City of South Padre Island Erosion Response Plan

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Texas General Land Office
In Compliance with
31 TAC 15.17

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SOUTH PADRE ISLAND EROSION RESPONSE PLAN

1.0 OVERVIEW

Recognizing the long-term benefits of effective shoreline management, the City of South Padre has elected to prepare and implement an Erosion Response Plan.

1.1 Purpose

In accordance with state law, the City of South Padre Island has elected to prepare an Erosion Response Plan. In general, the purpose of this plan is to explore means and methods to reduce the public expenditures due to damage to property and infrastructure that can result from shoreline change, erosion, and storm conditions.

In 2009, the Texas Legislature passed House Bill 2571 which mandated that each coastal community develop an Erosion Response Plan (ERP). While this legislative directive is "voluntary," cities and counties that fail to prepare an ERP are ineligible for state assistance under certain grant programs such as the Coastal Erosion Planning and Response Act. It is in the best interest of the City to develop an ERP in accordance with the statute and the regulatory requirements found in Texas Natural Resources Code, §33.607 and Chapter 31, Texas Administrative Code, §15.17 et. seq.

1.2 Scope of the Plan

In this plan, the City of South Padre Island has elected to address erosions and storm risks within the current City boundaries. Subsequent editions of the ERP may be added to address potential risks in the undeveloped areas north of the City in what is called its "extraterritorial jurisdiction" or ETJ. The City recognizes that Cameron County currently has principal jurisdiction over beach and dune matters in the ETJ, however, because it is likely the City will annex portions of the ETJ in the future, development in this area may lead to significant financial exposure to the City and its taxpayers from poor development practices and predicted storm damage and shoreline erosion.

1.3 ERP Requirements

The detailed requirements for local Erosion Response Plans are set forth in Chapter 31 Texas Administrative Code, §15.17. In general, the rules require that the ERP address the following elements:

- Construction setback limits
- Prohibitions on construction seaward of the setback line
- Exemptions from the setback line
- Requirements for exempt construction
- Procedures to preserve public access
- Procedures for protection and enhancement of dunes
- Criteria for voluntary acquisition or buyout

- Post-Storm recovery plans

1.4 Process for ERP Development, Adoption and Certification

The process for the development, adoption, and certification of the City's ERP is set forth in the General Land Office (GLO) rules governing the program. Local governments are charged with the responsibility to develop an ERP in draft form for submission to the state no later than July 2011.

Upon submission to the state, the GLO will review the Draft ERP and provide comments to the City. The City will then have the opportunity to undertake necessary and appropriate revisions to the Draft, leading to the submission of a Final ERP. Once in final form, the City will be required to include the Plan as an appendix to its existing Beach Access and Dune Protection Plan.

Following local adoption, the GLO will review the ERP for final certification in accordance with state procedures. To do so, the GLO is required to propose an administrative rule to either reject or certify the City's plan. The proposed certification is published in the *Texas Register* followed by a minimum of 30-day public comment period. Assuming acceptable public comments and compliance with all regulatory requirements, the GLO can then move forward with final certification of the City's ERP in the form of a final administrative rule. The certification process may require up to 180 days to complete.

Once certified, the City is then required to move forward with amendments to its Beach Access and Dune Protection Plan and ultimately to implementation of the certified ERP. This completes the adoption, approval, and certification process.

1.5 ERP Shoreline Data Sources

In developing its City's ERP, the City relied on three principal data sources: (1) the University of Texas Bureau of Economic Geology (UT-BEG); (2) the Texas General Land Office; and (3) data available through the City's beach management program archives.

Shoreline change rates, beach profiles, and projected shoreline positions were obtained from the UT-BEG. From the GLO, the City obtained the 2009 Texas Coastwide Erosion Response Plan, which includes substantial data and information necessary for the local plan, LIDAR elevation data, and updated aerial photography of the City's shoreline. Finally, the City compiled data on previous beneficial use projects, updated shoreline profiles, dune enhancement projects, and cost estimates for various shoreline management activities. No new survey data was collected in the field during the course of developing this ERP.

2.0 CURRENT SHORELINE MANAGEMENT PRACTICES

2.1 Periodic Nourishment/Beneficial Use

For more than ten years, the City has worked with the U.S. Army Corps of Engineers to place sand dredged from the federally maintained Brazos Santiago Pass on its beaches. This beneficial use project is a critical component of the City's shoreline management program and will remain a cornerstone of the ERP.

Table 1 shows the history of beneficial use projects within the City, beginning in 1997 and extending through March 2011. The beneficial use projects are shaded in orange and constitute the largest source of sand volume placed on the beach during the reporting period. Over the 14 years, total sand volume placed reached 2,774,390 cubic yards.

Project costs for all efforts identified totaled $18,885,015, with the City assuming $1,636,832 of the cost. The remaining costs were paid by the state or federal government, depending on the specific project type and the financial arrangements made among the parties.

Table 1: City of South Padre Island Renourishment History						Note: Beneficial Use Projects are in Orange
Project Date	***Sand Source***	***Project Location***	***Project Length (ft)***	***Fill Volume (cu yds)***	***Cost of Project***	***Cost to City***
Feb 1997	Dredge Brownsville Ship Channel	3.5 - 4.5 mi from Jetties; Padre S north to Suntide	8,100	489,211	$1,938,700	$661,259
Feb 1999	Dredge Brownsville Ship Channel	1.5 - 2.25 miles from Jetties; Radisson N to Padre Grand	4,600	494,766	$3,136,170	$55,388
May 1999	Highway 100 Sand	Tiki south to Inverness	3,200	41,628	$48,500	$22,565
Dec 2000	Dredge Brownsville Ship Channel	Bahia Mar S to Starlight Circle beach access	5,200	366,886	$2,277,893	$177,314
Feb 2001	Highway 100 Sand	Tiki south to Inverness	3,200	27,956	$107,200	$3,200
Jan 2002	Highway 100 Sand	Tiki south to Inverness	3,200	23,895	$109,917	$3,125
Nov 2002-Jan 2003	Highway 100 Sand	La Quinta/City limits S to Inverness	3,800	81,252	$37,644	$9,411
Nov 2002	Dredge Brownsville Ship Channel	Neptune Circle N to Gay Dawn Circle	2,400	306,402	$2,946,400	$183,210
Dec 2003	Highway 100 Sand	La Quinta/City limits south to Inverness	3,800	53,560		
Nov 2004 - Jan 2005	Dredge Brownsville Ship Channel	Neptune Circle N to Gay Dawn Circle	1,200	261,600	$1,495,000	$84,525
Feb - Mar 2007	Highway 100 Sand	La Quinta/City limits S to Good Hope Circle	4,400	71,045	$432,133	$108,033
Feb - Mar 2008	Highway 100 Sand	La Quinta/City limits S to Inverness	3,800	100,178	$528,545	$132,136
Dec 2008 – Mar 09	Dredge Brownsville Ship Channel	Gay Dawn Circle to White Sands	2,200	406,000	$5,600,000	$139,938
Mar 2009	Highway 100 Sand	White Sands to La Quinta/ City Limits	900	50,011	$226,913	$56,728
Mar 2010	Dredge Brownsville Ship Channel	Parkshore to N of La Quinta	2500	130,000	$1,839,222	$138,750
Mar 2011	Dredge Brownsville Ship Channel	Northern City Limits	2500	367,000	$4,017,000	$600,000
Totals				2,774,390	$18,885,015	$1,636,832

2.2 Dune Enhancement/Dune Planting Program

In 2009, the City initiated a Dune Enhancement and Planting Program to respond to dune losses following Hurricane Dolly and Hurricane Ike. This program has evolved and grown to become an integral element of the City's shoreline management program and a cornerstone of the Erosion Response Plan described in this report.

The preservation and restoration of the dune line provides many benefits to the City and its residents. Land Commissioner Jerry Paterson succulently articulated the value of dunes in the agency's *Dune Protection Manual*:

> "The Texas Coast is an environmental and economic treasure composed of interlocking, interdependent ecological systems. Coastal sand dunes are a crucial part of that system. Dunes serve not only as vital habitat for numerous native plants and animals, but an irreplaceable recreational resource upon which humans must tread lightly."

Most beachfront property owners today understand that the dune line provides an effective natural barrier to erosion, flooding, and storm damage that protects public and private property, including inland infrastructure. In addition, visitors appreciate that the dune system provides habitat for local plants and animals. It is generally well understood that healthy dunes create a "sand savings account" for the beach itself. While a seawall or other hard structures can undermine the beach -- because they focus and refract wave energy back to the sandy beach -- a healthy dune system can better absorb wave energy and provide a source of sand to the beach when it is under wave attack. Sand that is stored in the dunes is beneficial to the function and stability of the beach. During storms, dune sand can be redistributed down the beach face by wave attack and erosion, where summer currents can move it back to beach face. This "sand cycle" is well described in the GLO *Dune Protection Manual*:

> "During a storm, high-energy waves flatten the beach. Waves washing against the base of the foredunes erode sand, undermining and collapsing the seaward dune face. In severe storms, the dune face commonly recedes several yards — in extreme cases as much as 100 yards — leaving a steep cliff. Sometimes dunes are completely destroyed. Retreating waves carry the eroded sand offshore and deposit it just seaward of the surf zone in large bars. This process of dune erosion and sand movement dissipates much of the energy of storm waves. Sandbars also dissipate storm wave energy by causing waves to break further offshore.
>
> If the supply of sand remains constant, the natural exchange between the beach, dunes, and offshore areas will repair and rebuild dunes to a height

> and width determined by local conditions. However, the loss of vegetation that traps and holds sand makes the beach and dunes more susceptible to wind and water erosion, thus inhibiting their recovery from storms. Bays, channels, marshes, and grass flats behind the weakened foredune are exposed to storm-surge flooding and to accumulation of windblown sand." (*Dune Protection Manual*, Chapter 2, page 5).

Starting in 2008, the City of South Padre Island, in cooperation with the South Texas Surfrider Foundation South Texas Chapter and University of Texas Brownsville (UTB), initiated a pilot project to harvest dune plants for dune restoration projects following Hurricanes Dolly and Ike. Harvested plants were transported to the UTB greenhouse where they were propagated and eventually replanted on the City's dunes as part of the post-hurricane recovery effort. While this modest pilot program planted a few thousand plants here and there, it demonstrated that the parties could cooperatively work together and that dune plantings could be successfuly completed, leading to a more organized and comprehensive effort.

2.2.1 2010/11 Plantings

In 2010, the City developed a more aggressive dune-planting schedule with the goal of 8,000 to 10,000 plants per planting event. Planting projects started in December 2010 and were scheduled once a month through May 2011, with the specific goal of installing approximately 50,000 plants along the most narrow and vulnerable sections of the City's beaches. As the program expanded, property owners and homeowner associations raised concerns that the dune enhancement/planting projects could elevate the dunes, blocking the view from ground-level condos or rooms. However, but constructively working through these issues, many of these concerns have been resolved. Many property owners recalled that even though Hurricane Ike made landfall in the Galveston, Texas area, more than 300 miles to the north, the storm produced significant storm surge and dune damage in South Padre Island. Presently, there is greater appreciation for the dune enhancement/planting program and increasing landowner demand for projects along the City's beachfront.

The dune enhancement and planting program has been successful. Over the last year, the vegetation planted by the volunteers has become more established and, most importantly, monitoring has shown that the root systems have extended into the dunes, increasing their stability. Starting in December 2010, the City hosted one Saturday morning volunteer planting events each month until May. In all, more than 400 volunteers have participated in the program from various organizations including students from South Texas College and the University of Texas at Brownsville, Texas Master Naturalists, winter visitors, island locals, and students from school districts across the Rio Grande Valley. More than 350 local elementary school kids from the 3rd, 4th, and 5th grade levels have participated through school field trips to the beach where they were taught the importance of the dunes and given a chance to help plant dune vegetation.

Since the program's inception, the City purchased more than $21,000.00 of dune plants and, with the help of the volunteers, was able to substantially reduce its installation costs. To date, volunteer have donated approximately 2,100 man-hours to the program, saving the City approximately $50,000.00 in labor costs.

2.2.2 2011/12 Plantings

The City and the Surfrider Foundation South Texas Chapter hosted 7 volunteer events and school field trip for the 5th graders of a local elementary. Together a total of 50,000 indigenous plants were planted in bare areas that were low in elevation and vulnerable.

2.2.3 Volunteer Reports

The value of these dune enhancement/planting projects goes beyond the number of volunteers, the plants installed, or even the size of the dune area restored. Certainly, the projects have a positive environmental, ecological and even economic impact, as difficult as it may be to quantify these benefits. Through this program, the City and its partners are also changing the community's ethic and enhancing the public's understanding of beach and dune system. The City has brought together disparate groups from around the region and given them an opportunity to invest their time and energy in the betterment of South Padre Island's beaches. In the process, these volunteers are educated about the function and value of a healthy beach/dune system. Participants unavoidably gain a vested interest in the protection and maintenance of the island's beaches and dunes, an investment that cannot be measured in dollars or statistics. The SPI Dune Enhancement and Planting Program has helped create a more educated, caring, and motivated beach community and it is hoped the participating volunteers will share their knowledge and their desire to protect our local beaches with others for many years to come.

2.3 Seaweed Management

Over the years, the City has developed a set of guidelines governing seaweed management on the beach. These guidelines have originated through practice and experience and are generally consistent with sound practice. However, given the significant influx of seaweed that can occur during the Spring months, the City seeks to maximize the benefits to the dune system by improving its seaweed and beach maintenance practices.

