Beach Bluffs Restoration Project
Master Plan

April 2005

Beach Bluffs Restoration Project Steering Committee
Ann Dalkey and Travis Longcore, Co-Chairs

Editor's Note

This document includes text prepared by several authors. Julie Stephenson and Dr. Antony Orme completed research and text on geomorphology (Appendix A). Dr. Ronald Davidson researched and reported South Bay history (Appendix B). Sarah Casia and Leann Ortmann completed biological fieldwork, supervised by Dr. Rudi Mattoni. All photographs © Travis Longcore. GreenInfo Network prepared maps under the direction of Aubrey Dugger (http://www.greeninfo.org).

You may download a copy of this plan from:
http://www.urbanwildlands.org/bbrp.html

This plan was prepared with funding from California Proposition 12, administered by the California Coastal Conservancy and the Santa Monica Bay Restoration Commission through a grant to the Los Angeles Conservation Corps and The Urban Wildlands Group. Significant additional funding was provided by a grant from the City of Redondo Beach.

Preferred Citation

Longcore, T. (ed.). 2005. *Beach Bluffs Restoration Project Master Plan*. Beach Bluffs Restoration Project Steering Committee, Redondo Beach, California.

Table of Contents

Executive Summary

The Beach Bluffs Restoration Project is a resident-initiated effort to restore the natural diversity of the remnant dunes and bluffs along the Santa Monica Bay between Ballona Creek and the Palos Verdes Peninsula. This Master Plan prioritizes the sites that could be restored and describes actions for education and community involvement. The plan includes an assessment of the erosion risk for the bluffs and proposes remediative measures to protect the natural landforms.

Most residents and visitors know the beach bluffs as iceplant (scientific name *Carpobrotus edulis*) covered slopes between the beach and the first road, path, or parking lot. Iceplant was used historically to reduce the amount of drifting sand. While it works for this purpose, it does not work to reduce erosion on steeper slopes, such as those of the beach bluffs. Native plants, with their deep root systems, are actually much more effective at stabilizing the bluffs. Furthermore, iceplant is an invasive species from South Africa, which harms the ecosystem by crowding out native plants. These native plants once supported the endangered El Segundo blue butterfly throughout this area, but the presence of iceplant prohibits this species from returning. If the restoration is implemented as envisioned, beach visitors would observe many more butterflies, birds, and wildflowers on the bluffs.

The Master Plan therefore has the following goals: increase the ecological value of the beach bluffs by restoring the native vegetation, increase recreational value by providing stewardship opportunities for restored bluffs, and provide a public education program about the beach bluffs and their coastal environment.

The study area was surveyed for biological resources and geomorphology. These surveys showed that native plant cover was very low throughout the area, with only disturbance tolerant species remaining. Erosion threats varied throughout the study area, with physical disturbance of cut-through traffic predominating in the southern regions, and run-off from roads contributing most in the northern area.

The native vegetation of the dunes and bluffs prior to human disturbance would have been strand, southern California dune scrub, and southern California bluff scrub. The geographic extent of all of these vegetation types has been drastically reduced by urbanization and all three vegetation types are of high conservation value. In addition, several rare native plants, and the endangered El Segundo blue butterfly, would have been found in the study area.

Part of the educational opportunity of the Beach Bluffs Restoration Project is to share the rich history of the South Bay cities. This history is described in the Master Plan, ranging from Native American villages through the resort and tourist industry to modern residential and recreational centers.

Sites for potential restoration were identified by balancing ecological, educational, and recreational priorities. As a first premise, no sites were identified for restoration that would reduce public access to the beach, or that would impede the operation of the beach in any manner.

Top priority restoration sites included 19.54 acres, of which approximately 4 acres are already being revegetated with native plants. These were spread among Redondo Beach / Torrance, Manhattan Beach, and El Segundo / City of Los Angeles. Second priority sites included 16.5 acres, while third priority sites included 2.36 acres. A planting and maintenance scheme is provided, based on the pilot project now under way in Redondo Beach.

The Master Plan presents an educational program that would include a self-guided interpretive tour composed of high-quality signs along the length of the project area, a public volunteer and stewardship program, and a K–14 education program for school classes visiting the beach.

The estimated cost of the Master Plan for revegetation, maintenance, and the education program is $735,000 plus $57,500 per year. This estimate does not include engineering and construction costs for solving erosion issues in more difficult locations (e.g., along Dockweiler Beach), or any other physical infrastructure outside of plants and irrigation.

Beach Bluffs Restoration Project
Master Plan

Introduction

In summer 2001, a group of local residents, environmental groups, and local, state and federal agencies convened in Redondo Beach to discuss the prospect of restoring native vegetation to the bluffs along the Santa Monica Bay. This group, established by Redondo Beach resident Ann Dalkey and Dr. Travis Longcore of The Urban Wildlands Group, with the strong support of the Los Angeles County Department of Beaches and Harbors and the City of Redondo Beach, agreed upon a vision to remove exotic iceplant (*Carpobrotus edulis*) from the bluffs along the beach, restore native dune and bluff scrub vegetation, and more generally improve the physical infrastructure of the coastline. Since then, the group has operated as a steering committee for an effort to implement this vision.

The group participated in the development of a proposal to secure California state bond funds (Proposition 12) through the Santa Monica Bay Restoration Project and the California Coastal Conservancy. The Los Angeles Conservation Corps' SEA Laboratory served as the applicant for a pilot project, the purpose of which was to show what a native restoration of this habitat would look like, and to develop the infrastructure to implement such a project. The second component of the project was the development of this Master Plan to guide future work, which was also supported in part by a grant from the City of Redondo Beach.

This Master Plan presents a vision for the restoration of dune and bluff scrub along the southern portion of the Santa Monica Bay, from Ballona Creek to the Palos Verdes Peninsula, and between the ocean and the first road or structure. This linear study area ranges along a bike path through the cities of Los Angeles, El Segundo, Manhattan Beach, Hermosa Beach, Redondo Beach, and Torrance. The Master Plan identifies the locations that could be restored, the techniques for restoration, educational opportunities, potential associated infrastructure improvements, and approximate unit costs for suggested activities.

The plan begins with a description of the study area. It reviews the geological history of the landforms present, and describes the natural communities that once were found in the study area. The plan also presents a review of the human history of the study area, from Native villages through the modern beach cities so that the social history can be incorporated into educational interpretation of the beach bluffs environment.

The Master Plan describes the conditions currently found within the study area, based on surveys conducted for this project. The description identifies the meager biological resources remaining in the study area, a geomorphological assessment of erosion hazards, physical infrastructure, and other physical parameters. This description is followed by a prioritizing of potential restoration sites based on ease, access, existing conditions, and biological reserve design principles. We then describe restoration techniques, including detailed plant species lists and specifications for plant installation and maintenance.

The next section outlines considerations for improvements to the infrastructure that surrounds the potentially restorable bluff sites, reviewing issues of compatibility between intensive visitor use and maintenance of native vegetation. Options for fencing and other improvements are included.

The outlines of an educational signage program are included to guide the installation of interpretive materials that link the entire study area with signage of a common design. This educational program includes recommendations for interpretation of the biological, geomorphological, and historical aspects of the study area.

Finally, estimates of cost for the various project components are presented, based on experience with the pilot project completed in Redondo Beach.

Goals

The Beach Bluffs Restoration Project Master Plan implements the goals of the steering committee to enhance the natural ecology through restoration, to improve recreational opportunities, to promote aesthetic improvements, and to educate the public about the bluffs, their history, and their ecology.

Specifically for habitat restoration, the objective of the Master Plan is to increase the ecological values of the bluffs and dunes, such that the restored areas 1) contribute to the recovery of the El Segundo blue butterfly, 2) provide habitat for unique and rare plants of the El Segundo dunes, 3) increase biological connectivity between remnant populations of dune species, and 4) support more diverse bird, reptile, and arthropod communities.

The goal of increased recreational opportunities will be achieved through beautification of the bluffs through revegetation with native plants, providing synergistic opportunities for local jurisdictions to improve hardscape infrastructure, providing opportunities for volunteer stewardship, and creating a visual interest along the beach bluffs.

Education of the public will be achieved through an interpretive signage system that reaches from Ballona Creek to the Palos Verdes Peninsula, developing a volunteer

What's so bad about iceplant?

Iceplant was originally planted to reduce blowing sand, and people assumed that it was good at reducing erosion. But it turns out that on steep slopes its shallow roots and heavy leaves actually encourage erosion. The deep roots of native plants are much more effective at reducing erosion on slopes. Iceplant is also an "invasive species," meaning that it replaces native plants by crowding them out. Iceplant has displaced the El Segundo blue butterfly by displacing the plant upon which the butterfly lays its eggs. In South Africa, where iceplant is native, many insects and animals eat the leaves, while nothing eats it in California. Iceplant encourages erosion and crowds out our native plants and animals, so replacing it with a diverse set of native wildflowers is the goal of the Beach Bluffs Restoration Project.

program for local residents to act as stewards of restored vegetation, and providing an outdoor classroom and exercises for students visiting the beach.

Study Area

The study area for this Master Plan is limited to a subsection of the former El Segundo dunes ecosystem. The limits are defined by Ballona Creek to the north and the end of the Los Angeles County beach in Torrance to the south. The plan reviews all areas from the existing bicycle path on the seaward side to the first road, house, or parking lot. This study area omits areas between the bicycle path and the ocean that may support or currently support dune vegetation, as well as other areas inland that support or could support dune vegetation (e.g., Sand Dune Park, Hyperion Treatment Plant, Chevron Refinery, etc.). This geographic limitation allowed for a study area of tractable size that has the potential to provide sites that could be linked together along the immediate coast. This study area also follows an existing paved trail that receives heavy visitor use, making it an ideal site for public education and access to restored coastal resources.

Reconnaissance visits to the study area, combined with aerial photographs, quickly established that potentially restorable sites could be divided into three major sections. From the south, these include the Torrance and Redondo Beach segment, the Manhattan Beach Segment, and the Playa del Rey segment. The urban morphology of some sections, such as that in Hermosa Beach, does not include restorable land between the coastal path and homes or other development.

Figure 1. Regional locator map for Beach Bluffs Restoration Project.

Historical Background

This section describes the geomorphological, biological, and social history of the study area. This background information serves the dual purpose of establishing important physical conditions that limit or enable restoration and documenting the environment for use in an educational program.

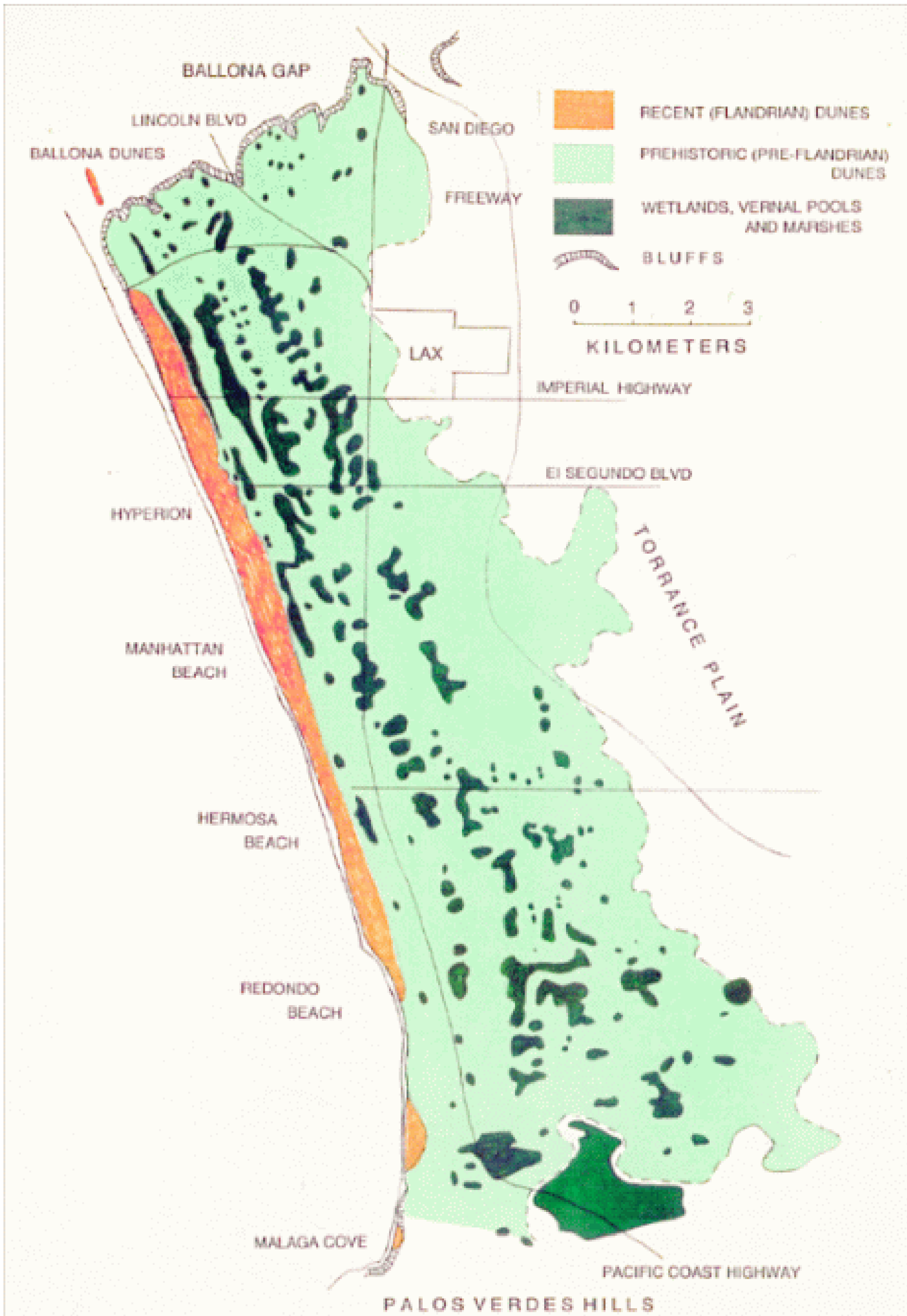

Figure 2. Extent of modern and historic El Segundo dune system (Mattoni 1993a).

Geomorphology of Dunes and Bluffs

The Santa Monica Bay dune field is composed of four separate dune systems extending southward as a series of ridges and troughs from the mouth of Ballona Creek to the Palos Verdes Peninsula (Figure 2). The dune systems rest upon a lowland comprising marine and non-marine terrace materials (Cooper 1967). Santa Monica Bay is characterized by net southward drift of currents along the beach, which provides sediment to beaches, from which sand is blown inland by prevailing northwest winds. The lowland character of the coast south of Ballona Creek has long allowed the development of coastal dunes as far south as the Palos Verdes Peninsula. All dunes in this region have been greatly modified by human activities over the past century but their general form remains decipherable beneath the urban and industrial framework of the coastal communities.

The bluffs that are the subject of this project are made of consolidated sandy soils that were formed from old coastal dune systems. These formations are exposed near the beach, with the active dune system perched on top of them.

Biota of Dunes and Bluffs

The strip of land under consideration in this plan is at the intersection of three vegetation communities: coastal strand, southern California dune scrub, and southern California bluff scrub. These plant communities would have been found historically within the study area.

The *strand* community is dominated by those plant species that can tolerate the harsh conditions of constant mechanical disturbance, salt spray, and occasional inundation (Barbour and Johnson 1988). Such plants have extraordinary abilities to conserve water in a desiccating salty environment and to withstand being partially buried by shifting sand from wind and sometimes wave action. Important among these plants are two species of what might be considered the local ecological equivalent of iceplant. Sand verbenas (both *Abronia umbellatum* and *Abronia maritima*) thrive in the

Figure 3. Beach sand verbena (*Abronia umbellatum*) has delicate purple flowers and succulent leaves that conserve water in the salt spray zone.

strand community, they have strikingly beautiful purple flowers and succulent leaves well adapted to water conservation. They are also notoriously difficult to grow in the nursery environment. Beach burr-bush (*Ambrosia psilostachys*) is also found in the strand environment. It is a hearty plant that can withstand burying and is one of the few native plants, along with beach evening primrose (*Camissonia chieranthifolia*), that is found seaward of the coastal path in the study area. It is important for stabilizing the soil to allow other species to establish. Other plants of the strand include the locally rare *Atriplex pacifica*, beach evening primrose, and saltgrass (*Distichlis spicata*).

