SURVEY OF MARINE BIOLOGICAL RESOURCES OF BROAD BEACH MALIBU, CALIFORNIA

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SECTION 1.0 – INTRODUCTION

Broad Beach is located in the City of Malibu in the northwestern portion of Los Angeles County (Figure 1). The project area is located within the Mugu-Malibu Area of Special Biological Significance, the Malibu Significant Ecological Area, and the Point Dume State Marine Conservation Area.

Since the 1970's Broad Beach has gradually narrowed, exposing beach front property to flooding and damage during winter storms and high tides (Moffatt & Nichol 2012). The public benefit of the historically wide beach also has diminished. In Broad Beach's current condition, only a narrow strip of sand to walk on at low tide is available to recreational users. In 2009, Broad Beach property owners hired Moffatt & Nichol to provide technical assistance in developing a long term solution to restore the beach to its 1970's beach width and restore its former dune system. In 2010, severe winter storms threatened beach front structures and an emergency temporary revetment was constructed to protect residences including septic systems and leach fields located seaward of the houses. The revetment was completed in the spring of 2010 and has provided temporary shore protection until a long term restoration project can be implemented.

The purpose of the Broad Beach Restoration Project is to design, permit, and implement a long term shoreline restoration program that balances erosion control, property protection, improved recreation and public access opportunities, aesthetics and environmental stewardship (Moffatt & Nichol 2012). The proposed project would include validation and permitting of the existing emergency revetment, beach nourishment and sand dune restoration. If approved, the revetment would remain in place and would be buried beneath a new system of sand dunes located at the landward edge of the widened, nourished beach. The revetment would serve as a last line of defense against future severe erosion during extreme storm events. The proposed project would place 600,000 cubic yards of sand on Broad Beach to create a wide sandy beach backed by a system of sand dunes. The sand for beach nourishment would be dredged and transported from offshore of Dockweiler Beach near Marina del Rey (Figure 2). For construction of the dunes landward of the beach, up to 100,000 cubic yards of finer sediments may be dredged from a deposit offshore of the eastern end of Broad Beach near the mouth of Trancas Creek (Figure 3). The project also includes future efforts to maintain the enlarged beach, including annual or biennial backpassing of sand from the wider eastern reach to the narrower western reach of Broad Beach, and one additional major renourishment event estimated to occur 10 years after completion of the initial nourishment.

The purpose of this report is to describe the marine resources in the vicinity of the proposed project, and to discuss potential effects of the proposed beach nourishment on existing marine habitats and biota.

Figure 1
Project Location

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Image Source

Figure 2: Dockweiler Dredge Site

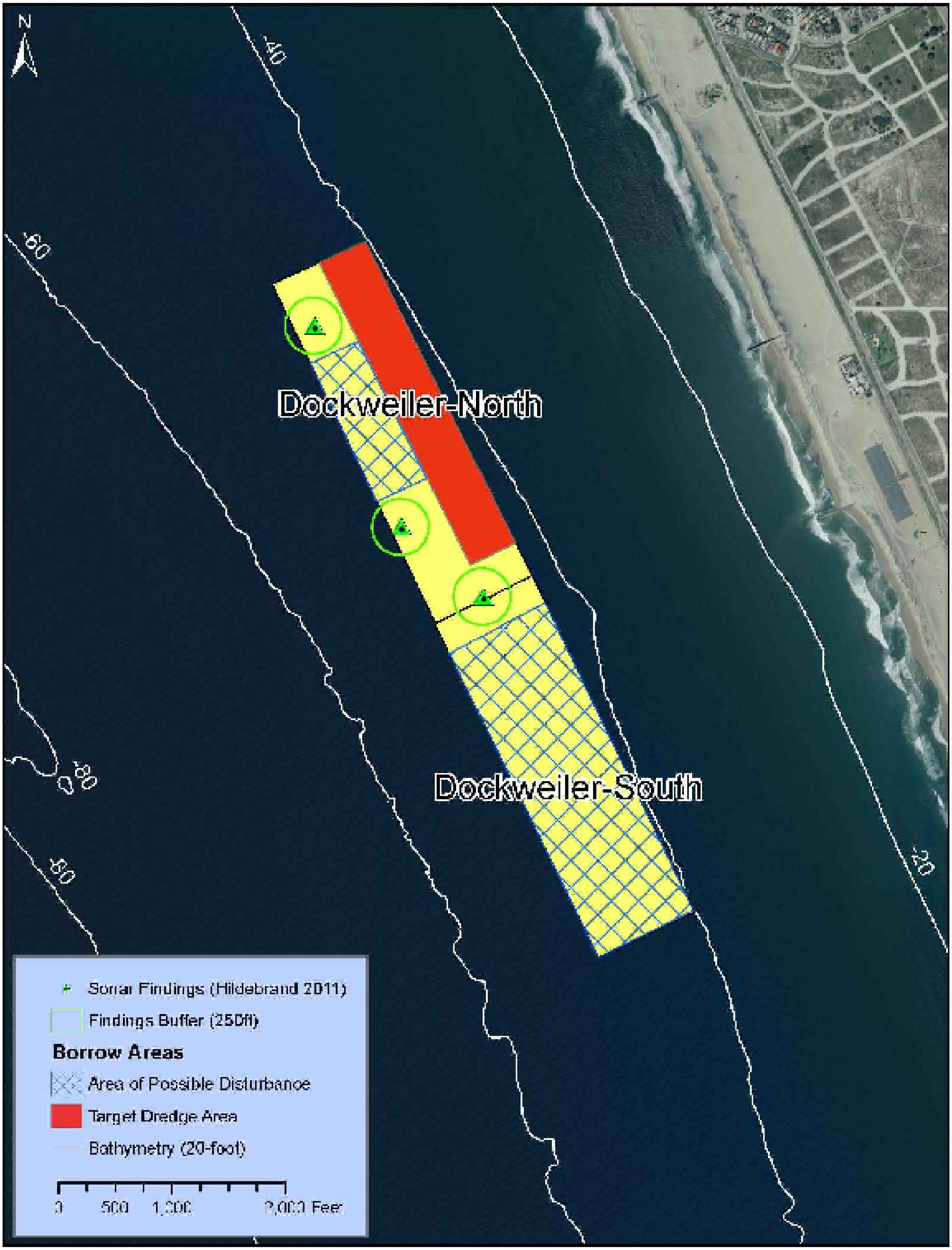
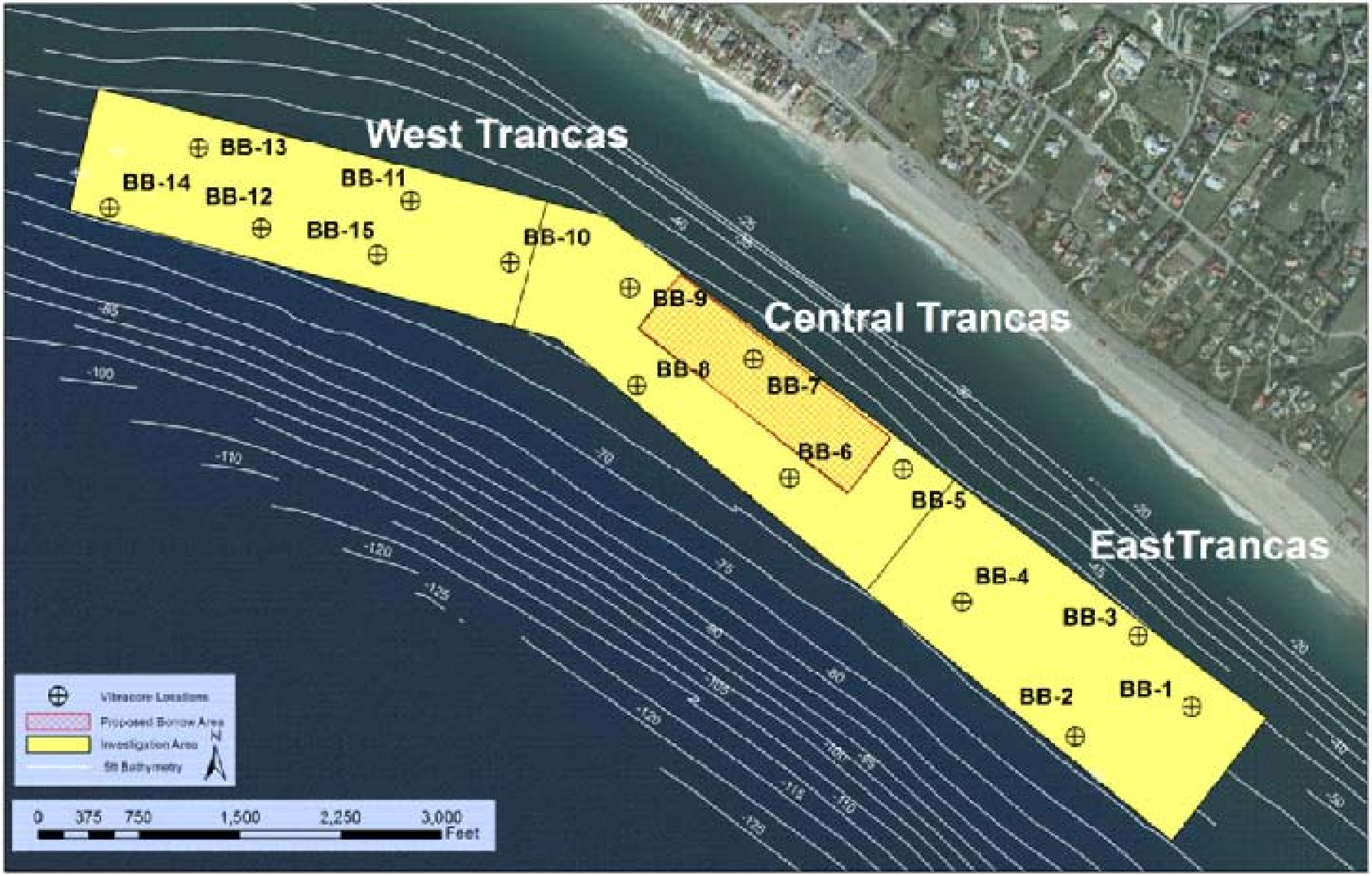


Figure 3: Central Trancas Dredge Site



1.1 METHODOLOGY

This assessment of marine resources in the Broad Beach project area was based on a review of existing information as well as four field surveys.

1.1.1 Literature Search

A literature search was conducted of existing marine biological information on the project area. Relevant studies with site specific information included:

- Reconnaissance Survey of the Mugu-Malibu Area of Special Biological Significance (Morin and Harrington 1978);
- The California Coastal Marine Resource Atlas (Blunt 1980);
- aerial maps of kelp beds (CDFG 2009);
- habitat coverages developed by the California Department of Fish and Game as part of the planning process for the Marine Life Protection Act (CDFG 2009); and
- The Los Angeles County Underwater Resource Inventory (Egstrom 1974). The Los Angeles County Underwater Resource Inventory included 10 transects in the project area. The transects were perpendicular to shore approximately every 500 feet and were surveyed by video or diver from the surfline to a water depth of about 60 feet.

The references from the 1970's were particularly valuable because they provide insight on marine resources at the site when there was a wide sand beach at Broad Beach. In addition, information on seasonal sand movement in the vicinity of Lechuza Point was obtained by talking to Graham Ferrier, a researcher at UCLA, who has been studying intertidal organisms there for 5 years. Finally, information on bird and grunion use of the project area was obtained from Chambers Group biologists who monitored for snowy plovers and grunions during emergency revetment construction between January and April 2010 (Buena 2010).

1.2 FIELD SURVEYS

1.2.1 Intertidal Surveys

The first intertidal survey was done on October 7, 2010, by Dr. Noel Davis and Billy Deane of Chambers Group. They walked the beach between Lechuza Point and Trancas Creek during a -0.5 feet (ft.) Mean Lower Low Water (MLLW) tide. The location of rocky intertidal habitat, boulders, and surfgrass (*Phyllospadix* spp.) were noted and surfgrass was mapped using a Garman sub-meter GPS. In addition, notes were made on the marine life associated with the intertidal habitats.

The second intertidal survey was on April 10, 2012, by Noel Davis and Sean Vogt of Chambers Group. The survey was done during a -0.8 feet MLLW tide. The purpose of the survey was to map surfgrass and rocky habitat along the western portion of Broad Beach in order to compare seasonal levels of sand exposure of these resources. Surfgrass and rocky intertidal habitat were mapped using a submeter GPS and a tablet with Nautilus, a GIS based mapping software application.

1.2.2 Shallow Subtidal Reconnaissance Survey

The shallow subtidal reconnaissance survey was done on September 29, 2010. The survey vessel was a 21-foot long Carolina skiff owned and operated by Rick Ware of Coastal Resources Management. The marine biologist-divers were Noel Davis, Rob Fletcher, Jr. and Mike Anghera of Chambers Group. The divers swam 6 equidistant transects parallel to shore between Lechuza Point and Trancas Creek. The start and end point of each transect was marked with a sub-meter GPS unit. Figure 4 shows the locations of the transects.

Conditions during the underwater survey were good. Skies were clear and winds were light. Surf was 2 to 3 feet and there was moderate bottom surge. Water temperature was 57 to 62 degrees Fahrenheit. Underwater visibility was 7 to 12 feet.

On each transect a pair of divers swam from just beyond the surfline (water depth 6 to 10 ft MLLW) to a water depth of 30 ft MLLW, which is the depth of closure for littoral transport for the project area. On each dive, the biologists noted the nature of the habitat on the transect and the relative abundance of indicator species. Indicator species were surfgrass , eelgrass (*Zostera pacifica*), giant kelp (*Macrocystis pyrifera*), feather boa kelp (*Egregia menziesii*), southern palm kelp (*Eisenia arborea*), palm kelp (*Pterygophora californica*), and gorgonians (*Muricea californica* and *M.fruticosa*). These species are considered indicator species because they add important structure to the environment and increase the value of the habitat when they are present. Other species observed were also noted. Although, no attempt was made to develop a comprehensive species list.

Transects

Kelp Survey 2009

Eel Grass

N W E S

0 495 990 1,980

1:12,500 Feet

Figure 4
Eel Grass, Kelp, and Survey Transects
Off Broad Beach Road

20252
Figure 2B.mxd
Version Date: 5/21/2012

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1.2.3 Survey of Sand Source Sites

The biological reconnaissance survey of the sand source sites was performed on November 8 and 9, 2011. The survey vessel was a 21-foot long Carolina skiff owned and operated by Rick Ware of Coastal Resources Management. Noel Davis and Mike Anghera were the marine biologist divers. Tom Gerlinger of Chambers Group managed the processing of the macroinvertebrate samples.

The Dockweiler North and Dockweiler South areas were surveyed on November 8. Three dives were made at the Dockweiler North site. Dive locations were selected to be representative of conditions at the site. Positioning was done with a differentially corrected Magellan Mobile Mapper GPS. At each dive site a buoy was dropped at the station location. The dive team went down the buoy line and took five 10-centimeter (cm) diameter by 10-cm deep hand-held sediment core samples to sample infaunal macroinvertebrates present at the borrow site. After taking the core samples, the divers clipped the bag with the cores to the buoys, and the cores were retrieved by the personnel on the boat. Tom Gerlinger processed the samples on board the boat by passing the materials through a 1 millimeter sieve. Materials retained on the sieve were fixed in a formaldehyde solution.

The dive team swam in a pre-determined compass direction from the buoy noting the nature of the substrate and organisms present. Each transect at the Dockweiler North site was for a duration of 25 minutes and covered approximately 400 meters. A fourth transect was swum at the Dockweiler South site but no core samples were taken.

On November 8, survey conditions at the Dockweiler North site were good. Underwater visibility ranged from 12 to 15 feet. Swells were a moderate 2 to 4 feet and winds were light. The bottom temperature was 56^0 Fahrenheit (F). On November 8, tides ranged from a high of 5.8 feet Mean Lower Low Water (MLLW) at 0710 and to a low of 0.2 feet MLLW at 1401. Water depth on the dives was about 45 feet MLLW.

The Central Trancas site was surveyed on November 9. The methodology was the same as for the Dockweiler North site. Three dives were made at the Central Trancas site. Dive locations were selected to be representative of conditions at the site. Five core samples were taken for macroinvertebrates at the start point for each dive. Then the divers swam a transect at a predetermined compass heading for about 20 minutes. The length of each transect was about 300 meters. The dives at the Central Transect site were shorter than at the Dockweiler North site because the area was smaller and the depths were deeper.

Survey conditions at the Central Tansect site on November 9 were excellent. Underwater visibility was about 25 feet. Swells were only 1 to 3 feet and winds were about 10 knots. The bottom temperature was 55^0 Fahrenheit (F). Tides on November 9 were a high of 5.9 feet MLLW at 0733 and a low of 0 feet MLLW at 1432. Water depth during the dives ranged from 50 to 55 feet MLLW.