2.3.1 Goal

The goal of the City's seaweed management program is to limit damage to the beach dune system from raking activities and promote the formation of a continuous dune system along the City's developed beachfront. The presence of seaweed along the beach is not detrimental to the condition of the shoreline itself but can be a nuisance

to beach visitors. In general, the City will seek to limit seaweed raking and mechanical beach manipulation to circumstances clearly warranting the relocation of seaweed.

Harvesting the Sargassum/other seaweeds for placement of coppices and dunes is a beneficial and valuable practice. Sargassum relocation from the beach, however, should conform to the City's management and scheduling requirements.

2.3.2 Methods for Sargassum Relocation

When relocating Sargassum from above the high-tide line, care should be taken to separate the seaweed from the sand substrate, i.e., with hay rakes (tine equipped) or sand sifting machinery rather than with bulldozer blades. Doing so will allow the surface sand, deposited there by the surf, to keep in service as a supply source for both the dunes, by wind-driven sand, and for nearshore berms and terraces. This dynamic of exchange back and forth between the beach and the nearshore serves to maintain a proper sand budget for both tiers. Removing sand along with the Sargassum and even more so with hauling beach sand to supplement dune elevation, subtracts some supply from the equation. While wind does move beach sand landward regularly, relocation of sand unauthorized by the Coastal Resources Manager should be prohibited.

2.3.3 Location & Timing of Seaweed Relocation.

The City seeks to limit the location and timing of its seaweed management practices to those areas that warrant seaweed relocation mechanically and to the seasonal demand of the beach. Within the City Limits all areas are highly used by the public since all beach areas are in front of condominiums and hotels. Areas that have a higher demand are generally more appropriate for seaweed relocation than rarely used stretches of the shoreline.

Weather forecasts and tides are always considered when determining the whether to relocate seaweed or to wait.

2.3.4 Seaweed Coverage.

The City seeks to limit seaweed relocation to circumstances where seaweed coverage and deposition interfere with the public's use and enjoyment of the beach. This subjective decision is a matter of judgment and can be exercised by the Mayor, City manager, Public Works Director, or the Coastal Resources Manager.

2.4 Management of relocated Seaweed.

In the course of the year, the City relocates thousands of cubic yards of seaweed on the beach. This volume constitutes a significant resource, as it is excellent dune building material. The City's intent is to maximize the benefits that can be obtained

by effectively using the raked seaweed to rebuild to dunes, fill in gaps, and raise the elevation of portions of the backbeach that lead to washouts and inundation. These areas are typically vegetated through the dune volunteer program to encourage seaward migration of the vegetation line.

The City is continually adapting its beach maintenance practices to use the most up to date information available.

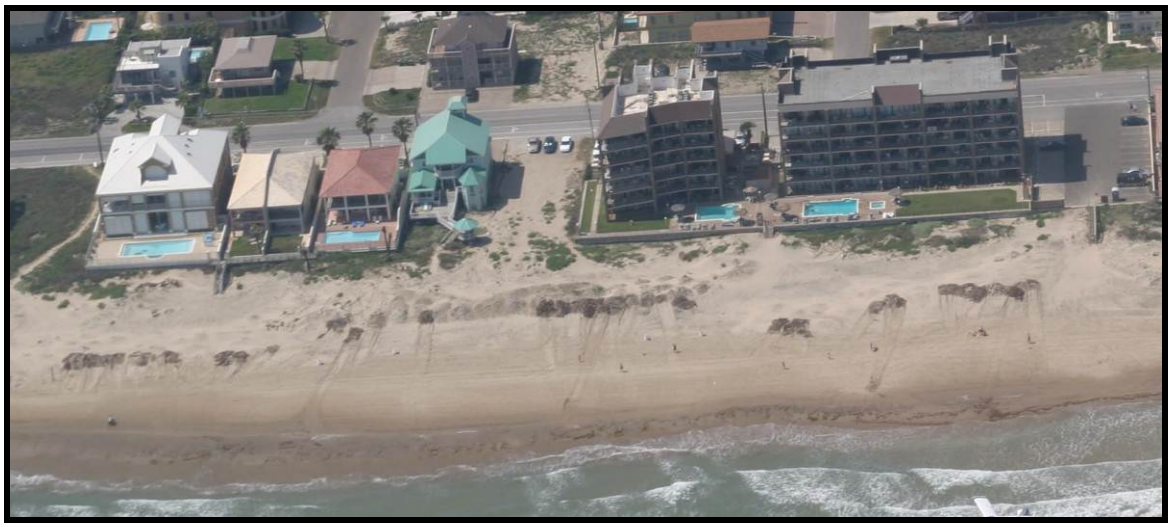


Photo 1 - Typical Seaweed Management showing deposition of seaweed on upper beach *(Photograph by Nancy Marsden, March 10, 2007)*

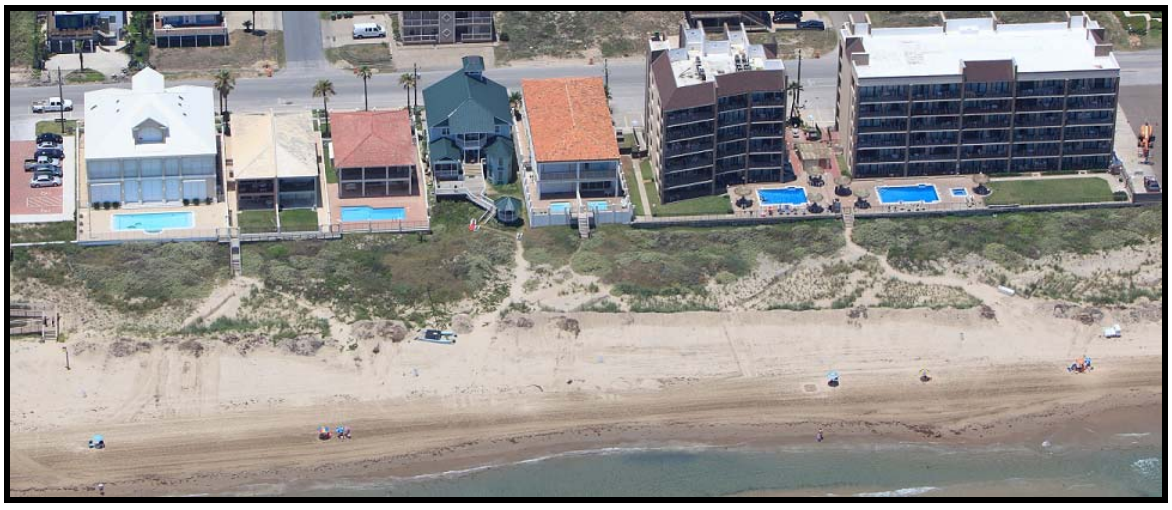


Photo 1b- Same section of beach from above showing the results of the City's seaweed management and volunteer plantings programs. (*Photograph by Richard Stockton, May 2012)*

3.0 EXISTING SHORELINE CONDITIONS

The purpose of this section is to generally describe the shoreline conditions that exist within the jurisdiction of the City of South Padre Island. In general, the assessment is divided into three broad subject areas: (§3.1) the Beach and Beach Profile, (§3.2) the Dune System, and (§3.3) Beach Accessways.

3.1 Beach and Beach Profile

The Gulf of Mexico shoreline is a continuous, sandy beach/dune system within the City and extending to the south and north of the City. To the south, about 1 mile of beach separates the City portion of the beach from the north jetty of the Brazos Santiago Pass, a deep-draft federal navigation channel. To the north, over six miles of undeveloped beach, most of which is within the City's extraterritorial jurisdiction (ETJ), separates the northerly City limit from the southerly limit of the Padre Island National Seashore.

About 5.5 miles of sandy beaches lie between the southerly and northerly City limits, including about 0.75 miles within Andy Bowie County Park near the north end of City. Virtually all of the property immediately landward of the beach is developed with the exception of the county park.

Construction of the navigation jetties at Brazos Santiago Pass in 1935 has caused profound changes to the beach/dune system in the City. The jetties as well as the deep-draft channel act as barriers to both northward and southward longshore transport of sand along the beach and in the submerged nearshore.

Over the long term (years to decades), more sand travels toward the north than to the south at this point along the Gulf shoreline. As a result, construction of the jetties caused sand to accumulate on the south side of the south jetty, while the beach to the north of the north jetty was starved. Initially, this resulted in a rapid retreat of the Gulf shoreline in the southerly part of the City. City beaches are also adjusting to ongoing sea level rise by migrating landward and upward over the long term.

After significant initial shoreline retreat during a period of adjustment to the new conditions with the jetties and channel, the beach to the north of the jetties became sheltered such that sand arriving from the north now becomes trapped in the jetty's shadow. Shoreline retreat in the southerly end of the City has effectively ceased and seaward advance has now been documented. The northerly portion of the City still experiences shoreline retreat, with a more or less stable shoreline segment in between (see Figure 1).

City streets and individual property lines were laid out decades ago, such that changes in the beach location due to shoreline advance and retreat have affected the depth of the beach/dune complex between the Gulf of Mexico and the beachfront development.

It is apparent when viewing the present shoreline location relative to streets and developed properties that the shoreline has rotated in a counterclockwise direction about a point roughly three miles north of Brazos Santiago Pass. Cross-shore beach

surface profiles extending from the dunes out into deep water and taken at intervals along the beach appear to be very similar from the south end of the City to the north end, even though the profiles are migrating seaward (south end) or landward (north end) over time such that the effects of development on the landward ends of the profiles are quite different.

3.1.1 Shoreline change rates

The State of Texas has designated the University of Texas—Bureau of Economic Geology (BEG) as the official repository of statewide shoreline change information. BEG mapped historical shorelines using data beginning with charts from the mid-19th Century, to 20th-Century aerial photography, to 21st Century Lidar. Longterm average annual rates of shoreline change were determined based on comparisons of these historical shorelines. The determinations generally do not consider the physical processes causing shoreline change; rather, they are only indications of past rates of such change.

Along the Texas coast, there is considerable variability in actual shoreline change rates from year to year. A typical cycle consists of a large storm-induced retreat followed by months and sometimes years of recovery during relatively benign wave conditions. Shoreline locations also vary seasonally, typically exhibiting winter retreat and summer advance.

For purposes of this Erosion Response Plan, the beaches within the City are divided into three zones based on BEG analyses (see Figure 1):

(1) The Southerly Zone of Accretion (green) -- average annual shoreline advance in excess of +2 ft, a shoreline reach roughly 12,000 feet in length;

(2) The Central Zone of Stability (yellow) -- average annual shoreline change of -2 ft to +2 ft, a shoreline reach roughly 4,000 feet in length; and

(3) The Northerly Zone of Erosion (red) -- average annual retreat of greater than -2 ft, a shoreline reach roughly 11,000 feet in length.

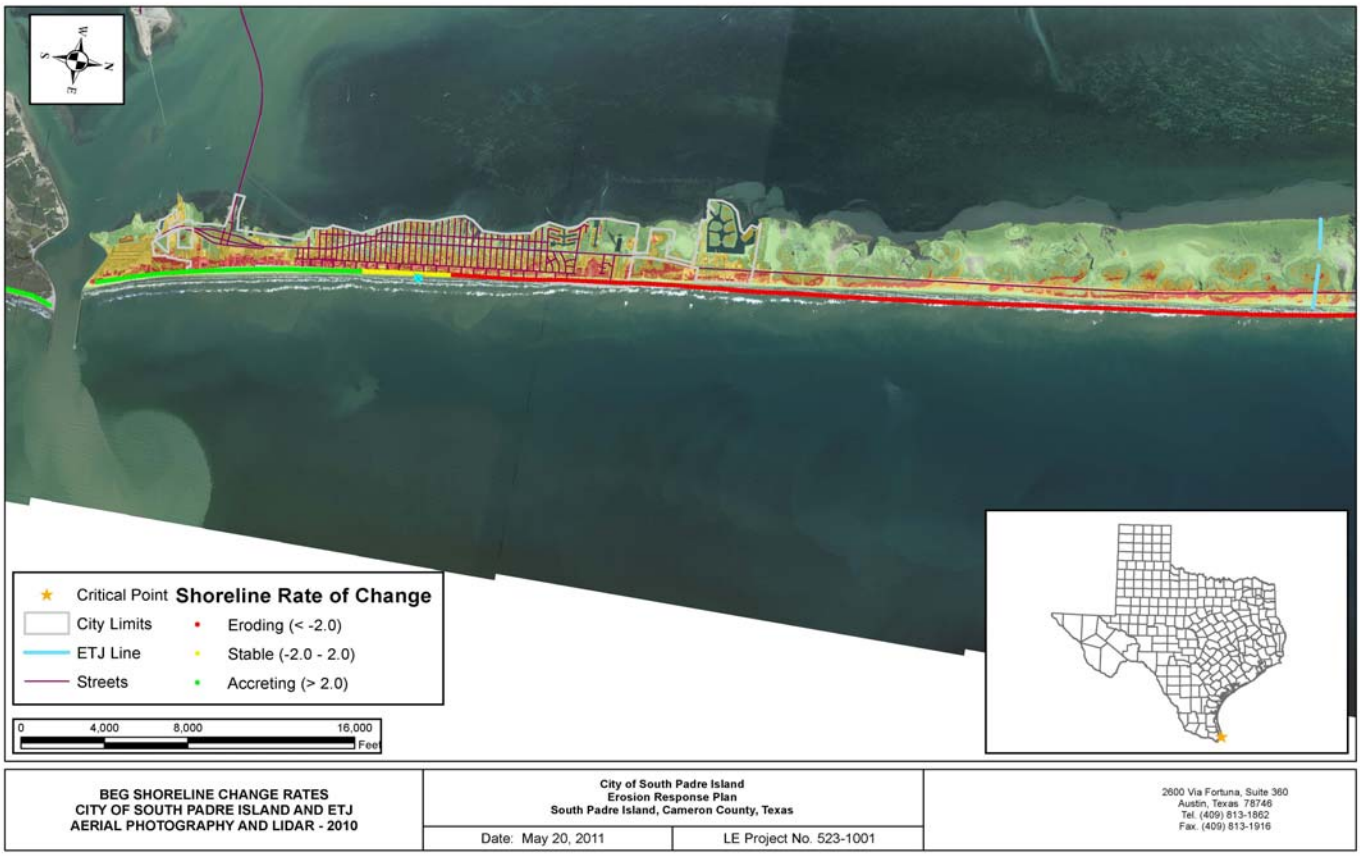


Figure 1: SPI accreting, Stable, and Eroding Zones

3.1.2 Annual volume losses and gains

Data regarding the magnitude of sand deficits and surpluses at locations along the City beachfront is useful to inform any discussion of reasonable alternative actions to address shoreline retreat and reduce future public expenditures due to erosion and storms. The BEG shoreline change rates provide an excellent basis for a planning-level estimate of the volume (quantity) of sand needed to offset some or all of the sand deficit within the City, (including the effect of sea level rise) that results in shoreline retreat.

