
Memorandum

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CC:

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Subject: Broad Beach Foredune Design Parameters

This memorandum outlines the methods used by WRA, Inc. (“WRA”) to design the proposed dunes for the proposed beach nourishment and foredune restoration project located on Broad Beach in Malibu, California. The primary goal of the project is to stabilize the shoreline along Broad Beach to protect existing residences, on-site sewage treatment systems, and other structures. To accomplish this objective, the project proponents propose a combination of beach nourishment and foredune creation and enhancement. Foredune creation and enhancement is proposed within the area between the seaward edge of the existing rock revetment and the residences along Broad Beach. Within the context of the larger project, foredune creation and enhancement is primarily intended to provide an additional buffer between the ocean and the residences. A secondary goal of foredune creation and enhancement is to increase the area of high-value foredune habitat at Broad Beach. The proposed foredune design was primarily based on observed and reported conditions at naturally occurring dune systems in southern California and on the historical extent of foredune habitat at Broad Beach. Although the foredune design was developed based on naturally occurring foredune habitat in the region, modifications were made to achieve the shoreline stabilization goals of the project and to accommodate existing levels of both public and private beach access. To develop the foredune design, WRA followed a three-step process involving (1) an assessment of foredune habitat at a nearby reference site, Ormond Beach, (2) a review of scientific literature on foredune geomorphology and ecology and reports on dune restoration and creation projects in southern California and elsewhere, and (3) an assessment of aerial imagery of Broad Beach to document the historical extent of foredune habitat at the site. The process for developing the dune design and planting palette is described in further detail below.

Reference Site

To determine the geomorphology and vegetation typical of foredune habitat in the region, WRA visited a nearby reference site, Ormond Beach. Ormond Beach is located in Oxnard, approximately 16 miles northwest of Broad Beach. The beach contains approximately two miles of foredune habitat backed by a large coastal wetland. The foredunes at Ormond Beach consisted of a series of small, incipient dune formations backed by a strand of low dune hummocks ranging from 3 to 6 feet in height and 10 to 30 feet in width. The foredunes were slightly ovoid in plan view and were oriented in the direction of the prevailing winds. The foredunes had relatively high levels of vegetative cover. Based on WRA's analysis, cover on the foredunes ranged from 15 to 97 percent, with an average cover of 70 percent. When the open sand between the foredunes was incorporated into the analysis, vegetative cover ranged from 15 to 27 percent, with an average of 23 percent. Vegetation on the dunes was limited to four species: red sand verbena (*Abronia maritima*), beach bur (*Ambrosia chamissonis*), big saltbush (*Atriplex lentiformis*), and sea rocket (*Cakile maritima*). The shape, size, and orientation of the dunes at Ormond Beach, as well as the composition and cover of the associated vegetation, served as the foundation for the Broad Beach dune design.

Literature Review

To supplement the observations of foredune geomorphology and vegetation made at the Ormond Beach reference site, WRA also reviewed scientific literature on naturally occurring dune systems in southern California and elsewhere, as well as reports on dune creation and restoration projects in southern California (Guinon and Allen 1990; LFR, Inc. 2006; Longcore 2005; Lortie and Engel 2008; Nordstrom 2008; Pickart and Barbour 2007; Pickart and Sawyer 1998; Pierce and Pool 1938; Rogers and Nash 2003; Sapphos Environmental 2004; U.S. Army Corps of Engineers 1987). Based on the results of the literature review, WRA developed suitable ranges for foredune geomorphology and developed a potential planting palette to augment the list of plant species observed in the reference foredunes at Ormond Beach.

Based on documentation in the literature and on designs used in other dune restoration and creation projects in southern California and elsewhere, WRA determined that the shape and size of the foredunes observed at the Ormond Beach reference site are typical of foredune habitat throughout the region. WRA also determined that suitable slopes for foredune creation range between 5 and 40 degrees (10 to 85 percent slope). These specifications were used to develop appropriate dune geomorphology for Broad Beach.

