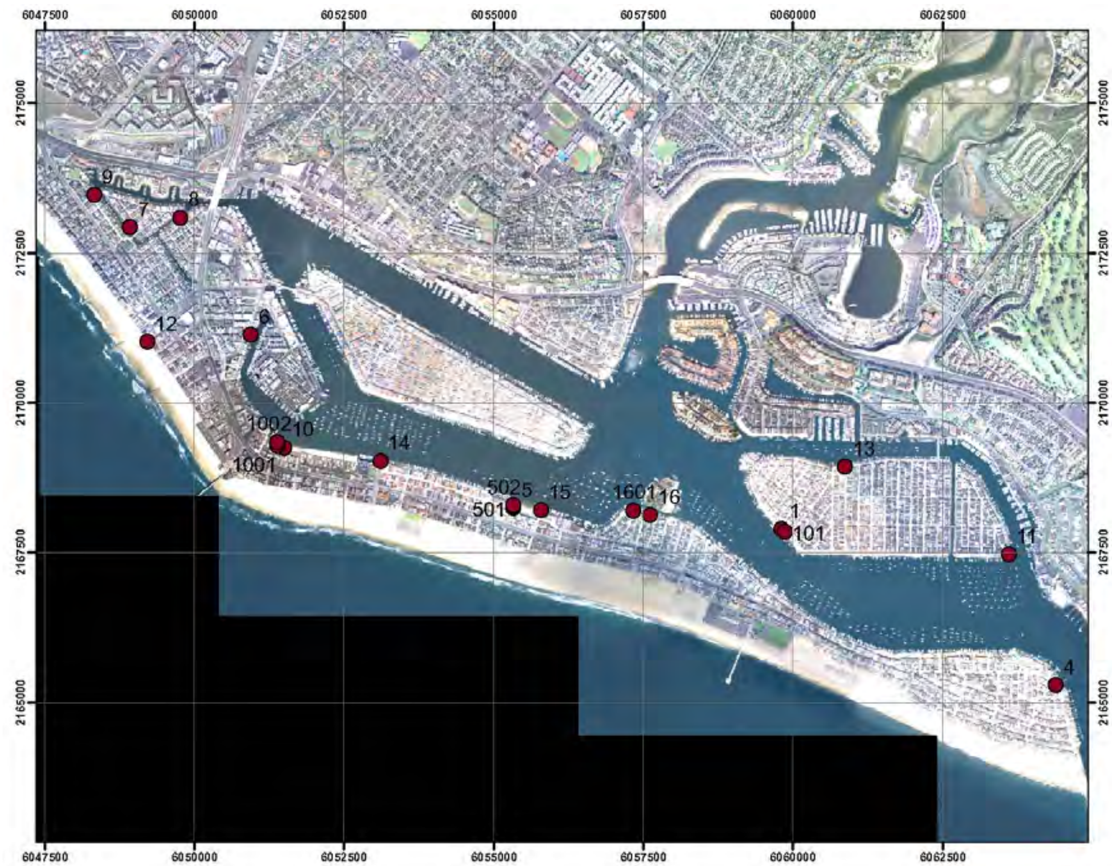

Figure 4.3. Sites where the elevation of sea defenses was estimated by adding wall heights to LiDAR estimates of ground height, as shown in Fig. 4.2.

These data suggest that overtopping of bulk heads can occur with tides as small as 7.0 ft (MLLW). This corresponds to the Balboa Island Ferry ramp on Balboa Island. Further, these data indicate heights for Balboa Island bulk head of 7.3, 8.4 and 8.5 ft and a height of 9.2 ft for the Little Balboa Island bulk head. Around Newport Island channels, heights ranging from 7.8 to 9.1 ft (MLLW) were estimated, along the Rhine channel a height of

8.8 ft was estimated, and further east along Balboa Peninsula heights ranging from 7.8 to 11.3 ft were estimated. The majority of Peninsula bulk heads are estimated to be lower than 9 ft based on these data.

The DTM shown in Fig. 4.1 also indicates that beach heights along the open coast vary considerably along the Peninsula, as low as 10-11 ft northwest of Newport Pier, and as high as 19-20 ft south of Balboa Pier. Based on these heights, it is not clear that all developed land along of the beach is adequately protected against wave-driven flooding, particularly the West Newport region northwest of Newport Pier. The effect of waves on flooding is outside the scope of this study, but a future study is recommended to examine this and determine the amount of beach sand that is needed for flood protection purposes.

Location	ID	notes	Wall Height ft	Ground Elev. ft (NAVD)	Bulk Head Elev. ft (NAVD)	Bulk Head Elev. ft (MLLW)
Balboa Is.	1		1.7	5.9	7.5	7.7
Balboa Is.	101		2.3	6.0	8.2	8.4
Balboa Is.	102	ramp to ferry	0.0	6.8	6.8	7.0
Peninsula	4	from_road	2.5	8.6	11.1	11.3
Peninsula	5	from_road	1.8	6.7	8.5	8.7
Peninsula	501	from_sidewalk	1.4	6.4	7.8	8.0
Peninsula	502	from_sidewalk	1.5	6.4	7.9	8.1
Rhine Ch.	6	from_road	3.1	5.5	8.6	8.8
Nwpt. Is. Ch.	7	no_defence	0.0	8.4	8.4	8.6
Nwpt. Is. Ch.	701	just to the NW	0.0	7.6	7.6	7.8
Nwpt. Is. Ch.	8		2.2	6.7	8.9	9.1
Nwpt. Is. Ch.	9	no_defence	0.0	7.8	7.8	8.0
Peninsula	10	from_road	1.0	7.3	8.3	8.5
Peninsula	1001	no_defence	0.0	7.6	7.6	7.8
Peninsula	1002		2.5	6.0	8.5	8.7
Balboa Is.	11		2.3	6.7	9.0	9.2
Peninsula	12	along_beach	0.0	10.9	10.9	11.1
Balboa Is.	13		1.6	6.7	8.3	8.5
Peninsula	14	no_defence	0.0	7.7	7.7	7.9
Peninsula	15	from_road	2.4	6.5	8.9	9.1
Peninsula	16	from_sidewalk	1.5	7.4	8.9	9.1
Peninsula	1601	from_sidewalk	2.0	6.8	8.8	9.0

Table 4.1. Results of first survey of bulk heads. Sites shown in Fig. 4.3.

4.2 Ride-Along with Mr. Thomas Miller, General Services Department

On evening of July 2, 2008, in anticipation of the summer maximum high tide, Dr. Sanders accompanied Mr. Thomas Miller of the General Services Department as he closed tide valves to prevent back-flooding through storm drains. Tide valves are located where storm drains empty to the Bay along the Peninsula, Balboa Island, and Little Balboa Island. During the ride-along, Mr. Miller provided a list of 86 tide valves maintained by General Services; these are shown in Fig. 4.1 and in the form of two "check lists" in Appendix IV. These "check lists" are filled out by General Services staff as tide valves are closed and opened. The vast majority of tide valves are manually closed prior to extreme high tide conditions, and opened subsequent to high tide conditions, as shown in Fig. 4.4. A very small minority of the tide valves are opened and closed with electronic, motorized valves. There is also one example where a plug is used instead of a valve. Mr. Miller noted that plugs were also used at many privately owned properties to prevent tidal flooding. He reported that several instances of flooding occurred the previous night because plugs on private property were not inserted. Mr. Miller also reported that low bulkheads along private property contributed to tidal flooding, and he noted several sites along the peninsula that were problematic. Most of these sites are utilized as boat yards (i.e., dry dock facilities). Mr. Miller subsequently prepared a list of "High Tide Problem Areas" associated with privately owned lots that contribute to flooding. The location of these is shown in Fig. 4.5.

Figure 4.4. General Services staff is responsible for closing 86 tide valves such as this one that prevent bay water from back-flooding the Harbor area during high tides. Once the tide has receded, the tide valve is opened again to permit drainage.

During the second site visit, Mr. Miller also exhibited several types of flood control facilities utilized by General Services: Temporary sand berms which are constructed at low points along bay-side beaches, seasonal pumps which are set up for Winter, and mobile pumps which can be deployed from pick-up trucks at various locations. The location of three temporary sand berms observed by Dr. Sanders are shown in Fig. 4.5, and each of these was observed to be between 18 and 24 inches tall. Mobile pumps were deployed on Finley Ave. near 36th St., and Newport Blvd at 26th St. Mr. Miller also indicated two additional locations where seasonal pumps were set up during Winter: 30th St. near Lafayette, and River Ave at Channel Place. During the second site visit, mobile pumps were also set up on Balboa Island but these were not observed by Dr. Sanders. The ride-along was limited to Balboa Peninsula.

Dr. Sanders observed several instances of tidal flooding over and through bulkheads during the ride-along. In some cases, flooding was clearly the result of water overtopping a low bulkhead, in other cases flooding resulted from water seeping through flood walls, and in other cases flooding occurred for reasons that are not clear (e.g., unknown leak in flood walls). The most severe case of flooding on the peninsula was observed on 26th Street at Newport Blvd., where back-flooding from a storm sewer caused one of the two northbound traffic lanes along Newport Blvd. to be flooded. The tide valve on the storm sewer at the east end of 26th St. was closed, but the bulkhead there was in poor condition and leaking. Overtopping of the bulk head of a neighboring boat yard was also observed, and this contributed to the observed flooding. Less significant flooding was also observed along Finley Ave. at 34th St., on Marcus Ave. at 38th St., at the East end of Channel Pl., on Bay Ave. at 10th St., along W. Edgewater Ave. between Island Ave. and Lindo Ave., along the Balboa Fun Zone, and at a marina along E. Bay Ave, just east of the Pavilion. The Balboa Pier parking lot was inspected for flooding which could result from the combination of high tides and waves, but none was observed. However, water marks indicated that wave run-up had come within 10 ft (approximately) of the parking lot shortly before our arrival. Further, radio conversations between Mr. Miller and another General Services staff member stationed on Balboa Island indicated that flooding had occurred there as well. Overtopping at the Ferry launch on Agate was reported, as well as flooding at other sites on the island due to a tide valve that would not close completely (it has since been replaced) and seepage through small cracks in the bulk head.

