Encinitas-Solana Beach Coastal Storm Damage Reduction Project

San Diego County, California

Appendix J

Coordination Act Report (CAR)

U.S. Army Corps of Engineers
Los Angeles District

December 2012

This page was intentionally left blank for duplex printing.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Carlsbad Fish and Wildlife Office
6010 Hidden Valley Road, Suite 101
Carlsbad, California 92011

In Reply Refer To:
FWS-SDG-09B0396-12CPA0127

NOV 09 2012

Colonel R. Mark Toy
District Engineer, Los Angeles
U.S. Army Corps of Engineers
P.O. Box 532711
Los Angeles, California 90053-2325

Attention: Mr. Larry Smith

Subject: Draft Fish and Wildlife Coordination Act Report for the Encinitas and Solana Beach Shoreline Protection Project, San Diego County, California

Dear Colonel Toy:

Enclosed is our Draft Fish and Wildlife Coordination Act Report (Report) for the Encinitas and Solana Beach Shoreline Protection Project in San Diego County, California. This Report is provided in partial fulfillment of Scope of Work Agreement Number W81EYN52160175 between our agencies, requesting us to provide Draft and Final Fish and Wildlife Coordination Act reports for the project.

This Report is prepared in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*) and constitutes the final report of the Secretary of Interior as required by section 2(b) of the Act.

If you have any questions regarding the Draft Report, please contact Jon Avery at 760-431-9440, extension 309.

Sincerely,

David for

Karen A. Goebel
Assistant Field Supervisor

Enclosure (1)

cc:
Loni Adams, California Department of Fish and Game
Bryant Chesney, National Oceanic Atmospheric and Administration
James Munson, Environmental Protection Agency

DRAFT
FISH AND WILDLIFE COORDINATION ACT REPORT

for the

Encinitas and Solana Beach Shoreline Protection Project
San Diego County, California

Prepared for the
U.S. Army Corps of Engineers
Los Angeles District
Los Angeles, California

By the
U.S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
Carlsbad, California

November 2012

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (Corps) is preparing a Draft Environmental Impact Statement/Environmental Impact Report (2012 Draft EIS/EIR) for the proposed Encinitas-Solana Beach Shoreline Protection Project (Project). The Corps Los Angeles District is the Federal lead agency for the Project under the National Environmental Protection Act (NEPA) of 1969. The cities of Encinitas and Solana Beach (Cities) are co-lead agencies under the California Environmental Quality Act (CEQA) of 1970. The Corps and Cities are preparing the 2012 Draft EIS/EIR, jointly with a Feasibility Study, to examine the potential for replenishing beach sand and reducing bluff erosion, in response to concerns for protecting property, local recreation and tourism along the coasts of Solana Beach and Encinitas, San Diego County, California. The 2012 Draft EIS/EIR will describe the Project's need, goals, objectives, and the potential environmental effects.

Beach nourishment is the placement of sand on the shoreline with the intent of widening a beach that is naturally narrow or where the natural supply of sand has been significantly reduced through human activities (California State Lands Comm. 2001). In the Study Area, the primary source for the region's beach sand is sediment carried from inland areas by rivers and streams (California State Lands Commission 2001, CDBW & SCC 2002, SCE 2005). An artificially decreased supply of sediments delivered to the ocean by local rivers and streams over the last several decades has allowed (otherwise natural) cyclically heavy storm wave erosion to effectively narrow many beaches north San Diego County, resulting in the depletion of sand from these beaches on a multi-seasonal basis (Griggs and Savoy 1985, Patsch and Griggs 2006, Terra Costa 2005, SCE 2005). Wave-induced erosion of bluffs, bluff failure, and associated damages to structures have also reportedly increased significantly in the last few decades from a combination of factors; most notably the reduced littoral sediment supply and subsequent narrowed beach widths, with the resultant increased access of ocean waves to the bases of these bluffs. Additionally, the episodic recurrence of "El Niño" climatic conditions and associated heavy waves have increased beach and bluff erosion during these periods.

Erosion to bluffs with associated structure damages in the region are projected to continue in the future, based on storm and wave studies, current reduced sediment supply conditions, and natural erosion (USACE 1991, California State Lands Comm. 2001, Terra Costa 2005, City of Solana Beach 2009). The narrowed beaches of the Study Area have increased the vulnerability of the adjacent coastal bluffs to accelerated erosion from wave energy, including the formation of notches at the toe of bluffs in some locations (California State Lands Comm. 2001, SCE 2005). The presence of these notches has considerable potential to result in bluff failures, due to the weight of the overburden of the steep slope above the notch (California State Lands Comm. 2001). In addition, upslope local water infiltration from irrigation and rainfall contributes to bluff-erosion, and has been a reported factor in bluff failures (e.g., slumping, block falls) in localized areas. Bluff failures have resulted in damages to structures and loss of human life in the Project region.

The proposed Project would provide stop-gap replenishment of beach sands that are subject to long-term erosion in the Study Area. However, the Project as proposed would not include measures to restore natural sediment supplies to the littoral system, which is the main cause of the long-term beach erosion in north San Diego County.

The Project could have direct, indirect, and cumulative impacts on biological resources during and after dredging, beach replenishment, and notch filling activities. These effects include physical disturbance from dredging and sand placement activities, impacts on terrestrial and marine biota from direct or indirect burying, and effects from increased noise, nighttime lighting, contaminant release from vehicles and equipment, and increased turbidity. Wintering federally threatened western snowy plovers (Pacific Coast population Distinct Population Segment; *Charadrius nivosus nivosus*; snowy plover) could be affected by beach-related equipment, nighttime lighting, and human activities associated with beach replenishment, including the potential for disturbance of plover foraging and loafing, and degradation of beach forage resources. Depending on Project timing, increased turbidity from dredging, transport, and/or sand replenishment activities could hinder foraging success of the brown pelican (*Pelecanus occidentalis*), federally and State-endangered California least tern (*Sternula antillarum browni*; least tern), and other water birds. The California grunion (*Leuresthes tenuis*; grunion), a unique trust resource, could also be adversely affected by increased turbidity levels, egg smothering/burying, and egg disturbance from sand replenishment activities onshore and in the nearshore.

PREFACE

This document constitutes the Draft Fish and Wildlife Coordination Act (FWCA) Report in partial fulfillment of a Military Interdepartmental Purchase Request between the U.S. Fish and Wildlife Service (Service) and the Corps regarding the potential effects of the proposed Encinitas and Solana Beach Shoreline Protection Project in San Diego County, California, on fish and wildlife resources. We have prepared this Draft FWCA Report pursuant to section 2(b) of the FWCA (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*) and in keeping with the intent of the NEPA (P.L. 91-190). However, this Draft FWCA Report does not constitute the final report of the Secretary of the Interior as required by section 2(b) of the FWCA. This Draft FWCA Report supersedes our 2005 Draft FWCA Report for the previous project described in the 2005 Draft EIS/EIR.

Our analysis of the proposed Project and the recommendations provided herein are based on information in: 1) the Scope of Work provided by the Corps, dated 28 July 2005; 2) the Corps' 2005 Draft EIS/EIR; 3) the Corps' August 2005 draft Feasibility Report; 4) the Corps' April 2012 Notice of Preparation of an EIS/EIR for the Project; 5) a March-April 2012 "functional assessment" series of meetings and discussion about the proposed Project and potential mitigation measures held between the Corps, California Coastal Commission, National Marine Fisheries Service, California Department of Fish and Game, and Service; 6) data provided by email correspondence between the Corps and Service in June 2012; 7) other reports and data provided by the Corps; 8) an extensive review of the published and unpublished literature on the terrestrial and aquatic biota and ecosystems of the shore, lagoon, and nearshore areas of the region; 9) field visits by Service personnel; 10) discussions and meetings with professional biologists and representatives from other Federal, State and local agencies; and 11) our best collective professional judgment.

Our goals in this analysis are to: a) identify and evaluate the potential effects of the Project as it likely will be proposed (including any likely 2012 EIS/EIR preferred alternatives) on fish and wildlife resources and the ecosystems they depend upon within the Study Area; b) determine if fish and wildlife resources outside of the Study Area may be affected by the proposed Project; c) to recommend methods for avoiding, minimizing, and offsetting any negative ecological effects; and d) to recommend actions that the lead agencies can participate in planning and implementing that would partially restore natural sediment transport from local drainages to the Oceanside littoral cell in north San Diego County.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The purpose of the proposed Encinitas and Solana Beach Shoreline Protection Project is to reduce and offset beach and bluff erosion, in response to growing concerns for protecting property, local recreation and tourism along the coasts of Encinitas and Solana Beach. The Corps, Los Angeles District, is the Federal lead agency for the Project. The Corps is preparing a draft EIS/EIR in compliance with the NEPA. The cities of Encinitas and Solana Beach are local sponsors and co-lead agencies for the Draft 2012 EIS/EIR, which is also being prepared in accordance with the CEQA. The Corps and Cities are preparing the 2012 Draft EIS/EIR, jointly with a Feasibility Study, to examine the potential for replenishing beach sand and reducing bluff erosion, in response to concerns for protecting property, local recreation and tourism along the coasts of Solana Beach and Encinitas, San Diego County, California. The 2012 Draft EIS/EIR will describe the Project's need, goals, objectives, and the potential environmental effects.

Besides the no-action alternative, the 2012 Draft EIR/EIS will evaluate various other alternatives, likely to include: 1) beach nourishment, 2) beach nourishment with notch fills, and 3) seawalls with notch fills. The Corps and Cities will determine which alternatives qualify as the least environmentally damaging practicable alternative, the National Economic Development Plan alternative, and the EIS/EIR preferred alternative.

Beach nourishment or replenishment is the placement of sand on the nearshore or shoreline to widen a beach that is narrow or where the natural supply of sand has been significantly reduced through human activities (CDBW & SCC 2002). Nourished shorelines provide a number of potential benefits including increased beach area for recreation, increased revenue from tourism, improvement of habitats for some beach/shore dependent species, greater protection of coastline structures or bluffs from coastal storms, reduced need for armor, and increased public access (CDBW & SCC 2002).

Beach erosion in the Project region is a concern and beach sand replenishment efforts likely benefit (after impacts of Project activity disturbances are abated) certain marine-related organisms, such as many shorebirds and sand dwelling invertebrates. However, replenishment activities have potential negative impacts on other organisms and natural community types. One of the main concerns with beach replenishment projects such as the proposed Project, is the repeated Project-caused deposition and movement of sand and the potential for long-term or recurrent burial of natural communities such as reefs (including those that normally support various kelps and surfgrass). Recovery of affected natural communities following burial can range from months to years (e.g., see Newell et al 1998, Versar 2004).

Implementation of any substantial project in the Study Area may indirectly affect biological resources beyond the political or jurisdictional boundaries used to delimit the Study Area. For example, most sand deposited along the shore within the Study Area moves through the littoral system along the coast and ultimately moves beyond the Study Area limits. Therefore, the analysis in this Draft FWCA Report considers all potential ecological effects associated with the potential alternatives to be evaluated, not just those effects limited to the Study Area. We also considered in our analysis the potential effects to biological resources resulting from the potential interactions between the proposed Project and other known regional planning efforts.

DESCRIPTION OF PROJECT STUDY AREA

The Corps defines the Project Study Area[1] as the shoreline within the cities of Encinitas and Solana Beach (Figure 1). The nearshore and coastal shoreline within the Study Area is approximately 8.1 miles (mi) (13 kilometers (km)) long and is bounded by the city of Carlsbad to the north and the city of Del Mar to the south. Portions of the communities of Cardiff, Encinitas, Leucadia, Olivenhain, Solana Beach, and an unincorporated area of San Diego County are included in the Study Area. The majority of the Study Area shoreline currently consists of sand and cobble beaches backed by coastal bluffs. One stretch of coastline in the Study Area, within the community of Cardiff, is a low lying natural sand spit forming a barrier between San Elijo Lagoon and the ocean; it is currently topped by the roadway of Pacific Coast Highway 101, parking lots, and several restaurants. The Study Area also includes sand borrow sites located off the coast of Solana Beach (SO-6) and Mission Beach (MB-1) in the Pacific Ocean. The two proposed borrow sites are about 0.9 mi (1.4 km) (SO-6) and 0.8 mi (1.3 km) (MB-1) from shore.

The Study Area shoreline is located in and along the Pacific Ocean within the Oceanside littoral cell, which spans southern Orange and northern San Diego counties of southern California, extending from Dana Point in the north to the Scripps-La Jolla submarine canyons in the south (Grandy and Griggs 2007). The Study Area shoreline is predominately southwest facing with currently narrow sand and cobble beaches backed in most places by coastal bluffs. Elevations of the Study Area range from sea level to approximately 100 ft (30 m) above sea level at the tops of the coastal bluffs, which occur north and south of San Elijo Lagoon. San Elijo Lagoon is the low elevation spot along the Study Area including a low lying, natural tidal spit.

The cities of Encinitas and Solana Beach are located along the western edge of the coastal plain of the Peninsular Ranges Geomorphic Province. The coastal plain consists of numerous marine and non-marine terraces dissected by stream valleys. The coastal plain in Encinitas and Solana Beach is dissected by Batiquitos Lagoon on the northern edge of Encinitas/Leucadia, Cottonwood Creek and Escondido Creek/San Elijo Lagoon in the middle of the Study Area, and the San Dieguito River/Del Mar Estuary along the southern edge of Solana Beach. Solana Beach is approximately 17 mi (27 km) south of Oceanside Harbor, and 10 mi (16 km) north of La Jolla. Solana Beach's shoreline is approximately 1.7 mi (2.7 km) long. Encinitas is approximately

[1] Study Area – as defined by the Corps: the area that includes the likely direct and indirect impacts of the proposed project. Indirect effects are described herein as the eventual gain or loss of the resources(s) through a process of deterioration or replacement of environmental resources indirectly caused or triggered by some aspect of the proposed project.

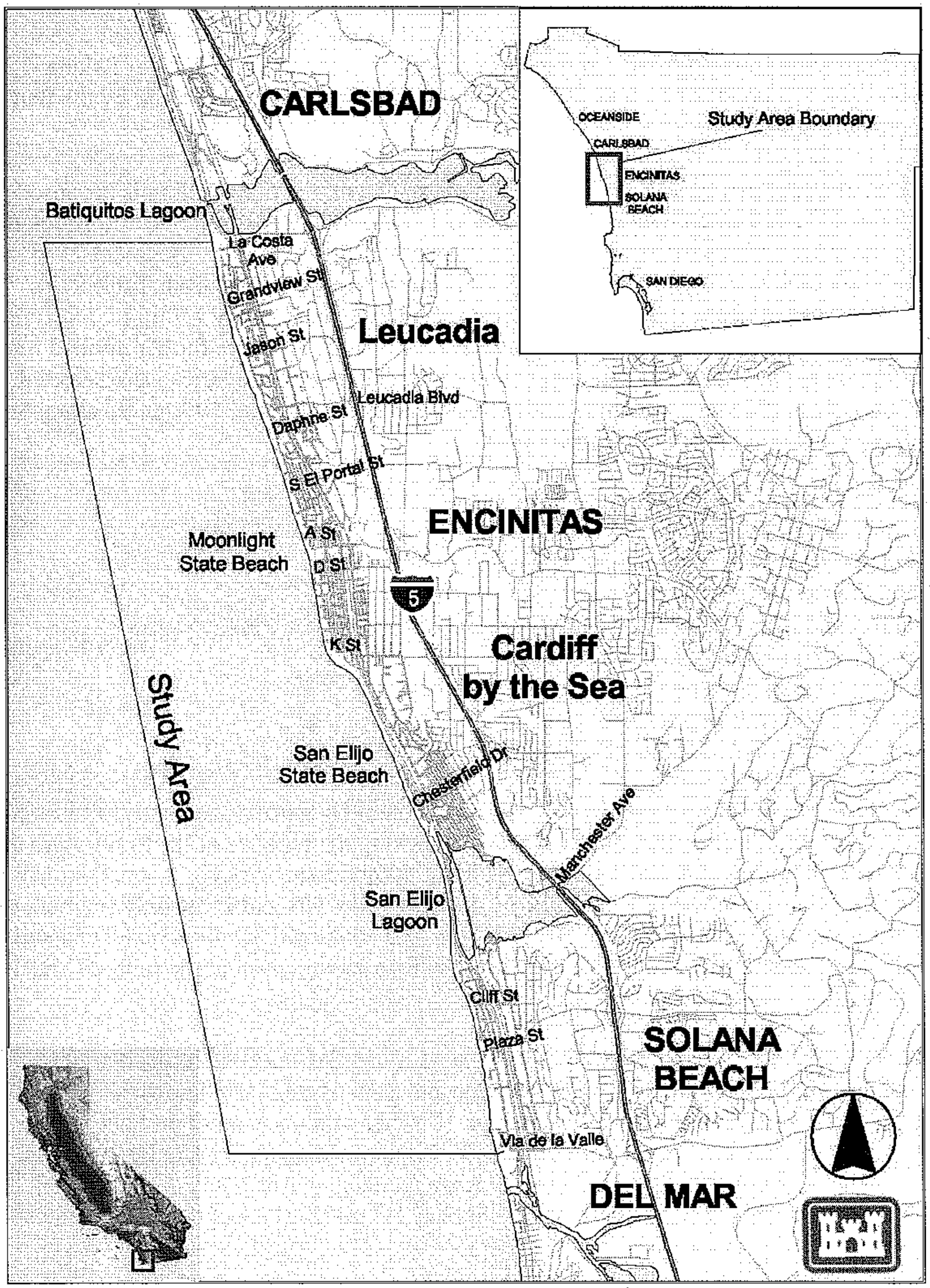

Figure 1. Project vicinity and study area.

10 mi (16 km) south of Oceanside Harbor, and 17 mi (27 km) north of La Jolla. The Encinitas shoreline is about 6 mi (10 km) long. Encinitas is bounded on the north by Batiquitos Lagoon and on the south by San Elijo Lagoon. Immediately south of Encinitas is the City of Solana Beach. Solana Beach is bounded by San Elijo Lagoon to the north and on the south by the San Dieguito Lagoon.

The Study Area includes two segments where beach nourishment and notch filling is proposed (Figure 2). Segment 1 is located within the City of Encinitas and extends from the 700 Block of Neptune Avenue to Swami's Reef and is approximately 2.0 mi (3.2 km) long. Segment 2 includes all of the beach area within the City of Solana Beach, and stretches from Table Tops reef in Encinitas to the southern limit of Solana Beach, and is approximately 1.7 mi (2.7 km) in length. The coastal shoreline and offshore of portions of the Study Area are further divided into nine reaches for characterizing environmental conditions. The reach boundaries were selected based on differences in geology, shoreline morphology, and other physical differences along the shoreline. The nine reaches, from north to south are:

1. Encinitas Northern City Limit to Beacon's Beach.
2. Beacon's Beach to 700 Block, Neptune Avenue.
3. 700 Block, Neptune Avenue to Stone Steps.
4. Stone Steps to Moonlight Beach.
5. Moonlight Beach to Swami's.
6. Swami's to San Elijo Lagoon Entrance.
7. San Elijo Lagoon Entrance to Table Tops reef.
8. Table Tops reef to Fletcher Cove.
9. Fletcher Cove to Solana Beach Southern City Limit.

Almost all of the shoreline in the Study Area consists of relatively narrow sand and cobblestone beaches fronting coastal bluffs. The tops of the bluffs backing the beaches of the Study Area are largely built out with houses and condominiums (City of Solana Beach 2009). A small stretch of beach west of the San Elijo Lagoon is backed by Coast Highway 101 and is the only segment of the beach not backed by coastal bluffs. Portions of this area contained the main outlet channel of San Elijo Lagoon at various times during flood flows, before construction of the railroad and what is now Pacific Coast Highway 101.

Four California State Parks are located in the Study Area along the coastline of the city of Encinitas. At the north end of the Study Area is Leucadia State Beach (also known as Beacon's), that includes about 1.4 mi (2.3km) of ocean frontage. Further south is Moonlight State Beach that includes about 0.4 mi (0.6 km) of ocean frontage. South of Moonlight State Beach is San Elijo State Beach that includes 1.4 mi (2.2 km) of ocean frontage (SANDAG 2000). Cardiff State Beach is directly west of San Elijo Lagoon, and has 1.2 mi (2.0 km) of ocean frontage.

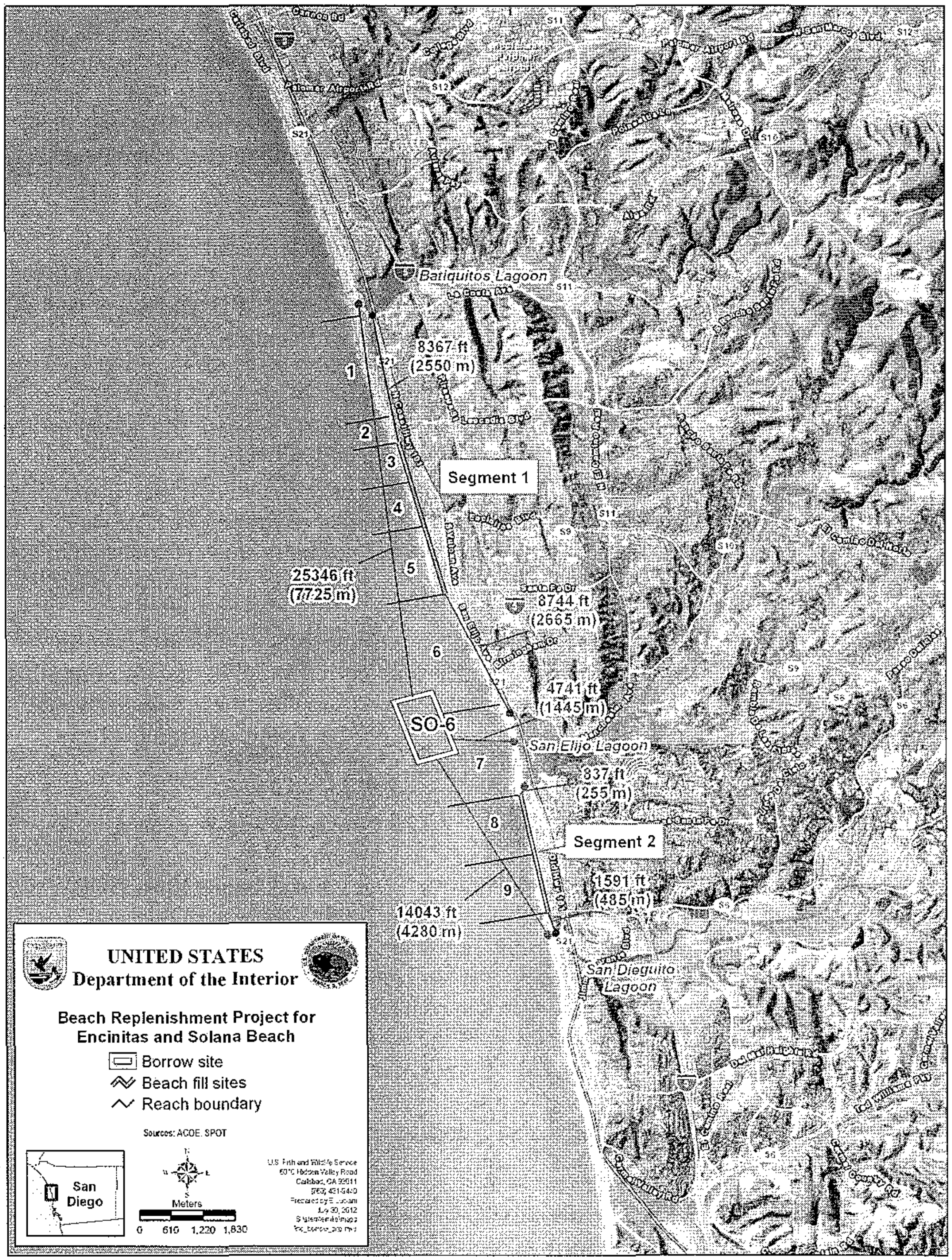

Figure 2. Study Area Project Map

Three County of San Diego parks are located within the Study Area. In the central portion of the Study Area, the San Elijo Lagoon County Park and Ecological Reserve includes diverse upland and wetland natural communities in and surrounding the lagoon. Encinitas Beach County Park is located north of Stone Steps Beach in the City of Encinitas. Tide Beach County Park is located south of Cardiff State Beach, in the City of Solana Beach. Local parks are also scattered along the Study Area and include areas such as Stone Steps, Swami's Beach, Fletcher Cove Beach Park, and North Seascape Surf Beach Park.

Offshore bathymetric contours within the Encinitas and Solana Beach coastal region are relatively straight and parallel to shore. The nearshore slope of the Study Area extends seaward to approximately minus (-) 39 ft (-12 m) Mean Lower Low Water (MLLW). The beach face and nearshore slopes of the Study Area at Leucadia, within the City of Encinitas, are somewhat steeper than those to the south.

Within the Study Area, a shore platform offshore of the coastal bluffs extends 500 to 900 ft (150 to 275 m) seaward to a depth of approximately -12 ft (-3.6 m) MLLW, followed by a steeper slope to a depth greater than –60 ft (-18 m) MLLW. This surface is an active wave-cut abrasion platform subject to erosion in the present wave and sediment input environment. The shelf offshore is generally about 2.5 mi (4 km) wide and rocky, and normally supports substantial kelp growth (City of Solana Beach 2009).

The coastal streams and rivers of the Oceanside littoral cell historically carried to the ocean approximately twice the sediment compared to what they are currently delivering (Scripps 2004, City of Solana Beach 2009). With uninterrupted (natural) sand supplies, these beaches would otherwise normally recover from the heavy wave action associated with such storms (Terra Costa 2005).

Over the last several decades beaches of San Diego's North County have experienced accelerated erosion due to urban and road development, sand mining, flood damage reduction structures and dams, and harbor development (California State Lands Comm. 2001, CDBW & SCC 2002, Terra Costa 2005, SCE 2005, Patsch and Griggs 2006). These activities and developments have severely diminished contributions of sand from streams and longshore sand transport, and are the predominant cause of sand loss on Encinitas and Solana Beach beaches (Terra Costa 2005, SCE 2005), which has in turn contributed to cliff and beach erosion (Patsch and Griggs 2006). Naturally cyclical increased storminess and associated heavy wave action generated by El Niño Southern Oscillations (El Niño) between 1978 and the late 1990's is a secondary cause. These El Niño-driven storms, while often causing increased rain and stream sediment delivery to the ocean in the region, also typically cause substantial erosion of the shoreline (normally temporary) through heavy wave action (University of Arizona 2010, Terra Costa 2005).

Beaches of the Study Area do not currently have a sufficient supply of sand available to coastal processes to respond naturally to storms and associated wave energy. Historically, these beaches naturally maintained equilibrium following winter storm (wave) erosion, through the subsequent accretion of beach sands that normally occurred through the following summer season. Currently, sand is naturally eroded from the beach in winter, but due to artificially reduced littoral system sand supply, reduced recovery (deposition and accretion) of beach sand occurs in the periods following storms. The cumulative effects of these anthropocentric developments and natural events have culminated in substantial erosion and narrowing of the beaches in the Study Area.