To augment the list of plant species observed at Ormond Beach, WRA compiled a list of plants that have been documented from southern foredune and coastal scrub habitats in southern California. The primary resources used by WRA to develop the list included Munz (1959, 1974), Holland (1986), Pickart and Barbour (2007) and references therein, and Sawyer et al. (2009). Based on descriptions of dune communities provided by Holland (1986), it was determined that the most likely plant community present at Broad Beach prior to the loss of foredune habitat would have been the *southern foredune* community. Holland describes southern foredune

vegetation as similar to northern foredune vegetation, but without perennial grasses and with a higher proportion of suffrutescent plants. Native species characteristic of this community include red sand verbena, pink sand verbena (*Abronia umbellata*), beach bur, big saltbush, beach morning glory (*Calystegia soldanella*), beach evening primrose (*Camissonia cheiranthifolia*), salt grass (*Distichlis spicata*), and Menzies' goldenbush (*Isocoma menziesii*, as *Haplopappus venetus*). Non-native species often found in this community include sea rocket and iceplant (*Carpobrotus edulis*). Species such as red sand verbena beach bur and sea rocket generally occur in exposed sites, and species such as pink sand verbena, beach morning glory, and beach evening primrose generally occur in more protected sites. Holland does not provide additional information on species composition such as density or cover.

In their chapter on beach and dune vegetation in the book *Terrestrial Vegetation of California, Third Edition*, Pickart and Barbour (2007) provide a meta-analysis of beach and dune vegetation in California. Pickart and Barbour recognize four major beach and dune zones: beach, nearshore dunes, moving dunes, and backdunes. Their analysis suggests that beach vegetation (i.e., coastal strand vegetation) is not significantly different from nearshore dune vegetation (i.e., Holland's southern foredune community) and does not warrant separate treatment. As such, WRA does not distinguish between coastal strand and southern foredune communities here or elsewhere. Although they do not provide information on species density or cover specific to southern California, Pickart and Barbour indicate that only a total of 15 to 30 species were common to the entire California coastline, with only five species present at any given beach. Their estimate of plant cover ranged from 10 to 25 percent, rising to more than 50 percent on the seaward face of foredunes. They recognize two major coastal floristic zones in California which meet at Point Conception in Santa Barbara County, with nearshore vegetation south of Point Conception being characterized by relatively few species relative to nearshore vegetation north of Point Conception. Pickart and Barbour describe nearshore vegetation in southern California as being dominated by a mix of annual and herbaceous to suffrutescent perennials similar in composition to Holland's southern foredune community.

In their book *A Manual of California Vegetation, Second Edition*, Sawyer et al. (2009) describe three vegetation alliances which may have occurred at Broad Beach prior to the loss of foredune habitat. These alliances include the yellow sand verbena-beach bur (*Abronia latifolia-Ambrosia chamissonis*) herbaceous alliance (also referred to as *dune mat*)¹, sea rocket (*Cakile edentula* or *C. maritima*) semi-natural provisional herbaceous stands (also referred to as *sea rocket sands*), and iceplant (*Carpobrotus edulis*) semi-natural herbaceous stands (also referred to as *iceplant mats*). They do not provide lists of specific species associated with these communities in southern California, nor do they provide specific information on species distribution, density, or cover for these communities.

¹ Observations at the Ormond Beach reference site and at Broad Beach indicated that this community is dominated by red sand verbena, rather than yellow sand verbena, and as such, may be more appropriately described as a *Abronia maritima-Ambrosia chamissonis* herbaceous alliance which is not described by Sawyer et al. (2009).

The shift in vegetation occurring around Point Conception described by Pickart and Barbour (2007) corresponds to the break between the Central Coast and South Coast geographic subdivisions identified by Baldwin et al. (2013). Although a number of other species have been employed in restoration projects in the Los Angeles region (e.g., Longcore 2005; Sapphos Environmental 2004), many of these species have not been documented from historic reports of the composition of dune vegetation in the region and may be more appropriate for restoration projects north of Point Conception. Historically, dune mat stands were the sole plant community to colonize foredunes south of Morro Bay; foredune grassland and dune swale vegetation were largely absent south of Point Conception (Pickart and Barbour 2007). Dune mat stands, as defined by Sawyer et al. (2009), correspond to Holland's (1986) southern foredune vegetation and consist largely of short-statured herbaceous perennials such as sand verbena (*Abronia* spp.) and beach bur, with annual herbs constituting a smaller portion of the species composition. Dune scrub is the vegetation type that would have been present on the stabilized backdunes in southern California (Pickart and Barbour 2007). This plant community would have been dominated by larger sub-shrub and shrub species such as California goldenbush (*Ericameria ericoides*) and bush lupine (*Lupinus chamissonis*). Although this vegetation type would have historically occurred further from the beach, the species that make up this plant community will be used to stabilize the landward side of the restored foredunes at Broad Beach.

Based on the list of species identified from southern foredune and coastal scrub habitats in southern California generated from the above sources, WRA identified a potential planting palette for the foredunes at Broad Beach. The palette was developed to include elements of naturally occurring southern foredune habitat, but with additional species included to achieve the necessary level of sand stability required by the shoreline stabilization goals of the project. The palette includes the dominant species observed at Ormond Beach, as well as species that would typically occur in more stabilized backdune and coastal scrub habitats. The latter species were added to the design to help stabilize the foredunes proposed for Broad Beach as required to achieve the shoreline stabilization goals of the project. The resulting potential planting palette is shown in Tables 1 and 2.

