Assessment of the Hillsboro Beach PEM Project
Second Year 6-Month Monitoring Report

Florida DEP Permit No. 0269543-001-JC

Prepared for

Town of Hillsboro Beach
1210 Hillsboro Mile
Hillsboro Beach, FL 33062

and

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Bureau of Beaches & Coastal Systems
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CEC File No. 06.082
November 23, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Coastal Engineering Consultants, Inc. (CEC) was contracted by the Town of Hillsboro Beach to conduct an independent analysis of the first annual monitoring results of the Town of Hillsboro Beach Pressure Equalizing Modules (PEM) experimental test project. The analysis was performed for the purpose of evaluating the performance of the PEM system within the project area, assessing any adverse impacts within the project area and two control areas, and recommending the need for any adjustments, modifications, or mitigative response to the project.

Based the second year, first 6-month monitoring analysis presented in this report, there were no documented adverse impacts to the natural resources or coastal system within the project area and control areas.

The shoreline measured at MHW between March 2009 and August 2009 gained, on average, approximately 7.0 feet within the project area and lost, on average, 6.1 feet and 0.4 feet within the north control and south control areas, respectively. Volumetric changes measured above MHW were approximately 8,600 cubic yards of accretion within the project area which equates to 1.6 cubic yards of accretion per shoreline foot, 2,450 cubic yards of erosion within the north control area which equates to 0.9 cubic yards of erosion per shoreline foot, and approximately 2,350 cubic yards of accretion in the south control area which equates to 0.9 cubic yards of accretion per shoreline foot.

During the time frame, the beach segments experienced total volumetric changes, measured above DOC, of approximately 900 cubic yards of erosion in the project area compared to 15,400 cubic yards of erosion and 2,800 cubic yards of erosion in the north control and south control areas, respectively. These volumetric changes equate to 0.1 cubic yards per shoreline foot of erosion, 5.6 cubic yards per shoreline foot of erosion, and 1.0 cubic yards per shoreline foot of erosion, for the project, north control, and south control areas, respectively.

Groundwater results obtained from EcoShore during the first year monitoring were inconclusive due to operational constraints that prevented full data collection and it was strongly recommended additional effort be made to provide and implement a reliable plan for groundwater data collection to satisfy the Experimental Test Plan in the second year of PEM monitoring. Such data have not been provided and, as a result, full validation and assessment of PEM influence and impacts on beach hydraulics could not be performed.

1 INTRODUCTION

Based on the results of the first year monitoring (CEC, 2009), it was recommended the PEM system be continued for a second year of monitoring. This report presents the second year first 6-month monitoring analysis of the Town of Hillsboro Beach PEM Experimental Test Project.

1.1 Project Location and History

Hillsboro Beach is located in northern Broward County along the barrier island and it extends from slightly north of Broward County R-7 south to Hillsboro Inlet at R-24 (Figure 1). Most of the coastal area is highly developed with homes, motels, and hotels.

According to historical records and published documents (Florida Department of Environmental Protection (FDEP), 2006), the south end of Deerfield Beach and the entire Town of Hillsboro Beach along northern Broward County is a 3.2 mile long critically eroded area. This means that the recession of the beach or dune system threatens upland development, recreational interests, wildlife habitat, or important cultural resources throughout the area. The beach is composed of fine sand and shell fragments. Erosion has been a persistent problem as numerous shore protection structures and nourishment projects have been constructed in the area.

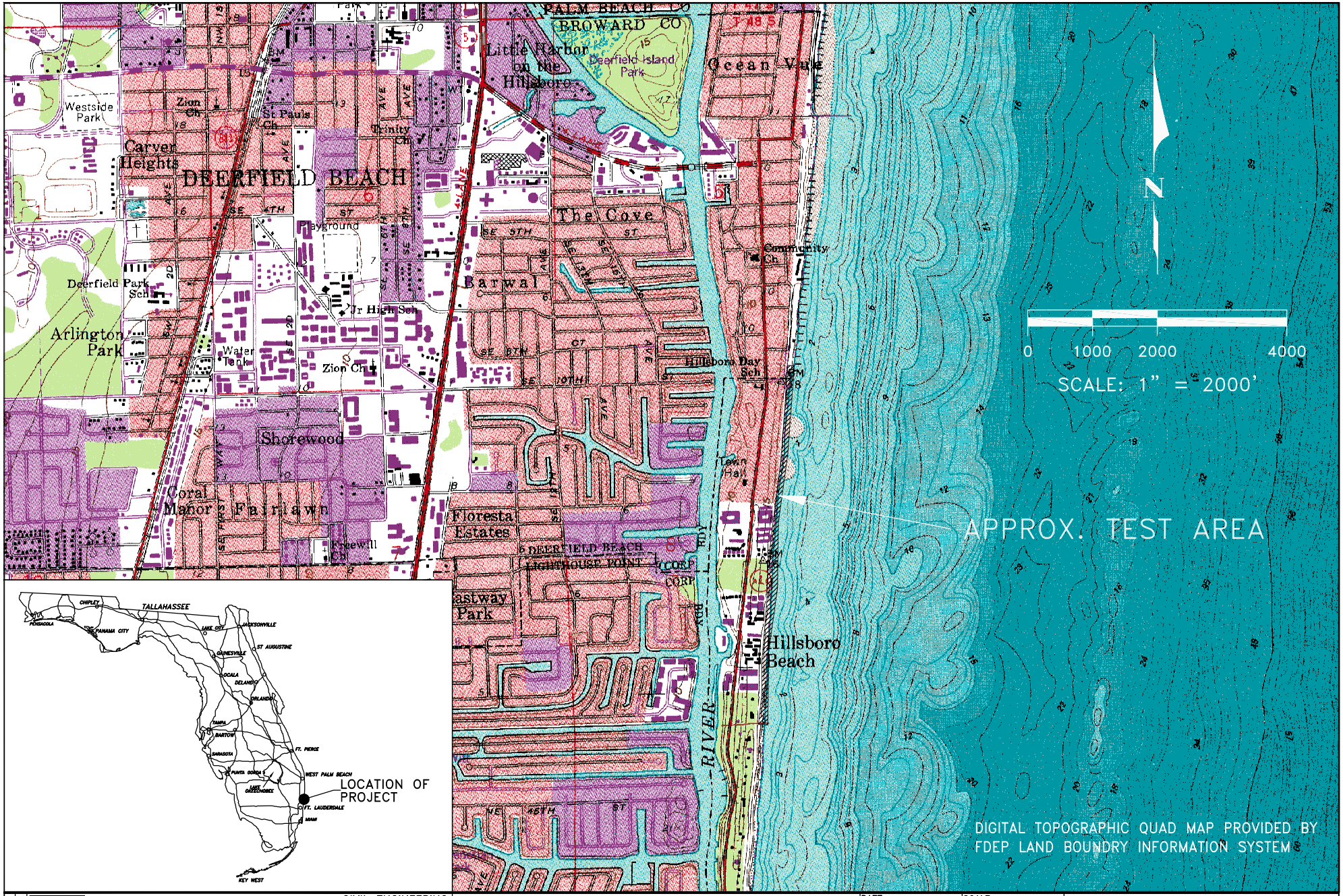
1.2 Project Permit and Objectives

On January 23, 2008, the FDEP approved the Experimental Test Plan for the Hillsboro Beach PEM Experimental Project, Permit No. 0269543-001-JC.

