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COASTAL REGIONAL SEDIMENT MANAGEMENT PLAN
FOR
SOUTHERN MONTEREY BAY

Prepared for

Association of Monterey Bay Area Governments

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EXECUTIVE SUMMARY

Over the next 50 years, the coastal dunes of southern Monterey Bay between the Salinas River mouth and Wharf II in Monterey are predicted to erode at rates between 1.0 and 6.0 ft/year. Over this planning time frame, seven oceanfront facilities are at high risk due to this erosion, and will require mitigation measures to be implemented to prevent their loss. Six of these facilities; Sand City and Tioga Avenue west of Highway 1, Seaside Pump Station, Monterey Interceptor between Seaside Pump Station and Wharf II, Monterey Beach Resort, Ocean Harbor House condominiums, and Monterey La Playa town homes, are located within a three-mile stretch in the southern bight of the bay between Sand City and Monterey. The seventh facility is the Sanctuary Beach Resort, located in Marina one mile south of the only remaining beach-sand mining operation on the west coast of the U.S.

Regional sediment management (RSM) is a recognized management tool that can be used by coastal managers to reduce or potentially eliminate future shoreline erosion. This Coastal RSM Plan recommends implementation of three regional sediment management strategies for the southern Monterey Bay shoreline.

1. ***Investigate beach restoration strategies including beach nourishment to ameliorate erosion in the southern three-mile stretch of shoreline from north of Sand City to Wharf II***. Here, the majority of high risk facilities are located, and healthy beaches are particularly important for recreation and tourism. Beach nourishment is feasible in the southern bight for a number of reasons. Low wave energy, low sediment transport, and the location within a defined sub-cell (the southern three miles of southern Monterey Bay is nearly self-contained in terms of sand transport) means that any placed sediment would remain at the site for a longer period of time. This Coastal RSM Plan shows that there is clear economic justification for beach nourishment of the southern bight and it has the potential to deliver substantial benefits for the recreational value of the shoreline and for protection of its infrastructure assets. Beach nourishment may also reduce the need for ‘hard’ shore protection, and therefore provides other benefits including ecologic benefits associated with wider beaches.
2. ***Stop the beach-sand mining operation at Marina***. The large extraction of beach sand by this operation permanently removes sediment that would otherwise feed beaches elsewhere along southern Monterey Bay. If this sediment is released and subsequently transported alongshore, it could provide a significant additional buffer to dune erosion by waves. The effect would be more immediate at the Sanctuary Beach Resort critical erosion site, but would eventually benefit the shoreline further away as the sediment migrates. The Marina sand mine exists in a regulatory loophole apparently inconsistent

with the public interest. This Coastal RSM Plan recommends several potential routes that could be taken to halt beach mining activities at Marina:

- environmental impacts of erosion
- impacts to endangered species
- revisit the U.S. Army Corps of Engineers determination of non-jurisdiction
- engage the mining company to examine the possibility of an alternative mining operation
- buy-out and/or change use to resort development.

3. ***Allow dune erosion to continue without human intervention between north of Sand City and the Salinas River***. This erosion will continue to provide large quantities of sand to the beaches, maintaining their healthy condition and provide benefits for sensitive species and habitats, and recreation and tourism. Apart from the Sanctuary Beach Resort, this area does not contain any facilities at high risk of erosion.

RECOMMENDED MANAGEMENT AND POLICY CHANGES

1. Formalize the governance structure for coastal RSM projects with staff from AMBAG member agencies, including a dedicated staff member to assist the AMBAG Executive Director. In the recommended structure, AMBAG as a Joint Powers Authority would be responsible for adopting and updating this Coastal RSM Plan, and implementing regional sediment management in southern Monterey Bay. Advice and guidance on RSM issues would come from the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW), a group of local stakeholders already set-up to address coastal erosion issues. Coordination with local cities, Monterey County, and relevant agencies would be essential to secure effective implementation of projects. A regular post-Plan program of outreach should be started by AMBAG (meetings, workshops) to disseminate information and educate the public on this Coastal RSM Plan, its goals and objectives, and potential RSM activities in the region.
2. Develop a strong set back ordinance in the Land Use Plans for oceanfront development that puts high use facilities at an appropriate distance from the ocean. As part of this ordinance, consider an extended planning horizon of 100 years for large cost or long-term projects to be incorporated into revised LUP's. Relative sea level rise causes shoreline recession (landward movement) and therefore needs to be considered when formulating setback distances. Estimates of future sea level rise are being evaluated by the State of California so that planning can be consistent and effective, even though the inherent uncertainty in climate change analyses makes selection of a universal number or rate very difficult. Often, a range of relative sea level rise rates are used.

3. Work with the Chambers of Commerce in Monterey, Sand City, Seaside and Marina to establish a transient occupancy tax to provide local matches to have a better chance of obtaining state and federal funding of beach nourishment projects. The Sanctuary Beach Resort charges a $15 per night fee to occupants to fund habitat restoration on its property. Other potential local sources of funding such as real estate transfer taxes, general sales taxes attributable to sporting goods, and parking and beach-user fees should also be explored.
4. Utilize the SCOUP process to obtain an opportunistic use program permit to facilitate nourishment projects when local sediment sources become available. This SCOUP permit process will streamline the regulatory compliance process through establishment of a program for placement of opportunistic and compatible sand at pre-defined beach receiver sites with limited review from regulatory agencies.
5. Secure and develop a sediment stockpiling and sorting facility at Fort Ord to aid in implementing an opportunistic use program to facilitate the use of appropriately sized sediments should any become available from future flood control and development projects.
6. Formalize coordination with the Monterey Bay National Marine Sanctuary for joint shoreline management and coastal zone planning.
7. AMBAG should work with the County of Monterey and coastal cities to have this Coastal RSM Plan recognized (referenced) in the county general plan and LCPs.

RECOMMENDED PROJECTS FOR FEASIBILITY ANALYSIS

Studies should be initiated to investigate the feasibility of large-scale beach nourishment using sand from offshore deposits. Sediment analyses should follow the protocols in the Sand Compatibility and Opportunistic Use Program Plan (SCOUP Tier II) to assess compatibility and include assessments of the technical feasibility of both subaerial and nearshore placement in southern Monterey Bay. The projects are prioritized as follows.

1. ***Technical and environmental feasibility of sand placement in the southern bight***. This study should investigate the feasibility of placing sand (both on the beach and nearshore) between Monterey Beach Resort and Ocean Harbor House condominiums as a beach nourishment solution. Important considerations in the study should include cross-shore and longshore sediment transport processes, sand dispersal rates and distribution, and the impacts of placement on sensitive species and habitats.
2. ***Investigate other 'soft' approaches to regional sediment management in southern Monterey Bay***. This study should evaluate and assess sediment management approaches such as sand retention devices, beach dewatering techniques and pressure equalizing

modules. These approaches are to be examined by an MBNMS-funded project, complementary to this Coastal RSM Plan, under the SMBCEW umbrella.

3. ***Use of offshore shelf sand deposits***. This study should assess the feasibility of using sand from relict offshore deposits and the identification and feasibility of using active offshore sand bodies. The sand offshore from the alongshore sediment transport convergence at Sand City should be investigated.
4. ***Use of offshore sand deposits intercepted before loss to Monterey Submarine Canyon***. This study should include the feasibility of intercepting and extracting sand before it is lost to the canyon. This effort would examine the results of the recent study supported by the U.S. Army Corps Engineers. The study should also address permitting issues given that the proposed source area is part of MBNMS.
5. ***Use of dune sand at Fort Ord***. This study should assess the feasibility of using dune sand at Fort Ord to nourish the southern bight beaches. Particular consideration should be given the particle size relationships of the source and receiver sites, and the regulatory requirements of removing sand from an inland dune source.
6. ***Re-use of sand from Monterey Harbor maintenance dredging***. This study requires investigation of the quantities of compatible sand that could be made available from dredging of Monterey Harbor.
7. ***Re-use of sand from Moss Landing Harbor entrance channel maintenance dredging***. This study should focus on the feasibility of using compatible sand (particle size and contamination) from Moss Landing Harbor entrance channel. Attention should be given to the potential competition for the sand from sites that are currently being nourished using the sediment and the potential need for sediment for restoration of Elkhorn Slough.

SUMMARY OF SCIENTIFIC FINDINGS

Sediment Budget

1. Approximately 96% of the southern Monterey Bay littoral cell is undeveloped, comprising sand beaches backed by actively eroding dunes, which supply sediment to the littoral system. Less than 4% of the shoreline is armored with concrete seawalls and rock revetments.
2. Shoreline armoring and the impacts of placement loss and passive erosion are evident at Monterey Beach Resort and Ocean Harbor House condominiums. The removal of the riprap at Stilwell Hall in 2004 and subsequent erosion of the previously armored dunes to an equilibrium position parallel with adjacent shoreline segments shows the restoration potential of the beach and shoreline, as well as the difficulty associated with armoring strategies.

3. Historically, the beaches and dunes were supplied with abundant sand-size sediment from the Salinas River. This supply has been significantly reduced because of the shallowing of the river gradient due to sea-level rise, and the relatively low flow at which the river overflows its banks and deposits sediments in the flood plain.
4. The current average discharge rate of beach-size sand by the Salinas River to the beaches of the littoral cell is estimated at approximately 65,000 yd^3/year. Only 10,000 yd^3/year is estimated to move south (at least as far as the sand mining operation at Marina), and 55,000 yd^3/year is estimated to be transported north.
5. The shoreline north of the Salinas River has been accreting since 1910 when the river mouth changed position from north of Monterey Submarine Canyon to its present location south of the Canyon.
6. The dominant supply of sediment to the littoral cell is from erosion of low resistance unconsolidated coastal dunes south of the Salinas River. Rates of erosion are greatest at the former Fort Ord decreasing to the north and south, consistent with the general distribution of wave energy approaching the coast.
7. The constant supply of sediment from dune erosion has meant that the beaches within the littoral cell have been sustainable over the long term. In areas with no shoreline armoring, the dune face has translated landward whilst the beaches retained their width.
8. Average dune erosion rates during the years of drag line sand mining between 1940 and 1984 ranged from 1.0 to 6.5 ft/year, equating to a sand volume of approximately 350,000 yd^3/year to the littoral system.
9. Up to 1990, large quantities of sand were mined from the surf/swash zone using drag lines at Sand City. Three operations mined a total average of approximately 111,000 yd^3/year. Up to 1986, two similar operations at Marina removed an average of approximately 33,000 yd^3/year. This sand mining was a predominant cause of coastal erosion in southern Monterey Bay prior to 1990.
10. Between 1985 and 2005, after closure of drag line sand mining operations, but continuation of hydraulic mining at Marina, the dune erosion rates ranged from 0.5 to 4.5 ft/year, equating to a sand volume of approximately 200,000 yd^3/year.
11. In 1965, hydraulic mining of sand from a dredge pond was introduced at Marina. Between 1965 and 1990, this removed a further 105,000 yd^3/year of sand from the littoral system.
12. As other mines closed, the ongoing operation at Marina increased its extraction to 200,000 yd^3/year today. This is similar to the annual sand volume eroded from the dunes. Erosion rates at Marina increased after 1985, and are believed to be related to an increase in sand extraction at the Marina sand mine in the mid 1980s, 1990s and 21st century.
13. Erosion rates at Sand City decreased after 1985, and are believed to be related to closure of drag-line mining at three sites at Sand City between 1970 and 1990.
14. The erosion of the shoreline is highly episodic and sensitive to extreme storm events and El Niño periods. During the 1997-98 El Niño the volume of sand eroded from the bluffs was 2.4 million yd^3, a seven-fold increase from the average annual eroded volume of 350,000 yd^3 (1940-1984).

15. Future dune erosion rates along the southern Monterey Bay shoreline may increase because of predicted sea-level rise.

Sediment Transport

16. Alongshore sediment transport rates are low in southern Monterey Bay because the dominant wave crests approach near-parallel to the shoreline.
17. The net direction of alongshore sediment transport varies along the coast and is affected by disturbances such as sand mining. North of the Salinas River the net transport is to the north and lost from the littoral system into the head of Monterey Submarine Canyon. South of the Salinas River to north of Sand City there is seasonal variability in transport direction with a net transport to the south. Sediment transport from Wharf II to Sand City is to the north resulting in a convergence of sediment transport north of Sand City.
18. The total sand transport in all directions (also called gross transport to distinguish from net transport) is high owing to the exposure to north Pacific swells and storms. The gross transport is greatest in the middle of southern Monterey Bay due to the effects of Monterey Submarine Canyon on incident waves. The high gross transport results in rapid redistribution of perturbations such as sand mining and local bluff erosion. Hence, sand mining in Marina affects the entire area from the Salinas River mouth to Monterey Harbor.
19. The winter offshore transport of sediment may result in temporary loss from the beaches, which recover during the dominant onshore transport in summer. However, during large wave and storm events, sand may be transported offshore to water depths where summer waves cannot transport it back onshore as suggested by the sediment budget calculations. This means that there is potentially a net transport of sediment from the beaches to the offshore over the long-term, resulting in a loss from the beaches.

Beach Sediment Characteristics

20. There is a general trend of decreasing beach particle size (not including the shoreface) from north to south in southern Monterey Bay. Mean particle sizes are greater between the Salinas River and Fort Ord, where the wave energy is highest and smaller near Monterey Harbor where wave energy is lowest.
21. The composite particle size envelope of the beaches for two miles north of Wharf II is 0.2-0.4 mm; between this two-mile marker and Sand City the envelope is 0.4-0.8 mm, and north of Sand City the envelope increases to between 0.5 and 0.9 mm.
22. Approximately 75% of the sediment stored in the eroding dunes has particle sizes that are large enough to be retained on the beaches and of the size desired by the sand miners. The smaller sand sizes are winnowed to the offshore

Critical Areas of Erosion

23. Critical areas of erosion were assessed using the following criteria:
    a. What is at risk?
    b. What is the probability that it will be impacted by coastal erosion over a management planning horizon of 50 years?
    c. What are the consequences of loss of the facility (economic, ecologic, recreational and public safety)?
24. The application of the above criteria identified seven segments of shoreline as high to moderate-risk, high-consequence critical areas of erosion. These are (from north to south) the Sanctuary Beach Resort near Reservation Road, beach access and hazardous rubble in the vicinity of the seaward end of Tioga Avenue , Seaside Pump Station at Bay Avenue, Monterey Interceptor wastewater pipeline between Seaside Pump Station and Wharf II, Monterey Beach Resort, Ocean Harbor House condominiums, and Monterey La Playa town homes.
25. Six of the seven critical erosion areas (apart from the Sanctuary Beach Resort) are located between Sand City and Wharf II, which is defined as a three-mile long littoral sub-cell within the larger 15-mile long southern Monterey Bay littoral cell.
26. Extension to a longer planning horizon (100 years) would increase the number of critical erosion areas of concern to include portions of Highway 1 and other regional wastewater facilities as well as private development.

Critical Species and Habitat

27. The beaches and dunes of southern Monterey Bay provide habitat for numerous native animals including the threatened western snowy plover and numerous rare plants, including Yadon's wall flower Sensitive subtidal habitat is located adjacent to Monterey Harbor and comprises rocky reef, kelp forest, and eelgrass meadow.
28. Beach nourishment has the potential to adversely impact critical species and habitat through disturbance or damage as a direct impact of placement or as an indirect impact through sediment transport away from the placement site. Of particular concern is the potential impact of sedimentation and turbidity on eelgrass and kelp/rocky reef in the southern bight. Beach nourishment also has potential to improve habitat for shorebirds and other beach users and is generally considered preferable to seawalls.
29. Mitigation measures for construction should include buffer zones around kelp forest and eelgrass meadow, avoiding placement during nesting seasons for western snowy plovers, and possibly implementing smaller-scale placements at several sites to maintain connectivity of the food chain.

Potential Receiver Site and Sediment Sources

30. In order to mitigate for potential construction and post-construction impacts to critical species and habitat in the southern bight, a receiver site for both subaerial or nearshore sand nourishment is recommended between the Monterey Beach Resort and the Ocean Harbor House condominiums. This location would allow dispersal of sand through gross alongshore sediment transport to feed critical areas of erosion to the north and south.
31. Four potential sediment sources recommended for further investigation are in coastal and offshore locations. These are Moss Landing Harbor entrance channel, Monterey Harbor, north and south of the Monterey Submarine Canyon, and the offshore shelf (particularly near Sand City). The two harbors would provide limited volumes of sand for nourishment and it would be necessary to supplement with sand from other sources. In contrast, both Monterey Submarine Canyon and the offshore shelf can potentially provide large (millions of yd^3) repositories of sand.
32. These potential sources appear to be physically compatible with the potential receiver sites and relatively clean and free from pollutants, because they contain sediment that has been transported and reworked along and across the beaches, shoreface and offshore in southern Monterey Bay.
33. The coastal dune field of Fort Ord represents a fifth recommended source of sand for beach nourishment. The sand in these dunes was originally derived from the beach, and could provide large quantities of sand compatible with the beaches of the southern bight.
34. Although no upland sources of beach quality sediment were identified, this Coastal RSM Plan recommends continued evaluation of any potential sources for smaller maintenance-style nourishment projects such as development projects at Fort Ord, river dredging, and CalTrans maintenance projects. Sediment trapped behind dams is not considered a priority source at this time owing to the distance and trucking impacts, which do not compare favorably with offshore sand sources.

Economics of Beach Nourishment

35. Beach nourishment of the southern bight has a positive benefit-cost ratio and has the potential to deliver substantial benefits to its recreational value, through increase in beach width, and protection of the many valuable assets located along this shoreline.
36. Sand offshore from Sand City is the most cost-effective source due to it's proximity to the southern bight receiver site.

Regulatory Processes

37. Potential beach nourishment projects in southern Monterey Bay would have to have regulatory compliance at federal, state, and local level.
38. The issuing of federal permits for beach nourishment is the responsibility of the U.S. Army Corps of Engineers and National Oceanic and Atmospheric Administration

(because of the Monterey Bay National Marine Sanctuary), with input from resource agencies such as U.S. Fish and Wildlife Service (endangered terrestrial species), National Marine Fisheries Service (endangered aquatic species), and the U.S. Minerals Management Service (public mineral resources).

39. State permits would need to be obtained from the California Coastal Commission, California State Lands Commission, and State Water Resources Control Board/Regional Water Quality Control Board, with input from resource agencies such as California Department of Fish and Game, and California Department of Parks and Recreation.
40. At a local level, the Cities of Marina and Sand City, and the County of Monterey have Local Coastal Programs (LCPs) certified by the Coastal Commission. The Cities of Seaside and Monterey have certified LUPs but do not have approved LCPs. Beach nourishment projects along the shorelines with certified LCPs would require a Coastal Development Permit issued by that jurisdiction.

Recommended Projects to Fill Sediment Budget and Critical Species and Habitat Data Gaps

1. Undertake a regional particle size assessment to:
    a. determine the littoral cell cut-off diameter and envelope of particle sizes for each sub-cell to better judge beach nourishment needs and compatibility of source sediments
    b. investigate sediment particle sizes of potential source areas necessary for SCOUP Tier II protocols and permitting
    c. examine the relationship between the particle size distributions of the dunes, beaches and shoreface to provide a better appreciation of the sediment retention in the littoral zone.
2. Use divers to survey the present-day distribution of nearshore kelp forest and eelgrass meadow in the southern bight to assess potential impacts of beach nourishment.
3. Establish the extent of species and habitats in the potential offshore borrow areas to assess the impacts on these communities of sediment extraction. The investigations will include locating the limits of reef, eel grass, and kelp. Investigation of beach and upland flora and fauna may also be needed although it appears there is sufficient data to evaluate these for environmental review, until more details are needed for the permit process for a particular beach nourishment activity (project).

FUNDING CREDIT AND DISCLAIMER

Funding for this project was provided by a California Department of Boating and Waterways grant as part of CSMWs efforts related to implementation of their Coastal Sediment Master Plan.
Recommendations are presented in this report solely for consideration by government agencies,

organizations, and committees involved in the management and protection of coastal resources in southern Monterey Bay. Finally, this document was prepared with significant input from CSMW members but does not necessarily represent the official position of any CSMW member agency.

1. INTRODUCTION

1.1 REGIONAL SEDIMENT MANAGEMENT

For social, recreational, economic, and environmental reasons, the coast of southern Monterey Bay is among the region's most prized natural resources. The beaches offer recreational activities and economic opportunities to Monterey Bay residents and visitors; they afford a natural barrier that protects the shoreline during storm events; they provide habitat for numerous shorebirds, including critical habitats for threatened or endangered species; and they are desirable places to live near, increasing property values and revenue for the community. Due to a persistent rise in sea level, changes in sand availability, and previous unsustainable public and private development practices, the southern Monterey Bay coastal dunes south of the Salinas River are eroding, on average, at the fastest rate in California (Hapke et al., 2006). Erosion compromises the ability of the dunes and beaches to buffer the oceanfront development and infrastructure from storms and flooding, to provide vital natural habitat, and to successfully accommodate recreation and tourism.

Along the California coast, state, federal, and local agencies are now attempting to address sediment supply and coastal erosion problems caused by human modification through Regional Sediment Management (RSM). RSM solves sediment-related problems by designing solutions that fit within a regional framework. RSM recognizes that sediment is a resource integral to economic and environmental vitality of coastal beaches, and sustainability can be achieved through beneficial reuse of littoral, estuarine, and river sediments. RSM in California is being facilitated through the California Coastal Sediment Master Plan (Sediment Master Plan) administered by the California Sediment Management Workgroup (CSMW).

Regional Sediment Management is a collaborative effort between federal, state, and local agencies, and non-governmental organizations to evaluate California's coastal sediment management needs on a regional basis (CSMW, 2006).
More information is available on the CSMW web-site (http://www.dbw.ca.gov/CSMW)

1.1.1 Southern Monterey Bay Coastal Regional Sediment Management Plan

The Association of Monterey Bay Area Governments (AMBAG) retained a team led by Philip Williams & Associates (PWA) to develop this Coastal Regional Sediment Management Plan

(Coastal RSM Plan) for southern Monterey Bay. The objective of the Coastal RSM Plan is to provide consensus-driven management and policy recommendations on ways to reduce shoreline erosion and restore and maintain coastal beaches through implementation of regional sediment management and beneficial re-use of sediment. Other potential solutions that don't involve beneficial reuse of sediment are being evaluated as part of the complementary effort by SMBCEW (see below).

The technical basis for the Plan is an understanding of the local sediment and coastal processes, erosion rates, and sediment budget. Using these data in combination with economic, environmental, and societal considerations, critical areas of erosion are identified, critical species and habitat are delineated, and recommendations are proposed for RSM. These recommendations are meant to inform the local decision making process to help maintain the beaches of southern Monterey Bay and other critical areas of sediment deficit, in order to sustain recreation and tourism, enhance public safety and access, and restore coastal sandy habitats. Other parts of this Coastal RSM Plan explore:

- economic benefits and costs of RSM in southern Monterey Bay
- permits required for planning and implementing RSM, and how to proceed through environmental review and regulatory compliance
- potential sources of funding for costs associated with managing sediment
- governance structure(s) applicable to southern Monterey Bay

This Coastal RSM Plan has been produced within the framework of the Sediment Master Plan (CSMW, 2006). Funding was provided by the California Department of Boating and Waterways (CDBW) on behalf of CSMW. In addition to the Plan's focus on how regional sediment management can help address coastal erosion problems within the region, it should also provide the benefit of enhancing the southern Monterey Bay region's ability to compete for limited state and federal funding for erosion control projects that involve sediment management. Both CDBW and the U.S. Corps of Engineers (major funding sources) are committed to regional sediment management, and may likely base future allocations of limited funding on whether a proposed project aligns with an approved Coastal RSM Plan.

This Coastal RSM Plan was also developed in close collaboration with the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW). The SMBCEW was initiated in 2005 by the Monterey Bay National Marine Sanctuary (MBNMS), in collaboration with state and local partners, as part of a process to update the Sanctuary's Management Plan. The SMBCEW was established to address the issues of shoreline erosion and armoring in southern Monterey Bay and to develop a regional planning approach. The goals of the SMBCEW are:

- compile and analyze existing information on coastal erosion rates and threats to private and public facilities within southern Monterey Bay
- identify and assess the range of options available for responding to coastal erosion

- develop a regional shoreline preservation, restoration, and management plan for responding to coastal erosion that minimizes environmental and socioeconomic impacts.

Since its inception the SMBCEW has completed several projects that feed into the RSM process and have been integrated into this Coastal RSM Plan. The results include information on critical areas of erosion (SMBCEW, 2006b), regulatory and policy considerations (SMBCEW, 2007a), and funding opportunities (SMBCEW, 2007b). It is anticipated that the SMBCEW would serve as a technical advisory committee to AMBAG in the proposed governance structure for implementation of this Plan.

These two efforts (Coastal RSM Plan and SMBCEW) are intended to be individual, yet complementary, components of a larger integrated approach for addressing sediment management and coastal erosion in the southern Monterey Bay region. The Monterey Bay National Marine Sanctuary is also funding a technical evaluation of alternative approaches to addressing coastal erosion in the region (i.e. those that have not been addressed in the Coastal RSM Plan process). This project will also be carried out under the direction of AMBAG and the SMBCEW. This Coastal RSM Plan provides a subset of solutions that the SMBCEW can then incorporate into an overall assessment of solutions to coastal erosion that works best for stakeholders within the southern Monterey Bay littoral cell, and provide a vehicle to enhance the region's ability to compete for limited state and federal funding for erosion control projects.

The retreat of the southern Monterey Bay shoreline creates complex management problems; property owners want to protect their homes and businesses, municipalities want to protect their tax base and infrastructure, sand mine owners want to continue to remove sand and generate income, environmental groups want to preserve habitat and minimize damage to the dunes and beaches, and resource managers want to balance public access and habitat protection. These broader shoreline management and coastal zone management challenges are beyond the scope of this Coastal RSM Plan, which focuses primarily on sand management and mitigation of shoreline erosion. Hence the Plan could be considered a component of the larger shoreline and coastal zone management efforts, including Land Use Plans, Local Coastal Programs, and the MBNMS Draft Management Plan.

This written Plan is one of three main deliverables. The other two are a searchable database of references relevant to southern Monterey Bay, and a set of GIS data files to complement the information provided here. The database and GIS data files are accessible on the CSMW web-site (http://www.dbw.ca.gov/CSMW).

1.2 GEOMORPHOLOGY

Monterey Bay is a lowland coastal embayment, bounded by resistant rock headlands at its north (Santa Cruz) and south (Monterey) ends (Figures 1 and 2). The shoreline between the Salinas

River mouth and Wharf II breakwater in Monterey is mainly composed of wide sandy beaches backed by relict (approximately 5,000 to 3,000 years old) sand dunes up to five miles wide and 150 feet high (Griggs and Patsch, 2005; Smith et al., 2005; Thornton et al., 2006). The sand dunes, referred to as the Flandrian and pre-Flandrian dunes, were deposited during the Quaternary. The seaward face of the dunes is an eroding bluff (Figure 3).

Figure 1. Location Map

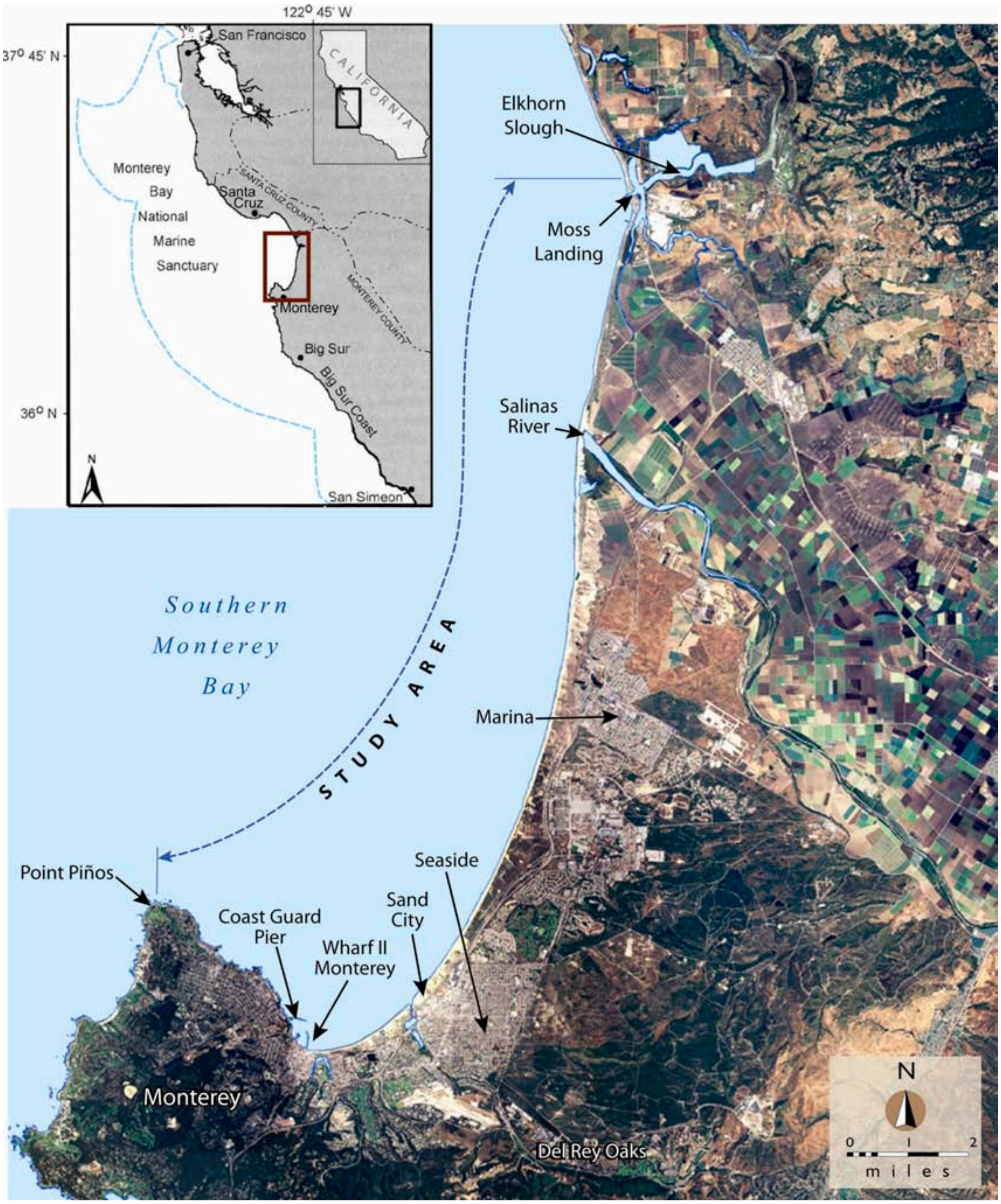
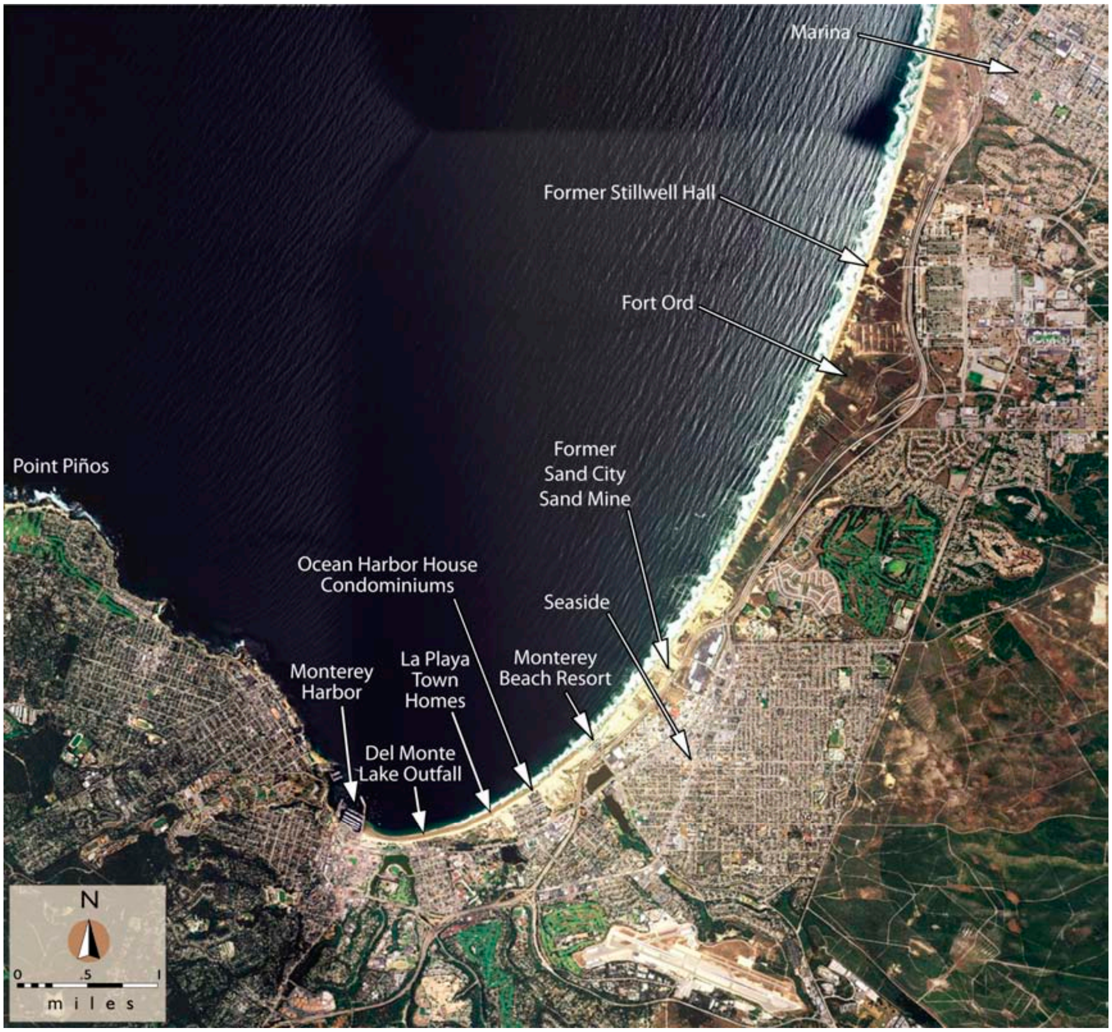


Figure 2. Locations at the Southern End of Southern Monterey Bay



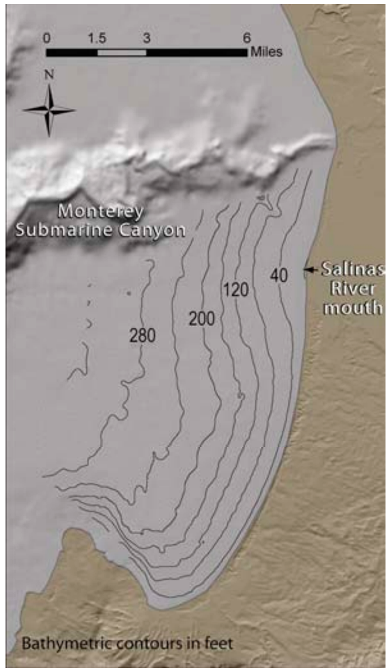
Approximately 18,000 years ago, at a lower stand of sea level, the dunes extended seven miles seaward of the present day shoreline (Chin et al., 1988). Historically, the beaches of southern Monterey Bay were supplied by large volumes of sand from the watershed of the Salinas River, when the river had a much steeper gradient and a larger transport capacity for sediments. The abundant sand in combination with dominant onshore winds created an extensive dune field in southern Monterey Bay. During the Flandrian (last 10,000 years) the shoreline eroded in response to sea-level rise, migrating landward to its present position at an average erosion rate of approximately 2.3 ft/year. This value is a rough measure of the historic average erosion rate due to natural causes such as sea-level rise and offshore losses. Since the present rate of sea level rise is lower than the Flandrian rate, but erosion rates in general are higher than the historical mean value, other processes have changed, such as a decrease in the amount of sand contributed by the Salinas River (Section 2.3.1) and sand losses due to sand mining (Section 2.5.4).

Figure 3. Eroding Dune Bluffs at Fort Ord

Photo taken: September 19, 2007 (Justin Vandever, PWA)

The shoreline from Moss Landing to two miles south of the Salinas River mouth is occupied by low relief recent, or active dunes (i.e. dunes that are currently being shaped by the wind) backing wide sandy beaches. The beach-dune interface is less obvious north of the Salinas River and here the dunes are stable or accreting (Cooper, 1967). Pockets of recent dunes are also present in the Sand City to Monterey area. Areas landward of the dunes are dominated by lowlands, and seaward the beaches are bounded by a continental shelf which descends into the Monterey Submarine Canyon approximately 9-12 miles offshore (Figure 4). A second prominent offshore bathymetric feature is the ancient sediment lobe off the mouth of the Salinas River, which forms a bulge in the coastline (Figure 4).

Figure 4. Bathymetry of Southern Monterey Bay



Source: Douglas Smith (CSUMB)

Historically, the Salinas River flowed north along the coast behind the dune field and entered Monterey Bay north of present day Moss Landing Harbor. It may also have discharged near its present location, which is aligned with the ancient sediment lobe (Figure 4). In 1910, the river breached the dunes and was diked at its current location to prevent the river from flowing north into its old channel. In 1946, the U.S. Army Corps of Engineers (Corps) constructed two jetties and dredged an entrance channel at the present opening to Moss Landing Harbor. The historic opening to the north eventually silted in as a result of the reduction in flow.

1.3 INFRASTRUCTURE

1.3.1 Coastal Armoring and Development

Apart from short lengths of riprap and seawalls at Sand City and Monterey, the majority of the southern Monterey Bay shoreline is unarmored (Stamski et al., 2005a, b). Approximately 0.6 miles at the southern end (southern bight or Del Monte Beach, Figure 2) of the 16-mile shoreline is currently armored (less than 4%). Shoreline armoring is focused at the privately-owned oceanfront Monterey Beach Resort and Ocean Harbor House condominiums. At these sites the shoreline is fixed, and adjacent beaches and dunes continue to erode, causing armored areas to protrude seaward into the beach runup zones, and even the surf zone. This results in an adverse effect by blocking lateral beach access and recreation, and can pose a public safety hazard (Figure 5, left panel). The armoring consists of 600 feet of seawall to protect Monterey Beach Resort and 700 feet of emergency riprap to protect the Ocean Harbor House condominiums. The riprap in front of the Ocean Harbor House condominiums (Figure 5, right panel) is due to be replaced with a permanent seawall within the footprint of the condominiums, and the seawall fronting the Monterey Beach Resort is due to be replaced with a new seawall abutting to the front of the present seawall.

