EAST SAN PEDRO BAY ECOSYSTEM RESTORATION STUDY

905(b) ANALYSIS

JULY 2009

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CHAPTER II - SECTION 905(b) (WRDA 86) ANALYSIS

1. STUDY AUTHORITY

a. This Section 905(b) (WRDA) Analysis was prepared in response to the Long Beach City Council, who authorized this study at the July 24, 2007 City Council meeting. While such studies are typically authorized by the federal government and conducted by the US Army Corps of Engineers (Corps), the City was interested in funding the study itself using the Corps procedures, requirements and formats for such a study. The City is providing this study to the Corps to evaluate the federal interest in proceeding to a Feasibility Study.

b. No federal funds were appropriated to conduct the reconnaissance phase of the study. The City of Long Beach is funding the reconnaissance study in the amount of $100,000 through City of Long Beach Tidelands Funding ($100,000) and reimbursed by a California State Coastal Conservancy grant ($50,000). The latter amount is contingent upon the Corps receiving funding for study review ($30,000). As of this report, the City of Long Beach had submitted an appropriation request of $30,000 for Corps study review, and a decision on this request is currently pending in Congress.

2. STUDY PURPOSE

The purpose of the reconnaissance phase study is to determine if there is a Federal (Corps) interest in participating in a cost-shared feasibility phase study to evaluate opportunities for providing ecosystem restoration (including restoration of habitat areas which historically existed in the region), increased recreational opportunities and other improvements to the nearshore area off the City of Long Beach, within East San Pedro Bay. The Corps will make the determination as to whether or not there is Federal interest and will determine the viability of proceeding to the next level (Feasibility Phase). In response to the study authority, the reconnaissance study was initiated in August 2008. The expedited reconnaissance study has resulted in the finding that there is (is not) a Federal interest (This will be determined by the US Army Corps of Engineers) in continuing the study into the feasibility phase. The purpose of this Section 905(b) Analysis is to document the basis for this finding and establish the scope of the feasibility phase. As the document that establishes the scope of the Feasibility Study, the Section 905(b) Analysis is used as the chapter of the Project Management Plan that presents the reconnaissance overview and formulation rationale.

3. LOCATION OF STUDY, NON-FEDERAL SPONSOR AND CONGRESSIONAL DISTRICTS

a. The study area is located offshore of the City of Long Beach, California in the easternmost part of San Pedro Bay. It includes the area between the Long Beach shoreline and the offshore Middle and Long Beach Breakwaters.

b. The non-Federal sponsor for the feasibility phase of the study is the City of Long Beach.

c. The study area lies within the jurisdiction of the following Congressional Districts:

1) The 46th District of U.S. Congressman Dana Rohrabacher;

2) The 37th District of U.S. Congresswoman Laura Richardson.

4. PRIOR REPORTS AND EXISTING PROJECTS

a. Numerous reports concerning San Pedro Bay and the breakwater have been produced by various parties. A bibliography of existing and available studies reviewed for the reconnaissance study effort is provided at the end of this document (Appendix A). Also included in Appendix A are summary abstracts of key documents.

b. This study is investigating potential modifications of the following Corps project(s):

1) Long Beach Breakwater. San Pedro Bay is protected by three breakwater sections, totaling 8.4 miles in length and with two openings to allow ships to enter the Ports of Los Angeles and Long Beach. These openings divide the breakwater into three sections: the San Pedro Breakwater, the Middle Breakwater, and the Long Beach Breakwater. The San Pedro and Middle Breakwaters protect the Ports of Los Angeles and Long Beach, respectively. The 2.2 mile Long Beach Breakwater is the easternmost breakwater. The Long Beach Breakwater was first authorized in 1930 through the Federal River and Harbor Act, to provide a protected anchorage for the U.S. Navy's Pacific Fleet and to provide protection to the Long Beach shoreline. Construction of the breakwater by the federal government began in 1941 and was completed in 1949. As a federal project, the Corps maintains jurisdiction of the breakwater. The purpose of the ecosystem restoration study is to evaluate potential changes to the East San Pedro Bay, including reconfigurations of the Long Beach Breakwater as it affects the water quality and hydrodynamics of the area. This reconfiguration would also provide an opportunity for rocky materials from the breakwater reconfiguration to be used for the re-creation of habitat and enhancement of recreational opportunities within the San Pedro Bay.

2) Los Angeles River. The Los Angeles River (LAR) is a major flood control waterway for the Los Angeles watershed basin. In the 1930s, the Army Corps began channelizing the river for flood control and by 1954, the entire length of the river was channelized. The river is now operated and maintained by the Corps and the LA County Department of Public Works. The LA River discharges into San Pedro Bay. The purpose of the ecosystem restoration study is to evaluate potential changes to the East San Pedro Bay, including changes to the LAR as it negatively impacts the water quality and clarity of the area.

c. Existing Corps projects/studies which provide relevant data to this study are the:

1) *Comprehensive Condition Survey – Los Angeles-Long Beach Breakwaters – January 1985.* This study provides useful details of the breakwaters' history, their construction and current condition.

2) *Peninsula Beach Erosion – Draft Feasibility Study.* This study provides data regarding erosion of the Long Beach peninsula beach, which is an area potentially affected by the reconfiguration of the Long Beach Breakwater.

3) *Los Angeles River Ecosystem Restoration Study.* This study is for a 32 mile stretch of the LA River within the City of Los Angeles. The study area includes several locations where potential exists for restoring a more natural riverine environment, while maintaining and improving levels of flood protection. Treating effluent river flows by the use of treatment wetlands is also included.

d. Other existing projects/studies which provide relevant data to this study are the:

1) *Water Board Total Maximum Daily Loads (TMDLs) Project*. Currently, there is an ongoing Water Board TMDL project to address pollutants in the Los Angeles River. Once implemented, the reduction of the pollutants discharged from the LA River will

improve water quality conditions in the East San Pedro Bay. These TMDL improvements may supplement the improvements that could arise from the East San Pedro Bay Ecosystem Restoration Study. The Total Maximum Daily Load (TMDL) is a number that represents the assimilative capacity of a receiving water to absorb a pollutant. The TMDL is the sum of the individual wasteload allocations for point sources, load allocations for nonpoint sources plus an allotment for natural background loading, and a margin of safety.

The following list identifies adopted TMDLs with their effective dates:

• Los Angeles River Trash TMDL (Sept 19, 2001)

• Los Angeles River Nitrogen TMDL (March 23, 2004)

• Los Angeles River and Tributaries Metals TMDL (January 11, 2006)

TMDLs in Development:

• Los Angeles River Bacteria TMDL

5. PLAN FORMULATION

During a study, six planning steps that are set forth in the Water Resource Council's *Principles and Guidelines* are repeated to focus the planning effort and eventually to select and recommend a plan for authorization. The six planning steps are: 1) specify problems and opportunities, 2) inventory and forecast conditions, 3) formulate alternative plans, 4) evaluate effects of alternative plans, 5) compare alternative plans, and 6) select recommended plan. The iterations of the planning steps typically differ in the emphasis that is placed on each of the steps. In the early iterations—those conducted during the reconnaissance phase—the step of specifying problems and opportunities is emphasized. That is not to say, however, that the other steps are ignored since the initial screening of preliminary plans that results from the other steps is very important to the scoping of the follow-on feasibility phase studies. The sub-paragraphs that follow present the results of the initial iterations of the planning steps that were conducted during the reconnaissance phase. This information will be refined in future iterations of the planning steps that will be accomplished during the feasibility phase.

a. National Objectives:

1) The national or Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to National Economic Development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

2) The Corps has added a second national objective for Ecosystem Restoration in response to legislation and administration policy. This objective is to contribute to the nation's ecosystems through ecosystem restoration, with contributions measured by changes in the amounts and values of habitat.

3) There can also be a Federal interest in other related outputs of the alternatives, including recreational benefits. Recreation costs cannot increase the total federal cost by more than ten percent and any recreation features should be formulated to avoid impacts to the primary restoration purpose. Finally, if the recreation features comply with the above, the recreation benefits would not be constrained since they are not used in a benefit-to-cost analysis for the restoration. The benefit-to-cost plan is identified based upon a CE/ICA analysis of restoration only features. Recreation features must be separably economically justified.

b. Public and Stakeholder Concerns: Public input was critical to this reconnaissance study, given the proposed funding partnership between the Army Corps and the City of Long Beach. A public introduction to the study and three public workshops were held over a two-month period in late 2008. The public outreach approach was structured not only to provide information and allow residents and other citizens the opportunity to provide statements of concerns and interests, but also to work in a hands-on fashion with the consultants and facilitators to develop specific visions incorporating their interests and concerns. Appendix B herein includes a number of sketches of the visions produced by individuals and small groups at the public workshops. Main examples of public concerns and goals from the workshops are summarized below.

1) Inputs from Public Workshops (not intended to be an exhaustive list, but representative of primary public inputs)

Inputs related to shoreline protection:

- Protect homes
- Control beach sand erosion
- Restore natural beach re-sedimentation as much as possible
- Reduce money spent to move sand from one end of beach to the other

Inputs related to recreation

- Increase surfing opportunities
- Enhance beach with waves to increase residential property values, local/tourist recreational use, downtown commercial values, parking revenue
- Maintain areas with favorable conditions for recreational sailing (low waves/high winds)

Inputs related to water quality

- Decrease trash / debris on the beach
- Train LA River away from shore to divert effluent from recreational areas, or through port area
- Prevent LA River trash from reaching the open sea
- Address cleaning pollutants from LA River
- Press surrounding cities to clean up LA River front and remove debris from main entry points
- Address public health issue associated with water quality
- Address high rate of illness on boat workers

Inputs related to habitat

- Restore bird / fish habitat
- Reintroduce / improve marine life / habitat
- Protect existing and develop new kelp habitat
- Minimize or at least consider response to displacement of current animals and plants by removal

Inputs related to Long Beach Breakwater reconfiguration

- Reuse breakwater material for new kinds of habitat (diving, fishing, birds, etc)

- Use removed breakwater materials as artificial reef and protection of vulnerable oil islands, beaches, Belmont pier
- Increase porosity of breakwater for selective wave passage
- Shorten west end of breakwater to allow waves to wash out area of highest contamination
- Remove the top of the breakwater to create a habitat and generate some wave action
- Remove breakwater and build more oil and recreational islands/habitat edges in the harbor to slow down and disperse wave energy while still allowing the circulation and cleansing effect of the waves
- Remove breakwater entirely, and build several smaller breakwaters instead
- Create retractable or deployable breakwater to mitigate storm and high swells
- Create access to expanded breakwater with new surf break and funding from real estate sales
- Harness wave energy at gaps in breakwater system

Other miscellaneous inputs

- Protect existing navigation ways and commercial use of the Port of Long Beach
- Investigate Navy's need for this specific ammunition loading area
- Reduce the amount spent by the Long Beach Aquarium to import water for their tanks by improving water quality
- Consider effects of rising sea level into simulations and calculations

In addition to the public workshops, meetings were conducted with individual stakeholder groups to solicit their input. Key constraints, as well as opportunities, were identified as part of this process. The concerns and interests from each of the stakeholder groups are listed below (in alphabetical order).

2) <u>Carnival Cruise Lines</u>

- Have experienced no downtime in their five years of operation
- Support potential community benefit, but want no negative impact on operations
- Potential for increased maintenance dredging resulting from increased wave action.

3) <u>City of Long Beach – Marinas / Lifeguards</u>

- Trash on beach easier to pickup than trash in harbor
- Breakwater provides critical recreational benefit – provides unique sailing environment – great wind and little wave action
- Increased wave penetration – impact on docks/facilities
- Impacts to navigation safety – cited the example of the Zuniga Jetty hazard at entrance to San Diego Bay
- Concerned if the breakwater was lowered, that a gap could not be marked well enough, as vessels already hit the breakwater in its current condition
- Impacts to fishing habitat

- Impacts to bait barge operations
- Increased surf and related activity may impact operations
- Breakwater provides recreational benefit for swimming – small surf great for young kids
- Belmont Pier dock and sport fishing operations

4) City of Seal Beach

- Also have water quality issues
- Impacts to sand transport and beach nourishment
- Impacts to coastal flooding along East Beach
- Impacts on disaster preparedness / tsunami

5) Peninsula Beach Preservation Group

- Many of Long Beach peninsula residents opposed to breakwater modification
- Concerned about:
  - Protection of property along the shoreline (potential for property damage and long-term costs for sand replenishment)
  - Rising sea level
  - Loss of "calm harbor" and resultant economic and recreational impacts
  - Pollutant "flushing" to open ocean (versus stopping pollutants at their source)
  - Loss of habitat along existing breakwater

6) Port of Long Beach / Jacobsen Pilots / Operators (PMSA / SSA)

- Impacts to existing habitat value
- Increased wave penetration into commercial berths, especially during south swell
  - Pier J
  - SE Basin
  - West Basin
  - Cost of tug operations if wave action increases – also fewer number of tugs available now to help keep ships in place at berth
  - Fatality to ship crew during surge
- Increased wave activity at anchorages
  - Transfer of personnel could become more difficult and unsafe
  - East anchorages get more use since can accommodate larger ships
- Potential impact to "Port of Refuge" – safe harbor for damaged ship
- Navigation hazard
- Impact to City's Confined Aquatic Disposal site

7) Surfrider Foundation

- Want beach like Seal Beach, Huntington Beach, South Bay beaches – the difference is waves
- Want to improve water quality and reduce trash and debris
- Want to improve sediment quality along shoreline
- Want to reduce breakwater height and plant kelp
- Want economic benefit of cleaner beach

8) THUMS Oil Islands

- Increased exposure to wave damage – cited significant damage in 1983 storms
- Impacts to operations – travel from SE Basin to islands 24/7
- Island White presently has surge problems during occasional wave events that impacts barge loading operations
- Make sure consider any impacts to underwater pipelines to THUMS – water/oil/gas

9) U.S. Coast Guard

- Loss of safe anchorage capacity
- Impact to lightering / bunkering operations
- Impact to cruise ship operations
- Navigation safety associated with any breakwater modifications
- Potential impact to present security benefit provided by physical barrier

10) U.S. Navy – Naval Weapons Station (NWS)

- Navy has an operational requirement to be able to load ammunitions inside the breakwater at least twice a year
- Impacts to ammunition transfer at Explosives Anchorage if the sea states rise to an unacceptable level
- Operations at Explosives Anchorage may increase in future due to increasing constraints with trucking of ammunitions
- Impact of increased wave penetration into NWS berth
- Impacts to dredging of NWS

11) USC Sea Grant Workshop (scientists and biologists familiar with San Pedro Bay)

- Not a lot of existing reports and data for the area, with the exception of the Ports Biological Baseline Studies and existing City of Los Angeles monitoring sites near the mouth of the LA River.
- The area is a "hotspot" for Harmful Algal Blooms (HABs), which are thought to be created by a combination of natural and non-natural inputs of nutrients and a circulation pattern which tends to retain the nutrients in the water column and allows the algal to bloom. These HABs are harmful to both marine life and humans.

- The breakwater itself provides an important protected habitat used by several bird species for roosting and nesting and for several invertebrate species.
- Perception that the LA River is probably not the only contributor to pollution in the Harbor. Other potential sources cited were the San Gabriel River and storm drains runoff.
- SCE staff provided insight as to how to best create conditions for successful kelp establishment.
- General consensus that increases to water clarity and reduction of nutrient load would improve conditions for marine habitat.

c. Problems and Opportunities: The evaluation of public concerns often reflects a range of needs, which are perceived by the public. This section describes these needs in the context of problems and opportunities that can be addressed through water and related land resource management. For each problem and opportunity, the existing conditions and the expected future conditions are described below.

There are two basic categories of problems and opportunities. One category is for the problems and opportunities associated with Ecosystem Restoration and the other is for the problems and opportunities associated with Recreational Enhancements (i.e. swimming, surfing and other beach-related activities).

The problems have been identified by the local sponsor, and supported by the inputs from the stakeholder groups and literature review. The specific problems of the existing condition are discussed below.

Ecosystem Problems

The problems associated with the existing ecosystem are sub-divided into those problems associated with: a) the pelagic habitat (living or growing within the water column of the open ocean); and b) the benthic habitat (living in or near the ocean bottom). Significant habitat areas (e.g. an extensive kelp bed) no longer exist or are significantly degraded in the region. The problems associated with the existing pelagic habitat are:

1) Impacted harbor water circulation. Recent water quality monitoring conducted in this region during dry weather conditions provides evidence that the plume from the Los Angeles River Estuary frequently impacts the western portion of the beach from Shoreline Harbor to Belmont Pier. Monitoring conducted subsequent to an early season storm event provided further evidence of poor flushing in this segment of the Bay. Decaying duckweed that had been discharged from the River during this event remained suspended in the nearshore waters for over a week. Recent three-dimensional modeling developed for the Port's Water Resources Action Plan (WRAP) and two dimensional-modeling of tracer particles from the Los Angeles River conducted as part of this reconnaissance study provide further corroboration of the poor circulation.

2) Reduced transmissivity (clarity) of the harbor waters. Transmissivity of the harbor waters is impacted during storm events as a result of discharges from the Los Angeles River or in association with Harmful Algal Blooms. Poor circulation within the breakwater contributes to persistence of turbid water in San Pedro Bay.

3) Contaminants in the water column (metals, nutrients). Water quality monitoring conducted to monitor conditions during placement of sediment at the North Energy Island Borrow Pit Confined Aquatic Disposal (CAD) site indicated that background concentrations of metals were elevated above California Ocean Plan criteria. Nutrient concentration in the Los Angeles River are often highly elevated during early season storm events, but also can be elevated in association with dry weather discharges.

Elevated nutrient concentrations from the Los Angeles and San Gabriel Rivers may contribute to HABs that appear to be more frequent and intense in San Pedro Bay.

4) Trash/floating debris. Trash and floating debris from the Los Angeles River are considered to be a major problem in this region. Due to the prevailing winds, trash and floating debris are ultimately deposited on the beaches. The largest quantities of trash and debris wash up on the western end of the City beaches, but significant quantities are also collected at the far eastern end, adjacent to the Alamitos Bay jetty. Aside from aesthetic issues, organic matter associated with these materials harbor bacteria and evidence suggests that bacteria regrowth may occur in the wrackline along the beach.

The problems associated with the existing benthic habitat are:

5) Contaminants in the sediment (metals, pesticides, bacteria). Concentrations of metals and pesticides in sediments have been shown to be highest at sites within the Los Angeles River Estuary. Limited spatial data suggests that concentrations decline substantially with distance from the mouth of the estuary. Bacteria in the sand along the shoreline is also potentially problematic.

6) Lack of rocky reef / hard bottom habitat. Rocky reef and other hard bottom habitat are considered to provide valuable habitat for economically important fish and macroinvertebrates. Current hard bottom habitat is limited to linear features of the breakwater and riprap protecting the THUMS oil islands and Port facilities. An artificial reef (mitigation as part of the Montrose settlement) is planned to be established west of Belmont Pier. Historically, rocky reef areas existed in San Pedro Bay prior to development of the Ports / Harbors. Restoring high and low relief rocky reef habitat would increase nursery habitat and refuge for rock fish.

7) Lack of kelp habitat. Both kelp and high relief, hard bottom habitats are considered to be important habitat for various rockfish species, ling cod, kelp and sand bass, as well as a variety of invertebrates. Kelp habitat within San Pedro Bay is limited to linear features associated with the breakwater and other rock structures. Historically, it is known that there have been extensive kelp beds in the San Pedro Bay area, e.g. Horseshoe Kelp. The Horseshoe Kelp Bed was reported to be two miles long and one-quarter to one-half mile wide (equates to 320 to 640 acres) and in water depths of 80 to 90 feet. This kelp bed completely disappeared in the 1920s to 1930s. Restoring kelp habitat would be a valuable resource to the area.

Recreation Problems

The problems associated with the existing recreational uses are characterized by those problems associated with water quality and those associated with wave height / wave activity.

8) Impaired swimming / water recreation due to elevated bacteria levels and trash/debris in the water and along the shoreline. Fecal indicator bacteria are commonly elevated in dry weather discharges from the Los Angeles River. Periodic sewage spills also contribute to elevated bacteria levels in the River. An average of 4,000 tons of trash and debris is deposited on City beaches annually. The prevailing winds out of the southwest tend to transport the brackish water surface plume towards the western end of the ocean beaches between Shoreline Marina and the Belmont Pier. During periods when the winds shift to a more southerly pattern, the plume is quickly transported to the beach face with limited additional dilution. Bacterial water quality criteria for full body contact are exceeded when such conditions are concurrent with elevated fecal indicator bacteria in the River.

9) Lack of wave activity for recreational activities. Wave height along the Long Beach shoreline is currently not suitable for some recreational activities such as surfing. In contrast, nearby beaches such as Seal Beach and Huntington Beach have larger waves and are popular areas. Many long-time residents of Long Beach have noted that prior to

the existence of the Long Beach Breakwater, the area was popular for surfing. In addition to the primary recreational objective of improving swimming conditions, local surfing groups (e.g. Surfrider Foundation) would like to restore the surfing conditions that Long Beach once had.

It is assumed that the existing conditions would remain unchanged and possibly would become worse over time if no project is implemented.

Ecosystem and Recreation Opportunities

Opportunities were identified by the public, stakeholder groups, and resource agencies. In general, the opportunities to address the existing ecosystem and recreation problems are as follows:

1) Restoration of ecosystem which once existed in the area. Rock removed from the breakwater reconfiguration could be used to create new rocky reef and kelp habitat areas. Coupled with the improved water quality, this is expected to create viable rocky reef / hard bottom and kelp habitat conditions which do not presently exist in the area, but that once did prior to development of the San Pedro Bay port complex.

2) Increase tidal circulation and wave-induced mixing of the harbor waters by reconfiguring the existing Long Beach Breakwater. This increased circulation and mixing is expected to improve water quality and clarity, which would lead to an improved ecosystem, as well as improved recreational swimming conditions.

3) Increase wave height along the shoreline, while still providing adequate shore protection, by reconfiguring the existing Long Beach Breakwater. This increased wave height is expected to help improve water quality, while also potentially creating recreational surfing and other wave activities conditions along certain sections of the shoreline.

4) Eliminate or reduce discharges of pollutants from the Los Angeles River into the East San Pedro Bay area.

5) Use rock removed from the breakwater reconfiguration to create a training structure that diverts the LA River flows away from the beach areas. This is expected to improve water quality for both ecosystem and recreational benefits.

These opportunities were used as the basis of the measures/alternatives developed for the reconnaissance study and discussed further below.

d. Planning Objectives: The national objectives of National Economic Development and National Ecosystem Restoration are general statements and not specific enough for direct use in plan formulation. The water and related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes in the without project conditions. The planning objectives are specified as follows:

1) To restore habitat types that previously existed in the San Pedro Bay region, e.g. kelp beds and shallow rocky reef areas;

2) To improve water quality and clarity (for both ecosystem restoration and recreational swimming) in the East San Pedro Bay as measured by long-term changes in water chemistry test results; and

3) To implement changes without adversely affecting existing constraints.

e. Planning Constraints: Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in this study are discussed below.

1) The Long Beach Breakwater is outside of the City's Local Coastal Program / land use plans, i.e. the breakwater is in federal waters. However, the breakwater definitely affects land and water use in its wave shadow. These uses are as follows and are considered to be constraints for all alternatives:

- Shoreline structures and beaches. Existing residences, public infrastructure, marinas, other structures and recreational beaches must be protected from increases in erosion, wave related damages, and coastal flooding.

- Port of Long Beach. Commercial berths must be protected from unacceptable increases in wave penetration. In addition, anchorages and the "port of refuge" area (safe harbor for damaged ships) must be protected from excessive wave activity.

- U.S. Navy explosives anchorage. This anchorage is located leeward of the Long Beach Breakwater and is used by U.S. Navy ships to transfer explosives and/or sensitive electronics equipment. This capability must be retained.

- Shoreline structures and beaches. Existing residences, public infrastructure, marinas, other structures and recreational beaches must be protected from unacceptable increases in erosion, wave penetration, and coastal flooding.

- THUMS Oil Islands. The existing shore protection around these oil islands was based on wave conditions with the existing breakwater configuration. These islands will continue to require protection from storm waves penetration.

- Confined Aquatic Disposal (CAD) site. A CAD site, for contaminated sediments disposal, exists leeward of the Long Beach Breakwater, near the mouth of the LA River. The CAD site cap stability must be preserved.

- Navigational safety. Safe navigation must be maintained for all vessels entering and exiting the area.

- Bird and fish habitat. Endangered/threatened/sensitive species must not be adversely affected. In addition, consideration must be given to the existing habitat uses of the breakwaters and the potential to impact/displace these habitats.

- There are also concerns regarding impacts to existing recreational uses of the area leeward of the breakwater (e.g. recreational sailing). The calmer waters leeward of the breakwater provide a unique open ocean condition for recreational sailors.

2) Sea Level Rise. The potential impacts of future sea level rise must be considered for all alternatives, including increased wave overtopping, erosion, and shoreline retreat.

3) Applicable Executive Orders, Statutes and Regulations - none.

f. Measures to Address Identified Planning Objectives. A management measure is a feature or activity at a site, which address one or more of the planning objectives. A wide variety of measures were considered (as listed below), some of which were found to be infeasible due to technical, economic, or environmental constraints (discussed further in section g). Each measure was assessed and a determination was made regarding whether it should be retained in the formulation of alternative plans. The descriptions and results of the evaluations of the measures considered in this study are presented below.

1) *No Action.* The Corps is required to consider the option of "No Action" as one of the alternatives in order to comply with the requirements of the National Environmental

Policy Act (NEPA). No Action assumes that no project would be implemented by the Federal Government or by local interests to achieve the planning objectives. No Action, which is synonymous with the Without Project Condition, forms the basis from which all other alternative plans are measured.

2) *Non-Structural* . Non-structural measures have not been identified for this study, as these are already in place or are being considered for implementation as part of other studies, environmental programs or the result of Federal, State and local regulations.

3) *Structural*. The types of structural measures identified include: i) reconfiguration of the Long Beach Breakwater, ii) creation of new kelp and/or rocky reef habitat areas (either by importing new rock or using rock available from breakwater reconfiguration), and iii) construction of a "training: structure and other changes to address specifically the Los Angeles River pollutant discharges. These are explained further below.

i) Long Beach Breakwater Reconfiguration Alternatives

- Lower the Long Beach Breakwater in one section ("Alternative 1" shown in Appendix C). In this measure, rock is removed from the top of an approximately 1,800-foot- long section at the western end of the Long Beach (LB) Breakwater (approximately 13% of the entire length of the LB Breakwater). This westernmost 1,800-foot-long section would then have a crest elevation at Mean Lower Low Water (MLLW). The remaining sections of the LB Breakwater would remain the same. This is a measure that has been previously proposed and studied by a Long Beach engineer, and was identified at the study outset to have potential to improve water quality at a relatively low cost.
- Remove a section of the LB Breakwater ("Alternative 2" shown in Appendix C). This measure would involve removing a section of the LB Breakwater down to a depth well below the water surface to provide sufficient wave transmission (e.g. down to 30 feet below Mean Sea Level) to modify the circulation leeward of the breakwater. This alternative could have several possible designs, for example, removing one or both ends of the breakwater or removing one or more specific sections to create gaps within the middle of the breakwater. Based on initial assessment, the most promising option is the removal of an approximately 4,500-foot-long section at the western end of the breakwater (approximately one-third of the entire length of the LB Breakwater). This was the configuration analyzed as part of the Reconnaissance Study and shown in Appendix C.
- Reconfigure the LB Breakwater to staggered breakwater sections ("Alternative 3" shown in Appendix C). This measure is similar to the measure above, but would involve re-locating sections of the existing LB Breakwater to create a staggered pattern of breakwater sections and thus create gaps for wave action upon the shoreline. Based on initial assessment, a potential configuration would be removal of an approximately 9,000-foot long section at the eastern end of the breakwater (two-thirds of the LB Breakwater length) and use the removed rock to construct two new more-shoreward-located breakwaters to protect the THUMS islands and shoreline. The resulting configuration would be a remaining 4,500-foot-long section at the western end of the LB Breakwater and two shorter breakwaters shoreward of the remaining LB Breakwater section and adjacent to the THUMS islands. This alternative would most likely require re-location of the Navy explosives anchorage.
- Re-align the end(s) of the LB Breakwater. This measure would remove an end section(s) of the LB Breakwater, but then a new section perpendicular to the existing breakwater would be constructed at that end. This would allow for some wave action upon the shoreline, but would provide a similar (to existing) level of protection to the Navy explosives anchorage leeward of the breakwater.

- Remove entire LB Breakwater. The LB Breakwater would be removed along its entire length and most of its depth.

ii) Construction of Habitat Areas (Re-establishment of historic ecoystems)

- Construct rocky reef. Rock could be placed to create high and low relief rocky reef areas in the eastern portion of San Pedro Bay. The removal of breakwater sections (breakwater reconfiguration) would provide a significant amount of rock to create these areas, but rock could also be imported from off-site sources. Not only would this rocky reef provide new habitat area, which does not exist in the area, but nearshore reef could be strategically located to provide shore protection and sand retention for critical areas that could be impacted from reduced breakwater protection.
- Construct kelp reef. Rock could be placed to create holdfasts for new kelp beds. Existing kelp habitat is currently limited. The removal of breakwater sections (breakwater reconfiguration) would provide a significant amount of rock to create these areas, but rock could also be imported from off-site sources. With improved water quality (water clarity) from implementation of other measures, and creation of kelp holdfast areas from placed rock, new kelp beds could be created.

iii) Changes to Los Angeles River

- Change alignment of LA River discharge (shown as "Alternative 4" in Appendix C). Water quality may be improved by constructing a shore-perpendicular rock "training" structure to redirect the LA River discharge away from the Long Beach shoreline. Rock from removed breakwater section(s) could be used for this construction, or rock could be imported from off-site sources. The new structure could also provide additional shore protection to the downtown marina and would provide new rocky habitat area.
- Measures to treat pollutants in the LA River. The water quality of San Pedro Bay may be improved by minimizing the amount of pollutants being discharged from the LA River into San Pedro Bay. LA River improvements are being evaluated as part of other ongoing projects, e.g. Water Board LA River TMDL Study, USACE LA River Ecosystem Restoration Study, and the LA River Watershed MS4 NPDES permits. Additional measures should be implemented to treat, infiltrate and/or eliminate pollutant discharges to and from the LA River into San Pedro Bay. These potential measures include, but are not limited to: a) constructing a sediment trap at the LA River mouth to isolate contaminated sediments within the trap; b) installing "turbulence generating features" at the LA River mouth to improve vertical mixing to dilute bacterial concentrations and reduce the effects of wind-driven transport of the plume towards the beaches, (water testing along the shoreline suggests that poor quality water from the LA River remains on the water surface as it moves along the Long Beach shoreline, i.e. a lack of mixing occurs); and/or c) installing a trash boom upstream of the LA River mouth to capture trash before it is discharged into the open ocean.

4) *Separable Features (such as for recreation or restoration if not already included above).* None identified.

5) *Additional Measures for Complete Alternatives (secondary features to make an alternative complete, such as dredging methods, interior drainage, etc).* The following are features, which help to minimize existing problems and/or to alleviate impacts to constraints caused by implementation of the basic structural alternatives.

- Install additional rock around THUMS oil islands. Several of the basic structural measures listed above could leave the THUMS oil islands vulnerable to wave damage and wave–induced flooding. In order to protect the islands, the rock from the removed breakwater section(s) would be used to either augment the existing rock revetment around the islands or create breakwaters on the seaward side of the islands. These new breakwaters would also provide new rocky habitat area.

- Groins. Several of the basic structural measures listed above could leave the Long Beach shoreline vulnerable to increased erosion. In particular, the Peninsula Beach is of concern. Construction of shore-perpendicular groins to retain sand along targeted sections of shoreline could mitigate for erosive effects caused by removal of breakwater section(s).

- Nearshore Reef Breakwater. Several of the basic structural measures listed above could leave the Long Beach shoreline vulnerable to increased erosion. In particular, the Peninsula Beach is of concern. Construction of nearshore reef breakwaters to dissipate waves and retain sand along targeted sections of shoreline could mitigate for erosive effects caused by removal of breakwater section(s).

- Beach Nourishment. Several of the basic structural measures listed above could leave the Long Beach shoreline vulnerable to increased erosion. In particular, the Peninsula Beach is of concern. Beach nourishment (sand import) along targeted sections of shoreline could mitigate for erosive effects caused by removal of breakwater section(s).

6) *Evaluations of Measures*. The measures listed above were evaluated on a conceptual level, in terms of ecosystem benefits, hydrodynamic/water quality performance, construction cost, and economic benefit. A summary of these preliminary evaluations for each measure/alternative are provided in Appendix D. In order to assess the potential magnitude of water quality improvements (and thus ecosystem restoration and recreation benefits), preliminary wave and circulation modeling/analysis was completed for three different LB Breakwater reconfigurations, as well as the stand-alone LA River training structure. Removal of the entire breakwater was not included in this modeling effort because it was considered to be not feasible due to existing constraints, and re-aligning the end of the breakwater was not included because other similar measures could provide similar benefits (discussed further below). The modeling results suggest that breakwater reconfiguration would change existing conditions relative to wave height and pollutant concentration reduction over time. A complete discussion of the hydrodynamic/water quality modeling results is provided in Appendix E.

g. Preliminary Plans: Preliminary plans are comprised of one or more management measures that passed the initial screening, (i.e. the evaluations discussed above). The descriptions and results of the evaluations of the preliminary measures/plans that were considered in this study are summarized below:

1) Preliminary Plans Eliminated from Further Consideration

- Remove the entire LB Breakwater. Removal of the entire breakwater is considered to not be feasible due to the extent of measures that would be required to mitigate for unacceptable impacts, such as impacts from reduced wave protections for the Port of Long Beach, THUMS oil islands, Long Beach peninsula, and the Navy anchorage area. It is anticipated that the implementation cost of removing the entire breakwater and constructing mitigation measures to maintain necessary wave protection would far outweigh the ecosystem and recreational benefits.

- Re-align end(s) of the LB Breakwater. It would not be worthwhile to pursue this alternative since the new perpendicular element would not be as efficient as other measures to mitigate for reduced breakwater length.

2) *Preliminary Plans for further Consideration*. The following could be considered in combination or individually.

- Construct the rocky reef and/or kelp reef feature to restore impacted/lost ecosystem habitat. These areas could be created from either imported rock or from removed breakwater sections. The latter (breakwater reconfiguration) could provide rock to create on the order of 500 acres of kelp bed (the size of the historic Horseshoe Kelp Bed) and 50 acres of high and low relief rocky reef areas. This is proposed for further consideration based on direct replacement of lost habitat in San Pedro Bay. This is considered to be technically feasible, although navigational constraints would need to be addressed.

- Reduce the LA River impacts to the ecosystem by providing a training structure to divert flows (Alternative 4) and implementing other measures to treat pollutants in the LA River. This is proposed for further consideration based on the known pollutants in the LA River and its discharge and the probable water quality improvements to East San Pedro Bay. This is considered to be technically feasible, although navigational constraints would need to be addressed.

- Remove a section of the LB Breakwater (Alternative 2) and construct the rocky reef and/or kelp reef feature(s). This alternative is proposed for further consideration based on the potential water quality improvements suggested by the hydrodynamics modeling and the potential ecosystem restoration benefits. This alternative is considered to be technically feasible, although navigational, wave impacts, and shoreline erosional constraints would need to be addressed.

- Reconfigure to staggered LB Breakwater sections (Alternative 3) and construct the rocky reef and/or kelp reef feature(s). This alternative is proposed for further consideration based on the potential water quality improvements suggested by the hydrodynamics modeling and the potential ecosystem restoration benefits. This alternative is considered to be technically feasible, but would likely require relocation of the Navy explosives anchorage area and construction of new breakwater sections to protect the THUMS oil islands. Navigational and shoreline erosion constraints would also need to be addressed.

- Lower the LB Breakwater in one section (Alternative 1). Although the hydrodynamic modeling results for Alternative 1 indicated only marginal improvements, as compared to the other alternatives, it would still be worthwhile to pursue this alternative. This result holds true for a single section or multiple sections of reduced breakwater elevation. It would be the least expensive to construct and it does not appear to be problematic relative to any existing constraints, although navigational constraints would need to be addressed.

- Groins. This secondary measure would be carried forward with the breakwater configuration alternatives for future consideration.

- Nearshore reef breakwaters. This secondary measure would be carried forward with the breakwater configuration alternatives for future consideration.

- Beach nourishment. This secondary measure would be carried forward with the breakwater configuration alternatives for future consideration.

- Any feasible plan must implement the necessary mitigation measures to accommodate the constraints previously listed.

h. Conclusions from the Preliminary Screening: The preliminary screening suggests that alternatives which address opportunities to both restore the marine ecosystem and enhance recreation, while accommodating constraints, have the greatest potential for implementation. Restoration of the reef and kelp habitat within San Pedro Bay can be enhanced by improving the water quality, clarity, and circulation. A means to accomplish this could be a reconfiguration of the Long Beach Breakwater, which

has the added benefit of providing an in-water, local source for reef creation material. The potential magnitude and types of benefits from the proposed actions were evaluated based on: a) hydrodynamic and water quality modeling results, b) discussions with resource agency staff and knowledgeable individuals, and c) literature review.

Ecosystem benefits associated with the proposed measures would include: a) re-establishment of kelp beds which once existed in the region (potentially 500+ acres, the size of the historic Horseshoe Kelp Bed); b) construction of high and low relief rocky reef areas (potentially 50 acres) for fish refuge and invertebrates habitat; b) c) reduction of occurrence of harmful algal blooms; and d) increased water clarity to improve conditions for kelp, eelgrass and other habitats. The former two benefits are to restore historic ecosystems, which once existed in the San Pedro Bay region. Both kelp and rocky reef / hard bottom habitats are considered to be important habitat for various rockfish species, ling cod, kelp and sand bass, as well as a variety of invertebrates (e.g. lobster).

The potential environmental impacts would be the loss of rocky habitat from the removal of breakwater section(s). This would be mitigated for by the creation of new rocky reef and kelp habitat areas elsewhere in the region using rock from the removed breakwater section(s).

As discussed previously and in Appendix E, preliminary hydrodynamic/water quality modeling results suggest breakwater reconfiguration could improve existing conditions relative to wave height and pollutant concentration. Both wave height and pollutant concentration are proxies of water quality. Improvements to water quality in turn would lead to improved ecosystem and recreational swimming conditions. In addition, increased wave height would improve conditions for wave activities (such as surfing and body-surfing). Therefore, the hydrodynamics modeling results suggest potential benefits to ecosystem restoration and recreational enhancements.

Construction costs of the alternatives would likely be on the order of the tens or hundreds of million dollars. Based on very preliminary concepts, the approximate construction costs for the breakwater reconfiguration alternatives ranged from $10 million (Alternative 1) to $310 million (Alternative 3). The latter Alternative 3 cost included construction of a LA River training structure and THUMS islands breakwaters, in addition to the breakwater reconfiguration. These costs were developed for the removal of the breakwater sections and placement of the removed rock to construct rocky reef / kelp areas, new THUMS island breakwaters, or the LA River training structure. The cost to build kelp and rocky reef habitat areas from <u>imported</u> rock is approximately $50 million. A summary of these costs, and the associated rock quantities are provided in Appendix D.

As discussed previously, the project could result in improved conditions for recreational swimming and surfing. Increased recreational use would in turn lead to long-term economic benefits to the region. If conditions were improved such that water quality standards were never/rarely exceeded and wave activity was increased along the entire open shoreline of Long Beach (maximum improvement scenario), an initial analysis indicates that increased recreational value of the beach, as measured using Corps' standards, would be on the order of $27.5 million per year. Assuming this gain is maintained over the long term, this equates to approximately one-half billion dollars (discounted present value) over a fifty year period. In addition, the increase in beach tourism will generate economic impacts to the State and City from local spending, parking revenue and fines, and taxes. The City of Long Beach could gain increases of approximately $52 million per year in local spending and economic activity, and nearly $7 million per year in taxes and parking fees for the maximum improvement scenario. An increase in wave activity could diminish recreational boating activity or value during periods where swells are significant, however the increased water quality, particularly the reduction in red tide, may offset some of these losses. It is also acknowledged that the increased number of beach-goers may impact parking along residential streets near the beaches. The supporting preliminary economic benefits analysis is provided in Appendix F. The initial alternative plans studied herein did not result in maximum improvement scenarios and thus their economic benefits would be substantially less than the maximum economic benefits cited in Appendix F. A preliminary analysis has been done to roughly estimate the range of potential economic benefits for each of the alternatives, based on the alternative's hydrodynamic and water quality modeling results. These numbers are provided in the Alternatives Analysis Summary table provided in Appendix D. Potential

recreational benefit to cost ratios could range from 0 (no quantifiable recreational benefit) to 4 based on this cursory analysis.

An important factor in the decision to move forward with the feasibility study is the basic assumption that the planning constraints listed previously can be accommodated. Key constraints include the Port of Long Beach berths, Navy anchorage, Long Beach peninsula, THUMS islands, CAD site and navigational safety. Significant effort (and potentially additional costs) will be required to address these constraints for Long Beach Breakwater reconfigurations and any other structural changes in the San Pedro Bay area.

Based on this information, alternatives to address the planning objectives appear viable and long-term ecosystem and recreational economic benefits have the potential to outweigh implementation costs.

i. Establishment of a Plan Formulation Rationale: The conclusions from the preliminary screening form the basis for the next iteration of the planning steps that will be conducted in the feasibility phase. The likely array of alternatives that will be considered in the next iteration includes re-creating reef and kelp habitat, reconfiguring the Long Beach Breakwater, and/or creating a LA River training structure. Future screening and reformulation will be based on the following factors: ecosystem benefits (as measured by changes in both the amounts and values of habitat), recreational benefits, constraints accommodation, and construction costs.

6. FEDERAL INTEREST

Since ecosystem restoration is an output with a high budget priority and ecosystem restoration is the primary output of the alternatives to be evaluated in the feasibility phase, there is (is not) a Federal interest (This will be determined by the US Army Corps of Engineers) in conducting the feasibility study. There is also a Federal interest in other related outputs of the alternatives, including recreational benefits, which could be developed within existing policy. Recreational benefits (e.g. improved water quality and increased wave activity) are incidental to many of the alternatives identified.Based on the preliminary screening of alternatives, there appears to be potential project alternatives that would be consistent with Army policies, costs, benefits, and environmental impacts. This is based on:

- Restoration of historical reef and kelp bed habitats.
- Improvements to water quality (and thus habitat and recreational opportunities) from implementation of potential structural measures.
- Long-term economic benefits to the region from enhanced recreational opportunities.

7. PRELIMINARY FINANCIAL ANALYSIS

As the local sponsor, the City of Long Beach will be required to provide 50 percent of the cost of the feasibility phase. Not more than one-half of the non-Federal (local sponsor) share may be made by the provision of services, materials, supplies or other in-kind services necessary to prepare the feasibility report. The local sponsor is also aware of the cost sharing requirements for potential project implementation. A letter of intent from the local sponsor stating a willingness to pursue the feasibility study and to share in its cost, and an understanding of the cost sharing that is required for project construction is included as Appendix G (PENDING CITY COUNCIL DECISION).

8. ASSUMPTIONS AND EXCEPTIONS

a. Feasibility Phase Assumptions: The following critical assumptions will provide a basis for the feasibility study:

1) Modifications to the wave climate and circulation within East San Pedro Bay can lead to improvements in water quality and clarity that will benefit both ecosystem and recreational uses. The increases in water quality and clarity are required to increase the feasibility of restoring the historic reef and kelp ecosystem within San Pedro Bay.

2) The rock removed as part of breakwater reconfiguration, to increase circulation within East San Pedro Bay, can be used to create new rocky reef and kelp habitat areas.

3) All constraints can be accommodated or mitigated for in conjunction with any of the alternative plans identified.

4) The without project conditions are that the LA River will continue to discharge pollutants into East San Pedro Bay and the existing uses (or lack thereof) of the East San Pedro Bay area will continue to be the same or possibly even degrade.

b. Policy Exceptions and Streamlining Initiatives: The study will be conducted in accordance with the Principles and Guidelines and the Corps of Engineers regulations. No exceptions to established guidance have been identified at this time.

c. Other Approvals Required: Certain models to be used for the study will require certification by the appropriate USACE center of expertise.

9. FEASIBILITY PHASE MILESTONES

The proposed milestones for the feasibility phase of the East San Pedro Bay Ecosystem Restoration Study are shown in the table below and are described further in Enclosure B of the PMP. The dates associated with these milestones are listed in the Project Management Plan Chapter VI.

Milestone	Description	Duration (mo)	Cumulative (mo)
Milestone F1	Initiate Study	0	0
Milestone F2	Public Workshop/Scoping	2	2
Milestone F3	Feasibility Scoping Meeting	11	13
Milestone F4	Alternative Review Conference	9	22
Milestone F4A	Alternative Formulation Briefing	5	27
Milestone F5	Draft Feasibility Report	3	30
Milestone F6	Final Public Meeting	1	31
Milestone F7	Feasibility Review Conference	1	32
Milestone F8	Final Report to SPD	3	35
Milestone F9	DE's Public Notice	1	36
Milestone F10	Chief's Report	4	40
Milestone F11	Project Authorization	4	44

10. FEASIBILITY PHASE COST ESTIMATE

The estimated costs for the feasibility phase of the East San Pedro Bay Ecosystem Restoration Study are shown in the table below. The scope of work associated with each of these tasks is discussed in the Project Management Plan Chapter IV and Enclosure C.

WBS#	Description	Cost
JAA00	Feas - Surveys and Mapping except Real Estate and GIS	$360,000
JAB00	Feas - Hydrology and Hydraulics Studies/Report (incl. Coastal)	$1,500,000
JAC00	Feas – Geotechnical Studies/Report	$300,000
JAE00	Feas – Engineering and Design Analysis Report	$400,000
JAF00	Feas – Value Engineering	$30,000
JB000	Feas – Socioeconomic Studies	$300,000
JC000	Feas - Real Estate Analysis/Report	$70,000
JD000	Feas – Environmental Studies/Report (Except USF&WL)	$810,000
JE000	Feas - Fish and Wildlife Coordination Act Report	$20,000
JF000	Feas - Geographic Information System Development	$360,000
JG000	Feas - HTRW Studies/Report	$50,000
JH000	Feas - Cultural Resources Studies/Report	$40,000
JI000	Feas - Cost Estimates	$120,000
JJ000	Feas - Public Involvement Documents	$180,000
JK000	Feas - Plan Formulation and Evaluation	$620,000
JL000	Feas - Final Report Documentation	$100,000
JMD00	Feas - Technical Review Documents	$70,000
JN000	Feas - Washington Level Report Approval (Review Support)	$20,000
JPA00	Project Management and Budget Documents	$120,000
JPB00	Supervision and Administration	$120,000
L0000	Project Management Plan for Project Implementation	$50,000
Q0000	PED Cost Share Agreement	$20,000
JPC00	Contingencies	$1,410,000
Total		**$7,070,000**

11. VIEWS OF OTHER RESOURCE AGENCIES

Because of the funding and time constraints of the reconnaissance phase, only limited and informal coordination has been conducted with other resource agencies. Discussions focused on identifying any additional study reports or information regarding the San Pedro Bay region, and general views regarding the need for ecological restoration. Agency views were also sought regarding the types of habitats that they would be considered of particular value in a restoration effort. The persons contacted, on an individual basis, are shown below:

Agency	Contact
National Marine Fisheries Service (NMFS)	Bryant Chesney
U. S. Fish and Wildlife Service (USFWS)	Ken Corey
U. S. Environmental Protection Service (EPA)	Peter Kozelka
California Department of Fish and Game (CDFG)	Bill Paznokas, Loni Adams
Regional Water Quality Control Board, Los Angeles Region	Shirley Birosik, Michael Lyons, L.B. Nye

Most agency staff indicated that data for the East San Pedro Bay area was sparse but a few additional documents of relevance were obtained (in addition to those documents that had already been obtained). These included: a) recent kelp surveys that document the linear kelp beds associated with the breakwater and other riprap protects areas within San Pedro Bay, b) a survey conducted for the City of Long Beach desalinization intake structure that identified the presence of eelgrass in nearshore waters

fronting the beach at approximately Cherry Avenue, and c) the draft toxics TMDL for the greater Los Angeles/Long Beach Harbor waters.

Agency contacts generally recognized that the Harbor water is degraded, but also noted that information on habitat and water quality is limited in this portion of the Harbor and that additional survey work would be necessary to quantify the magnitude and extent of degradation. Concerns were expressed by NMFS and CDFG staff regarding the apparent frequency and impacts of red tides that appear to be associated with this region, although neither agency maintains historical records of red tides or fish kills in this area. Both agencies recognized that blooms are known to occur all along the coastline including areas without major input from urban rivers. As discussed previously, USC faculty stated that the area is a "hotspot" for Harmful Algal Blooms (HABs), which are harmful to both marine life and humans.

The breakwater itself was noted to provide an important protected habitat used by several bird species for roosting and nesting and for several invertebrate species. This was considered a positive element of the current configuration that should be considered. Several people questioned whether the current protected waters within the breakwater provided for unique nursery and foraging habitat or if these waters would likely not differ from uses along open coastal areas of southern California.

Most agencies expressed interest in restoration/improvement activities to increase rocky bottom and kelp habitat areas. Both types of habitats provide refuge and nursery habitat for important managed fisheries.