Global sea levels are predicted to rise through the 21st century (e.g., see Jevrejeva et al. 2008, Grinsted et al. 2009, Rahmstorf 2010) and will likely contribute to further beach and bluff erosion. Although the exact magnitude of future sea level rise is unknown, the main contributions will come from both ocean water thermal expansion and the meltwater from continental glaciers and the Antarctic ice sheet. Former estimates regarding future sea level rise within the Study Area varied from 0.1 to 0.2 ft (0.03 to 0.06 m) in a time span of the next 25 years (Collins 1993; USACE 1991). This correlated to an approximate 0.4 to 0.8 ft (0.12 to 0.24 m) potential future increase in mean sea level (MSL) elevations over the course of the 21st century. The consensus estimate of sea level rise by 2100, published in the Intergovernmental Panel on Climate Change's Fourth Assessment (IPCC 2007), was estimated at 0.6 to 2.0 ft (0.18 to 0.6 m). Further improved estimates of the range of sea level rise by 2100, which now include estimated effects of ice dynamics, range from 2.6 and 6.6 ft (0.8 to 2.0 m), a significantly higher estimate (Pfeffer et al. 2008, Vermeer and Rahmstorf 2009, Rahmstorf 2010).

The San Diego Association of Government's (SANDAG) Regional Beach Sand Project (RBSP) placed approximately 2.1 million yd^3 (1.6 million m^3) of sand on 12 San Diego County beaches in 2001 by dredging sand from offshore and pumping it onto beaches in Oceanside, Carlsbad, Encinitas, Solana Beach, Del Mar, San Diego, and Imperial Beach (SANDAG 2012b). Three of these beaches were located within the Study Area in Encinitas and one in Solana Beach. In total, the RBSP deposited 580,100 yd^3 (443,500 m^3) of sand on the beaches within Study Area. This $17.5 million RBSP public works effort was coordinated through SANDAG (SANDAG 2012b). SANDAG has an additional sand replenishment project scheduled for late 2012 on eight San Diego County beaches: Imperial Beach, Oceanside, Moonlight Beach, Cardiff State Beach, Batiquitos, Solana Beach, North Carlsbad Beach, and South Carlsbad Beach (SANDAG 2012a). Three of these beaches are within the Study Area, and seven are within the Oceanside littoral cell. This 2012 RBSP project will provide a total of approximately 1.4 million yd^3 (1.1 million m^3) of sand (SANDAG 2012a).

PROJECT HISTORY

An Encinitas/Solana Beach Shoreline Feasibility Study was authorized by a resolution of the U.S. House Public Works and Transportation Committee (now the U.S. House Committee on Transportation and Infrastructure) in May 1993. Planning for the proposed Project was initiated in March 2000 with the preparation of a Reconnaissance Study by the Corps, which determined that there was a Federal interest in the Project. In 2005, the Corps and the Cities issued a Draft EIS/EIR (2005 Draft EIS/EIR), and the Service issued a Draft FWCA report, for the Project as described in the 2005 Draft EIS/EIR.

However, the project description and range of alternatives have been modified since 2005, and the 2005 Draft EIS/EIR was never finalized. Changes to the Project, and the lapse of time since 2005, have prompted the Corps and Cities to prepare a new Draft EIS/EIR, which is anticipated to be released for public review in late 2012. The Corps requested a new Draft FWCA Report from the Service based on a new Project description provided in March 2012.

The previously proposed project analyzed in the 2005 Draft EIS/EIR for both the Encinitas and Solana Beach sites would have placed approximately 1,226,900 yd^3 (938,030 m^3) of sand dredged from two offshore borrow sites along 2.9 mi (4.7 km) of shoreline with renourishment of about 527,750 yd^3 (403,490 m^3) for each 5-year cycle. It also would have included the filling of notches in the beach buffs. As originally proposed, initial sand placement described in the Project would have required 821,400 yd^3 (628,010 m^3) for Encinitas and 405,500 yd^3 (310,030 m^3) for Solana Beach, with cyclical renourishment requiring approximately 344,375 yd^3 (263,290 m^3) and 183,375 yd^3 (140,300 m^3) for these two areas, respectively.

After evaluating comments received on the 2005 Draft EIS/EIR, the lead agencies re-evaluated that project as it was then proposed, and studied ways to better estimate potential impacts that would result from implementation of that action. As a result, the proposed Project alternatives analyzed herein have changed compared to those proposed in 2005. A Notice of Intent to prepare a new Draft EIS/EIR for the proposed Project analyzed herein was published in April 2012.

The Corps and Cities are currently preparing a joint Draft EIS/EIR to assess beach replenishment and shoreline protection options and associated potential effects along the coastlines of these two cities (USACE 2012a). One of the stated purposes of the 2012 Draft EIS/EIR is to evaluate options for reducing beach and shoreline erosion over a 50-year period from 2015 through 2065 (USACE 2012a). The 2012 Draft EIR/EIS will analyze the potential impacts of the Proposed Project and a range of reasonable alternatives to the Project. The new 2012 Draft EIS/EIR is anticipated to be released in late 2012 (USACE 2012a).

PROJECT PURPOSE AND NEED

The purpose of the Project is to protect public safety and reduce storm-related damages to public infrastructure (USACE 2012c). The Corps has identified the following needs to be addressed by the Project (USACE 2012b):

A number of public concerns have been identified including:

1. Bluff erosion threatens property, including state and city owned lands, roads, railroads and infrastructure, as well as private residences atop the bluffs.
2. Public safety due to episodic bluff failure.
3. Closure of Pacific Coast Highway 101 at Cardiff during storm events.
4. Bluff toe erosion and curtailed recreation activity resulting from eroded beach conditions.

DESCRIPTION OF PROPOSED ACTION ALTERNATIVES

The Corps provided the following general statement regarding the proposed action alternatives (USACE 2012b):

> The Los Angeles District will investigate and evaluate all reasonable alternatives to address the problems and needs identified above. In addition to the No Action alternative, both structural (breakwaters, artificial reefs, groins, revetments, notch fills, and seawalls) and non-structural (best management practices, and beach nourishment) measures will be investigated.

Preliminary non-structural alternatives include (USACE 2012b):

- Best Management Practices
- Dredging and Beach Replenishment

Preliminary structural alternatives include (USACE 2012b):

- Breakwaters
- Submerged Breakwaters/Artificial Reefs
- Groins
- Notch Fills
- Seawalls

In March 2012, the Corps provided the Service a brief revised Project description (USACE 2012c), which was then updated with alternatives in spreadsheet form on June 2012 (Table 1; USACE 2012d). No preferred alternative was identified. The Project alternatives provided to us in March and June 2012 only included combinations of notch fills with various beach replenishment scenarios. As such, our analysis in this Draft FWCA Report only considers notch fills and beach replenishment alternatives as provided to us in March and June 2012 (Table 1). We have not herein evaluated potential activities and effects associated with other structural and non-structural alternatives.

Table 1. Proposed Project Alternatives, June 2012

Encinitas (EN)	Potential Sea Level Rise	Alternative EN -1A: Beach Nourishment	Alternative EN -1B: Beach Nourishment		Alternative EN-2A: Hybrid	Alternative EN-2B: Hybrid	Alternative EN -3: No Action
Initial Placement Volume (cy)*	High SLR	730,000	390,000		800,000	390,000	Assumes that the continued practice of emergency permitting for seawalls along the segment would continue.
	Low SLR	680,000	340,000		700,000	340,000	
Re-Nourishment Cycle	High SLR	5-yr	5-yr		10-yr	5-yr	
	Low SLR	5-yr	5-yr		10-yr	5-yr	
Added Beach Width at Mean Seal Level	High SLR	100 ft	50 ft		100 ft	50 ft	
	Low SLR	100 ft	50 ft		100 ft	50 ft	
Solana Beach (SB)		**Alternative SB -1A: Beach Nourishment**	**Alternative SB -1B: Beach Nourishment**	**Alternative SB-1C: Beach Nourishment**	**Alternative SB-2A: Hybrid**	**Alternative SB-2B:**	**Alternative SB-3: No Action**
Initial Placement Volume (yd^3)	High SLR	1,620,000	790,000	540,000	790,000	540,000	Assumes that the continued practice of emergency permitting for seawalls along the segment would continue.
	Low SLR	960,000	700,000	440,000	700,000	440,000	
Re-Nourishment Cycle	High SLR	14-yr	10-yr	10-yr	10-yr	10-yr	
	Low LSR	13-yr	10-yr	10-yr	10-yr	10-yr	
Added Beach MSL Width	High SLR	300 ft	150 ft	100 ft	150 ft	100 ft	
	Low SLR	200 ft	150 ft	100 ft	150 ft	100 ft	

*Volumes do not include an estimated 10 percent loss during construction operations, with losses primarily occurring offshore and in the nearshore.

Dredging and Beach Nourishment

Outside of the No Action Alternative, sand would be dredged from previously surveyed and dredged offshore borrow sites (designated MB-1 and SO-6; Figures 3 and 4) and placed directly onto the beach at the receiver sites (USACE 2012c & d). Further development of the Project description during the NEPA and CEQA documentation process will specify additional details. Ultimately, detailed construction design specifications would control where the sand would dredged and placed, and the dredging contractors would select the exact methods and equipment to be utilized. The discussion below includes all important equipment that we expect could be selected for the Project.

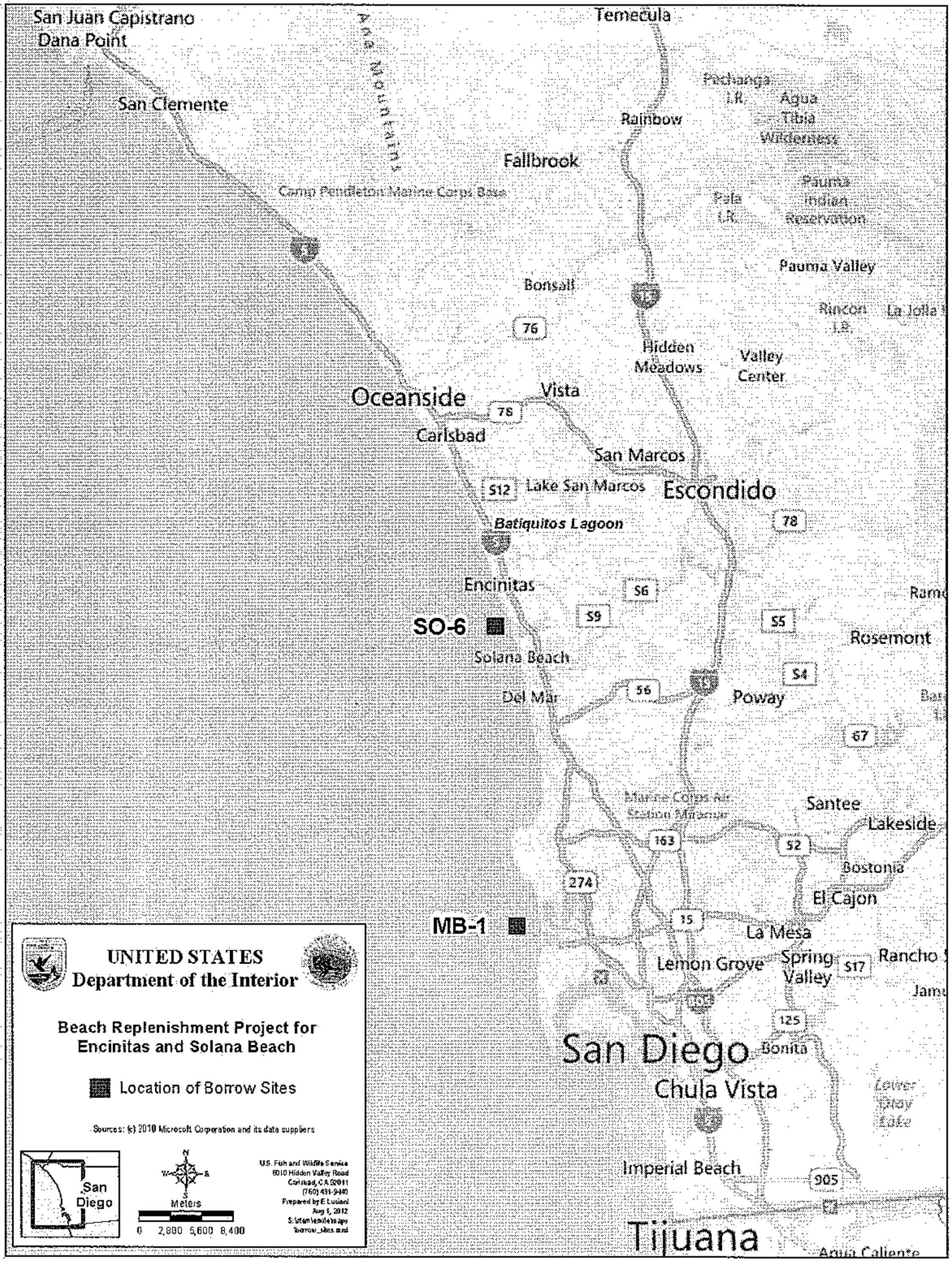

Figure 3. Location of Proposed Borrow Sites

Figure 4. Proposed Mission Beach Borrow Site (MB-1)

A total of up to 2,420,000 yd^3 (1,850,000 m^3) of sand would be initially placed at Segments 1 and 2 (Figure 2). In Segment 1, up to 800,000 yd^3 (610,000 m^3) of sand would be placed along 1.5 mi (2.4 km) of beach in Reaches 3, 4, and 5 (Table 1, Figures 2 and 5). Under the various alternatives, the top of the beach fill berm created by dredged sand would be constructed to an elevation of up to +13 ft (+4 m) MLLW, and would be relatively flat and up to 100 ft (30 m) wide. The beach fill would then extend seaward up to 69 ft (21 m) at a slope of 10:1 (horizontal distance to vertical distance). The total area of beach fill in Segment 1 would be up to 3 ac (1.2 hectares (ha)).

In Segment 2, up to 1,620,000 yd^3 (1,240,000 m^3) of sand would be placed along 1.4 mi (2.2 km) of beach in Reaches 8 and 9 (Table 1, Figures 2 and 6). Under the various alternatives, the top of the beach fill berm created by dredged sand would be constructed to an elevation of up to +13 ft (+4 m) MLLW, and would be relatively flat and up to 200 ft (61 m) wide . The beach fill would then extend seaward up to 130 ft (40 m) at a slope of 10:1 (horizontal distance to vertical distance). The total area of beach fill in Segment 2 would be up to 2 ac (0.8 ha)

Over the 50-year life of the Project, subsequent replenishment events could occur every 5 to 10 years in Segment 1, and every 10 to 14 years for Segment 2, with sand volumes of as much as 700,000 yd^3 (535,000 m^3) in Segment 1, and as much as 960,000 yd^3 (734,000 m^3) in Segment 2. Therefore, these subsequent replenishment events could involve up to 1,660,000 yd^3 (1,290,000 m^3). Each replenishment cycle would restore design beach widths to those of the initial replenishment to maintain protection of the shoreline (USACE 2012a).

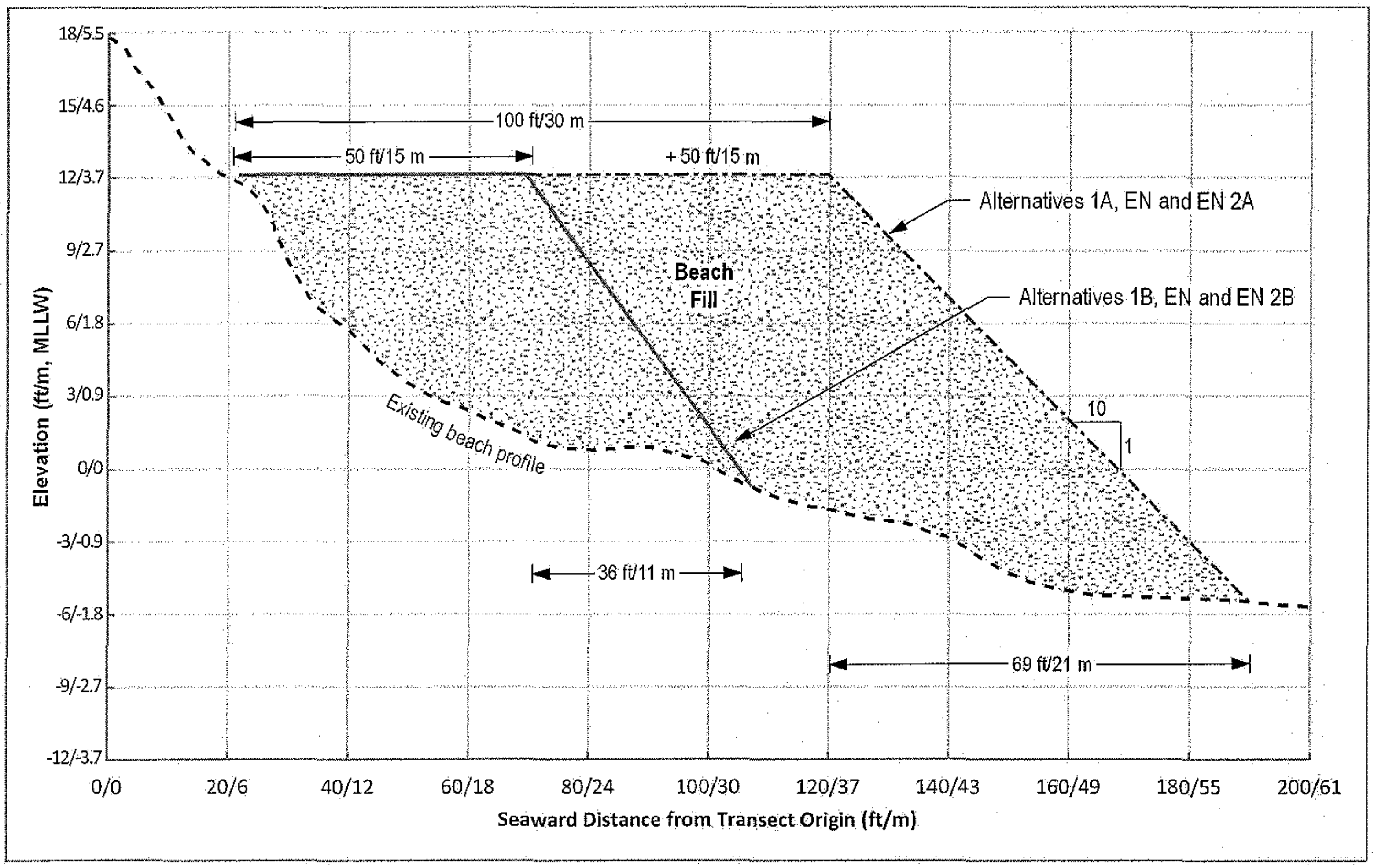

Figure 5. Segment 1 Proposed Beach Fill Profile

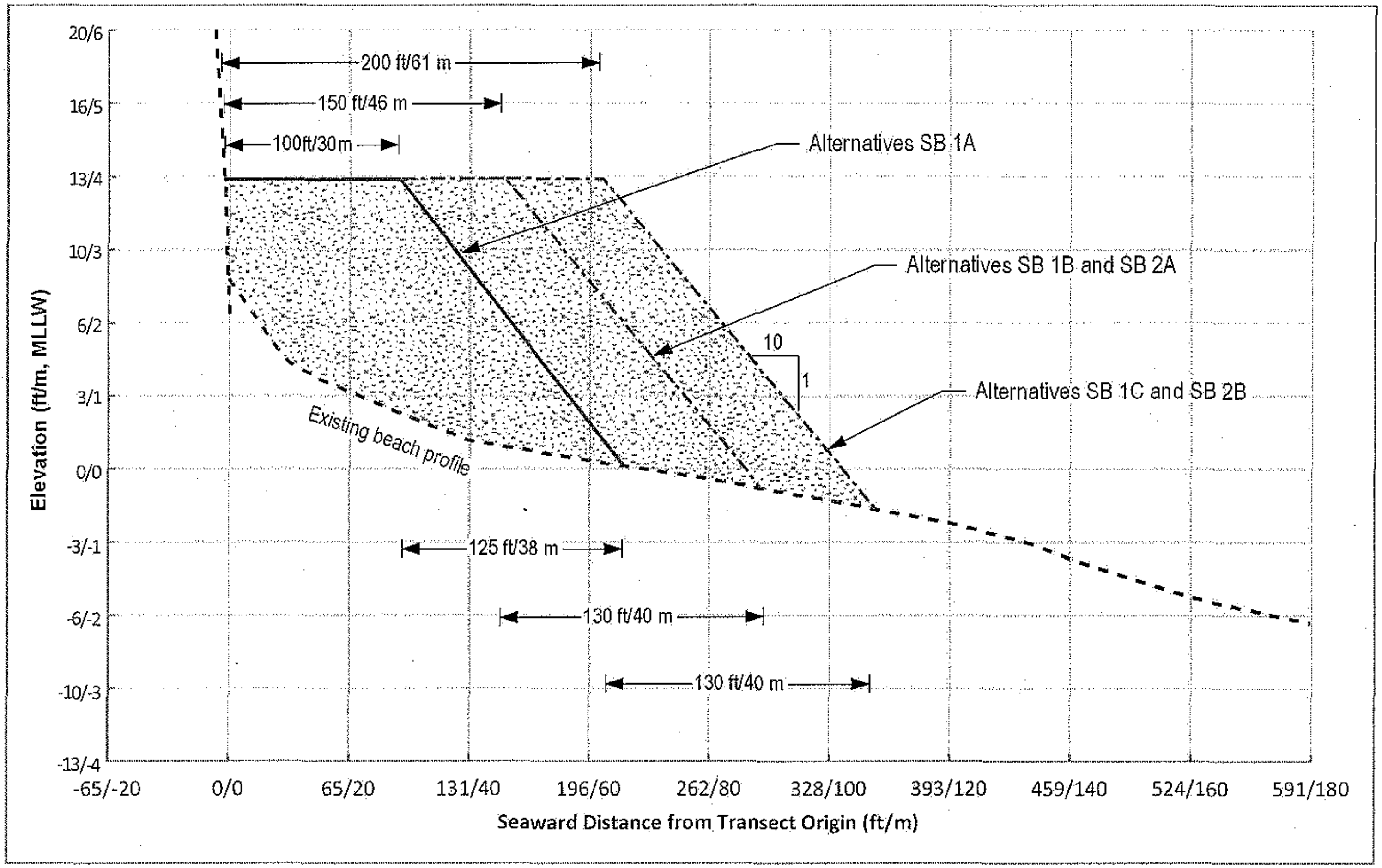

Figure 6. Segment 2 Proposed Beach Fill Profile

Methods

The general process for proposed sand dredging, transport, and dispersal is very similar for both borrow sites and for both receiver site segments. Potential methods proposed for dredging apparently include both the hopper and cutterhead dredges.

The hopper dredge is a self-propelled vessel that collects sand material by suction directly from the ocean bottom and stores the material in the hoppers of the vessel. Typically, as material is loaded into the hoppers of the dredge, overflow water carrying fine sediments (carriage water) is allowed to run off the top of the hoppers and spill directly into the ocean, generating a turbidity plume. Morning glory spillways were designed to reduce ocean turbidity when this type of dredge is used.

If a hopper dredge is utilized for the Project, it would be loaded with dredged material from the borrow site and then moved to a monobuoy or a small floating platform close to the beach area designated to receive the dredged material. At this monobuoy or platform site, seawater would be mixed with the dredged material, creating a slurry, and would then be pumped through floating or submerged pipelines directly to the highest portions of the beach, utilizing booster pumps if necessary.

The other dredge that may be employed for this project is a cutterhead, which is essentially a floating barge with onboard pumping equipment. This dredge uses the rotating cutter head to loosen the seabed material and suction it up as the pipe swings across the ocean floor, excavating a swath about 300 ft (100 m) wide and 3 to 5 ft (1 to 1.5 m) deep. The dredge material would be mixed with seawater, creating a slurry, and then pumped onshore by a submerged or floating discharge pipeline.

Existing sand at each receiver site would be used to build a small, "L"-shaped berm to anchor the sand placement operations. The short side of the "L" would be perpendicular to the shoreline and approximately the same width as the flat portion of the beach-fill area for each segment. The long side would be parallel to the shore, at the seaward edge of the planned beach-fill footprint. The long side would initially be approximately 200 ft (60 m) long.

The dredged slurry would be pumped into the angle of the "L" between the berm and the bluff toe. This berm would reduce ocean water turbidity by allowing most the sand to settle out inside the bermed area while the seawater is channeled just inside the long berm until it reaches the open end where it drains across the shore platform and into the ocean. As filling progresses the berm would be continuously extended to maintain its 200 ft (60 m) length. In this way return water has to flow approximately 200 ft (60 m), across which it would drop most of its sand load, before returning to the ocean.

It is expected that, should spawning and/or grunion eggs be detected during construction of the berm, the Corps would require a second perpendicular berm be constructed to close off a cell to help protect the beach section where grunion spawning occurred. The cell would then be filled;

the section of beach with grunion would be avoided and bypassed by Project activities. Sand placement would then resume by forming a berm beyond the bypassed grunion spawning area. It is expected that a boundary of at least 100 ft (30 m) on both downcoast and upcoast directions around any grunion spawning areas would be avoided for a minimum of one lunar month following the grunion spawning event.

As the sand slurry material would be deposited behind the berm, the sand would likely be spread using two bulldozers and one front-end loader, to direct the flow of the sand slurry and to form a gradual slope to the existing beach elevation. A crew of up to 10 people would be required for the beach replenishment work. The construction sequence is described in further detail below.

For each receiver site, berm construction would be adjusted from the design requirements during fill placement depending on actual field conditions. The measurements indicated herein for the width of the berms are the initial placement widths. The berms would be subject to the forces of the waves and weather once constructed and would erode and settle over time to a natural grade for the beach segment.

Construction Sequence and Duration

Implementation of various alternatives would likely occur on a 24-hour, 7-day a week (24/7) basis, by operating three crew shifts per day. Approximately two days would be required to set up the pipeline leading from the dredge or monobuoy to the shoreline. The contractor would typically assemble two sets of pipelines, to avoid delays associated with moving and setting up the pipelines, as each section of sand placement is completed. Sand discharge and grading would therefore be continuous, as long as the dredge is operating.

Daily average production rate of dredge material would likely range from 10,000 yd^3 to 15,000 yd^3 (7,650 m^3 to 11,500 m^3). To complete the beach replenishment in the two segments, dredging, placing, and dispersing of sand would require approximately 180 days.

Access and Staging

Beach fill activities would involve a shore crew of about 10 people. Beach access for the construction equipment and crew in Segment 1 would be at Moonlight Beach. Beach access for the construction equipment and crew in Segment 2 would be at Fletcher Cove. No new access roads would need to be constructed. Since the work would not be done during winter storms, and because the construction equipment would be used on a 24/7 basis, staging areas would only be needed occasionally. Should equipment need to be temporarily moved off the beach, it would be stored in parking lots at the beach access points. All fueling and maintenance activities would occur at the staging areas, and the contractor would be required to prepare and implement a Spill Prevention, Control, and Containment plan for hazardous spill containment. The dredge crew would park at the port of operations for the dredge, and the shore crew would park in available public parking lots or street parking near the beach access points.