PEMs are independent permeable drain tubes installed vertically into the foreshore, ranging from the dune foot to the shoreline, with an objective to build a beach or reduce erosion. According to EcoShore International, PEMs are designed to enhance a naturally functioning beach draining system. The modules are intended to equalize water pressure and result in a subtle increase in inter-granular friction near the shoreline. The waves infiltrate the beach easier during uprush, leaving sediments on the beach.

The main objectives of the project include:

- Installation of the PEM system in the Town of Hillsboro Beach, for the purpose of reducing beach erosion;
- Monitoring of the PEM system performance using beach profiles;
- Attempt validation of the physics behind the beach draining process using measurement of groundwater levels in the beach;
- Confirmation of lack of impact to turtles, their nests and habitat;
- Evaluation of financial success or failure of the experiment pursuant to the agreement between the Town and EcoShore.



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SHEET 1
FILE NO.: 06.082-FIG-1

CLIENT: TOWN OF HILLSBORO BEACH

TITLE: FIGURE 1
LOCATION MAP

DATE: DEC 7, 2006	SCALE: 1" = 2000'		
DRAWN: JMC	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO.	06082P2		
REF. NO.	06.082		

NO.	DATE	BY	REVISION DESCRIPTION

1.3 Timeline of Events

A chronology of events during the first and second years of monitoring including permit approval, installation, monitoring surveys, beach fill truck hauls, and storms is presented below.

2008

Permit Approval:	
January 23, 2008	FDEP No. 0269543-001-JC
February 7, 2008	USACOE No. SAJ-2006-7167 (IP-KLV)
February 13, 2008	Broward County No. DF06-1191
February, 2008	Groundwater Monitoring Wells Installed (Pre-construction)
February 19-20, 2008	Initial Survey (Pre-construction) by Sea Diversified
February 15-28, 2008	Construction – PEMs Installed
February 28, 2008	Sand Moisture / Temperature Monitors Installed
March 17, 2008	Beach Sand Samples Grain Size Analysis
June 2, 2008	Three (3) Month Monitoring Survey by Sea Diversified
June 14-16, 2008	Truck Haul at R-7 (Port De Mer) 8,900 cy placed
August 19-20, 2008	Tropical Storm Fay
September 5, 2008	Tropical Storm/Hurricane Hanna
September 9, 2008	Hurricane Ike
September 15, 2008	Six (6) Month Monitoring Survey by Sea Diversified
December 18, 2008	Nine (9) Month Monitoring Survey by Sea Diversified

2009

January, 2009	2008 Turtle Monitoring Report Issued
January-February 2009	Deerfield Beach / Dune fill above MHW N ½
February, 2009	2009 Sand Moisture / Temperature Monitor Units Installed
February 23-29, 2009	Sand Compaction Report and Beach Tilling
March 11, 2009	Twelve (12) Month Annual PEM Monitoring Survey by Sea Diversified
August 29-31, 2009	Eighteen (18) Month Annual PEM Monitoring Survey by Sea Diversified

2 MONITORING ANALYSES

Survey data presented in this report were collected by Sea Diversified, Inc. (SDI). EcoShore contracted SDI to perform shoreline change and beach volume change analyses. The Town of Hillsboro Beach contracted CEC to perform independent analyses to confirm SDI's results. These analyses based on the SDI survey profiles are presented below and include a shoreline change analysis between March 2009 and August 2009 and a volume change analysis computed to Mean High Water (MHW), -5-foot NAVD88 contour line, and depth of closure, between March 2009 and August 2009.

2.1 Shoreline Change Analysis

Table 2.1 and Figure 2.1 present shoreline changes at MHW (+0.25 feet NAVD88) that occurred between March 2009 and August 2009. Figure 2.1 also presents FSC areas described in Section 3 and the number of PEMs installed along the project area.

Table 2.1: March 2009 to August 2009 Shoreline Change at MHW.

SURVEY LINES	DISTANCE FROM MONUMENT (FEET)			SHORELINE CHANGE (FT)
	AREA	MARCH, 2009	AUGUST, 2009	
R-4	NORTH CONTROL	189.4	185.7	-3.7
R-4.3	NORTH CONTROL	151.0	158.8	7.8
R-4.6	NORTH CONTROL	138.6	145.3	6.7
R-5	NORTH CONTROL	134.4	120.9	-7.4
R-5.3	NORTH CONTROL	132.3	127.4	-5.0
R-5.6	NORTH CONTROL	132.7	121.2	-11.5
R-6	NORTH CONTROL	204.3	191.5	-12.8
R-6.3	NORTH CONTROL	191.9	166.7	-25.2
R-6.6	NORTH CONTROL	133.3	129.1	-4.2
R-7	PROJECT AREA	73.3	84.6	11.2
R-7.3	PROJECT AREA	60.0	75.2	15.2
R-7.6	PROJECT AREA	56.4	56.4	0.0
R-8	PROJECT AREA	30.5	41.2	10.7
R-8.3	PROJECT AREA	8.7	28.3	19.6
R-8.6	PROJECT AREA	26.3	23.8	-2.5
R-9	PROJECT AREA	79.3	121.5	42.2
R-9.3	PROJECT AREA	89.7	110.8	21.1
R-9.6	PROJECT AREA	99.1	99.6	0.5
R-10	PROJECT AREA	110.2	102.0	-8.2
R-10.3	PROJECT AREA	80.9	86.1	5.2
R-10.6	PROJECT AREA	70.8	76.7	5.8
R-11	PROJECT AREA	67.5	77.8	10.3
R-11.3	PROJECT AREA	77.6	70.7	-6.9
R-11.6	PROJECT AREA	83.2	78.5	-4.7
R-12	PROJECT AREA	69.7	62.7	-7.0
R-12.3	SOUTH CONTROL	56.2	69.2	13.0
R-12.6	SOUTH CONTROL	163.6	66.4	2.8
R-13	SOUTH CONTROL	84.3	77.3	-7.0
R-13.3	SOUTH CONTROL	73.3	87.3	14.0