NOAA tide observations at Los Angeles indicate that the tide reached a height of 7.5 ft (MLLW) on the evening of July 2, 2008, 0.3 ft above the predicted high tide level. Given the moderate amount of flooding that was observed on July 2, these observations indicate that the present-day threshold for flooding is between the 7.0 and 7.5 ft level (MLLW). In addition, overtopping of several bulkheads occurred at the 7.5 ft level notably the Balboa Island Ferry ramp and several sites along the peninsula. Leakage of sea defense infrastructure was also observed with water at the 7.5 ft level.

At the beginning of the ride-along, Mr. Miller pointed to a tide stick near Marcus Ave. and 32nd St. that the city uses to indicate and record the height of tides. Further, Mr. Miller noted that heights indicated by the tide stick regularly exceed heights predicted in tide charts. This is likely explained by differences in datums, and the City is encouraged to survey this tide stick to record its height relative to NAVD 88 and MLLW.

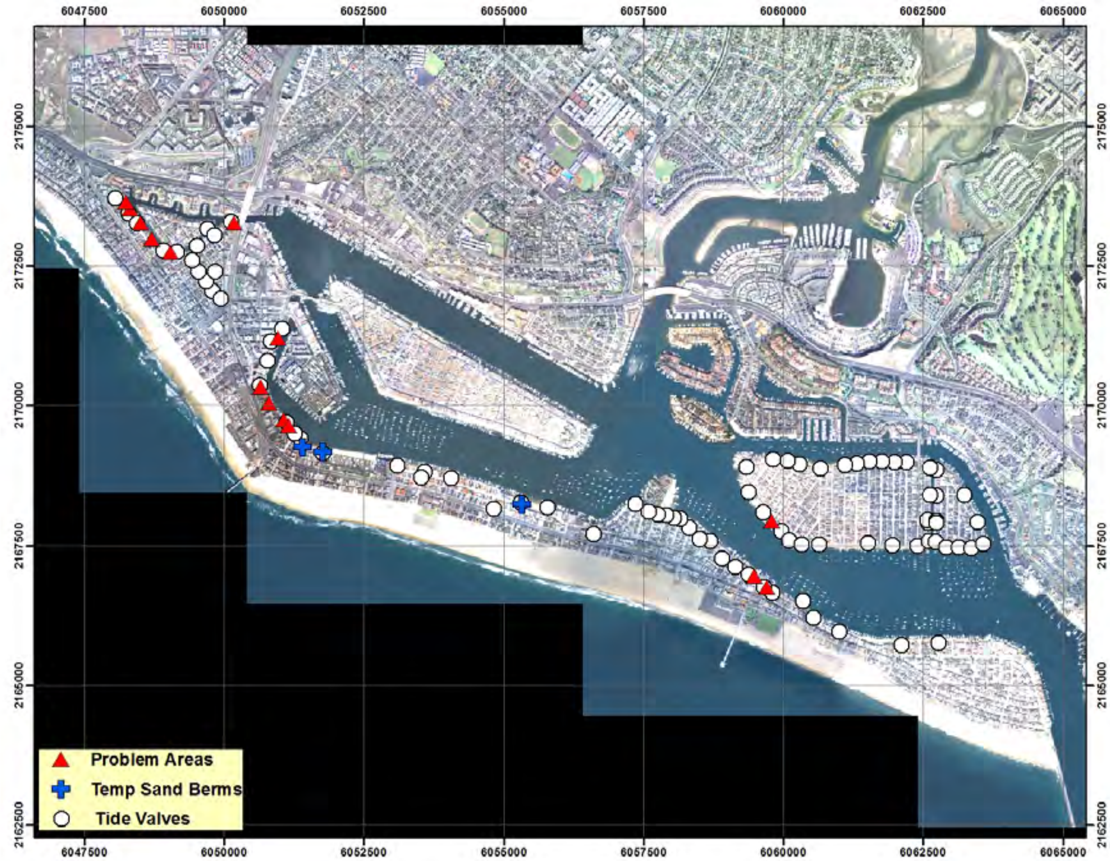

Figure 4.5. Map of Newport Harbor showing "Problem Areas" reported by City General Services staff, the location of temporary sand berms, and tide valves.

4.3 Second Survey of Bulk Heads

A second survey of bulk head heights was completed on September 4, 2008 to improve the characterization of the Balboa Island and Little Balboa Island bulk heads for flood modeling purposes. As in the first survey, bulk head height was estimated by adding LiDAR-based ground elevation data to tape measurements of wall heights. Heights were estimated at each of the tide-valve locations listed in Appendix IV and shown in Fig. 4.1 (around Balboa and Little Balboa islands).

The results of this second survey indicate that the Balboa Island sea wall varies in height between 7.9 and 9.2 ft (MLLW), and the little Balboa Island sea wall varies between 8.7 and 9.8 ft. Recall from the first survey that the ramp to the Balboa Island Ferry corresponds to 7.0 ft, and adjacent to the ramp the bulk head was estimated to be 7.7 ft (MLLW). Hence, the ferry ramp represents the lowest section of the bulk head around Balboa Island.

Island	Location	Wall Height ft	Ground Elev. ft (NAVD)	Bulk Head Elev. ft (NAVD)	Bulk Head Elev. ft (MLLW)
Balboa	Onyx Avenue @ North Bay Front	1.3	7.2	8.5	8.7
Balboa	Amethyst Avenue @ North Bay Front	1.3	7.3	8.6	8.7
Balboa	Apolena Avenue @ North Bay Front	1.2	6.7	7.9	8.1
Balboa	Coral Avenue @ North Bay Front	1.4	6.5	7.9	8.1
Balboa	Sapphire Avenue @ North Bay Front	1.8	6.0	7.8	8.0
Balboa	Diamond Avenue @ North Bay Front	1.7	6.1	7.8	8.0
Balboa	Collins Avenue @ North Bay Front	1.5	6.4	8.0	8.2
Balboa	Pearl Avenue @ North Bay Front	1.7	6.0	7.8	7.9
Balboa	Garnet Avenue @ North Bay Front	1.9	6.0	7.9	8.1
Balboa	Emerald Avenue @ North Bay Front	1.8	6.0	7.9	8.1
Balboa	Park Avenue @ South Bay Front	1.7	6.2	7.9	8.1
Balboa	Emerald Avenue @ South Bay Front	2.2	5.9	8.1	8.3
Balboa	Pearl Avenue @ South Bay Front	2.4	6.3	8.7	8.9
Balboa	Opal Avenue @ South Bay Front	2.1	6.0	8.1	8.3
Balboa	Topaz Avenue @ South Bay Front	1.9	6.3	8.2	8.4
Balboa	Turquiose Avenue @ South Bay Front	2.1	6.3	8.4	8.6
Balboa	Collins Avenue @ South Bay Front	1.9	6.4	8.3	8.5
Balboa	Coral Avenue @ South Bay Front	2.0	6.6	8.6	8.8
Balboa	Amethyst Avenue @ South Bay Front	1.9	6.6	8.5	8.7
Balboa	Marine Avenue @ South Bay Front	1.4	6.8	8.2	8.4
Balboa	109 Grand Canal In Alley	2.2	6.7	8.9	9.0
Balboa	127 Grand Canal @ Park Avenue	2.1	6.9	9.0	9.2
Balboa	201 Grand Canal @ Park Avenue	2.5	6.4	8.9	9.1
Balboa	Balboa Avenue @ Grand Canal	2.3	6.3	8.6	8.7
Balboa	333 Grand Canal In Alley	2.2	6.8	9.0	9.2
Little Balboa	200 Grand Canal @ Park Avenue	2.1	6.7	8.7	8.9
Little Balboa	126 Grand Canal @ Park Avenue	2.1	6.4	8.5	8.7
Little Balboa	106 Grand Canal @ South Bay Front	2.2	6.3	8.5	8.7
Little Balboa	Abalone Avenue @ South Bay Front	2.4	6.8	9.2	9.4
Little Balboa	Crystal Avenue @ South Bay Front	2.3	6.9	9.2	9.4
Little Balboa	Jade Avenue @ South Bay Front	2.3	7.0	9.3	9.5
Little Balboa	107 E. Bay Front @ South Bay Front	2.1	6.8	9.0	9.2
Little Balboa	Park Avenue @ East Bay Front	2.0	6.8	8.8	9.0
Little Balboa	Balboa Avenue @ East Bay Front	2.1	6.8	8.9	9.0
Little Balboa	326 Grand Canal @ Crystal Avenue	1.9	7.7	9.6	9.8
Little Balboa	Balboa Avenue @ Grand Canal	2.0	6.6	8.6	8.8

Table 4.2. Results of second survey of bulk heads. Sites shown in Fig. 4.6.

In Fall of 2007, Dr. Sanders met with Mr. Tom Rossmiller of the Harbor Resources Division, who indicated that Balboa Island and Little Balboa Island bulk heads were designed to be 9 ft above MLLW. Given the vertical accuracy of the bulk head height estimates (less than 0.6 ft), these data suggest that the Little Balboa Island bulk head remains at the design height. However, these data suggest that the Balboa Island bulk head may locally be up to 1.0 ft below the design height. The lowest elevations appear to correspond to the western side of Balboa Island, which Fig. 4.1 shows as being lower than the eastern side. To corroborate this finding, photographs from January 10, 2005 provided by Mr. Tom Rossmiller and shown in Fig. 4.6 were inspected. This corresponds to an extreme high tide that reached a height of 7.8 ft above MLLW according to the Los Angeles NOAA tide gage. The image on the left in Fig. 4.6 indicates that the bay level is within several inches of the wall, while the image on the right indicates that the bay level is closer to six inches below the height of the wall. Collectively, these images show that the sea wall elevation is close to the 8 ft level at these locations which is consistent with the survey results presented earlier.

Figure 4.6. Photographs of the January 10, 2005 high tide that reached the 7.8 ft (MLLW) level. (Photographs provided by Mr. Tom Rossmiller of the Harbor Resources Division).