Upon returning to the laboratory, the benthic macroinvertebrate samples were transferred to an ethanol solution. Organisms were sorted from the debris under a dissecting microscope and each organism was identified to the lowest possible taxon. Identification of macroinvertebrates was under the direction of Tom Gerlinger. The borrow site survey report is included as Appendix A to this report.

1.2.4 Prediction of Future Conditions

To predict future conditions after implementation of the proposed beach nourishment program, the sand placement footprint and predicted depth of cover following distribution of the sand from wave action was overlain on the distribution of sensitive marine resources at Broad Beach. The information on sand placement and movement was obtained from the Coastal Engineering Appendix (Moffatt & Nichol 2012).

SECTION 2.0 – MARINE RESOURCES AND HABITATS OFF BROAD BEACH ROAD AND AT THE SAND SOURCE SITES

2.1 OVERVIEW

Figure 5, based on California Department of Fish and Game GIS layers, is an overview of habitat types between Lechuza Point and Point Dune. Subtidal hard bottom, kelp beds and rocky shores are found at the western end of Broad Beach and from Point Dume to the east. Critical Habitat for the federal threatened western snowy plover is found between the extreme southeastern end of Broad Beach and Point Dume. The discussion below focuses on marine biological resources in the vicinity of the sand source and sand placement sites for the Broad Beach Restoration Project.

2.2 INTERTIDAL

Figure 6 shows rocks and surfgrass mapped in the project area in October 2010. The area off Lechuza Point and in its lee was almost all rocky intertidal substrate during that survey. Substantial amounts of surfgrass were observed from about MLLW down into the shallow subtidal. Figure 7 shows the rocky intertidal area in the lee of Lechuza Point in October 2010. From Lechuza Point east, the continuous rocky intertidal dwindled to scattered outcrops and boulders with one substantial area of intertidal boulders and cobble about 800 feet east of Lechuza Point (Figure 8). These boulders apparently are often covered by sand because they do not appear on many aerial photographs of the project area, and they supported sparse biological growth.

Some patches of surfgrass were observed on the scattered rocks in the low intertidal southeast of Lechuza Point. Feather boa kelp also was common throughout this rocky intertidal area. No intertidal rocks were observed from about 2500 feet east of Lechuza Point to the end of the project area at Trancas Creek. Figure 9 shows the isolated rock outcroppings east of Lechuza Point. In addition to surfgrass and feather boa kelp, other conspicuous organisms observed in the rocky intertidal in the project area included California mussels (*Mytilus californianus*), gooseneck barnacles (*Policipes polymerus*), acorn barnacles (*Chthamulus* spp. and *Balanus glandula*), limpets, aggregate anemones (*Anthopleura elegantissima*), ochre sea stars (*Pisaster ochraceus*), tube worms (*Phragmatopoma californica),* sea lettuce (*Ulva* spp.), and various species of red algae (including *Corallina* sp., *Mastocarpus papillatus,* and *Mazzaella leptorhynchos*).

These boulder and rock outcrops likely become periodically covered and uncovered with sand. During the intertidal survey, feather boa kelp and surfgrass were observed partially covered with sand. Therefore, the extent of intertidal rock along the western portion of Broad Beach would be expected to fluctuate as sand moves onshore and offshore.

Figure 5

Habitat Types Between Lechuza Point and Point Dune

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Source: California Department of Fish & Game
Figure 4 Habitat Types.mxd
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Figure 6
Rocks and Surf Grass Mapped in October 2010

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Figure 7: Rocky Intertidal off Lechuza Point

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Figure 8: Boulder and Cobble Intertidal East of Lechuza Point

Surfgrass
Observed Surfgrass
Extrapolated Surfgrass
Rocky Out Crops
Sanded in Rocky Area
Boulder Field

N
W E
S

0 110 220 440 660
Feet
1:3,500 @ 8.5" X 11"

Figure 9
Surfgrass Survey
Broad Beach

20252 | Fig 9 - Broad Beach - Surfgrass Survey
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Figure 10 Rocky Area at Lechuza Point in April 2012

Figure 11 Partially Buried Rocks at Lechuza Point in April 2012

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To obtain comparative information on seasonal sand movement, a second intertidal survey was done on April 10, 2012. Figure 9 shows the surfgrass and rocky intertidal mapped during this survey. The outer edge of the surfgrass, shown by green lines on the figure, was extrapolated based on the presence of rocky habitat and the occasional glimpse of surfgrass on the top of rocks when waves receded. Frequent patches of surfgrass were observed during the April, 2012 survey in the vicinity of Lechuza Point in approximately the same location they were observed in the October, 2010, survey. However, the rocky area near Lechuza Point observed in October, 2010, had experienced considerable sand inundation (Figure 10). The tidepools observed in October, 2010, were sanded in and the rocks were buried or partially buried (Figure 11). Some of the most inshore surfgrass observed in October, 2010, also may have been buried. Some surfgrass was observed with just blades sticking out of the sand. The list of species observed during the April 2012 survey are shown in Appendix B.

In April, 2010, scattered rocks and surfgrass southeast of Lechuza Point were similar to those observed in October, 2012 (Figure 9, Figure 12). The boulder field observed in October, 2010, was also observed in April, 2012, but the most landward portion of it was covered with more sand than in October, 2010 (Figure 13).

Additional information on sand movement at Broad Beach was obtained by talking to Graham Ferrier, a researcher at UCLA who has been conducting studies of intertidal organisms in the intertidal on the Broad Beach side of Lechuza Point for 5 years (personal communication to Noel Davis, October 3 2011). Every year between late November and early December the rocks at the western end of Broad Beach get buried by sand. The sand moves out of the area in late spring and the rocks are uncovered. The sand burial occurs primarily in the upper to mid-intertidal. The mussels and other organisms apparently can survive the burial because they are alive when the sand moves out in spring.

The Federal threatened western snowy plover (*Charadrius alexandrinus nivosus*) is a small shorebird that nests on sparsely vegetated beaches, dry sand flats and lagoons, dredge spoils, salt evaporation pond flats, and river bars. Snowy plovers do not breed at Broad Beach. The closest nesting area is at Mugu Lagoon, approximately 15 miles to the northwest. Snowy plovers do forage on Broad Beach, particularly during the winter. They were observed almost daily during construction of the emergency revetment between January and April, 2010 (Buena 2010). They were primarily seen foraging in the vegetation wrack deposited between the water's edge to a few meters above the high tide line, or roosting in small depressions in the sand at the southeast end of Broad Beach near Trancas Creek. Designated Critical Habitat for snowy plovers occurs at the very east end of Broad Beach from just east of the mouth of Trancas Creek to the north side of Point Dume near the mouth of Zuma Creek (USFWS 2005). Figure 14 shows snowy plover Critical Habitat in the vicinity of Broad Beach. Zuma Beach is considered an important wintering area for snowy plovers.

Grunion (*Leuresthes tenuis*) are a nearshore fish that lays its eggs on southern California sandy beaches during nighttime extreme high tides between March and August. Although grunion are not listed as threatened or endangered, NOAA Fisheries requires that their eggs be protected from disturbance. Grunion runs were monitored at Broad Beach between March and August, 2010 (Buena 2010). No grunion were observed in the project area. Because of the lack of beach at Broad Beach, during the extreme high tides when grunion run, the waves were crashing against the revetment and there was no high intertidal sandy beach for the grunion to deposit their eggs. Grunion were observed to spawn east of the project area on Zuma Beach near Trancas Creek.

2.3 SHALLOW SUBTIDAL OFF BROAD BEACH

Based on the six transects surveyed during the September, 2010, reconnaissance survey as well as ten transects perpendicular to shore surveyed by the County of Los Angeles and UCLA between 1972 and 1974 (Egstrom 1974), the extent of rocky subtidal habitat mirrors the distribution of rocky intertidal habitat. Extensive reefs occur off Lechuza Point. The reefs become increasingly scattered proceeding east from Lechuza Point. Egstrom (1974) identified a major reef feature at the eastern end of the project area, but this reef lies in 33 to 40 feet of water and is beyond the depth of closure for littoral sand transport.

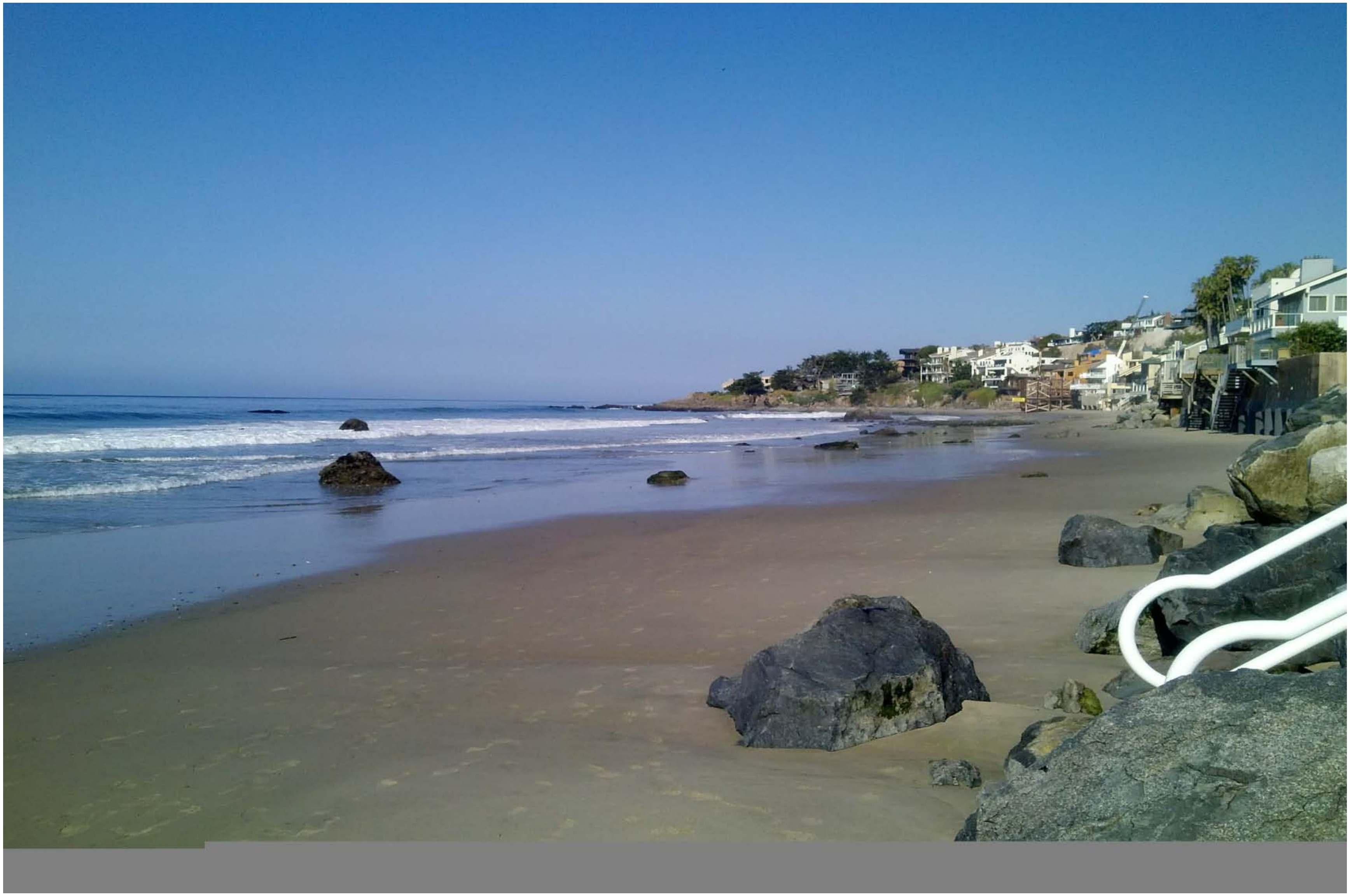

Figure 12 Scattered Rocks in April 2012

Figure 13 Broad Beach Boulder Field in April 2012

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Legend

Western Snowy Plover Critical Habitat

Revetment Footprint

N
W E
S

0 100 200 400
Feet

Figure 14 Western Snowy Plover Critical Habitat at East End of Broad Beach

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Z:\PROJ\20252 Broad Beach Marine\Snowy Plover Critical Habitat.mxd

The subtidal reef formations off Lechuza Point support the growth of giant kelp. Figure 15 shows the extent of kelp beds in the project area as mapped by CDFG in 2009. The kelp canopy within the project area is off Lechuza Point and does not extend very far to the east.

Eelgrass occurs in the lee of Lechuza Point at water depth of about 24 feet MLLW to about 47 feet. This eelgrass bed has been present in this area since at least the 1970's (Egstrom 1974, N. Davis, Chambers Group, dive logs from 1971 and 1972). The approximate location of the eelgrass is shown on Figure 15, based on the 2010 transects, Egstrom's transects, and Noel Davis dive notes from the 1970's. The eelgrass bed has not been mapped precisely. Offshore eelgrass is uncommon off the southern California mainland open coast.

The subtidal reefs between Lechuza Point and Little Sycamore Canyon were described by Morin and Harrington (1978). The reefs in the project area are indurated rock reefs notable for the general physical heterogeneity created by large igneous bed rock protrusions, which produce cliffs, overhangs, cracks and crevices. The major reef blocks usually run parallel to shore and are interspersed with large sand flats. Morin and Harrington divided the reef structures into shallow water rocks and reefs, nearshore reefs, and offshore reefs. Offshore reefs occur at depths greater than 30 feet and would not be affected by the movement of sand from beach nourishment. The following paragraphs describe in general the characteristics of shallow and nearshore reefs in the project area (based on Morin and Harrington 1978) followed by a description of the reefs on the two transects (Transects 5 and 6) that crossed rocky habitat in the September, 2010, reconnaissance survey. Additional information from Egstrom's (1974) transects is included.

Shallow water rocks and reefs, which are the most likely to be affected by beach sand, occur from the intertidal zone to about 15 foot water depth. These low reefs and isolated boulders, are close to shore and are strongly affected by swell, longshore currents, sanding in, high turbidity and scour, by local runoff from the land, and even by lowered salinity from rain storms (Morin and Harrington 1978). Biological communities on these shallow rocks are often characterized by rapid turnover of species. Bare rock can be extensive after catastrophic events such as sanding in and subsequent re-exposure of rock. Long-lived sand-tolerant species typical of nearshore rocks at this depth include aggregate anemones, surfgrass, feather boa kelp and California mussels.

Nearshore reefs at depths between 15 feet and 30 feet represent a transition between shallow water reefs and offshore reefs. The most prominent species on the tops of these reefs tend to be the shrub-like intermediate height brown kelps like the sea palms (*Eisenia arborea* and *Pterygophora californica*) and the bladder kelp (*Cystoseira osmundacea*). The sides of the reefs generally support a rich encrusting fauna of sponges, tunicates and bryozoans. Giant kelp occurs on these nearshore reefs. Sea urchins (*Strongylocentrotus purpuratus* and *S. franciscaus*) are abundant.

Transect 6 off Lechuza Point consisted of reefs between 1 to 6 feet in height with some sand patches in between. Giant kelp and feather boa kelp were both present on these reefs. Palm kelp (*Pterygophora californica*) was abundant. At depths beyond 20 feet gorgonians were abundant on the tops of the reefs. Almost all of the reefs were covered with sea urchins. Surfgrass was not observed on Transect 6 but Egstrom (1974) noted it from intertidal depths out to 25 feet on a transect directly off Lechuza Point. Fishes observed in the reef habitat on Transect 6 included convict fish (*Oxylebius pictus*), seniorita (*Oxyjulis californica*), Garibaldi (*Hypsypops rubicunda*), kelp bass (*Paralabrax clathratus*), sand bass (*Paralabrax nebulifer*), rubberlip perch (*Rhacochilus toxotes*), pile perch (*Damalichthys vacca*), rainbow seaperch (*Hypsurus caryi*), black perch (*Embiotica jacksoni*), sheephead (*Semicossyphus pulcher*), opaleye (*Girella nigricans*), shiner surfperch (*Cymatogaster aggregate*) and several species of rockfishes (*Sebastes* spp).

Only one reef (at 20 to 22 ft. water depth) was encountered on Transect 5. Sparse giant kelp and palm kelp (*Pterygophora californica*) were observed on this reef. Egstrom (1974) found scattered low reefs and rocks at depths between 15 and 30 feet in the area between Lechuza Point and Transect 4. Kelp and gorgonians were observed on these reefs.

Two species of abalone, white abalone (*Haliotis sorenseni*) and black abalone (*Haliotis cracherodii*) have recently been listed as endangered under the Federal Endangered Species Act. No abalone was observed during the September, 2010, reconnaissance survey. Both species of abalone were known to occur in the Mugu-Malibu Area of Special Biological Significance during the 1970's (Morin and Harrington 1978). Blunt (1980) listed black abalone as present but sparse between Lechuza Point and Latigo Point. He did not list white abalone as being present in the area. White abalone generally occur at depths of 75 feet or greater and would not be expected in the shallow nearshore habitats that could be affected by beach nourishment. Black abalone is most common in intertidal and shallow subtidal depths. Black abalone populations have declined dramatically since the 1970's from overfishing and a bacterial disease known as withering syndrome. Black abalones have gone locally extinct in most locations south of Point Conception. The project area is not listed as Critical Habitat for black abalone (NMFS 2011). The potential for black abalone to be present in the project area is low.