Farther from the ocean and away from the immediate salt influence is the foredune vegetation community. While still characterized by active sand transport and open ground, more shrubs are present and the substrate is more stable. Plant species from the strand are also found here, but are joined by deerweed (*Lotus scoparius*, in its prostrate growth form), the coastal ecotype of California poppies (*Eschscholzia californica*; perennial with yellow flowers), silvery blue lupine (*Lupinus chamissonis*), coastal sagebrush (*Artemisia californica*), California sunflower (*Encelia californica*), coast buckwheat (*Eriogonum parvifolium*), goldenbush (*Ericameria ericoides*), and many annual wildflowers. This community would have been found on the sandy portions of the slopes in the project area.

Some portions of the subject sites have more consolidated soils from the underlying consolidated dune systems. This creates different soil conditions that would allow the establishment of a bluff scrub vegetation community. This vegetation would have been dominated more by shrubs, such as black sage (*Salvia mellifera*), California sagebrush, goldenbush, butterbush (*Senecio californicus*), bladderpod (*Isomeris arborea*), and *Rhus integrifolia*. Also included in the consolidated soils would be cacti (*Opuntia littoralis* and *Opuntia prolifera*), and many annual species.

With these vegetation types would be found a number of species that are now

What's so important about native plants?

- ❖ Native plants are the habitat for our native wildlife. Some butterflies depend on just one species of native plant. The El Segundo blue butterfly cannot live without coast buckwheat, one of the plants of the coastal dune and bluff.
- ❖ Native plants are part of our history and symbolize our state, like the California poppy.
- ❖ Native plants have deep root systems that reduce erosion and stabilize the bluff.

considered rare. Among these are the local wallflower population, pacific saltbush, beach spectaclepod (*Cardionema ramosissimum*), the now-extinct coastal dunes milkvetch (*Astragalus tener titi*), and the El Segundo spineflower (*Mucronea californica* var. *suksdorfii*).

Historically, the rich coastal environment, at the intersection of the ocean and land, would have supported a rich and diverse vertebrate fauna. Birds ranged from California condors foraging on carcasses of marine mammals on the beach to the tiny snowy plover nesting in the strand, to burrowing owls nesting in ground squirrel burrows on the dunes. The bird community included many shorebirds and gulls along with the species of open shrub and grasslands, such as roadrunner and many raptors. The mammal fauna ranged from the now-endangered Pacific pocket mouse (*Perognathus longimembrus pacificus*) and Pacifc kangaroo rat (*Dipodomys agilis agilis*) and numerous other small mammals to foraging long-tailed weasel (*Mustela frenata latirostra*), badger (*Taxidea taxus jeffersonii*), bobcat (*Lynx rufus californicus*), mule deer (*Odocoileus hemionus californicus*), and grizzly bear (*Ursus arctos californicus*). Reptiles and amphibians included the now-rare silvery footless lizard (*Anniella pulchra*) and San Deigan horned lizard (*Phrynosoma blainvillii blainvillii*), up to eight snake species, and other toads, salamanders, and frogs.

The insect community of the El Segundo dunes and strand includes a number of endemic species — organisms that have adapted unique characteristics in the isolation of the dune system. These include the federally endangered El Segundo blue butterfly (*Euphilotes bernardino allyni*), and other unique organisms, including a Jeruselam cricket, a cossid moth, and a crab spider that have not be given scientific names.

Because of the biogeographic isolation of the El Segundo dune system — it is isolated from other major dune systems north and south by tens of miles — the flora and fauna contain many locally unique populations. While not all of these variants have been described by science, they constitute a significant expression of native California biodiversity. The development of Los Angeles and the beach cities has drastically reduced the geographic extent of the dune and strand habitats. This human history is recounted in the following section.

Current Conditions

With this rich natural and social environment the opportunity to restore coastal zone resources remains. To evaluate such possibilities, we obtained aerial photographs of the study area from the Los Angeles County Department of Beaches and Harbors and digitized all of the open areas between the coastal path and the first street or home. Each polygon was delineated based on existing paths, stairways and other built infrastructure for beach access. Each polygon represents a contiguous block through which no foot or vehicle traffic should pass (although cut-through foot

Figure 4. California sunflower (*Encelia californica*) is a small shrub found in the bluff scrub habitat.

traffic is an ongoing problem). Surveys of the entire study area were conducted for vegetation and geomorphology and attributes were collected for each polygon. These polygons are, therefore, the unit of analysis to investigate the feasibility of restoration.

Public Infrastructure

The entire study area is adjacent to a bicycle path that runs from the Ballona Channel to Torrance Beach. As documented in field surveys, trashcans are available at nearly every site in Torrance, Redondo Beach, and Manhattan Beach. Lights are also present illuminating both walkways and in some areas the beach along the study area. Many formal access sites to the beach exist, but many other pioneered trails are found, especially through the sites with longer distances between developed paths.

Recreation opportunities in the study area are active (e.g., volleyball, surfing, walking, biking, roller blading) and passive (e.g, looking at the ocean, sitting on the beach). Several sites have unique recreational activites that deserve mention. First, is a site at the northern end of the Esplanade in Redondo Beach where model plane enthusiasts fly their planes (sites 15 and 16). They often go down on to the slope to retrieve planes, which would conflict with the establishment of vegetation in that site. Second is a site at the southern end of Dockweiler Beach where hang gliders use the bluff to take off and to teach hang gliding (near site 71).

Ownership and Other Relevant Plans

All of the property within the study area is owned by local or state government. The largest landowner is the Los Angeles County Department of Beaches and Harbors. Other areas are owned by the State of California and operated by the County and others owned by one of the beach cities. While this land is public, some locations, especially in Manhattan Beach, nearby property owners have planted and maintain gardens between the sidewalk and bike path along the beach.

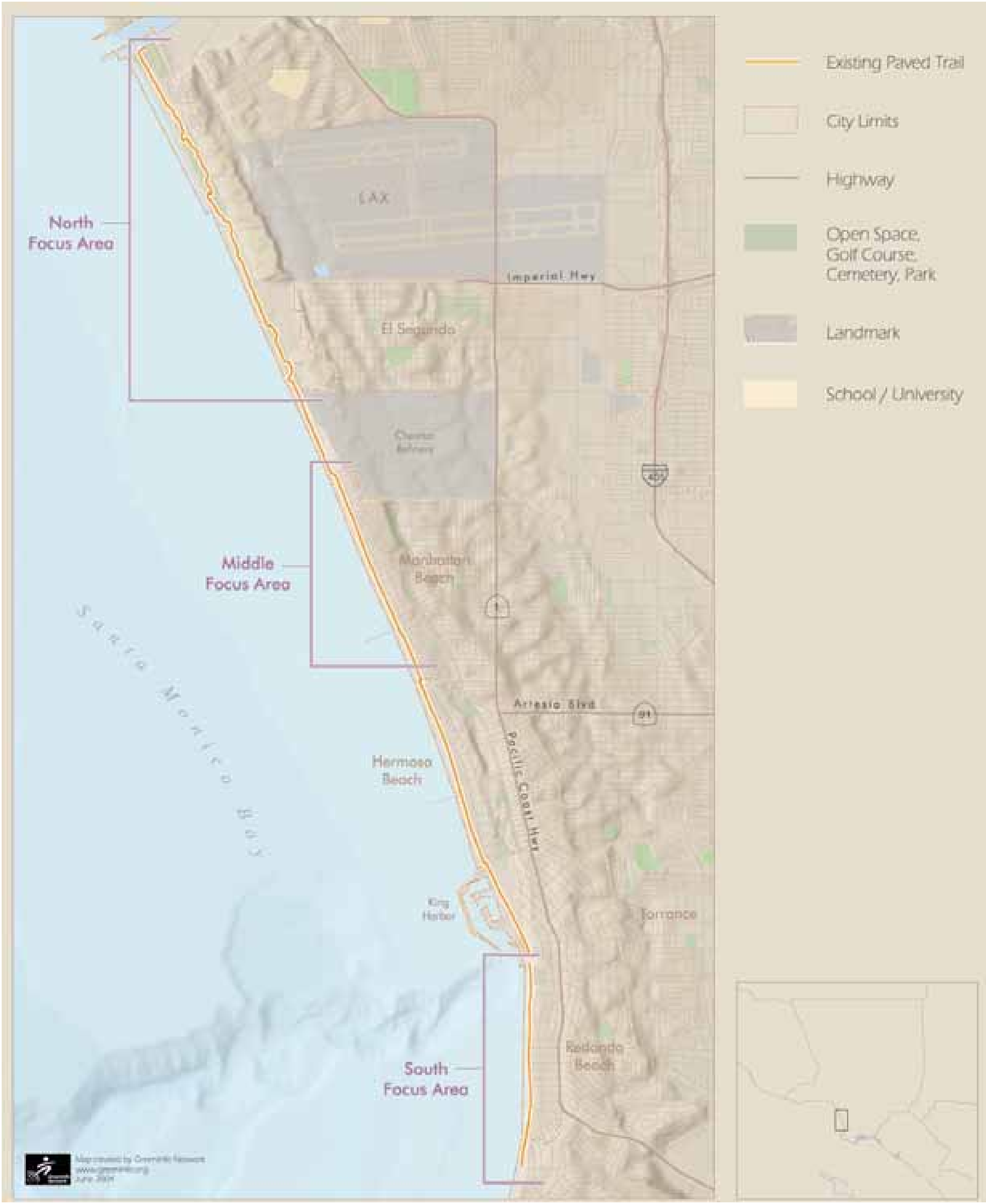

Figure 5. Bicycle path along Santa Monica Bay from Ballona Creek to the Palos Verdes Peninsula connecting the cities of the South Bay.

Geomorphology

Redondo Beach and a sliver of Torrance are in the southernmost region of interest. The windward dune slopes range between 25 and 40 degrees and are associated with compacted soils forming a bluff-top ledge from 6 to 25 feet wide. The slopes are primarily vegetated by iceplant, covering 40–95% of the polygons. Those areas not vegetated are susceptible to erosion from pedestrian traffic and runoff from adjacent parking lots, roads or walkways. Access from the bluff top to the beach is limited in some areas, which has encouraged short cut trampling. The dune slopes decline gradually into a broad flat beach, largely devoid of vegetation.

Iceplant was planted here, and throughout the study area, to stabilize the dunes and prevent erosion. As the beach cities were developed, drifting sand across roadways was a significant problem — motorists had to bring a shovel to remove the sand drifts from the road. Iceplant was efficient at reducing the amount of free sand, but it makes slopes susceptible to slump erosion. Roots of the iceplant are not deep and it becomes quite heavy when wet. These features make it an undesirable plant for slopes, in addition to its undesirable ecological characteristics.

The area of study in Manhattan Beach lies between Redondo Beach and Playa del Rey and consists of the windward coastal ridge slope as well as portions of the foredune system. The exposed coastal ridge is situated between the eastward-bounding pedestrian strand and the westward-bounding bike path where slopes range from 5 to 25 degrees. The slopes have vegetal covers ranging from 60 to over 95%, which vary in their concentrations of iceplant, trees, shrubs and cacti. Such areas are primarily subject to erosion from concentrated discharges of pipes draining the pedestrian walkway through a one-foot curb. Privately maintained gardens on the top one third of the slope commonly serve to stabilize slopes by dissipating energy from concentrated runoff and preventing trampling. The foredunes lie west of the bike path and are characterized by gentler slopes ranging from 5 to 10 degrees and a more hummocky topography. Vegetation covers approximately 30% of the area and consists of patchy iceplant and low shrubs. The foredunes are susceptible to sheet wash erosion as runoff drains from the adjacent impermeable bike path but this is only of concern where runoff is able to concentrate.

The dune ridge in Playa del Rey is the northernmost region of interest and lies directly west of the Los Angeles International Airport. Although a much broader expanse of the local dune field is exposed, this study is only interested in the publicly owned land west of Vista del Mar Street. Slopes on the coastal ridge range from 25 to 55 degrees. These slopes gradually decrease westward and open into a hummocky foredune system, much like in Manhattan Beach, with slopes ranging from 0 to 10 degrees. Vegetation in the form of iceplant, cacti and shrubs covers 70 to 95% of the ridge slopes and 0 to 35% of the foredunes. The dune slopes are particularly susceptible to runoff overflow from the street and trampling adjacent to areas where street parking is allowed. The low foredunes fronting much of the Manhattan Beach and Playa del Rey segments result from sand moving in the prevailing winds from the broad beaches whose natural instability is maintained by recreational and beach-grooming activities.

There are various geomorphic concerns associated with the dune slopes that warrant effective management. Of particular importance are raindrop impact, sheet erosion, rill erosion, gully erosion, mass movement, and wind erosion and redeposition. The susceptibility of slopes to the adverse impacts of these processes varies depending upon the prevailing local conditions and is enhanced by channelized runoff, pedestrian trampling and vegetation loss.

Exposed soils on the bluff-top ledges of Redondo Beach and Playa del Rey and the areas of patchy vegetation in Playa del Rey are susceptible to degradation by raindrop impacts. Raindrops may dislodge soils on exposed surfaces where the force of the raindrop impact exceeds the gravitational and cohesive forces maintaining sediment positions. This loosens soils for further erosion and transport and is particularly important where soils are susceptible to mobilization because of a lack of cohesion or vegetation. In the areas of concern, however, raindrop impacts are only of minor importance. These impacts alone are of little consequence but the resulting availability of sediment for more destructive processes warrants consideration.

Sheet erosion occurs naturally on steep slopes with relatively uniform soil resistance and permeability. It may also occur where impermeable surfaces drain unobstructed and unchannelized onto more pervious materials. The sheet wash effectively dislodges sediment by overcoming frictional forces and is capable of transporting it downslope. For the purposes of this study, sheet erosion, like raindrop impact, plays a larger role in setting up conditions more vulnerable to other processes than by degrading slopes by itself. This is of particular concern in Redondo Beach and Playa del Rey where bluff-top ledges consist of soils compacted to the point of limited permeability. Therefore, storm runoff is discharged as sheet flow immediately onto the dune slopes, it may be where it is directed into already established rills and gullies by local vegetation and topography, accentuating erosion processes. Sheet erosion is also of concern in Manhattan Beach and Playa del Rey where bike paths drain directly onto the foredune systems. Erosive impacts are limited to the area immediately adjacent to the concrete paths because of the permeability of the sandy soils and the patchy vegetation.

Dune slopes are susceptible to rill erosion where vegetation is patchy and sparse. Runoff is locally channelized and capable in such mass and velocity to incise shallow rills. Because vegetation coverages for most areas of this study are 70 to 90%, erosion due to rill formation in most places is limited in extent and depth. The only region where this may warrant more consideration is in those areas of Playa del Rey where vegetation is patchy and distinct unvegetated avenues have been cut through the slopes. In this region, vegetation is a mixture of iceplant and shrubs, the sparse distribution of which facilitates the rilling of bare soils.

Rills may lead to gully formation, which has the greatest adverse effects on the stability of the dune slopes. Gullies form much like rills but require the concentration of greater quantities of discharge and result in deeper, more incised channels. Gullies also serve as major routes for sediment transport during storm flows as the depth and velocity of the channels support sediment in suspension as well as bed load. This is especially important in the area of study because soils are removed from slopes and ultimately delivered to the impervious westward bounding pedestrian and bike paths. This creates maintenance and safety concerns and decreases the utility of the right of way. Gullying is problematic in all three areas of the study. In Torrance and Redondo Beach, deep gullies have formed where pedestrians have taken short cuts down the slopes. These may be exacerbated where runoff from the adjacent bluff-top street overflows during larger storm events onto the dune slopes from collection areas or from breaks in the curb. Gullies in Manhattan Beach are of similar depth but occur at specific intervals associated with the location of pipes draining adjacent bluff-top and mid-bluff walkways. Incision capabilities are enhanced where discharges fall a substantial distance onto dune soils lacking sufficient vegetation to dissipate impact energies. Gullies in Playa del Rey are the most severe, occurring at more frequent intervals and in greater depth than elsewhere. They have been formed by the channelization of overflow runoff from the adjacent street and have been accentuated where storm drains prevent local infiltration. In all areas, pedestrians use gullies as paths and therefore slope and beach-access influence the degree to which erosion has occurred.