SURVEY LINES	DISTANCE FROM MONUMENT (FEET)			SHORELINE CHANGE (FT)
	AREA	MARCH, 2009	AUGUST, 2009	
R-13.6	SOUTH CONTROL	78.5	79.2	0.7
R-14	SOUTH CONTROL	60.4	70.7	10.3
R-14.3	SOUTH CONTROL	72.2	67.2	-5.0
R-14.6	SOUTH CONTROL	88.8	85.6	-3.2
R-15	SOUTH CONTROL	148.3	119.1	-29.2

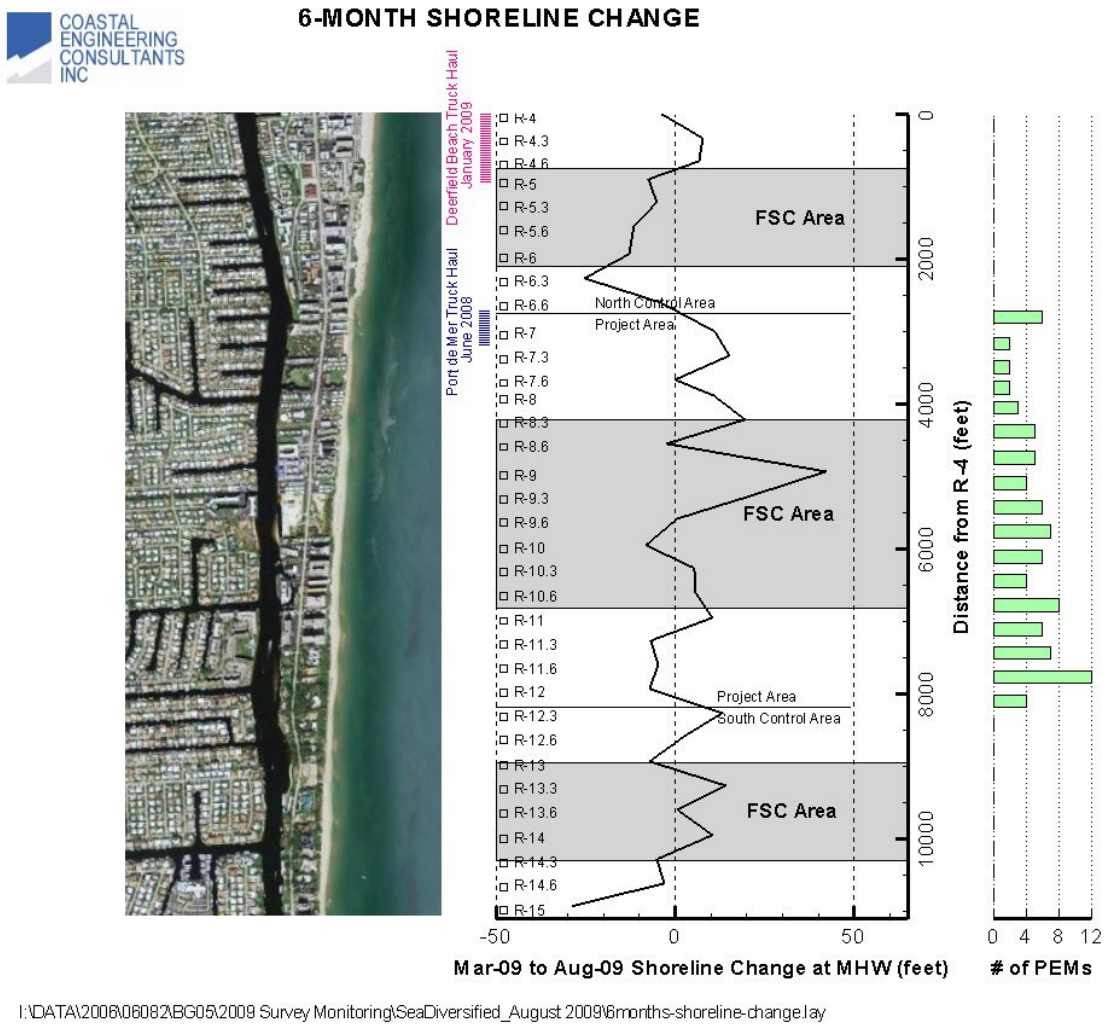

Figure 2.1. Shoreline Change at MHW between March 2009 and August 2009.

The average shoreline changes within the north control area, project area and south control area were 6.1 feet of erosion, 7.0 feet of accretion and 0.4 feet of erosion, respectively. According to Olsen and Associates (2008), between September 2001 and April 2007, the average shoreline change rates within the north control area, project area and south control area were 6.6 feet of erosion per year, 39.3 feet of erosion per year and 3.1 feet of accretion per year, respectively. The March 2009 to August 2009 shoreline changes within the north control area followed the historic trend, however, the historically highly erosive project

area between R-7 and R-12 accreted during this period and the south control area experienced a slight retreat compared to the historic shoreline advancement.

Along the project area, the distribution of the PEMs does not appear to correlate well with shoreline changes. On the south end of the project area, between R-11.3 and R-12 where a high density of PEMs was installed, shoreline retreat occurred. On the other hand, on the north end of the project area, between R-7 and R-8.3 where fewer PEMs were installed, shoreline advancement was observed.

2.2 Volumetric Change Analysis

2.2.1 To Mean High Water

Tables 2.2 through 2.4 and Figure 2.2 present measured volumetric changes that occurred along the beach face to MHW between March 2009 and August 2009 within the north control area, project area, and south control area, respectively. Figure 2.2 also presents the number of PEMs installed along the project area.

Table 2.2: March 2009 to August 2009 Volumetric Change to MHW within North Control Area.