From Transect 4 to Trancas Creek (Transects 1 through 4) the habitat was entirely sand bottom. Sand dollar (*Dendraster excentricus*) beds were observed at depths of between 10 and about 14 feet. Other characteristic organisms observed in this sand bottom habitat were tube worms (*Diopatra ornata*), sea pens (*Stylatula elongate*), sea pansies (*Renilla kollikeri*) and several species of crabs (*Cancer gracilis, Randallia ornata,* and *Heterocrypta occidentalis*).

Pismo clams (*Tivela stultorum*) have occurred historically in the shallow sand bottom habitat off the eastern end of Broad Beach (Morin and Harrington 1978, Blunt 1980). Pismo clams are most common at depths of from 10 to 20 feet. No live Pismo clams were observed on the September, 2010, transects, but empty shells were found.

2.4 SAND SOURCE SITES

The substrate at both of the potential sand source sites consisted of sand. No sensitive habitats were observed. With the exception of large numbers of migrating lobsters at the Dockweiler North site, organisms observed at these sites were typical of southern California sand bottom habitats at 45 to 55 foot water depth.

The Central Trancas borrow area supported a more abundant and diverse benthic invertebrate community than the Dockweiler North site. The Central Trancas site, which is in 50 to 55 feet of water, was a little deeper than the Dockweiler North site, which was in 45 feet of water. Deeper subtidal sand bottom communities are subjected to fewer disturbances by wave action and the associated bottom surge and sand movement than shallower communities and typically support a more diverse and abundant infauna community. Furthermore, the Dockweiler North site is subjected to additional disturbance from potential discharges from nearby Marina Del Rey and Ballona Creek that may affect habitat suitability for invertebrates.

In summary, no sensitive habitats or species were observed at the proposed sand source sites. The organisms observed during the survey are adapted to shifting sands and would be expected to recolonize the area after dredging. The full sand source sites report with species list of organisms observed or collected is included in Appendix A.

2.5 MARINE WILDLIFE

Broad Beach and its nearshore waters are used by a variety of seabirds, shorebirds, and marine mammals. Appendix C lists birds and marine mammals observed at Broad Beach during snowy plover monitoring while the emergency revetment was being constructed.

SECTION 3.0 – POTENTIAL IMPACTS OF THE BROAD BEACH RESTORATION PROJECT

3.1 CONSTRUCTION

3.1.1 Dredging at Sand Source Sites

Dredging at the sand source sites offshore Trancas Creek and Dockweiler Beach would impact marine resources directly by killing benthic invertebrates living in the sediments that would be dredged and indirectly by reducing the prey base for higher order predators such as demersel fishes and by generating turbidity. Most of the benthic invertebrates within the area dredged from the two sand source sites would be killed by the dredging. Some mobile organisms such as crabs may escape the dredge. The benthic invertebrate community at these sites is typical of southern California soft bottoms at these depths (Appendix A). Recovery of the benthic invertebrate community would be expected to begin almost immediately with settlement of larvae and immigration of mobile species from nearby unaffected areas. Recovery of the infaunal community to values comparable to pre-dredging levels may occur in as little time as six months or as long as four years (CSLC, USFWS, and USACE 2001, SAIC 2011). Because the sand source sites for the Broad Beach project are on offshore sand bottoms at depths frequently disturbed by the surge associated with large waves, recovery would be expected to be in the shorter end of this range. A sand source site off Sunset Beach in Orange County has been used for many years by the U.S. Army Corps of Engineers for beach nourishment. Reish (1981) sampled the site in 1977 before the first sand was dredged and in 1978, 1979 and 1980 after dredging. He concluded that the dredging and sediment removal did not have any measurable effect on the benthic fauna. Periodic sampling following the 1990 dredging of the same Surfside/Sunset borrow site initially found fewer macroinvertebrates than undredged control areas, but within less than 1 year there were no differences compared to control areas (Chambers Group 1992). Chambers Group (1996) sampled a borrow pit within Long Beach Harbor and found that the abundance, number of taxa, and species composition within the borrow site was similar to that in shallower areas outside the pit. Similarly, sampling of 3 sand source sites used to obtain sand for the San Diego Regional Beach Sand Project found that invertebrate populations at the site in 2009, following 2001 dredging of the sites, were similar to the populations in 1999 before the dredging (SAIC 2011). The amount of soft bottom habitat that would be dredged at each of the sand source sites is small relative to the large amount of soft bottom habitat offshore Los Angeles County. The dredging area would be approximately 110 acres at the Dockweiler site and between 24 and 150 acres at the Trancas site (depending on the dredging scenario implemented).

In addition to the direct impacts of dredging, the dredging would generate turbidity plumes by the resuspension of sediments. Hard bottom and vegetated habitats, including surfgrass, eelgrass, giant kelp and other kelp species, occur off Broad Beach west of the Central Trancas sand source site. These sensitive habitats are over 2000 feet from the proposed Trancas dredging site. The sediments at the Trancas site consist of mostly fine to very fine sand with a median grain size range between 0.12 and 0.15 millimeters. Sand sized particles settle rapidly and dredging at this site would not be expected to generate extensive turbidity plumes. A sand source site with similar sediment composition was dredged in 2001 for the San Diego Regional Beach Sand Project using a hopper dredge. Turbidity at the dredge site was monitored (AMEC 2002). Turbidity plumes generally were only observed close to the dredge and dissipated quickly. The largest plume reported was 330 feet by 67 feet and it dissipated quickly. Dredging at the Central and West Trancas sites would not be expected to generate turbidity plumes that would reach eelgrass, surfgrass or kelp at the western end of Broad Beach. Sediments at the Dockweiler site are coarser than at Central Trancas. Therefore turbidity would be expected to be less during dredging at that site and no sensitive marine habitats occur in the vicinity of the Dockweiler site.

The noise and turbidity generated during dredging would disturb fishes in the vicinity of the dredge. Fishes would be expected to avoid the dredging area during dredging operations. Fish sampling was conducted following dredging in Marina del Rey Harbor and an unusually low number of fish species was collected compared to pre-dredging surveys (Soule et al. 1993). The investigators concluded that the dredging had disturbed the fishes. Within a few months, the number of fish species collected returned to pre-dredging levels. Laboratory studies have found that all life stages of estuarine and coastal fishes can survive high levels of turbidity for 24 hours or more (La Salle et al. 1991, Clarke and Wilber 2000). Fishes within the Trancas and Dockweiler source sites would not be expected to be exposed to high enough sediment concentrations for long enough duration to suffer lethal or sublethal effects. Because subtidal soft bottom habitat is the dominant habitat offshore Los Angeles County, temporary avoidance of the immediate dredging area and the turbidity plume generated during dredging would have minimal adverse impact on fishes.

Dredging at the offshore sand source sites will temporarily reduce the invertebrate prey base for fishes such as turbots and white croakers that feed on benthic invertebrates. Recovery of the benthic invertebrate community is expected to begin within less than a year, with complete recovery in 1 to 2 years. Temporary degradation of a relatively small amount of foraging habitat is not expected to have a significant impact on fishes. Surveys of the Surfside/Sunset borrow site off Orange County found fewer fish immediately following a 1990 dredging episode, but within less than a year there were no differences compared to control areas (Chambers Group 1992).

3.1.2 Placement of Sand at Broad Beach

The sand for nourishment of Broad Beach would be pumped to the beach from a hopper dredge located offshore of the beach. It is also possible that sand may be pumped directly to Broad Beach from a cutterhead dredge at the Trancas sand source site. A submerged pipeline would be placed along the sea floor from the vessel to Broad Beach. If the pipeline is placed on rocks, kelp, eelgrass or surfgrass habitat, resources could be damaged by the crushing and scraping of the pipeline. In addition, if the sand is pumped from a hopper dredge, the dredge would be anchored offshore. The placement of anchors on the bottom could damage sensitive resources if anchors or anchor chains landed on or scraped across sensitive subtidal habitats. No anchors or pipelines would be placed near the sensitive kelp, rock, eelgrass and surgrass habitats at the western end of Broad Beach. To avoid damaging any resources that may be present at the central and eastern ends of Broad Beach, marine biologists will perform an underwater survey of all proposed anchor and pipeline areas. If any rocks, kelp, surfgrass, or eelgrass are observed in these areas, alternative anchoring and/or pipeline placement locations will be selected. Anchoring and the discharge pipeline will be located away from reef to avoid impacts.

Onshore pipeline segments would be placed along the toe of the revetment. Training dikes would be constructed to reduce turbidity and aid in the retention of pumped sand. The sand would be placed at a single discharge point landward of the dikes. The discharged material would be a slurry mix of sand and water. The dikes would be used to direct the flow of the discharge and slow the velocity of the slurry effluent to allow more sediment to settle onto the beach rather than being transported back to the surf zone.

Placement of sand on the beach would be expected to kill most of the organisms within the placement footprint. This footprint would be about 40 acres and would include the upper intertidal rocks at the west end of Broad Beach as well as the upper portions of the boulder field downcoast from Lechuza Point. The rocks that would be directly within the placement footprint are seasonally covered by sand

and support only sand-resistant or rapidly colonizing organisms. The sand placement footprint would bury 0.94 acres of high to mid-intertidal rocks and boulders.

The majority of the placement footprint is sand beach. During beach construction, a large volume of sand would be pumped directly onto the beach, burying the existing sand and its invertebrate community. Although a few organisms may escape on the edges of the placement footprint, most sand beach invertebrates within the construction footprint would be killed. Most studies have reported that sandy beach organisms recover within 1 year or less after beach nourishment (SAIC 2011, Ray and Clarke 2001, Parr et al 1978). Because beach construction will occur in winter, impacts to invertebrates will be during the season that populations are at a low point. Sandy beach organisms are adapted to colonize beaches in the late spring and early summer. For beach nourishment projects completed in winter or early spring prior to the peak spring to early summer recruitment periods, invertebrate recovery in the order of weeks have been reported (SAIC 2011). Therefore, invertebrate populations would be expected to rebound substantially within six months or less of sand placement.

By killing sand beach invertebrates in the high and mid intertidal, beach construction would temporarily reduce the prey base for shorebirds. However, beach construction would not directly impact the lower intertidal. Therefore, invertebrate prey would be available for shorebirds in the lower intertidal as well as on adjacent beaches. Substantial recovery of invertebrate populations would be expected within 6 months or less of beach construction.

Pismo clams historically occurred off Broad Beach. No live Pismo clams were observed during the subtidal reconnaissance survey, but a shell was found and they may still be present in low density. No sand would be placed in the low intertidal or subtidal where Pismo clams occur. Therefore, beach construction would not directly affect Pismo clams.

Sand placement would begin during the winter when grunion do not spawn. Therefore the Broad Beach Restoration Project would not have an adverse impact on grunion spawning if beach construction is completed before March when the grunion spawning season begins. It is possible that beach construction activities may continue into March and even April. However, under its current eroded condition, Broad Beach does not support grunion spawning because the waves crash against the revetment during the high spring tides when grunions spawn (Buena 2010). Therefore, beach construction at Broad Beach would not be expected to impact grunion.

It is expected that shorebirds will avoid the immediate areas where people and equipment are constructing the beach. Chambers Group (2005) monitored dredging of a sand bar in the Talbert Channel in Huntington Beach and placement of the dredged sand in the upper intertidal of the adjacent beach. Shorebirds avoided the immediate areas where the dredging and disposal activities were occurring but foraged undisturbed in the mid- to lower intertidal on the adjacent beaches. However, AMEC (2002) noted that during the SANDAG project some shorebirds (e.g., sandpipers, godwits, curlews) were present on the receiver sites during beach discharge of sediments. Gulls were attracted to the discharge and fed on invertebrates and fishes that were in the dredged material as it was being pumped to the beach.

Federal threatened western snowy plovers forage on Broad Beach, particularly during the winter. Snowy plovers can be disturbed by the noise and activity of beach construction. A plover could even be injured by machinery, because these small, cryptically colored shorebirds have a tendency to hide in depressions in the sand including depressions caused by tire tracks. To prevent disturbance and/or injury to snowy plovers, it is recommended that a biological monitor be present during all construction activities on the beach. A biological monitor was present during emergency revetment construction and effectively prevented any disturbance or injury to snowy plovers (Buena 2010).

In addition to the direct impacts of sand placement, beach construction has the potential to impact marine resources from turbidity generated when the sand slurry pumped to the beach runs into the ocean. The proposed placement of sediments behind a dike would allow sediment particles to settle and would reduce the suspended sediment concentrations in the discharge. The sediments that would be used for beach fill consist of clean sands that would not contain contaminants, bacteria, or materials with a high oxygen demand. Therefore, the only degradation of ocean water quality would come from the turbidity generated by the suspended sediments that would run off from the beach. The turbidity plumes from the beach fill would generally be confined to the surf zone although rip currents have the potential to carry suspended particles offshore. Turbidity plumes during beach construction were monitored during the San Diego Regional Beach Sand Project (SAIC 2011, AMEC 2002). Plume dimensions generally ranged from 100 to 328 feet long and 66 by 164 feet wide. On one occasion a plume of 984 feet long by 656 feet wide was measured but was short-lived after the training dike was lengthened and water content of the discharge was adjusted.

Turbidty in the surf and nearshore zones is common off the southern California mainland coast especially in the winter and early spring when beach construction at Broad Beach is proposed. Larger waves and creek run off during the winter and early spring can cause nearshore waters to be turbid for much of the period between January and April. Therefore, localized turbidity plumes generated during beach construction would not be expected to have a substantial adverse impact on nearshore marine resources. Although beach construction may occur over a period of 2 to 5 months depending on the type of dredge used, only a portion of the beach would be receiving the discharge at any one time. Therefore, sensitive resources such as surf grass would not be subjected to on-going turbidity during the entire construction period. However, it is recommended that turbidity be monitored during beach construction and adjustments made to reduce turbidity if extensive plumes are observed.

3.2 POST-CONSTRUCTION

Some of the sand placed on the beach during initial construction will eventually be transported offshore, downcoast, and, to a lesser extent, upcoast. Beach profiles evolve after construction of a beach by assuming a slope that is in equilibrium between the grain size of the sand and wave conditions of the beach (Moffatt & Nichol 2012). Moffat & Nichol predicted equilibrium beach profiles using a computer program that estimates a post nourishment profile based on the characteristics of the existing beach profile, the beach fill quantity and slope, sand grain size and position of the closure depth of littoral transport.

As discussed above, the intertidal and shallow subtidal hard bottom habitat at the western end of Broad Beach is characterized by considerable seasonal sand movement. Figure 15 shows the seasonal sand profiles on a transect off the western end of Broad Beach in the lee of Lechuza Point in the area where most of the rocky habitat and surfgrass occurs. On average, there is about a 2 foot difference in sand depth seasonally with rocks uncovered in spring and covered with about 2 feet of sand in fall.

Figures 16 a through h show the predicted seasonal depth of cover following beach nourishment in January through March. Figure 16 a shows the spring profile approximately 6 months following sand placement on the west end of Broad Beach in the winter. The beach fill was predicted to add approximately 2 to 3 feet of sand to the low intertidal and shallow subtidal compared to the average spring profile. This additional amount of sand cover compared to the typical spring profile would mean that in the first spring following beach construction, rocks that are typically buried in fall but uncovered in spring would be covered with sand. Some of the surfgrass may be partially or even completely buried. Organisms on low relief rocks and the bottom portions of the higher relief rocks would not be uncovered in the spring the way they typically are. The predicted profile shows an area of greater increased sand cover (about 4 feet of sand) at about -12 foot depth. This depth of sand may bury organisms on the upper portions of high relief reefs that are not adapted to seasonal sand cover.