Figure 5. Armoring at Monterey Beach Resort and Ocean Harbor House Condominiums

Monterey Beach Resort | Ocean Harbor House condominiums

Photo taken: January 13, 2003 (Ed Thornton, NPS) | Photo taken: April 2006 (Gary Griggs, UCSC)

Shoreline armoring in the form of concrete and other debris is also present fronting the former sand mining complex at Sand City. Here, remnants of a cement mixing facility are located immediately north of Tioga Avenue (Figure 6). The facility is now used for temporary storage of construction equipment. Until at least 1990, concrete slurry was dumped here parallel to the shore to form an 800 foot-long concrete ridge that effectively acts as a seawall. In addition, at the seaward end of Tioga Avenue there is a 750 foot-long collection of debris and riprap, composed predominantly of un-engineered cement blocks, and the remains of a former road (Vista del Mar Street) where much of the asphalt has fallen over the bluff. A further 130 feet of riprap fronts the Del Monte Lake outfall (Figure 2). There is also a 470 foot-long concrete seawall in front of the main Monterey Bay Aquarium Research Institute (MBARI) building at Moss Landing.

Figure 6. Coastal Structures at Sand City

Collapsed former road at the end of Tioga Avenue

Photo taken: September 19, 2007 (Justin Vandever, PWA)

Concrete slurry 'wall'

Photo taken: September 19, 2007 (Justin Vandever, PWA)

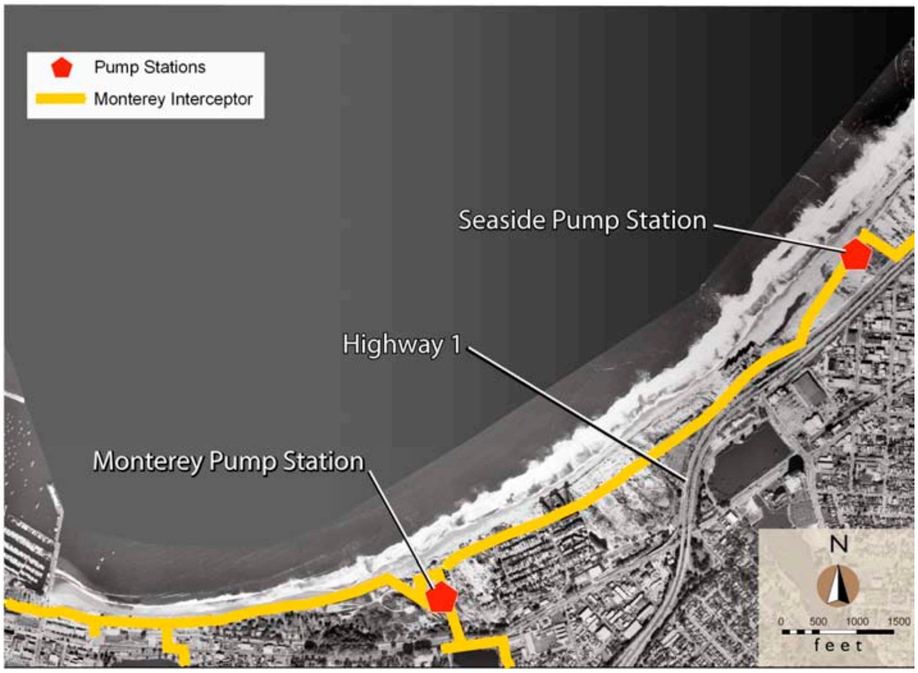
1.3.2 Utilities

Monterey Regional Water Pollution Control Agency (MRWPCA) pump stations, pipelines, and outfalls extend along the southern Monterey Bay shoreline from Marina to Wharf II (PWA and Griggs, 2004). Pump stations are surface or sub-surface structures housing wastewater pumps and pipeline connections. At the shoreline, pipelines are typically buried in the dunes or beneath the beach. The MRWPCA oceanfront facilities include (Figure 7):

- Monterey Interceptor pipeline extending from Seaside Pump Station to Wharf II. This pipeline is buried in the dunes between Seaside and Monterey Pump Stations and beneath the beach between Monterey Pump Station and Wharf II
- Seaside Pump Station which is set back about 100 feet from the present shoreline
- Monterey Pump Station which is set back about 350 feet from the present shoreline

The Monterey Interceptor pipeline was constructed between 1977 and 1981 to collect the raw wastewater from the cities of Pacific Grove, Monterey, Seaside, Sand City and Fort Ord for regional secondary treatment at the Marina sewage treatment plant before discharge into the ocean. The pipe ranges in diameter from 3.0 to 3.5 feet, and there are manholes approximately 500 feet apart along the pipe and at each point of connection. The manholes, in accordance with California Coastal Commission permit requirements, were set so that their tops were approximately four feet below the lowest 'normal' sand level on the beach. Several of the manholes are now sometimes exposed, and are at risk of damage due to erosion (PWA and Griggs, 2004).

Figure 7. Monterey Regional Water Pollution Control Agency Facilities and Highway 1



Source: Location of pipeline provided by Jennifer Gonzalez (MRWPCA)

1.3.3 Highway 1

Portions of Highway 1 curve seaward at Sand City and in the vicinity of Monterey Beach Resort (Figures 2 and 7). These sections of the highway may be threatened by coastal erosion in the future.

1.4 PHYSICAL PROCESSES

1.4.1 Tidal Regime

The southern Monterey Bay coast experiences mixed semidiurnal tides, with two high and two low tides of unequal height each day. The mean tidal range (defined as mean low water minus mean high water) at Monterey Harbor (Station ID: 9413450) is 3.5 feet and the diurnal range (defined as mean higher high water minus mean lower low water) is 5.3 feet (Table 1). Tidal range determines the extent of beach exposure and inundation throughout the tidal cycle. Particularly important are the timing and height of high tides coincident with maximum wave heights and surge developed during storms.

Table 1. NOAA Tidal Datums for Monterey Harbor (Station ID: 9413450)

	MLLW (feet)	NAVD 88 (feet)
Mean higher high water (MHHW)	5.34	5.48
Mean high water (MHW)	4.64	4.78
Mean tide level (MTL)	2.87	3.01
Mean sea level (MSL)	2.83	2.97
Mean low water (MLW)	1.10	1.24
Mean lower low water (MLLW)	0.0	0.14

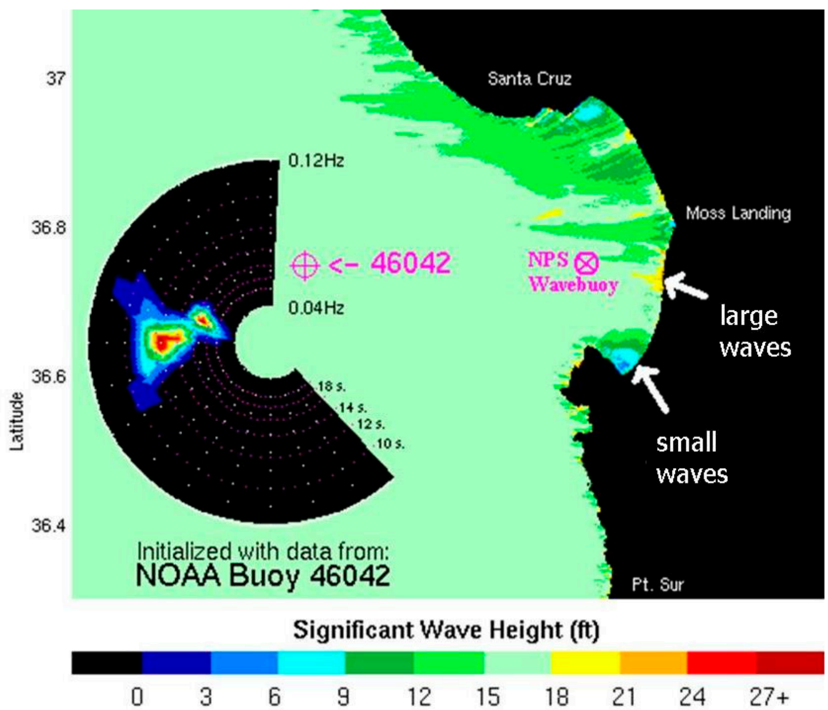
1.4.2 Wave Climate

With respect to sediment management, the wave climate of southern Monterey Bay is important for two reasons. First, differential wave energy alongshore causes variations in the magnitude of erosion due to wave impacts at the dune toe. Second, the direction and magnitude of wave approach relative to the shoreline orientation, controls the direction and strength of alongshore sediment transport.

The nearshore wave climate of southern Monterey Bay is impacted predominantly by waves from the northwest (Storlazzi and Wingfield, 2005). Xu (1999) reported a time series of wave height, period and energy data between 1990 and 1995 from a gauging station located 0.6 miles offshore from Marina. The time series showed that significant wave heights in winter are greater than in the summer and the highest waves arrive from the northwest in either season. Presently, the directional wave spectrum is measured every four hours at the NOAA wave directional buoy (Buoy ID: 46042) offshore of Monterey Bay and waves are refracted throughout the bay as part of the Coastal Data Information Program (CDIP). As a complement to this program, the wave height, direction, momentum flux and sediment transport have been calculated every 200 m (600 feet) alongshore in Monterey Bay since October 2007 (http://www.oc.nps.navy.mil/~thornton/cencoos) as part of the California Ocean Current Management Program (COCMP). Refraction occurs as the waves pass over Monterey Submarine Canyon focusing wave energy at Marina and Fort Ord and defocusing energy at Moss Landing. In addition, the shoreline of the southern bight is sheltered by Point Piños headland from waves from the south and west, resulting in reduced wave energy at

Monterey. The net result is a large alongshore energy gradient with relatively small wave heights at Monterey increasing to relatively large wave heights at Fort Ord and Marina (Figure 8) (Thornton et al., 2007).

Figure 8 Significant Wave Heights in Monterey Bay



Source: Coastal Data Information Program (http://cdip.ucsd.edu)

Longer term variations in wave climate are linked to large scale atmospheric variations, particularly El Niño-Southern Oscillation and Pacific Decadal Oscillation (PDO) events. El Niño events are characterized by above average rainfall and large waves generated by Pacific storms, and generally last between six and eighteen months. The two most energetic El Niño's of the past 50 years along the California coastline occurred in 1982-83 and 1997-98. The PDO is a 20-25 year climate oscillation based on sea surface temperature phases, which have implications for ecosystems, physical processes, and beaches (Revell and Griggs, 2006; Adams et al., 2007). The PDO controls the jet stream and storm tracks in the North Pacific, which affects wave direction. During negative phases (relatively low water temperatures), La Niña conditions are more prevalent (dominated by northwest waves), while during positive phases (relatively high water temperatures), El Niño conditions are more dominant (more westerly-directed waves). Higher intensity PDO and El Niño events were more common from 1910 to 1940, and after 1978, possibly continuing today, with the 1940 to 1978 period marked by a gentler climate.

The most destructive waves occur most commonly during El Niño events (Storlazzi and Griggs, 2000; Dingler and Reiss, 2002; Storlazzi and Wingfield, 2005) when storms increase in frequency and intensity, producing waves of exceptional height and period at the shoreline. El Niño winter

storm waves tend to approach the Monterey Bay shoreline from the west or west-southwest, which diverge less due to refraction, resulting in larger waves at the shoreline than with storms from the northwest. Storlazzi and Griggs (2000) found significant correlations between El Niño events and the occurrence of large waves, higher than normal sea-surface elevations, and storms that caused significant erosion. A higher water surface together with the increased wave setup associated with the higher storm waves elevates the level of wave attack relative to the bluff toe. The timing of the El Niño storms also tends to be later in the winter season when the protective beach is already reduced, further exposing the bluff toe to wave attack. The 1982-83 and 1997-98 El Niño winter storms caused severe beach and dune erosion along central California's coast including southern Monterey Bay (Storlazzi and Griggs, 2000; Thornton et al., 2006).

1.4.3 Base Flood Elevations

The Federal Emergency Management Agency (FEMA) coastal flood studies in southern Monterey Bay (FEMA, 2007) projected the maximum elevations of wave runup and overtopping during a 100-year flood event, denoted by the Base Flood Elevation (BFE) (Table 2). Structures at elevations below the BFE may be subject to damages from direct wave impacts or undermining by wave scour. The BFE estimates do not include a future sea-level rise component.

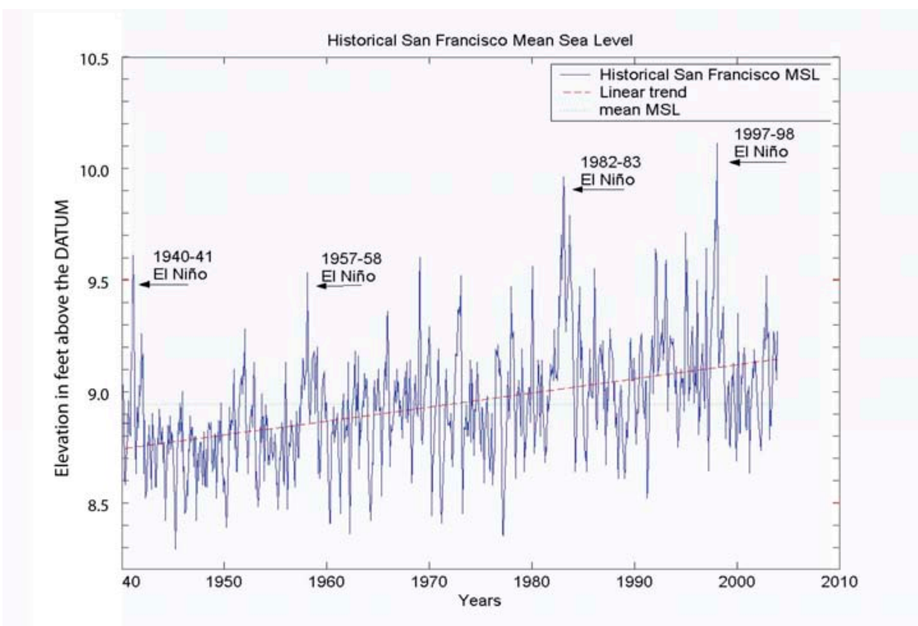
Table 2. FEMA (2007) Base Flood Elevations (BFE)

Location	BFE (feet NAVD)
North of the Salinas River mouth	23-24
Sand City (Tioga Avenue)	27
Seaside Pump Station	27
Monterey Beach Resort	24
North Del Monte Beach	26
Wharf II and South Del Monte Beach	22

1.4.4 Relative Sea-Level Rise

Measurements of monthly-averaged relative mean sea-level rise at Monterey started in 1973, providing only a short recent record for analysis. The Monterey record shows that relative sea-level has risen at a rate of 1.86 mm/year (0.31 ft/50 years) between 1973 and 1999. In order to determine if a longer record could be used to establish the long-term relative sea-level rise rate in southern Monterey Bay, the Monterey tide gauge data was compared to the San Francisco tide gauge data, which started in 1853 and is the longest continuous record in the U.S. The two time series have a high correlation coefficient (>0.9) with a slope of 0.77 at Monterey (Sesto, 2004) indicating that the San Francisco record can be used to infer relative sea level at Monterey since the regional land subsidence rates at these tide gauges is low (Battalio and Everts, 1989). The San Francisco record shows that relative sea-level has risen at a rate of 2.13 mm/year (0.35 ft/50 years) since 1906. The record shows significant annual variations, and spikes in mean sea level correlate with El Niño events (Battalio and Everts, 1989; Ryan et al., 1999) (Figure 9).

Figure 9. Historical Monthly Averaged MSL at San Francisco Relative to Station Datum



Source: Adapted from Sesto (2004)

2. SEDIMENT BUDGET

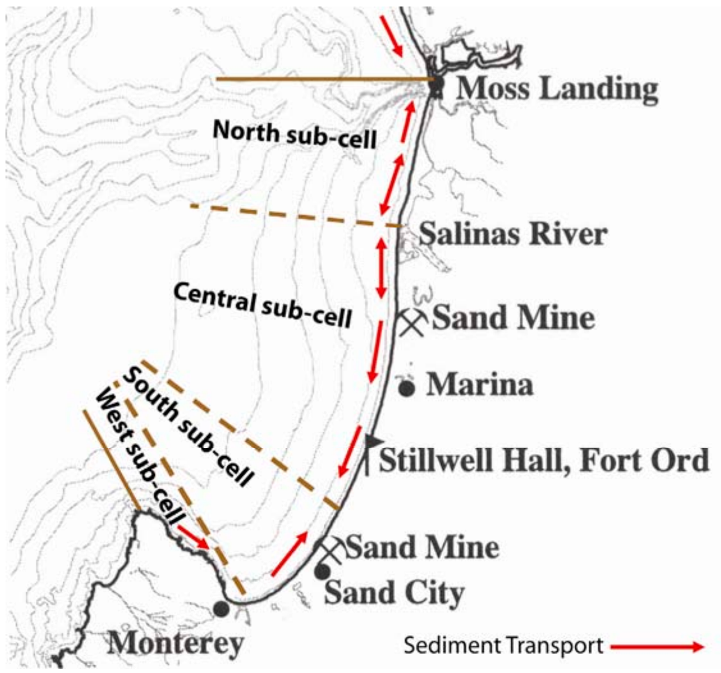
Sediment (sand) budgets are important tools in understanding regional sediment processes (Best and Griggs, 1991; Rosati, 2005) and to quantify the sediment sources (inputs) and sinks (outputs) from a littoral cell; a defined length of shoreline along which the cycle of sediment erosion, transportation, and deposition is essentially self-contained. Sediment enters a cell from one or more rivers (the Salinas River in southern Monterey Bay) draining the coastal watersheds and/or from erosion of coastal bluffs (coastal dunes in southern Monterey Bay). A littoral cell includes the beach above the highest tides, sediment transported by wind, and any sediment within the surf/swash zone and out to the depth on the shoreface at which wave energy stops transporting sediment. Some of the sediment inputs and outputs are not well defined, such as those from or to offshore, and these components are often treated as an unknown and estimated by the residual in the budget.

2.1 DEFINITION OF SOUTHERN MONTEREY BAY LITTORAL CELL

Monterey Bay is currently divided into two primary littoral cells; Santa Cruz to the north and southern Monterey Bay to the south (Patsch and Griggs, 2007). The Santa Cruz littoral cell stretches from Point San Pedro to the head of Monterey Submarine Canyon close to the shoreline at Moss Landing. Sediment is transported south within this cell (Best and Griggs, 1991; Eittreim et al., 2002) until it is deflected offshore into Monterey Submarine Canyon by Moss Landing Harbor north jetty, and lost from the littoral system (Wolf, 1970).

The southern Monterey Bay littoral cell is considered in this Coastal RSM Plan to be comprised of four sub-cells (north, central, south, and west) between Monterey Submarine Canyon and the Point Piños headland, around which no sand enters the bay (Figure 10). The boundary between the north and central sub-cells is located at the Salinas River mouth. Refraction of waves over Monterey Submarine Canyon (Section 1.4.2) and the relict Salinas River delta results in a net alongshore sediment divide, with a portion of the sand discharged from the Salinas River transported north towards Monterey Submarine Canyon, and a portion transported south towards Sand City (Figure 10) (Habel and Armstrong, 1978). Thornton et al. (2006) suggested seasonal variability in sand transport directions in the central sub-cell. During winter, sand is transported to the north, with transport to the south during the rest of the year, with an overall net southerly movement. The northerly transport during the winter coincides with the time of year when the Salinas River is flowing into the bay and providing sediment input (Section 2.3.1), suggesting that most of the river sediments are transported to the north.

Figure 10. Southern Monterey Bay Littoral Sub-Cells and Transport Directions



A third (south) sub-cell exists within the southern bight between Wharf II and to north of Sand City (Figure 10). Orzech et al. (2008) showed that the net sand transport at Sand City is to the north, resulting in a convergence of alongshore transport with the net southerly transport at Fort Ord (Section 2.2). At the location of convergence, approximately three miles northeast of Wharf II (although seasonally variable in location), sand may migrate offshore, demarcating the boundary between the central and south sub-cells. Little sand has accumulated against the Wharf II breakwater since it was built in 1932, and the beach sand there appears to be derived primarily from runoff, suggesting little or no southerly transport into the south sub-cell.

A fourth (west) sub-cell is defined between Point Piños and Monterey Harbor (Coast Guard Pier) where the alongshore sand transport is to the east (Patsch and Griggs, 2007). The shoreline of this sub-cell is comprised primarily of erosion-resistant granite, and hence, has probably not contributed a large amount of sand to the Bay. Monterey Harbor blocks most sand transport from the east with only a small amount passing the breakwater. After the Coast Guard Pier was built in 1959, the breakwater impounded sand such that San Carlos Beach adjacent to the pier increased in width to 80 feet by 1990 (Storlazzi and Field, 2000) and has since stabilized at about that width.

Monterey Harbor requires periodic dredging. Approximately 4,000 yd^3 was dredged in 2003 and it is estimated that approximately 75,000 yd^3 could be targeted for dredging in 2010-2011. The sand in the harbor appears to be primarily derived locally based on mineralogy and sand size (Dingler et al., 1985). Sand enters the harbor past the east and west breakwaters, through three runoff outfalls within the harbor, and through an overflow runoff pipe just inside Wharf II.

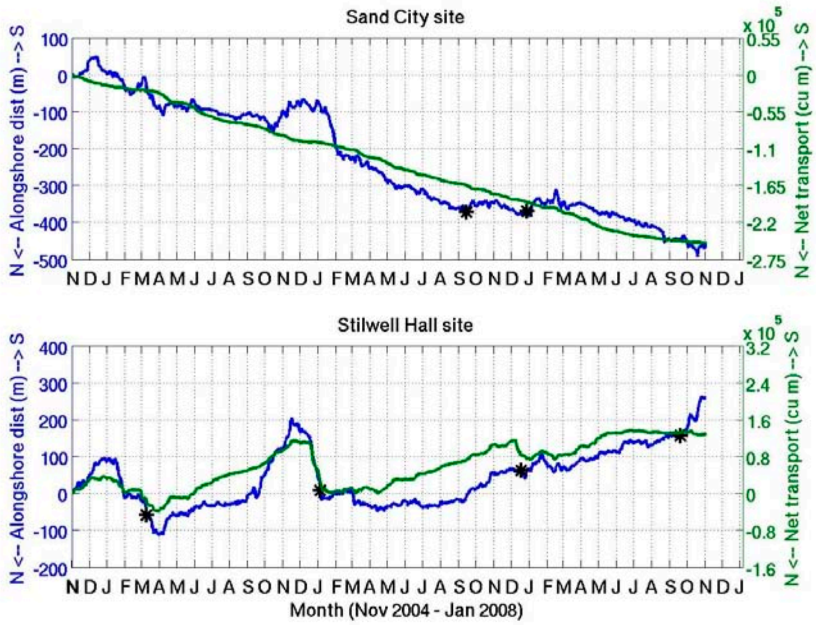
Based on the potential for sand to be transported from the central sub-cell into the north sub-cell, it is recommended using Monterey Submarine Canyon as the northern boundary of the littoral cell (the littoral cell defined by Patsch and Griggs, 2007) (Figure 10). The 16 miles of shoreline between Monterey Submarine Canyon and Wharf II encapsulates all of the sediment that should be considered in RSM for southern Monterey Bay.

2.2 SEDIMENT TRANSPORT

The net alongshore sediment transport rates within the southern Monterey Bay littoral cell are relatively low. This is because waves approach the shoreline at near-normal angles due to refraction across offshore bathymetric contours including the Monterey Submarine Canyon, and the evolution of the shoreline in response to the wave climate. Southern Monterey Bay is essentially a crenulate-shaped bay between the Monterey Peninsula and Monterey Submarine Canyon. The shoreline is a near-equilibrium shape. These processes along with the shorelines exposure to the North Pacific, results in large total sand transport but a small net transport rate over a given year or longer period. The near-normal incidence of waves approaching the southern Monterey Bay shoreline is conducive to rip current generation and maintenance, creating a cross-shore component to the sediment transport (Thornton et al., 2007).

Sediment transport rate calculations are inherently inaccurate and it is most important to get the transport direction correct. Orzech et al. (2008) measured the daily migration of rip current channels over a three year period (2005-2008) using time-lapse video images taken at Sand City, Fort Ord and Marina, and hypothesized the migration was due to alongshore sediment transport. They calculated daily net sediment transport rates over the same three years applying a modified version of the CERC formula (Corps, 1984) on wave spectra refracted from an offshore NOAA wave directional buoy (Buoy ID: 46042) (Figure 8). They found correlation values of 0.83-0.96 between daily migration distance and calculated net alongshore sediment transport giving confidence in the calculated directions (Figure 11). Sediment transport at Stilwell Hall (Fort Ord) and Marina (not shown as it is similar to Fort Ord) is seasonally variable with transport to the north during the winter and to the south the rest of the year, with a net calculated rate to the south of approximately 0-40,000 yd^3/year.

Figure 11. Calculated Sediment Transport (green) and Net Transport of Rip Channel Morphology (blue)

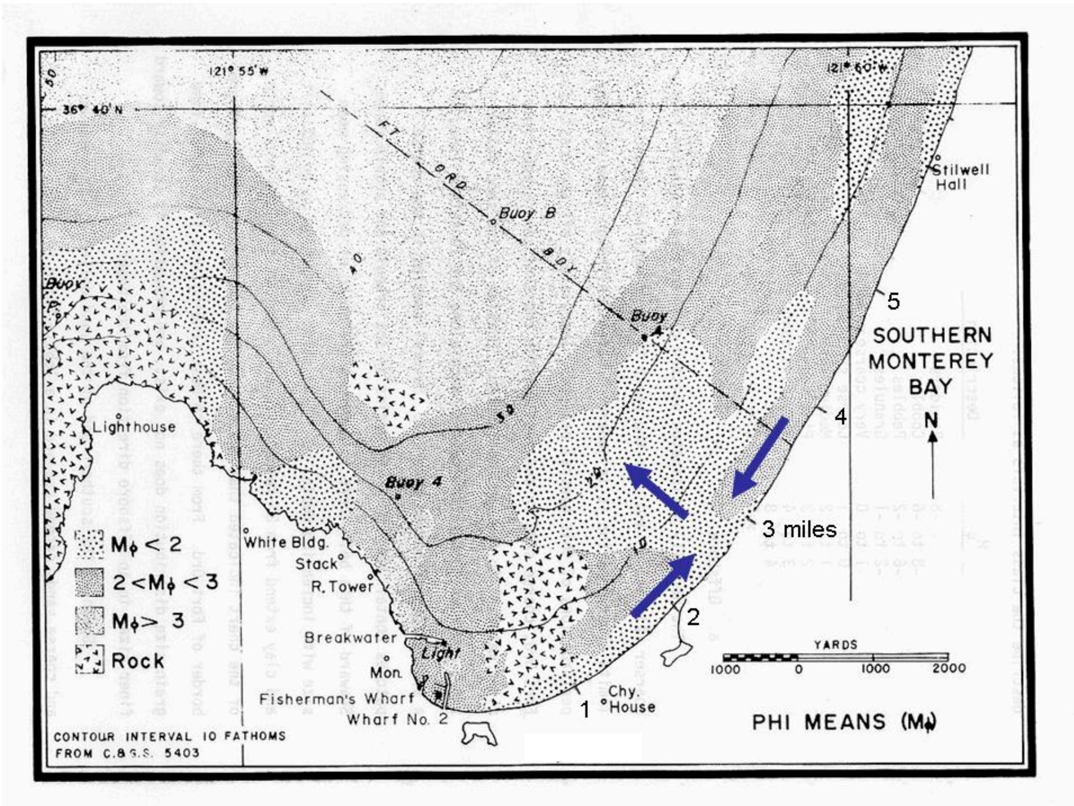


Source: Adapted from Orzech et al. (2008)

An important boundary in the alongshore sediment transport regime is north of Sand City where sand transported south from Fort Ord meets sand transported north from Monterey to form a zone of convergence. Sediment transport at Sand City is complicated by its sheltered location in the shadow of the Point Piños headland. Wave directionality drives the transport consistently to the north. However, because of its sheltered location, there is also a transport component to the south. The gradient of wave energy (Section 1.4.2) creates a pressure gradient driving currents to the south that are seasonally variable and strongest in the winter when waves are largest. The resulting net transport is to the north is calculated to be approximately 0-80,000 yd^3/year.

Evidence corroborating a convergence zone is found in Combellick and Osborne (1977) and Reid et al. (2006). Combellick and Osborne (1977) combined the surface sediment studies at the southern end of Monterey Bay by Dorman (1968) and Greene (1970). They found a relatively narrow band of surface medium sand (particle size 0.25-0.5 mm) extending offshore from Sand City with mineralogy and physical characteristics consistent with the dune and beach sands (Figure 12). The location of the shore connection of this band of sand is consistent with the location of the sediment transport convergence zone.

Figure 12. Distribution of Surface Medium and Coarse Sand South of the Salinas River



Source: Adapted from Dorman (1968). Medium sand (less than 2 phi = greater than 0.25 mm). Fine sand (2-3 phi = 0.125-0.25 mm). The blue arrows indicate the direction of net sediment transport. Distance in miles from Wharf II is indicated.

Sand mining in southern Monterey Bay has increased erosion rates, and modified shoreline orientation and sand transport rates (Battalio and Everts, 1989). A detailed review of historic shoreline positions and a sand budget indicated that sand mining in Sand City and Marina had caused the bay shoreline to recede landward in the vicinity of the mines, thereby increasing alongshore sand transport toward the mines. The Fort Ord shoreline experienced the highest erosion rates due to its location between the Sand City and Marina mining operations, and also due to the greater wave exposure (Battalio and Everts, 1989). The conceptual model and numerical model used to evaluate these processes is based on an equilibrium shoreline with small net transport, but large gross (back and forth total) transport, where perturbations like sand mining and river discharge result in net transport toward and away, respectively, from the perturbation (Section 5.2). Therefore, the net alongshore sand transport rate has varied over time in response to sand mining, which continues today.

The important sediment transport findings are:

- net sand transport is to the north in the southern bight and converges with the net southerly transport from the north near Sand City
- sand transport between Fort Ord and the Salinas River is to the north in the winter when the Salinas River is flowing and contributing sediments to the littoral budget (Section 2.3.1)
- transport of sand is to the north during the winter when the dredge pond at Marina is being filled extracting sediments from the littoral system (Section 2.5.4)
- calculated net transport rates are potential rates which may be affected by sediment availability
- gross transport rates are higher owing to the seasonal variation in the direction of transport
- higher gross and low net transport rates are pertinent to sand placement design considerations.

Apart from the littoral cell boundaries at Moss Landing (jetties) and Wharf II (breakwater), southern Monterey Bay has no shore-normal structures that would act as barriers to alongshore sediment transport. There are also no shore-parallel offshore structures that would inhibit cross-shore transfer of sediment. However, the mining of sand from the back beach at Marina is a major barrier to sediment transport (Section 2.5.4).

2.3 SEDIMENT SUPPLY

Sources of sand to the southern Monterey Bay littoral cell are discharge by the Salinas River, erosion of the beaches and coastal dunes, and possibly transport of sand from offshore.

2.3.1 Salinas River

The quantity of sand-size sediment that is contributed to the littoral cell by the Salinas River is a significant uncertainty in the sediment budget of southern Monterey Bay. The Salinas River has the third largest watershed in California (Willis and Griggs, 2003) and the sediment processes are characterized by an over supply of fine sediments (McGrath, 1987). The sediments are generated partially from the natural dryness of the eastern portion of the watershed, partially from the expansion of agriculture, and partially from modification of the stream channel.

Farnsworth and Milliman (2003) showed that sediment delivery to Monterey Bay from the Salinas River is episodic. During many years, the mouth of the Salinas River is blocked by a sand bar, which changes morphology with seasonal changes in wave climate and rainfall. During periods of low river discharge the bar grows through alongshore sediment transport and interrupts sediment supply from the Salinas River. Breaching of the bar may occur during periodic flood events in winter. Breaching also takes place annually by removal of part of the bar by the Monterey County Water Resources Agency (MCWRA) to prevent flood damage to the surrounding areas. Farnsworth and Milliman (2003) suggested that during major flood events, when the sand bar is breached, sediment concentrations are extremely high (Figure 13).

Figure 13. Salinas River during a Flood and Bar Breach

Source: Unknown

The majority of sediment delivered to the coast during flood events is very fine sand and mud that bypass the inner shelf as a plume. The fate of fine sediments supplied by the Salinas River and other rivers to the California coast was summarized by Farnsworth and Warrick (2007). The Salinas River discharges on average nearly two million tons of fine sediment annually, which dominates the discharge of fine sediments along the central coast. After sediment is introduced into coastal waters, it undergoes intervals of deposition, resuspension, and transport until it is ultimately deposited where it will no longer be disturbed (Wright and Nittrouer, 1995). A distinct fine-sediment region is present in the northern Monterey Bay mid-shelf. This Salinas River mud lobe is a convex bulge on the mid-shelf in water depths of 30 to 300 feet covering an area of 28 square miles (Figure 4) (Chin et al., 1988). Due to the fine particle size of this sediment, it is not a source of material for beach nourishment.

McGrath (1987) argued that the Salinas River no longer contributes substantial beach-size sand to the littoral cell because the river gradient has greatly decreased with rise in sea level, decreasing the flow rate. In addition, the dissipation of the flood waves in the channel (for example, during the February 1969 flood, which peaked at 117,000 cfs at Soledad, the flow was only 83,000 cfs at Spreckles) and the limited capacity of the active river channel provide evidence that the lower river is depositional. The river overflows at a relatively low flood stage (approximately 20,000 cfs) spilling the flow onto the adjacent wide floodplain where the sediment load is deposited and stored. Hence, the Salinas River deposits much of its beach-building sediment before it can be carried to the coast.

Further evidence that the river is depositional is provided by sediment studies. Combellick and Osborne (1977) found that the sediment size in the river decreased downstream towards the mouth indicating that the coarse-sand fraction is deposited before reaching the bay. They found that the sand in the river near the mouth is finer-grained and less well sorted than sand on the beaches, and they estimated that the quantity of medium and coarse sand near the mouth available for discharge into the bay was less than 5%. Clark and Osborne (1982) performed texture, petrographic and Fourier grain-shape analysis to discriminate between the more angular river sands and the more rounded dune and beach sands, and found only a small influence of river sand on the beaches of Monterey Bay south of the river even after the major flood of 1978. Based on statistical analysis tests, they found little similarity in shape between the river sand and that of the southern beaches or offshore areas. They concluded that the Salinas River is a minor local sand source to the beaches south of the river, even during periods of abnormal flooding. Sand contribution to the beaches appears to be minimal except to those within 1.6 miles south of the Salinas River mouth. Another possible reason the river contribution does not extend to the south may be that the medium to coarse sand contribution is intercepted by the Marina sand mine located approximately two miles south of the river, that was started in 1965.

Willis and Griggs (2003) studied river sediment discharge along the entire California coast, but focused on the Salinas River as a specific example, which provides detailed information on this system. In their analysis, they determined suspended sediment concentrations by applying rating curves produced by an empirical power formula using daily measured suspended sediment concentrations and stream flow at Spreckels (11 miles upsteam from the river mouth) for water years 1967-1979 and 1986. They then applied the rating curves to the entire time series of measured discharge. The fraction for sand particle size >0.063 mm of suspended load was included. However, the bedload was not measured and was assumed to be 20% of the total annual suspended flux and sand size or coarser. The calculated average annual sand and gravel flux at Speckels was calculated at 490,000 yd^3/yr. However, this is judged an overestimate for several reasons:

- sand on the beaches of southern Monterey Bay contain little fine sand smaller than 0.25 mm, which is the majority of suspended sediments
- the river is depositional between the measurement locations at Spreckels and the bay

- the assumption that the bedload is equivalent to 20% of the suspended sediments appears to be an overestimate.

McGrath (1987) focused only on beach sand-size sediments. He first quantified the hydraulic behavior of the river, and then obtained relationships between stream flow and sediment discharge. He calculated rating curves based on the suspended sediment data for discharge flows greater than 1,000 cfs (similar to Willis and Griggs, 2003), but only included beach size sand (>0.25 mm) in his rating curves. Rather than assuming bedload to be a percentage of the suspended load, he calculated the bedload transport using a variety of formulations, ultimately applying a modified Einstein approach. McGrath (1987) estimated that approximately 50,000 yd^3/year of the Salinas River sediment load has large enough particle size for the high-energy beaches of southern Monterey Bay. Since 28% of the suspended sediments are in the range 0.125 to 0.25 mm, the discharge would only increase to 64,000 yd^3/year if these particle sizes are included. Since the study was completed in 1987, the estimates do not include the water years to date during a time of positive PDO and increased rainfall, which could increase the yearly average yield.

For the purposes of the budget used in this Coastal RSM Plan, a beach-size sand supply from the Salinas River to Monterey Bay of 65,000 yd^3/year is used. Given the distance over which the Salinas River sands have been found south of the mouth (1.6 miles) (Clark and Osborne, 1982) and given that sediment transport is generally to the north during the winter when the river is flowing into the bay, the budgetary contribution to the south is judged to be relatively small. For this sediment budget a value of 10,000 yd^3/year is estimated. This leaves approximately 55,000 yd^3/year of sediment transported north, supporting the contention of Patsch and Griggs (2007) that most of the supply from the Salinas River is driven north and potentially lost into Monterey Submarine Canyon.

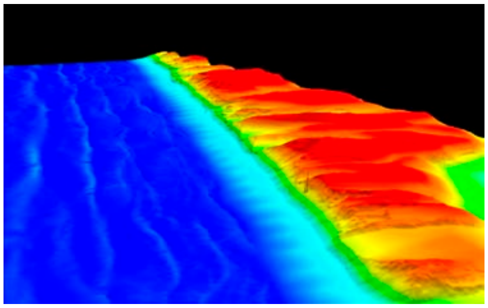
2.3.2 Potential Barriers to River Sediment Transport

Reductions in river sediment discharge to the ocean by coastal dams in California were examined by Slagel and Griggs (2006, 2008). Damming of these rivers has reduced sediment discharge by impounding sediment behind the dam and by changing (usually reducing) the sediment carrying capacity by reducing flow in the river, particularly during times of floods. Slagel and Griggs (2006, 2008) calculated that at Spreckles (11 miles upstream of the mouth) the impact of the dams has been to reduce the total annual sediment flux by 31%.

Three dams along the main tributaries of the Salinas River have changed the timing and amount

of flow. The Salinas Dam (Lake Santa Margarita) was constructed in 1941 a few miles southeast of the town of Santa Margarita in San Luis Obispo County, close to the origin of the Salinas River. Nacimiento Dam in northern San Luis Obispo County is a 210-feet high earth-fill dam, built by the MCWRA on the Nacimiento River, which completed construction in 1961. Lake San Antonio in southern Monterey County is formed by an earth-fill dam on the San Antonio River. The dam is 202 feet high and was constructed in 1965. The lake and dam are owned by the MCWRA and are about 115 miles from the southern Monterey Bay shoreline.