NORTH CONTROL AREA					
PROFILE CONTROL	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE	
	SQ. FT.	SQ. FT.	FEET	CY	CY/FT
R-4	-0.6				
R-4.3	25.6	12.5	328.0	151.9	
R4.6	6.0	15.8	328.0	191.9	
R-5	-86.2	-40.1	241.8	-359.1	
R-5.3	-5.2	-45.7	328.0	-555.2	
R-5.6	-34.4	-19.8	328.0	-240.5	
R-6	-61.2	-47.8	389.2	-689.0	
R-6.3	-101.4	-81.3	328.0	-987.6	
R-6.6	50.2	-25.6	328.0	-311.0	
R-6.6+157.1	69.7	60.0	157.1	348.9	
TOTAL NORTH CONTROL AREA			**2756.1**	**-2449.8**	**-0.9**

Within the north control area, the beach face landward of MHW experienced approximately 2,450 cubic yards of erosion which equates to 0.9 cubic yards of erosion per shoreline foot. According to Olsen Associates (2008), the long-term annual rate above Mean Low Water (MLW) within the north control area was 2.6 cubic yards of erosion per year between September 2001 and April 2007.

Table 2.3: March 2009 to August 2009 Volumetric Change to MHW within Project Area.

PROJECT AREA					
PROFILE CONTROL	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE	
	SQ. FT.	SQ. FT.	FEET	CY	CY/FT
R-7-250	69.7				

R-7	100.8	85.3	250.0	789.5	
R-7.3	86.8	93.8	328.0	1139.5	
R-7.6	41.0	63.9	328.0	776.3	
R-8	55.8	48.4	227.3	407.5	
R-8.3	36.2	46.0	328.0	558.8	
R-8.6	37.4	36.8	328.0	447.1	
R-9	211.8	124.6	389.1	1795.6	
R-9.3	64.0	137.9	328.0	1675.2	
R-9.6	5.2	34.6	328.0	420.3	
R-10	-38.2	-16.5	355.0	-216.9	
R-10.3	-12.2	-25.2	328.0	-306.1	
R-10.6	8.4	-1.9	328.0	-23.1	
R-11	61.4	34.9	343.7	444.3	
R-11.3	-21.0	20.2	328.0	245.4	
R-11.6	8.6	-6.2	328.0	-75.3	
R-12	15.2	11.9	336.5	148.3	
R-12+250	63.2	39.2	250.0	363.0	
TOTAL PROJECT AREA			**5431.6**	**8589.3**	**1.6**

Within the project area, the beach face landward of MHW experienced approximately 8,600 cubic yards of accretion which equates to 1.6 cubic yards of accretion per shoreline foot. According to Olsen Associates (2008), the long-term annual rate above MLW within the project area was 16.6 cubic yards of erosion per year between September 2001 and April 2007.

Table 2.4: March 2009 to August 2009 Volumetric Change to MHW within South Control Area.

SOUTH CONTROL AREA					
PROFILE CONTROL	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE	
	SQ. FT.	SQ. FT.	FEET	CY	CY/FT
R-12.3-78	63.2				
R-12.3	78.2	70.7	78.0	204.3	
R-12.6	20.8	49.5	328.0	601.3	
R-13	17.6	19.2	349.7	248.7	
R-13.3	69.2	43.4	328.0	527.2	
R-13.6	27.6	48.4	328.0	588.0	
R-14	94.6	61.1	359.0	812.4	
R-14.3	0.4	47.5	328.0	577.0	
R-14.6	-23.2	-11.4	328.0	-138.5	
R-15	-158.6	-90.9	316.5	-1065.6	
TOTAL SOUTH CONTROL AREA			**2743.2**	**2354.9**	**0.9**

Within the south control area, the beach face landward of MHW experienced approximately 2,350 cubic yards of accretion which equates to 0.9 cubic yards of accretion per shoreline foot. According to Olsen Associates (2008), the long-term annual rate above MLW within the south control area was 1.6 cubic yards of accretion per year between September 2001 and April 2007.

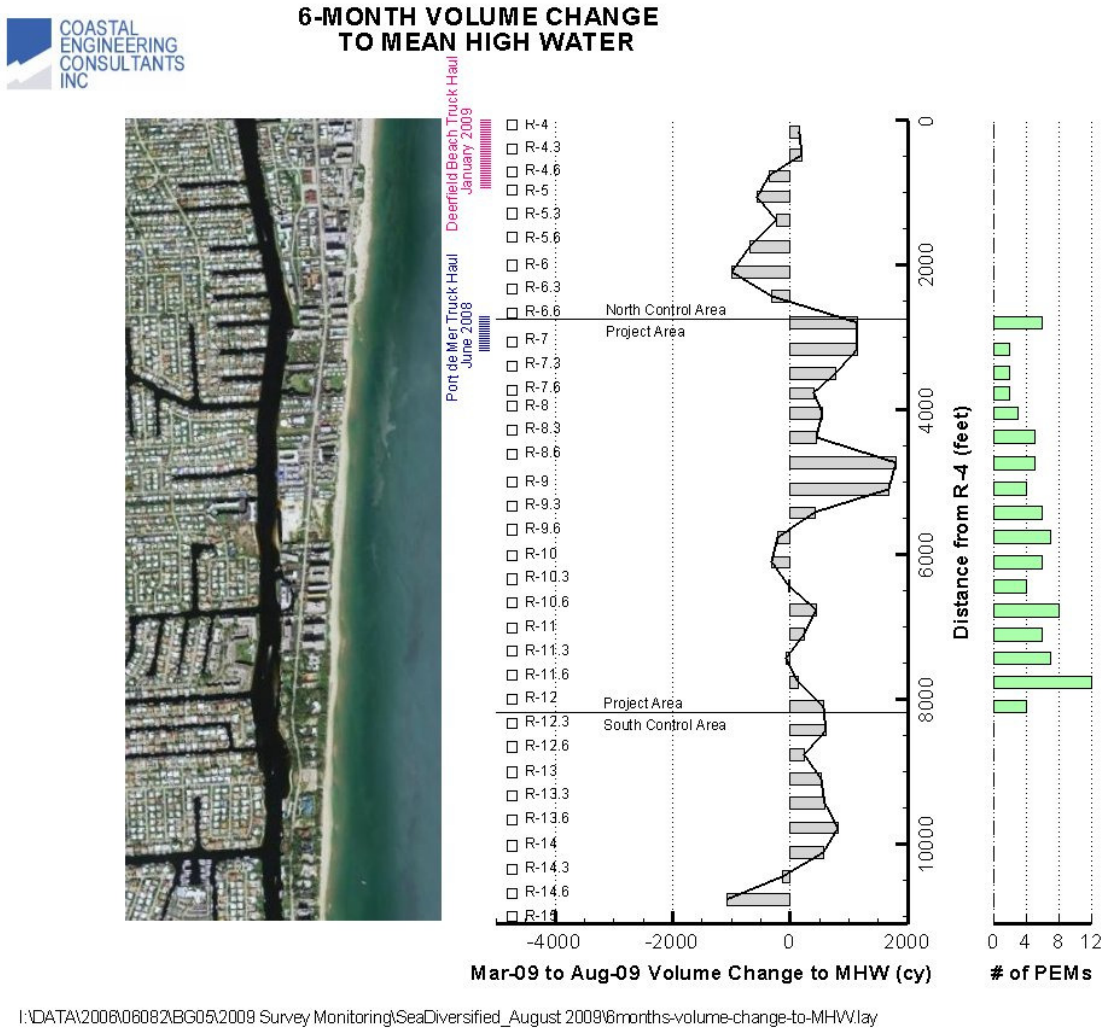

Figure 2.2. Volumetric Changes Landward of MHW between March 2009 and August 2009.