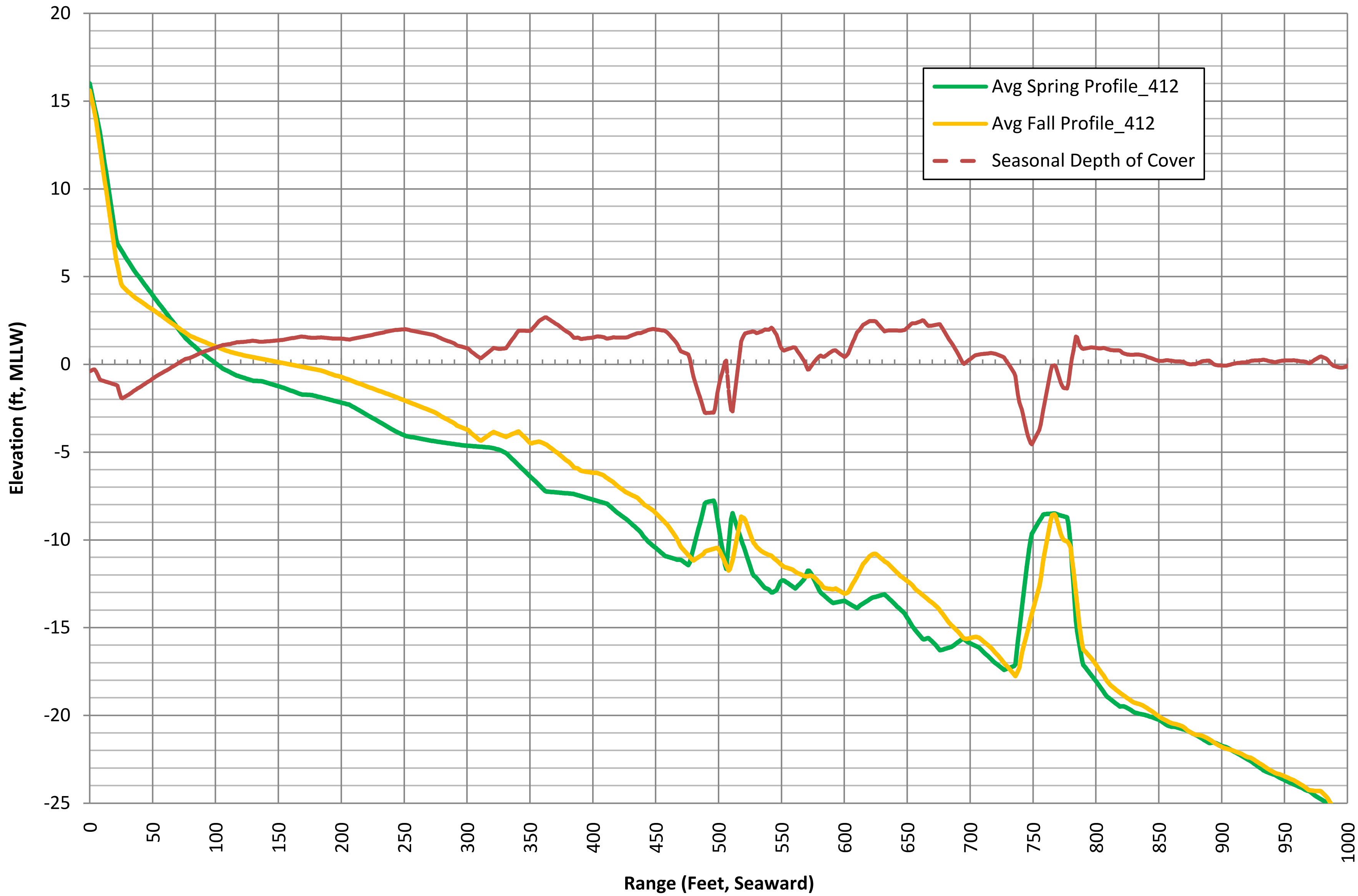
Figure 16 b shows the predicted fall profile at the western end of Broad Beach approximately 1 year after beach construction. The total predicted sand cover in the low intertidal and shallow subtidal is 3 to 5 feet compared to the 2 foot average fall sand cover. The average height of intertidal rocks measured during the sanded in condition in April 2012 was 20 inches. Therefore, many rocks that typically are not completely buried would be buried in the first fall after beach nourishment. Rocks with greater than 5 feet relief would still have their tops exposed the first fall after beach construction. More of the surfgrass would be covered with sand following beach nourishment although blades should still be partially exposed in much of the area.

In summary, in the first several months to a year following beach nourishment, sand levels in the intertidal and shallow subtidal areas are predicted to be about 2 to 3 feet deeper than average seasonal levels. The deeper cover means that fewer rocks will be exposed in spring when sand levels are seasonally low and burial during the fall when sand levels typically are high will be greater than under the existing condition.

The predicted profiles following the sand placement show little additional sand cover beyond 15-feet and none beyond 17-feet water depth. Therefore, no impacts would occur to eelgrass or giant kelp. The impacts would be to shallow reefs that are typically subjected to sand movement. As discussed above, the organisms that live on these shallow reefs are adapted to sand movement. These species include rapid colonizers such as sea lettuce (*Ulva)* and sand tube worms (*Phragmatopoma*) and sand tolerant species such as aggregate anemones (*Anthopleura* spp.) and surf grass. These organisms are adapted to the seasonal cycles of sand movement, but it is unknown whether the greater predicted burials in the year following beach construction would be beyond their tolerance levels. Surveys from the 1970's when the beach at Broad Beach was much wider than today (and similar to the proposed project condition that is based on replicating historic shoreline widths), observed surfgrass and other rocky intertidal organisms in the lee of Lechuza Point (Egstron 1974, Morin and Harrington 1978) indicating that these species existed at Broad Beach during a period when there was a greater amount of sand in the system.

Figures 16 c through 16 h show the predicted sand cover at the western end of Broad Beach from about 1.5 years after sand placement to 4 years following beach fill. By the second spring following beach construction (Figure 16 c, 1.5 years after beach fill) sand levels between 0 MLLW and -12 feet MLLW would be 1 to 3 feet greater than the average spring profile. At these levels of sand cover some of the lower relief rocks would still be buried and there may still be partial burial of some surfgrass, but the tops of the higher relief rocks would be uncovered. In the second fall (Figure 16 d, year 2) sand cover above normal fall profiles would range from no additional cover to about 2 feet above average seasonal levels. From 2.5 years after beach fill to 4 years after the fill, increases in sand cover over existing profiles are minimal.

Figure 15: Average Seasonal Sand Profiles Near Lechuza Point



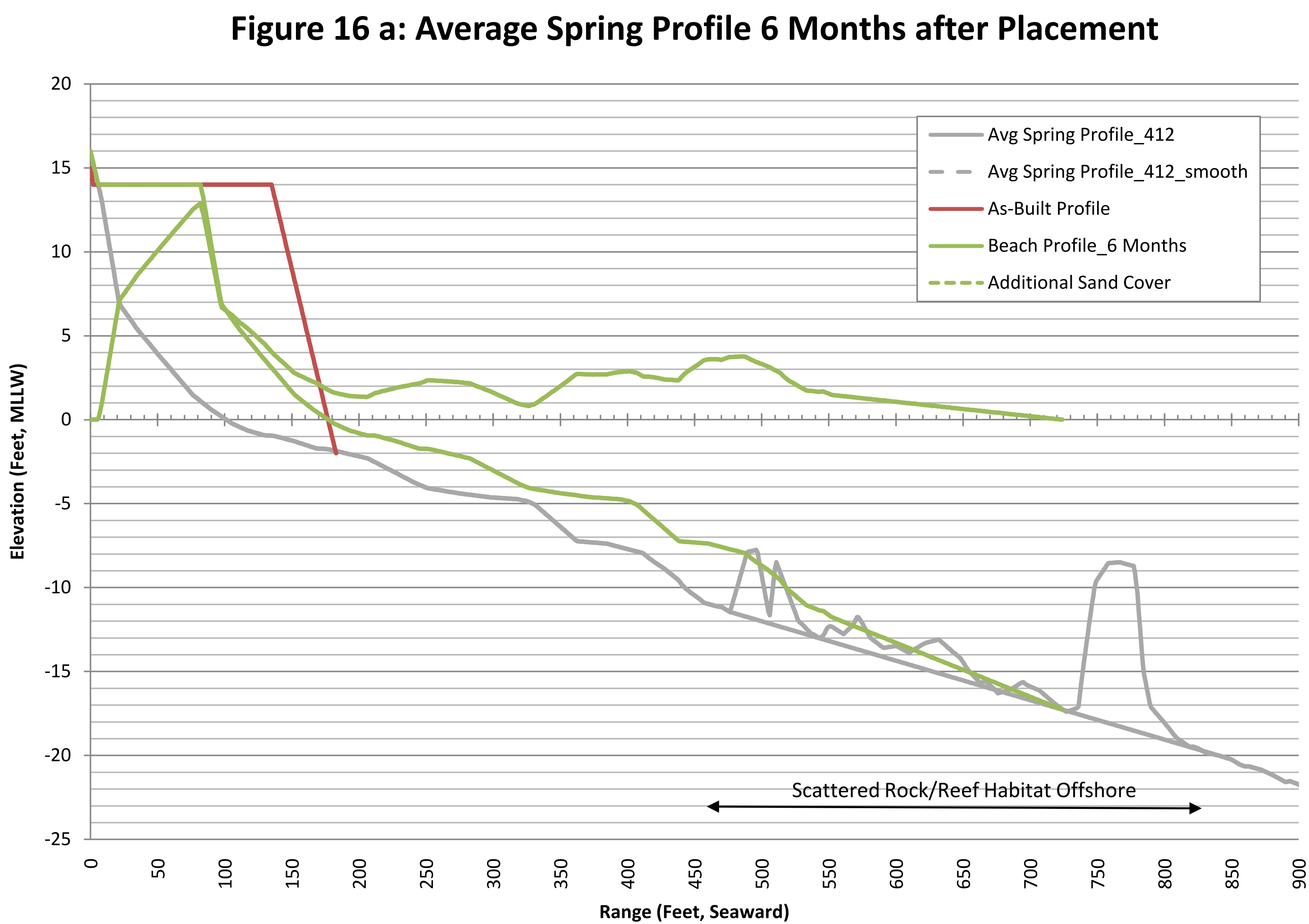
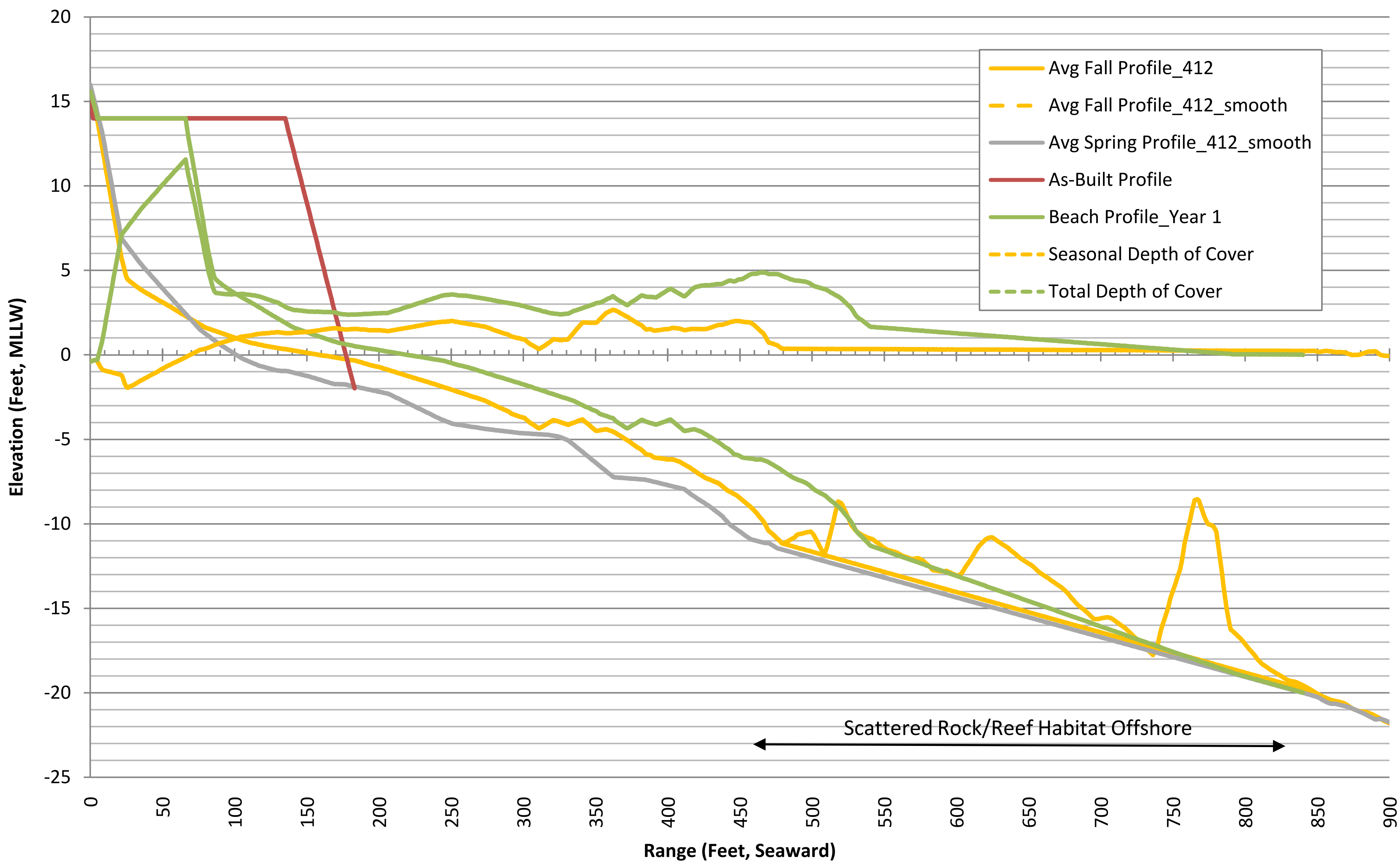


Figure 16 a: Average Spring Profile 6 Months after Placement
Avg Spring Profile_412
Avg Spring Profile_412_smooth
As-Built Profile
Beach Profile_6 Months
Additional Sand Cover
Scattered Rock/Reef Habitat Offshore
Elevation (Feet, MLLW)
Range (Feet, Seaward)
20
15
10
5
0
-5
-10
-15
-20
-25
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900

Figure 16 b: Average Fall Profile1 Year after Placement



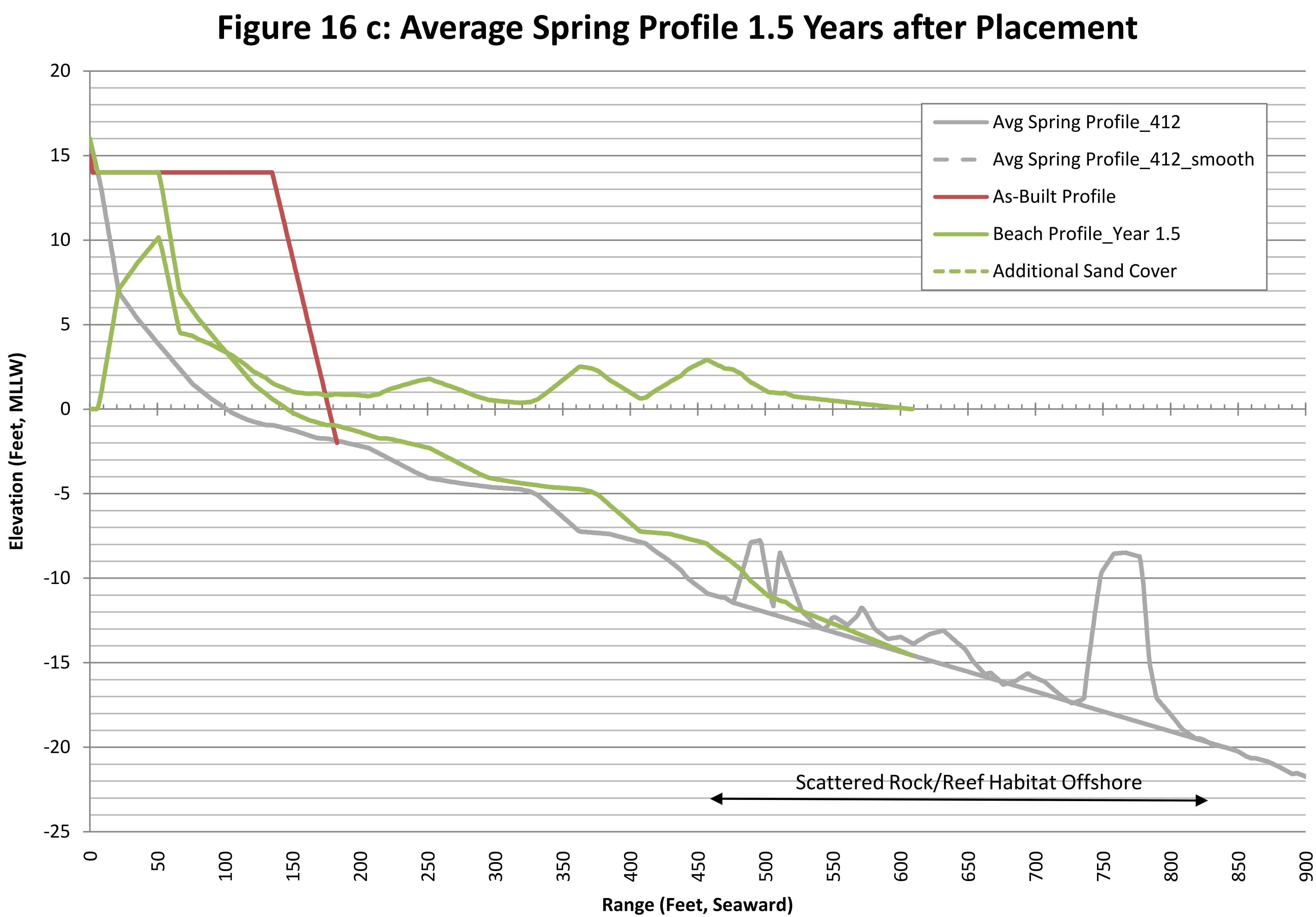


Figure 16 c: Average Spring Profile 1.5 Years after Placement
Elevation (Feet, MLLW)
20
15
10
5
0
-5
-10
-15
-20
-25
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
Range (Feet, Seaward)
Avg Spring Profile_412
Avg Spring Profile_412_smooth
As-Built Profile
Beach Profile_Year 1.5
Additional Sand Cover
Scattered Rock/Reef Habitat Offshore

