Town of Fort Myers Beach
Agenda Item Summary — Blue Sheet Number: **2013-008**

Meeting Date: January 7, 2013

1. **Requested Motion:** Approve the transfer of $134,234 from the Beach Nourishment Fund for Phase II of the Coastal Management Plan, thus allowing the Town Manager to enter into a Professional Services Agreement (PSA) with Coast and Harbor Engineering.

Why the action is necessary: Town Council must approve the transfer of funds from the Beach Nourishment Fund.

What the action accomplishes: Enables staff to work with the consultant on the Coastal Management Plan

2. **Agenda:**	3. **Requirement/Purpose:**	4. **Submitter of Information:**
__ Consent	Resolution	_ Council
X Administrative	_ Ordinance	X Town Staff
	X Other	_ Town Attorney

5. **Background:** Town Council directed staff to develop a feasibility study for alternative technology use for improved stewardship and monitoring of the beach. Coast and Harbor Engineering Inc. has completed Phase I of the CMP (Coastal Management Plan) which quantified all known information about Estero Island and its coastal process. The study also determined what data gaps and needs existed in order to develop a robust Phase II of the CMP that will serve as the basis for all future costal management on Estero Island. Phase II will develop and model sediment budgets, coastal bathymetry, as well as hydrodynamic (e.g. waves and currents) forces that act upon Estero Island. Phase II will also help explain the causes for erosion and accretion at various locations on the island. Phase II will also analyze different coastal management options and determine which may have positive benefit for long term coastal stewardship.

Attachment 1- Estero Island Coastal Management Plan - Review of Existing Data and Studies
Attachment 2- Estero Island Coastal Management Plan- Recommendations for Coastal Management Plan Work
Attachment 3- Estero Island Coastal Management Plan- Engineering Fee Estimate
Attachment 4 (Action Item)- Estero Island Coastal Management Plan- Phase 2 Scope of Work and Fee Estimate

6. **Alternative Action:**
Do nothing.

7. **Management Recommendations:**
Approve the transfer of funds and direct staff to work with Coast and Harbor Engineering to develop Phase II

8. **Recommended Approval:**

Town Manager	Town Attorney	Finance Director	Public Works Director	Community Development Director	Parks & Recreation Director	Town Clerk
[signature] Acting TM				[signature]		

9. **Council Action:**

_ Approved _ Denied _Deferred _Other

Estero Island Coastal Management Plan - Plan Approach

Review of Existing Data and Studies

October 8, 2012

1 INTRODUCTION

This Technical Memorandum summarizes the results of work conducted by Coast & Harbor Engineering, Inc. (CHE) under Task 2 of the Scope of Work in accordance with the Town of Fort Myers Beach (TFMB) Professional Services Agreement dated 2/21/2012 for RFQ-11-01-CD for the Estero Island Coastal Management Plan Phase 1 - Coastal Management Plan Approach. The specific objectives of this Technical Memorandum are:

- Develop an understanding of the available existing data relevant to coastal processes and previous coastal engineering projects at Estero Island (EI) and vicinity;
- Provide an assessment of additional data required for a comprehensive study of the coastal processes of the island

2 LITERATURE REVIEW

A literature review was conducted to identify all available data, reports, design, and publications from previous studies and designs relevant to Estero Island. Sources investigated include TFMB, Lee County Archives, US Army Corps of Engineers, Florida Department of Environmental Protection, and scholarly journals and conference proceedings. Three primary studies capture the majority of the understanding of coastal processes available on Estero Island and vicinity: (1) the USACE 1969 Beach Erosion Control Study, which first authorized beach nourishment by USACE on EI (USACE, 1969), (2) a study conducted by Godshalk and Associates for Lee County in 1988 (primarily the subsection of Volume II titled "Evaluation of the Lee County Barrier-Island Coastline: Dominant Processes, Shoreline Trends, Past Stabilization Efforts, and Recommendations for Beach Management" by Albert C. Hine of the University of South Florida (Godshalk and Assoc., 1988), and (3) the USACE Lee County Shore Protection Project General Re-evaluation Report prepared in 2001 with several technical appendices prepared by consultants (USACE, 2001). Numerous other studies and reports have been prepared, but all rely heavily on these three primary documents for technical information. The full bibliography of the literature reviewed is provided in Section 4. This section summarizes the technical information on coastal processes, regional morphology, and coastal construction projects in the EI vicinity.