12. POTENTIAL ISSUES AFFECTING INITIATION OF FEASIBILITY PHASE

a. Continuation of this study into the cost-shared feasibility phase is contingent upon an executed FCSA. Failure to achieve an executed FCSA within 18 months of the approval date of the Section 905(b) Analysis will result in termination of the study.

b. The schedule for signing the Feasibility Cost Sharing Agreement (FCSA) is May 2010. Based on the schedule of milestones in Paragraph 9, completion of the feasibility report would be in May 2013, with a potential Congressional Authorization in a WRDA Year 2014.

13. PROJECT AREA MAP

A map of the study area is provided as Enclosure A.

14. RECOMMENDATIONS

I recommend /do not recommend (that the East San Pedro Bay Ecosystem Restoration study proceed into the feasibility phase.

*Date*_____

Thomas Magness
Colonel, US Army
District Engineer
Los Angeles District

APPENDIX A - PRIOR REPORTS –
Bibliography and Abstracts of Key Reports

BIBLIOGRAPHY - LIST OF EXISTING AND RELEVANT STUDIES AND DATA

*** Denotes Abstract Provided in Following Pages**

BREAKWATER AND SHORELINE AREA REPORTS

Coastal Erosion Issues Within the City of Long Beach – Draft Report – Prepared by City of Long Beach – June 1994

Comprehensive Condition Survey – Los Angeles-Long Beach Breakwaters – US Army Corps of Engineers – January 1985

- Provides useful history and details of construction

East Beach Stabilization Project – Tetra Tech, Inc. – August 1991

Environmental Impact Concerns for Long Beach Harbor – CP "Bud" Johnson – February 2008

Peninsula Beach Erosion – Draft Feasibility Study – US Army Corps of Engineers, LA District

Physical and Environmental Changes from the Proposed Removal of the Long Beach CA Breakwater: Implications for Sand Transport, Beach Profiles, Circulation and Water Quality – K. Morris – May 1998

Review of K. Morris Study by Coastal Frontiers – August 1999

Port of Long Beach – Pier J Breakwater – Beach Impacts Study – SeaDyn, Inc., July 1995

- Study addressed potential shoreline erosion impacts associated with construction of the breakwaters adjacent to the Pier J Expansion Landfill
- Used wave modeling and review of historic data

WATER AND SEDIMENT QUALITY DATA SOURCES

ABC Laboratories 2004. Los Angeles Contaminated Task Force Confined Aquatic Disposal Site Long Term Monitoring Program 2002 – 2003

- Sediment quality and benthic community analysis for reference sites and NEIBP CAD site.
- Sediment quality information from SEIBP site used as cap material.
- Sediment quality information from LARE material disposed at the NEIBP CAD site.

* *RWQCB-LA Region and U.S. EPA – Region 9, 2008. Total Maximum Daily Loads for Toxic Pollutants in Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters, Draft: Water Quality Assessment, Problem Statement, Numeric Targets.*

2006 Final 303(d) List – Impairments for San Pedro Bay (includes area shoreward of LB Breakwater): Fish Tissue – DDT, PCBs. Sediment – Chlordane, PAHs, Cr, Cu, Zn, Toxicity. Fish consumption advisory for DDT and PCBs exists in San Pedro Bay and is supported by recent fish tissue results.

Kinnetic Laboratories, Inc. 2008. City of Long Beach, Recreational Water Quality Source Investigation, Open Coastal Beach Sites.

- 30 days (9-10/2007of surface water quality data (temperature, conductivity, salinity, dissolved oxygen, turbidity) at LA River Mouth (near the Queen Mary), north entrance to Shoreline Harbor, and paired sampling points at 2 meter contour and swashzone at 7 sites along the beach.
- 24 hour sampling (every 1.5 hours on 9/27-28/2008 of surface water quality at LA River Mouth, Shoreline Harbor Entrance and paired 2-meter/swashzone sites extending to out to Belmont Pier.
- DO ranged 4-5 mg/L in surface plume from LA River in over 40% of samples.

U.S. Army Corps of Engineers 2004.Los Angeles District. Los Angeles Regional Dredged Material Management Plan Feasibility Study.

- Summarizes available sediment chemistry, biology for San Pedro Bay including Long Beach Harbor and Los Angeles River Estuary.
- Most recent data derived from MEC 2002 portwide survey and MBC 2003 study for Golden Shore Marine Reserve.

* *U.S. Army Corps of Engineers, 2007. North Energy Island Borrow Pit CAD Site Pilot Study 2001-2006 Draft Monitoring Results*

- Provides data on sediment contaminants within the East San Pedro Bay.

Weston 2006, Supplemental Sampling and Tier III and IV Analysis for LA River Estuary (LARE)

- Summarizes sediment sampling results from four sites within the LARE

* *SCCWRP Bight 2003 Study – Water Quality*

- Describes storm water runoff which flows into San Pedro Bay from the Los Angeles River and San Gabriel River

Blooms of Pseudo-nitzschia and Demoic Acid in the San Pedro Channel and Los Angeles Harbor Areas of the Southern California Bight, 2003-2004.

- Implies that nutrient and salinity levels may affect HABs

BIOLOGY DATA SOURCES

* *MEC 2002. Ports of Long Beach and Los Angeles Year 2000 Biological Baseline Study of San Pedro Bay. Prepared by MEC Analytical Systems Inc. for the Port of Long Beach Planning Division. June 2002.*

MBC 1984. Outer Long Beach Harbor – Queensway Bay Biological Baseline Survey. Prepared for the Port of Long Beach.

- Aged but local to area of concern

* *MBC 2003. Physical and Biological Monitoring at Golden Shore Marine Reserve, Long Beach, California Year 5 (2002). Final Report. Prepared for the City of Long Beach.*

MBC 2006. Eelgrass, Caulerpa, and Giant Kelp Surveys, Prepared for Under Ocean Floor Seawater Intake/Discharge Demonstration Facility, in Long Beach Harbor offshore of Ocean Boulevard between Temple and Cherry Avenues.

- Within survey area, eelgrass found at 15 (of 20) sites at depths of 5-8 ft MLLW and 9-12 ft MLLW.
- No Caulerpa or Giant Kelp found.

MBC 2008. Status of the Kelp Beds, Ventura and Los Angeles Counties, Central Region Kelp Survey Consortium, 2007 Surveys.

- Found kelp along POLA, POLB and LB Breakwaters.

* *SCCWRP Bight 2003 Study – Benthic Microfauna*

- Sediment toxicity, benthic community analysis, sediment chemistry at three pertinent sites

* *SCCWRP Bight 2003 Studies - Demersal Fishes and Megabenthic Invertebrates*

- Fish and macroinvertebrate community, fish ectoparasites, debris, pelagic fish whole chemical body burdens at two relevant trawl sites.

Document:
California Regional Water Quality Control Board, Los Angeles Region and United States Environmental Protection Agency Region 9. 2008. *Total Maximum Daily Loads for Toxic Pollutants in Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters.* Draft water quality assessment, problem statement, numeric targets. May 2008.

Relevance:
This draft water quality assessment for the Harbor Toxics total maximum daily load (TMDL) contains a section that identifies specific water body-pollutant combinations on the 1998, 2002, and 2006 303(d) lists. It provides a summary of water quality issues within Los Angeles/Long Beach Harbor complex, however, the Los Angeles and San Gabriel River watersheds are not focus of the TMDLs.

Abstract:
The California Regional Water Quality Control Board, Los Angeles Region developed this TMDL to attain the water quality standards for the Dominguez Channel and greater Los Angeles and Long Beach Harbors waters in the Dominguez Channel Watershed. The waters of Dominguez Channel, Los Angeles and Long Beach Harbors, Cabrillo Marina, San Pedro Bay and Los Angeles River Estuary are impaired by heavy metals and organic pollutants.

Impairments on the 1998 303(d) list for San Pedro Bay, Long Beach Harbor and LARE are listed in Table 1. Impairments listed on the 2002 303(d) list are included in Table 2. For these two lists, Long Beach Harbor is listed separately from the inner and outer harbor of the Port of Los Angeles (POLA). The 2006 303(d) list changed the way areas were named; the water bodies named "Inner Harbor" and "Outer Harbor" include portions of POLB as well as portions of the Port of Los Angeles (POLA). The 2006 303(d) list is included as Table 3. Brief discussions of the data which supports the listings are described after the tables.

Table 1. 1998 303(d) list of metal and organic compound impairments.

Water body name	Tissue	Sediment
Long Beach Harbor	DDT, PCBs	Toxicity, benthic community effects, PAHs
San Pedro Bay	DDT, PCBs	Toxicity, PAHs, Cr, Cu, Zn
Los Angeles River Estuary	DDT, PCBs	Toxicity

Table 2. 2002 303(d) list of individual pollutant impairments by water body.

Water body name	Tissue	Sediment
Long Beach Harbor	DDT, PCBs	Toxicity, benthic community effects
San Pedro Bay	DDT, PCBs	DDT, PAHs, Cr, Cu, Zn, Toxicity
Los Angeles River Estuary	--	Chlordane, DDT, PCBs, Pb, Zn
San Gabriel River estuary	Abnormal fish histology	--

Table 3. 2006 final 303(d) list of individual pollutant impairments by water body.

Water body name	Tissue	Sediment
San Pedro Bay	DDT, PCBs	Chlordane, PAHs, Cr, Cu, Zn, Toxicity
Los Angeles River Estuary	--	Chlordane, DDT, PCBs, Pb, Zn
Inner Harbor	DDT, PCBs	Cu, Zn, Toxicity, benthic community effects
Outer Harbor	DDT, PCBs	Toxicity

The Port of Long Beach collected ambient samples from one site within Long Beach Harbor from 1996 to 2005. These results were found to have quality assurance issues and will not be included in the assessment of Inner Harbor waters until these issues are resolved. POLB also performed a sampling event in 2006 with numerous sites within the Inner Harbor. All samples were below criteria.

SCCWRP sampled DDE and PCBs within the inner and outer harbor in the San Pedro Bay in 2003. Solid phase microextraction devices provided ambient results with extremely low detection levels. Four stations within Inner and Outer Harbor waters showed elevated levels of DDE in comparison to California Toxics Rule (CTR) human health numeric criteria. Total PCB measurements also exceeded the CTR human health numeric criteria at these stations.

OEHHA collected fish tissue samples off Belmont Pier in 1991, 1999 and 2000. Tissues samples collected from white croaker, queenfish, and spotted turbot were found to contain DDT and PCBs at levels that represent a human health risk.

The Los Angeles River Estuary (LARE) fish consumption advisory for DDT and PCBs is based on the fish results collected at Pier J/Fingers Pier, both near the estuary mouth. Sediment toxicity was observed during Bight '03 monitoring. Historical sediment results showed elevated levels of chlordane. In recent sediment triad studies, bulk levels of chlordane, PCBs, and benzo[a]pyrene were above sediment guidelines (Bight '03). Very few reliable measurements of aqueous metals or organics exist in this waterbody, and no exceedences have been recorded. Based on available data in this pre-TMDL assessment, this waterbody is no longer impaired for lead and zinc, although it is on 2006 303(d) list.

The San Pedro Bay fish consumption advisory for DDT and PCBs is supported by recent fish tissue results. Historical sediment results showed elevated levels of chlordane; and to lesser extent PCBs. Sediment toxicity was observed during Bight '03 monitoring. Elevated levels of chlordane corresponded to sediment toxicity for one sample in 1998, but not in more recent data. Very few reliable measurements of aqueous metals or organics exist in this waterbody; no exceedences have been recorded. Based on available data in this pre-TMDL assessment, this waterbody is no longer impaired for chromium, copper and zinc, although it is on 2006 303(d) list.

Document:
U.S. Army Corps of Engineers. 2007. *North Energy Island Borrow Pit CAD site pilot study 2001-2006 draft monitoring results.*

Relevance:
This draft report indicates that the sediments within the Long Beach Breakwater are contaminated with metals and organic compounds. The highest concentrations of contaminants were detected in the mouth of the Los Angeles River.

Abstract:
In early 2001, the Los Angeles District of the U.S. Army Corps of Engineers (USACE) initiated pilot studies to evaluate treatment and disposal options for contaminated dredge sediments within the Los Angeles County Region. Four alternatives were evaluated: cement stabilization, sediment washing, sediment blending, and aquatic capping. For the aquatic capping study (the subject of this report), 105,000 cubic meters (m^3) of contaminated sediment were mechanically dredged from the mouth of the Los Angeles River Estuary (LARE), deposited into a demonstration cell (i.e. the North Energy Island Borrow Pit or NEIBP), and capped with 1-1.5 m of clean fill collected from the South Energy Island Borrow Pit (SEIBP). Dredging activities occurred during the summer of 2001. The cap was completed by February 2002.

This abstract focuses on the results of the pre-construction sediment sampling at each of the three sites and the water column sampling performed prior to, during, and immediately after the dredging, disposal, and capping. Each of the sites (LARE, NEIBP, and SEIBP) is located within the breakwater (Figure 1).

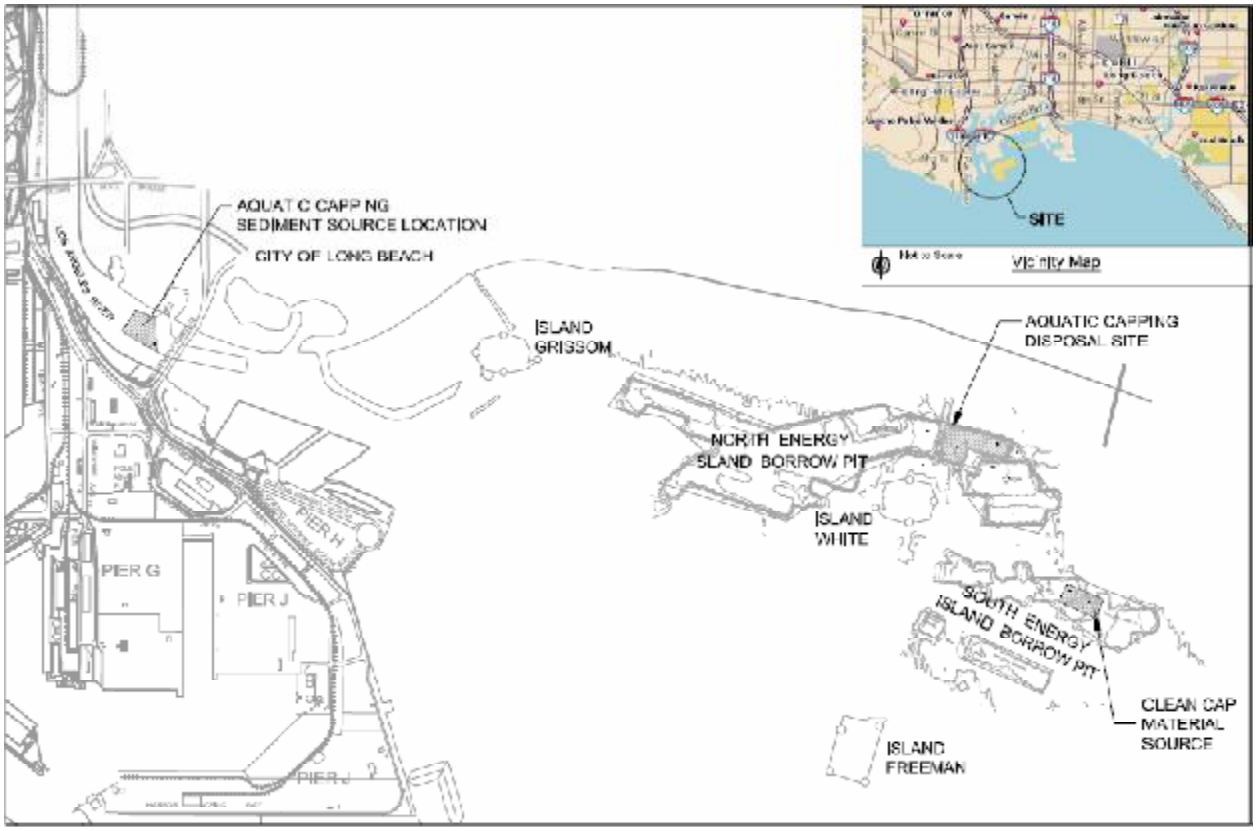


Figure 1. Locations of LARE, NEIBP, and SEIBP.

Sediments from each of the areas were analyzed for physical properties as well as for bulk chemistry including metals and organic compounds. Results were compared to toxicity guidelines (Long et al. 1995). Water column samples were collected up-current and down-current from dredging and placement operations and analyzed for basic field parameters (temperature, salinity, dissolved oxygen, light transmission, and pH), as well as for total suspended solids (TSS), metals, and organic compounds.

Sediment cores samples from each of the three areas were found to be contaminated with metals and organic compounds, with the highest levels detected in the LARE area. Metals, pesticides, and polycyclic aromatic hydrocarbons (PAHs) were detected at LARE at concentrations above Effects Range-Low (ER-L) toxicity guidelines in both the coarser surface sediments and finer subsurface sediments. Several pesticides and zinc also exceeded the Effects Range-Median (ER-M) in the subsurface sediments at LARE. Contaminant mobility through the LARE material was testing using standard leaching and elutriate tests, which also detected metals and organotins in the leachate samples. Sediment cores collected in the NEIBP foundation sediment were found to have several metals exceeding ER-L levels. Organotins were also detected in every NEIBP sample, with dibutyltin detected the most frequently. DDE and related DDT-like compounds were found in all NEIBP cores taken prior to construction. Results from cores from the SEIBP found all metals below the ER-L levels, but organotins were detected in every SEIBP sample, with tetrabutyltin detected the most frequently.

Water quality monitoring of field parameters, TSS, metals, and organics was conducted from stations fixed on transects extending up-current and down-current from the LARE dredging and NEIBP placement operations. Chromium, mercury, and nickel were detected in a few cases downstream of the LARE site at concentrations above background conditions and California Ocean Plan (COP) daily maximum objectives. During the placement of the LARE materials at the NEIBP, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc were detected at background concentrations that were well in excess of COP instantaneous maximum criteria. This would indicate that background variations in metals concentrations in this part of the Los Angeles/Long Beach Harbor were already high, and for purposes of the abstracted report, well in excess of any total or dissolved metals that might be liberated during the disposal process. No metal was detected at concentrations above both background and COP criteria concentrations at NEIBP.

Water samples collected for organics analysis were collected from a depth strata, chosen by the level of light transmissivity, during dredging at LARE and during disposal at NEIBP. Samples were analyzed for selected PAHs, pesticides, and polychlorinated biphenyls (PCBs). No LARE or NEIBP samples had concentrations of the analyzed constituents above the detection limits of the analysis method during dredging or placement activities.

Document:
Weston Solutions, Inc. 2006. *Supplemental Sampling and Tier III and IV Analysis for LA River Estuary (LARE).* Prepared for U.S. Army Corps of Engineers, Los Angeles District. December 2006

Relevance:
This report summarizes sediment sampling results from four sites in August, 2006, within the Los Angeles River Estuary (LARE). Physical, chemical, and biological analyses were performed on composited samples from these sites. Results show that LARE is contaminated with metals, DDT, and chlordanes, although sediments from three of the four sites were determined to be suitable for ocean disposal.

Abstract:
Heavy rains during 2005 deposited a large volume of sediment at the mouth of the Los Angeles River and created a potential navigational hazard. The U.S. Army Corps of Engineers, Los Angeles Region (USACE-LA) issued an emergency permit which allowed the main navigational channel to be dredged in Spring 2005, but the mouth of the estuary in the main navigation channel needed further dredging. Results from a Tier III sediment sampling and analysis (conducted in February 2005) triggered further sampling. In August 2006, physical, chemical, and biological testing was conducted on representative dredged material collected from four areas (Areas ½A, ½B, 4A, and 4B) to determine suitability of the material for selected disposal options (Figure 1).

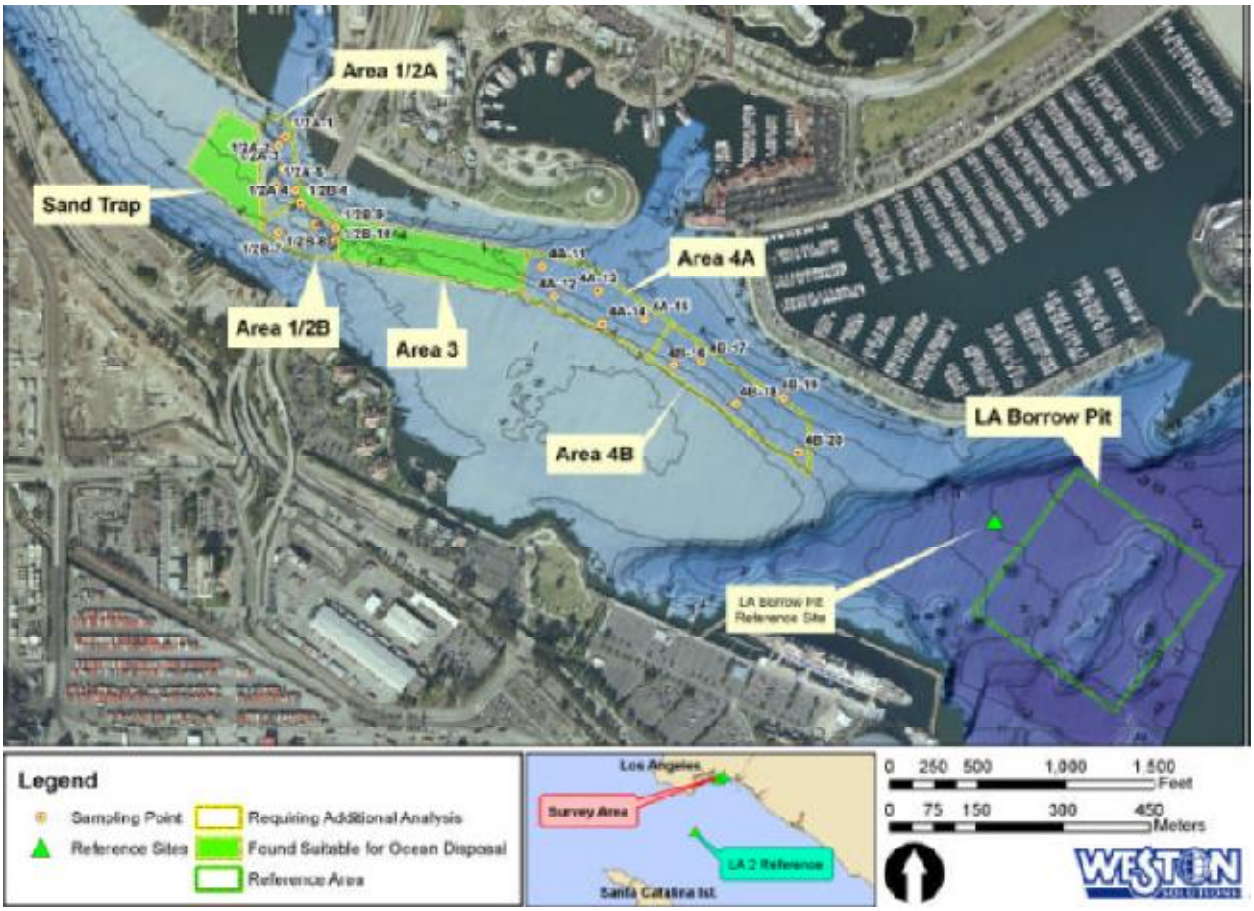


Figure 1. Sediment sampling locations.

Sediments were analyzed for chemical constituents including metals, organotins, chlorinated pesticides, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), phenols, and phthalates, as well as for conventional including total and dissolved sulfides, dissolved ammonia, oil and grease, total recoverable petroleum hydrocarbons (TRPHs), and total volatile solids. Physical analyses of the sediment included grain size, specific gravity, TOC, total solids, and Atterberg Limits. Sediment chemical concentrations in this study were compared to ER-L and ER-M values (Long et al., 1995). Bioassay testing performed on each composite sample for this project consisted on two solid phase toxicity tests, a pore water test, and two bioaccumulation potential toxicity tests. Chemical analyses of tissues from bioaccumulation potential tests included lipids, metals, organotins, pesticides, PCBs, and PAHs.

There were a few exceedances of effects range-low (ER-L) sediment quality values for metals and dichlorodiphenyltrichloroethane (DDT) within project sediments. Silver exceeded the ER-L at all four sites. Cadmium, copper and zinc were each detected above ER-L at two sites. Lead was found above ER-L at one site. Results from one reference site (LA Borrow Pit), which is also located in mouth of the LA River, show exceedances of the ER-Ls for copper, nickel, silver, zinc, DDT, and chlordanes. Concentrations of meals did not exceed effects range-median (ER-M) values at any site. Estimated concentrations (i.e., below the minimum reporting limit) of total chlordanes exceeded ER-M sediment quality values, while the individual compounds were below reporting limits. All contaminant concentrations in tissues of organisms exposed to LARE sediments were below published relevant effect levels. Bioaccumulation test results indicated that sediment from all four areas was suitable for ocean disposal. Results of SP tests with sediments from one area, Area ½A, did not meet requirements for ocean disposal.

Based on the results of this report, sediment from Areas ½B, 4A, and 4B were deemed suitable for ocean disposal. Sediment from Area ½A was not suitable for ocean disposal.

Document:
Nezlin, N.P., DiGiacomo, P.M., Weisberg, S.B., Diehl, D.W., Warrick, J.A., Mengel, M.J., Jones, B.H., Reifel K.M., Johnson, S.C., Ohlmann, J.C., Washburn, L., Terrill, E.J. 2007. *Southern California Bight 2003 Monitoring Program: V. Water Quality*. Southern California Coastal Water Research Project, Costa Mesa, CA.

Relevance:
The water quality component of Bight '03 focused on contaminant-laden stormwater runoff. This report describes the stormwater plume and associated contaminants which flow into San Pedro Bay from the Los Angeles River, San Gabriel River, Santa Ana River, and Newport Harbor. The stormwater flowing into the Bay contains nutrients and bacteria.

Abstract:
The three primary goals of Bight '03 water quality monitoring were to:

- Describe the temporal evolution of stormwater plumes produced by the major southern California rivers,
- Describe how the physical properties of the plume related to elevated bacterial concentrations, toxicity, and nutrients, and
- Determine whether remote sensing data is robust enough to become a part of routine water quality monitoring programs.

Water quality data were collected from four areas of the Southern California Bight (SCB) during two stormwater events in February 2004 and March 2005. Conductivity-Temperature-Depth (CTD) profiles extending from the surface to within two meters of the bottom, or to 60 meters were recorded. These continuous water column vertical profiles measured the distribution of temperature, salinity, density, dissolved oxygen, pH, turbidity, chlorophyll-a, and color dissolved organic matter (CDOM). Profiles were supported by surface batch measurements of chlorophyll concentration, total suspended solids (TSS), nitrite (NO_2), nitrate (NO_3), phosphate (PO_4), silicate (SiO_4), bacteria (total coliforms, fecal coliforms, and *Enterococcus*), and toxicity. Data were also analyzed in combination with MODIS ocean color satellite remote sensing, buoy meteorological observations, drifters, and high-frequency radar current measurements to evaluate the dispersal patterns, dynamics, and impacts of the freshwater runoff plumes and whether physical parameters corresponded with appearance. Discharge points for the Los Angeles River, San Gabriel River, Santa Ana River, and Newport Harbor were grouped as the "San Pedro Shelf".

Among the four areas sampled (Santa Clara/Ventura Rivers, Ballona Creek/Santa Monica Bay, San Pedro Shelf, and the San Diego/Tijuana Rivers), the greatest amounts of freshwater were consistently observed along the San Pedro Shelf. The San Pedro Shelf had the largest river discharge inputs and a sampling area 2–20 times larger than the other sites. The San Pedro Shelf runoff plume was observed at times to extend well into the San Pedro Channel, approaching Catalina Island.

The highest nitrate concentrations (~40 micromolar [μM], 1 μM NO_3 = 2.48 mg NO_3 L^{-1}) of any site were also detected in Los Angeles/Long Beach Harbor (within the breakwater at the mouth of the Los Angeles River) during the first storm, in late February 2004 (Figure 1). In addition, a *Pseudo-nitzschia* bloom that reached moderate levels of toxicity was observed in the San Pedro Channel area following one of the runoff events. *Pseudo-nitzschia* is a diatom that produces the neurotoxin domoic acid. *Pseudo-nitzschia* abundances and toxin concentrations were associated with decreases in macronutrient concentrations

(phosphate and silicate) as well as with changes in nutrient ratios. Generally, highest domoic acid concentrations were observed close to the shoreline and inside the Los Angeles harbor, suggesting that near-shore processes play a major role in bloom dynamics. However, *Pseudo-nitzschia* growth and domoic acid production could not be tied to the river runoff based on field observations.

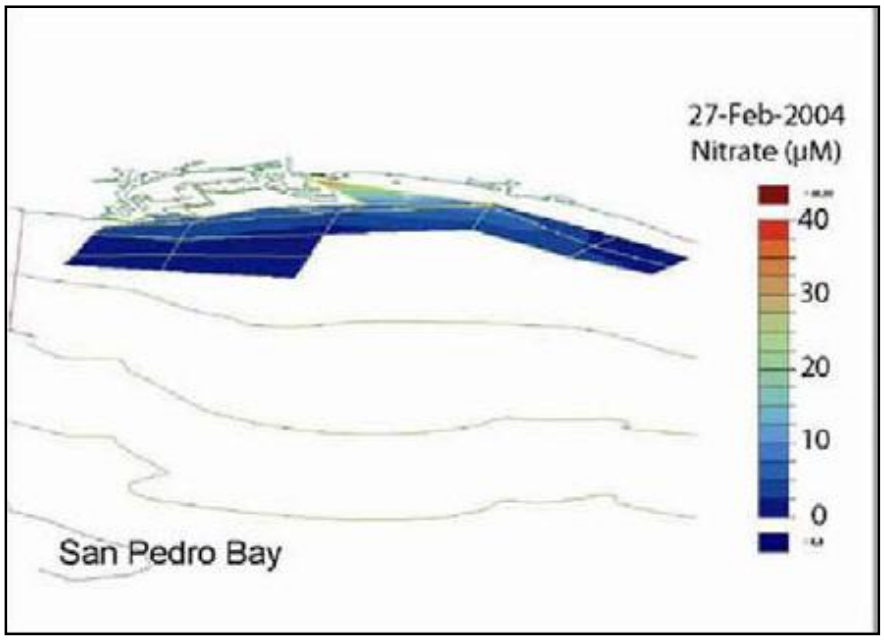


Figure 1. Nitrate levels in San Pedro Bay (2/27/04).

Relationships between salinity and fecal indicator bacteria (FIB) were variable but generally negative. FIBs were generally at very low concentrations in water where the salinity was >32–33 psu. Higher levels of *Enterococcus* were generally located within the breakwater after the first storm (Figure 2). There was also a total coliform hot spot located within the breakwater after the second storm (Figure 3).

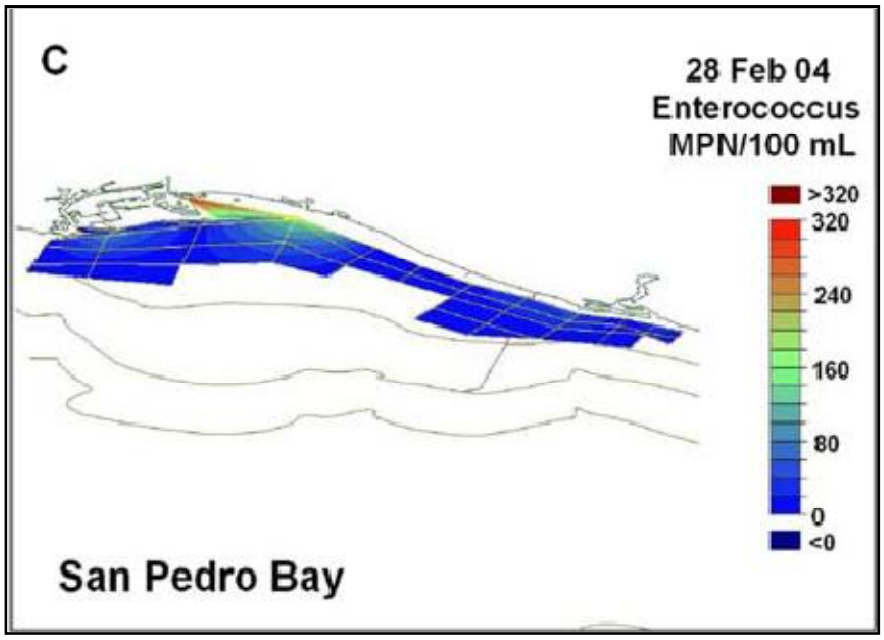


Figure 2. *Enterococcus* in San Pedro Bay (2/28/04).

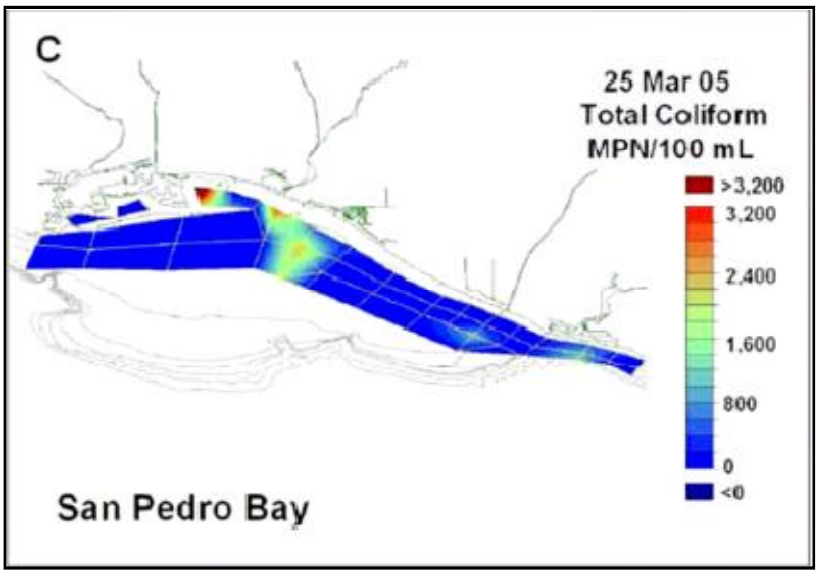


Figure 3. Total coliform in San Pedro Bay (3/25/05).

The Los Angeles River, San Gabriel River, Santa Ana River, and Newport Harbor discharge a large volume of stormwater into the San Pedro Shelf area during periods of rain. An improvement in circulation would assist in better flushing of stormwater contaminants.

Document:
Schnetzer, A., P.E. Miller, R.A. Schaffner, B.A. Stauffer, B.H. Jones, S.B. Weisberg, P.M. DiGiacomo, W.M. Berelson and D.A. Caron. 2007. *Blooms of Pseudo-nitzschia and Domoic Acid in the San Pedro Channel and Los Angeles Harbor Areas of the Southern California Bight, 2003-2004*. *Harmful Algae* 6:372-387.

Relevance:
This report implies that nutrient and salinity levels may affect the production of a toxic acid by the diatom *Pseudo-nitzschia*.

Abstract:
Some members of the diatom genus *Pseudo-nitzschia* can produce domoic acid (DA), a neurological toxin which can lead to illness and mortality in birds and mammals through food web transfer. DA poisoning was implicated in more than 1,400 California sea lion and dolphin stranding incidents within the Southern California Bight during 2003-2004. Regional surveys in 2003 and 2004 documented that the coastal waters within and around the Los Angeles Harbor and San Pedro Channel experience toxic *Pseudo-nitzschia* blooms.

Dry weather surface grabs in May 2003 detected high particulate DA concentrations throughout the Los Angeles/Long Beach Harbor complex (the Harbor) which decreased offshore by two to three orders of magnitude. The highest particulate DA concentration was observed within the outer breakwater, approximately 1 km from the Los Angeles River mouth. The expanded June 2003 survey also found particulate DA concentrations within the Harbor to be higher relative to values outside the harbor, although concentrations throughout the surveyed area were generally lower.

Samples collected in late February/early March 2004 found concentrations of particulate DA to be higher outside the breakwater and lower within the Harbor. These surveys were conducted after heavy rains, when high nutrient concentrations and lower salinity levels were detected near the Los Angeles, San Gabriel, and Santa Ana rivers. *Pseudo-nitzschia* abundances and DA concentrations were found to be higher where the salinity was higher.

In addition, a time-series of surface seawater samples collected south of the Harbor also found substantial particulate DA concentration in 2004, as did three sediment trap samples collected in the San Pedro Channel during spring 2004. Sediment trap material collected from as deep as 800 m tested positive for particulate DA. This is as deep as it has ever been detected.

There may be multiple scenarios in nature that could stimulate toxin production in *Pseudo-nitzschia*, including macronutrient and trace metal availability, as well as anthropogenic factors. Previous research has linked coastal upwelling and river runoff to phyto-plankton blooms, although the varied scenarios under which *Pseudo-nitzschia* blooms and DA is produced have so far prevented any broadly applicable theories. Although a direct connection cannot be made at this time, it is likely that the significantly higher levels of particulate DA concentration found within the breakwater during dry weather would be improved by an increase in circulation.

Document:
MEC Analytical Systems, Inc. 2002. *Year 2000 Biological baseline study of San Pedro Bay*. Prepared for the Port of Long Beach.

Relevance:
The Los Angeles River and Long Beach breakwater were not directly surveyed during this baseline study, however, results are likely comparable as the breakwaters are similarly constructed and close to each other. In general, the outer harbors support a higher diversity of species and better water quality than the inner harbor. Extensive use of the breakwater as substrate, protection, and habitat was documented. The freshwater inputs of Dominguez Channel and Los Angeles River were found to reduce surface salinities at inner harbor sampling stations during winter months.

Abstract:
The Year 2000 Baseline Study provided an update on the physical, chemical, and biological conditions within the Los Angeles and Long Beach Harbor complex. The study was the first comprehensive examination of the status of biological communities within the inner and outer harbor areas of the Port of Long Beach (POLB) and Port of Los Angeles (POLA) since the 1970s. Biological surveys were conducted at varying frequencies, depending upon typical natural variability, and included water quality and sediment grain size, adult and juvenile fish, larval fish (ichthyoplankton), benthic invertebrates, attached organisms on breakwaters and other rocky riprap, kelp and macroalgae, eelgrass, and birds. This was the first survey to map kelp and eelgrass distribution within the Ports.

Water quality was measured on a quarterly basis at each of the stations surveyed for benthos, fish, and ichthyoplankton, for a total of 32 sites. Parameters measured included temperature, salinity, dissolved oxygen (DO), pH, and water clarity (transmissivity). Sediment grain size was also measured during the first survey. In general, water quality characteristics within the harbor complex did not exhibit large spatial or seasonal trends. DO concentrations slightly decreased with increasing depth, but generally ranged between 5 and 8 mg/l. Salinity was slightly lower during winter in surface waters at sites influenced by freshwater inputs from Dominguez Channel and the Los Angeles River. Reduced salinity at these sites was consistent with the presence of a lower density, brackish surface lens. Values of pH did not exhibit any distinct spatial patterns, but did exhibit a temporal pattern which may reflect seasonal differences in productivity. pH values during August and November were generally higher than those occurring during January and April. Water temperatures exhibited expected temporal trends, with warmer conditions in summer. Spatially, inner harbor and other channel, basin, and slip areas with restricted circulation generally had warmer temperatures than deeper, open areas of the harbor, due to solar heating and limited mixing with colder water. Results of the 2000 Baseline indicate a continued trend of water quality improvement since the 1970s.

Fish surveys were conducted quarterly at 18 sites using a combination of gear types, including a lampara net for pelagic fish, an otter trawl for bottom-associated (demersal) fish and invertebrates, and a beach seine for nearshore shallow water species. Day and night samples were collected to provide a more comprehensive list of species and higher abundance estimates. The outer harbor assemblages generally

had relatively higher abundances and higher species diversity than those in the middle and inner harbor areas. In general, more fish were collected from Long Beach Harbor than Los Angeles Harbor, due to large catches of northern anchovy within basins of the middle and outer Long Beach Harbor. In comparison to previous sampling efforts, pelagic fish abundance in Los Angeles Harbor was lower in 2000 than in 1986-1987. Abundance in Long Beach Harbor was within the range previously reported in 1994 and 1996, with some localized areas reporting higher abundance values in 2000 than in the mid-1990s. Many of the fish caught in 2000 were juveniles. The harbors provide important nursery habitat for a variety of species.

Ichthyoplankton was surveyed quarterly at 18 stations. The entire water column was sampled by using two different net types over three different strata. Mean larval abundance was highest in the Long Beach Channel and the Pier 300 Shallow Water Habitat. The stations showing the highest total annual number of species were shallow waters next to the San Pedro Breakwater, deep waters in outer Los Angeles Harbor near Pier 400, and Pier 300 Shallow Water Habitat. Riprap associated with the breakwater and Pier 400, as well as the eelgrass beds in Pier 300, was believed to have contributed to the relatively higher number of rock and/or vegetation-associated species at those stations. Generally, more fish larvae were collected in Long Beach Harbor habitats than in corresponding habitats in Los Angeles Harbor. Fish eggs exhibited a patchy distribution in abundance that did not necessarily correspond to larval fish abundance patterns. Fish eggs were most abundant in shallow waters off Cabrillo Beach, in the Long Beach Channel, and in the Los Angeles East Basin. Fish eggs were least abundant in the Pier 300 Shallow Water Habitat and Los Angeles West Basin.

Infaunal and epibenthic macroinvertebrates were each sampled quarterly from a range of habitats within the Ports. Mollusks and polychaetes accounted for most of the infaunal biomass. Infaunal station cluster groups indicated a gradient of increasing environmental stress (enrichment/contamination) that ranged from the outer to inner harbor, basins to slips, and Long Beach to Los Angeles Harbors. Species assemblages in the outer harbor had the highest habitat quality, as indicated by the dominance of species that are characteristic of uncontaminated areas. Based on infaunal data, the basins and slips of Los Angeles Harbor appeared to have somewhat lower habitat quality than the basins and slips of Long Beach Harbor. Benthic epifaunal macroinvertebrates were collected during the day and night during the otter trawl fish surveys. The most commonly collected species were black spotted shrimp (*Crangon nigromaculata*), tuberculate pear crab (*Pyromaia tuberculata*), and Xantus' swimming crab (*Portunus xantusii*). Macroinvertebrate catch abundance was higher in basin habitats in Long Beach Harbor than in the open waters of the outer harbor. The lowest catch was obtained in the inner harbor.

Riprap-associated invertebrates and algae within the Ports were sampled quarterly. Divers surveyed eight different sites, four in each harbor; one site was located within Long Beach Harbor at the Pier J breakwater. Abundance of invertebrates followed a gradient, with higher numbers in the outer harbor and lower numbers in the inner harbor. Abundance and number of species were greatest in the open water stations due to greater water circulation and tidal flushing in these areas. Increased water circulation and tidal flushing could potentially benefit riprap-associated biota within the Ports.

Kelp and macroalgae distribution and community composition were surveyed twice in 2000. Aerial surveys were followed up by on-the-ground transects. The focus of the investigation was on canopy-forming kelp species giant kelp and feather boa kelp, although other dominant species of macroalgae were reported on as well. Kelp communities within the Ports were not abundant in 2000, totaling about 25 acres in the spring about 14 acres in the fall. Although kelp habitat has never been a significant target for Port habitat management efforts, the microalgal community has benefited from Port improvement projects. All kelp beds within the Ports were found to occur on artificial structures, as there are no native hard-bottom habitats within either Port. The protection provided by the breakwater also allows kelp to grow at shallower than normal depths.

Eelgrass was surveyed at the end of the winter season and at the height of the summer growing season in order to detect seasonal variability, area, and density. An aerial photogrammetric survey of the Ports was performed first. The edges of the eelgrass beds identified by the aerial survey were then confirmed by acoustic and diver surveys. Two areas supporting eelgrass beds were identified within Los Angeles Harbor, Cabrillo Beach and Pier 300. Within Long Beach Harbor, a single plant was found along the north shoreline of Pier A in the Cerritos Channel.

Birds were surveyed throughout the harbors (monthly or bimonthly, depending on season) for one year. The inner and outer harbors of the Ports were divided into survey zones, which were established in the same locations as previous studies to facilitate historical comparisons. In general, the greatest densities of birds in 2000-2001 were observed along the outer middle breakwater within the Port of Long Beach. Densities of small and large shorebirds were highest along the outer breakwater. Black oystercatchers were observed within several survey zones, but the majority of these observations were recorded along the riprap of the outer breakwater. Brown pelicans were also observed in all survey zones, but 40% of pelican observations were along the outer breakwater. The two zones along the middle breakwater also accounted for nearly half of all birds observed in 1983-1984. This indicates a pattern of high usage of the breakwater as a foraging and resting area (MBC 1984).

Document:
MBC Applied Environmental Sciences. 2003. *Physical and biological monitoring at Golden Shore Marine Reserve, Long Beach, California, Year 5 (2002) Final Report*. Prepared for City of Long Beach.

Relevance:
This is a monitoring report for a constructed wetland in the Los Angeles River Estuary. Monitoring results indicate that poor tidal circulation may be impeding recruitment of mudflat invertebrates.

Abstract:
The Golden Shore Marine Reserve (GSMR) is a 6.4 acre wetland habitat created by the City of Long Beach along the Los Angeles River (Figure 1). The GSMR was designed as a mitigation project for construction of a commercial complex at Shoreline Aquatic Park. The mitigation goals were to were to offset the loss of subtidal and low intertidal habitats in Shoreline Lagoon, which supported marine invertebrates and fish. Construction of the GSMR, including removal of a parking lot and boat ramp, contouring, and plantings, was completed in 1998 and monitored for five years. The abstracted report summarizes the results of the five-year monitoring effort, which included the following parameters:

Biological Monitoring
- Invertebrates
- Fish
- Birds
- Vegetation

Physical Monitoring
- Topography
- Hydrology
- Water Quality
- Sediments

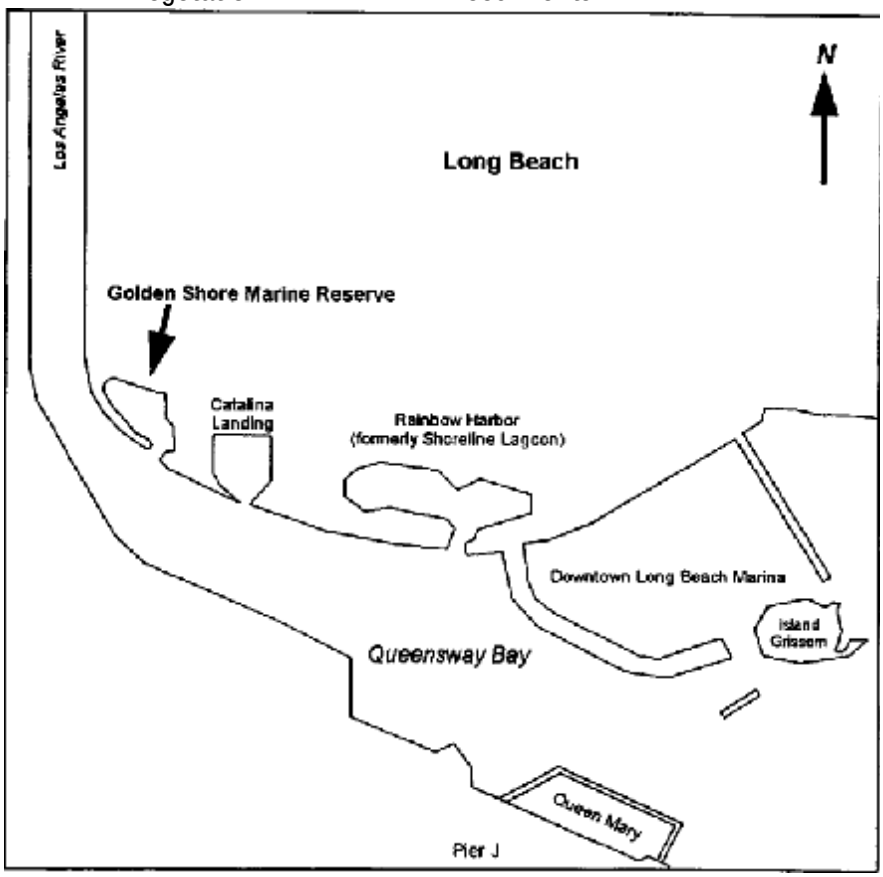


Figure 1. Location of the Golden Shore Marine Reserve.

Water quality was monitored at four stations within the GSMR and two stations in the Los Angeles River. Parameters included temperature, dissolved oxygen (DO), pH, salinity, and light transmittance. Temperatures within the Reserve averaged slightly higher than temperatures within the River stations by a difference of less than one degree Celsius. Average DO concentration over five years was 4.66 mg/L in the River and 4.96 in GSMR. DO concentrations both within GSMR and the Los Angeles River were commonly below 5 mg/L, which is the level considered potentially limiting for some aquatic organisms. Results were compared to data from Shoreline Lagoon collected in 1994. Concentrations of DO at Shoreline Lagoon were commonly slightly higher (5-6 mg/L) in 1994. Salinity ranged from 27.6 to 32.4 parts per thousand (ppt) within GSMR, except for the stations furthest in the Reserve, where salinity ranged from 20.8 to 27.0 ppt. Water quality at GSMR was found to be similar to the source water from the Los Angeles River, with higher temperatures and lower DO values than that from Shoreline Lagoon. Shoreline Lagoon's water quality in 1994 was similar to the Outer Harbor.