2.3.3 Dune and Beach Erosion South of the Salinas River



The largest input to the sediment budget of the southern Monterey Bay littoral cell is from erosion of the coastal bluffs south of the Salinas River, which are composed of relict dune sand with low cohesion. Erosion occurs during large winter wave events when wave setup and runup coincide with high tides to overtop the beach and undercut the base of the bluff causing the overlying sand to slump. This process causes aprons or cones of loose sand to accumulate at the top of the beach (Figure 3), from where the sediment is redistributed by wind or water, and replenished by further sloughing from the bluff face. The ability of the dunes to recover from erosion is limited. While onshore winds can re-build active dunes, such as those to the north of the Salinas River, the heights and volumes of the relict dunes south of the Salinas River cannot be re-established at current sea levels. These relict dunes therefore form sandy bluffs behind the beaches.

Long-term dune erosion

Long-term erosion of the dunes has been previously measured using a variety of techniques and references. Two recent studies were undertaken by Thornton et al. (2006) and Hapke et al. (2006), and their results are presented below.

Dune erosion was measured by Thornton et al. (2006) using a combination of stereo-photogrammetry (1940, 1946, 1956, 1966, 1970, 1976, 1978, 1980, 1984), LIDAR (1997, 1998) and GPS-walking surveys (2003). Since there was little to no dune erosion during the 2003-04 and 2004-05 winters, the date of the GPS survey was ascribed to 2005. The year 1984 approximately divides the 1940-2005 period into an earlier time when intense sand mining from the surf/swash zone was operational and a later time when it had ceased, except for the ongoing operation at Marina (Section 2.5.4). The comparative results are presented in Table 3. The dune erosion rates between 1940 and 1984 equate to an average sand volume of approximately 350,000 yd^3/year to the littoral cell. Between 1985 and 2005 this volume decreased to 200,000 yd^3/year. Since some of the dune sand is finer than the beach sand, it is estimated that about 75% of the sand volume (or about 150,000 yd^3/year) stays on the beach (Section 2.6). The differential changes in erosion rate in the vicinities of Sand City and Monterey (decreases) and Marina (an increase) (Table 3) may be related to cessation of sand mining at Sand City and an increase in sand extraction at Marina due to the ongoing operations.

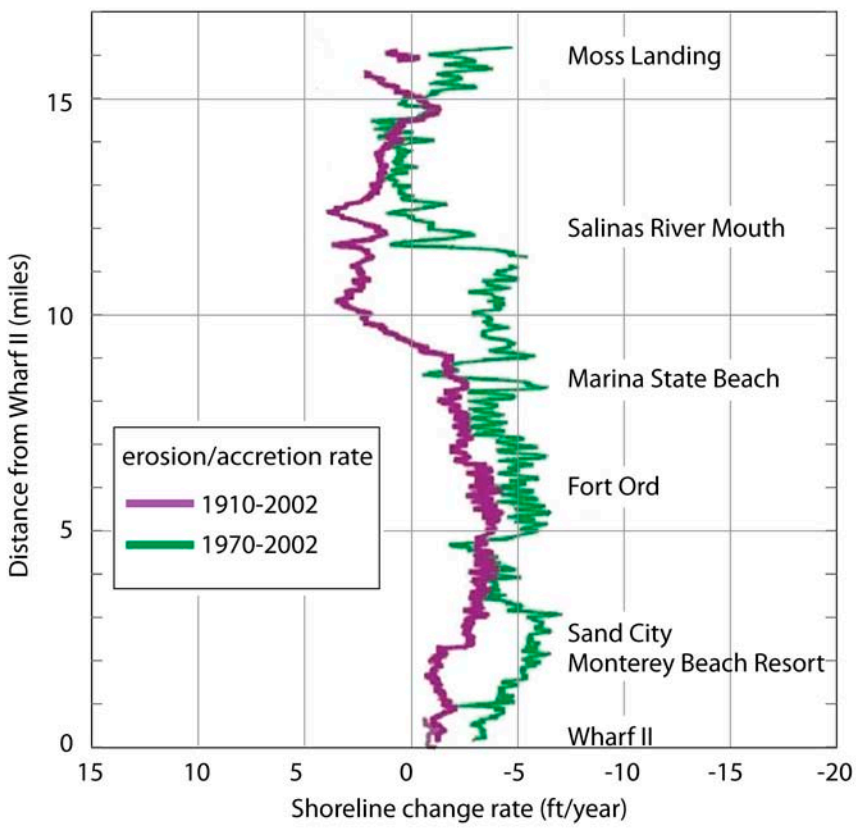
Table 3. Estimated Historic Long-term Average Erosion Rates (ft/year)

Location	Thornton et al. (2006)	Thornton et al. (2006)	Hapke et al. (2006)	Hapke et al. (2006)
Year	**1940-1984**	**1985-2005**	**1910-2002**	**1970-2002**
Moss Landing			+1.2	-1.7
Salinas River			+3.7	0
Marina State Beach	-1.0	-4.7	-1.4 to -2.0	-3.1 to -5.2
Stilwell Hall (Fort Ord)	-5.2 to -6.2		-2.5 to -3.7	-3.7 to -6.6
Sand City	-3.9 to -6.4	-2.7	-1.4	-3.7 to -6.2
Monterey Beach Resort	-2.4	-0.9	-1.4	-3.0
Del Monte Beach	-2.0	-0.4		

Hapke et al. (2006) estimated dune erosion by measuring the movement of the line of mean high water (MHW) along the entire California coastline. Corrections were made to adjust the measured high water line on the survey charts (T-sheets) to MHW to minimize biases between shoreline reference features. Erosion rates were calculated as end points between 1910 and 2002 and between 1970 and 2002. The mean erosion rate from 1970 to 2002 of 4.0 ft/year for southern Monterey Bay between the Salinas River mouth and Monterey was the highest for all of California. However, between 1910 and 2002, the shoreline for several miles south of the Salinas River was accretional (Figure 14) whereas from 1970 to 2002 it eroded. This anomaly may be related to the ongoing sand mining operation that began at Marina in 1965 (Section 2.5.4).

A comparison of the 1970-2002 erosion rates using MHW calculated by Hapke et al. (2006) with the dune-top edge erosion rates calculated by Thornton et al. (2006) during the same time period shows that the results are consistent. Both show that the highest erosion rates are at Fort Ord decreasing to the north and south (Table 3). This pattern is also consistent with the general distribution of wave energy approaching this coast, which is a maximum in the Fort Ord area (Figure 8).

Figure 14. Dune Erosion Rates in Southern Monterey Bay



Source: Adapted from Hapke, et al. (2006)

<u>Long-term beach stability</u>

Reid (2004) used the 1930 T-sheet and combined it with five aerial photography surveys between 1956 and 2001 to assess 70-year beach width change throughout southern Monterey Bay. He found that while the dune bluff retreated landward, the beach itself maintained a constant width, indicating that the beaches are maintained by the constant supply of sand from erosion of the dunes.

Over the long-term the southern Monterey Bay shoreline is migrating landward through space as the dunes erode but the beaches maintain their width, except in locations of coastal armoring such as Monterey Beach Resort and Ocean Harbor House.

Short-term dune erosion and beach recovery

Erosion of the southern Monterey Bay shoreline is not a consistent process but occurs episodically. Large amounts of erosion have occurred during El Niño winters, followed by several 'regular' years producing less erosion, all of which can be summed to provide an average erosion trend (Figure 14). During the winter months, high-energy waves move sand offshore where it forms nearshore bars, and in the process steepens and narrows the beach profile. Dingler and Reiss (2002) measured at least yearly changes to five portions of the shoreline in southern Monterey Bay between 1982-83 and 1997-98, using traditional survey methods. They showed that at Fort Ord most of the erosion occurred during the El Niño events of 1982-83 and 1997-98, with the beaches eroding then recovering. Over the 15-year period, the total dune toe erosion was 70 feet, with 25 feet occurring between February and April 1983, and 30 feet over the 1997-98 El Niño winter, with only 15 feet over the other 14 years. They found that the beaches took approximately two years to recover both their width and volume after the severe erosion during the 1982-83 El Niño. Thornton et al. (2006) showed that during the 1997-98 El Niño winter storms the beaches lost 1.0 million yd^3 of sediment offshore. The 1997-98 El Niño also caused the most severe erosion along southern Monterey Bay when the volume of sand eroded from the dunes was 2.4 million yd^3, a seven-fold increase from the average annual volume (Thornton et al., 2006).

As the high-energy conditions subside in late spring and early summer, the beach recovers as sand is moved onshore to rebuild the beach berm, which flattens and widens the beach profile. At the end of the summer or early fall when typically calm seas occur, the berm is well developed, reaching its peak width.

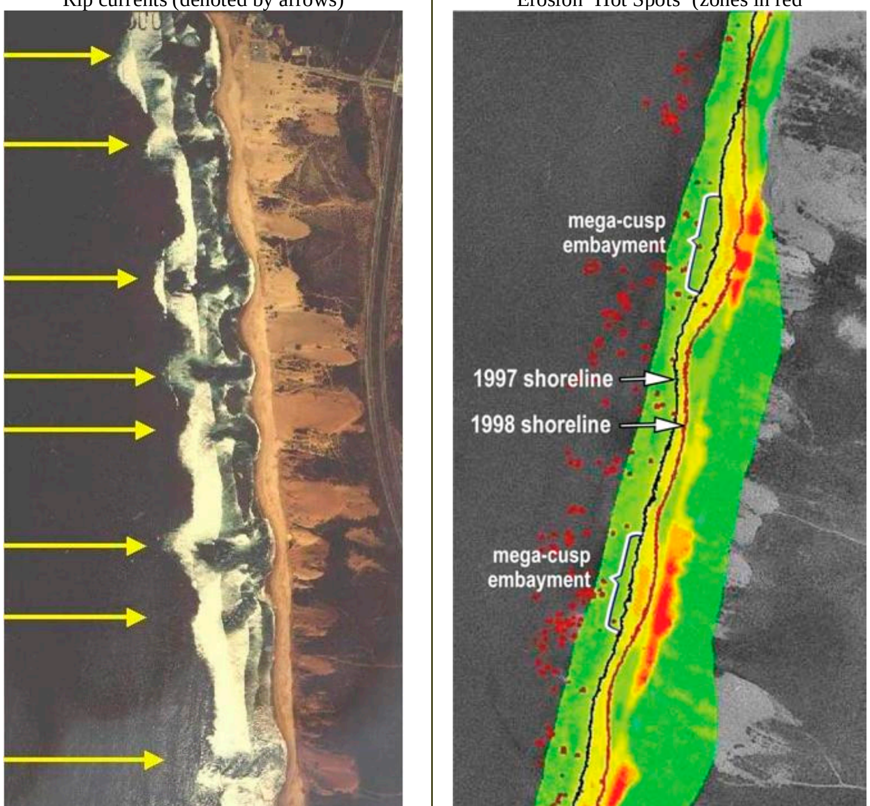
During coincident high water levels and extreme wave conditions, it is possible for sand to be transported offshore into water depths (beyond the shoreface) where summer waves cannot transport it back onshore. Hence, it is possible to have an imbalance in how much sand is transported back to the beaches in summer once the winter storms have moved it offshore.

Enhanced erosion due to rip currents

The mean erosion rate in southern Monterey Bay is the highest in California (Hapke et al., 2006). Thornton et al. (2007) hypothesized that the erosion in southern Monterey Bay is enhanced by the presence of persistent rip currents and associated large-scale alongshore mega-cusps (order 650 feet alongshore between horns) throughout the year (Figure 15, left panel). Erosion of the dune face is enhanced at the center of the mega-cusp embayment where the beach is narrower and the swash of large waves at coincident high tide can more easily reach the dune face. 'Hot spots' of dune erosion occur at the center of the embayments, as shown by the difference in LIDAR measurements of dune volumes over the 1997-98 El Niño winter. Figure 15 (right panel) shows volumetric change between October 1997 and April 1998. The rip currents and associated rip channels and mega-cusps migrate (Orzech et al., 2008) moving the hot spots along the shore, eroding the dune at an enhanced rate. The rip current's strength, spacing between rip channels, and associated alongshore mega-cusp scale are a function of wave height. Therefore, this process of enhanced dune erosion is less effective in the protected southern bight between Monterey and Sand City and more effective in the Fort Ord and Marina areas.

Figure 15. Rip Currents and Erosion 'Hot Spots'

Rip currents (denoted by arrows) | Erosion 'Hot Spots' (zones in red



Source: Thornton et al. (2007) | Source: Thornton et al. (2007)

2.4 FUTURE EROSION RATES IN RESPONSE TO SEA-LEVEL RISE

One of the most important long-term concerns for RSM in southern Monterey Bay is the physical response of the shoreline to future sea-level rise. Predicting shoreline and bluff erosion rates is critical to planning a sediment management strategy, forecasting future problem areas, and assessing biological impacts due to habitat change or destruction. One solution is to assume that historic rates can be projected into the future. However, it is likely that the erosion rate of the dunes will accelerate (and the littoral shoreline will continue to translate inland) in response to higher sea level. Higher baseline water levels will result in a greater occurrence of waves impacting the toes of the dune bluffs, increasing their susceptibility to erosion. However, without proliferation of coastal armoring in southern Monterey Bay, beach widths should be maintained, continuing to provide recreation, ecologic, and economic opportunities.

The U.S. Geological Survey (Gutierrez et al., 2007) convened a scientific committee to address potential shoreline changes due to sea-level rise along the U.S. Mid-Atlantic region. Although the west coast shoreline is different, the conclusions are relevant and adopted here. The committee decided from the outset that existing shoreline change prediction techniques such as the Bruun Rule (Bruun, 1962), extrapolation of historic shoreline change rates (NRC, 1987) and simple inundation of a static topography are based on assumptions that are either difficult to validate or too simplistic to account for the complex processes of shoreline change. The committee agreed that the sediment budget is a critical determinant on how the shoreline will respond to rising sea-level, but is also dependent on physical processes (e.g. increased or decreased storminess) and anthropogenic influences (e.g. erosion mitigation efforts such as beach nourishment or the cessation of sand mining).

A different approach for assessing the potential for future shoreline changes is the Coastal Vulnerability Index (CVI) (Thieler and Hammar-Klose, 2000). The CVI uses the physical characteristics of the coastal system (e.g., geology, coastal slope, wave energy, tidal range) to classify the potential effects of sea-level rise. Although this tool allows identification of portions of the shoreline at higher or lower risk relative to other parts of the shoreline, it is not a predictive tool. Southern Monterey Bay between Moss Landing and Wharf II is classified as having a ‘very high’ vulnerability (the highest designation). This classification indicates that the combination of unstable geomorphology, high rates of historic shoreline change, high wave energy, and moderate tidal range make this area highly susceptible to the adverse effects of sea-level rise.

Over the next century, the Intergovernmental Panel on Climate Change (IPCC, 2007) predicted a global average rate of sea-level rise of approximately 0.6 to 1.8 feet, although considerable uncertainty surrounds these values. For example, Rahmstorf (2007) projected higher rates of global sea-level rise between 1.6 and 4.6 feet over the next century. In this Coastal RSM Plan a rate of 3.0 ft/century is used (one foot over the next 50 years, assuming an exponentially accelerating rise). This estimate is precautionary for long-term planning for sea-level rise and is in line with Coastal Commission measures which require consideration of a three feet sea-level rise over the next century (Susan Craig, Coastal Commission, personal communication).

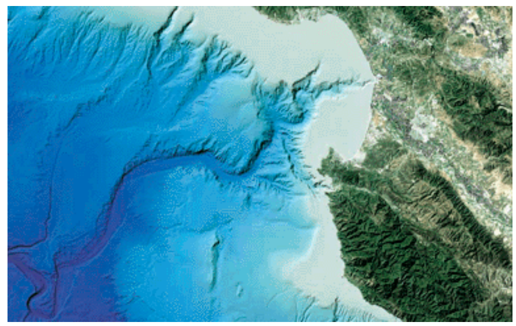
2.5 SEDIMENT SINKS

Potential sand sinks in the southern Monterey Bay littoral cell include removal by wind on to adjacent active dunes, Monterey Submarine Canyon, sand mining (currently only Marina), and offshore transport onto the continental shelf during winter storms.

2.5.1 Dune and Beach Accretion North of the Salinas River

Hapke et al. (2006) showed that between 1970 and 2002 the shoreline from approximately one mile south of Moss Landing Harbor to the Salinas River has slowly accreted (Figure 14). Recent dunes at the Salinas River are about 800 feet wide, then gradually narrow and end against the Flandrian dunes two miles south of the river mouth. The recent dunes to the north of the river extend to Elkhorn Slough and vary in width from 300 to 600 feet with crests rising 20-30 feet above sea level. Overall, the shoreline between Moss Landing and the Salinas River appears stable, with a relatively small net output of approximately 10,000 yd^3/year from the littoral budget by wind-blown sand building dunes.

2.5.2 Monterey Submarine Canyon



Monterey Submarine Canyon marks the boundary between the Santa Cruz littoral cell and the southern Monterey Bay littoral cell (Patsch and Griggs, 2007) (Section 2.1). Given its proximity to the shoreline (Figure 4), the head of Monterey Submarine Canyon is effective at capturing littoral sediments from the north and south that are diverted offshore by the Moss Landing harbor jetties. Smith et al. (2007) examined sequential multibeam sonar images sampled over 29 months and found substantial bedload sediment lost down the canyon over that short period of time. Patsch and Griggs (2006) estimated that the Canyon captures approximately 300,000 yd^3 of sand per year. This Coastal RSM Plan estimates that approximately 45,000 yd^3/year of this sand enters the Canyon from the south, transported alongshore from the discharge of the Salinas River. A potential sediment management alternative could be to capture this sand before it is lost down the canyon and beneficially re-use it for beach nourishment (Section 6.5.1).

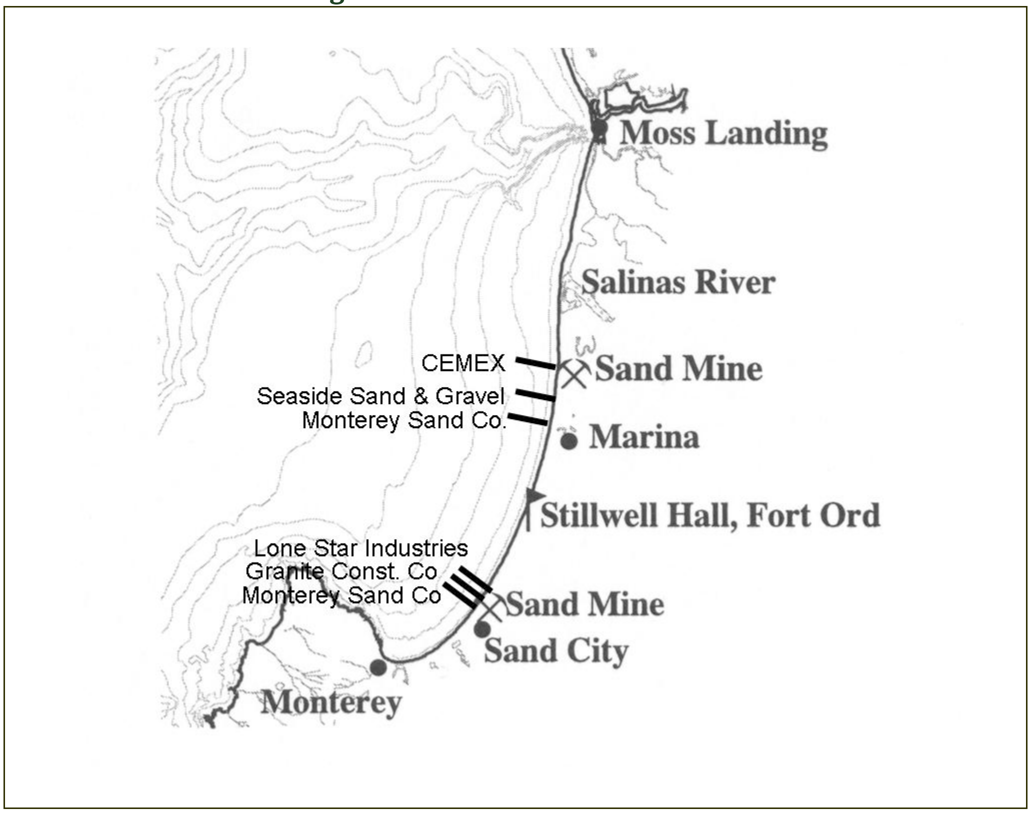
2.5.3 Historic Sand Mining at Marina and Sand City Using Drag Lines

Southern Monterey Bay has been the most intensively mined shoreline in the U.S. Sand mining near the mouth of the Salinas River started in 1906, and expanded to six commercial sites; three at Marina and three at Sand City (Figure 16). Five of these operations used drag lines to mine coarse sand from the surf/swash zone. In the summer months, when swell waves transported finer particle sizes back onshore, the operations were sometimes suspended. The sixth mine is located at Marina approximately two miles south of the Salinas River mouth, where the sand is hydraulically extracted just landward of the beach berm by a dredge floating on a self-made pond. Although all drag line sand mines were

closed by 1990, the Marina operation (Pacific Lapis Plant) owned by RMC Cemex is ongoing (Section 2.5.4). The sand of southern Monterey Bay is economically valuable owing to high silica content, hardness, roundness, amber color and a wide range of usable sizes, and is used for a variety of purposes including filtration, packing for water well casings, sandblasting, foundry and surface finishing (Combellick and Osborne, 1977). The time line of sand mining in southern Monterey Bay is as follows:

- ***1906* -** Sand mining started near the Salinas River mouth
- ***1940*** – Start of intensive drag line sand mining directly from the surf/swash zone
- ***1965*** – Start of hydraulic sand mining of the pond at Marina
- ***1980s* -** Larger hydraulic dredge introduced to mine pond at Marina continuing today
- ***1986* -** Sand mining by drag lines stopped at Marina
- ***1990* -** Sand mining by drag lines stopped at Sand City

Figure 16. Location of Sand Mines



Sand mining in southern Monterey Bay was not regulated until 1960, when the California State Lands Commission (CSLC) asserted jurisdiction on extractions below MHW, which by law, belongs to the State of California, and began licensing the operations through issuance of leases and charging royalties. The CSLC interest promoted mining, so they imposed a royalty rate with a base minimum mining volume for each company ranging from 26,000 yd^3/year to 52,000 yd^3/year. In the 1960s, the sand mining companies obtained a court order, which made the volumes of sand mined from specific mines proprietary to each other and the public, ostensibly to prevent price fixing, and hence, the amount of sand mined was unknown. In 1974, the U.S. Army Corps of Engineers (Corps) also required leases under the Rivers and Harbors Act of 1899, which regulates activities below MHW. They, however, attached maximum mining volumes to their leases ranging from 100,000 yd^3/year to 150,000 yd^3/year to protect the environment. After the first ten-year lease expired, the Corps concluded that the sand mining caused coastal erosion, and the permits were not renewed. Estimates of sand mining rates and the effects of sand mining can be found in Battalio and Everts (1989).

The actual quantities of sand mined as reported to the CSLC have now been obtained through a Freedom of Information request. A decadal break down of the volumes extracted at each mining operation is provided in Table 4. The mines were located either in Sand City or Marina (Figure 16) and their distances from Wharf II are shown. The amounts reported were audited by the CSLC based on sales receipts and are deemed accurate. Some of the files were missing, which resulted in gaps in the records, which were filled using a ten-year moving average filter.

Table 4. Decadal Sand Mined at Sand City and Marina (yd^3/year x 1000)

	Sand City				Marina				
	MSC[4]	GC[5]	PCA[2]	Sub-total	MSC[4]	SS[3]	PCA[1]	Sub-total	Total
Miles from Wharf II	3.0	3.1	3.5		9.1	9.5	9.8		
Years of Operation	1931-1990	1950-1969	1927-1986		1944-1986	1957-1970	1965-		
1940s	37	0	65	102	20	0	0	20	122
1950s	37	22	65	124	33	7	0	40	164
1960s	36	21	61	118	33	8	43	84	202
1970s	34	0	81	115	31	0	98	129	244
1980s	41	0	56	97	21	0	122	143	240
1990s	0	0	0	0	0	0	200	200	200
2000s	0	0	0	0	0	0	200	200	200

[1]PCA = Pacific Concrete and Aggregates was bought by Lone Star Industries and then by RMC Cemex in 2005
[2]PCA = Pacific Concrete and Aggregates was bought by Lone Star Industries
[3]SS = Seaside Sand and Gravel Company was bought by Floyd Bradley in 1970 and then sold to Standard Resources in 1974.
[4]The Monterey Sand Company decreased the reported values by 3% to account for wash loss, and this has been added back into the volumes.
[5]GC = Granite Construction.

2.5.4 Ongoing Hydraulic Sand Mining at Marina

The biggest change in the volume of sand mined in southern Monterey Bay was the introduction in 1965 of the dredging operation on the back beach at Marina (Table 4). The sand is mined by a floating dredge creating a large pond just landward of the beach berm (Figure 17, left panel). It is then pumped to a dewatering tower, kiln dried, screened and blended at a processing plant on the site. The height of the berm is at a similar elevation to the toe of the adjoining dunes. This mining operation efficiently takes advantage of the cross-shore sorting of sediment where coarse sand is washed over the berm to fill the pond during times of high winter waves and high tide. The pond is refilled with sediment every year as documented by aerial photographs. An example of when the pond has been filled is shown in Figure 17 (right panel) with the wrack line landward of the outline of the pond indicating the maximum extent of the swash carrying sediments onto the beach. This is direct evidence that the sand being mined in the dredge pond is derived directly from the ocean and constitutes a loss of sand from the littoral system.

Figure 17. Aerial Photographs of Marina Sand Mine

Normal dredging operation showing extent of dredge pond (Photo taken: October 28, 2005; California Coastal Records project by Kenneth and Gabrielle Adelman)

Pond filled by high waves at high tide carrying sand over the berm. Note dredge for scale (Photo taken: January 15, 2008 by Robert Wyland, NPS)

Between 1965 and 1970, Pacific Concrete and Aggregates (PCA) mined both the pond and the backing dunes, and when reporting the volumes extracted, differentiated the coarse fraction from the pond ('ocean sand') from the dune sand. The total volumes reported ranged from 68,000 yd^3/year to 98,000 yd^3/year. After 1970, PCA's Marina permit was to be combined with their Sand City operation, but was never implemented, and the subsequent volumes of sand mined at Marina were not reported. The last reported value of 98,000 yd^3/year to CSLC was in 1970 and is conservatively used as the estimate for the amount dredged until the mid 1980s when the operation started using an improved larger dredge. It is assumed that the amount of sand extracted increased with the new improved dredging operation, and that the mine increased their operation after the other mines closed in 1990, to meet consumer demand.

The total amount of sand sold annually today from the ongoing operation at Marina is 3.0 million tons, or approximately 235,000 yd^3/year, as reported by RMC Cemex (the owners since March 2005). It is assumed that at least 85% of the sand mined is from the dredge pond (the other 15% from dune sand), or approximately 200,000 yd^3/year (Table 4). This value is conservative (some dune sand is mixed with the beach sand to create the correct constitution for construction sand) and similar to the estimate obtained by assuming the pond is effectively filled every year and subsequently dredged to the area measured from aerial photographs, which is approximately 20,000 yd^2. The maximum depth of the dredged pond is based on the depth to which the dredge can reach, which is estimated to be 23-33 feet based on the reach of the dredge head. Assuming the pond could be dredged to the maximum depth, and no sand migrates into the pond from the ocean during the dredge period, the potential amount of sand mined ranges from 153,000 to 220,000 yd^3/year, which is consistent with the reported amount.

2.5.5 Offshore

Beach-size sand in southern Monterey Bay is transported both onshore and offshore. Swell wave action tends to move sand onshore because the magnitudes of wave-induced onshore velocities and accelerations generally exceed those in the offshore direction. Evidence of the onshore sediment during the summer is based on reports by sand miners that the sand in the summer was of smaller particle size at all sites along the shoreline (to the extent that they often ceased operation during the summer). Based on the mean, skewness, and sorting characteristics of sand distributions collected in southern Monterey Bay, Dorman (1968) concluded that sand moved offshore at the convergence of littoral currents just north of Sand City. The Fourier grain-shape analysis of Clark and Osborne (1982) showed that in southern Monterey Bay the offshore sands at 30 feet water depth are similar to the beach sands. However, the maximum distance that beach sands are transported offshore has not been resolved. The distance that rip currents can transport sand offshore is less than two surf zone widths (MacMahan et al., 2005). Using an extreme wave height estimate of 33 feet, two surf zone widths is a depth of approximately 40 feet.

2.6 SAND BUDGET

2.6.1 Sand Inputs and Outputs

In order to understand the sedimentary processes operating in the region, the sediment budget is broken down into spatial and temporal components. Table 5 presents a sand budget for the portion of the littoral cell between Moss Landing and the Salinas River mouth (north sub-cell).

This length of shoreline is fairly stable based on the 1970-2002 erosion/accretion rate data of Hapke et al. (2006) (Figure 14); the prevailing onshore winds are blowing sand onto the low accreting dunes backing the beach (Section 2.5.1). The balance of the beach-size sediment is lost down Monterey Submarine Canyon or to the offshore.

Table 5. Sand Budget Salinas River to Moss Landing (x1000 yd^3/year)

	Volume
Inputs	
Salinas River	55
Dune erosion	0
Outputs	
Dune accretion	10
Canyon and offshore	45

Table 6 presents a sand budget for the portion of the littoral cell between Wharf II and the Salinas River mouth. The budget is estimated for the 1940-1984 period when drag line sand mining was operational and 1985-2005, during which time drag line mining ceased, but hydraulic mining at Marina continued. In the 1985-2005 budget the residual offshore loss is much less than 1940-1984. This might suggest that either the shoreline is out of balance or the impact of mining sand directly out of the surf zone caused dune erosion to progress at a higher rate, possibly due to a higher overfill ratio compared to filling the dredge pond with marine sand. Overfill ratio refers to the fact that the primary replacement for the mined sand is dune sand, which has a smaller mean particle size than the mined sand; hence more dune sand is required to replace the mined sand. The larger and heavier sand particles remain in the energetic surf zone while the smaller sands are carried offshore where they can reside in less energetic wave conditions. The overfill ratio has been estimated to range from 25 to 75%.

Table 6. Sand Budget Wharf II to Salinas River mouth (x1000 yd^3/year)

	Volume	
Inputs	1940-1984	1985-2005
Salinas River	10	10
Dune erosion	350	200
Outputs		
Sand mining (Sand City and Marina)	190	200
Littoral transport and offshore	170	10

The sand budget for the portion of the littoral cell between Wharf II and north of Sand City encompassing three miles of shoreline (the south sub-cell) is presented in Table 7. The northern boundary of this sub-cell is assumed to coincide with the location of the medium sand stretching into the offshore (Figure 12). The historical drag line sand mining operations at Sand City were located between 3.0 and 3.5 miles from Wharf II (Figure 16). In the historical sediment budget (1940-1984) only the Monterey Sand Company extraction located at 3.0 miles is included, which is a gross estimate as the littoral transport is to the south. The residual of balance is assumed to be sand transported offshore. Assuming the offshore sediment transport is constant over time, the sediment budget since the sand mining ceased suggests that the dune erosion input is out of balance, and that it is possible further decreases in dune erosion rates may occur in the future or the offshore rate is incorrect.

Table 7. Sand Budget Wharf II to Sand City (x1000 yd^3/year)

	Volume	
Inputs	1940-1984	1985-2005
Dune erosion	48	21
Outputs		
Sand mining (Sand City)	37	0
Littoral transport	11	11

2.6.2 Sand Deficits Analysis

The above sediment budget analysis does not include the volume of sand lost with the recession of the beach. Beach recession means that the sand has eroded and not returned. The volume of sand associated with beach recession can be calculated based on the recession rate, the length of shore, and the height of the shore profile. Taking the height of the profile to be approximately 46 feet (Battalio and Everts, 1989), the conversion becomes 1.7 yd^3 per square foot of beach change. In this way it is possible to convert shore recession to the sand deficit for the entire littoral cell. The net sand deficit to southern Monterey Bay can be estimated by calculating the volume of beach sand eroded minus known sinks and plus known sources (Section 2.6.1).

Using an average erosion rate of 4.0 ft/year for the nine miles of shoreline between Sand City and the Salinas River, and assuming 1.7 yd^3 of sand equates to one square foot of beach, means that approximately 320,000 yd^3/year of sand is lost from these beaches. The same calculation for the three-mile stretch of beach between Sand City and Wharf II (southern bight) using an average erosion rate of 1.5 ft/year, indicates that 40,000 yd^3/year of sand is lost. Summing these two estimates equates to approximately 360,000 yd^3/year of sand eroded from the beaches of southern Monterey Bay between the Salinas River and Wharf II. Between the Salinas River and Moss Landing the four miles of beaches are accreting at a rate of approximately 1.0 ft/year, which equates to a beach-sand gain (sink) of 35,000 yd^3/year. In addition, the dunes here are also accreting with approximately 10,000 yd^3/year of sand (Figure 14).

Table 6 shows that bluff erosion provides approximately 200,000 yd^3/year to the southern Monterey Bay littoral cell. Multiplying this value by a 75% overfill factor (about 25% of the dune sand is too fine) indicates that 150,000 yd^3/year is retained within the littoral system. Approximately 200,000 yd^3/year is removed by the beach sand mining operation at Marina (Section 2.6.1).

Summing all these estimates indicates that between Moss Landing and Wharf II there is a sand deficit of 265,000 yd^3/year. This deficit equates to an erosion rate of 2.5 ft/year over the 12 miles of shoreline of the littoral cell (assuming 1.7 yd^3 of sand equates to one square foot of beach). Using an overfill factor of 25% reduces dune supply to 50,000 yd^3/year, and a lower net deficit of approximately 165,000 yd^3/year, which is equivalent to an erosion rate of 1.5 ft/year. This calculation indicates that coastal erosion will continue, but at a lower rate, due to a sediment deficit even if beach sand mining is stopped.

If the sand mining has a greater effect because coarser material is selectively mined, then the 200,000 yd^3/year mining rate has an amplified effect. Selecting a range from 1.5 to 4.0 (mined volume to shoreface volume), the 200,000 yd^3/year is similar to 300,000 to 800,000 yd^3/year of beach volume, which would increase net loss to 100,000 to 600,000 yd^3/year. The net deficit calculated previously (265,000 yd^3/year) is within this increased beach volume, indicating the net sediment deficit could be completely attributed to sand mining. This indicates that sand mining is a significant contribution to erosion; the post-sand mining recession rate may be small and governed by sea-level rise rather than sediment deficit. Based on this analysis it appears that sand mining contributes to between 50% and 100% of the erosion.

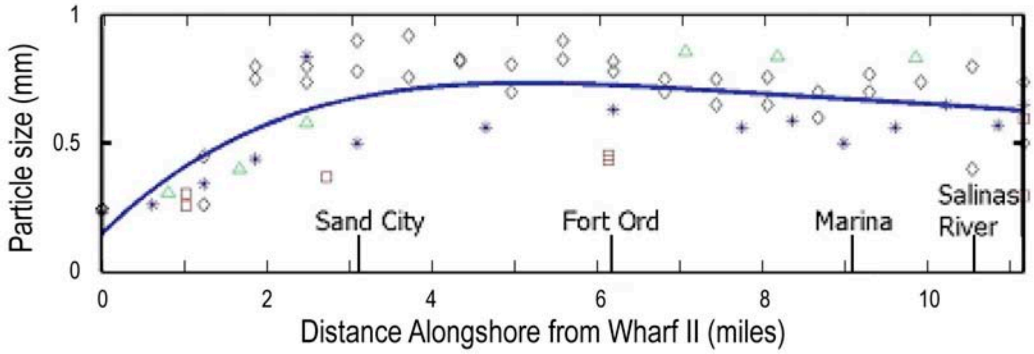
2.7 BEACH AND SHOREFACE SEDIMENT PARTICLE SIZE

The beaches and shoreface of southern Monterey Bay are potential receiver sites for beach nourishment and it therefore important to characterize their particle size distribution.

2.7.1 Beach Sand

Beach sand particle size distributions have been measured in several previous studies and the mean particle sizes are summarized in Figure 18 and Tables 8 and 9. This sand is already part of the active beach and is not a source of sand for nourishment. Clark and Osborne (1982) compared particle-size statistics from a year of low river discharge (February and June 1975) obtained by Combellick and Osborne (1977) to a year of high discharge (June 1978); samples were acquired approximately three feet above the line of MHW. Dingler and Reiss (2002) sampled at mid-tide level during September 1988 and April 1989, and qualitatively related the mean particle size to beach slope and wave climate. Sayles (1966) also collected samples at mid-tide level.

Figure 18. Mean Particle Size of Beach Sand



Samples acquired by Sayles, 1965 (triangles), Combellick and Osborne, 1977 (diamonds), Clark and Osborne, 1982 (stars), and Dingler and Reiss, 2002 (squares). The solid line is a second order polynomial fit in a least-square sense

Table 8. Mean Particle Size of Beach Sand in Southern Three Miles

Distance Wharf II (miles)	Mean Particle Size (mm)	Source
0.0	0.23	Clark and Osborne (1982)
0.0	0.245[1] & 0.24[2]	Combellick and Osborne (1977)
0.6	0.26	Clark and Osborne (1982)
0.8	0.307	Sayles (1966)
1.0	0.255[3] & 0.305[4]	Dingler and Reiss (2002)
1.2	0.34	Clark and Osborne (1982)
1.2	0.45[1] & 0.26[2]	Combellick and Osborne (1977)
1.7	0.4	Sayles (1966)
1.9	0.44	Clark and Osborne (1982)
1.9	0.8[1] & 0.75[2]	Combellick and Osborne (1977)
2.5	0.58	Sayles (1966)
2.5	0.8[1] & 0.74[2]	Combellick and Osborne (1977)
2.5	0.84	Clark and Osborne (1982)
2.7	0.37[3] & 0.37[4]	Dingler and Reiss (2002)

[1]Sample taken February 1975.
[2]Sample taken June 1975.
[3]Sample taken September 1988.
[4]Sample taken April 1989.