2.1 Coastal Processes

2.1.1 Geologic Setting

Understanding the geological setting is important in gaining insight into the larger morphodynamic processes at work in the project vicinity, as they often drive smaller and local processes that influence project-scale processes. USACE (1969), Godshalk and Assoc., (1988), and USACE (2001) have discussed the geologic setting of the project vicinity.

Florida occupies a larger geologic unit the Floridian Plateau. During geological time the plateau has been dry or shallow seas. Each retreat of the sea left marine deposits which, during subsequent advances of the sea, were moved by waves to form beaches, offshore bars, islands, and similar features. Each sea advance left shorelines successively lower above the present sea level. The last sea advance, the Pamlico, may have produced Pine Island - it appears that Pine Island was an offshore barrier bar of the Pamlico age. The current Lee County bars (islands) are younger post-Pleistocene deposits related to the present emerging shoreline. The shoreline consists of a series of barriers and inlets. The two largest inlets are Boca Grande and San Carlos Bay; they are larger and deeper as rivers empty to the Gulf through them (the Caloosahatchee River empties through San Carlos Bay).

Sediments along the project reach are primarily quartz sand and shell in varying mixtures. The geologic source is not definitively known. During the USACE (1969) study, sediment samples at the backshore, foreshore, and elevation of -3, -6, -12 and -18 ft MLW were obtained on 12 profiles across EI. The median diameter ranged from 0.07 to 1.4 mm, with the Average median diameter on backshore = 0.38 mm, foreshore = 0.26 mm, at -18ft = 0.09 mm. Geotechnical data collected in 1990 showed a mean grain size of 0.32mm on beach (USACE, 2001).

Godshalk and Assoc. (1988) noted that no new quartz sands are being introduced into present coastal system as it is a closed sand budget. The contribution of carbonate sand from shell and shell fragments are not considered a dominant factor considering the total quantity of sand (although it is significant at some local sites); this is a factor that is poorly understood and needs more quantification.

2.1.2 Tides and Sea Level

USACE (1969) stated the tides at EI are mixed semidiurnal and diurnal, with a mean range of 2 ft to 2.9 ft. Highest annual tide (not storm-induced) estimated at +3.3 ft. Tide elevations at the nearest vertically controlled tide gage located in Naples (NOAA Tide Gage 8725110) are shown in Table 1 relative to NAVD88.

Table 1. Tide Elevations relative to NAVD88 at Naples FL NOAA Tide Gage 8725110.

	NAVD88 [ft]
Mean Higher High Water (MHHW)	0.58
Mean High Water (MHW)	0.33
Mean Sea Level (MSL)	-0.64
Mean Low Water (MLW)	-1.68
Mean Lower Low Water (MLLW)	-2.29

Sea level rise was not addressed at the project site until USACE (2001); no previous record of sea level rise was available, and the closest long term sea level records was from Key West from 1850-present and was estimated at 1.219 mm/yr. Recent data from NOAA (2012) at Naples computes the sea level rise from 1965 to 2012 at 2.02 ± 0.6 mm/yr.

2.1.3 Meteorological Climate - Winds and Waves

The meteorological climate in the project vicinity is important in that wind waves are the primary driver of sediment transport and therefore morphology along barrier beaches. USACE 1969 and Hubertz and Brooks (1989) stated that during the winter, winds are from the northeast to the north, and that during the remainder of the year winds are predominantly from the east and south. USACE 2001 noted that diurnal seabreeze (onshore-offshore) are present but are not an appreciable cause of sediment transport.