Knowledge of volume requirements leads directly to cost estimates of sand management strategies. Once these strategies can be viewed in dollar terms, they can be compared to the costs of dissimilar alternative strategies such as land purchases or constraints placed upon development or post-disaster reconstruction.

To the extent that the ERP is by definition intended to address the effects of erosion, the southerly accreting beach is not an obvious focal point of planning efforts. Dune resilience and public access issues in the accreting area are addressed elsewhere in the ERP. However, it is important to understand the extent of sand accretion in this area as a potential resource for combating sand deficits and shoreline retreat in

areas further to the north while acknowledging potential equity issues that may arise depending on the response approach being considered.

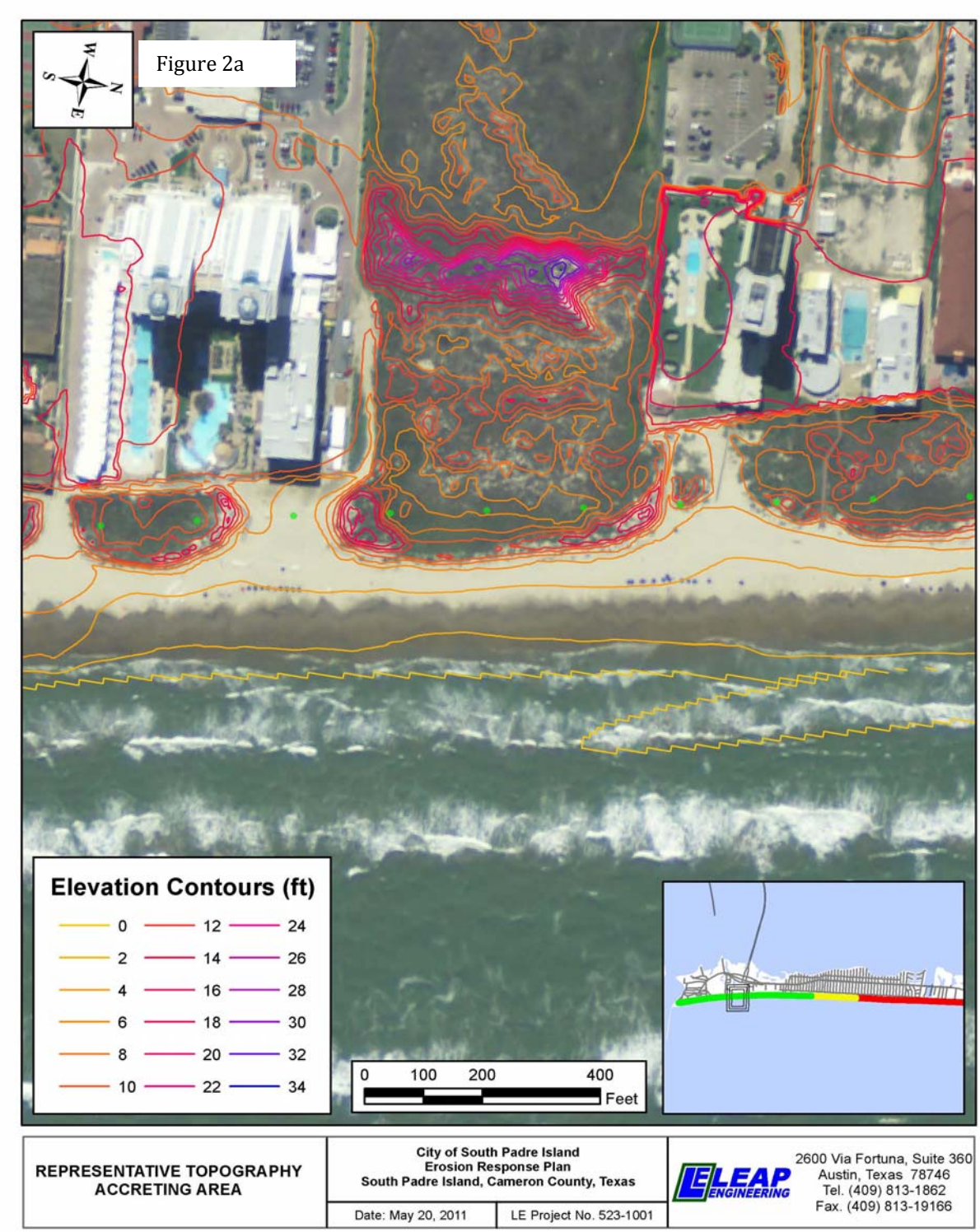
The notion of an annual volume change is useful for planning and cost estimating, but to reiterate the discussion of shoreline change rates, the mechanism of change is generally not a steady gain or loss of sand. Rather, episodes of large changes are separated by potentially long periods of recovery to equilibrium. That equilibrium may be (and generally is) a gradual gain or loss over the long term. These mechanisms should be kept in mind during the development of response measures.

Planning-level estimates of average annual volume change were developed using typical beach profiles taken in the accreting (south), stable (central), and eroding (north) zones of the City beachfront and translating them landward or seaward. This simple estimation approach is appropriate in the context of the ERP level of effort and is not the result of an original, rigorous analysis of coastal processes. For ease of comparison, quantities are broken down to cubic yards of sand per foot of beach (cy/ft) throughout the ERP. This unit can be multiplied by a selected dollar amount per cubic yard ($/cy) to arrive at a cost per foot of alongshore beach length ($/ft).

- In the accreting zone, where average annual shoreline advance ranges from 2 ft to about 10 ft, the average annual increase in sand volume ranges from 2 cy/ft to 11 cy/ft.
- The stable zone, by definition, does not have an average annual accretion or erosion quantity.
- In the eroding zone, where average annual shoreline retreat ranges from -2 ft to about -5 ft (within the City limits), the average annual decrease in sand volume ranges from 2 cy/ft to 5 cy/ft.

Note that the effects of sea level rise are captured within the BEG rates and do not need to be added to the calculations based on the BEG rates.

In the three figures below (designated 2a, 2b and 2c), typical areas are shown in each of the three beach sections – accreting, stable and eroding.



In Figure 2a, it is apparent that sufficient beach depth exists for a dune system and dune elevations can reach +14 feet or greater. Beach conditions in the accreting

area are thus conducive to dune restoration, enhancement and replanting.

Figure 2b depicts a typical section of the beach/dune system in the stable area. Here, dunes are typically narrower than those found further south and dune

elevations are usually lower. The lack of dune walkovers results in the proliferation of footpaths through the dunes and fragmentation of the system.

Figure 2c depicts a typical section of the beach/dune system in the eroding area. Here, dunes are extremely narrower than those found further south.

3.1.3 Areas of Concern

It comes as no surprise locally that the area of greatest general concern is the northerly zone of retreating shorelines, as depicted in Figure 2c, above. Progressing northward from the jetties, the beach generally narrows and is subjected to increasingly higher erosion rates. At the northern City limit, in the vicinity of Andy Bowie Park, the narrow beaches leaves limited area for the formation of dunes and, where dunes are found, they are typically lower, more fragmented, and provide less protection to the dunes found in the southern reach of the City's beach.

As described previously, the shoreline is rotating in a counterclockwise direction, while the historical building line and the existing beachfront buildings within the City remain stationary. Other more localized areas of concern are portions of the beach were dunes do not exist at the landward side of the dry beach, as shown in Photo 2 below.

Photo 2 - Dunes are limited or poorly formed in eroding areas along the northern reach of the City's beach. (*Photograph by Richard Stockton, May 2012)*

These narrow beach areas are more susceptible to downcutting (vertical erosion), causing sand loss either seaward into deeper water or landward into the developed area and lost to the beach/dune system. This is because the dune provides a barrier to landward washover as well as a reservoir of sand that is drawn down to the beach during elevated tides and high wave action. Without this barrier and reservoir, much more sand loss can occur.

Washovers do occur periodically, and result in the transport of significant quantities of sand into the Laguna Madre and seaward into deep water. These quantities are effectively lost to the beach/dune system, although sand washed into the Laguna is a natural part of the barrier island's response to rising sea level as the island moves landward and upward.

Natural washovers tend to reappear in similar locations over time. In addition, development patterns can create manmade washover opportunities. A shore-perpendicular street end not adequately protected by a dune is an example of a washover opportunity.

In terms of other beach responses to storm activity, any structural feature that is impacted by wave action has an effect on the beach profile at that location and upon adjacent areas. Any exposed feature such as a seawall, dune walkover, or pavement will have an effect. Mitigation opportunities to address washovers and structural impacts are discussed elsewhere in this report.

Although dunes and dune maintenance/mitigation are also discussed elsewhere in this report, it is worth noting that dunes cannot be readily sustained at a location on the beach that is too low to provide for a roughly 200 ft depth of sandy beach between the typical water line and the foredune (see Figure 2c, Photo 3, and Photo 3b).

Photo 3 - Narrow beach at Whitesands St., dune restoration would be problematic seaward of the structure *(Photograph by Nancy Marsden, March 10, 2007)*

Photo 3b- Narrow beach at Whitesands St. *(Photograph by Richard Stockton, May 2012)*

That is to say, in northerly areas or any area where the wet beach is typically within roughly 200 ft of the historical building line, beach nourishment of the dry beach and submerged nearshore is appropriate before or in conjunction with dune building efforts. Otherwise, restored dunes will tend to be short-lived and only serve to nourish the beach with sand while losing the value of any dune mitigation/planting/watering efforts.

3.1.3.1 Hot spots

The BEG shoreline change data portrays a fairly consistent progression of changing rates from south to north along the City beachfront. One example of a relative hot spot can be seen near the northerly City limit. This localized increase in the BEG retreat rate is likely an artifact of the location being a historical natural washover area, although fill associated with the development of this portion of the beachfront has restored elevations such that the washover will not be easily activated.

3.1.3.2 Developed and undeveloped beachfront tracts

The vast majority of beachfront properties within the City are developed, including bulkheads along the historical building line. From an erosion response perspective, there is little to suggest at this point that infill development of the remaining undeveloped parcels will be detrimental to City-wide erosion response.

Protection of the built environment landward of the beach from damage caused by coastal storms is dependent upon the maintenance of a healthy, continuous dune system which is itself predicated on a dry beach of some depth between the typical water line and the dunes.

Anecdotal evidence suggests that ongoing dune building/restoration activities have resulted in some seaward advance of the beach itself. Such a result is not inconsistent with the coastal processes at work in SPI to the extent that the restored dunes are contributing sand to the beach over time. However, within the limited scope and level of effort facilitated by the production of this ERP, there is insufficient evidence to make a strong determination of either correlation or causation of this effect.

3.1.3.3 Vulnerability

The City, including its public infrastructure and private property, is vulnerable to the effects of beach erosion in several ways, including the following:

- Discrete events (storms)—High tides and waves can directly impact and cause damage to infrastructure and property that is not adequately separated from Gulf waters by a continuous and robust beach/dune system.
- Washover—Internal flooding within the City can occur as a result of activation of natural or manmade washover locations allowing high Gulf water levels to encroach landward of the dune system.

- Sand deficit—Assuming a static building line, sand deficit causes the landward retreat of the beach/dune system over time. Eventually the stationary structures impact the retreating dunes and beach, weakening the City's defense against coastal storms and increasing the frequency and severity of damage.

- Relative sea level rise—The natural response of a barrier island to progressive sea level rise is for the island to "roll over" as washover deposits raise elevations in the back bay. This process is ongoing in SPI despite the presence of development.

- Effects of built environment—The built environment primarily affects the availability of sand to the beach/dune system. The navigation channel and jetties starve the entire City of beach sand, while beachfront development both captures sand beneath pavement and causes more wind-transported sand to be lost to landward areas.

- Vehicle/pedestrian impacts—Public vehicles and pedestrians cause damage to dune vegetation and the loss of dune elevation. The resulting weakened dune system is more susceptible to wave erosion and washover.

3.2. Dune Complex and Uplands

The following descriptions are based on 2011 observations and data, which follow a period of relative quiet, in terms of the absence of severe storms and wave action along South Padre Island's Gulf shores. i.e., without serious beach/dune erosion and loss.