Table 9. Mean Particle Size of Beach Sand North of Sand City

Distance Wharf II (miles)	Mean Particle Size (mm)	Source
3.1	0.5	Clark and Osborne (1982)
3.1	0.78[1] & 0.9[2]	Combellick and Osborne (1977)
3.7	0.76[1] & 0.92[2]	Combellick and Osborne (1977)
4.3	0.82[1] & 0.83[2]	Combellick and Osborne (1977)
4.7	0.56	Clark and Osborne (1982)
5.0	0.81[1] & 0.7[2]	Combellick and Osborne (1977)
5.6	0.83[1] & 0.9[2]	Combellick and Osborne (1977)
6.2	0.455[3] & 0.435[4]	Dingler and Reiss (2002)
6.2	0.63	Clark and Osborne (1982)
6.2	0.78[1] & 0.82[2]	Combellick and Osborne (1977)
6.8	0.7[1] & 0.75[2]	Combellick and Osborne (1977)
7.1	0.86	Sayles (1966)
7.5	0.75[1] & 0.65[2]	Combellick and Osborne (1977)
7.8	0.56	Clark and Osborne (1982)
8.1	0.76[1] & 0.65[2]	Combellick and Osborne (1977)
8.2	0.84	Sayles (1966)
8.4	0.59	Clark and Osborne (1982)
8.7	0.6[1] & 0.7[2]	Combellick and Osborne (1977)
9.0	0.5	Clark and Osborne (1982)
9.3	0.7[1] &0.77[2]	Combellick and Osborne (1977)
9.6	0.56	Clark and Osborne (1982)
9.9	0.835	Sayles (1966)
9.9	0.74[1] & 0.74[2]	Combellick and Osborne (1977)
10.3	0.65	Clark and Osborne (1982)
10.6	0.4[1] & 0.8[2]	Combellick and Osborne (1977)
10.9	0.57	Clark and Osborne (1982)
11.2	0.5[1] & 0.74[2]	Combellick and Osborne (1977)
11.2	0.595[3] & 0.295[4]	Dingler and Reiss (2002)
11.2	0.65	Clark and Osborne (1982)

[1]Sample taken February 1975.
[2]Sample taken June 1975.
[3]Sample taken September 1988.
[4]Sample taken April 1989.

The smallest mean particle size of approximately 0.2 mm (fine sand) occurs near Monterey Harbor (Figure 18 and Table 8). The mean particle size then increases northwards to a maximum of approximately 0.7 mm (coarse sand) at Fort Ord, followed by a general decrease to 0.6 mm (coarse sand) further north towards the Salinas River mouth (Table 9). The composite particle size envelope south of Sand City is between 0.2 (fine) and 0.8 mm (coarse), but this range increases significantly approximately two miles from Wharf II. South of this two-mile marker the envelope is approximately 0.2-0.4 mm (fine-medium), whereas from mile two to mile three the envelope is larger at 0.4-0.8 mm (medium-coarse). North of Sand City the composite particle size envelope is between 0.5 and 0.9 mm (coarse).

Seasonal variations occur with coarser beach sands present during the more energetic winter months, and finer sands during summer months, when smaller particles are moved onshore by milder swell waves. Some of the alongshore variability in particle size also appears to be related to different sampling procedures. For example, the mean particle sizes reported by Dingler and Reiss (2002) are smaller than those of the other studies as they were acquired higher on the beach face. The increasing particle size of the beaches from Wharf II to Marina is positively correlated with wave height (Thornton et al., 2007).

2.7.2 Shoreface Sand

The shoreface is the part of the littoral cell between the beach (above MLLW) and the water depth where sediment is not disturbed by wave action during fair-weather conditions. The sand on the shoreface is likely to be constantly moving, either alongshore, onshore or offshore depending on seasonal wave conditions. Along most of the shoreline from the north to Sand City the sediment particle sizes are much smaller than on the beach. However, a considerable region of medium-size sand occurs on the outer shoreface and further offshore at Sand City, which is comparable in particle size to the beach sands to the south. The sand offshore of the shoreface could be a potential source for nourishment for the south sub-cell.

3. CRITICAL AREAS OF EROSION

This section provides an analysis of critical areas of erosion within the southern Monterey Bay littoral cell. In order to delineate these areas, two criteria are adopted that are used to prioritize erosion responses; risk of erosion and consequences of erosion.

3.1 RISK AND CONSEQUENCES OF EROSION

The risk of erosion is based on the risk analysis developed by PWA and Griggs (2004). This method establishes our first level of risk assessment over a planning horizon of 50 years:

- what facility is at risk?
- what is the probability that it will be impacted by erosion?

PWA and Griggs (2004) defined three risk categories to Monterey Regional Water Pollution Control Agency (MRWPCA) facilities between Marina and Wharf II. These risk categories were determined by assuming that current long-term historic erosion rates would continue over the next 50 years. For this assessment of critical areas of erosion, the historic erosion rate results of Thornton et al. (2006) are used (Table 3) with an increment to the erosion rate added for potential increases due to future sea-level rise (Section 2.4). The risk categories are:

- ***Low risk*** - facilities with a low probability of being impacted by erosion over the next 50 years.
- ***Moderate risk*** - facilities not likely to be affected by chronic erosion over the next 50 years, but potentially susceptible to short-term storm event erosion within the planning horizon.
- ***High risk*** - facilities that are located seaward of the shoreline position anticipated in 50 years or presently vulnerable to short-term event-based erosion.

Future erosion rates could be lower if sand mining at Marina ceases (Section 2.5.4). In this case, moderate and high risk facilities would have a larger buffer zone of protection, and management action could be delayed beyond the time lines recommended in this Coastal RSM Plan. Conversely, erosion rates may increase if future sea-level rise accelerates over the predicted estimates (Section 2.4), and management may need to be more immediate.

All the facilities identified as at high or moderate risk of erosion were then assessed as to their future value. This assessment is based on the SMBCEW (2006c) evaluation of the economic (potential loss of facility), environmental (potential loss of habitat), and safety and human health (potential loss of life) consequences of loss of the facility. The facilities are designated as high consequence, moderate consequence, or low consequence.

3.2 SITE SHORT-LIST

The locations of high to moderate risk and high consequence critical areas of erosion are shown in Figure 19, summarized in Table 10, and described in detail in Section 3.3. They are also available as GIS data files in CSMWs GIS database.

Figure 19. Location of Critical Areas of Erosion

Table 10. Critical Areas of Erosion

Location	Summary of Facility	Erosion Rate (ft/year)	Risk of Erosion	Consequences of Erosion
Sanctuary Beach Resort near Reservation Road	Vacation complex approximately 120 feet from the bluff top	~5.5	High (compromised in approximately 20 years)	High economic
Tioga Avenue and Highway 1 at Sand City	Bluff top road, storage facility, Highway 1 and proposed hotel developments	~3.5	High (seaward end of Tioga Avenue eroding)	High environmental safety economic
Seaside Pump Station at Bay Avenue	Raw wastewater pump station approximately 100 feet from the bluff top	~3.0	High (compromised in approximately 30 years)	High economic environmental human health
Monterey Interceptor between Seaside Pump Station and Wharf II	Raw wastewater pipeline approximately 115 to 175 feet from the bluff top or buried mid-beach	~1.0-3.0	High to moderate (some dune portions compromised in approximately 40 years; beach sections exposed in winter)	High economic environmental human health
Monterey Beach Resort, Highway 1 and Resort Access Road	Hotel on Del Monte Beach, hotel access road and Highway 1	~1.5	High (erosion already compromising fronting seawall)	High economic safety
Ocean Harbor House Condominiums and Del Monte Beach Subdivision	Condominium complex on the bluff top	~1.0-1.5	High (erosion compromising fronting riprap)	High economic safety
Monterey La Playa Town Homes at La Playa Street	Homes, one of which is 30 feet from the bluff top	~1.0	High to moderate (some homes compromised in approximately 30-50 years)	High economic

3.3 HIGH TO MODERATE RISK AND HIGH CONSEQUENCE AREAS

3.3.1 Sanctuary Beach Resort near Reservation Road

Site

The Sanctuary Beach Resort is located on a 17-acre site between Dunes Road and the coastal bluff fronted by 550 feet of shoreline (Figure 20). The development includes 112 vacation units, a 72-unit hotel, a conference center, retail facilities, a large restaurant, a health club, a recreational building, two tennis courts, a pool, playground and nearly 500 parking spaces. The resort was constructed in the mid 1990s on land formerly owned by the Monterey Sand Company. Because the dunes had been mined for sand for about 45 years (Table 4), the site lies at a lower elevation than adjacent dunes to the north and south. The resort contains buildings and paving on 6.5 acres, landscaping on four acres, and restored dune habitat on 6.5 acres. A boardwalk provides beach access across the southern portion of the dunes. The seaward-facing wall and buildings of the Sanctuary Beach Resort complex are set back approximately 120 feet from the top of the bluff (Figure 20).

Figure 20. Sanctuary Beach Resort

Photo taken: Unknown

Risk

The bluff at this location has eroded approximately 4.5 ft/year over the past 20-30 years (Table 4), and with relative sea-level rise is estimated to erode at approximately 5.5 ft/year over the next 50 years. The erosion rate has increased over the past 20 years (Table 3), which may be the result of increased extraction of beach sand from the mine located only one mile north of the resort. Future dune erosion of 5.5 ft/year would mean that the Sanctuary Beach Resort would be compromised in approximately 20 years time and is therefore designated as a facility at high risk of erosion.

Consequences

The loss of this facility would have high economic consequences to the region as it is a popular tourist destination. The loss of the dunes on this site would also impact endangered western snowy plover, and the black legless lizard (Section 4.2).

The Sanctuary Beach Resort currently raises funds from a restoration fee (currently $15 per night) to protect endangered species and habitat on its property. The resort has already invested in mitigating threats by installing a 'lizard crossing' beneath the main entry road.

Figure 20 also shows the location of a number of Marina Coast Water District (MCWD) facilities. The facilities include infrastructure and offices on a 12-acre site along 400 feet of shoreline. The seaward fence of the site is at the dune cliff edge in places. Buildings and infrastructure are set back 70-90 feet from the fence. Using an erosion rate of 5.5 ft/year the on-site facilities would be under threat of erosion in 10 to 15 years time. Hence, the MCWD site is at high risk of erosion. Indeed, wells on the beach at the end of Reservation Road that used to supply water to a small desalination plant were compromised by coastal erosion and are no longer operational. Although the MCWD site is at high risk of erosion, there are plans to abandon and remove the facility over the next few years, and hence, there are only low future consequences.

3.3.2 Sand City and Tioga Avenue West of Highway 1

Site

From 1927 to around 1990 the parcel of dunes west of Highway 1 and for about 0.8 miles north of Tioga Avenue was the location of sand mining operations (Section 2.5.3), which left the site in an environmentally degraded condition. In order to boost the economy, Sand City has, since the 1970s, sought to provide for commercially viable resort and recreational development on designated portions of its coastline. In the early 1980s, the certified Sand City Local Coastal Program (LCP) (Section 8.3.1) designated the former sand mine dune location for visitor-serving commercial uses, with a density not to exceed 650 units. In 1996, the City of Sand City entered into a Memorandum of Understanding with Regional and State Park agencies (the Coastal Commission was not party to the agreement) to permit visitor-serving and residential uses at two specific areas north of Tioga Avenue, which are still designated as such in the LCP.

Currently, remnants of a cement mixing facility are located immediately north of Tioga Avenue in Sand City. The facility is now used for temporary storage of construction equipment (Figure

21). Un-engineered structures are holding the shoreline seaward of its natural position creating a peninsula effect (Figure 6) and in the process they block lateral public access (creating safety hazards), prevent natural shoreline retreat, and beach area is lost both for recreation and as a habitat. Also, portions of Highway 1 curve seaward towards the dunes at Sand City. This section of the highway is approximately 400 feet from the dune edge and will ultimately be threatened by coastal erosion.

Figure 21. Storage Facility at the end of Tioga Avenue

Photo taken: September 19, 2007 (Justin Vandever, PWA)

Risk

The future erosion rate of the unprotected dunes adjacent to the Sand City site is estimated to be approximately 3.5 ft/year. Continued loss of beach in front of the structures at Sand City will lead to further undermining, erosion, and eventually total failure. The existing storage facility and part of Tioga Avenue which provides access to the facility and the beach would be lost. The Tioga Avenue/Sand City complex is designated as a facility at high risk of erosion.

Consequences

The current land use has a relatively low economic consequence, but a future threat to Highway 1 (approximately 100 years) could have moderate levels of consequence over the 50 year planning horizon. However, there are several proposed development projects at the Sand City site, located along the west side of Highway 1, north of Tioga Avenue, which would increase the economic consequence of erosion. The Sterling Center is a proposed resort on eight acres immediately north of Tioga Avenue. This proposed development would consist of a 136-unit hotel with restaurant, conference and retail space, and parking garage. North of the Sterling Center is a plot of land owned by the Sand City Redevelopment Agency, on which they are pursuing development of a 16-acre resort complex including 155 vacation condominium units, an 80-unit hotel, three restaurants, conference and meeting facilities, a spa and health/wellness center, and parking structures.

In addition, Monterey Peninsula Water Management District (MPWMD) intends to implement a water project at the site to address water resources issues in Sand City. The Sand City Desalination Plant would be constructed on a parcel of land approximately 0.7 miles north of Tioga Avenue and three horizontal directionally drilled wells and three radial wells are proposed seaward of Sand Dunes Drive between Tioga Avenue and Monterey Beach Resort (see also Section 3.3.5). Water would be obtained from the shallow groundwater aquifer. As of October 2007, Sand City had completed and certified the Environmental Impact Report (EIR) in accordance with California Environmental Quality Act (CEQA) requirements, obtained Coastal Development Permit approval and permit amendment from the Coastal Commission, and obtained a U.S. Fish and Wildlife determination that the project construction would not result in a taking of species listed under the Endangered Species Act.

As part of their condition compliance, the City of Sand City submitted an adaptive management plan to address the potential risk to the desalination components that could be subject to shoreline erosion. The plan includes surveying the bluff and shoreline edge at regular intervals to assess the risk to the wells and pipeline infrastructure, as well as monitoring the salinity level of the feed water. At the onset of a 'risk condition' (i.e. when the bluff retreats to within five feet or the salinity level exceeds an established threshold), measures will be taken to relocate the wells to an approved location in consultation with the Coastal Commission. Coastal armoring is not contemplated as a means of protecting the project components and would only be considered as a last resort.

Overall, the potential future consequence of erosion at Sand City west of Highway 1 is high due to potential future environmental, safety, and economic factors.

3.3.3 Seaside Pump Station at Bay Avenue

Site

Seaside Pump Station (completed in 1983) is located at the junction of Bay Avenue and Vista del Mar Street. Seaside County Sanitation District's former wastewater treatment plant was originally located adjacent to Seaside Pump Station. That plant was decommissioned in 1990 when a Regional Treatment Plant was completed north of Marina, and all of the treatment plant tanks and structures were demolished. The bulk of the site was sold to the California Department of Parks and Recreation (CDPR), although MRWPCA retains ownership of the Seaside Pump Station site. The Seaside Pump Station is approximately 100 feet from the base of the low-lying dunes that front the facility (Figure 22).

Figure 22. Seaside Pump Station

Photo taken: October 28, 2005; California Coastal Records project by Kenneth and Gabrielle Adelman

Risk

The historic rate of erosion has been approximately 2.5 ft/year, and the future rate is estimated at 3.0 ft/year. The facility could be compromised by erosion in about 30 years. However, the site would be vulnerable to significant wave damage and flooding before that time due to the low elevation of the fronting dunes. The top of the dunes are at approximately 25 ft NAVD compared to the base flood elevation (BFE – maximum elevation of wave runup and overtopping during a 100-year flood event) at this location of 27 ft NAVD (FEMA, 2007). Seaside Pump Station is considered a high erosion risk facility (PWA and Griggs, 2004).

Consequences

Seaside Pump Station pumps all of the raw (untreated) wastewater from the cities of Pacific Grove, Monterey, Del Rey Oaks, Seaside, and Sand City through the regional wastewater system to the MRWPCA Regional Treatment Plant. The pumps are a key component of the system and need to remain in full operation indefinitely, so erosion would have significant economic, environmental, and human health impacts. A breach of this facility would have environmental impacts to the dunes and beaches, and water quality impacts within the MBNMS. Seaside Pump Station is therefore designated as a high consequence facility.

3.3.4 Monterey Interceptor between Seaside Pump Station and Wharf II

The Monterey Interceptor pipeline can be divided into three segments each with a different set of erosion concerns; Seaside Pump Station to Monterey Beach Resort, Monterey Beach Resort to Tide Avenue, and Tide Avenue to Wharf II (Figure 7).

Site

The Monterey Interceptor between Seaside Pump Station and Monterey Beach Resort is buried in dunes, approximately 100 to 175 feet from the dune bluff. Between Monterey Beach Resort and Tide Avenue the pipeline is not under imminent threat of erosion damage (PWA and Griggs, 2004). However, the pipeline could be vulnerable to erosion damage during a large storm event towards the end of the 50-year planning horizon. From Tide Avenue to Monterey Pump Station, the pipeline is located a minimum of 115 feet from the shoreline. Between Monterey Pump Station and Wharf II, the Monterey Interceptor was originally buried beneath the back beach, but due to erosion is now at mid-beach.

Risk

Based on approximate future erosion rates of between 1.5 and 3.0 ft/year, the shoreline between Seaside Pump Station and Monterey Beach Resort would be expected to erode 75-150 feet over the next 50 years, and parts of the pipeline between these two locations may be compromised over the next 40 years. The erosion could uncover the pipe and/or manholes and make them vulnerable to damage. Hence, the Monterey Interceptor between Seaside Pump Station and Monterey Beach Resort is a facility at high risk of erosion (PWA and Griggs, 2004).

Between Monterey Beach Resort and Monterey Pump Station, the future erosion rate is estimated at approximately 1.5 ft/year, and therefore the pipeline would be at low risk of chronic erosion over the next 50 years. However, given the accuracy of the base map (+/- 16 feet) used to define the position of the pipeline in the dunes here (PWA and Griggs, 2004), it is designated as a moderate risk facility with the potential for storm damage towards the end of the 50-year planning horizon (PWA and Griggs, 2004).

Between Monterey Pump Station and Wharf II the shoreline is estimated to erode at an average rate of approximately 1.0 ft/year and the beach has been observed to scour during storms (Dingler and Reiss, 2002). Manhole covers are now sometimes exposed at low tide during the winter and are vulnerable to damage. At this location, the Monterey Interceptor pipeline is under imminent threat of erosion damage and is at high risk of erosion (PWA and Griggs, 2004).

Consequences

The Monterey Interceptor carries all of the raw (untreated) wastewater from the cities of Pacific Grove and Monterey. This flow is pumped through Monterey and Seaside Pump Stations to the MRWPCA Regional Treatment Plant. The exposure of the pipeline could ultimately be a threat to marine resources if erosion caused a spill to occur. The pipeline is a vital facility that needs to remain fully operational indefinitely, and the consequences of erosion would be significant economic, environmental, and human health impacts. A breach to this facility would have environmental impacts to the dunes and beaches, and water quality impacts within the MBNMS. The Monterey Interceptor between Seaside Pump Station and Wharf II is therefore a high consequence facility.

3.3.5 Monterey Beach Resort, Highway 1 and Resort Access Road

Site

The 196-room Monterey Beach Resort hotel was constructed on north Del Monte Beach in 1968 and consists of five four-story buildings, a restaurant, meeting rooms, a pool, and parking structures (Figures 5 and 23). It was originally constructed with surrounding seawalls and a large beach area fronting the hotel. This part of Del Monte Beach was a major attraction of the hotel. Since the hotel was built, shoreline erosion has occurred up coast and down coast, and the hotel has become a headland.

Figure 23. Monterey Beach Resort

Photo taken: August 12, 2003; California Coastal Records project by Kenneth and Gabrielle Adelman

Risk

Here future erosion rates are estimated to be approximately 1.5 ft/year. When the existing seawall was built in 1968, beach elevations in front of the hotel were over three feet higher than today. Erosion has lowered the beach elevations such that during high tides there is now no beach access in front of the hotel. The existing seawall is not embedded deep enough into the sand to withstand further beach erosion. This structure was partially breached during the severe El Niño winter of 1983 when large waves coincident with very high tides surged through the stairwell opening in the wall, broke through the joints in the wall causing loss of fill behind. In 2004, much of the south wing wall of the seawall failed with collapse of the fill behind the wall. Emergency riprap was brought in to fill this void (Figures 5 and 23). Because of the erosion problem the hotel has received approval from the Coastal Commission to build a new seawall. The seawall has not yet (June 2008) been constructed. It would comprise a 600-foot long driven sheet-pile metal seawall with a footprint of 1,000 square feet immediately adjacent to the existing seawall. The permitted project would also involve removal of the existing end walls and replacement with driven sheet-pile walls.

In addition to the Resort, the access road on Sand Dunes Drive and the offramp to Highway 1 are within the 50-year erosion zone. The Monterey Beach Resort and the road infrastructure are designated as facilities at high risk of erosion.

Consequences

The hotel continues to be a popular tourist destination and loss of this facility would have high economic consequences. In addition, the presence of the seawall has led to loss of the fronting beach for recreational purposes and at high tide there is a public safety issue as lateral access along the beach is compromised. Monterey Beach Resort, access road, and Highway 1 access ramps are designated as high consequence facilities.

3.3.6 Ocean Harbor House Condominiums/Del Monte Beach Subdivision

Site

Beginning in 1968 the first eight buildings (Ocean House) of an apartment complex were constructed on the dunes on Surf Way in Monterey. An additional six buildings (Harbor House) were constructed further landward in 1974. At the time of construction, the City of Monterey allowed the front buildings to overhang the utility easement running parallel to the bay in return for all land seaward of the easement, which means the City owns all land up to the edge of the front buildings. Collectively, the 172 units, now converted to condominiums, are called Ocean Harbor House (Figures 5 and 24).

Figure 24. Ocean Harbor House Condominiums

Photo taken: October 11, 2004; California Coastal Records project by Kenneth and Gabrielle Adelman

Since its construction, Ocean Harbor House has had a history of erosion problems. Following the 1982-83 El Niño, erosion of the dunes had approached to within 14 feet of the shallow pilings supporting the complex (the bases of the pilings were at an elevation ten feet above MLLW). Emergency riprap (600 feet of rock over 20 feet high) was placed on Del Monte Beach to provide protection to the buildings but subsequently had to be removed, following completion of an Environmental Impact Report (EIR) in 1984, because of City of Monterey regulations regarding placement of materials on a public beach. The front pilings were subsequently removed and 50-55 foot deep concrete caissons were then poured along with grade beams to support the front row of condominiums. Despite the deep caissons and grade beams, waves continued to erode the dune face back beyond the two rows of caissons (Figure 5, right panel). Additional emergency riprap was required to protect the condominium units in 2002 and another EIR was completed to assess a number of longer-term alternatives to the riprap. While the preferred alternative was to remove the frontal units, the owners of the condominiums preferred to build a seawall to protect their property. The application was approved by the Monterey City Planning Commission, the Monterey City Council, and the Coastal Commission, with substantial mitigation fees involving nourishing the beach in front of the seawall. The seawall will be within the footprint of the existing building foundations, and will not encroach onto the City of Monterey (Del Monte Beach) property.

There is no infrastructure to the east of the condominiums, whereas to the west, Tide Avenue with 15 homes runs parallel to the shore on the dune top. Tide Avenue is generally greater than 150 feet from the dune edge, although a short stretch appears to be within 50 feet. Landward of Tide Avenue is Del Monte Beach subdivision comprising several apartment buildings and 128 single-family homes, and associated infrastructure. The neighborhood has some problematic storm drain and sewer infrastructure that are targeted for improvements, including abandonment of a sewer main within the open space dune area and the consolidation of storm drain outfalls.

Risk

A new seawall fronting Ocean Harbor House is being engineered to withstand storm wave-attack and is considered a long-term (50-year planning) solution to erosion of the condominiums. However, it is likely that the new seawall will cause the fronting beach to further lower in elevation because the armoring will provide a surface for wave reflection. The seawall will also enhance the peninsula effect at this location, with the dunes to the east and west continuing to erode. Because of the seaward position of Ocean Harbor House and the limited set back of the Tide Avenue community, the condominiums and the Del Monte Beach subdivision are designated as facilities at high risk of erosion.

Consequences

The condominiums and properties along Tide Avenue are privately owned and the consequences of their loss would be economically damaging and hazardous to safety, especially to individual owners. There is no lateral access along the beach in front of the condominiums at high tide now and the frequency of access loss will increase in the future. Coastal Commission conditions of approval are being designed to provide lateral access around the back of the most seaward condominiums. The loss of access roads can also have impacts to public safety for emergency services. Ocean Harbor House condominiums, Tide Avenue and Del Monte Beach subdivision are designated as high consequence facilities.

3.3.7 Monterey La Playa Town Homes at La Playa Street

Site

The La Playa town homes are located in the dunes at the end of La Playa Street in Monterey, and were originally constructed as apartments in 1964. The development was later converted to condominiums (Figure 25).

Figure 25. Monterey La Playa Town Homes

Photo taken: October 28, 2005; California Coastal Records project by Kenneth and Gabrielle Adelman

Risk

The westernmost condominium sits only 30 feet from the dune edge and is protected by a small pile of riprap, with most of the remaining complex over 50 feet from the shoreline. Long-term erosion rates are likely to be greater than 1.0 ft/year, and therefore structures towards the western end of the complex are at high risk of erosion over the next 50 years. In addition, the structures could be vulnerable to wave damage and flooding due to the low elevation of the fronting dunes, compared to the base flood elevation (BFE – maximum elevation of wave runup and overtopping during a 100-year flood event) at this location of 22-26 ft NAVD (FEMA, 2007).

Consequences

The town homes are privately owned and the consequences of their loss would be economically damaging to individual owners. Lateral access along the beach in front of the westernmost condominiums would also be lost and the beach would be hazardous at high tide. The La Playa town homes are considered to be high consequence facilities.

3.4 LOW RISK AND/OR LOW CONSEQUENCE AREAS

Numerous facilities along the southern Monterey Bay shoreline have either a low risk of erosion or a low consequence factor, and are not discussed further in this Coastal RSM Plan. It is recommended however that these facilities be considered for set back or relocation opportunistically as maintenance or other funds become available. These facilities are:

- Moss Landing spit community including the research facilities of MBARI
- Monterey Dunes Colony

- Ocean outfall pipeline near Marina sand mine
- Marina Coast Water District facilities near Reservation Road
- Fort Ord storm water and sewer outfalls
- Fort Ord monitoring and injection wells
- Bay Avenue storm water outfall
- Roberts Lake/Laguna Grande outfall
- Sand Dunes Drive
- Monterey Pump Station
- Del Monte Lake outfall
- Lake El Estero Pump Station and outfall
- Catellus East property near Wharf II.

3.5 CRITICAL AREAS OF EROSION SHORT-LIST

In summary, the following lengths of beach are short-listed as high-risk and high-consequence critical areas of erosion, for three main reasons:

1. Areas where the facility is located beneath the beach and is under threat over the next 50 years from exposure due to beach lowering as the shoreline profile migrates landward. These critical erosion areas include:
   - Monterey Interceptor between Monterey Pump Station and Wharf II.

2. Areas where the facility is located on the dune top and is under threat over the next 50 years through continued erosion of the dune face. These critical erosion areas include:
   - Sanctuary Beach Resort
   - Seaside Pump Station
   - Monterey Interceptor between Seaside Pump Station and Monterey Beach Resort.
   - Monterey La Playa town homes at La Playa Street

3. Areas where armoring of the facility exists causing reduction of local supply of sediment to the beach, causing passive erosion and increasing the potential for undermining the armoring once the sea walls are impacted by waves as well as retreat of the beach on either side of the hard structure. These critical erosion areas include:
   - Tioga Avenue at Sand City
   - Monterey Beach Resort
   - Ocean Harbor House condominiums.

The sections of the Monterey Interceptor from Monterey Beach Resort to Tide Avenue, and from Tide Avenue to Monterey Pump Station are at moderate risk of erosion, with high consequences.

4. CRITICAL SPECIES AND HABITAT

One of the most critical functions of the southern Monterey Bay dune and beach system is its role as a habitat for a unique flora and fauna. As the dune system has been reduced and fragmented, the risk of extinction has increased for some of these species. For this reason, evaluation of potential impacts to these fragmented population remnants needs to be considered in the larger context of cumulative impacts as well as site specific impacts. The beaches of southern Monterey Bay are habitat for numerous invertebrate species, which provide an important food source for shorebirds, seabirds, marine mammals, and fish. A key factor that needs to be considered as part of the feasibility for beach nourishment is the potential for smothering or temporary loss of marine life or habitats when placing the sand. The locations of critical species and habitat are available as GIS data files in CSMWs GIS database and are discussed in this section. The impacts of beach nourishment on critical species and habitat are explained in Section 5.1.

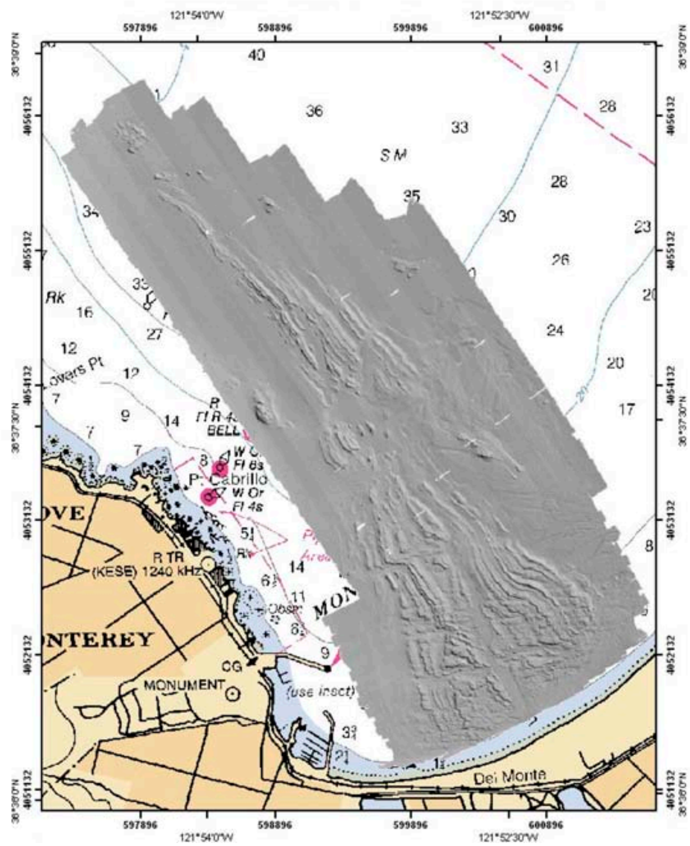
4.1 SENSITIVE HABITAT

The Corps requires a sensitive habitat survey for beach nourishment projects, which includes pre- and post-project monitoring and proposals for mitigation for any impacts to sensitive habitats adjacent to and down coast of the receiver site. In southern Monterey Bay, these habitats would include rocky reef, kelp forest, eelgrass meadow, sandy beaches, sandy subtidal, and coastal dunes.

4.1.1 Rocky Reef

A low relief rocky reef of shale known as Del Monte Shale Beds (or Tanker Reef) lies off the south end of Del Monte Beach (approximately 1.5 miles from Wharf II and stretching almost to the Monterey Beach Resort), approximately 600 feet from the beach in 30-230 feet of water (Kvitek et al., 2004; Iampietro et al., 2005). The shale outcrop covers an area of over 3.5 square miles (stretching over three miles offshore, Figure 26) and is composed of Miocene Monterey Formation. The reef supports a kelp forest and other submerged aquatic vegetation as well as a number of species of fish and invertebrates. In 2005, the Natural Resources Defense Council (NRDC) submitted a proposal to the California Resources Agency which included nominating this reef for Marine Protected Area (MPA) status as a marine park. The proposed MPA was not adopted by the CDFG as part of the central coast MPAs and therefore does not appear in the published 2007 MPA network. Since then, the NRDC has not further pursued designation of this area.

Figure 26. Location of Del Monte Shale Beds



Source: Kvitek et al. (2004)

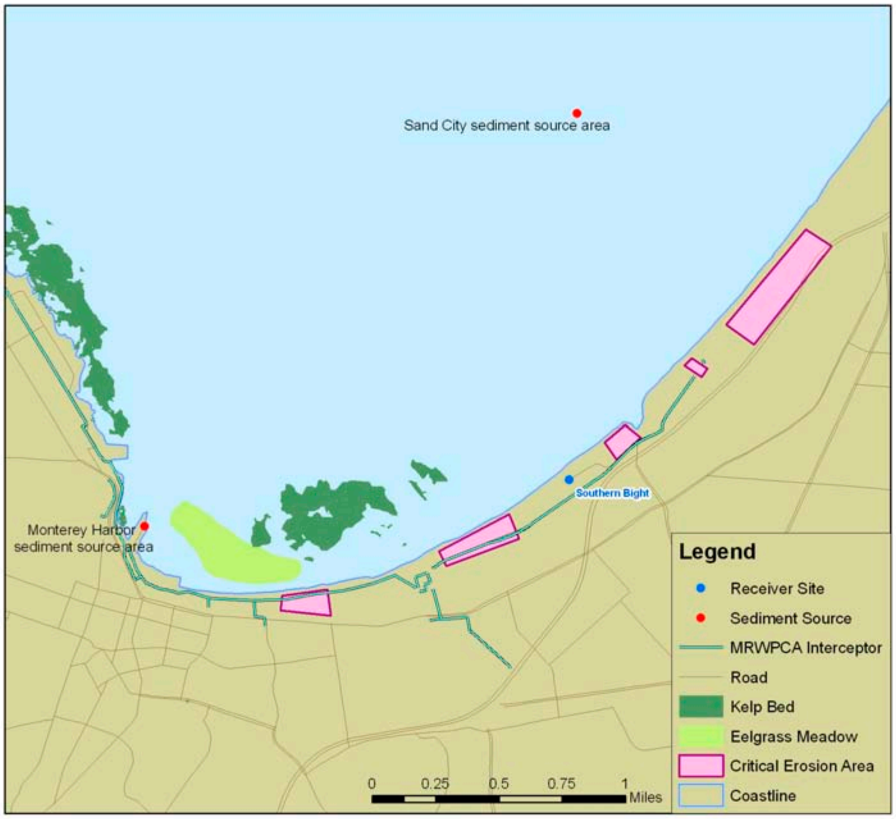
The reef is home to over 20 species of rockfish (*Sebastes* spp.), several of which have been identified by the National Marine Fisheries Service (NMFS) as over-fished. It provides juvenile fish habitat for deeply depleted species such as yelloweye and canary rockfish, and habitat for vermilion, and blue and copper rockfish adults and juveniles. All rocky subtidal areas are considered Essential Fish Habitat for managed fishery species. This reef is also known for worms and beds of boring clams that inhabit the soft shale substrate.

4.1.2 <u>Kelp Forest</u>

Attached to the rocky reef is a kelp forest consisting of giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystis leutkeana*). Kelp favors nutrient-rich, cool clear water through which light penetrates easily, and generally occurs near the closure depth (Figure 27). The kelp forest may support thousands of invertebrate individuals, including polychaetes, amphipods, decapods, and ophiuroids, that are prey for birds and marine mammals and support commercial fisheries.

California sea lions, harbor seals, sea otters, and whales feed in the kelp or escape storms or predators in the shelter of kelp, which help weaken currents and waves. Kelp forests are considered a submerged aquatic vegetation of special interest in California and Essential Fish Habitat. The distribution of this kelp forest varies seasonally and from year to year in the southern bight.

Figure 27. Location of the Kelp Forest and Eelgrass Meadow

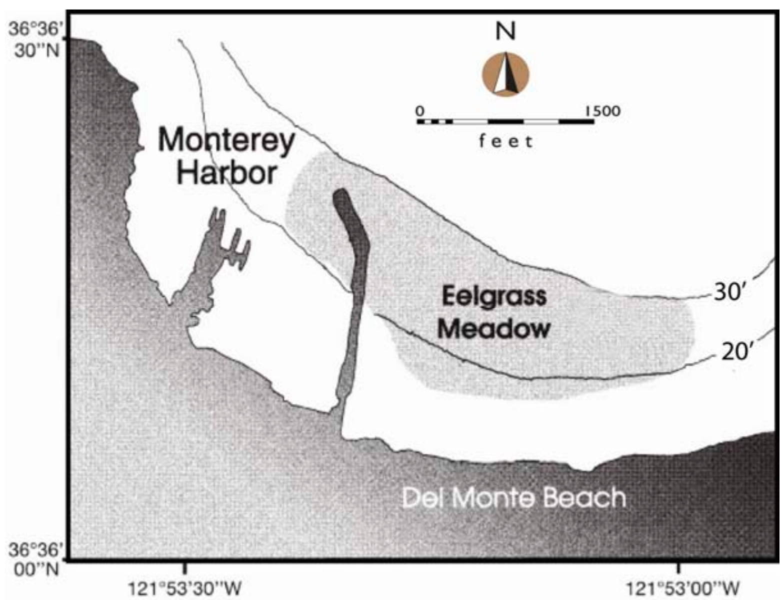


4.1.3 Eelgrass Meadow

Eelgrass (*Zostera marina*) is considered important submerged aquatic vegetation of special interest in California, special aquatic sites (SAS) (vegetated shallows) under the federal Clean Water Act of 1972 (SAIC, 2007), and Essential Fish Habitat. Cutting and disturbing eelgrass is prohibited by California fishing regulations. Eelgrass provides habitat for a variety of invertebrates and fishes, including nursery habitat. The primary factors controlling eelgrass growth are light availability, substrate composition, temperature, salinity, nutrient availability, and wave/current energy. Light affects the depth distribution of eelgrass through its role in photosynthesis. The degree to which light is attenuated with depth in the water column is a strong determinant of the lower limit to which eelgrass can grow. Eelgrass can grow in a wide variety of substrates, but generally they flourish in medium to fine sands that contain relatively high levels of organic matter and nutrients.

Prior to 1993, the Del Monte eelgrass meadow covered a continuous 0.1 square miles (30 hectares) of the sea bed in water depths of 10-30 feet inshore and west of the rocky reef and kelp forest and east of Wharf II (Figures 27 and 28). Zimmerman et al. (2001) indicated that the bed was fragmented and reduced to less than 50% of its total size following heavy grazing by a southern species of limpet that began in 1993. The prospects for recovery of the bed to its former size were not considered favorable due to the limpet grazing. However, data after 2001 are limited and the status of this eelgrass meadow was not known as of 2005 (CDFG, 2005).

Figure 28. Location of the Eelgrass Meadow



Source: Zimmerman et al. (2001)

4.1.4 Sandy Beaches

Dune-backed sandy beaches exposed to surf are the most prevalent habitat in southern Monterey Bay. Beaches are primary habitat for a variety of invertebrate species including crustaceans, mollusks, polychaetes and insects, as well as meiofauna that can reach high abundance and biomass. These species are prey resources for fishes, seabirds, shorebirds and marine mammals. Beaches also provide roosting areas for shorebirds, pelicans, gulls, and other seabirds and haul-out habitat for pinnipeds, such as harbor seals and sea lions. Western snowy plovers (a threatened shorebird species) nest and rear chicks on beaches in southern Monterey Bay, and California grunion are known to use the beaches of southern Monterey Bay for spawning.