Table 1. Potential Planting Palette for the Seaward Side of the Dune System

SCIENTIFIC NAME	COMMON NAME	LIFE FORM
<i>Abronia maritima</i>	Red sand verbena	Perennial herb
<i>Abronia umbellata</i>	Pink sand verbena	Perennial herb
<i>Ambrosia chamissonis</i>	Beach bur	Perennial herb
<i>Calystegia soldanella</i>	Beach morning glory	Perennial herb
<i>Camissoniopsis cheiranthifolia</i>	Beach evening primrose	Perennial herb
<i>Dithyrea californica</i>	California spectaclepod	Annual herb
<i>Heliotropium curassavicum</i>	Seaside heliotrope	Perennial herb

Table 2. Potential Planting Palette for the Landward Side of the Dune System

SCIENTIFIC NAME	COMMON NAME	LIFE FORM
<i>Abronia maritima</i>	Red sand verbena	Perennial herb
<i>Ambrosia chamissonis</i>	Beach bur	Perennial herb
<i>Artemisia californica</i>	California sagebrush	Sub-shrub
<i>Atriplex leucophylla</i>	Beach saltbush	Perennial herb
<i>Atriplex parishii</i>	Parish's saltbush	Annual herb
<i>Calystegia soldanella</i>	Beach morning glory	Perennial herb
<i>Camissoniopsis cheiranthifolia</i>	Beach evening primrose	Perennial herb
<i>Croton californicus</i>	California croton	Perennial herb
<i>Dithyrea californica</i>	California spectaclepod	Annual herb
<i>Ericameria ericoides</i>	California goldenbush	Sub-shrub
<i>Eriogonum parvifolium</i>	Coast buckwheat	Perennial herb
<i>Heliotropium curassavicum</i>	Seaside heliotrope	Perennial herb
<i>Lupinus chamissonis</i>	Chamisso bush lupine	Sub-shrub
<i>Peritoma arborea</i>	Bladderpod	Shrub
<i>Rhus integrifolia</i>	Lemonade berry	Shrub

Historical Photograph Review

To determine the historical beach and dune landscape present at Broad Beach, WRA reviewed historic aerial images from the California Coastal Records Project (Adelman and Adelman 2013). Historic photographs from 1972 and 1979 indicate that foredune habitat similar to the reference foredunes at Ormond Beach was present along nearly the entire length of Broad Beach (Figures 1 through 3). The foredune system appears to have been relatively narrow and less well developed at the western end of the beach, expanding into a wider, more well developed foredune system at the eastern end of the beach. These observations served to guide the location and extent of the foredunes proposed for Broad Beach, although the ultimate location and extent of the foredunes was dictated by the shoreline stabilization goals of the project.

The shape and size of foredunes apparent in the historic aerial images also served to corroborate the observations of foredune geomorphology and vegetation made at the Ormond Beach reference site. Figures 1 through 3 show a series of low, relatively densely vegetated foredune mounds extending along the length of Broad Beach in 1979 (Figures 1 and 2) and 1972 (Figure 3). The foredunes are more well developed at the eastern and middle sections of the beach (Figures 1 and 2), grading into a narrow strip of less well developed foredunes at the western end of the beach (Figure 3). Although it is not possible to discern the composition of the vegetation shown in the aerial images, the foredune mounds appear to be relatively densely vegetated, similar to the foredunes at the Ormond Beach reference site. Vegetation on the

foredune mounds at Broad Beach appears to become more dense moving inland from the beach, suggesting that the vegetation near the houses may have been dominated by ornamental landscaping or iceplant (*Carpobrotus* spp.), similar to the existing vegetation patterns at Broad Beach.



Figure 1. Eastern end of Broad Beach in 1979 (photograph courtesy of California Coastal Records Project)



Figure 2. Middle section of Broad Beach in 1979 (photograph courtesy of California Coastal Records Project)



Figure 3. Western end of Broad Beach in 1972 (photograph courtesy of California Coastal Records Project)

Synthesis

Based on the observations made at the Ormond Beach reference site, as well as the review of historical photographs and reports on similar foredune systems in southern California and elsewhere, WRA developed a conceptual dune design that incorporates aspects of the natural geomorphology and vegetation of foredunes in the region, but which also achieves the shoreline stabilization goals of the project and accommodates existing levels of both public and private access to the beach.