Borrow Sites

Tables 2 shows the likely maximum potential parameters (volumes, depths, etc.) for material to be dredged over the potential 50-year Project life at each of the proposed borrow sites. The borrow sites, identified as SO-6 and MB-1, are shown in Figures 3 and 4. SO-6 would likely be utilized exclusively for replenishment efforts through about Project year 30. When the capacity of S0-6 is reached, MB-1 would then be used exclusively for remaining replenishment efforts.

Table 2. Dredge information at each borrow site: maximum potential values

	SO-6	MB-1
Volume of material to be dredged	5,200,000 yd^3 4,000,000 m^3	1,300,000 yd^3 1,000,000 m^3
Surface area affected	0.36 mi^2 0.92 km^2	0.67 mi^2 1.67 km^2
Depth of the dredge	16 ft 4.9 m	16 ft 4.9 m
Water depth	- 59 to -79 ft MLLW -18 to -24 m MLLW	-69 to -79 ft MLLW -21 to -24 m MLLW

Notch Fill

The Project could include extensive beach bluff notch fills, utilizing erodible concrete at the bases of bluffs backing the Study Area beaches (Figure 7). These notch fills could occur prior to or after the placement of beach sand fill. This bluff protection would be limited to filling notches or small sea caves at the bases of the bluffs. The goal would be to help stabilize the lower bluff, and the proposed work would not include seawalls or upper bluff stabilization measures.

Methods

Filling of small sea caves and notches with engineered concrete has reportedly been proven to be an effective method of protecting the bluff toe of slope, when properly maintained. As indicated in the 1994 Corps Reconnaissance Report, notch fills effectively improve overall sea-cliff stability, preventing significant further wave erosion of the cliff base and providing vertical support of any bluff overhang (USACE 1994). The 1994 Reconnaissance Report discussed fill designs using reinforced concrete and constructing a 5.9 in (15-cm) thick shotcrete wall applied directly to the bluff face, extending up to an elevation of about 15.4 ft (+4.7 m) MLLW.

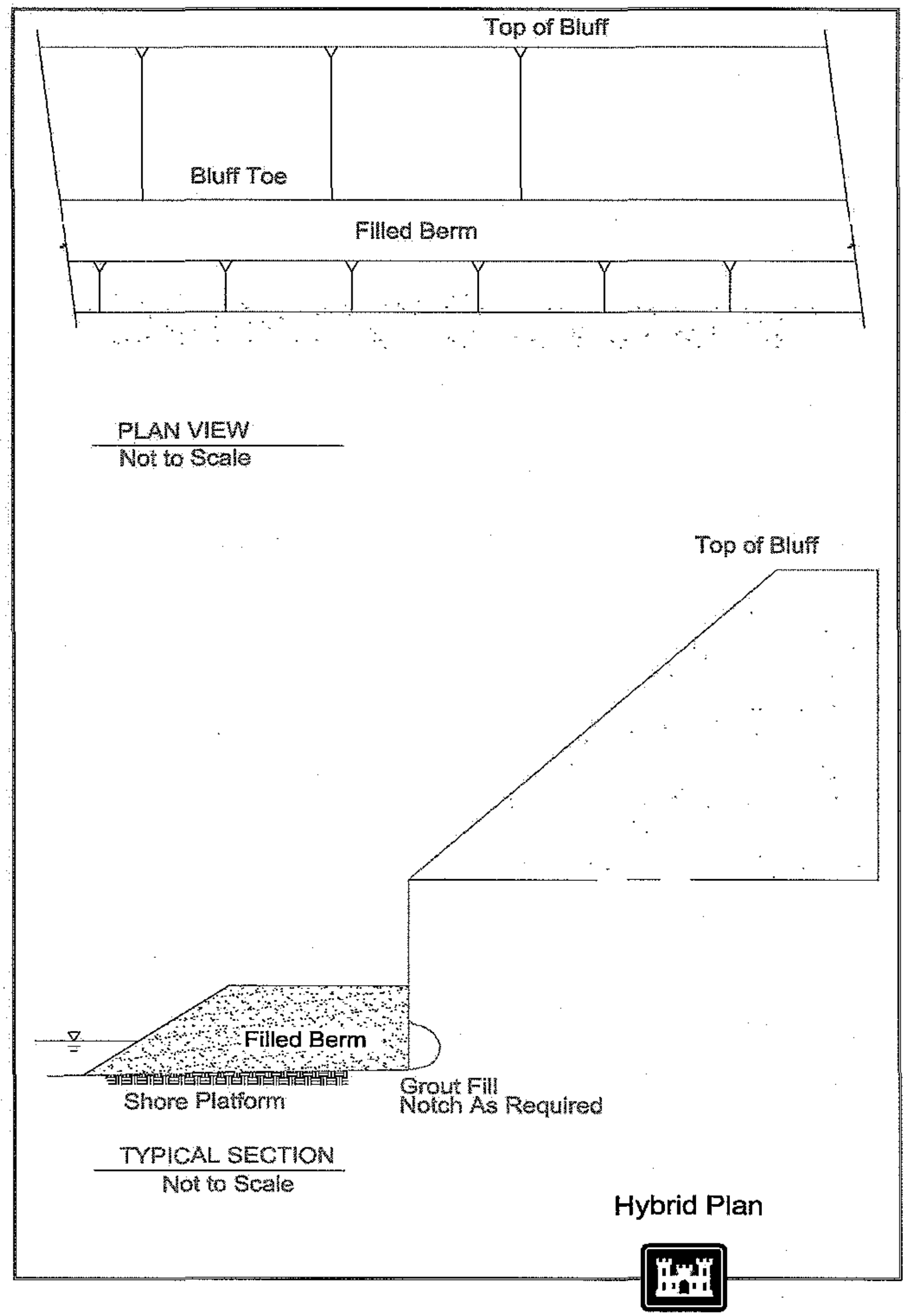

Figure 7. Cross Section Notch Fill

Shotcrete walls have already been implemented in some portions of Reaches 3 and 4. Notch fills differ from seawalls in that they are not designed to protect the entire bluff face from constant wave attack, but only to stabilize the lower bluff, reduce erosion, and to help prevent bluff collapse during occasional periods of wave exposure. As such, they are generally smaller and less conspicuous than seawalls.

Types of Notch Fill Equipment

The main construction equipment required for filling notches includes sand excavating equipment, a trailer-mounted high-pressure pump and nozzle for concrete fill, a minimum of two concrete trucks, and powered hand tools.

Construction Sequence and Duration

If constructed prior to beachfill sand placement, notch fills would need to occur during low tides in most or all locations. The area immediately in front of the notch would be cleared of sand by the contractor. It would be the contractor's option to schedule this work either before or after the proposed beach fill. Should the contractor opt to do this work after beach fill, additional sand material would have to be cleared prior to the application of concrete; this includes sand originally present at the bottom of the bluff face, plus any additional sand from beach fill activities. If the work activities would occur post-beachfill, work would likely be able to proceed during any tide, due to the greater sand surface elevation above high tides that would be available. Should the contractor opt to do this work before beachfill, smaller volumes of sand material would need to be removed from in front of the bluff face. However, work would likely only be able to occur approximately 2 weeks per month and 6 hours per day, due to tides otherwise interrupting activities. In either case, this work would likely be done concurrently, but not co-located, with beach replenishment.

Proposed notch fill activities in Segments 1 and 2 would require approximately 10 to 15 trucks of concrete per day. The total volume of concrete required to fill notches in the bluff base would be determined by the specific site conditions at the time of Project construction. However, based on an estimate of roughly 1.0 mi (1.6 km) of bluff protection to be installed for the whole proposed Project, approximately 6,000 yd^3 (4,600 m^3) of concrete would be needed, which would be provided by concrete trucks driven into the work area. Quick-drying erodible shotcrete gunite would be spread using a concrete pump and high-pressure hose, and approximately 100 ft (30 m) horizontal length of bluff face per day would typically be covered, assuming about 8 yd^3 (6 m^3) of shotcrete can be produced with each concrete truckload. At an estimated production rate of 100 ft (30 m) per day, approximately 46 days would be required to complete the proposed notch fills.

Access and Staging

Proposed notch fill activities would involve about five people at the site at a time. Beach access for the construction equipment and crew in Segment 1 would be at Moonlight Beach. Beach access for the construction equipment and crew in Segment 2 would be at Fletcher Cove. Since the work would not likely be done during winter storms, and because the construction equipment would be used on a 24/7 basis, staging areas would only be needed occasionally. Should equipment need to be temporarily moved off the beach, it would be stored in parking lots at the access points. All fueling and equipment maintenance activities would occur at the staging areas, and the contractor would be required to prepare and implement a Spill Prevention, Control, and Containment plan for hazardous spill containment. The shore crew would park in available public parking lots or street parking near the beach access points.

BIOLOGICAL MONITORING

Proposed construction activities would likely occur outside of the period of winter storms, and would likely occur from April through September. To help ensure that no significant biological impacts occur as a result of the proposed Project, biological monitoring would occur during construction. Biological monitoring would include bi-monthly grunion monitoring during spring tides for up to four consecutive days. Should spawning and/or grunion eggs be encountered during periods of construction of the proposed beach replenishment berms, a second perpendicular berm would be constructed to close off the cell ahead of the beach section where spawning occurred. That cell would then be filled, and the section of beach with grunion presence would be bypassed by Project activities. Filling of a new cell with sand would then commence down the coast with construction of a new transverse and berm. A boundary of at least 100 ft (30 m) in both down-coast and up-coast directions around the grunion spawning area would be avoided for a minimum of one lunar month following the grunion spawning event.

Additionally, weekly biological monitoring would occur to help ensure that Federal and State listed species would not be adversely affected. A detailed monitoring plan would be submitted to the appropriate resource agencies for review and comment during the Corps Preliminary Construction Engineering and Design phase of the Project. Nearshore underwater surveys would be conducted prior to construction and after construction with the goal of determining if any natural/biological resources/habitats have been adversely affected by the Project. Coordination with the appropriate resource agencies would occur on how to mitigate for predicted or observed biological resource losses.

DESCRIPTION OF BIOLOGICAL RESOURCES

General Description

The proposed beach replenishment and notch fill footprint areas contain stretches of sand and cobble beaches with high and low profile reefs immediately offshore. Extensive marine resources exist directly offshore of some of the proposed Project sand replenishment receiver sites (Cumberland et al. 1997). The shoreline and reefs are home to or are utilized by a variety of macroalgae, invertebrate, and vertebrate resources. The reefs in northern San Diego County are important for commercial fisheries, especially lobster, crab, and urchin. Recreational activities dependent on these biological resources include diving, sport fishing, tide pooling, bird watching, and whale watching.

The notches proposed to be filled generally consist of unvegetated bluff faces, while the bluffs above the notch fill areas contain mostly non-native vegetation associated with bluff- top development interspersed with remnants of native vegetation.

San Elijo Lagoon partially occurs within the Study Area, and Batiquitos and San Dieguito lagoons occur adjacent to the north and south Study Area boundaries, respectively. These lagoons are integral components of the coastal ecosystem within the region, and contain many important biological resources. Batiquitos and San Dieguito lagoons have been both subject to restoration projects which partially restored tidal flows and improved lagoon ecosystem functioning.

The two proposed sand borrow sites consist of open ocean with a sandy substrate at about -60 to -80 ft (-18 to -24 m) MLLW.

Marine Environment

The characterization herein of marine resources the Study Area was based on the Corps Draft 2005 EIS/EIR, resource mapping and assessments conducted for the RBSP (SANDAG 2000, MEC 2000, AMEC 2002a, b), marine resource evaluations and mapping by the U.S. Navy (1997a,b), kelp mapping by MBC (2001), and the Service's knowledge of the resources.

Marine Natural Communities

Three types of vegetated natural communities typically occur in association with shoreline and reefs of the Study Area and Project region: surfgrass beds, nearshore kelp and macroalgae, and offshore kelp beds (Figures 8, 9 and 11). Bedrock intertidal reefs comprise 14 percent of the coastline of San Diego County, with the remaining 86 percent consisting of sand, gravel, or cobble beaches (Engle 2005); they are important features of portions of the Study Area (Figures 10 and 12). Most rocky intertidal shores in the county occur on the Point Loma and La Jolla peninsulas, with relatively few isolated reefs farther north (which includes the Study Area) (Engle 2005). Intertidal reefs typically contain diverse natural communities of plants and animals. Kelp forms some of the dominant nearshore and offshore natural communities in southern California and provides habitats for hundreds of species of fish, invertebrates, and algae (DeMartini and Roberts 1990).

Surfgrass (*Phyllospadix* spp.) and kelp (e.g., *Macrocystis* sp.) beds are particularly important marine natural communities in the Project region, because they provide shelter and cover for many fishes and invertebrates, attachment sites for a variety of sessile invertebrates, and form the basis of many marine food chains. Surfgrass and kelp beds occur in limited areas along the southern California coast, usually on hard bottom substrate, compared to much more common soft-bottom natural communities.

Surfgrass Beds

Surfgrass (*Phyllospadix torreyi* and *P. scouleri.*) beds provide important habitats for a variety of algae, invertebrates, and fish. About 34 species of algae and 27 species of invertebrates have been associated with surfgrass on San Diego County beaches (Stewart and Myers 1980). One notable invertebrate is the California spiny lobster (*Panuliris interruptus*), which uses surfgrass as nursery habitat (Williams 1995).

Surfgrass in the Study Area and Project region typically occur in submerged active portions of the beach profile (Figure 8). Surfgrass is considered stress-tolerant and morphologically adapted to withstand a moderate amount of shifting sand movement (O'Brien and Littler 1977, Taylor and Littler 1982, Littler et al. 1983), though the roots and rhizomes of *Phyllospadix* spp. attach to rocks are that are normally exposed (unburied) (Craig et al. 2008). Recovery can take several years if the rhizome mat is removed associated with disturbance (Stewart 1989, Turner 1985). Surfgrasses are likely to be adversely affected by actions that place sand either directly or indirectly onto surfgrass beds (Craig et al. 2008). A laboratory study of *P. scouoleri* found that short term sand burial may result in shoot mortality, decreased shoot counts, and reduced growth of surfgrass (Craig et al. 2008). The study found that shoot density decreased compared to controls for a sand burial depth of 0.8 feet (25 cm), but not shallower burial depths, and mean shoot growth rate decreased in all sand burial treatments (Craig et al. 2008). Sand burial that reduces shoot density of seagrasses may influence population stability for several years (Craig et al. 2008).

Nearshore Kelp and Macroalgae

Feather boa kelp (*Egregia menziesii*) is a conspicuous and common annual species that ranges from low intertidal to shallow subtidal depths of the Project region (Aleem 1973, Black 1974, Gunnill 1980) and Study Area (Figures 9 and 11). It is an opportunistic colonizer characterized by high recruitment in spring and rapid growth (Black 1974). Feather boa kelp occurs on exposed hard substrates; impacts to feather boa kelp from sand burial would be expected to last as long as a reef was covered by sand through the following summer, assuming the holdfasts for the kelp were not killed (SANDAG 2012a). The plant sea palm (*Eisenia arborea*) may co-occur with feather boa kelp at subtidal depths. The shorter height of the sea palm, and occurrence on reefs without interspersed sand patches and/or high-relief (greater than 3 ft/1 m), suggests they may be less tolerant of sand sedimentation than surfgrass and feather boa kelp (Ogden 1999). A variety of red (*Corallina* spp., *Erythroglossum californicum*, *Gigartina* spp., *Gracillari*a spp., *Jani*a spp., *Lithothrix* spp. , *Rhodoymenia* spp.) and brown macroalgae (*Cystoseira osmundacea*, dictyotales, *Zonaria farlowi*) may co-occur with feather boa kelp and/or sea palms on nearshore reefs (MEC 1995, U.S. Navy 1995). Lobsters, marine snails, sea stars, sea urchins, and a variety of fish commonly occur within nearshore kelp and macroalgae.

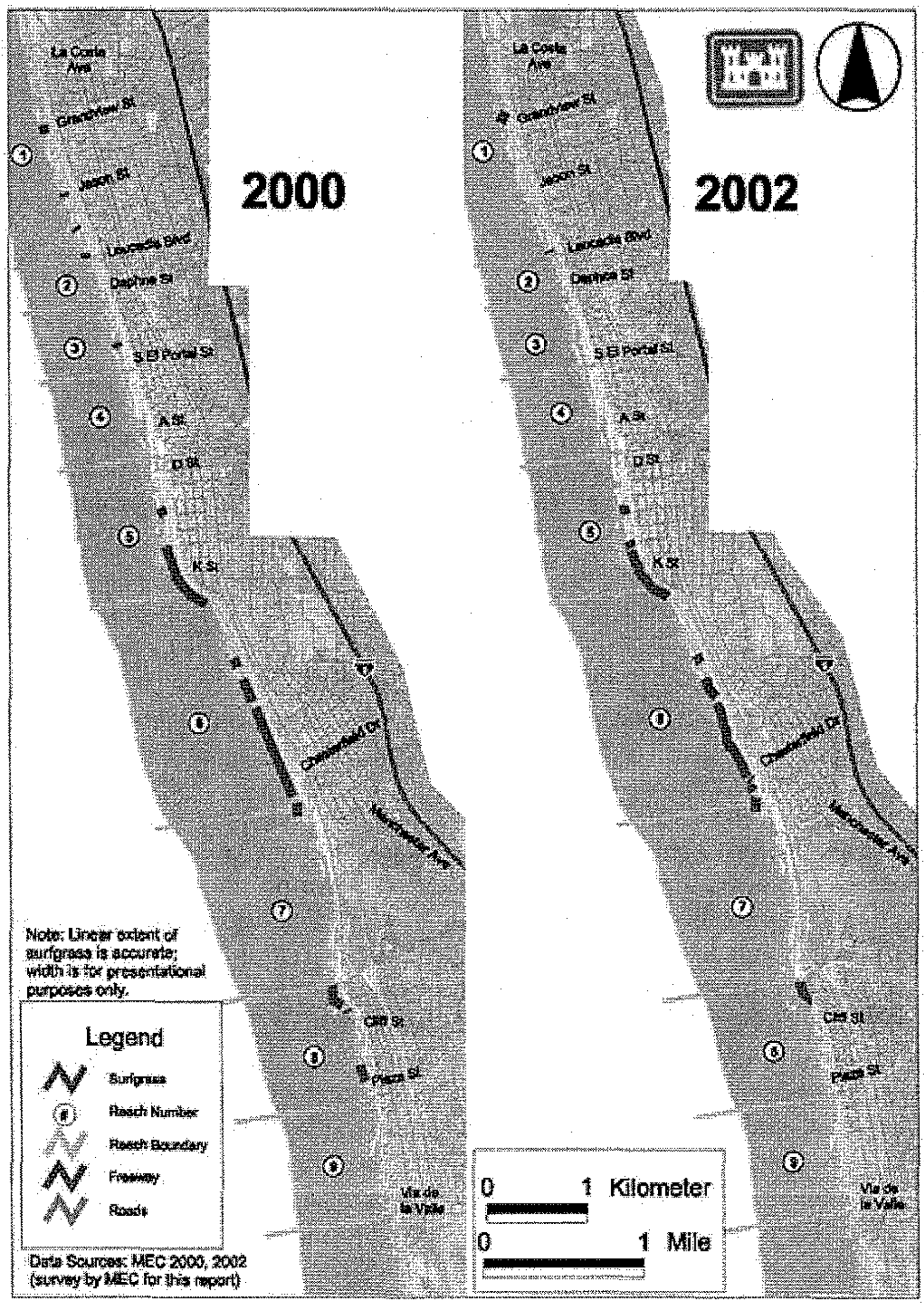

Figure 8. Locations of intertidal and inshore surfgrass beds between Encinitas and Solana Beach, January 2000 and May 2002