Waves are generally from the northwest to west-southwest, with a mean wave height and period of 1.6 ft and 4 seconds (a mild wave climate). Only light swell waves 1 to 6 ft high move toward Lee County from the northwest and south. A summary of the wave climate is shown in Table 2.

Table 2. Percent occurrence (x1000) of wave height and wave period offshore Lee County computed by WIS wave hindcast; reproduced from USACE (2001).

Percent Occurrence (X1000) of Height and Period
for All Directions (Station G2017)

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
.00- .49	51358	3084	498	140	18	.	.	.	.	16	55114
.50- .99	25863	7319	1193	151	22	1	.	.	.	15	34564
1.00-1.49	1718	4060	1223	260	22	13	2	1	.	17	7316
1.50-1.99	5	817	740	346	20	12	.	.	.	10	1950
2.00-2.49	.	111	199	213	27	3	.	.	4	2	559
2.50-2.99	.	13	62	107	20	3	.	.	.	1	206
3.00-3.49	.	2	19	49	33	7	.	.	.	.	110
3.50-3.99	.	.	9	11	34	4	1	.	.	.	59
4.00-4.49	.	.	1	12	13	.	.	.	.	.	26
4.50-4.99	.	.	.	10	2	.	.	.	.	.	12
5.00+	.	.	.	12	14	.	6	.	.	14	46
TOTAL	78944	15406	3944	1311	225	43	9	1	4	75	
MEAN Hmo(M) = .5			LARGEST Hmo(M) = 11.3			MEAN TP(SEC) = 3.9					

Godshalk and Assoc (1988) summarized the conditions the best: EI is a low energy environment, has low ground elevations, a low tide range, and has a low frequency of major storms. These conditions make EI susceptible to large damage and dramatic morphology from rare but large events (hurricanes).

2.1.4 Storms

EI is subject to extratropical storms (cold fronts), tropical storms and hurricanes. Extratropical storms associated with westerly moving low pressure cold fronts can cause beach erosion and shorefront damage, and are the major contributor to sediment transport and morphology on EI outside of individual tropical events (Godshalk and Assoc., 1988). The USACE (1969) estimated that based on the record from 1830 to 1968, hurricanes occur at a frequency of 1 every 6 years while some tropical event (a hurricane or tropical storm) occurs at a frequency of 1 storm every 3 years.

Godshalk and Assoc (1988) computed that the storm surge at EI is 5.2 ft for a 10 yr event, 8.3 ft for a 25 yr event, and 13.2 ft for a 100 yr event. During the 1929 Hurricane, surge was estimated at +12 ft MLW on Sanibel Island, and during the 1935 Hurricane surge was measured at +15 ft MLW.

Neal (2005) provided an assessment of Hurricane Charley on EI in 2004. The storm made landfall with winds of 145 mph and a surge estimated at +8 ft on EI. Shoreline losses were on average 28 ft along EI, with more significant impacts on the north end of the Island; erosion in this area exceeded 100 feet in some cases. The sand spit at the southern tip of EI protected the infrastructure in its lee. Seawalls and rock revetments protected infrastructure in many other areas. Scour occurred at the base of these some shoreline armaments.

2.1.5 Littoral Transport

The littoral transport along EI is uncertain, due primarily to the complexity that is a result of the low-energy environment which leads to a mixed transport signal. The USACE (1969) concluded that littoral transport is to north on north end of the Island and to the south on remainder of the Island. Reversals in trends occur, and are modified by the influence of passes. A previous study on Matanzas Pass dredging estimated the northerly transport on northern 2 mi on north end of EI at 22,000 cy/yr. Estimates from dredging at Gordon Pass (15 mi south of south Lee County) put littoral transport on southern Lee County at 66,000 cy/yr to the south, and USACE suggested that this rate applies on the south end of EI as well.

Olsen (1987) stated that littoral transport is to the north on northern part of island and to the south on southern part of the Island. The northward transport is caused by sheltering from northern waves by Sanibel Island and San Carlos Bay. Godshalk and Assoc. (1988) provided and estimate of transport rates and directions shown in Figure 1.