4.1.5 Sandy Subtidal

Extensive sandy subtidal and surf zone habitats bound most of the southern Monterey Bay coast. This dynamic habitat is not well studied but can support a diversity of fish and invertebrate species including, flatfish, surfperch, amphipods, isopods, mole crabs, Dungeness crabs, swimming crabs, Pismo clams, northern razor clams, sand dollars, sea pansies, sea stars and polychaetes, many of which are prey for seabirds and marine mammals.

Two sandy subtidal benthic infaunal communities are recognized along a gradient of wave activity in Monterey Bay. Closest to shore and characterized by strong water motion and sandy sediments is the crustacean zone. This zone is occupied by small, mobile, deposit-feeding crustaceans, such as amphipods, which do not build permanent burrows. In deeper waters, characterized by more stable, fine sand with a significant amount of mud, is the polychaete zone which is generally well developed in depths of 60 feet or more. Polychaete worms living in relatively permanent tubes and burrows dominate this zone. Many other relatively sessile and suspension-feeding groups, including brittle stars, clams, tube anemones, sea pens, are common here. The depth limits of these two benthic zones vary with wave activity with zones extending deeper with higher wave energy. For example, off a high-energy beach in Monterey Bay, the transition between the two benthic zones occurred at a depth of approximately 40 feet.

Subtidal sands are primary, foraging, and reproductive habitat for a variety of invertebrates and demersal fish including juvenile lingcod, white croaker, plainfin midshipman, staghorn sculpin, sand sole, English sole, speckled sand dab and curlfin sole. Marine mammals including otters, pinnipeds and cetaceans forage on water column and benthic fish and invertebrates over sandy subtidal habitats. Subtidal sands are also important as habitats that support commercial and recreational fisheries for marine invertebrates (e.g. Dungeness crabs, sea cucumbers) and fish (e.g. California halibut, sanddabs).

4.1.6 Coastal Dunes

The coastal dune system of southern Monterey Bay is one of the most important in California. Native coastal strand and dune vegetation is designated as rare in California. Much of the area of active sand dunes with or without vegetative cover is designated as Ecologically Sensitive Habitat Area (ESHA). The stable vegetated dunes south of the Salinas River also qualify as ESHA because of the presence of 1) typical sand dune species, 2) species and plants that are ESHA in their own right, and 3) physical substrates that support or could support the above species. Coastal dunes are vulnerable to trampling, erosion and invasion by exotic species. Dune restoration and conservation is actively ongoing in southern Monterey Bay, including the southern three miles of coast. A number of endangered and threatened plant and animal species inhabit the dunes.

4.2 NATIVE ANIMALS

A number of native animals inhabiting the dunes and beaches of southern Monterey Bay have special status, are already listed, or are on the candidate list for the federal register. A few other animal species of interest as prey resources for endangered species or as fishery species are also considered.

4.2.1 Western Snowy Plover

The western snowy plover (*Charadrius alexandrinus nivosus*) was listed as a threatened species in 1993 by the U.S. Fish and Wildlife Service (USFWS). In 2005, the USFWS published a final rule on snowy plover critical habitat along the coast of California, which did not include any of the southern Monterey Bay shoreline. The final recovery plan for the species was published in 2007, in an attempt to remove the Pacific coast population from the list of endangered and threatened wild life and plants.

Western snowy plovers forage on the shoreline and nest on the beaches and dunes along southern Monterey Bay, and are present year round in the area. Southern Monterey Bay is an important nesting area for snowy plovers, with 61 to 104 nesting birds each year. It is also an important wintering area, with up to 190 birds using this area of coast each winter. Chicks leave the nest to forage soon after hatching. Adults move chicks along the beach (even miles) to reach suitable foraging areas. Habitat features essential to the species include areas of sandy beach above and below the high tide line with surf-cast macrophyte wrack and other debris supporting small invertebrates (for nesting and foraging) and generally open barren to sparsely vegetated terrain (for foraging and predator avoidance). Although excluded from the USFWS critical habitat designation for this species in the final rule in 2005, the southern portion of Monterey Bay provides suitable or potentially suitable habitat for snowy plover foraging and nesting. The distribution, including nesting sites, of this endangered species in this area is expected to vary with beach conditions and the dynamics of the snowy plover population.

At the Sanctuary Beach Resort, the dunes between the bluff edge and resort wall are being preserved to provide dune habitat for the western snowy plover. The dunes to the north of the Ocean Harbor House condominiums are also protected from human and canine disturbance to provide mating and nesting habitat for the western snowy plover.

4.2.2 Shorebirds

Many species (17) of shorebirds use the beaches of southern Monterey Bay during migration periods and over the winter months (Table 11). The average abundance of shorebirds is 119 birds per kilometer of shoreline with peak use occurring between August and March (Neuman et al., 2008). The rich and productive invertebrate prey resources of sandy beaches are critical to the survival and success of breeding and nonbreeding shorebirds in coastal ecosystems. Shorebirds have high metabolic rates and relatively high daily energy requirements (Kersten and Piersma, 1987) and are capable of consuming a large percentage (49-65%) of the annual production of invertebrate prey on beaches. The beaches of southern Monterey Bay provide important foraging and roosting habitat for shorebirds particularly when wetlands, such as Elkhorn Slough, are inundated during high tides. Many shorebird populations are declining in the U.S. and the maintenance of high quality foraging habitats is considered important to their conservation.

Table 11. Bird Counts in Monterey Bay (Neuman et al., 2008)

Common name	Scientific Name	Maximum	Density (birds km^{-1})	
			Low Tide Mean	High Tide Mean
Sanderling	*Calidris alba*	6,796	83.70 (37.4)	73.00 (31.8)
Willet	*Tringa semipalmata*	2,299	19.10 (16.3)	5.40 (6.6)
Marbled Godwit	*Limosa fedoa*	805	10.50 (5.5)	5.90 (4.4)
Black-bellied Plover	*Pluvialis squatarola*	497	3.20 (3.5)	1.70 (1.7)
Whimbrel	*Numenius phaeopus*	535	2.70 (4.2)	1.40 (1.9)
Snowy Plover	*Charadrius alexandrinus*	330	2.50 (1.7)	3.20 (2.2)
Western Sandpiper	*Calidris mauri*	1,175	0.78 (1.72)	4.80 (9.7)
Long-billed Curlew	*Numenius americanus*	94	0.50 (0.64)	0.19 (0.26)
Ruddy Turnstone	*Arenaria interpres*	42	0.17 (0.29)	0.22 (0.29)
Killdeer	*Charadrius vociferus*	85	0.17 (0.32)	0.34 (0.68)
Dunlin	*Calidris alpina*	61	0.14 (0.30)	0.21 (0.41)
Dowitcher spp.	*Limnodromusspp.*	43	0.14 (0.31)	0.03 (0.06)
Semipalmated Plover	*Charadrius semipalmatus*	60	0.03 (0.05)	0.30 (0.50)
Red Knot	*Calidris canutus*	9	0.03 (0.07)	0.01 (0.04)
American Avocet	*Recurvirostra americana*	14	0.03 (0.10)	0.01 (0.03)
Black Turnstone	*Arenaria melanocephala*	9	0.02 (0.05)	0.03 (0.06).
Least Sandpiper	*Calidris minutilla*	89	0.01 (0.02)	0.28 (0.67)
All Shorebirds		7,586	123.80 (44.5)	97.0 (37.6)

NB. Table shows maximum bay-wide count and low-tide and high-tide mean density (standard deviation in parentheses) of the 17 shorebird species observed between November 2002 and April 2003.

4.2.3 Black Legless Lizard

The black legless lizard (*Anniella pulchra nigra*) is considered a species of concern by the CDFG because of its limited distribution. Much of the habitat for this lizard has been lost to agriculture and other development including recreation, especially in coastal dune areas, and by the introduction of non-native plants such as ice plant. It occurs in the Marina and Ford Ord dunes, although the exact distribution of these populations of the species is not known. Kuhnz et al. (2005) suggested that standard survey methods may not be effective in establishing presence or absence of this species when low densities are present. The Sanctuary Beach Resort has installed a 'lizard crossing' beneath the main entry road to allow the California legless lizard to safely traverse the eastern edge of the property.

4.2.4 Smith's Blue Butterfly

The tiny Smith's blue butterfly (*Euphilotes enoptes smithi*) is a species of concern and is federally protected and was listed as endangered by the USFWS in 1976 due to loss of dune habitat. At least 12 reserves for the butterfly have been established on Fort Ord. Coast buckwheat (*Eriogonum latifolium*) and dune buckwheat (*Eriogonum parvifolium*) are host plants for this endangered butterfly. The distribution of coast buckwheat is limited and patchy in southern Monterey Bay, but some patches are fairly extensive. These host plants grow in coastal dunes and are needed by Smith's Blue Butterfly for reproduction in their natural habitat. Coast buckwheat has been or is planned to be planted in a number of restoration projects in the area between Sand City and the Salinas River. The emergence of the butterfly is timed to coincide with the blooming of the host plants (approximately 4-6 weeks in late summer-early fall). Each adult butterfly lives about a week, mating and laying eggs on the host plant.

4.2.5 Globose Dune Beetle

The globose dune beetle (*Coelus globosus*) is a Category 2 species of concern for USFWS, meaning it is a potential candidate for listing, but sufficient information to support a proposed rule is lacking. This species of flightless beetle inhabits coastal dune habitats usually within 100 feet of the shoreline. These beetles are primarily subterranean as adults and larvae, tunneling through sand underneath dune vegetation such as sand verbena, beach bursage and sea rocket. This species may be absent from Monterey Bay; however, the exact status of the population is not known.

4.2.6 Southern Sea Otter

The southern sea otter (*Enhydra lutris nereis*) occurs along southern Monterey Bay year round. This species is listed as federally threatened and is fully protected by both state and federal regulations. This endangered marine mammal species requires abundant benthic invertebrate prey of large body size including large crabs, sea urchins, abalone, snails and clams. Sea otters feed in rocky and kelp forest habitats as well as low intertidal and surf zones of beaches in southern Monterey Bay. Kelp forests are critical areas for resting, foraging and nursery sites. Otters are important predators on major invertebrate herbivores and thus considered a key factor in the dynamics of kelp forests. The highest density of sea otters occurs in the southern portion of the Bay. Reproduction of otters as indicated by pup numbers is also relatively high in this area.

4.2.7 California Grunion

The California grunion (*Leuresthes tenuis*) is a beach nesting fish that breeds regularly on Monterey State Beach (Karen Martin, Pepperdine University, personal communication) and may well breed on other beaches in southern Monterey Bay. This fish spawns in the upper intertidal zone between March and August, and occasionally in February and September. Peak spawning is late March to early June. Grunion leave the water at night for four consecutive nights starting the nights of the full and new moons. Spawning begins after high tide and continues for several hours. Eggs incubate in the sand for two or more weeks and during this period are vulnerable to burial and disturbance. Adult fish inhabit shallow nearshore water from the surf zone to a depth of approximately 60 feet. The most critical problem facing the grunion resource is the loss of spawning habitat caused by beach erosion. By the 1920's the fishery was showing definite signs of depletion and a regulation was passed in 1927 establishing a closed season of three months, April through June. The fishery improved and in 1947 the closure was shortened to April through May. This closure is still in effect to protect grunion during the peak spawning period.

4.2.8 Pismo Clam

The Pismo clam (*Tivela stultorum*) is a large heavy-shelled bivalve that inhabits low intertidal and shallow subtidal zones along open sandy coasts from Monterey Bay to Baja California. This clam can reach shell lengths of greater that 6 inches and can exhibit zonation by size, with juvenile clams located higher in the intertidal zone than older adults. Southern Monterey

Bay is close to the northern range end for this species. This long-lived (>50 years) and delectable bivalve formerly supported large commercial and recreational (sport) fisheries in the Monterey Bay area and other parts of the California coast until population numbers declined and the fishery collapsed. This shallow-burrowing and slow-moving clam is important prey for sea otters in southern Monterey Bay.

4.2.9 Beach Invertebrates

Beach invertebrates including spiny and common sand crabs, beachhoppers, razor clams, polychaete worms, insects, and a variety of small crustaceans can reach high abundance (>100,000 individuals per meter of shoreline) and biomass on the beaches of southern Monterey Bay These invertebrates are an important prey resource for shorebirds, seabirds, fish and marine mammals. Many of the invertebrate animals inhabiting the lower intertidal and swash zone can be dispersed relatively long distances as planktonic larvae. The upper shore invertebrates are associated with drift seaweed or wrack, avoiding direct contact with the waves. These animals which include beachhoppers, isopods and a number of flightless insects develop directly on the beach and thus can be limited by dispersal and distance from source populations.

4.3 NATIVE PLANTS

Several native plants in southern Monterey Bay are either already listed or are on the candidate list for the federal register of endangered and threatened species. These include the seaside bird's-beak, sand gilia, sandmat manzanita, Eastwood's ericameria, coast wallflower, Yadon's wallflower, and Monterey ceanothus. All seven species are recognized as rare by the California Native Plant Society. Of these species, Yadon's wallflower (*Erysimum menziesii ssp. yadonii*) occurs closest to the shoreline. This species is reported to occur on coastal strand close to the high tide line but in areas largely protected from wave action. It is exposed to strong wind, salt spray and occasional wave action. This endangered species is reported to be restricted to four occurrences in the vicinity of the Marina Dunes; two at Marina State Beach and two close to the Marina sand mine. Augmentation, through propagation and reintroduction, has been attempted for populations at Marina State Beach.

Critical habitat is designated by USFWS for the Monterey spineflower (*Chorizanthe pungens var. pungens*) an endangered annual dune plant that occurs in recent dunes and extends along almost the entire southern Monterey Bay coast. Another endangered annual, Monterey gilia (*Gilia tenuiflora ssp arenaria*), also grows in the coastal dunes but generally in locations protected from waves, salt spray and strong winds. The seaside bird's-beak is protected under the California Plant Protection Act of 1977. The sand gilia is both state-listed (threatened) and federal listed (endangered).

5. REGIONAL SEDIMENT MANAGEMENT APPROACHES

This section focuses on RSM approaches as solutions to coastal erosion problems in southern Monterey Bay. Based on the information outlined in Sections 2 to 4, three main approaches to RSM are considered appropriate. These are:

- beach restoration strategies including beach nourishment to slow erosion rates
- eliminate factors that exacerbate erosion
- allow the natural process of dune erosion to continue without intervention.

SMBCEW (2006a) carried out an initial investigation and ranking of a wide variety of erosion response alternatives (including but not exclusively RSM). The list created by SMBCEW (2006a) is presented in Table 12 and includes beach restoration alternatives (beach dewatering and pressure equalizing modules, sand retention devices and other structures/alternatives), and making sure that any future developments have adequate set backs. A full investigation of these methods is outside the scope of this Coastal RSM Plan, but the MBNMS will fund a study for the SMBCEW that further evaluates the higher ranking alternatives, and assesses their role within the RSM framework for southern Monterey Bay.

Table 12. Potential Erosion Response Alternatives (SMBCEW, 2006a)

Alternative	Approach	Specific Method	Rank
Approaches to be used when addressing future developments	Prevent or discourage development in areas threatened by erosion	Transfer of Development Credit	20
		Conservation Easements	19
		Fee Simple Acquisition	18
		Present Use Tax	18
	Avoid threats from erosion permanently or for many years	Rolling Easements	19
		Structural or Habitat Adaptation	17
		Setbacks for Bluff Top Development	17
		Setbacks (Plus Elevation) for Beach Level Development	16
Regional approaches to be used for larger area-wide responses to slow beach erosion		Beach Nourishment - Nearshore Placement	15
		Beach Nourishment – Subaerial Beach Placement	14
		Beach Nourishment - Dredge Sand from Deep or Offshore Deposits	14
		Dune Nourishment (adding both sand and vegetation)	14
		Pressure Equalizing Modules	14
		Beach Dewatering	12
		Submerged Breakwaters/Artificial Reefs	12
		Inter-littoral Cell Transfers	11
		Perched Beaches	11
		Groins	11
		Emergent Breakwaters	10
Site-specific approaches to be used for existing structures that are threatened by erosion	Move or remove structures away from erosive forces	Managed retreat	18
	Move erosive forces away from the threatened structure	Seawalls	8
		Revetments	8
Approaches that reduce factors that exacerbate erosion	Site-specific (often used in combination with other approaches)	Native Plants	12
		Sand Fencing/Dune Guard Fencing	11
		Controlling Surface Runoff	11
		Controlling Groundwater	11
		Berms/Beach Scraping	9/10
	Regional	Sand Mining Cessation	19

5.1 BEACH NOURISHMENT

At locations where it is not considered acceptable to allow natural processes to continue, because the beach resource is being lost and/or important facilities are at risk of erosion, human intervention to alter the shoreline is often considered. In general, there are two types of alteration strategies that are traditionally implemented; soft approaches (a variety of options including beach nourishment) and hard approaches (mainly armoring of different types).

The California Beach Restoration Study (CDBW and SCC, 2002) defines beach nourishment as the introduction of sand on to a beach to supplement a diminished supply of natural sediment, for the purpose of beach restoration, enhancement, or maintenance. The southern Monterey Bay shoreline has no history of beach nourishment, because the majority of the shoreline is undeveloped and the beaches are healthy, being provided with significant amounts of sediment from erosion of the relict dune bluffs (Section 5.3). Beach nourishment, where sand is actually placed using new sources (either from onshore or offshore), is distinct from beach replenishment, where sand sources that have been cut off (e.g. sand mining at Marina), can again become sources (Section 5.2).

SMBCEW (2006b) strongly recommended analysis of the feasibility of beach nourishment for sites at and south of Sand City and this Coastal RSM Plan supports this recommendation. Six of the seven areas of critical erosion are located along the three-mile stretch of shoreline between Sand City and Wharf II where healthy beaches are especially important for recreation and tourism; hence this shoreline could potentially be a receptor for beach nourishment.

Sand City to Wharf II corresponds with the south sub-cell (Section 2.1), which is the stretch of shoreline impacted by relatively low wave energy and low sediment transport rates. The clustering of critical areas of erosion within this single relatively short sub-cell impacted by relatively ‘quiet’ physical conditions provides potential benefits for implementation of beach nourishment strategies. These benefits include:

- The impacts of the nourishment would only be felt within the confines of the sub-cell with little or no far-reaching impacts to the rest of the bay
- The nourishment strategy can be implemented on a sub-cell scale and is not dictated by the problems facing only single facilities
- Beach nourishment is likely to be more feasible if critical areas of erosion are close together and not separated by large distances within a littoral cell
- Low wave energy and low alongshore sediment transport would mean that sediment would remain at the receiver site for a longer period of time. This may lead to a reduced frequency of maintenance of the site through further nourishment, reducing costs
- The location of an apparent alongshore sediment transport convergence close-by (at Sand City) and the associated potential accumulation of sediment offshore that is suitable for nourishment would simplify implementation and reduce costs. The sub-cell is also

adjacent to Monterey Harbor providing a second easily accessible potential source (although much smaller volume)

- The sub-cell is the most accessible area of southern Monterey Bay for transportation of sand from inland sources (if appropriate).

This Coastal RSM Plan recommends investigation of beach restoration strategies, including beach nourishment, to ameliorate erosion in the southern three-mile stretch of shoreline from north of Sand City to Wharf II.

Two different beach nourishment approaches could be adopted in the southern bight of southern Monterey Bay. These are:

- subaerial placement (on beach)
- nearshore placement (in surf zone)

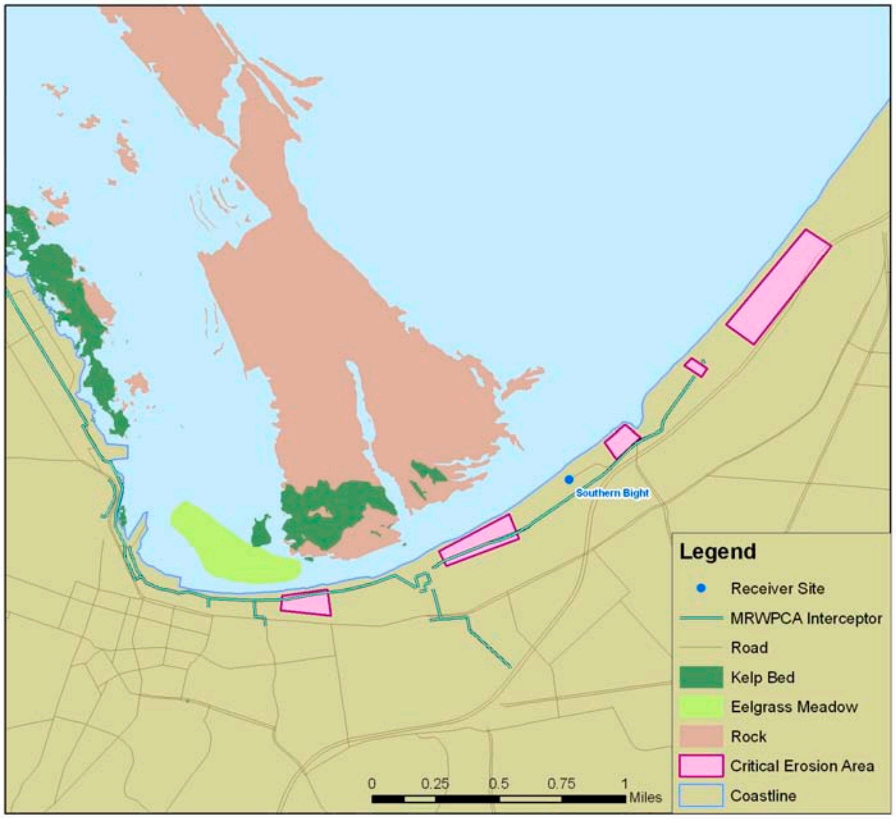
Subaerial placement of sand is nourishment of the dry beach and near the water line (CDBW and SCC, 2002), which results in an immediate artificially wide beach. Waves then redistribute the sand across the entire beach and shoreface profile until equilibrium is reached. Through this process the dry beach narrows from its initial width to accommodate the profile adjustment. The placement location and timing is an important consideration in southern Monterey Bay. The placement should occur away from sensitive resources (kelp, eelgrass, rocky reef, Section 4.1), should not take place during nesting (such as western snowy plover nesting season, March-September, Section 4.2.1), should not occur at times of high beach use (May to September), and should not be constructed so as to interrupt beach access. A strategy to mitigate placement impacts should be a key objective of the placement design (Section 5.1.2).

Nearshore placement nourishes the part of the littoral cell immediately seaward of the surf zone (CDBW and SCC, 2002). The intent is that this sand will buffer waves and at the same time the waves will transport some of the sand onshore to increase the beach width. Nearshore placement of sand should result in a wider dry beach, but at a slower rate than if the same volume of sand were placed directly onto the beach. The viability of nearshore placement depends on a number of factors; sediment compatibility and ecologic impacts are key considerations.

5.1.1 Potential Environmental Impacts of Beach Nourishment

A number of sensitive habitats and species are present in southern Monterey Bay. The southern three-mile stretch of the bay where this Coastal RSM Plan supports potential beach nourishment contains rocky reef, kelp forest and eelgrass meadow (Figure 29), and may contain endangered birds, plants and invertebrates as well as grunion spawning habitat in the dune and beach areas.

Figure 29. Sensitive Habitat, Critical Areas of Erosion, and Proposed Receiver Site



Impacts of beach nourishment can occur at the site where the sediments are placed. Sand placement is a concern for two reasons; as a direct impact and as an indirect impact through dispersal of the sand by alongshore and cross-shore transport. Impacts to biological resources can be classified into three major categories (Speybroeck et al., 2006):

- impacts directly related to the construction phases of a nourishment project
- impacts related to the characteristics of the sediments used
- impacts related to the quantity of sediment applied.

The magnitude of these impacts is strongly influenced by the place, time, and size of the project, and the strategy of the activity. Cumulative impacts are also important to consider with respect to the frequency and scale of activity, and for multiple sediment management projects. Indirect effects of nourishment on adjacent habitats via alongshore, cross-shore or wind-driven transport also need to be considered.

Impacts of beach nourishment activities (both subaerial and nearshore placement) associated with construction may include direct damage and disturbance, placement of sediments which can bury habitat at the site and in down coast areas (the thickness of sand applied can influence the degree of impacts to biological resources), and water quality effects resulting from resuspension and settling of sediments. Mortality of intertidal and subtidal organisms resulting from burial and compaction of sediments can be extremely high. Disturbance to wildlife during construction can be both visual and auditory. The use of heavy equipment to transport and arrange sediments can destroy dune vegetation including threatened species, and compact beach sediments negatively affecting vascular plants and invertebrates, as well as affecting air quality.

Increased turbidity resulting from nearshore and intertidal placement of sediments in the southern bight could negatively affect vegetation and animals living on the offshore rocky reefs, subtidal sand, eelgrass meadows, and kelp forests (Figure 29). Turbidity can adversely affect kelp recruitment and/or juvenile growth depending on proximity of the operations, duration of the turbidity related to project size, sediment characteristics, and hydrodynamics. Eelgrass meadow can also be disturbed by construction activities, indirect sedimentation and turbidity as well as anchoring of support vessels and other activities. Recovery of these habitats can be very slow (2-7 years) and transplantation of eelgrass has been needed in a number of areas where damage to benthic habitat has occurred (SAIC, 2007).

The characteristics of the placed sediment, such as the particle size and proportion of shell fragments can affect habitat quality for burrowing animals and subsequent recovery of the biota and food chain support (Peterson et al., 2000, 2006; Speybroeck et al., 2006). Particle size can also affect beach morphology, compaction, and the subsequent biotic community. Sediments with a high proportion of shell fragments can potentially cement into a pavement, reducing wind-blown and hydrodynamic sand transport and creating a barrier to burrowing animals.

The amount and timing of sediment placement may affect the mortality of the benthic community, its potential recovery, and the prey available to higher trophic levels, birds, fish, marine mammals, following either subaerial or nearshore placement. Species with pelagic larval stages would recolonize more readily than those with direct development as would shorter-lived species in general. The total amount of sediment applied could also affect the potential for post-construction transport of sediments.

Post-construction transport of sand in the southern bight following placement (both subaerial and nearshore) could negatively affect the adjacent kelp forest, rocky reef, and eelgrass meadow through indirect sedimentation of these habitats with the effects depending on project volume and proximity to the habitat. Low relief rocky reefs such as Del Monte Shale Beds are considered potentially more vulnerable to sand inundation and scour. Kelp forests generally occur at depths outside the depth of closure; however, inshore portions of kelp forests may extend into shallow waters during years lacking major storms. Sedimentation can adversely affect all life stages of kelp due to scour and increased mortality of both adults and juveniles.

The beaches and coastal dunes of southern Monterey Bay provide important habitat and resources for the western snowy plover. Management to protect nests, chicks and adults of this threatened bird is ongoing, particularly during the March to September breeding season. The importance of the area to snowy plovers is high and maintaining prey resources for foraging and chick rearing needs to be considered in beach nourishment activities. The entire southern Monterey Bay was originally proposed for designation as critical habitat for western snowy plover; however, it was removed from critical habitat designations in the final rule for this species (September 2005).

Beach invertebrate mortality would be high at subaerial beach nourishment sites due to disturbance and/or burial. Recovery rates vary among species and depends on the scale and timing of the impacts. Periods of six months to greater than two years may be needed for recovery of shorter-lived species depending on the recruitment of planktonic larvae, their survival, and subsequent growth and resulting habitat changes. Recovery of longer-lived species, such as Pismo or razor clams, could take more than 5-10 years. Grunion may respond poorly to nearshore turbidity, but more information is needed. Burial of eggs by a layer of added sediments can prevent successful hatching. Changes in beach profile can reduce spawning activity or potentially trap adult fish above the high tide line.

5.1.2 Mitigation Measures

Adverse impacts to the coastal habitats in the southern bight from beach nourishment activities can be reduced by:

- establishing no work zones to avoid disturbance by vehicles, equipment and other activities
- restricting vehicles and pipeline alignments to outside vegetated dune areas and sensitive habitats
- minimizing use of heavy equipment with use of lighter equipment preferred to reduce mortality and habitat damage from compaction during construction
- matching the particle size characteristics of sand used for nourishment with those at the receiver site as closely as possible
- creating refuges in project design to reduce impacts, maintain food chain support and facilitate biological recovery by nourishing small sections of beach (less than 2,000 feet) interspersed with undisturbed sections of habitat
- selecting a placement location that avoids direct impacts to sensitive habitats and species and minimizes potential indirect turbidity and sedimentation impacts to sensitive nearshore habitats (eelgrass meadow, kelp forests, rocky reef)
- incorporating buffer distances from kelp forests, rocky reef and eelgrass meadow into project design to minimize potential impacts from turbidity; recommended buffers range from 500 feet (MEC, 2000) to 1,000 feet (Chambers Group, 1992).
- timing project construction activities to avoid key biological periods such as breeding and recruitment

  - avoiding nesting and spawning seasons for western snowy plovers and grunion.
  - avoiding recruitment periods for key invertebrates with planktonic larvae, such as sand crabs and clams
  - avoiding peak shorebird migration periods and wintering
- implement monitoring and protective measures for sensitive species and habitats during construction (e.g. shorebird, sea otter, grunion)
- conducting pre- and post-project monitoring of ecological responses and recovery for a sufficient time period to inform design of future projects and adaptive management using a modified BACI (Before-After, Control-Impact) approach
- implementing mitigation (e.g. restoration, transplantation etc.) to offset any inadvertent and/or unavoidable habitat loss.

5.1.3 Potential Receiver Site in the Southern Bight

Given the location of the critical areas of erosion and the need to avoid adverse impacts to local sensitive habitat in the southern bight, this Coastal RSM Plan recommends a receiver site location for both subaerial and nearshore sand placement between the Monterey Beach Resort and the Ocean Harbor House condominiums (Figure 29). This receiver site is considered suitable for two main reasons:

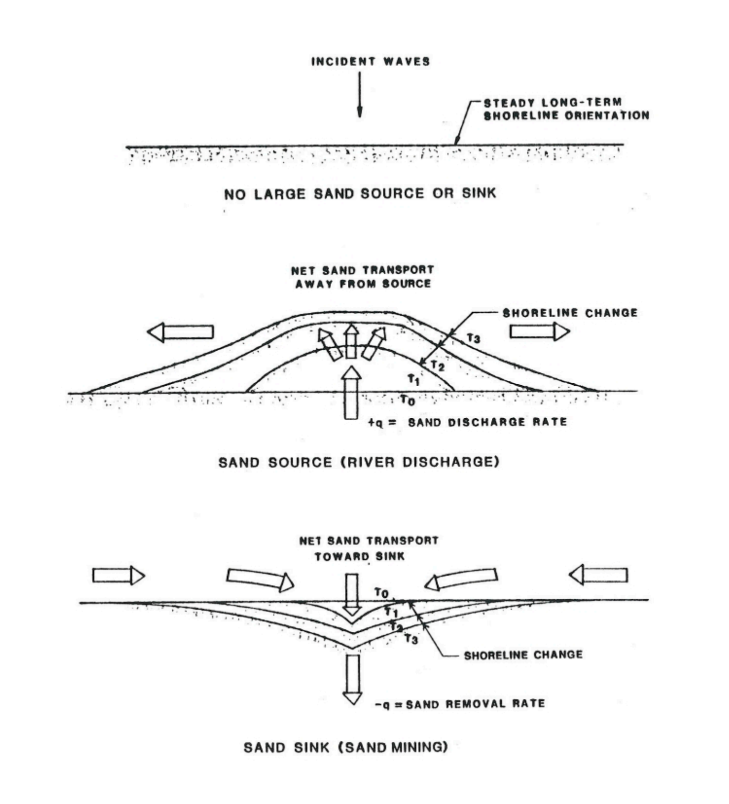
- The net alongshore sediment transport rate is low and to the north, but the gross transport rate is high in both northerly and southerly directions. This location is fairly central to the southern bight and would allow the sand to be transported most effectively to cover the critical erosion areas. A location further to the north would be unlikely to cover critical areas of erosion towards Monterey Harbor given the overall net transport to the north, and a location further to the south would place it too close to the critical habitat located offshore
- This location is far enough away from the sensitive kelp, eelgrass and rocky reef habitat so as not to cause disturbance through sedimentation or turbidity during construction and post-construction phases of the project

5.2 ELIMINATE FACTORS THAT EXACERBATE EROSION

The main human factor that affects the sediment budget, exacerbating shoreline erosion in southern Monterey Bay, is hydraulic sand mining from the beach at Marina. Closure of the operation would allow approximately 200,000 yd^3/year of sand to remain in the littoral budget, to supply both up coast and down coast beaches (beach replenishment). Battalio and Everts (1989) determined that the former sand mining operations at Sand City acted as sediment sinks drawing in large quantities of sand from the surrounding littoral zone, and re-orienting the shoreline (Figure 30). They described a process whereby sediment from up coast and down coast moves towards the sink, created by the removal of beach sand by the mines, causing those portions of the shoreline to erode. Battalio and Everts (1989) model shows reasonable agreement with measured shoreline erosion rates (from aerial photographs) between 1949 and 1988. In this

Coastal RSM Plan, the conceptual model is used to explain the impacts to shoreline erosion that sand mining has had both historically and currently.

Figure 30. Conceptual Model of Sand Mining Impacts on Sediment Transport



5.2.1 Impacts of Sand Mining at Sand City

The 1985-2005 dune erosion rates at Sand City and south of Sand City (Monterey Beach Resort and Del Monte Beach) are lower than those during the sand mining period between 1940 and 1984. The decrease in erosion rate is likely to be related to the complete cessation of mining at Sand City in 1990 (Section 2.5.3). In this case, the mine has ceased to be a sink for sediment from the surrounding littoral zone (Figure 30), the shoreline has re-adjusted to the new condition, resulting in lower erosion rates.

5.2.2 Impacts of Sand Mining at Marina

After the Salinas River changed course in about 1910, there was significant accretion of the shoreline both north and south of the Salinas River as measured by the long term (1910-2002) shoreline change (Figure 14, Hapke et al., 2006). However, between 1970 and 2002 the shoreline eroded between the Salinas River and Marina sand mine. The switch from accretion to erosion is believed to correlate with the start-up and continuation of hydraulic sand mining at Marina. The change from accretion to erosion only occurs south of the Salinas River mouth, whereas to the north of the mouth the shoreline continues to accrete (Figure 14). Assuming that the input of sediment from the river has remained constant, the recent losses to the south of the mouth are likely to be related to the mining operation, which acts as a sediment sink (Figure 30).

The estimates of Thornton et al. (2006) show that at Marina State Beach (south of the mining operation) there has been significant increase in erosion rates post-1984 (Table 3). This increase is believed to be related to the increase in extraction rate at the Marina sand mining operation in the mid-1980s, with further increases in extraction in the 1990s and 21st century (Table 4). The mining effectively intercepts the predominant transport of sand to the north during the winter (Section 2.2) resulting in a large loss from the littoral budget. Since the sediment transport is both north and south at the mine location (Oradiwe, 1986), the increase in extraction rate has resulted in less sand available to be transported down coast, exacerbating the rate of erosion at the Sanctuary Beach Resort and Marina State Beach.

An aerial photograph of the dredge pond at Marina taken after the storm of January 2008 (Figure 17, right panel) shows how effective the mined area is at trapping sediment from the littoral zone. Prior to the storm, the pond was filled with water. During the storm, waves and surge overtopped the berm and broke loose the 80-ton dredge that was chained inside the pond. The overtopping waves transported large quantities of sand from the littoral zone, which was deposited in the pond. The photograph in Figure 17 (right panel) was taken on January 15, 2008 and shows the pond has been completely filled with sediment. The wrack line is landward of the former pond indicating that swash entered the pond and then swept further inland.

5.2.3 Beneficial Impacts of Sand Mine Closure

Stopping the mining of sand from the beach at Marina would release approximately 200,000 yd^3/year of sediment to replenish down coast (and up coast) beaches in southern Monterey Bay. This estimate of sediment lost from the littoral cell is equivalent to the volume of sediment supplied to the cell from erosion of the 12 miles of dunes between the Salinas River and Wharf II. The mining of 200,000 yd^3/year of sand is the equivalent of approximately two feet of beach over a ten-mile length (distance to Wharf II) every year (assuming 1.7 yd^3 of sand equates to one square foot of beach). Loss of two feet of beach each year is approximately 50% of the ongoing erosion along southern Monterey Bay. Considering the coarser sizes of the mined sand and the finer sizes of the dune sands, the impact of sand mining may be larger than 50% of all erosion. Hence, retention of the sediment that would otherwise be lost from the budget through mining would have a major benefit, not only for Marina, but for all of southern Monterey Bay.

The sand mining operation at Marina disrupts sand transport, removes vegetation, adversely affects shorebirds, and ultimately results in beach erosion and loss of habitat needed by sensitive species and other biological resources (Brown and McLachlan, 2002; Magoon and Lent, 2005). Mining sand from the surf zone causes erosion and loss of western snowy plover breeding and wintering habitat. Sand removal by dredging can disturb incubating western snowy plovers, destroy their nests or chicks, and result in the loss of invertebrates and natural wave-cast kelp and other debris that western snowy plovers use for foraging. Reducing or stopping sand mining would result in increased beach widths, reduced erosion and enhanced beach and dune habitats for shorebirds and other sensitive species, as well as the biological resources that support them.

This Coastal RSM Plan recommends closure of the beach sand mining operation at Marina because of its impact on the regional rates of shoreline erosion, particularly at the Sanctuary Beach Resort critical area of erosion. This resort is located approximately one mile south of the sand mine and the erosion rates of the dunes on which it is located are directly affected by the extraction of sand from the beach at the mine. Replenishment of the beach in front of the Sanctuary Beach Resort with sand that would otherwise be removed from the system by the mine would provide a larger and more effective buffer to waves in front of the dunes, reducing the erosion rate.

5.2.4 Potential Strategy for Stopping Mining

One of the primary conclusions of this Coastal RSM Plan is that the ongoing sand mining operation in Marina by CEMEX is contributing significantly to down coast beach erosion. The appropriateness of the CEMEX operation could be questioned on the basis of environmental impacts related to erosion and endangered species, and whether U.S. Army Corps of Engineers jurisdiction does in fact exist, despite a historic finding to the contrary. The possibility of an alternative mining operation or a buy-out and/or resort development alternatives could also be examined. The primary value of the mined sand is sand pack around well casings for domestic and monitoring wells. There is reportedly no other commercial source for this kind of sand on the west coast with the present closest alternative source in Colorado. Hence, the economic consequences to CEMEX of closing the mine would need to be weighed against the continuing loss of critical habitat, impact on endangered species and damages to down coast structures from erosion. Below are suggested approaches to address this problem.