Figure 16 d: Average Fall Profile 2 Years after Placement

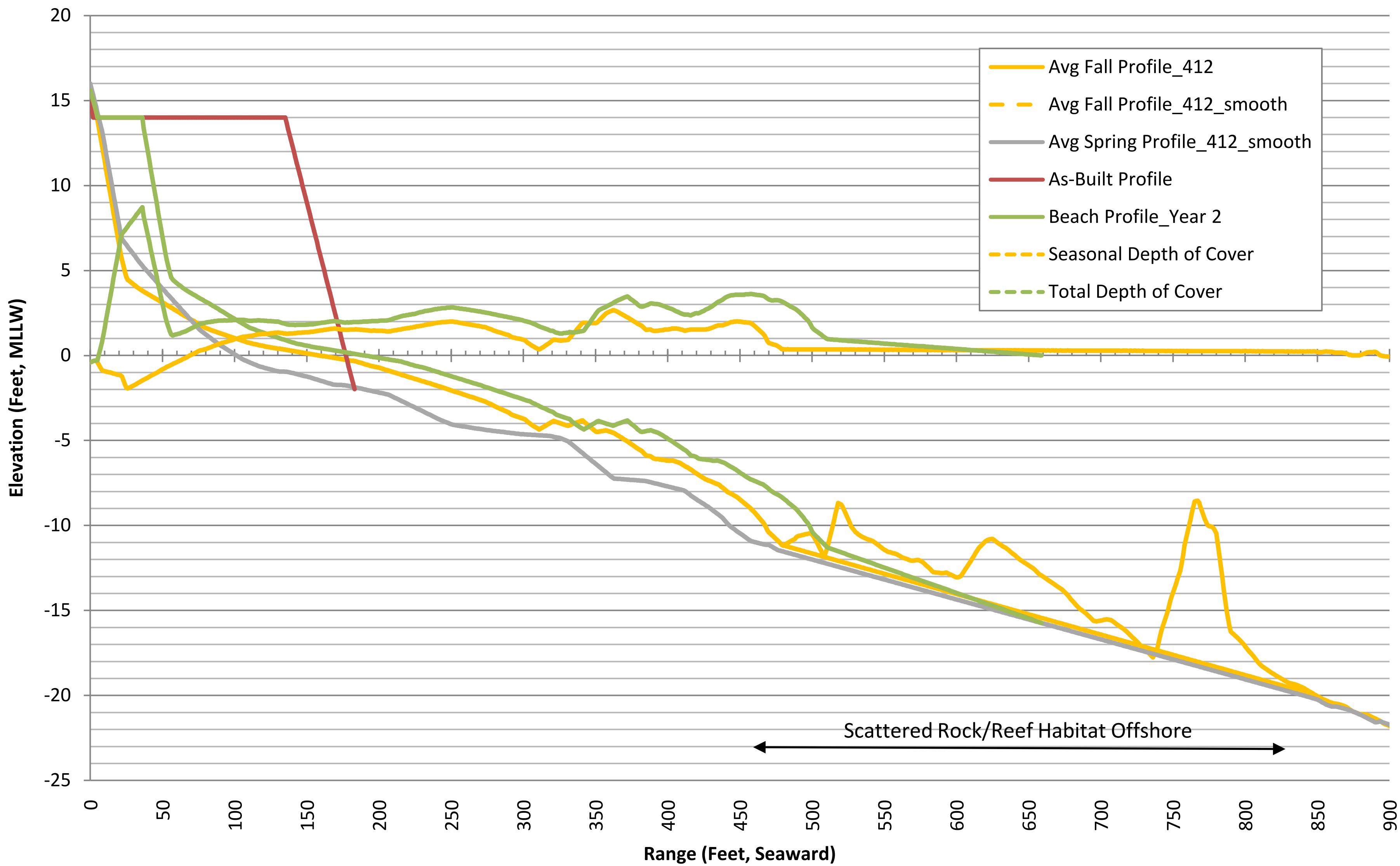


Figure 16 e: Average Spring Profile 2.5 Years after Placement

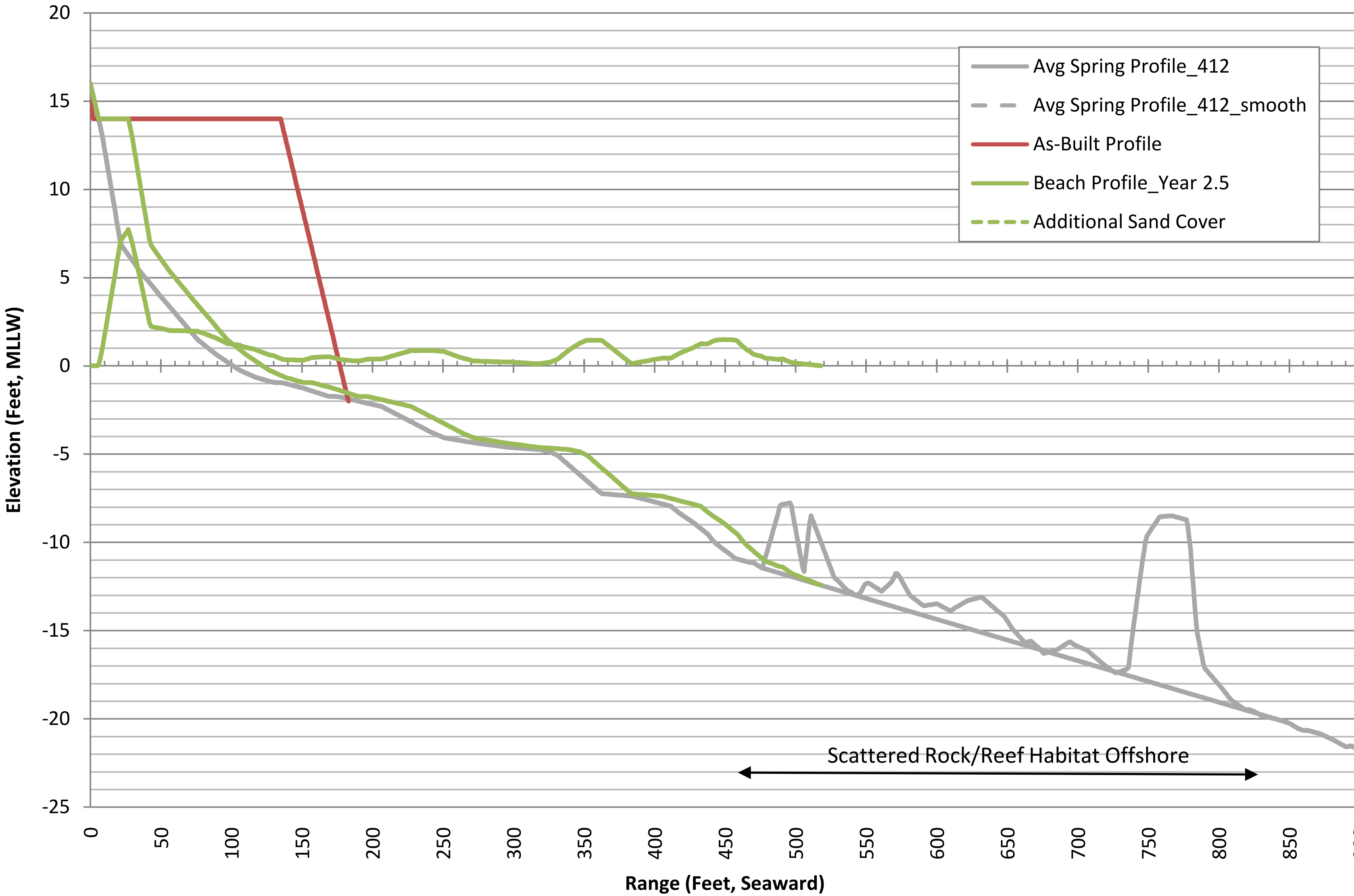


Figure 16 f: Average Fall Profile 3 Years after Placement

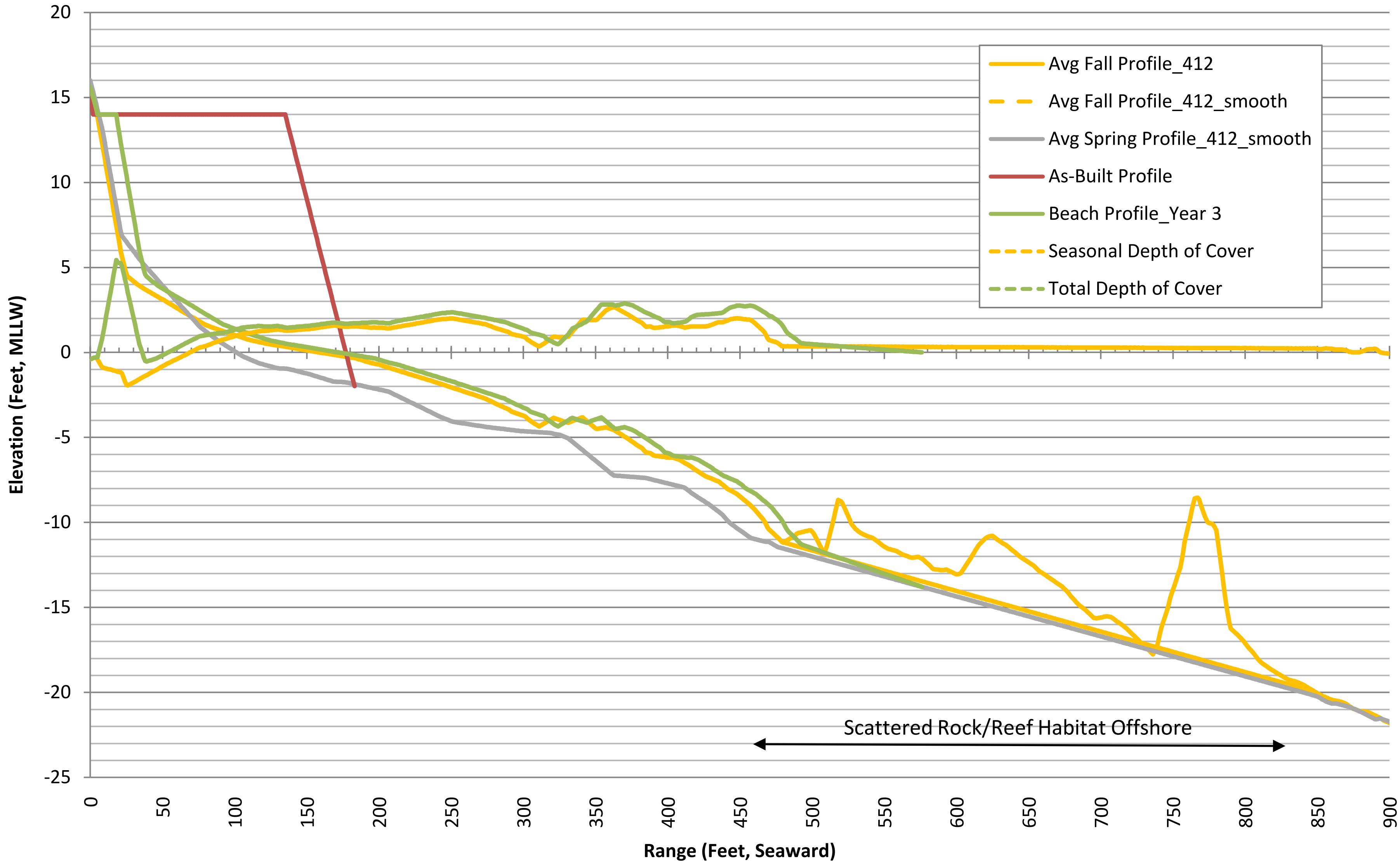
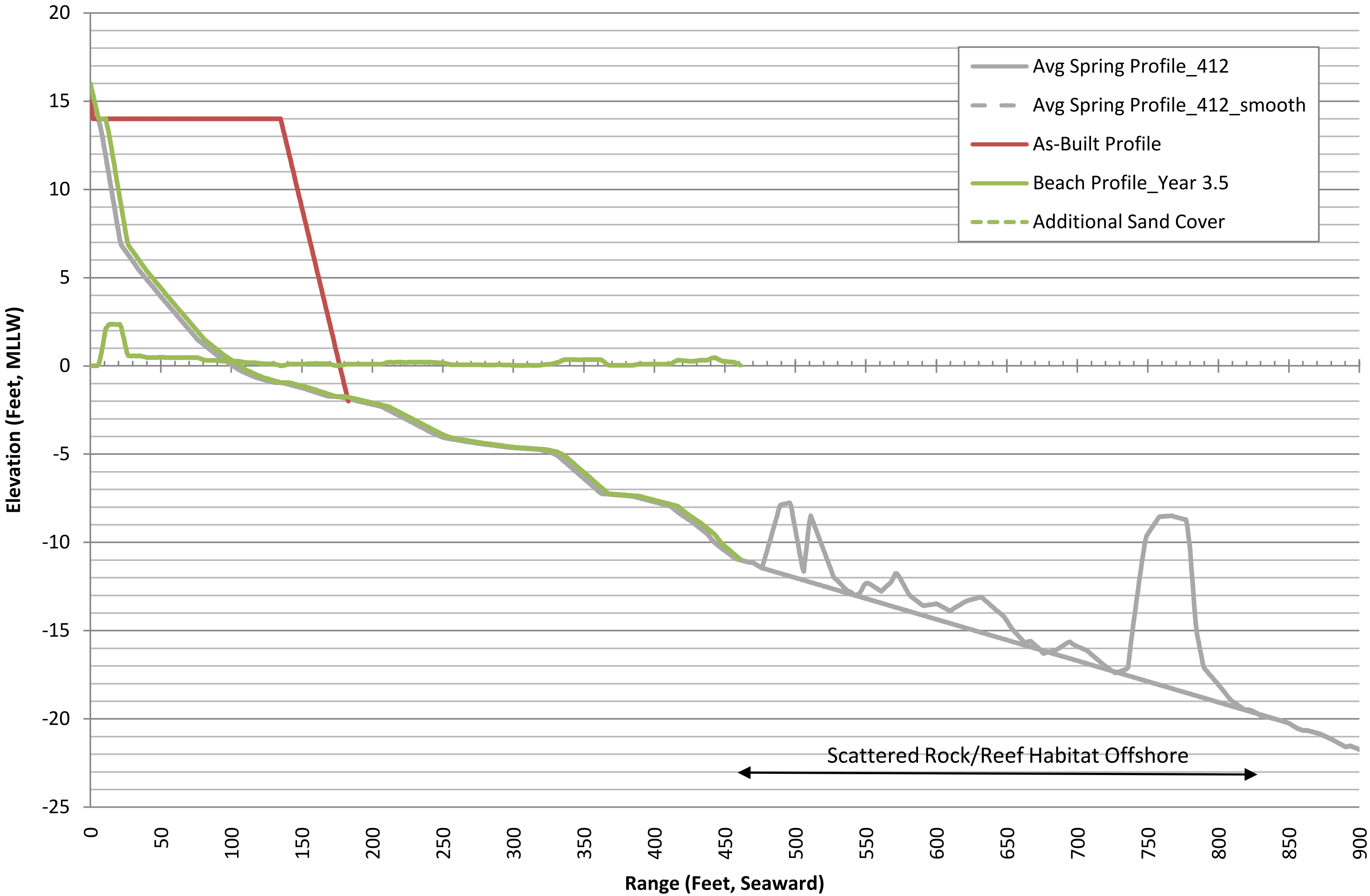