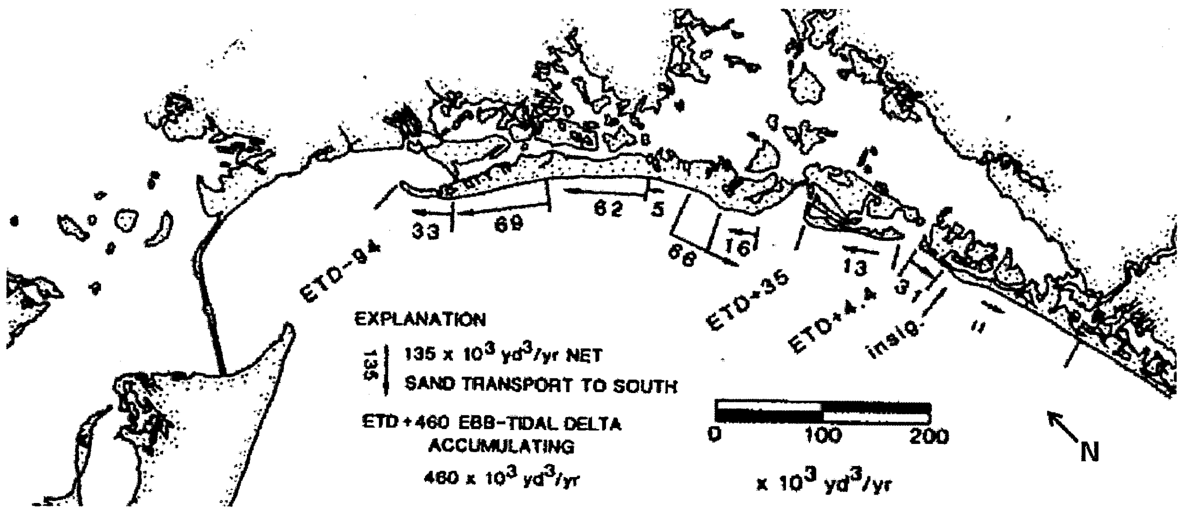

Figure 1. Littoral sand transport along the EI shoreline, excerpt from Godshalk and Assoc., 1988b.

USACE in 2001 stated that for a variety of reasons the longshore transport rate for EI Island ranges from near zero to a maximum of 69,000 cy/yr, while estimates from Poff and Stephen (1998) indicate a lower value of 29,000 cy/yr. GENESIS simulations conducted during the USACE 2001 study had a maximum transport rate of 59,000 cy/yr within the design runs.

2.1.6 Inlets and Tidal Currents

EI is bounded by two inlets, Matanzas Pass to the north and Big Carlos Pass to the south. The USACE 1969 study indicated that currents in the larger passes are generally 3 to 3.7 ft/sec and that currents in Matanzas Pass were minimal. Godshalk and Assoc. (1988) determined that Big Carlos Pass tidal prism is 8.10 x 10^8 ft^3. The tidal prism for Matanzas Pass was not provided.

2.2 Estero Island Vicinity Morphology

2.2.1 Island

The EI shoreline is a low, gently sloping mixed quartz and carbonate shell beach. The average EI average berm elevation is +4 ft, average slope above MLW 20H:1V and below MLW 50H:1V (USACE, 1969). Godshalk and Assoc. (1988) noted that dunes and fore-dune ridge are discontinuous and low in relief. Few dunes are present along developed sections. None exist where seawalls have been installed.

The morphology of the Island is a function of the wave climate; Sanibel Island shelters EI from the dominant northwesterly waves, which is a major factor in morphology and littoral transport on EI. It is commonly thought to be the cause of a nodal point in the littoral drift near the center of the island, which results in northward transport on the north of the island and southward transport on the south of the island (USACE, 1969; Godshalk and Assoc., 1988; Humiston and Moore, 1997; CEC, 1998; USACE 2001). CEC (1998) proposed structures such as groins or breakwaters be installed at the nodal point to hold sand in place longer. This results in erosion rates near the center of the island and also on the north of the island higher than adjacent areas. The southern end of the island's dominant morphologic influence is Big Carlos Pass.