4.4 Summary

A combination of infrastructure and operating practices are in use around the Harbor to guard against tidal flooding. Infrastructure includes bulk heads (some elevated like sea walls), storm drains with valves or plugs to prevent back flooding, temporary sand berms and pumps. Operating practices include an awareness of environmental factors affecting flooding, procedures to close and open storm drains according to tide levels, an ability to deploy pumps, and efforts to encourage public cooperation with privately owned storm drains and bulk heads that are prone to back-flooding or overtopping, respectively.

This approach demands a high level of readiness and competence of General Services staff. Staff must closely track tide heights and rainfall and prepare to close and open tide valves with the rise and fall of the tide and changes in weather conditions. Staff must also closely coordinate with many private property owners; this is a challenging responsibility. It involves knocking on doors to remind residents to plug drains, encouraging those with low bulkheads to build temporary sea walls with sand bags, fielding complaints and concerns from those expecting the City to provide flood protection, and investigating and remedying instances of flooding related to both public and private infrastructure. Despite these challenges, a very high level of readiness, competence and professionalism was observed of General Services Staff.

When all flood control infrastructure is in place and operating procedures are active, the preceding observations and analysis suggests that the present-day threshold for flooding of Balboa Island is approximately 7.0 ft above MLLW based on overtopping of the Balboa Island Ferry ramp. On Little Balboa Island, the threshold for overtopping is 8.7 ft based on the minimum observed bulk head height but flooding may occur at lower levels due to seepage. On the peninsula, the threshold for flooding is somewhere between 7.0 and 7.5 ft. On July 2, 2008, flooding of the Peninsula commenced at roughly the 7.0 ft level because of a leaky bulkhead on 26th St.

Chapter 5: Modeling of Tidal Flooding Scenarios

5.1 Background

A computer model, BreZo, developed by Dr. Sanders at UC Irvine was applied to simulate flooding caused by the combined effects of an extreme high tide and stream flow into Upper Newport Bay from San Diego Creek and Santa Ana Delhi Channel. The computer model solves 2D flow equations to predict the spatial and temporal distribution of water depth and horizontal velocity. The equations are solved in each of the approximately 250,000 cells that make up the computational mesh shown in Fig. 5.1. At the southern boundary of the model domain, far offshore of the harbor, the water level is specified using Eq. 3.1 to simulate the rise and fall of an extreme high tide. Concurrently, water is added to the domain at a point in Upper Newport Bay close to Jamboree Road to simulate the input of stream flow from San Diego Creek and Santa Ana Delhi Channel. Based on these two constraints, i.e., the water level offshore of the harbor and the stream flow into Upper Newport Bay, the computer model predicts the depth and velocity of water inside the bay. If and when water rises above bulk heads along the shoreline of the bay, the model resolves the flooding of water inland and the subsequent recession that ensues once the tide reaches its maximum height and begins to fall.

BreZo is state-of-the-art, multi-dimensional flood inundation model. A comprehensively description can be found in a series of archival journal papers (Begnudelli and Sanders 2006, Begnudelli et al. 2008, Sanders 2008, Schubert et. al. 2008). Nevertheless, note that the model was applied to account for tidal and stream flow effects only. It was not configured to account for flooding caused by waves or precipitation.

5.2 Computational Mesh

The computational mesh used by BreZo, shown in Fig. 5.1, requires that ground elevation be assigned to each of the mesh vertices and a flow resistance parameter be assigned to each of the cells in the mesh. For this study, NAD 1983 California State Plane Zone VI (feet) was adopted for horizontal control and NAVD 1988 was adopted for vertical control. This made it straightforward to use the DTM presented in Chapter 2 to assign an elevation to each of the vertices. However, the DTM does not necessarily reflect the height of bulkheads (particularly sea walls) because these are relatively thin, linear features that cannot be detected by the airborne laser sensor. To accurately depict sea walls, the strategy adopted in this study was to align edges of the mesh with each wall (x and y coordinate) and to assign vertex elevations (z coordinate) consistent with bulkhead heights reported in Chapter 4. The model also accounts for flow resistance (or friction) using a parameter known as the Manning coefficient which was set to $n=0.025\ m^{-1/3}s$. This value was selected based on previous modeling studies of Newport Bay.

A spatially variable mesh resolution was used in this study to focus computational resources on the areas most likely to be impacted by tidal flooding, as indicated by Fig. 5.1. The finest resolution (*ca*. 30 ft) was used for all islands and shoreline around lower bay, an intermediate resolution was used for the channels and open water areas of the bay (*ca*. 80 ft), and the coarsest resolution (*ca.* 1000 ft) was used offshore. The meshes consist of approximately 250,000 computational cells.

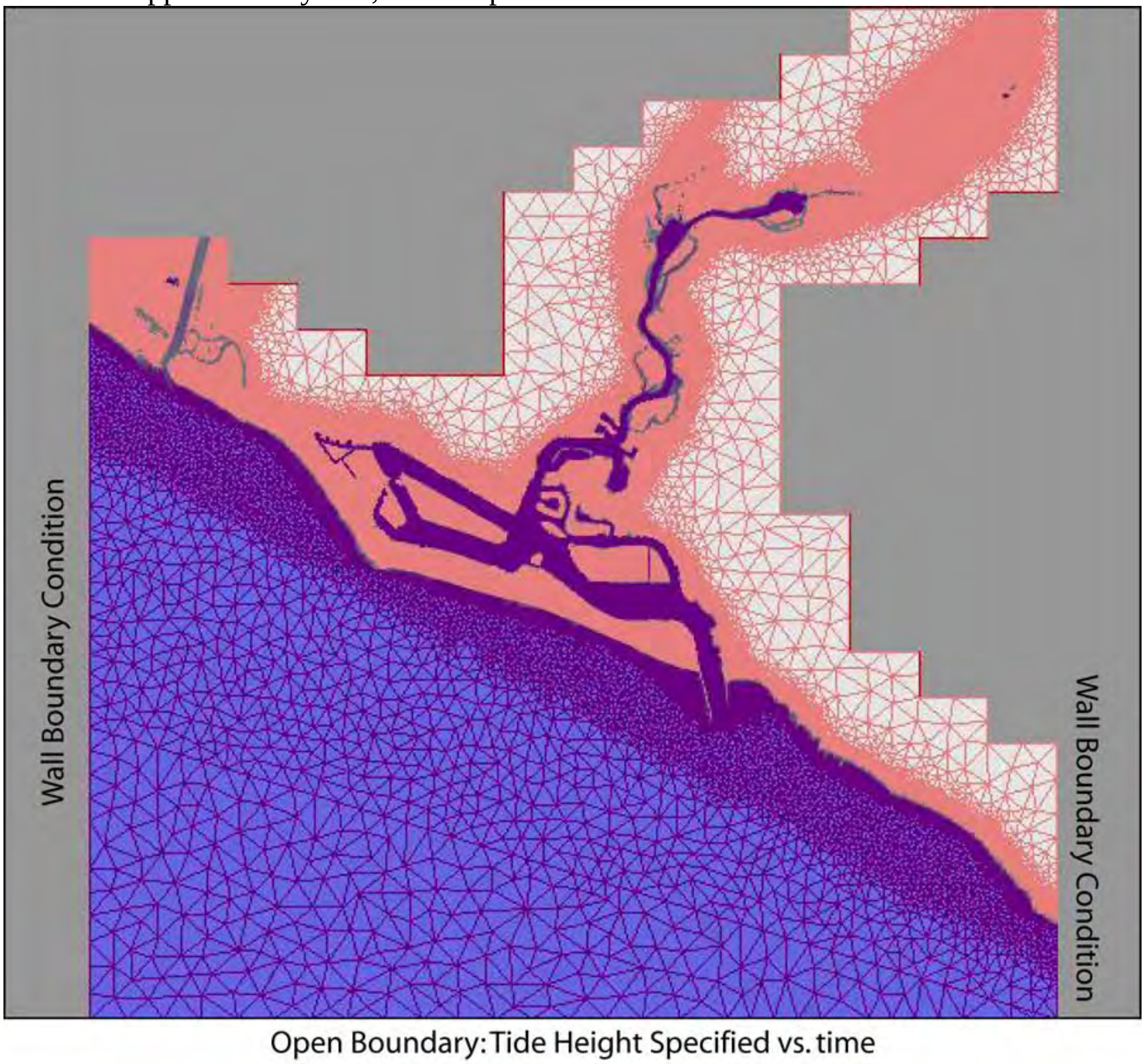

Figure 5.1. Computational mesh used for flood inundation modeling.

5.3 Infrastructure Scenarios

Two slightly different meshes were created to reflect: (a) the existing condition of bulk heads, and (b) the expected condition following a number of planned improvements described by City General Services staff in a spreadsheet provided to Dr. Sanders. These will be termed the “as-is” and “improved” conditions, respectively.

5.4 Tide and Stream Flow Scenarios

Three tide scenarios were examined in this study corresponding to an 8, 9 and 10 ft tide. The rise and fall of the tide, which was specified offshore of the harbor at the southern boundary of the model domain shown in Fig. 5.1, was described using Eq. 3.1.

To model stream flow, a point source of 30,000 cfs was specified at a point in Upper Bay very close to San Diego Creek, just east of Jamboree Road. This value was selected to account for storm flow contributed by both San Diego Creek and Santa Ana Delhi Channel, based on a previous study by McLaughlin et al. (2007).

5.5 Modeling Scenarios

A total of nine scenarios were completed to depict the range of flooding that could occur as a consequence of the infrastructure scenarios, tide scenarios and stream flow scenarios described above. First, using the “as-is” condition of infrastructure, the model was executing using 8, 9 and 10 ft tides and without any stream flow (Simulations 1-3). Second, using the “improved” condition of infrastructure, the model was executing using 8, 9 and 10 ft tides and without any stream flow (Simulations 4-6). And third, using the “improved” condition of infrastructure, the model was executing using 8, 9 and 10 ft tides and stream flow entering Upper Bay at rate of 30,000 cfs (Simulations 7-9).

