USDA NRCS
Natural Resources Conservation Service

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EVALUATION OF CONSTRUCTION TECHNIQUES IN THE ESTABLISHMENT OF COASTAL SAND DUNES

FINAL REPORT
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Introduction:

The Texas General Land Office (GLO) conducted a study for Brazoria and Galveston counties that projected erosion into the year 2056. The study predicted that a large stretch of state Highway 87, as well as hundreds of expensive houses, will be under water. Along most of the Texas Gulf Coast there is an estimated shoreline erosion of 2- to 10-feet per year. About 5.4 million people live along the Texas Gulf Coast and this area accounts for $6.6 billion of Texas tourism dollars in 2001. Thus, there is a lot of pressure to find economically and environmentally acceptable solutions to this erosion problem.

According to Dr. Orrin Pilkey Jr., James B. Duke Professor of Earth Science emeritus at Duke University, rising sea level is the single biggest cause of erosion, followed by damming of rivers which keep sediments from reaching coastal beaches and hard structures like jetties which trap sediments and thus cut-off sediments from reaching down current beaches. Hard structures like seawalls and bulkheads found at Galveston and Corpus Christi have been used for decades to prevent erosion of the land and structures behind it. The unfortunate consequence is that the beach that attracted the landowners in the first place is soon washed away.

More recently, people have turned to geotextile tubes as part of the solution to treat beach erosion. Dr. Jim Gibeaut, a researcher with the Bureau of Economic Geology's Coastal Studies Group at the University of Texas in Austin, says "They [geotextile tubes] are significant structures on the beach – it is very obvious where they are, particularly the installations we have along the upper Gulf of Mexico shoreline." Dr. Gibeaut, who led a study of the tubes' performance between May 2000 and March 2003, comments that "They rise up abruptly from the back beach area in an unnatural form and they've had a lot of trouble keeping them covered with sand and planted with native vegetation, which the project designs called for. Some people would say they are rather unsightly. They are also not sturdy enough to hold up." According to Dr. Gibeaut, "If the beach erodes in front of them and the waves start attacking, the tubes will become undermined and often the tubes will fail under direct wave attack."

Efforts are made to cover the tubes with sand and vegetation as a "dune restoration project." However, because the geotubes are so large, it causes the beach in front of them to be unnaturally narrow." Furthermore, Gibeaut says, "They do not resemble dunes whatsoever and they do not function the same as dunes. People need to recognize these geotextile tubes as significant engineering structures that are really changing the beach and dune environment. People should not look at them as innocuous, temporary things that will be taken out shortly."

The most popularly supported projects to treat beach erosion are "soft engineering" approaches that don't involve using hard structures but include rebuilding sand dunes and nourishing beaches with new sand or transporting sand from one side of a structure to the other in a process called bypassing. A significant amount of dollars has been invested over the past five years in the establishment of geotextile tubes and beach nourishment along the Texas Gulf Coast. However, very little money has been invested on the creation and rebuilding of sand dunes. Dr. B.E. Dahl led a team of researchers that detailed procedures for creating sand dunes in his 1974 publication, "Stabilization and Reconstruction of Texas Coastal Foredunes with Vegetation." This publication along with new biodegradable products allows for economical and environmentally sound methods for dune creations and coastal shoreline protection.

Objective:

The USDA/NRCS E. "Kika" de la Garza Plant Materials Center (PMC) proposed to coordinate with The Nature Conservancy (TNC), U.S. Fish and Wildlife Service (USFWS), the South Padre Island Parks Department (SPIPD) and South Padre Island Master Gardeners (SPIMG) to form 300 feet of encapsulated soil in order to construct and vegetate a 4-foot high by 40-feet wide sand dune.

Materials and Methods:

In January 2005, the PMC coordinated with TNC, SPIPD, and the USFWS to form 300 feet of encapsulated soil in order to construct and vegetate a 4-foot high by 40-foot wide sand dune. The dune was constructed by having a front-end loader and operator provided by SPIPD level out a 300 foot-long area. The PMC along with TNC volunteers placed down 300 feet of biodegradable coir fabric. The fabric was staked down and then folded over batter boards. The batter boards form a temporary framing for the sand used to make the lift layers. Sand was brought in by SPIPD and placed on the fabric to a height of 12 inches and then watered and compacted. Then the extra fabric was pulled back over the sand and secured with 24-inch stakes.

Once a lift was completed, the batter boards were removed and used for the next lift. The outer edge of the next lift was set back 2 feet from the previous lift. A total of 4 lifts were constructed. The distribution of the fabric lift was 3 feet on the bottom, 12 inches on the edge and 3 feet on the top. Additional sand was also needed to form the 3:1 dune backslope. The dune was planted with PMC supplied plant material. The beach front was planted with 2 rows with alternating spacing of containerized bitter panicum (*Panicum amarum)* and seaoats (*Uniola paniculata*), as well as with bareroot bitter panicum and seaoats. Plants were spaced 1 foot apart. Alternating species were planted every foot into the exposed shelf of the soil lifts. The 20 foot area on top of all the soil lifts was planted as 9 staggered rows with the rows 2 feet apart. An alternating sequence of the 2 grass species was planted every 2 feet. The 3:1 back slope was planted as 4 staggered rows

with the rows 2 feet apart. An alternating sequence of the 2 species was used at a 2 foot spacing. The PMC conducted an as-built survey once the dune had been constructed.