3.2.1 Location, Elevation, and Depth of Dunes.

Dunes are found in both healthy and degraded states in the City's jurisdiction, the better dunes being components or parts of continuous dune fields or systems. In the south, certain areas are devoid of dunes, having been removed over time by recreational use, beach access, and storm surge. (see Photo 4 below).

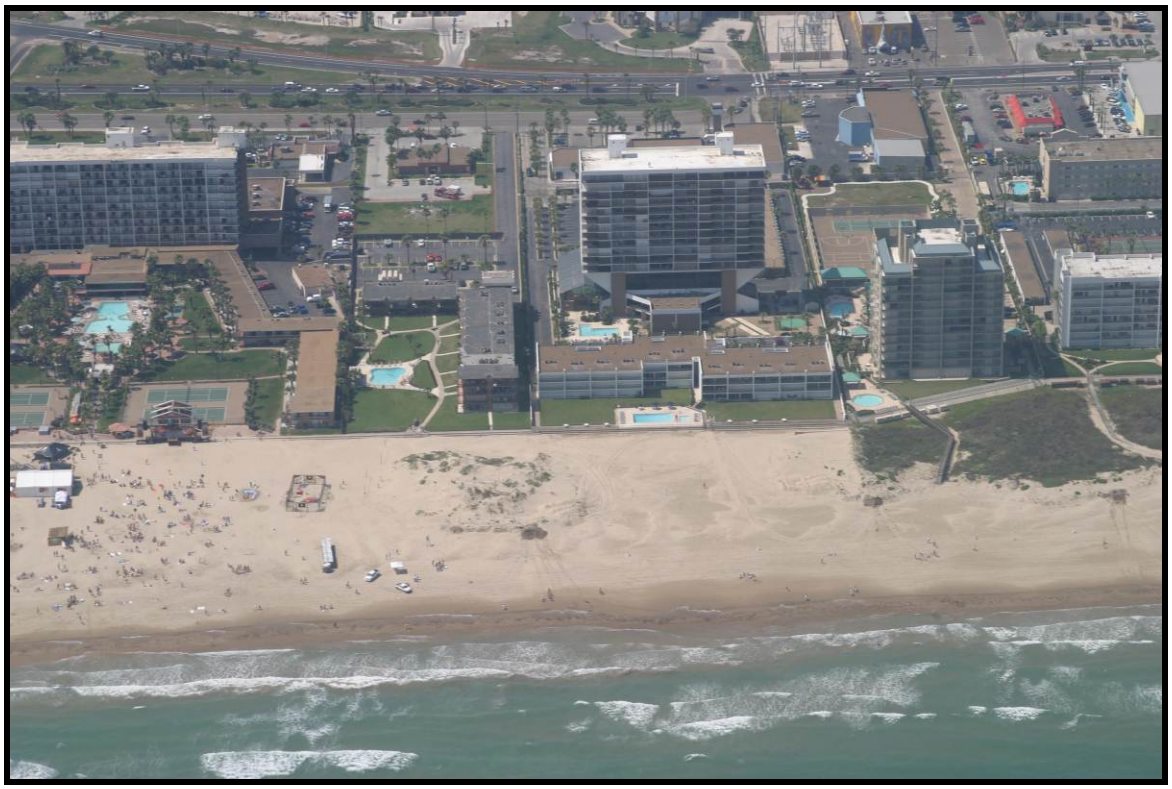


Photo 4 - Typical area where dunes have been damaged by recreational use and beach access (showing Franke Plaza, Radisson & "Coca Cola Beach *(Photo by Nancy Marsden, March 2007)*

In the beach's central section, dunes are fairly continuous, with disruptions for the causes similar to the south beach examples but of generally smaller magnitudes. In the north, particularly in the City's ETJ, with sparser development to date, dunes are generally broader and higher, are components of integrated natural dune fields, and have experienced fewer disturbances other than natural dune migration and wind-erosion dynamics.

Photo 5 - Area of generally continuous dunes with intermittent footpath damage *(Photo by Richard Stockton, May 2012)*

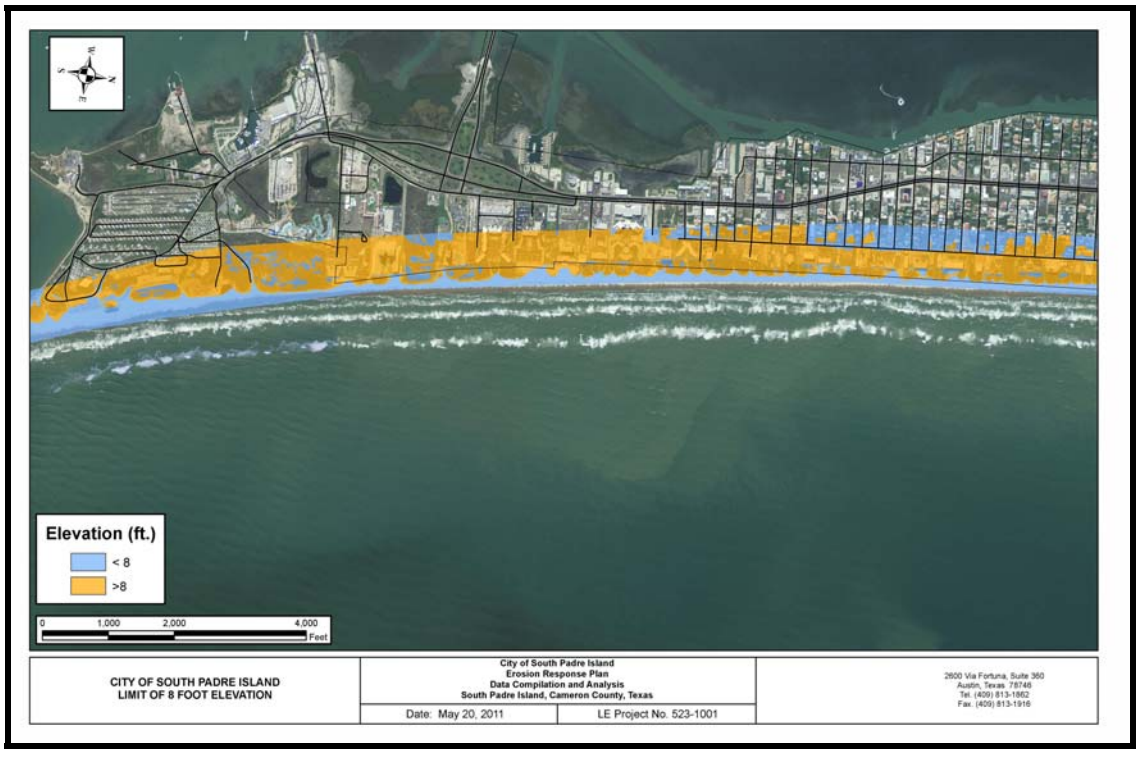
Dune Elevation: At the south end, most dunes are on average below 7 feet in elevation above grade, with many below 5 feet. In the center, stable and vegetated

dunes range in elevation, on average, between 6 and 11 feet above grade. In the north, the average is higher, with some stable and vegetated dunes reaching 12 to 16 feet in elevation or higher. In the developed areas of the beach, as previously noted, many dunes have been disturbed, eroded, and/or removed.

Dune Depth: In the more extensively disturbed areas, some dune formations have disappeared entirely, while remnant dunes, mainly low in elevation, vary from 20 to 40 feet in depth (running landward from the shore), in many examples. In the slightly disturbed reaches, some largely intact dune clusters extend 50 to more than 100 feet in depth, with fairly distinct foredunes, interdune areas, and backdunes. In the least disturbed areas, primarily in the north of Andy Bowie Park, including the ETJ, dune fields are found in excess of 200 feet in depth. Where housing and other development has not yet occurred along Gulf Boulevard in the north, many dune fields extend the full distance between high beach and the road, in many cases in excess of 300 feet.

Analysis of 2010 survey data reveals that a significant percentage of the landward beach area within the City limits -- the zone of potential for dune development -- is actually covered by established and emerging dunes. The City would gain in protection from storm damage protection were this percentage to increase.

Figure 3a below shows beach elevations above and below +8 feet, with areas shaded gold being greater than +8 ft. In this figure, it is typical that beach and dune elevations reach at least eight feet, but areas of lower elevation, usually coinciding with foot paths, access roads, or dune areas cleared to expand the dry beach, can be seen.



3.2.2. Dune Vegetative Cover.

Where dunes have been protected, both by dune fencing set to augment the dunes by sand trapping and by owner and visitor adherence to City and non-profit organizational guidance on dune protection and sustainability, dune plants are well established (see Photo 5 above). The City, with extensive help from visitors, and non-profits through the Dune Planting efforts has established a planting program. Through the program these plants have naturalized onto the dune surfaces, resulting in successful cover and a build-up of dune defenses against storm effects.

Further analysis of the 2010 aerial photos reveals that most of the established and emerging dunes within the City limits are well vegetated, where the dunes are allowed to exist. To the extent that further vegetated cover is planted and supported and dunes are restored and expanded in the bare areas, properties and infrastructure landward of these zones can be made more secure from storm damage.

3.2.3 Dune Hotspots and Overwash Areas.

The City's dune system is fragmented and inconsistent limiting the protective value of this natural storm and flood barrier. There are several causes for this condition, which can be catalogued as follows:

Excessive number pedestrian trails and walkways through the dunes – Along the City's 4 mile-long beachfront, there are dozens of unimproved pedestrian trails or paths through the dunes. Cumulatively, these paths result in a substantial loss of dune mass from down cutting due to foot traffic.

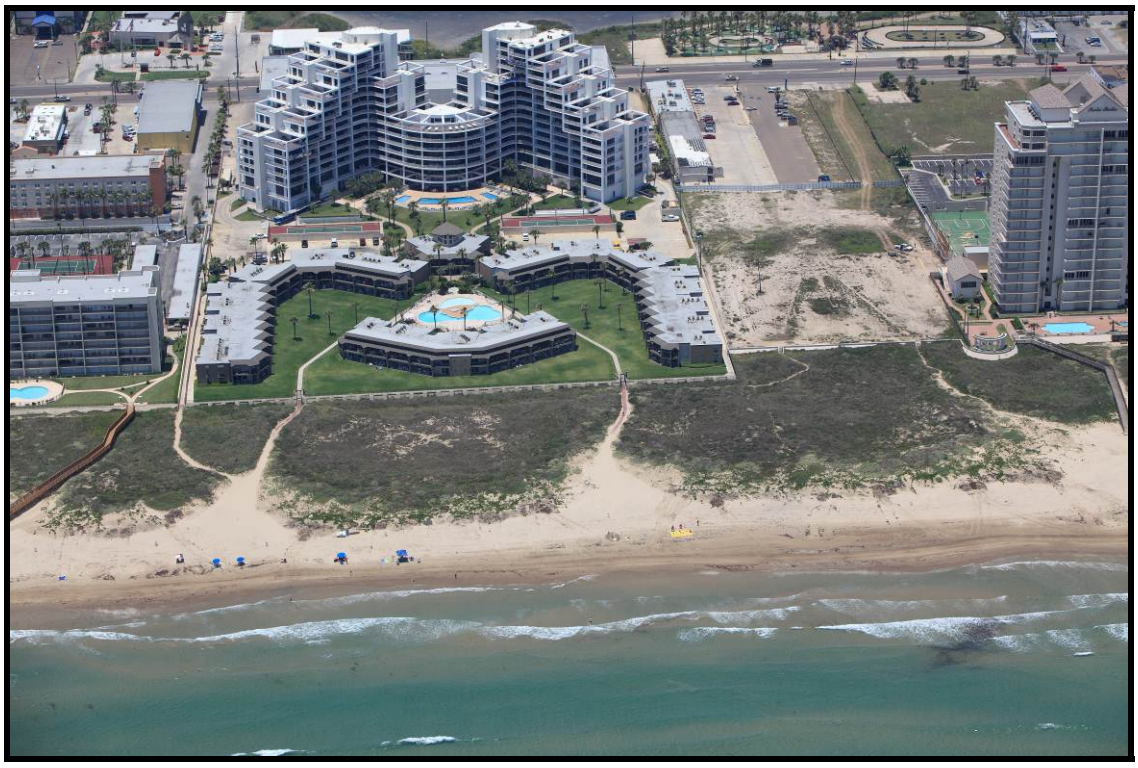


Photo 6 - Typical footpaths causing dune fragmentation. Opportunities for consolidating these paths should be explored *(Photo by Richard Stockton, May 2012)*.

In addition, no effort has been made to consolidate or limit the number of dune walkovers along the developed shoreline. While dune walkovers are clearly preferable to unimproved pedestrian trails or paths, the dune system could be strengthened if public and private walkovers were consolidated where appropriate.

Poor Dune Walkover Design - The low profile of some dune walkovers hinders sand accumulation and dune growth, primarily on the lee of the walkovers. Poor walkover design also curtails dune building overall by preventing sand blow from moving and accumulating beneath the low spans.

Intentional dune excavation and relocation of dune sand – In previous decades, significant portions of the City's dune system were intentionally removed in an effort to create or expand recreational areas on the beach, improve ocean views, and expand pedestrian trails and paths. While this practice has ceased in the City and efforts are underway to restore and enhance the dune system, the impact of these activities is still visible today. Based on the data available, it is roughly estimated that 144,000 cubic yards of imported sand would be needed to construct a continuous dune along the city-front with a 10-foot elevation and a minimum base depth of 60 feet:

- Southern zone of accretion 89,550 cu.yds.
- Central zone of stability 15,740 cu.yds.
- Northern zone of erosion 39,000 cu.yds.