1. Examine history of mining operation. The current Marina mining operation was started in 1965 by Lone Star Industries, who originally reported to the California State Lands Commission (CSLC) under their general permit for mining, but stopped reporting mining amounts from the dredging operation in 1967. A question to answer is did the CSLC have jurisdiction over this operation originally. The North Monterey County LCP was certified by the Coastal Commission in 1983. The sand mining activity description and resource addendums in the certified LCP should be examined. The City of Marina annexed part of the plant property in 1986. In 1987 Lone

Star Industries filed a mining restoration plan, which is available through the County Public Works and also at the California Mining and Geology Board. This should be obtained. After annexing, Marina amended their LCP so the plant property could have a hotel of destination. Therefore, it is recommended that the LCP be examined. In addition, and the amount of taxes or royalties (if any) received from this operation by government entities needs to be considered because these funds might be affected if beach sand mining is halted.

2. Increase public awareness of the adverse impacts associated with continued operations. It is important that efforts to resolve the adverse impacts associated with the present mining operation have the full support of the general community, including business leaders and government officials. It is therefore recommended that the findings of this Coastal RSM Plan be given wide distribution through official and media channels. An article should be published in the Monterey Herald newspaper and other media outlets. Such an article would raise many issues that need to be addressed beforehand that include the local economic value of how much royalties and taxes are derived from the mining operation by the City of Marina, Monterey County and the State of California, how many local people are employed, alternative sources of sand, and in particular sand that is used for water wells. The local communities and businesses that are particularly adversely impacted, such as the nearby Sanctuary Beach Resort and tourist communities along with beaches along the entire southern Monterey Bay shoreline, need to be made aware of how the negative impacts of the mining operation are directly affecting them. Informing CEMEX of the situation, including concern from local officials, may result in voluntary modifications to their beach sand extraction operations.

3. Challenge the regulatory loophole allowing mining on the back beach by requesting the U.S. Army Corps of Engineers revisit their determination on non-jurisdiction. The Corps normally makes a jurisdictional determination before it processes or demands permit applications. The public never sees jurisdictional determinations unless they are requested. Public notices for permits occur only if the Corps asserts jurisdiction and requires permits. If the Corps 'disclaims' jurisdiction over a geographic area or activity, public notice is not required. The USACE has reportedly determined that they did not have jurisdiction over the back beach sand mining operation.

The Corps determination of non-jurisdiction for the back-beach sand mining may be demonstrably inconsistent with later determinations of jurisdiction the Corps has made (at other beach locations in the San Francisco Corps District) for beach grading and barrier beach breaching to regulate flooding. Since the late 1990s, the Corps has asserted jurisdiction over beach grading below the high tide line (legal boundary for Corps Clean Water Act Section 404 jurisdiction) at multiple sites in the Golden Gate National Recreation Area (public notice and permits issued). The Corps has also issued public notices and permits for beach breaching at stream mouth lagoons in Santa Cruz, Sonoma (Russian River), and Lake Talawa and Earl (Del Norte County). It should be determined if a permit is required for the Salinas River mouth breaching, which would be even closer. Also, the Corps generally regulates gravel and sand mining in rivers. The main point is that the Corps' prevalent analysis of jurisdiction in these cases indicates that the geographic area in which beach grading and breaching occurs falls within Corps jurisdiction, and the activity of dredging sand from areas that intermittently fall within tidal influence (lagoons that breach) is also within Corps jurisdiction.

The Corps has regulatory authority under two laws: Clean Water Act Section 404 and Rivers and Harbors Act Section 10. The two jurisdictions differ, but both are predicated on 'commerce clause' nexus for federal jurisdiction, which is based on interstate or foreign commerce. Even before the nuances of Section 10 and 404 are in view, sand mining itself in 'waters of the U.S.' helps establish jurisdiction because sand may be sold in interstate commerce and the lagoon is subject to intermittent tidal action. At Marina beach, the mined lagoon has a drift-line delineating its edge evident in aerial photos (Figure 17), and tides in winter capture the lagoon and make it at least temporarily subject to tidal flows. The lagoon is by definition an impoundment. The industrial activity of sand mining and potential interstate sales of sand (or concrete) obtained from waters supports federal jurisdiction.

Section 404 regulates discharges of earthen fill (including sand), but not excavation or dredging per se. But the Corps has determined that enough incidental discharge is associated with excavation in gravel and sand mining operations along California rivers to support regulation under 404.

So, there seems to be a disparity in that the Marina sand mine (lack of) regulatory environment radically differs from other sand or gravel mining operations or other beach grading operations in the San Francisco District office. The USACE should therefore be asked to revisit their rationale in disclaiming jurisdiction under 404 at Monterey Bay beaches quarried for sand.

Under Section 10 of the Rivers and Harbors Act (RHA), the Corps jurisdiction may even be stronger. Section 10 is also based on the federal nexus of 'interstate commerce', but the legal construction of 'navigable waters' has been expanded by courts to include 'existing improvements: artificial waterbodies' (33 CFR 329.8(a)). A canal or other artificial waterbody that is subject to ebb and flow of the tide is also a navigable water of the U.S. This is explained further in Section 329.12 and 329.13, which establish the shoreward limit of Section 10 jurisdiction at the mean high water line, including enclosed embayments, shoals, or marshes that may not currently be navigable, but remain navigable in law. In short, once the lagoon the mine digs is captured by tides, it remains permanently subject to Section 10 jurisdiction even after the re-growth of the berm cuts it off from tides.

There are a number of consequences of re-regulation of beach mining by the Corps. The Corps would have to assert jurisdiction consistent with other substantially similar activities and areas regulated, and initiate the permit process. This would include:

- the issuance of a public notice for public comment and public interest review

- a NEPA (National Environmental Policy Act) analysis including whether 'significant' indirect impacts may occur (this includes analysis of sand budget for beach and indirect effects on beach erosion), which would necessarily trigger an EIS and full alternatives analysis if significant impacts are supported by substantial evidence
- Endangered Species Act (ESA) Section 7 consultation with USFWS for impacts to at least Yadon's wallflower

Once the Corps issues a disclaimer of jurisdiction, landowners can legally challenge re-assertion of jurisdiction in court and argue 'estoppel' issues (based on their reliance on Corps previous determination), so the Corps is reluctant to reverse itself. But if convincing evidence exists such that the corps previous determination could be so inconsistent that they would not hold up to legal challenge, the most defensible legal position would be to reassert jurisdiction.

Thus the key to getting a review of jurisdiction is:

- making the case for inconsistency
- showing at least implicitly that a successful legal challenge to the jurisdictional disclaimer at Marina could be brought forward as a result of their other relevant jurisdictional determinations for gravel/sand mining activity and beach grading below the high tide line.

4. Assess the mining operation's adverse impacts on the basis of the Endangered Species Act. There are many endangered species in the area; snowy plover, legless lizards, Yadon's Wall Flowers etc. Lone Star Industries did not get a take permit for endangered species. An example of a recent precedent case is the pumping of the Sacramento River that caused a big loss of endangered salmon fingerlings that resulted in a decision of 'taking' and the pumping had to be greatly decreased.

5. Alternative mining operation on the property. Are there sufficient placer sands of the same quality on the property to move the mining operation further back on the property so as not to 'take' sand from the littoral zone? This would be a more expensive mining operation, but would have less of an environmental impact.

6. Buy-out and/or change use to resort development. A buy-out of the property would be expensive, although may be shown to be cost effective over the long term. The problem would be to generate the funds for a buy-out. The alternative is for CEMEX to either develop or sell to a developer. The property is already permitted in the Marina LCP to be developed with a hotel of destination with conditions of restoring the dunes. It may be possible to negotiate a buy-out of the mining operation, while CEMEX retained the rights for development at a much reduced cost. It was suggested by a knowledgeable local politician that if agreements for development could be obtained through the Coastal Commission in a simplified manner, then CEMEX would be highly interested in developing the property for other uses.

5.3 ALLOW DUNE EROSION TO CONTINUE

This 'no action' approach allows the natural processes of dune erosion to continue without human intervention. Section 3 shows that within the portion of the littoral cell north of Sand City (apart from the Sanctuary Beach Resort), there are no permanent structures or facilities known to be at risk either on the beach or on top of the dunes. The dunes are also sufficiently wide so there is no immediate threat of flooding to the low-lying areas behind the dunes. In addition, erosion of the dunes along this stretch of shoreline is providing large quantities of sediment to the littoral system, maintaining the beaches in a healthy condition and providing benefits for sensitive species and habitats (Section 4).

This Coastal RSM Plan recommends that the dunes between the Salinas River and north of Sand City be allowed to erode without intervention.

5.4 OTHER POTENTIAL EROSION RESPONSE ALTERNATIVES

5.4.1 Hard Structural Approaches

Hard structural approaches generally refer to armoring the shoreline to prevent erosion, and include seawalls, revetments, and riprap. As coastal development has grown in California, the use of coastal armoring to protect oceanfront property and infrastructure has become more common. Ten percent of the entire 1100 mile coastline of California has now been armored, including 33% of the coastline of the four southern California counties (San Diego, Orange, Los Angeles and Ventura).

Shoreline armoring may lead to physical changes to the beach, ecological impacts, and beach access limitations. Physical impacts include the placement loss of usable beach caused by the footprint of the armoring structure. Armoring prevents erosion of sand from the bluffs that would normally nourish the beach, incrementally increasing erosion potential. Passive erosion is the drowning and narrowing of a beach in front of a structure while adjacent, unarmored shoreline segments continue to retreat (Griggs, 2005). Eventually, a peninsula effect can occur when the armor juts out into the water, impacting alongshore sediment transport. In addition, erosion rates tend to be increased at the flanks of the armoring, thus exacerbating erosion of adjacent stretches of shoreline. Armoring also fixes the back beach while the rest of the shoreface erodes. This can change wave energy dissipation and the adjacent shore geometry.

Ecological impacts occur primarily from the enhancement of reflected wave energy from the structure interacting with the incoming waves. This active erosion affects the entire sandy beach ecosystem by reducing the distribution and abundance of wrack, sandy beach invertebrates, and shorebirds (Dugan et al., 2008). From a recreational viewpoint, shoreline armoring reduces the usable beach width and over time on an eroding shoreline, can significantly reduce lateral beach access. There is also the visual impact of most existing coastal protection structures.

One example of historic shoreline armoring along southern Monterey Bay shows the harm associated with this practice as well as the restoration potential when it is removed. Stilwell Hall was built in the 1940s as the Fort Ord soldier's club between Sand City and Marina (Figure 1). In 1978, 650 feet of riprap and broken concrete was placed at the base of the bluff to protect Stilwell Hall from bluff erosion, which was further augmented in 1985 (Figure 31). The riprap extended out onto the beach (placement loss), reducing the width of the beach in front of the armoring compared to the adjacent beaches. As dune erosion continued on the adjacent shoreline, the beach in front of the structure continued to narrow and disappear (passive erosion), while adjacent to the structure the shoreline and bluff continued to erode back. Erosion on the flanks of the structure is increased owing to enhanced wave energy by waves reflected off the sidewalls of the structure (or bluffs in this case) exacerbating erosion to the shoreline, which is evident in Figure 31 (left panel). Continuing erosion along the adjacent shoreline created a riprap armored peninsula jutting out into the bay, which disrupted public access along the beach as well as reduced alongshore sediment transport. The riprap was eventually removed and Stilwell Hall was torn down in 2004. The now unprotected sandy bluff eroded rapidly during the winters of 2005 and 2006, and has reached a new equilibrium with restoration of the beach in front of the former structure (Figure 31, right panel).

Figure 31. Stilwell Hall Armoring Before and After Removal

Photo taken: Unknown

Photo taken: October 28, 2005; California Coastal Records project by Kenneth and Gabrielle Adelman

This Coastal RSM Plan recommends that, whenever possible, soft approaches should be adopted for RSM.

5.4.2 Dewatering

Dewatering is defined as the manipulation of groundwater within the beach to increase natural accretion processes. Beach dewatering works on the principle that if the beach face is dry when the wave runup swashes up the beach, then the water can infiltrate into the beach and deposit sediment. If the beach face is saturated, then the infiltration is limited and sediment is transported off the beach with the receding backwash. Dewatering is an effort to lower groundwater levels to enhance this natural infiltration process. Dewatering can either be active (with pumps and pipes), or passive (without pumps such as the pressure equalizing module - PEM). These dewatering technologies are relatively new to shoreline management and are not being investigated as part of this Coastal RSM Plan because they are to be investigated as part of the complementary project that will be funded by MBNMS and carried out under the SMBCEW process.

5.4.3 Retention

Sand retention, while often covered under hard structures such as groins or jetties, can also be a soft approach through the use of geotextiles. Retention techniques enhance the ability of the beach to retain sand. They include artificial reefs which can serve dual purposes as habitat and recreation (surfing), and geotextiles placed in a cross–shore orientation acting as ‘soft’ groins, which can accumulate sand on their up coast side while still enabling sediment to overtop and thus avoid some of the down coast impacts associated with harder groins and jetties. Retention techniques are not being investigated as part of this Coastal RSM Plan, but may be investigated as part of the associated MBNMS project.

5.4.4 Bluff Top Development Set Back

Bluff top set back is a technique for locating new development so that it can be safe from erosion and slope failure for some identified time period. Normally the set back is established by determining where the facility can be placed at present, so that it will have an acceptable factor of safety (FS) against slope instability (normally taken as FS greater than or equal to 1.5 for static conditions and FS greater than or equal to 1.1 for dynamic or pseudo-static conditions) and add to that both the anticipated amount of erosion over the identified time period and a buffer. After the identified time period is over, the facility can be expected to be at risk from erosion and there will be the future question about whether the development should be removed or whether it should be protected. In order to secure the future of new development along southern Monterey Bay this Coastal RSM Plan recommends:

- consideration of an extended planning horizon of 100 years for large cost or long-term projects to be incorporated into revised Local Coastal Programs.

- development of a strong set back ordinance in the Land Use Plans for oceanfront development that puts high use facilities at an appropriate distance from the ocean.

6. POTENTIAL SEDIMENT SOURCES

The potential beach nourishment strategies outlined in Section 5.1 require sources of sediment. This section investigates and characterizes potential sources of sediment for beach nourishment including:

- areas of excess sediment such as harbors and wetlands, where sand must be removed to restore function
- flood control projects such as dams and reservoirs where sand may become available as a result of dredging or excavation to restore capacity or closure of the dam
- inland commercial sand sources and sand sources which may become available during new development projects
- dunes at Fort Ord
- offshore sand sources

Three main criteria are used as an initial basis for screening source locations; availability of large quantities of beach compatible sand, levels of contamination, and the location of the source relative to the potential southern Monterey Bay receiver site. Potential sources are then targeted, using Tier I evaluation criteria of the Sand Compatibility and Opportunistic Use Program Plan (SCOUP) (Moffatt and Nichol Engineers, 2006), for more detailed compatibility studies. The locations of potential sediment sources are available as GIS data files in CSMWs GIS database.

The characteristics of the available source sediment are important in the design of beach nourishment strategies (CDBW and SCC, 2002). Sediment to be placed on the beach should contain only a small mud fraction. Sediment with a higher percentage of fines or smaller sand particle sizes may be appropriate for placement in the nearshore. The source sediment should be similar in particle size (or larger) than the receiver site, so as to behave in a similar way to the natural beach sediment. To evaluate source-receiver site compatibility, it is important to determine two parameters; the littoral cell cut-off diameter of the receiver site (LCD) (Limber et al., 2008) and the composite particle size envelopes of source and receiver (Moffatt and Nichol Engineers, 2006).

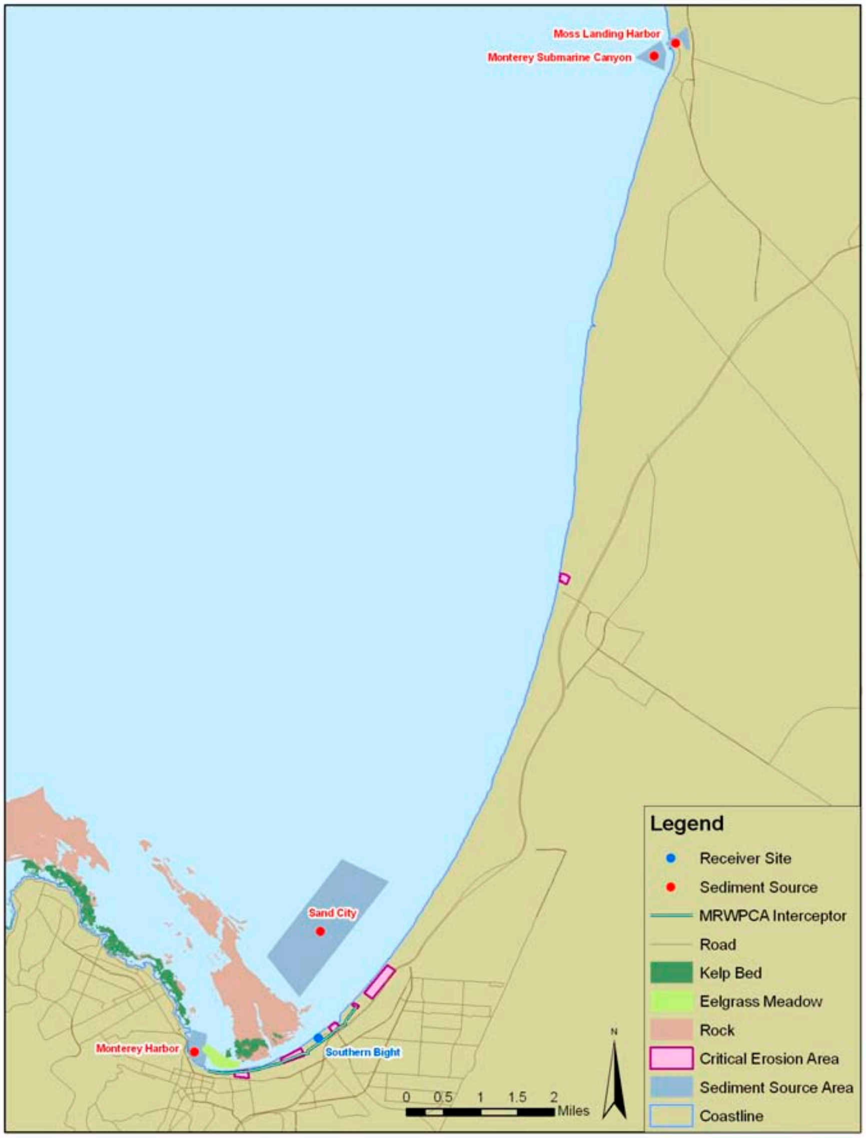
The littoral cut-off diameter is the particle size diameter of the sediment below which it is generally removed from the beach to leave only the sediment with particle sizes greater than the cut-off diameter. The littoral cut-off diameter is strongly controlled by wave energy. Typically, fine-grained sand in the particle size range 0.063 to 0.125 mm does not remain on the exposed beaches of central California because they are high-energy wave environments. For potential beach nourishment projects the LCD is important because any sediment finer than the cut-off that is placed on the dry or subaerial beach will likely move offshore of the beach, driven by wave processes. In northern Santa Cruz County where wave energy is high, the littoral cut-off diameter is approximately 0.18 mm (Patsch and Griggs, 2006). However, finer sands could be placed in the nearshore, where they would support the overall receiver site profile.

Moffatt and Nichol Engineers (2006) recommended determination of a ‘composite particle size envelope’ for the surface sediment at each receiver site. This brackets the range of particle sizes, from the coarsest to finest fractions (LCD) that characterizes the receiver site. They also recommended characterization of the wider littoral zone around the footprint of placement in order to understand how the sediment may disperse once placed. If the source’s sand gradation falls within the receiver site composite grain size envelope, then the source and receiver sites are compatible with respect to particle size.

In addition, source materials must be free of harmful chemical and biological contamination. Sediment is appropriate for placement on the subaerial beach if it is sand or possibly gravel, and is found in areas of high energy. Testing protocols for contamination are set out in the Inland Testing Manual (USEPA and Corps, 1998).

In this Coastal RSM Plan, available information was collated on the physical and chemical characteristics of the potential source sediments. The essential data include particle size, and chemical signatures (metals and other analytes). This is defined as a Tier I analysis in SCOUP. From these data, provisional recommendations are made regarding the suitability of the source sediments for placement at the potential receiver site, which should then be carried forward into Tier II analysis. Tier II analysis requires sampling and testing for particle size distribution, chemistry, and physical properties, at each of the source sites and comparison with the potential receiver site sediments to assess compatibility. Analysis of these Tier II data would provide a definitive statement regarding the suitability of the source materials for placement at the potential receiver sites. The Tier I analysis carried out for this Coastal RSM Plan targets five potential sources of sand for beach nourishment, which are described below (Figure 32).

Figure 32. Location of Potential Sediment Sources



6.1 HARBORS AND WETLANDS

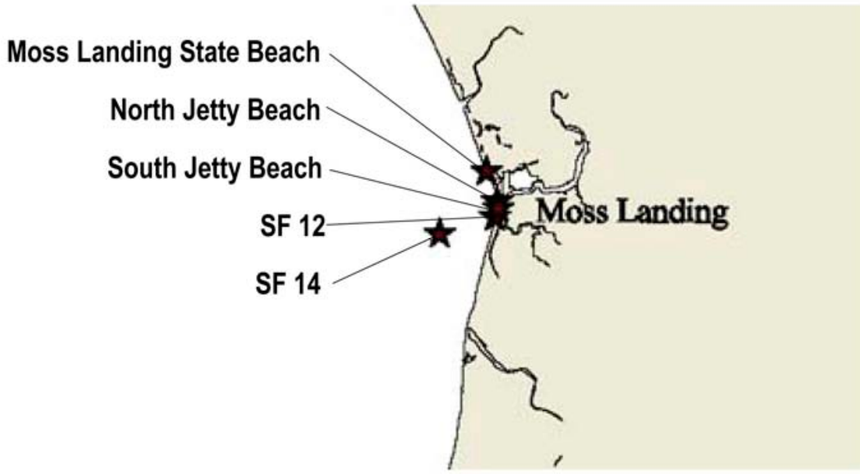
Three coastal harbors are situated in Monterey Bay; Santa Cruz, Moss Landing, and Monterey. Each harbor dredges sediment to keep their navigation channels and berths open for safe passage of commercial fishermen, recreational fishermen, and boaters. Moss Landing Harbor and Monterey Harbor are within the southern Monterey Bay littoral cell and considered potential opportunistic sources of sand. Santa Cruz Harbor was not considered further because it is within another littoral cell and the vast majority of the sand is being used to successfully nourish beaches immediately down coast in the same cell. No surplus sediment would be available for nourishment of southern Monterey Bay beaches without negatively impacting Santa Cruz beaches. No wetlands with compatible sediments for beach nourishment are identified in this Coastal RSM Plan.

6.1.1 Moss Landing Harbor Entrance Channel

The Corps and Moss Landing Harbor District have conducted maintenance dredging of Moss Landing Harbor since it opened in 1947. Sediment samples collected for the Environmental Assessment for maintenance dredging of the harbor in 2007 (Corps, 2007) showed that sediments in the entrance channel are greater than 90% (medium) sand and free of contaminants. Sediments further into the harbor are predominantly fine-grained (83-98% silt and clay), approximately 90% of which were contaminant-free in 2007. The primary sediment contamination issue for Moss Landing is chemical contamination from erosion of agricultural soils in the watershed. Soil loss from the surrounding land results in sediment deposition on roads, drainage channels, and ultimately into the harbor. In addition, Moss Landing Harbor provides haven to over 600 vessels year round, some of which may dispose wastewater into the harbor, or be subject to minor accidental oil spills during routine maintenance. However, chemical testing by Corps (2007) for metals, pesticides (including DDT), and PAHs, showed that the majority of the samples were below the threshold limit for aquatic disposal suitability.

Uncontaminated dredged materials are disposed at two offshore unconfined discharge sites (SF-12 and SF-14) and at three beach nourishment sites located north and south of the harbor (Figure 33). Finer-grained sediments (greater than 20% mud) are disposed at the offshore sites. When the dredged sediment contains less than 20% fines, it is placed at up to three beach disposal sites (Moss Landing State Beach, North Jetty Beach, and South Jetty Beach). Moss Landing Harbor has typically dredged approximately 50,000 yd^3 of sediment every three years, although the present permit (California Coastal Commission Permit 3-01-049) allows up to 100,000 yd^3/year to be removed. Sand in Moss Landing Harbor not abundant and would for beach nourishment purposes would need to be supplemented with sand from other sources.

Figure 33. Moss Landing Harbor Dredge Disposal Sites



Source: MBNMS

Having determined that the Moss Landing Harbor entrance channel sediments meet the particle size and contamination requirements, the only constraint on their use to nourish southern Monterey Bay beaches is that they are already placed on beaches adjacent to the harbor. With additional transportation costs, this sediment could be placed elsewhere in the southern Monterey Bay littoral cell. Therefore, Moss Landing Harbor entrance channel has the potential to be a source of sediment and is recommended as a target for more detailed Tier II compatibility analysis. It should be noted that Elkhorn Slough is rapidly eroding and therefore may also be targeted for receipt of dredged sediments.

6.1.2 Monterey Harbor

Historically, Monterey Harbor has been dredged approximately every 7-8 years with removal of around 4,000-10,000 yd^3 of sediment from the main channels. Most of the sediment has been placed either in shallow water immediately adjacent to Wharf II or on the beach above MHW (Steve Scheiblauer, Monterey Harbormaster, personal communication). Approximately 2,000-3,000 yd^3 of the sediment was placed inland. In the near future there is the possibility of a dredging operation to remove approximately 75,000 yd^3 from the entire harbor basin. The intention would be a complete

dredge of the berths and main channels to last for 40 years. Because of its complexity, particularly in obtaining permits to dispose of the sand, this dredging is unlikely to take place before 2010-2011.

Monterey Harbor is a potential source of sand for nourishment of the southern Monterey Bay beaches south of Sand City. The sediment infilling the harbor is locally derived through the pervious Coast Guard Pier breakwater, from three runoff outfalls within the harbor, and from an overflow runoff pipe just inside Wharf II. Little sand in the harbor appears to be derived from Del Monte Beach to the east. Monterey Harbor may have potential for minor contamination including agricultural chemicals from runoff, and wastewater and oil discharge from vessel operations.

Sand from Monterey Harbor is not plentiful and would provide only a very small portion of the necessary volume and would need to be supplemented with sand from other sources. However, Monterey Harbor is recommended as a target for more detailed Tier II compatibility analysis. AMBAG would need to coordinate with Monterey Harbor harbormaster about near-term (possibly 2010-2011) future dredging activities and the potential use of the sand for beach nourishment.

6.2 FLOOD CONTROL PROJECTS

6.2.1 Sediment Impounded by Dams

There are three dams along the main tributaries of the Salinas River that have sediment accumulated in the reservoirs behind them (Salinas, Nacimiento and San Antonio). Two more dams (San Clemente and Los Padres) are located along the nearby Carmel River but in a different watershed. None of the sediment bodies impounded behind these dams are considered potential sources of sand, for several reasons:

- the reservoirs on the Salinas River and behind Los Padres Dam contain sediment with a high percentage of mud, and so are unsuitable for beach nourishment purposes
- the Salinas Dam is approximately 120 miles from southern Monterey Bay, and the Nacimiento and San Antonio Dams are approximately 80 miles, so transportation of sand would likely be uneconomical
- although the particle size characteristics of the San Clemente Reservoir sediment may be compatible they are derived from granite rocks in a different watershed and would be unsuitable in terms of mineralogy and/or color
- although the San Clemente Dam is only 20 miles by road from southern Monterey Bay it is remote and access to the source sediment would be difficult, and transporting the sand by truck to southern Monterey Bay would be expensive (approximately \$20-\$30 per yd^3). This cost is approximately two to three times higher per yd^3 than the most expensive offshore source (see Section 7 for results of economic analysis for offshore sources)

6.2.2 Salinas River Sand Bar Breaching

In order to prevent flood damage to the surrounding floodplain areas, Monterey County Water Resources Agency periodically removes part of the sand bar fronting the Salinas River mouth. A ten-foot wide notch is cut through the bar to allow water at high tide to pass over the bar and begin a process of scour which eventually creates a breach 150-200 feet wide. The notch is cut with an excavator which disposes of the sediment adjacent to the notch. No sediment is removed from the littoral cell during excavation and hence no new sediment becomes available for nourishment purposes.

6.3 INLAND COMMERCIAL SITES

The SCOUP Plan (Moffatt and Nichol Engineers, 2006) provides a generic list of potential inland sources of beach quality sediment, including:

- road and railway construction
- landslides
- quarries

Currently there are no future major roads or railway construction projects identified in proximity to southern Monterey, and in general most of the materials yielded through these construction activities would not be suitable for beach nourishment purposes. However, there is a small chance that routes cut through coastal terrain comprised of marine sedimentary deposits may yield some beach-compatible sediment. In addition, landslides wouldn't in all likelihood provide beach compatible material nor large enough volumes to consider. However, slides in uplifted marine deposits in coastal regions may prove to be possible sources. Quarried sand and gravel may be appropriate for smaller nourishment projects in close proximity to the quarry. These sources would become available opportunistically and possibly not at a time suitable for immediate use. Hence, for these opportunistic sources, the sediment would require relatively rapid identification and characterization to determine compatibility with receiver sites, and then stockpiled for future nourishment needs.

6.3.1 Stockpiling

In order to temporarily store beach compatible sand from opportunistic inland sources (and potentially from offshore if the nourishment is phased) requires a stockpiling site. This Coastal RSM Plan suggests two potential stockpile sites (Figure 32):

- the former Fort Ord where there are many acres of unused land (recommended)
- a large pit (approximately 600 feet by 450 feet by 90 feet deep at the north end of Sand City.

For the Fort Ord recommended option, AMBAG would need to approach the Fort Ord Reuse Authority (FORA) and the County of Monterey to receive permission. The Fort Ord site is large, accessible, and local to the southern bight (the southern end of Fort Ord is adjacent to Sand City), and hence transportation by truck of the stockpiled sand along established routes (Highway 1 and access roads) from the stockpile to the placement area should be relatively straightforward.

The alternative pit location at north Sand City is between Highway 1 and the shoreline and is a former sand mining pit. This site could accommodate approximately 1,000,000 yd^3.

Although no inland commercial sites with compatible sediments for beach nourishment are identified in this Coastal RSM Plan, it is recommended that part of the SCOUP process secures part of Fort Ord as a stockpile site where sediment can be stored to the appropriate volumes for nourishment projects.

6.4 DUNES AT FORD ORD

There are 40.4 square miles of sand dunes in the southern Monterey Bay dune field south of the Salinas River that extend inland as far as five miles in the Fort Ord area. The dunes north of the Salinas River mouth are less extensive, and narrower, and consist of several smaller complexes that total 8.8 square miles. Thus, the total southern Monterey Bay dune area is about 51 square miles with nearly 80% of this lying south of the Salinas River mouth (Cooper, 1967).

The particle size characteristics of the dune sand is important because it provides information on what volume of sediment eroded from the dunes is large enough to remain on the beaches and shoreface. Using the methods of Dean (1974) shows that approximately 25% of the dune sand has particle sizes equivalent to those that would reside on the beach. However, according to Dingler et al. (1985), who based his statement of the work of Dorman (1968), the eroded dune sand contains on average 76% medium-to-coarse sand (>0.25mm) that can remain within the beach and shoreface, leaving 24%, which is lost offshore. The finer dune sands may also result in a wider, flatter shoreface and increased shore recession until the widening is complete.

Although the particle size of the dunes is finer than the beach, the data suggest a potential 76% retention on the beach and shoreface of sediment eroded from the dune bluffs. With over 40 square miles of sand dunes adjacent to the bay, derived originally from the beach, the southern Monterey Bay dune field is a large potential source of sediment for nourishment of the southern Monterey Bay beaches. There are some significant areas of dune sand within Fort Ord that have been disturbed and do not contain endangered species that would provide large quantities of compatible sand. Hence, the sand dunes within the Fort Ord complex are recommended as a target for more detailed Tier II compatibility analysis.

6.5 OFFSHORE LOCATIONS

Large volumes of sand exist offshore in southern Monterey Bay (Figure 12) (Combellick and Osborne, 1977; Reid et al., 2006). This sand is a potential source that could be dredged and placed either on the beach or in the nearshore, where it can become part of the littoral cell. The main opportunities with offshore sources include relatively low cost, high placement rates on the receiver beach, and minimal disturbance onshore while the project is underway. One main constraint is that the offshore zone of southern Monterey Bay is part of the MBNMS, and dredging of the sand may be a complex issue due to a sanctuary prohibition on alteration of the seafloor. These activities can however be permitted if it can be determined that the impacts from these activities are neither significant nor long term.

Textural analyses of the offshore surface sediments in southern Monterey Bay reveal major sandy environments based on mean particle size. The delineation of particle size variations in the bay is critical for identifying appropriate source sands for potential beach nourishment. The offshore sand environments of southern Monterey Bay that are potential sources are:

- Monterey Submarine Canyon
- a zone of sand offshore from Sand City
- a nearshore relict sand corridor

6.5.1 Monterey Submarine Canyon

The upper 2.5 miles of the Monterey Submarine Canyon experiences both local deposition due to supply from adjacent littoral cells and erosion due to slope failure and landslides (Smith et al., 2007). Frequent episodes of sediment build-up and subsequent down-slope failure transport littoral sediments from the canyon rim to deeper in the canyon, where sediment is stored. Hence, the upper canyon is a temporary storage site for sediment.

A study is being undertaken by the Corps to examine the feasibility of capturing littoral sediments adjacent to canyons (Moffatt and Nichol Engineers, 2008). In the examination of all the canyons along the California coast, the two identified with the most potential were Monterey and Mugu Canyons. Monterey Submarine Canyon meets three critical criteria used in the analysis:

- it meets the minimum critical capture rate (greater than 10,000 yd^3/year), determined to be economically worth pursuing
- the location of the sand to be captured is relatively near a critical coastal erosion area as identified by CSMW (southern Monterey Bay)
- there is an additional benefit that the nearby and eroding Elkhorn Slough, a federal reserve, is in need of sediment.

Several means to recover sediment from Monterey Submarine Canyon were considered in the feasibility study. First, the sand that has already been lost down the canyon could be extracted. Second, it may be possible to intercept the sediment as it moves toward the canyon head and redirect it back into the littoral system. Interception would prevent the sand from being lost into the canyon. Several interception alternatives were considered by Moffatt and Nichol Engineers (2008):

- use the north jetty to intercept sediments with an array of stationary jet pumps attached to the breakwater
- a jet pump on a moveable crane on the breakwater
- an offshore breakwater on the south side to impound sediments and provide shelter for a dredge
- use a hopper dredge to create an offshore pit south of the canyon to serve as a sand trap for future mining of sand

The latter approach (although only the utilizing the south side of the canyon) was suggested as having the least environmental impact with the best cost-benefit ratio.

Monterey Submarine Canyon is a large potential source of sediment for nourishment of the southern Monterey Bay beaches. Given the proximity of the canyon head to the nearshore zone, sediment in the vicinity of the canyon head should match the characteristics of the adjacent littoral cell, and be a suitable source with respect to particle size and chemistry. The volumes available are probably sufficient to nourish all the critical areas of erosion south of Sand City. The Monterey Submarine Canyon is recommended as a target for more detailed Tier II compatibility analysis. Identifying an appropriate offshore pit area closer to the critical erosion areas, between the Salinas River Mouth and the submarine canyon head, could reduce transport costs.

6.5.2 Zone of Sand Offshore from Sand City

It is likely that offshore transport of sediment from the southern Monterey Bay beaches is taking place. This repository for sediment could be a potential zone for obtaining sand for beach nourishment purposes. In particular, the possibility that sand is moving offshore from a probable alongshore convergence zone in the vicinity of Sand City should be investigated in more detail. The analyses of Combellick and Osborne (1977) describe a zone of medium sand (particle size 0.25-0.5 mm) offshore from Sand City (Figure 12). These sands are potentially the offshore extension of a zone of convergence of alongshore sediment transport in the vicinity of Sand City.

Reid et al. (2006) compiled particle size data for the Pacific coast including southern Monterey Bay. Their data offshore from the southern bight shows a grouping of surface samples in the 0.3 to 0.5 mm particle size range in a similar location to the medium sand zone of Dorman (1968) and Combellick and Osborne (1977). Particle size data from the offshore zone is presented in Table 13 (Reid et al., 2006), and describes sediments with mean/median particle sizes between 0.3 and 0.5 mm (medium sand).

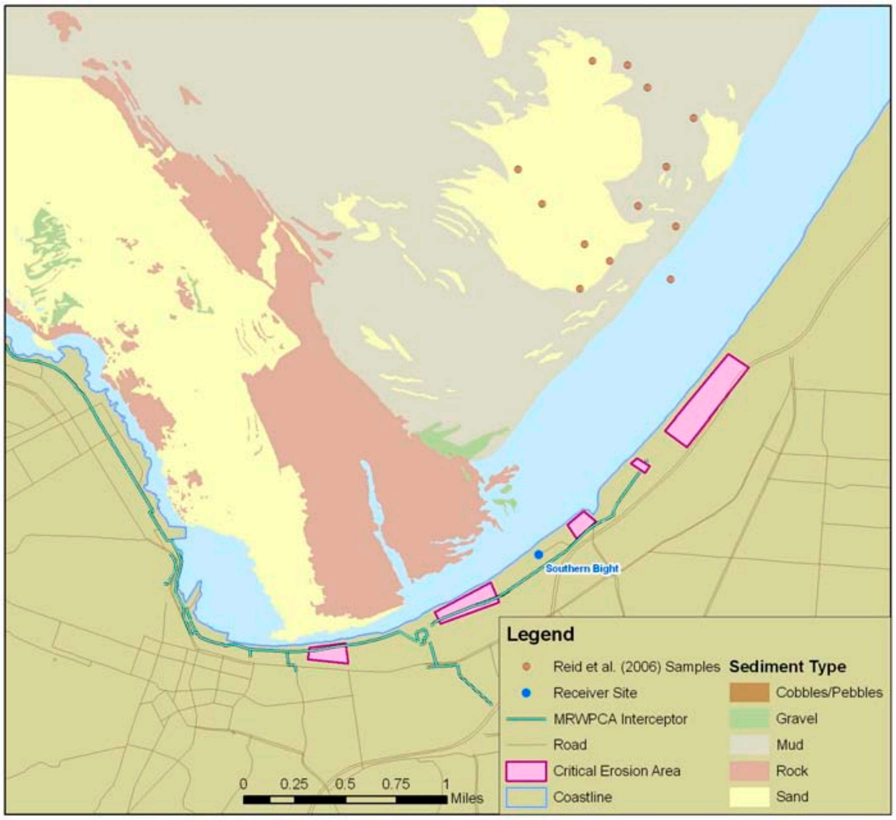
Table 13. Particle Size of Sand Offshore from Sand City (Reid et al., 2006)

Latitude	Longitude	% sand	Particle size[1] (mm)
36.64240	121.85500	100	0.38
36.64040	121.85080	100	0.31
36.63683	121.85300	100	0.27
36.63610	121.86610	99	0.31
36.63370	121.86380	100	0.35
36.62780	121.86010	100	0.31
36.63100	121.85990	100	0.33
36.64410	121.86000	99	0.50
36.64390	121.85690	100	0.33
36.63390	121.85530	100	0.47
36.63260	121.85190	100	0.47
36.62880	121.85210	100	0.33
36.62990	121.85760	100	0.33

[1]Particle size reported as either mean or median.