Based on the first year monitoring analysis, significant erosion occurred near R-9 just south of where a seawall is located. This erosion was believed to be a result of exposure of the seawall during episodic storm events which in all probability amplified the reflective wave energy exaggerating the erosion immediately adjacent thereto (Silvester and Hsu, 1997). As depicted in Figure 2.2, during the first six months of the second year monitoring, this location experienced significant accretion.

Along the project area, the distribution of the PEMs does not appear to correlate well with volumetric changes landward of MHW. On the south end of the project area, between R-10 and R-12 where the larger concentration of PEMs was installed, relatively small accretion occurred. On the other hand, on the north end of the project area, between R-7 and R-8.3 where fewer PEMs were installed, significantly larger accretion was observed.

2.2.2 To -5-foot NAVD88 Contour Line

Tables 2.5 through 2.7 and Figure 2.4 present measured volumetric changes that occurred along the beach face to -5-foot NAVD88 contour line between March 2009 and August 2009 within the north control area, project area, and south control area, respectively.

Table 2.5: March 2009 to August 2009 Volumetric Change to -5.0 feet NAVD88 within North Control Area.

NORTH CONTROL AREA					
PROFILE CONTROL	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE	
	SQ. FT.	SQ. FT.	FEET	CY	CY/FT
R-4	26.2				
R-4.3	90.0	58.1	328.0	705.8	
R4.6	52.6	71.3	328.0	866.2	
R-5	-77.6	-12.5	241.8	-111.9	
R-5.3	-32.8	-55.2	328.0	-670.6	
R-5.6	-103.8	-68.3	328.0	-829.7	
R-6	-37.6	-70.7	389.2	-1019.1	
R-6.3	-128.0	-82.8	328.0	-1005.9	
R-6.6	117.8	-5.1	328.0	-62.0	
R-6.6+157.1	92.1	104.9	157.1	610.7	
TOTAL NORTH CONTROL AREA			**2756.1**	**-1516.6**	**-0.6**

Within the north control area, the beach face landward of -5-foot NAVD88 contour line experienced approximately 1,500 cubic yards of erosion which equates to 0.6 cubic yards of erosion per shoreline foot.

Table 2.6: March 2009 to August 2009 Volumetric Change to -5.0 feet NAVD88 within Project Area.

PROJECT AREA					
PROFILE CONTROL	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE	
	SQ. FT.	SQ. FT.	FEET	CY	CY/FT
R-7-250	92.1				
R-7	51.2	71.6	250.0	663.4	
R-7.3	266.4	158.8	328.0	1929.1	
R-7.6	75.6	171.0	328.0	2077.3	
R-8	-21.6	27.0	227.3	227.3	
R-8.3	-90.0	-55.8	328.0	-677.9	
R-8.6	-213.2	-151.6	328.0	-1841.7	
R-9	490.0	138.4	389.1	1994.5	
R-9.3	194.8	342.4	328.0	4159.5	
R-9.6	27.0	110.9	328.0	1347.2	
R-10	-2.8	12.1	355.0	159.1	
R-10.3	38.2	17.7	328.0	215.0	
R-10.6	144.6	91.4	328.0	1110.3	
R-11	157.0	150.8	343.7	1919.6	
R-11.3	25.0	91.0	328.0	1105.5	
R-11.6	28.2	26.6	328.0	323.1	
R-12	25.6	26.9	336.5	335.3	
R-12+250	124.8	75.2	250.0	696.5	
TOTAL PROJECT AREA			**5431.6**	**15743.3**	**2.9**

Within the project area, the beach experienced approximately 15,750 cubic yards of accretion which equates to 2.9 cubic yards of accretion per shoreline foot.

Table 2.7: March 2009 to August 2009 Volumetric Change to -5.0 feet NAVD88 within South Control Area.

SOUTH CONTROL AREA					
PROFILE CONTROL	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE	
	SQ. FT.	SQ. FT.	FEET	CY	CY/FT
R-12.3-78	124.8				
R-12.3	155.8	140.3	78.0	405.4	
R-12.6	50.2	103.0	328.0	1251.3	
R-13	-5.6	22.3	349.7	288.8	
R-13.3	154.4	74.4	328.0	903.8	
R-13.6	41.0	97.7	328.0	1186.9	
R-14	159.8	100.4	359.0	1334.9	
R-14.3	-3.4	78.2	328.0	950.0	
R-14.6	-19.8	-11.6	328.0	-140.9	
R-15	-370.8	-195.3	316.5	-2289.4	
TOTAL SOUTH CONTROL AREA			**2743.2**	**3890.8**	**1.4**

Within the south control area, the beach experienced approximately 3,900 cubic yards of accretion which equates to 1.4 cubic yards of accretion per shoreline foot.