5.6 Results

To illustrate computer model results, predictions of maximum flood depths (maximum over the tide cycle) were color contoured and superimposed upon aerial imagery using ArcGIS (ESRI, Redlands, CA). A summary slide showing the results of all nine simulations is presented Fig. 5.2, and then Figs. 5.3-5.11 show the results of Simulations 1-9, respectively. The coloring scheme used here depicts deep water with dark blue, shoreline with a dark red, and intermediate depths with light blue, green, yellow and orange.

These results indicate that two regions are likely to be impacted by an 8 ft tide: Balboa Island and Balboa Peninsula. On Balboa Island, the model depicts water overtopping the bulk head at the Balboa Island Ferry ramp and flooding the western half of the island with water as deep as two feet, but mostly less than 1 feet. On Balboa Peninsula, the model depicts water overtopping bulkheads at several places along the bay side and causing flooding as deep as 1 feet, but typically less than 0.5 feet. Areas impacted by the 8 ft “as is” flooding scenario without stream flow (Simulation 1) include: several blocks between Edgewater Ave. and Bay Ave., from Buena Vista to Main St.; several blocks along the Rhine channel, roughly between 19th St. and 30th St.; several blocks in the vicinity of Finley Ave. and 36th St.; portions of Newport Island, several points along Bay Ave. including 7th, 10th and 14th Streets.; and Balboa Blvd. between A St. and C St. The 8 ft “improved” scenario without stream flow (Simulation 4) depicts considerably less flooding in the vicinity of Finley Ave. and 36th St. and less flooding along the Rhine channel. On the other hand, the 8 ft “improved” scenario with 30,000 cfs entering Upper Bay (Simulation 7) indicates more widespread flooding along Park Ave. and Balboa Ave. on Balboa Island, and along Balboa Blvd. on Balboa Peninsula, compared to the “improved” case without stream flow.

Focusing now on the 9 ft tide predictions, model predictions indicate complete flooding of Balboa Island with depths exceeding 3 ft near the Balboa Island Ferry ramp and exceeding 2 ft on key routes such as Marine Ave. and Park Ave. (Scenarios 2, 5 and 8). Flooding on Little Balboa Island is predicted with depths less than 2 ft., and near complete flooding of Newport Island is predicted. On Balboa Peninsula, predictions indicate the 9 ft tide would impact most developed areas north of Balboa Blvd. as well as key access routes. Depths exceeding 2 ft are predicted for Balboa Blvd. between 40th and 45th streets; depths exceeding 1 ft are predicted from Newport Blvd. at Finley Ave., southeast to Balboa Blvd. at 8th St.; and depths exceeding 1 feet are predicted for Lido Park Dr. It appears that Bay Island would also be impacted by a 9 ft tide, as well as shoreline south of Pacific Coast Highway (PCH) along Lido Channel. Comparing Scenarios 2, 5, and 8 (Fig. 5.2), it appears that differences in infrastructure configurations and stream flow would have little impact on flood extent. Hence, the role of the tide is clearly dominant at this tide stage.

Focusing now on the 10 ft tide predictions (Scenarios 3, 6 and 9), these indicate flooding of Balboa Island with water over 4 ft deep, and Little Balboa Islands with water over 3 ft deep. Along Balboa Peninsula, the vast majority of developed land are predicted to be impacted by flooding including Newport Island. Further, Linda Island, Bay Island, shoreline south of Harbor Island Drive, shoreline south of PCH along Lido Channel are predicted to be impacted. Lastly, the 10 ft tide is predicted to submerge a section of PCH near Superior Ave.

5.4 Disclaimer

Predictions presented here are sensitive to the height of bulk heads that encircle the bay, and every attempt was made to depict these features as accurately as possible given the time and budget constraints which did not involve a comprehensive survey of bulk head height, continuity or integrity. Furthermore, it should be stressed that the vertical accuracy of bulk head heights was limited by the vertical accuracy of the LiDAR terrain survey which corresponds to approximately 0.6 ft. Hence, there may be areas around the harbor where we incorrectly predict flooding based on a given tide height because our depiction of the bulk head is too low compared to reality. Conversely, there may be areas likely to flood that we have missed because our depiction of the bulk head is too high. Furthermore, we have simplified the depiction of flooding in our model by only considering tide and Upper Bay stream flow effects, and by ignoring the effects of rainfall, waves and the storm drain system.

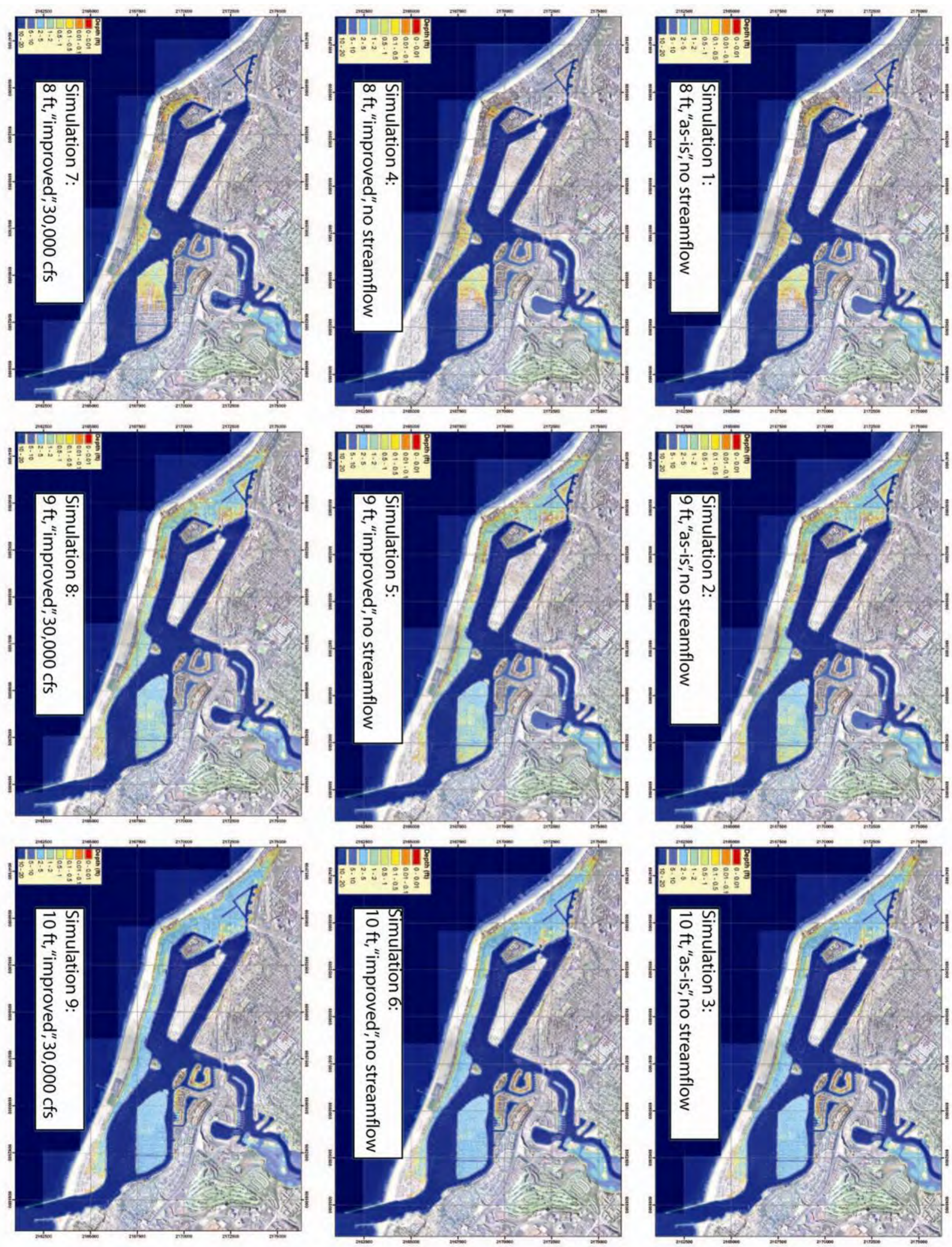

Figure 5.2. Summary slide showing maximum flood depth based on Simulations 1-9.