The mitigation criteria for mudflat macrofauna was for GSMR to have 75% of the abundance and species diversity as was documented at Shoreline Lagoon (during Summer 1994 and 1996) by Year 5 of the monitoring period. These mitigation criteria were not met. Year 5 abundance was 2-3% of that in Shoreline Lagoon while the number of species was 8-9%. Low salinity and low dissolved oxygen levels possibly impeded recruitment of larvae dispersed by water movement.

The mitigation criteria for seine-caught fish at GSMR by Year 5 was for 75% of the density and species diversity as had been documented at Shoreline Lagoon during baseline sampling in 1990, 1991, and 1994. Fish were sampled during Year 5 in November 2001 and June 2002, the average fish density was higher than those from Shoreline Lagoon. When Shannon-Wiener species diversity was used to compare diversity between GSMR and Shoreline lagoon, the mitigation criterion was met during Year 5 sampling in summer, but not in winter.

Bird surveys were conducted four times during Year 5 GSMR monitoring, in December 2001, March 2002, June 2002, and September 2002. The results of these surveys were compared to bird surveys conducted in Shoreline Lagoon in 1983-1984, which was the only full year of bird data available for Shoreline Lagoon. The average number of species identified at GSMR in Years 2-5 was slightly higher than the number of species found in Shoreline Lagoon in 1983-1984. The number of individual birds was also slightly higher at GSMR (140 vs. 176); however, only marine-associated species were reported in 1983-1984.

Salt marsh vegetation in the GSMR was found to exceed the performance criterion for Year 5 by 14%. A trash boom/sea curtain had to be installed to exclude trash from entering the area from the Los Angeles River.

Monitoring conducted at GSMR found that mitigation criteria for mudflat invertebrates were not met by Year 5. Criteria for vegetation, birds, and fish were met. Low salinity and low dissolved oxygen levels were found to have possibly impeded recruitment of those invertebrate larvae which are dispersed by water movement. Increased tidal flushing through changes to the breakwater might improve water quality within the Reserve and allow for more successful recruitment of these larvae.

Document:
Ranasinghe, J.A., A.M. Barnett, K. Schiff, D.E. Montagne, C. Brantley, C. Beegan, D.B. Cadien, C. Cash, G.B. Deets, D.R. Diener, T.K. Mikel, R.W. Smith, R.G. Velarde, S.D. Watts, and S.B. Weisberg. 2007. *Southern California Bight 2003 Regional Monitoring Program: III. Benthic Macrofauna*. Southern California Coastal Water Research Project. Costa Mesa, CA.

Relevance:
The Bight '03 benthic survey indicates that the health of the benthic community within San Pedro Bay is likely negatively affected by freshwater inputs from the Dominguez Channel and Los Angeles River. Benthic community health was generally lowest at the most inland sites.

Abstract:
Benthic macrofauna were successfully collected and processed from 388 sites between Point Conception and the United States-Mexican border during the Bight '03 survey. The sampling area included the mainland and island shelves down slopes and basins to a depth of 1,000 meters, estuaries, and lagoons. Thirty-three samples were collected from Los Angeles County estuaries.

In general, bays and estuaries were in the worst condition of any type of benthic habitat in 2003. The most severely altered benthic communities occurred only in these habitats. The Los Angeles County estuaries had 55% of their area classified as clearly disturbed. In the Dominguez channel, 3 of 3 samples were clearly disturbed, as were 5 of 6 samples taken from the San Gabriel Estuary. Previously, Anderson et al. (2001) determined that the Dominguez Channel/Consolidated Slip had the most degraded benthos in Los Angeles/Long Beach Harbor.

Benthic condition at each site was placed into one of four categories:

- Reference Level: community expected to occur at undisturbed sites.
- Response Level 1: community exhibits some indication of stress, but only within the measurement variability of reference condition.
- Response Level 2: community exhibits clear evidence of physical, chemical, or other anthropogenic or natural stress.
- Response Level 3: community exhibits a high magnitude of stress.

Response Levels 2 and 3 are considered to be clear evidence of disturbed benthic communities ("poor condition") while Reference and Level 1 are considered to be in "good" condition. Figure 1 shows the location and condition of each of the San Pedro Bay sites sampled during the Bight '03 study. This graphic shows a general trend of "good" benthic community health just inside and outside the breakwater and "poor health" as the sites move inland.

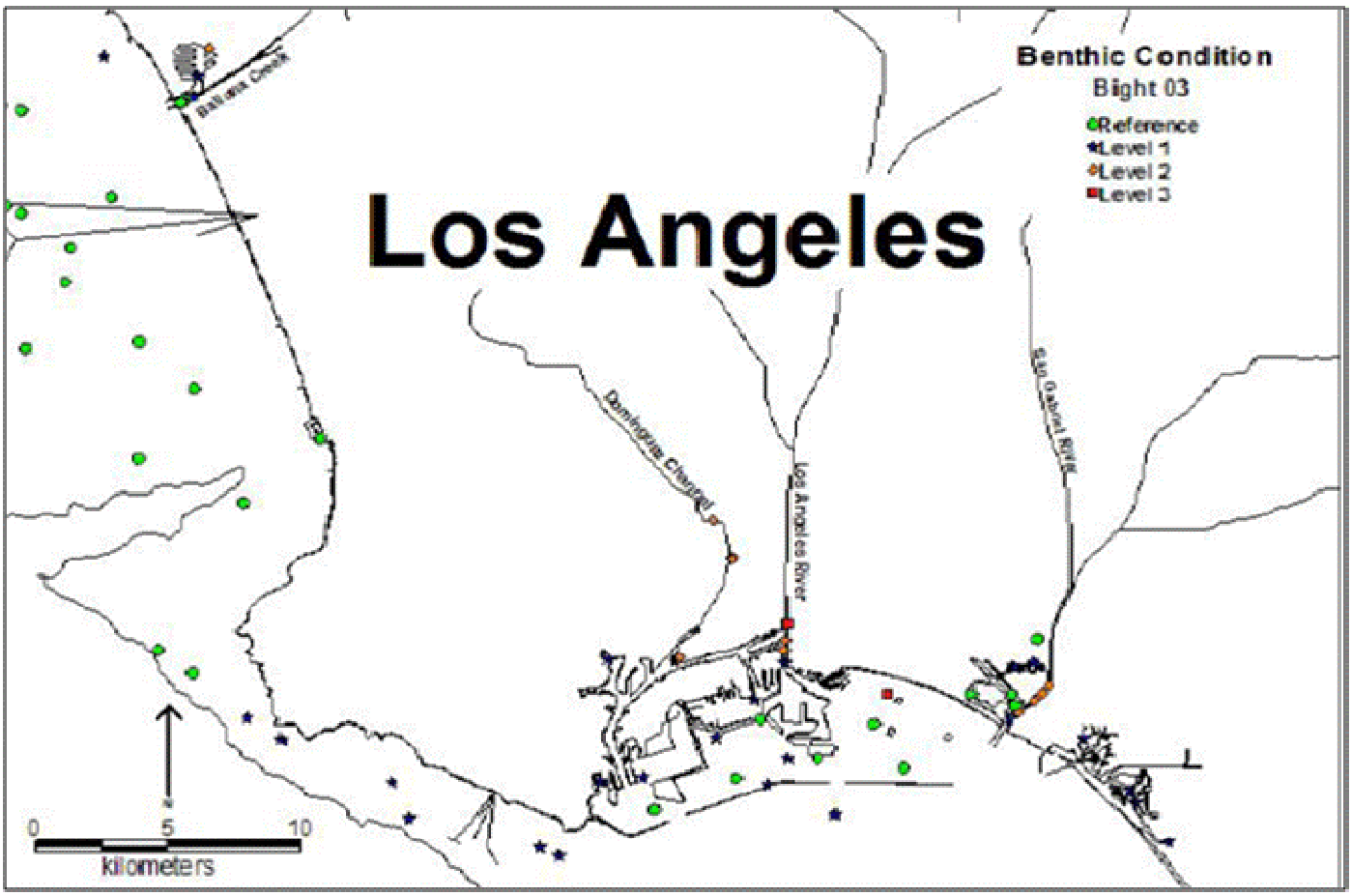


Figure 1. San Pedro Bay Bight '03 Sites.

Document:
Allen, M. J., T. Mikel, D. Cadien, J. E. Kalman, E. T. Jarvis, K. C. Schiff, D. W. Diehl, S. L. Moore, S. Walther, G. Deets, C. Cash, S. Watts, D. J. Pondella II, V. Raco-Rands, C. Thomas, R. Gartman, L. Sabin, W. Power, A. K. Groce, and J. L. Armstrong. 2007. *Southern California Bight 2003 Regional Monitoring Program: IV. Demersal Fishes and Megabenthic Invertebrates*. Southern California Coastal Water Research Project. Costa Mesa, CA.

Relevance:
The Bight '03 fish and invertebrate survey reveals that, while the Los Angeles/Long Beach Harbor complex does not mimic natural lagoon habitat, Harbor structures may enhance the abundance of certain types of fish. The report also found high amounts of trash within the Harbor complex, as well as high amounts of contaminants in flatfishes caught on the Los Angeles Margin.

Abstract:
The Bight '03 regional trawl survey collected fish and invertebrate samples from 210 stations from Point Conception to the U.S.-Mexican Border between July and October 2003. The objectives were to determine:

1) Condition and health of fish and invertebrate assemblages of southern California bays and harbors, shelf, and upper slope (200-500 m depth);
2) Extent of contamination of concern in pelagic forage fish and squid in the Southern California Bight (SCB);
3) Prevalence of ectoparasites in demersal fishes on middle shelf relative to publicly owned treatment works (POTW) and reference areas;
4) Distribution of marine debris in bays/harbors and on the mainland shelf and upper slope;
5) Changes in fish and invertebrate populations and assemblages, anomalies, contaminant levels, and debris among the three previous regional surveys.

The survey design grouped LA/LB Harbor and San Diego Bay as a bays and harbors subpopulation, due to their similarities in human activities (e.g., shipping and recreational boating). The ecological differences between the two regions, however, were emphasized by the differences in sampling results (Figure 1). Fish and and invertebrate analyses showed distinctly different recurrent groups and site clusters between the two areas. San Diego Bay is a large natural bay, while LA/LB Harbor is an artificially enclosed part of the inner shelf zone. The San Diego Bay supports a faunal population similar to that of natural lagoons along the southern California coast. LA/LB Harbor supports a population of typical inner shelf fauna, with enhanced abundance of some schooling species such as white croaker and queenfish. Therefore, while the breakwater may enhance the abundance of inner shelf schooling species, it does not mimic a natural lagoon habitat.

Tissue concentrations of total DDT and total PCB in flatfish were also measured. The highest sediment total DDT concentrations in the SCB were found on the Palos Verdes Shelf on the Los Angeles margin. Tissue concentrations of flatfish were also found to be highest on the Palos Verdes Shelf. Bightwide relationships between sediment contaminant concentrations and flatfish tissue concentrations were generally highly correlated for both total DDT and total PCB (Schiff and Allen 2000; Allen et al. 2002a,b, 2004b).

The LA/LB Harbor was also grouped in the Bays/Harbors Central site cluster during invertebrate sampling, which included 9 stations at a depth of 9 m in Bays/Harbors of the central mainland region.

The most frequently occurring species were tuberculate pear crab (89%) and California aglaja and Pacific calico scallop (*Argopecten ventricosus*; 78% each). The most abundant species were trailtip seapen, cobblestone sea squirt (*Styela plicata*), and New Zealand papperbubble.

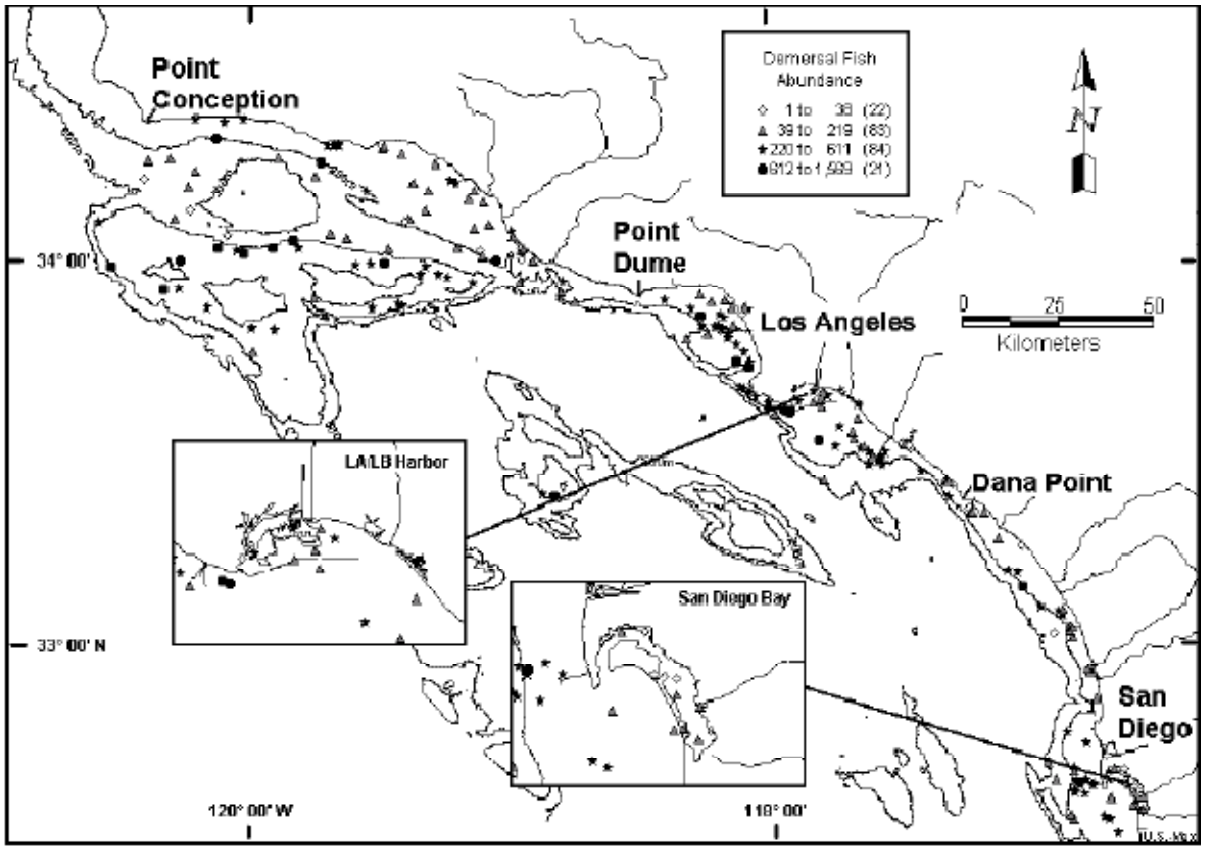


Figure 1. Distribution of fish abundance per haul (July-October 2003).

Anthropogenic debris (mostly plastic) was found in 25% of the southern California shelf (Figure 2). The highest occurrence of anthropogenic debris was found in the central region, near Los Angeles metropolitan areas. The Los Angeles Regional Water Quality Control Board has set a total maximum daily load (TMDL) of zero trash for several area watersheds based on the amounts of trash flowing from rivers and storm drains. It appears that more anthropogenic debris was detected within the breakwater than outside (Figure 2).

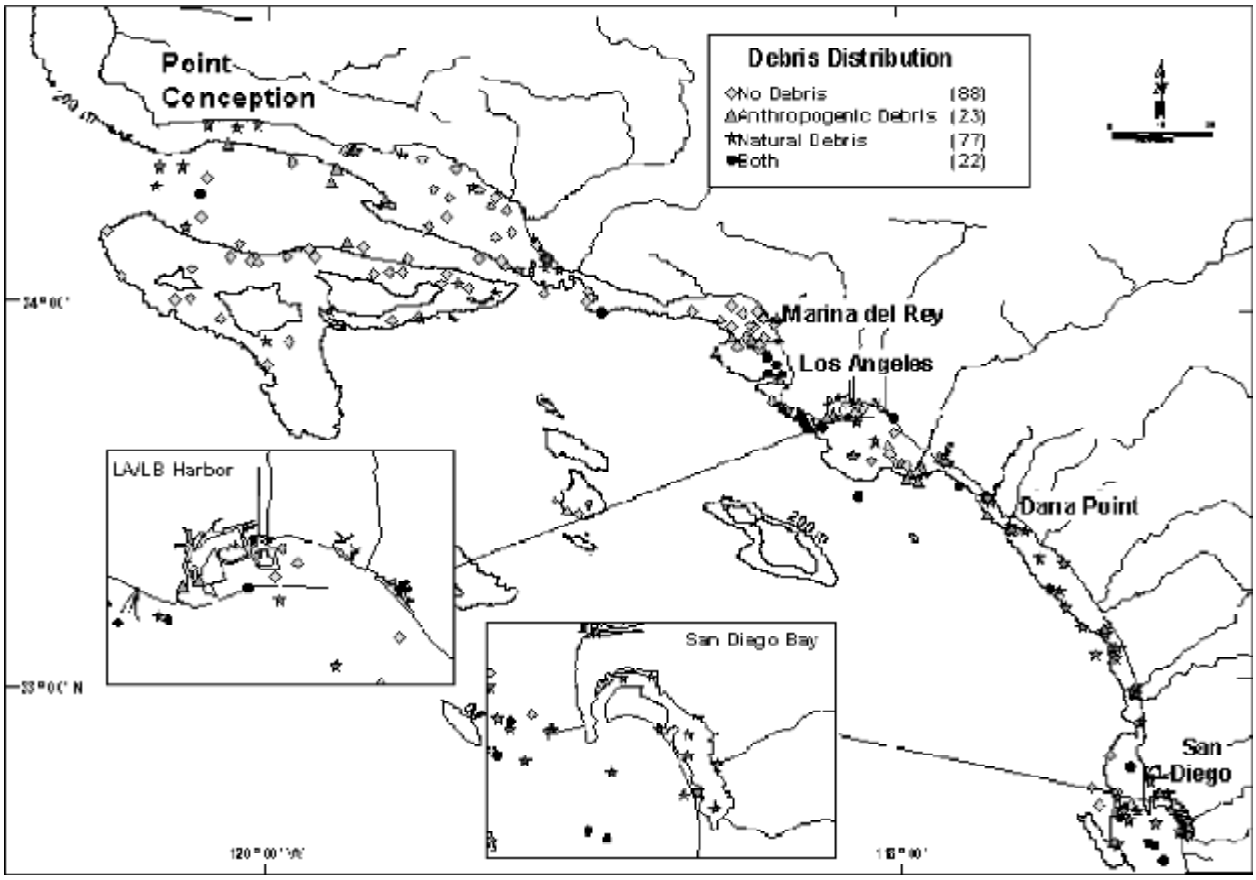


Figure 2. Distribution of natural and anthropogenic debris on the mainland shelf and upper slope of southern California at depths of 2-476 m, July-October 2003.

APPENDIX B – PUBLIC INPUT

- Summary of Public Workshops
- Presentation Charts from One of the Workshops
- Sketches Produced by the Public during the Workshops

A public introduction to the study and three public workshops were held over a two-month period in late 2008. The workshops were conducted by the City of Long Beach and Moffatt & Nichol. The meetings were structured not only to provide information and allow the public the opportunity to provide input, but also to work in a hands-on fashion with the consultants and facilitators to develop specific visions incorporating the public's interests and concerns. Approximately 60 people attended each of the workshops.

The following pages are the actual introductory charts presented at one of the public workshops. These charts explain the objectives and process of the workshop, as well as provide an overview of the reconnaissance study. Also following are copies of charts and sketches of the visions produced by individuals and small groups at the workshops.

Workshop #3
at The Aquarium of the Pacific
The Long Beach Breakwater Expedited Reconnaissance Phase Study
November 19, 2008

Can reconfiguring the LB Breakwater restore our beaches?

This study can help us answer these questions

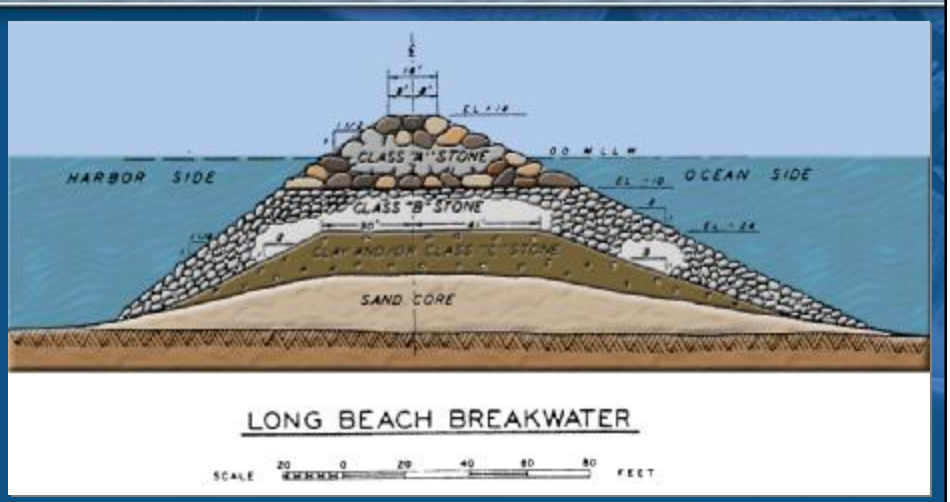
- Moffatt & Nichol
- Kinnetics Laboratories, Inc.
- Dr. Phil King
- Clark Stevens

The Breakwater is a federally owned and operated structure

The Breakwater is a federally owned and operated structure

SP-384. Roosevelt Base, Terminal Island, California. 29 Sept. 1941; 2:05 p.m. Tide +4.2 ft. Contract NDy-4279. Item 18. Floating derricks No. K-600 (right) and No.4 (left) placing Riverside "A" rock on outer breakwater.

Breakwater Profile View



Purpose of recon study is to determine potential for federal interest

Need the community's best and brightest ideas now

From the public and City Council debate on this issue, the primary Army Corps mission that this Reconnaissance Study will address is Ecosystem Restoration through improved water quality, while continuing to protect navigation and coastal areas from storms. Increased recreational and tourism benefits, although outside the Army Corps' core mission, are also important to Long Beach.

City of Long Beach RFP

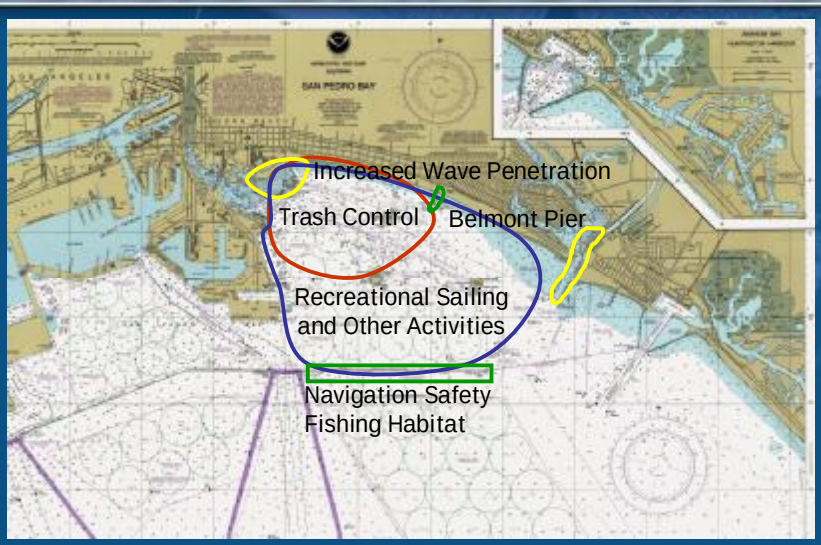
Local sponsors must also be aware of potential costs

- Fed is driving the bus since their breakwater
- City also has mission and goals
  - Improve water quality
  - Improved water-related recreation
  - Improve tourism
- Feasibility study is a 50-50 cost sharing arrangement with the Fed
- Locals responsible for 35% of construction costs

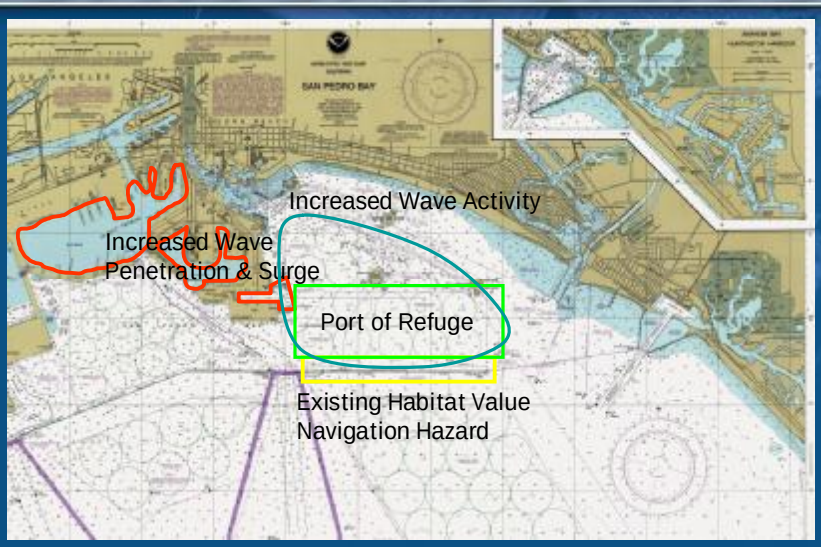
Stakeholder Issues: Surfrider Foundation

- Want beach like Seal, Huntington Beach, South Bay – the difference is waves
- Want to improve water quality and reduce trash and debris
- Want to improve sediment quality along the shoreline
- Want to consider reduced breakwater height and opportunities to plant kelp
- Want economic benefit of a cleaner beach

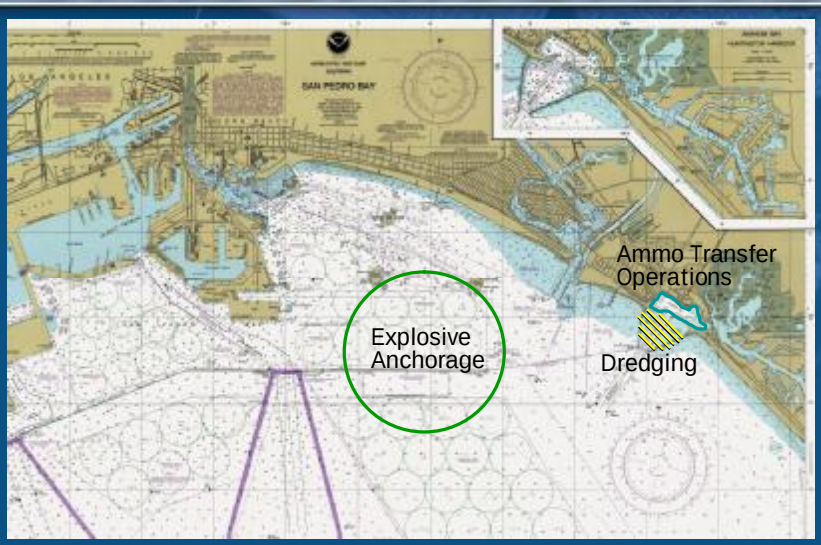
Stakeholder Issues: LB Lifeguards & Marinas



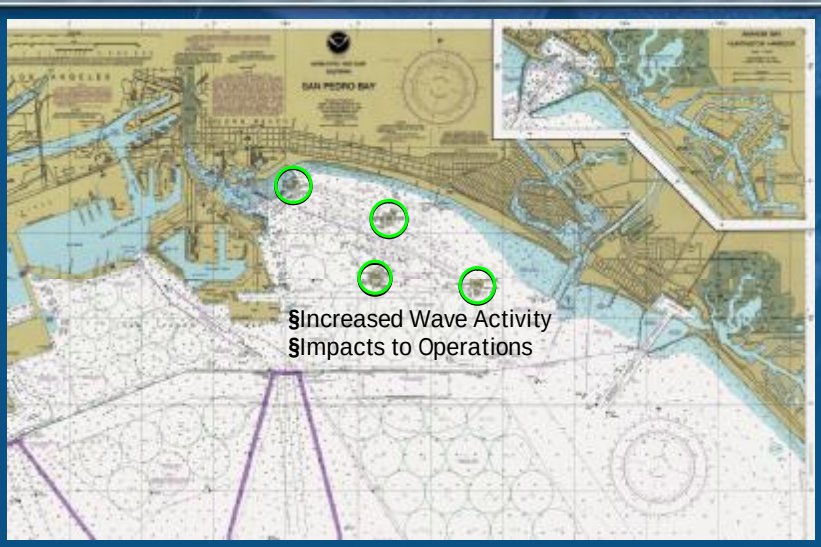
Stakeholder Issues: Port of Long Beach / Port Pilots / Port Operators / USCG



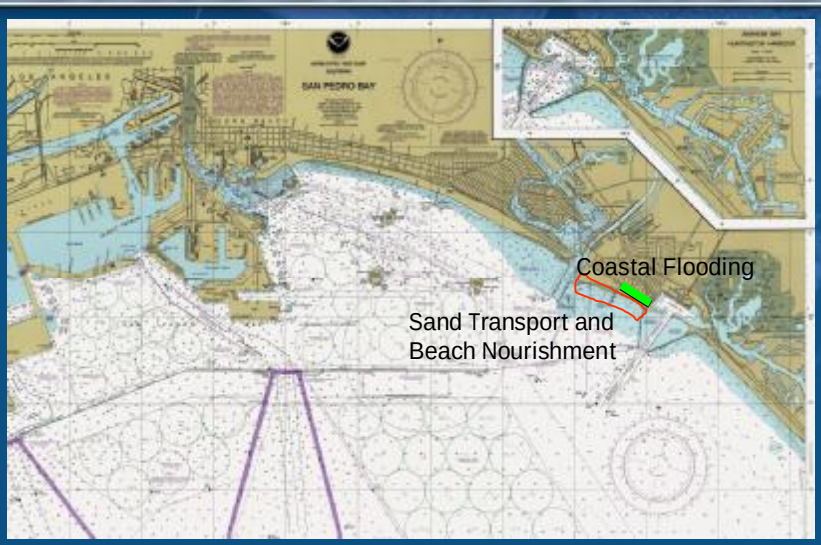
Stakeholder Issues: U.S. Navy – Seal Beach Naval Weapons Station



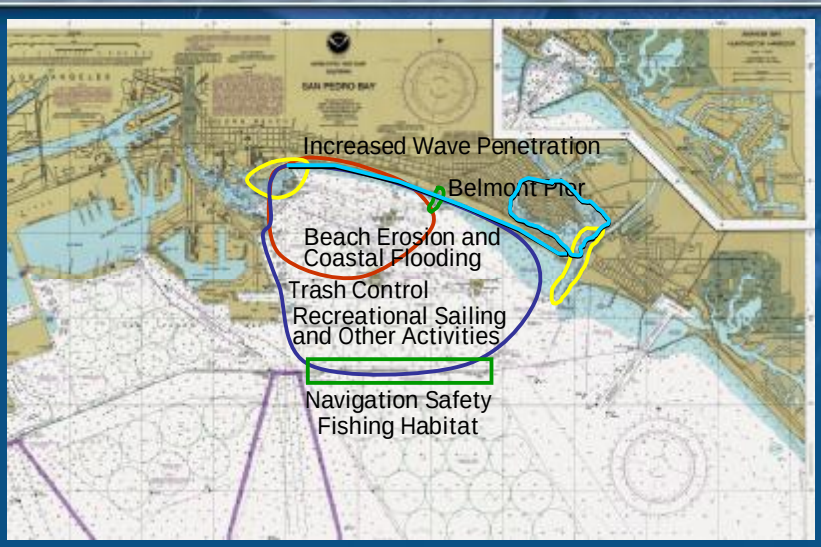
Stakeholder Issues: THUMS



Stakeholder Issues: City of Seal Beach

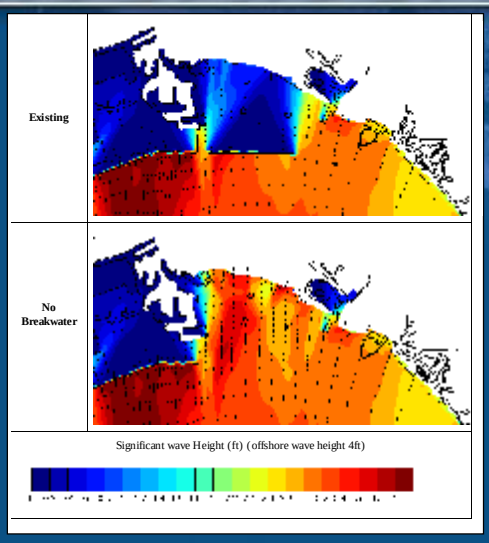


Stakeholder Issues: Peninsula Beach Preservation Group



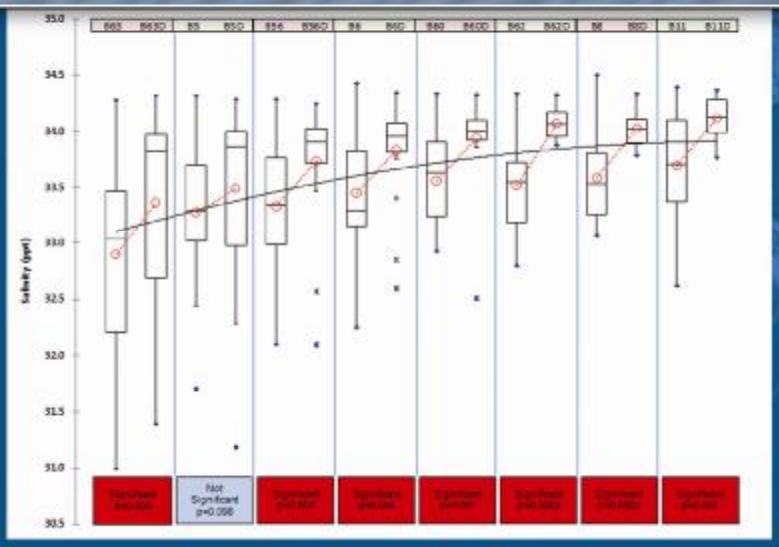
Breakwater does provide important function that must be considered

Breakwater does provide important function that must be considered

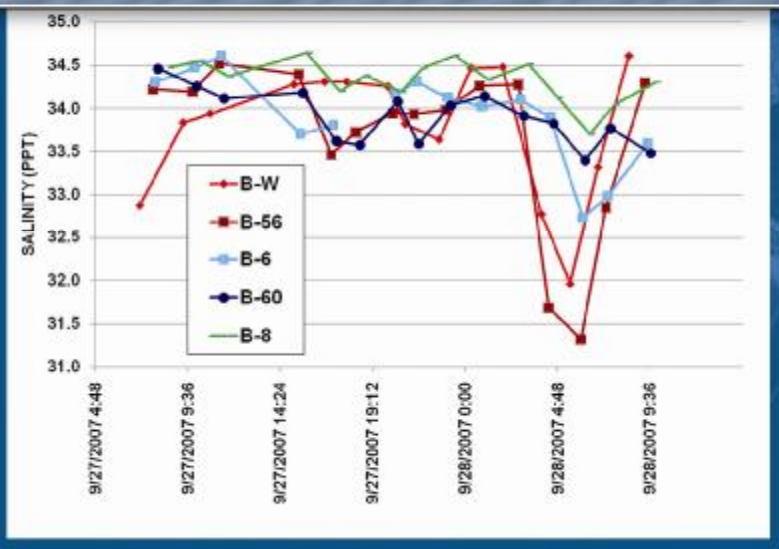


City of Long Beach
Microbial Source Investigation
SD-3
B-5
B-53
B-W
B-6
SD-1
SD-2
SD-4
SD-5
B-60
B-50
B-56B
B-53OB
B-53O
B-62
B-8
B-62D
B-8D
B-11
B-11D
B-11BD
LARH
Beach Swash Zone Sample Point
Offshore Sample Point
Potential Sources of FIB
Storm Drain Network
Water Depth Contour (meters)
N
Feet
2,400
1,200
0
2,400
KINNETIC LABORATORIES INCORPORATED
moffatt & nichol

Box Plots of Salinity-Paired Sites

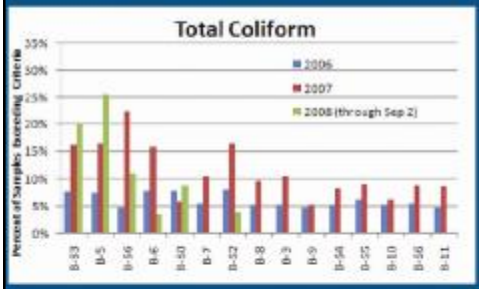


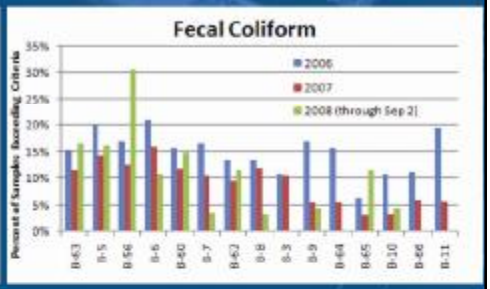
Shoreline Salinity Over 24 Hours



Exceedence of Single Sample Criteria

City of Long Beach AB411 Monitoring Data, 2006-2008





The Economic Benefits of Reconfiguring the Long Beach Breakwater

Dr. Philip King
Economics Dept.
San Francisco State University
Email: pking@sbcglobal.net

Potential Economic Benefits

- Increased Attendance due to Cleaner Water/Better Surf
- Higher Recreational Value per Visitor
- Decreased Water Borne Illness

Methodology: Demand

- Estimate Demand from Local Residents who now go Elsewhere
  - Increase in Demand for Recreation
  - Increase in Demand for other Beach Activities
  - Increase in Demand Nearby Pavement Activities

Methodology: Day Use Value

- Cleaner Water/Better Surf Increases Recreational Value/Visit
- Estimate Increase
  - Estimate Day Use Value Currently
  - Estimate Day Use Value After
- Estimate Reduction in Illness

Challenges

- Budget Limited
- USACE Methodology must be Used
  - Limits Recreational Benefits to 50% of Total
  - Methodology must be consistent with USACE
- Non-Recreational Benefits may be Small
- Since current attendance limited, reduction in water-borne illnesses likely to be small

COE Policy for Ecosystem Restoration

- Restore to Less-Degraded, More Natural Conditions
- Full Integration with Social and Economic Goals
- Consider from Watershed Perspective
- Analyze both Monetary and Non-Monetary Benefits
- Coordination with Missions of Other Agencies

Is it feasible to reconfigure the Long Beach Breakwater?

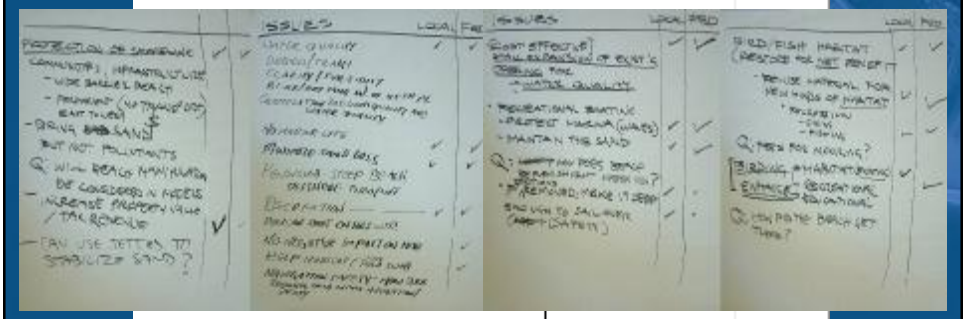
- Restoration of nearshore to open coast habitat
- Improved transport of river sediments and contaminants away from the beach and nearshore habitat
- Improved benthic habitat
- Increasing rocky shallow water habitat
- Reduction of bacterial water quality exceedences on the beach

Public Workshops

- Turning “input” into authorship
- Identify the diverse groups in the community
- Work with the City to identify strategy
- Three meeting format
  - Separate locations
  - Interest group meetings within each meeting
  - Sequential meetings build on previous input

Public Input Documentation

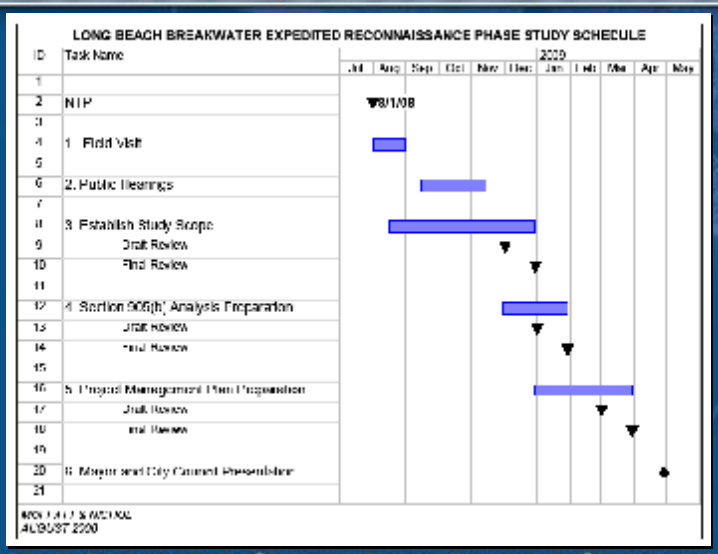
ISSUES / OPPORTUNITIES / CONSTRAINTS	LOCAL	FEDERAL
PROTECT SHORE	✓	✓
MORE PARKING	✓	
GENERATE ECONOMIC VALUE FROM BEACH PARKING	✓	✓



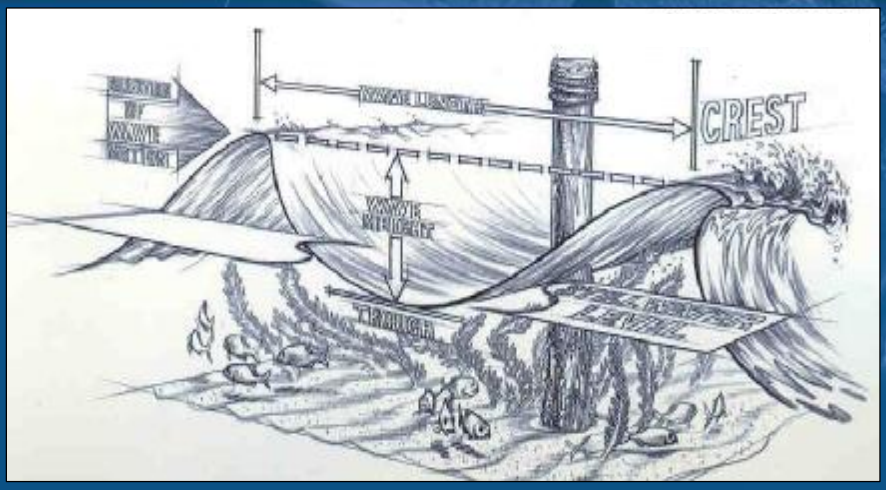
Sample Workshop Design Exercise

Workshop Outcome
Potential Breakwater Relocation Options

Next Steps

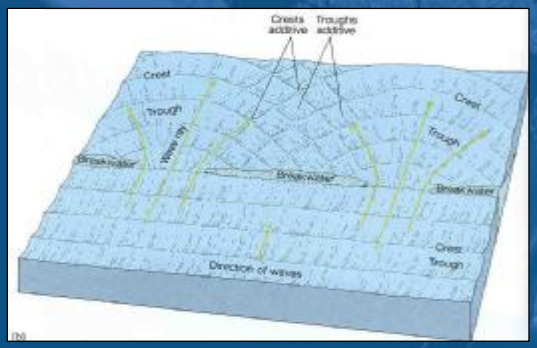


Wave Kinematics



"Book of Waves" (Kampion)

Wave Diffraction



Hydraulic Stability of Rubblemound Structures

Stay Tuned...

Project Website:

www.longbeach.gov/citymanager/ga/breakwater

PROTECTION OF SHORELINE	✓	✓
COMMUNITIES, INFRASTRUCTURE - WIDE BARRIER BEACH - PERMANENT (NO TRANSPORT EAST TO WEST) - BRING ~~SAD~~ SAND $ BUT NOT POLLUTANTS Q: WILL BEACH MANIPULATION BE CONSIDERED IN MODELS - INCREASE PROPERTY VALUE / TAX REVENUE - CAN USE JETTIES TO STABILIZE SAND?	✓	✓

	LOCAL	FED
BIRD/FISH HABITAT (RESTORE FOR NET BENEFIT	✓	✓
· RE-USE MATERIAL FOR NEW KINDS OF HABITAT	✓	✓
· RECREATION - DIVING - FISHING	✓	✓
Q: FEES FOR MOORING?		
[BIRDING → HABITAT (EXISTING) ENHANCE - RECREATIONAL → EDUCATIONAL	✓	✓
Q: HOW DID THE BEACH GET THERE?		

ISSUES	LOCAL	FED
· [COST-EFFECTIVE] SMALL EXPANSION OF EXIST'G OPENING FOR - WATER QUALITY	✓	✓
· RECREATIONAL BOATING		
- PROTECT MARINA (WAVES)	✓	✓
- MAINTAIN THE SAND	✓	✓
Q: ~~WHAT~~ HOW DOES BEACH REPLENISHMENT HAPPEN NOW?		
- IF JETTIONS REMOVED; MAKE IT DEEP ENOUGH TO SAIL OVER	✓	✓
(~~ADD~~ + (SAFETY)	✓	✓

UNITED STATES - WEST COAST
CALIFORNIA
SAN PEDRO BAY
LONG BEACH
LONG BEACH OUTER HARBOR
REMOVE
MAINTAIN
ANAHEIM
HUNTINGTON

ISSUES	LOCAL	FED
WATER QUALITY	✓	✓
DEBRIS/TRASH		
CLARITY/TURBIDITY		
BLACK/OILY SAND W. OF 55TH PL		
CORRELATION BAD SAND QUALITY AND WATER QUALITY		
NO MARINE LIFE		
MINIMIZE SAND LOSS	✓	✓
PENINSULA - STEEP BEACH, OFFSHORE DROPOFF	✓	✓
RECREATION	✓	✓
PELICAN ROOST ON BRK/LWTR		
NO NEGATIVE IMPACT ON NAV		✓
KELP HABITAT (LIKE POLA SWH)		✓
NAVIGATION SAFETY - HOW BRK RECONFIG COULD IMPACT NAVIGATION/SAFETY		

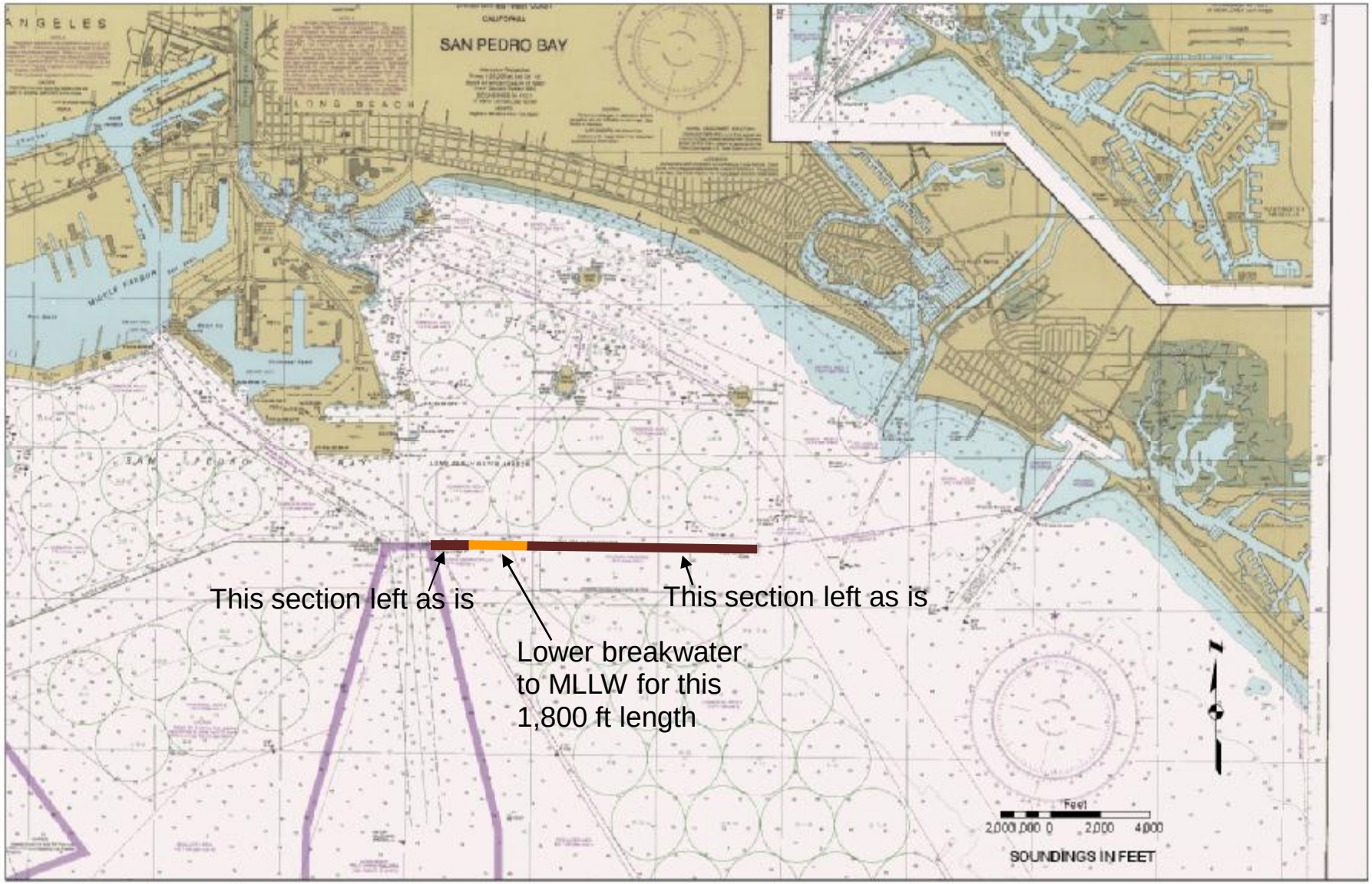
UNITED STATES - WEST COAST
CALIFORNIA
SAN PEDRO BAY
LONG BEACH
SOUNDINGS IN FEET
LONG BEACH OUTER HARBOR
LONG BEACH BREAKWATER
ANAHEIM BA
HUNTINGTON HA
TRAIN RIVER AWAY FROM SHORE
HARD REEF
UXO
CREATE ARTIFICIAL SAND RETENTION REEF
LOCAL BREAKWATER PROTECTION ?
INCREASE POROSITY VIA PIPES
GREEN ALTERNATIVE
- WAVE ENERGY HARNESSED @ BREAKWATER
GOOD QUESTION - PRODUCTION LIFE OF THEMS ?
LOTS INTEREST IN PURPOSE OF BOX CONSTR.