Figure 16 g: Average Fall Profile 3.5 Years after Placement



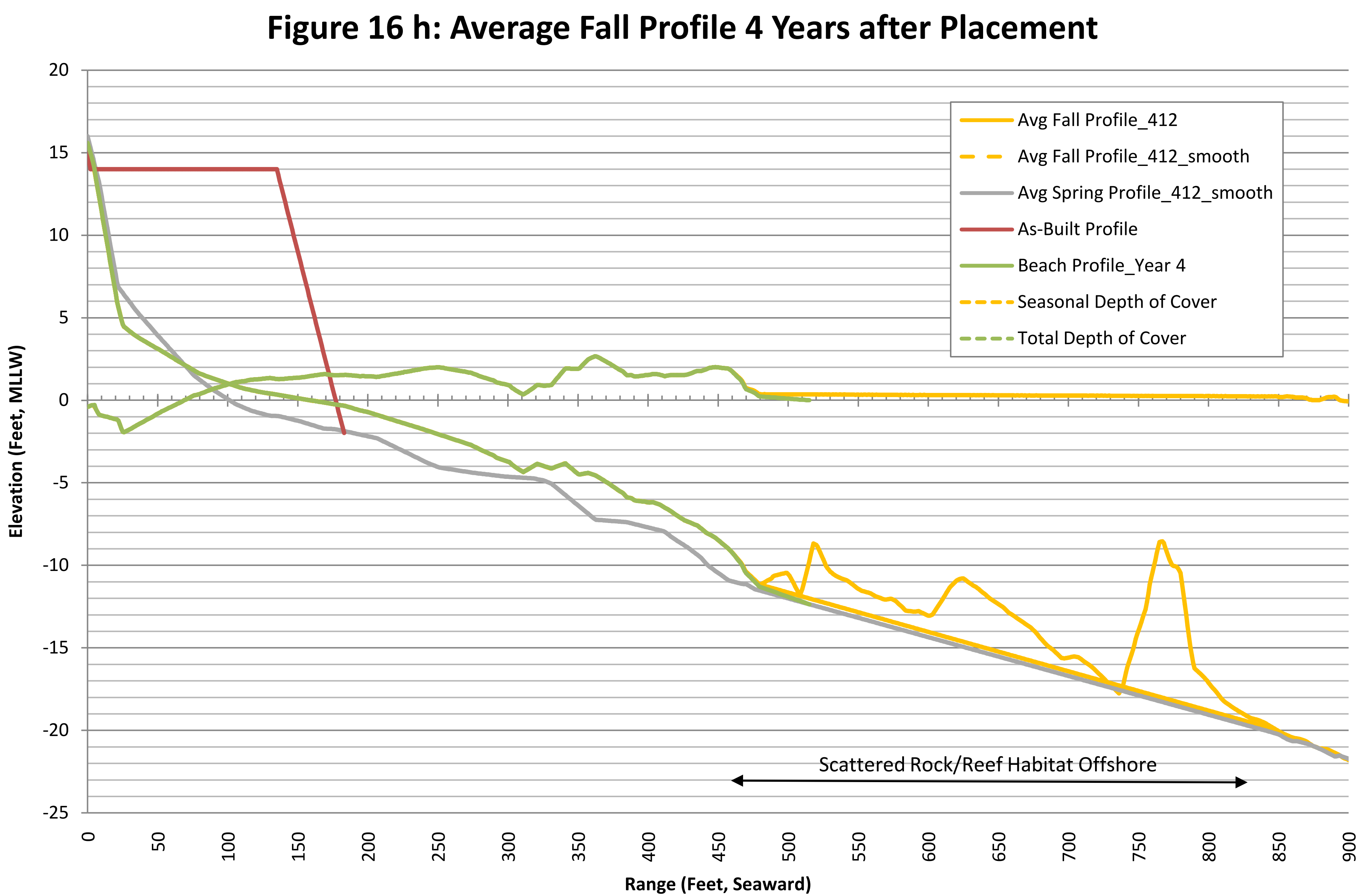


Figure 16 h: Average Fall Profile 4 Years after Placement
Elevation (Feet, MLLW)
Range (Feet, Seaward)
20
15
10
5
0
-5
-10
-15
-20
-25
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
Avg Fall Profile_412
Avg Fall Profile_412_smooth
Avg Spring Profile_412_smooth
As-Built Profile
Beach Profile_Year 4
Seasonal Depth of Cover
Total Depth of Cover
Scattered Rock/Reef Habitat Offshore

In summary, in the first 8 or 9 months to one year following beach fill the additional sand placed on Broad Beach will result in considerably greater seasonal sand cover to intertidal and shallow subtidal rocks and surfgrass habitat. The most landward rocks will be permanently buried. Upper to mid-intertidal rocks will be gradually exposed and will support rapid colonizers. By the second spring sand cover is predicted to decrease. It is unknown what effect the additional sand cover will have on marine resources. Surfgrass is adapted to seasonal sand movement and has been observed to recover from complete burial (Chambers Group 2008). However, the duration that surfgrass can withstand burial is unknown. Although rocky habitat and surfgrass existed at Broad Beach during the 1970's when the beach was wider (Egstrom 1974), it is possible that the predicted levels of burial following beach fill could have an adverse impact on the surfgrass and other rocky intertidal organisms at the western end of Broad Beach. Because sand transport primarily would be offshore and downcoast, the eastern portion of the surfgrass habitat near Lechuza Point may be affected. Potential impacts could occur to approximately 0.98 acres of surfgrass habitat. Although some sand from the beach fill may be transported upcoast to the western portion of the surfgrass habitat, sand deposition would not be expected to be substantial enough to have adverse impacts. About 0.98 acres of surfgrass habitat on the western side of Lechuza Point would not be expected to be affected by the beach fill. Therefore the beach fill could impact about half of the surfgrass habitat at Lechuza Point. Observed impacts to surfgrass habitat from beach nourishment projects in San Diego (SAIC 2011) and Santa Barbara (Chambers Group 2008) has been limited to minor transitory effects even though models predicted an increase in sand cover. Therefore, it is probable that impacts to the surfgrass at Broad Beach would be less than predicted by the model. In addition, the model does not consider sand grain size. Sand for nourishment will be very coarse-grained if taken from the Dockweiler site and will therefore remain higher on the beach profile and assume a steeper foreshore slope. The steeper slope will remain farther landward than a flatter slope of finer sand, and the position of the toe of the slope will be higher on the beach profile and impact less mid-tidal and sub-tidal habitat.

Because the impacts to surfgrass from the Broad Beach Restoration Project are unknown, but have the potential to result in degradation of habitat the following actions are recommended:

- Place the sand at the west end of Broad Beach near Lechuza Point in two separate intervals so that only half the total amount of sand is placed at one time. Placement of sand in two intervals would be expected to maximize the extent of sand dispersion over time and reduce the depth of burial near the placement site. The intervals should be at the beginning of the placement, and then at the last stage of placement to allow the maximum time span between placements.

- The surfgrass community at Broad Beach should be monitored for 5 years following sand placement. Permanent transects should be established within the surfgrass habitat east of Lechuza Point. Control transects should be established in surfgrass habitat west of Lechuza Point where minimal sand transport is expected. Baseline monitoring should be done in both areas prior to sand placement. Parameters that should be monitored include percent cover of surfgrass, red algae, green algae, brown algae, invertebrates, bare rock and sand as well as sand depth on each transect. Monitoring should be done immediately following sand placement, six months after placement and annually until year 5 after placement.

- If at the end of three years, substantial degradation without recovery is documented, mitigation for loss of intertidal habitat shall be implemented. Mitigation shall be determined by negotiation with the resource agencies but may consist of the construction of a shallow subtidal reef. To date no large scale surfgrass transplant has been successful but researchers at UCSB have had some success with experimental surfgrass transplants (Bull, J.S., D.C. Reed and S.J. Hollbrook 2004). Therefore, a small scale surfgrass transplant may be warranted. Another potential mitigation measure may be to fund protective measures (signs, monitors) to safeguard heavily visited rocky intertidal sites in Los Angeles County from damage from beachgoers.

Sand beach organisms would be expected to benefit from the increased beach width at Broad Beach. The increased beach width following the San Diego Regional Sand Beach Project resulted in increased invertebrate diversity earlier in the season compared to the pre-nourishment condition (SAIC 2011). The high intertidal sandy beach community would benefit the most from the increase in beach width. The high intertidal is lacking from most of Broad Beach under its current condition because of the severe erosion. The high intertidal zone of mainland southern California beaches supports a diverse and important macroinvertebrate community with macrophyte wrack as a food base (Dugan et al 2008). The high intertidal macroinvertebrate communities provide a food base for foraging gulls and foraging shorebirds, including western snowy plover. Restoration of the high intertidal macroinvertebrate sand beach community is especially important because this high sand beach community of southern California mainland beaches is being lost or impacted by a variety of factors including coastal armoring, beach grooming, and sea level rise.

The greater amount of sand on Broad Beach following beach nourishment would be expected to have a beneficial effect on marine birds by increasing resting habitat. The San Diego Regional Beach Sand Project appeared to have had a positive effect on bird use of receiver beaches in Encinitas (SAIC 2005). Prior to beach nourishment, few birds were observed on beaches with extensive cobble cover or shallow sand depths in the upper and middle intertidal zones. Following beach nourishment, the total number of bird species and bird abundance increased on receiver sites and was higher than on non-receiver sites. The increase in bird use at the sand placement sites following beach nourishment was thought to be a result of the greater beach widths created by the beach nourishment project. Similarly CZR Incorporated (2003) found that resting behavior of laughing gulls and royal terns increased following beach nourishment in North Carolina, although feeding behavior by gulls and terns did not change following beach nourishment. The behavioral data suggested that gulls and terns increased the percentage of their time spent resting after beach nourishment probably because of the greater available beach space. However, CZR Incorporated found little evidence that the North Carolina beach nourishment project affected shorebird abundance.

The wider beach following sand placement at Broad Beach will increase potential foraging and roosting habitat for the Federal threatened western snowy plover. In addition to using the beach, snowy plovers may use the reconstructed dunes.

Grunion do not spawn on Broad Beach in its current eroded condition because the waves break against the revetment at high tide and there is no upper beach for the grunion to lay their eggs. The wider beach following sand placement will provide appropriate sandy beach spawning habitat for grunion.

SECTION 4.0 – CONCLUSIONS

The Broad Beach Restoration Project will have temporary impacts to biological resources during construction. Substantial impacts to marine biological resources can be avoided by monitoring during construction and post-construction, and implementation of measures to reduce impacts if potential impacts are detected. These measures include improving sand dike containment at the beach if excessive turbidity is observed, placing offshore anchors and pipelines to avoid sensitive habitats, and monitoring of snowy plovers to avoid impacts to these species.

Following sand placement, the Broad Beach Restoration Project would be expected to have beneficial impacts on sandy intertidal organisms but will have some adverse impacts on rocky intertidal organisms. Rocky habitat in the high intertidal, which currently is buried by sand seasonally, may be permanently buried. Surfgrass habitat in the low intertidal and shallow subtidal would be expected to experience increased sand burial during the first two years following sand placement. The extent to which surfgrass will be damaged by this increased sand is unknown and should be monitored and, mitigated if recovery does not occur.

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APPENDIX A – BIOLOGICAL SURVEY OF PROPOSED SAND SOURCE SITES FOR BROAD BEACH SHORE PROTECTION PROJECT

BIOLOGICAL SURVEY OF PROPOSED SAND SOURCE SITES FOR BROAD BEACH SHORE PROTECTION PROJECT

MALIBU, CALIFORNIA

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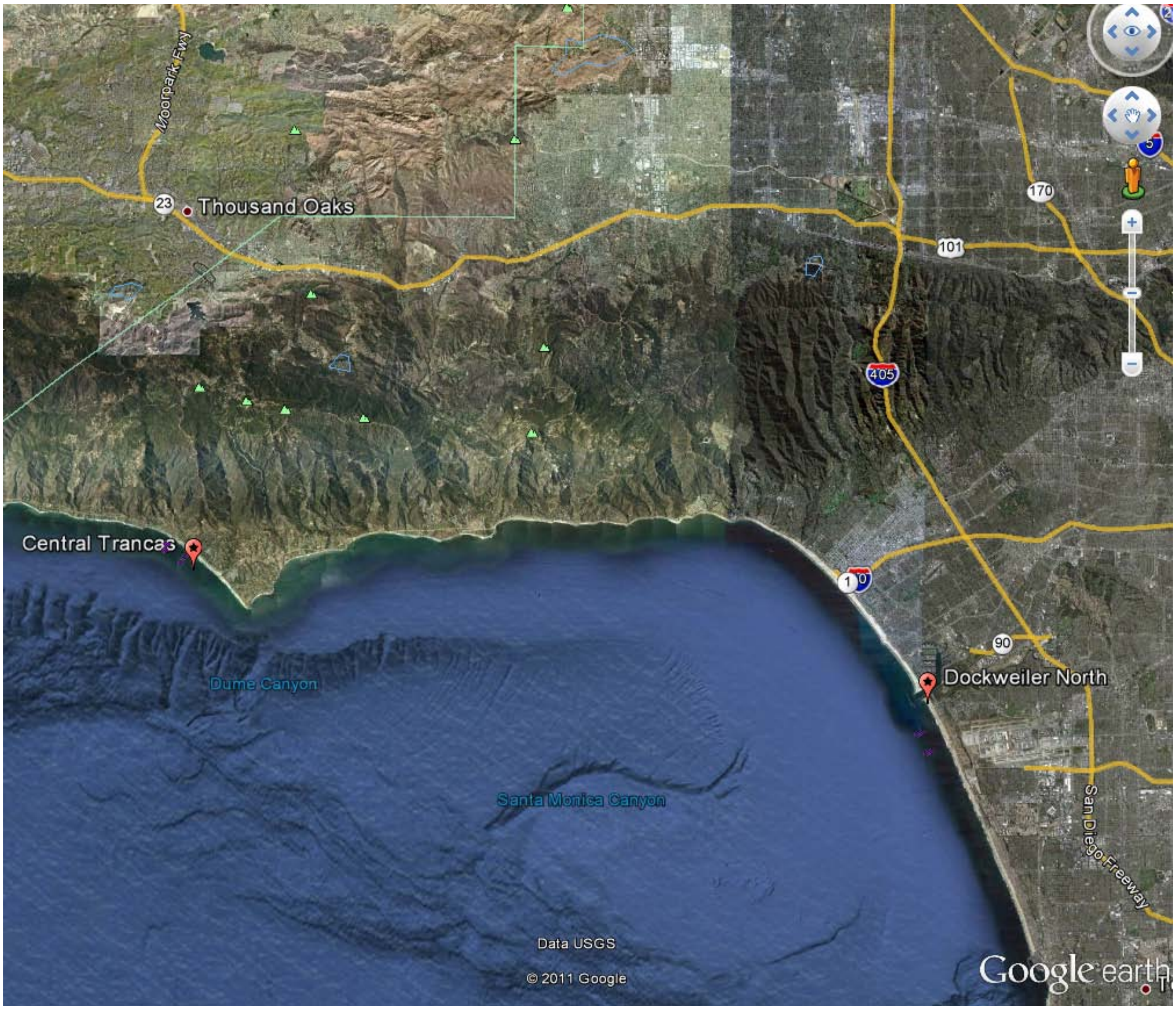
SECTION 1.0 – INTRODUCTION

Broad Beach in Malibu has suffered damage due to wave action. The Trancas Property Owner's Association is proposing to nourish the beach and dunes with sand to provide protection against wave damage. Two potential sources of sand have been identified. Figure 1 shows the general location of these sites. One source (Central Trancas) is offshore of Trancas Creek just east of Broad Beach. The other site (Dockweiler North) is just southeast of Marina del Rey. The purpose of this survey was to describe biological resources at each of these potential sand source sites to identify potential sensitivity and any constraints to dredging.

Figure 1: Site Locations



SECTION 2.0 – METHODS

The biological survey was performed on November 8 and 9, 2011. The survey vessel was a 21-foot long Carolina skiff owned and operated by Rick Ware of Coastal Resources Management. Noel Davis, Ph.D. of Chambers Group, Inc. and Mike Anghera were the marine biologist divers. Tom Gerlinger of Chambers Group oversaw the processing of the macroinvertebrate samples.

The Dockweiler North and Dockweiler South areas were surveyed on November 8. Three dives were made at the Dockweiler North site. Dive locations were selected to be representative of conditions at the site. Positioning was done with a differentially corrected Magellan Mobile Mapper GPS. Table 1 and Figure 2 show the location of each dive. At each dive site a buoy was dropped at the station location. The dive team went down the buoy line and took five 10 centimeter (cm) diameter by 10 cm deep hand held sediment core samples to sample infaunal macroinvertebrates present at the borrow site. After taking the core samples, the divers clipped the bag with the cores to the buoys, and the cores were retrieved by the personnel on the boat. Tom Gerlinger processed the samples on board the boat by passing the materials through a 1 millimeter sieve. Materials retained on the sieve were fixed in a formaldehyde solution.

The dive team swam in a pre-determined compass direction from the buoy noting the nature of the substrate and organisms present. Each transect at the Dockweiler North site was for a duration of 25 minutes and covered approximately 400 meters. A fourth transect was swum at the Dockweiler South site but no core samples were taken.