Shoreline change rates were determined in the USACE 1969 study to be 24 ft of recession between 1885 to 1967, and 100 ft of recession from 1957 to 1967. Offshore of the island, the 6 and 12 ft contours generally receded offshore during the same time frame. From 1867 to 1967, USACE estimated that the island eroded approximately 138,000 cy/yr.

In 1997, Humiston and Moore described the Critical Wildlife area. Local reports suggest these bars formed during Hurricane Donna in 1960 and have since created an extensive region of vegetated dunes and bars (USACE, 2001). The area is thought to be a result of portions of the ebb shoal from Big Carlos Pass migrating onshore and becoming emergent. In 1992 the areas was established as a Critical Wildlife Area. Shoals are prevalent in the area due to the confluence of wave induced littoral transport southward along Estero Island with the tidal current induced transport at Big Carlos Pass. In 1997, the southern end of Estero Island experienced erosion primarily as a result of the southern sediment transport by the emergent shoals (Humiston and Moore, 1997).

USACE studied the shoreline change rates in detail. They noted that a region of shoreline advance is located at the northern portion of the island, through a significant erosional area present at the northern extreme of the island around R-180. Shoreline changes from 1982 to 1995 indicate a slight advance over the central portion of the island with a mean advance of 24.4 ft. Slight recession is noted between R-191 and R-194. Overall advance during this period is due to placement of fill in 1986. From 1989 to 1995 the region exhibited a mean recession of -26.1 ft with the greatest region being R-176 to R-180 and appears consistent with a historical hot spot. Recession between R-180 and R-198 is limited due to the presence of a seawall in the region. R-200 southward indicates a dramatic advance in shoreline position due to the migration of offshore bars shoreward in the area. Figure 2 shows the layout of the R-monuments along EI.

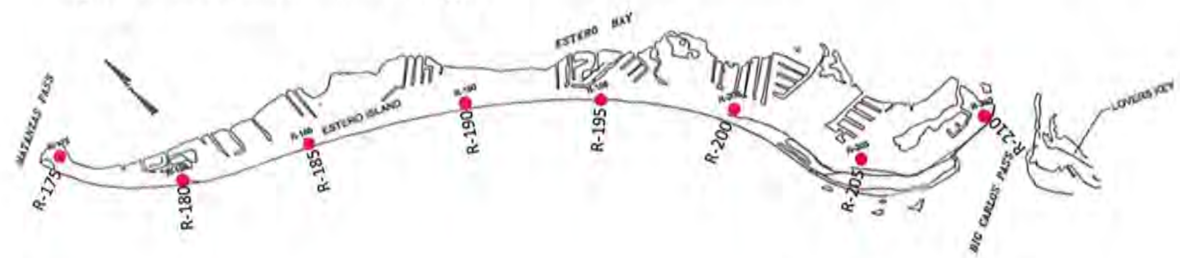

Figure 2. Estero Island and location of R-monuments.

USACE (2001) computed historical volume change rates. Discrepancies exist in volume change rate calculations, and quantities should therefore be treated with some skepticism. Depth of closure was estimated at 13.25 ft using the Hallermeier method, but observations of survey transects indicate a depth of 8 ft may be more appropriate; 8 ft was used in volume calculations. From 1982 and 1989, estimates suggest Estero Island gained 245,400 cy, however, 190,000 cy of fill was placed in 1986 resulting in a net gain of 55,400 cy, which equates to annual accretion rate of 7,900 cy/yr. From 1989 to 1995 the region had a net loss of 340,000 cy or 56,700 cy/yr.

USACE (2001) also estimated the influence of sea level rise of shoreline change. Base on National Research Council's 1987 estimate, sea level rise by 2043 is estimated to be 0.7 to 1.5 ft. This translates into a shoreline recession of 38.9 ft and 83.3 ft, respectively based on Bruun rule and using the surveys collected for the 2001 study.