Proposed Breakwater

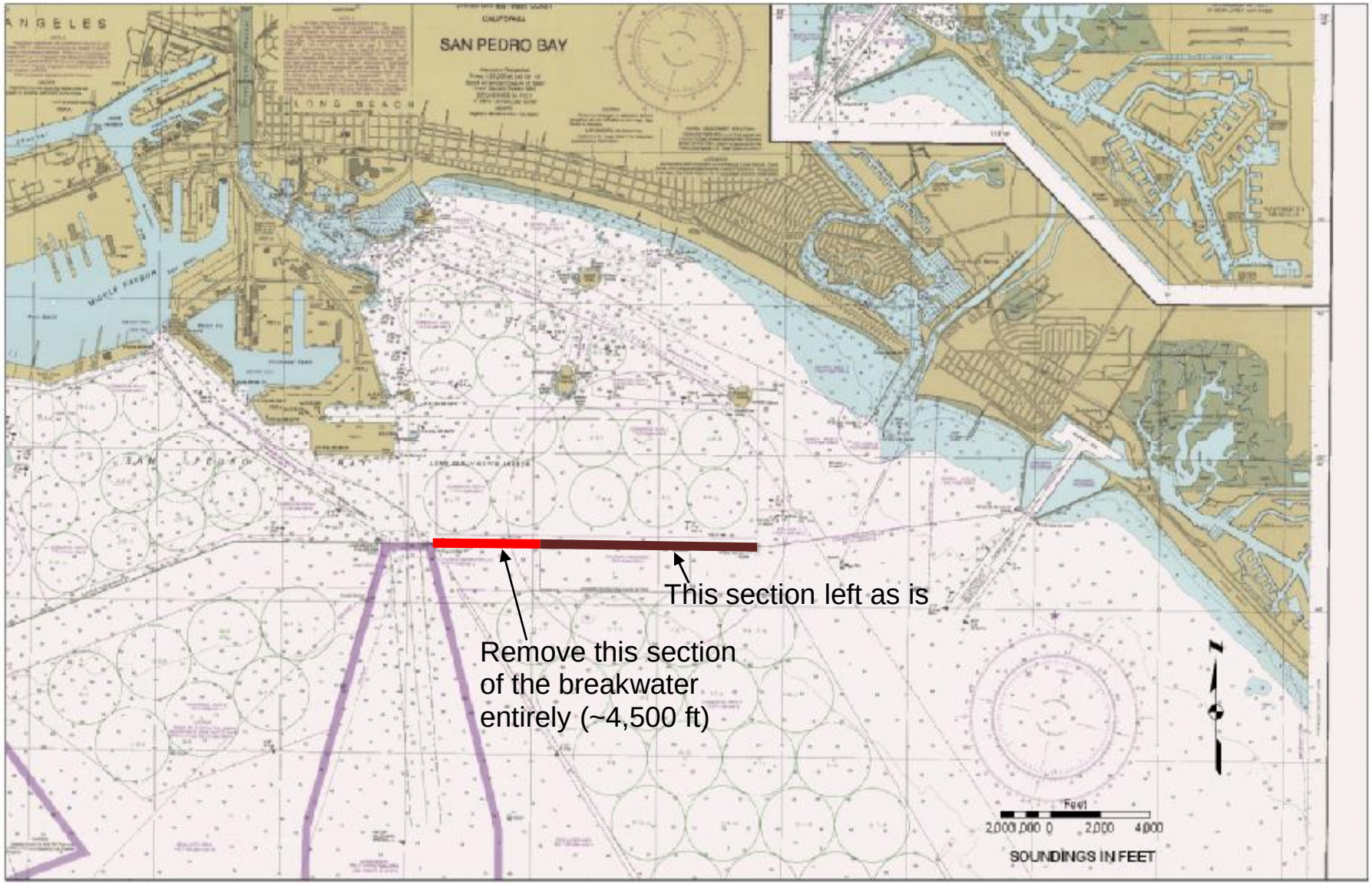
BOGART ENGINEERING
5786 Campo Walk
Long Beach, CA 90803
562 439-3632
jdbogart@self-serv.net

APPENDIX C –BREAKWATER RECONFIGURATION ALTERNATIVES ANALYZED IN HYDRODYNAMIC MODELING

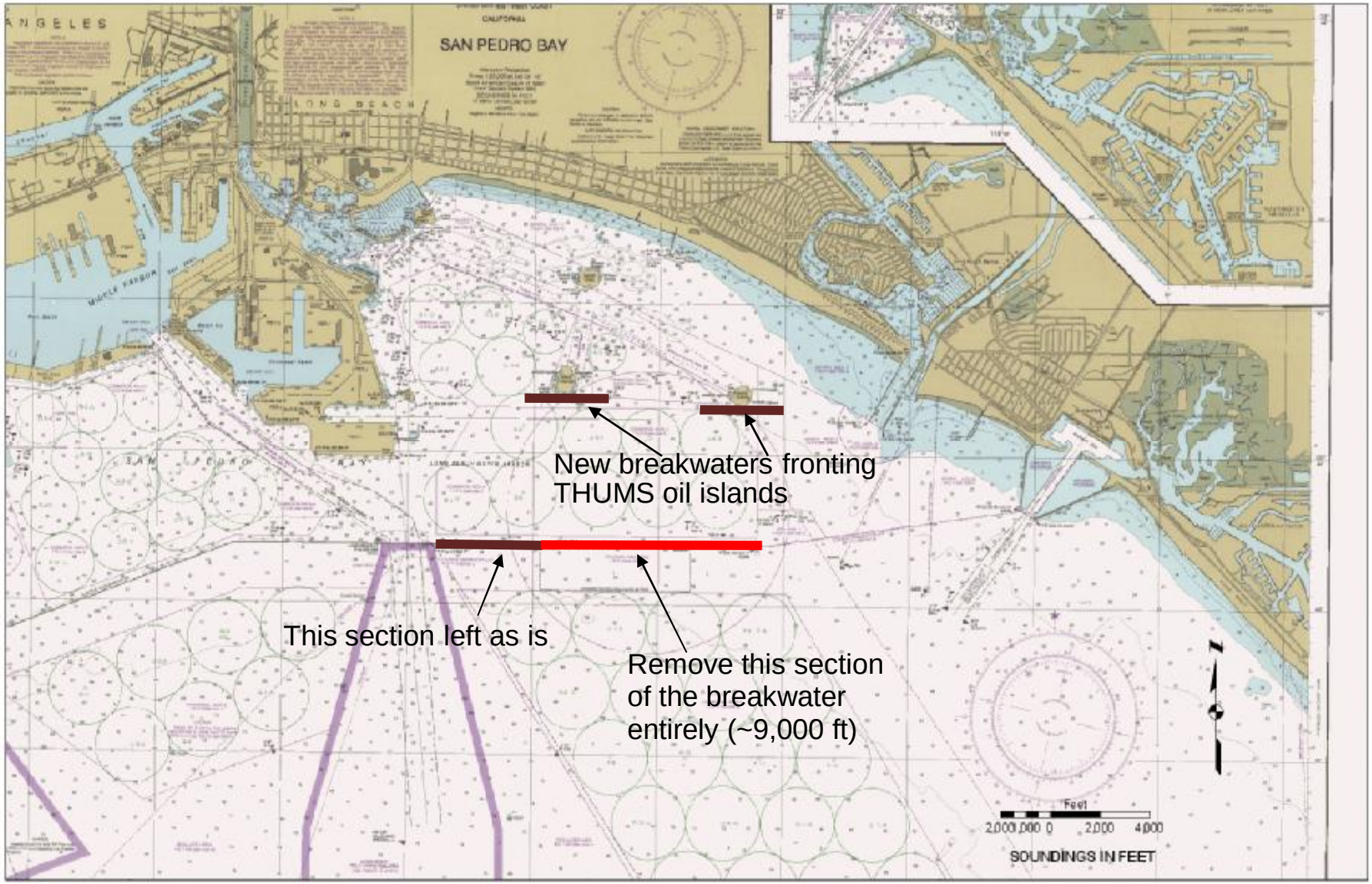
Alternative 1



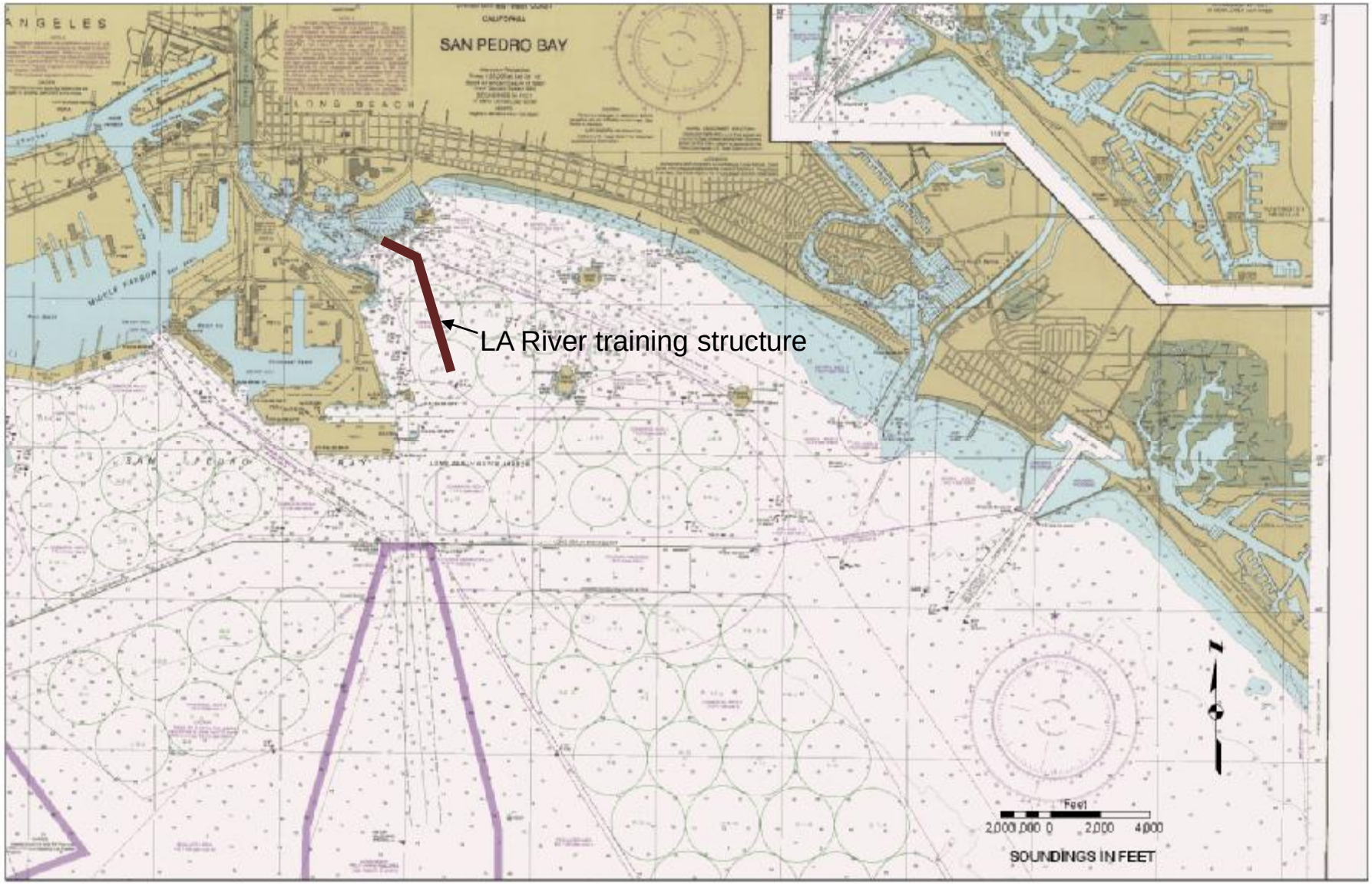
Alternative 2



Alternative 3



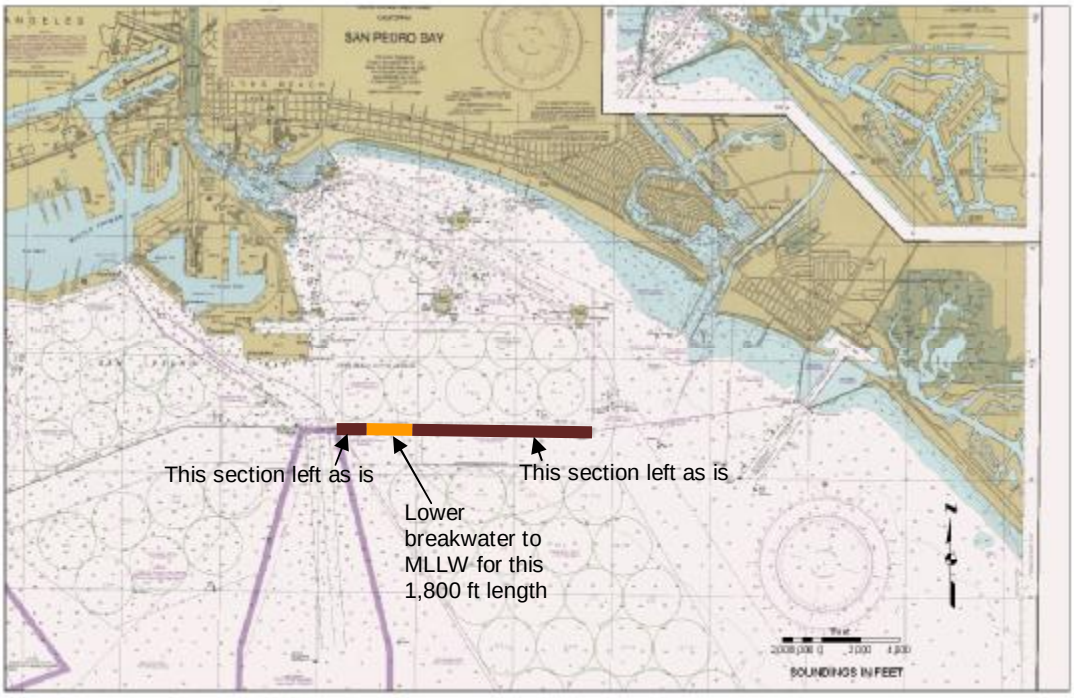
Alternative 4



APPENDIX D – SUMMARY EVALUATIONS OF MEASURES/ALTERNATIVES

- Write-up of Each Alternative Analyzed in Hydrodynamic Modeling
- Summary Matrix of Alternatives
- Details of Rock Quantities, Construction Costs, and Habitat Acreages of Each Alternative

Alternative 1



ALTERNATIVE 1

Alternative 1 is the alternative suggested by Bud Johnson, a Long Beach based engineer and long time resident. His initial study garnered city-wide interest, and his proposed concept provided a logical starting point for the preliminary assessment of breakwater reconfiguration alternatives. The idea is to lower a small section of the breakwater to allow more water to "get out" and help flush pollutants from the basin while allowing more waves to "get in" to provide more circulation. This option received considerable media attention when the original report was released due to the reported low cost of the system.

Description

Lower 1,800 linear feet of the western end of the breakwater to Mean Lower Low Water. This results in the recovery of approximately 54,000 tons of stone that could be used to create approximately 20 acres of nearshore rocky reef habitat.

Preliminary Performance Assessment

Wave Modeling

For the westerly waves, there was a slight (15%) increase in energy in the outer harbor and on the eastern shoreline. The wave energy along the remaining western shoreline, POLB, and THUMS islands was unchanged. Increased southerly wave energy did reach shoreline between the Long Beach Marina and Bluff Park. The greatest change in wave height along the shoreline was a 30% increase in the existing wave height (for southerly waves), located near the western end of the beach.

Hydrodynamic and Water Quality Modeling
For Alternative 1, the results of both modeling scenarios showed very little benefit to water quality and circulation.

Benefits
Physical Benefits
The potential ecosystem benefits are the creation of approximately 20 acres of nearshore rocky reef habitat. The potential recreational benefits include a slight increase in water quality, but this plan does not result in the potential for surfable waves.

Fiscal Benefits
Generally speaking, the potential fiscal benefits from improving the quality of the City's beaches are significant. It is very difficult at this very early stage to assign any reliable specific estimate of the amount of improvement, if any, results from this alternative. Ranges of potential improvement, and the associated economic benefits, were therefore assigned based on the preliminary numerical model results.

The potential City of Long Beach revenues range from 0 to $5 million per year, with a Benefit to Cost Ratio that ranges from 0 to 9 over a 50 year period. The potential Recreational Value increase per year is $0 million to $2 million per year, with a Benefit to Cost Ratio of 0 to 4 over 50 years.

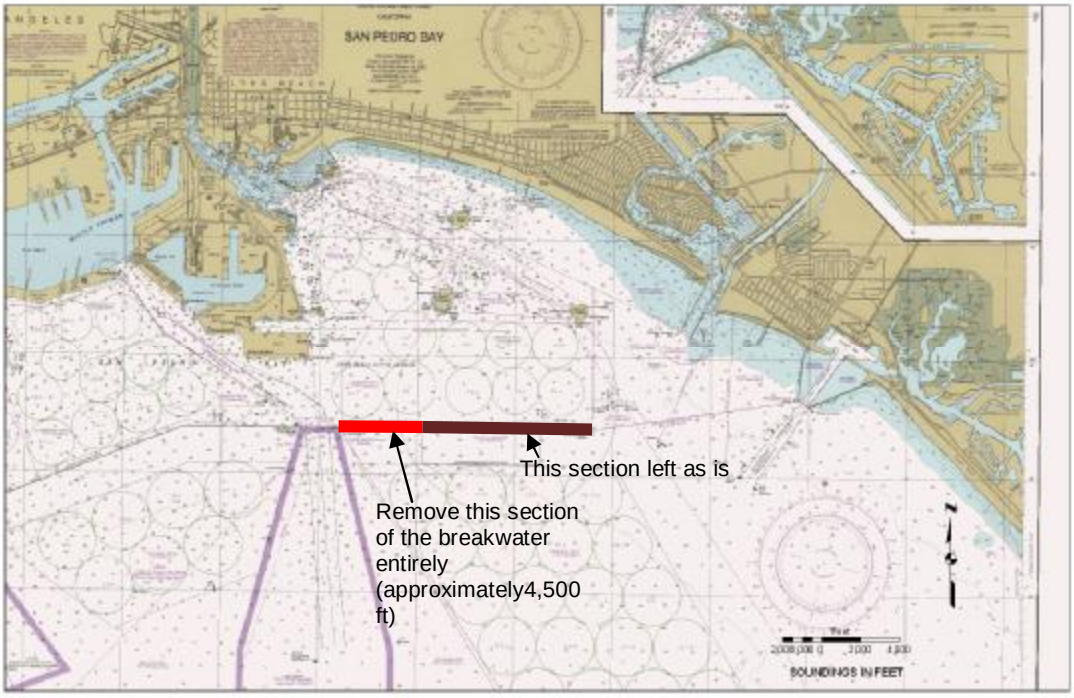
Potential Impacts
The lowered breakwater is very close to Queen's Gate, which could lead to navigation issues, otherwise, since this alternative does little to modify the conditions in the harbor, there is very little potential mitigation required. Potential navigational impacts due to the nearshore rocky reef habitat can likely be mitigated by limiting the height of the reef and placing additional navigational markers.

Cost
Construction costs were estimated to range between $10 million and $15 million. There are no anticipated mitigation costs, except for the possibility of adding navigation aids demarking the lowered area as a hazard.

Discussion
While this option is the lowest cost option for modifying the breakwater, the preliminary modeling effort indicates that it does very little to address the water quality, recreational, or habitat improvements. Lowering the breakwater to MLLW only allows smaller, shorter period wind waves to penetrate the harbor, and does not significantly increase the flushing of the harbor. This result would be consistent even if the number of gaps were increased.

The cost per acre for creating the reef habitat with the breakwater rock is higher than the cost of creating the Southern California Edison's Wheeler Kelp Reef, therefore, if the goal of the project is to improve the ecosystem of the harbor, it can be done more economically by importing new rock for the reef.

Alternative 2



ALTERNATIVE 2

Alternative 2 removes the entire western third of the breakwater down at least to -30 feet. This alternative is a logical expansion of Alternative 1 in an effort to increase the potential for water quality, ecosystem, and recreational benefits, while reducing the potential navigational hazard that lowering the breakwater to MLLW presents. In general, this alternative presents a ten-fold increase in cost over Alternative 1, with a corresponding increase in benefits, performance, and risk. This alternative added a subalternative of also building an LA River training structure (Alternative 4) using the rock removed from the breakwater and imported rock.

Description

Lower 4,500 linear feet of the western end of the breakwater to at least -30 feet to re-establish significant penetration of wave energy to the inner harbor area. This results in the recovery of approximately 810,000 tons of stone that could be used to create approximately 500 acres of kelp reef and 170 acres of nearshore rocky reef habitat. Alternatively, a portion of the rock could be used to build a portion of the LA river training structure. This option would result in the creation of approximately 25 acres of habitat on the training structure itself, 500 acres of kelp reef and 50 acres of rocky reef habitat.

Preliminary Performance Assessment

Wave Modeling

There was a significant increase in wave energy for both of the wave cases. For the westerly waves, there was a significant (60-70%) increase in energy at the THUMS

Islands and the shoreline between the Belmont Pier and Bayshore Drive. For the southerly waves, there was a significant increase in wave energy near POLB, from the Long Beach Marina to Bluff Park, and near the THUMS Islands. The increase in southerly wave energy was nearly double that of the present conditions in several locations (i.e. 100% increase).

Hydrodynamic and Water Quality Modeling
The results of the pollutant concentration modeling showed improvements for both wave directions, but particularly with the southern waves. The addition of the LA River Training Structure prevented the pollutants from reaching the Long Beach shoreline, but may increase the total time required for the pollutants to leave the greater harbor area.

The LA River discharge tracer modeling showed very little difference from existing conditions for either wave condition.

Benefits
Physical Benefits
The potential ecosystem benefits are the creation of approximately 500 acres of kelp habitat and between approximately 75 and 170 acres of rocky reef habitat. The potential recreational benefits include increased water quality and the potential for surfable waves. The addition of the LA River Training Structure increases the water quality benefit slightly.

Alternative 2 also poses the potential benefit of reducing or eliminating the need for the sand management program currently conducted by the City to replenish beach width along the east end of the Peninsula Beach. The added wave energy from the west could act to restore easterly sand transport into the erosion “hot-spot” area.

Fiscal Benefits
Generally speaking, the potential fiscal benefits from improving the quality of the City’s beaches are significant. It is very difficult at this very early stage to assign any reliable specific estimate of the amount of improvement, if any, results from this alternative. Ranges of potential improvement, and the associated economic benefits, were therefore assigned based on the preliminary numerical model results.

The potential City of Long Beach revenues range from $20 million to $35 million per year, with a Benefit to Cost Ratio that ranges from 3 to 6 over a 50 year period. The addition of the LA River Training Structure increases the potential revenues to $25 million to $40 million per year, with a Benefit to Cost Ratio that ranges from 2 to 4 over a 50 year period.

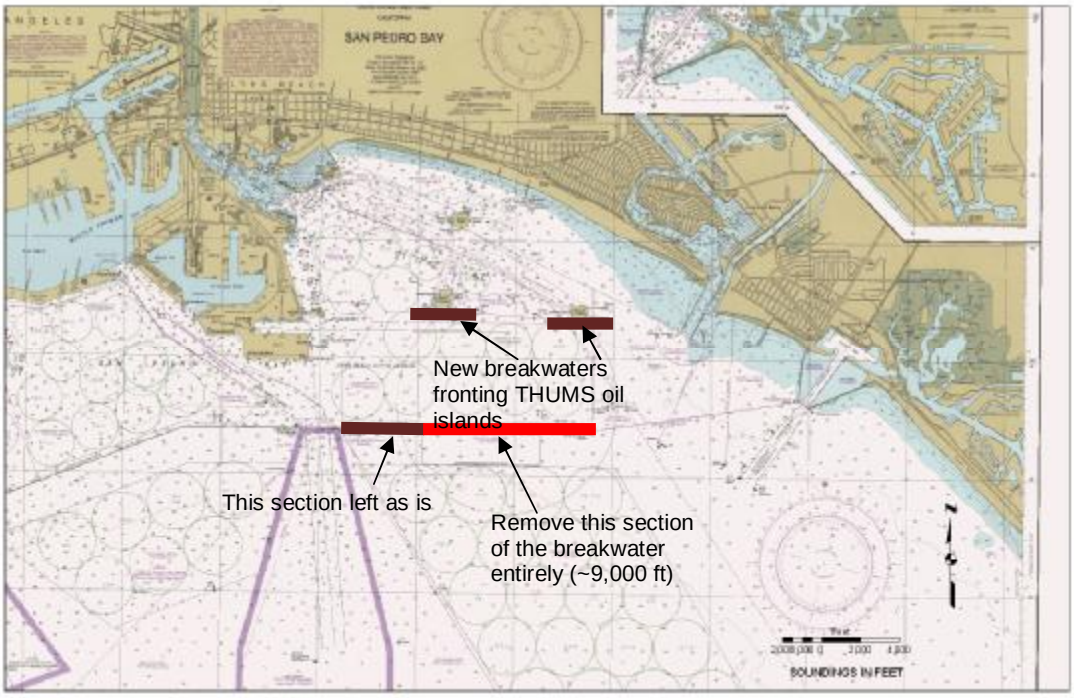
Potential Recreational Value increase per year ranges from $5 million to $15 million per year with a Benefit to Cost Ratio of 1 to 3 over 50 years. The addition of the LA River Training Structure increases the potential Recreational Value to $10 million to $20 million per year, with a Benefit to Cost Ratio that ranges from 0.5 to 2 over a 50 year period.

Potential Impacts
There are potential wave-related impacts to POLB and the THUMS Islands that would require significant additional investigation and likely mitigation. The cost for this mitigation is not included in the present Cost/Benefit analysis as there is not enough technical information currently available to accurately estimate these costs. Potential navigational impacts due to the rocky reef and kelp habitat can likely be mitigated by limiting the height of the reef and placing additional navigational markers on the reef and kelp areas. There would be navigational "convenience" issues associated with the LA River Training Structure. It is the intention that any negative impacts to shoreline erosion would be mitigated by the nearshore rocky reefs which can provide sand retention benefit in addition to ecosystem and recreational benefit.

Cost
Construction costs range from approximately $110 million to $120 million. The total cost for Alternative 2 with the LA River Training Structure is approximately $210 million to $220 million. There is a possibility that the localized increases in wave energy would require more beach maintenance and a modified sand-management plan, as well as increase in the wave protection at POLB and the THUMS Islands.

Discussion
This option represents a measurable increase in wave energy and demonstrable increase in circulation and water quality improvement potential. However, there are potentially serious wave-related implications to the POLB and THUMS Islands that would have to be considered in the feasibility study. Adding the LA River Training Structure to this option appears to provide a significant enough improvement in potential water quality to justify the increased costs, but this conclusion would require additional investigation. On a per acre basis, the cost for creating the reef habitat with the breakwater rock is similar to the costs for creating the Southern California Edison's Wheeler Kelp Reef, unless the LA River Training Structure in built, then the costs are higher.

Alternative 3



ALTERNATIVE 3

Alternative 3 reconfigures the breakwater to staggered breakwater sections. This measure is similar to Alternative 2 in that the removal near to or completely to the bottom, but would involve re-locating sections of the existing breakwater to create a staggered pattern that results in several gaps for transmitting wave action to the shoreline and increasing the circulation of the harbor. This alternative would be remove approximately 9,000-foot long section at the eastern end of the breakwater (two-thirds of the LB Breakwater length) and use the removed rock to construct two new more-shoreward-located breakwaters to protect the THUMS islands. The THUMS island breakwaters also provide protection along some of the shoreline. The resulting configuration would be a remaining 4,500-foot-long section at the western end of the LB Breakwater and two approximately 3,500-foot-long breakwaters shoreward of the remaining LB Breakwater section and adjacent to the THUMS islands. This alternative was based on input from the public meetings and expands on Alternative 2 in an effort to further increase the potential for water quality, ecosystem, and recreational benefits. In general, this Alternative is double the cost of Alternative 2, with a corresponding increase in performance and risk at the expense of potential benefits. This alternative also includes a subalternative to build a LA River Training Structure using the rock removed from the breakwater and imported rock.

Description

Lower 9,000 linear feet of the eastern end of the breakwater to the bottom. Relocate rock to construct two approximately3,500' breakwaters seaward of the THUMS Islands. This requires the removal of approximately 1,620,000 tons of stone that could be used to

create the secondary breakwaters, approximately 500 acres of kelp reef, 300 acres of rocky reef habitat, and an additional 10 acres of reef habitat associated with the THUMS Islands breakwaters. Alternatively, a portion of the rock could be used to build a portion of the LA river training structure (See Alternative 4). This option would result in the creation of approximately 25 acres of habitat on the training structure itself, 260 acres of kelp reef, 70 acres of rocky reef habitat and 10 acres of reef habitat associated with the THUMS Islands breakwaters.

Modeling Results

Wave Modeling

There was a significant increase in wave energy for both of the wave cases. For the westerly waves, there was a significant increase in energy at the THUMS Islands (350% increase) and the Peninsula Beach (100% increase). For the southerly waves, there was a significant increase in wave energy over all of the beach and the THUMS Islands. The greatest increase in southerly wave energy was more than 4x (300% increase of) the present wave climate near the THUMS Islands and Belmont Pier.

Hydrodynamic and Water Quality Modeling

The results of the pollutant concentration modeling showed an increase in the pollutant concentration near the shoreline as the waves tended to trap the pollutant at the beach. The addition of the LA River Training Structure prevented the pollutants from reaching the Long Beach shoreline, but may increase the total time required for the pollutants to leave the greater harbor area.

The LA River discharge tracer modeling showed very little difference for either wave condition.

Benefits

Physical Benefits

The potential ecosystem benefits are the creation of approximately 500 acres of kelp habitat and between approximately 85 and 310 acres of rocky reef habitat. The potential recreational benefits include increased water quality and the potential for surfable waves. This alternative would result in the highest potential for surfing waves of all of the alternatives. The addition of the LA River Training Structure increases the water quality benefit significantly.

Fiscal Benefits

Generally speaking, the potential fiscal benefits from improving the quality of the City's beaches are significant. It is very difficult at this very early stage to assign any reliable specific estimate of the amount of improvement, if any, results from this alternative. Ranges of potential improvement, and the associated economic benefits, were therefore assigned based on the preliminary numerical model results.

The potential City of Long Beach revenues range from $5 million to $20 million per year, with a Benefit to Cost Ratio that ranges from 0.5 to 2 over a 50 year period. The addition of the LA River Training Structure increases the potential revenues to $25 million to $40

million per year, with a Benefit to Cost Ratio that ranges from 1 to 3 over a 50 year period.

Potential Recreational Value increase per year range from $5 million to $15 million per year with a Benefit to Cost Ratio of 0.5 to 1 over 50 years. The addition of the LA River Training Structure increases the potential Recreational Value to $10 million to $20 million per year, with a Benefit to Cost Ratio that ranges from 0.5 to 2 over a 50 year period.

Potential Impacts

There are potential wave-related impacts to the THUMS Islands, Peninsula Beach, Navy ammunition transfer area, and anchorage areas that would require significant additional investigation and likely mitigation. There would be a significant increase in wave activity at the Peninsula beaches that might increase the area of erosion. It is the intention that any negative impacts to shoreline erosion would be mitigated by the nearshore rocky reefs which can provide sand retention benefit in addition to ecosystem and recreational benefit. Increased wave energy at the Navy ammunition transfer and anchorage areas leeward of the breakwater could possibly require relocation of these areas. Potential navigational impacts due to the rocky reef and kelp habitat can likely be mitigated by limiting the height of the reef and placing additional navigational markers on the reef and kelp areas. There would be navigational "convenience" issues associated with the LA River Training Structure.

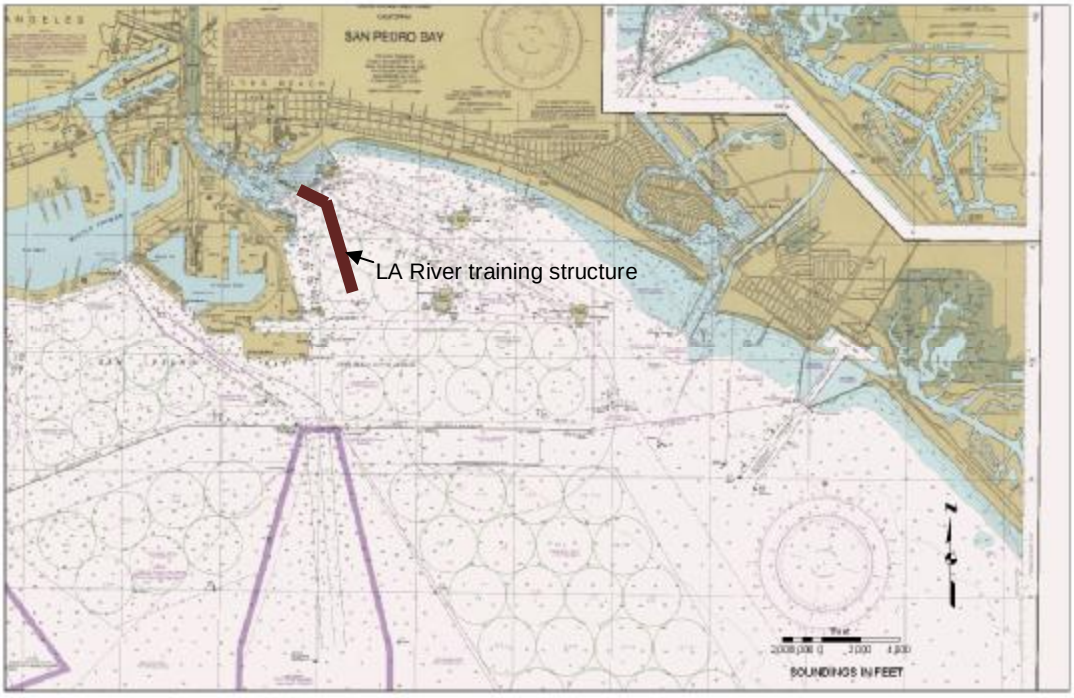
Cost

Construction costs range from approximately $250 million to $260 million. The total cost for Alternative 3 with the LA River Training Structure is approximately $300 million to $310 million. There is a possibility that the localized increases in wave energy would require more beach maintenance, a modified sand-management plan, especially for the Peninsula Beach. There may also be requirements to increase the wave protection at POLB and to relocate the Navy ammunition transfer area.

Discussion

This option represents a large-scale increase in wave energy and costs from all of the other alternatives without a significant increase in circulation and water quality improvement potential. There are potentially serious wave-related implications to the THUMS Islands and beaches that would have to be considered in the feasibility analysis. Adding the LA River Training Structure to this option appears to provide a significant enough improvement in potential water quality to justify the increased costs, but this conclusion would require additional investigation. The cost per acre for creating the reef habitat with the breakwater rock is higher than the cost of creating the Southern California Edison's Wheeler Kelp Reef, therefore, if the goal of the project is to improve the ecosystem of the harbor, it can be done more economically by importing new rock for the reef.

Alternative 4



ALTERNATIVE 4

Alternative 4 does not involve the reconfiguration of the breakwater at all, but attempts to address the problem of pollutant flow from the LA River reaching the beaches through the construction of a shore-perpendicular rock training structure to redirect the LA River discharge away from the Long Beach shoreline. In Alternatives 2 and 3, rock from the removed breakwater section could be used to construct this Alternative; however, the present analysis is for using imported rock, which is less expensive than modifying the breakwater.

Description

Construct a 6,000 foot long shore-perpendicular rock training structure that extends from the existing Long Beach Marina breakwater towards the south. This requires the import of approximately 1,902,000 tons of stone and creates approximately 25 acres of rocky habitat.

Modeling Results

Wave Modeling

The wave modeling demonstrated a slight reduction in waves at the western end of the Beach.

Hydrodynamic and Water Quality Modeling

The addition of the LA River Training Structure prevents the pollutants from reaching the Long Beach shoreline, but may increase the total time required for the pollutants to leave the greater harbor area.

Benefits

Physical Benefits

The potential ecosystem benefits are the creation of approximately 25 acres of rocky reef habitat. The potential recreational benefits include increased water quality but not change in the potential for surfable waves.

Fiscal Benefits

Generally speaking, the potential fiscal benefits from improving the quality of the City's beaches are significant. It is very difficult at this very early stage to assign any reliable specific estimate of the amount of improvement, if any, results from this alternative. Ranges of potential improvement, and the associated economic benefits, were therefore assigned based on the preliminary numerical model results.

The potential City of Long Beach revenues range from $20 million to $35 million per year, with a Benefit to Cost Ratio that ranges from 2 to 5 over a 50 year period. The potential Recreational Value increase per year ranges from is $5 million to $15 million per year with a Benefit to Cost Ratio of 1 to 2 over 50 years.

Potential Impacts

The LA River training structure has the potential to increase the amount of time required for pollutants to dissipate from the harbor area. There would be navigational "convenience" issues associated with this Alternative.

Cost

Construction costs range from approximately $130 million to $140 million. The cost for constructing the LA River Training structure from imported rock is less expensive than utilizing breakwater rock. The cost for creating the reef habitat in the form of the training structure is higher than the costs of creating the Southern California Edison's Wheeler Kelp Reef. Therefore, if the goal of the project is to improve the ecosystem of the harbor, it can be done more economically by importing new rock for the reef.

Discussion

Although this alternative does not involve a modification to the breakwater, it does address the pollutant flow from the LA River directly. While the water quality improvement could be significant, this alternative does not improve conditions for recreational wave activities and provides only limited additional habitat area.

Appendix D - Alternatives Analysis Summary - Based on Preliminary / Conceptual Screening

Alternative / Plan	Description	Hydrodynamic / Water Quality Modeling Results		Ecosystem Benefits	Recreational Benefits	Impacts / Concerns	Construction Cost Estimate	Mitigation Costs	Ecosystem Relative Cost to Benefit Ratio (Cost Per Acre to Create Habitat as Compared to SCE's Wheeler Kelp Reef)	Potential Economic Benefits to COLB (Per Year)	Economic Benefit to Cost Ratio (50-Yr NPV Economic Benefit / Life Cycle Cost)	Potential Recreational Value (Per Year)	Recreation Value to Cost Ratio (50-Yr NPV Rec Value / Life Cycle Cost)	Finding
		Wave Height / Wave Energy Changes	Pollutant Concentration Changes											
1 *	Lower a west end section (~1,800 ft) of the LB Breakwater to 0 MLLW. Use removed breakwater rock to build rocky reef habitat area.	Westerly wave energy penetration minor and limited to deeper waters of LB Harbor. Southerly wave energy did reach shoreline, but substantially less than for Alternatives 2 and 3. The greatest change in wave height along the shoreline was 1.3 times the existing wave height.	Minor/ very small improvement	Could create ~20 acres of rocky reef habitat (but not kelp bed without additional construction costs).	No surfing benefit. Could have some improvement to water quality and thus some recreational swimming benefits.	Navigational hazard concerns associated with submerged breakwater section and submerged rocky reef.	$10M - $15M	None	Higher	$0 - $5M	0 to 9	$0 - $2M	0 to 4	Benefits do not appear to be significant, but this alternative should be carried forward for further consideration as it is the least cost alternative.
2a *	Remove the west end (~4,500 ft) of the LB Breakwater. Use removed breakwater rock to build kelp and rocky reef habitat areas.	Increased wave energy penetration along the western shoreline of Long Beach, particularly for south waves. Also increased wave energy penetration along the shoreline between the Belmont Pier and Bayshore Avenue for both south and west waves. The greatest change in wave height along the shoreline was 1.9 times the existing wave height.	Improved flushing of pollutants with southerly waves.	Could create ~500 acres of kelp bed and ~170 acres of rocky reef habitat.	Both surfing and non-surfing (swimming, etc.) benefits	Navigational hazard concerns associated with submerged rocky reefs. Increases to wave height in deeper waters of east San Pedro Bay could impact existing recreational boating uses. Potential wave-related impacts to Port of Long Beach and THUMS islands.	$110M - $120M	Potentially cost for long-term beach sand management (or other shoreline erosion protection) and measures for mitigating wave impacts to Port of Long Beach and THUMS islands.	Similar	$20M - $35M	3 to 6	$5M - $15M	1 to 3	Potentially significant ecosystem, recreational and economic benefits, both with and without LA River training structure. Further analysis of potential wave impacts required.
2b	Remove the west end (~4,500 ft) of the LB Breakwater. Use removed breakwater rock to build kelp and rocky reef habitat areas <u>and</u> LA River training structure. Latter requires import of some rock.		Improved flushing of pollutants with southerly waves. Additionally, inclusion of LA River training structure effectively keeps pollutants away from LB shoreline, although the LAR training structure tends to break down the nearshore area of increased net transport , thereby reducing the transports of pollutants out of the area .	Could create ~500 acres of kelp bed and ~75 acres of rocky reef habitat.	Both surfing and non-surfing (swimming, etc.) benefits. Water quality, and thus non-surfing recreational benefits, are slightly better with LA River training structure.		$210M - $220M		Higher	$25M - $40M	2 to 4	$10M - $20M	0.5 to 2	
3a *	Create a staggered LB Breakwater configuration. Remove the east end (~9,000 ft) of the LB Breakwater and construct two new breakwaters for THUMS islands. Use removed breakwater rock to build kelp and rocky reef habitat areas and THUMS breakwaters.	Increased wave energy penetration along the eastern shoreline of Long Beach, particularly for south waves. Also some increased wave energy penetration along the western shoreline for south waves. The greatest change in wave height along the shoreline was 4.3 times the existing wave height.	Breakwater reconfiguration, without LA River Training Structure, worsened flushing of pollutants, as pollutants are trapped along the shoreline.	Could create ~500 acres of kelp bed and ~310 acres of rocky reef habitat.	Surfing conditions improvement is the most of all alternatives. Would also have some non-surfing (swimming, etc.) benefit, but not as much as Alternative 2.	Increased wave energy at Navy ammo transfer area; could require relocation of Navy ammo transfer area. Potential beach erosion and storm damage along peninsula beach due to increased wave energy. Navigational hazard concerns associated with submerged rocky reefs. Increases to wave height in deeper waters of east San Pedro Bay could impact existing recreational boating uses. Potential wave-related impacts to THUMS islands and anchorage areas leeward of breakwater.	$250M - $260M	Relocation of Navy ammo transfer area and anchorage areas. Potentially costs for peninsula beach groins (or other shoreline erosion protection) and additional measures for mitigating wave impact to THUMS islands.	Higher	$5M - $20M	0.5 to 2	$5M - $15M	0.5 to 1	Highest cost alternative. Possibly requires relocation of the Navy ammo transfer area. Potentially significant ecosystem, recreational, and economic benefits. Further analysis of potential wave impacts required.
3b	Create a staggered LB Breakwater configuration. Remove the east end (~9,000 ft) of the LB Breakwater and construct two new breakwaters for THUMS islands. Use removed breakwater rock to build kelp and rocky reef habitat areas, THUMS breakwaters, <u>and</u> LA River training structure.		With inclusion of LA River training structure, pollutants from LA River effectively kept away from LB shoreline. However, the LAR training structure also tends to break down the nearshore area of increased net transport, thereby reducing the transport of pollutants out of the area.	Could create ~260 acres of kelp bed and ~100 acres of rocky reef habitat.	Surfing conditions improvement is the most of all alternatives. Would also have some non-surfing (swimming, etc.) benefit, especially with LA River training structure.		$300M - $310M		Higher	$25M - $40M	1 to 3	$10M - $20M	0.5 to 2	
4 *	Build LA River training structure from imported rock.	Minor reduction in wave height along western shoreline of Long Beach.	Pollutants from LA River effectively kept away from LB shoreline. However, the LAR training structure also tends to break down the nearshore area of increased net transport, thereby reducing the transport of pollutants out of the area.	Could create ~25 acres of rocky reef habitat.	No surfing benefit. Would have improvement to water quality and thus recreational swimming benefits.	Navigational changes	$130M - $140M	None	Higher	$20M - $35M	2 to 5	$5M - $15M	1 to 2	Ecosystem benefits (creation of new habitat areas) not as significant as other alternatives, but water quality / recreational benefits are potentially significant.
-	Build kelp and rocky reef habitat areas from imported rock.	Not modeled, but assumed to be some wave height decreases along shorelines landward of low relief rocky reef areas	Not modeled, but assumed to be <u>no</u> improvement to water quality.	Could create ~500 acres of kelp bed and ~50 acres of rocky reef habitat.	No recreational benefits.	Navigational hazard concerns associated with submerged rocky reefs.	$45M - $50M	None	Similar	None/ Minimal	-	None/ Minimal	-	Ecosystem benefits signficant and ecosystem benefit to cost ratio appears to be similar to other ecosystem mitigation projects. However, no recreational or economic benefits.

** = Specific Configuration of Alternative Modeled for Hydrodynamic / Water Quality Analysis.*

Appendix D - Preliminary Rock Quantities, Construction Costs, Habitat Areas Created - Alternatives Summary

	Alt 1			Alt 2a			Alt 2b			Alt 3a			Alt 3b			Alt 4					
	Lower West End Section of LB B/W - Build Rocky Reef			Remove West End Section of LB B/W - Build Habitat Areas (Kelp Beds and Rocky Reef), but not LAR Training Structure			Remove West End Section of LB B/W - Build Habitat Areas and LAR Trng Struct			Create Staggered B/W - Build THUMS Island Breakwaters and Habitat Areas, but not LAR Training Structure			Create Staggered B/W - Build THUMS Island Breakwaters, Habitat Areas and LAR Training Structure			Build LAR Training Structure from Imported Rock			Build Kelp Beds and Rocky Reef from Imported Rock		
	Rock Quantity (Tons)	*Habitat Area Created (acres)*	Construction Cost	Rock Quantity (Tons)	*Habitat Area Created (acres)*	Construction Cost	Rock Quantity (Tons)	*Habitat Area Created (acres)*	Construction Cost	Rock Quantity (Tons)	*Habitat Area Created (acres)*	Construction Cost	Rock Quantity (Tons)	*Habitat Area Created (acres)*	Construction Cost	Rock Quantity (Tons)	*Habitat Area Created (acres)*	Construction Cost	Rock Quantity (Tons)	*Habitat Area Created (acres)*	Construction Cost
Rock Removed from LB Breakwater																					
Armor Rock	54,000		*$5,400,000*	360,000		*$59,000,000*	360,000		*$59,000,000*	720,000		*$129,000,000*	720,000		*$129,000,000*	0			0		
Underlayer Rock	0			450,000			450,000			900,000			900,000			0			0		
Rock to be Placed for Kelp Bed																					
Underlayer Rock	0	*0*		340,000	*500*		340,000	*500*		340,000	*500*		174,000	*260*		0	*0*		340,000	*500*	
Rock to be Placed for High/Low Relief Fish Reef						*$32,000,000*			*$20,000,000*												*$20,000,000*
Armor Rock	54,000	*20*	*$3,600,000*	360,000	*170*		124,000	*50*		440,000	*300*	*$74,000,000*	204,000	*70*	*$41,000,000*	0	*0*		70,000	*50*	
Underlayer Rock	0			110,000			20,000			400,000			0			0			70,000		
Rock to be Placed for THUMS Islands Breakwaters (2)																					
Armor Rock	0	*0*		0	*0*		0	*0*		280,000	*10*		280,000	*10*		0	*0*		0	*0*	
Underlayer Rock	0			0			0			160,000			160,000			0			0		
Rock to be Placed for LA River Training Structure																					
Armor Rock	0			0			236,000			0			236,000			236,000			0		
Underlayer Rock	0	*0*		0	*0*		566,000	*25*	*$49,000,000*	0	*0*		566,000	*25*	*$49,000,000*	566,000	*25*	*$49,000,000*	0	*0*	
Quarry Run	0			0			1,100,000			0			1,100,000			1,100,000			0		
Import Rock Needed																					
Armor Rock	0			0			0			0			0			236,000			70,000		
Underlayer Rock	0			0			476,000		*$45,000,000*	0			0		*$28,000,000*	566,000		*$60,000,000*	410,000		*$18,000,000*
Quarry Run	0			0			1,100,000			0			1,100,000			1,100,000			0		
Total Habitat Area Created (acres)		*20*			*670*			*575*			*810*			*365*			*25*			*550*	
Total Construction Cost - Without Contingency			$9,000,000			$91,000,000			$173,000,000			$203,000,000			$247,000,000			$109,000,000			$38,000,000
Total Construction Cost - With Contingency (25%)			$11,000,000			$114,000,000			$216,000,000			$254,000,000			$309,000,000			$136,000,000			$48,000,000
Cost ($1,000s) Per Habitat Acre			*$550*			*$170*			*$376*			*$314*			*$847*			*$5,440*			*$87*
Reference Site - SCE Wheeler Kelp Reef																					
Kelp Area Created (acres)		*128*																			
Construction Cost			$16,000,000																		
Cost ($1,000s) Per Habitat Acre			*$125*																		

APPENDIX E – HYDRODYNAMIC AND WATER QUALITY MODELING RESULTS

- Description of Modeling
- Graphics of Modeling Results for Existing Condition and Each Alternative

In order to assess the potential magnitude of water quality improvements (and thus ecosystem restoration and recreation benefits), preliminary wave and circulation modeling/analysis was completed for three different LB Breakwater reconfigurations, as well as the stand-alone LA River training structure. The preliminary modeling considered waves from southerly and westerly general directions. These directions were chosen based on review of locally recorded wave data at San Pedro Wave Buoy since 1998 which showed summertime waves occurring from these quadrants 43% and 47% of the summer months for the southerly and westerly directions, respectively. Typical summer low flow condition of 80 million gallons per day (mgd) was used for the Los Angeles River. The water quality and circulation modeling included coupling of waves, winds, tidal action, and river inflow in a 2-dimensional, vertically averaged model framework.