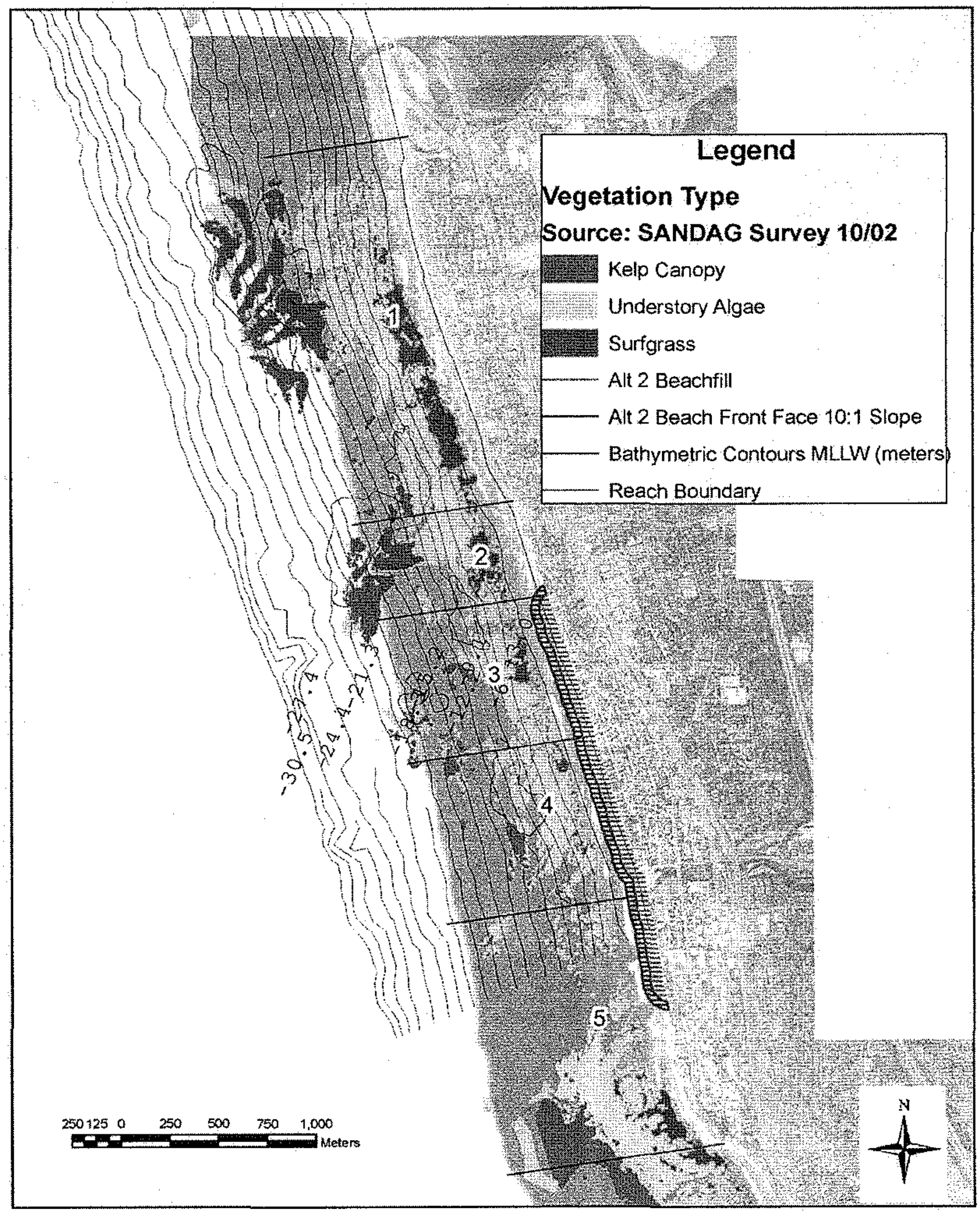

Figure 9. Segment 1 Marine Vegetation Community Types

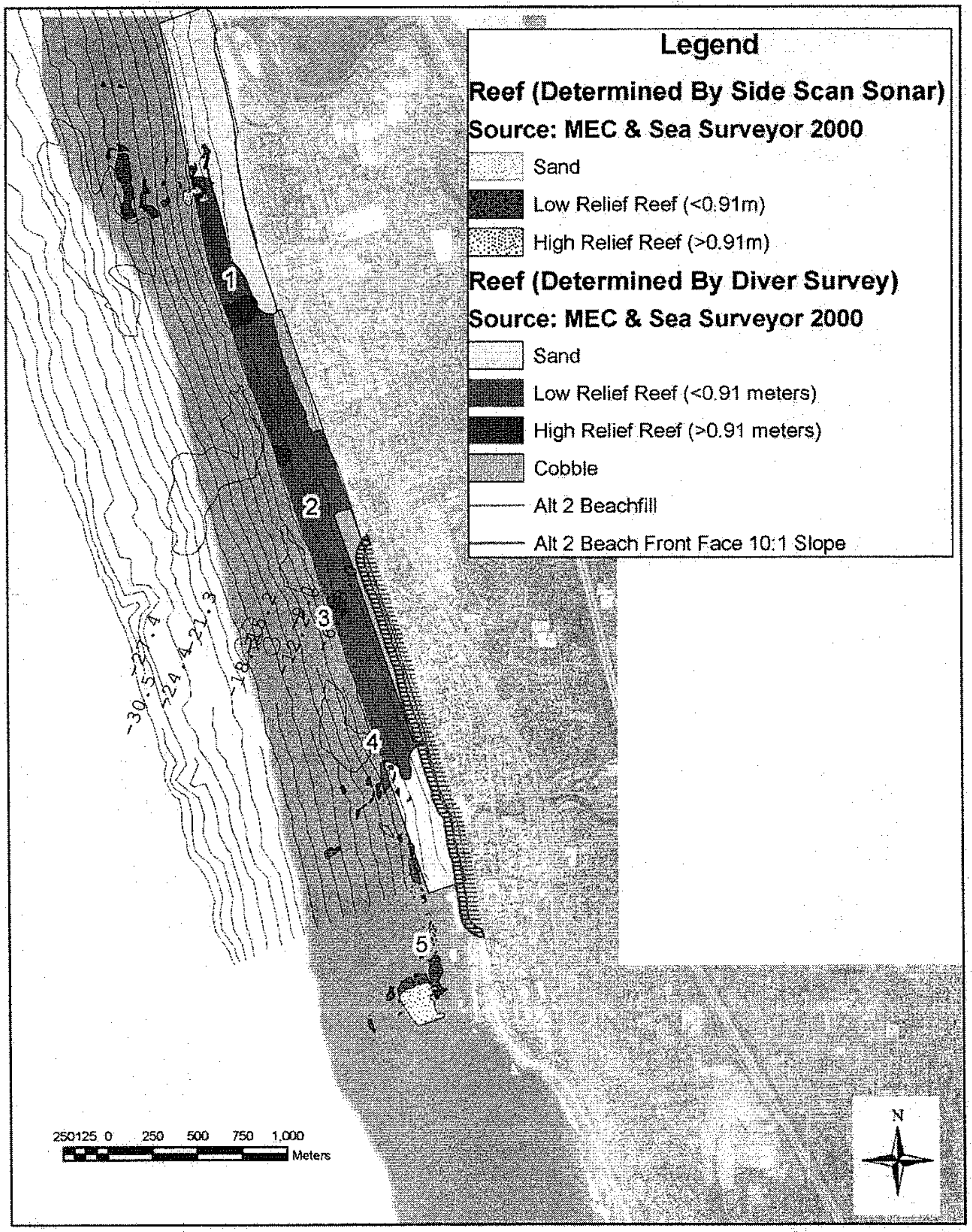

Figure 10. Segment 1 Marine Substrate Types

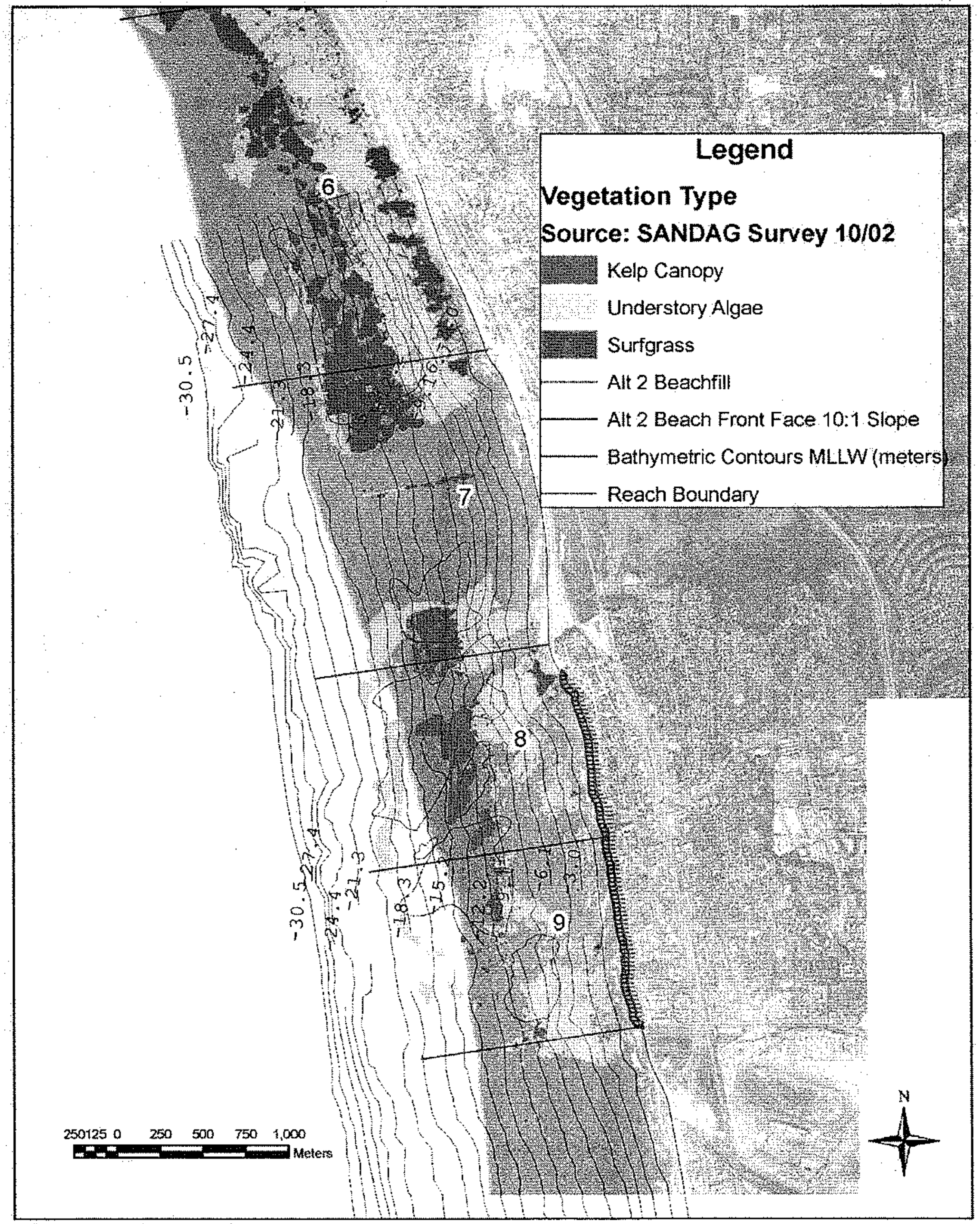

Figure 11. Segment 2 Vegetation Community Types

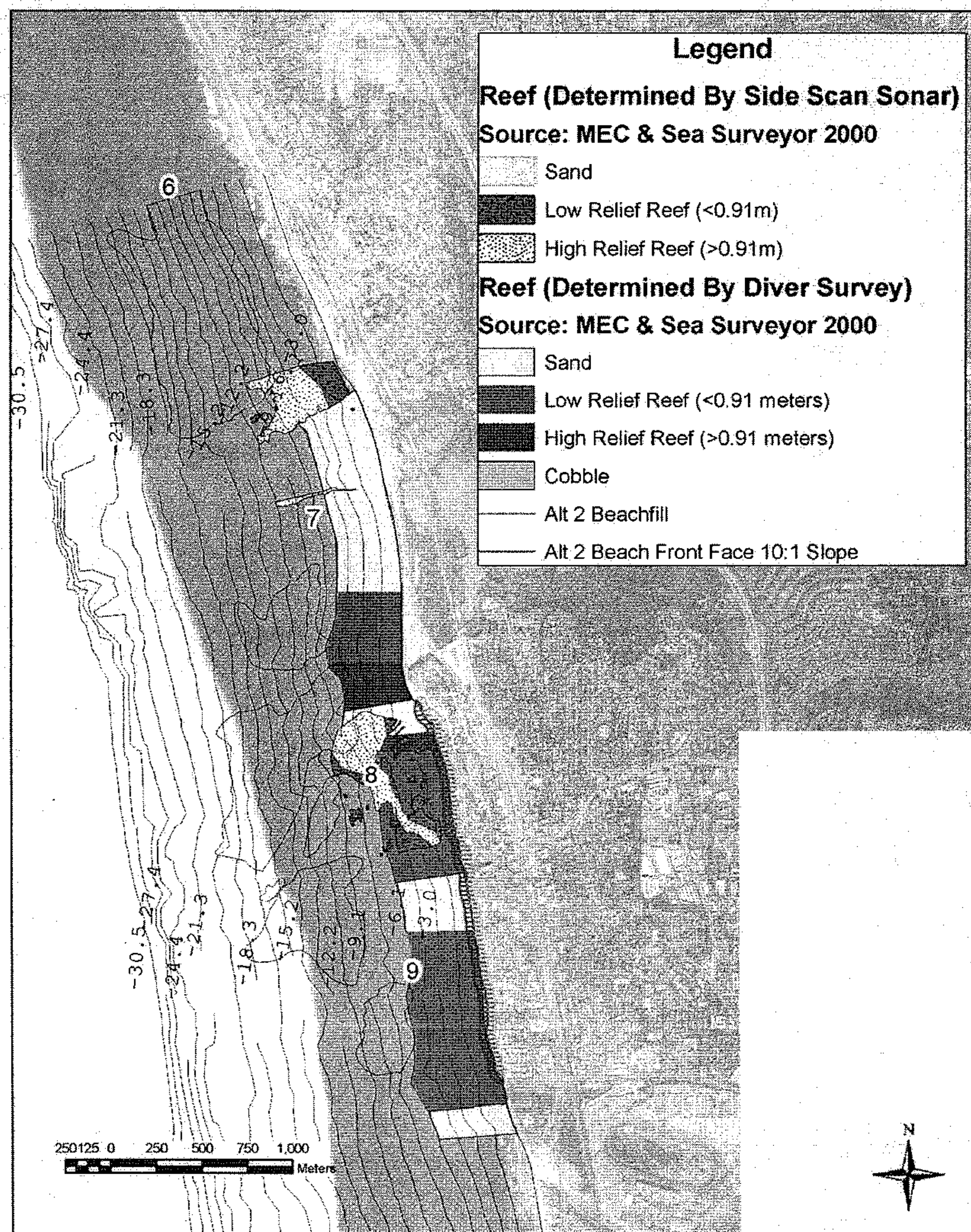

Figure 12. Segment 2 Marine Substrate Types

Offshore Kelp Beds
Southern California kelp forests and beds are dominated by giant kelp (*Macrocystis pyrifera*), which grows at depths between -20 and -118 ft (-6 and -36 m) MLLW (Aleem 1973, Leet et al. 1992). Giant kelp, and its associated hard-bottom substrates, supports a diverse community of algae, invertebrates, and fish. Lobsters, marine snails, sea stars, sea urchins, and a variety of fish commonly occur within giant kelp beds. In addition, kelp beds provide or support substantial food resources for marine birds and mammals, including detritus that is distributed outside of kelp beds.

The density and distribution of the kelp canopy exhibits seasonal and interannual variability related to a variety of physical and chemical factors (e.g., nutrient concentrations, sedimentation, temperature, turbidity). Giant kelp is considered sensitive to sand movement and disturbance and is one of the first species eliminated under wave or sand scour stress (Dayton et al. 1984).

Southern California kelp beds generally deteriorate to some degree during summer and fall when temperatures are higher and water nutrient concentrations are lower (Foster and Schiel 1985, Tegner and Dayton 1987). Kelp beds also may show dramatic die-back during El Niño conditions, and then recovery during La Niña conditions. Giant kelp is very sensitive to sand scour and burial (Dayton et al. 1984, Foster and Schiel 1985). Sediment can affect giant kelp forests by scouring or burying established populations or by affecting the survivorship of microscopic life history stages (SAIC 2007). Compared to segrasses, kelp usually display less tolerance to sand burial before critical thresholds (e.g., growth, mortality, etc.) are reached (SAIC 2007).

Marine Biota

Plankton
Plankton includes a diverse group of microscopic plants (phytoplankton), larval fish and eggs (ichthyoplankton), and other animals (zooplankton); they and are the primary producers in the marine food web.

Zooplankton that would be expected within the Study Area include microscopic animals (e.g., radiolarians, ciliates, foraminifera), larval forms of macroinvertebrates (e.g., crabs, lobster, shrimps, mollusks), and animals that live within the plankton community (e.g., arrow worms, copepods, cladocerans, ctenophores, salps). Larger zooplankton (greater than 1.4 in/35 mm) serve as a major food source for fish.

Ichthyoplankton includes larvae and eggs of resident fish that spawn nearshore, migratory species, and subarctic and temperate/tropical species whose spawning ranges extend into the area (Loeb et al. 1983).

Invertebrates
Common invertebrates observed on San Diego County sandy beaches include beach hoppers (*Orchestodea* spp.), sand crabs (*Emerita analoga*), bean clams (*Donax gouldii*), olive snails

(*Olivella biplicata*), and polychaete worms (e.g., *Euzonus* spp., *Lumbrineris* spp., *Nephtys californiensis*, *Scololepis* spp., *Scoloplos* spp.) (Straughan 1981). In her 12-year study of sandy beaches from Estero Bay (San Luis Obisbo County, California) to Coronado (San Diego County, California), Straughan (1981) found that higher abundance and species diversity were found on long, gently sloping, relatively fine grain beaches with no periodically-exposed beach rock. Beaches that were short and steep, coarse-grained, and/or experienced more erosion had fewer organisms, and, in some cases, only sand crabs were detected.

The beaches within the Study Area vary between having no detected marine invertebrates, limited marine invertebrates (sand crabs, worms), or more abundant marine invertebrates (sand crabs, worms, and bean clams or amphipod crustaceans) (MEC 2000). None of the beaches within the Study Area that were surveyed in 1999 had a particularly diverse invertebrate fauna (i.e., with a variety of species of worms, mollusks, and crustaceans) prior to beach sand placement that occurred in 2001.

Pismo clams (*Tivela stultorum*), which live in sandy areas from the intertidal zone to -79 ft (-24 m) MLLW, were not observed during surveys of beaches within the Study Area prior to sand placement in 2001 (Leet et al. 1992; MEC 2000).

Low-relief reefs within the Study Area ranged from being essentially devoid of detected animals to supporting low numbers of hermit crabs, aggregating sea anemones, chitons, and in some cases, newly recruited mussels (MEC 2000). Several of these species are known to be sand tolerant and/or to opportunistically settle newly exposed substrate (Taylor and Littler 1982, Littler et al. 1983). Chitons (e.g., *Mopalia muscosa*) can withstand sand burial over relatively long periods (several weeks). The aggregating sea anemone (*Anthopleura elegantissima*) can withstand sand burial for periods greater than 3 months, and has the ability to quickly reoccupy exposed space through asexual reproduction. Opportunistic species such as the sand castle worm (*Phragmatopoma californica*) and mussels (*Mytilus* spp.) are rapid colonizers of bare substrate. Mobile species such as turban snails (*Tegula funebralis*) and hermit crabs (*Pagurus* spp.) may migrate to and from reef areas as they become exposed from or covered with sand.

Invertebrates on persistent, high-relief reefs exhibit a distinct zonation with tidal level in the region (Reish 1972). The upper intertidal or splash zone is characterized by acorn barnacles (*Cthamalus* spp.), limpets (*Collisella* spp., *Lottia* spp.), and periwinkles (*Littorina* spp.). California mussel (*Mytilus californianus*), gooseneck barnacle, aggregating sea anemones, chitons, hermit crabs, and a variety of marine snails (e.g., *Acanthina* spp., *Lithopoma undulosa*, *Kelletia kelletia*, *Ocenebra* spp., *Tegula* spp.) are commonly observed in the middle intertidal zone of rocky shores of the area (Stewart 1982, MEC 2000). The low to minus intertidal zone of persistent reefs are characterized by a greater diversity of animals, including aggregating and green sea anemones, purple sea urchin (*Strongylocentrotus purpuratus*), California sea hare (*Aplysia californica*), crabs, marine snails, brittlestars (e.g., *Ophithrix* spp.), and starfish (*Asterina miniata*, *Pisaster* spp.). Subtidal reefs support a variety of invertebrates including: ectoproct (*Bryozoan*); sea fan (*Muricea californica*); California spiny lobster; nudibranch

(*Dendrodoris albopuncata*); seastar (*Pisaster gigantus*); tube anemone (*Pachycerianthus fimbriatus*); and urchin (*Strongylocentrotus franciscanus*).

Invertebrate observations for borrow sites SO-6 and MB-1 were not reported in the Corps 2005 Draft EIR/EIS or other documents provided. In the absence of information for these sites, we expect that the invertebrates observed at other similar sites (classified by the Corps as SO-5 and SO-7) are representative of what would likely also be found at SO-6 and MB-1. Invertebrates observed by divers and collected by otter trawl in 1999 at sand borrow sites used for the 2001 RBSP (SO-5, SO-7; located offshore of Batiquitos Lagoon and Del Mar at depths of -59 to -62 ft (-18 to -19 m) MLLW) included tube worms (*Diopatra ornata*), crabs (*Heterocrypta occidentalis, Portunis xantusii, Randallia ornata*), shrimp (*Crangon nigromaculata*), marine snails (*Kelletia kelletia, Nassarius perpinguis*), sand dollar (*Dendraster* sp.), sea star (*Astropecten verrilli*), and white urchin (*Lytechinus pictus*) (MEC 2000). Limited hard substrate was observed at borrow site SO-7, which had red algae turf and a few tunicates and sea anemones.

Fish

The California grunion (*Leuresthes tenuis*) is a regulated species that uses sandy beaches for spawning. The species ranges from south of Point Conception, California, to Magdalena Bay, Baja California Sur, in nearshore waters from the surf to a depth of -59 ft (-18 m) MLLW (Miller and Lea 1972). To spawn, grunion travel from their nearshore water use-areas to specific sandy beaches, just after certain full and new moons (which correlate with the highest tides of the month). Spawning takes place during nighttime high tides between March and August. Eggs and sperm are deposited into the sand of the upper intertidal and then hatch 10 days later following exposure during the next high tide (Cross and Allen 1993, Middaugh et al. 1983). In her surveys of southern California sandy beaches, Straughan (1981) reported that grunion were found on relatively longer and gently sloping beaches with moderately fine grain size.

Although grunion and their eggs were not detected on beaches within the Study Area during reconnaissance surveys prior to the 2001 RBSP, beach receiver sites south of Batiquitos Lagoon, in north Leucadia, and at Moonlight Beach were considered to have potentially suitable spawning habitat for grunion (MEC 2000). Other potential receiver sites at Leucadia, Cardiff, and Solana Beach were considered to have unsuitable habitat for grunion spawning either because they lacked sufficient sand or were too narrow (i.e., wave run-up covered the beach over higher tide cycles) (MEC 2000). Surveys in 2001 confirmed the presence of potentially suitable habitat for grunion at proposed Batiquitos and Leucadia receiver sites, but indicated habitat was unsuitable for spawning at Moonlight Beach, Cardiff, and Solana Beach (AMEC 2002a). The spawning habitat suitability at north Leucadia was confirmed during the 2001 RBSP sand placement, when the footprint of the receiver site was altered to avoid impacts to grunion that had spawned on the beach. It is not expected that conditions have improved for grunion on these beaches since 2002.

Fish commonly found associated with sandy subtidal communities off San Diego County beaches include barred surfperch (*Amphistichus argenteus*), California corbina (*Menticirrhus* *undulatus*), California halibut (*Paralichthys californicus*), queenfish, round stingray (*Urolophus halleri*), shovelnose guitarfish (*Rhinobatos productus*), spotfin croaker (*Roncador stearnsii*), and white croaker (*Genyonemus lineatus*) (USACE 1994, U.S. Navy 1997a). Speckled sanddabs (*Citharicthys stigmaeus*) and bat rays (*Myliobatis californica*) also have been observed in these waters at depths of -10 to -33 ft (-3 to -10 m) MLLW. Schooling water column fish, abundant just beyond the surf zone, include northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), Pacific bonito (*Sarda chiliensis*), and topsmelt (*Atherinops affinis*) (Cross and Allen 1993, Garfield 1994).

Flatfish, including speckled sanddab, hornyhead turbot (*Pleuronichthys verticalis*), and fantail sole (*Xystreurys liolepis*), generally are more common at deeper inner shelf depths ranging from -33 to -79 ft (-10 m to -24 m) MLLW (Allen 1982, Love et al. 1986). Twenty species of fish were observed by divers and collected by otter trawl at sites SO-5 and SO-7 (MEC 2000); these sites are expected to be similar to proposed Project borrow sites SO-6 and MB-1. The most abundant fish included barred sand bass (*Paralabrax nebulifer*), California halibut, California lizardfish (*Synodus lucioceps*), English sole (*Pleuronichthys vetulus*), horneyhead turbot, queenfish, speckled sanddab, and white croaker.

Fish abundance on reefs is related to available vegetative cover, substrate complexity, and relief; however, increases in relief height greater than 3 ft (1 m) reportedly have minimal effects on observed reef fish abundance (Cross and Allen 1993, Patton et al. 1985). Fish commonly found in surfgrass communities off San Diego include barred sand bass, black perch (*Embiotoca jacksoni*), blacksmith (*Chromis punctipinnis*), garibaldi (*Hypsypops rubicundus*), opaleye (*Girella nigricans*), señorita (*Oxyjulis californica*), and topsmelt (DeMartini 1981, MEC 1995).

Fish associated with nearshore reef communities within the Study Area include kelp bass (*Paralabrax clathratus*) and barred sand bass; black, shiner, walleye, and dwarf surfperches (Embiotocidae); señorita; California sheephead (*Semicossyphus pulcher*); garibaldi; opaleye; white seabass (*Atractoscion nobilis*); sargo (*Anisotremus davidsoni*); salema (*Xenistius californiensis*); giant kelpfish (*Heterostichus rostratus*); painted greenlings (*Oxylebius pictus*); and halfmoon (*Medialuna californiensis*). Transient fish such as jack mackerel, Pacific bonito, Pacific barracuda (*Sphyraena argentea*), and silversides also commonly occur over reefs with kelp (Feder et al. 1974, Ebeling et al. 1980, Foster and Schiel 1985).

<u>Marine-Associated Birds</u>

Seabirds and shorebirds are very commonly observed along and near southern California beaches. Seabirds such as cormorants, pelicans, and terns forage for fish offshore. Gulls may feed on fish and invertebrates and are notable scavengers. Shorebirds probe for marine invertebrates in the damp sands of the intertidal zone and may feed on small fish and crustaceans in tide pools. Approximately 50 species of marine-associated birds have been reported to occur along the shoreline and adjacent nearshore ocean between Carlsbad and Del Mar (MEC 2000). A total of 12 species of birds was observed along the shoreline during the September 2002 reconnaissance survey.

The most commonly observed seabirds within the Study Area during the September 2002 survey included Heerman's gull (*Larus heermanni*), ringed-billed gull (*Larus delawarensis*), and western gull (*Larus occidentalis*). Other commonly observed seabird species in the ocean waters offshore of northern San Diego County include the surf scoter (*Melinita perspicillata*); western grebe (*Aecmophorus occidentalis*); and double-crested (*Phalacrocorax auritus*), Brandt's (*P. pencillatus*), and pelagic (*P. pelagicus*) cormorants. Terns, including the elegant tern (*S. elegans*), Caspian tern (*S. caspia*), California least tern, and Forster's tern (*S. forsteri*), often forage in nearshore waters of the Study Area.

The most commonly observed shorebirds during the September 2002 survey were black turnstone (*Arenaria melanocephala*), marbled godwit (*Limosa fedoa*), sanderling (*Calidris alba*), whimbrel (*Numenius phaeopus*), and willet (*Caloptrophorus semipalmatus*). Marsh birds, including great blue heron (*Ardea herodias*), great egret (*Casmerodius albus*), and black-crowned night heron (*Nycticorax nycticorax*), were observed foraging on exposed reefs south of Swami's during the May 2002 surfgrass mapping survey. Other commonly observed and/or expected shorebirds in the Study Area include killdeer (*Charadrius vociferus*), black-bellied plover (*Pluvialis squatarola),* wandering tattler (*Heteroscelus incanus*), and spotted sandpiper (*Actitis macularia*).

Sensitive Marine-Associated Birds

Two listed marine-associated bird species are found within the Study Area: the California least tern and the western snowy plover.

California least tern – the least tern is known to occur within the Study Area. Focused surveys for least terns have resulted in nesting documentation in San Elijo and Batiquitos Lagoons (Fancher 1992, Powell and Collier 2000). Between 1 to 15 pairs nested between 1998-2004 within San Elijo Lagoon (Patton 2002, CDFG 2004), with no breeding activity detected at this location in 2004 through 2010 (CDFG 2008, CDFG 2011). Batiquitos Lagoon has a much larger nesting least tern subpopulation with 205 nesting pairs observed in 2001, 203 in 2002, 574 in 2003, 416 in 2004, approximately 579 to 619 pairs in 2009, and about 458 to 480 pairs in 2010 (CDFG 2004, Squires and Wolf 2009, CDFG 2011).

The least tern nesting colony at Batiquitos is approximately 1.6 mi (2.5 km) from closest proposed sand placement or notch fill activities (the northern end of proposed sand placement activities in Reach 3), while the historic least tern colony at San Elijo is less than 0.3 mi (0.4 km) from closest proposed sand placement activities (the northern end of proposed sand placement activities in Reach 8) (Figure 2). Proposed borrow site SO-6 is approximately 4,741 ft (1,445 m) west of San Elijo Lagoon (Figure 2). Approximately 6,841 ft (2,085 m) west of proposed borrow site MB-1 is Mariners Point in Mission Bay (Figure 4), which was in the past one of the more successful least tern breeding areas in California, with between 220 and 562 breeding pairs between 1998 and 2002 (CDFG 2003), and about 75 to 99 breeding pairs between 2007 and 2010 (CDFG 2008, CDFG 2011).

Least terns sight-feed for small fish from the air within nearshore ocean waters and lagoons and dive into the water to capture prey items. During the nesting season, least terns usually forage within 2.0 mi (3.2 km) of their colony; however, they have been observed foraging up to 5.0 mi (8 km) from their colony.

Breeding least terns usually begin arriving in the Project region in mid to late April. California least terns typically began departing some breeding areas in early July, but remain at others until late August/early September (CDFG 2011).

No critical habitat has been designated for the California least tern.

Western snowy plover – the snowy plover is known to occur within the Study Area beaches near San Elijo Lagoon; however, a more substantial occurrence is located north of the Study Area at Batiquitos Lagoon.

Snowy plovers breed in loose colonies. Sand spits, dune backed beaches, sparsely to unvegetated beach strands, open areas around estuaries, and beaches at river mouths are preferred nesting areas. Nest sites are typically flat, open areas with sandy substrates and little to no vegetation. Snowy plovers have been shown to display breeding site fidelity. The breeding season extends from March 1 through September 15. Egg laying typically begins in mid-March. Three eggs are commonly laid in a shallow depression nest. Incubation lasts approximately 27 days. Chicks are precocial and leave the nest almost immediately, but do not gain the ability to fly for about 31 days. Males attend their young for approximately 29 to 47 days (Warriner et al. 1986). Snowy plovers forage on invertebrates. An influx of "overwintering" birds is a typical phenomenon for southern California beaches. The majority of birds in the Study Area region are found in beach and/or estuarine flat habitats. Extant undisturbed nesting habitat in the Study Area is limited.

Snowy plovers have been consistently documented on the beach approximately 0.5 mi (0.8 km) south of the San Elijo Lagoon mouth, primarily during the fall and winter months (September to January). Wintering bird surveys for this area typically detected 0 to 28 birds for this area before 2000 (USFWS 2007). Wintering bird surveys at this location documented 31 individuals in January 2005 and 28 individuals in September 2005 (S. Wolf, Avian Research Associates consulting biologist, pers. comm., 2005). Wintering snowy plovers have been documented approximately 1,000 ft (300 m) north of proposed sand placement activities in proposed Segment 2 (S. Wolf, Avian Research Associates consulting biologist, pers. comm., 2005).

Nesting by snowy plovers was observed at San Elijo Lagoon in 2000 when 3 adults were observed (S. Wolf, Avian Research Associates consulting biologist, pers. comm., 2005). Nesting has apparently not been reported in San Elijo Lagoon and adjacent beach areas since 2000, most likely due to a lack/degradation of suitable nesting habitat (K. Clark, USFWS biologist, pers. comm., 2005). The snowy plovers are now likely sporadic nesters at San Elijo Lagoon, the site of 12 nesting pairs in 1978 (Unitt 2004), although future restoration efforts in the lagoon and environs will likely improve nesting potential and numbers in the future. The recovery plan for the western snowy plover states that the San Elijo Lagoon/beach area can contribute significantly to the conservation goal for the region, as it provides a management potential of 20 breeding birds (USFWS 2007, Appendix B).

Wintering bird surveys south of the Batiquitos Lagoon mouth have consistently documented the presence of snowy plovers, particularly in the fall and winter months. Flocks of as many as 100 were documented in October 2004 (S. Wolf, Avian Research Associates consulting biologist, pers. comm., 2005). Wintering numbers for plovers reported for Batiquitos Lagoon typically ranged from 0 to 51 for the period 2000 to 2005 (USFWS 2007).