Overwash Areas - The locations in which storm and spring high tide overwash occur are governed by a complex set of coastal processes and dynamics. Human impacts also help determine where overwash may occur, as in the instances of street-end beach access improvements where dune crossovers are built to insufficient elevations. In such cases the low profiles of the crossovers and walkway extensions, combined with the absence of high and moderate-height vegetated dunes in these locations contribute to the funneling of surging waves and wind through these "windows of opportunities" and into the streets.

Overwash also occurs in undeveloped or sparsely developed areas of the City at the north end. Here, too, causative factors are complex, but wind and wave forces generally act freely where dunes are absent, whatever the cause and where the high beach has been lowered by either wind erosion or human activity or both. Here, in the north, natural forces dominate, while in the southern and central reaches of the City's shoreline, human intervention can contribute to the sharpening of natural storm impacts.

3.2.4 Conclusion

In the case of South Padre Island, the best approach to reduce public expenditures and property damage due to erosion and storms is to undertake a program to nourish the beach and enhance and restore the dune system that forms the first tier of protection for upland development and infrastructure.

3.3. Beach Access Handbook (Available on the City website)

The City inventories and documents all beach access conditions on an annual basis to show improvements and track conditions of existing walkovers or mobi-mats that may be in need to repair. Information available in the document includes: photos, amenities, disabled accessibility, construction year and costs, and funding sources. This document is used to plan for budget and grant needs. Because the document is updated on an annual basis the most recent version can be accessed on the City of South Padre Island's website.

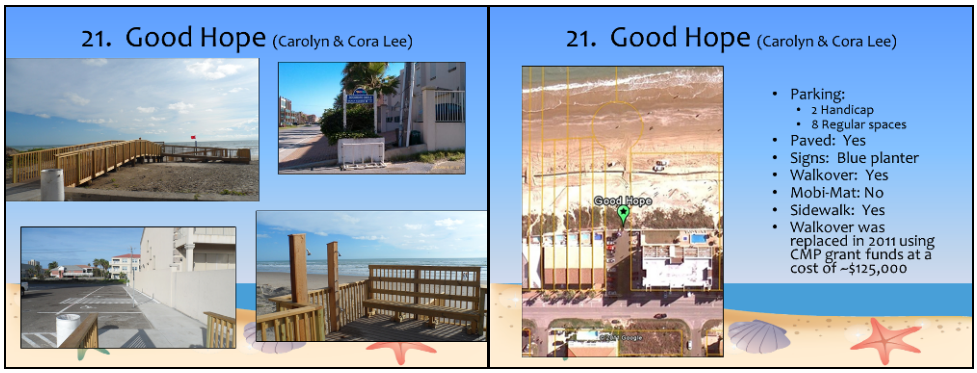


Photo 7 – An example of information available in the Beach Access Handbook

4.0 DESIRED SHORELINE CONDITIONS

4.1 Beach and Beach Profile

In the desired condition, there is adequate space between the Gulf of Mexico and the developed beachfront to maintain a natural beach depth and healthy protective dune system.

The beach along the south end of South Padre Island is continuous, healthy, and unhampered by structural encroachments during times of normal water levels. It is only to the extent that insufficient space remains between the beach and existing beachfront development that active intervention such as beach nourishment is needed to sustain the City's desired buffer zone. Such is the case only in the northerly erosion zone within the City.

The profile or "shape" of the beach—including its slope, the number, size and location of sandbars in shallow water, beach depth between water's edge and the dunes—is determined by the water levels and wave conditions present over long periods, as occasionally interrupted and changed by storms. As such, it is difficult and expensive, if not altogether futile, to attempt to create a lasting beach profile that differs from the "natural" profile.

There must be a clear understanding among decision makers and the community that in order to provide space for a healthy dune system in the northerly erosion zone, the entire beach profile including the submerged part must be "moved" seaward by providing the appropriate quantity of sand. In practice, the added sand can be placed on the visible beach, but it must be recognized that the Gulf will rework the material over the entire profile including the offshore area to 15 ft or more of depth. Thus, when discussing the long-term approach to maintaining a healthy beach-dune buffer, we are talking about everything between 15 ft depth and the historical building line.

4.1.1 Beach depth and elevation

The typical beach depth in SPI between a typical water level (say Mean Sea Level) and the vegetated foredune is about 200 ft. The actual depth can vary seasonally and in response to storms, but for planning purposes this typical depth is useful.

The elevation at which foredunes emerge and tend to sustain vegetation is a minimum of about 5 ft above the typical sea level in SPI. That is, the beach elevation varies from sea level to about 5 ft within the roughly 200 ft depth.

4.1.2 Sand volume and sources

Two goals must be achieved to protect and maintain development along the historical building line without retreat and with a healthy beach-dune buffer. First, sufficient room must be provided between the water's edge and the building line by moving the beach profile seaward to create a stable beach depth and healthy dune

system. Second, once the beach and dune are established at the desired location, the annual sand deficit must be brought to zero thereafter.

Planning-level estimates of sand quantities needed to create and maintain a relatively stable shoreline location were determined by accounting for the amount needed to move the entire beach profile (between 15 ft depth and the foredune) seaward.

In round numbers for the specific case of SPI (not applicable to all beaches), each 1 ft of profile movement represents a volume of approximately 1 cy/ft of beach. Based on this approximation, the sand required to move the profile of the northerly eroding zone (11,000 linear feet of beach) is roughly 660,000 cubic yards. This assumes the present beach depth is acceptable but space for an additional 60 ft of dune is needed.

An additional sand contribution will then be necessary to offset the average annual shoreline retreat, which will continue to occur. The approximate amount needed to maintain the new shoreline location in the northerly zone, and including a small amount to maintain the central "stable" zone as defined, is 40,000 cubic yards per year (cy/yr). This figure is based on an annual retreat rate of 0 ft to 2 ft in the "stable" area, and retreat varying from 2 to 5 ft in the northerly eroding zone, multiplied by the beach length (say 2,000 ft of stable beach and 11,000 ft of eroding beach) and the profile movement figure of 1 cy per ft of beach per ft of retreat.

Potential sand sources include the federal navigation channel at Brazos Santiago Pass, accretions located immediately south and north of the pass jetties, offshore borrow sites, the state highway right of way (per historical practice), maintenance dredging material from the Gulf Intracoastal Waterway (GIWW), and land-based sources (including barge-accessible deposits located near the GIWW many miles north of the City.

Conservation can also be viewed as a "source." Examples include reducing losses of windblown sand into developed areas, losses of waterborne sand through washovers, avoidance of pavement over sand that is within the active beach/dune system, and the recycling and crushing of glass into sand-size grains.

4.1.3 Methods

Dredging of sand from submerged sources will likely continue to be the most cost-effective method of producing required volumes of sand. The beneficial use of material dredged from the federal navigation channels is particularly cost effective.

Healthy dunes represent perhaps the best trapping mechanism to limit the landward loss of beach sand from the active beach/dune system. Sand fencing can boost the trapping of windblown sand as well.

A pre-positioned contract with Corps of Engineers should be explored for emergency dredging events that tend to be associated with significant coastal storms, to ensure that valuable sand is not simply dumped offshore in deep water.

4.1.4 Estimated annual cost

The historical cost (to the City) for the receipt of material dredged from the federal navigation channel has averaged about $1/cy. The actual cost to pay for similar dredging not associated with channel maintenance, as may be the case for a large, stand-alone beach nourishment, is estimated to be about $6 to $8/cy based on recent navigation dredging costs. A recent example of sand imported into the City from a mainland source was priced at $10/cy which should perhaps be inflated to between $10 and $12/cy given current fuel costs.

Thus, a planning estimate for a large initial nourishment to move the profile seaward to provide room for a healthy dune system in the eroding zone could use $10/cy as a conservative estimate. This unit cost multiplied by 660,000 cy suggests a $6.6 million sand cost to which planning, engineering and permitting costs can be added.

Similarly, the annual maintenance volume of 40,000 cy can be multiplied by $10/cy to arrive at a $400,000 annual sand cost for planning purposes.

4.2 Dune Complex

In general terms, a strong and stable dune system, with a capacity for relatively effective resistance to minor and moderate storm and tidal events, capable of sustaining dune vegetation, and protection in some measure of backshore property and infrastructure, exhibits the following parameters:

- Relatively high quantities of dune and beach sand, over the beach-dune cross-section, for each linear foot of beach-line
- Dune landforms that conform to mature dune types, that is, classically stable shapes that are primarily wind-carved, with wind-delivered accreting sand balancing, by and large, wind-driven sand loss
- Absence of human (foot and vehicle) disturbance in the dunes and on the beach surfaces fronting the foredunes
- Minimum primary dune and inter-dune elevations of 10 feet, with some dunes in the system reaching an optimum 12 feet in elevation or greater
- Vegetation with minimum eighty-five percent coverage, or better, of dune surfaces

Although protection of South Padre Island's beach and dunes from erosion, a central subject of this plan, is vital to defense of the urban fabric and the lives of its citizens, protection of natural habitat is also a matter of highest priority. It is as well a matter

of interest to thousands of beachgoers, citizen and visitor alike, and protection of natural habitat is an obligation of the City of South Padre Island.

Securing ample beach depth and well-vegetated high and deep dunes are essential to beach wildlife as they are for erosion protection. As stated on the City's Website, habitat restoration (and maintenance in a quality state) is a public priority: ". . . numerous species such as the Kemp Ridley sea turtles and Piping Plovers rely on wide, healthy beaches as a place to live, feed and nest." As do various terns, gulls, sanderlings, willets, crabs, and other life forms that help make up the complete shore ecosystem – and serve as key visitor attractions.

The City's Website concisely points out that "Dunes are important because they are our first line of defense from storms and flooding. Coastal communities are protected from the storms that occur in the Gulf by a system of vegetated sand dunes which provide a protective barrier. The General Land Office has directed coastal communities to protect these dunes because stabilized, vegetated dunes offer the best natural defense against damage caused by storms."

4.2.1 Goals and Objectives of a SPI Dune Enhancement Program

The goal and objectives of restoring and enhancing dune vegetative cover are defined above. Locally, the City is working with the Shoreline Task Force to develop a dune enhancement technique first effectively demonstrated by Padre Grande Condominiums and second by La Concha Condominiums. The GLO approved these two pilot projects before the beach and dune plant amendment was approved. Following the pilot projects success the City's beach and dune plan was amended to allow for such projects to take place. In general, the technique is intended to work in areas where dunes have been lost or only remnants remain or where excessive sand has built up in excess of +10 feet elevation. The technique also seeks to make effective use of raked seaweed to advance the dune system from its most landward position seaward to the extent of the natural line of vegetation. Using sand fence and raked seaweed, piles are placed on the seaward edge of remnant dunes or in dune gaps. Vegetation is encouraged by irrigation and allowed to propagate. As the vegetation line advances, relocated seaweed piles are added to the toe of the dune, shaped to 10 ft elevation, and irrigated. Over time, dune vegetation has advanced seaward to the position it will naturally occur, such that no encroachment of the public easement occurs.

In areas were dune elevations exceed a specified elevation in the Beach and Dune Plan, dunes can be "topped" and the sand used first to add depth and sand volume to the immediate surrounding dune field in the areas of low elevation bring the area to a 10' elevation which will strengthen the dune system against blowouts. Secondly the sand can be transported to areas with weak dunes to elevate and strengthen the dune system against over wash and inundation. These projects require individual beach dune permits and should be undertaken sparingly and preferably only in areas that are stable.

Location: The goal of an erosion-control and protective dune program is to both preserve mature, high, vegetated dunes, and to restore and revegetate disturbed and missing dunes, yielding fully vegetated dune fields with ample elevations and depths between the high-beach and the building setback line (SBL). Objectives that will need to be met in this regard are dune preservation, repair and revegetation of disturbed and missing dunes, infilling of disturbed and dune-depleted areas with new dunes and plantings, installation of dune-fencing and other dune development and maintenance measures, consolidation of walkways wherever feasible, development of new walkways and dune crossovers that achieve sustainable beachgoer access and are of superior design and durable construction, and elimination of beach access ways that are detrimental to the dune system. The foregoing recommendation for consolidation is consistent with the *2007 Dune Gap Report, which* recommended that the City, "consolidate paths, when possible, through the dunes for less impact."

Elevation: Dune building and rehabilitation should meet the goal of providing sufficient elevation in the dune fields to enable the dune system to function as a protective feature in moderate storm conditions. By defending beachfront and upland buildings, infrastructure, and lives from severe storms. Where sufficient beach depth exists, the City's objective is to provide a continuous dune system with a minimum elevation of +10 feet in areas where visibility of the surf zone is an important consideration, and a target optimum elevation of +12 feet or higher, as determined as appropriate by the SPI Coastal Resource Manager, where visibility of the surf zone is a secondary consideration.