The mass movement of slope materials occurs when a large portion of the hillslope is dislodged as a massive unit or as a collection of individual grains and moves downhill in response to gravitational forces. Materials are mobilized initially by bank destabilization, which may occur with saturation or vegetation removal. The material, depending on its consistency and hillslope declivity, moves downhill by sliding, falling or mass flowage. Such processes can substantially deform hillslope profiles and transport large quantities of material very rapidly. In all three sections of the area of study, there are signs of relict mass movements that have been stabilized by vegetation and retaining walls. Mass movement does not appear to be a current problem because problem slopes have been maintained at conservative grades and provided with dense plant coverage. On the occasion that substantial erosion occurs, the Los Angeles County Department of Beaches and Harbors completes repairs to return the area to the original configuration.

Active dunes are, by definition, subject to frequent change as a result of the introduction of fresh sand and/or effective wind velocities (Nordstrom et al., 1990). Under natural conditions, the coastal ridge of the Santa Monica Bay dunes would still be active. Indeed, in the Manhattan Beach and Playa del Rey segments in particular, deflation of broad flat beaches under prevailing wind conditions continues to provide for active foredune development and sand transport towards the main dune ridge. The latter, however, is not as susceptible to wind erosion because of its vegetation coverage and engineered slopes although sediment from the foredunes may rise onto the coastal ridge. Such processes do not pose any immediate management problems with respect to coastal bluff stability.

Figure 6. Undeveloped bluffs along Santa Monica Bay showing percent native vegetation (Southern Focus Area).

Figure 7. Undeveloped bluffs along Santa Monica Bay showing percent native vegetation (Central Focus Area).

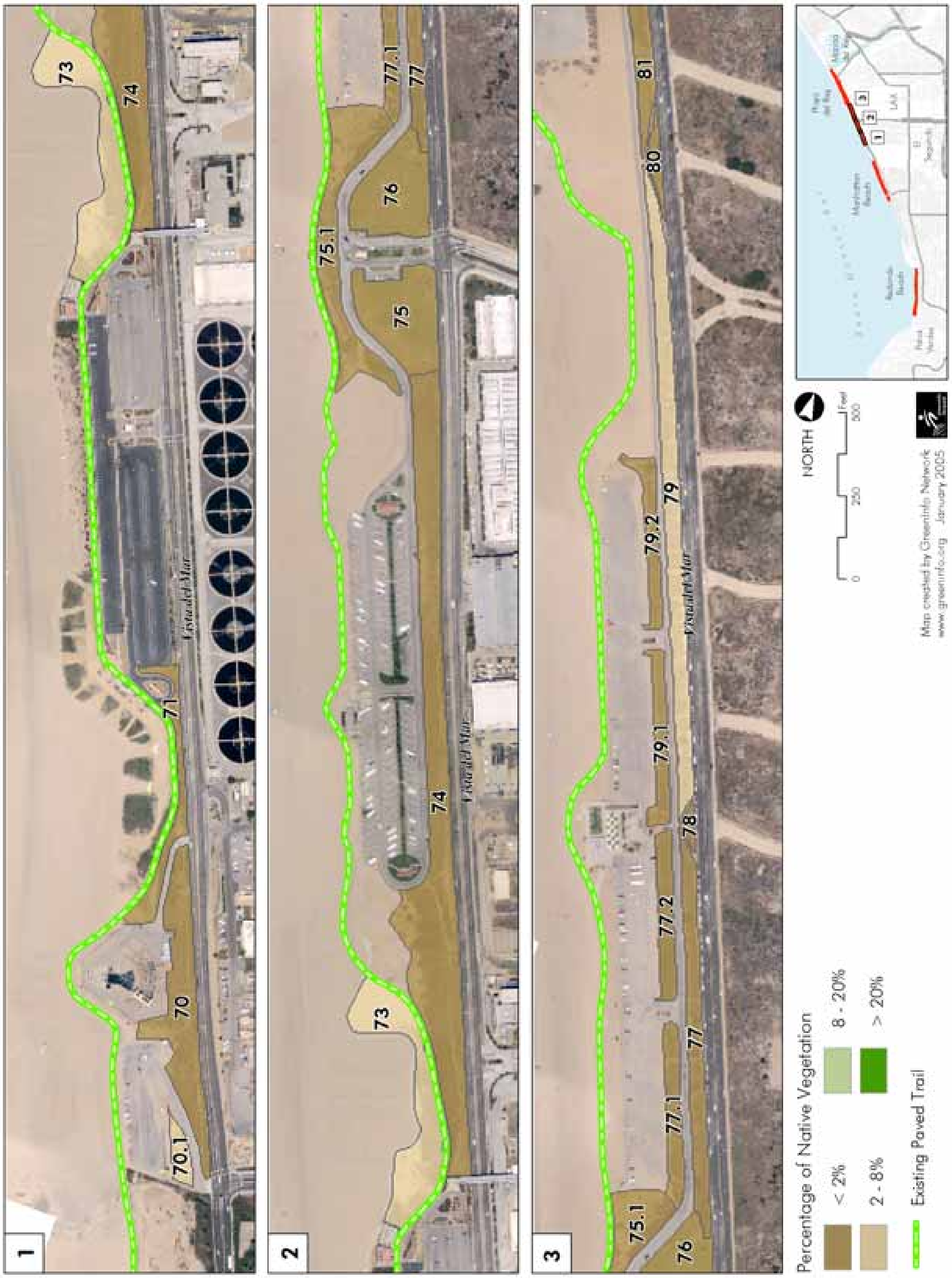

Figure 8. Undeveloped bluffs along Santa Monica Bay showing percent native vegetation (Northern Focus Area, Part 1).

Figure 9. Undeveloped bluffs along Santa Monica Bay showing percent native vegetation (Northern Focus Area, Part 2).

Biological Resources

The Redondo Beach portion of the study area is almost entirely dominated by iceplant (*Carpobrotus edulis*), with the exception of the three sites recently restored in Torrance (0.7 acres), Redondo Beach (3.1 acres), and Manhattan Beach (0.1 acres). 92% of the polygon areas included for this study contained iceplant (Table 1). This invasive species, which overruns and precludes growth by other species, constituted 67% of cover, with the next greatest cover from open sand. No other plant species could be considered dominant; bermudagrass has 2.9% cover, statice at 1.3% and bird of paradise at 1.3%.

Seventeen native plant species were found within in the study area (excluding the three restored sites), all of which were at extremely low density. These species are perennials quite tolerant of human disturbance, such as beach burr-bush, or are opportunistic annual species such as beach evening primrose and telegraph weed, or other disturbance associated species (e.g., Deerweed, *Lotus scoparius*). The presence of these species indicates that some native seedbank may be left in the study area. The persistence of the seedbank was illustrated in the revegetation of the Torrance beach site, where the coastal form of deerweed germinated from seed on a site previously dominated by iceplant. As a whole, the sites surveyed for this project did not contain significant botanical resources, and no rare or endangered species.

The recently restored sites in Torrance, Redondo Beach and Manhattan Beach all now have coast buckwheat (*Eriogonum parvifolium*), foodplant of the El Segundo blue butterfly, and could therefore likely support a population of the butterfly. Several other less common species have also been reestablished at these sites.

Table 1. Plant species found within study area, ranked by percent cover and number of polygons. Excludes recently restored sites at Torrance, Redondo Beach, and Manhattan Beach.

Scientific Name	Common Name	Total Percent Cover	Number of Polygons	Status
Carpobrotus edulis	Iceplant	67.0	81	Exotic
Cynodon dactylon	Bermudagrass	2.9	11	Exotic
Limonium sinuatum	Statice	1.3	2	Exotic
Strelitzia reginae	Bird of paradise	1.3	1	Exotic
Bromus diandrus	Rupgut brome	0.8	17	Exotic
Cakile maritima	Sea rocket	0.8	17	Exotic
Ambrosia chamissonis	Beach burr-bush	0.5	10	Native
Opuntia sp. / *Aloe* sp.		0.5	7	Exotic
Pittosporum sp.	Pittosporum	0.4	4	Exotic

Ricinus communis	Castor bean	0.3	8	Exotic
Ambrosia ancanthicarpa	Burr ragweed	0.2	6	Native
Malva parviflora	Cheeseweed	0.2	1	Exotic
Heterotheca grandiflora	Telegraph weed	0.1	22	Native
Oxalis pes-capri	Oxalis	0.1	18	Exotic
Camissonia cheiranthifolia	Beach evening primrose	0.1	17	Native
Salsola tragus	Russian thistle	0.1	13	Exotic
Sonchus oleraceus	Common sow thistle	0.1	12	Exotic
Atriplex semibaccata	Australian saltbush	0.1	11	Exotic
Brassica tournefortii	Asian mustard	0.1	10	Exotic
Acacia cyclops	Acacia	0.1	8	Exotic
Washingtonia filifera	Mexican fan palm	0.1	6	Exotic
Gazania sp.	African daisy	0.1	5	Exotic
Achillea millefolium	Yarrow	0.1	3	Native
Atriplex nummalaria	Bluegreen saltbush	0.1	2	Exotic
Chenopodium album	Pigweed	0.0	7	Exotic
Lobularia maritima	Sweet alyssum	0.0	7	Exotic
Croton californicus	Croton	0.0	6	Native
Gnaphalium sp.	Cudweed	0.0	6	Native
Lotus scoparius	Deerweed	0.0	6	Native
Cortaderia selloana	Pampas grass	0.0	5	Exotic
Matthiola incana	Stock	0.0	3	Exotic
Isomeris arborea	Bladderpod	0.0	3	Native
Rhus integrifolia	Lemonadeberry	0.0	3	Native
Myoporum laetum	Myoporum	0.0	2	Exotic
Tetragonia tetragonoides	New Zealand spinach	0.0	2	Exotic
Atriplex lentiformis	Brewer's saltbush	0.0	2	Native
Calystegia soldanella	Beach morning glory	0.0	2	Native
Datura wrightii	Jimson weed	0.0	2	Native
Lotus purshianus	Spanish lotus	0.0	2	Native
Lupinus succulentus	Succulent lupine	0.0	2	Native
Centaurea melitensis	Yellow star thistle	0.0	1	Exotic
Erodium sp.	Filaree	0.0	1	Exotic
Pinus sp.	Pine	0.0	1	Exotic
Baccharis pilularis	Coyote bush	0.0	1	Native
Heliotropium curassavicum	Seaside heliotrope	0.0	1	Native

Habitat Restoration Plan

The goals of the habitat restoration component of the Master Plan are to increase the ecological values of the bluffs and dunes, such that the restored areas 1) contribute to the recovery of the El Segundo blue butterfly, 2) provide habitat for unique and rare plants of the El Segundo dunes, 3) increase biological connectivity between remnant populations of dune species, and 4) support more diverse bird, reptile, and arthropod communities.

The habitat restoration also has the practical goal of removing iceplant and replacing it with species that are more efficient at controlling erosion and discouraging the cut-through foot traffic that causes the most erosion damage to the bluffs. Improvements to infrastructure to address this concern are discussed below.

These ecological goals will provide the opportunity to achieve educational goals of increasing awareness of the El Segundo dunes and bluffs as natural features in the landscape, targeting local residents and beach goers. It also has the goal of educating the public about cooperative efforts to recover endangered species.

Prioritization of Sites

All of the sites investigated as part of this study could be restored, given adequate funding and management. A prioritization of restoration sites is needed, however, to identify which sites are most feasible, which would conflict least with other uses, and which would require the least long-term management. While one could envision restoring all sites eventually, the following principles should aid in selection of those sites to be targeted first.

1. Sites with lower edge to area ratios (i.e., compact rather than long and skinny) are preferable because they will be less likely to experience disturbance in the interior.
2. Larger sites are generally preferable to smaller sites for ease of management and restoration.
3. Steeper sites present more challenges than less steep sites.
4. Restoration sites should be spread throughout the length of the study area, both to create a series of ecological stepping-stones and to provide an interesting visitor experience.
5. Within any given subarea, restoration of adjacent parcels is preferable to scattered parcels.
6. Conflicts with other established uses should be avoided.
7. Sites with lower measures of human activity will serve ecological goals better.

8. Sites with higher measures of human activity will serve educational goals better.
9. Restoration actions must be desired by site landowners, and preferably desired by adjacent landowners.

Many restoration projects are limited by the minimum area required to support a target species. For many birds, and larger vertebrates this poses a serious restriction. Even for some butterflies, a significant area, on the order of acres or tens of acres is required. But for the most sensitive species that could be introduced to the project site, the minimum area is quite small. El Segundo blue butterflies are very closely tied to their host plants and are quite sedentary (Mattoni 1992, 1993b). Small populations can persist on extremely small areas, even less than an acre. This is seen with the preserve at the Chevron Refinery, and at Malaga cove, where roughly 125 foodplants support a small El Segundo blue butterfly population. Any area that is restored with appropriate foodplant could potentially aid in the recovery of the El Segundo blue butterfly.

Surveys of the sites reveals that much of the infrastructure necessary to conduct restorations is already in place. Irrigation, which is necessary as a temporary measure to establish plants, is found throughout the study area. The many paths and coastal access sites provide ample and adequate access to the sites. These considerations are therefore not relevant in prioritizing the sites.

Inspection of the results of the surveys, along with calculation of the area and edge to area ratio for each site, quickly identifies those sites that would be best for ecological purposes. The greatest restoration area could be achieved most efficiently in Torrance and southern Redondo Beach as one unit, and along Dockweiler Beach near LAX and El Segundo as a second unit. From a biological perspective it would make sense to restore areas near the existing dunes at LAX because of the possibility of colonization by fauna from that site, perhaps even the El Segundo blue butterfly. At the southern end of the study area in Torrance, Site 1 is only ~1,000 feet from a population of El Segundo blue butterfly. To spread sites out, both for ecological and educational purposes, it would also be important to establish a series of restored sites in the central area of Manhattan Beach.

Top Priority Restoration Sites (19.54 acres)

Torrance/Redondo Beach sites 1–5 (4.05 acres). Part of this area (0.7 acre) has already been restored as part of a Department of Beaches and Harbors infrastructure improvement project. Irrigation is available and this site is closest to the Malaga Cove El Segundo blue butterfly population. Sites between pathways are large, with much interior area that would be largely undisturbed by cut-through foot traffic.

Redondo Beach sites 8–13 (6.38 acres). Part of this area (3.08 acres) is already under restoration as part of the pilot project. It continues along a highly used portion of the coast and the restoration would address some management issues such as cut-through trails.

Manhattan Beach sites 43–56 (2.55 acres). This area gets heavy use and is close to many residences, but there are many paths so cut-through is at a minimum. The choice of this section of Manhattan Beach derives from the slightly wider polygons and the proximity adjacent to the existing restoration at Site 46.

El Segundo/Dockweiler site 73–74 (6.56 acres). Offers opportunity to restore large area, with perhaps less disturbance from foot traffic than other sites

Second Priority Restoration Sites (16.5 acres)

Manhattan Beach sites 31–38 (1.79 acres), and Manhattan Beach sites 60–69 (1.46 acres). These polygons are smaller, with more edge to area than others in Manhattan Beach.

El Segundo/Dockweiler sites 77–86b (13.25 acres). The bluffs along Vista Del Mar at Dockweiler Beach would constitute a significant area for restoration. Advantages of this site are its proximity to the protected dunes at LAX, which would increase the probability of colonization by El Segundo blue butterfly, and the large area. Several challenges keep this from being a top priority. The slope is steep and would require substantial remediative grading to fill in the gullies caused by pedestrian traffic. Ownership patterns are more complex than other sites, with different jurisdictions owning and managing portions of the site. Providing a detailed funding estimate for restoration of these polygons would require additional engineering studies.

Third Priority Restoration Sites (2.36 acres)

Manhattan Beach sites 26–30 (0.34 acres). The smallest of the Manhattan Beach polygons, these sites would be difficult to maintain.

Redondo Beach sites 17–25 (2.92 acres). Compared to other areas in Redondo Beach (e.g, Sites 8–13), these polygons are narrow and steeper in many places. They also are immediately adjacent to apartment buildings, which would require extensive outreach, education, and cooperation to ensure restoration success.

Redondo Beach sites 6–7 (0.22 acres). These are smaller areas located in front of benches at Miramar Park. Restoration plantings would need to be carefully designed to avoid conflicts with views from existing benches.

Restoration Methodology

Over three acres of bluff and dune habitat have been restored in Torrance, Redondo Beach, and Manhattan Beach as part of the pilot project and independently by the Los Angeles County Department of Beaches and Harbors and the City of Manhattan Beach. The restoration approach is to remove perennial exotic vegetation, install container plants and seed from native plants, then allow growth of shrubs to exclude annual exotic species. This approach requires a number of years for the shrubs to mature but it avoids the use of herbicides. Weeding is only required as shrubs and native perennials are established but can then be reduced.