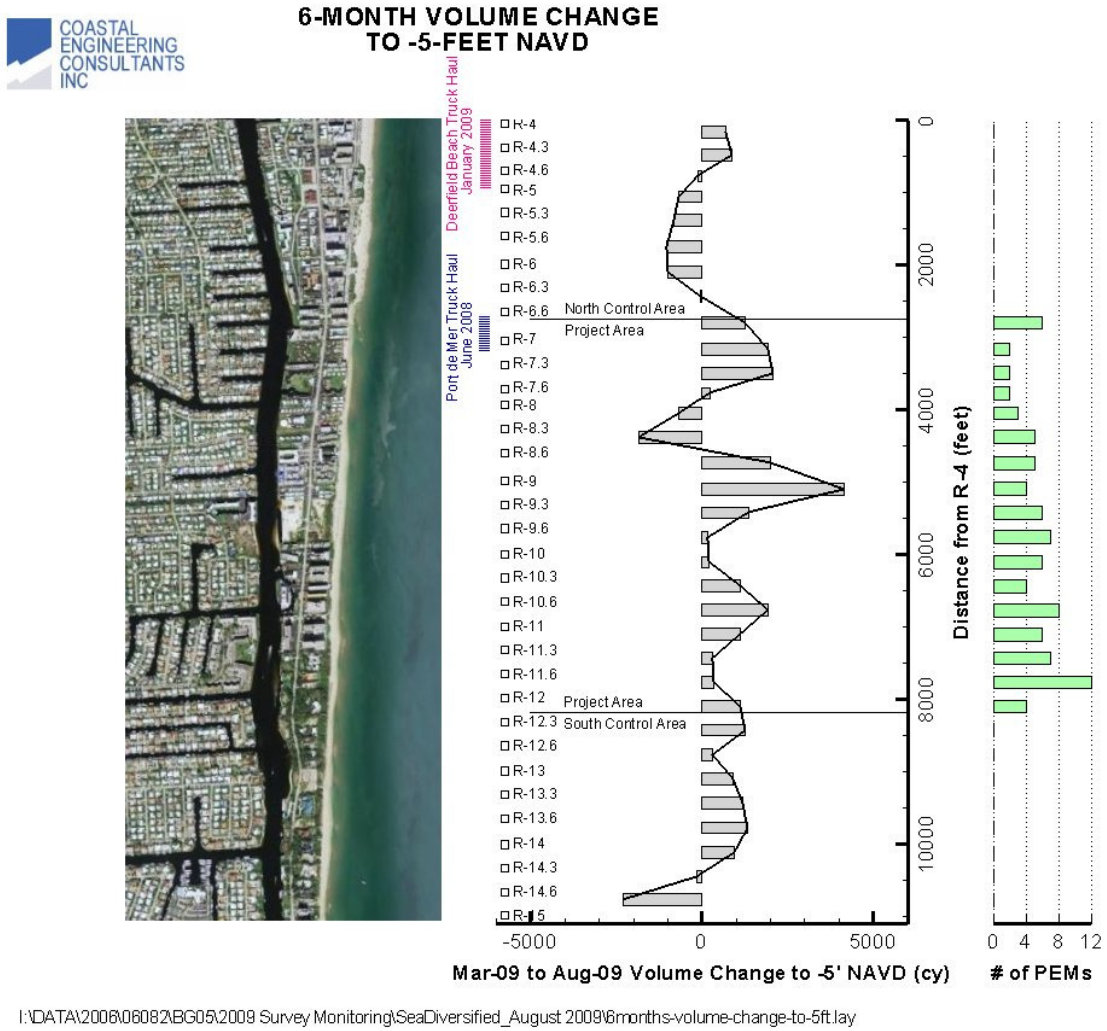

Figure 2.3. Volumetric Changes Landward of -5-foot NAVD88 Contour Line between March 2009 and August 2009.

2.2.3 To Depth of Closure

The offshore depth beyond which the net sediment transport does not result in significant changes is known as the depth of closure (DOC).

Tables 2.8 through 2.10 and Figure 2.5 present measured volumetric changes that occurred along the entire length of the beach profiles to DOC between March 2009 and August 2009 within the north control area, project area, and south control area, respectively.

Table 2.8: March 2009 to August 2009 Volumetric Change to DOC within North Control Area.

NORTH CONTROL AREA					
PROFILE CONTROL	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE	
	SQ. FT.	SQ. FT.	FEET	CY	CY/FT
R-4	-340.4				
R-4.3	-7.2	-173.8	328.0	-2111.3	

R4.6	-176.8	-92.0	328.0	-1117.6	
R-5	-164.4	-170.6	241.8	-1527.8	
R-5.3	-223.4	-193.9	328.0	-2355.5	
R-5.6	-224.8	-224.1	328.0	-2722.4	
R-6	-89.2	-157.0	389.2	-2263.1	
R-6.3	-286.8	-188.0	328.0	-2283.9	
R-6.6	84.0	-101.4	328.0	-1231.8	
R-6.6+157.1	-14.0	35.0	157.1	203.6	
TOTAL NORTH CONTROL AREA			**2756.1**	**-15409.9**	**-5.6**

Within the north control area, the beach experienced approximately 15,400 cubic yards of erosion which equates to 5.6 cubic yards of erosion per shoreline foot.

Table 2.9: March 2009 to August 2009 Volumetric Change to DOC within Project Area.

PROJECT AREA					
PROFILE CONTROL	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE	
	SQ. FT.	SQ. FT.	FEET	CY	CY/FT
R-7-250	-14.0				
R-7	-170.0	-92.0	250.0	-851.9	
R-7.3	146.2	-11.9	328.0	-144.6	
R-7.6	-46.6	49.8	328.0	605.0	
R-8	-37.2	-41.9	227.3	-352.7	
R-8.3	-427.6	-232.4	328.0	-2823.2	
R-8.6	-156.6	-292.1	328.0	-3548.5	
R-9	629.4	236.4	389.1	3406.8	
R-9.3	116.2	372.8	328.0	4528.8	
R-9.6	171.2	143.7	328.0	1745.7	
R-10	-247.8	-38.3	355.0	-503.6	
R-10.3	120.0	-63.9	328.0	-776.3	
R-10.6	159.8	139.9	328.0	1699.5	
R-11	136.0	147.9	343.7	1882.7	
R-11.3	-163.8	-13.9	328.0	-168.9	
R-11.6	-154.8	-159.3	328.0	-1935.2	
R-12	-206.4	-180.6	336.5	-2250.8	
R-12+250	-52.6	-129.5	250.0	-1199.0	
TOTAL PROJECT AREA			**5431.6**	**-686.2**	**-0.1**

Within the project area, the beach face experienced approximately 900 cubic yards of erosion which equates to 0.1 cubic yards of erosion per shoreline foot.

Table 2.10: March 2009 to August 2009 Volumetric Change to DOC within South Control Area.

SOUTH CONTROL AREA					
PROFILE CONTROL	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE	
	SQ. FT.	SQ. FT.	FEET	CY	CY/FT
R-12.3-78	-52.6				
R-12.3	-4.6	-28.6	78.0	-82.6	
R-12.6	-87.2	-45.9	328.0	-557.6	
R-13	-86.6	-86.9	349.7	-1125.5	
R-13.3	402.2	157.8	328.0	1917.0	

R-13.6	-241.0	80.6	328.0	979.1	
R-14	278.6	18.8	359.0	250.0	
R-14.3	346.0	312.3	328.0	3793.9	
R-14.6	-523.2	-88.6	328.0	-1076.3	
R-15	-658.6	-590.9	316.5	-6926.7	
TOTAL SOUTH CONTROL AREA			**2743.2**	**-2828.8**	**-1.0**

Within the south control area, the beach experienced approximately 2,800 cubic yards of erosion which equates to 1.0 cubic yards of erosion per shoreline foot.