The modeling results suggest that breakwater reconfiguration would change existing conditions as follows, i.e. breakwater reconfiguration would potentially result in:

1) Increased wave heights along the shoreline.

The reconfigured breakwater alternatives resulted in wave changes along the shoreline ranging from no difference to four times the wave heights of the existing condition. The resultant wave increases in the deeper East San Pedro Bay waters ranged from no change to almost five times the wave heights of the existing condition. The wave modeling did not indicate any increased wave activity in the vicinity of the Port of Long Beach. However, the modeling effort did not take into account propagation of long-period wave energy into the harbor area which could impact harbor resonance which has historically been an issue in the Port.

Westerly wave energy penetration was increased the most for Alternative 2 and Alternative 3 at different areas of the shoreline. The increased westerly wave energy penetration for Alternative 1 was limited to the deeper East San Pedro Bay areas adjacent to the breakwater. Wave penetration for southerly wave energy is substantially greater than for westerly waves for existing conditions and all alternatives. Alternative 2 and Alternative 3 allowed the greatest wave penetration for southerly waves. Southerly wave energy along the shoreline for Alternative 1 did increase in an area similar to Alternative 2, but the increased wave energy was substantially less. One significant impact associated with Alternative 3 is the increased wave energy at the Navy ammunition transfer area which would have to be mitigated. In addition, the increased wave exposure along the peninsula beaches could exacerbate existing shoreline erosion issues with Alternative 3 (and thus additional shore protection would be required), although it is possible the increased exposure to westerly wave energy could improve littoral transport to this area and reduce or reverse shoreline retreat. The shoreline erosion impacts along the peninsula require additional analysis and mitigation will be required if shoreline erosion increases at any location along the beach.

2) A decrease to pollutant concentration over time.

Two scenarios were modeled with the results of the westerly and southerly wave modeling used as input to a 2-dimensional water quality and transport model. The transport model incorporated the Los Angeles River inflow, diurnal seabreeze wind effects, and tidal propagation along the coast in addition to the wave-induced transport. The first scenario discharged a pollutant from the LA River and traced the pollutant concentrations within the East San Pedro Bay after one week of time. This analysis showed that the LA River training structure feature (Alternative 4) effectively keeps LA River pollutants away from the Long Beach shoreline, but the basic breakwater reconfigurations (e.g. removal of breakwater sections) did not significantly change the existing distribution of a discharged pollutant.

The second scenario modeled was to start with a condition in which the entire East San Pedro Bay was filled with a pollutant to evaluate how quickly the pollutant is flushed from the area, i.e. each alternative's impact on water turnover. The water quality and transport model was run for a period of 15 days at which point the remaining contaminant concentration was plotted. The results for existing conditions show that the contaminant is effectively flushed from the East San Pedro Bay area with westerly waves while southerly waves tend to contain the contaminant within the area. Review of the velocity data for existing conditions indicates the presence of a nearshore higher velocity "jet" which provides a net easterly transport. Net transport of this nature is common along coastlines and frequently dominates pollutant concentration when compared with dilution due to turbulent mixing due to waves or other mechanisms. The westerly waves and seabreeze inputs to the water quality and transport model tend to

reinforce this jet and move contaminants out of the area. With southerly waves, the angle of wave approach to the contours and associated wave-induced transport tends to reduce the flushing effectiveness of this jet and push flow towards the west. This circulation feature also suggests that increased wave penetration towards the westerly end of the LB Breakwater will enhance the movement of water towards the east with the resultant improve flushing. This improvement is evident with Alternative 2. Alternative 1 also shows some flushing improvement adjacent to Queen's Gate, although not as effectively due to the shallow, narrow gap compared to Alternative 2. Alternative 3 allows more southerly wave energy into the area. The westerly waves with Alternative 3 also tend to trap the contaminant along the eastern shoreline area. The results of Alternative 3 also suggest that additional breakwater gaps similar to Alternative 1 and repeated towards the east will reduce movement of water out of the area. The presence of the LA River training structure also tends to break down the nearshore area of increased net transport, thereby reducing the transport out of the area. However, since the main source of contaminants in the East San Pedro Bay area is the LA River and not the harbor area itself, this impact to the water exchange may not be critical since the training structure would reduce contaminant concentrations resulting from this source.

The models used in these analyses are 2-dimensional vertically averaged and are not capable of reproducing 3-dimensional mechanisms such as freshwater river flow "floating" on the ocean water or possible return flows along the seafloor with wind or wave forcing on the water surface. In addition, the model was used to simulate two separate wave scenarios held constant for extended periods of time where naturally fluctuating and superimposed wave trains would normally occur. These mechanisms may alter the results to some degree, but the conclusions should remain the same.

Graphics follow for:

Wave Height and Mean Direction – Existing Condition and Each Breakwater Reconfiguration Alternative
One set for each wave direction (west waves and south waves)

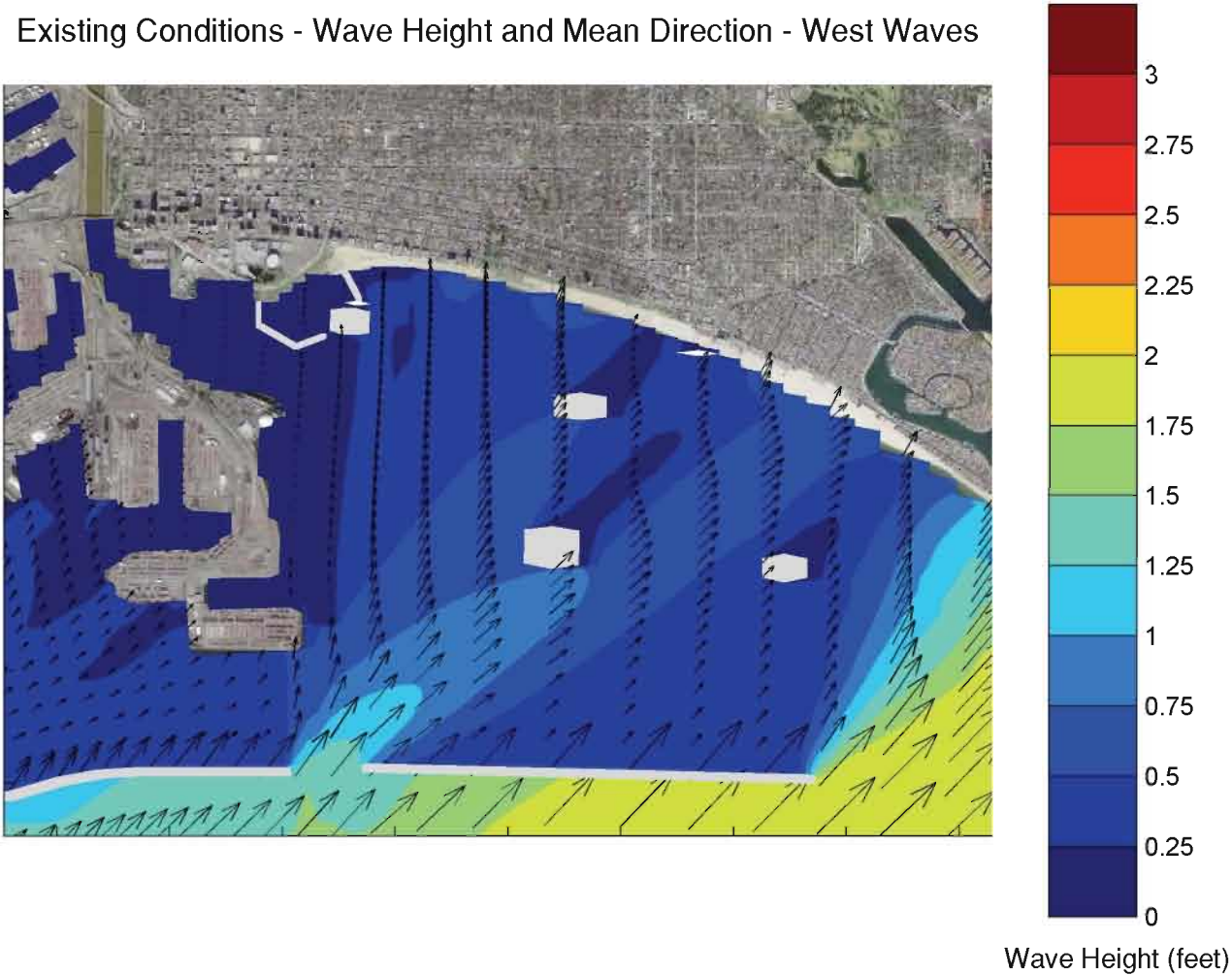
Percent of Deepwater Incident Wave Height at Select Locations within East San Pedro Bay – one page for westerly waves and one for southerly waves)

Tracer (Pollutant) Concentrations After One Week (With Tracer Released from LA River) – Existing Condition and Each Breakwater Reconfiguration Alternative
One set for each wave direction (west waves and south waves)

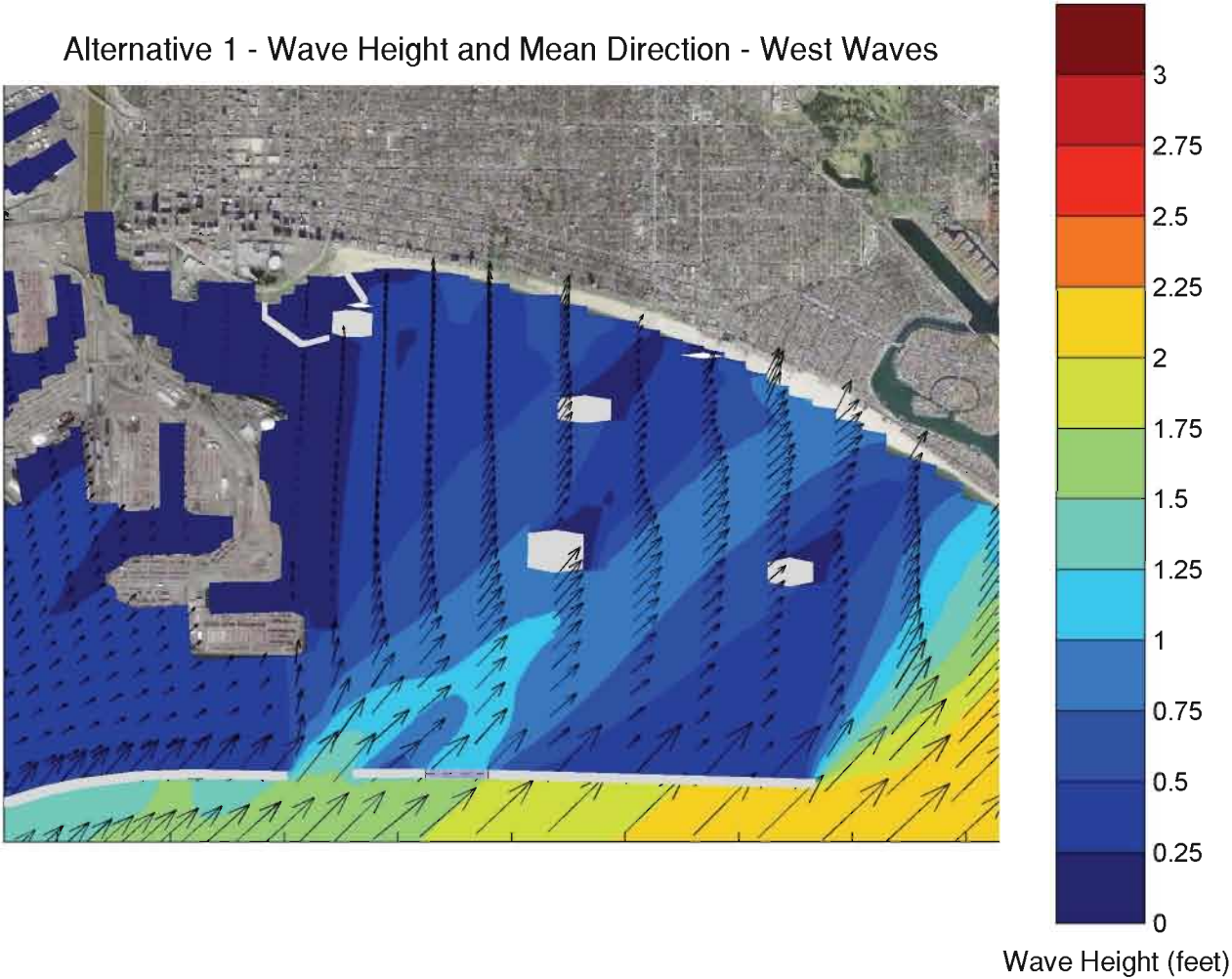
Tracer (Pollutant) Concentrations After 15 Days (With Entire East San Pedro Bay Initial Contamination) – Existing Condition and Each Breakwater Reconfiguration Alternative
One set for each wave direction (west waves and south waves)

Depth-Averaged Velocities During Ebb Tides and Westerly Waves for Existing Condition and Alternative 4

Existing Conditions - Wave Height and Mean Direction - West Waves



Alternative 1 - Wave Height and Mean Direction - West Waves



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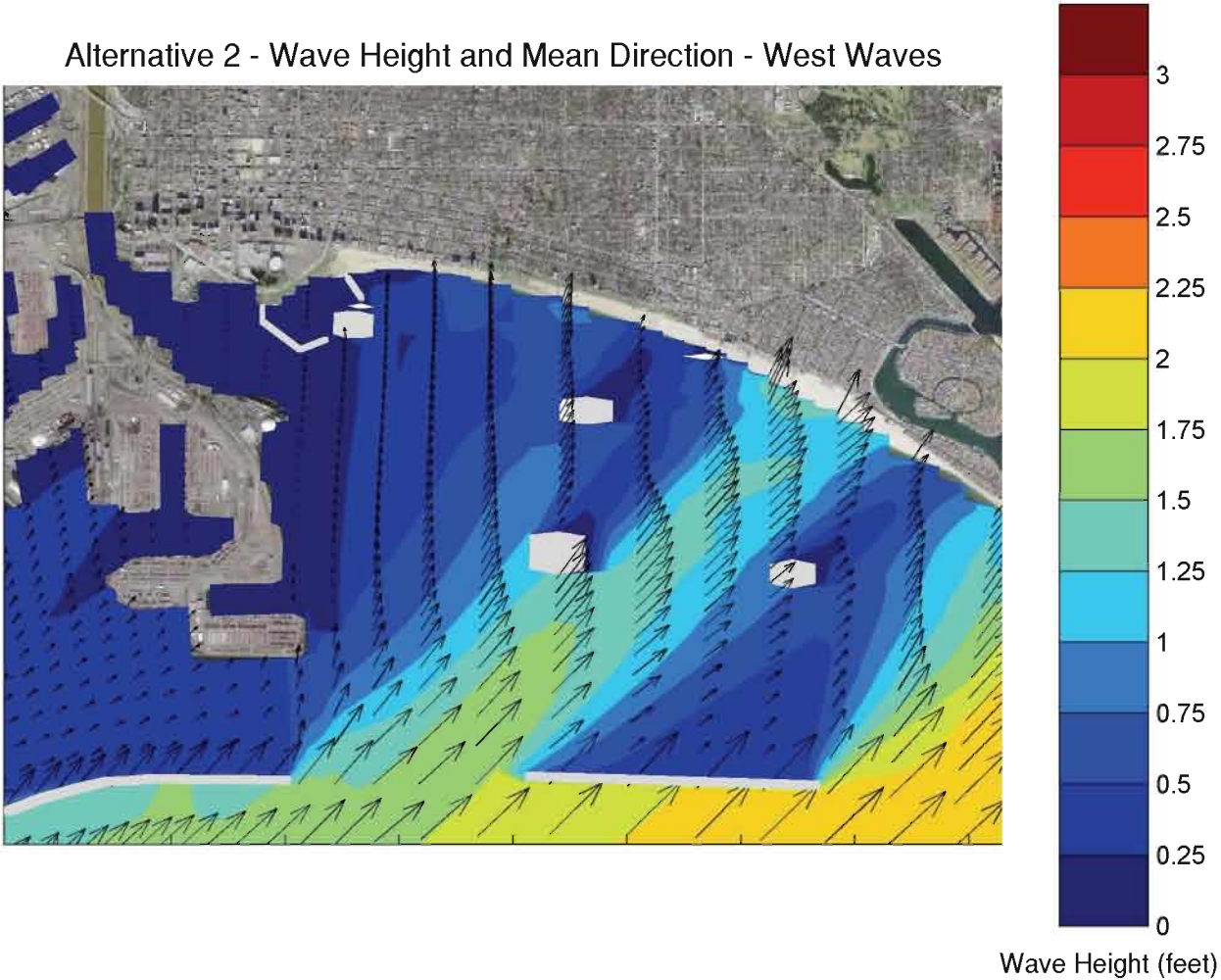

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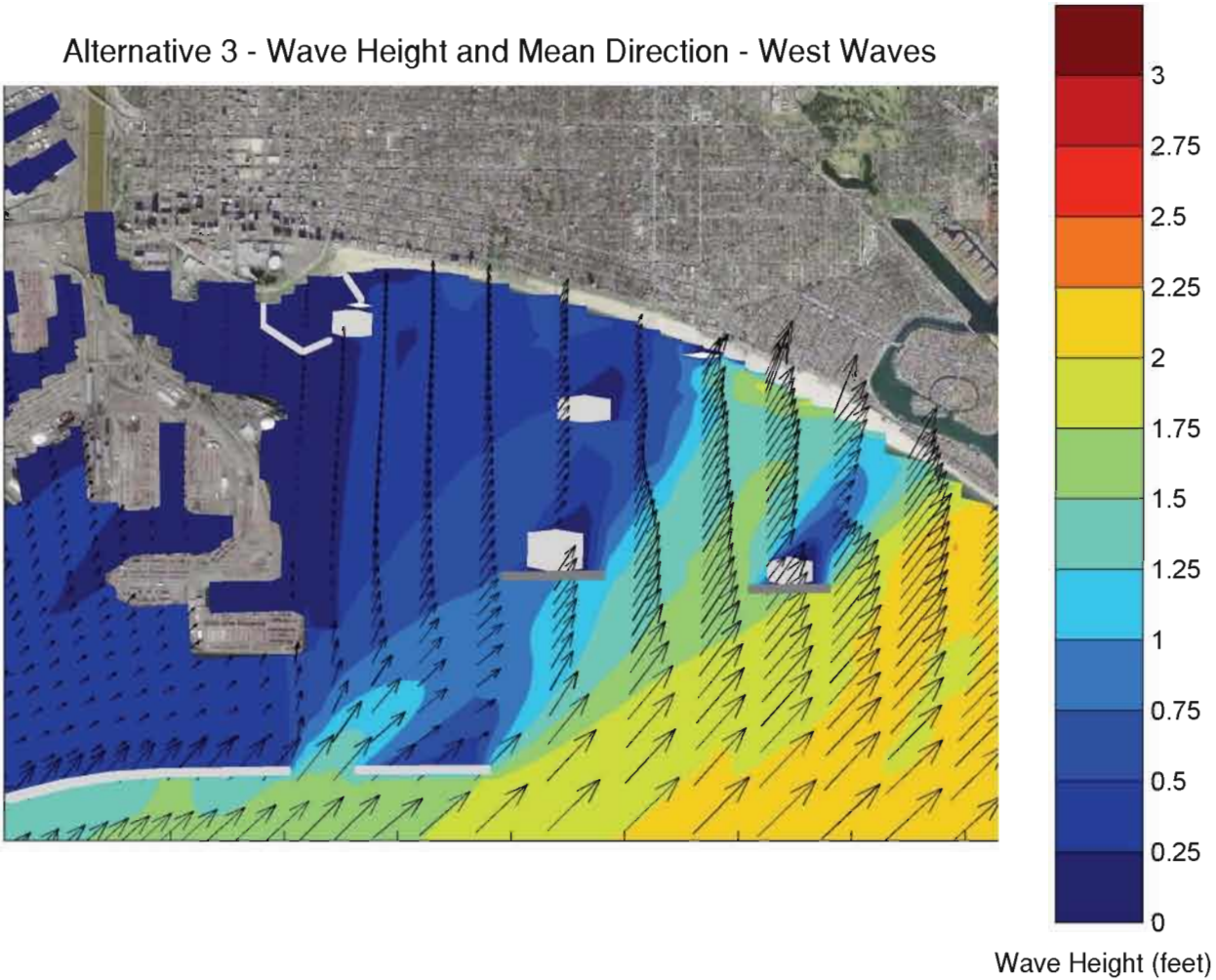

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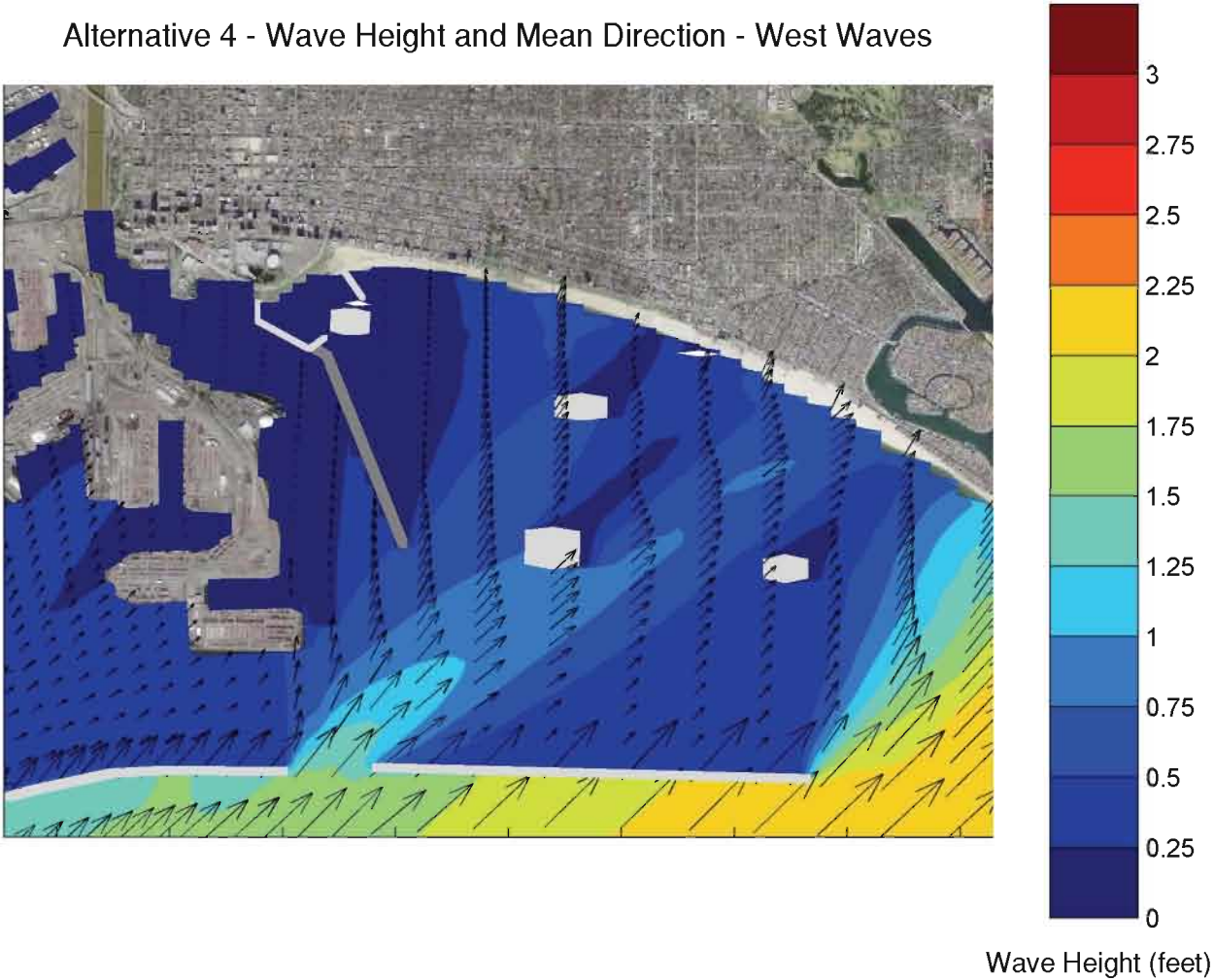

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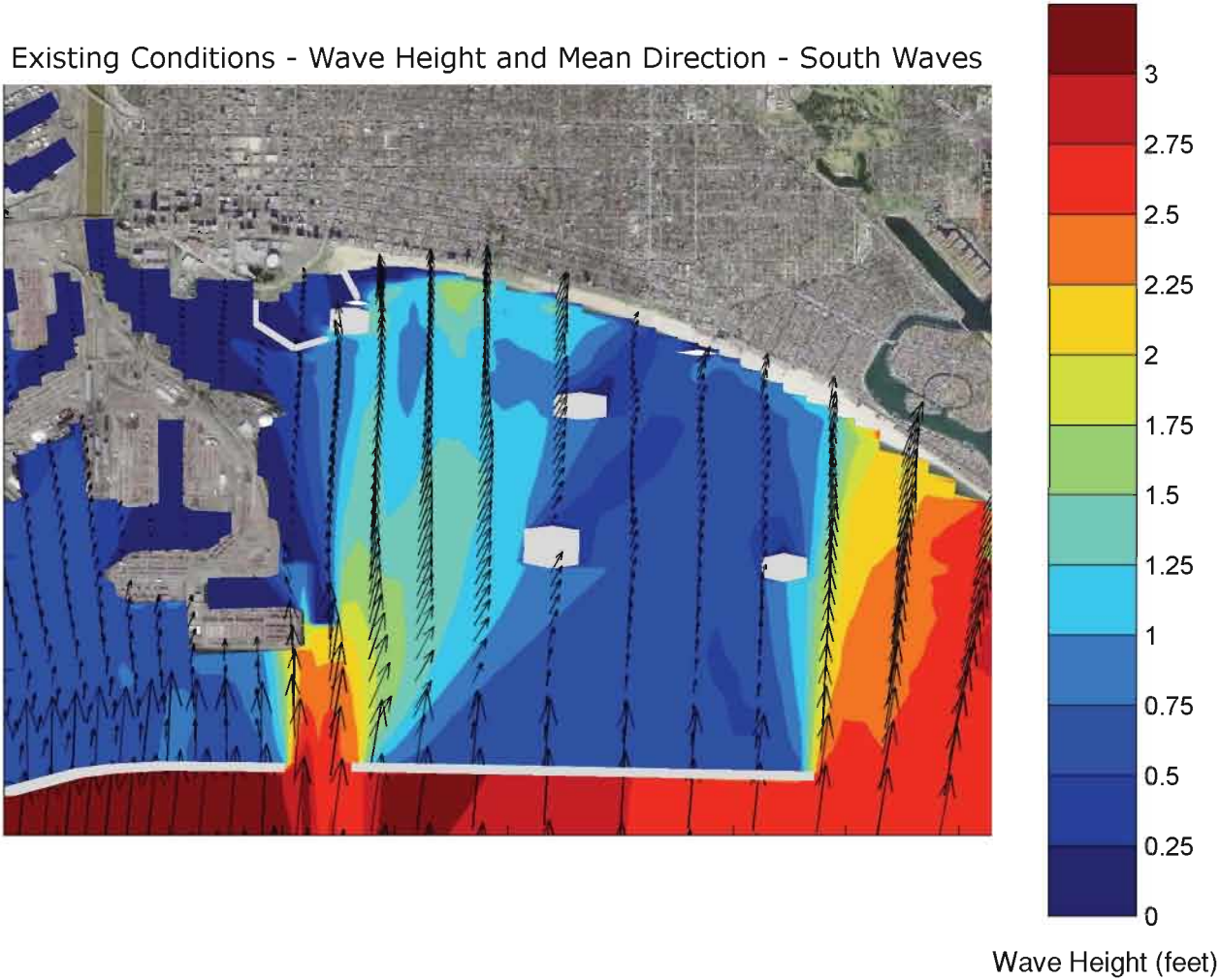

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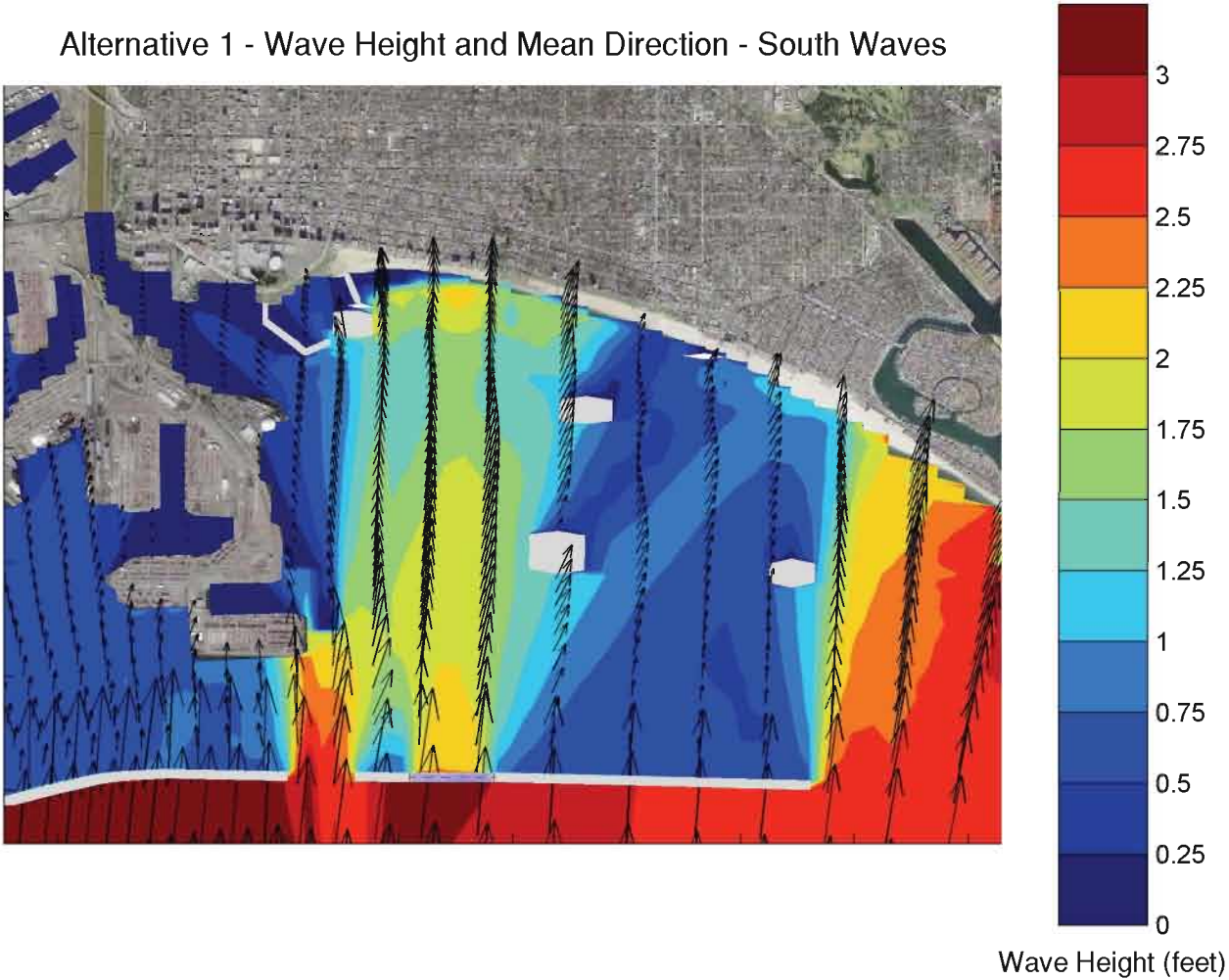

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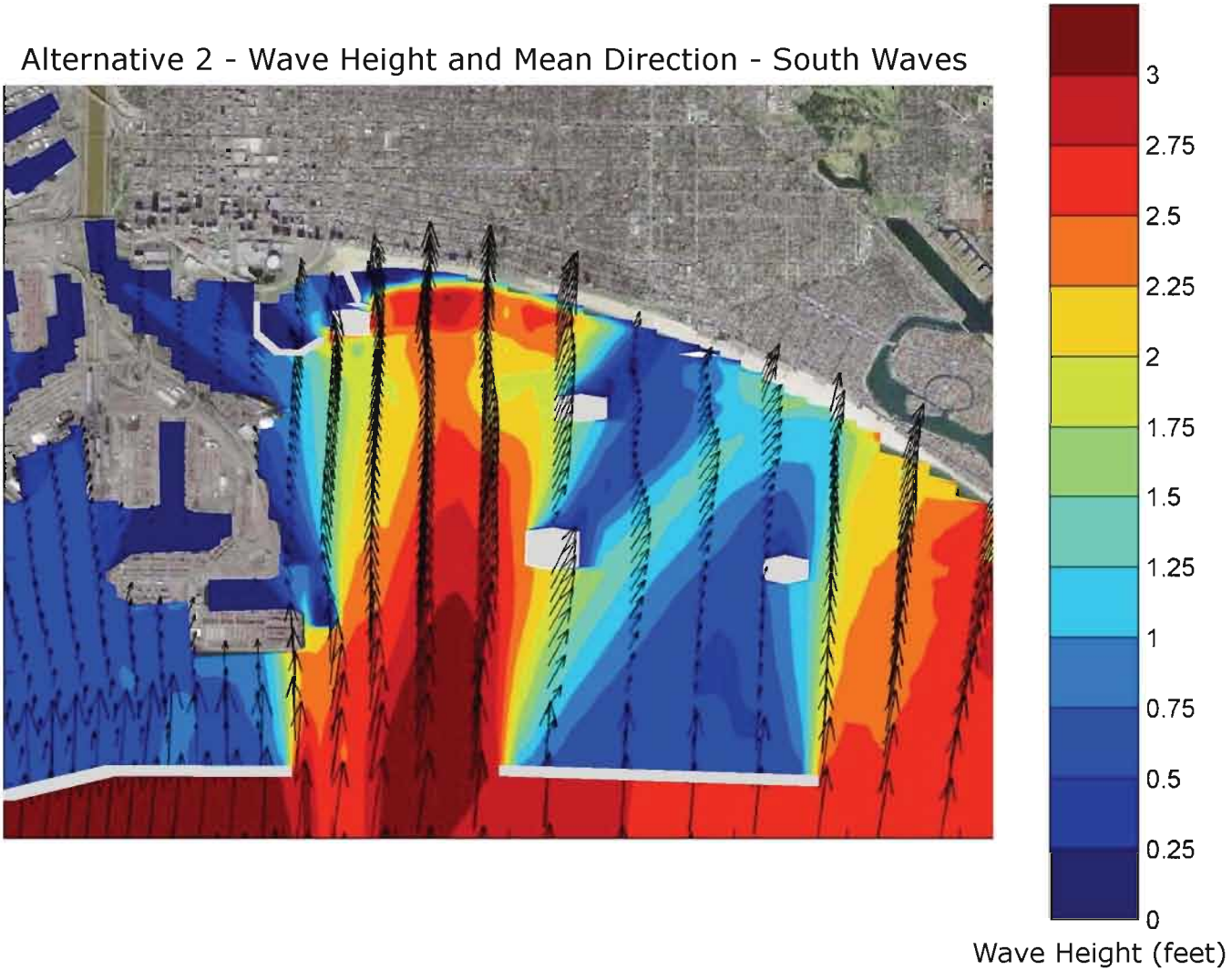
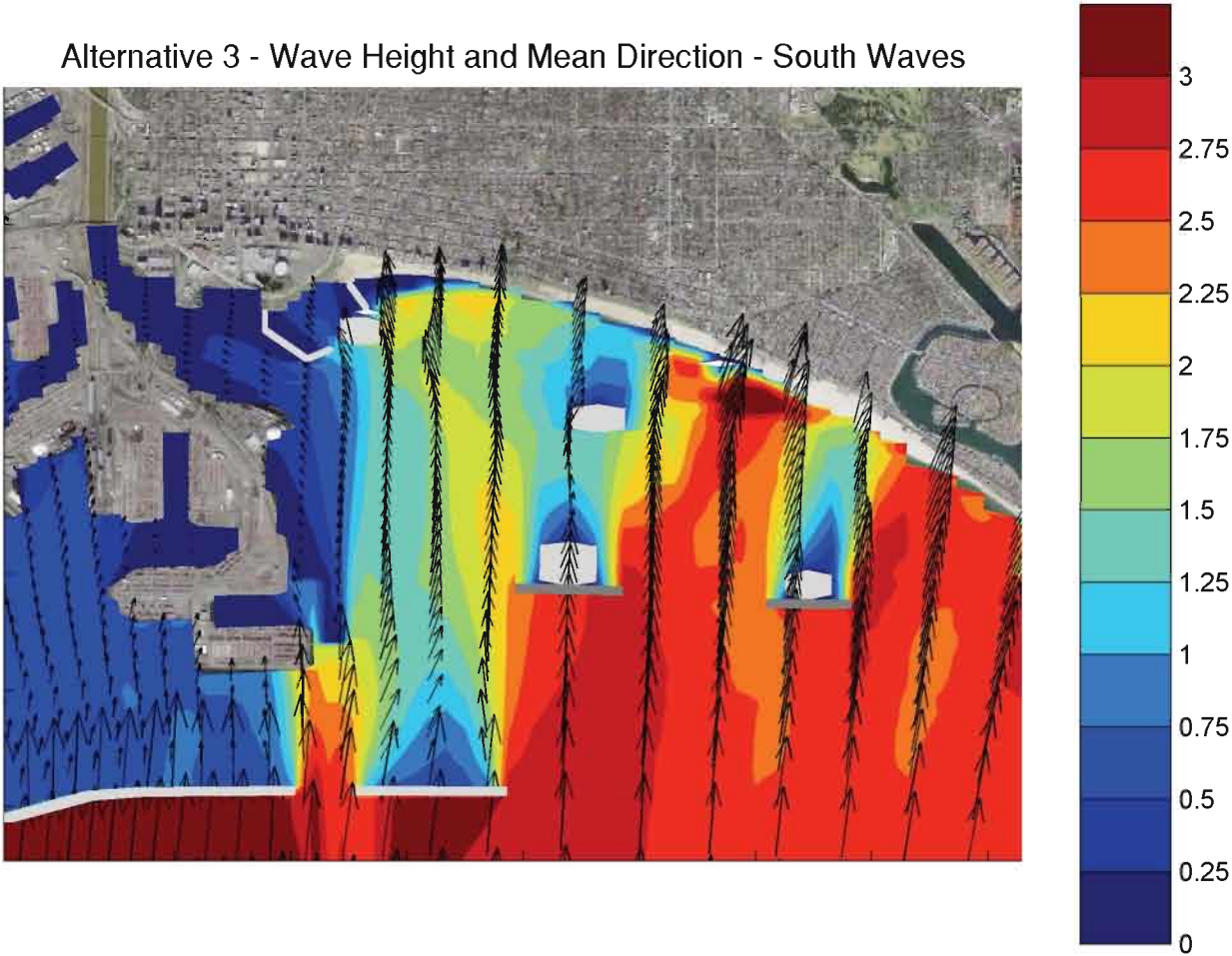
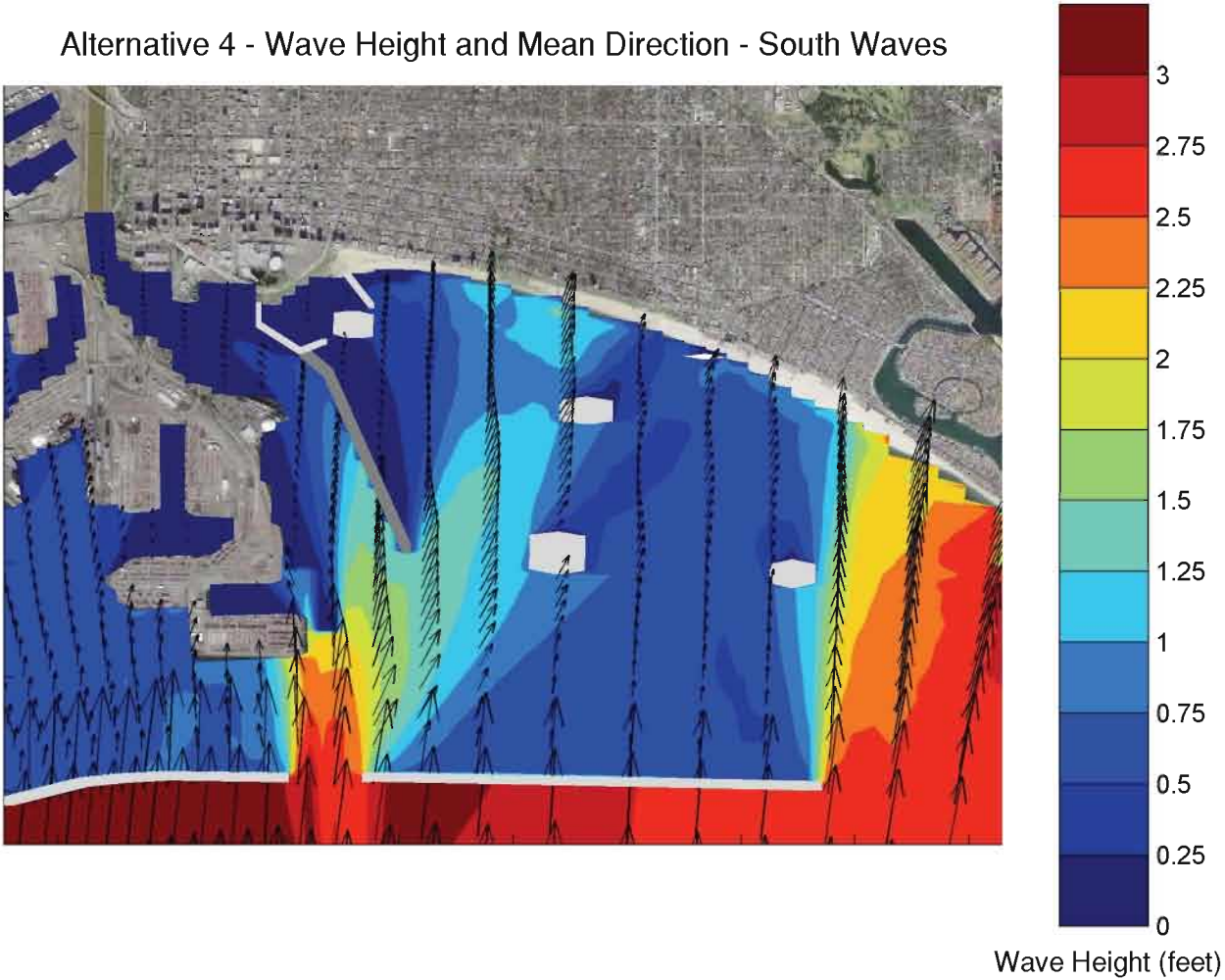
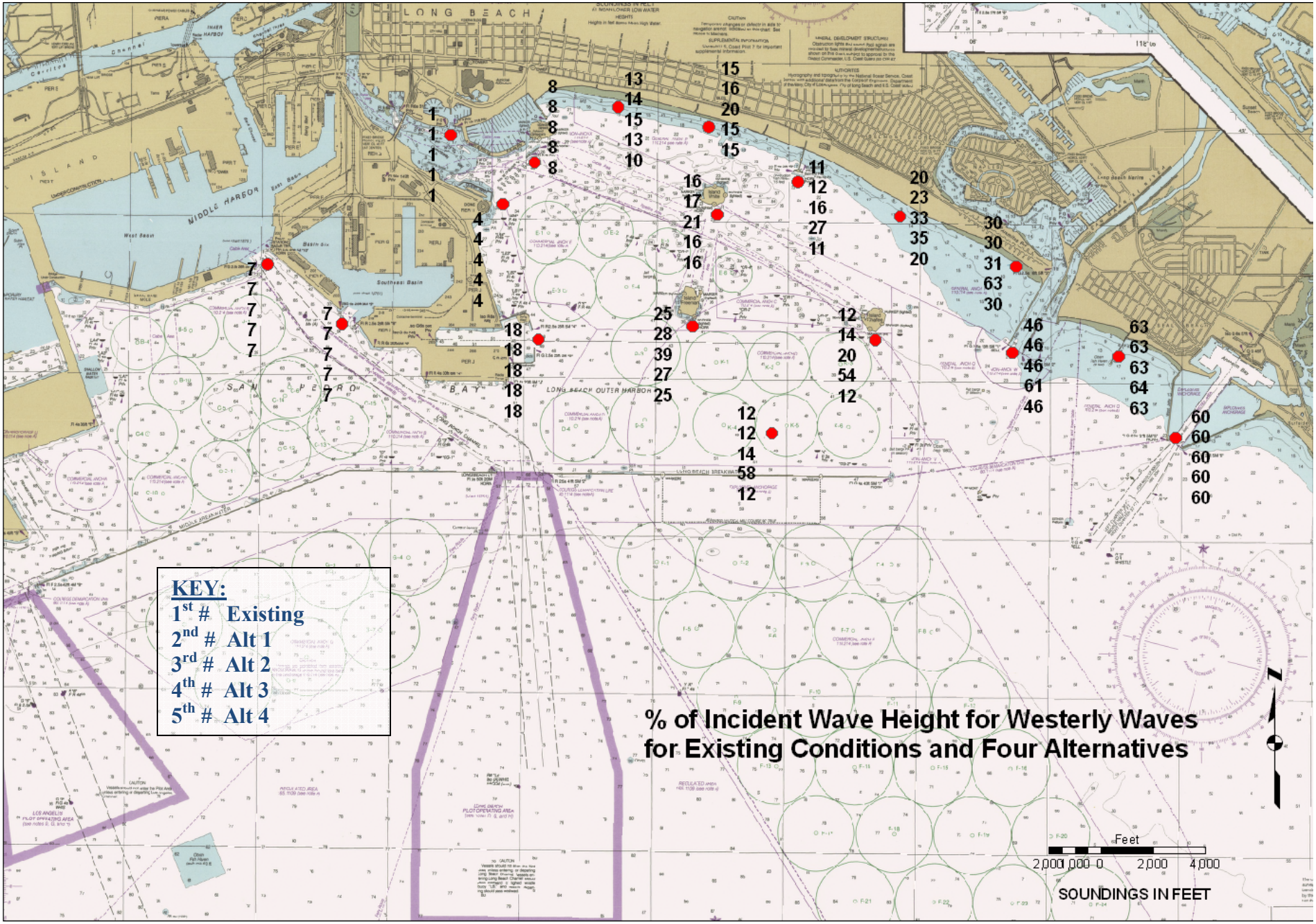