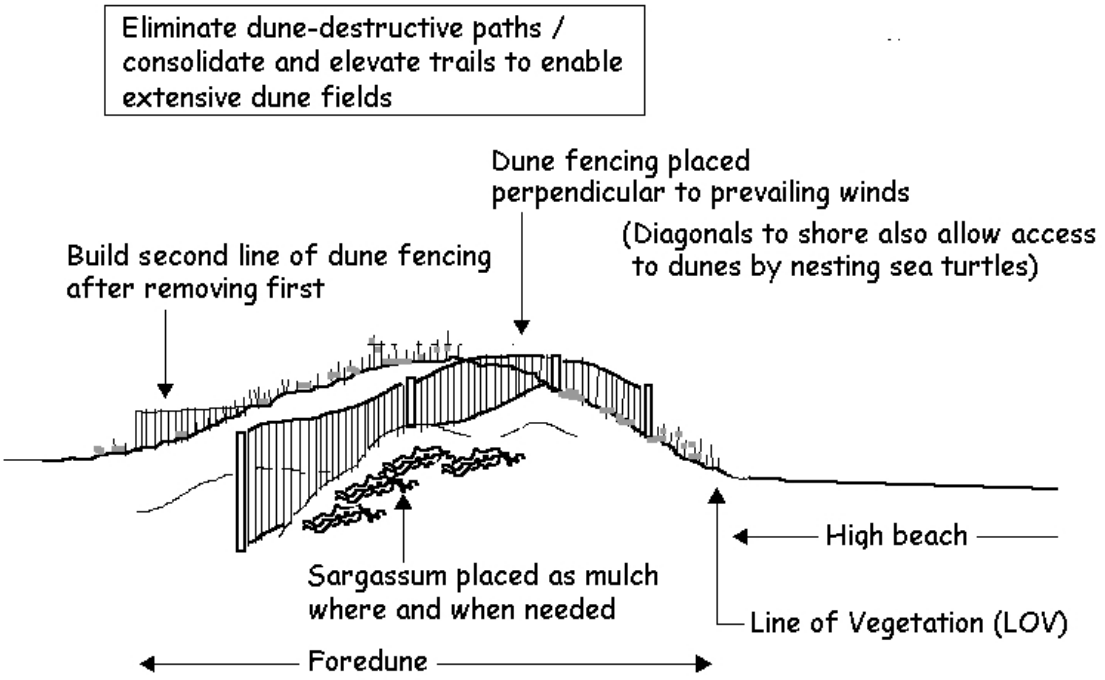
Depth: Beach dynamics will need to be taken into account, with deeper beach and dune fields more achievable in the southern (accreting beach) reaches, narrower beach and dune fields probable in the northern (depleting) reach, and mixed conditions in the center. The City intends to develop a continuous dune field, along the entire beachfront, between the high beach and the SBL. Where beach depth is sufficient, the base dune depth should be a minimum of 60 feet, with 100 feet preferable. In the northern eroding areas, a minimum base dune depth of 60 feet should be attained and efforts to nourish the shoreline should be aggressively pursued such that base dune depth of 100 feet can be sustained.

Dune Volume: In order to function as a protective feature in moderate storm conditions a target sand volume should be used. The City will strive for every beach front property to have a Dune Volume (DV) at a minimum 66 cy and a goal of 110 cy per linear yard. Using the above desirable dune conditions at a 10' (3.3 yd) elevation with 100' (33.3 yd) of depth equals to a target volumetric goal of 110 cy per linear yard of beach. Where beach widths do not allow for a dune with a 100' depth the elevation requirements can be adjusted in order to meet the target dune volume.

Methods: In the Figure, below, recommended dune plant species are identified. Sargassum and other seaweed in the wrack line will continue to be critical in both retaining moisture on the wet beach, thereby sustaining its resistance to wind

erosion, and in protecting dunes, especially the fore-dunes, from wind erosion and high surf erosion.

Remediation and/or consolidation of footpaths will be critical if the City is to establish a continuous dune field at a minimum elevation of +10 feet and base depth of 60 feet. Close coordination with landowners will be required.



Dune Building and Foot-Traffic Control

Dune Fencing to Control Foot Traffic: Installation of stable dune fencing approximately 2 feet away from the toe of slope on one or more sides of the healthy dune, as ruled as necessary by the City's coastal resources manager, should be installed to deter foot traffic across dunes. These barriers should be opened significantly or fully removed during turtle nesting seasons. The alignment of this fencing should be adjusted as necessary as determined by the Coastal Resources Manager. This protective fencing need not follow guidelines for sand entrapment (dune building) as the perimeter alignments are intended to preserve (protect from human impacts) rather than build.

4.2.2 Sand Volume and Sources

Sand Volume: The estimated volume of sand needed to restore the dune field is 144,000 to 161,540 cubic yards with the Southerly Zone of Accretion requiring approximately 39,000 cu. yds, the Central Zone of Stability requiring 15,740 cu. yds.,

and the Northerly Zone of Erosion requiring 89,550 cu .yds. up to as much as 106,800 cu. yds.

Sand Sources: Sand sources for dune building may include: (1) offshore sources; (2) sand dredged from the Brazos Santiago Pass as part of the USACE's routine maintenance of the channel; (3) windblown sand on and within the right-of-way of Park Road 100; and (4) truck-hauled river sand

4.2.3 Methods

Given the limited amount of sand in the sand budget utilizing all available sources is a must. Through the Dune Planting program and utilization of sand fences the City can build dunes that will provide protection to public infrastructure and store sand to replenish the beach system after a storm.

Through the Dune Ridge Enhancement program sand that is stored in sand dunes in elevations above +10 feet or higher can be used to fill in low elevations to prevent blowouts of frontal dunes and to build a solid continuous dune system with a goal of building a dune system to function as a protective feature in storm events.

4.2.4 Estimated Costs

Given the variety of potential sand sources for dune building, no single cost estimate for dune sand can be provided. It is expected however that obtaining sufficient quantities of off-beach sand (sources other than windblown sand of seaweed management) could cost at least $10 per cubic yard and increase significantly from there.

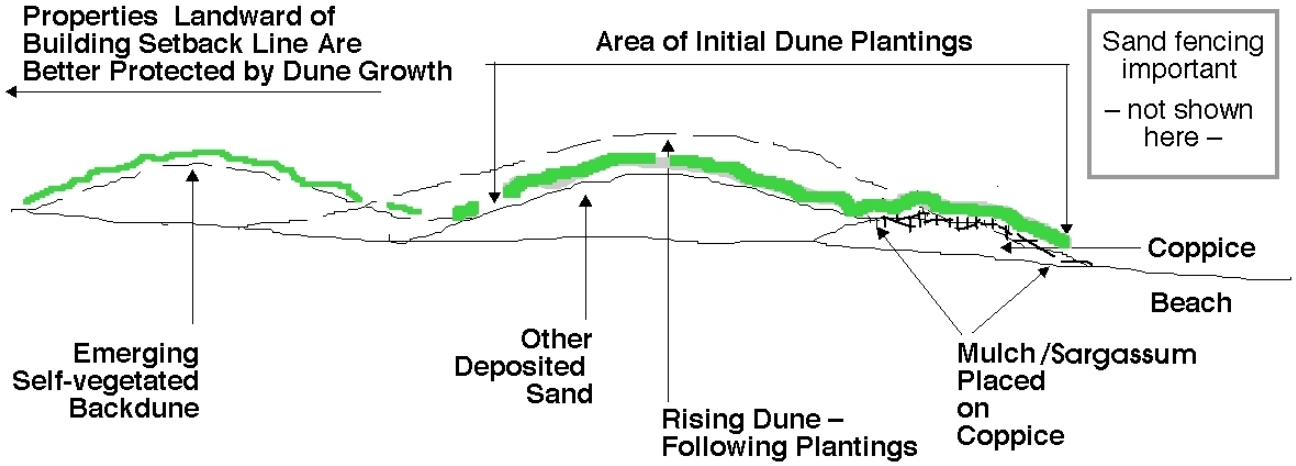
The species and types of plants needed for the dune revegetation efforts are noted above and fully described in the GLO Dune Protection Manual. Based on available information plants are currently available to the City at $0.42 per plant.

Dune Stabilizing Grasses for South Padre Island

Species	Roles	Transplanting	Watering
Bitter Panicum Panicum amarum	Strong foredune stabilizer	January/April	Transplant after rain or water before and after (for 3-4 weeks, sparingly).
Sea Oats Uniola paniculata	Good for main dune/interplant	November/April	
Marshhay Cordgrass Spartina patens	Best backslope grass	November/April	
Ave. planting density:24" on-ctr.	Mulch before/after with Sargassum desposited on beach		

Other Stabilizing & Attractive Plants	
Seaward Face of Foredunes	**Back Sides of Dunes***
Beach Morning Glory (vine) Sea Grape (vine)	Cucumber Leaf Sunflower Lantana Partridge Pea Prickly Pear Rose Ring Gallardia Seacoast Bluestem * Ample dune width needed for certain species

References: City of South Padre Island Coastal Resources Manager
Coastal Dunes:Dune Protection and Improvement Manual
for the Gulf Coast, Fifth Edition, Texas General Land Office



Dune Planting / Dune Building

4.3 Beach Access Points – Public And Private

4.3.1 Access Enhancement Goals:

The City is dedicated to providing the public access to the beach. When possible the City will fund access improvements through hotel/motel tax but relies heavily on grants for matching funds.

4.3.2 Walkovers, Mobi-mats

Walkover Design Standards: Both public and private access ways should meet standards for upgraded construction methods and design in order to reduce storm damage and post-storm repair costs.

Stainless steel cable-stay railing systems are recommended for access ramps, staircases, and crossovers. Though they are costlier than wood counterparts, they are highly resistant to storm damage and salt spray corrosion and require lower maintenance and repair attention.

For ramp, crossover, and other hardened walking surfaces, several highly durable materials have been substituted for wood planking in recent years. These include TREX and other plasticized composites and boards made from kenaf, a plant grown and processed, among other locations, in Willacy County.

As the City proceeds in the design of additional street-end and other ramps, crossovers, and walkways/boardwalks, such alternative materials and their costs – initial and life-span – should be investigated.

With employment of sturdier structural elements and more durable railing systems and walkway surfaces, O&M costs may be kept at minimal levels over a multi-decade life-span.

ADA-conforming Handicapped Ramps Linking to Dune Crossovers: The City builds handicapped accessible ramps from street-ends on a continuing schedule. By Texas Accessibility Standards and Americans with Disabilities Act criteria, handicapped ramps must by law not exceed 8.33 percent where railings are installed; 5.0 percent is the maximum where pathways lack railings. The steeper, 1:12 designs must also have landings of specified dimensions at given ramp intervals.

Mobi-Mats: When unable to provide a walkover the City will use, if available, a polymer mat that is able to create a solid walking surface for the public to use to access the beach. These mats protect the dunes from erosion and damage to the surrounding vegetation.

Eliminating Duplicative and Dune-damaging Paths to the Beach: One alternative to the existing multitude of private walkways between the built beachfront and the beach is to reduce the number of walkovers and open walkways to the shore in exchange for a more limited number of crossovers, ramps, and walkways built with stronger components and more durable materials, while at the same time

constructed more sustainably with respect to the dune systems over which the new elements will traverse.

Continuation of the City's street-end handicapped ramp program will expand the number of general access structures that are well-built and offer the potential for eliminating nearby duplicative and /or dune-damaging private trails to the beach that lie between the street-ends.

It is therefore recommended that the City confer with property owners where private paths to the beach have been fashioned with resulting dune depletion and loss to determine whether agreement can be reached for such eliminations – given easily reached alternative crossovers such as nearby street-end accessways that would serve their residents or other users without significant loss of convenience.

Options would include the retaining of one private walkway midway between two adjacent street-ends and acquisition by the City and dismantling of other private walkways in this reach. The remaining walkway should also be upgraded, as needed, to yield a raised crossover built of durable and sustainable materials that arches over the regenerated dune system beneath. The cost of this improvement would be borne by the City in exchange for a perpetual access easement to allow sharing of access by the owner with the public.

4.3.3 Conceptual Walkways & Footpaths

North-south Walkways (at-grade "Boardwalks") Linking to Public Street-end Crossovers and Approved Intermediate Crossovers. The foregoing improvements would be dependent on the construction of north-south walkways or "boardwalks" that would afford access from in-the-block addresses to the street-end public walkways.

Here, too, access easements would need to be purchased by the City from agreeable property owners. To preserve owner privacy, the north-south walkways would be aligned a reasonable short distance Gulf-ward from the buildings and gated approaches to the building entrances would ensure access by residents and guests only. The distances from the buildings the north-south walkways would be offset would take into account the dune system in each location. Where dunes are close by, the walkways would be raised somewhat to clear the dune slope. The walkway surfaces would also be permeable, as is provided by spaced wood or other sustainable-material boards or by such manufactured materials as "Mobi-Mat". This permeability will also secure conformance with the Texas and City requirements for construction within the building Setback Lines.

Convenience for beachfront residents and guests, where existing private paths are eliminated except for a mid-point improved and raised private crossover, would easily be conserved. The time lost by the short detours would not exceed a half-minute on average where a midpoint crossover is retained and 1 minute on average where no private paths are retained between two street-ends.

Such walkway consolidation was recommended in the 2007 South Padre Island Dune Gap Report.