Exotic vegetation within the revegetation areas will be removed by hand. Removed plant material will either be disposed of off site or composted onsite for use as mulch for container plants.

A temporary irrigation system made with 3/4” PVC pipe and Hunter gear-driven sprinkler heads will be used. Irrigation will be used only between 2 A.M. and 6 A.M. to comply with existing Department of Beaches and Harbors policy.

Plant Propagation

All container plants will be propagated from local seed or cuttings, including from the El Segundo dunes. Container plants will be grown from seed in greenhouse conditions such that the plant fills the container size specified. Roots will reach the bottom of the container but not show signs of being root-bound. Seeds will be hand collected and cleaned and refrigerated until application.

A nursery has been established at the Los Angeles Conservation Corps SEA Laboratory in Redondo Beach, jointly operated by The Urban Wildlands Group and the SEA Laboratory. The growing space is sufficient to produce approximately 30,000 plants per year if operated continuously and efficiently, sufficient to revegetate 20 acres. If funding is available to restore habitat at a quicker pace, an alternative or additional nursery site should be located.

Irrigation

Prior to plant installation, the site will be watered for eight hours over two days to saturate the soil to a depth of 18 inches if sufficient rain has not fallen to already do so. After container plant installation, irrigation will be used to supplement natural rainfall as necessary. During the first three months after plant installation, we will irrigate as necessary to keep the soil moist to a depth of 18 inches. Irrigation will be halted three months after plant installation, and no irrigation will be utilized during any following spring or summer months.

During the first two years of establishment, additional water may be beneficial to the vegetation. Irrigation should use the existing overhead spray system to provide a substantial soaking at long intervals. The timing for such additional water should be between October 15 and the first large natural rainstorm. During this period, the system should be set to run for two hours once each week. If other timers are used or the system is run by hand, then four hours once every other week would be preferable.

Planting Scheme

The planting scheme will assume a founder model of succession. This model assumes that those plants that establish early during ecological succession ultimately define the community. Therefore the plantings will emulate the density and proportion of shrub and subshrub species that we intend to comprise the bluff and dune scrub at project completion.

The restoration plantings will predominantly recreate two vegetation types: southern foredune scrub and southern bluff scrub (Table 2). Elements of the strand community will be represented at the base of the bluff as allowed by edaphic conditions.

Table 2. Plant species for beach bluffs revegetation. Zone A: base of bluff in very sandy soils. Zone B: On bluff in more developed soils. Density: 1,500 plants (shrubs and subshrubs) per acre.

Perennials	Name	Planting Zone
Abronia maritima	Sand verbena	A
Abronia umbellatum	Beach sand verbena	A
Ambrosia chamissonis	Beach burr-bush	B
Artemisia californica	California sagebrush	B
Artemisia dracunculus	Mugwort	B
Astragalus trichopodus leucopsis	Southern California milk-vetch	B
Atriplex californica	California saltbush	B
Baccharis salicifolia	Mule fat	B
Calystegia macrostegia	Bindweed	B
Calystegia soldanella	Morning glory	A
Camissonia chieranthifolia	Beach evening primrose	A
Cardionema ramosissima	Sand carpet	B
Corethrogyne filaginifolia	Sand aster	B
Croton californica	California croton	AB
Cucurbita foetidissima	Calabazilla	AB
Cuscuta californica	Dodder	AB
Datura wrightii	Jimson weed	AB
Distichlis spicata	Saltgrass	A
Dudleya lanceolata	Lance-leaf liveforever	B

Encelia californica	California sunflower	B
Ericameria [=Haplopappus] ericoides	Goldenbush	B
Eriogonum parvifolium	Coast buckwheat	AB
Erysimum capitatum [=E. suffrutescens]	Western wallflower	AB
Eschscholtzia californica	California poppy	AB
Galium angustifolium	Bedstraw	AB
Gnaphalium bicolor	Two-tone everlasting	AB
Isomeris arborea	Bladderpod	B
Lotus scoparius	Deerweed	B
Lupinus chamissonis	Silvery blue lupine	AB
Marah macrocarpus	Wild cucumber	B
Mirabilis laevis	Four o'clock	B
Opuntia littoralis	Prickly pear	B
Opuntia prolifera	Cholla	B
Phacelia ramosissima	Branching phacelia	AB
Rhus integrifolia	Lemonadeberry	B
Salvia mellifera	Black sage	B
Senecio flaccidus douglasii	Butterbush	B
Verbena lasiostachys	Verbena	B
Annuals		
Calandrinia maritima	Seaside redmaids	AB
Calyptridium monandrum	Pussypaws	AB
Camissonia micrantha	Minature suncup	AB
Chaenactis glabriuscula	Pincushion flower	AB
Clarkia purpurea	Purple clarkia	B
Crassula connata	Pygmyweed	AB
Cryptantha clevelandii	Cleveland cryptantha	AB
Descurainea pinnata	Tansy mustard	B
Heterotheca grandiflora	Telegraph weed	AB
Lepidium lasiocarpum	Peppergrass	AB
Linaria canadensis	Blue toadflax	AB
Lotus purshianus	Spanish lotus	AB
Lotus strigosus	Strigose bird's-foot-trefoil	AB
Lupinus bicolor	Two-tone lupine	AB
Lupinus succulentus	Succulent lupine	AB
Lupinus truncatus	Truncated lupine	AB
Phacelia cicutaria hispida	Caterpillar phacelia	AB
Plantago erecta	Dwarf plantain	B
Stephanomeria virgata	Wand chicory	AB

Other sensitive species may be added to the planting scheme, as propagules are available. These could include *Dithyrea maritima* (Beach spectaclepod), *Dudleya virens* (Bright green liveforever; at southern end of study area), and *Mucronea californica* var. *suksdorfii* (California spineflower).

Maintenance

Trampling presents a danger to the success of plantings. Fencing to discourage cut-through traffic should remain up one more year to allow for greater shrub establishment.

The largest concern about restoration projects is often "weed control". The reality of restoration in urban areas is that weed sources will always be nearby and complete control of weeds is impossible. It is important therefore to distinguish between weeds that may displace the newly established vegetation (e.g, perennials) and those that are do not (e.g., annuals).

In the dune scrub system, annual weeds are essentially impossible to eradicate. They will decrease in abundance as the native shrubs mature and eliminate the conditions that allow their germination. The common weeds that fit this description are sow thistle (*Sonchus* sp.), ox tongue (*Picris* sp.), pigweed (*Chenopodium* sp.), and three grasses (oats and two brome species). These species do not need to be eradicated as long as shrub cover is gradually eliminating regeneration possibilities.

Several biennial and perennial weed species do threaten the system because of their more competitive characteristics. Such invasive species are identified in *Invasive Plants of California's Wildlands* (Bossard et al. 2000) and other publications by the California Invasive Plant Council. These include, for example, iceplant (*Carpobrotus* sp. and *Mesembryanthamum* sp.) and Bermuda grass. At six-month intervals the site should be searched for invasive species — iceplant should be removed by hand and Bermuda grass killed with a spot application of Round-up.

No clearing of dead vegetation (except for perennial weeds) is recommended or desirable. Trimming of large shrubs is permissible if necessary for aesthetic reasons but is not recommended.

Infrastructure Improvements

The built infrastructure around potential restoration sites could be improved in many locations. This plan does not detail all potential infrastructure improvements because these must be implemented at the initiative of the local jurisdiction. The following types of improvements would be desirable in coordination with restoration efforts.

Runoff and Erosion Control

The geomorphology technical report (Appendix A) details many problems with curbs and other hardscape elements that contribute to erosion of the bluffs. For example, for Site 5 it is recommended to raise the curb one foot to prevent overflow of stormwater onto the bluff. For Site 15, breaks in the curb should be repaired to divert runoff from slope. In other areas, fencing should be used to reduce cut-through traffic. The intention behind these recommended improvements is to reduce the amount of runoff from adjacent impermeable surfaces that is discharged onto the slopes and to reduce the frequency and intensity of cut-through pedestrian traffic. The third aspect of reducing erosion is to increase infiltration by increasing plant cover and making compacted soils more permeable, both of which would be achieved by the revegetation of the bluffs.

Stormwater Improvement

The beach and bluff environment would be enhanced by improving the quality of stormwater that is discharged into the beach and nearshore area. This may be accomplished through a number of structural best management practices, including low-flow diversion of run-off to water treatments plants, filters, grates, and other engineered solutions. As local jurisdictions contemplate restoration of the beach bluffs, such projects may be paired with infrastructural improvements to improve stormwater quality and reduce dryweather flows.

Traffic Improvements

The enjoyment of the beach bluffs, and its educational value, depends on visitors being able to access sites safely and comfortably. In some locations, conflicts arise between different modes of transportation. For example, along the Esplanade in Redondo Beach there are frequent conflicts between pedestrians, cyclists, joggers, and vehicular traffic and parking areas. An improved multimodal transportation design would improve the experience of the beach bluffs in this and other locations. These improvements may take the form of improved signage, lane striping, or even construction of separate paths where necessary.

Design Considerations

In the design of infrastructure improvements, jurisdictions should be aware of the beach bluffs and considerations to protect the native vegetation of restoration sites. As evident from the discussion above, all stormwater management should divert flows from the bluffs to reduce erosion, and to avoid the input of contaminants in urban runoff. Designs should continue to discourage cut-through traffic down the slopes and pedestrians should be restricted from walking out to the edge of the bluffs by fencing where feasible. Night lighting should not be directed on the bluffs, but rather full cut-off lights on the lowest feasible poles should be used when illumination of paths or streets is desired. Artificial lights disrupt the ecology of many organisms (see Longcore and Rich 2004 for a full discussion), and detract from the aesthetics of the beach environment.

Education Plan

The restoration of native habitats along the beach bluffs provides an excellent opportunity to educate the public. Because of the heavy recreational use of these beaches by local, national, and international visitors, the efforts here will have more visibility than almost any other restoration project in California. It is therefore imperative for the long-term success of the project that the public appreciates and values the restored environment. The education plan to accomplish this goal has three parts. First is an interpretive program targeted at tourists and infrequent visitors. Second is a volunteer program for local residents to participate in stewardship of the sites. Third is outreach to local schools to incorporate the beach bluff environment into the educational experience, linked to the statewide science standards.

Interpretive Self-Guided Tour

The interpretive self-guided tour will consist of a series of signs installed along the bike and walkways from Ballona Creek to the Palos Verdes peninsula. The signs will be similar in design and appearance to provide a uniform, recognizable set of landscape features that connect these areas. The signs will meet National Park Service quality. Laminate color panels have high resolution and detail and weather well, requiring replacement after more than ten years. Signage will include interpretation of the biophysical environment and the history of the beach bluffs.

The following general areas are suggested for interpretive signs about history. Details of the history of the area are provided in Appendix B.

1. The plaque memorializing the Hollywood Riviera Beach Club in Miramar Park (Torrance)
2. A site about gambling and alcohol smuggling during Prohibition.
3. A site to mark the presence of the Chowigna (Redondo Beach)
4. The Plunge site (Redondo Beach)
5. Shakespeare's Beach at the foot of Longfellow Avenue (Hermosa Beach). To identify the artists' colony now only apparent in the street names.
6. Surfer's Walk of Fame (Hermosa Beach). This site should discuss the history of surfing along the beaches of the south bay.
7. Bruce's Beach (Parque Culiacan in Manhattan Beach). To discuss the name of the city.
8. Standard Oil Site (El Segundo). The City of El Segundo was created by Standard Oil.

The following topics are suggested for interpretive signs about the biophysical environment. Locations to be determined as indicated but paired with restored vegetation.

1. Geological explanation of the Palos Verdes peninsula (southern end).
2. Creation of the El Segundo dune system and its structure.
3. Dunes at Los Angeles International Airport as major site for endangered El Segundo blue butterfly, ten endemic insects, and rare plants.
4. Life forms of plants in the dune and bluff environment (e.g., suffrutescent, drought deciduous, creeping).
5. Birds, reptiles, and mammals of the beach and dunes (e.g, least tern, western snowy plover, legless lizard).
6. Mutualism and competition in dune communities.
7. Habitat loss and conservation of El Segundo dunes species.
8. Ballona Creek as the outlet of the Los Angeles River and the source of sand for the El Segundo dunes (northern end).

All signs will include a common introductory text explaining the route and the revegetation project so that each can stand alone.

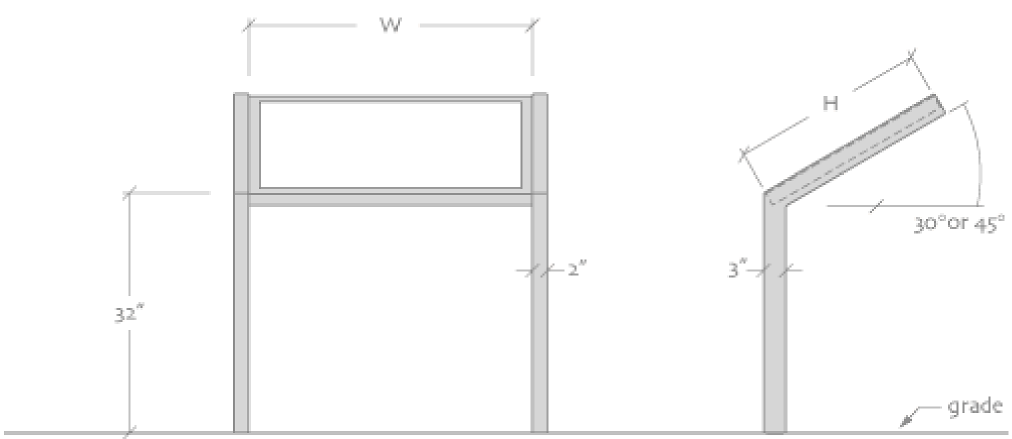

Figure 10. Design of base for interpretive signs.

Volunteer Program

A community-based volunteer program will be established to allow local residents to participate in the stewardship of revegetation sites. This program will be coordinated by the Los Angeles Conservation Corps S.E.A. Laboratory. Volunteer days will be arranged to conduct trash pick-up and light weeding of sites. If interest is sufficient, docents will be trained for revegetation sites to provide educational materials to the public during high use periods.

School Program

Revegetation sites will be used as instructional sites for elementary and middle school visits to the coast. These visits and activities will be coordinated by the Los Angeles Conservation Corps S.E.A. Laboratory to complement the state science education standards. Activities will include investigations into the concept of "habitat," diversity, pollination, mutualism and adaptation.

Financial Estimates

The implementation of this master plan will take place as a series of smaller projects, with this document serving as a guide. Costs of individual projects will vary greatly depending on the degree to which hardscape infrastructure improvements are included. Hardscape development is an order of magnitude more costly than revegetation under most circumstances. The following cost estimates address the revegetation and education portions of the project only.

Restoration

Total revegetation costs per acre, including permits and reporting, will be approximately $20,000 per acre as follows:

Irrigation supplies	$1,300 / acre
Installation of irrigation	$200 / acre
Plant propagation labor and materials	1,500 plants per acre @ $4 / plant = $6,000 / acre
Site preparation (iceplant removal)	$2,500 / acre ($20 / hour total labor cost)
Plant installation	$1,000 / acre
Weeding	$1,000 / acre
Write site-specific revegetation plan, write Coastal Commission application, meet with Coastal Commission, coordinate site access and permission, assess progress, prepare reports	$8,000 / acre

Ongoing maintenance would require removal of invasive weeds once or twice a year, litter clean-up, and periodic replacement plantings in the event of abnormal disturbances. Under normal circumstances plants will set seed and reproduce without human intervention; this will build up a seed bank that should eliminate the need for supplementary plantings, so long as invasive weeds are excluded. This minimal maintenance might be expected to cost $2,000 / year per acre.

Using this cost per acre, restoration of the remaining first priority restoration sites (~16) acres could be accomplished for $320,000. The second priority sites could be completed for another $320,000 while the third priority sites would cost $50,000. The total cost for revegetation of all feasible sites is therefore $690,000. This estimate does not include any fencing or other physical infrastructure beyond the irrigation system and plants.

Education Program

Costs for the interpretive sign program include graphic design and text for 16 signs ($16,000), sign production with high-pressure laminate display and a weatherproof base ($24,000), and sign installation ($5,000) for a total, one-time cost of $45,000.