A substantial amount of nesting has occurred within Batiquitos Lagoon with nesting bird surveys documenting 13 nests in 2002 (K. Clark, USFWS biologist, pers. comm., 2005), while surveys in 1996 documented 39 nests. Breeding bird numbers for the lagoon ranged from 5 to 26 for the period of 2000 to 2005 (USFWS 2007). The recovery plan for the western snowy plover states that the Batiquitos Lagoon/beach area can contribute significantly to the conservation goal for the region, as it provides a management potential of 70 breeding birds (USFWS 2007, Appendix B). Project sand placement activities are proposed less than 0.3 mi (0.5 km) south of nesting and wintering habitats for these Batiquitos Lagoon area birds.

The nesting season of the western snowy plover extends from early March through late September (USFWS 2007). Nesting western snowy plovers at coastal locations consist of both year-round residents and migrants (USFWS 2007). The earliest snowy plover nests on the California coast occur during the first week of March in some years and by the third week of March in most years (USFWS 2007). Peak nesting is from mid-April to mid-June. Hatching lasts from early April through mid-August, with chicks reaching fledging age approximately one month after hatching (USFWS 2007).

Critical habitat for the western snowy plover was designated in 2012, with no designated areas within the direct activity footprint area of the proposed Project. Critical habitat Subunits 51A and 51B, within San Elijo Lagoon and just east of Coast Highway 101, are close to the Study Area. Subunit 51C, located east of Interstate 5, is over 1 mile (1.6 km) from proposed Project activity areas. Subunit 52A is located within San Dieguito Lagoon, about 1 mile (1.6 km) southeast of the Project activity area. Critical habitat designation excluded all proposed subunits within Batiquitos Lagoon (subunits 50A–C), as they were addressed by the City of Carlsbad's Habitat Management Plan.

Marine Mammals

Numerous marine mammals are known to occur within the Study Area. All marine mammals are considered sensitive and protected by the Marine Mammal Protection Act (MMPA), which prohibits harassment and harm to these animals. Under the 1994 amendments to the MMPA, harassment includes disturbance that would cause injury or disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

California sea lions (*Zalophus californicanus*) and harbor seals (*Phoca vitulina*) are commonly seen in the water, and occasionally on beaches, in northern San Diego County (U.S. Navy

1997a,b) and are expected in the Study Area. Common dolphins (*Delphinus delphis*) and bottlenose dolphins (*Tursiops truncatus*) occur in the surf zone and in offshore waters of the Study Area (Geraci and St. Aubin 1990). A coastal population of bottlenose dolphins normally occurs within 0.6 mi (1 km) of shore in the Study Area and environs (Bonnell and Dailey 1993). Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) and Risso's dolphins (*Grampus griseus*) also are known to occur in the Study Area seasonally.

California gray whales (*Eschrichtius robustus*) transit the Study area. The southbound migration of these whales off the southern California coast occurs in December through February, and the return northbound migration is from February through May (Bonnell and Dailey 1993). The southbound migration begins in the Bering and Chukchi seas in the Artic and ends in the warm-water lagoons of Mexico's Baja California peninsula and the southern Gulf of California. Gray whales often migrate quite close to shore while passing through the Southern California Bight, including the Study Area.

Marine Resources by Reach (see Figures 8, 9, 10, 11 and 12)

- Reach 1 – Encinitas Northern City Limit to Beacon's Beach
  During the 1999 survey, the majority of the beach in Reach 1 was sand, and cobble formed an extensive band in the upper intertidal near the northern boundary of the reach; the cobble became sparse in occurrence towards the southern reach boundary. Reach 1 includes the area surveyed in 1999 for the Batiquitos and proposed Leucadia receiver sites for the RBSP (MEC 2000). Sand depths averaged from 11 to 17 in (28 to 43 cm) across the intertidal zone at Batiquitos during the spring, and they averaged 19 to 27 in (48 to 69 cm) during the summer at Leucadia in 1999 (MEC 2000). Worms and sand crabs were present in the beach sand natural communities; no marine life was detected in cobble areas that were devoid of sand. These beaches were considered suitable for grunion spawning prior to the 2001 sand placement (MEC 2000, AMEC 2002a).

  Hard substrate occurs from the low intertidal zone to greater than -66 ft (-20 m) MLLW off the northern and southern ends of Reach 1, and occurs closer to shore (within -33 ft (-10 m) MLLW) in the middle portion of the reach. Most hard substrate consists of low-relief reef, and areas with high-relief occur in localized patches.

  The occurrences of sensitive resources are patchy within this reach, both in the intertidal and nearshore zones. Small areas of surfgrass were mapped in the lower intertidal between Grandview Beach and Beacon's Beach in 2000; the largest bed occurred off Grandview Street. Surfgrass was mapped off Grandview Beach and Beacon's Beach, but was not observed in the lower intertidal between these locations in 2002. The surfgrass occurred in patches flush with the sand both in 2000 and 2002. Commercial fishermen have reported the presence of surfgrass on nearshore reefs in this reach. Nearshore dive surveys noted that surfgrass and feather boa kelp have scattered occurrence on the low- and high-relief reefs in this reach (U.S. Navy 1997a,b, MEC 2000).

SANDAG has three shallow subtidal monitoring stations (BL-SS-1, BL-SS-2, BL-SS-3) offshore of Batiquitos/Leucadia in Reach 1 that were being surveyed as part of a 5-year study to document any post-construction impacts resulting from the RBSP. The monitoring stations are located primarily on low-relief substrate (less than 3 ft /1 m), with patchy high-relief substrate (greater than 3 ft/1 m) and sand (AMEC 2002b). The occurrence of indicator species was variable on these reefs during 2001 and 2002. Percent cover of surfgrass differed among monitoring stations; the mean percent cover was lowest near Batiquitos Lagoon (0 to 1 percent at BL-SS-1), and low to moderate cover was reported at stations offshore of Leucadia (11 to 57 percent at BL-SS-2, 30 to 40 percent at BL-SS-3). Mean percent cover of feather boa kelp at all sites ranged from less than 2 percent to 4 percent. Similarly, mean density of sea palms at all sites ranged up to 0.2 per 10 ft^2 (up to 0.2 per m^2). Sea fans were only observed in low densities at station BL-SS-1 (less than 0.1 individual per 10 ft^2 /m^2); they were not observed at the other monitoring stations offshore of Leucadia.

Giant kelp beds occur offshore in the northern and southern areas of Reach 1 between the depths of -20 and -70 ft (-6 and -21 m) MLLW. Giant kelp offshore of Reach 1 is commonly referred to as the Leucadia kelp bed, which experienced substantial die back during the 1997-1998 El Niño. The bed reportedly looked healthy during 2001 (MBC 2001) and the 2002 reconnaissance survey.

SANDAG has three kelp survey stations (BL-K-1, BL-K-2, BL-K-3) offshore of Batiquitos/Leucadia in Reach 1 that were being surveyed as part the RBSP. The mean total number of stipes of giant kelp ranged from 0.1 to 2.0 per 10 ft^2 (0.1 and 2.2 per m^2) at these stations in 2001 and 2002 (AMEC 2002b). The understory kelp *Cystoseira osmundacea* had a mean density that ranged from 0.2 to 9.5 per 10 ft^2 (0.2 to 10.3 plants per m^2). Other understory kelp included feather boa kelp and sea palms, both of which had a mean density ranging from less than 1 to approximately 4 plants per 10 ft^2 (1 to approximately 4 plants per m^2). Low-growing red algae (coralline, leafy, turf) ranged from a mean of 0.3 to 11 percent cover. Encrusting invertebrates (i.e., sponges, ectoprocts, and tunicates) ranged from 0 to 3 percent cover. Boring clams (*Chaceia ovoidea*, *Parapholas californica*) and ornate tube worms (*Diopatra ornata*) had a mean density of 0 to 2.2 and 1.4 to 3.3 individuals per 10 ft^2 (0 to 2.4 and 1.5 to 3.6 individuals per m^2), respectively. Sea fans (*Muricea* spp.) and Kellet's whelk snails (*Kelletia kelletia*) had a mean density of less than 1 individual per 10 ft^2 (less than 1 individual per m^2). Other indicator macroinvertebrates such as sea urchins (*Strongylocentrotus* spp.), starfish (*Pisaster* spp.), and trochid snails (*Lithopoma* spp.) were not observed at these stations.

Shorebirds observed during the September 2002 survey included killdeer, sanderling, willet, marbled godwit, and whimbrel. Western gulls were common, and Heermann's gulls and double-crested cormorants also were observed.

- Reach 2 – Beacon's Beach to 700 Block, Neptune Avenue

The beach in Reach 2 consists of a mix of sand and hard substrate natural communities. Reach 2 corresponds to the northern portion of an alternative Leucadia receiver site evaluated for the RBSP. During a 1999 survey of the site, cobble formed an extensive band in the upper intertidal, and the mid to lower intertidal areas had a mix of sand and low-relief sandstone reefs (MEC 2000). Sand depths ranged from 6 to 20 in (15 to 51 cm) throughout the different tidal zones during early spring, but increased to 21 to 27 in (53 to 68 cm) in the summer of 1999. Worms, sand crabs, and bean clams were observed in the beach sand communities. The site was considered largely unsuitable for grunion due to exposed hard substrates and narrow beach width.

Hard substrates, in the form of low-relief reef (less than 3 ft /1 m), extends throughout the intertidal and nearshore zone. The intertidal low-relief reefs were subject to seasonal sedimentation impacts prior to the RBSP. Scattered occurrences of surfgrass and feather boa kelp, coralline and filamentous red algae, small leafy brown algae, *Ulva* green algae, aggregated sea anemone, California mussel, wavy top turban snails (*Lithopoma undosa*), hermit crabs, and *Cancer* crabs were associated with the intertidal reefs during the 1999 winter season when sand depths were lower on the beach (MEC 2000). During the summer in 1999, most of the sandstone bench was covered with sand, with only a few exposed patches of surfgrass, and hermit crabs were the only invertebrates observed.

Dive surveys by the U.S. Navy mapped scattered occurrence of surfgrass and feather boa kelp on the nearshore reefs in this reach. No sea fans or sea palms were mapped on reefs within Reach 2.

Giant kelp in Reach 2 is part of the Leucadia kelp bed. Giant kelp occurs between depths of --20 and -70 ft (-6 and -21 m) MLLW near the northern reach boundary, but mainly occurs at deeper depths between -46 and -70 ft (-14 and -21 m) MLLW. Commercial fishermen have indicated that scattered rocks also occur offshore between depths of approximately -46 and -66 ft (-14 and -20 m) MLLW.

SANDAG has one kelp station (EN-K-1) offshore of Leucadia in Reach 2 that was surveyed as part the RBSP. The mean total number of stipes of giant kelp ranged between 0.7 to 3.0 stipes per 10 ft^2 (0.7 and 3.2 per m^2) in 2001 and 2002 (AMEC 2002b). Understory kelp included *Cystoseira osmundacea* (5.0 to 10.1 plants per 10 ft^2 /5.5 to 10.9 plants per m^2), feather boa kelp (1.5 to 4.7 per 10 ft^2 /1.6 to 5.1 plants per m^2), and sea palms (1.8 to 2.0 plants per 10 ft^2 /1.9 and 2.2 plants per m^2). Low growing red algae (coralline, leafy, turf) ranged from a mean of 16 to 27 percent cover. Encrusting invertebrates (i.e., sponges, ectoprocts, and tunicates) had a mean percent cover that ranged from 1 to 3 percent. Observed indicator macroinvertebrates (boring clams, Kellet's whelk, ornate tube worms, sea fans) each had an average density of about 1 individual per 10 ft^2 (about 1 individual per m^2). Sea urchin, starfish, and trochid snail indicator macroinvertebrates were not observed.

Sanderling, marbled godwit, and spotted sandpipers were observed foraging along the shoreline during a September 2002 survey of Reach 2. Several western gulls, a few ring-billed gulls, and numerous California brown pelicans also were observed.

- Reach 3 –700 Block, Neptune Avenue to Stone Steps

  Prior to the RBSP, the beach in this reach was similar to that described for Reach 2; however, hard substrate formed more extensive coverage. Reach 3 includes the southern portion of the alternative Leucadia receiver site evaluated for the RBSP. During 1999, cobble formed an extensive band in the upper intertidal, and the mid to lower intertidal was covered by a low-relief sandstone bench and cobbles during the spring (MEC 2000). The sandstone reef had few marine resources (coralline and filamentous red algae) and was covered with 1 to 3 ft (0.3 to 1 m) of sand during summer. The site was considered unsuitable for grunion spawning due to extensive hard substrate in 2000 and likely is unsuitable currently.

  Hard substrate has scattered occurrence offshore in Reach 3. Low-relief reef extends throughout the nearshore zone and one localized patch of high-relief reef occurs in the northern half of the reach. Dive surveys by the U.S. Navy mapped scattered occurrences of surfgrass and feather boa kelp on the low relief nearshore reefs; these species and sea palms were observed on the high-relief reef.

  SANDAG has one shallow subtidal survey station (ML-SS-1) offshore of Encinitas in Reach 3, upcoast of the Moonlight Beach receiver site, that was surveyed as part of the RBSP. The location had seasonally variable amounts of low-relief substrate (41 to 60 percent), high-relief substrate (5 to 36 percent), and sand (9 to 33 percent) in 2001 and 2002 (AMEC 2002b). The occurrences of indicator species were similar in 2001 and 2002. The mean percent cover of surfgrass ranged from 35 to 41 percent, and the mean percent cover of feather boa kelp was about 3 percent. The number of sea palms ranged from 0.1 to 0.3 per 10 ft^2 (0.1to 0.3 per m^2). No other indicator species (sea fans) were observed at this station in 2001 and 2002.

  Giant kelp in Reach 3 is part of the Leucadia kelp bed, and occurs at depths of -20 to -56 ft (-6 to -17 m) MLLW. Commercial fishermen have indicated that scattered rocks also occur offshore, between depths of approximate -46 to -66 ft (-14 to -20 m) MLLW.

  SANDAG has one kelp survey station (EN-K-2) offshore of Leucadia in Reach 3 that was surveyed as part the RBSP. The mean total number of stipes of giant kelp ranged between 3.3 and 5.1 per 10 ft^2 (3.5 and 5.5 per m^2) in 2001 and 2002 (AMEC 2002b). Understory kelp included sea palms (0.4 to 1.8 plants per 10 ft^2 /0.4 to 1.9 plants per m^2), and few feather boa kelp and *Cystoseira osmundacea* (less than 1 plant per 10 ft^2 /m^2). Low growing red algae (coralline, leafy, turf) ranged from a mean of 1 to 4percent cover. Encrusting invertebrates (i.e., sponges, ectoprocts, and tunicates) ranged from a mean of 1 to 2 percent cover. The most abundant macroinvertebrates included boring clams (mean of 0 to 2.9 10 ft^2 /0 to 3.1 individuals per m^2) and sea fans (mean of 0.7 to 1.7 per 10 ft^2 /0.8 to 1.8 individuals per m^2). Other observed macroinvertebrates (Kellet's whelk, ornate tube worms, sea urchins, starfish) each had an average density of 1 or less individual per 10 ft^2 /m^2. Trochid snail indicator macroinvertebrates were not observed.

Spotted sandpipers were observed on the beach during the September 2002 survey.

- Reach 4 – Stone Steps to Moonlight Beach

  Prior to the RBSP, the beach in this reach mainly consisted of sand; however, 30 to 100 percent cobble was present in the upper intertidal. The southern portion of Reach 4 includes the Moonlight Beach receiver site evaluated for the RBSP. Sand depths within the Moonlight Beach receiver site ranged from 6 to 24 in (15 to 61 cm) in the spring of 1999, and supported worms and sand crabs. The Moonlight Beach site was considered marginally suitable to unsuitable for grunion spawning (MEC 2000, AMEC 2002a).

Hard substrates were reported to be of scattered occurrence offshore in Reach 4. Reef areas mapped by side-scan sonar are small and of low relief. Only one patch of surfgrass of about 0.04 ac (0.02 ha) was mapped on one small reef in 2000. Coralline and red turf algae were observed on most of the low-relief reefs, and feather boa kelp had scattered occurrences (MEC 2000). The Navy noted scattered occurrence of surfgrass and feather boa kelp; no sea fans or sea palms were observed on reefs within this reach.

SANDAG has one kelp station (EN-K-3) offshore of Leucadia in Reach 3 that was surveyed as part the RBSP. The mean total number of stipes of giant kelp ranged from 1.4 to 2.9 per 10 ft^2 (1.5 and 3.1 per 1 m^2) in 2001 and 2002 (AMEC 2002b). Feather boa kelp had a mean density that ranged between 1.0 to 2.0 per 10 ft^2 (1.1 and 2.2 plants per m^2). Other understory kelp species (sea palms, *Cystoseira osmundacea*, *Desmerestia ligulata*) each had a density of less than 1 plant per 10 ft^2 /m^2. Low growing red algae (coralline, leafy, turf) ranged from a mean of 13 to 21 percent cover. Encrusting invertebrates (i.e., sponges, ectoprocts, and tunicates) ranged from a mean of 7 to 29 percent cover. The most abundant macroinvertebrates included sea fans (mean of 2.4 to 5.6 individuals per 10 ft^2 /2.6 to 6.1 individuals per m^2) and Kellet's welk (mean of 0.4 to 2.5 individuals per 10 ft^2 /0.4 to 2.7 individuals per m^2). Other observed macroinvertebrates (boring clams, ornate tube worms, starfish) each had an average density of 1 or less individual per 10 ft^2 /m^2. Trochid snail and sea urchin indicator macroinvertebrates were not observed.

Giant kelp in Reach 4 is part of the Leucadia kelp bed, which ends offshore of the northern half of this reach. Prior to the 1997 to 1998 El Niño, kelp was mapped between -16 to -36 ft (-5 and -11 m) MLLW, but has had limited recovery since then.

Marbled godwit, willet, and Heermann's and western gulls were observed on the shoreline in Reach 4 during the September 2002 survey.

- Reach 5 – Moonlight Beach to Swami's

  Prior to the RBSP, the northern half of this reach was similar to the southern end of Reach 4, in being mainly sand; however, 30 to 100 percent cobble was present in the upper intertidal (MEC 2000).

  Scattered occurrences of hard substrate were observed offshore of the northern half of the reach, and likely remains more extensive in the southern portion of Reach 5. The hard substrate includes scattered low-relief reef and rocks in the northern half of the reach, and extensive low- to high-relief reefs south of H Street. Although substrates have not been fully mapped offshore of the southern portion of the reach, reef communities are known to extend offshore from the intertidal reefs (AMEC 2002b).

  No surfgrass or other sensitive resources were mapped on the low-relief reef offshore of the northern half of the site in 2000; whereas, sea fans, sea palms, feather boa kelp, and surfgrass occurred on the nearshore reefs south of H Street and around Swami's Point (Ogden 1999, MEC 2000). One small area of surfgrass was mapped in the lower intertidal zone near G Street, and extensive surfgrass coverage extended from approximately I Street to the end of Swami's Point in both 2000 and 2002.

  SANDAG has one shallow subtidal survey station (SW-SS-1) offshore of Swami's Point in Reach 5 that was surveyed as a control site for the RBSP. The location had a seasonally variable amount of low-relief substrate (5 to 80 percent), high-relief substrate (0 to 20 percent), and sand (0 to 95 percent) in 2001 and 2002 (AMEC 2002b). The occurrence of indicator species was similar in 2001 and 2002. The mean percent cover of surfgrass ranged from 6 to 8 percent, and the mean percent cover of feather boa kelp ranged from 2 to 17 percent. The mean density of sea palms was relatively low (less than 1 plant per 100 ft^2 /10 m^2). No other indicator species (sea fans) were observed at this station in 2001 and 2002.

  Giant kelp occurs near the southern boundary of Reach 5, and represents the northern part of the Encinitas kelp bed. Prior to the 1997 to 1999 El Niño, kelp occurred between -33 to -49 ft (-10 and -15 m) MLLW, but this kelp has reportedly had limited recovery since then.

  SANDAG has one kelp survey station (SW-K-1) offshore of Swami's Point in Reach 5 that has been surveyed as a control site for the RBSP. The mean total number of stipes of giant kelp ranged from 1.4 to 2.9 per 10 ft^2 (1.5 and 3.1 per m^2) in 2001 and 2002 (AMEC 2002b). The mean density of understory kelp was relatively similar for sea palms (3.8 to 9.2 per 10 ft^2 /4.1 to 9.9 plants per m^2), *Cystoseira osmundacea* (2.0 to 6.7 plants per 10 ft^2 /2.2 to 7.2 plants per m^2), and feather boa kelp (1.5 to 4.1 per 10 ft^2 /1.6 to 4.4 plants per m^2). Low growing red algae (coralline, leafy, turf) ranged between a mean of 6 and 20 percent cover. Encrusting invertebrates (i.e., sponges, ectoprocts, and tunicates) averaged between 0 and 3 percent cover. Observed macroinvertebrates (boring clams, Kellet's whelk, ornate tube worms, sea fans, sea urchins) each had a mean density of less than 1 individual per 10 ft^2 /m^2. Trochid snail and starfish indicator macroinvertebrates were not observed

No shorebird or seabirds were observed along Reach 5 during the September 2002 survey.

- Reach 6 – Swami's to San Elijo Lagoon Entrance

  The beach consists of sand in the upper to mid intertidal. Intertidal reefs with surfgrass occur at Swami's Beach and from about mid reach to the southern reach boundary. The intertidal reefs support a variety of marine resources including several species of algae, feather boa kelp, and invertebrates. Marine birds, including black-crowned night heron, great blue heron, and great egret were observed foraging on the reefs during the 2002 reconnaissance survey.

  Hard substrate is extensive offshore of the whole reach. However, no detailed mapping of substrate type, height, and marine resources has been reported to date.

  SANDAG has two shallow subtidal control survey stations (SW-SS-2, SW-SS-3) offshore of Swami's Beach at the north end of Reach 6 that were being surveyed for the RBSP. These locations had seasonally variable amounts of low-relief substrate (22 to 87 percent), high-relief substrate (0 to 6 percent), and sand (9 to 78 percent) in 2001 and 2002 (AMEC 2002b). The occurrence of indicator species was similar in 2001 and 2002. The mean percent cover of surfgrass was moderate at station SW-SS-2 (16 to 26 percent) and seasonally low at station SW-SS-3 (0.5 to 7 percent). Similarly, the mean percent cover of feather boa kelp was higher at station SW-SS-2 (9 to 17 percent) than at station SW-SS-3 (2 to 6 percent). The mean density of sea palms was relatively low (less than 0.1 plant per 10 ft^2 /m^2) at each of these stations. No other indicator species (sea fans) were observed at these stations in 2001 and 2002.

  The major portion of the Encinitas kelp bed occurs offshore at depths between -20 and -59 ft. (-6 and -18 m) MLLW. SANDAG has two kelp survey control stations (SW-K-2, SW-K-3) offshore of Swami's Beach at the north end of Reach 6, and one station offshore of Cardiff (CF-K-1) at the south end of this reach, that were being surveyed for the RBSP. The mean total number of stipes of giant kelp ranged between 2.7 and 7.1 per 10 ft^2 (3.0 and 7.7 per m^2) at the stations offshore of Swami's, and from 0.6 to 5.9 per 10 ft^2 (0.6 to 6.4 per m^2) offshore of Cardiff in 2001 and 2002 (AMEC 2002b). A variety of other indicator species occurred in the kelp beds offshore of Swami's, but at relatively low densities and percent cover. The mean density of sea palms ranged from 1.4 to 4.8 per 10 ft^2 (1.5 to 5.2 plants per m^2), and other species of understory kelp (*Cystoseira osmundacea*, *Desmerestia ligulata*, feather boa kelp, *Laminaria farlowii*) each had less than 2 plants per 10 ft^2 (2 plants per m^2) at stations SW-K-2, SW-K-3. Low growing red algae (coralline, leafy, turf) averaged 1 to 8 percent cover. Encrusting invertebrates (i.e., sponges, ectoprocts, tunicates) had less than 5 percent cover, and observed macroinvertebrates (boring clams, Kellet's whelk, ornate tube worms, sea fans, sea urchins, starfish, trochiid snails) each had a mean density of less than 2 individuals per 10 ft^2 (less than 2 individuals per m^2). The density of indicator species was slightly higher at Cardiff station CF-K-1, but fewer indicator species were observed than offshore of Swami's Beach. Sea palms and *Cystoseira osmundacea* had mean densities that ranged from 5.5 to 9.2 plants per 10 ft^2 (5.9 to 9.9 plants per m^2) and 3.7 to 6.7 plants per 10 ft^2 (4.0 to 7.2 plants per m^2), respectively, at station CF-K-1. Feather boa kelp density was less than 2 plants per 10 ft^2 (2 plants per m^2). Low growing red algae (coralline, leafy, turf) had a moderate (20 to 40) percent cover. Encrusting invertebrates (i.e., sponges, ectoprocts, tunicates) averaged less than 5 percent cover, and observed macroinvertebrates (Kellet's whelk, ornate tube worms, trochiid snails) each had a mean density of less than 1 individual per 10 ft^2 (less than 1 individual per m^2).

Several shorebirds were observed during the September 2002 survey, including black turnstone, marbled godwit, whimbrel, and willet. Hermann's, ring-billed, and western gulls also were observed. Giant egret, great blue heron, and black-crowned night heron were observed on exposed reefs during a minus tide during the May 2002 survey.

- Reach 7 – San Elijo Lagoon Entrance to Table Tops Reef

  In the several years prior to the RBSP, the mid to upper intertidal zone of this reach consisted of 80 to 100 percent cobble, and the low intertidal consisted of sand with moderate cobble coverage. No marine organisms were found on the cobble beach during surveys (MEC 2000).

  Riprap revetment/slope protection has been placed on the beach in front of three restaurants near the north end of the reach, west of Coast Highway 101. Few marine organisms were observed on the riprap prior to the RBSP. Acorn barnacle (*Cthamalus* spp.) was common in the splash zone; whereas, feather boa kelp (*Egregia menziesii*) and goose-neck barnacle (*Pollicipes polymerus*) had localized occurrence along the lower elevations of the riprap (MEC 2000).

  Sand occurs offshore of most of the reach, and low- to high-relief reefs occur near the northern and southern boundaries of the reach.

  Low- to high-relief reef, which corresponds to Cardiff reef, was mapped from the intertidal zone through the nearshore of the northern portion of the reach. Surfgrass occurred on the intertidal portion of Cardiff reef in 2000 and 2002. Surfgrass, feather boa kelp, sea palm, and sea fans were noted on offshore of portions of Cardiff reef in 2000.

  High-relief substrate also was mapped mid reach; this substrate corresponds to the San Elijo outfall pipeline. Reef also occurs at the southern end of the reach, which transitions from patchy low-relief reef into high-relief reef at Table Tops. Surfgrass was present offshore on the low-relief reef. Most of Table Tops reef occurs in Reach 8 and is described below under that subsection.