In 2000, Applied Technology and Management, Inc (ATM) computed the shoreline change associated with storm events using the SBEACH model. They computed that for a 15-yr storm the shoreline would erode an average of 6.8 cy/ft of beach or approx 44.2 ft of beach width at the MHW line, and for the 25-yr storm, the shoreline would erode an average of 7.8 cy/ft of beach or approx 42.3 ft of beach width at MHW.

Shoreline change rates are summarized in Figure 4 by Monument location, and in Figure 4 on an aerial photo.

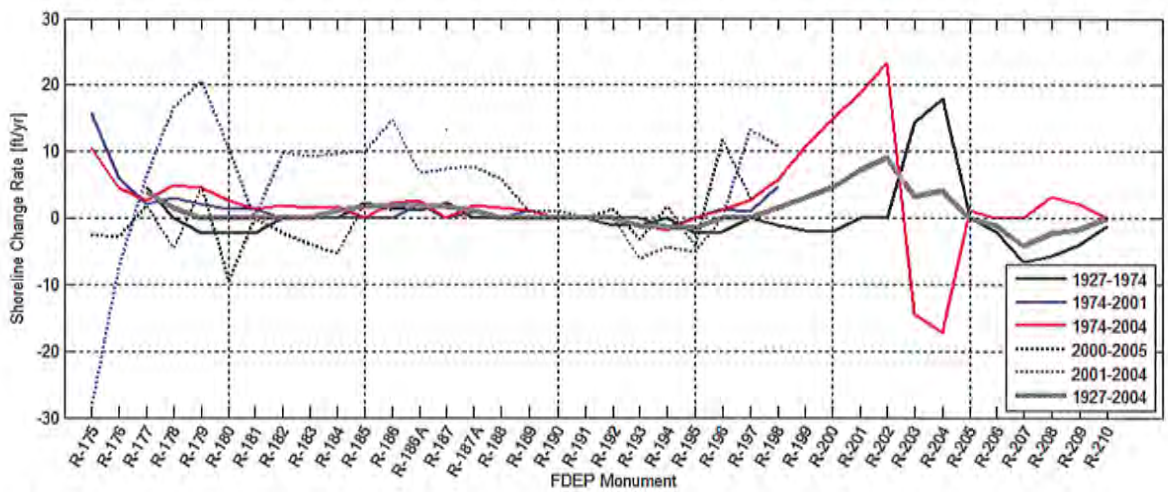

Figure 3. Estero Island Shoreline Change Rates for available time periods.