A public volunteer program could be coordinated by a 1/4-time employee at a cost of approximately $15,000 per year and a budget of $5,000 per year for materials. Any nonprofit hosting this position would require an additional $2,500 per year for liability insurance.

The school program should be integrated into the existing educational programs in the project area (e.g., S.E.A. Laboratory in Redondo Beach, Round House Aquarium in Manhattan Beach). Development and implementation of the educational program could be accomplished by a 1/2-time staff person ($30,000/year) with a budget of $5,000 for materials and expenses.

References

Barbour, M. G., and A. F. Johnson. 1988. Beach and dune. In *Terrestrial Vegetation of California*, edited by M. G. Barbour and J. Major. Sacramento, CA: California Native Plant Society.

Brossard, C. C., J. M. Randall, and M. C. Hoshovsky. 2000. *Invasive plants of California's Wildlands*. Berkeley: University of California Press.

Cooper, W. S.. 1967. *Coastal dunes of California*. Vol. 104, *Geological Society of America Memoir*. Boulder, CO: Geological Society of America.

Longcore, T., and C. Rich. 2004. Ecological light pollution. *Frontiers in Ecology and the Environment* 2:191–198.

Mattoni, R. H. T. 1990. Species diversity and habitat evaluation across the El Segundo sand dunes at LAX. Los Angeles: Los Angeles Department of Airports.

Mattoni R. H. T. 1992. The endangered El Segundo blue butterfly. *Journal of Research on the Lepidoptera* 29(4):277–304.

Mattoni, R. H. T. 1993a. Natural and restorable fragments of the former El Segundo sand dunes ecosystem. In *Interface Between Ecology and Land Development in California*, edited by J. Keeley. Los Angeles: Southern California Academy of Sciences.

Mattoni, R. H. T. 1993b. The El Segundo Blue, *Euphilotes bernardino allyni* (Shields). In *Conservation Biology of Lycaenidae (Butterflies)*, edited by T. R. New: Occasional Paper of the IUCN Species Survival Commission, No. 8.

Mattoni, R., and T. R. Longcore. 1997. The Los Angeles coastal prairie, a vanished community. *Crossosoma* 23 (2):71–102.

Nordstrom, K. F., N. Psuty, and W. Carter. 1990. *Coastal Dunes: Form and Process*. John Wiley and Sons, Chinchester, England.

Pipkin, B. 1985. Santa Monica to Dana Point. Pp. 307–329 in *Living with the California coast*, ed. by G. Griggs and L. Savoy. Durham, North Carolina: Duke University Press.

Appendix A: Coastal Dune Morphology and Erosion Assessment

Julie Stephenson and Antony R. Orme, Ph.D.
University of California, Los Angeles

This study of the morphology and erosion characteristics of the coastal dunes flanking Santa Monica Bay was commissioned by Travis Longcore as part of a larger study concerned with the potential revegetation of the dunes seaward of the developed areas of portions of Playa del Rey, Manhattan Beach and Redondo Beach, California. The study was undertaken by Julie Stephenson, a graduate student in geomorphology, under the direction of Antony Orme, Professor of Geography and geomorphologist at UCLA. Field observations were conducted during November and December 2003, the notes from which have been compiled, organized by aerial photographed polygon numbers, in the attached Appendix. This short report summarizes our general findings from such field observations in the context of a broader application.

Local Scientific Background

The Santa Monica Bay dune field is composed of four transverse systems extending southward as a series of ridges and troughs from the mouth of Ballona Creek to the Palos Verdes Peninsula. The dune systems rest upon a lowland comprising marine and non-marine terrace materials. (Cooper 1967) Santa Monica Bay is characterized by net southward littoral drift, which provides sediment to beaches, from which sand is blown inland by prevailing northwest winds. The lowland character of the coast south of Ballona Creek has long accommodated coastal dune development but the Palos Verdes Peninsula has blocked the farther southward transport of sediment. This constructive coastal environment has been enhanced by short intermittent periods of southwest winds, which drive littoral drift northward, further minimizing the escape of sediment around the Peninsula. (Orme and Tchakerian 1986) All dunes in this region have been much modified by human activities over the past century but their general form remains decipherable beneath the urban and industrial framework of the coastal communities.

The dune field covers approximately 96 square kilometers and can be discussed in two parts as designated by form and age. The first part consists of the young, distinct coastal ridge, which is though to have advanced onshore ahead of prograding sea levels during the Flandrian transgression, which culminated around 4,000 years ago. It is well defined as a 300–600 meter wide ridge north of Manhattan Beach but becomes less clearly expressed to the south where it is often confused with the older dunes upon which it has been superimposed. The second part consists of the older dune ridges that extend inland approximately 3–7 km. These dunes were formed prior to the Flandrian transgression and therefore have a more weathered topography. Various hypotheses have been put forth in explanation of their formation. It was formerly believed that these older dune ridges were once offshore bars at times of higher sea levels and emerged during marine regressions. (Cooper 1967) It is now thought that these ridges are of aeolian origin, reflecting distinctive phases of dune formation associated with relative sea-level changes. (Orme 1988; 1992) Regardless, there are three older ridges similar in relief and extent that extend inland from the more prominent coastal ridge.

Nature of Dune Bluffs and Dunefields Seaward of Developed Areas

Development now covers the majority of the Santa Monica Bay dune field, except in the northernmost portion owned by the Los Angeles International Airport. Thus, for the purposes of this study, we are only concerned with the westernmost slope of the coastal ridge, which remains exposed and, in the absence of human constraints, would likely remain active. The region examined can be discussed in three parts that share general characteristics and are subject to similar disturbances. These are Redondo Beach, Manhattan Beach and Playa del Rey segments.

Redondo Beach is the southernmost region of interest. The windward dune slopes range between 25 and 40 degrees and are associated with compacted soils forming a bluff-top ledge from 6 to 25 feet wide. The slopes are primarily vegetated by iceplant, with coverage from 40 to 95%. Those areas not vegetated are susceptible to erosion from pedestrian traffic and runoff from adjacent parking lots, roads or walkways. Access from the bluff top to the beach is limited in some areas, which has encouraged short cut trampling. The dune slopes decline gradually into a broad flat beach, devoid of vegetation.

The area of study in Manhattan Beach lies between Redondo Beach and Playa del Rey and consists of the windward coastal ridge slope as well as portions of the foredune system. The exposed coastal ridge is situated between the eastward-bounding pedestrian strand and the westward-bounding bike path where slopes range from 5 to 25 degrees. The slopes have vegetal covers ranging from 60 to >95%, which vary in their concentrations of iceplant, trees, shrubs and cacti. Such areas are primarily subject to erosion from concentrated discharges of pipes draining the pedestrian walkway through a one-foot curb. Privately maintained gardens on the top one third of the slope commonly serve to stabilize slopes by dissipating energy from concentrated runoff and preventing trampling. The foredunes lie west of the bike path and are characterized by gentler slopes ranging from 5 to 10 degrees and a more hummocky topography. Vegetation covers approximately 30% of the area and consists of patchy iceplant and low shrubs. The foredunes are susceptible to sheet wash erosion as runoff drains from the adjacent impermeable bike path but this is only of concern where runoff is able to concentrate.

The dune ridge in Playa del Rey is the northernmost region of interest and lies directly west of the Los Angeles International Airport. Although a much broader expanse of the local dune field is exposed, this study is only interested in the publicly owned land west of Vista del Mar Street. Slopes on the coastal ridge range from 25 to 55 degrees. These slopes gradually decrease westward and open into a hummocky foredune system, much like in Manhattan Beach, with slopes ranging from 0 to 10 degrees. Vegetation in the form of iceplant, cacti and shrubs covers 70 to 95% of the ridge slopes and 0 to 35% of the foredunes. The dune slopes are particularly susceptible to runoff overflow from the street and trampling adjacent to areas where street parking is allowed. The low foredunes fronting much of the Manhattan Beach and Playa del Rey segments are active reflections of sand moving in the prevailing winds from the broad beaches to seaward whose natural instability is maintained by recreational and beach-grooming activities.

Management Problems and Causes

As noted below, there are various geomorphic concerns associated with the dune slopes that warrant effective management. For the purposes of this study, the areas of interest are bounded by streets, houses and walkways, which limit the concerns that may arise. Of particular importance given the circumstances are raindrop impact, sheet erosion, rill erosion, gully erosion, mass movement, and wind erosion and redeposition. The susceptibility of slopes to the adverse impacts of the above processes varies depending upon the prevailing local conditions and is enhanced by channelized runoff, pedestrian trampling and vegetation loss.

Raindrops may dislodge soils on exposed surfaces where the force of the raindrop impact exceeds the gravitational and cohesive forces maintaining sediment positions. This loosens soils for further erosion and transport and is particularly important where soils are susceptible to mobilization because of a lack of cohesion or vegetation. In the areas of concern, raindrop impacts are only of minor importance. Exposed soils on the bluff-top ledges of Redondo Beach and Playa del Rey and the areas of patchy vegetation in Playa del Rey are susceptible to degradation by raindrop impacts. These impacts alone are of little consequence but the resulting availability of sediment for more destructive processes warrants consideration.

Sheet erosion occurs naturally on steep slopes with relatively uniform soil resistance and permeability. It may also occur where impermeable surfaces drain unobstructed and unchannelized onto more pervious materials. The sheet wash effectively dislodges sediment by overcoming frictional forces and is capable of transporting it downslope. For the purposes of this study, sheet erosion, like raindrop impact, plays a larger role in setting up conditions more vulnerable to other processes than by degrading slopes by itself. This is of particular concern in Redondo Beach and Playa del Rey where bluff-top ledges consist of soils compacted to the point of limited permeability. Therefore, storm runoff is discharged as sheet flow immediately onto the dune slopes, it may be where it is directed into already established rills and gullies by local vegetation and topography, accentuating erosion processes. Sheet erosion is also of concern in Manhattan Beach and Playa del Rey where bike paths drain directly onto the foredune systems. Erosive impacts are limited to the area immediately adjacent to the concrete paths because of the permeability of the sandy soils and the patchy vegetation.

Dune slopes are susceptible to rill erosion where vegetation is patchy and sparse. Runoff is locally channelized and capable in such mass and velocity to incise shallow rills. Because vegetal coverage for most areas of this study are 70 to 90%, erosion due to rill formation in most places is limited in extent and depth. The only region where this may warrant more consideration is in those areas of Playa del Rey where vegetation is patchy and distinct unvegetated avenues have been cut through the slopes. In this region, vegetation is a mixture of iceplant and shrubs, the sparse distribution of which facilitates the rilling of bare soils.

Rills are also important in that they may lead to gully formation. Gullying is widespread in the study area and has the greatest adverse impacts on the stability of the dune slopes. Gullies form much like rills but require the concentration of greater quantities of discharge and result in deeper, more incised channels. Gullies also serve as major routes for sediment transport during storm flows as the depth and velocity of the channels support sediment in suspension as well as bed load. This is especially important in the area of study because soils are removed from slopes and ultimately delivered to the impervious westward bounding pedestrian and bike paths. This creates maintenance and safety concerns and decreases the utility of the right of way. Gullying is problematic in all three areas of the study. In Redondo Beach, deep gullies have formed where runoff from the adjacent bluff-top street overflows during larger storm events onto the dune slopes from collection areas or from breaks in the curb. Gullies in Manhattan Beach are of similar depth but occur at specific intervals associated with the location of pipes draining adjacent bluff-top and mid-bluff walkways. Incision capabilities are enhanced where discharges fall a substantial distance onto dune soils lacking sufficient vegetation to dissipate impact energies. Gullies in Playa del Rey are the most severe, occurring at more frequent intervals and in greater depth than elsewhere. They have been formed by the channelization of overflow runoff from the adjacent street and have been accentuated where storm drains prevent local infiltration. In all areas, gullies are used by pedestrians as paths and therefore slope and beach-access influence the degree to which erosion has occurred.

The mass movement of slope materials occurs when a large portion of the hillslope is dislodged as a massive unit or as a collection of individual grains and moves downhill response to gravitational forces. Materials are mobilized initially by bank destabilization, which may occur with saturation or vegetation removal. The material, depending on its consistency and hillslope declivity, moves downhill by sliding, falling or mass flowage. Such processes can substantially deform hillslope profiles and transport large quantities of material very rapidly. In all three sections of the area of study, there are signs of relict mass movements that have been stabilized by vegetation and retaining walls. Mass movement does not appear to be a current problem because problem slopes have been maintained at conservative grades and provided with dense vegetal coverage.

Active dunes are, by definition, subject to frequent change as a result of the introduction of fresh sand and / or effective wind velocities. (Nordstrom et al. 1990) Under natural conditions, the coastal ridge of the Santa Monica Bay dunes should still be active. Indeed, in the Manhattan Beach and Playa del Rey segments in particular, deflation of broad flat beaches under prevailing wind conditions continues to provide for active foredune development and sand transport towards the main dune ridge. The latter, however, is not as susceptible to wind erosion because of its vegetation coverage and engineered slopes although sediment from the foredunes may rise onto the coastal ridge. Such processes do not pose any immediate management problems with respect to coastal bluff stability.

Management Solutions

The destabilization and deformation of the exposed dune ridge in Redondo Beach, Manhattan Beach and Playa del Rey are primarily the result of erosion caused by storm runoff and pedestrian traffic. There are a number of ways in which drainage, pedestrian access and slope susceptibility may be managed to mitigate the adverse impacts of development on the dunes.

As discussed in the previous section, directed runoff from adjacent streets, parking lots or walkways initiates a multitude of destructive processes, most notably rill and gully formation. While most impervious surfaces in the area of study (except for Manhattan Beach) do not discharge runoff directly onto the dune slopes, overflow events occur during large storm events and poorly maintained infrastructure allows for breaks in the system, as evident in curb failures and downspout problems at Redondo Beach and Playa del Rey. While it is unlikely that such impervious surfaces will be reengineered to fix minor glitches, attention should be given to reducing the capacity of collection areas during storm events and to the repair of the curb breaks to reduce the impact of excess runoff on dune slopes. The area of concern in Manhattan Beach is unique because runoff from the pedestrian strand is directed through pipe culverts at intervals ranging from 20 to 50 feet on to the dune slopes, not all of which are presently functioning. In such cases, it is more important to prepare the dune with hardy vegetation at the outfall to dissipate the erosive energy.

Erosion caused by runoff has been exacerbated by pedestrian trampling of the dunes and their vegetation cover, which has led in many places to rilling and gullying. The dune ridge presents an obstruction to the direct access of the beach and therefore stairways and ramps have been designed to provide safe avenues of travel. Such access points must be properly placed to provide access to the greatest number of recreational users. Therefore, planning and circulation concerns such as pathway directness, continuity and accessibility are important in encouraging use and preventing the trampling of the dunes. In Redondo Beach and Playa del Rey in particular, access is limited and pedestrians are required to walk some distance to reach a stairway or ramp to descend to the beach. Many people are simply too lazy to walk that distance when sand and surf beckon! Therefore, to discourage short-cutting and the resulting trample erosion of the dunes, providing more frequent access paths should be considered. Less expensive bluff-top fences and/or revegetation of informal access paths with plants that deter pedestrian traffic (e.g. native cactus!) should also be considered.

Finally, dune vegetation and slope should be maintained to reduce vulnerability to the adverse impacts of natural processes. Gullies may be filled and revegetated to stop active erosion of local slopes. Furthermore, bare soils may be revegetated to stabilize slopes and reduce exposure to weathering. Such actions would be most effective in combination with the drainage and access measures discussed above.

Conclusion

The primary purpose of this report is to assess the local physical, chemical and biological forces acting on the exposed coastal ridge of the Santa Monica Bay dune field. From the field observations, it is apparent that hillslope profiles are altered predominantly by natural processes, such as rill and gully erosion caused by stormwater runoff, and enhanced by pedestrian trampling. The occurrence and rates of erosion processes are therefore dependent not only on rainfall intensity and hillslope susceptibility but also on the channelization of runoff and pedestrian access to the beachfront and dune slopes. Vegetation can play a vital role in naturally stabilizing slopes by retaining the cohesiveness of slope materials with extensive root systems and by dissipating rainfall and runoff energies that would otherwise erode exposed soils. Larger prickly shrubs may also be used to physically block pedestrian access to dune slopes and therefore prevent short-cut trample erosion. Revegetation efforts should consider the geomorphic benefits of slope vegetation as well as the prevailing local conditions (summarized in Appendix) in selecting locations and species for renovation. Areas that would be conducive to revegetation trials are the bluff-top ledges that line many of the slopes in Redondo Beach and Playa del Rey as well as the foredunes of Manhattan Beach and Playa del Rey. It is recommended that further revegetation be evaluated on a section-by-section basis in consideration of slopes, soils, adjacent development and its drainage, and the history of pedestrian trampling. Lastly, revegetation success would be greatly enhanced by the implementation of the other drainage and access suggestions contained throughout the body of this report.