SANDAG has two shallow subtidal survey stations (CF-SS-1, CC-SS-1) offshore of Cardiff in Reach 7 that were surveyed for the RBSP. Station CF-SS-1 had a seasonally variable amount of low-relief substrate (18 to 60 percent), high-relief substrate (7 to 15 percent), and sand (30 to 76 percent) in 2001 and 2002 (AMEC 2002b). Station CC-SS-1 primarily had low-relief substrate (53 to 80 percent) with seasonally patchy high-relief substrate (17 to 46 percent) and sand (2 to 9 percent). The mean percent cover of surfgrass was seasonally low to moderate at station CF-SS-1 (2 to 15 percent) and moderate at station CC-SS-1 (23 to 24 percent). The percent cover of other surveyed indicator species was low to moderate. At station CF-SS-1, the mean percent cover of feather boa kelp ranged from 7 to 16 percent, and the mean densities of sea palms and sea fans were less than 0.1 individual per 10 ft^2 (less than 0.1 individual per m^2). At Station CC-SS-1, feather boa kelp had 6 to 9 percent cover, sea palms ranged from 0.2 to 0.3 individuals per 10 ft^2 (0.2 to 0.3 individuals per m^2), and no sea fans were observed.

Giant kelp occurs offshore of the northern and southern portions of the reach. Giant kelp also has been found growing on the San Elijo outfall pipe, which discharges farther offshore with the outlet at a depth of -148 ft (-45 m) MLLW. Kelp in the northern part of the reach belongs to the Cardiff kelp bed, and kelp in the southern part of the reach belongs to the Solana Beach kelp bed, both of which have had substantial recovery since the 1997 to 1998 El Niño. Giant kelp is expected between depths of -20 and -49 ft (-6 and -15 m) MLLW offshore of Reach 7.

SANDAG has two kelp survey stations offshore of Cardiff (CF-K-2, CF-K-3) in Reach 7 that have been surveyed for the RBSP. The mean total number of stipes of giant kelp ranged between 0.4 and 3.9 per 10 ft^2 (0.5 and 4.2 per m^2) offshore of Cardiff in 2001 and 2002 (AMEC 2002b). The mean density of sea palms ranged from 4.8 to 7.1 plants per 10 ft^2 (5.2 to 7.7 plants per m^2), and other species of understory kelp (*Cystoseira osmundacea, Desmerestia ligulata*, feather boa kelp, *Laminaria farlowii, Pterygophora californica*) each averaged 4 or fewer plants per 10 ft^2 (4 or fewer plants per m^2). Low growing red algae (coralline, leafy, turf) averaged 10 to 31 percent cover. Encrusting invertebrates (i.e., sponges, ectoprocts, and tunicates) generally had less than 5 percent cover. The mean density of boring clams and Kellet's whelk ranged from approximately 0.1 to 3.7 individuals per 10 ft^2 (0.1 to 4 individuals per m^2). Other observed macroinvertebrates (ornate tube worms, sea fans, sea urchins, starfish, trochiid snail) each had a mean density of less than 1 individual per 10 ft^2 (less than 1 individual per m^2).

Shorebirds, including black turnstone, marbled godwit, and willet were observed on the shoreline during the September 2002 survey. Heermann's gulls also were seen in this reach.

- Reach 8 – Table Tops Reef to Fletcher Cove
  Prior to the RBSP, the northern portion of the reach consisted of sand in the upper intertidal with various densities of cobble cover (up to 60 percent) next to the cliff (MEC 2000). The southern half of the reach corresponds to the alternative Solana Beach receiver site evaluated for the RBSP. Sand depths were less during winter (average of 14 in/35 cm) than summer (average of 28 in/71 cm) (MEC 2000). No marine resources were associated with the cobble substrate. Sand crabs, worms, and amphipod crustaceans occupied the sand communities.

  Low- and high-relief reefs occur in mid to low intertidal zones and extend offshore. Surfgrass forms extensive beds in the northern part of the reach, which corresponds to Table Tops and Tide Park reefs. An intertidal to shallow subtidal reef, known as "Pill Box", occurs in the southern part of the reach, just north of Plaza Street. Seasonal sand sedimentation was observed to affect marine resource development at these reefs prior to the RBSP. The low- to high-relief reefs at Table Tops had surfgrass, a variety of algae, aggregated sea anemones, California mussel, chitons, crabs, hermit crabs, limpets, sand castle worms, marine snails, sea hares, and sea stars during both winter and summer, although substantial sand sedimentation (up to 3 ft/1 m) buried some marine resources, including surfgrass, on the lower portions of the reef in the summer of 1999 (MEC 2000).

  The intertidal to shallow subtidal reef at Tide Park also exhibited considerable seasonal change in resource development in 1999. This low-relief reef supported feather boa kelp, coralline and filamentous red algae, *Ulva* green algae, *Colpomenia* and dictyotales brown algae, hermit crabs, aggregated sea anemones, and a variety of marine snails during the winter, but most of the low lying reef was covered with sand in the summer. Only feather boa kelp, filamentous red algae, and a few hermit crabs were observed (MEC 2000).

  The higher relief portions of Pill Box reef had coralline and leafy red algae, *Ulva*, small leafy brown algae, feather boa kelp, surfgrass, and aggregated sea anemones during both winter and summer. However, the lower portions of the reef exhibited a similar pattern of burial and reduction in marine resources between winter and summer as described above for the low-relief reef offshore of Tide Park (MEC 2000).

  SANDAG has two shallow subtidal survey stations (CC-SS-2, CC-SS-3) offshore of Solana Beach in Reach 8 that are being surveyed for the RBSP. Station CC-SS-2 had seasonally variable amounts of low-relief substrate (27 to 51 percent), high-relief substrate (6 to 20 percent), and sand (40 to 67 percent) in 2001 and 2002 (AMEC 2002b). Station CC-SS-3 had seasonally variable amounts of low-relief substrate (36 to 82 percent) and high-relief substrate (18 to 64 percent), and very little sand (0 to 0.2 percent). The mean percent cover of surfgrass was moderate at these stations (21 to 35 percent). The mean percent cover of feather boa kelp was low to moderate (2 to 14 percent). The mean density of sea palms ranged from 0.02 to 0.3 individuals per 10 ft^2

(0.02 to 0.3 individuals per m^2) at station CF-SS-1. No other indicator macroinvertebrate species (sea fans) were observed at these stations.

Giant kelp in this reach belongs to the Solana Beach kelp bed, which has substantially recovered since the 1997-1998 El Niño. Kelp occurs offshore at depths of -20 to -66 ft (-6 to -20 m) MLLW.

SANDAG has one kelp station (SB-K-1) offshore of Solana Beach in Reach 8 that has been surveyed as part of the RBSP. The mean total number of stipes of giant kelp ranged between 1.7 and 3.5 per 10 ft^2 (2.3 and 3.8 per m^2) in 2001 and 2002 (AMEC 2002b). The mean density of understory kelp was less than 1 plant per 10 ft^2 (m^2) for each observed species (*Cystoseira osmundacea*, feather boa kelp, *Laminaria farlowii*, *Pterygophora californica*). Low growing red algae (coralline, leafy, turf) ranged between a mean of 3 and 7 percent cover. Encrusting invertebrates (i.e., sponges, ectoprocts, and tunicates) averaged between 1 and 11 percent cover. Observed macroinvertebrates (boring clams, Kellet's whelk, ornate tube worms, sea fans, sea urchins, and starfish) each had a mean density of less than 1 individual per 10 ft^2 (less than1 individual per m^2). No other indicator macroinvertebrate species (i.e., trochid snails) were observed at this station.

Black turnstone, marbled godwit, and sanderling were observed foraging along the shoreline during the September 2002 survey. Heermann's gull, ring-billed gull, and western gull also were commonly observed in this reach.

- Reach 9 - Fletcher Cove to Solana Beach Southern City Limit

  Intertidal natural communities in this area are primarily sand with localized areas of low-relief reef. The northern half of the reach corresponds to the proposed Solana Beach receiver site evaluated for the RBSP. Sand depths ranged from 2 to 40 in (5 to 102 cm) with an overall average depth of 19 in (48 cm) during the winter and 25 in (63 cm) during the summer of 1999 (MEC 2000). Sand crabs, worms, and amphipod crustaceans occurred in the sand communities.

  Four low relief reefs were observed in the low intertidal between 499 to 794 ft (152 and 242 m), 994 and 1142 ft (303 and 348 m), 2,684 and 2,762 ft (818 to 842 m), and 3,107 and 3,540 ft (947 to 1,079 m) south of Fletcher Cove during 1999. Marine resources associated with these reef areas included coralline and filamentous red algae, feather boa kelp, small leafy brown and red algae, aggregated sea anemones, chitons, and hermit crabs during early spring 1999 (MEC 2000). During the summer of 1999, sand covered large portions of these low-lying reefs, and feather boa kelp was the only exposed marine resource. Surfgrass was not observed during surveys of the intertidal of this reach in 2000 or 2002.

Sand natural communities occur in the nearshore subtidal zone directly offshore of Fletcher Cove, and extend south approximately 1,100 ft (335 m) from the southern edge of the cove. Patch and low-relief finger reefs occur in the nearshore south of that point and continue to the end of the reach boundary. Surfgrass, feather boa kelp, sea fans, and sea palm occur on reefs within this area.

SANDAG has one shallow subtidal survey station (SB-SS-1) offshore of Solana Beach in Reach 9 that has been surveyed as part of the RBSP. The location had seasonally variable amounts of low-relief substrate (36 to 58 percent), high-relief substrate (8 to 14 percent), and sand (28 to 52 percent) in 2001 and 2002 (AMEC 2002b). The occurrence of indicator species was similar in 2001 and 2002. The mean percent cover of surfgrass ranged from 8 to 12 percent, and the mean percent cover of feather boa kelp was less than 1 percent. The mean density of sea palms was relatively low (less than 0.1 plant per 10 ft^2 /m^2). No macroinvertebrate indicator species (sea fans) were observed at this station in 2001 and 2002.

Giant kelp in this reach belongs to the Solana Beach kelp bed. Kelp occurs offshore at depths of -20 to -59 ft (-6 to -18 m) MLLW. Kelp has undergone recovery in the northern, but not southern, portion of the reach since the 1997 to 1998 El Niño.

SANDAG has two kelp survey stations (SB-K-2, SB-K-3) offshore of Solana Beach in Reach 9 that are being surveyed as part of the RBSP. The number of stipes of giant kelp per area was higher at station SB-K-2 (mean total of stipes 2.6 to 5.2 per 10 ft^2 /2.8 to 5.6 per m^2) than at station SB-K-3 (mean total of stipes 0.7 to 1.6 per 10 ft^2 /0.7 to 1.7 per m^2) in 2001 and 2002 (AMEC 2002b). A relatively low mean density was reported for understory kelp (less than 1 plant per 10 ft^2 /m^2), and low growing red algae (coralline, leafy, turf) ranged from 6 to 9 percent cover at station SB-K-2. Similarly, encrusting invertebrates had a relatively low mean (1 to 3) percent cover, and observed macroinvertebrates (boring clams, ornate tube worms, sea fans, sea urchins, starfish) each had a mean density of less than 1 individual per 10 ft^2 (less than 1 individual per m^2) at station SB-K-2. Mean density and/or percent cover were slightly higher at station SB-K-3 for understory algae (1.5 to 8.3 plants per 10 ft^2/1.6 to 9.0 plants per m^2), low growing red algae (3 to 13 percent cover), and encrusting invertebrates (3 to 12 percent cover). The mean density of sea fans ranged from 0.7 to 2.6 individuals per 10 ft^2 (0.8 to 2.8 individuals per m^2), and other observed macroinvertebrate species (boring clams, ornate tube worms, sea urchin, starfish) each had a mean density of less than 2 individuals per 10 ft^2 (less than 2 individuals per m^2) at Station SB-K-3. No Kellet's whelk or trochiid snail indicator macroinvertebrate species were observed at stations SB-K-2, and SB-K-3 in 2001 to 2002.

Shorebirds observed during the September 2002 survey included willet and whimbrel. Ring-billed gulls were observed foraging along the shoreline.

Terrestrial Environment

The Study Area includes terrestrial environments upslope of the intertidal zone and extends to the top of bluffs or the first parallel road, whichever is closer. The characterization of terrestrial shoreline natural communities between Batiquitos Lagoon and the southern boundary of the City of Solana Beach is based on a biological survey completed in September 2002 by the Chambers Group, the Service's knowledge of the local environment, relevant studies, and applicable literature.

The terrestrial survey submitted for this Project occurred in the fall of 2002, which would result in an inclusive determination for the majority of flora and some fauna. The majority of botanical surveys within the coastal zone typically take place during the prime growing season (spring, early summer). Therefore, the survey effort for this Project was outside of the seasonal window deemed appropriate to make conclusive botanical identifications and determinations. However, proposed Project implementation activities (e.g., notch fill activities) would almost totally take place on the beach and water, with minimal encroachment on bluff natural communities. Activities occurring on bluffs would be limited to the bases of bluffs, within and immediately surrounding bluff notches.

Plants and Vegetation Communities

In general, the Study Area consists of a mixture of non-native and native vegetation along the coastal bluffs and shoreline beach communities adjacent to the bluffs. Fig marigold (*Carpobrotus* sp.), which is a non-native species, was the dominant plant in all study reaches. Identifiable native plant communities do not occur along the immediate coastal bluff area; native species were sparse and occurred in localized areas. The lagoon communities, which occur outside of the Study Area and were not surveyed, contain predominately native natural communities (e.g., coastal salt marsh).

Diegan coastal sage scrub species were found interspersed with a large amount of exotic vegetation occurring in a relatively small (remnant) somewhat natural area south of Batiquitos Lagoon near the northern boundary of Reach 1. The more commonly occurring native plant species included coastal prickly pear (*Opuntia littoralis*), salt marsh fleabane (*Pluchea odorata*), and western marsh rosemary (*Limonium californicum*).

<u>Sensitive Plants</u>

Numerous sensitive plants are known to occur within the Study Area. However, the majority of these species are located further upslope/inland from the actual proposed Project activity footprint. These species are unlikely to occur within the Project footprint due to a lack of suitable habitats associated with development and continued disturbance.

Nuttal's lotus (*Lotus nuttallianus*) – the Nuttal's lotus has the potential to occur within the Study Area based on its habitat affinities and historical observations along the beaches at both Encinitas and Del Mar, at the southern ends of Cardiff and Carlsbad State Beaches, and south of the mouth of Batiquitos Lagoon (Reiser 1994). This species may have been overlooked during September botanical surveys.

Del Mar sand aster (*Corethrogyne filaginifolia* var. *linifolia*) – the sand aster has the potential to occur within the Study Area based on its habitat affinities. However, this species prefers coastal sage scrub/chaparral natural communities and could have been observed during the September botanical survey.

Sea dahlia (*Coreopsis maritima*) – sea dahlia has a limited potential to occur within the Study Area due its normal habitat (coastal eroded cliffs) being largely occupied by development. Sea dahlia would have been difficult to observe during the September botanical survey and therefore potentially overlooked.

Coastal wooly-heads (*Nemacaulis denudata* var. *denudata*) – the coastal wooly-head has a potential to occur within the Study Area based on its known habitat affinities. This species occupies similar areas as Nuttal's lotus and may have been overlooked during the September botanical survey.

Orcutt's spineflower (*Chorizanthe orcuttiana*) – Orcutt's spineflower has a potential to occur within the Study Area based on its known habitat affinities. Orcutt's spineflower occurs in open patches of sandy soil in relatively flat areas at the toe of coastal bluffs, often on Carlsbad gravelly loamy sand (Reiser 1994). This species may have been overlooked during the September botanical survey.

Blochman's dudleya (*Dudleya blochmaniae* ssp. *blochmaniae*) – Blochman's dudleya has a potential to occur within the Study Area based on its habitat affinities (coastal bluff, coastal sage scrub) and documented species locations.

Decumbent goldenbush (*Isocoma menziesii* var. *decumbens*) - decumbent goldenbush has potential to occur within the Study Area based on its habitat affinities. It has been reported from sea bluffs at the southern tip of Point Loma, about the salt marsh at Imperial Beach, and at scattered locales north of La Jolla, usually quite near the ocean (Reiser 1994).

Orcutt's pincushion (*Chaenactis glabriuscula* var. *orcuttiana*) - Orcutt's pincushion has potential to occur within the Study Area based on its habitat affinities (coastal bluff scrub, coastal bluffs and coastal dunes). This species may have been overlooked during the September botanical survey.

Cliff spurge (*Euphorbia misera*) - Cliff spurge has a potential to occur within the Study Area based on its affinity for coastal bluff scrub. This deciduous species may have been overlooked during the September botanical survey.

Lewis's primrose (*Camissonia lewisii*) - Lewis's primrose has a potential to occur within the Study Area based on its affinity for very sandy substrates near the beach, typically on beach bluffs. This species may have been overlooked during the September botanical survey.

Wildlife

The majority of terrestrial natural communities within the Study Area consist of isolated bluffs that support mostly non-native plant natural communities, in which few wildlife species were documented or expected to be present. In addition, the bluffs of the Study Area are narrow, effectively small in area, and generally isolated from larger areas of surrounding native plant natural communities (such as within Batiquitos, San Elijo, and San Dieguito lagoon areas) by roads and urban development. The terrestrial areas of San Elijo Lagoon, which were not surveyed as part of this Project, support a predominately native and highly diverse wildlife ecosystem.

Invertebrates

Two species of butterfly were observed along the coastal bluffs during the September 2002 survey. The cabbage white (*Artogeia rapae*) was observed along five of the nine reaches. The western pygmy blue (*Brephidium exilis*) was observed in Reach 6.

Sensitive Invertebrates

The salt marsh skipper butterfly (*Panoquina errans*) has the potential to occur within the Study Area. Focused surveys for this species were not completed; however, the appropriate habitat occurs within the salt marsh of San Elijo Lagoon (outside of areas subject to proposed Project activities). No sensitive terrestrial invertebrates are known or expected to occur within in the Project footprint area.

Reptiles

Beach and bluff natural communities are expected to support several species of reptiles, mainly lizards. The western fence lizard (*Sceloporus occidentalis*) was observed during the September 2002 reconnaissance survey. Other species with substantial potential to occur include California side-blotched lizard (*Uta stansuriana elegans*), coastal western whiptail lizard (*Cnemidophorus tigris multiscutatus*), orange-throated whiptail (*Cnemidophorus hyperythrus beldingi*), and silvery legless lizard (*Anniella pulchra pulchra*) (MEC 1997). No sensitive reptiles are known or expected to occur within the Study Area.

Birds

A total of 12 terrestrial bird species were observed during the September 2002 reconnaissance-level survey. Numerous species of terrestrial birds are known to occur within the terrestrial portions of the proposed Project footprint. Terrestrial birds associated with the shoreline and bluff natural communities observed during the September 2002 survey consisted of urban adapted species such American crow (*Corvus brachyrhynchos*), house finch (*Carpodacus mexicanus*), and rock pigeon (*Columba livia*). In addition, black phoebe (*Sayornis nigricans*), bushtit (*Psaltriparus minimus*), and song sparrow (*Melospiza melodia*) were commonly observed.

Sensitive Bird Species

Numerous sensitive bird species are known to occur within the Study Area; however, most of these species are of transitory nature and/or would be present for short durations of time and predominately within upland natural communities. None of these species are normally expected to use the bluff portions of the Project activity footprint.

Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) – this savannah sparrow is known to occur within the Study Area, with subpopulations at San Elijo and Batiquitos lagoons. They are year-round residents, restricted to salt marshes, mud flat, and low coastal strand vegetated habitat areas. They frequent areas dominated by *Salicornia* (pickleweed), *Allenrolfea, Suaeda, Atriplex*, and *Distichlis* and prefer to nest in the mid- to upper-littoral zones of coastal salt marshes (Wheelwright and Rising 1993). In 2001, Zembal and Hoffman recorded 75 individuals at San Elijo Lagoon and 66 at Batiquitos Lagoon. Salt marsh communities for the species within Agua Hedionda, Batiquitos, and San Elijo lagoons are considered major subpopulation areas and are important conservation locations in the Multiple Habitat Conservation Program Subregional Plan (MHCP) for north coastal San Diego County.

Coastal California gnatcatcher (*Polioptila californica californica*) – California gnatcatchers typically occur in or near coastal sage scrub communities; coastal sage scrub is present amongst some of the upland areas adjacent to the Study Area. No gnatcatchers are known or expected to occur in the Project footprint area, but they have been documented in the upland areas of the noted lagoons.

American peregrine falcon *(Falco peregrinus anatum)* - This species is not known to breed within the Study Area. However, it winters regularly at Batiquitos and Aqua Hedionda lagoons, has been seen over the coastline near Fletcher Cove (John Martin and Kurt Roblek, USFWS biologists, pers. obs.), and nests near Torrey Pines State Park (Jon Avery, USFWS biologist, pers. obs.). All coastal wetlands and lagoons in the region are considered essential locations for foraging by the species.

Osprey (*Pandion haliaetus*) - Osprey occur regularly in the area at San Elijo and Batiquitos lagoons (John Martin and Kurt Roblek, USFWS biologist, pers. obs.). No major populations of ospreys occur in the Study Area, but all the coastal lagoons and estuaries of the region are considered essential foraging areas for the species. Osprey are currently regular fall and winter visitors, with up to 11 individuals reported from Batiquitos Lagoon in December 1999 (Unitt 2004). This species is increasing in number in northern coastal San Diego County. The osprey's fall migration extends from mid July to early November, and the spring migration occurs from late February to May (Poole et al. 2002). During these periods migrants are expected to pass through, and forage in the Study Area.

Light-footed clapper rail (*Rallus longirostris levipes*) - The light-footed clapper rail is resident at Batiquitos, San Elijo, and San Dieguito lagoons (Zembal, Hoffman, Konecny 2011). Batiquitos Lagoon has a recently expanding and relatively large subpopulation of light-footed clapper rails (43 pairs in 2011). San Elijo Lagoon had a subpopulation of 15 pairs of clapper rails in 2011. Although San Elijo Lagoon has had substantial efforts to maintain tidal inlet/outlet functions through repeated dredging of the lagoon mouth, the lagoon still closes to the ocean with regularity resulting in wide fluctuations in habitat suitability for clapper rails, particularly during high rainfall years (Zembal, Hoffman, Konecny 2011). San Dieguito Lagoon and proximal inland areas of the San Dieguito River Valley had 12 clapper rail pairs and 33 advertising males calling in 2011 (Zembal, Hoffman, Konecny 2011). All of the clapper rails reported in recent years in areas surrounding the Study Area were detected a fair distance from the proposed Project footprint; no clapper rails were reported within the Project footprint. The closest potential clapper rails (and potential clapper rail habitat) to the proposed Project activity areas would be in San Elijo Lagoon near the railroad tracks, with clapper rails separated from Project activities by Coast Highway 101 and distances of more than 0.1 mi (0.2 km) from proposed Project activities.

Mammals

Three species of mammals were observed during the September 2002 reconnaissance survey: California ground squirrel (*Spermophilus beecheyi*), desert cottontail (*Sylvilagus audubonii*), and domestic cat (*Felis catus*). Mammal species with the potential to occur in the terrestrial shoreline natural communities include Botta's pocket gopher (*Thomomys bottae*), house mouse (*Mus musculus*), black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), opossum (*Didelphis virginiana*). Domestic dogs (*Canis familaris*) also have been observed on the beach. No sensitive terrestrial mammal species are known or expected to occur within the Study Area.

Coastal Lagoons

Three coastal lagoons occur near the Study Area: San Elijo Lagoon, Batiquitos Lagoon, and the San Dieguito Lagoon. Between the 1880s and 1970s, landfilling for development, the construction of rail and road corridors, and agricultural operations reduced the extent of estuarine open waters and wetlands in these lagoons, while also constraining or eliminating tidal and riverine influences in the remaining wetlands (SCE 2005, San Elijo Lagoon Conservancy 2012). The amount of water exchanged between the ocean and these lagoons was subsequently reduced during each tidal cycle. As a consequence of the reduced tidal prism and less frequent flood scouring, lagoon closures due to natural berming of the river mouth became common from the 1940s onward (SCE 2005). These lagoon closures undoubtedly exacerbated the effects of sewage effluent and urban and agricultural runoff released into the lagoons; for example, sewage effluent was discharged into San Dieguito Lagoon from 1940 to 1974. Episodes of flooding have also resulted in large volumes of sediment being deposited in the existing lagoon wetlands (MEC 1993, SCE 2005, San Elijo Lagoon Conservancy 2012). In their present conditions, these lagoons represent valuable but diminished wetland ecosystems and beach sand resources relative to historic conditions (SCE 2005).

San Elijo Lagoon

The current ocean inlet to San Elijo Lagoon is in Reach 7 of the Study Area, approximately 0.2 mi (0.4 km) north of proposed beach replenishment activities in Segment 2, and immediately to the east of the SO-6 borrow site. The lagoon mouth is artificially narrow as compared to historic conditions (e.g., as likely occurred during larger storm flow events before the surrounding area was developed with a railroad and roads), and the lagoon inlet/outlet is now artificially confined to the extreme northern edge of the lagoon by road and railroad fill and associated structures (e.g., the Coast Highway 101 bridge and the Burlington Northern Santa Fe Railroad (BNSF) trestle).

Up until the late 19th century, the natural conditions of the lagoon were likely characterized by a lagoon mouth that was approximately 5,500 ft (1,700 m) wide, dominated by sand bar-building processes, with the lagoon outlet of Escondido Creek migrating over time from the existing bluffs (Cardiff by the Sea/San Elijo State Beach Campground) to the north (the location of the current creek/lagoon mouth outlet/inlet) south to the bluffs at what is now the northern edge of developed Solana Beach. During this period, fluvial processes likely continued to infill the Escondido Creek valley, depositing alluvial sediments into the littoral zone of the ocean during the larger flood flows, and slowly building up the elevation of the valley floor during more quiescent periods between storm flow events.

It has been decades since San Elijo Lagoon and Escondido Creek were naturally connected to the Pacific Ocean. Human modifications to the hydrology of the lagoon occurred at a rapid pace after the 1880s. The first bridge (trestle) and berm crossing the lagoon was constructed around 1881 for the Atchison, Topeka and Santa Fe Railroad (a subsidiary rail line called, at the time, the California Southern Railroad), when a railroad bed was constructed as a filled causeway across the lagoon mouth, with only a small trestle opening provided to pass stream storm flows and to allow flow between the ocean and lagoon. This was followed by road construction in 1891, with much of the roadbed on fill extending into the lagoon and only a small bridge opening to pass flood flows (San Elijo Lagoon Conservancy 2012). Between 1880 and 1940 dikes and levees were built in the lagoon for duck hunting, salt harvesting, and sewage settling ponds (San Elijo Lagoon Conservancy 2012). In 1965, Interstate 5 construction was completed across the lagoon, dividing the lagoon in half with a large filled causeway and another narrow bridge opening. This "partitioning" of the lagoon created altered flows for both fresh and saltwater, leading to accelerated sediment deposition, dramatically-reduced water quality, and a degradation of native estuarine natural communities (San Elijo Lagoon Conservancy 2012). Additional structures and fill (e.g., for restaurants, stores, parking lots, sewer lines, etc.) have also been constructed on and near the area of the sandbar that fronts the lagoon, including construction of U.S. Route 101 (now Coast Highway 101) in 1912. All these features together have altered the previous natural fluvial conditions in the long-term, forcing the lagoon inlet/outlet to remain at its present northerly location. Since the early 1990's the artificially narrow inlet/outlet of the lagoon has been normally maintained in an open condition by repeated sediment removal from the inlet/outlet channel using heavy equipment, with funding partially provided by the California State Coastal Conservancy and California Department of Transportation.