Survey conditions at the Dockweiler North site on November 8 were good. Underwater visibility ranged from 12 to 15 feet. Swells were a moderate 2 to 4 feet and winds were light. The bottom temperature was 56^0 Fahrenheit (F). Tides on November 8 were a high of 5.8 feet Mean Lower Low Water (MLLW) at 0710 and a low of 0.2 feet MLLW at 1401. Water depth on the dives was about 45 feet MLLW

The Central Trancas site was surveyed on November 9. The methodology was the same as for the Dockweiler North site. Three dives were made at the Central Trancas site. Dive locations were selected to be representative of conditions at the site. Table 1 and Figure 3 show the location of each dive. Five core samples were taken for macroinvertebrates at the start point for each dive. The divers then swam a transect at a predetermined compass heading for about 20 minutes. The length of each transect was about 300 meters. The dives at the Central Transect site were shorter than at the Dockweiler North site because the area was smaller and the depths were deeper.

Survey conditions at the Central Tansect site on November 9 were excellent. Underwater visibility was about 25 feet. Swells were only 1 to 3 feet and winds were about 10 knots. The bottom temperature was 55^0 Fahrenheit (F). Tides on November 9 were a high of 5.9 feet MLLW at 0733 and a low of 0 feet MLLW at 1432. Water depth during the dives ranged from 50 to 55 feet MLLW.

Figure 2: Dockweiler North and Dockweiler South Dive Locations

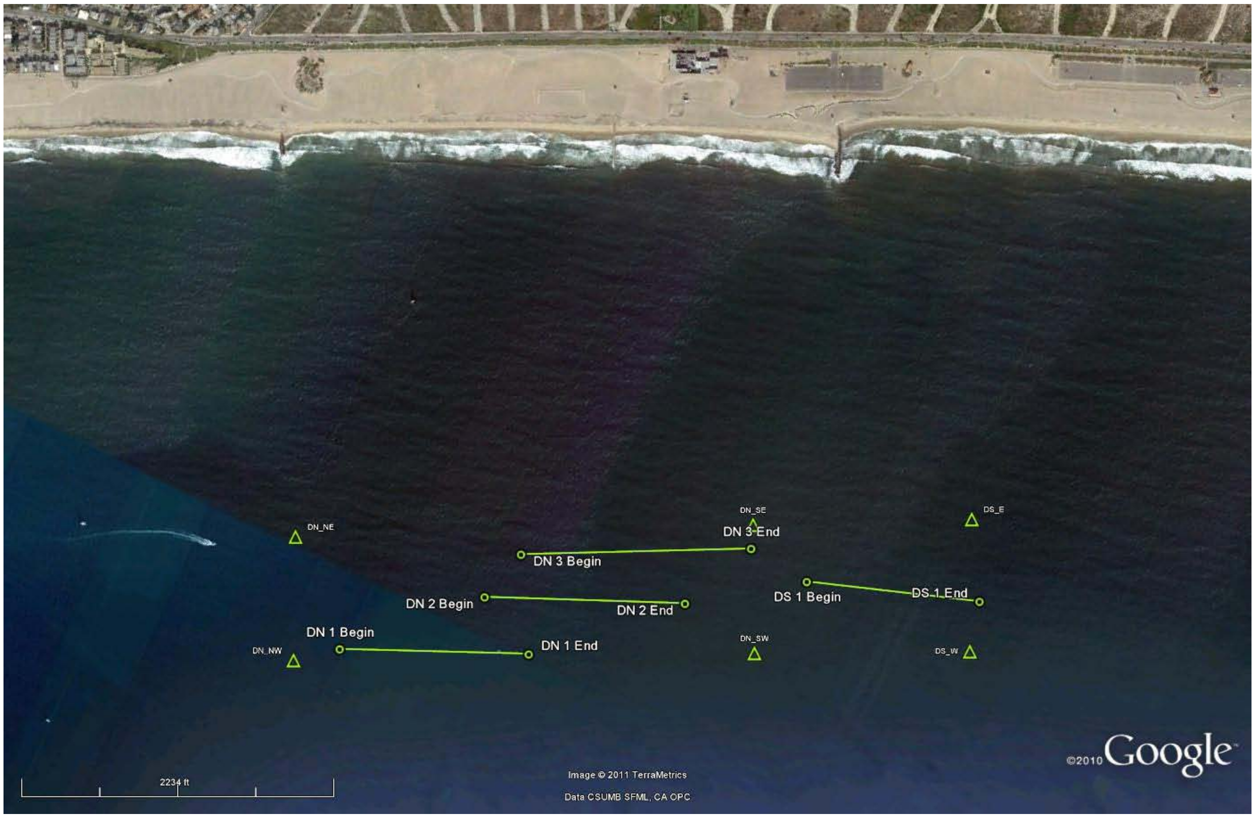


Figure 3: Central Trancas Dive Locations

Table 1: Borrow Area Corner and Transect Locations

Name	POINT_Y	POINT_X
DOCKWEILER		
DN_NE	33.94682647180	-118.45659437400
DN_NW	33.94582861370	-118.45926399400
DN_SE	33.93878781990	-118.45172570600
DN_SW	33.93769104490	-118.45446230700
DS_E	33.93494608090	-118.44939957100
DS_W	33.93387408400	-118.45225314300
DN 1 Begin	33.94509500000	-118.45854500000
DN 1 End	33.94169000000	-118.45674800000
DN 2 Begin	33.94295300000	-118.45596800000
DN 2 End	33.93933500000	-118.45408600000
DN 3 Begin	33.94266100000	-118.45468600000
DS 1 Begin	33.93735000000	-118.45239000000
TRANCAS		
CT_CE	34.02667602790	-118.84649864100
CT_SE	34.02336488140	-118.84133245900
CT_SW	34.02223402450	-118.84236917800
CT_CW	34.02556942830	-118.84749637700
CT 1 Begin	34.02536000000	-118.84709400000
CT 1 End	34.02370700000	-118.84474500000
CT 2 Begin	34.02488700000	-118.84455000000
CT 2 End	34.02269400000	-118.84238600000
CT 3 Begin	34.02620000000	-118.84620300000
CT 3 End	34.02415400000	-118.84442600000

Upon returning to the laboratory, the benthic macroinvertebrate samples were transferred to an ethanol solution. Organisms were sorted from the debris under a dissecting microscope and each organism was identified to the lowest possible taxon. Identification of macroinvertebrates was under the direction of Tom Gerlinger.

SECTION 3.0 – RESULTS

3.1 DIVER TRANSECTS

3.1.1 Dockweiler North and South

The substrate observed on the transects at the Dockweiler North and South sites was entirely sand bottom. Patches of coarse sand were observed on these dives.

The organisms observed on the transects were typical of sand bottom habitats in southern California (Morin et al 1988, Davis and VanBlaricom 1978, Thompson et al 1993). Table 2 lists the organisms observed on the transects. Frequently observed animals on the Dockweiler transects included the tube worm *Diopatra ornata*, the sand star *Astropecten armatus*, the crab *Cancer gracilis*, the sea pen *Stylatula elongata* and the mantis shrimp *Hemisquilla ensigera.* An unusual observation was large numbers (as many as 20 per dive) of California spiny lobster (*Panulirus interruptus*) seen on each of the transects. Spiny lobsters usually are found in rocky habitat, where they take shelter in holes and crevices. The large numbers of lobsters observed in sand bottom habitat on these dives were probably lobsters in migration.

Table 2: Organisms Observed on Dockweiler Transects

Scientific Name	Common Name	DN1	DN2	DN3	DS
Cnidaria					
Harenactis attenuata	Sand anemone				X
Stylatula elongata	Sea pen	X	X	X	X
Virgularia californica	Sea pen		X		X
Mollusca					
Flabellinopsis iodinia	nudibranch	X	X	X	
Kelletia kelleti	Kellet's whelk		X		
Megasurcula carpenteriana	Carpenter's turrid	X			
Terebra pedroana	San Pedro Auger	X			
Annelida					
Diopatra ornata	Ornate tube worm	X	X	X	X
Pista pacifica	worm	X	X		
Arthropoda					
Cancer antennarius	Brown rock crab	*X*			
Cancer gracilis	Slender cancer crab	X	X		X
Hemisquilla ensigera	Mantis shrimp	X	X		
Panulirus interruptus	California spiny lobster	X	X	X	X
Taliepus nuttalli	Southern kelp crab	X			
Echinodermata					
Astropecten armatus	Spiny sand star	X	X	X	X
Bryozoa					
Thalamoporella californica	Bryozoan		X		
Vertebrata					
Citharichthys stigmaeus	Speckled sanddab			X	
Pleuronichthys sp.	Turbot	X			
Synodus lucioceps	Lizard fish	X			
Syngnathus sp.	Pipefish		X		
Zalophus californianus	California sea lion	X	X		

3.1.2 Central Trancas

With the exception of 3 or 4 small boulders, the substrate on the Central Trancas transects was entirely sand. The boulders probably either came from Trancas Creek discharges or were dislodged from emergency revetments installed to protect homes along Broad Beach Road.

The organisms observed on the transects were similar to those observed on the Dockweiler transects and were characteristic of sand bottom communities off southern California. Table 3 shows the organisms observed on the Central Trancas transects. Common organisms on the Central Trancas transects included the tube worm *Diopatra ornata,* the slender cancer crab *Cancer gracilis* ,and the speckled sand dab *Citharichthys stigmaeus*. Four or five juvenile individuals of the giant kelp *Macrocystis pyrifera* were observed growing on tubes of the worm *D.ornata*.

Table 3: Organisms Observed on Central Trancas Transects

Scientific Name	Common Name	CT1	CT2	CT3
Phaeophyta				
Macrocystis pyrifera	Giant kelp	X		X
Ptyregophora californica	Palm kelp	X		
Cnidaria				
Stylatula elongata	Sea pen	X		
Virgularia californica	Sea pen	X	X	
Mollusca				
Cancellaria cooperi	Cooper's nutmeg	X		
Kelletia kelleti	Kellet's whelk	X		
Terebra pedroana	San Pedro Auger	X	X	
Annelida				
Diopatra ornata	Ornate tube worm	X	X	X
Arthropoda				
Cancer gracilis	Slender cancer crab	X	X	
Hemisquilla ensigera	Mantis shrimp		X	
Loxorhynchus crispatus	Masking crab	X	X	X
Echinodermata				
Amphiodia occidentalis	Brittle star	X		
Astropecten verrilli	Sand star	X		
Pisaster brevispinus	Short spined sea star		X	X
Pisaster giganteus	Giant spined sea star	X		
Bryozoa				
Thalamoporella californica	Bryozoan		X	
Vertebrata				
Citharichthys stigmaeus	Speckled sanddab	X	X	X
Syngnathus sp.	Pipefish	X	X	

3.2 BENTHIC INVERTEBRATE SAMPLES

3.2.1 Dockweiler North

Table 4 shows the macroinvertebrates found in the core samples taken at the Dockweiler North stations. A total of 100 taxa were collected in the 15 cores at the Dockweiler North dredge area. As is typical of infaunal communities at these depths, the samples were dominted by polychaete worms. Of the 100 taxa identified in the samples, 67 were polychaetes. The second most abundant taxonomic group was crustaceans with 14 taxa. A total of 8 mollusc taxa were identified. The remaining 11 taxa included cnidaria, platyhelminthes, sipunculids, echinoderms, brachiopods and enteropneusts.

Table 4: Macroinvertebrates Found in Core Samples at Dockweiler North, November 2011

	DN1 rep1	DN1 rep 2	DN1 rep 3	DN1 rep 4	DN1 rep 5	DN2 rep 1	DN2 rep 2	DN2 rep 3	DN2 rep 4	DN2 rep 5	DN3 rep 1	DN3 rep 2	DN3 rep 3	DN3 rep 4	DN3 rep 5
PHYLUM CNIDARIA															
Class Hydrozoa															
Laomedia calceolifera						1									
PHYLUM PLATYHELMINTHES															
Stylochus exiguus															1
PHYLUM NEMERTEA															
Carinoma mutabilis								1		1	1		1		
Lineidae														1	
Paranemertes californica											1				
PHYLUM MOLLUSCA															
Class Gastropoda															
Odostomia sp											1				
Turbonilla sp HYP1					1										
Class Bivalvia															
Cooperella subdiaphana															1
Ensis myrae								1							
Macoma yoldiformis							1								
Modiolus sp (juv)						1									
Pectinidae (juv)						1									
Rochefortia grippi		1													
Siliqua lucida									1						
Tellina modesta	1	1	1	1	3		1		1	1					
PHYLUM SIPUNCULA															
Sipunulus nudus															
PHYLUM ANNELIDA															
Class Polychaeta															
Amaeana occidentalis		1													2
Amphicteis scaphobranchiata				1											
Anotomastus gordiodes												1			
Apoprionospio pygmaea				1				1		1					
Arabella pectinata														1	
Axiothella sp															
Boccardia sp, juv			1												
Brania brevipharyngea														1	
Chaetopteridae, juv															
Chaetozone glandaria										1					
Chone paramollis															
Chone veleronis	1		1			1									

Table 4: Macroinvertebrates Found in Core Samples at Dockweiler North, November 2011

	DN1 rep1	DN1 rep 2	DN1 rep 3	DN1 rep 4	DN1 rep 5	DN2 rep 1	DN2 rep 2	DN2 rep 3	DN2 rep 4	DN2 rep 5	DN3 rep 1	DN3 rep 2	DN3 rep 3	DN3 rep 4	DN3 rep 5
Cirratulidae, frag															
Diopatra ornata						1									
Dipolydora socialis											1				
Drilonereis sp, frag		1													
Eteone pigmentata											1				1
Euclymeninae sp A SCAMIT				1						1					
Eumida longicornuta						1									
Exogone lourei															
Glycera americana									1						
Glycera macrobranchia		1						1			1			1	
Glycera oxycephala															
Glycinde armigera	1		1	1				1					1		1
Goniada littorea		1	1	1								2			
Goniada maculata				2	2	1				1		1		1	
Lanice conchilega															
Laonice cirrata			1		2										
Loimia sp A SCAMIT															
Lumbrineridae, frag															
Lumbrineris ligulata						1									
Lumbrineris sp, juv											1				
Magelona sacculata															
Maldanidae, frag															
Mediomastus acutus									1						
Mediomastus ambiseta										1					
Mediomastus sp					1										
Monticellina cryptica							1		1				1		
Monticellina siblina	2		2	2	2			2		1	1				1
Mooreonuphis nebulosa															
Nephtys caecoides										1					
Nereiphylla ferruginea Cmplx															
Nereis latescens														1	
Nereis sp A SCAMIT		1		1		2	1								
Notomastus sp, juv															
Onuphis sp A SCAMIT	1														1
Parandalia fauveli															
Paraonides platybranchia				1											
Paraprionospio alata								1							
Phyllochaetopterus prolifica															

Table 4: Macroinvertebrates Found in Core Samples at Dockweiler North, November 2011

	DN1 rep1	DN1 rep 2	DN1 rep 3	DN1 rep 4	DN1 rep 5	DN2 rep 1	DN2 rep 2	DN2 rep 3	DN2 rep 4	DN2 rep 5	DN3 rep 1	DN3 rep 2	DN3 rep 3	DN3 rep 4	DN3 rep 5
Phyllodoce hartmanae															
Phyllodoce longipes						1									
Phyllodoce sp, juv															
Pista wui			1											1	
Platynereis bicanaliculata															
Poecilochaetus johnsoni															
Polycirrus sp A SCAMIT											1				
Polydora bioccipitalis														4	
Polydora cirrosa														16	
Polydora sp, juv														3	
Prionospio (Prionospio) jubata															
Sigalion spinosus			1	1								1			1
Spiochaetopterus costarum Cmplx			1												
Spionidae, frag															
Spiophanes duplex			1								1		1		1
Spiophanes norrisi												1			
Sthenalais verruculosa															
PHYLUM ARTHROPODA															
Class Malacostraca															
Order Amphipoda															
Ampelisca brachycladus								3					1		
Ampelisca cristata cristata				1					1	1					
Caprella californica														1	
Foxiphalus obtusidens															1
Gibberosus myersi						2							1		
Hartmanodes hartmanae	1														
Incisocalliope newportensis								1							
Listriella diffusa		1													
Listriella goleta		1													
Photis lacia						1		1							
Rhepoxynius abronius							1								
Order Cumacea															
Diastylopsis tenuis							1								
Order Decapoda															
Neotrypaea gigas											1				
Pinnixa schmitti		1													

Table 4: Macroinvertebrates Found in Core Samples at Dockweiler North, November 2011

	DN1 rep1	DN1 rep 2	DN1 rep 3	DN1 rep 4	DN1 rep 5	DN2 rep 1	DN2 rep 2	DN2 rep 3	DN2 rep 4	DN2 rep 5	DN3 rep 1	DN3 rep 2	DN3 rep 3	DN3 rep 4	DN3 rep 5
PHYLUM ECHINODERMATA															
Class Ophiuroidea															
Amphiuroidae (juv)													1		
PHYLUM BRACHIOPODA															
Glottidia albida		1			1										
PHYLUM CHORDATA															
Class Enteropneusta															
Saccoglossus sp			1								1				
Abundance per replicate	7	11	13	14	12	14	6	13	6	10	12	6	7	31	11
Abundance per Station	57					49					67				
Number species per replicate	6	11	12	12	7	12	6	10	6	10	12	5	7	11	10
Number of species per Station	31					34					36				

Table 5 summarizes the characteristics of the invertebrate community collected at the three stations within the Dockweiler North sand source site.