References

Cooper, W.S. 1967. Coastal dunes of California. *Geological Society of America Memoir 104,* Boulder, Co.

Nordstrom, Karl F., Psuty, N, and Carter, W. (editors) 1990. *Coastal dunes: form and process*. John Wiley and Sons, Chinchester, England.

Orme, A.R. 1988. Coastal dunes, changing sea level and sediment budgets. *Journal of Coastal Research*, Special Issue No. 3.

Orme, A.R. 1992. Late Quaternary deposits near Point Sal, south-central California: a time frame for coastal dune emplacement. In *Quaternary Coasts of the United States*, Society for Sedimentary Geology, 48, 308–315.

Orme, A.R. and Tchakerian, V.P. 1986. Quaternary dunes of the Pacific Coast of the Californias. *Aeolian Geomorphology*, Allen and Unwin, London, 149–175

Dune Morphology and Erosion Assessment by Aerial Photograph Polygon Number

TORRANCE/REDONDO BEACH

1 iceplant vegetated bluff; some past slope failure stabilized by ~90% vegetative cover

1-2 (3–5 m wide sandy track from bluff parking lot) no vegetation and heavily trafficked ----> erosion prone
Recommendation: close bluff-top access

2 iceplant coverage of 70%, remaining 30% bare due to heavily trafficked diagonal tracks which increase vulnerability to erosion
Recommendation: restrict bluff-top access by means of a fence or impenetrable vegetation

3 80% iceplant coverage; 1/3 from bluff top – distinctly indurate, hardened sand; has suffered gullying and erosion, downslope sandbagging indicating active erosion north of men's restroom
*recently re-vegetated segment with new zig-zag wheelchair access ramp, slope engineering during construction of ramp eliminated gullies (north of men's restroom)

4 largely refurbished segment with gullies repaired during construction of zig-zag concrete access path
*polygon boundary change – south boundary path is now at a greater angle diagonal to dune orientation, old ramp eliminated

5 40% iceplant coverage, actively eroding gully 4–6 inches in depth at northern boundary adjacent to relict re-vegetated gully, consecutive trampled gullies, receives parking lot runoff overflow during larger storm events (parking lot drains to storm drain via intervallic culverts)
Recommendation: prevent further erosion by raising curb 1 foot to prevent overflow and restricting access (move bluff top fence east 4 feet to the parking lot curb AND/OR plant prickly hedge grove to deter shortcutting instead of iceplant near bluff top parking lot

6 newly trampled swath, unvegetated, eroded
Recommendation: extend bluff top fence to south bounding zig zag path to prevent short cutting

7 recently graded, 40% iceplant coverage, slight gullying but not significant due to small watershed size, cliff top above — grass covered with distributed Japanese black pines

8 bluff divided in half by chain link fence which has been successful in protecting area downslope, upslope area extensively degraded –> 15–18 foot barren ledge and potential gullying because of denuded bluff top, significant gullying near north boundary in places 1 foot deep
Recommendations: restrict access at bluff top by placing barrier fence immediately adjacent to street curb, close holes in chain link fence under which people can climb to short cut
**Bluff top barren ledge ideal location for revegetation with natives with protection of fence*

9 bluff divided in half by chain link fence, significant erosion above and below fence due most likely to impacts of rain on 18–25 foot wide barren bluff top strip ----> actively eroding gullies exacerbated by trampling where holes under fence, gully 50 feet north of Vista del Mar excavated to depths > 2 feet forming alluvial fan mid-slope
Recommendations: construct or plant discouraging barrier at sidewalk curb to prevent people from short cutting through gullies already established by rainfall (critical points = benches), construct additional access ramps or stairs to mitigate need to bypass foredune slopes

10 bluff divided in half by chain link fence, trampling less problematic because polygon lies between more closely placed access ramps, bluff top ledge of compacted soils 6–10 feet wide
Recommendation: extend chain link fence all the way to path to prevent any attempts at short cuts

11 bluff divided in half by chain link fence, bounded by relatively close access ramps ---->minimal gullying, 4–6 foot compacted bluff top ledge, steep slopes

12 bluff divided in half by chain link fence, 3–6 foot compacted bluff top ledge, 30° slope (too steep for trampling), relict gullying largely arrested by iceplant revegetation, actively eroding gully at north bounding path
Recommendation: extend mid-slope fence to path edge to prevent short cutting

13 bluff divided in half by chain link fence, 6–8 foot denuded bluff top ledge enabling minimal gully initiation, actively eroding gully at north bounding path
Recommendation: extend mid-slope fence to path edge to prevent short cutting

14 bluff divided in half by chain link fence, small aerial extent, 80% iceplant coverage, limited watershed, no significant gullying

15 bluff divided in half by chain link fence, 40° slope, barren cemented dune sand exposures at bluff top ----> sheet erosion onto steep slopes, severe gullying in places depths >3 feet, upper slopes largely exposed, vulnerable to street drainage where breaks in sidewalk allow runoff to breach curb and wash downslope
Recommendation: maintain integrity of curb, fix breaks where runoff can breach slope

16 severe gullying at south boundary caused by street runoff allowed to enter dune slope due to cut in sidewalk for pedestrian access trail, mass slump in middle, 95% iceplant coverage
Recommendation: prevent runoff from dune slope by directing it away from path entrance (additional storm drain, diffusion and/or dissipation)

17 runoff from pathway washes over small curb---->gullying (sandbags now protect up and downslope of critical areas of erosion), recent debris flow activity caused by runoff from break in berm protecting slope from pathway runoff, 30–40° slope

18 95% iceplant coverage with patchy cactus, patches of bare soils on upper boundary may enable erosion from rain impacts, hummocky topography throughout polygon atop 40° slope indicative of relict slumping or unstable slopes, lower boundary retained by wall 5–15 feet in height, gullying

primarily focused in three locations resulting from runoff from barren upper bounding ledge and short cut trampling
Recommendation: re-vegetate barren soils with vegetation to discourage trampling

18-19 boundary no longer exists ---> stairwell destroyed and slope retained by 10 foot wall with fence barrier at top, revegetated in tiered iceplant

19 boundaries no longer exist, upper slope bounded by fence, 95% iceplant coverage, no gullying

20 erosion caused by short cut trampling because of restricted access near south boundary (Sapphire Street access blocked off), no runoff gullying
Recommendation: construct access path at Sapphire Street

21 95% iceplant coverage, no visible runoff channelization, trampled pathways vulnerable to further trample erosion and enhanced channelization from concentration of upslope runoff, retaining wall breaks indicate slow creep of slope under weight of soils, barren ledge ~9 feet wide at top near benches
Recommendation: prevent pedestrian access from above by planting discouraging plants on bluff top ledge or constructing a fence

22 severe trample erosion from parking lot to all sides of restroom further enhanced by concentrated, channeled runoff ----> gullies ~2 feet in depth, 25° slope, 90% iceplant coverage, no apparent drainage from parking lot, upper boundary pathway may encourage short cut trampling

23 severe trample erosion from parking lot further enhanced by concentrated, channeled runoff ----> gullies ~1 feet in depth, slope at south boundary ~25° gradually decreases northward, 95% iceplant coverage, upper boundary pathway may encourage short cut trampling

24 stable slopes, 95% grass coverage, bounded upslope by fence

25 stable slopes, 95% grass coverage, bounded upslope by fence

*all subsidiary 1.1, 2.1, 3.1, … beach segments were relatively flat and devoid of vegetation

MANHATTAN BEACH

26 99% vegetation coverage (private irrigated gardens predominate south of 720 The Strand, north of which is characterized by iceplant), level “planter” of ~10 feet width (0° slope), private planters have extensively fertilized, 2 foot retaining wall adjacent to western bounding bike path

*iceplant areas ----> runoff from strand (walking path) drains through 1 foot curb to planters where localized channelization has resulted (gullies no deeper than 6 inches)
Recommendation: plant vegetation to dissipate concentrated flows from drains, reduce height at which runoff falls from drain to reduce initial impact

27 80% vegetation coverage, minimal slope (<5°) retained by 3 foot wall lining bike path to west, minimal gully erosion at drains

28 no vegetation coverage at north end of polygon, minimal slope (<5°), localized channelization at drains, retained by 3 foot wall lining bike path to west

28-29 access boundary no longer exists, retaining wall now blocks soils from splay on bike path, sandy pathway – no vegetation cover

29 minimal, patchy vegetation increases southward with spotty trees and cacti, localized channelization at drains, minimal slope (<5°), retained by 3 foot wall lining bike path to west, slope may be decreasing

30 minimal iceplant coverage at north end where two large storage containers (10 ft x 10 ft) have been placed, truck access through sandy area to parking lot tracks soils from dune into adjacent parking lot, 30% iceplant and grass cover, slight gully erosion at drains from strand where there is a 5 foot drop from strand elevation (drain spout) to underlying dune slope (receiving vegetation) ----> downslope alluvial fans, apparent soil denudation as unfinished concrete is exposed on west side of strand wall

26.1-30.1 (west of bike path)

Patchy, sparse iceplant and low scrub cover; minimal trampling because existing large barren areas provide naturally constructed access paths; hummocky terrain; depth of sands and infiltration capacity appears to prevent extensive gully erosion or channelization of runoff from bike path, vulnerable to sheet wash from bike path especially in locations across from stairways or access ramps which contribute additional localized runoff; gentle slopes

31 95% vegetation cover (iceplant and prickly bushes), un-vegetated path vulnerable to erosion used as access path down to parking lot, local channelization originating at drains has been enhanced by trampling erosion, ~7° slope, gullying fronting 13th street where drain outfalls drop 3 feet and have caused localized channelization (~4 inches deep), 85% iceplant coverage
Recommendation: plant hardy vegetation at foot of drains to dissipate energy from runoff

32 99% vegetation cover (iceplant and brush), one private garden atop bluff on ledge, >5 foot drop from drain outlet to dune soils deters trampling, no apparent gully erosion from strand runoff most likely due to vegetation density, relict re-vegetated gullies evident where drains have been filled in with concrete, slope profile shows slumping (gently sloped foredune ridge backed by steeper upslope scarp face)

33 90% iceplant cover, patchy cactus, minimal gullying due to vegetation density, ~25° slope

34 relict gullies below old concrete-filled drains that have been re-vegetated, 80% vegetation cover (iceplant and cacti), minimal trampling, ~20° gentle slope more stable where cactus lines upper boundary

35 top 1/3 slope leveled and planted with private gardens, bottom 2/3 – 75% iceplant cover, fence lining strand on upper slope preventing trampling, some runoff channelization where drainage outfalls onto slope, upper slopes vegetated by hardy bushes stabilize lower slopes by dissipating runoff and preventing trampling
Recommendation: line strand with bushes that discourage trampling and dissipate energy from drainage outfalls, incorporate soils capable of infiltration as opposed to compacted soils over which runoff can flow

36 upper slope lined by cacti, bushes, and fence, >20° slope, top 1/3 of slope leveled for private gardens, bottom 2/3 – 95% iceplant coverage, minimal gullying from trampling or runoff most likely due to garden maintenance and irrigation

37 fairly stable 20° slope, top 1/3 of slope leveled for private gardens, bottom 2/3 slope – 95% iceplant coverage, erosion potential where gardens lack full vegetation coverage

38 relict gully blocked and re-vegetated with abundant iceplant, west side of downslope bike path sandbagged due to apparent sheet wash from concrete onto sand, several locations of severe gullying (>1–3 feet in depth) from pipes through curb draining strand (sand bags and plastic reinforcement has not prevented erosion due to runoff coupled with trampling) ----> resulting debris fans onto lower bounding bike path, where cacti and bushes lining strand ---> minimal erosion, some private gardens covering top 1/3 slope, otherwise, 90% iceplant coverage

31.1 – 38.1 (west of bike path)
patchy vegetation (iceplant and low scrub), hummocky topography, stable slopes (3°–7°), intermittent paths continuing from stairways or ramps as access

to beach, infiltration capacity of soils minimizes gullying erosion, potential for erosion from sheet wash off of bike path (especially where wash comes from stairway or access ramp as well)
Recommendation: possible site for revegetation with native species.

39 70% slope, patchy vegetation, polygon adjacent to lifeguard headquarters and parking lot ---> vulnerable to parking lot, street and bike path runoff (evidenced by sand bags)

40 patchy iceplant coverage (80%), hummocky topography, stably vegetated tops with less stable and minimally vegetated side-slopes, no significant gullying

41 60% iceplant cover, large barren sandy soil at mid-slope vulnerable to erosion, 20° slope, very small polygon abutting lifeguard headquarters (protected from street, bike path runoff)

42 20° slope, 90% iceplant coverage, small polygon abutting lifeguard headquarters (protected by structure from street, bike path runoff)

43 pipe drain gullying facilitated where receiving soils lack vegetation (>1 foot in depth), ledge at upper slope ~20 feet wide ---> trampled paths have been created where widest and lacking vegetation, hummocky 25° slope
Recommendation: re-vegetate barren ledge to dissipate drainage outfall energy and deter trampling

44 stable slopes, 95% iceplant cover, no significant trampling or drainage erosion most likely due to existence of private gardens on top 1/3 which deter people from short cutting and dissipate energy

45 85% iceplant cover, 12 foot grass or soil ledge upslope between 1 foot curb and 25° slope, gullying due to runoff and trampling erosion
Recommendation: revegetate ledge to dissipate runoff and deter trampling

46 gullying primarily from trampling erosion; northern end ---> potentially unstable sands with 50% iceplant cover, upper slope (30°) stably vegetated, lower slope (<5°) unvegetated with potential to spill out onto bike path; southern end ----> area restored with native vegetation and stabilized by netting (major erosion potential where sparse vegetation – some signs of erosion but not gullying yet), 40% vegetation cover

47 severe erosion from trampling as people step over 1 foot curb at benches and walk through iceplant, barren ledge at top of slope, 85% vegetation cover, stable 20° slope decreasing northward to about 5°, minimal trampling where bushes adjacent to strand restrict access

Recommendation: replant discouraging vegetation adjacent to strand to deter trampling

48 99% iceplant cover, top 1/3 covered by private garden, manmade pathways surrounded by dense vegetation leading down to bike path from private gardens show no erosion, gentle slope with flat ledge at top, no significant gullying or trampling (private gardens deter people from cutting through and strand now graded inslope to drain to storm drains instead of dune soils)

49 top 1/3 planted with private gardens, trampling occurs where there are breaks in the gardens and people can get through bushes to bike path, 80% iceplant coverage with erosion potential concentrated in areas devoid of vegetation
Recommendation: close vegetation gaps adjacent to strand between private gardens to prevent further trampling erosion

50 top 1/3 planted with private gardens, 95% vegetation cover, stable 25° slope, some trampling between gardens
Recommendation: close vegetation gaps adjacent to strand between private gardens to prevent further trampling erosion

51 top 1/3 planted with private gardens, no significant gullying, densely iceplant vegetated 25° slope

52 95% iceplant cover, top 1/3 planted with private gardens, no significant gullying, large area at northern polygon edge devoid of vegetation and vulnerable to erosion during storm events

53 top 1/3 leveled and replanted as private gardens, elsewhere 95% iceplant cover, 35° slope stabilized by dense vegetation, no significant gullying

54 top 1/3 leveled and replanted as private gardens, elsewhere 95% iceplant cover, 35° slope stabilized by dense vegetation, no significant gullying, Northern end -> hummocky topography due to relict slumping that has since been stabilized by vegetation

55 portions of extremely steep slopes >60° that are stabilized by iceplant, gullying potential from runoff where iceplant has been cleared for private garden which has been sparsely replanted and leads out onto steep slope, steep slopes vulnerable to slippage, slumping, etc.