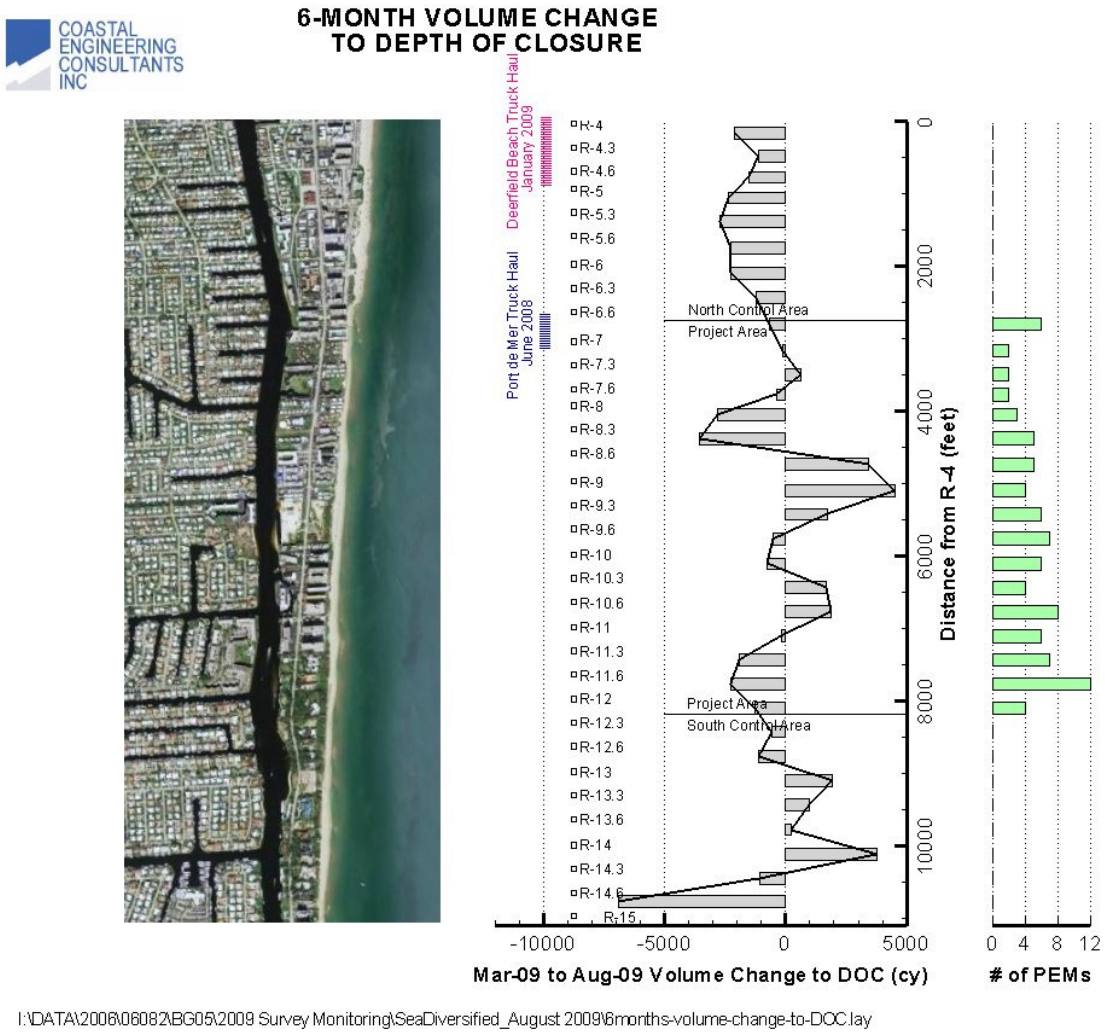

Figure 2.4. Volumetric Changes to DOC between March 2009 and August 2009.

3 PEM PERFORMANCE, EFFECTIVENESS, AND IMPACTS

One measure of the effectiveness of the PEM system is based on comparative analyses of surveys performed to measure volumetric changes of the beach along the 1-mile long project area and two ½-mile long control areas located immediately to the north and south

of the project area. Details on quantifying the performance are described in the Experimental Test Plan (CEC, 2007).

3.1 Functional Success Criteria

Functional Success Criteria (FSC) were developed to measure the effectiveness of the PEMs which is to be evaluated every 6 months during a 3-year monitoring period.

As outlined in the Contract between the Town of Hillsboro Beach and EcoShore, in order for the test to be deemed successful and FSC fulfilled, one of the following sand volumes expressed in cubic yards per shore foot and measured above 0.0 feet NGVD29 (-1.57 feet NAVD88) shall be achieved (A or B):

A. In case of sand accretion in the project area
   The volume density of sand accreted in the middle half mile of the project area must be at least 25% higher than the average volume density of sand accreted in the middle quarter miles of the control areas.
B. In case of sand erosion in the project area
   The volume density of erosion must be at least 25% higher in the middle quarter miles of the control areas than in the middle half mile of the project area.

During the first 6 months of second year monitoring, the volume change within the FSC limits along the north control, project, and south control areas were 2.0 cubic yards of erosion per shoreline foot, 2.4 cubic yards of accretion per shoreline foot, and 2.2 cubic yards of accretion per shoreline foot, respectively. This yields an average accretion for the two control areas of 0.1 cubic yards per shoreline foot compared to 2.4 cubic yards per foot of accretion in the project area. Therefore, PEM performance met FSC during this time period.

3.2 Holistic Approach

Beyond FSC, a more holistic and scientific approach and base effectiveness measure of the overall performance of the PEM system was performed as provided for in the Experimental Test Plan (CEC, 2007). Measured volumetric changes in project area and control areas were compared to historical trends to determine if the PEM system mitigated erosion or resulted in impacts on the downdrift beach.

3.2.1 To Mean High Water

Table 3.1 presents long-term, September 2001 to April 2007, and short-term, March 2005 to February 2006 and February 2006 to April 2007, volumetric changes measured to MLW (-2.27 feet NAVD88) within the project and control areas (Olsen Associates, 2008) along with the March 2008 to March 2009 (CEC, 2009) and March 2009 to August 2009 volumetric changes conducted for the PEM study and measured to MHW (+0.25 feet NAVD88). The volumetric changes are expressed in terms of average annual change rates in cubic yards per shoreline foot per year within each beach segment. The 6-month second year volumetric changes between March 2009 and August 2009 were doubled in order to

convert them to annual change rates. The historic trends were computed to MLW versus the PEM analysis computed to MHW so variability is expected, however, for comparative purposes it was assumed these trends were comparable.