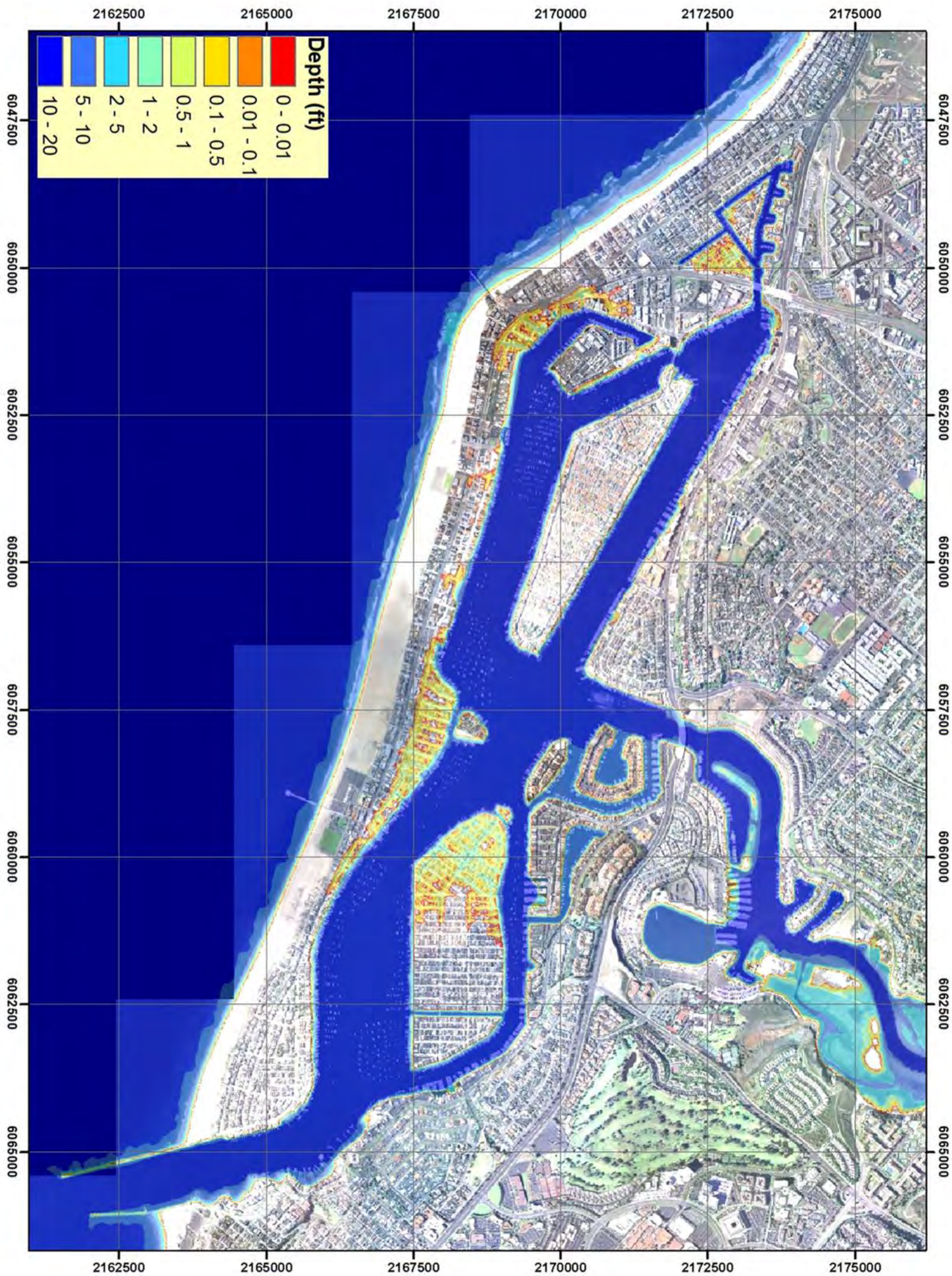

Figure 5.3. Simulation 1 predictions of maximum flood depth: 8 ft tide, “as-is” condition of infrastructure, and no stream flow entering Upper Bay.

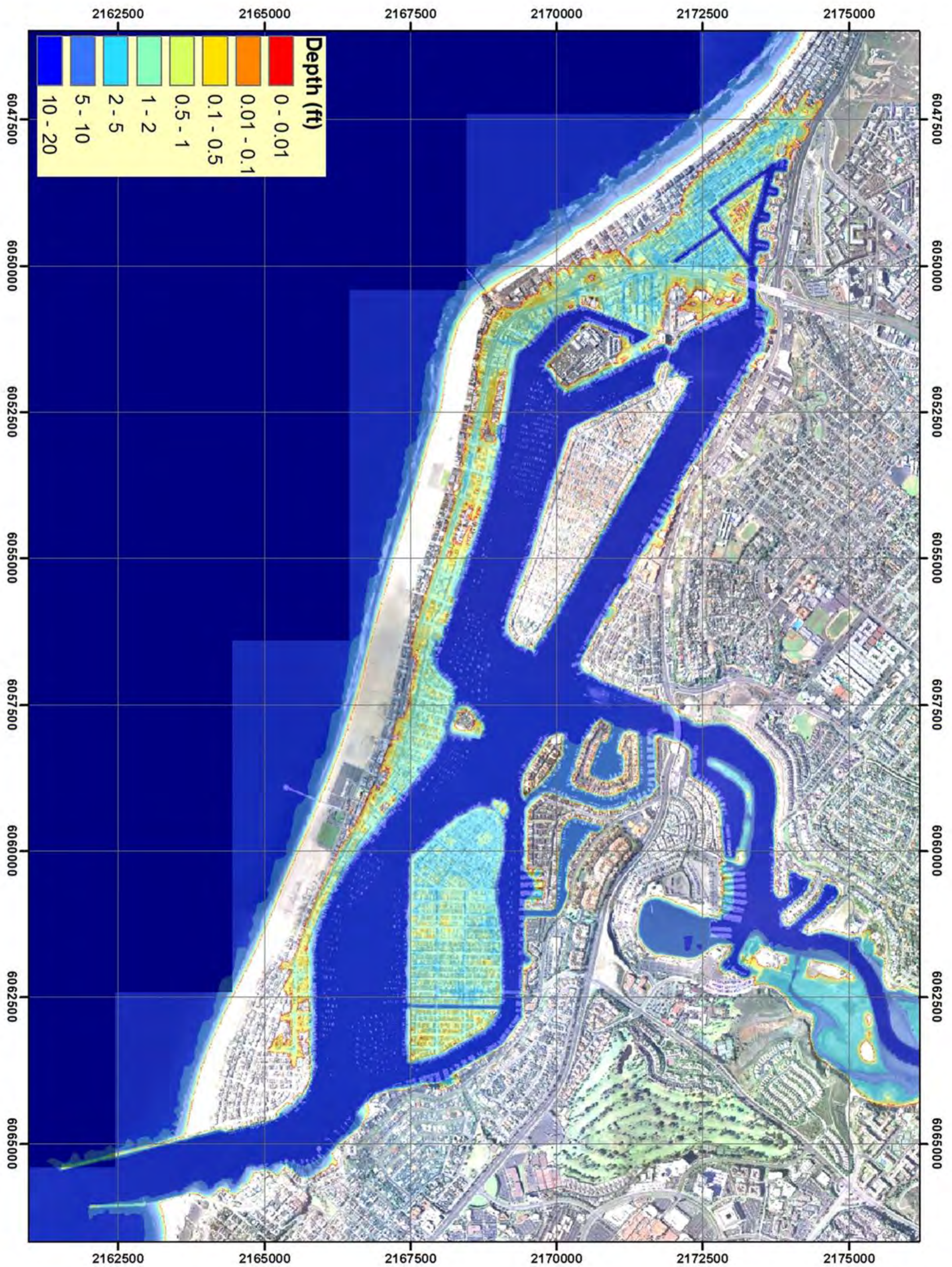

Figure 5.4. Simulation 2 predictions of maximum flood depth: 9 ft tide, “as-is” condition of infrastructure, and no stream flow entering Upper Bay.

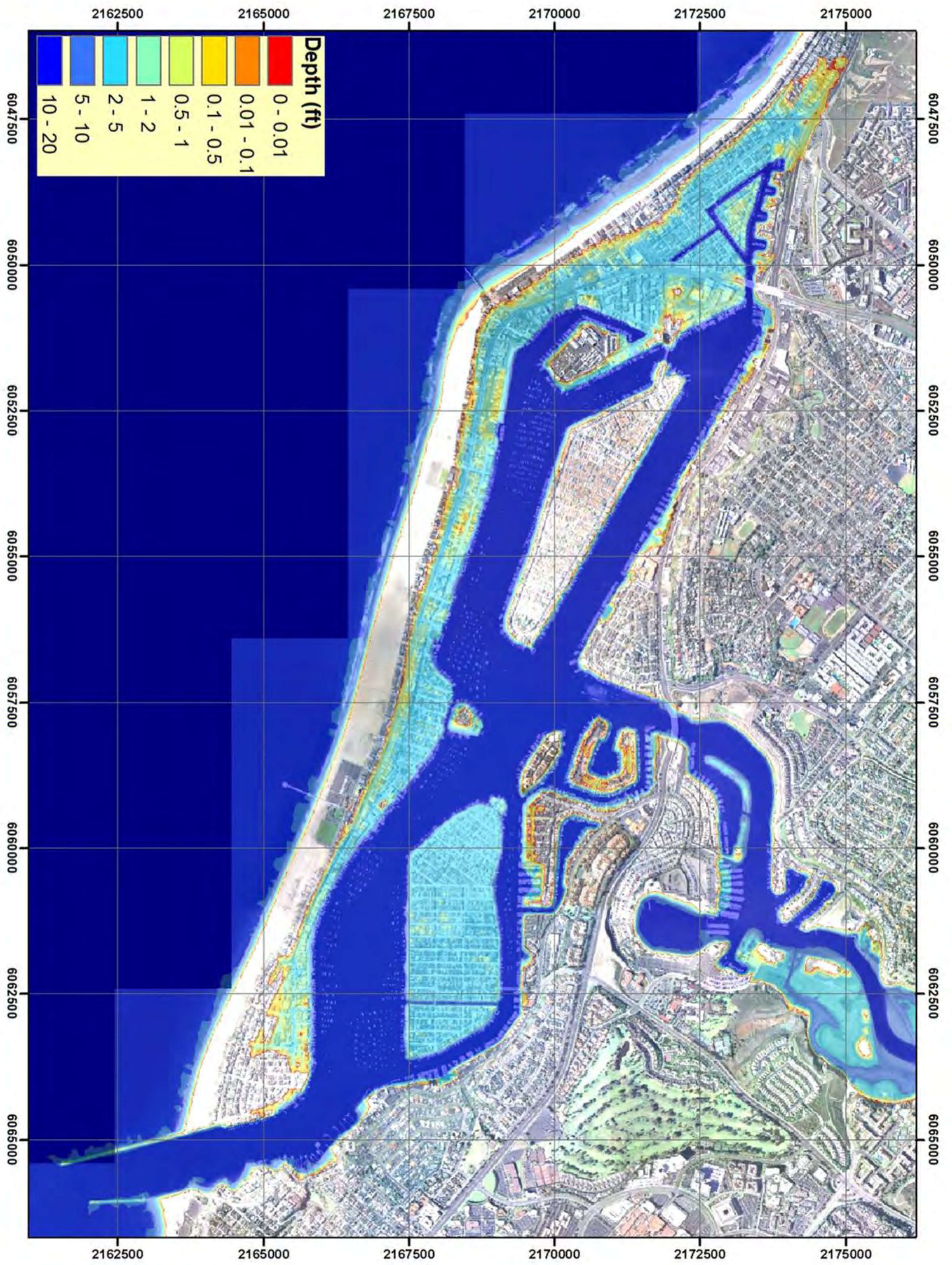

Figure 5.5. Simulation 3 predictions of maximum flood depth: 10 ft tide, "as-is" condition of infrastructure, and no stream flow entering Upper Bay.