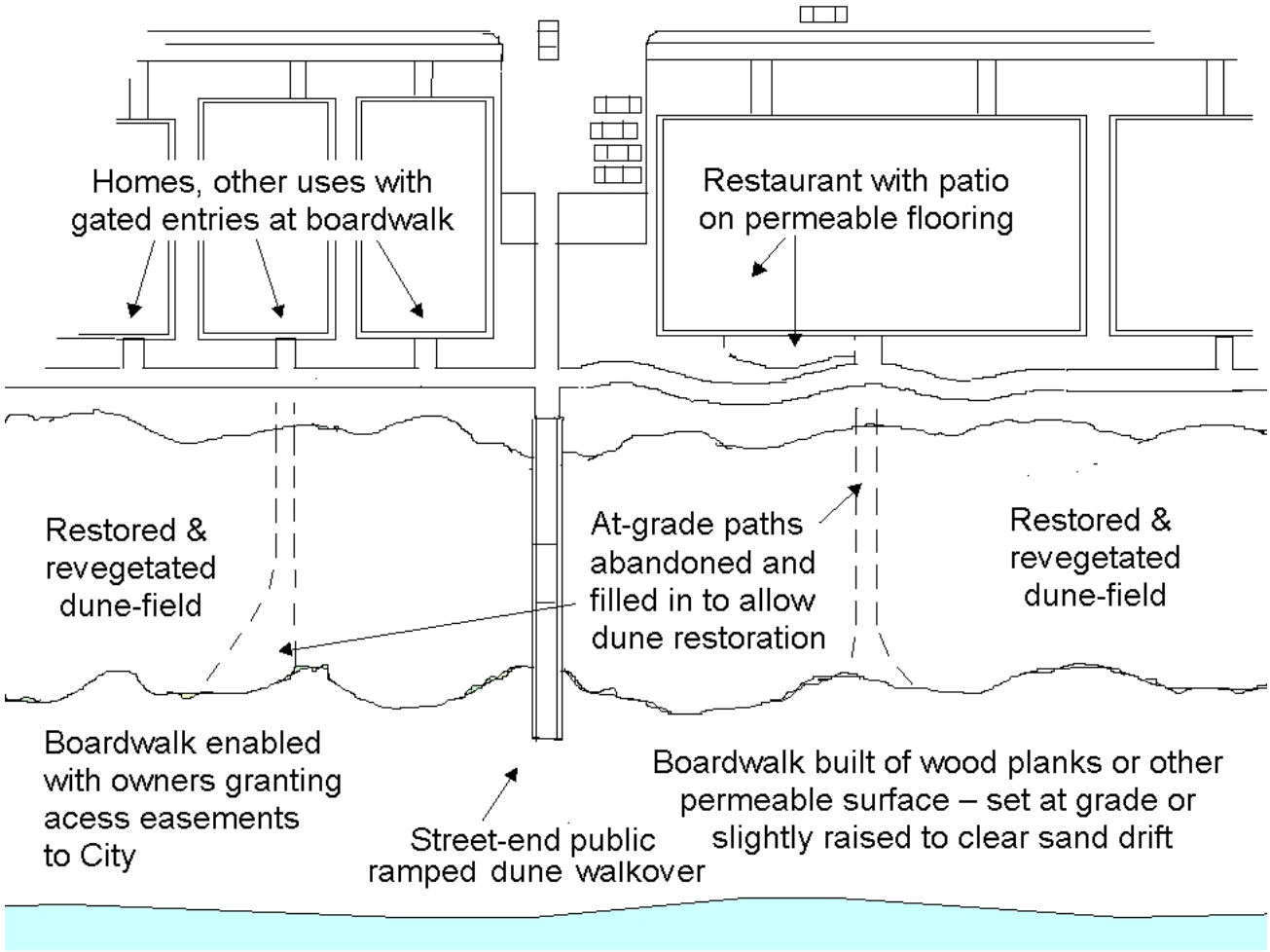


Figure : Path Consolidation/Boardwalk Concept

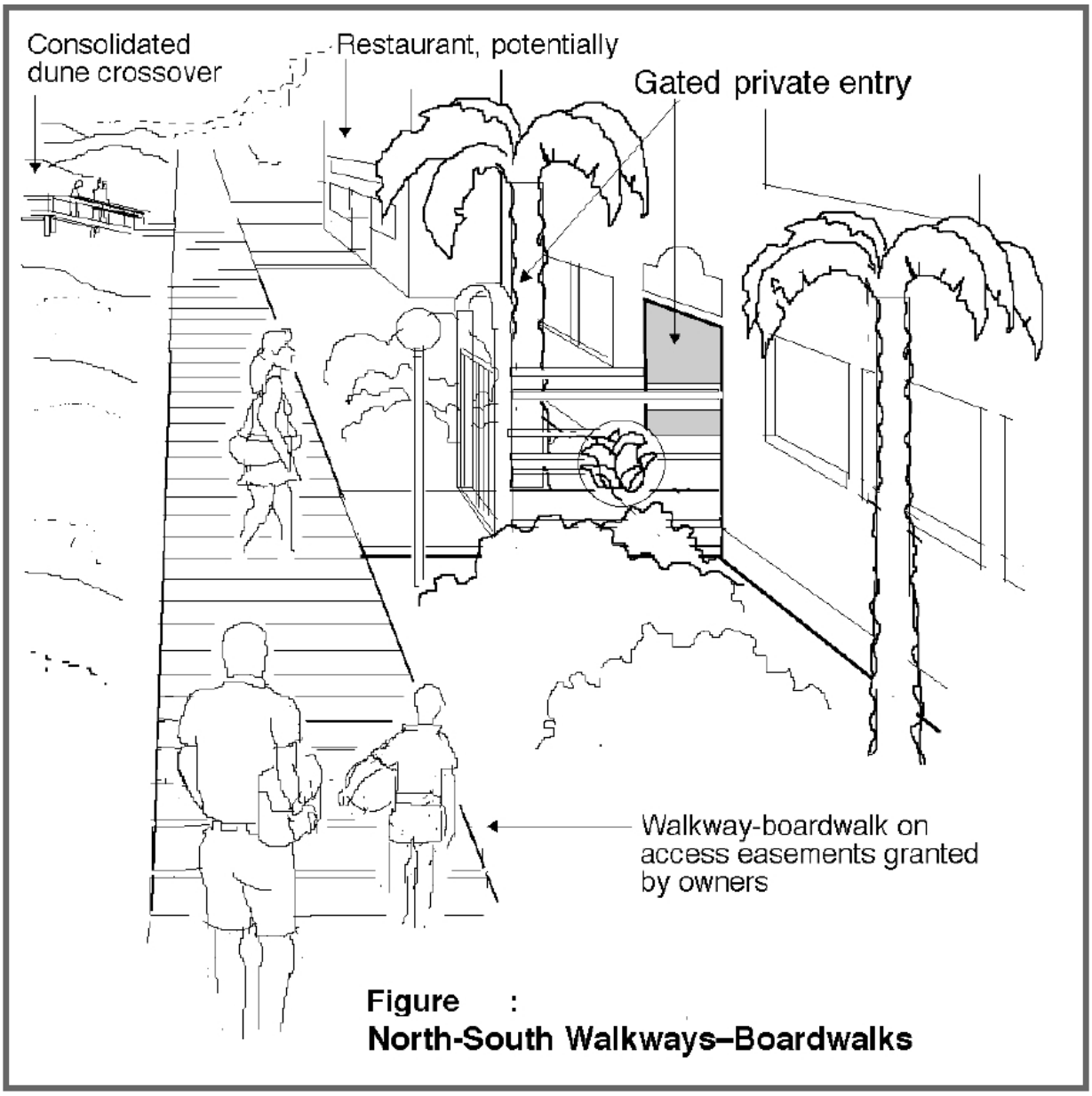


Figure :
North-South Walkways–Boardwalks

Applicability of Walkways–Boardwalk Concepts to South Padre Island's Hotel / Dining Districts: The principal of protecting and restoring dunes by consolidating walkways and channeling foot traffic along beach-parallel boardwalks is also applicable to the City's hotel-dining districts. As with the examples discussed here, economic benefits to the private sector, in addition to long-term cost savings and sustainability in the public sector, are possible.

4.3.4 Estimated Annual Cost

The annual cost for beach access improvements cannot be calculated as it's based on project size. The cost to construct a walkover based on historical projects is $775.00 a linear foot. The cost of Mobi-Mat ranges from $110 - $135 a linear foot.

The City operates on a beach maintenance budget solely funded by hotel/motel tax. The City does not have a beach user fee at this point but may be a necessary option in the future for revenue.

5.0 SEMI-ANNUAL PRE-STORM MONITORING PROGRAM

5.1 Goal

The purpose and need of a monitoring program is to accomplish at least two goals: (1) to inform local decision makers and the community at large about the status and upcoming maintenance needs; and (2) to ensure that adequate, recent data is available to document storm losses and ensure eligibility for federal disaster assistance related to nourished beaches.

5.2 Frequency, Method, and Location

A twice-annual program consisting primarily of profile surveys augmented with other forms of data collection (e.g., photography, sand tracer studies, numerical simulations) can provide year to year comparisons as well as indications of seasonal variations to inform decision making. Previously established profile locations can be used to ensure the best use of existing data and the cost effectiveness of new data collection/analysis efforts.

In addition to periodic profile surveys, project-specific surveys of nourishment activities and the progressive movement of material from designed nourishment prisms by natural forces can allow the optimization of subsequent nourishment activities. Maintenance practices that result in movement of sand resources (and seaweed) along and across the beach can be factored into monitoring tasks and results to provide a clear picture of the program's achievements.

5.3 Output Report/ Recordkeeping

The deliverable products generated through monitoring can include the profile data reduced and presented graphically, comparisons to historical profiles at the same location, trend analyses, quantity calculations, and projected maintenance needs. The information will also be available to City officials dealing with FEMA in post-storm response mode to determine federal assistance qualifications.

5.4 Estimated annual monitoring cost.

A detailed scope of monitoring effort can be developed to suit the City's needs and budget. The order of magnitude cost can be expected to be $50,000 to $100,000 per year.

6.0 EROSION RESPONSE PLAN FOR SPI CITY LIMITS

The specific contents each local government's erosion response plan are set forth in 31 TAC Part I, section 15.17. These elements are identified and described below.

6.1 Construction Setbacks

For the purpose of the ERP, the "setback" is the line seaward of which no new construction should occur. In establishing the setback line, the state requires that the City utilize data obtained from the University of Texas Bureau at Economic Geology. The most further allow the City for options in establishing of baseline from which the setback line is measured. These options are:

- The line of vegetation (LOV)
- The Mean Low Tide (MLT)
- The Mean High Tide (MHT)
- GL O-approved Coastal Boundary Survey

The rules further specify that the setback line cannot be further landward then the dune protection line and must protect as much of the critical dune area as practicable.

The existence of the setback line is intended to improve shoreline management practices in Texas by reducing the risks to beachfront structures from erosion, storms and waves. Currently, no statewide setback limit exists in state law, however, current GLO rules specify that no construction is permitted seaward of the line of vegetation, as this is within the public beach easement. In eroding areas, GLO rules impose certain construction limits and restrictions within 200 feet landward of the mean low tide line. Subjectively, state rules also require that new construction along the Gulf beaches of the state be located "as far landward as practicable."

For the purposes of this erosion response plan, the City of South Padre Island proposes that its setback line be the Historic Building Line (HBL) established by the City and approved by the General Land Office in the City's certified Beach Access and Dune Protections Plan. The HBL is shown apparent as the line of retaining walls that front all existing and developed properties within the City limits.

This Historical Building Line (HBL) was established on September 3, 1981. A letter from John W. Fainter, Jr., First Assistant Attorney General, representing the State of Texas written to then-Mayor Glen McGeHee, establishing a building line, commonly referred to as the Historic Building Line, for the City of South Padre Island Beachfront Construction that would provide a minimum of two hundred feet of open beach above the mean low tide line according to then available data. The letter stated that the Attorney General could review the line and change it to ensure the protection of the State's open beaches. The line was located on a map (drawn by Chas R. Haile Associates, Inc., Consulting Engineers, Houston, Texas City, Corpus Christi, Nederland, and is dated March 1981) provided by the Texas Attorney

General and is on file with the Public Works Department of the City of South Padre Island. See pictures 8a, 8b, and 8c.

The HBL has unmistakably established the public beach on South Padre Island and has also given beachfront property owners an understanding of where they can build up to. The HBL also makes it clear where the dune field should start to provide protection for beachfront properties. With the clear knowledge of where the dunes should be the City has the ability to build a continuous dune line of similar elevation to withstand storm surge. The natural cycle of a barrier island is to migrate landward but with healthy dune fields east of the HBL that store and hold the sand volumes needed to provide protection and supply the beach with sand following major storms. With the ability to keep a healthy dune/beach system seaward of the HBL we are able to reduce public expenditures due to erosion and storm damage loss.

The Shore subdivision has a building line (formerly called the “440-foot Line”) it was established to ensure that proposed construction on the site would be located far landward of the beach so as to protect the fore-dune area and reduce the risk of storm damage to the subdivision. See photo 8d.

As a developed urban shoreline, it is impractical for the City to establish a new or different setback line other than the HBL, established more than a decade ago and upon which this highly developed shoreline was constructed. The City recognizes that for it to maintain the HBL as its designated Setback Line for the ERP, the City is obligated to manage the position of the shoreline -- the beach and dune system -- so that existing development is not subject to an undue risk of damage from erosion, waves and storm surge. The City’s strategy to accomplish this outcome – and thereby limit public expenditures due to shoreline erosion, waves and storms – is to undertake a dedicated program of beach nourishment and dune restoration, as described in Section 4.0, Desired Shoreline Conditions.

Photo 8a- Aerial photo showing the Southern portion of the City. The Dune Protection Line (DPL) is in red and the Historical Building Line (HBL) is in green.