WRA's foredune design centers around a set of three foredune "templates" which represent a range of dune heights and widths, within the range documented at the Ormond Beach reference site and from reports in the literature. The templates range from 2 to 3 feet in height, 15 to 30 feet in width, and have side slopes between 10 and 30 percent. Varying combinations of these three templates were used to create one to two rows of foredunes in the space landward of the existing rock revetment and seaward of the residences at Broad Beach. The combination of foredune templates used in front of each property were dictated by the width of each lot, the area between the revetment and the developed portions of each lot, existing levels of beach access at each lot, and 2 public access points that provide pedestrian access from Broad Beach Road down to the beach.

The seaward row of foredunes will be planted primarily with the species observed on the foredunes at Ormond Beach: red sand verbena, beach bur, and big saltbush. Additional low-growing herbaceous species typical of dune habitats in southern California may be included in these areas to increase native plant diversity within the constructed foredunes (Table 1). The landward row of foredunes will be planted with a similar palette of species; however, low-growing shrubs typical of more stabilized dune and coastal scrub habitats in the region will be added to the palette to increase sand stability (Table 2). As a further measure to increase foredune stability, target levels for plant cover were set at between 30 and 60 percent. This is level of cover was determined necessary to achieve the required levels of sand stability at the site.

The foredune design proposed for Broad Beach incorporates elements of naturally occurring foredune habitat in the region, while contributing to the shoreline stabilization goals of the project and accommodating existing levels of both public and private beach access. Although habitat restoration is not a primary goal of the project, the proposed foredune design will result in the development of high-value habitat for a diversity of dune-associated native plant and wildlife species. The proposed foredune habitat at Broad Beach will be especially valuable given the high rate at which dune habitat has been lost in the region.

References

- Adelman, K. and G. Adelman. 2013. California Coastal Records Project. Online at: www.californiacoastline.org; most recently accessed September 2013.
- Baldwin, B.G., D.H. Goldman, D.J. Keil, R. Patterson, T.J. Rosatti, and D.H. Wilken (eds.). 2012. *The Jepson Manual: Vascular Plants of California, Second Edition*. University of California Press, Berkeley, California.
- Guinon, M. and D. Allen. 1990. Restoration of Dune Habitat at Spanish Bay. In: J.J. Berger (ed.). *Environmental Restoration: Science and Strategies for Restoring the Earth*. Island Press, Washington, D.C.
- Holland, R.F. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. Prepared for the California Department of Fish and Game, Sacramento, California.
- LFR, Inc. 2006. Coastal Dune Scrub Restoration and Enhancement Plan, Morro Bay Harborwalk, Morro Bay, California. Prepared for The City of Morro Bay.
- Longcore, T. (ed.). 2005. Beach Bluffs Restoration Project Master Plan. Beach Bluffs Restoration Project Steering Committee, Redondo Beach, California.
- Lortie, A. and J.D. Engel. 2008. Pierpont Beach Sand Management Plan. Prepared for the City of Ventura.
- Munz, P.A. 1959. *A California Flora*. University of California Press, Los Angeles, California.
- Munz, P.A. 1974. *A Flora of Southern California*. University of California Press, Los Angeles, California.
- Nordstrom, K.F. 2008. *Beach and Dune Restoration*. Cambridge University Press, Cambridge, New York.
- Pickart, A.J. and J.O. Sawyer. 1998. *Ecology and Restoration of Northern California Coastal Dunes*. California Native Plant Society, Sacramento, California.
- Pickart, A.J. and M.G. Barbour. 2007. Beach and Dune. In: M.G. Barbour, T. Keeler-Wolf, and A.A. Schoenherr (eds.). *Terrestrial Vegetation of California, Third Edition*. University of California Press, Berkeley, California.
- Pierce, W.D. and D. Pool. 1938. The fauna and flora of the El Segundo sand dunes: I. General ecology of the dunes. *Southern California Academy of Sciences Bulletin* 37: 93-97.
- Rogers, S. and D. Nash. 2003. *The Dune Book*. North Carolina Sea Grant, Wilmington, North Carolina.
- Sapphos Environmental, Inc. 2004. Los Angeles/El Segundo Dunes Habitat Restoration Plan. Prepared for US Department of Transportation Federal Aviation Administration, Hawthorne, California.
- Sawyer, J., T. Keeler-Wolf, and J. Evens. 2009. *A Manual of California Vegetation, Second Edition*. California Native Plant Society, Berkeley, California.
- U.S. Army Corps of Engineers. 1987. Buhne Point Shoreline erosion demonstration project, vols. 1-4 and appendices. San Francisco, California.