Data compiled by the NOAAs National Coastal Data Development Center presented as part of the Sanctuary Interactive Monitoring Network (SIMoN) interactive map series also shows a large patch of sand in a similar location to the Combellick and Osborne (1977) and Reid et al. (2006) data sets (Figure 34). The locations of sediment samples taken by Reid et al. (2006) are also shown on Figure 34.

Figure 34. Offshore Sediment Types



The particle size of these sands appears compatible with the southern Monterey Bay beach sands and therefore they are a potential source of sand for beach nourishment. The zone of sand offshore from Sand City is therefore recommended as a target for more detailed Tier II compatibility analysis.

6.5.3 Nearshore Relict Sand Corridor

Relict medium to coarse sand occurs on the inner shelf of southern Monterey Bay as irregularly shaped depressions, approximately three feet deep out to water depths of 200 feet. In shallower water depths of 30-60 feet, these medium-coarse-sand deposits trend parallel to the shoreline as bands 60-300 feet wide, and alternate with bands of fine-medium sand that are of similar width (Hunter et al., 1988). The medium-coarse sands have a mean particle size of 0.35-1.0 mm, and the fine-medium sands have a mean particle size of 0.125-0.35 mm. Further offshore, patches of the medium-coarse sand are exposed through an overlying mud layer. The source of the sand may be a pre-Flandrian transgressive lag deposit underlying much of the shelf (Chin et al., 1988). It would appear that these coarse sands do not move onshore and contribute to the sand budget, so they may be a potential source of sand for beach nourishment.

6.6 SEDIMENT SOURCE SHORT-LIST

The Tier I screening of potential sediment sources for beach nourishment shows that currently considered opportunistic inland sources are unsuitable. A regional stockpile area somewhere on Fort Ord lands close to the southern bight receiver site is recommended to allow accumulation of appropriate sediment of opportunity to a volume sufficient for a nourishment project. Also, the dunes at Fort Ord may themselves provide a suitable source. Of the three harbors in Monterey Bay, Moss Landing Harbor entrance channel and Monterey Harbor contain sediment that could potentially be beneficially re-used. Potential offshore sand sources include the area between the Salinas river mouth and head region of Monterey Submarine Canyon, and the shelf offshore of the transport convergence zone at Sand City.

In this Plan, the following five potential sources of sand are recommended for more detailed Tier II compatibility studies.

- **Monterey Submarine Canyon**
- **Shelf offshore from Sand City**
- **Fort Ord dune field**
- **Moss Landing Harbor entrance channel**
- **Monterey Harbor**

All of the potential sediment sources for nourishment of the beaches in southern Monterey Bay are in coastal and nearshore locations. It is anticipated that the feasibility of the use of sand sources from much further inland to nourish the southern Monterey Bay shoreline may change. Feasibility may increase due to the need to restore dam capacity by removing sediment, the need to decommission the dam, and the increased value of sand for nourishment if future erosion is great enough. Consequently, the feasibility assessments in this Coastal RSM Plan should be updated, as appropriate, in the future.

6.7 ENVIRONMENTAL IMPACTS AT POTENTIAL SOURCE AREAS

Dredging in subtidal sandy habitats to obtain sediment for beach nourishment disturbs and removes benthic habitat and results in elevated turbidity (NRC, 1995; Green, 2002) with potential impacts to invertebrates and fish in nearshore and offshore environments. Borrow site dredging removes sediment and associated benthic organisms and has the potential to entrain organisms as a result of near-bottom water being withdrawn by suction dredgers. Generally, complete mortality is assumed for dredge-removed and/or entrained organisms, although a small percentage may survive depending on discharge location (LaSalle et al., 1991).

Recovery of benthic communities following borrow site dredging varies depending on sediment infill rates, hydrodynamics, and dredging method but can be protracted (SAIC, 2007). In Monterey Bay, Oliver and Slattery (1976) found dredging in channel areas removed 60% of the benthic animals. Abundance remained low 1.5 years after dredging, but indexes of species diversity and evenness were higher than before dredging. They suggested that the timing of dredging in relation to the reproductive cycles and distributive abilities of the benthic organisms in the area affects recovery.

6.7.1 Mitigation Measures

Recovery may be facilitated by shallow dredging over a larger area rather than creation of deep pits covering a limited area. Dredging shifting sands rather than more stable bottoms, retaining similar surface sediment type, and leaving undisturbed areas within the larger dredged area may also reduce disturbance (Thompson, 1973; Oliver and Slattery, 1976; Hurme and Pullen, 1988; Jutte, 2002; Diaz et al., 2004).

7. ECONOMIC FEASIBILITY OF BEACH NOURISHMENT

7.1 POTENTIAL BEACH NOURISHMENT ALTERNATIVES

This Coastal RSM Plan describes two potential alternatives for nourishment of the southern Monterey Bay beaches (Table 14):

- Alternative 1: small-scale nourishment of the southern bight
- Alternative 2: large-scale nourishment of the southern bight

Alternative 1 considers the use of opportunistic sand sources from Monterey Harbor to nourish the southern three miles of the bay. Approximately 75,000 yd^3 of sand may become available from dredging of the harbor for placement on to the beach. Sand would be placed at a location away from the rocky reef, kelp forest and eelgrass meadow (if still present) and be allowed to spread along the three miles of shoreline through sediment transport processes (this Coastal RSM Plan recommends a receiver site between Monterey Beach Resort and Ocean Harbor House condominiums, Figure 29). Using an estimate of 1.7 yd^3 of sediment to nourish one square foot of beach, the estimated increase in width of the nourished three-mile stretch of shoreline, after the sand has spread and equilibrium is reached, would be three feet.

Alternative 2 is a scenario in which large-scale extraction of sand from offshore sources (offshore Sand City and Monterey Submarine Canyon head) is placed in the southern bight, either as a nearshore or beach placement. Sand would be extracted and transported using a hopper dredge, and be placed at one or more locations in the southern bight away from sensitive habitat. To increase the width of the three-mile equilibrium beach by 75 feet would require approximately two million yd^3 of sand. However, this volume would not be placed all at one time, as the materials would be placed in strips along the three-mile stretch to minimize environmental disturbances.

For Alternative 2, two methods of placement are considered for the beach nourishment material: subaerial placement (directly onto the beach); and nearshore placement (in the surf zone). Placement onto the beach creates a wider beach more quickly but is more expensive as additional equipment and time is required to place the material, whereas nearshore placement simply involves depositing the material, which then takes longer to be worked onto the beach (by wave action) and hence produces less beach width increase. The relative merits of these approaches are further described in Section 5.1.

Table 14. Potential Beach Nourishment Alternatives for Southern Monterey Bay

	Alternative	Receiver Site	Shore Length (miles)	Equilibrium Width (feet)	Required Volume (yd^3)	Source Site	Excavation / Dredge Method	Transport Method	Placement Method
1	**Southern Bight Small**	South Sub-cell	3	3	75,000	Monterey Harbor			
a						Opportunistic/stockpile	Hopper Dredge	Hopper	Hydraulic Discharge to Beach
b						Opportunistic/stockpile	Hopper Dredge	Hopper	Place in nearshore
2	**Southern Bight Large**	South Sub-cell	3	75	2,000,000				
a						Offshore Sand City	Hopper Dredge	Hopper	Hydraulic Discharge to Beach
b						Offshore Sand City	Hopper Dredge	Hopper	Place in nearshore
c						Canyon Head	Hopper Dredge	Hopper	Hydraulic Discharge to Beach
d						Canyon Head	Hopper Dredge	Hopper	Place in nearshore

7.2 APPROACH TO ECONOMIC ANALYSIS

This section provides a review of the relative costs and benefits of each of the beach nourishment alternatives. At this regional scale of analysis the intention is not to determine exact costs and benefits for funding and approval purposes, but to determine the likely economic viability of proposed alternatives. For regional planning purposes, if it can be determined that an alternative is likely to have a benefit to cost ratio robustly greater than 1 (i.e. benefits are greater than costs) then it can be considered viable and appropriate for further investigation and development.

Costs for the beach nourishment options and recreational benefits of the nourishment have been calculated using a decision support tool developed for CSMW. Benefits associated with prevention of erosion, and hence protection of coastal assets, have been calculated using property values provided by the Monterey County Property Assessor and the Monterey Regional Water Pollution Control Agency (MRWPCA).

7.2.1 Application of the Coastal Sediment Benefits Analysis Tool

The benefit-cost analysis for beach nourishment in this Coastal RSM Plan uses the Coastal Sediment Benefits Analysis Tool (CSBAT) developed by CSMW (Corps, 2008), populated with data from southern Monterey Bay to investigate the economics of the small-scale and large-scale alternatives summarized Table 14.

CSBAT was originally developed for application in San Diego County, and the southern Monterey Bay application represents the first use outside San Diego. The tool focuses principally on the value of recreational benefits arising from beach nourishment works. Consequently, it utilizes a range of data on both the physical attributes of the source and receiver sites and the economic value of beach visitors.

Where possible data specific to southern Monterey Bay has been obtained and used in the analysis; however there has been very little study of the economics of beach use in this area, so average and pro-rated values from the San Diego application have been used for many of the attributes. This application of analogous data (from another site within the state) in the absence of locally specific data is considered valid for a regional planning assessment such as this, where it is necessary to determine the likely viability of beach nourishment alternatives.

The CSBAT tool allows the user to appraise various beach nourishment alternatives through different combinations of:

- sediment source site
- receiver site
- volume of dredged material
- mode/s of transportation.

Utilizing background attribute data such as unit costs, beach visitor numbers, and other parameters, the tool produces reports containing information such as:

- baseline data on the sites
- results from the model including estimated beach nourishment costs
- change in recreational benefits
- projected increases in spending and tax value
- potential environmental impacts
- estimated change in beach width
- cumulative cost/benefits using various transportation routes and scenarios.

The calculation of economic benefits within CSBAT is based on potential changes in the amenity/recreation value of the beach. These benefits are derived from increased visitor numbers due to increased capacity on the larger (post-nourishment) beach, the associated increased visitor spend, increased taxation on that spend, and increased recreational 'value' (economic equivalent of the recreational benefit) derived by visitors to a wider beach. The increase in visitor numbers and their corresponding increase in economic benefit are calculated based on King (2001), where visitor surveys at a number of southern California beaches showed that in general respondents preferred wider beaches and would attend wider beaches more often. From the work of King (2001) and the analyses for the San Diego application of CSBAT, it was concluded that a doubling in beach width would increase attendance by 2.5% and recreational value (per visitor) by 18%. This is an underlying assumption in the CSBAT analysis.

The tool makes calculations of the changes in beach width and hence visitor numbers and recreational benefits for up to a 20 year period from the original beach nourishment. Over time the beach fill spreads laterally along the shoreline, and this process together with ongoing erosion gradually reduces the width of the beach and hence the additional recreational benefits provided by the nourishment. A 20-year period is assessed as this is considered a reasonable maximum duration of the positive affect of the nourishment on beach widths.

One of the most important inputs for the analysis is beach visitor numbers. Table 15 presents observed visitor numbers from 1995 to 2007 for Monterey State Beach in the southern bight. The visitor numbers show a large degree of fluctuation from year to year, with low values in the early part of the record rising to peaks in excess of one million visitors then settling to a more consistent level in recent years. CSBAT uses an 'average' annual attendance figure for benefit estimates, so in order to define a value relevant to current beach usage, an average from the last five years has been used. Using the last five years avoids the large fluctuations in the earlier years, and is more representative of the present day beach use. Based on this approach the visitor numbers used in the CSBAT analysis are 644,677 for Monterey State Beach.

Table 15. Annual Visitor Numbers for Monterey State Beach

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean Last 5 years
107,946	131,340	251,994	258,771	919,104	457,161	493,170	1,259,688	841,461	834,850	598,204	534,322	414,548	**644,677**

On the costs side of the analysis, generic cost rates defined for the San Diego application of CSBAT (the tool was originally developed for that application) have been used. It is recognized that the actual cost rates in southern Monterey Bay may be different from those in southern California; however it is considered appropriate to use these rates for a regional plan such as this, as they are adequate to assess the overall economic viability of the nourishment alternatives.

7.2.2 Estimation of Protection Benefits

The CSBAT tool does not calculate the economic benefits arising from the protection of infrastructure and built assets. However, beach nourishment projects not only provide larger amenity beaches, but also slow the rate of beach/dune erosion. As such, nourishment projects prevent the loss of assets located within areas vulnerable to erosion (Section 3). Depending on the nature and location of coastal development and infrastructure, this can be a major contributor to the overall benefits arising from the nourishment.

Values for the majority of assets at risk of erosion (Section 3) were obtained from the records of the Monterey County Property Assessor. However, one of the most important built assets located along this coast is the Monterey Interceptor pipeline and the pump stations associated with the pipeline. Estimates of the replacement value of this infrastructure were obtained from MRWPCA. MRWPCA undertook an analysis of the replacement cost for the Salinas Interceptor approximately five years ago, which concluded a replacement cost of $600-$700 per linear foot would be appropriate for that 36 inch-diameter pipeline. The Monterey Interceptor is 24 inches and larger in sections, and it was recommended that $600/foot be used for replacement taking account of local ground conditions, access and property issues (Jennifer Gonzales, MRWPCA, personal communication). In addition, an estimated replacement cost of £75 million was recommended for Seaside Pump Station.

Beach nourishment generally has a finite life and only acts to delay the erosion process. Consequently, the true value of the protection benefit from beach nourishment is the value of the delay in loss of an asset. The process of evaluating this delay requires the definition of likely time scales for erosion loss with and without the nourishment project, then application of a discount rate to determine the present value of that benefit.

The potential timescale until loss of facilities without any beach nourishment are provided in Section 3.3. It was then assumed that the nourishment of 2,000,000 yd^3 of sand would delay the onset of erosion by 20 years (to be consistent with the time period considered in the recreation benefits analysis). Discounted values for the loss of the asset (using a 5% discount rate) with and without project were then calculated and the difference between those values is the benefit of the delay. A three-year delay was also considered for the 75,000 yd^3 nourishment alternative. It was assumed that the delay in erosion would be the same regardless of whether sand was placed on the beach or in the nearshore, as the overall impact on erosion rates would be the same for both (even though the dry beach area is less for nearshore placement).

Another aspect of the protection benefits of beach nourishment that is not taken into account by CSBAT is the benefit of maintaining the current recreational amenity of the beach by preventing the loss of beach width. While no attempt has been made to estimate the number of visitors that would not visit the beach if it were allowed to erode, it is reasonable to assume that a smaller beach would attract/accommodate less people. However, this benefit is difficult to quantify and has not been included in these analyses. This means that the results of the economics are conservative as any positive outcomes would be enhanced through the addition of these recreational benefits.

7.3 COSTS AND BENEFITS

This section outlines the costs and benefits for each of the two beach nourishment alternatives using CSBAT, plus the additional benefits from protection of properties.

7.3.1 Costs

The costs associated with each of the potential beach nourishment alternatives all using the hopper dredge technology are presented in the Tables 16 and 17.

Table 16. Small-Scale Nourishment of the Southern Bight sourced from Monterey Harbor (Alternative 1)

Cost component	1a. Beach	1b. Nearshore
Sand volume (yd^3)	75,000	75,000
Transport Distance (miles)	2.53	2.53
Total Trips	28	28
Construction Period (days)	6	5
Total Transport Cost ($)	431,560	193,503
Mob/Demob. ($)	600,000	500,000
Cost per Yard ($)	14	9
Total Beach Nourishment Cost ($)	**1,030,000**	**694,000**

Table 17. Large-Scale Nourishment of the Southern Bight (Alternative 2)

Cost component	2a. Sand City Beach	2b. Sand City Nearshore	2c. Canyon Head Beach	2d. Canyon Head Nearshore
Sand volume (yd^3)	2,000,000	2,000,000	2,000,000	2,000,000
Transport Distance (miles)	1.81	1.81	15.33	15.33
Total Trips	741	741	741	741
Construction Period (days)	151	118	309	265
Total Transport Cost ($)	11,044,907	4,832,451	19,747,047	10,873,016
Mob/Demob. ($)	600,000	500,000	600,000	500,000
Cost per Yard ($)	6	3	10	6
Total Beach Nourishment Cost ($)	**11,650,000**	**5,330,000**	**20,350,000**	**11,400,000**

The results show that placing sand directly on to the beach is substantially more expensive than placing sand in the nearshore. This is to be expected due to the significant increase in effort and equipment required to undertake the beach placement. However, Section 7.3.2 demonstrates the differences in the benefits resulting from the two approaches.

7.3.2 Recreational Benefits

The benefits generated by the application of CSBAT provide an estimate of the economic value of the improved recreational amenity of southern Monterey Bay beaches. Tables 18 to 21 present the details of the benefits calculated for the two alternatives. For each alternative, the value of the increase in recreational benefit is calculated in three parts, based on the increased beach width providing for increased visitor numbers and an increased recreational benefit value for all visitors. The parameters presented are:

- beach width increase: this varies dependant on the method of sand delivery (subaerial beach or nearshore) and is used to determine the increase in beach visitors
- increase in state and local spending: the increased spend resultant from more visitors
- increase in state and local taxes: income based on spending
- increase in recreational value: reflects the increased value derived by visitors from a wider beach, plus the increased visitor numbers
- total increase in recreational benefit: the discounted total of the above three benefits increases over a full 20 years (note only the first ten years are presented individually in Tables 18 to 21).

Table 18. Recreational Benefits of Small-Scale Nourishment of the Southern Bight with Beach Placement (Alternative 1a)

	Increases in:			
	Beach Width (ft)	State & Local Spending ($)	State & Local Taxes ($)	Recreational Value ($)
Year-1	3.75	11,243	1,293	38,329
Year-2	0.3	899	103	2,940
Year-3	0.0	0.0	0.0	0.0
Year-4	0.0	0.0	0.0	0.0
Year-5	0.0	0.0	0.0	0.0
Year-6	0.0	0.0	0.0	0.0
Year-7	0.0	0.0	0.0	0.0
Year-8	0.0	0.0	0.0	0.0
Year-9	0.0	0.0	0.0	0.0
Year-10	0.0	0.0	0.0	0.0
Total Increase in Recreational Benefit ($)	**54,995**			

Table 19. Recreational Benefits of Small-Scale Nourishment of the Southern Bight with Nearshore Placement (Alternative 1b)

	Increases in:			
	Beach Width (ft)	State & Local Spending ($)	State & Local Taxes ($)	Recreational Value ($)
Year-1	0.0	0.0	0.0	0.0
Year-2	0.6	1,799	207	5,877
Year-3	0.98	2,923	336	9,088
Year-4	1.09	3,261	375	9,652
Year-5	0.0	0.0	0.0	0.0
Year-6	0.0	0.0	0.0	0.0
Year-7	0.0	0.0	0.0	0.0
Year-8	0.0	0.0	0.0	0.0
Year-9	0.0	0.0	0.0	0.0
Year-10	0.0	0.0	0.0	0.0
Total Increase in Recreational Benefit ($)		**36,264**		

Table 20. Recreational Benefits of Large-Scale Nourishment of the Southern Bight with Beach Placement (Alternatives 2a and 2c)

	Increase in:			
	Beach Width (ft)	State & Local Spending ($)	State & Local Taxes ($)	Recreational Value ($)
Year-0	100.0	299,818	34,479	880,495
Year-1	77.76	233,136	26,811	671,330
Year-2	69.15	207,325	23,842	575,432
Year-3	62.84	188,413	21,668	502,571
Year-4	57.94	173,728	19,979	444,523
Year-5	54.01	161,928	18,622	396,936
Year-6	50.56	151,585	17,432	355,752
Year-7	47.11	141,241	16,243	317,382
Year-8	43.66	130,897	15,053	281,655
Year-9	40.21	120,553	13,864	248,411
Year-10	36.76	110,210	12,674	217,498
Total Increase in Recreational Benefit ($)		**8,067,127**		

Table 21. Recreational Benefits of Large-Scale Nourishment of the Southern Bight with Nearshore Placement (Alternatives 2b and 2d)

	Increase in:			
	Beach Width (ft)	State & Local Spending ($)	State & Local Taxes ($)	Recreational Value ($)
Year-0	0.0	0.0	0.0	0.0
Year-1	16.0	47,971	5,517	152,212
Year-2	26.0	77,953	8,965	231,435
Year-3	29.0	86,947	9,999	244,587
Year-4	15.0	44,973	5,172	123,493
Year-5	11.55	34,629	3,982	91,138
Year-6	8.1	24,285	2,793	61,267
Year-7	4.65	13,942	1,603	33,718
Year-8	1.2	3,599	414	8,343
Year-9	0.0	0.0	0.0	0.0
Year-10	0.0	0.0	0.0	0.0
Total Increase in Recreational Benefit ($)		**1,479,160**		

It is notable that the increased recreational benefits provided where the sand is placed directly on to the beach are significantly greater than those for nearshore placement. This is because the maximum beach width increase is realized in the first year, and, more importantly, because the overall beach width increase is much greater and lasts longer (as erosion and dispersion gradually reduce the beach width over time).

7.3.3 Property Protection Benefits

The protection of built assets from long-term erosion is a tangible benefit of the beach nourishment proposals. Using the risk analysis in Section 3.3, Table 22 estimates the economic value of these assets vulnerable to erosion (Figure 19) together with an estimate of when they would be lost to erosion without beach nourishment, when the delayed loss would occur if nourishment was undertaken, and the 'present value' of that delay in loss.

Table 22. Assets Protected by Beach Nourishment

Asset	Land Value	Buildings/Facility value	Total Value	Approx. year of loss		Value of delay in erosion
				No project	With 2m cy fill	
Monterey Interceptor (8,600 foot from Wharf II to Monterey Pump Station)		$5,160,000		20	40	$1,211,794
Monterey Interceptor (1,750 foot section south from Seaside Pump Station)		$76,050,000		40	60	$6,731,198
Monterey Beach Resort	$5,061,190	$12,977,895	$18,039,085	20	20	$4,236,367
Ocean Harbor House Condominiums	$15,933,694	$19,389,305	$35,322,999	50	70	$1,919,366
La Playa Street Town Homes	$4,777,434	$6,325,399	$11,102,833	20 (ongoing)	40 (ongoing)	$1,448,546
Total erosion prevention benefits in the southern bight						**$15,550,000**

Table 22 demonstrates the high value of the beach front facilities and properties along this coast, and in particular in the southern reach. In addition to the simple value of the assets, their loss would have significant secondary impacts such as disruption to wastewater facilities for the cities of Pacific Grove and Monterey, as well as major environmental consequences, if the Monterey Interceptor was breached; and impacts on the local tourist economy if oceanfront resorts were lost.

In order to appropriately represent the likely nature of erosion losses at the facilities identified in Table 22, assumptions were made regarding the progression of loss:

- Given it's proximity to the shoreline, a 8,600 foot section of the Monterey Interceptor pipeline is considered to be at risk between Monterey Harbor and Monterey Pump Station. Elsewhere the pipeline is set back from the coast, except near Seaside Pumping

Station, where the Station itself and a 1,750 foot section of the pipeline are considered at long-term risk.

- For the Monterey Beach Resort it is assumed that the seawall constructed in 1968 has a design life of 50 years and hence is likely to remain effective for no more than 20 years, after which erosion of the property would begin.
- For Ocean Harbor House condominiums it is assumed that the seawall that is due to be constructed will have a 50-year life, after which erosion of the property would be immediate as the fronting beach would be lost and the property outflanked by erosion.
- Twenty six property parcels are identified as being at risk in the Monterey La Playa town homes development. It is assumed that the first losses occur in year 20, with 25% of the at-risk parcels lost every 10 years thereafter.

This analysis demonstrates that the erosion delay benefits of the proposed beach nourishment projects could be significant.

7.3.4 Ecologic Protection Benefits

Recent analyses indicate that reduction of beach widths associated with seawall construction results in severe ecologic degradation (Dugan et al., 2008). If no beach nourishment occurs it is possible that armouring would be installed to protect development. Therefore, beach nourishment would maintain ecology closer to existing conditions. This benefit has not been quantified.

7.4 ECONOMIC VIABILITY OF ALTERNATIVES

Sections 7.1 to 7.3 present the various aspects of the costs and benefits of beach nourishment in the southern bight of southern Monterey Bay. This section amalgamates these aspects to review the economic viability of the alternatives.

7.4.1 Alternative 1: Small-Scale Nourishment of the Southern Bight

Table 23 presents a summary of the costs and benefits for Alternative 1, the placement of 75,000yd^3 of sand from Monterey Harbor directly on to the southern bight beaches.

Table 23. Economic Summary of Alternative 1

Scenario	Total Cost	Increase in Recreational Benefits	Property Protection Benefits	Total Benefits	Net Benefits	Cost/Benefit Ratio
1a. Beach Placement	$1,031,560	$54,955	$3,397,397	$3,452,352	$2,420,792	3.35
1b. Nearshore Placement	$693,503	$36,264	$3,397,397	$3,433,661	$2,740,158	4.95

The data demonstrates that there is a clear economic justification to placing sand from Monterey Harbor on to the adjacent shoreline. Indeed, the additional cost of placing the sand from the harbor onto the adjacent beaches could be minimized if coordinated with maintenance dredging of the harbor, potentially reducing the cost side of the equation. It is notable that placing this relatively small volume of sand onto this frontage has little benefit in terms of increasing the beach for amenity purposes, but it is the benefits in delaying erosion that provide the clear justification.

7.4.2 Alternative 2: Large-Scale Nourishment of the Southern Bight

Table 24 presents a summary of the costs and benefits for Alternative 2, the nourishment of the three mile frontage of the southern bight with 2,000,000 yd^3 of sand from three potential offshore sources. Both subaerial beach and nearshore placement are considered.

Table 24. Economic Summary of Alternative 2

Scenario	Total Cost	Increase in Recreational Benefits	Property Protection Benefits	Total Benefits	Net Benefits	Cost/Benefit Ratio
2a. Offshore Sand City source to beach	$11,644,907	$8,067,127	$15,547,271	$23,614,398	$11,969,491	2.03
2b. Offshore Sand City source to nearshore	$5,332,452	$1,479,160	$15,547,271	$17,026,431	$11,693,979	3.19
2c. Canyon head source to beach	$20,347,048	$8,067,127	$15,547,271	$23,614,398	$3,267,350	1.16
2d. Canyon head source to nearshore	$11,373,016	$1,479,160	$15,547,271	$17,026,431	$5,653,415	1.50

The economic summary for Alternative 2 demonstrates clearly that these beach nourishment alternatives are economically viable. All alternatives have a positive benefit-cost ratio, with the Sand City borrow area proving most cost-effective due to it’s proximity to the southern bight frontage.

Section 7.3.1 showed that the costs of placing sand on to the beach are substantially greater than placing in the nearshore; however it also delivers a greater recreational benefit. Considering the benefit-cost ratio, the nearshore placement option (from offshore Sand City) looks most attractive (ratio of 3.19). However, the incremental benefit of placing the sand directly on the beach is greater than one (i.e. the additional cost to place the sand on the beach is $6.3 million and the additional recreational benefits are $6.6 million), suggesting the additional investment is economically worthwhile. This is supported by this alternative having the highest net benefit at $12.59 million.

The results indicate that there is a clear economic justification for undertaking beach nourishment in the southern bight of southern Monterey Bay. Although the analysis does not guarantee funding for these alternatives (Section 9), it has shown that beach nourishment in southern Monterey Bay would deliver net economic benefits to the area and region.

8. REGULATORY PROCESSES

The Beach Restoration Regulatory Guide (BRRG) (EIC, 2006) details federal and state regulatory processes for implementation of beach nourishment projects in California. The document describes the relevant regulatory requirements and the agencies responsible for administering permits, and should be consulted for California-wide federal and state regulatory processes that are relevant to southern Monterey Bay. However, several regulatory organizations administered by federal or state entities have jurisdiction that is specific to the Monterey Bay region and these are discussed in this Coastal RSM Plan. These organizations are:

- Monterey Bay National Marine Sanctuary (MBNMS)
- California Coastal Commission (Coastal Commission) (related to southern Monterey Bay Local Coastal Programs)
- California Department of Parks and Recreation (CDPR) (Salinas River, Marina, and Monterey State Parks).

This section provides an overview of the regulatory roles of these agencies and their policies regarding potential beach nourishment projects in the region. State and federal regulations other than MBNMS, Coastal Commission, and CDPR are tabulated from the BRRG but are not described in detail. Given the large number of local governmental organizations (coastal cities, counties) and the transitory nature of many of their regulations, the BRRG does not cover local regulatory processes. Hence, all relevant local regulations (principally those in Local Coastal Programs) are described in this Coastal RSM Plan.

8.1 REGULATORY COMPLIANCE PROCESS

The regulatory compliance process for beach nourishment projects comprises three phases:

- Environmental review
- Permitting
- Compliance review.

Environmental review consists of both National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) compliance, and is typically completed first. NEPA and CEQA documents should be prepared concurrently and are used as the basis upon which the regulatory and resource agencies process permits. The Corps typically serves as the lead agency under NEPA. For CEQA, several state agencies may be involved (such as the Coastal Commission, CDPR). Once the environmental review is completed the permit process begins, and the applicant submits the necessary permit applications to the appropriate agencies. Beach nourishment projects involve placement of sediment into waters of the U.S., which may result in significant environmental impacts, and hence they receive a high level of scrutiny during the environmental and permitting process. The details of both the NEPA and CEQA compliance processes are described in the BRRG (EIC, 2006) and they are not described in this Coastal RSM Plan.

8.1.1 SCOUP Permitting Process

The intent of a SCOUP permit is to establish a process approved by regulatory agencies for environmentally-responsible use of opportunistic materials to nourish pre-established receiver site(s) when sediment becomes available (Moffatt and Nichol Engineers, 2006). There are two types of SCOUP permit; a single opportunistic permit and an opportunistic use program. The single permit is for a project in which source material is identified and the receiver beach site and method of delivery is permitted (Moffatt and Nichol Engineers, 2006). These are typically applied for by either the developer supplying the sand or the local jurisdiction receiving the sand. The opportunistic use program establishes a predefined program for placement of sediment at receiver beach sites. An approved SCOUP program permit streamlines the regulatory compliance process and enables opportunistically acquired materials that meet certain criteria to be placed at pre-established receiver sites at various quantities and times throughout the year with minimal review required from the regulatory agencies. Generally, these program permits are applied for by a local jurisdiction, county or regional association. This Coastal RSM Plan recommends that AMBAG pursue a regional SCOUP program permit.

To receive a SCOUP program permit, several steps are required that are described in more detail in Moffatt and Nichol Engineers (2006). There are ten federal and state agencies, not including local jurisdictions, which need to be involved in the programmatic permitting; Federal – Corps, USEPA, USFWS; California – CDFG, Coastal Commission, CSLC, State Parks, SWRCB, and RWQCB. In summary, the steps include developing a sediment sampling and analysis plan, used to evaluate potential sources of sand and to identify appropriate receiver sites. For each potential receiver site, components include: a sediment budget analysis to establish need for sediment, and a summary of transport mechanisms and routes to identify potential impacts. Monitoring plans for each site including sensitive habitat surveys that occur at established pre, post, and during construction intervals. The final step is an environmental review that must receive review and approval from all of the permitting agencies. As complicated as the process sounds, SANDAG has managed to receive a program permit on a Mitigated Negative Declaration (MND) which avoided significant environmental impacts by constraining the volume, % of fines, and timing of nourishment activities (EDAW, 2005).

8.2 FEDERAL REGULATIONS

Implementation of federal regulatory processes and the issuing of permits for beach nourishment in southern Monterey Bay is the responsibility of several organizations including the Corps, National Oceanic and Atmospheric Administration (NOAA), USFWS, and the U.S. Minerals

Management Service (USMMS). Table 25 summarizes federal regulations affecting beach restoration projects in California (EIC, 2006). All these regulations are described in detail in the BRRG.

Table 25. Relevant Federal Regulations Affecting Beach Restoration Projects

Policy/Regulation	Requirement	Responsible Agency
National Environmental Policy Act	Compliance	Lead Federal Agency
Coastal Zone Management Act	Coastal Consistency Determination	California Coastal Commission
Rivers and Harbors Act	Section 10 Permit	U.S. Army Corps of Engineers
Clean Air Act	Title V Operating Permit	California Air Resources Board
Clean Water Act	Section 401 Certification or Waiver (401 Permit)	Regional Water Quality Control Boards
Clean Water Act	Section 402 NPDES Permit (NPDES Permit)	Regional Water Quality Control Boards
Clean Water Act	Section 404 Permit (404 Permit)	U.S. Army Corps of Engineers
Endangered Species Act	Section 7 Consultation	U.S. Fish and Wildlife Service
National Historic Preservation Act	Section 106 Approval	State Historic Preservation Officer
Fish and Wildlife Coordination Act	Coordination Act Report	U.S. Army Corps of Engineers
Magnuson-Stevens Fishery Conservation and Management Act	Assessment of Impacts to Essential Fish Habitat	National Marine Fisheries Service
Outer Continental Shelf Lands Act	Lease Agreement for Utilization of Outer Continental Shelf Sand	U.S. Minerals Management Service

The MBNMS has jurisdiction through NOAA specifically within the boundary of the Sanctuary, which includes the waters off the southern Monterey Bay beaches from the MHW line to offshore. Details on MBNMS regulations are provided below.

8.2.1 Monterey Bay National Marine Sanctuary

The MBNMS is administered by NOAA, and spans over 5,300 square miles of coastal waters off central California. The Sanctuary stretches from Marin County to Cambria, encompassing nearly 300 miles of shoreline and extending an average distance of thirty miles offshore. The Sanctuary was designated in 1992, in response to potential offshore oil and gas development, for the purpose of resource protection, research, education, and public use. The MBNMS mission is to understand and protect the ecosystem and cultural resources of central California.

The MBNMS was designated in accordance with the National Marine Sanctuaries Act (NMSA) and their regulatory and enforcement powers are specified in the Act. The MBNMS enforces eleven federal regulatory prohibitions designed to preserve and protect the natural and cultural resources and qualities of the ocean and estuarine areas within its boundaries. Depending upon the nature of the project, two of these prohibitions may directly regulate beach nourishment in southern Monterey Bay:

- Drilling into, dredging or otherwise altering the sea bed of the Sanctuary; or constructing, placing or abandoning any structure, material or other matter on the sea bed of the Sanctuary.
- Discharging or depositing, from within the boundary of the Sanctuary, any material or other matter.

Although some potential beach nourishment projects may be technically prohibited by MBNMS regulations, it is still possible for the projects to be authorized through the Sanctuary's permitting program. Permits or authorizations may be issued by the MBNMS Superintendent under special circumstances for activities otherwise prohibited by Sanctuary regulations, when related to:

- research to enhance scientific understanding of the Sanctuary environment or to improve management decision-making
- education to further public awareness, understanding, and to establish access, use, and/or understanding of Sanctuary resources and wise use of the Sanctuary environment.

Authorizations may also be issued under special circumstances for activities otherwise prohibited by Sanctuary regulations if:

- an activity has been authorized by a valid lease, permit, license, approval or other authorization issued after the effective date of MBNMS designation by any federal, state, or local authority
- the Superintendent finds that the activity will not cause long-term or severe impacts to Sanctuary resources
- the applicant complies with all applicable regulations and any specific conditions/terms specified by the Superintendent.

An authorization may be issued in conjunction with a valid lease, permit, license, approval or other authorization issued by any federal, state, or local authority of competent jurisdiction. In cases where projects require a Coastal Commission Coastal Development Permit, the MBNMS would review and potentially authorize that permit. MBNMS approval would be required for any beach nourishment project where sediment is placed within Sanctuary boundaries, or where sediment is dredged from within Sanctuary boundaries.

In order to obtain an MBNMS authorization, the applicant must submit a permit application to the MBNMS Permit Coordinator; guidelines for submitting applications can be found on the Sanctuary website at: http://montereybay.noaa.gov/resourcepro/authorization.html. Authorization applications must be submitted at least 45 calendar days in advance of the requested effective date to allow sufficient time for evaluation and processing. In order to expedite processing, applicants are encouraged to contact the Sanctuary in advance of submitting a formal application to discuss any questions or issues they feel may complicate or delay the application process. Complete applications are reviewed by Sanctuary personnel, and, when deemed necessary, peer-reviewed by outside experts. Based on the reviews of the application, authorization will be approved or denied. If approved, the Sanctuary superintendent will issue the authorization. If denied, applicants are notified of the reason(s) for denial and informed of the appeal process.

8.3 STATE REGULATIONS

The main state legislations regulating beach nourishment projects in southern Monterey Bay are CEQA and the California Coastal Act (CCA). In addition, in 1978, the State of California adopted a Policy on Coastal Erosion 'to prevent the loss of the state's beaches through coastal erosion and to preserve its coastal resources.' The primary state agencies involved in regulatory processes and the issuing of permits for beach nourishment in California are the Coastal Commission, California State Lands Commission (CSLC), State Water Resources Control Board (SWRCB)/Regional Water Quality Control Board (RWQCB), California Department of Fish and Game (CDFG), and California Department of Parks and Recreation (CDPR). Table 26 summarizes state regulations affecting beach restoration projects in California (EIC, 2006). All these regulations are described in more detail in the BRRG.

Table 26. Relevant State Regulations Affecting Beach Restoration Projects

Policy/Regulation	Requirement	Responsible Agency
California Environmental Quality Act	Compliance	Lead CEQA Agency
California Coastal Act	Coastal Development Permit	California Coastal Commission
Porter-Cologne Water Quality Control Act	Compliance: Permits under CWA Sections 401, 402, and 404	State Water Resources Control Board Regional Water Quality Control Boards
California State Lands Public Resources Code	Lease Agreement for Utilization of Sovereign Lands	California State Lands Commission
California Public Resources Code Section 1600	Streambed Alteration Agreement	California Department of Fish and Game

Policy/Regulation	Requirement	Responsible Agency
California Endangered Species Act	Section 2081(b) Incidental Take Permit (State) Section 2081.1 Consistency Determination (State and Federal)	California Department of Fish and Game
Water Quality Control Plans California Ocean Plan	Consistency Compliance	Regional Water Quality Control Boards
Clean Air Act	Title V Operating Permit	APCDs and AQMDs

Details on the Coastal Commission and CDPR regulations specific to southern Monterey Bay are described below.

8.3.1 California Coastal Commission and Local Coastal Programs

The Coastal Commission, in collaboration with local counties and cities, is the primary state agency responsible for planning and regulating the use of land and water within California's coastal zone, in accordance with the specific policies of the CCA. In addition to development within the coastal zone, the Coastal Commission also has jurisdiction over projects requiring federal permits or approval in federal waters. The Coastal Commission was also established to assist local governments in implementing local coastal planning and regulatory powers by adopting Local Coastal Programs.