Results:

Hurricanes Emily and Rita in 2005 destroyed most of this dune. The fortunate aspect of the destruction of the dune is that it allowed the PMC to evaluate some new construction methods. The PMC reconstructed a dune 220 feet long on the same site in 2006. The new dune included the use of coconut fiber bales, coconut fiber blocks with matting, and also "concertainers," metal cages filled with sand and covered with coconut fiber. The dune was also used to compare the success of plant material from a population near Corpus Christi and from a population near the dune. Watering and hydrogel techniques were evaluated for their effect on plant survival.

The dune was constructed, planted, and watered in March 2006. PVC tubing and hydrogel treatments were installed in April. A second watering was applied in May. The PMC conducted an as-built survey following the dune construction on March 13, 2006 (Table I). Plant evaluations occurred in May and November of 2006 (Table II). A final topographic and plant evaluation occurred on February 15, 2008.

EDWIN KING ATWOOD PARK
SOUTH PADRE ISLAND

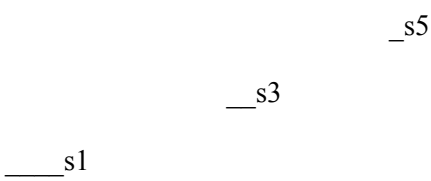
INSTR. MAN - J. Lloyd-Reilley
Constructed Length 225 ft.
LASER LEVEL

TBM #1 = (Base of railing to County Park Bathroom/Dressing Room)
(GPS = N 26 9.902' ; W 097 10.334' ; 14.8 accuracy)

	March 13, 2006		February 15, 2008	
	Reading	Elevation	Reading	Elevation
TBM #1	8.06	10.0	10.31	10.0
TBM #2	9.85	8.21	12.03	8.28

TABLE 1. Topographic Survey at Edwin King Atwood Park, 2006-2008.

	March 13, 2006				February 15, 2008		
STAT	**S1**	**S3**	**S5**		**S1**	**S3**	**S5**
0+00	**9.07**	**10.39**	**12.83**		**10.6**	**12.33**	**12.68**
0+25	**9.05**	**10.57**	**12.63**		**9.27**	**10.96**	**15.01**
0+50	**9.21**	**10.51**	**12.25**		**9.90**	**12.72**	**14.59**
0+70	**8.14**	**10.23**	**12.03**		**10.07**	**12.06**	**13.16**
0+85	**8.17**	**10.07**	**11.79**				
1+00	**8.36**	**10.0**	**11.65**		**10.28**	**11.49**	**13.13**
1+15	**8.35**	**9.78**	**11.35**				
1+30	**8.1**	**9.59**	**11.25**		**10.18**	**11.98**	**12.06**
1+55	**8.35**	**9.73**	**11.23**		**9.74**	**12.22**	**13.33**
1+80	**8.43**	**9.78**	**11.48**		**9.53**	**13.35**	
2+05	**8.28**	**9.98**	**11.49**		**9.21**	**11.0**	**13.43**
2+25	**9.15**	**10.38**	**11.59**		**10.31**	**12.34**	**12.49**
X	**8.56**	**10.08**	**11.80**		**9.91**	**12.05**	**13.32**



DUNE CROSS-SECTION

Back slope of dune was approximately 16.6%
Shoreward slope was approximately 8.5%

Table II. Bitter Panicum Survival at Edwin King Atwood Park from 2006-2008.

Treatments	May 2006	November 2006	February 2008
Encapsulated Soil (ES)/ Dry Gel	**10%**	**40%**	**40%**
ES-Gel + Water	**13%**	**10%**	**10%**
ES-PVC pipes + Water	**13%**	**20%**	**20%**
ES – Control	**0%**	**23%**	**23%**
ES-SPI-Water	**33%**	**0**	**-**
ES-SPI-No Water	**20%**	**0**	**-**
ES-NPI-Water	**40%**	**0**	**-**
ES-NPI-No Water	**50%**	**0**	**-**
Concertainers-Dry Gel	**0%**	**0**	**0**
Concertainers-Water + Gel	**17%**	**13%**	**13%**

Discussion:

Over the course of 23 months, there was an average accumulation of 1.6 feet of sand at all locations on the constructed dune (Table I). There was a loss of sand at only one location. At station S5 - 0+00, which was at the top of the dune, there was a recorded loss of 0.15 feet. The greatest accumulation occurred at S5 – 0+25 with a recorded increase of 2.38 feet of sand. All of the dune construction methods worked very well. We were especially pleased with the speed and ease in using the "concertainers."

Two months after planting survival rates of bitter panicum ranged from 0 to 50 percent (Table II). By February of 2008, there was about a 10% overall survival rate with ranges from 0 to 40%. No treatment was significantly better than another treatment due to the high variation and inconsistencies between treatment replications. Only 32 plants survived of the 400 planted. Drought conditions were too severe for the plants to survive without monthly irrigation. Even the hydrogel treatments were inadequate to maintain plant survival. From January through April 2005, the site received only 1.6 inches of rainfall, versus the average of 5.4 inches, and January through August of 2005 the site only received 6.9 inches, versus the average of 10.5 inches. In 2006, the rainfall pattern was much the same with 1.3 inches received from January through April and only 9.8 inches from January through August.

Conclusions:

The encapsulated soil technique was very effective for constructing a sand dune. However, we were especially pleased with the speed and efficiency of using the concertainers.

Because of the unreliability of rainfall that we encountered over the past 2 years in South Texas, we recommend that any additional plantings at this site should have an irrigation system established in order to assure that any dune planting will have adequate monthly watering the first year to ensure survival.

Appendix:

First Dune Construction - January 2005

First Dune After Rita – September 2005

Second Dune Construction – March 2006





Second Dune – September 2006