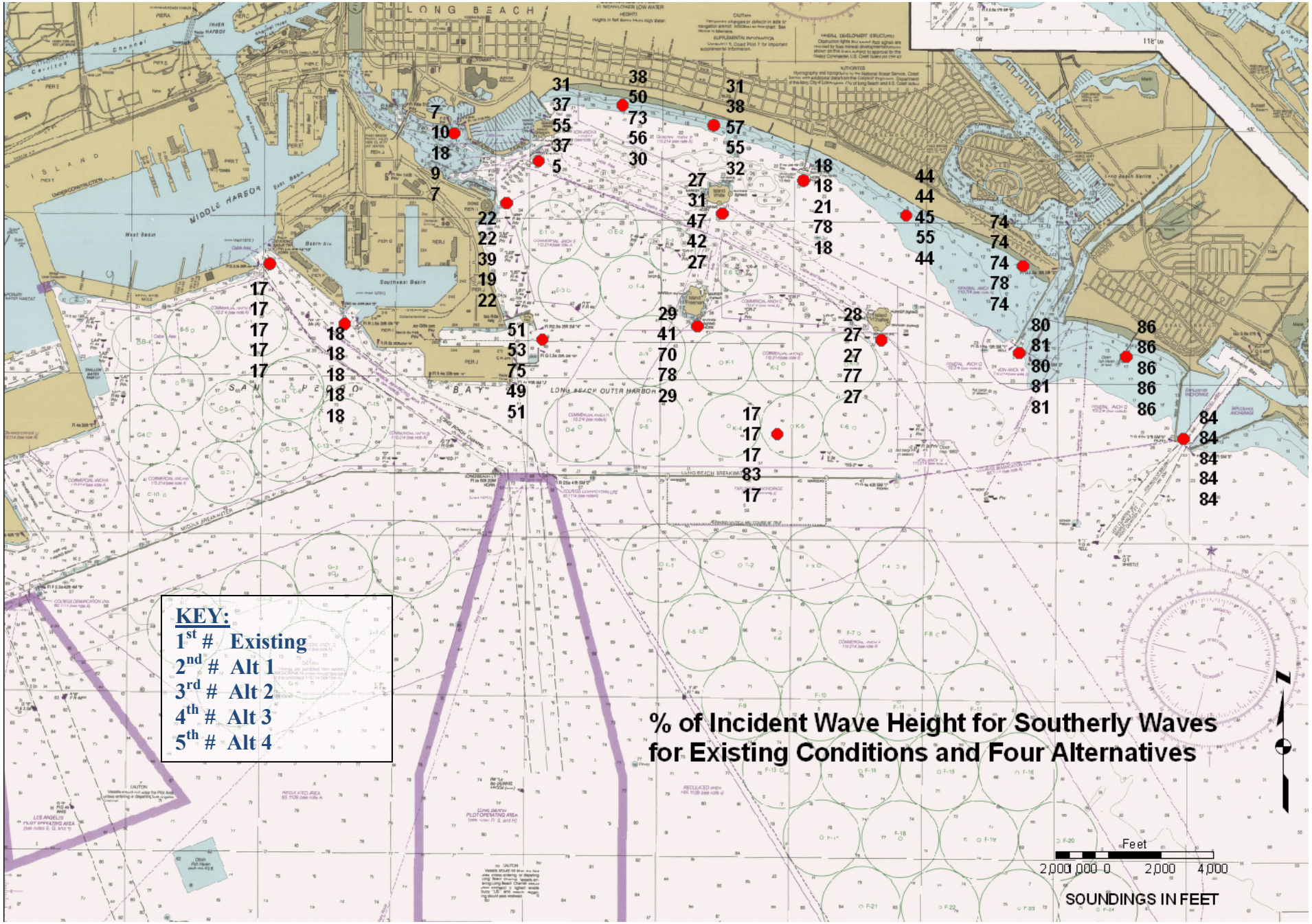
Alternative 3 - Wave Height and Mean Direction - South Waves



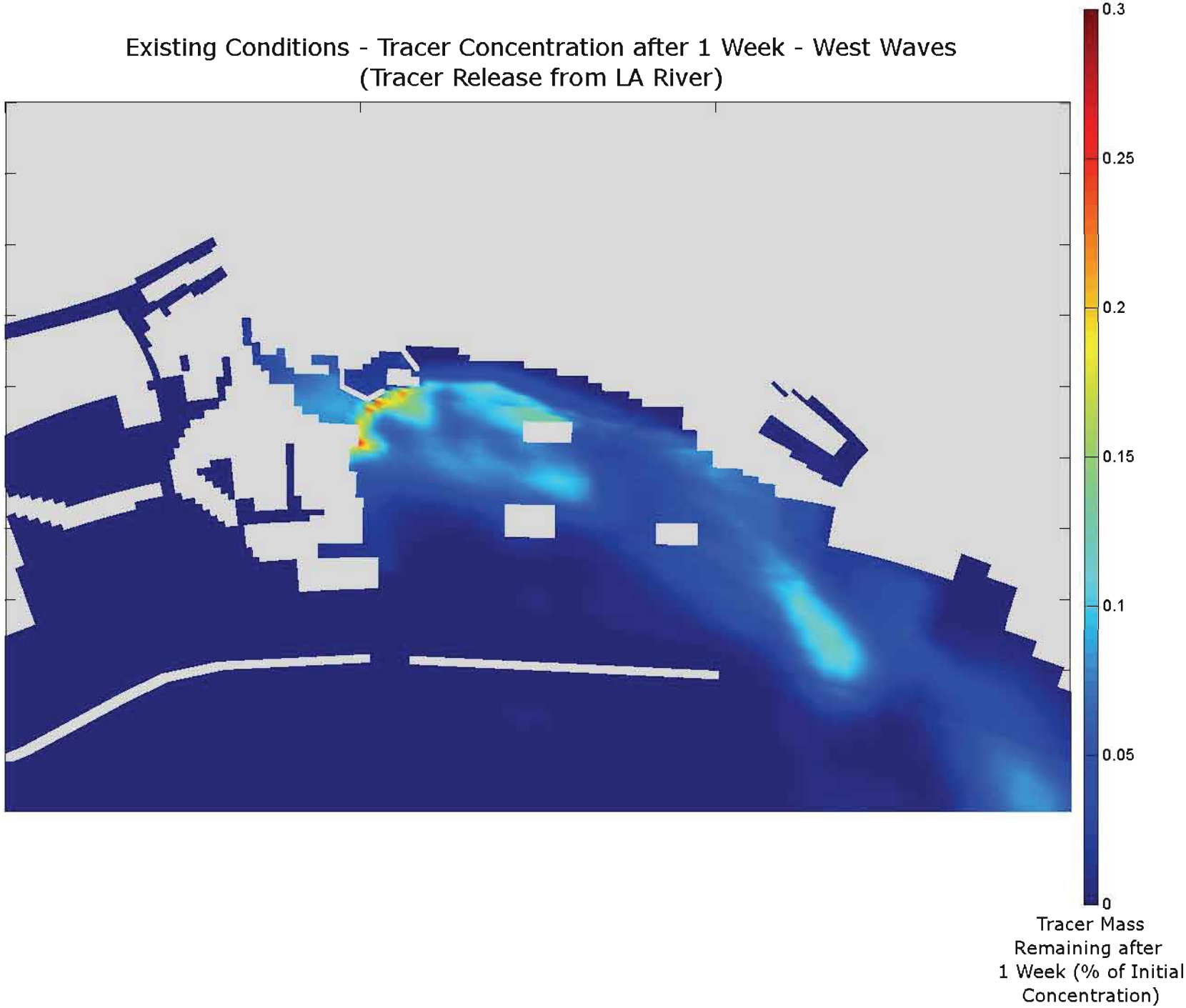
Alternative 4 - Wave Height and Mean Direction - South Waves



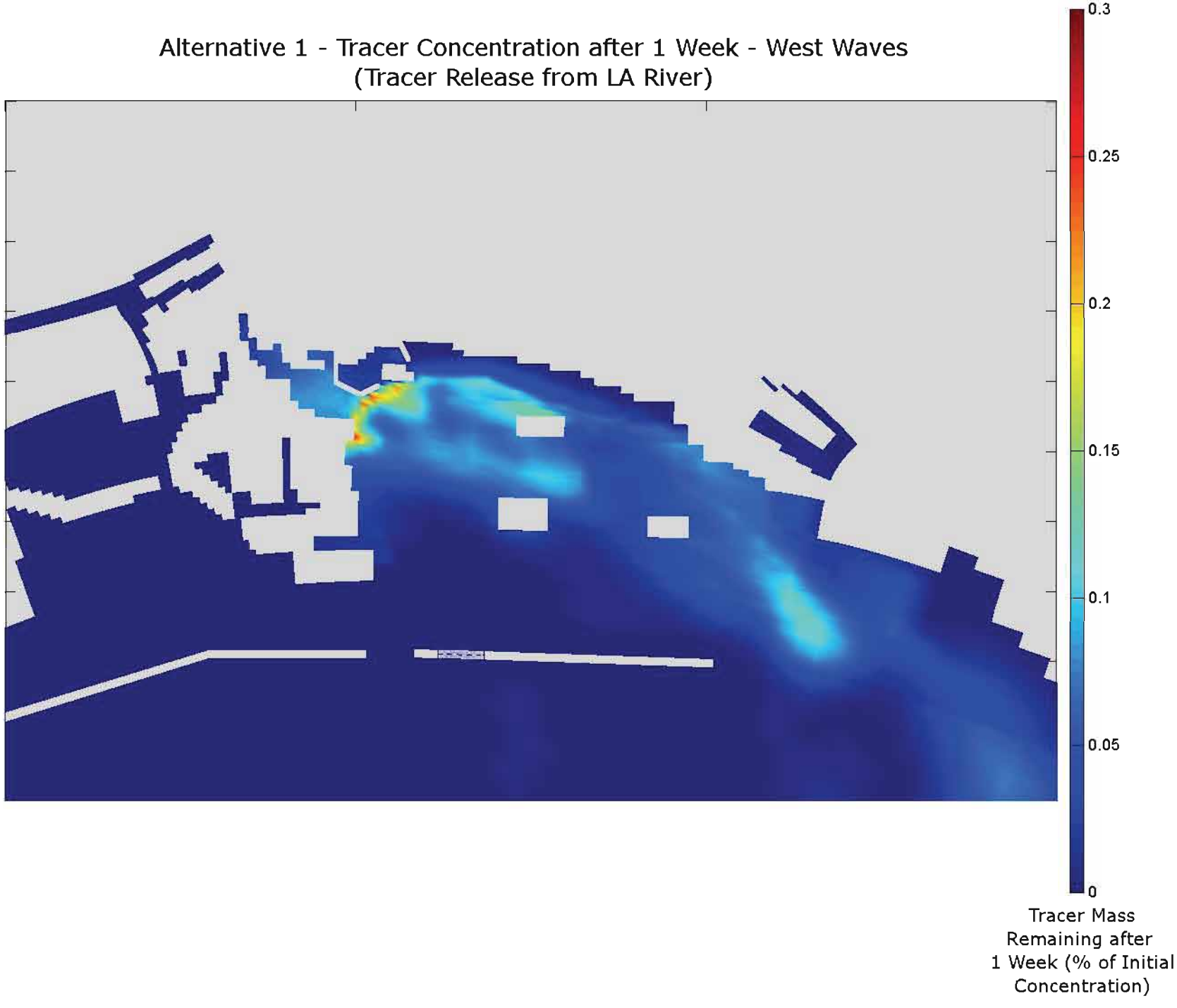

LONG BEACH
MIDDLE HARBOR
LONG BEACH OUTER HARBOR
SAN PEDRO BAY
KEY:
1st # Existing
2nd # Alt 1
3rd # Alt 2
4th # Alt 3
5th # Alt 4
% of Incident Wave Height for Westerly Waves
for Existing Conditions and Four Alternatives
Feet
2,000 1,000 0 2,000 4,000
SOUNDINGS IN FEET


LONG BEACH
MIDDLE HARBOR
West Basin
Southeast Basin
SAN PEDRO BAY
LONG BEACH OUTER HARBOR
KEY:
1st # Existing
2nd # Alt 1
3rd # Alt 2
4th # Alt 3
5th # Alt 4
% of Incident Wave Height for Southerly Waves
for Existing Conditions and Four Alternatives
Feet
2,000 1,000 0 2,000 4,000
SOUNDINGS IN FEET

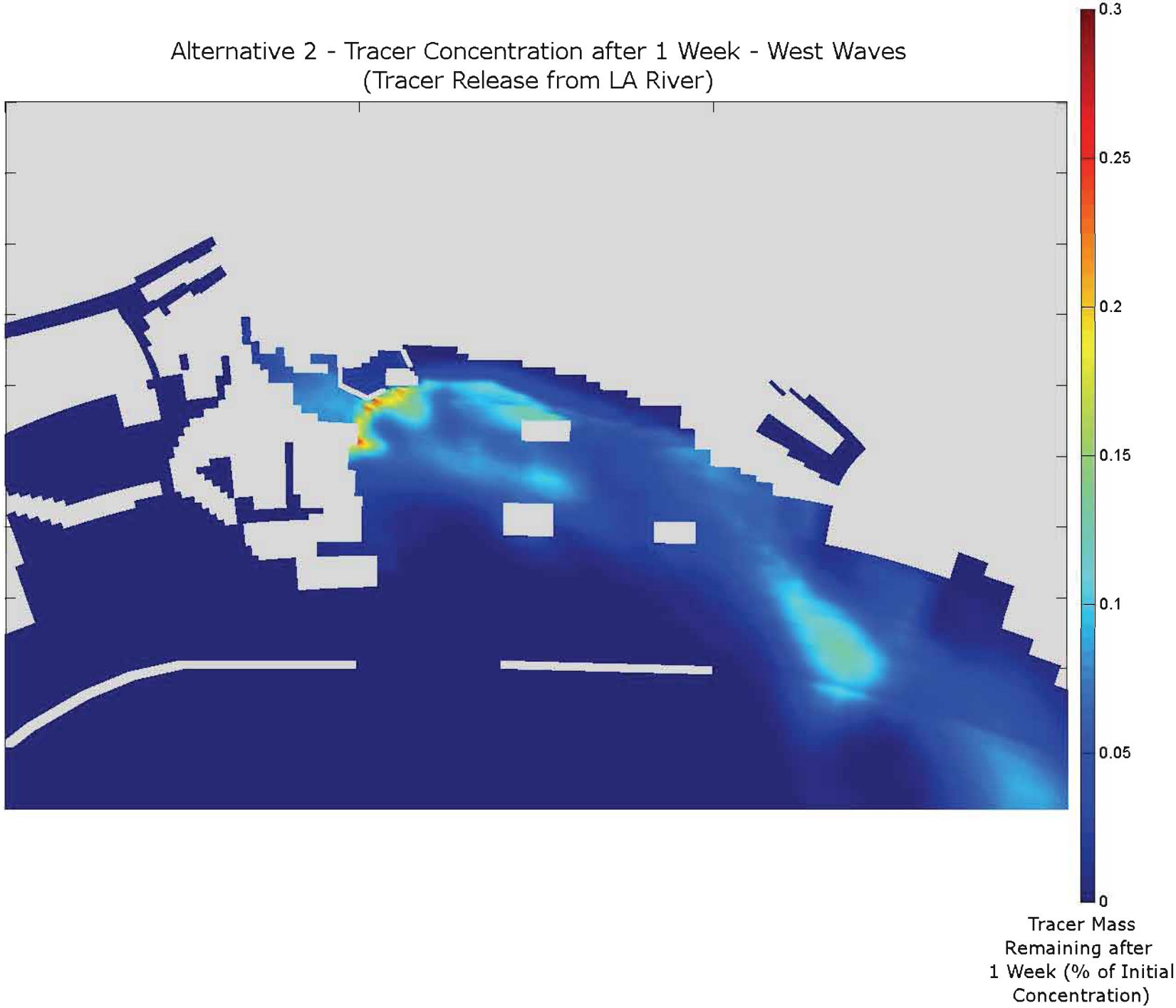
Existing Conditions - Tracer Concentration after 1 Week - West Waves
(Tracer Release from LA River)



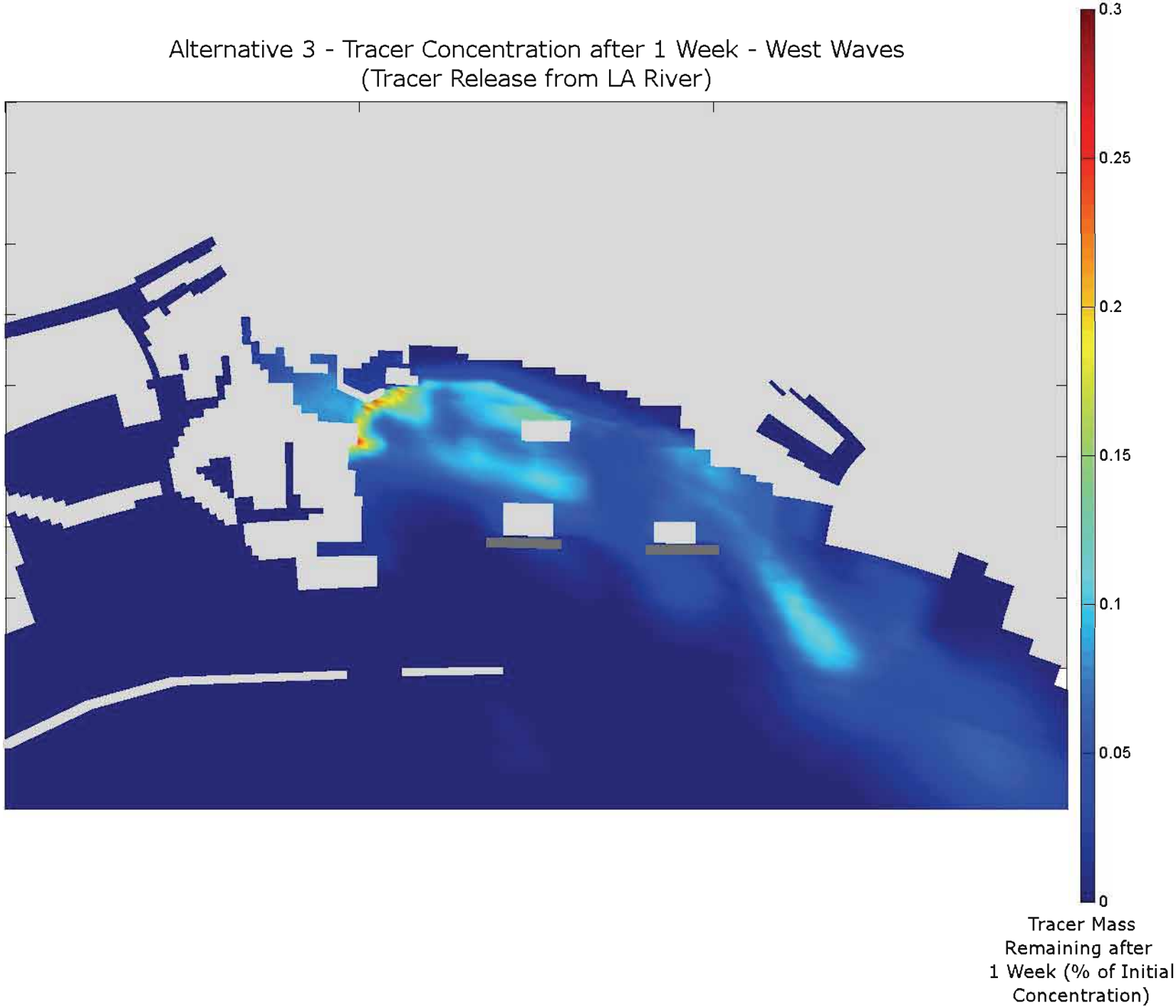
Alternative 1 - Tracer Concentration after 1 Week - West Waves
(Tracer Release from LA River)



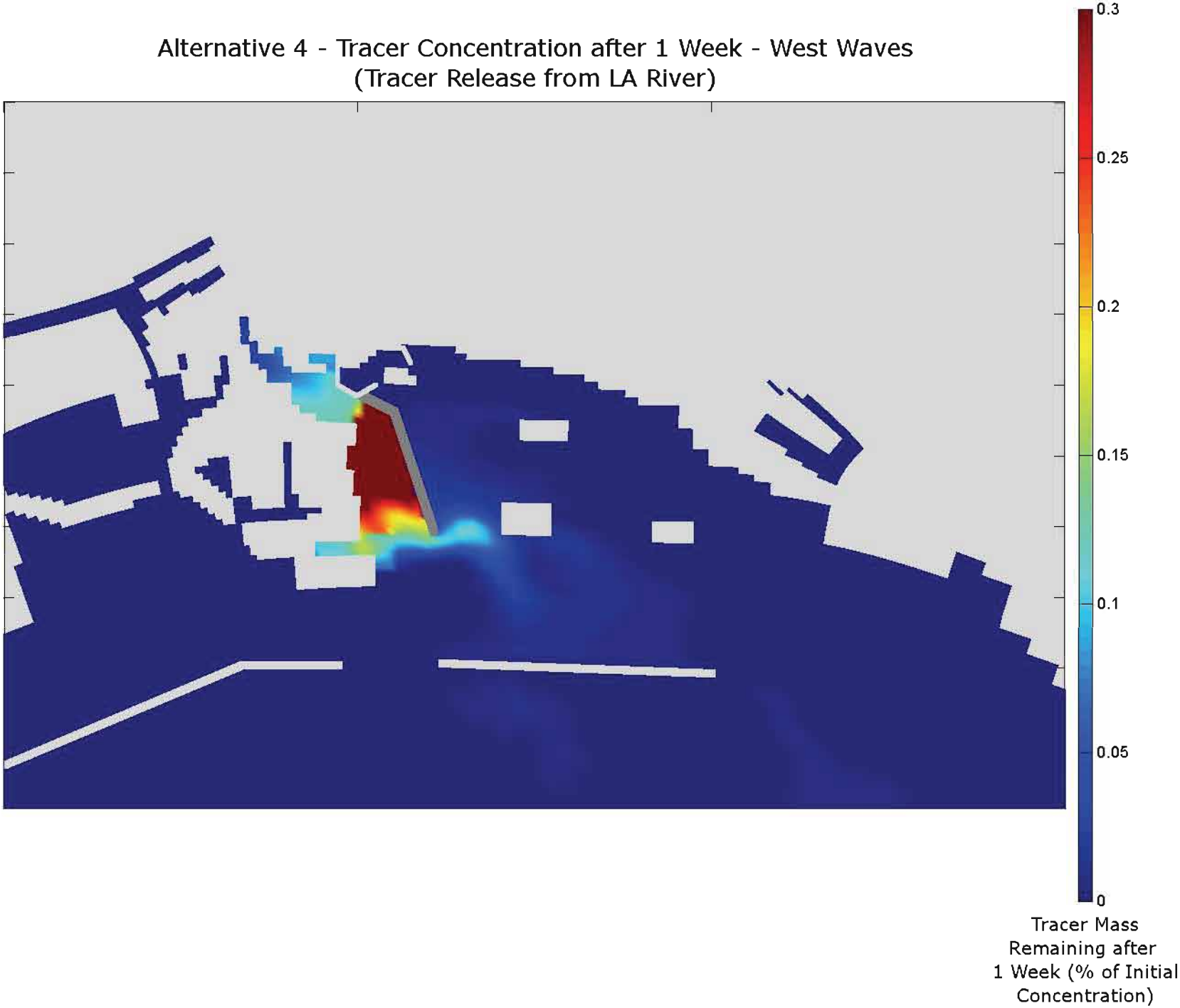
Alternative 2 - Tracer Concentration after 1 Week - West Waves
(Tracer Release from LA River)



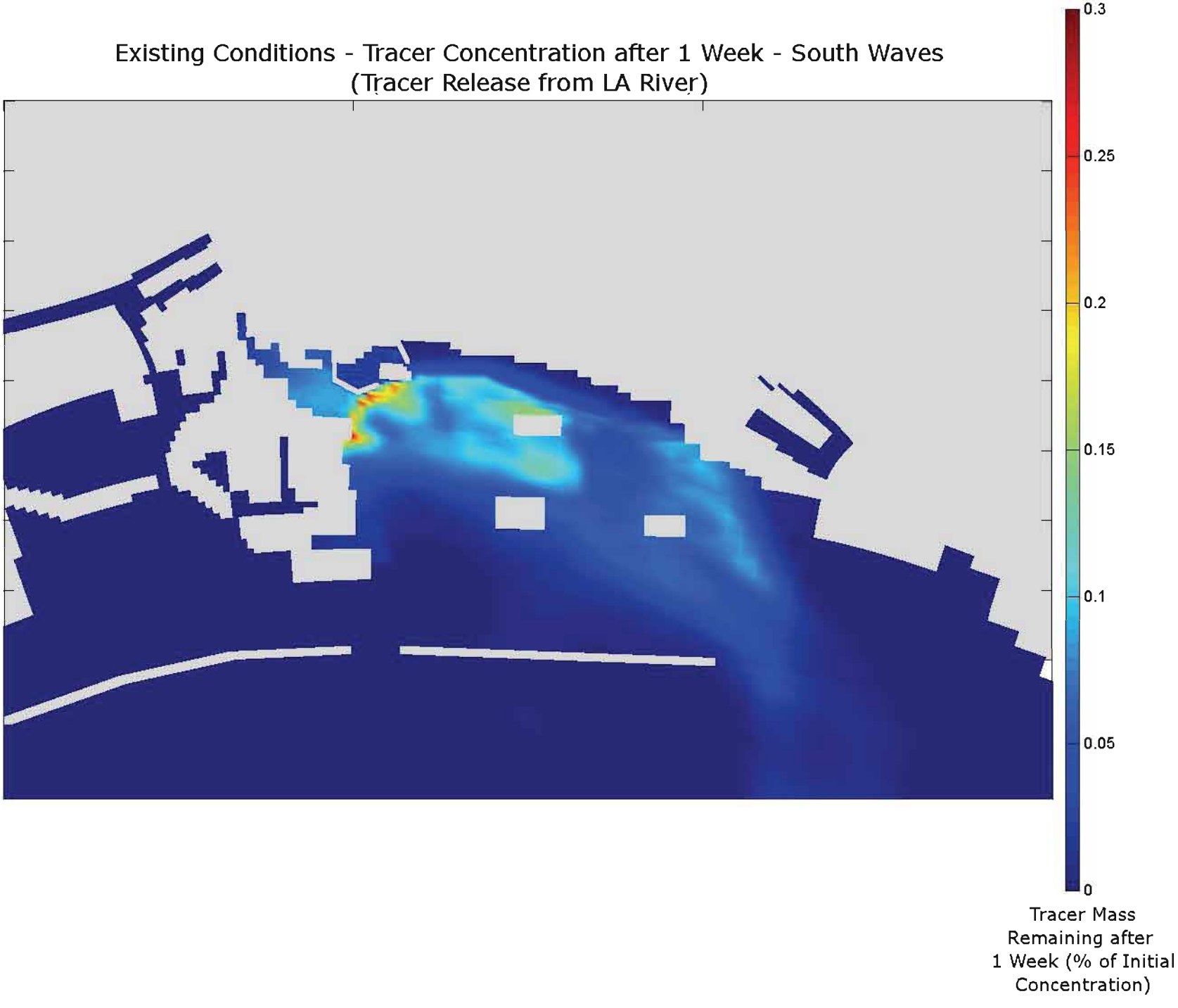
Alternative 3 - Tracer Concentration after 1 Week - West Waves
(Tracer Release from LA River)



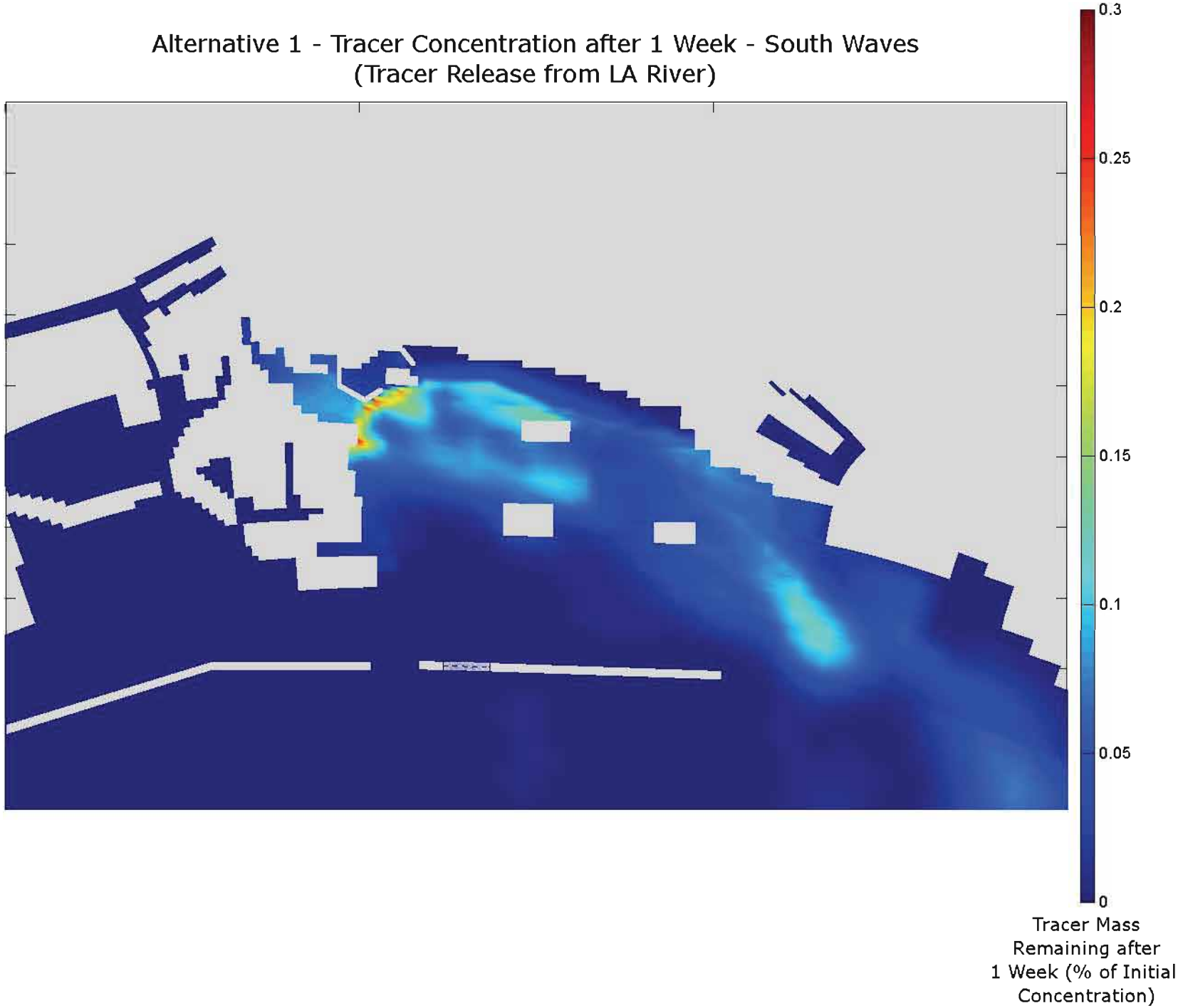
Alternative 4 - Tracer Concentration after 1 Week - West Waves
(Tracer Release from LA River)



Existing Conditions - Tracer Concentration after 1 Week - South Waves
(Tracer Release from LA River)



Alternative 1 - Tracer Concentration after 1 Week - South Waves
(Tracer Release from LA River)



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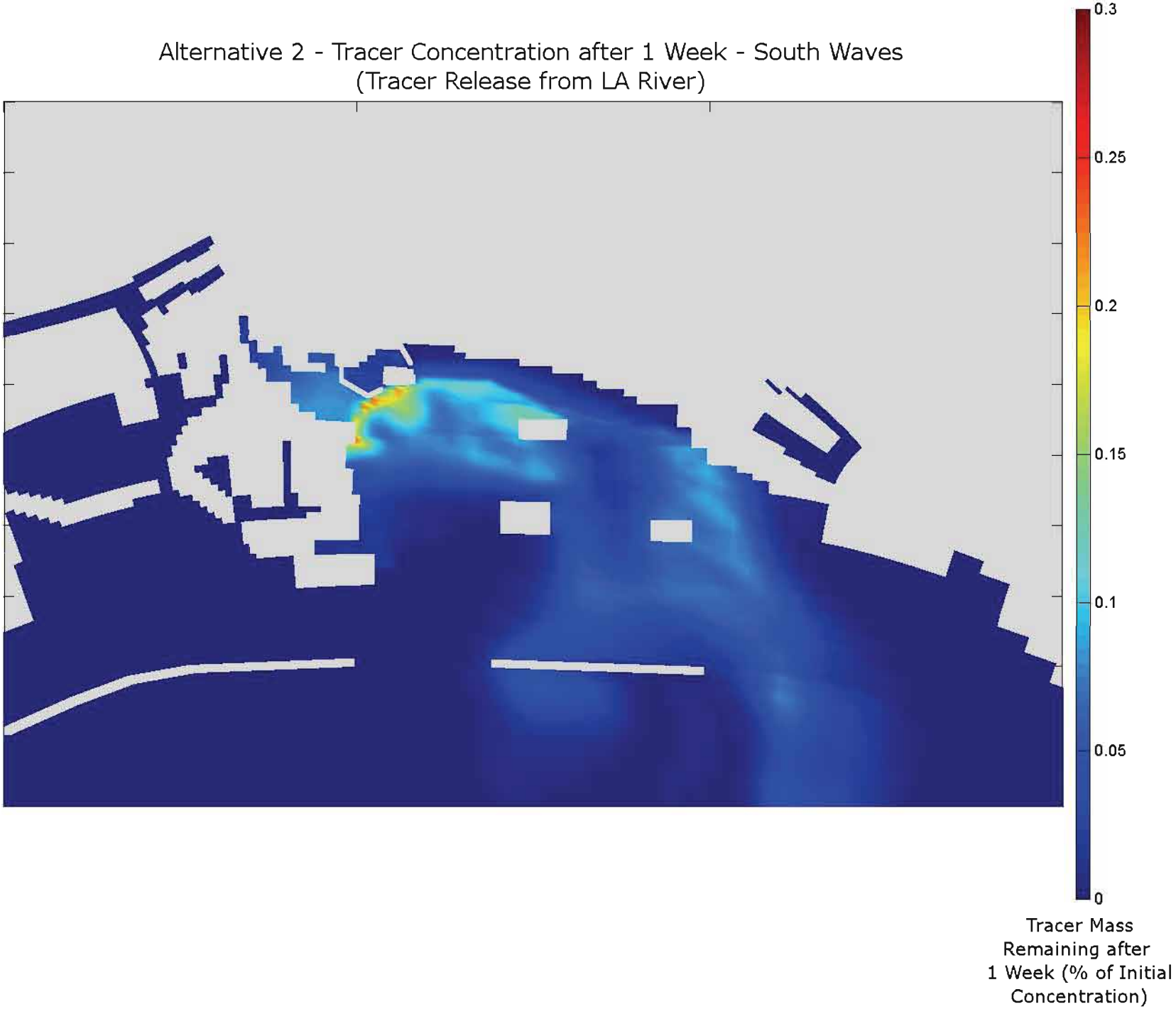
(Tracer Release from LA River)



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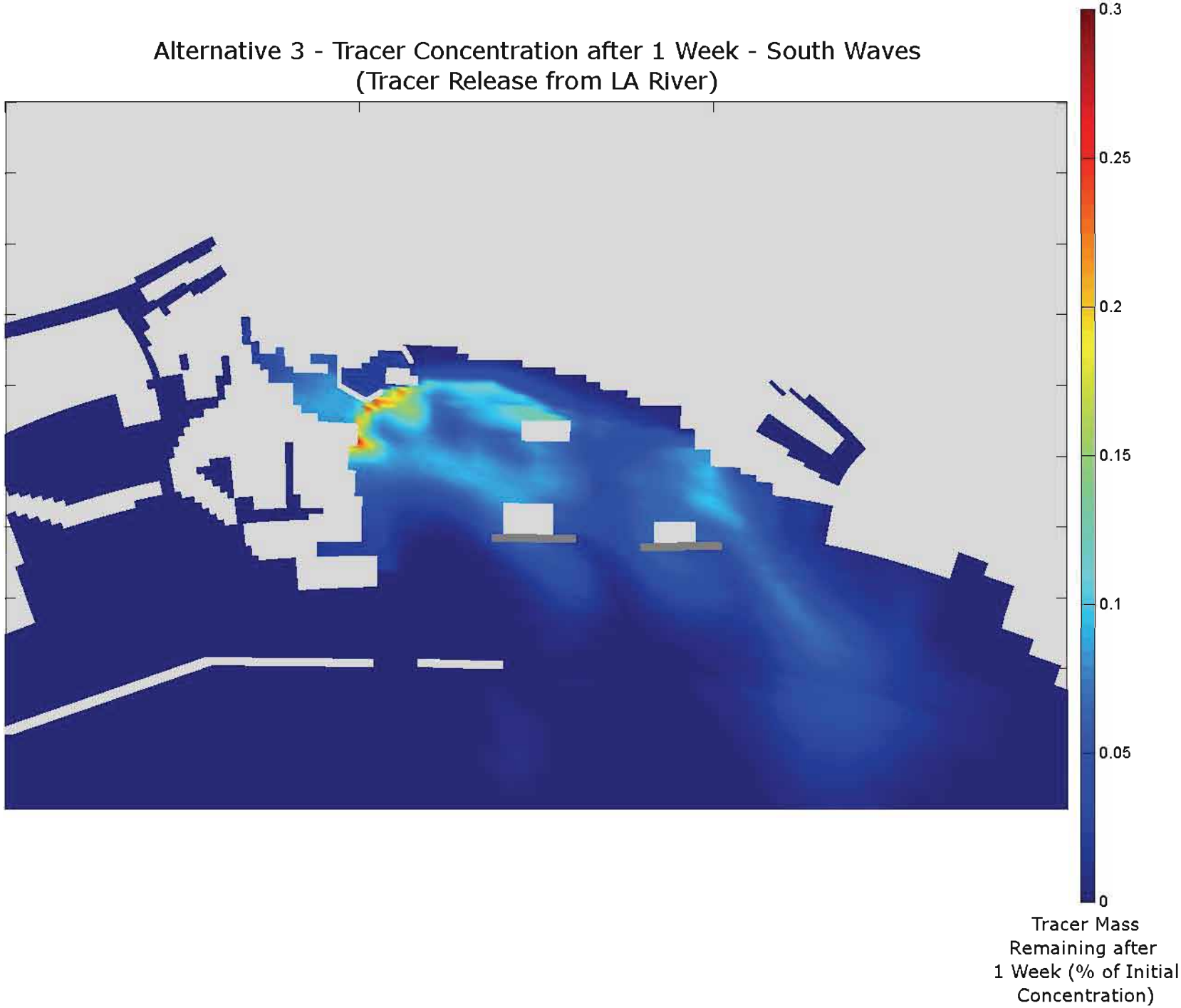
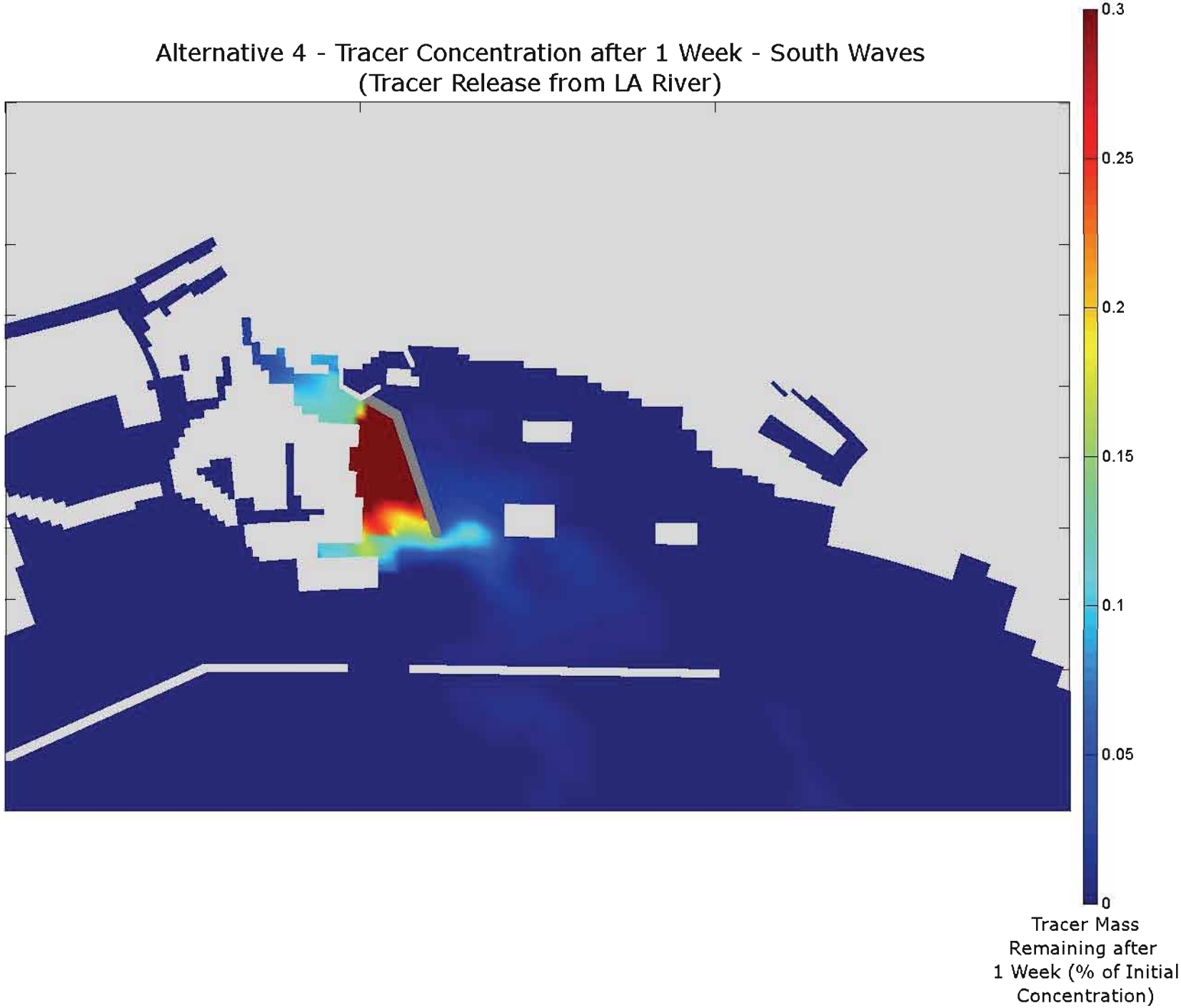
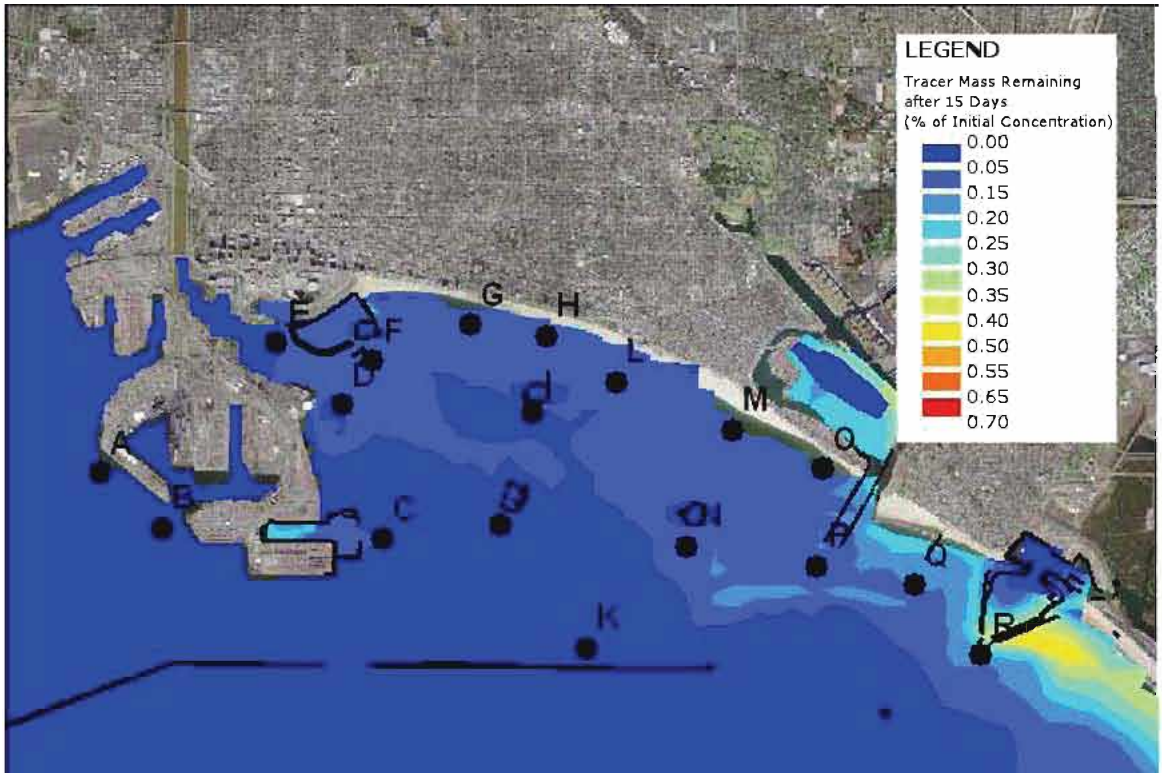
(Tracer Release from LA River)

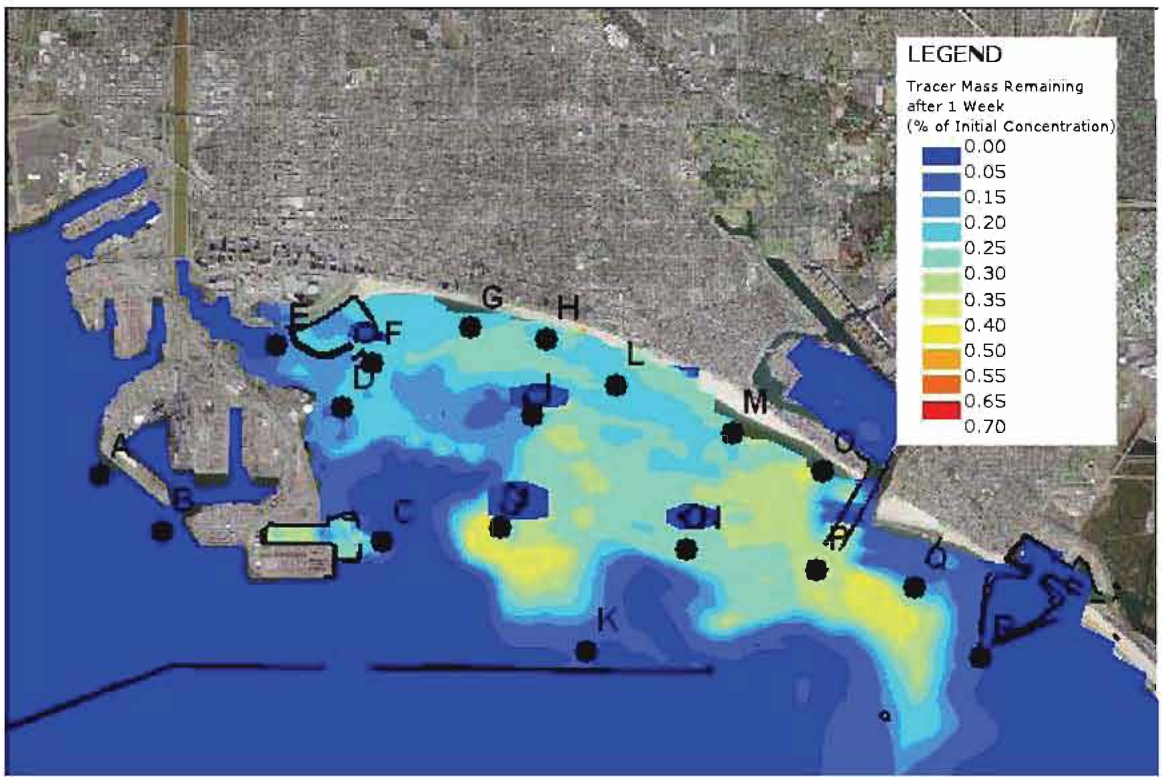


Alternative 4 - Tracer Concentration after 1 Week - South Waves
(Tracer Release from LA River)

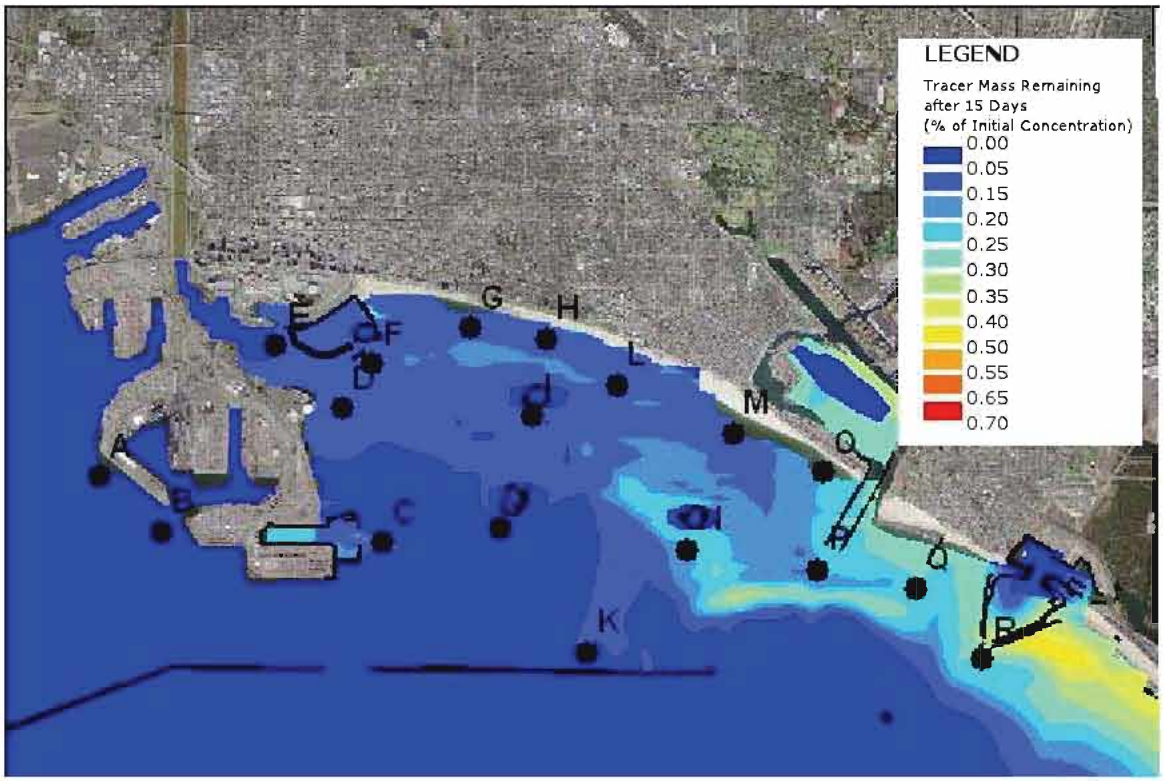




Existing Conditions - Concentrations 15 Days following Unit Initial Contamination - West Waves