Table 3.1: March 2009 to August 2009 Volumetric Changes to MHW vs. 1st Year Monitoring Changes and Historic Annual Change Rates Measured to MLW.

Area	Description	Long-term Sep-01 - Apr-07 (cy/ft per year)*	Short-term Mar-05 - Feb-06 (cy/ft per year)*	Short-term Feb-06 - Apr-07 (cy/ft per year)*	Mar-08 - Mar-09 (cy/ft per year)**,***	**Mar-09 - Aug-09 (cy/ft per year)****
North	R4 to R6.7+157.1	-0.5	-5.9	2.0	0.02	**-1.8**
Project	R7-250 to R12+250	-3.0	-5.5	-2.4	-2.2	**3.2**
South	R12.3-78 to R15	0.3	-8.5	3.6	-1.0	**1.8**

* volumes computed to Mean Low Water
** volumes computed to Mean High Water
***accounts for Jun-08 and Jan-09 truck haul beach fill volume

Based on the results presented in Table 3.1, the March 2009 to August 2009 average erosion of 1.8 cubic yards per shore foot above MHW within the north control area falls within the historic range computed above MLW. In the project area, 3.2 cubic yards of accretion per shore foot does not follow the historic trend. This segment of the shoreline was consistently eroding in the past. In the south control area, the 1.8 cubic yards of erosion per shore foot falls within the historic range computed above MLW.

Because the volumetric shoreline changes measured between March 2009 and August 2009 follow the recent historic trends in the control areas, the PEM system is believed to not have caused adverse impacts within the areas above MHW during the first six months of second year monitoring.

3.2.2 To Depth of Closure

Table 3.2 presents long-term, September 2001 to April 2007, and short-term, March 2005 to February 2006 and February 2006 to April 2007, volumetric changes measured to DOC within the project and control areas (Olsen Associates, 2008) along with the March 2008 to March 2009 (CEC, 2009) and March 2009 to August 2009 volumetric changes conducted for the PEM study. The volumetric changes are expressed in terms of average annual change rates in cubic yards per shoreline foot per year within each beach segment. . The 6-month second year volumetric changes between March 2009 and August 2009 were doubled in order to convert them to annual change rates.

Table 3.2: March 2009 to August 2009 Volumetric Changes to DOC vs. 1st Year Monitoring Changes and Historic Annual Change Rates.

Area	Description	Long-term Sep-01 - Apr-07 (cy/ft per year)	Short-term Mar-05 - Feb-06 (cy/ft per year)	Short-term Feb-06 - Apr-07 (cy/ft per year)	Mar-08 - Mar-09 (cy/ft per year)*	**Mar-09 - Aug-09 (cy/ft per year)**
North	R4 to R6.7+157.1	1.9	7.6	-6.7	2.3	**-11.2**
Project	R7-250 to R12+250	-3.9	-6.2	-1.7	1.8	**-0.2**
South	R12.3-78 to R15	1.2	1.4	0.3	-2.0	**-2.0**

*accounts for Jun-08 and Jan-09 truck haul beach fill volume

Based on the results presented in Table 3.2, the March 2009 to August 2009 average erosion of 11.2 cubic yards per shore foot within the north control area is outside the historic range and demonstrates increased erosion. In the project area, 0.2 cubic yards of erosion per shore foot is also outside the historic range and demonstrates reduced erosion. In the south control area, the 2.0 cubic yards of erosion per shore foot does not follow the historic trend which shows this segment of the beach accreted in the recent past.

The reverse in the trend of volumetric changes measured to DOC within the north control, project and south control areas is not concluded as an adverse impact to the adjacent beaches. Beach profiles vary seasonally and the 6-month changes may be due the seasonal variation.

3.3 Impacts

As stated in Sections 3.2.1 and 3.2.2, based on the beach volume change analyses, the PEM system is believed to not have resulted in adverse impacts on the adjacent beaches.

3.4 Groundwater Monitoring

Despite being required in the Experimental Test Plan (CEC, 2007), EcoShore has not conducted sufficient groundwater measurements. The lack of data negatively affects validation and assessment of PEM influence and evaluation of beach hydraulics. This analysis is critical and should be completed by EcoShore by the end of February 2010 .

4 CONCLUSIONS

This report describes the second year first 6-month monitoring analysis of the Town of Hillsboro Beach PEM Experimental Test Project. The information presented herein provides the necessary data for both the Town of Hillsboro Beach and FDEP to observe and assess, with quantitative measurements, the performance of the project, any adverse effects which have occurred, and the need for any adjustments, modifications, or mitigative response to the project. The scientific monitoring process also provides the Town and FDEP information necessary to plan, design, and optimize subsequent follow-up projects, potentially reducing the need for and costs of unnecessary work, as well as potentially reducing any environmental impacts that may have occurred or be expected. Based on the

monitoring, there were no documented adverse impacts to the natural resources or coastal system within the project area and control areas.

The shoreline measured at MHW between March 2009 and August 2009 gained, on average, approximately 7.0 feet within the project area and lost, on average, 6.1 feet and 0.4 feet within the north control and south control areas, respectively. Volumetric changes measured above MHW were approximately 8,600 cubic yards of accretion within the project area which equates to 1.6 cubic yards of accretion per shoreline foot, 2,450 cubic yards of erosion within the north control area which equates to 0.9 cubic yards of erosion per shoreline foot, and approximately 2,350 cubic yards of accretion in the south control area which equates to 0.9 cubic yards of accretion per shoreline foot.

During the time frame, the beach segments experienced total volumetric changes, measured above DOC, of approximately 900 cubic yards of erosion, 15,400 cubic yards of erosion, and 2,800 cubic yards of erosion for the project, north control, and south control areas, respectively. These volumetric changes equate to 0.1 cubic yards per shoreline foot of erosion, 5.6 cubic yards per shoreline foot of erosion, and 1.0 cubic yards per shoreline foot of erosion, for the project, north control, and south control areas, respectively.

Groundwater measurements during the second year monitoring have not been conducted by EcoShore. Groundwater results obtained during the first year monitoring were inconclusive due to operational constraints that prevented full data collection and it was strongly recommended additional effort be made to provide and implement a reliable plan for groundwater data collection to satisfy the Experimental Test Plan in second year of PEM monitoring. Thus full validation and assessment of PEM influence and impacts on beach hydraulics could not be performed.

5 REFERENCES

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