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.