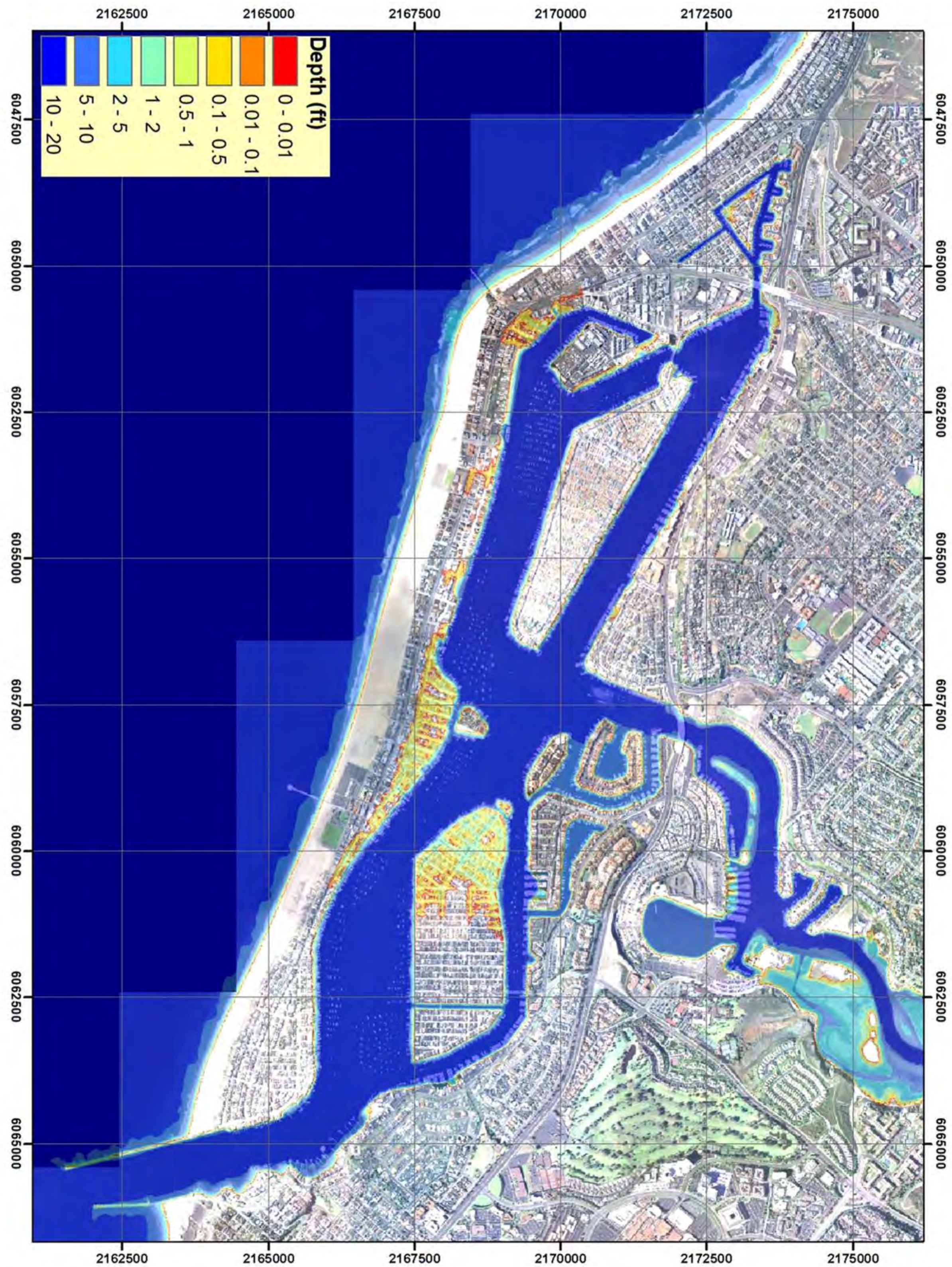

Figure 5.6. Simulation 4 predictions of maximum flood depth: 8 ft tide, "improved" condition of infrastructure, and no stream flow entering Upper Bay.

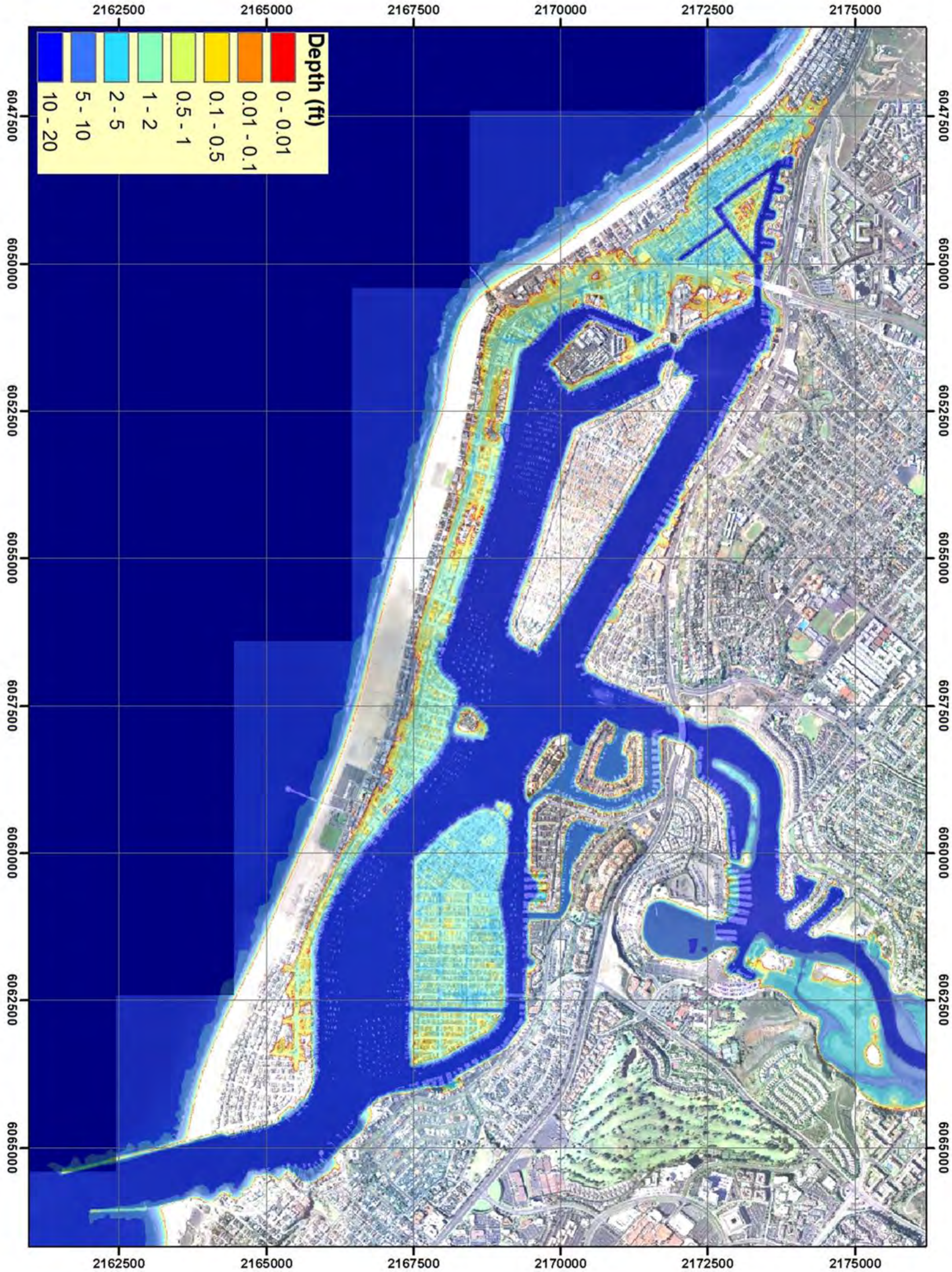

Figure 5.7. Simulation 5 predictions of maximum flood depth: 9 ft tide, “improved” condition of infrastructure, and no stream flow entering Upper Bay.