San Elijo Lagoon currently encompasses approximately 1,065 ac (431 ha). Natural communities in and surrounding the lagoon consist of coastal salt marsh, brackish/freshwater marsh, mudflats, tidal creeks, salt pannes, and a mix of upland communities including coastal sage scrub and Eucalyptus woodland. San Elijo Lagoon is one of the highest ranked areas for supporting waterfowl in San Diego County, because of its diverse natural communities, substantial marsh and open water areas, and high ecological productivity (MEC 1993). Belding's savannah sparrow and light-footed clapper rail nest at the lagoon. As noted above, until recently, the California least tern nested at the lagoon. Substantial restoration of the lagoon and adjacent areas will likely occur during the 50-year life of the Project, including enhancement and restoration of nesting by Belding's savannah sparrow, light-footed clapper rail, snowy plover, and California least tern.

Batiquitos Lagoon

Batiquitos Lagoon is approximately 25,346 ft (7,725m) north of the SO-6 borrow site. The lagoon inlet/outlet is approximately 1.6 mi (2.5 km) north of Segment 1, the closest proposed Project activity (beach replenishment) area (see Figure 2). The lagoon is about 610 ac (246 ha).

Batiquitos Lagoon underwent a substantial restoration (beginning in 1994) that included construction of a permanent inlet/outlet to substantially restore tidal flushing to the lagoon. The lagoon mouth is artificially narrow and confined as compared to historic conditions (e.g., as occurred during larger storm flows), due to fill and structures associated with roads and the railroad, as well as the relatively new permanent hard-structure inlet/outlet developed as part of the recent restoration. The lagoon is managed as a State Ecological Reserve by the CDFG and routine dredging is required to maintain hydrological circulation within the lagoon. Substantial quantities of sediments settle into the lagoon during storms flows, rather than being naturally flushed to the ocean, due to the hydrologically-constraining artificial fill and structures noted above. The primary natural communities of the lagoon are estuarine open water followed by coastal salt marsh. Nesting islands/peninsulas recently created within the lagoon with dredge spoils support endangered California least terns and threatened western snowy plover, as described above. The lagoon also provides very important habitats for marine and estuarine species of invertebrates and fish.

San Dieguito Lagoon

San Dieguito Lagoon is approximately 14,043 ft (4,280 m) south of the SO-6 borrow site (Figure 2). The ocean inlet/outlet to San Dieguito Lagoon is approximately 0.3 mi (0.5 km) south of the nearest proposed Project activities (beach replenishment in Segment 2). The lagoon is part of the San Dieguito River Park System.

The lagoon and San Dieguito River channel are hydrologically constrained by fill and structures associated with Interstate 5, the Del Mar Racetrack, roads and the railroad, and surrounding urban development (SCE 2005). Five bridges cross San Dieguito Lagoon; from west to east, they include Camino Del Mar (Highway 101), the BNSF Railroad, Jimmy Durante Boulevard, Grand Avenue, and Interstate-5. Utility line easements cross portions of the lagoon. The small flow openings associated with these fill constrictions and hydrological choke points have altered the physical behavior of the lagoon over the last 100 years (SCE 2005). These conditions promote the retention of beach sand materials, as well as fine-grained sediment from upland sources, within the lagoon (SCE 2005). This, in turn, reduces the tidal prism and increases sedimentation rates in the lagoon (SCE 2005).

The marsh portion of the lagoon historically was likely over 600 acres (240 ha), while the entire lagoon probably covered 1,000 acres (400 ha) (San Dieguito River Park 2012). Over the years, San Dieguito Lagoon was subjected to major filling activities, reducing the marsh and lagoon to about half these acreages (San Dieguito River Park 2012).

The lagoon was the location of a 116 ac (47 ha) $90 million mitigation/restoration project recently implemented (construction phrase 2006 to 2011) by Southern California Edison (SCE) (SCE 2012). One primary effort of the restoration project was to remove the sand that had deposited in the river channel and lagoon over the last several decades; approximately 125,000 yd^3 (95,500 m^3) of sand was removed from the constrained channel and lagoon (SCE 2012). Implementation of the total San Dieguito Wetlands Restoration Project (of which the SCE restoration project is a part) will require excavation and disposal of approximately 2.3 million yd^3 (1.8 million m^3) of dredge material (SDRP 2012). The lagoon inlet/outlet is now required to remain open to tidal flushing, per the conditions placed on the restoration project by the California Coastal Commission, and SCE agreed to keep the inlet/outlet open to the ocean in perpetuity as part of the project (SCE 2012). As part of the restoration, four new bird nesting sites (two east and two west of Interstate 5) were created within the constructed sub-tidal basins, using sand as topping for the nesting areas (SCE 2012).

Before the SCE restoration project, the 22nd Agricultural District formerly used a bulldozer to periodically open the lagoon inlet/outlet to tidal flushing. The lagoon provides foraging and nesting habitats for endangered Belding's savannah sparrows and threatened western snowy plover, and endangered California least terns forage in the lagoon.

EFFECTS OF THE PROPOSED PROJECT ON BIOLOGICAL RESOURCES

Implementation of the proposed initial and subsequent dredging and beach replenishment, and notch filling, are expected to result in direct and indirect effects to biological resources during dredging, staging of equipment offshore of the beach replenishment sites, site access, and placement of sand on the replenishment sites. These effects are expected to include direct mortality to biological resources, especially benthic invertebrates. Indirect effects would likely occur from increased turbidity, night-time lighting, and migration of sand from the replenishment sites onto reef, kelp, and seagrass areas. Recurring direct and indirect impacts would likely occur over the proposed 50-year course of the Project through the planned repetitive replenishment of the Study Area beach areas. The Project would likely provide benefits to some biological resources by creating or enhancing certain sand spawning habitats and periodically increasing the benthic invertebrate prey base during the periods between sand replenishment events and subsequent passive restoration.

Dredging and Beach Replenishment Activities

Proposed dredging operations at the borrow sites would result in the mortality of benthic invertebrates present at SO-6 and MB-1. The total area affected at the dredge sites is expected to be about 0.4 mi^2 (0.9 km^2) at SO-6 and 0.7 mi^2 (1.7 km^2) at MB-1 for a total of 1.0 mi^2 (2.6 km^2). The SO-6 site would be used as the source material for the renourishment episodes up to about year 30. Starting in about year 35 of the Project, sediment would probably only be dredged from MB-1.

Most benthic invertebrates within the dredging footprint would be killed by the dredging. Following each dredging event, a temporary reduction in the localized prey base for fishes that feed on benthic invertebrates would occur within the borrow site(s). Empirical models for shelf waters such as the North Sea indicate that as much as 30 percent of total fisheries yield to humans is derived from benthic resources, and that these resources become an increasingly important component of the food web in nearshore waters where primary production by seaweeds (macrophytes) and seagrasses living on the sea bed largely replace the productivity of phytoplankton in the water column (Newell et al.1998).

Dredging activities can also result in the release of nutrients from sediments and promote unseasonable and/or larger than normal algal blooms. Consequences of increased algal blooms can be the depletion of oxygen levels and the increased potential for fish kills and mortality of other marine biota.

Turbidity plumes associated with dredging at SO-6 and beach replenishment at Segment 1 and 2 could reach nearby kelp and reef natural communities, especially if a hopper dredge is used, or during strong current conditions. Turbidity can effect/degrade growth of kelp through reduced light transmission through the water column, particularly when water remains turbid for extended periods (Deysher 1993). Increased turbidity typically disproportionately decreases feeding rates by piscivorous fish, which feed on larger and more visible prey than particle-feeding planktivorous fish (De Robertis et al. 2003).

Turbidity plumes can also temporarily hinder sight-feeding birds, such as the least tern and brown pelican, from effectively capturing their fish prey in the affected area. Even if schools of fish utilized by least tern and brown pelican are not totally obscured, turbid water conditions can adversely affect the success of capturing of prey items by the two bird species. This is of particular concern for the least tern because dredging and sand placement is proposed during the least tern nesting season (April 1 to September 15). The least terns would probably be most sensitive to turbidity plumes in the Study Area in the early May through late July period when eggs, chicks, or fledglings would very likely be present in nesting areas and foraging displacement could be important. Turbidity plumes, generated by dredging activities and/or carriage water return from beach replenishment, may obscure available forage fish in the nearshore waters that potentially could be preyed upon by least tern and/or brown pelicans.

The closest currently active tern nest area to SO-6 and the two proposed beach replenishment segments is at Batiquitos lagoon. The tern nesting area at Batiquitos Lagoon is approximately 4.8 mi (7.7 km) north of SO-6 and 1.6 mi (2.5 km) north of the northern end of proposed Project activities, beach replenishment in Reach 3 of Segment 1 (Figure 2). Batiquitos Lagoon in the recent past has typically experienced a relatively large nesting subpopulation with up to 574 nesting pairs observed in 2003 (CDFG 2004).

The historic tern nesting area at San Elijo Lagoon is less than 0.9 mi (1.5 km) from the eastern end of SO-6 and less than 0.3 mi (0.4 km) from the northern end of proposed beach replenishment in Reach 8 in Segment 2 (Figure 2). Least terns may nest again at San Elijo Lagoon during the life of the Project, especially is restoration of the lagoon is implemented. A range of 1 to 15 pairs nested between 1998-2004 within San Elijo Lagoon (Patton 2002, CDFG 2004.

Least tern nesting areas were also created as part of the recently completed San Dieguito Lagoon restoration project; the closest tern nesting area is approximately 3.5 mi (5.6 km) south of SO-6 and 1.2 mi (1.8 km) south of the southern end of proposed beach activities, beach replenishment in Reach 9 of Segment 2 (Figure 2). Although least terns have not yet nested in these newly created areas, they are expected to nest there during the life of the Project, with foraging likely occurring in the nearby ocean offshore and nearshore areas.

The closest active tern nesting area to MB-1 is approximately 1.2 mi (2.0 km) away at Mariners Point in Mission Bay (Figure 4). Mariners Point has been one of the more successful breeding areas in the state with between 220 and 562 breeding pairs from 1998 to 2004 (CDFG 2004).

The brown pelican is present year-round in southern California coastal water bodies and beaches, including the Study Area. While no local brown pelican breeding colonies are in close proximity to the Project region, the nearshore area waters of the Pacific Ocean within the Study Area are a substantial foraging area for pelicans.

Success in capturing fish as prey items is significant for the least tern. During the nesting season, the least tern feeds exclusively on small marine fish captured in the local coastal lagoons, the river mouths, and the nearshore waters of the Pacific Ocean. Adult least terns catch and deliver small fish to flightless young; these fish are typically smaller than those consumed by adult least terns. The young begin to fly at about 20 days of age, but continue to be fed and are taught how to feed by their parents for some time after fledging. Reproductive success is, therefore, closely related to the availability of undisturbed nest sites and nearby waters with adequate supplies of appropriately sized fishes. Reduced food availability at a southern

California least tern colony site was determined to affect the reproductive success of the tern including smaller clutch sizes, significantly lower weights of chicks, and increased levels of egg abandonment and non-predator chick mortality (Atwood and Kelly 1984). Increased chick mortality decreases recruitment to the breeding population. Shortages of food for adults can also be manifested in small clutch sizes and increased levels of egg abandonment.

A pelican apparently forages by selecting an individual fish from the air, even if it is in a school (Schrieber et al. 1975). The potential of reducing the local food supply availability would be of particular importance to juvenile pelicans that have been shown to have a first year mortality of about 60 to 70 percent (Theander and Crabtree 1994). Surface visible turbidity plumes in the Study Area during any month would likely displace some brown pelican foraging.

Surface turbidity plumes from dredging may not totally preclude foraging efforts by all seabirds. Monitoring during dredging operations for the U.S. Navy Homeporting project in San Diego Bay in 1996 observed brown pelicans, Forster's terns (Sterna forsteri), and royal terns (Sterna maxima) foraging within surface turbidity plumes (U.S. Navy 1996).

MEC Analytical Systems, Inc. (1997) evaluated tern foraging during a sand placement project between eastern Anaheim Bay Jetty and Warner Avenue in Huntington Beach, California. The project involved the use of a cutterhead dredge. Disposal involved pumping sand slurry directly into a 1,970 ft (600 m) long by 50 ft (15 m) wide sedimentation pond on the beach. While field observers documented least tern foraging during dredging operations, it appeared that least terns foraged more frequently in the fringe areas of the dredged-induced turbidity plumes than other locations surveyed. These observations are considered anecdotal due to an insufficient baseline and the absence of reporting that addressed the level of success for each foraging dive and the amount of additional time that may have been needed by a bird to successfully locate and capture an individual prey item. These factors may be important in influencing egg predation, chick survival, clutch sizes, and egg abandonment. For example, situations where tern adults must spend additional time away (due to human activities within foraging areas) from eggs or chicks in a nest often provide additional opportunities for nest predators such as American crows. It should be noted that in years of poor fish availability near nesting areas, least tern nest productivity is usually low rangewide, largely regardless of surrounding human activities.

Because the sediments at the SO-6 site and the MB-1 site have a relatively low fines content (1-14 percent silt/clay), the Corps does not expect dredging to generate large turbidity plumes. Turbidity plumes at the borrow sites were estimated by the Corps to rarely exceed 400 ft (120 m) in a down current direction. Because the dredged sediments would have a relatively low fines content and because they would be placed onto the beach behind berms that would allow much of the sediment to settle before the associated carriage water discharges back into the ocean, the Corps expects turbidity to be relatively localized and occur mainly within the surf zone except when rip currents carry it offshore. Overall, we expect potential impacts to least terns and brown pelicans to be minimal considering the small sizes of predicted turbidity plumes and distance from the likely prime foraging locations of these species in the Study Area.

The proposed Project alternatives provided by the Corps for analysis all involve onshore placement of replenishment sand. If nearshore placement of sand for nourishment of Project beaches is ultimately proposed, then some sand could be lost from the littoral system to offshore areas or other unintended areas, depending on sand deposition depths. Equipment-related limits can restrict how shallow sand material may safely be placed, particularly when dredged sand is placed via bottom-dump scows or hopper dredges (EPA 2012). Sand placed in the nearshore with the intent to supplement the littoral zone and beaches is typically recommended to be placed directly within the littoral zone, in depths as shallow as practicable to ensure that greatest nourishment benefit and reduce most in-water impacts (EPA 2012).

Natural sand movement on the Study Area beaches is a seasonal cycle, with movement offshore in winter and onshore in summer; sand is also transported down-current between beaches (Cumberland et al. 1997). The sand movement of the newly placed Project sand would become part of the natural sand transport system of the littoral zone, and could potentially bury or scour established sensitive biological resources such as seagrass and kelp beds (Cumberland et al. 1997). Following each sand placement event, beach fill would gradually retreat (erode) from the receiver sites due to the artificially reduced level of natural sand within the littoral system (as noted above). To what extent and rate retreat of the receiver sites would occur over the life of the proposed Project is unknown, in part due to vagaries of climate, winter storms, and wave energy. Sand that erodes from the receiver sites if expected to moved predominately down coast.

The Study Area has a number of sensitive marine resources that could be adversely affected by the proposed beach replenishment, including those resources associated with the intertidal and subtidal zones, kelp beds, lagoon natural communities, and the general beach environment. In the shallow subtidal zone, sand movement influences substrate type and the presence of associated biota, and natural communities undergo temporal and spatial variation in response to sand movement (AMEC 2002b). For some sensitive marine organisms to remain viable, a firm substrate with little or no sand is required for initial settlement and growth (AMEC 2002b). Eventually, these organisms may reach a size that will provide a refuge from sand burial; however, repetitive scour and/or burial by sand could eventually cause mortality and variation in population structure (Foster and Schiel 1985). Sand scour and burial can create substrate disturbance; the effects of these disturbances on marine organisms are closely related to reef elevation and can determine if the habitats involved remain suitable for surfgrass, macroalgae, and/or sessile invertebrates (AMEC 2002b). High-relief reefs are normally exposed to less disturbance from burial and scour, which allows recruitment and persistence of particular sessile organisms. Low-relief reefs are more exposed to disturbance from burial and scour, and provide less stable habitats for most sessile species (Dayton et al. 1984). If a substrate is highly disturbed, it becomes too unstable to support most organisms (AMEC 2002b).

The 2001 RBSP used analytical and numerical modeling to predict the movement of sand from receiver sites and the potential impacts to sensitive biological resources. The 2001 RBSP analyzed the potential impacts to nearshore marine resources by using a Generalized Model for Simulating Shoreline Change (GENESIS) to predict longshore sediment movement. A separate analytical program was used by the 2001 RBSP to calculate the seasonal cross-shore transport of sediments. Results for the 2001 RBSP as initially proposed indicated that nearshore marine resources would be adversely affected, and the project was subsequently modified to substantially minimize potential impacts. In some cases, receiver site footprints were eliminated and/or modified in length and location to avoid impacts to sensitive resources. The 2001 RBSP also did extensive monitoring during and following construction to confirm the predicted low-level effects to nearshore marine resources. Monitoring of the RSBP concluded that dredging and beach replenishment did not appear to result in any long-term adverse effects (Engle 2005).

However, the proposed Project could involve initial sand placement of up to 2,420,000 yd^3 (1,850,000 m^3) of sand, which is over four times more than the approximately 580,100 yd^3 (443,500 m^3) of sand the 2001 RBSP deposited in the Study Area. In addition, subsequent replenishment events could occur every 5 to 10 years in Segment 1, and every 10 to 14 years for Segment 2, with sand volumes of as much as 700,000 yd^3 (535,000 m^3) in Segment 1, and as much as 960,000 yd^3 (734,000 m^3) in Segment 2. Therefore, these subsequent replenishment events could involve up to 1,660,000 yd^3 (1,290,000 m^3) which is almost three times as much sand as in the 2001 RBSP.

Although it could include significantly larger initial and subsequent replenishment volumes than the 2001 RBSP, the Corps did not provide any sediment movement modeling for the proposed Project. Therefore, we are concerned that any sand replenishment project of larger magnitude than the 2001 RSBP could result in significant negative effects on nearshore marine resources, in part due to the likelihood of subsequent replenishment events precluding passive restoration of any affected resources.

The proposed beach replenishment fills could directly bury portions of some exposed reef and surfgrass beds. In particular, low relief hard substrate in Reach 4 of Segment 1 could be directly buried by the sloping of the proposed replenishment berms, depending on beach profiles existing at the time of replenishment and sand replenishment sand volumes applied. Proposed replenishment beach berms may also bury another area of patchy surfgrass near G Street in Reach 5, again depending on the existing beach profile combined with the sand replenishment volumes actually applied. In Segment 2, the proposed beach fill would mostly cover sand or low relief reef, and one substantial area of mapped high relief reef in Reach 8 could be covered by the sloping of the proposed replenishment berms (Figure 12).

Some of the sand proposed to be placed on the beach could also migrate from the receiver sites to the inlets of Batiquitos Lagoon, San Elijo Lagoon, and San Dieguito Lagoon causing increased shoaling of the inlets. Based on the 2001 RBSP monitoring results and the best professional judgment of the Corps, the proposed beach replenishment may cause up to approximately 12,000 yd^3 (9,000 m^3) and 980 to 2,000 yd^3 (750 to 1,500 m^3) of additional sand per year to migrate into the San Elijo Lagoon and Batiquitos Lagoon inlets/outlets, respectively. Expected volumes of sand that would migrate to San Dieguito Lagoon have not been quantified but are thought to be potentially higher than the other lagoons given the proximity and down-coast location of the lagoon to that of the sand placement activities. The increased sedimentation of lagoon outlets/inlets has the potential to result in increased closure periods of one or more of the lagoon mouths, particularly at San Elijo and San Dieguito lagoons. Most southern California estuarine ecosystems require regular tidal inundation to remain healthy, particularly with modified barrier beaches (e.g., with compacted road fills and the resultant reduced tidal inflow/outflow through the barrier beach matrix) and urban/agricultural freshwater inflows (e.g., modified runoff lowflows and contaminants). Both San Elijo and San Dieguito lagoon outlets/inlets are currently artificially maintained by periodic dredging and the proposed beach replenishment activities would likely result in increases in costs, volume, and/or frequency of dredging necessary to keep the lagoon outlets/inlets open.

Placement of sand is also expected to bury and thereby temporarily reduce the benthic invertebrate assemblage on the receiver beaches. Rates of recovery reported in the literature suggest that sand and gravel natural communities may take 2 to 3 years to recover, depending on the proportion of sand and level of environmental disturbance by waves and currents, and may take even longer where rare slow-growing components were present in the community prior to disturbance (Newell et al. 1998, Versar 2004). As the deposits get coarser along a gradient of environmental stability, estimates of 5 to 10 years are probably realistic for development of the complex biological associations between the slow-growing components of equilibrium (late succession stage) natural communities characteristic of reef structures following removal of disturbance (e.g., reef becoming unburied) (Newell et al. 1998).

On existing cobble and rock beaches, the invertebrate community would likely increase in diversity and biomass following replenishment events (SAIC 2005). This increase would in turn likely benefit most shorebirds that prey on invertebrates along these beach types, if replenishment cycles are of a sufficient period for substantial recovery. Considering the disturbance to macro-invertebrates associated with replenishment on existing beaches, it is likely that many foraging birds obtain comparatively less food at replenished beaches until benthic natural communities recover (Grippo et al. 2007).

The proposed repeated sand replenishment would likely cause repeated short-term impacts to grunion if done during its spawning season, depending on timing and location of each replenishment event. However, grunion spawning habitat in Segments 1 and 2 would likely also be temporarily improved or restored in many areas by the temporary conversion of cobble or low relief hard substrate shoreline to sand beach, as well as by the temporary widening of existing sand beaches.

Sand placement activities would involve effects to a relatively small portion of beach at any one time, but it would disturb shorebirds. However, shorebirds would likely avoid the immediate construction area and continue to forage in adjacent areas. Due to the expected increase in invertebrate diversity and biomass following sand placement events, most shorebirds and gulls that would use the Study Area would likely benefit overall from the increase in prey base.

The long-billed curlew (*Numenius americanus*) is a California Species of Special Concern that winters in southern California and likely forages on the proposed receiver site beaches. Curlews would be expected to avoid the immediate beach area where construction operations are taking place. Avoidance of the Project activity portion of the beach would likely be a minor impact on long-billed curlews.

A small potential exists for the proposed Project to directly affect sensitive terrestrial plant species by the placement of sand up above MLLW at the toe of slope along the bluffs of the Study Area. However, a rather low probability exists that sensitive plant species occur within the Project footprint for sand placement based on the condition of the bluffs (eroded, low plant cover, and non-native species dominance) and the absence of documented observations for the area.

No post-construction monitoring of potential long-term adverse impacts to biological resources is currently proposed for the Project. The proposed Project does contain a measure to avoid most adverse effects to grunion: sand placement activities in immediate grunion spawning areas would be curtailed/avoided during the proposed Project, through monitoring for spawning and avoiding any sand placement activities in occupied locations until grunion eggs are hatched.

Notch Filling

The proposed process of filling notches with engineered concrete would likely have minimal impacts on marine, shoreline, and bluff natural communities and their associated biota. Equipment and Project personnel on the upper beach would disturb shorebirds and gulls in the immediate vicinity of the activity. Marine birds would likely avoid the work areas. In addition, because the area of disturbance would be relatively small compared to the amount of beach available, the impacts of notch fills on marine resources are expected to be insignificant, provided vehicle access avoids areas in use at the same time by western snowy plovers. Because the bluffs notches to be filled are unvegetated and almost all potential native or sensitive species potentially affected by notch filling are located further upslope/inland from the actual Project footprint (with the potential exception of snowy plovers as noted above), we do not expect any impacts to sensitive terrestrial plant or animal species.

Most shore protection structures such as seawalls reflect wave energy rather than dissipating energy, as a wide or "equilibrium" sandy beach does (Scripps 2004). Depending on the final geometry of the notch fill face, a notch fill could reflect energy much like a typical seawall in this regard (compared to the original notch geometry). Dissipative structures such as rock riprap occupy beach space and constrain the beach's ability to establish equilibrium (Scripps 2004). Because proposed notch fills would be relatively small fills (occupying a small area of beach space), the hard/protective covering on portions of an existing bluff likely would be the most important aspect of the fill: the effects would mostly involve reflecting wave energy of larger waves during high tides, reducing bluff erosion, slowing bluff collapse and the landward migration of the local bluff, and slightly reducing the contribution of the bluff to the sands of the littoral system.

Cumulative Effects

SANDAG initiated a second RSBP in September 2012, which includes five beaches within or near the Study Area (SANDAG 2012a). The sand volumes for the 2012 RBSP project could be additive to the volumes of the proposed Project depending on when the proposed replenishment activities occur. Potential turbidity impacts of the proposed Project would be largely unaffected by the 2012 RBSP project. However, potential impacts from burying (e.g., reefs, seagrass beds, kelp beds) could be increased with the additive volumes of the 2012 RBSP.

The following are portions of.the 2012 RBSP project within or near the Study Area:

> **South Carlsbad**: Approximately 140,000 yd^3 (107,000 m^3) of sand to be placed between Palomar Airport Road and the south end of Oceanview Drive.
>
> **Batiquitos Beach**: Approximately 105,000 yd^3 (80,300 m^3) of sand to be placed between the Batiquitos Lagoon mouth and the bluff-backed area of the beach.
>
> **Cardiff Beach**: Approximately 89,000 yd^3 (68,000 m^3) of sand to be placed between the Chart House restaurant and just south of Las Olas restaurant.
>
> **Moonlight Beach**: Approximately 92,000 yd^3 (70,300 m^3) of sand to placed north of the D Street at Moonlight Beach.
>
> **Solana Beach**: Approximately 140,000 yd^3 (107,000 m^3) of sand to be placed at Fletcher Cove.

RECOMMENDATIONS

The FWCA states that "…wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation…"

In accordance with the FWCA, we make the following recommendations to avoid and minimize negative effects to fish and wildlife resources.