Existing Conditions - Concentrations 15 Days following Unit Initial Contamination - South Waves



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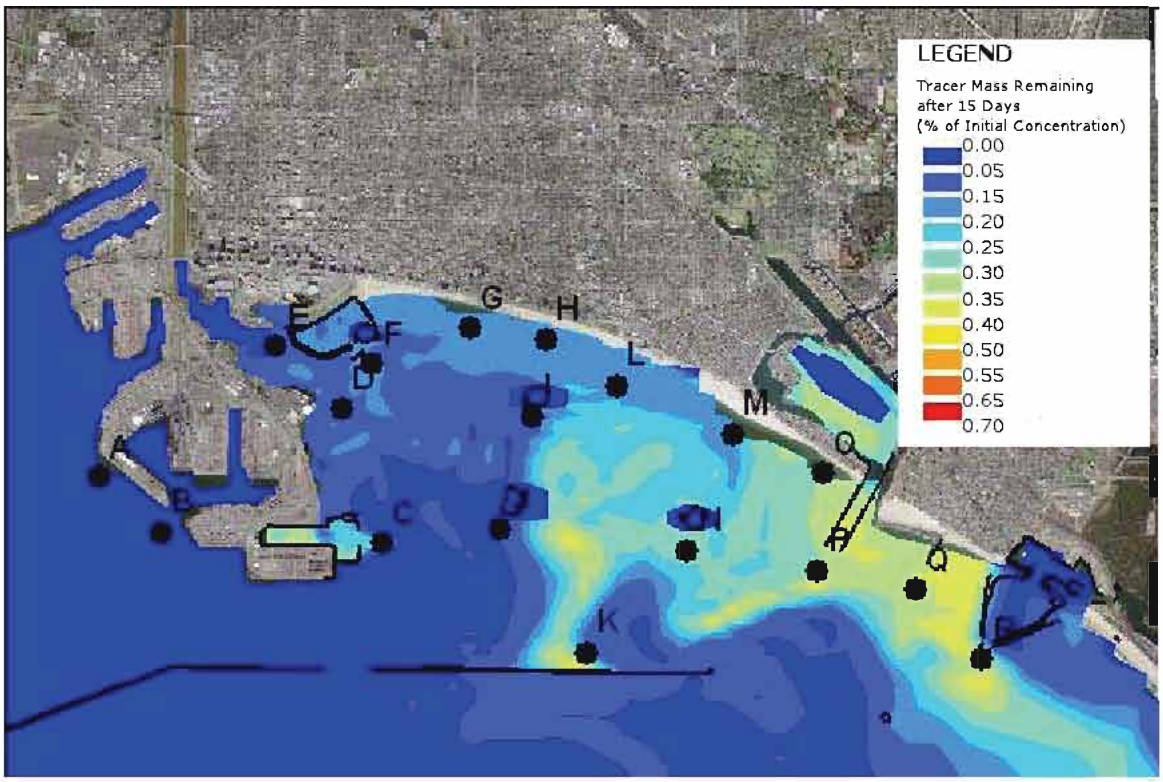
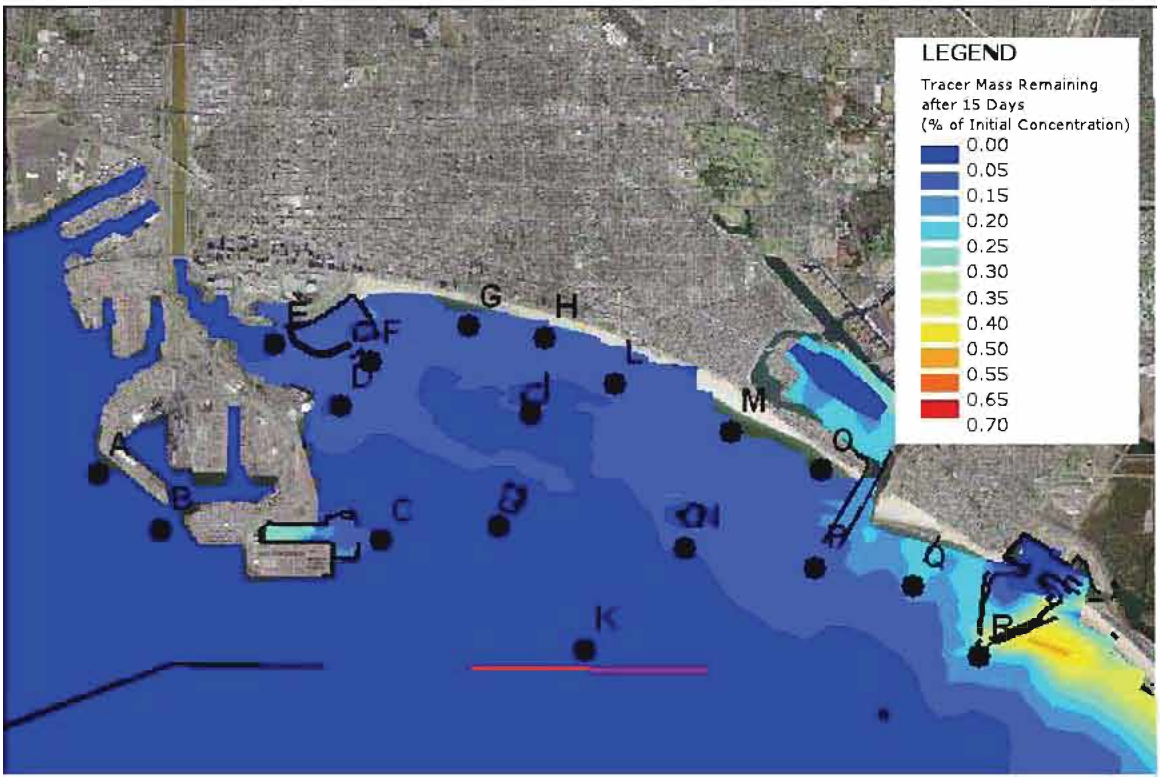


Alternative 1 - Concentrations 15 Days following Unit Initial Contamination - South Waves



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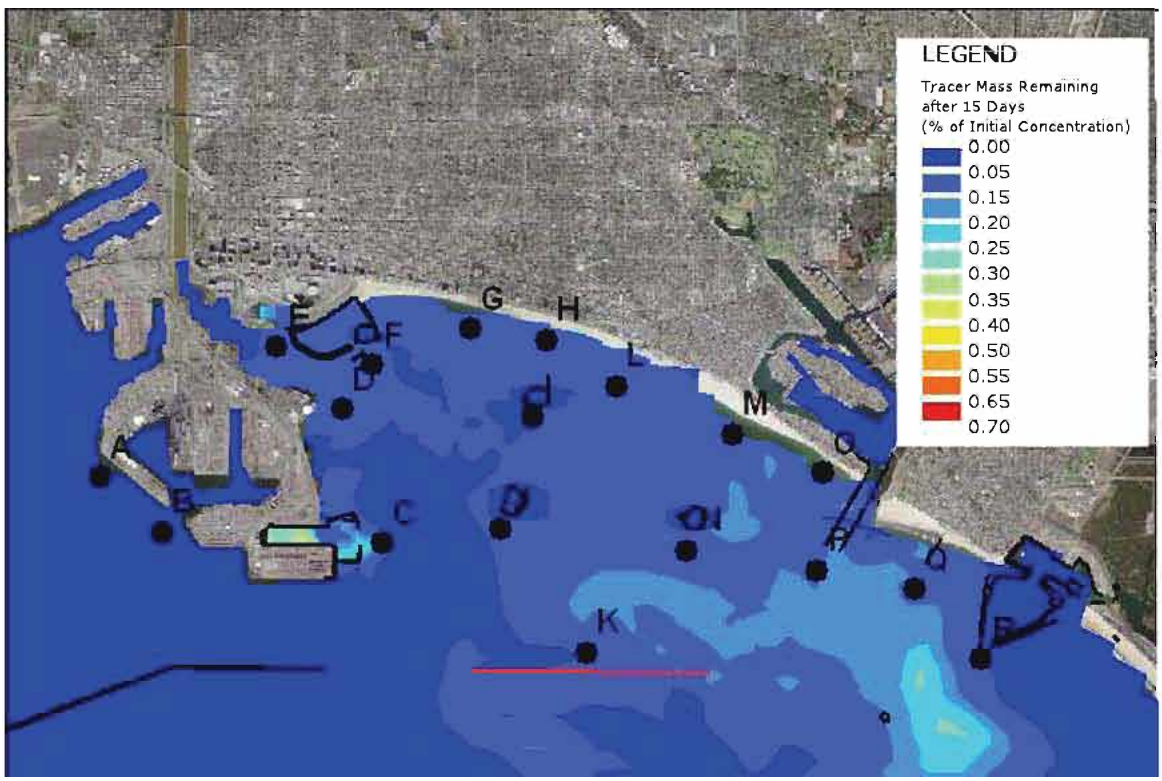
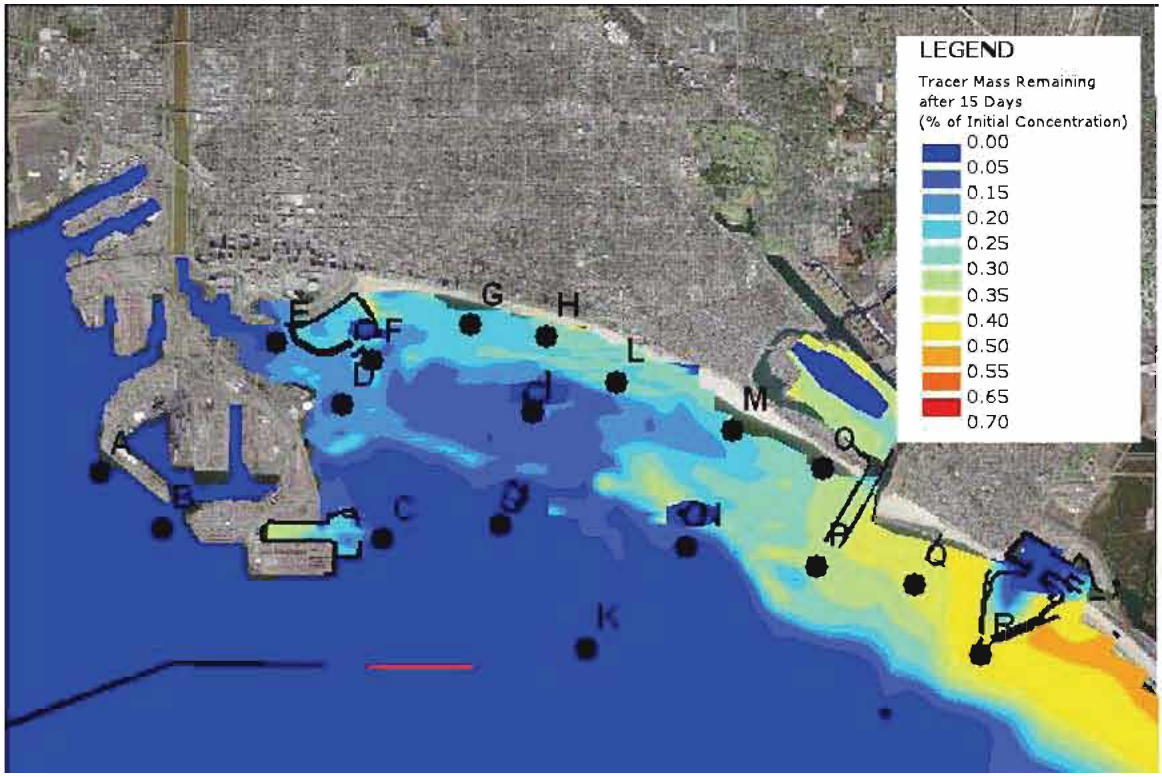
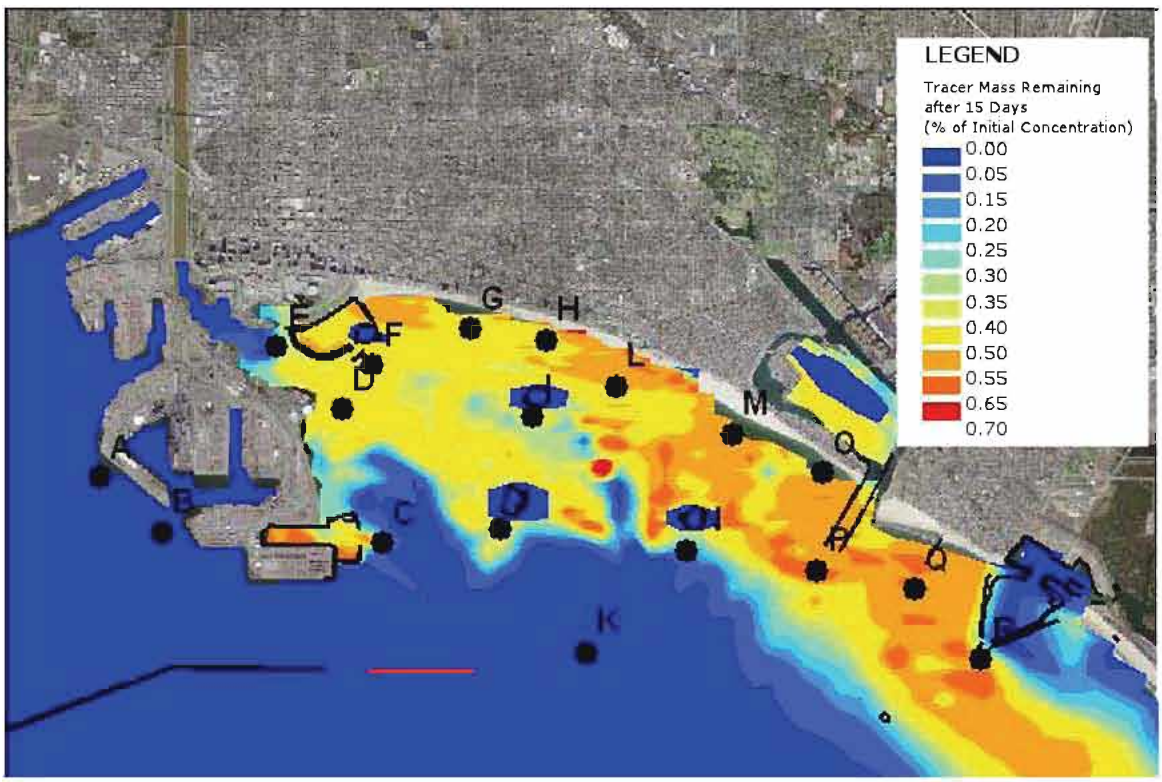


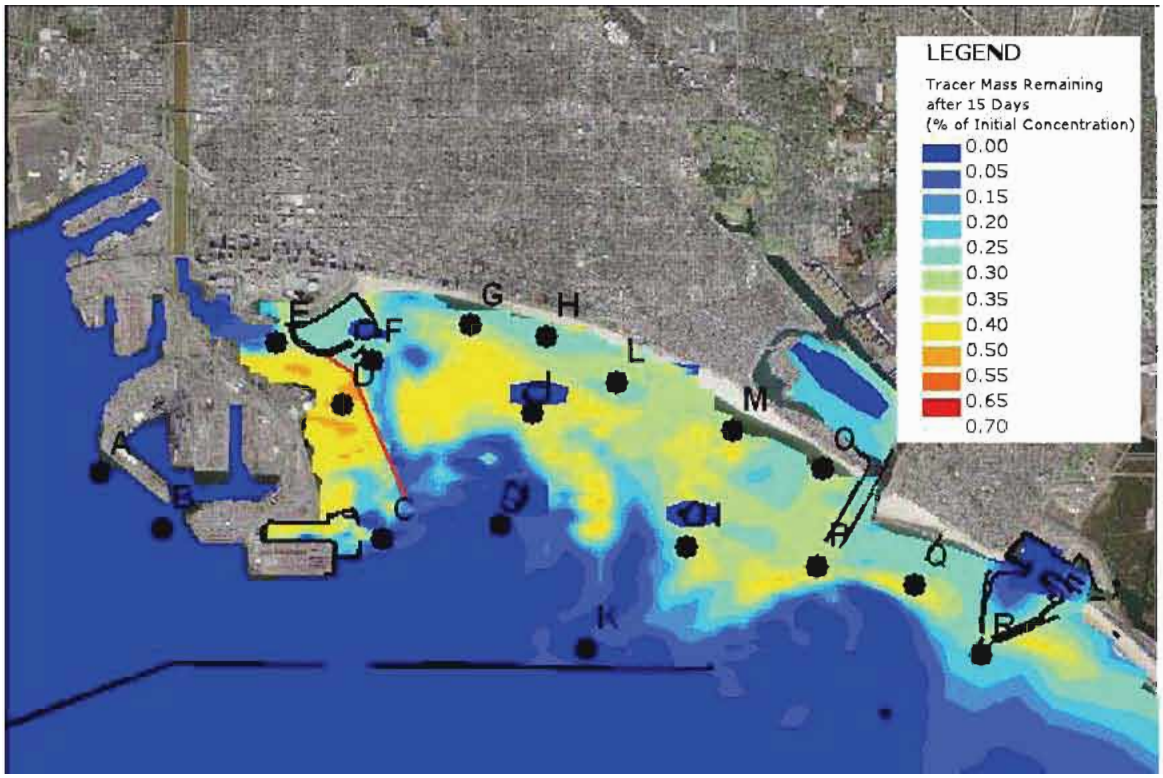
Alternative 2 - Concentrations 15 Days following Unit Initial Contamination - South Waves



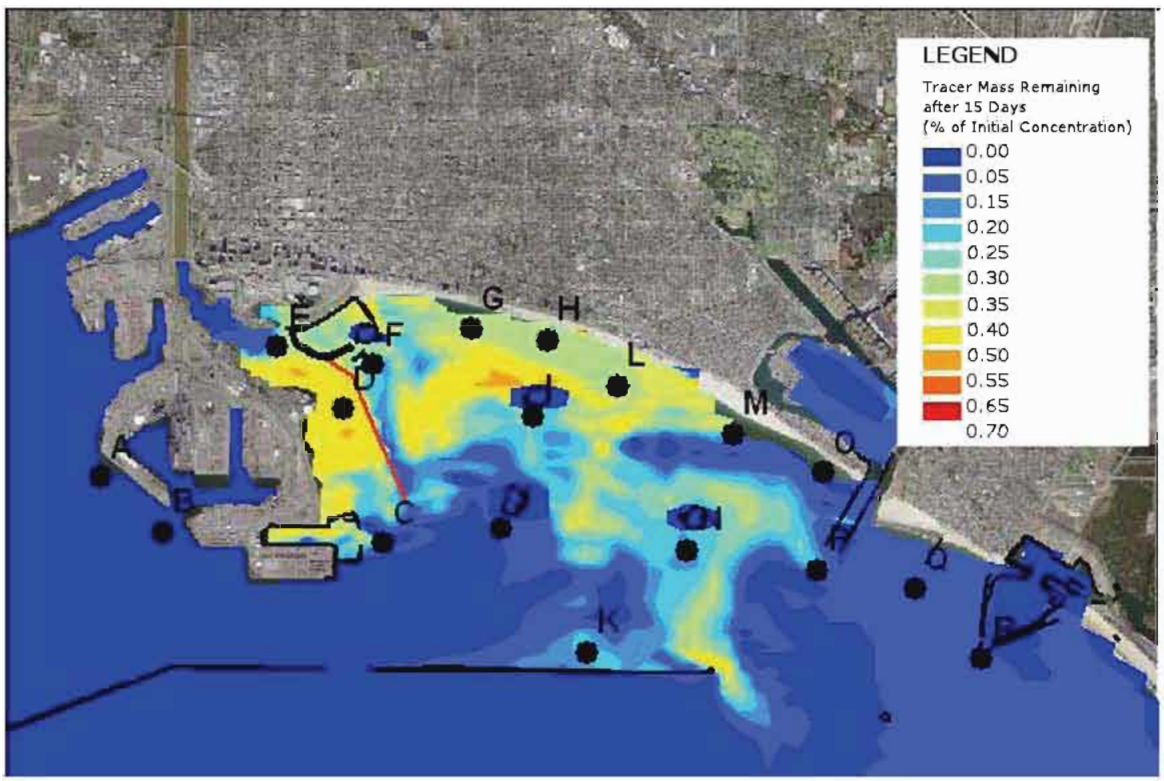
Alternative 3 - Concentrations 15 Days following Unit Initial Contamination - West Waves



Alternative 3 - Concentrations 15 Days following Unit Initial Contamination - South Waves

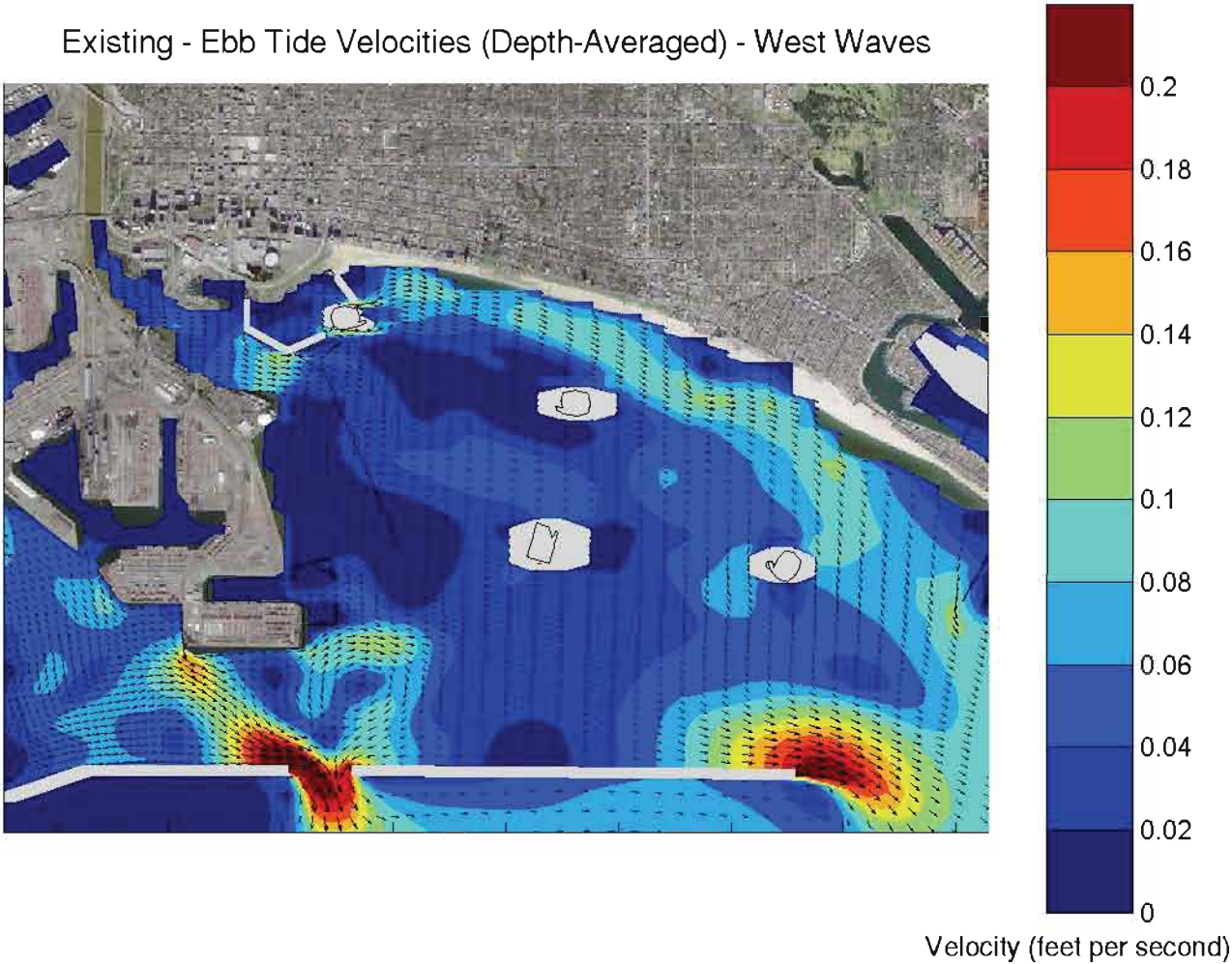


Alternative 4 - Concentrations 15 Days following Unit Initial Contamination - West Waves

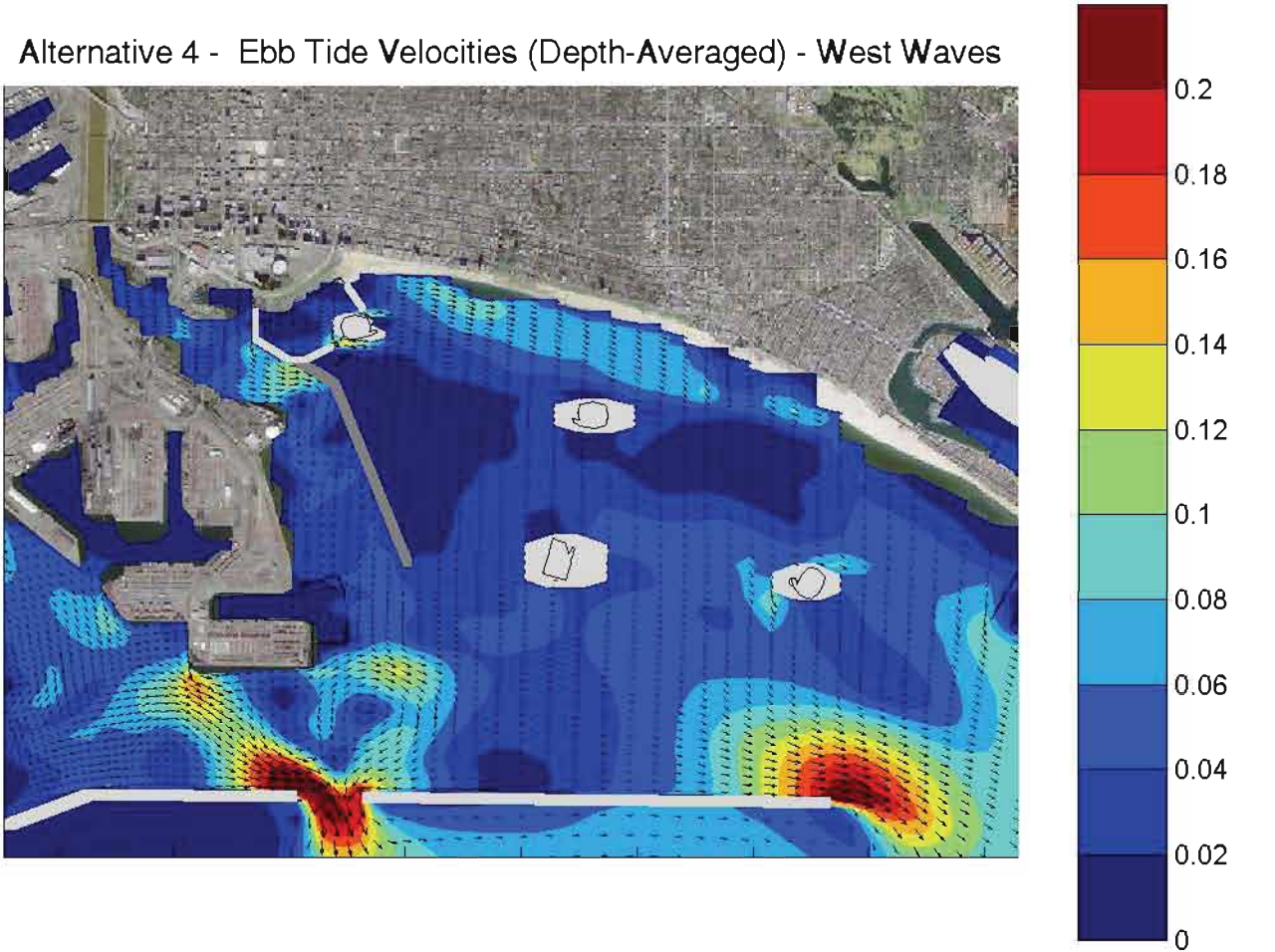


Alternative 4 - Concentrations 15 Days following Unit Initial Contamination - South Waves

Existing - Ebb Tide Velocities (Depth-Averaged) - West Waves



Alternative 4 - Ebb Tide Velocities (Depth-Averaged) - West Waves



APPENDIX F – ECONOMIC IMPACTS ANALYSIS

ECONOMIC ANALYSIS OF

RECONFIGURING THE

LONG BEACH BREAKWATER

By

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Prepared as part of a US Army Corps of Engineers 905(b)
with Moffatt & Nichol

July 2009

EXECUTIVE SUMMARY

- This paper was prepared as part of a 905(b) reconnaissance report for the City of Long Beach and the US Army Corps of Engineers to analyze the proposed reconfiguration of the Long Beach breakwater. We are a subcontractor under Moffatt and Nichol.
- Our report analyzes and provides some preliminary estimates of the recreational benefits and losses associated with the proposed reconfiguration of the breakwater at Long Beach. The report also provides estimates of State and local (City) economic impacts.
- The current breakwater configuration limits water circulation inside the San Pedro Bay adjacent to the beach. This, in conjunction with water emanating from the LA River, has lead to poor water quality at Long Beach, substantially reducing recreational value:
    - Poor water quality increases bacterial counts in Long Beach, leading to very poor water quality scores, and reducing recreational value.
    - Trash from the LA River also reduces recreational value despite City efforts to clean up this trash on the beach.
    - "Red Tide" events caused by algae also create fowl smells, poor aesthetics and, in some cases, potential health issues, reducing recreational value.
    - Reconfiguring the breakwater could mitigate all of these negative impacts, increasing recreational value.
- Reconfiguring the breakwater could also increase wave activity, increasing demand for surfing, bodyboarding and other wave activities.
- Our <u>preliminary</u> estimates, based on parking capacity, beach carrying capacity and densities at nearby beaches, indicate that, assuming a substantial increase in water quality and some wave activity:
    - An increase of beach visitation in the neighborhood of three million people per year is reasonable.
    - This increase in attendance and recreational quality will increase recreational benefits by $27.5 million per year, or $555 million (PV) over a fifty-year period.
    - For the City of Long Beach, the increase in spending is $52 million per year or just over $1 billion (PV) over 50 years. Increased beach tourism will generate $2.5 million per year in taxes and $4.3 million in parking revenues/fines. Over 50 years, this implies $52 million in taxes, $87.9 million in parking fees, totaling $140 million in revenues for the City of Long Beach.
    - Increased beach activity generates $58.6 million dollars spent in the State of California and $6.7 million dollars in taxes. Over 50 years the present value of this spending is just under $1.2 billion in spending and $136 million in taxes.
- An increase in wave activity could diminish recreational boating activity or value during periods where swells are significant, although, improved water quality, particularly the reduction in red tide events may offset some of these losses.

INTRODUCTION

The purpose of this study is to analyze and, in some cases, estimate, the most significant recreational economic benefits and losses associated with a potential reconfiguration of the breakwater at Long Beach. Recreational benefits and costs will be measured both in terms of non-market values and local economic impacts due to increased spending in Long Beach and in California. The main focus of the analysis is twofold:

1. The projected changes in recreational activity due to improved water quality. Reconfiguring the breakwater will increase the flow of water to the coast, in particular to water used by recreational bathers. Several water quality issues should be improved by reconfiguration:
    a. Improved circulation could lower coliform bacteria counts that are used by the EPA and nongovernmental organizations like Heal the Bay to rate water quality at beaches. These ratings influence the demand for beach recreation and perceptions of beach quality.
    b. Improved circulation could reduce “red tide” events that often occur in Long Beach, reducing the recreational value of the beach to swimmers and non-swimmers.
    c. Improved circulation could reduce the flow of trash that flows from the Los Angeles River to Long Beach (though this trash would be transported elsewhere). Trash substantially reduces the aesthetic value of coastal water and beach, reducing recreational value for everyone using the beach and potentially for boaters inside the breakwater as well.
2. Reconfiguring the breakwater will increase wave activity, which could significantly enhance surfing at Long Beach. It is also possible that surfing activity could improve the desirability of Long Beach to non-surfers, as friends and relatives accompany surfers and since watching surfers may enhance recreational benefits.

This section will also discuss potential impacts of breakwater reconfiguration on recreational boating, kiteboarding and other activities in the area.

ASSUMPTIONS

A 905(b) analysis does not require a full quantitative analysis or a complete analysis of every alternative and option. However, given the potential expense of this project, we thought it would be useful to present preliminary estimates of the key impacts that could be created by this project. The analysis contained below assumes a reconfiguration of the Long Beach Breakwater, which could substantially improve water quality issues inside the Breakwater. This analysis also assumes that wave activity in the two adjacent marinas could be fully mitigated and beach erosion due to increased wave action could be fully mitigated. Each of these alternatives should be considered in a full feasibility study, but not in a 905(b).

EXISTING COASTAL RECREATION STUDIES

Economic Impacts and Value for Changes in Coastal Water Quality

Few academic or government sponsored studies of recreational activities in Long Beach exist. The most relevant study is the Southern California Beach Valuation Model (SCBVM). In 2007, Leeworthy and Wiley released a report utilizing the SCBVM to predict the change in use, economic impacts and economic value for changes in water quality in the Long Beach surf zone[1] To model changes in water quality, the SCBVM employs counterfactual scenarios for changes in standardized Heal the Bay (HTB) water quality grades. Unfortunately, this study was confined to the western shoreline of Long Beach and only addressed changes in bacteriological water quality. The study did not account for the entire area that would need to be considered in this project, nor did it account for reductions in trash, "red tide" and other visible pollutants or potential increases in recreational demand associated with increased wave activity.

HTB standardizes California municipal surf zone water tests by analyzing a complex variety of shoreline bacteria levels – enterococcus, fecal coliform and total coliform. This data is published annually in the Beach Report Card, providing individuals pursuing water-based activities with coastal water quality information. The Beach Report Card provides water quality letter grades (A to F) for (1) AB 411 testing period from April to October, (2) year around dry season and (3) year around wet season. To standardize grades, HTB utilizes a geometric mean criterion to calculate scores ranging from 0 – 100 total available points. In recent years, Long Beach's coastal water quality, specifically on the shoreline west of Belmont Pier, has faired poorly in the HTB Beach Report Card. For three consecutive years, HTB has classified western potions of Long Beach's surf zone as a Top 10 California "Beach Bummer"[2] for its failure to meet defined coastal water quality standards. The widely distributed Beach Report Card invites concern for coastal locations like Long Beach when considering the difficulty of displacing environmental quality perceptions maintained by the public.

Environmental Perceptions by Coastal Users

A 1999 study conducted by the Southern California Beach Project[3] (University of Southern California) documents environmental perceptions held by Los Angeles County beachgoers. The study suggests that Los Angeles County residents often perceive the ocean as a place of contamination rather than a place for safe water-based recreation. Moreover, survey respondents'

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[1] Wiley, Peter C., Leeworthy, Vernon R., and Stone, Edward, A. 2006. Economic Impact of Beach Closures and Changes in Water Quality for Beaches in Southern California. National Oceanic and Atmospheric Administration, National Ocean Service, Management and Budget Office, Special Projects: Silver Spring, Maryland. 16pp. http://marineeconomics.noaa.gov/SCBeach/Econ_Imp.pdf.

[2] In 2006-2007, Long Beach was recognized as a "Beach Bummer" for poor water quality grades at 14 testing sites (eighty-eight percent of testing sites in Long Beach); in 2007-2008 the City of Long Beach was identified as a "Beach Bummer" for multiple testing locations west of the Belmont Pier; and in 2008-2009, testing locations at the City of Long Beach LA River outlet resulted in the classification of Long Beach as a "Beach Bummer".

[3] Martin, Nicole, Linwood Pendleton, and D.G. Webster. Public Perceptions of Environmental Quality: A Survey Study of Beach Use and Perceptions in Los Angeles County. *Marine Pollution Bulletin* Vol. 42, No. 11 pp.1155-1160, 2001.

perceptions of local water quality starkly contrasted with bacteria water quality tests collected by local municipalities. To identify the source of misguided public perceptions of coastal water quality levels, researchers concluded, "perceptions of coastal water quality may be influenced less by current coastal education campaigns and more by media and other factors" (Pendleton, Martin and Webster, 1,555).

Respondents from the Southern California Beach Project provided their perceptions of important sources of water pollution. The most frequently volunteered response was that trash was the most important source of water pollution at 43% (± 4.8), followed closely industrial waste at 41% (±4.8%).[4] Bacterial sources of contamination were thought to be less important sources of pollution than visible pollutants – trash, industrial facilities, and storm drains. This evidence is particularly relevant for the City of Long Beach. The Los Angeles River mouth displaces significant amounts of trash on the western portion of the Long Beach shoreline. The presence of trash has significantly decreased in recent years because of an aggressive campaign by the City of Long Beach, however, trash and particulates continue to be deposited on the shoreline. The combination of visible pollutants, the large-scale distribution of the HTB Beach Report Card, and numerous media outlets that have publicized Long Beach's trend of poor coastal water quality have potential welfare impacts extending beyond the western shoreline.

The Southern California Beach Project developed a master list of publicly accessible beaches in Los Angeles and Orange Counties to assist in delineating beach visits and identifying mean water quality grades reported by HTB. Creating a master list required reducing an expansive list of all identified beaches in the Los Angeles and Orange Counties study area into 53 major publicly accessible beaches. For the stretch of shoreline within the City of Long Beach's borders, the Southern California Beach Project divided Long Beach into three distinct sites: Long Beach, from the western shoreline to approximately Coronado Ave.; Belmont Shore, ranging approximately from Coronado Ave. to 55th Place; and Alamitos Peninsula, from 55th Place to 72nd Place, including accessible portions of shoreline adjacent to Bay Shore Ave. and E. Bay Shore Walk.

The study was confined to the western end of Long Beach's shoreline, adjacent to the Los Angeles River mouth. This geographic area represents 18% of the accessible beach area on the Long Beach shoreline. Belmont Shore and Alamitos Peninsula are two additional beaches along the Long Beach shoreline where HTB produces water quality grades. These two sections of beach annually record far superior water quality levels than the beach on the western shoreline. Consistently poor water quality ratings adjacent to the western portion (defined as Long Beach by the Southern California Beach Project) may have significant welfare impacts on the areas of beach defined as Belmont Shore and Alamitos Peninsula if beachgoers fail to distinguish environmental quality standards associated distinct beaches along Long Beach's 5 miles of shoreline.

Red Tide

Red tide occurs when high levels of algae accumulate in a water source. Long Beach, primarily the western portion of the surf zone and the Marina Green docks, has been the host of significant red tide events. The discoloration of coastal water and pungent smells has had visible impacts on

[4] See Pendleton, Martin and Webster, 2001.

coastal recreation in this section of Long Beach's accessible coastline. According to Long Beach lifeguards, the limited wave activity and tidal circulation can result in the blooming of phytoplankton, resulting in water discoloration (i.e., red tides) and noxious odors, both of which have the capacity to deter costal visitors.

No specific study analyzing the economic impacts of red tide events has been conducted in Long Beach. Additionally, it is important to recognize that red tides are not synonymous with harmful algae blooms (HAB). Literature associated with HAB and red tide events indicate the large negative impact these events can have on beach visitation and tourism in general, as well as other economic activities.[5] Given the numerous red tide events that have occurred near the western marinas, boat owners could potentially benefit from increased tidal circulation, minimizing the effects of red tide and HAB events.

EXISTING ATTENDANCE AND RECREATIONAL AMMENITIES

Long Beach has numerous recreational opportunities to choose from. The primary recreational activities are: swimming, walking, biking, volleyball, kiteboarding, dog walking and boating. Multiple sites for beach volleyball-use are located along Belmont Shore. Adjacent to the volleyball courts is the off-leash dog zone. Long Beach dog beach is the only dedicated legal off-leash beach area in Los Angeles County and is one of the more frequented areas of beach utilized by beachgoers.

To obtain information on attendance and the composition of beach visitors at Long Beach, preliminary beach attendance counts and in-person surveys were collected on Long Beach's beaches from July 2008 to September 2008. Long Beach beachgoers were asked what activities they would be engaging in on the beach. The most frequented response was hanging out on the beach at 92%, followed by children swimming/playing at 55%, swimming at 27%, walking at 5% and other at 25% (see Appendix A for more detailed methods of the preliminary survey).

In addition to the survey data, beach attendance counts were collected to assist in estimating high-season (June – August) attendance estimates. High season estimates are based on these counts. Extrapolated attendance estimates are consistent with attendance estimates from the Southern California Beach Project and communication with the Long Beach Lifeguard Division. Estimates of attendance at Long Beach's beaches range from 50,000 per year to 500,000. Annual estimates of 250,000 (Table 1) are deemed reasonable given the data limitations, though there is obviously a significant error band around these estimates.

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[5] For example, a preliminary analysis of the economic impacts of HAB has demonstrated significant dollar impacts for isolated and individual instances of HAB. Recent events in Massachusetts resulted in $12 to $20 million in losses, a fraction of the impacts of a 1997 outbreak of HAB in the Chesapeake Bay tributaries where it was estimated that "the direct cost was at least $43 million dollars, based solely on the decline in seafood sales. When losses to tourism, recreational fisheries, and increased costs of monitoring and analysis are factored in, the economic impacts of this event were staggering" (www.whoi.edu).
Florida's Fish and Wildlife Institution list the major societal impacts of HAB' as:

* Massive fish mortalities that the corresponding deposits on local beaches
* Closure of recreational fisheries
* Beachgoer respiratory ailments contracted from aerosolized toxins
* Unpleasant and noxious piles of macroalgae that deposits on beaches

Table 1: Estimates of Beach Attendance at Long Beach Shoreline[6]

Weekend Average	Weekday Average	High Season	Low Season	Total
3,024	1,136	175,301	79,497	254,798

Veteran Long Beach lifeguards and Marine Safety personnel were contacted to comment on previous and existing beach visitation patterns, identify noticeable changes to the Long Beach shoreline (natural and human induced) and assess if collected survey, attendance and recreational data was representative of year-to-year beach visitation and recreational patterns. Summary statistics produced from the collected preliminary survey and attendance data were presented to the lifeguards. Lifeguards interviewed thought that our data was consistent with their experience. An effort was made to directly compare data collected for this study with official data recorded by the Long Beach Lifeguard Division. Official beach attendance estimates to assess data collected in the summer of 2008 and identify annual trends in beach visitation were not available.[7] The contacted personnel estimated that Long Beach's beaches from the Shoreline Marina to Alamitos Peninsula received 500,000 annual visitors.

Over the past two decades, there has been a general decline in annual beach visitation. Reduced visitation has been documented on the western shoreline. Decreasing attendance could be the consequence of increasingly poor bacteriological water levels, onshore trash deposits from the Los Angeles River and the 1980's extension of the Port of Long Beach that reduced wave activity and tidal circulation. Lifeguards noted the displacement of recreational users after expansion of the Port of Long Beach. Before the expansion, the western surf zone was used for water-based activities dependent on wave activity (i.e., bodyboarders, skimboarders). The eastern shoreline has maintained relatively similar visitation densities, highlighted by volleyball players, dog walkers and the recent phenomenon of kiteboarding in Belmont Shore coastal waters.[8]

[6] Low season estimates were based on an average ratio for the area. See Dwight, Ryan H., Mitchell V. Brinks, Gajapathi SharavanaKumar, and Jan C. Semenza. Beach attendance and bathing rates for southern California beaches. *Ocean & Coastal Management.* 50 (2007) 847-858.

[7] Circa 2003-2004, the City of Long Beach stopped maintaining attendance records. Around this time, the city opted to change their system of collecting parking fees at their beach lots from man-operated booths to metered parking. Previously, a system of estimating beach attendance from parking receipts was in use.

[8] Information on changes in beach visitation patterns, recreational use, and costal development come from personal communiqué in the form of an in-person interview with the Long Beach Lifeguard and Marine Safety personnel on April 16th, 2009.

ESTIMATED CHANGE IN WATER- BASED RECREATIONAL DEMAND

Potential Demand for Surfing and Bodyboarding

Reconfiguration of the Long Beach Breakwater and subsequent changes in bacteriological water quality levels and wave activity can significantly alter the existing recreational demand in Long Beach's coastal waters. Measurable changes in water quality levels and wave activity will directly influence the demand for water-based recreational activities, primarily surfing and bodyboarding. Analysis of beaches within close proximity of Long Beach - Seal Beach, Bolsa Chica State Beach and Huntington City Beach and Huntington State Beach - illustrate the popularity and demand for surfing and bodyboarding as recreational activities.

Our interviews with coastal users and lifeguards indicated that surfing is a recreational activity that is synonymous with southern California's beaches. Long Beach lifeguards noted the demand for surfing as a recreational activity and indicated that non-surfers also find surfing beaches more desirable. Visitors to Long Beach have approached lifeguards asking where are the surfers. Lifeguards respond to these inquiries by directing them east to Seal Beach and Huntington Beach.

Prior to the construction of the Long Beach Breakwater, Long Beach was renowned for its high-quality surfing conditions that are characteristic of many southern California beaches. We spoke with individuals at Surfline[9] to identify the potential demand for recreational surfing in Long Beach if the Long Beach Breakwater were to be reconfigured. Surfline maintains a significant archive of prior and predictive swell models allowing one to interpolate the potential wave energy and subsequent surfing conditions that would occur in Long Beach's coastal waters if the Long Beach Breakwater was to be partially reconfigured or completely removed. Archived swell models indicate that absent the Long Beach Breakwater, surfing conditions would closely mirror, if not exceed, the existing conditions at Seal Beach, the Alamitos Bay Jetty, and Bolsa Chica State Beach and that on an average year Long Beach could expect an upwards of 400,000 surfing visits if the Long Beach Breakwater was completely removed.

Existing infrastructure (e.g., oil islands, pier), a unique bathymetry, and an expansive shoreline stretching over 5 miles from west to east, would allow Long Beach to host a variety of surfing conditions at points along the shoreline. Also unique to Long Beach is the influence of the San Pedro Hill that provides shelter to the western shoreline from characteristic afternoon winds. This feature makes Long Beach one of the few Southern California locations protected from afternoon winds, providing surfable conditions from sunrise to sunset. This attribute has the capacity to draw surfers from north and south of Long Beach and increase the window of time where surfing can be pursued as a recreational activity.

While it is difficult to measure increases in attendance due to improved water quality and waves, our preliminary analysis indicates that increases in beach attendance at Long Beach could be

[9] "Surfline is one of the largest sports sites in the world with nearly 1.5 million unique people visiting the site each month. Over the past 30 years, Surfline has helped to develop a sophisticated, proprietary system of wave forecasting - much of which is currently used in LOLA, Surfline's Global Swell Model…Surfline provides weather and forecasting services to every lifeguard agency in California, the Coast Guard, US Navy Seals, National Weather Service, numerous television and movie production companies, multiple domestic and international governmental agencies and nearly every surf company in the world." http://www.surfline.com/surfaz/surfaz.cfm?id=784

substantial. As indicated above, the current recreational amenities and access at Long Beach are quite good, comparable in many ways to beaches like Huntington Beach, which has thirty to forty times the attendance of Long Beach. It is reasonable to assume that the demand for beach attendance by citizens of Long Beach would be similar to other nearby areas. In addition, it is likely that Long Beach State would also create a significant demand for beach recreation.

We have assumed a substantial increase in water quality (reduced trash, red tide and e coli) due to the reconfiguration of the breakwater and wave activity on comparative levels to nearby Bolsa Chica State Beach and Seal Beach. Given the amenities and level of development (condos near the water, many hotels near the water) the demand for beach tourism at Long Beach should be higher than Seal Beach, Sunset Beach and Bolsa Chica State Beach. Even after the breakwater is reconfigured it is unclear if the water quality will be as good as other local beaches such as Huntington, however the gap should close substantially. Further, as discussed earlier, increased surf activity also adds to recreational amenities for non-surfers and provides a draw.

Given these factors, communication with Surfline that indicates Long Beach could draw an upwards of 1,500 surfers on days with quality surfing conditions, and the trend for surfing to grow in popularity annually, we believe that a conservative estimate of increased surfing activity is 200,000 surfer-days per year post reconfiguration.

Potential Effects on Existing Water-Based Recreational Activities

Increased wave activity and improved water quality has the potential to increase demand for water-based recreation activities like surfing and bodyboarding, yet, it is unclear how changes to wave activity could effect existing water-based recreational activities like boating and kiteboarding.