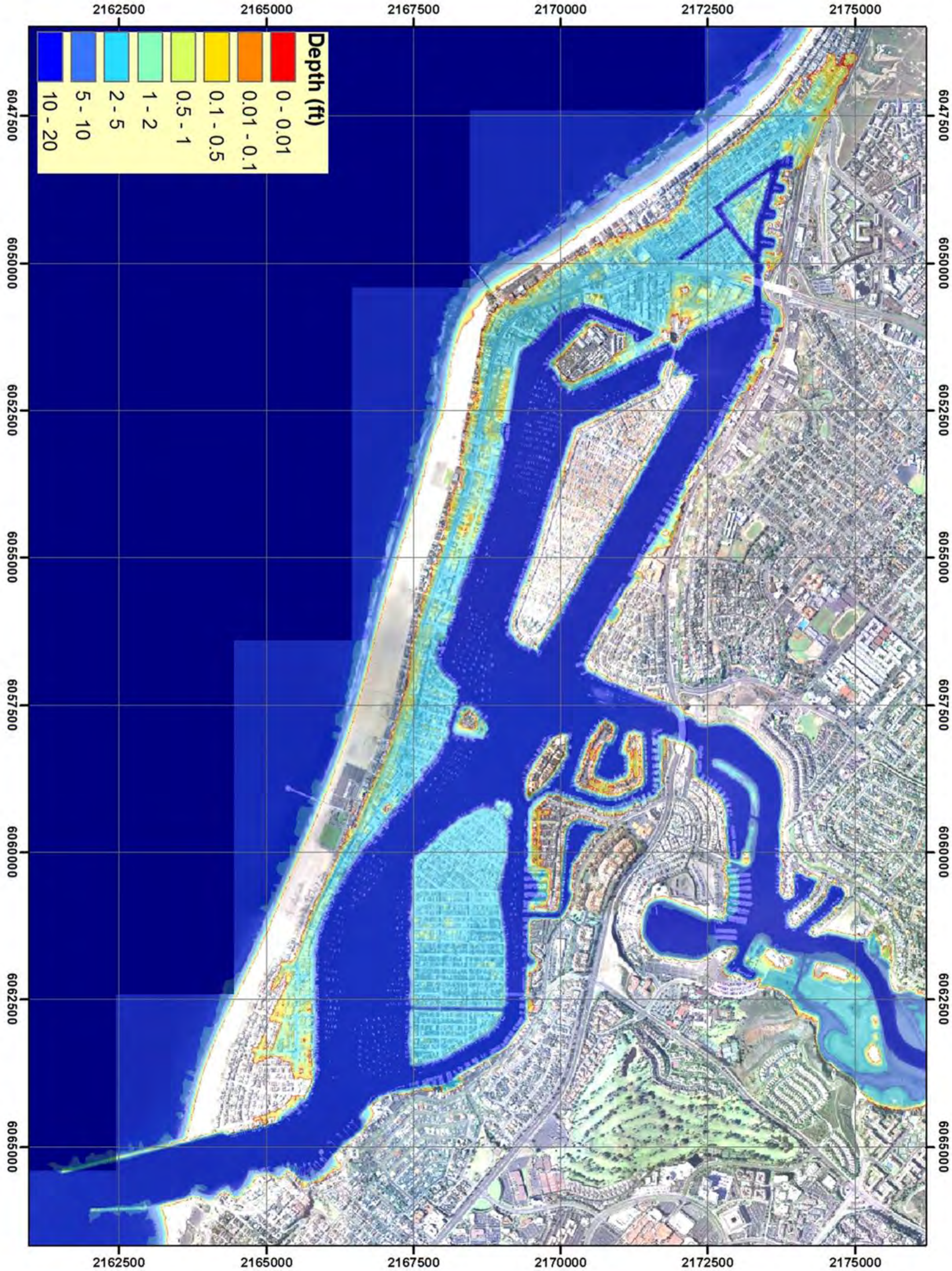

Figure 5.8. Simulation 6 predictions of maximum flood depth: 10 ft tide, “improved” condition of infrastructure, and no stream flow entering Upper Bay.

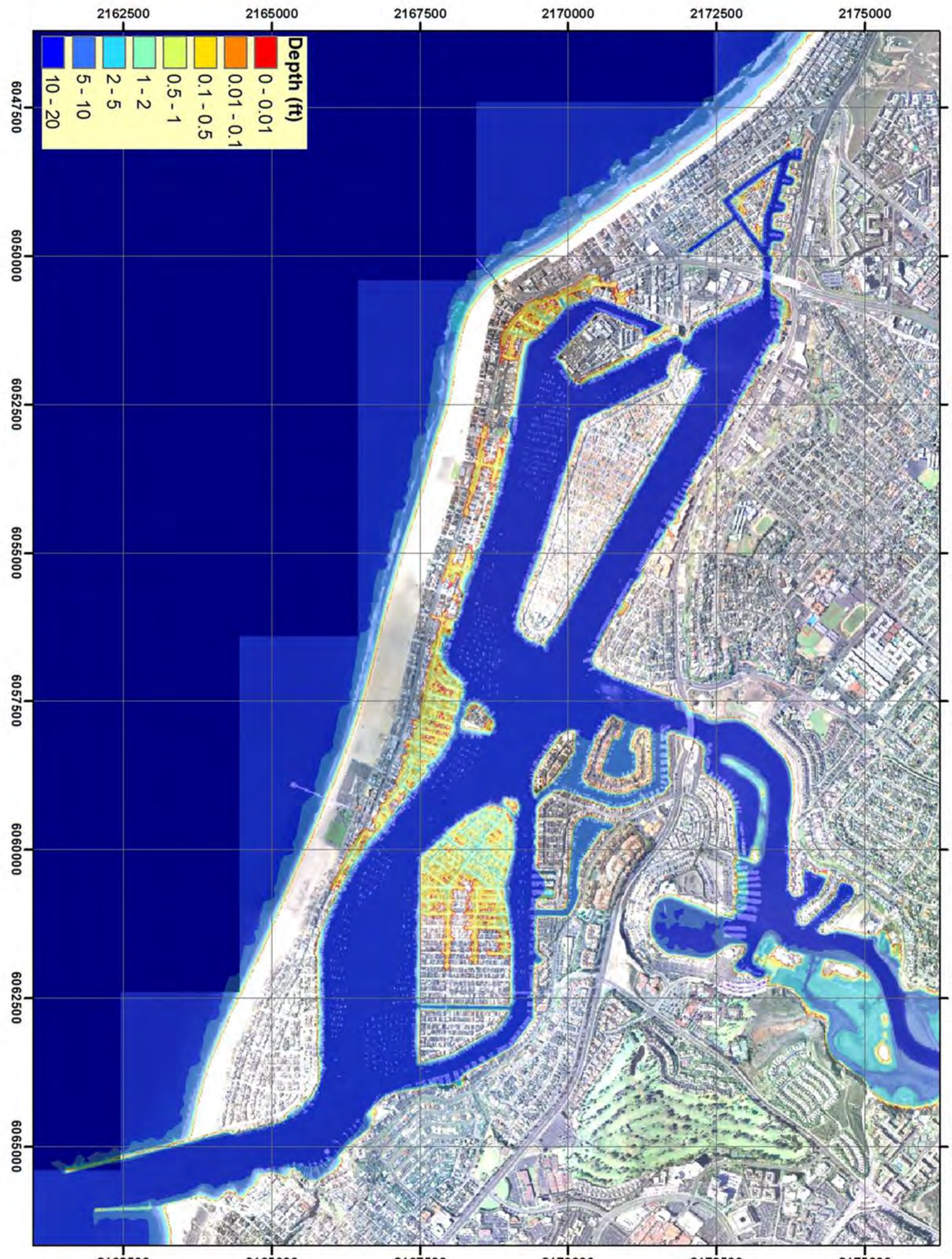

Figure 5.9. Simulation 7 predictions of maximum flood depth: 8 ft tide, “improved” condition of infrastructure, and 30,000 cfs entering Upper Bay.

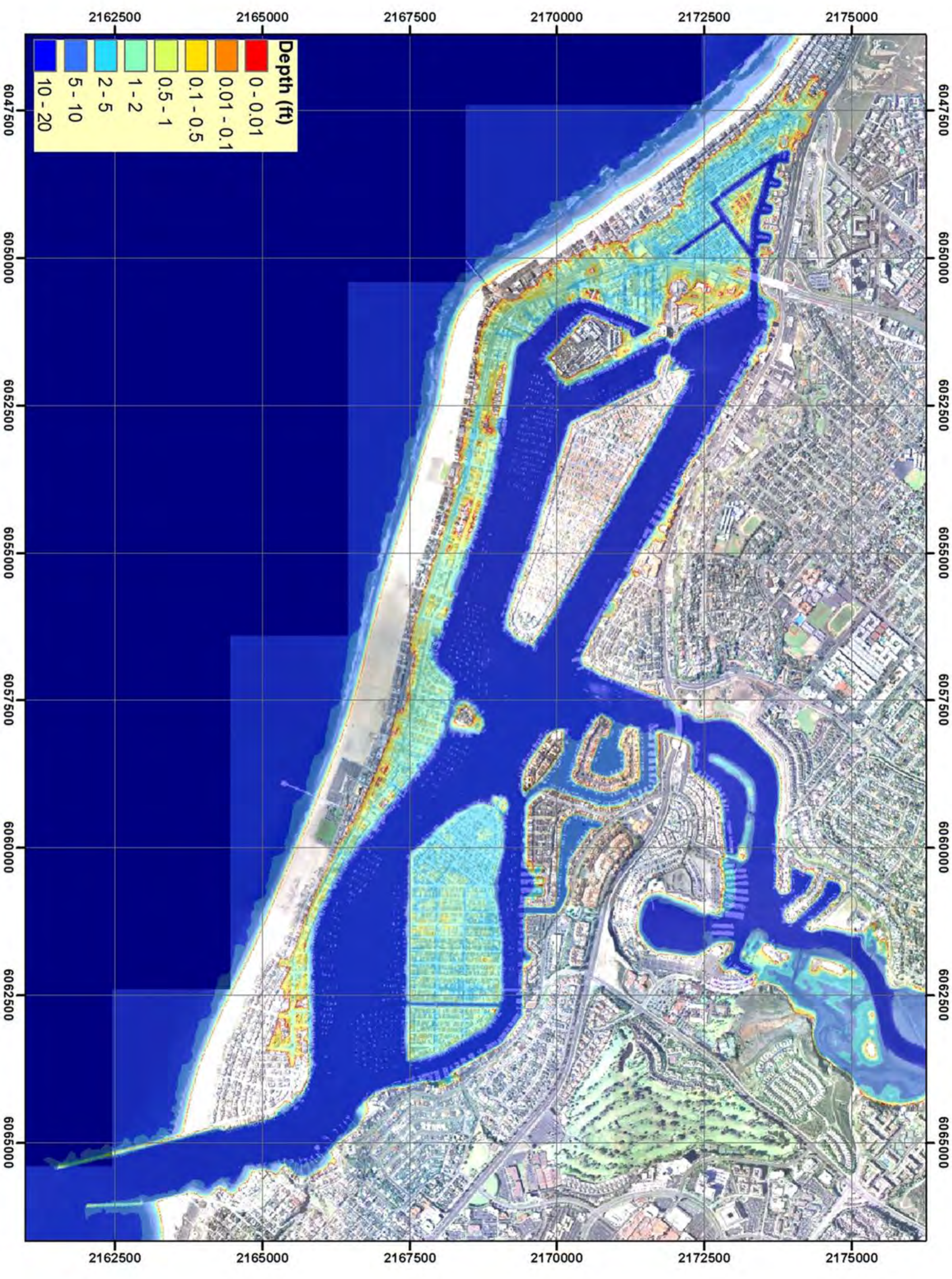

Figure 5.10. Simulation 8 predictions of maximum flood depth: 9 ft tide, “improved” condition of infrastructure, and 30,000 cfs entering Upper Bay.