1. Considering the RBSP pre-project modeling, the subsequent reduction in sand replenishment quantities of the RBSP based on this modeling, and post-project monitoring that determined no significant long-term impacts to biological occurred, the Corps should use the same (or smaller) sand replenishment quantities as those used in the RBSP. If the Corps decides to proceed with larger sand replenishment quantities than the RBSP, the Corps should use the GENESIS model and/or a similar equivalent model to predict sand movement over the life of the Project. This model should take into account (as model baselines for initial and recurrent proposed replenishment volumes) the recent and likely future sand replenishment efforts by others in the Study Area over the life of the Project (e.g., 2012 RSBP) and predict what: a) biological resources may be affected (e.g., reefs, surfgrass beds, or kelp beds buried) by Project-associated sand movement in the littoral system; and b) effects may occur to the coastal lagoons in the area (i.e., Batiquitos, San Elijo, and San Dieguito). The Corps should identify the spatial and temporal extent of Project-related sand that would likely bury sensitive resources. The Corps should also predict the magnitude of sand predicted to enter the lagoons or reduce the present fluvial exchange regimes of lagoon mouths, and the associated removal costs of any additional sand. The proposed Project beach replenishment quantities, footprints, and or timing should then be modified to avoid any significant long-term impacts to biological resources or from sand migration into the lagoons. Any predicted remaining biological impacts from replenishment sand should be mitigated as directed by a biological working group consisting of representatives from the California Department of Fish and Game, Corps, National Marine Fisheries Service, and the Service.

2. If the Corps decides to proceed with larger sand replenishment quantities than the RBSP, the Corps should implement the monitoring protocol used for the RBSP (Engle 2005), and/or a similar equivalent protocol, to determine if the Project causes any significant long-term impacts to biological resources and/or lagoons.

   Implementation of a monitoring program should be overseen by the above-noted biological working group. The biological working group would also review monitoring reports and make recommendations for the future replenishment activities during the 50-year life of the proposed Project.

3. The Corps should perform surveys for least terns, snowy plovers, and grunion in the Study Area during the environmental review process and before each replenishment event, to determine current nearshore use for foraging by breeding least terns, and beach use by grunion and wintering or breeding snowy plovers. If Project activities must occur during the breeding seasons of these species (or wintering season for snowy plovers) and they are present in the Project area, measures developed by the biological working group should be implemented to avoid, minimize, and offset potential impacts.

4. As was done for the RBSP, the Corps should place funds in an interest bearing account of sufficient quantity to guarantee a means to mitigate any significant long-term adverse impacts documented by the monitoring program. Such mitigation could include creation of artificial reefs and the clearing of lagoon inlets, as determined to be appropriate by the biological working group.

5. The Corps should monitor the extent of turbidity plumes at the dredge and beach replenishment sites throughout the duration of dredging and sand placement activities. Each turbidity plume should not exceed 2.5 ac (1.0 ha) at any given time. If a plume is documented to be greater 2.5 ac (1.0 ha), Project operations should cease until the plume has receded to less than 2.5 ac (1.0 ha). Surface turbidity plumes should be avoided during the most sensitive periods for California least terns, from early May to late July. For the purpose of monitoring, surface turbidity is defined as a change in ambient conditions in the water column visible to the naked eye and where a secchi disc reading is less than 3.3 ft (1 m). Turbidity plumes with a secchi disc reading greater than 3.3 ft (1 m) would not require monitoring per these recommendations.

6. If a hopper dredge is used, a morning glory spillway or similar type spillway that conveys overflow water below the bottom of the hull for discharge should be used.

7. If a cutterhead dredge is used, it should back flush a minimum of 16 ft (5 m) below the surface and not at the surface. Turbidity monitoring would not be necessary if this method and back flush technique are implemented.

8. Sand placed in the nearshore with the intent to replenish beaches should be placed directly within the littoral zone, in depths as shallow as practicable, to reduce in-water impacts and provide the most nourishment to beaches. Any Project replenishment sand not deposited onshore should be deposited directly into the littoral zone, at depths of-19 ft (-6 m) MLLW or less, wherever practicable (SANDAG and CSMG 2006). No sand intended for beach replenishment should be deposited at depths greater than -30 ft (-9 m) MLLW (SANDAG and CSMG 2006, EPA 2012).

9. To help avoid and/or minimize potential impacts due to operation of equipment offshore of the beach replenishment sites, the Corps should develop a plan based on diver surveys that includes details of the proposed locations of all pipelines, cables, anchors, and any other equipment to be used. If submerged pump lines are used to place dredged material

onto the beach, they should be outfitted with tractor tires or equivalent bumpers to minimize abrasion of the ocean floor or reefs. Construction monitoring should include monitoring of equipment and activities offshore of the beach replenishment sites. Pumpout of fluids from offshore equipment (such as holds or ballast tanks) should be avoided. If problems are detected, operations should cease until the any problems observed during monitoring are remedied. Pre- and post-construction surveys should be performed to document any adverse biological impacts. Any impacts should be mitigated as directed by the biological working group.

10. The Corps should maintain and operate all Project-related equipment in such a manner as to prevent contaminants (e.g., fuel, oil, grease, coolant, hydraulic fluid, hold and tank pump-outs, etc.) from entering the ocean, local streams/storm drains, or beach areas directly or indirectly).

11. The Corps and Cities should work with the California Department of Transportation, Caltrans, San Diego Association of Governments, North County Transit District, the 22nd District Agricultural Association, the cities of Oceanside, Carlsbad, and Del Mar, resource agencies, and others, to develop and implement hydrological/fluvial solutions to the sediment capturing effects of the artificial fill (e.g., road and railroad berms) and bridge-related structures associated with the freeway, railroad, and road crossing of the lagoons and stream/rivers in north San Diego County. For example, the Corps and Cities should investigate the benefits and costs of partially restoring storm flow sediment delivery capacity of Escondido Creek/San Elijo Lagoon to the ocean, through substantially expanding the water-flow openings of the road and railroad crossings (two bridges and a trestle) over the lagoon. The potential benefits of this would be to: a) restore more natural levels of sediment delivery to the ocean and beaches; b) reduce the anthropocentric trapping of sediments in, and concomitant degradation of, local lagoons; and c) increase the effective longevity, and reduce the needs, costs, and impacts of, beach replenishment and lagoon restoration efforts in north San Diego County.

LITERATURE CITED

Aleem, A.A. 1973. Ecology of a kelp-bed in southern California. *Botanica Marina* 16:38-95

Allen, L.G. 1982. Seasonal abundance, composition, and productivity of the littoral fish assemblage in Upper Newport Bay, California. *Fisheries Bulletin* 80:769-790.

AMEC. 2002a. Regional Beach Sand Project Preconstruction and Construction Monitoring Report. Prepared for San Diego Association of Governments (SANDAG). January.

AMEC. 2002b. Regional Beach Sand Project Year 2 (2002-2003) Post-Construction Monitoring Report for Intertidal, Shallow Subtidal, and Kelp Forest Resources. Prepared for SANDAG. September.

Atwood, J. L., and P.R. Kelly. 1984. Fish dropped on breeding colonies as indicator of least tern food. *The Wilson Bulletin* 96(1):34-47.

Black, R. 1974. Some biological interactions affecting intertidal populations of the kelp *Egregia laevigata*. *Marine Biology* 28:189-198.

Bonnell, M.L., and M.D. Dailey. 1993. Chapter 11. Marine Mammals. ***In***: M.D. Dailey, D.J. Reish, and J.W. Anderson (eds.). Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press. Pp. 604-681.

California Department of Boating and Waterways and State Coastal Conservancy (CDBW & SCC). 2002. California Beach Restoration Study. CDBW. Sacramento, CA.

California Department of Fish and Game (CDFG). 2003. California least tern breeding survey 2002. CDFG, Nongame Wildlife Program. CDFG, Nongame Wildlife Program.

CDFG. 2004. California least tern breeding pairs and fledgling production. CDFG. CDFG, Nongame Wildlife Program.

CDFG. 2008. California least tern breeding survey 2007. CDFG, Nongame Wildlife Program.

CDFG. 2011. California least tern breeding survey 2010. CDFG, Nongame Wildlife Program.

California State Lands Commission. 2001. Shoreline Protective Structures. Staff Report. April.

Collins, J.I. 1993. Review Report of Existing State of Orange County Coast. Prepared for U.S. Army Corps of Engineers, Los Angeles District. 4-6,7.

Craig, C., S. Wyllie-Echeverria, E. Carrington, and D. Shafer. 2008. Short-term sediment burial effects on the seagrass *Phyllospadix scouleri*. Ecosystem and Management Restoration and Research Program. ERDC TN-EMRRP-EI-03.

Cross, J.N., and L.G. Allen. 1993. Chapter 9: Fishes. ***In***: M.D. Dailey, D.J. Reish, and J.W. Anderson (eds.). Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press. Berkeley, CA. Pp. 459-540.

Cumberland, H.L. , M.A. Perdue, L.O. Honma. 1997. Beach replenishment and Navy Homeporting: Ecological implications of beach replenishment in California. Prepared for the U.S. Department of the Navy, Southwest Division.

Dayton, P.K., V. Currie, T. Gerrodette, B.D. Keller, R. Rosenthal, and D. Ven Tresca. 1984. Patch dynamics and stability of some California kelp communities. *Ecological Monographs* 54(3):253-289.

DeMartini, E.E. 1981. The spring-summer ichthyofauna of surfgrass (*Phyllospadix*) meadows near San Diego, California. *Bulletin of Southern California Academic Scientists* 80:81-90.

DeMartini, E.E., and D.A. Roberts. 1990. Effects of giant kelp (Macrocystis) on the density and abundance of fishes in a cobble-bottom kelp forest. *Bulletin of Marine Science* 46:287–300.

De Robertis, A., C.H. Ryer, A. Veloza, and R.D. Brodeur. 2003. Differential effects of turbidity on prey consumption of piscivorous and planktivorous fish. *Canadian Journal of Aquatic Science* 6012: 1517–1526.

Deysher, L.E. 1993. Evaluation of remote sensing techniques for monitoring giant kelp populations. *Hydrobiologia* 260/261: 307-312.

Ebeling, A.W., R.L. Larson, W.S. Alevizon, and R.N. Bray. 1980. Annual variability of reef-fish assemblages in kelp forests off Santa Barbara, California. *U.S. National Marine Fisheries Service Fishery Bulletin* 78:361-377.

Engle, J.M. 2005. Rocky intertidal resource dynamics in San Diego County: Cardiff, La Jolla, and Point Loma (1997-2005). U.S. Navy & AMEC Earth & Environmental, Inc. 79 p.

Environmental Protection Agency (EPA). 2012. Depth of Closure and Beneficial Reuse: Background for Nearshore Sand Placement Along California Shorelines. Policy paper prepared for CSMW discussion by Brian Ross, EPA Region 9, Dredging & Sediment Management Team. Draft October 2.

Fancher, J.M. 1992. Population status and trends of the California least tern. *Transactions of the Western Section of the Wildlife Society* 28:59-66.

Feder, H.M., C.L. Turner, and C. Limbaugh. 1974. Observations on fishes associated with kelp beds in southern California. *Fisheries Bulletin* 160:1-144.

Foster, M.S., and D.R. Schiel. 1985. The Ecology of Giant Kelp Forests in California: A Community Profile. Prepared for U.S. Fish and Wildlife Service.

Garfield, J.L. 1994. The San Diego-La Jolla Underwater Park Ecological Reserve; A Field Guide. Picaro Publishing, San Diego, CA. 64 pp.

Geraci, J.R., and D.J. St. Aubin. 1990. *Sea Mammals and Oil, Confronting the Risks.* Academic Press, San Diego, CA.

Grandy, C.C., and G.B. Griggs. 2007. Variability of Sediment Supply to the Oceanside Littoral Cell. Proceedings of Coastal Zone 07. Portland, Oregon. July 22-27. http://www.csc.noaa.gov/cz/CZ07_Proceedings/PDFs/Poster_Abstracts/3150.Chenault%20Grandy.pdf

Griggs, G.B., and L.E. Savoy. 1985. Living with the California coast. Duke University Press, Durham, N.C. 393 pp.

Grinsted, A., J.C. Moore, and S. Jevrejeva. 2009. Reconstructing sea level from paleo and projected temperatures 200 to 2100 AD. *Climate Dynamics*. January 6.

Grippo, M.A., S. Cooper, A.G. Massey. 2007. Effect of Beach Replenishment Projects on Waterbird and Shorebird Communities. *Journal of Coastal Communities*. 23(5):1088-1096.

Gunnill, F.C. 1980. Recruitment and standing stocks in populations of one green alga and five brown algae in the intertidal zone near La Jolla, California, during 1973-1977. *Marine Ecology Progress Series* 3:231-243.

Intergovernmental Panel on Climate Change (IPCC). 2007. Fourth assessment report: Climate change 2007. Cambridge, United Kingdom: Cambridge University Press. http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml.

Jevrejeva, S., J.C. Moore, A. Grinsted,, and P.L. Woodworth. 2008. Recent global sea level acceleration started over 200 years ago? *Geophysical Research Letters* 35. L08715, doi:10.1029/2008GL033611, 2008.

Leet, W.S., C.M. Dewees, and C.W. Haugen. 1992. *California's Living Marine Resources And Their Utilization.* California Sea Grant Extension Publication UCSGEP-92-12.

Littler, M.M., D.R. Martz, and D.S. Littler. 1983. Effects of recurrent sand deposition on rocky intertidal organisms: Importance of substrate heterogeneity in a fluctuating environment. *Marine Ecology Progress Series* 11:129-139.

Loeb, V.J., P.E. Smith, and H.G. Moser. 1983. Recurrent groups of larval fish species in the California Current area. California Cooperative Oceanic Fisheries Investigations 24:152-164.

Love, M.S., J.S. Stephens, Jr., P.A. Morris, M.M. Singer, M. Sandhu, and T.C. Sciarrotta. 1986. Inshore soft substrata fishes in the Southern California Bight: An overview. California Cooperative Oceanic Fisheries Investigations 27:84-106.

MBC Applied Environmental Sciences. 2001. Presentation for San Diego County – Region Nine Kelp Consortium, Status of the Kelp Beds, 2000-2001 Survey. MBC.

MEC Analytical Systems, Inc. (MEC) 1995. Evaluation of Potential Impacts to Marine Biota from the Beach Replenishment Component of the Proposed Lomas Santa Fe Drive Grade Separation Project. MEC.

MEC. 1997. Encina Receiving Water Annual Analysis Report, July 1996 – June 1997. MEC. August.

MEC. 2000. Appendix D to the SANDAG Regional Beach Sand Project EIR/EA, Evaluation of Impacts to Marine Resources and Water Quality from Dredging of Sands from Offshore Borrow Sites and Beach Replenishment at Oceanside, Carlsbad, Leucadia, Encinitas, Cardiff, Solana Beach, Del Mar, Torrey Pines, Mission Beach, and Imperial Beach, California. Prepared for KEA Environmental, Inc. March 2000.

Middaugh, D.P., H.W. Kohl, and L.E. Burnett. 1983. Concurrent measurement of intertidal environmental variables and embryo survival for the California Grunion, *Leuresthes tenuis* and the Atlantic silverside, *Menida menida* (Pisces: Atherinidae). California Department Fish Game. 69: 89-96.

Miller, D.J., and R.N. Lea. 1972. Guide to the coastal marine fishes of California. Fish Bulletin 157. California Department of Fish and Game. 249 pp.

Newell, R.C., L.J. Seiderer and D.R. Hitchcock. 1998. The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. *Oceanography and Marine Biology: an Annual Review* 36 (127):78.

O'Brien, P.Y., M.M. Littler. 1977. Biological Features of Rocky Intertidal Communities at Coal Oil Point, Santa Barbara County, California. ***In***: M.M. Littler (ed.). Spatial and

Temporal Variations in the Distribution and Abundance of Rocky Intertidal and Tidepool Biotas in the Southern California Bight. Bureau of Land Management, U.S. Department of the Interior, Washington, D.C., pp. 317-405.

Ogden Environmental. 1999. P-706 Shallow Subtidal Monitoring, 1998 Survey Results. Submitted to U.S. Navy, Southwest Division. *Kairos.spawar.navy.mil*.

Patsch, K., and G. Griggs. 2006. Littoral Cells, Sand Budgets, and Beaches: Understanding California's Shoreline. Institute of Marine Sciences, University of California, Santa Cruz. California Department of Boating and Waterways California Coastal Sediment Management Work Group. October. http://www.dbw.ca.gov/csmw/PDF/LittoralDrift.pdf

Patton, R. 2002. The status of western snowy plovers, California least terns and breeding waterbirds at south San Diego Bay National Wildlife Refuge in 2002. Unpublished draft.

Patton, M.L., R.S. Grove, and R.F. Harman. 1985. What do natural reefs tell us about designing artificial reefs in southern California? *Bulletin of Marine Science* 37:279–298.

Pfeffer, W.T., J.T. Harper, and S. O'Neel. 2008. Kinematic Constraints on Glacier Contributions to 21st- Century Sea Level Rise. *Science* 321. September.

Poole, A.F., R O. Bierregaard, and M.S. Martell. 2002. Osprey (*Pandion haliaetus*). ***In:*** A. Poole and F. Gill (eds.). The Birds of North America, No. 683. The Academy of Natural Sciences, Philadelphia, PA and the American Ornithologists' Union, Washington, D.C.

Powell, A.N., and C.L. Collier. 2000. Habitat use and reproductive success of western snowy plovers at new nesting areas created for California least terns. *Journal of Wildlife Management* 64: 24-33.

Rahmstorf, S. 2010. A New View on Sea Level Rise. *Nature Reports Climate Change*. doi:10.1038/climate.2010.29. April 6. http://www.nature.com/climate/2010/1004/full/climate.2010.29.html

Reish, D.J. 1972. The use of marine invertebrates as indicators of varying degrees of marine pollution. Pp. 203–207 ***in***: M. Ruivo (ed.). Marine pollution and sea life. Fishing News (Books) Ltd.: London.

Reiser, C.H. 1994. Rare Plants of San Diego County. Aquafir Press.

San Diego Association of Governments (SANDAG). 2000. San Diego Regional Beach Sand Project EIR/EA. Prepared for SANDAG and U.S. Department of the Navy, June 2000 Final Environmental Impact Report/Environmental Assessment by KEA Environmental, MEC Analtyical Systems, Moffatt and Nichol Engineers, and GeoArch Marine Archaeology Consultants.

SANDAG and CSMG. 2006. Final Sand Compatibility Opportunistic Use Program (SCOUP) Plan. Prepared for the San Diego Area Governments and the Coastal Sediment Management Workgroup. Prepared by Moffatt and Nichol, Long Beach, CA.

SANDAG. 2012a. 2012 Regional Beach Sand Project. SANDAG. http://www.sandag.org/index.asp?projectid=358&fuseaction=projects.detail

SANDAG. 2012b. 2001 Regional Beach Sand Project. SANDAG. Environment: Shoreline Management. http://www.sandag.org/index.asp?projectid=101&fuseaction=projects.detail

San Dieguito River Park (SDRP). 2012. San Dieguito Lagoon Wetlands Restoration Project. San Dieguito River Park. http://www.sdrp.org/projects/coastal.htm

San Elijo Lagoon Conservancy. 2012. Tidal Circulation. San Elijo Lagoon Conservancy. http://www.sanelijo.org/inlet

Science Applications International Corporation (SAIC). 2005. Coastal Habitat Study, 2003-2004: Influence of Beach Nourishment on Biological Resources at Beaches in the City of Encinitas, California. SAIC. January.

SAIC. 2007. Review of Biological Impacts Associated With Sediment Management and Protection of California Coastal Biota; In Support of the California Sediment Management Master Plan. Prepared for: California Coastal Sediment Management Workgroup. SAIC.

Scripps Institute of Oceanography (Scripps). 2004. Living with coastal challenges: sand starvation. Coastal Morphology Group, Scripps. http://coastalchange.ucsd.edu/st2_challenges/sand.html

Solana Beach, City of. 2009. City of Solana Beach Local Coastal Program Land Use Plan. City of Solana Beach. September. http://solana-beach.hdso.net/LCPLUP/CD_LCPLUP.pdf

Southern California Edison (SCE). 2005. San Dieguito Wetland Restoration Project. Final Restoration Plan. SCE. http://asset.sce.com/Documents/Environment%20-%20Power%20Generation/san_dieguito_final_restoration_plan.pdf

SCE. 2012. Power Generation – Marine Mitigation: San Dieguito Lagoon Restoration. Edison International. http://www.sce.com/PowerandEnvironment/PowerGeneration/MarineMitigation/sandieguitolagoonrestoration.htm

Schreiber, R.W., G. Woolfenden, and W. Curtsinger. 1975. Prey capture by the brown pelican. The Auk 92:649-654.

Squires, L., and S. Wolf. 2009. The status of the California least tern and western snowy plover at Batiquitos Lagoon, California in 2009. Unpublished report prepared for the California Department of Fish and Game South Coast Region, San Diego, California.

Stewart, J.G. 1982. Anchor species and epiphytes in intertidal algal turf. *Pacific Science* 36(1):45–59

Stewart, J.G. 1989. Maintenance of a balanced, shifting boundary between the seagrass *Phyllospadix* and algal turf. *Aquatic Botany* 33:223-241.

Stewart, J.G. and B. Myers. 1980. Assemblages of algae and invertebrates in southern California *Phyllospadix*-dominated intertidal habitats. *Aquatic Botany* 9:73-94.

Straughan, D. 1981. Inventory of the Natural Resources of Sandy Beaches in Southern California. Technical Report No. 6 of the Allan Hancock Foundation, University of Southern California, Los Angeles. 447 pp.

Taylor, P.R., and M.M. Littler. 1982. The roles of compensatory mortality, physical disturbance, and substrate retention in the development and organization of a sand-influenced, rocky-intertidal community. *Ecology* 63(1):135-146.

Theander, C.G., and M. Craptree (eds.). 1994. Life on the Edge: A Resource Guide to California's Endangered Plants and Wildlife--Vol. I: Wildlife. Biosystems Books, Santa Cruz & Heyday Books, Berkeley, California.

Tegner, M.J., and P.K. Dayton. 1987. El Niño effects on southern California kelp forest communities. *Advances in Ecological Research* 17 ISBN 0:013917-0.

Terra Costa Consulting Group (Terra Costa). 2005. Mixed use Solana Beach train station opportunistic beach fill Project, Solana Beach, California. Report to Mooney/Jones and Stokes. http://www.ci.solana-beach.ca.us/uploads/Appendix%20D%20Sediment-Erosion%20Analysis.pdf

Turner, T. 1985. Stability of rocky intertidal surfgrass beds: persistence, preemption, and recovery. *Ecology* 66:83-92.

Unitt, P. 2004. San Diego County Bird Atlas. Sunbelt.

U.S. Army Corps of Engineers (USACE). 1991. State of the Coast Report, San Diego Region, Volume 1, Main Report, and Volume 2, Appendices, Coast of California Storm and Tidal

Waves Study (CCSTWS), Final Report. Los Angeles District Corps of Engineers. September .

USACE. 1994. Reconnaissance Report, Pacific Coast Shoreline, Carlsbad, San Diego County, California, Main Report. Los Angeles District Corps of Engineers. January.

USACE. 2012 a. Notice of Preparation, Draft Environmental Impact Report (EIR) & Environmental Impact Assessment (EIS), City of Encinitas & City of Solana Beach Shoreline Protection Project. USACE, Los Angeles District. April 18.

USACE. 2012b. Notice of Intent To Prepare an Environmental Impact Statement/Environmental Impact Report for the Encinitas and Solana Beach Shoreline Protection Project, San Diego County, CA. Federal Register 77:77; 23670-23671. April 20. http://www.gpo.gov/fdsys/pkg/FR-2012-04-20/html/2012-9579.htm

USACE. 2012c. Background Information Functional Assessment, Encinitas Encinitas/Solana Beach Shoreline Protection Project. Email from Larry Smith of the USACE, Los Angeles District, to Jon Avery, USFWS, Carlsbad Fish and Wildlife Office., dated March 22.

USACE. 2012d. Final Alternatives for SPP.--.21May2012 (updated alternatives for proposed Encinitas/Solana Beach Project). Email from Susan Ming, USACE, Los Angeles District, to Jon Avery, USFWS, Carlsbad Fish and Wildlife Office. June 4.

U.S. Navy. 1995. Final Environmental Impact Statement for the Development of Facilities in San Diego/Coronado to Support the Homeporting of One NIMITZ Class Aircraft Carrier. Prepared by the Southwest Division, Naval Facilities Engineering Command, U.S. Department of the Navy in November 1995.

U.S. Navy. 1996. Turbidity/Waterfowl Monitoring Report for Nimitz Class CVN Naval Air Station North Island Coronado, 6 September to 28 October 1996. Naval Facilities Engineering Command.

U.S. Navy. 1997a. Environmental Assessment for Beach Replenishment at South Oceanside and Cardiff/Solana Beach, California. Prepared by the Southwest Division, Naval Facilities Engineering Command, U.S. Department of the Navy in April 1997.

U.S. Navy. 1997b. Environmental Assessment for Beach Replenishment at North Carlsbad, South Carlsbad, Encinitas, and Torrey Pines. Prepared by the Southwest Division, Naval Facilities Engineering Command, U.S. Department of the Navy in May 1997.

U.S. Fish and Wildlife Service (USFWS). 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover. USFWS. September.

http://www.fws.gov/arcata/es/birds/WSP/documents/RecoveryPlanWebRelease_09242007/WSP%20Final%20RP%2010-1-07.pdf

University of Arizona. 2010. Southwest Climate: El Niño Nino Southwest Oscillation. Climate Assessment for the Southwest. http://www.climas.arizona.edu/sw-climate/enso.

Vermeer, M., and S. Rahmstorf. 2009. Global Sea Level Linked to Global Temperatures. Proceedings of the National Academy of Science of the USA 106:21527-21532.

Versar. 2004. Year 2 Recovery From Impacts of Beach Nourishment on Surf Zone and Nearshore Fish and Benthic Resources on Bald Head Island, Caswell Beach, Oak Island, and Holden Beach, North Carolina; Final Study Findings. Army Corps of Engineers. Contract No. DACW54-00-D-001. January.

Warriner, J.S., J.C. Warriner, G.W. Page, and L.E. Stenzel. 1986. Mating System and Reproductive Success of a Small Population of Polygamous Snowy Plover. *Wilson Bulletin* 98(1):15-37.

Wheelwright, N.T., and J.D. Rising. 1993. Savannah sparrow (*Passerculus sandwichensis*). ***In:*** A. Poole and F. Gill (eds.). The Birds of North America No. 45. The Academy of Natural Sciences, Philadelphia, PA and the American Ornithologists' Union, Washington, D.C.

Williams, S.L. 1995. Surfgrass (*Phyllospadix torreyi*) reproduction: Reproductive phenology, resource allocation, and male rarity. *Ecology* 76(6):1953-1970.

Zembal, R., S.M. Hoffman, and J. Konecny. 2011. Status and Distribution of the Light-footed Clapper Rail in California, 2011. California Department of Fish and Game, Wildlife Branch, Nongame Wildlife Program Report 2011-11. Sacramento, California. 19 pp.

Personal Communications:

Clark, K. 2005. Verbal comments to Service biologist Kurt Roblek.

Wolf, S. 2005. Verbal comments to Service biologist Kurt Roblek.