56 85% vegetation cover (iceplant), vulnerable to runoff from adjacent street and parking lot, sidecast cover over vegetation in places vulnerable to erosion during storm events

43.1–56.1 (west of bike path)

30% vegetation coverage, hummocky terrain with intermittent trampled paths, gullying erosion minimal due to infiltration capacity of sands, vulnerable to sheet wash immediately adjacent to bike path especially where stairways and ramps may provide additional runoff. **80–100 yard wide beach is more than sufficient to resupply foredunes*

57 80% iceplant coverage, vulnerable to sheet wash during storm events from bike path and lifeguard parking lot (sand bagged upslope), erosion at foot of slope from trampling or resulting from removal of vegetation serving as stabilization, soils from upslope wash over iceplant
Recommendation: protect slopes from sheet wash from impermeable areas by constructing a berm or curb

58/59 85% iceplant cover, additional distributed rocks and cacti, upslope curb protects slopes from lifeguard parking lot runoff but there is potential for overflow into dunes, fence upslope prevents trampling, northern end devoid of curb protection shows signs of erosion from sheet wash from parking lot
Recommendation: extend curb to meet edge of vegetated area

60 95% vegetation cover (80% iceplant, 15% bushes and palms), 20–25° stable slope, no significant gullying, southern end hummocky formations

61 95% iceplant cover with patchy cactus and trees, enclave gardens, lower bounding retaining wall, 20° slope, fence lining upper slope, no significant gullying, minimal trampling erosion originating in gardens
Recommendation: replace piling ~50 feet from southern border which is no longer present – soil is spilling into parking lot

62 95% iceplant cover with patchy grasses, cacti, bushes and trees, stable 15° slope, fence lining strand prevents people from trampling, no significant gullying, areas cleared of vegetation near southern boundary show signs of erosion

63 sporadic gardens on top ledge portions of slope adjacent to walkway / strand, fence and bushes (3–5 feet in height) lining strand, pilings retain 15° slope, 95% iceplant cover, no significant gullying

64 fence, trees and bushes line strand and prohibit trampling, pilings retain lower slope, 95% iceplant cover, top ledges planted with private gardens, gentle slope ~10°, no significant gullying

65 fence lining strand preventing people from cutting through vegetated areas, 95% vegetation cover (iceplant, cactus and bushes), <10° slope, lower slopes bounded by retaining wall, no significant gullying

66 <10° slope, 95% iceplant cover with sparse trees and bushes, fence lining strand and retaining wall at lower boundary with parking lot, stable slopes, no significant gullying, northern end ----> trampling and runoff erosion
Recommendation: construct fence and curb or plant discouraging vegetation to prevent trampling and runoff erosion at northern end

67 95% vegetation cover (iceplant, patchy trees, grasses, bushes), 15° slope, fence lining strand and lower slopes retained by pilings, stable slopes, no significant gullying, runoff directed away by 4 inch curb

68 95% vegetation cover (iceplant, patchy trees and bushes), 25° slope, fence lining strand and lower slopes retained by pilings, stable slopes, no significant gullying, potential for erosion at northern end where path from trampling is vulnerable to runoff during storm events

68.1 area leveled and revegetated with lawn and boxed planters holding flowers and plants, potential runoff from parking lot over wall into soils directly adjacent

69 80% vegetation cover (iceplant, trees, bushes, flowers in planters), upslope protection from street within hyperion plant by wooden planks which prevent runoff from entering planters, stable slopes

PLAYA DEL REY

70 level area (0° slope), 12 yd ledge leading into well vegetated 20° slope, ledge containing patchy ground cover, chain link fence at ledge separates ledge from slope leading onto plant property, protected from street runoff by 1 foot curb and densely lining vegetation, minimal gullying due to lack of slope, compacted soils most vulnerable to erosion during storm events from rain impact

71 slope decreases northward from 25° to 5°, 85% vegetated with iceplant, protected from street runoff by 1 foot curb, no significant gullying or trample erosion (street is 4 lane highway with speed limits of 50 mph, plant is immediately across street, street does not host parallel parking ----> area subject to minimal foot traffic)

71.1 13 yard barren ledge atop grass and scrub vegetated 25° slope with interspersed trampled pathways from HANGLIDING, 2.5 foot net fence lining ledge in between pathways, area appears to be maintained -----> no significant erosion, soils loose on slope pathways facilitating infiltration as opposed to runoff downwards, stable slopes and abundant vegetation, may be vulnerable to sheet wash from bike path during storm events; irrigated by sprinklers approximately 15 yards apart.

72 10 foot un-vegetated ledge ----> sheet wash from bike path does not infiltrate and goes directly to 20° slope where it is channelized, eroding interspersed gullies (< 1 foot in depth), gullies quickly decrease in gradient and fan at top of slope (channels are initiating, potential for future erosion during heavy storms), fence and curb line adjacent parking lot ----> access limited to bikers traveling on the bike path

73 foredune system with sparse grass cover, hummocky terrain, minimal sliding where slopes are un-vegetated, minimal gullying where runoff energy from bike path is not dissipated by vegetation

74 stable 30° slope, well vegetated, no significant gullying

74.1 foredune system sparsely vegetated with grasses, iceplant patches, erosion potential where devoid of vegetation, some gullying from runoff from adjacent street (<1 foot in depth), some larger gullies with downslope debris fans

74.2 subject to sheet wash erosion from street (sand bagged)

75 gently sloping lawn, stable with patchy tree planters, maintained by lifeguards or campsite managers

75.1 40% patchy iceplant cover, storm drain discharge gully; north of drain --> sparsely vegetated, minimal slopes; south of drain ---> street graded to drain inslope, minimal runoff erosion as curb protects slopes from street runoff, some trampled pathways

76 gently sloping lawn, stable with patchy tree planters, maintained by lifeguards or campsite managers

77 unstable slope (sliding, debris fans), fence _ downslope, vegetated but active erosion where sparse, severe gully erosion ----> road and fence undercutting

77.1 1 foot curb adjacent to street/pathway, almost entire grass coverage, few gullies continued from upslope (77)

77.2 70% vegetation coverage (grass and iceplant)

78 runoff gullying (4 feet deep), runoff originating from diagonal concrete pathways which ultimately crosses asphalt street and ends up in 79.1 near stairway where curb cuts (locally eroding / sandbagged)

79 unstable slope (45º), actively eroding steep slopes, Northern end vegetation sparse _ active erosion due to unstable soils
well vegetated at 8 foot retaining wall stretching 50 feet at mid-slope
Southern end : 70% vegetation cover (iceplant, low scrub and bunch grasses), upper slope road exposures (possible where storm drains built into slopes from street), _ further channelized runoff and increases amount creating gullies downslope of exposures, severe road undercutting – giving way in places, evidence of mice and lizard habitation
Recommendation (77–79): prevent short-cut trampling from above by prohibiting access from street side parking areas and walkway.

79.1-79.2 10º slope, 80% vegetation coverage (iceplant), minimal trampling erosion, some gully erosion from upslope 79

80 80% vegetation coverage (iceplant and low scrub), severe gully erosion (greater than 3.5 feet deep) _ soils spilling into pathways at various points, 45º slope – hummocky topography
vegetation unhealthy (healthier vegetation might stabilize slopes)
1 foot curb separating adjacent road – may be some overflow runoff concentrated where road exposed in slopes – gullies have formed, area not lined by roadside parking which limits the amount of trampling due to access

81 45º slope, iceplant coverage, some gullying from runoff (1 foot deep), asphalt outcropping, apparent slides from slope profile and slope, erosion where unvegetated, lower slump scars revegetated, some unhealthy vegetation

82 stable 45º slope, no gullying, 95% iceplant cover

83 stable 45º slope, no gullying, 95% iceplant cover

84 45º slope, dried vegetation with patchy shrubs, iceplant (shrubs are dead, iceplant alive) – 80% cover
gullying where asphalt from road exposed on slopes at top
adjacent roadside parking – some trampling but slope is rather steep
curb at top unable to prevent runoff during storms – gullies at 30 feet intervals (2 feet in depth)
Southern end more stable with minimal gullying
Recommendation: replace upslope curb

85 severe gully erosion from trampling and walkway runoff overflow – soils spilling into walkway (channels every 20 feet), 55º slope, vegetation cover where no gullies, road undercutting and asphalt exposures
Recommendations: restrict access from above and repair curb to prevent run-on from street overflow

85.1 – 85.5 gentle slopes, vegetation mixture of grass, iceplant, palm trees, stable slopes, up slope portions may receive sheet wash from adjacent eastward bounding asphalt street

86 Northern end – private condo development (not pictured) under construction, aerial coverage extends to bottleneck at southern end of polygon
Southern end not claimed by construction area — 85% vegetation coverage (iceplant, grasses, scrubs), stable 30º slope, some gullying due to runoff (may be seeping through curb where road is undercut)
areas where there is no curb separating asphalt walkway from vegetated slope

87 no slope, all sand – no vegetation coverage, not subject to erosion from runoff from impermeable surfaces

88 hummocky dunes, no net slope, patchy grass coverage, some iceplant and low scrub, 35% vegetation cover but distributed evenly, fence surrounding entire area restricting human access, not vulnerable to runoff from impermeable surfaces (permanence of fence?)
Recommendation: curtail all access by pedestrians to allow for the revegetation of barren patches.

89 no slope, all sand, potential to re-vegetate perimeters of sandy pathways through houses, vulnerable to minimal runoff from adjacent houses – no erosion

GENERAL CONSIDERATIONS

1. limited access in Redondo Beach – municipal boundaries
2. extension of median fence all the way to path to prevent possibility of short cuts (Redondo Beach)
3. curb maintenance – fix breaks to prevent runoff breaches
4. upper boundary ledges (Redondo Beach)
5. drains from strand through curb onto dunes (Manhattan Beach south of 27th street – north of which, strand is graded inslope and runoff goes into storm drains
6. sheet wash erosion from bike path on west side dunes (especially at access points)

7. in-slope storm drain exposures – concentrate and increase flows leading to downslope gullying (Playa del Rey)

8. roadside parking leading to trample erosion because of access (Playa del Rey)

9. unhealthy vegetation (Playa del Rey)

Appendix B: History of the South Bay Cities

Ronald Davidson, Ph.D.
University of California, Los Angeles

The South Bay communities of El Segundo, Manhattan Beach, Hermosa Beach, Redondo Beach and Torrance are separate, incorporated cities with their own identities and historical experiences. In large and small ways, the histories of their coastal landscapes reflect these differences.

The Pre-History of the South Bay Communities

The first inhabitants of the South Bay were lodges of the so-called Gabrielino Tribe (this was the name given by the Spanish) of Native Californians. The Chowigna lodge inhabited the Redondo Beach area and the Engnovangna lodge inhabited Manhattan Beach, for example. Linguistically, the Gabrielinos are classified as having been of Shoshone stock (Johnson 1965). As many as 10,000 Gabrielino Indians lived in the South Bay at the time of first European contact (Shanahan 1982:17). As hunter-gatherers, the Gabrielinos did not practice agriculture. They had abundant food, however. The Indians caught fish near the shore in Redondo, where an underwater canyon channeled fish close to land. They gathered shellfish from tidepools at the base of the Palos Verdes cliffs and hunted game in the hills above. Fowl was abundant at inland marshes (Johnson 1965). The Gabrielino also ate lizards, acorn meal, mesquite pods yucca stalks and other foods (Shanahan 1982, Shanahan and Elliot 1984).

The natives were accomplished weavers of baskets. They also carved pipes from steatite, a white-green talc found on the Channel Islands (Shanahan 1982, Shanahan and Elliot 1984). A settlement of stick huts was located beside a group of five salt ponds in present-day Redondo Beach. The ponds, north of present-day Beryl Street between Pacific Avenue and the ocean, covered fifty acres and were known to the Spanish as Las Salinas (Grenier and Gillingham 1987). The name Chowigna – the lodge that lived at the ponds – reflects the importance of salt. "Chowi" was the native name for the hills of Palos Verdes, while "igna" comes from "egne", the Indian name for a salty plant that they used to flavor mush (Johnson 1965). There was also a concentration of Indians at what is today the Esplanade north of Sapphire street (Shanahan 1982). The Indians obtained fresh water from a stream near the present-day location of Ainsworth Court. They had a camping site at a small hill at present-day Beryl and Catalina streets. The Chowigna sold and bartered goods with other Indians, especially those in the San Bernardino Mountains. They traded salt, fish, baskets and steatite pipes for pottery or for strings of small shells that were used as currency (Shanahan 1982, Shanahan and Elliot 1984).

European History

The permanent presence of Europeans in the South Bay began with Gaspar de Portola's expedition in 1769, which escorted Father Junipero Serra, the founder of the California missions (Shanahan 1982). Serra removed the natives to the San Gabriel Mission, which was founded in 1771. Two hundred years later, virtually all of the natives would be dead from the ravages attendant upon European settlement: infectious diseases, alcohol, syphilis and tuberculosis (Shanahan 1982).

In the nineteenth century the South Bay was divided between two vast ranchos. The El Sausal-Redondo Rancho included the present-day locations of El Segundo, Manhattan Beach and Hermosa Beach. The Rancho San Pedro (later called the Dominguez Rancho) included the present-day locations of Redondo Beach and Torrance (Shanahan and Elliot 1984).

United States History

1800s. After California became part of the United States and US settlers arrived in significant numbers in the late nineteenth and early twentieth centuries, the South Bay cities were established and developed along their own separate trajectories.

In the mid- to late-nineteenth centuries much of the South Bay had been used for cattle ranching and, after the drought of 1875 that decimated that industry, dry farming. In 1855 businessmen Henry Allanson and William Johnson, who had bought over 200 acres of land from the Dominguez Rancho, founded the first Anglo-American industry in the Redondo Beach area (Johnson 1965). The Pacific Salt Works was located at Las Salinas, the ponds where the Chowigna lodge had lived and sold and traded salt. Wood to heat the salt works boilers was supplied by willows growing on the north slope of the Palos Verdes hills (Grenier and Gillingham 1987). During the land boom two years later, the firm of Vail and Freeman established the townsite of Redondo Beach (which would be incorporated in 1892) (Myers and Stewart 1976). The name of the town, Spanish for "round", was inspired either by the curving shoreline, the curving streets planned around an oval in the center of town, or from the name of the Rancho of which it had been part (the El Sausal Redondo rancho, meaning "The round clump of willows"; Myers and Stewart 1976).

Subsequently, developers Capt. J.C. Ainsworth and Capt. R.R. Thompson sought to stimulate tourist trade in the area. Working out a deal with the Dominguez sisters, heirs to the original rancho, they re-laid the city in blocks and named the north-south streets after Spanish women and the east-west streets after precious stones. Population growth and development would come slowly until the involvement of Henry Huntington in 1905, however (Johnson 1965). Meanwhile, in 1889 the Santa Fe Railroad completed laying track from Los Angeles to Redondo Beach. The following year a deepwater canyon was discovered offshore at Redondo and the rail line became a conduit between cargo ships at a newly constructed wharf and Los Angeles (Pipkin 1985). In 1890 the railroad constructed a passenger line to Redondo and built a 225-room hotel at the present-day site of Veteran's Park. The hotel had an English motif and luxuries such as a bathroom on every floor, steam heat, landscaped gardens, a ballroom, an 18-hole golf course and tennis courts on the beach. Writes Redondo Beach historian Ken Johnson (1965), "If you want a more vivid picture of what the Hotel Redondo was like, visit the Hotel Coronado in Coronado, California. This hotel, built at the same time, was a sister-operation to the Redondo facility, and still stands as a major tourist attraction in the San Diego area."

The Santa Fe Railroad and local boosters strove to make Redondo – rather than San Pedro or Santa Monica, two locations pushed by Collis Huntington, controller of the rival Southern Pacific Railroad – to be the main port of Los Angeles. Redondo was closer to San Francisco than San Pedro and, unlike Santa Monica, it had a natural deep water harbor. However, Redondo did not have a protective breakwater. For that reason a five-man board of engineers recommended in 1897 that San Pedro become the main port for Los Angeles (Port of Los Angeles 2003). After this decision tourism and recreation once again became the main activities at Redondo (Pipkin 1985).

1900–1910. Manhattan Beach, which would receive its charter in 1912, benefited from the Santa Fe railroad line since it passed through the area. In addition, in 1903 the Pacific Railway Company laid track from Los Angeles to Santa Monica and from there down the coast to Redondo Beach. Passengers could come by Santa Fe or trolley to spend weekends or summers in beach cottages (Manhattan Beach Historical Society 2003). In 1902 two major developers of Manhattan Beach, George Peck and John Merrill, reportedly flipped a coin to decide the name of the area. Peck had been calling his northern section "Shore Acres" (after the local Santa Fe station) and Merrill had named the southern part Manhattan (after his home town). Merrill won, and the town became Manhattan Beach at the behest of the postmaster, who sought to avoid confusion with fourteen other Manhattans in the country (Manhattan Beach Historical Society 2003). Prior to the railroad era, people had traveled to the South Bay beaches from Los Angeles and Inglewood by horse and buggy (Dennis 1987). They had had to tie their horses to trees on the inland sides of the dunes and walk to the shore because it was difficult to get buggy wheels through beach sand (Dennis 1987). The trolley system also benefited Hermosa Beach, which incorporated in 1907 (Gazin 1991).