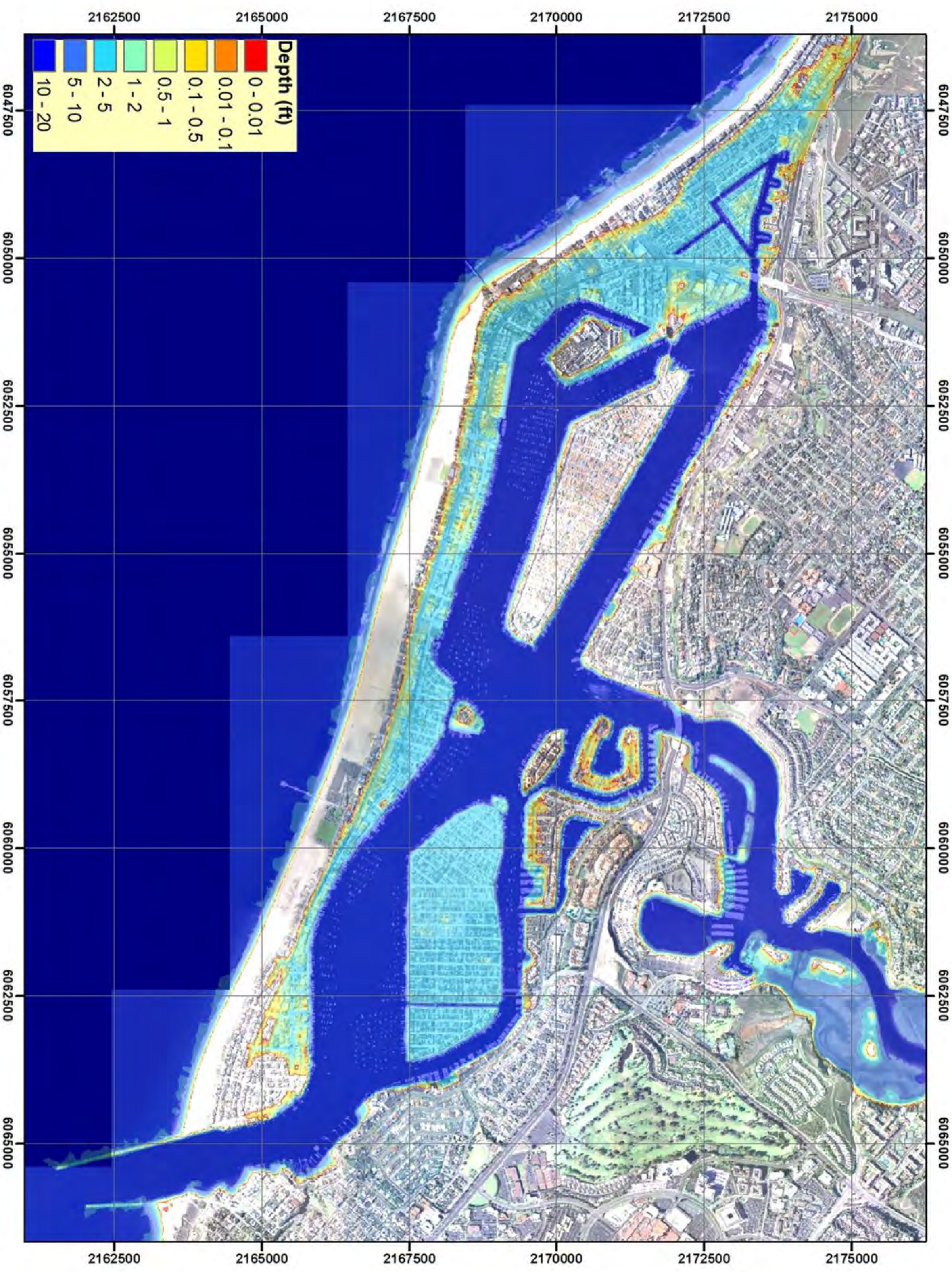

Figure 5.11. Simulation 9 predictions of maximum flood depth: 10 ft tide, “improved” condition of infrastructure, and 30,000 cfs entering Upper Bay.

Chapter 6: Conclusions and Recommendations

The largest tides in recent history have nearly reached the 8 ft level relative to Mean Lower Low Water (MLLW), attaining heights of 7.8 ft in 1983 and 2005. Strong storms can cause tides to crest more than 1 ft above the predicted tide height, and the highest high tides of each year are typically 7.0 ft (+/- 0.3 ft), so an 8 ft tide is approximately representative of the combined effects of a high tide and a winter storm that elevates sea levels. Furthermore, climate projections presently call for between 1 and 3 ft of sea level rise by 2100, and as much as 1 ft by 2050. Hence, a 9 and 10 ft tide could be taken to be approximately representative of 2050 and 2100 conditions, but it should be recognized that this represents only an educated guess. It is too early to quantify the probability of these levels occurring.

Several developed parts of Newport Harbor presently fall below the height of extreme high tides including Balboa Island, Little Balboa Island, Newport Island and much of Balboa Peninsula along its bay-ward side. To guard these areas from flooding during extreme high tides, bulk heads (i.e., sea walls) encircle the bay, valves at the outlets of storm drains are closed by City staff to prevent back flooding, temporary sand berms are constructed, and pumps are deployed.

On Balboa Island, the Balboa Island Ferry ramp represents the low point in the bulk head encircling the island. A field survey indicates that an 8 ft (MLLW) tide would overtop the ramp by approximately 1 ft and model predictions indicate that this would flood the western half of the island. Analysis of recent topographic data indicates the western half is lower than the eastern half. Results of a field survey also indicate that bulk head may be as low as 8 ft in places, so overtopping from an 8 ft tide is likely to occur in other places aside from the Ferry ramp. Complete flooding of the island is predicted to result from a 9 and 10 ft tide.

On Little Balboa Island, a field survey indicates that the bulk head is closer to the 9 ft level and the 8 ft tide is not predicted to cause flooding here. However, dips in the wall below the 9 ft level are predicted to enable significant flooding from a 9 ft tide, and complete flooding of the island is predicted for a 10 ft tide.

On Balboa Peninsula, the vast majority of bulk heads are privately owned and bulk heights vary considerably in height and integrity. The integrity of bulk heads can be compromised by storm drains that allow back flooding if not properly plugged, gaps at parcel boundaries, as well as cracks and poor or outdated construction practices that enable seepage. City General Services staff seek cooperation from owners and occupants of bulk heads to ensure that drains are plugged, low bulk heads are sand bagged, and deficient bulk heads are improved. However, this is a challenging task because the level of public cooperation is varied. Based on a field survey and observations of flooding from a 7.5 ft tide, the threshold for flooding along Balboa Peninsula is somewhere between the 7.0 and 7.5 ft levels. Model predictions indicate that the 8 ft tide would cause flooding in several places along Balboa Peninsula which are described in detail in Chapter 5. Both the 9 and 10 ft tide are predicted to cause near complete flooding of the developed parts of Balboa Peninsula, because most bulk heads fall below the 9 ft level.

There are predictable and unpredictable aspects to the height attained by extreme high tides that should be recognized for effective short and long-term planning purposes. The effect of astronomical factors is predictable. This causes the highest extreme high tides to occur in Winter and Summer but never in Fall or Spring. In addition, there is a cycle lasting several years that causes tide heights to vary by approximately 0.5 ft. This causes tides to be higher one year versus another. This cycle is peaking at present (2007- 2008 time frame) and will peak again in 2011-2012. *Through 2020, the highest extreme tide is predicted for December, 2008.*

The effects of inter-annual phenomena such as El Nino/La Nina, weather conditions, and global warming on tide heights are more difficult to predict. These effects can be characterized by studying historical differences between actual and predicted tides or the Non-Tide Residual (NTR). A review of data for Los Angeles shows that NTRs exceeding 0.5 ft have persisted for days at a time, and 1.0 ft for hours at a time, during Winter. NTRs exceeding 1.0 ft have occurred during strong El-Nino conditions as well as neutral El Nino/La Nina conditions, but never during weak or strong La Nina conditions. Hence, climatic conditions give some indication of flooding risk. The worst case scenario for coastal flooding is a strong winter storm that approaches the California coastline from the Gulf of Alaska during an El Nino winter, arriving simultaneously with a high astronomical tide. By monitoring climatic conditions seasonally, and weather conditions daily, it should be possible to forecast a worse-case scenario on a 24-48 hour basis and have a good indication of its severity.

To be better prepared for future extreme high tides, the following is recommended:

1) The City should consider creating or formalizing a monitoring system for environmental conditions that affect coastal flooding. This would include not only high astronomical tides but also climatic and weather conditions that contribute to damaging high tides (large NTRs). On a short term basis (24-48 hours), the system could be used to improve the City's emergency preparedness. On a seasonal or inter-annual basis, the system could help staff to prioritize and guide infrastructure improvement efforts (e.g., sand replenishment).
2) The City should consider creating and maintaining a database of public and private flood control infrastructure, and implementing a monitoring system to track key factors that bear on flood control. For example, the database could provide an inventory of the location, height and condition of bulkheads encircling the harbor, the height and thickness of beach sand along the coastline, and other important data such as tide valves and plugs. This data would logically be integrated into the City GIS, and could be coupled to the flood model developed here to maintain up-to-date maps of flood-vulnerable areas. The model could also be used to evaluate the benefit of proposed flood control measures.

3) In support of item (2) above, the City should consider hiring or employing a qualified surveyor to precisely measure the height of bulk heads around the harbor.
4) The City should consider exploring the legal or policy framework that would allow for more systematic improvement of the condition and continuity of bulkheads around the bay in the future, particularly considering that most bulk heads appear to be privately owned.
5) The City should consider developing and adopting a flood risk management plan for the Harbor area before moving forward with any major efforts to improve flood control infrastructure (e.g., raising bulk heads). Flood risk management plans consider the economic, environmental and social consequences of flooding to identify the optimal structural (e.g., bulk heads, pump stations) and non-structural (e.g., zoning, insurance) measures for implementation.
6) The City should examine the impact of waves on flooding in a future study. Based on a cursory review of LiDAR data characterizing the height of beach sand along Balboa Peninsula, it is not clear that there is adequate protection against the combined effects of an extreme high tide and ocean waves typical of storm conditions. Such a study could be used to guide future sand replenishment efforts.

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