Boating is a highly visible recreational activity in the City of Long Beach. Long Beach has three marinas: Alamitos Bay Marina, Shoreline Marina, and the Rainbow Harbor Marina. These three marinas have a total capacity of 3,922 slips (Table 2) for recreational and commercial boaters. For the 2007-2008 the three marinas produced approximately $18 million in revenue through the leasing of boat slips. Further, the San Pedro Bay plays host to several annual events and major boating organizations and yacht clubs: Long Beach Marina Boat Owners Association (LMBOA); Shoreline Yacht Club; Alamitos Bay Yacht Club; Navy Yacht Club; Long Beach Yacht Club; Little Ships Fleet Yacht Club; and Seal Beach Yacht Club. These organizations, both large and small, represent a powerful interest group, whose opinions concerning the potential reconfiguration of the Long Beach Breakwater should be documented.

Table 2: Boat Slips in Long Beach

Marina	Type	Slips
Alamitos Bay Marina	Recreational	1,991
Shoreline Marina	Recreational	1,844
Rainbow Harbor Marina	Recreational-Commercial	87
Total		3,922

To incorporate the opinions of boat owners who utilize the waters in the San Pedro Bay, LMBOA was contacted to assist in providing information relevant to: the number of year-around regattas and boats in Long Beach's marinas marina; various boating and sailing events hosted in

the San Pedro Bay; and other constituent takings on the impact increased wave activity could have on boating. Board members from the LMBOA were provided with a survey instrument to distribute to their constituents, of which, has failed to be returned for analysis.

An additional group of recreational enthusiasts who could be impacted by the reconfiguration of the Long Beach Breakwater include kiteboarders who recreate in the surf zone adjacent to Belmont Shore. Representatives for the Southern California Kiteboarding Association (SCKA), a non-profit organization committed to promoting the image, safety and importance of kiteboarding in Southern California, were contacted to introduce any concerns they may have respective to potential reconfiguration scenarios. Additionally, efforts were made to contact kiteboarding businesses that provide individual and group lessons at Belmont Shore. At this point in time representatives from both the SCKA and local kiteboarding establishments have failed to respond to informational requests.

Review of coastal recreational literature and conversations with kiteboarders interviewed on Belmont Shore indicated that reconfiguration of the breakwater would not significantly reduce the current kiteboarding population utilizing the waters adjacent to Belmont Shore. Instead, increased wave levels could change the composition of users, with more intermediate and advanced kiteboarders recreating on days with sizeable wave conditions and beginners continuing to recreate when wave conditions are mild. Additional analysis and input from kiteboarders familiar with Long Beach will benefit any future analysis.

In any event, kiteboarders and boaters gain from any increases in coastal water quality. However, measuring the economic impacts of increased wave activity in coastal waters adjacent to the Long Beach shoreline is dependent on numerous factors, including the specific reconfiguration alternative selected and mitigation measures taken to reduce impacts to marina channels and within Alamitos Bay. A full analysis of these impacts should be performed in a full feasibility study but is beyond the resources and scope of this 905b study.

ESTIMATED CAPACITY FOR INCREASED RECREATIONAL ACTIVITY

Increased beach visitation and subsequent welfare impacts are contingent on Long Beach's capacity to host increased visitor densities. Preliminary survey results indicated that approximately 70% of coastal users utilize private forms of transportation to visit Long Beach's beaches (see Appendix A). Estimating the capacity for increased attendance levels was calculated by identifying the total available lot and street parking in a defined geographic range. Parameters for estimating parking capacity followed from our interviews with Long Beach lifeguards who are familiar with beach visitation patterns and maximum daily parking loads.

Table 3: Total Lot And Street Parking Spaces

Parking Type	Parking Spaces
Lot	2,005
Street	4,591
Total	6,596

Table 4: Estimated Daily Capacity Parking for Beach Use

Day Type	Beach Use Availability	Beach Use Spaces	Persons Per Vehicle	Vehicle Turnover	Daily Capacity
Weekend	20%	2,923	2.7	2.5	19,731
Weekday	30%	3,382	2.7	2.5	22,830

For our analysis, we examined all parking lots dedicated to beach use and street parking within a quarter mile radius of the beach. Given these parameters, we estimate that 2,000 beach parking lot spaces, and between 4,500 – 6,600 street spaces are available. It is important to note that street parking in neighborhoods adjacent to the beach are impacted at varying levels throughout the day. To account for existing parking demand and identify the percentage of available street parking for beach use, multiple site visits were made before and after primary commuting times. Preliminary estimates demonstrated that street parking capacity changes depending on the day (weekend vs. weekday), resulting in different capacity estimates. On weekend days, between the hours of 10:00 AM and 5:00 PM (primary beach visitation hours), a conservative estimate of 2 out of every 10 street spaces within the defined study area is available for beach patrons. On weekdays, when neighborhood residents are more likely to vacate parking spaces and commute to work, 3 out of every 10 spots within the study area were available for beach use.

For weekend days, when an estimated 20% of the 4,590 street spaces and 100% of parking lot spaces are available for beach use, there is a capacity for 4,600 cars to park within a quarter mile at a given time, and an estimated 19,700 people to visit the beach per day. Weekdays, when 30% of the 4,590 street spaces 100% of parking lot spaces are available for beach use, capacity estimates increase to 6,600 available spaces, producing a capacity estimate of 22,800 individuals per day. Our data indicates that parking capacity can support 2 million people in high season (Memorial day to Labor day). Low season demand is approximately half of high season demand and should not be influenced by parking capacity.[10]

BEACH CARRYING CAPACITY

Another way to look at beach recreational demand often used in USACE studies is to look at carrying capacity, particularly during peak days or seasons. Given the constraints of this study, a full carrying capacity analysis was not undertaken. However, the data provided below is indicative of the potential for beach recreation in Long Beach.

[10] See Dwight, Ryan H., Mitchell V. Brinks, Gajapathi SharavanaKumar, and Jan C. Semenza. Beach attendance and bathing rates for southern California beaches. *Ocean & Coastal Management.* 50 (2007) 847-858.

Table 5: Beach Area, Attendance and Density of Comparable Beaches in LA and Orange Counties[11]

Beach	Mean Width Ft.	Length Ft.	Area Sq. Ft.	Daily Carrying Capacity @ 100 sq ft/person100 Sq. Ft.	2008 Attendance & est. LB attendance	Annual Attendance/ Sq. Ft.
Huntington City	252	21,437	5,409,773	54,098	10,569,438	1.95
Seal Beach	389	7,022	2,732,941	27,329	2,200,000	0.80
Hermosa	399	8,870	3,540,872	35,409	2,146,500	0.61
Manhattan/El Segundo	666	23,443	8,027,831	80,278	4,332,900	0.54
Average						0.98
Alamitos Peninsula	206	7,286	1,503,344	15,033		
Belmont Shore	397	12,725	5,052,591	50,526		
Long Beach	199	7,867	1,563,763	15,638		
Total Reach at Long Beach			8,119,698	81,197	3,200,000	0.39

Table 5 presents data on length, average width, and total area of selected beaches in Los Angeles and Orange counties which are comparable in many ways to Long Beach. The last column divides beach area by estimates of annual beach recreation obtained from the US Lifeguard Association and Los Angeles County Beaches and Harbors, producing average annual densities per square foot. As one can see, Huntington State Beach has the highest density at 1.95 annual beach visitors per square foot and Seal Beach, Hermosa and Manhattan/El Segundo between 0.5 and 0.8 beach visitors per square foot.

For this study we assume an annual attendance rate of 3.2 million after the breakwater is reconfigured. This estimate corresponds to a density of 0.39 people per square foot per year, which is substantially lower than any of the comparable beaches and less than half of the average for this group. This is a reasonable estimate for beach attendance if water quality is significantly improved to the point where Long Beach becomes desirable again for water activities.

ECONOMIC BENEFITS AND IMPACTS

Given estimates of increased attendance, one can estimate economic benefits and impacts. To estimate economic benefits a standard procedure used by the USACE was followed, applying unit day values for beach recreation. The unit day value depends on the level of amenities at the recreation site. The USACE has a standard methodology for assigning point values, which was used here.[12]. Given the point values, a unit day value was assigned for different types of recreational activities:[13]

[11] The area for Alamitos Peninsula, Belmont Shore and Long Beach beaches is consistent with the aforementioned spatial references of these three sections of beach defined by the SCBVM and the Southern California beach Project.

[12] See US Army Corps of Engineers, Economics Guidance Memorandum, Unity Day Values for Recreation, Fiscal ear 2007: http://www.usace.army.mil/CECW/PlanningCOP/Documents/egms/egm07-03.pdf and USACE Planning Guidance Notebook: http://www.iwr.usace.army.mil/waterresources/docs_wr/11052100.pdf

[13] Since Long Beach provides a relatively low level of amenities due to trash and pollution and little opportunity water activities, we felt there was no need to separate high and low season estimates. Surfing activities are dependent upon waves more than season.

1) Current recreational value for Long Beach's beaches,

2) High season recreational value for the beach after breakwater reconfiguration,

3) Low season recreational value for the beach after breakwater reconfiguration,

4) Recreational value of surfing after breakwater reconfiguration.

Given our estimates of attendance and unit day values, the potential recreational benefits from reconfiguring the breakwater can be estimated. An expanded discussion is contained in the detailed economic report contained in Appendix C.

Table 6: Economic Benefits from Increased Beach Recreation after Breakwater Reconfiguration[14]

Recreational Activity	Unit Day Value	Estimated Visitation	Total Recreational Value	PV over Project Life (50 years)
High Season Beach Visitation (Non-surfing)	$ 8.10	2,000,000	$ 16,200,000	$ 327,017,250
Low Season Beach Visitation (Non-surfing)	$ 7.06	1,000,000	$ 7,060,000	$ 142,514,925
Surfing	$ 26.58	200,000	$ 5,316,000	$ 107,310,105
Total after Project		3,200,000	$ 28,576,000	$ 576,842,280
Current Recreational Value	$ 4.36	250,000	$ 1,090,000	$ 22,003,013
Net Project Benefit		2,950,000	27,486,000	554,839,268

Our estimates indicate that reconfiguring the breakwater would increase recreational value of the beach by $27.5 million per year (Table 6 above, bottom line, fourth column). We assume that this gain would be maintained over a fifty year period and that the present value of the benefits over a 50 year period would be equal to just under $555 million.[15]

Economic Impacts

In addition to increases in recreational value, the increase in beach tourism will also create State and local economic impacts. To estimate these impacts a study by King and Symes[16] was used to provide estimates of beach spending in southern California. In addition, the City of Long

[14] A full feasibility study should also estimate the reduction in recreation at substitute sites.

[15] A 4.625% discount rate was applied as dictated by USACE methodology. See http://www.usace.army.mil/CECW/PlanningCOP/Pages/egms.aspx.

[16] See King, Philip and Douglas Symes, *The Potential Loss in GNP and GSP From a Failure to Maintain California's Beaches*, prepared for the California Resources Agency, 2002, http://userwww.sfsu.edu/~pgking/pubpol.htm l. The study found that key factor influencing spending was whether a visitor was a day-tripper or overnight visitor. We used survey data at Long Beach to estimate the % overnight visitors.

Beach will also obtain substantially increased parking revenues from increased beach tourism which are also estimated here. The methodology for these estimates is discussed in more detail in Appendix E.

Table 7: Economic Impacts to State of California from Increased Beach Recreation[17]

Season	Overnight Spending per Person (CA)	% Overnighters	Day Tripper Spending per Person (CA)	Avg. Spending per Person	Total Spending (CA)	Taxes Generated	PV Spending	PV Taxes
Current	55.00	28%	$ 16.00	$ 19.88	$ 4,970,000	$ 571,550	$ 11,537,451	$ 11,537,451
After Reconfiguration	55.00	28%	$ 16.00	$ 19.88	$ 63,616,000	$ 7,315,840	$ 147,679,375	$147,679,375
Net Impact					$ 58,646,000	$ 6,744,290	$ 1,183,842,818	$136,141,924

Table 8: Economic Impacts to the City of Long Beach from Increased Beach Recreation[18]

Scenario/Fee	Overnight Spending per Person (Local)	% Over-nighters	Day Tripper Spending per Person (Local)	Avg. Spending per Person	Total Spending (Local)	Local Sales Tax Generated	Local TOT's Generated	Taxes/Fees Generated	PV Spending	PV Taxes
Current	50.00	28%	$ 13.20	$ 17.70	$ 4,424,000	$ 50,669	$ 168,000	$ 218,669	$ 89,303,970	$ 4,414,107
After Reconfiguration	50.00	28%	$ 13.20	$ 17.70	$ 56,627,200	$ 648,563	$ 2,150,400	$ 2,798,963	$ 1,143,090,816	$ 56,500,571
Net Spending/Taxes					$ 52,203,200	$ 597,894	$ 1,982,400	$ 2,580,294	$ 1,053,786,846	$ 52,086,464
Net Parking Fees								$ 4,354,359		$ 87,898,174
Net Impact					$ 52,203,200			$ 6,934,653	$ 1,053,786,846	$ 139,984,638

Overall, we estimate that increased beach activity will generate $58.6 million dollars spent in the State of California and $6.7 million dollars in taxes (Table 7 above). Over a fifty-year period the present value of this spending (4.625% discount rate) is just under $1.2 billion in spending and $136 million in taxes.

For the City of Long Beach, the net increase in (local) spending is $52 million per year and the present value of this spending over a fifty-year period is just over $1 billion (Table 8 above). City beach tourism will generate an estimated increase of $2.5 million per year in local taxes (transient occupancy taxes and sales taxes) and $4.3 million in increased parking revenues and fines. Over a fifty-year period, this generates a present value of $52 million in taxes, $87.9 million in parking fees, for a total of just under $140 million in revenues for the City of Long Beach. In addition, it is anticipated that beach activity would generate a significant amount of revenue from other taxes such as the utility users tax, which is not estimated here. Property taxes could also rise, especially on commercial property, but no attempt has been made to estimate this impact.

[17] Based on data from the State of California's Statistical Abstract and from the Board of Equalization, we assumed that 11.5% of state spending would translate into state taxes.

[18] All data for this analysis was taken from King and Symes, previously cited. It was assumed that the City share of sales tax is equal to 1%, even though 0.25% of this amount was recently rescinded. We anticipate the traditional 1% will be restored. Sales taxes were estimated from survey data in King and Symes for food/takeaway, sundries, beer and liquor, sit down restaurants, and gas. For food/takeaway it was assumed 75% was not subject to sales tax. For day trippers average taxable sales per day were $15.70 and $32 for overnight visitors. Hotel spending per capita was assumed to be $20 per person per day, which is very conservative; transient occupancy tax for Long Beach is 12%.

Additional Costs to the City of Long Beach

The increased attendance created by reconfiguration will also increase the City of Long Beach's expenditures on public safety and create an increased demand for public facilities, in particular bathrooms on or near the beach. (The current capacity and maintenance of bathrooms on the beach is an issue.) Estimating the full fiscal impacts of reconfiguration, which would include not only revenues and taxes generated, but also the increased costs to the City of Long Beach[19] (and possibly the State as well) is well beyond the scope of a 905b analysis. Indeed, fiscal impact studies are not common or required even in a full Corps of Engineers feasibility study, though the City of Long Beach may want to consider requesting that a fiscal impact analysis be performed as part of a feasibility study, if the reconfiguration project moves to the feasibility study stage. This study will not attempt a full fiscal impact analysis. However, we very tentatively estimate that the additional costs to the City will be on the order of several hundred thousand dollars a year, for increase lifeguard, police and other public safety staff and increased restroom facilities (assuming this is financed over time). This estimate is small in relationship to our estimates or taxes and parking revenues generated but could be considered in a full feasibility study.

ADDITIONAL ISSUES

Water Quality and Public Health

Academic and policy studies assessing the economic and ecological effects of coastal water quality primarily utilize bacteriological measures of water quality. The reasoning for this is threefold: (1) virus monitoring techniques are costly (approximately $1,000 per sample), (2) virus monitoring does not provide an accurate measure to quantify the number of viruses per a given measure of unit volume and (3) at this time, there is a deficiency of authoritative data that connects health risks associated with human water contact to levels of virus concentrations.

Finally, improvements in water quality should also lead to lower rates of water borne illness, although with the substantially increased attendance, it is quite possible that one would see an increase in such illnesses. High levels of bacterial coliform are documented to having significant economic impacts for coastal bathers.

CONCLUSION

Although it is difficult to estimate the recreational benefits and impacts of the potential reconfiguration of the breakwater (and not required in a 905b report) we have attempted to provide preliminary estimates of benefits. Our preliminary results our based on a familiarity with beaches in southern California, where Dr. King has been preparing reports for 14 years. Our estimates are also based on interviews with a number of folks who have particular expertise. Nevertheless, we do not claim that these estimates are precise or sufficient for the project to go

[19] An economic impact analysis typically estimates spending and taxes. A fiscal impact analysis typically includes all the elements of an economic impact analysis plus an estimate of increased costs to a City, State or other government.

forward, but these results would aid in the decision on whether a full feasibility study needs to be conducted.

There would be significant recreational benefits from this project. Our study indicates that over a fifty year period these benefits would be on the order of one-half billion dollars (discounted present value). The City of Long Beach would also gain substantial increases in local taxes and parking fees, likely over $100 million (discounted) over a fifty year period.

An increase in wave activity could diminish recreational boating activity or value during periods where swells are significant although the increased water quality, particularly the reduction in red tide may offset some of these losses.

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Appendix A: Attendance and Recreational Estimates

To obtain information on attendance and the composition of beach visitors at Long Beach, beach attendance counts and in-person surveys were collected on Long Beach's beaches from July 2008 to September 2008. Counts and surveys were conducted between 72nd Place in the east to Alamitos Beach in the west. Attendance counts and surveys were conducted during peak visiting periods – primarily on weekends and during the hours of 11:30 AM – 3:30 PM from July-September. It is important to note that the design of the survey as well as the frequency of data collection was intended for preliminary results to guide beach attendance and activity estimates for the reconnaissance study. Because of budget and time constraints and challenges posed by non-market valuation techniques, we do not claim that this preliminary survey will yield the same statistical accuracy as a full survey with ample controls to ensure random sampling and a larger sample size. However, efforts were made to ensure a representative sample at the time of data collection. The survey instrument and protocol are detailed below, followed by the results of the survey are provided below.

Survey Instrument and Protocol

The instrument used for this analysis was a written, mostly closed end preliminary instrument. Respondents were given a choice between filling out the survey themselves or having the surveyor read the survey to the respondent and while the surveyor filled it out. We have found that this type of survey yields an extremely high rate of response (90%) as compared to surveys where respondents are asked to mail back their responses; mail-back surveys from beaches typically yield only 33-50% response rates even after the respondent agrees to participate. Our sampling strategy minimizes the possibilities for any selection bias (and research indicates that there are serious biases that occur from this type of sample selection).

Surveys were given by a research assistant who was trained to sample randomly. Days were chosen to reflect typical beach attendance patterns (i.e., weekend days were sampled more often). The surveyor zigzagged across the beach covering the entire beach area in one day. They were instructed to survey every nth group, where n depended on the number of surveys they expected to collect that day and the density of the crowd. Surveyors were trained how to help respondents if they asked without biasing the responses. Most respondents found the survey straightforward and there were few glitches (though a significant number did not report income or other variables).

Surveyors introduced themselves by stating that they were conducting a survey for the Federal government and their response would be appreciated.

All surveyors were trained on-site and supervised. The following protocol was given to all surveyors:

1) Since you are on the beach dress accordingly, but try to look neat, friendly and professional nevertheless. If someone asks "do I get anything for the survey" you can offer them a mechanical pencil and smile.
2) Wear SUNSCREEN and bring plenty of water.
3) The survey should be RANDOM and should be a representative sample. To ensure this you should try to cover the entire beach in a day and zigzag up and down the beach choosing every nth party.

a) Your sample should also reflect attendance patterns—i.e., the number of people in the sample surveyed on weekends should be in line with attendance on weekends. As a rule of thumb about 40% of beach attendance occurs on Saturday and Sunday with heavy attendance on Friday as well, but this varies by beach.

b) Make sure you cover all parts of the beach in accordance to attendance.

c) Keep in mind the sample group is a **household**. Often one group will contain several households.

4) Before or right after surveying make sure you fill out the top part of the survey (where it says "to be completed by surveyor") with the time and date as well as who you are (nickname or initials are fine) and use a consistent number system so we can refer to each survey if we need to. The best way is to number the surveys consecutively for each beach. That way we will have a good count of how many in the sample.

a) It is possible to have several people filling out surveys at the same time; just make sure you are available for questions.

b) Never cajole respondents—they are doing us a huge favor-but politely reminding them is fine.

c) Some people like to converse, some will fill it out quickly—every respondent has a different style.

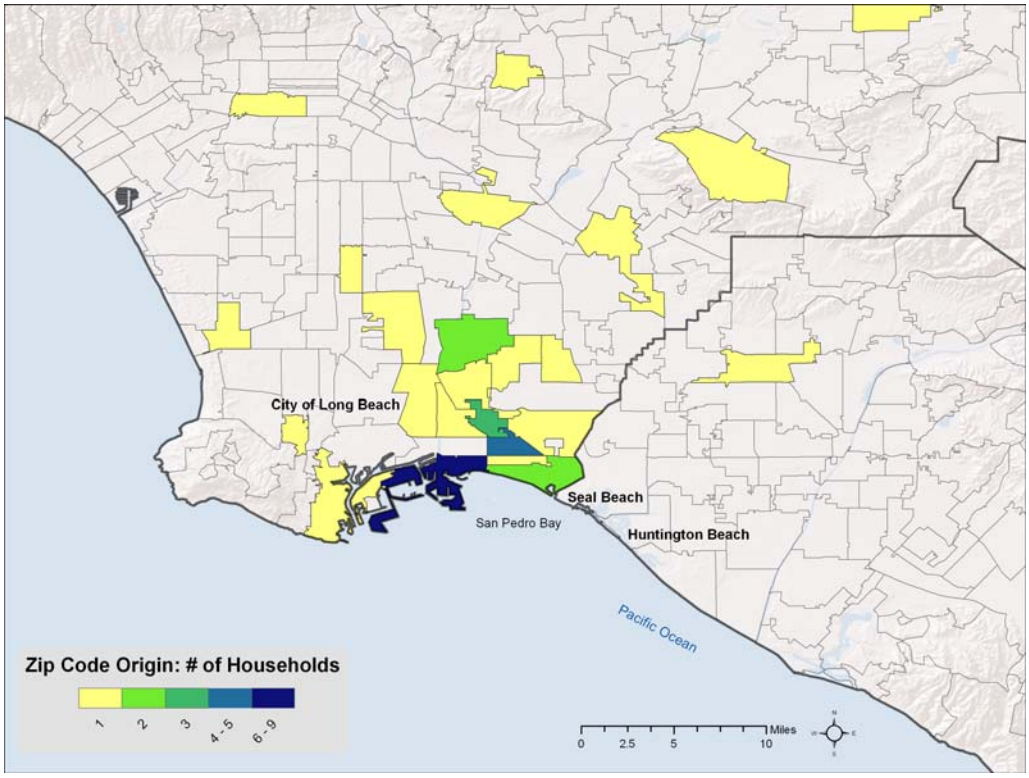
d) Often people will want to know more about the survey. You should always mention the city and the government, but don't say things like "this will help the beach" since that could bias responses. You can say this will help the Federal government make intelligent decisions.

Preliminary Survey Results

Question 1: Is your **primary** residence within the City of Long Beach?

Within the City of Long Beach	Outside the City of Long Beach
35%	65%

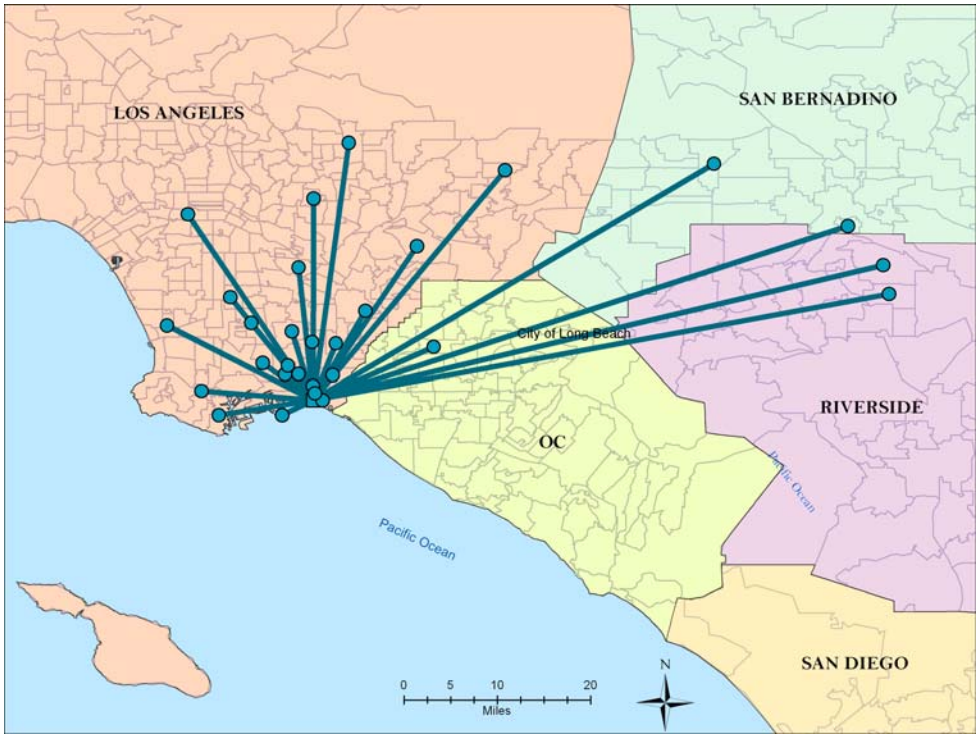
Map A.1: Number of Surveyed Households by Zip Code



Question 1a: How far from this beach is your **primary** residence?

Within 20 Miles	Within 60 Miles	More than 60 Miles, in California	In US, outside California	Outside US
49%	18%	11%	17%	5%

Map A.2: Network Analyst of Households in Four Surrounding Counties



Question 2: How many people from your **household** are with you at the beach?

Group Size	Percent
1	22%
2	28%
3	19%
4	14%
5,6	14%
7,8	2%
9,10	2%

Question 3: How did you get to the beach today?

Car	Foot	Bicycle	Other
83%	11%	1%	5%

Question 4: **If you frequent another beach more often than this beach, please list this beach and compare this alternative beach to Long Beach. Compare your overall satisfaction, including amenities available.** Do not **consider travel time.**

Worse than Long Beach **Same** **Better than Long Beach**

I----------I----------I----------I----------I----------I----------I----------I----------I

0% 25% 50% 75% 100% 125% 150% 175% 200%

Beach	Frequency	Comparison to Long Beach
Bolsa Chica	1	125%
Corona Del Mar	1	200%
Dockweiler	1	200%
Heromosa	3	150%
Huntington	19	152%
La Jolla	1	200%
Laguna Niguel	1	200%
Malibu	3	108%
Newport	4	163%
Oxnard	1	200%
Redondo	2	175%
Santa Monica	2	125%
Seal Beach	4	144%
Venice	2	100%
Long Beach	18	100%
Santa Cruz	1	100%

Question 5: Please check the most appropriate box for trip type.

Day Trip	Vacation
72%	28%

Question 6: How would you rate the quality of water at Long Beach?

High	Relatively High	Acceptable	Poor
3%	5%	61%	31%

Question 7: What activities are you engaging in on the beach today?

Swimming	Children Swimming	Surfing	Walking	Hanging Out	Other
27%	55%	0%	5%	92%	25%

Question 8: How many hours will you spend at the beach today?

Length of Time	1-2 hours	2-3 hours	3-4 hours	4-6 hours	More than 6 Hours
Frequency	14%	31%	26%	22%	7%

Table A.1: Attendance Counts [20]

Date	Time	Attendance	Beach	Volleyball	Kiteboarding	Sky	Mean Temp	Mean Wind
7/24/08	11:30-15:00	508	92%	0%	8%	Sunny	69	7 MPH
8/9/08	11:00-14:30	1288	95%	5%	0%	Sunny	72	6 MPH
8/29/08	11:30-14:30	353	95%	5%	0%	Overcast	72	5 MPH
8/30/08	11:30-14:30	725	84%	16%	0%	Sunny	73	5 MPH
9/20/08	12:30-16:00	557	87%	12%	1%	Sunny	67	4 MPH

Long Beach lifeguards and Marine Safety personnel attendance estimates of 500,000 were approximately two-times greater than estimates derived from collected survey and attendance data in the summer of 2008. One account for this variation could stem from the time of day that survey and beach counts were proctored. According to Long Beach's coastal personnel, visitation patterns at Long Beach are dissimilar to visitation patterns at a majority of southern California's beaches. Visitors to Long Beach's beaches begin arriving at 1:00 PM, resulting in a peak visitation time between 4:00 PM and 5:00 PM. This pattern of beach visitation is unusual for southern California, where beachgoers commonly arrive between 10:00 AM and 11:00 AM and peak visitation occurs between 1:00 PM and 3:00 PM. In accordance with widespread beach visitation patterns, survey and attendance counts were proctored between 11:00 AM and 3:00 PM. Collected beach counts were applied to a Los Angeles County beach visitation multiplier for the respective collection hours. The applied multipliers, which were representative of adjacent beach use, could have resulted in underestimation of high season and low season counts. However, it is important to consider that on multiple days when data was collected, special events were being held on the beach, resulting in relatively unrepresentative samples.

Prior to 2003-2004, the City projected their annual beach visitation by incorporating a standard methodology as developed by the City of Huntington Beach. Long Beach would account for daily attendance by (1) totaling the number of day-use parking receipts collected at man-operated pay booths located at the entrance of their parking lots and (2) estimating the total number of visitors who utilized adjacent non-metered street parking. Long Beach's attendance methodology was the output of the American Trader Oil Spill legal suit in Huntington Beach, which utilized beach attendance estimates to estimate to the economic impact of a hazardous oil spill and the corresponding closure of multiple Southern California beaches.

In addition to the aforementioned survey data, beach attendance counts were collected to assist in estimating high-season (June – August) attendance estimates. Initial high-season statistics were computed, resulting in a weekend day average of 3,024 beachgoers and a weekday average of 1,136 beach goers. High-season daily attendance projections were extrapolated to calculate a

[20] Weather records were extracted from http://www.wunderground.com at Lat. 33.75, Lon. -118.11, and Elev. 7ft
7/24/08 – AVP Professional Beach Volleyball tournament hosted at Alamitos Beach.
8/9/08 – Sand castle competition at Belmont Shore, between Prospect Ave. and La Verne Ave.
9/20/08 – Alamitos Beach parking lot closed for Long Beach Triathlon preparation.

high-season total of 152,436 beachgoers. Walkers and cyclists utilizing the bike path were not reported in our estimates. To account for this population of beachgoers, weekend and weekday estimates were increased by 15%[21], resulting in a total high-season count of approximately 175,000 beachgoers. Interpolative techniques were used to estimate low-season attendance at roughly 79,500 beachgoers for a annual visitation total of 254,500 beachgoers.[22] Long Beach reported a total visitation of 1,075,000 visits for 2008. This number represents beachgoers at the geographic area under investigation and at the Bay Shore beaches, which are not part of the study focus. Long Beach lifeguards believed the annual attendance estimates in the Long Beach surf zone to be approximately 500,000 visits, two-times greater than our preliminary estimates.

Surveying beachgoers provides numerous challenges. An obstacle to in-person surveying is approaching individuals participating in a recreational activity at the time survey instrument are proctored. Walking, biking, volleyball, swimming, surfing, boating and kiteboarding are some examples of recreational activities where it is difficult to intercept the beachgoer for the purpose of survey participation. To account for this obstacle, in addition to surveying, beach counts were recorded for individuals utilizing the volleyball facilities and kiteboarders in the surf zone. From the total population of beachgoers accounted for, 8% were utilizing the volleyball facilities and kiteboarders accounted for approximately 1% of the population. Relative to beachgoers, kiteboarders comprised a small amount of the total population. However, kiteboarding, like other recreational activities, is dependent on sensitive weather conditions – primarily high winds. When attendance counts were recorded corresponding to measurable wind conditions, kiteboarders accounted for over 8% of the total beachgoing population.

[21] Personal communiqué with Long Beach lifeguards alluded that the percentage of beachgoers using the bike path to be approximately 20% of the total beach population. Walkers and cyclists are two groups of beachgoers that are difficult to accurately estimate utilizing in-person surveying and recreation counts. A majority of these beachgoers utilize the bike path, which was not incorporated in this analysis because of complexities associated with double counting this population of beachgoers and the bike path relative separation from other recreational activities.

[22] Interpolative techniques to estimate low-season attendance were based on monthly beach visitation frequencies recorded by Dwight (2007).

Appendix B: Parking Capacity and Revenue

Parking capacity estimates were generated by accounting for all parking lots dedicated to beach use and street parking from the Marina Green parking lot at 500 E. Shoreline Dr., north to 800 E. First St., west to 80 Bay Shore Ave., south to 5400 E. Ocean Blvd, west to 7200 E. Ocean Blvd., and all areas bordered by E. Bay Shore Walk, E. Seaside Walk and the beachfront bike path. Parameters for street parking were developed from site reviews and conversations with Long Beach lifeguards familiar with beach use parking. Parking spaces and occupancy rates were determined by multiple site visits accounting for weekday v. weekend use and were confined to a quarter-mile radius of accessible beach. Because the neighborhoods adjacent to the beach are built on a grid, it would be fair to estimate the increased capacity offered from E. First St. to E. Second St. and everything in between. A rough estimate would be that there is an additional capacity for 5,000-7,000 individuals per day – similar to the amount of parking between E. Ocean and E. 1st First St. - if parking parameters were extended one block north.

Table B.1: Lot Parking Adjacent to Long Beach's Shoreline

Parking Lot	Hr. Rate	Operating Hours	Operator	Restrictions	Type	Spaces
Marina Green	$1.00	8 AM-6 PM, Mon-Sun	City of Long Beach	2 Hrs.	Pay Station	250
Alamitos Beach	$1.00	8 AM-6 PM, Mon-Sun	City of Long Beach	None	Meter	131
Junipero Beach	$1.00	8 AM-6 PM, Mon-Sun	City of Long Beach	None	Meter	460
Belmont Veteran Memorial Pier	$1.00	8 AM-6 PM, Mon-Sun	City of Long Beach	None	Meter	263
Granada Beach	$1.00	8 AM-6 PM, Mon-Sun	City of Long Beach	None	Meter	540
La Verne	$1.00	8 AM-6 PM, Mon-Sun	City of Long Beach	None	Meter	162
54th Place	$1.00	8 AM-6 PM, Mon-Sun	City of Long Beach	None	Meter	54
72nd Place Overflow	$1.00	8 AM-6 PM, Mon-Sun	City of Long Beach	None	Meter	50
72nd Place	$1.00	8 AM-6 PM, Mon-Sun	City of Long Beach	None	Meter	95
Total						2,005

Table B.2: Street Parking in a 400-Yard Radius of Long Beach's Shoreline

Street	Restrictions	Spaces
E. Ocean Blvd	Street Sweeping 2 Hr./week	2,424
E. Ocean Blvd - E. First St	Street Sweeping 2 Hr./week	1,548
1st Pl. - 15th Pl. Cul-De-Sacs	Street Sweeping 2 Hr./week	161
E. Seaside Walk - E. Bay Shore Walk	Street Sweeping 1 Hr./week	408
Olympic Plaza	Street Sweeping 2 Hr./week; 2 Hr. Parking	50
Total		4,591

Appropriately pricing lot and street parking can (1) generate public revenue, which can be used to maintain sidewalks, streets, restrooms, and other public facilities and (2) encourage the balance between supply and demand so not too few or too many spaces are available for patrons. Performance-based parking studies have identified an 85 percent occupancy rate as ideal to maintain revenues and allow patrons to find parking without circling lots and increasing accident related risks.[23] To estimate the potential revenue of existing City operated beach-lot parking, an 85% lot occupancy rate and a mean of 4 hours of use per day between the hours of 8:00 AM and 6:00 PM were assumed. Annual parking revenues generated from $1.00 per hour fees total approximately $2,488,205.

[23] Shoup, Donald. The Price of Parking on Great Streets. *Planetizen.* http://www.planetizen.com/node/19150.

Beyond meter revenue, municipalities can generate significant amounts of revenue, often exceeding parking meter revenue, from parking violations. Municipal revenues generated from metered parking and parking violations vary significantly. For example, in the 2000-2001 fiscal year, the nearby City of Hermosa Beach generated revenues totaling $780,000 for parking meters and approximately $828,000 from parking fines.[24] From May to October 2008-2009, neighboring City of Manhattan Beach generated $1,355,803 in revenues from parking meters and $1,102,356 from parking violations. For every $1.00 in revenue generated from parking meters in the City of Hermosa Beach, $1.06 was generated in parking violation revenue. In the City of Manhattan Beach, for every $1.00 generated in parking meter revenue $0.81 was generated in parking violations.

Given the similar coastal amenities and proximity of Long Beach to Hermosa Beach and Manhattan Beach, a conservative rate of $0.75 in parking violation revenue was estimated for every $1.00 in parking meter revenue. Applying the parking violation estimate to our estimated potential annual parking revenue results in an annual estimate of $1,866,154 in parking violation revenue for a combined annual meter and violation revenue of $4,354,359.

Table B.3: Estimated Annual Revenue from Lot Parking

Hr. Fee	Occupancy %	Occupancy Hrs.	Parking Revenue	75% Violation Revenue	Tota Annual Revenue
$1.00	85%	4	$2,488,205	$1,866,154	$4,354,359

It is important to note that a majority of the beach parking lots east of the pier are under utilized. Easily accessible fee-free street parking on Ocean Ave. encourages beach users to avoid metered lot parking when accessing the beach. Appropriately pricing existing metered parking, accompanied by increased demand for Long Beach's beaches could result in significant parking revenues. Additional analysis of parking finance strategies is suggested, including the possibility of regulating street parking adjacent to the beach.

[24] http://www.hermosabch.org/departments/cityclerk/agenmin/4a-61201.html.

Appendix C: Estimates of Recreational Benefits

Recreational Benefits were estimated using unit day values and following the procedure laid out in the U.S. Army Corps of Engineers Economic Guidance Memorandum. In particular, the Corps guidelines examine recreational values depending upon the quality of recreation, the number of substitutes available, crowding, etc. The Corps memo assigns criteria for assessing point values (Table B.1 below) and then a dollar unit day value given the point value. For more information on this methodology, please consult this memo.[25]

Table C.1: U.S. Army Corps of Engineers Point Values for Recreation

USACE Benefits Transfer Methodology	
Criteria	**Total Possible Points**
Recreation Experience	30
Availibility of Opportunity	18
Carrying Capacity	14
Accessibility	18
Environmental	20
Total	100

For the purposes of this study, we first examined current recreational amenities at Long Beach. As discussed in the main text, current recreational amenities are severely limited by poor water quality. The lack of waves also limits a number of beach recreational activities such as surfing and boogie boarding.

Table C.2: Unit Day Value of Current Recreation at Long Beach

Current Recreational Value		
Criteria	**Total Possible Points**	**Total Points Assigned**
Recreation Experience	30	3
Availibility of Opportunity	18	6
Carrying Capacity	14	5
Accessibility	18	10
Environmental	20	2
Total	100	26
Day Use Value 2007		$ 4.36

- **Recreation Experience**: The current recreational experience is very poor. Very few people swim due to poor water quality and few people lay on the beach due to the trash, though the City does collect trash deposited on the beach periodically. There is limited

[25] See US Army Corps of Engineers, Economics Guidance Memorandum, Unity Day Values for Recreation, Fiscal ear 2007: http://www.usace.army.mil/CECW/PlanningCOP/Documents/egms/egm07-03.pdf and USACE Planning Guidance Notebook: http://www.iwr.usace.army.mil/waterresources/docs_wr/11052100.pdf.

activity on the boardwalk and volleyball. The lack of waves prevents any wave activity such as boogie boarding or surfing.

- **Availability of Opportunity**: There are a number of similar recreational opportunities within 30-60 minutes depending upon traffic.
- **Carrying Capacity**: Long Beach contains the basic facilities for a beach.
- **Accessibility**: Access is good. Traffic and parking are potential impediments.
- **Environmental**: Environmental Conditions are poor, among the worst for a southern California Beach. Water quality and trash on the beach are particular concerns.

After Project Unit Day Values

For after project conditions (if the breakwater is reconfigured), we divided recreation into three categories: high season general beach use (swimming, lying on beach, walking/biking/skating on path, boogie-boarding, volleyball, etc.), low season general beach use, and surfing. We assigned separate point values for each activity as discussed below.

Table C.3: Unit Day Value of High Season General Beach Recreation after Project

Recreational Value for High Season		
Criteria	**Total Possible Points**	**Total Points Assigned**
Recreation Experience	30	22
Availibility of Opportunity	18	14
Carrying Capacity	14	11
Accessibility	18	12
Environmental	20	12
Total	100	71
Day Use Value 2007		$ 8.10

- **Recreation Experience**: The recreational experience after breakwater reconfiguration should be much better. Water quality should be improved for swimming. Wave activity would allow surfing and bodyboarding. The trash generated on the beach from the LA River should be reduced.
- **Availability of Opportunity**: Congestion is an issue here. Although there are other activities in the area, (e.g. Huntington Beach), these are at capacity on many summer days, hence the relatively high score.
- **Carrying Capacity**: This assessment assumes some improvement in facilities.
- **Accessibility**: This is the same as before.
- **Environmental**: Environmental Conditions would improve substantially due to better water quality and reduced trash.

Table C.4: Unit Day Value of Low Season General Beach Recreation after Project

Recreational Value for Low Season		
Criteria	**Total Possible Points**	**Total Points Assigned**
Recreation Experience	30	9
Availibility of Opportunity	18	9
Carrying Capacity	14	11
Accessibility	18	12
Environmental	20	12
Total	100	53
Day Use Value 2007		$ 7.06

- **Recreation Experience**: The recreational experience after breakwater reconfiguration should be better but mitigated somewhat by colder weather which limits beach activities.
- **Availability of Opportunity**: Reduced trash on beach and improved water quality imply somewhat fewer substitutes available locally.
- **Carrying Capacity**: This assessment assumes some improvement in facilities.
- **Accessibility**: This is the same as before.
- **Environmental**: Environmental Conditions would improve substantially due to better water quality and reduced trash.

Surfing

Surfing is considered a specialized recreational activity. Numerous studies assign higher values to surfing than general beach activity.[26] For this study, we used the Corps' unit day value for specialized recreation.

Table C.5: Unit Day Value of Surfing after Project

Recreational Value for Surfing (Year Round)		
Criteria	**Total Possible Points**	**Total Points Assigned**
Recreation Experience	30	19
Availibility of Opportunity	18	15
Carrying Capacity	14	12
Accessibility	18	12
Environmental	20	12
Total	100	70
Day Use Value 2007		$ 26.58

[26] For example, see Chapman and Hanemann, 2001.

- **Recreation Experience**: Note that this is for good surfing days only. Reconfiguration of the breakwater should provide adequate wave height for surfing though not as good as at some other beaches such as Huntington Beach.
- **Availability of Opportunity**: While nearby Seal Beach and Bolsa Chica State Beach have surfing, Long Beach has more parking capacity and better access for people who live in Long Beach.
- **Carrying Capacity**: This assessment assumes some improvement in facilities.
- **Accessibility**: This is the same as before.
- **Environmental**: Environmental conditions should improve substantially due to better water quality and reduced trash.

Appendix D: Economic Impact Estimates

Policy makers want to know how much economic activity is generated by beach recreation. This appendix will provide estimates of direct total spending generated at the State and local (City) levels as well as taxes generated from this spending.

Dr. King has quantified this for the State and for a number of communities in several studies.[27] The estimates used in this report are based on survey data conducted at similar beaches in southern California. Local spending is lower than State spending simply because visitors may not spend all of their dollars in town. For example, a visitor to Long Beach may drive in from Los Angeles - some of her travel expenditures will be out of the City. Local taxes generated do not include increases in property taxes generated by improvements in the beach or water quality. Adequate data does not exist to make such an estimate, but it is clear that this impact is significant and thus our estimates are conservative.

Dr. King's previous studies indicate that the primary determinant of beach spending is whether a visitor has come in for the day or is staying overnight. For a beach with the amenities of Long Beach, after reconfiguration, we estimate that, on average, overnight visitors will spend $50 per person. This figure may seem small given hotel and meal rates, however it includes people who stay with friends or relatives and is per person, not per group. We estimate that day trippers will spend on average $13.20 per day. For more information on how these numbers were derived, please see to King and Symes.[28] We also estimated the increased parking revenue. A more detailed discussion of this estimate is contained in Appendix A.

Our preliminary survey followed up by our discussions with lifeguards, indicate that currently 28% of visitors to Long Beach's beaches are on overnight trips and we have assumed, conservatively, that this proportion will not change. If the percentage of overnight visitors increase (which is quite possible as amenities improve) then the economic impacts would be larger than estimated here.

Spending per person was multiplied by estimated attendance before and after reconfiguration (250,000 and 3.2 million respectively—see main text for a discussion of how these figures were derived). State taxes were estimated as a fixed percentage of total spending as is standard in most economic impact models. We used data from the California Statistical Abstract[29] to estimate the percentage of spending that would accrue as State taxes.[30] Following the U.S. Army Corps methodology, we used a discount rate of 4.65% for all calculations of present value.

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[27] See, in particular: "The Potential Loss in GNP and GSP from a failure to Maintain California's Beaches," prepared for the California State Resources Agency, 2002, http://userwww.sfsu.edu/~pgking/pubpol.htm and "The (Economic) Benefits of California's Beaches," prepared for the California State Resources Agency, 2002.

[28] Ibid.

[29] See http://www.dof.ca.gov/HTML/FS_DATA/STAT-ABS/Statistical_Abstract.php.

[30] 11.5% of spending was assumed to go to State taxes including sales taxes, excise taxes, income taxes, etc.

Table D.1: Economic Impacts to the City of Long Beach from Increased Beach Recreation[31]

Scenario/Fee	Overnight Spending per Person (Local)	% Over-nighters	Day Tripper Spending per Person (Local)	Avg. Spending per Person	Total Spending (Local)	Local Sales Tax Generated	Local TOT's Generated	Taxes/Fees Generated	PV Spending	PV Taxes
Current	50.00	28%	$ 13.20	$ 17.70	$ 4,424,000	$ 50,669	$ 168,000	$ 218,669	$ 89,303,970	$ 4,414,107
After Reconfiguration	50.00	28%	$ 13.20	$ 17.70	$ 56,627,200	$ 648,563	$ 2,150,400	$ 2,798,963	$ 1,143,090,816	$ 56,500,571
Net Spending/Taxes					$ 52,203,200	$ 597,894	$ 1,982,400	$ 2,580,294	$ 1,053,786,846	$ 52,086,464
Net Parking Fees								$ 4,354,359		$ 87,898,174
Net Impact					$ 52,203,200			$ 6,934,653	$ 1,053,786,846	$ 139,984,638

Table D.1 above presents our estimates of the economic impacts to the City of Long Beach. For the City of Long Beach, the net increase in (local) spending is $52 million per year and the present value of this spending over a fifty-year period is just over $1 billion (Table 8 above). City beach tourism will generate an estimated increase of $2.5 million per year in local taxes (transient occupancy taxes and sales taxes) and $4.3 million in increased parking revenues and fines. Over a fifty-year period, this generates a present value of $52 million in taxes, $87.9 million in parking fees, for a total of just under $140 million in revenues for the City of Long Beach. In addition, it is anticipated that beach activity would generate a significant amount of revenue from other taxes such as the utility users tax, which is not estimated here. Property taxes could also rise, especially on commercial property, but no attempt has been made to estimate this impact.

Table D.2: Economic and Tax Revenue Impacts of Breakwater Reconfiguration to California

Season	Overnight Spending per Person (CA)	% Overnighters	Day Tripper Spending per Person (CA)	Avg. Spending per Person	Total Spending (CA)	Taxes Generated	PV Spending	PV Taxes
Current	55.00	28%	$ 16.00	$ 19.88	$ 4,970,000	$ 571,550	$ 11,537,451	$ 11,537,451
After Reconfiguration	55.00	28%	$ 16.00	$ 19.88	$ 63,616,000	$ 7,315,840	$ 147,679,375	$147,679,375
Net Impact					$ 58,646,000	$ 6,744,290	$ 1,183,842,818	$136,141,924

Table D.2 presents our estimates of the economic impacts to the State of California. Reconfiguration of the breakwater would generate $58.6 million in State spending and generate $6.7 million in taxes per year.[32] The present value of this spending over a fifty-year period is just under $1.2 billion; for State revenues the corresponding level is $136 million.

[31] All data for this analysis was taken from King and Symes, previously cited. It was assumed that the City share of sales tax is equal to 1%, even though 0.25% of this amount was recently rescinded. We anticipate the traditional 1% will be restored. Sales taxes were estimated from survey data in King and Symes for food/takeaway, sundries, beer and liquor, sit down restaurants, and gas. For food/takeaway it was assumed 75% was not subject to sales tax. For day trippers average taxable sales per day were $15.70 and $32 for overnight visitors. Hotel spending per capita was assumed to be $20 per person per day, which is very conservative; transient occupancy tax for Long Beach is 12%.

[32] Based on data from the State of California's Statistical Abstract and from the Board of Equalization, we assumed that 11.5% of state spending would translate into state taxes.

APPENDIX G – LETTER OF INTENT FROM LOCAL SPONSOR

ENCLOSURE A – PROJECT AREA MAP

San Gabriel River
Seal Beach
Long Beach
East San Pedro Bay
Long Beach Breakwater
LA River
Port of Long Beach
General Project Area
Port of Los Angeles