After San Pedro had been chosen as the site for Los Angeles' main harbor, development of Redondo Beach slowed. Henry Huntington's brother quipped that the very name Redondo made a capitalist "shy like a horse at an automobile" (quoted in Whitcomb 2000, p. 39). Nonetheless, in 1905 Henry Huntington announced his intention to purchase the Redondo Improvement Company, which owned most of Redondo Beach (Friedericks 1989). Huntington had already gained control of the Redondo Railway, which operated two lines from Los Angeles. "The magic name of Huntington", as the *Los Angeles Times* put it (ibid.), emboldened speculators and others and triggered a two-week real estate frenzy. Agents set up over 100 real estate offices, some in tents, on Front Street. Huntington placed ads in the *Los Angeles Times* promising "Free Excursions Every Twenty Minutes!" to Redondo where the "Dirt is Flying! Spikes Are Being Driven!" (Whitcomb 2000, p. 39). As a result of the boom Huntington sold about three million dollars worth of Redondo Beach property (Whitcomb 2000).

Although some investors lost money when property values fell after the boom, Huntington invested heavily in Redondo Beach and did encourage development. In 1907 he constructed a 3-story pavilion with a ballroom, restaurant and theater at Coral Way and Midway (Friedericks 1989). In 1909 he opened the largest indoor saltwater plunge in the world. It had three heated pools, steam and Turkish baths and over 1000 dressing rooms. The complex could hold 2000 bathers at a time. For thirty years the plunge was a major west coast attraction (Shanahan 1982).

To lure the public to Redondo, Huntington hired George Freeth, now considered the father of modern-day surfing, to exhibit the sport to crowds on the shore. Huntington had learned of Freeth from Jack London, who had written an account of Freeth and his littoral avocation in "A Royal Sport", an essay first published in *A Woman's Home Companion* in 1907 (Whitcomb 2000). London had met Freeth after sailing his *Snark* to Waikiki Beach earlier that year. Entranced by Freeth's ability to "walk on water", London asked for lessons. He wrote in his essay, "Shaking the water from my eyes as I emerged from one wave and peered ahead to see what the next one looked like, I saw him tearing in on the back of it, standing upright on his board, carelessly poised, a young god bronzed with sunburn" (Bandana College 2003). Soon after the essay was published Huntington's agents arrived in Hawaii to offer Freeth a job. From then until his death from influenza a dozen years later, Freeth would demonstrate surfing on a heavy wooden board at Redondo Beach. He also demonstrated diving techniques in the plunge. Freeth not only introduced surfing to southern California, but became the first professional lifeguard and the inventor of a "rescue can", a large bucket on a cable that could be thrown to drowning swimmers.

Redondo Beach grew around Huntington's splashy resorts. The population rose from 855 in 1900 to 2935 in 1910 to 4900 in 1920 (Friedericks 1989). Meanwhile a more highbrow beach community was being planned nearby at the Hermosa Beach - Manhattan Beach border. In 1903, Moses Sherman and Eli P. Clark – the developers who built the Los Angeles Pacific Railway down the coast – attempted to establish a literary colony called Shakespeare's Beach at the site (Roebuck 1987). The bid was unsuccessful, however, so the developers built and sold beach cottages (Roebuck 1987). While the exact borders of the planned literary colony are disputed, the tract was probably demarcated by the Strand, Hermosa Avenue, Twenty-Seventh Street and the northern boundary of Hermosa Beach, according to Hermosa Beach Building Director Bill Grove (Roebuck 1987). Evidence of the abandoned dream can be found today in the street names of the area, which include Longfellow Avenue and Keats, Shelly and Tennyson Streets.

1910–1920. Large-scale industry came to the South Bay coast in the 1910s, and with them came El Segundo and Torrance. El Segundo was a product of the Standard Oil Company, which built a refinery for oil pumped from the Fullerton and Torrance oil fields in 1911. Standard Oil chose the refinery site because the land was cheap and undeveloped, was located near water for cooling, and included a large dune tract. Storage tanks were located on the dune ridge, so that oil could flow by gravity to tankers offshore. Pocket-depressions in the dunes would contain leaks and minimize the danger of explosions. The sparseness of the dune vegetation meant there would be a reduced fire hazard (Gerlach 1940). The El Segundo Land Improvement Co. acquired the townsite – for housing the refinery's workers – to the north of the refinery. The name El Segundo ("the Second One") refers to the fact that it was the second oil refinery in California (Gerlach 1940). A harbor was constructed for tankers to load the oil, but it was destroyed by an underwater earthquake in 1914. The company then built a pipeline to allow tankers to load up and take the oil to other ports in the US, Asia and Australia (Gerlach 1940).

The creation of the El Segundo refinery spurred the growth of Hermosa Beach and Manhattan Beach as well. Until 1910 these areas had existed as resorts with beach cottages and had several hundred permanent residents. Now they became "black gold suburbs" – residential suburbs for refinery workers (Viehe 1991). In the teens and twenties black gold suburbs were the fastest growing areas in Southern California. For example, in 1910–1920 Hermosa Beach grew at a 243% rate (Viehe 1991). The growth of these suburbs indicated the preference of oil industry workers to live near their jobs but in residential rather than industrial suburbs. Other black gold suburbs included the San Pedro-Long Beach and Vernon-Huntington Park clusters (Viehe 1991).

Torrance was founded in 1912 (and incorporated in 1921). The city's founding father and namesake, Jared S. Torrance, was vice president of Union Oil and its subsidiary Union Tool Companies (Phelps 1995). In 1912 he persuaded Union Tool to purchase land from the Dominguez Estate Company. The land, a windy tract of sand and agricultural fields, was inexpensive at a time when Los Angeles real estate prices were rising sharply (Shanahan and Elliot 1984). It was also removed from the utilitarian, gritty industrial corridor along the Los Angeles River and offered room for residential and industrial development (Phelps 1995). At the time labor unrest had erupted into violence in the region. In 1910 the main building of the assertively open-shop *Los Angeles Times* had been bombed by union activists. Other bombings and examples of labor unrest flared that year in Southern California. In this context Torrance attempted to create an industrial town based on the garden city concept that would please both labor and management (Shanahan and Elliot 1984, Phelps 1995). The firm of John C and Frederick Law Olmsted, Jr. was hired, for $5000 (and subsequent consulting fees), to design the western United State's first "modern industrial city" with a planned population of 15,000 inhabitants (Shanahan and Elliot 1984). The Olmsted plan borrowed elements from the City Beautiful, City Practical and National Playground movements, in an attempt to combat the ugliness of industrial cities by creating a place that synthesized utility, efficiency and beauty (Phelps 1995). The Pacific Electric station formed the hub of the city, and industrial properties lay near the tracks. Housing was located upwind of the smoky factories. A shopping center and residential park were located to maximize interaction among different social classes. One hundred thousand trees were planted to create a garden-like feel (Phelps 1995).

Not as many workers bought lots as the developers hoped, however. Shortly after the housing sites went to market the economy soured. Moreover, much of the work offered in Torrance was sporadic and did not raise the confidence of house buyers. The town also met fierce resistance from labor leaders who saw the project as an attempt by capitalists to pacify and control non-union workers. As a consequence of these factors, most Union Tool employees chose to live outside the town and commute to work on the Pacific Electric cars. In 1922 the city had only 2500 residents, far fewer than planned. Only after Torrance shed its model industrial city image did the population significantly grow (Phelps 1995).

1920s. In 1920, as a symbol of its growth and hometown pride, Manhattan Beach constructed a 928-foot long cement pier with a rounded front end (Manhattan Beach Historical Society 2003). In 1991, after decades of wear and tear, the city decided to restore it to its 1920s form. Restoration was complete in 1992 and in 1995 the pier – the oldest standing cement pier on the west coast – was declared a state historic landmark.

As Manhattan Beach grew in the 1920s it confronted a longstanding obstacle to its development, shifting mountains of sand. Sand frustrated development by inhibiting the construction of buildings on level land and by constantly blowing across boardwalks, roads and railroad tracks. Railroad companies hired teams of Mexican workers to clear the sand from the tracks, but trains were delayed for hours at a time. To level the landscape for the construction of buildings, a more radical solution was needed. The Kuhn Brothers Construction Company solved the problem when they found a buyer for Manhattan Beach sand in Hawaii. For nearly ten years the sand was taken by Santa Fe railroad cars to San Pedro harbor and shipped to Waikiki Beach, where it was spread over the pebbly shore (Manhattan Beach Historical Society 2003). A letter writer noted in the *Los Angeles Times*: "Many a honeymooner has since returned from Hawaii with a little vial of Waikiki Beach sand – that actually came from the South Bay" (McCafferty 1992). Manhattan Beach sand was also used as ballast in Santa Fe and Southern Pacific railroad cars, in the flooring of Los Angeles Memorial Stadium and elsewhere in the state and in Arizona (Dalton 1976, Moon 1952). Not all of the sand dunes were removed, however. The dune system stretching from El Segundo south through Manhattan Beach was used for the location shooting of desert scenes in early Hollywood films such as "The Sheik"

(Pipkin 1985).

Also during the 1910s and 1920s Manhattan Beach became a site that represented the negative attitudes towards minorities in the South Bay communities. When Manhattan Beach was incorporated in 1912, no places on the southern California coast welcomed minorities. Racially restrictive covenants prevented blacks from moving into white shorefront neighborhoods. Flouting this tradition, Manhattan Beach developer George Peck established a 2-block area fronting the beach between Twenty-Sixth and Twenty-Seventh Streets for minority residents. The first African Americans to buy lots at the site were Charles and Willa Bruce, who were born in Union states during the Civil War (Rasmussen 2002). Peck helped the Bruces and other blacks build a fishing pier (Rasmussen 2002).

As the value of coastal real estate increased, however, white hostility toward the residents of Bruces' Beach (as it had come to be called) increased. Racial intolerance expressed itself in various forms, reportedly including a cross-burning by the Ku Klux Klan (Drake 2003). Long time (white) resident Wilmer Drake recalls that African Americans risked being thrown in jail if they went to public places in the city after dark (Drake 2003).

In 1924 city officials condemned the neighborhood ostensibly to build a park on the site. When the families refused to sell their properties to the city at below market value, the city seized the land under eminent domain. The Bruces and three other families sued the city. The judge insisted that the plaintiffs be allowed to live elsewhere in the city, if not adjacent to the beach. In 1927 Bruces' Beach Resort was razed along with other cottages on the site. The Bruces received $14,500 and left the city. In 1924 a blacks-only section of Santa Monica Beach, called the Inkwell, opened near the foot of Pico Boulevard (Rasmussen 2002).

Manhattan Beach finally built a park on the site of Bruces' Beach in the 1950s. Since the 1970s it has been designated Parque Culiacan, signifying the link to Manhattan Beach's sister city in Sinaloa, Mexico (Rasmussen 2002).

In the mid 1920s Oregon-born entrepreneur Clifford Reid arrived in Southern California with several big plans. One of them was to develop a square mile of land in present-day Torrance into California's equivalent of the French Riviera (Shanahan and Elliot 1984). Reid planned the "Hollywood Riviera", linked by a local parkway to the Culver City and Gower Street studios, to be a coastal playground for the region's movie stars. Initial sales were strong, but few Hollywood people were among buyers. The onset of the Depression slowed sales considerably. In 1931 the Hollywood Riviera Club opened above the beach west of Paseo de la Playa at the foot of Calle Miramar. The boundary separating Torrance and Redondo Beach ran through the club, and because the rules about drinking alcohol differed in the two cities, people had to change their positions within the building to comply with the hours for the legal consumption of alcohol. The club burned down in 1958 and a plaque dedicated to preserving its memory can be found today by the steps in Miramar Park (Payne 2003).

Smuggling and gambling were among the more seamy aspects of South Bay life into the early 1930s and after. During Prohibition alcohol runners would sail their cargo past the shore. Once, recalls Manhattan Beach resident and historian Wilmer Drake, liquor smugglers in a boat offshore were chased by police. The smugglers dumped their cargo overboard, and cases of Canadian Club whiskey washed ashore. The precedent for smuggling in Manhattan Beach was set long ago: in the early nineteenth century a Manhattan Beach resident known as Col. Duncan would signal from his white beachfront house to smugglers from Mexico, England, and the Spanish Phillipines (Shanahan 1982). They brought cloth and foodstuffs ashore to sell in Los Angeles without having to pay a tariff.

Gambling also took place along — or rather off — the coast. Mob associate Anthony Cornero owned several barges that had been converted into floating casinos. The ships anchored three miles offshore, beyond the pale of police and tax authorities. Congress abolished gambling in coastal waters in 1948.

References

Bandana College. 2003. http://www.bandannacollege.com/bandannabooks/surftext.html. Accessed December 5, 2003.

Banham, R. 2001. *Los Angeles: The architecture of four ecologies*. Berkeley: University of California Press.

Dalton, R. 1976. Manhattan: Isle's sandman. *Daily Breeze* October 13, B1.

Dennis, J. 1987. *A walk beside the sea*. Manhattan Beach: Jansatan Studio.

Drake, W. 2003. Docent at Manhattan Beach Historical Society. Interview November 2003 with Dr. Ronald Davidson.

Friedericks, W. 1989. Henry E. Huntington and Real Estate Development in Southern California, 1898–1917. *Southern California Quarterly.* Winter 1989: 327–40.

Gazin, Patricia A. 1991. *Footnotes on the sand*. Hermosa Beach: Myron Gazin.

Gerlach, A. C. 1940. Growth of El Segundo, California. *Economic Geography* 16(2):225–230.

Grenier, J. A. and R. C. Gillingham. 1987. *California legacy: the James Alexander Watson-Maria Dolores Dominguez de Watson family, 1820–1980.* Los Angeles: Watson Land Company.

Johnson, K. 1965. *Fun, frustration and fulfillment: An historical study of the City of Redondo Beach*.

Manhattan Beach Historical Society. 2003. :http://www.geocities.com/history90266/. Accessed November 2003.

McCafferty, J. 1992. (Letter to the editor) *Los Angeles Times* Jan. 5. M4.

Moon, J. 1952. Story of Manhattan written in sands; but they moved 'em to allow growth. *Daily Breeze* Jan. 1.

Myers, W. A. and I. L. Swett. 1976. *Trolleys to the surf: The story of the Los Angeles Pacific Railway*. Glendale: Interurbans.

Payne, J. 2003. Vice President of Torrance Historical Society. Interview December 2003 with Dr. Ronald Davidson.

Phelps, R. 1995. The search for a modern industrial city: Urban planning, the open shop, and the founding of Torrance, California. *Pacific Historical Review* 64:503–535.

Port of Los Angeles. 2003. http://laporthistory.org/. Accessed December 5, 2003.

Rasmussen, C. 2002. Resort was an oasis for blacks until racism drove them out. *Los Angeles Times* July 21, B4.

Roebuck, K. 1987. Shakespeare society would put bard back on the beach Manhattan. *Los Angeles Times* April 26, South Bay edition p.1.

Shanahan, D. F. and C. Elliot, Jr. 1984. *Historic Torrance: A pictorial history of Torrance, California*. Redondo Beach: Legends Press.

Shanahan, D. 1982. *Old Redondo: A pictorial history of Redondo Beach*. Redondo Beach: Legends Press.

Viehe, F. W. 1991. The social-spatial distribution in the black gold suburbs of Los Angeles, 1900–1930. *Southern California Quarterly* 73(1):33–54.

Whitcomb, I. 2000. The beach boy. *American Heritage* 51(41):34–45.

Appendix C: Selected Native Plants of the Beach Bluffs

California poppy

Black sage

Coast buckwheat

California sunflower

Mule fat

California verbena

Pincushion flower

Beach evening primrose

Deerweed

Prickly pear

Cholla

Bladderpod

Bright green liveforever

Western wallflower

California saltbush

Succulent lupine

Purple clarkia

Chia


Silvery blue lupine


California sagebrush


Beach-burr


Telegraph weed


Butterbush


Branching phacelia


California four o'clock


Coyote bush


Bedstraw


Milkvetch


Lemonadeberry


Beach sand verbena