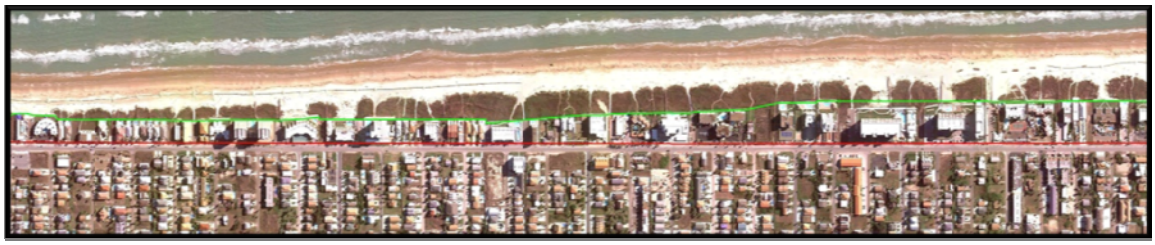


Photo 8b- Aerial photo showing the middle portion of the City with the HBL and DPL shown.

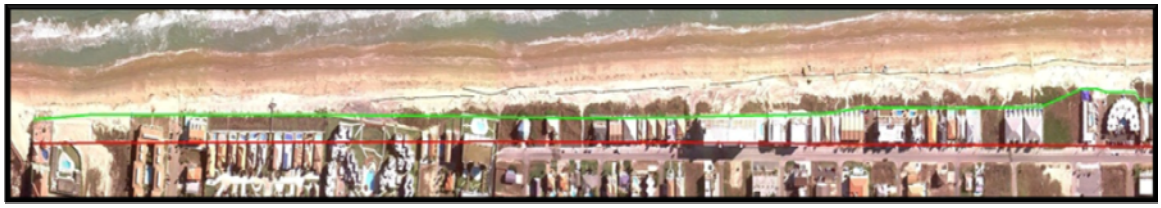


Photo 8c- Aerial photo showing the middle portion of the City with the HBL and DPL shown.

Photo 8d- The Shores Subdivision. The "440-foot line" is in green

6.2 Prohibition on Construction Seaward of Setback line

In accordance with state rules and the requirements of this ERP, all new or rebuilt habitable structures must be constructed landward of the building setback line, to the maximum extent practicable. Except for those non-habitable amenities specifically exempt below, all new construction within the City of South Padre Island will be required to be constructed landward of the setback line.

In this ERP, the City is not proposing to allow construction or repair of any habitable structures seaward of the HBL, which serves as the SBL.

6.3 Exemptions from the Setback Line

Exemptions from the setback line have only been granted for non-habitable structures such as dune walkovers. Dune walkovers remove the pedestrian traffic from the dunes that lead to erosion and blowouts along the frontal dunes. The most harmful activity that takes place on the dunes is the continuous pedestrian traffic that leads to low elevations. Storm surge makes its way up the paths and erodes the path with each wave which can eventually undermine the massive dunes that provide protection (see Photo 9).

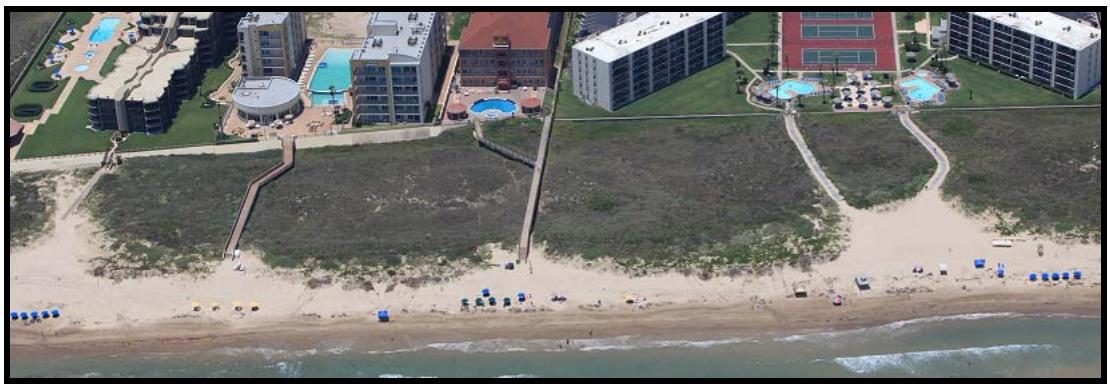


Photo 9- Shows the effectiveness of using dune walkovers to keep pedestrian traffic off the dunes.

6.4 Requirements for Exempt Structures.

Habitable structures may be exempt from the SBL limitations in three limited circumstances: (1) if the owner demonstrates that there is no practicable location for the construction to occur landward of the setback line; (2) the construction is consistent with an existing setback line certified by the General Land Office prior to the ERP; or (3) the construction consists of minor repairs to an existing structure that does not increase the footprint of the structure.

In this case, the ERP requires all new habitable construction or repairs to existing habitable structures to occur landward of the setback line – which is the Historic Building Line as specified herein. Non-habitable amenities such as walkways, dune crossovers, small decks, and other access improvements are exempt from the construction setback limit.

State rules establish the requirements for exempt structures for local governments that choose to permit more seaward construction. First, the exempt structure must be elevated to a minimum of 2 feet above the FEMA base flood elevation (BFE) and

the foundation for the structure must conform to ASCE flood resistant standards. In addition, the structure must be designed for feasible relocation and it must be planned in a way that minimizes impact natural hydrology. The rules also prohibit enclosures below the BFE. In any event, all exempt structure construction must be located landward of the landward toe of the foredune ridge whenever practicable. Registered professional engineers must certify that these requirements have been met.

6.5 Enhancing and Preserving Public Access.

The state requirements for erosion response plans are also intended to enhance public access to the shoreline in addition to reducing potential public expenditures for erosion and storms. With respect to access, the rules require that the City evaluate the vulnerability of access points to erosion and storm surge damage. The rules require that the City upgrade public access construction methods and designs to reduce post-storm repair costs. The City is required to create a schedule for public access design improvements and inventory existing access amenities in order to support any future FEMA post-storm funding claims. Finally, the City is required to establish post-storm beach access assessment procedures so that damages can be cataloged.

The steps for the improvement of preservation of public access are described above in Desired Conditions 4.3 Beach Access Points.

Beach Access Handbook: The City inventories and documents all beach access conditions on an annual basis to show improvements and track conditions of existing walkovers or mobi-mats that may be in need of repair. Information available in the document includes: photos, amenities, disabled accessibility, construction year and costs, and funding sources. This document is used to plan for budget and grant needs. It can also be used for FEMA reimbursement requests.

Post-storm assessment procedures will take place immediately following the storm event once it is safe to enter the beach. The Coastal Resources Manager will inventory all beach access conditions pre storm and post storm. A list of access points not in compliance with the local plan and Beach/Dune rules, descriptions of repairs, and replacements needed will be compiled. This assessment will also be used for FEMA reimbursement requests along with the annual fixed assets report that values all City property for the fiscal year.

6.6 Dune Protection & Enhancement

Dune protection and enhancement projects are a critical component of the City's ERP. GLO rules require that the City specify the target dune elevation and percent vegetative cover for its dune protection and enhancement program. The City is further required to identify specific locations of dune gaps and blowouts for

potential dune restoration projects. Finally, the City is required to outline specific dune re-vegetation projects, identify measures to protect the landward side of the foredune ridge, and identify the goals, schedules, and funding sources to accomplish its dune protection and enhancement program.

As specified under Desired Conditions, above, the City seeks to establish a continuous dune system with a minimum 10 foot elevation and 60-foot base depth. In the accreting areas and in areas where beach nourishment has created and can sustain a beach with of 200 feet, the City's goal is to establish the dunes with a minimum base depth of 100 feet.

As illustrated above, dune gaps have been identified using LIDAR data and aerial photography. Through the Dune Volunteer Planting program the City will be able to fill in these gaps and narrow beach access paths enhancing our continuous dune line. The City was successful in getting the Dune Planting Program funded through the CMP Cycle 17. The City will continue to apply for grant funds in order to fund this program.

6.7 Criteria for Voluntary Acquisition or Buyouts.

One recognized strategy to reduce public expenditures following storms and erosion events is to purchase or buyout vulnerable properties along the shoreline. The state rules allow local governments to develop criteria governing the voluntary acquisition or buyout of beachfront parcels and structures. If such an approach is to be employed, the City was required to identify properties entirely seaward of the building setback line, provide for voluntary acquisition, and establish procedures for prioritizing property to be acquired.

Using the HBL as the setback, no habitable structures currently exist seaward of the proposed setback line. The City of South Padre Island has also elected an ERP strategy based upon maintenance of the beach and restoration and enhancement of the dune system. This approach is an alternative to the available strategy for voluntary acquisition and buyouts. The City has not elected to develop a voluntary acquisition and buyout program at this time.

7.0 Conceptual Funding Strategy – SPI Shoreline Management Program

As ERP strategies are refined and cost estimates are developed, the City intends to develop a funding strategy to support implementation of the ERP. Preliminary discussions indicate that there is community support for establishment of a Dedicated Shoreline Maintenance Account to provide funds for:

1. On-going beach nourishment projects;

2. Annual beach monitoring, including aerial photography, beach transects, mapping, and assessment of the condition of beach accesses;
3. Dune enhancement and restoration projects, including the dune gap projects and volunteer dune planting program;
4. Public access improvements and enhancements, including walkovers, parking improvements, consolidation of walkovers and pathways,
5. Planning, permitting and design costs associated with the projects above; and
6. Minor program administration and support costs.

While annual revenue needs cannot be accurately predicted at this time, conceptual funding options have been discussed with the City and Shoreline Task Force. In general, the City expects to develop a funding plan broadly reflecting the following principles:

1. Seek to maximize state and federal support for the City's shoreline management program, particularly seeking on-going CEPRA and CMP grant funds whenever possible and continued efforts to secure USACE commitment to the beneficial use projects;
2. Seek to indentify the local and visitor beneficiaries of sound beach, dune and shoreline management practices and employ, to the extent practical, a "beneficiaries pay" strategy;
3. Seek to implement a "blended" funding stream such that revenues supporting the Dedicated Shoreline Maintenance Account are derived from multiple funding sources at the federal, state and local level;
4. Seek to develop a long-term funding strategy that is stable, predictable and sufficient to support current and future shoreline management needs;
5. Seek to develop a funding strategy through a community-based process that is transparent, engages the public and provides robust opportunities for public input and discussion.

Though no specific recommendations can be made at this time, there are three potential funding sources at the local level that the City may wish to "blend" to support the local share of the Dedicated Shoreline Maintenance Account:

1. *Ad valorem* Revenues: The City may wish to consider a Shoreline Maintenance *ad valorem* assessment as one contributing revenue stream to the dedicated account. Currently, property owners in South Padre Island pay a total *ad valorem* tax rate of $1.962379 per $100 of assessed value. This tax rate is comprised of assessments from a number of taxing entities besides the city, including Cameron County and the school district. The City's current *ad valorem* tax rate is $0.2456 per $100 of assessed value, which is the lowest municipal tax rate in Cameron County. A modest increase in the City's ad valorem tax rate of three cents per $100 would increase to local rate from $0.2456 to $0.2756 per $100 value. Even at this increased rate, the City's *ad valorem* rate would still be the lowest in Cameron

County -- less than that of Los Fresnos, San Benito, Brownsville, Port Isabel, Harlingen, and Laguna Vista.

Based on a total assessed value of property in the City of about $2.6 billion, an additional three-cent *ad valorem* assessment would generate about $780,000 per year for the Dedicated Shoreline Maintenance Account.

2. Hotel Occupancy Tax Revenues: Like most beach resort communities, the City is blessed with a diverse and substantial hotel and rental market sector. Visitorship to the City increases substantially beginning in the spring months, peaks in the summer, and gradually declines in the winter. This visitorship pattern is typical of many beach resort communities and reflects the strong influence of the beach as the cornerstone of the local tourist economy. Currently, hotel patrons and short-term vacation property renters pay Hotel Occupancy Taxes that benefit the City and state. Below is a typical breakdown of HOT revenues on a one-night stay at a SPI hotel:

Room at $99.00/night	HOT Rate	$99.00
City Occupancy Tax	8.0%	$7.92
State Occupancy Tax	6.0%	$5.94
City Beach Nourishment Occupancy Tax	0.5%	$0.50
TOTAL HOTEL OCCUPANCY TAXES	14.5%	$14.36

Out of the 14.5% occupancy tax rate, the City currently dedicates a one-half of one percent to support its beach nourishment program. Given that a substantial percentage of out-of-town visitors come to South Padre Island to enjoy the beach and given the substantial long-term cost of beach and dune management, the City may wish to consider some adjustment to the rate or allocation of revenues. Modifying HOT rates is a sensitive subject and would require close coordination with hotel owners and operators and other stakeholders before any proposal could be developed. Nationally, the use of HOT revenues as a component of a comprehensive funding strategy has proven to be a useful and reliable revenue source to support beach and shoreline management projects.

3. Sales Tax Revenues: In a beach resort town like South Padre Island, sales taxes revenues typically increase substantially during the tourist season. Out-of-town

visitors swell the summer population contributing substantial revenues to the community. Attracted to the beautiful beaches, these visitors are clearly benefit from a well-maintained beach and public access improvements. As the community continues to grow, sales taxes typically grow as well. Though the financial and community issues regarding the use of sales tax revenues for shoreline management would be complex, it would be prudent to explore this revenue stream as a potential component of the blended funding stream.

Overall, the City would benefit if it can identify a reliable and predictable funding strategy to support its long-term shoreline management program. Erosion is a persistent force that directly and substantially threatens many barrier island beach towns. The response strategy and funding plan must be equally persistent if the City is to maintain its place as the premier beach resort community in Texas.