Table 5: Infaunal Invertebrate Community Characteristics at Three Stations within the Dockweiler North Sand Source Area

	Station DN1	Station DN2	Station DN3	Average
Total Number of Taxa	31	34	36	33.7
Density (#/m2)	1452.4	1248.5	1707.2	1469.4
Diversity Index	3.14	3.42	3.18	3.25
Most Abundant Taxa (% abundance)	Monticellina siblina 14%	Tellina modesta 6.1%	Polydora cirrosa 23.9%	
	Tellina modesta 12.3%	Monticellina siblina 6.1%	Polydora bioccipitalis 6%	
	Goniada maculata 7.0%	Nereis sp A SCAMIT 6.1%	Polydora sp, juv 4.5%	
		Ampelisca brachycladus 6.1%	Spiophanes duplex 4.5%	

The total number of taxa per station ranged between 31 at Station DN1 and 36 at Station DN3 with an average of 33.7 for the 3 stations. The infuanal macroinvertebrate density at the Dockweiler North stations ranged from 1248.5 organisms per square meter (m^2) at Station DN2 to 1707.2 organisms per m^2 at Station DN3 with an average of 1469.4 per m^2. The number of taxa and densities are slightly on the low side for infaunal invertebrate communities at 45 foot depth off the southern California mainland coast (for example, Chambers Group 1988).

The Shannon-Wiener Diversity Index ranged between a low of 3.14 at Station DN1 and a high of 3.42 at Station DN2 with an average of 3.25. The Shannon-Wiener index of species diversity considers the number of species present and the apportionment of the individuals among those species.

$$H_s = - \sum_{I=1} P_i \log P_i$$

where

H_s = the symbol for the amount of diversity in a group of s species,
P_i = the relative abundance of the i^{th} species measured from 0 to 1.0,
log = natural logarithm (base e).

The diversity indices calculated for the Dockweiler North stations indicate that the infaunal community in this proposed dredge area is relatively diverse. The area supports a moderately high number of taxa that are fairly evenly distributed. The samples were not dominated by one or two taxa.

The most abundant taxa at Station DN1 and DN2 were the polychaete *Monticellina siblina* and the clam *Tellina modesta*. These are characteristic organisms of southern California sand bottoms at these depths. Station DN3 contained several individuals of the spionid polychaete *Polydora cirrosa*. All of the individuals of this species were collected in one core at this station and were embedded within a *Diopatra* tube. *Polydora cirrosa* is an opportunistic species that occurs in a wide variety of habitats and depths from intertidal and bay and estuary areas to offshore (Rodriguez-Villanueva et al 2002, Quiroz-Vasquez et al 2005).

3.2.2 Central Trancas

Table 6 shows the macroinvertebrate taxa collected at the Central Trancas stations. A total of 115 taxa were collected in the 15 core samples in the Central Trancas sand source area. Of these 115 taxa, 42 were polychaete worms, 31 were crustaceans and 20 were mollusks. The remaining 22 taxa included cnidarians, nemertean worms, flatworms (platyhelminthes), sipunculids, oligochaete worms, echinoderms, phoronids, brachiopods, and enteropneusts.

Table 7 summarizes the community characteristics of the infaunal invertebrate community at the three stations within the Central Trancas sand source site.

The total number of taxa per station ranged from 49 taxa at Station CT2 to 55 taxa at Station CT3 with an average of 52.7 taxa per station. The density ranged from 2548 invertebrates per m^2 at Station CT3 to 3312.4 per m^2 at Station CT1 with an average of 2862.3 invertebrates per m^2. The number of taxa per station and density at the Central Trancas stations is on the high side for stations at 55 ft. depth off the Malibu coast (Chambers Group 1988). The diversity indices at the Central Trancas stations ranged from 3.59 to 3.74 with an average of 3.65. The diversity indices at the Central Trancas sand source site are high and represent an even distribution of a fairly high number of taxa.

The most abundant infauna taxa at the Central Trancas stations were the brachiopod *Glottidea albida,* the nemertean worm *Carinoma mutabilis*, the polychaete worm *Monticellina siblina,* the clam *Tellina modesta*, and the amphipod crustacean *Rhepoxynius abronius.* These are all common species at 50 to 55 foot depth in the Malibu area (Chambers Group 1988).

Table 6: Macroinvertebrates Found in Core Samples at Central Trancas

	CT1 rep1	CT1 rep 2	CT1 rep 3	CT1 rep 4	CT1 rep 5	CT2 rep 1	CT2 rep 2	CT2 rep 3	CT2 rep 4	CT2 rep 5	CT3 rep 1	CT3 rep 2	CT3 rep 3	CT3 rep 4	CT3 rep 5
PHYLUM CNIDARIA															
Class Anthozoa															
Ceriantharia								1							
Diadumene sp			1			1			1						
Halcampa decemtentaculata		1													
PHYLUM NEMERTEA															
Carinoma mutabilis		1		1	5		3	1	1		1	2	1	2	
Lineus bilineatus		1													
Paranemertes californica					1										
Tubulanidae sp E				1											
PHYLUM PLATYHELMINTHES															
Cryptocelis occidentalis	1														
Polycystidae sp Zuma1														1	
Stylochus exiguus											1				
PHYLUM MOLLUSCA															
Class Gastropoda															
Astyris aurantiaca														1	
Callianax baetica										1					
Calliostoma turbinum															2
Cyathodonta pedroana			1												
Cylichna diegensis				1							1				
Epitonium bellastriatum		1													
Kurtziella plumbea					1										
Odostomia (Evalea) sp				1										1	
Rictaxis punctocaelatus					1		1					1			
Turbonilla sp Zuma 1		2													
Turbonilla sp Zuma 2														1	
Class Bivalvia															
Cooperella subdiaphana															1
Ensis myrae						1									
Leptopecten latiauratus														1	
Lucinisca nuttalli				1											
Macoma sp (juv)										1					
Mytillidae (juv)				1											
Parvilucina tenuisculpta				1						1					
Rochefortia tumida		2	1			2				1	1		1		
Tellina modesta	1			9		1		1	1						
PHYLUM SIPUNCULA															
Sipunulus nudus						1									
PHYLUM ANNELIDA															
Class Polychaeta															
Amaeana occidentalis											1				
Apoprionospio pygmaea			1							2					
Axiothella sp														1	
Chaetopteridae, juv			1												
Chone paramollis			1												
Chone veleronis									1						

Table 6: Macroinvertebrates Found in Core Samples at Central Trancas

	CT1 rep1	CT1 rep 2	CT1 rep 3	CT1 rep 4	CT1 rep 5	CT2 rep 1	CT2 rep 2	CT2 rep 3	CT2 rep 4	CT2 rep 5	CT3 rep 1	CT3 rep 2	CT3 rep 3	CT3 rep 4	CT3 rep 5
Cirratulidae, frag													1		
Euclymeninae sp A SCAMIT				3		1			1					1	
Eumida longicornuta														1	
Exogone lourei												1			3
Glycera americana				1											
Glycera macrobranchia						1		2		1	1	1			
Glycera oxycephala		2	1												
Glycinde armigera		2	1	1					2	1	1	1		1	
Lanice conchilega												1			
Laonice cirrata						1	1								
Loimia sp A SCAMIT						1									
Lumbrineridae, frag			1												
Magelona sacculata															1
Maldanidae, frag	2									1					
Monticellina cryptica		1		1	1		1				1	1		1	1
Monticellina siblina	2		1	1		1	3	2	3		1	1		2	
Mooreonuphis nebulosa								1							
Nephtys caecoides															1
Nereiphylla ferruginea Cmplx								1							
Nereis sp A SCAMIT				1	1	1			1			1			
Notomastus sp, juv				1											
Onuphis sp A SCAMIT									1						
Parandalia fauveli								1							
Paraprionospio alata									2						
Phyllochaetopterus prolifica										1					
Phyllodoce hartmanae	1						1								
Phyllodoce longipes														2	
Phyllodoce sp, juv														1	
Platynereis bicanaliculata														1	
Poecilochaetus johnsoni		1											1		
Prionospio (Prionospio) jubata				1			1		2			1			
Spiochaetopterus costarum Cmplx				1			1	2							2
Spionidae, frag	2														
Spiophanes duplex		1												2	
Spiophanes norrisi		2	2							1	1			1	3
Sthenalais verruculosa					1				1						
Class Oligochaeta															
Oligochaeta									1						
PHYLUM ARTHROPODA															
Class Ostracoda															
Leuroleberis sharpei											1				
Postasterope barnesi													1		
Class Malacostraca															
Order Amphipoda															
Americhelidium shoemakeri		2		2			1		2	1				3	
Ampelisca agassizi					1	1			1				1		2
Ampelisca brachycladus															

Table 6: Macroinvertebrates Found in Core Samples at Central Trancas

	CT1 rep1	CT1 rep 2	CT1 rep 3	CT1 rep 4	CT1 rep 5	CT2 rep 1	CT2 rep 2	CT2 rep 3	CT2 rep 4	CT2 rep 5	CT3 rep 1	CT3 rep 2	CT3 rep 3	CT3 rep 4	CT3 rep 5
Ampelisca cristata cristata						1			1						
Ampelisca sp (juv)									1						1
Aoroides intermedius														3	
Bemlos concavus														2	
Caprella californica															
Erichthonius brasiliensis															1
Foxiphalus obtusidens	1	2		1				1	1						
Gibberosus myersi				1			1	1		2				1	
Hartmanodes hartmanae											1				
Incisocalliope newportensis															
Ischyrocerus anguipes														1	
Ischyrocerus pelagops														1	
Listriella diffusa															
Listriella goleta															
Photis lacia														2	
Photis sp OC1								2							
Photis sp (juv)														1	
Rhepoxynius abronius	2	2		4				2	3					2	2
Rhepoxynius stenodes	1			2											
Order Tanaidacea															
Leptochelia dubia														1	
Order Cumacea															
Diastylopsis tenuis	1			2											1
Hemilamprops californicus		2	1	1											
Order Decapoda															
Crangon alaskensis				1											
Metacarcinus anthonyi								1						1	
Neotrypaea gigas															
Pinnixa longipes												1			
Pinnixa schmitti															
Pinnixa sp (juv)						1									
PHYLUM ECHINODERMATA															
Class Ophiuroidea															
Amphiodia digitata				1											
Amphiodia sp (juv)				1	1										
Amphiuroidae (juv)						1									
Ophiuroconis bispinosa									2						
Class Echinoidea															
Dendraster sp (juv)	3	2		4				2			1	1		1	1
PHYLUM PHORONA															
Phoronis sp			1					1							
PHYLUM BRACHIOPODA															
Glottidia albida	3	1	3	4	1	2	2	4	2	2		2			4
PHYLUM CHORDATA															
Class Enteropneusta															
Saccoglossus sp															

Table 6: Macroinvertebrates Found in Core Samples at Central Trancas

	CT1 rep1	CT1 rep 2	CT1 rep 3	CT1 rep 4	CT1 rep 5	CT2 rep 1	CT2 rep 2	CT2 rep 3	CT2 rep 4	CT2 rep 5	CT3 rep 1	CT3 rep 2	CT3 rep 3	CT3 rep 4	CT3 rep 5
Abundance per replicate	20	28	17	51	14	18	16	26	31	16	13	15	6	40	26
Abundance per Station	130					107					100				
Number species per replicate	12	18	14	29	10	16	11	17	21	13	13	13	6	29	15
Number of species per Station	54					49					55				

Table 7: Infaunal Invertebrate Community Characteristics at Three Stations within the Central Trancas Sand Source Area

	Station CT1	Station CT2	Station CT3	Average
Total Number of Taxa	54	49	55	52.7
Density (#/m2)	3312.4	2726.4	2548	2862.3
Diversity Index	3.62	3.59	3.74	3.65
Most Abundant Taxa (% abundance)	Glottidea albida 9.2%	Glottidea albida 11.2%	Carinoma mutabilis 6.0%	
	Tellina modesta 7.7%	Monticellina siblina 8.4%	Glottidea albida 6.0%	
	Dendraster excentricus juv. 6.9%	Carinoma mutabilis 4.7%	Spiophanes norrisi 5.0%	
	Rhepoxynius abronius 6.2%	Rhepoxynius abronius 4.7%		

SECTION 4.0 – CONCLUSIONS

The substrate at both of the potential sand source sites consisted of sand. No sensitive habitats were observed. With the exception of large numbers of migrating lobsters at the Dockweiler North site, organisms observed at these sites were typical of southern California sand bottom habitats at 45 to 55 foot water depth.

The Central Trancas borrow area supported a more abundant and diverse benthic invertebrate community than the Dockweiler North site. The Central Trancas site, which is in 50 to 55 feet of water, was a little deeper than the Dockweiler North site, which was in 45 feet of water. Deeper subtidal sand bottom communities are subjected to less disturbance by wave action and the associated bottom surge and sand movement than shallower communities and typically support a more diverse and abundant infauna community. Furthermore, the Dockweiler North site is subjected to additional disturbance from potential discharges from nearby Marina Del Rey and Ballona Creek that may affect habitat suitability for invertebrates.

In summary, no sensitive habitats or species were observed at the proposed sand source sites. The organisms observed during the survey are adapted to shifting sands and would be expected to recolonize the area after dredging.

SECTION 5.0 – LITERATURE CITED

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APPENDIX B – LIST OF INTERTIDAL SPECIES OBSERVED DURING APRIL 2012 SURVEY

Appendix B
Species Observed at Broad Beach

Seaweeds and Plants	Invertebrates
RHODOPHYTA	**MOLLUSCA**
Caulacanthus ustulatus	*Chlorostoma funebralis*
Chondracanthus canaliculatus	*Lottia digitalis*
Chondracanthus spinosus	*Lottia limatula*
Corallina pinnatifolia	*Lottia strigatella*
Corallina vancouveriensis	*Mytilus californianus*
crustose Corallinaceae	*Nuttallina* spp.
Cryptopluera corallinaria	
Cryptopleura crispa	
Gastroclonium subauriculatum	
Mastocarpus papillatus	
Melobesia mediocris	
Porphyra spp.	
Smithora naiadum	
CHLOROPHYTA	**CNIDERIA**
Ulva californica	*Anthopleura elegantissima*
Ulva intestinalis	*Anthopleura sola*
Chaetomorpha linum	
PHAEOPHYTA	**ARTHROPODA**
Egregia menziesii	*Balanus glandula*
Macrocystis pyrifera	*Chthamalus* spp.
Sargassum agradhianum	*Pollicipes polymerus*
Endarachne binghamiae	*Tetraclita rubescens*
Psuedolithoderma negra	
Ralfsia spp.	
ANGIOSPERMS	**ECHINODERMATA**
Phyllospadix spp.	*Pisaster ochraceus*

APPENDIX C – LIST OF BIRD AND MAMMAL SPECIES OBSERVED AT BROAD BEACH DURING SNOWY PLOVER MONITORING

ATTACHMENT 1 – WILDLIFE SPECIES DETECTED

Scientific Name	Common Name
CLASS AVES	**BIRDS**
PODICIPEDIDAE	**GREBES**
Aechmophorus occidentalis	western grebe
PELECANIDAE	**PELICANS**
Pelecanus erythrorhynchos	American white pelican
Pelecanus occidentalis	brown pelican
PHALACROCORACIDAE	**CORMORANTS**
Phalacrocorax auritus	double-crested cormorant
ANATIDAE	**DUCKS, GEESE, SWANS**
Anas platyrhynchos	mallard
CHARADRIIDAE	**PLOVERS**
Charadrius alexandrinus	snowy plover
Charadrius vociferus	killdeer
Pluvialis squatarola	black-bellied plover
HAEMATOPODIDAE	**OYSTERCATCHERS**
Haematopus bachmani	black oystercatcher
SCOLOPACIDAE	**SANDPIPERS**
Calidris alba	sanderling
Calidris mauri	western sandpiper
Catoptrophorus semipalmatus	willet
Limosa fedoa	marbled godwit
Numenius phaeopus	whimbrel
LARIDAE	**SKUAS, GULLS, TERNS, AND SKIMMERS**
Larus argentatus	herring gull
Larus californicus	California gull
Larus delawarensis	ring-billed gull
Larus occidentalis	western gull
Larus heermanni	Heerman's gull
Sterna caspia	Caspian tern
Sterna elegans	elegant tern
Sterna maxima	royal tern
ALCIDAE	**AUKS, MURRES, AND PUFFINS**
Uria aalge	common murre
COLUMBIDAE	**PIGEONS AND DOVES**
Columba livia	rock pigeon
Zenaida macroura	mourning dove