Local Coastal Programs (LCPs) are basic planning tools prepared and used by local governments to guide development in the coastal zone, in partnership with the Coastal Commission. LCPs contain the ground rules for future development and short-term and long-term conservation and protection of coastal resources. Each approved LCP specifies appropriate locations, types, and scales of new or changed uses of land and water. Each LCP includes one or more Land Use Plans (LUPs) with goals and regulatory policies and measures to implement the plan (such as zoning ordinances). While each LCP reflects unique characteristics of individual local coastal communities, regional and statewide interests and concerns must also be addressed to conform to CCA goals and policies. Following adoption by a city council or county board of supervisors, an LCP is submitted to the Coastal Commission for review for consistency with CCA requirements.

After an LCP has been certified by the Coastal Commission, the Commission's coastal permitting authority is transferred to the local government, which applies the requirements of the LCP in reviewing proposed new developments. All project proposals located within the coastal zone will be reviewed for consistency with the LCP or the CCA (where no certified LCP exists) and will require a Coastal Development Permit. Any projects located on sovereign lands below MHW remain within the Coastal Commission appeal jurisdiction (as are lands between the ocean and the first public road). Therefore, in some cases, two permits may be necessary; one from the local jurisdiction with a certified LCP and one from the Coastal Commission. The beach nourishment projects being evaluated for southern Monterey Bay would require Coastal Commission approval pursuant to Section 30106 of the CCA, which regulates coastal development. The definition of development includes beach nourishment, removal, dredging, mining, or extraction of materials, and discharge or disposal of any dredged material.

Within southern Monterey Bay, the Cities of Marina and Sand City (north of Bay Avenue) and the County of Monterey have certified LCPs. The Cities of Seaside and Monterey have certified LUPs but do not have approved LCPs. Beach nourishment projects in the cities with certified LCPs would require a Coastal Development Permit issued by that city.

The coastal strip between Moss Landing and Wharf II is divided into six planning areas. From Moss Landing to the northern boundary of the City of Marina (approximately 0.5 miles north of Marina sand mine), the shoreline falls within the jurisdiction of the Monterey County LCP, more specifically the North County LUP. Along this frontage, this Coastal RSM Plan does not identify any critical areas of erosion. The City of Marina LCP provides jurisdiction for the coast south of the northern city limit to the northern boundary of Fort Ord, a distance of approximately three miles. Within this length of coast, this Coastal RSM Plan identifies a single critical area of erosion; the Sanctuary Beach Resort. Also, the LCP covers the sand mine at Marina. Fort Ord is currently an uncertified coastal area, with no identified critical zones of erosion, however historic erosion in front of Stilwell Hall was eventually mitigated by pursuing a long-term managed retreat strategy. South of Fort Ord is the City of Sand City LCP planning area which extends to approximately 500 feet northeast of the Monterey Beach Resort. Within the City of Sand City jurisdiction are the critical areas of erosion at Tioga Avenue, Seaside Pump Station, and the Monterey Interceptor. The coast for the 500 feet to the northern boundary of Monterey Beach Resort is part of the City of Seaside LUP. The remaining stretch of coast southwest to Wharf II is part of the City of Monterey planning area, which currently is an uncertified LCP. Here the critical areas of erosion are the Monterey Beach Resort, Ocean Harbor House condominiums, the Monterey Interceptor, and Monterey La Playa town homes. Any proposed amendments to permitted projects or additional projects in the City of Monterey planning area must go through the Coastal Commission.

The details of each LCP and the regulations and policies they contain pertaining to regional sediment management, particularly beach nourishment activities are provided below.

<u>County of Monterey</u>

The Monterey County LCP was certified by the Coastal Commission in 1988, whereby the County assumed permit-issuing authority. Most beach nourishment projects within the jurisdiction of the County of Monterey will require a Coastal Development Permit issued by the County's Planning Department. In addition a Grading Permit and an Erosion Control Permit may be required.

The LCP is composed of four LUPs, including the unincorporated section of southern Monterey Bay between the City of Marina northern boundary and Moss Landing, which is part of the North County LUP. The North County LUP (latest update, December 1999) designates the beaches and dunes (except the parking lots of the Salinas River State Beach) as Scenic and Natural Resource Recreation Areas to be maintained at a low level of development to protect dune habitats and preserve the natural character of the shoreline. The LUP recommends that the state acquire privately-owned dune areas that are offered for sale. The North County LUP does not designate set back requirements for new development like most other local LUPs. The following policies from the North County LUP relate to RSM:

- LUP Policy 2.3.2: With the exception of resource dependent uses, all development, including vegetation removal, excavation, grading, filling, and the construction of roads and structures, shall be prohibited in the following environmentally sensitive habitat areas: riparian corridors, wetlands, dunes, sites of known rare and endangered species of plants and animals, rookeries, major roosting and haul-out sites, and other wildlife breeding or nursery areas identified as environmentally sensitive. Resource dependent uses, including nature education and research hunting, fishing and aquaculture, where allowed by the plan, shall be allowed within environmentally sensitive habitats only if such uses will not cause significant disruption of habitat values.
- LUP 2.3.3: A dune stabilization and restoration program should be implemented by the California Department of Parks and Recreation. Damaged dune areas should be replanted with native vegetation. Dune areas of high sensitivity should be protected from disruptive uses and development. The dune area between the City of Marina and the Salinas River should be acquired by the U.S. Fish and Wildlife Service or the California Department of Fish and Game and managed as a wildlife reserve.
- LUP 2.4.2: 1. Further alteration of natural shoreline processes including drainage, erosion, water circulation, and sand transport, shall be limited to protection of public beaches, existing significant structures, coastal dependent development, and the public health and safety.
- LUP 2.4.2: 3. Dredging and spoils disposal should be planned and carried out to avoid significant disruption to marine, estuarine and wetland habitats, and the pattern and volume of water circulation. Dredged spoils suitable for beach replenishment shall be transported for such purposes to appropriate beach areas with suitable longshore current systems. Dredged spoils shall meet all state and federal standards for the protection of the marine biologic environment and shall be disposed of consistent with all current policies and sites.

The remaining southern Monterey Bay coast is under the jurisdiction of City LCPs, apart from Fort Ord, which is within the Monterey County coastal zone in an uncertified area. The Fort Ord Reuse Authority (FORA) has published a Fort Ord Reuse Plan (adopted June 1997) which outlines a set of recommended objectives and associated programs for appropriate land use including the beaches fronting the former base. The following objective and program relates to Monterey County and RSM:

- Monterey County Objective E: Coordinate open space and recreation land use with other affected agencies at the former Fort Ord, such as the California Department of State Parks and Recreation and the Bureau of Land Management. Program E-1.1: The County of Monterey shall assist the CDPR to develop and implement a Master Plan for ensuring the management of the Fort Ord coastal dunes and beaches for the benefit of the public by restoring habitat, recreating the natural landscape, providing public access, and developing appropriate day use and overnight lodging facilities (limited to a capacity of 40 rooms).

Given the conversion from military to suburban land uses it is important that any future development on the dunes at Fort Ord be sited via set backs or a transfer of development rights to avoid future erosion hazards.

<u>City of Marina</u>

The City of Marina LCP was certified by the Coastal Commission, and the City assumed permit-issuing authority in April 1982. Several amendments to the LCP have been made in the years up to 2001, with the effective LCP now dated 2002. Further amendments as appealed by the Coastal Commission went to the City Council meeting on November 20, 2007. The following policies from the City of Marina LCP are relevant to RSM:

- LUP Policy 1: to insure access to and along the beach, consistent with recreational needs and environmental sensitivity of Marina coastal area.
- LUP 2: to provide beach access and recreational opportunities consistent with public safety and with the protection of the rights of the general public and of private property owners.
- LUP 8: to prohibit further degradation of the beach environment and conserve its unique qualities.
- LUP 19: to promote restoration and protection of native dune habitat and vegetation.
- LUP 23: to support continuation of the coastal dependent sand mining operations as long as they are economically feasible and their operations are managed with sensitivity to the adjacent dune environment.
- LUP 25: to protect the habitat of recognized rare and endangered species found in the coastal dune area.
- LUP 33: to protect scenic and visual qualities of the coastal area including protection of natural landforms, views to and along the ocean, and restoration and enhancement of visually-degraded areas.

More specific policy is provided in the LCP with respect to the sand mining operations at Marina:

- existing surf zone sand mining operations, as established coastal dependent uses, shall be permitted to continue at their existing locations in substantially the same manner as they are currently being conducted, and have been conducted in the past. All provisions of the LCP (including the Implementation Plan) relating to mining shall be construed and applied in a manner that supports such continuation of existing surf zone sand mining operations, so long as such existing surf zone sand mining operations are in accordance with the LCP.

- further, the City shall establish in its Implementation Plan a method of monitoring shoreline erosion along the Marina coast for the purpose of establishing a continuing project impact analysis. This analysis shall consist of the submission by sand mining operation on an annual basis, of meaningful information on shoreline retreat by way of a benchmark program or other equally effective measurement.
- the City shall not approve or renew a Mining Permit and/or Coastal Development Permit for new surf zone or beach sand mining, if it finds that such new sand mining, either individually or cumulatively, will have significant adverse impacts on shoreline erosion. Such determination shall be made upon consideration of the results of the continuing project impact analysis, available evidence on the impact of beach and surf zone sand mining on coastal erosion and other relevant social, economic, environmental and technological factors.
- any Mining Permit and/or Coastal Development Permit shall be issued subject to the condition that will permit the City to require that new sand mining activity be reduced to previous levels (prior to the issuance of a Mining Permit and/or Coastal Development Permit) or terminated in the event of a new sand mining operation, if the continuing project impact analysis or other available evidence on the impact of beach and surf zone sand mining on shoreline erosion shows that such operations have a significant adverse impact on shoreline erosion.

The following objective and program from the Fort Ord Reuse Plan also relates to the City of Marina and RSM:

- City of Marina Objective A (also City of Seaside Objective A): Integrate the former Fort Ord's open spaces into the larger regional open space system, making them accessible as a regional resource for the entire Monterey Peninsula. Recreation Policy A-1: The City of Marina (Seaside) shall work with the California State Park System to coordinate the development of Fort Ord Beach State Park.

<u>City of Sand City</u>

The City of Sand City LCP was certified by the Coastal Commission in 1986 with the exception of the part of the city south of Bay Avenue, which has been designated as an area for delayed certification. In 1990, the Coastal Commission issued a report to the City of Sand City (Coastal Commission, 1990) recommending major revisions to the LCP to reduce the amount of development allowed. This report came almost simultaneously with an LCP amendment recommended by the Monterey Peninsula Regional Park District (MPRPD) to make public parks and open space the preferred land use along Sand City's coast. In addition MPRPD and CDPR sought to acquire coastal land within Sand City for park purposes. The City of Sand City resisted the efforts of MPRPD, because it wished to preserve certain coastal parcels for development to ensure a stable fiscal future for the city.

In 1996, the Sand City LCP was amended to allow public parks and open space over the vast majority of its coastal area. At the same time, MPRPD, CDPR and the City entered into a

'Memorandum of Understanding,' outlining a few remaining 'development envelopes' on the coast where visitor-serving development (a priority use by the CCA) could be permitted. One of these envelopes is the area occupied by the former Sand City sand mining operation (Section 2.5.3). Now, MPRPD and CDPR would support reasonable development along the coast that does not block views of Monterey Bay, in exchange for acquisition of the majority of Sand City's coast for sensitive habitat reconstruction, public parks, and general open space.

8.3.2 California Department of Parks and Recreation

The CDPR is responsible for the management and protection of natural and cultural resources, and facilitating outdoor recreational opportunities within the State Parks. Any project located on or affecting state parkland would require approval by CDPR in the form of an Encroachment Permit. This includes a number of sites in southern Monterey Bay including Monterey, Marina, and Salinas River State Beaches. The CDPR policy on coastal erosion is to allow coastal processes (such as wave erosion, beach deposition, dune formation, lagoon formation, and bluff retreat) to continue without interference. The CDPR will not construct permanent new structures and coastal facilities in areas subject to wave erosion and bluff retreat, or areas with unstable bluffs. Structural protection and re-protection of existing developments is appropriate only when the cost of protection over time is commensurate with the value of the development to be protected, and it can be shown that the protection will not negatively affect the beach or the nearshore environment. Where existing developments must be protected in the short term to achieve park management objectives, CDPR would use the most natural-appearing method feasible, while minimizing impacts outside the threatened area.

9. POTENTIAL FUNDING SOURCES

This section describes potential sources of federal and state funding and potential matching local funds to implement beach nourishment in southern Monterey Bay. MBNMS (2007a) provided an initial assessment of potential funding mechanisms for short- and long-term shoreline nourishment projects, which is used as a basis for this review.

9.1 FEDERAL FUNDING SOURCES

9.1.1 U.S. Army Corps of Engineers

The Corps is the primary federal agency funding shoreline restoration projects. Funds are available for a wide range of projects and are not limited to beach nourishment or large-scale structural alternatives; for example the Corps can participate in managed retreat projects. Funding mechanisms within the Corps consist of two major programs; the Continuing Authorities Program (CAP) and the General Investigations (GI) approach. For smaller projects, the Corps may act directly under CAP without authorization from Congress. CAP includes a number of standing authorities to study and construct certain specific projects. Projects that are larger in scope require congressional authorization and would fall under GI (i.e. a project larger than the CAP program funding limits). GI recommendations go before Congress for project (construction) authorization and funding. Requests for projects with the Corps can be made at any time; however for new starts under the GI program, and the CAP in recent years, the requests are always linked to the budget cycle. All projects funded by the Corps require a study prior to implementation, unless the Corps is directed by a member of Congress to move ahead with the project. In either case the Corps will conduct NEPA and/or CEQA environmental documentation prior to implementation.

Continuing Authorities Program

The CAP program is made up of nine individual programs that are categorized by the type of project being proposed. All projects are cost shared between the federal government and a non-federal sponsor. A non-federal partner is a legally constituted public body, such as a city, state, county, or conservancy district that is capable of financing the project and providing for operation and maintenance of the project once completed. Sections 14, 103, 204, and 206 could potentially provide funding for beach nourishment projects in southern Monterey Bay:

- Section 14 Emergency stream bank and shoreline erosion: This program is authorized by Section 14 of the Flood Control Act and funds shoreline protection projects that protect public facilities including water and sewage treatment facilities, and roads that are in imminent danger of erosion. Private property is not eligible. Cost share requirements are 65% federal to 35% non-federal, and the maximum federal contribution is $1 million.

- Section 103 Hurricane and storm damage reduction (Beach erosion control): This program is authorized by Section 103 of the Rivers and Harbors Act and funds protection or restoration of public shorelines by the construction of revetments, groins, jetties, and sometimes beach nourishment. Design and construction cost share requirements are 65% federal to 35% non-federal, and the maximum federal contribution is $3 million.
- Section 204 Beneficial uses of dredged material: This program is authorized by Section 204 of the Water Resources Development Act and allows the use of dredged material from new or existing federal projects to restore, protect, or create aquatic and ecologically related habitats, including wetlands. The total project cost is shared 75% federal and 25% non-federal, and the maximum federal contribution for project development and construction is $5 million.
- Section 206 Aquatic ecosystem restoration: This program is authorized by Section 206 of the Water Resources Development Act and funds aquatic ecosystem restoration projects that will improve the environmental quality, are cost-effective, and are in the public interest. Although not directly related to beach nourishment, it may be possible to link with projects that restore species habitat such as that of western snowy plovers. The total project cost share requirement is 65% federal to 35% non-federal, and the maximum federal contribution is $5 million.

General Investigations

In addition to CAP funding, it is possible to get GI funding for larger projects that do not fit within the CAP program, or a collection of several smaller projects. This type of funding requires congressional authorization through either a Senate Resolution (Environment and Public Works Committee) or House Resolution (Transportation and Infrastructure Committee). Alternatively authorization could be accomplished with language in the Water Resources Development Act which, in theory, is passed by Congress and signed by the president every two years. The General Investigations process comprises four phases:

- Reconnaissance Phase: Duration 9-12 months. Corps covers full cost. This phase identifies the Project Study Plan and cost share details.
- Feasibility Phase: Duration 1-3 years. 50% to 50% cost share (up to 50%, either sponsor share or can be in-kind). Average cost $700,000 to $1.5 million or more.
- Pre Construction Engineering and Design Phase: Duration 1-2 years. Cost share varies depending on the type of project (typically 65% to 35%, federal/non-federal).
- Construction Phase: Time varies depending on the project. Cost share varies depending on the type of project (typically 65% to 35%, federal/non-federal).

The GI process may take six years to reach the construction phase, once the funds are authorized, and then appropriated. After the reconnaissance phase there is a significant (50%) matching requirement by the local sponsor.

9.1.2 U.S. Fish and Wildlife Service

The USFWS administers a variety of natural resource assistance grants to government, public and private organizations, groups and individuals. One potential source of funding assistance for projects that restore wildlife habitat is the Cooperative Conservation Initiative. This program provides funding for projects that restore natural resources and establish or expand wildlife habitat. A 50% match is required of the project sponsor. The Cooperative Endangered Species Conservation Fund also provides funding for implementation of conservation projects or acquisition of habitat that will benefit federally-listed threatened or endangered species. The required match for this program is a minimum 25% of the estimated project cost by the local sponsor.

9.1.3 Monterey Bay National Marine Sanctuary

The MBNMS occasionally receives settlement funds from Sanctuary violations involving disturbance of the sea bed. These funds must be used to protect and restore Sanctuary habitats, and could potentially be used for evaluation, planning and implementation of projects related to retention of beach habitat. Provision of such funds would need to be complemented by funding from other sources.

9.2 STATE FUNDING SOURCES

9.2.1 California Department of Boating and Waterways

The CDBW is the California agency with responsibility for studying and reporting beach erosion issues in the state, and for developing measures to stabilize the shoreline pursuant to Article 2.5 of the Harbors and Navigation Code. Following the passage of the Public Beach Restoration Act (1999) the CDBW is also responsible for allocating funds for beach restoration projects (CDBW has no jurisdiction from a regulatory standpoint). The Public Beach Restoration Program (PBRP) developed as part of the Public Beach Restoration Act provides the funding vehicle for the legislature to support restoration, enhancement, and maintenance of California beaches (CDBW and SCC, 2002). The CDBW primarily funds promotion of boating activities, safety programs and boating access; beach erosion and restoration grants are the organizations only non-boating expenditures.

The PBRP funds beach nourishment projects, dune restoration, biological and sediment transport monitoring, and feasibility and research studies. In many cases, state money has been used to leverage federal Corps funding. The PBRP also allows for 100% funding of project construction costs for beach nourishment at state parks and state beaches, and a maximum (could be less depending on availability of funding) of up to 85% funding for projects at non-state beaches (the local sponsor provides a 15% match). CEQA documentation must be submitted with grant applications, and public beach access must be adequately addressed by the project.

Since the CDBW grant programs are limited fiscally, one possibility would be for various partners to approach state legislators and request funds be earmarked for a nourishment project. The southern Monterey Bay region has a potential advantage over locations in southern California since there is a 60% to 40% split between southern and northern California for funding not assigned to a specific project. While there is intense competition due to the large number of projects in the south, the only major project area competing for funding in the northern part of the state is Ocean Beach in San Francisco. However, funds deposited in the PBRP are often earmarked for specific projects. Regardless, a local source of funding is required to provide matching funds for any project.

9.2.2 California Coastal Conservancy

The California Coastal Conservancy (Conservancy) is a state agency that uses entrepreneurial techniques to purchase, protect, restore, and enhance coastal resources, and to provide access to the shoreline. The Conservancy works in partnership with local governments, other public agencies, non-profit organizations, and private landowners, and has carried out more than 1,000 projects along the California coastline and in San Francisco Bay. The Conservancy funds shoreline protection projects that are consistent with the goals of the CCA. Similar to CDBW grants, the availability of Conservancy grant money is entirely dependent upon availability of funds (mostly bond issues). The Conservancy can fund pre-project feasibility studies, property acquisition, planning (for large areas or specific sites), environmental review, construction, monitoring, and in limited cases, maintenance.

9.2.3 California Coastal Commission

A potential source of funding is fees collected by the Coastal Commission through the Coastal Development Permit (CDP) process, from special conditions on individual permits requiring mitigation fees. The Coastal Commission and SANDAG entered into a cooperative agreement through which a Public Recreation Beach Impact Mitigation Fund. The fund consists of fees collected by the Coastal Commission as mitigation for the adverse impacts on public recreational use of the region’s beaches. Monies from the fund will be used to implement projects that provide public recreational improvements, including but not limited to public beach access, bluff top access, viewing areas, public restrooms, public beach parking, and public trail amenities. The role of SANDAG is to collect funds mandated by the Coastal Commission and hold the money in an interest-bearing account. SANDAG staff will work with local jurisdictions to process requests for funds. The use of funds requires local jurisdiction, Coastal Commission, and SANDAG approval. A similar fund could potentially be established to help fund beach restoration projects in southern Monterey Bay, with contributions from various future CDP processes.

In southern Monterey Bay, mitigation fees for a seawall currently being constructed at Ocean Harbor House were allocated by the Coastal Commission to dune acquisition. In order to change the allocation, the recommendation would need to be revisited and approved by the Coastal Commission. Such a change would need to be supported by quantitative projections of the amount of sand estimated to be retained by the proposed project so that it could be compared to the estimated sand lost due to the seawall. It may also be possible to utilize some of these funds to aid in buying out the Marina sand mine operation.

9.3 LOCAL/REGIONAL MATCHING FUNDS

If the southern Monterey Bay area is going to be successful in attracting state or federal funding, some form of revenue stream must be developed at the local/regional level in order to leverage the state and federal funds. The local sponsor is typically required to provide 50% (Corps) or a minimum (and sometimes more) 15% (CDBW) to studies and construction. Revenue streams developed elsewhere to generate matching funds include a transient occupancy tax (TOT) levied on hotels (southern California and elsewhere), real estate transfer tax (RETT), tax levied on sporting goods (e.g. Texas), and parking or beach user fees. Other strategies that could potentially be implemented include cost-sharing among project beneficiaries and special assessments.

9.3.1 Transient Occupancy Tax

Transient occupancy taxes (TOTs) are hotel taxes levied on visitors. They are the primary source of local funding in several east coast states that have well established beach nourishment programs (e.g. Florida and New Jersey). In Florida, 55% of funding for beach nourishment projects is from local sources, mainly local TOTs. TOTs have recently been implemented by a few municipalities in southern California. The City of Carlsbad estimated that approximately $1 million could be raised annually by implementing a 1% increase in TOTs. In Solano Beach the City Council voted to increase the TOT by 3% (phased in over three years), of which two thirds will be used for sand replenishment/retention and coastal access projects (estimated to be $160,000 annually). Encinitas has a similar program in place.

The Sanctuary Beach Resort currently levies a $15 per night fee to occupants to fund restoration of habitat on its property.

9.3.2 Real Estate Transfer Tax

Real estate transfer taxes (RETTs) are assessed on real estate when a property changes hands. In California, the RETT is currently 0.11%. RETTs may be applied to residential sales or to other types of real estate transactions including commercial and industrial sales. Revenue raised from a RETT may be added to the jurisdiction’s general fund or earmarked for specific uses, which could include beach nourishment.

9.3.3 Tax Levied on Sporting Goods

In 1993, the Texas State Legislature passed a bill for the revenue source for state and local parks to a draw from the general sales tax attributable to sporting goods. There is no separate state tax on sporting goods. Park funding comes from a portion of Texas general sales tax revenue that is 'attributed' to sporting goods. Sporting goods are defined as personal property designed and sold for use in a sport or sporting activity.

9.3.4 User Fees

Many local municipalities on the east coast and in southern California have implemented user fees as a source of funding for beach nourishment projects. This can include parking or beach-use fees, which are often levied on visitors, but not required of local residents. For example the City of Del Mar charges for parking in most areas near the beach.

9.3.5 Cost-Sharing Among Project Beneficiaries

In this strategy, the local share of the cost of a project would be distributed among the various entities that benefit from that project. The cost could be divided proportional to the total benefits attributed to each group (e.g. by the value of the property and the risk being averted). For example, for a project in southern Monterey Bay using this approach, the local costs may be borne by the City of Monterey, the City of Sand City, the private landowners (e.g. Ocean Harbor House homeowners, Monterey Beach Resort), and other potentially affected parties (e.g. MRWPCA, CDPR).

9.3.6 Special Assessments

In this strategy the local government places assessments on properties that would receive a higher proportion of the benefits derived from the project. For example, private property at high risk of erosion damage would be required to pay a special fee that would not be required of other properties that are not at risk and proportionally higher than those that are at moderate or low risk. In Florida, the state assesses a tax based upon the distance of the structure from the beach.

10. GOVERNANCE STRUCTURE

A governance structure provides a framework for the Coastal RSM Plan to be used, including interpretations, updates and implementation of particular actions. Governance structure also provides a framework for input from citizens as well as federal, state, regional, and local entities. Several existing RSM entities were reviewed and are discussed in this section, along with the recommended governance structure for the southern Monterey Bay Coastal RSM Plan.

10.1 AMBAG AND JOINT POWERS AUTHORITY

A Joint Powers Authority (JPA) is an institution permitted under the laws of many states whereby two or more public authorities can operate collectively. They are permitted under Section 6500 of the State of California Government Code. JPAs may be used where an activity naturally transcends the boundaries of existing public authorities (such as southern Monterey Bay coastal erosion). It is distinct from the member authorities; the JPA has a separate operating board of directors, and the board can be given any of the powers inherent in all of the participating agencies. In setting up a JPA, the constituent authorities must establish which of their powers the new authority will be allowed to exercise, and a term, membership and standing orders of the board need to be specified. Also, the JPA can employ staff and establish policies independently of the constituent authorities. JPAs are flexible and can be tailored to meet specific needs, and there are many differences among individual JPAs.

AMBAG is a JPA governed by a Board of Directors composed of locally elected officials appointed by their respective city council or board of supervisors. Each member city has one representative on the Board, while each member county has two. The AMBAG Board of Directors sets policy and oversees a small professional staff. AMBAG's funding comes primarily from the state and federal governments for mandated planning activities and grant projects. Local funding comes primarily from annual membership dues contributed by each member agency.

In order to define a governance structure and implementation for this Coastal RSM Plan using a JPA model we have investigated the governance models adopted by San Diego Association of Governments (SANDAG) and Beach Erosion Authority for Clean Oceans and Nourishment (BEACON).

10.1.1 San Diego Association of Governments

SANDAG comprises 18 cities and county governments and is a forum for decisions on a wide range of issues (not just coastal erosion). Similar to AMBAG, SANDAG is governed by a Board of Directors composed of mayors, council members and county supervisors, as well as advisory members (non-voting) from Department of Defense, Caltrans, San Diego Port District, San Diego

Water Authority, and others. In addition to the Board, SANDAG also have a staff of professional planners, engineers, and research specialists. SANDAG builds consensus, makes strategic plans, obtains and allocates resources, plans, engineers, and builds public transportation, and provides information on a wide variety of topics; they have a broader spectrum of responsibilities than AMBAG. SANDAG also has the ability to issue bonds, as established in specific state legislation (SB 1703, Feb 12, 2002). SANDAG has a Shoreline Preservation Working Group with staff members and a Shoreline Preservation Strategy that was adopted by their Board in 1993. This strategy places a large emphasis on beach nourishment. The Working Group advises the Regional Planning Committee of SANDAG on issues related to the Shoreline Preservation Strategy.

10.1.2 Beach Erosion Authority for Clean Oceans and Nourishment

BEACON is a JPA with member agencies comprising the cities of Carpenteria, Goleta, Oxnard, Port Hueneme, Ventura, Santa Barbara, and the counties of Santa Barbara and Ventura. BEACON was established for the limited purposes of dealing with coastal erosion and beach problems in that coastal region. They have also recently expanded their purview to water quality issues and beach and ocean pollution. BEACON maintains technical staff to assist with coastal engineering issues inherent with beach nourishment.

10.1.3 Joint Powers Authority Options

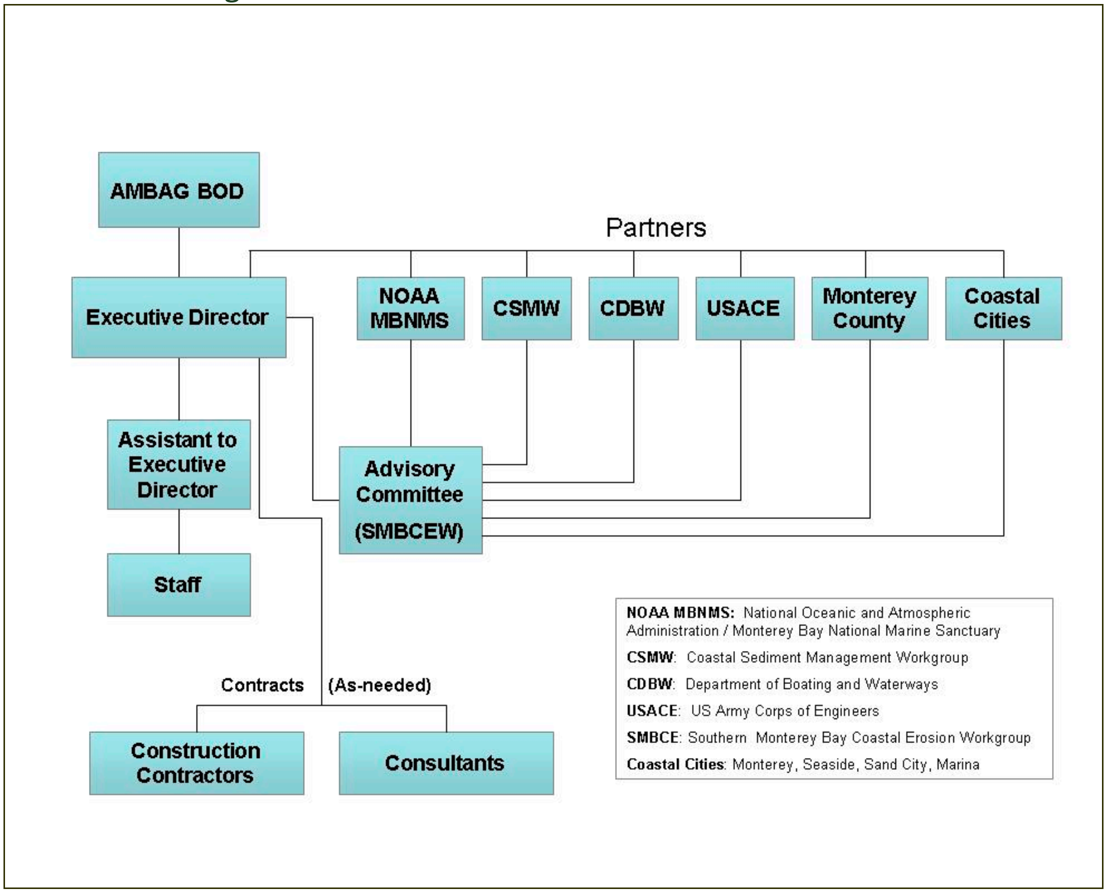
Adopting the SANDAG model, the governance structure would employ AMBAG as an existing JPA and include a multi-stakeholder coastal erosion committee that advises the Executive Director and Board of Directors who would have the ultimate decision making authority. This structure would negate the need to establish a new JPA, it could be extended to other geographic regions in the future (e.g. northern Monterey Bay, Santa Cruz), and the organization would already be set up to receive funding and implement projects. For this option to be adopted the AMBAG Board would need to expand their scope to take on this new coastal erosion/sediment management role.

Adopting the BEACON model would require formation of a new JPA that is only focused on erosion issues in the southern Monterey Bay area, rather than using AMBAG as an existing JPA. The scope of the new JPA would be limited to erosion/sediment management issues and the geographic area would be limited to southern Monterey Bay, rather than the larger three-county AMBAG region.

10.2 RECOMMENDED GOVERNANCE STRUCTURE

This Coastal RSM Plan recommends a governance structure for implementation of RSM in southern Monterey Bay using AMBAG as an existing JPA, expanding their scope into coastal erosion and regional sediment management issues. The recommended governance structure for southern Monterey Bay is outlined in Figure 35.

Figure 35. Recommended AMBAG Governance Structure



In this structure AMBAG adopts, implements, and updates the Coastal RSM Plan, and the Executive Director for the Coastal RSM Plan is the Executive Director of AMBAG. AMBAG would receive funds, complete environmental documentation, acquire permits, and plan, design and construct coastal projects, as appropriate. This Coastal RSM Plan recommends that AMBAG investigates hiring a dedicated staff member to assist the Executive Director to specifically manage sediment management issues and co-ordinate staff. The Executive Director would be advised and guided on regional sediment management issues by a committee comprising representatives from local cities, academic institutions and industry. It is recommended to continue the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW) in this role. The Executive Director would then report to the Board of Directors who would be the prime decision making authority.

It is important to note that this structure may be updated as experience is gained with sand management in southern Monterey Bay. For example, the need to raise local funds for sand placement projects may lead to formation of increased powers for AMBAG. AMBAG may also find, like SANDAG and BEACON, that one or more technical staff may be desired to help implement particular projects which require special capabilities in coastal engineering, construction contract administration, and/or monitoring.

10.2.1 Partners

Three main partners working closely with the advisory committee in the implementation of RSM in southern Monterey Bay are identified in this Coastal RSM Plan. The Coastal Sediment Management Workgroup (CSMW) provides the framework for Coastal RSM Plans throughout coastal California. The California Department of Boating and Waterways (CDBW) is the state department that funds many beach nourishment and erosion control projects, and is a member of CSMW. CDBW could cost share with any public agency that has a Board comprised of elected officials and that has the authority to enter into an agreement. AMBAG has authority for planning and environmental aspects of beach nourishment but for implementing projects (construction) they may need additional authority. The U.S. Army Corps of Engineers (Corps) is a federal agency that funds many beach nourishment, erosion control, and ecosystem restoration projects. The Corps could cost share with any non-Federal public agency, and generally if CDBW can partner with AMBAG then so can the Corps. To partner with the Corps, AMBAG would need to sign an agreement and demonstrate an ability to pay.

AMBAG would enter into contracts for coastal processes studies, planning, environmental review, permitting and engineering as needed. AMBAG would also enter into construction contracts for beach nourishment.

10.2.2 Implementation

In order for the Coastal RSM Plan to be considered when sediment management activities are being planned or implemented, AMBAG should promote referencing of the Plan in individual Local Coastal Programs (cities of Monterey, Seaside, Sand City, Marina, and County of Monterey). AMBAG should pursue the Coastal Commission to mandate the use of the Coastal RSM Plan, by requesting that the local office of the Coastal Commission begin requiring all sediment management projects along the southern Monterey Bay coast be consistent with the Coastal RSM Plan by beneficially re-using surplus sediment for nourishment.

AMBAG should also suggest that all local agencies (city and County-level) pursue consistency with specific elements of the Coastal RSM Plan in their zoning ordinances and municipal codes in their General Plans. For example, any project component that requires a grading permit would be asked to show how that project could beneficially re-use surplus sediment (if it has the appropriate quality for nourishment purposes) within the coastal zone rather than for other purposes (such as construction materials or fill).

This Coastal RSM Plan recommends that AMBAG consider having all their member agencies add to their CEQA Initial Study checklist items/questions such as 'Is the proposed project consistent with the Coastal RSM Plan, If not, why not?' or 'Specify how the proposed project will result in regional sediment management such as that identified in the Coastal RSM Plan for this region.' These questions compel the RSM issue to be addressed in each CEQA document to be prepared for future projects.

10.2.3 Outreach and Dissemination

In order for AMBAG to coordinate with the agencies and local jurisdictions (County of Monterey, Cities of Monterey, Seaside, Sand City, Marina) to implement the Coastal RSM Plan, a post-Plan outreach program should be established. AMBAG should develop existing resources including contact lists to provide a focused outreach campaign to encourage discussion amongst the southern Monterey Bay agencies. Public meetings should be convened as appropriate in which AMBAG should seek public input and consensus to guide the implementation of the recommended actions in the Plan. This Coastal RSM Plan should also be supported through publication of brochures, fact sheets, and provision of information on the AMBAG, SMBCEW, and CSMW web pages.

11. DATA GAPS

11.1 SEDIMENT BUDGET

Sections 1 and 2 outline the current knowledge about geomorphological and sedimentary processes in southern Monterey Bay. However, in certain areas the knowledge is incomplete, and assumptions have been made. Two prioritized data gaps are summarized below, which should be filled in order to improve implementation of RSM initiatives.

Regional particle size characteristics and the littoral cell cut-off diameter: Data on regional sediment distribution and character are limited and is considered a critical data gap in this Coastal RSM Plan. Filling this gap is important for several reasons:

- littoral cell cut-off diameters for each sub-cell need to be calculated to better assess beach nourishment needs and compatibility of source sediments.
- sediment particle size distributions of potential offshore source areas need to be established for compatibility with potential receiver sites. Side scan surveys to determine detailed bottom type, composition and depth are planned for Monterey Bay. These surveys will provide better information on offshore sand resources.
- the relationship between the particle size distributions of the dunes, beaches and shoreface should be examined to better quantify the amount of eroded sediment that remains in the littoral zone, and the impact of finer dune sand on beach slope and recession rate

Sediment transport calculations: Sediment transport will be calculated every 200 m as part of the COCMP and CDIP. An additional directional wave buoy was installed in southern Monterey Bay in 2007 to define the influence of sea breeze generated wind waves. This has improved the estimates of nearshore waves within southern Monterey Bay. The continually expanding information will provide better estimates on transport and definition of the south sub-cell between Wharf II and Sand City. This is critical information for the design of a nourishment plan.

11.2 SENSITIVE SPECIES AND HABITAT

The current knowledge of the distribution of critical species and habitat in southern Monterey Bay is incomplete, and several areas need to be investigated further in order to understand the potential significance of sediment management activities. Two prioritized data gaps are summarized below, which should be filled in order to improve implementation of beach nourishment initiatives.

Distributions of kelp forest and eelgrass meadow: The general locations of kelp forest and eelgrass meadow in the southern bight are known from previous surveys undertaken several years ago. However, these areas could have change over periods of years and new up-to-date subsurface information on distribution of kelp and eelgrass is needed for use in beach nourishment planning. This Coastal RSM Plan recommends new diver field surveys for project planning and assessment of the sensitivity of these habitats to potential beach nourishment.

Species and habitat of potential offshore borrow sites: Synchronous with the investigation of regional particle size identified as a data gap, the extent and types of benthic communities associated with the potential sediment sources (offshore Sand City, Monterey Submarine Canyon) and their relationships to specific substrates is a critical data gap. Without these data it is difficult to assess the impacts on these communities of sediment recovery by dredging in the offshore.

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