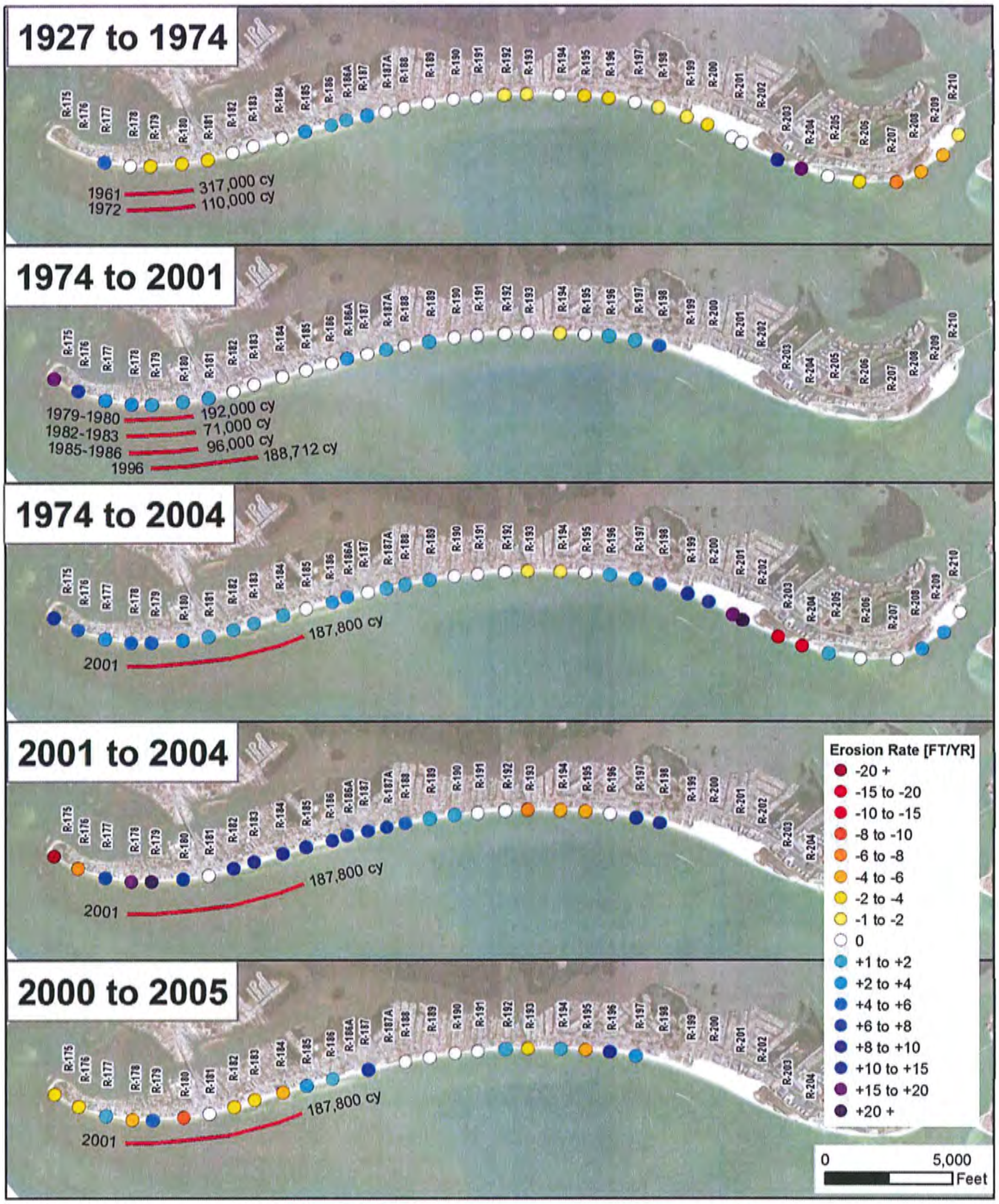

Figure 4. Estero Island Shoreline Change Rates and Sand Placement extents for different time periods.

2.2.2 Inlets

EI is bounded by two inlets, Matanzas Pass to the North and Big Carlos Pass to the south. Due to shallow depths and 3 mile width of Matanzas Pass, USACE (1969) stated that tidal currents appear to have little effect on the littoral transport of material on Estero Island. Olsen (1987) provided a summary of Matanzas Pass and the entrance to San Carlos Bay. They stated that the Matanzas Pass entrance to San Carlos Bay has never been improved, is more than 3 mi in width, and is the main tidal outlet for Caloosahatchee River. Historic trends indicate that the majority of sand eroded from eastern Sanibel was deposited in the vicinity of this entrance. The ebb tidal shoal was estimated at 26.1 million cy, indicating that eroded material from Sanibel likely remains in the area. Matanzas Pass captures much of the littoral drift transported to the north from EI. Between 1961 to 1989, more than 330,000 cy was dredged from Matanzas Pass and placed on northern EI.

USACE (2001) noted that significant tidal currents in the Big Carlos Pass affect littoral processes on the southern portion of EI. It appears that the pass intercepts and stores littoral material in its ebb and flood shoals. It is estimated that the flood and ebb shoals contain about 4.2 and 8.0 million cy of material, respectively. USACE noted that material from periodic dredging of the pass has been placed on the adjacent beaches of EI; no specific dredging of Big Carlos Pass was provided. A noticeable widening and deepening of the pass occurred in 1965 immediately following the construction of the causeway between Ft Myers and Bonita Beach. This resulted in an increase in the total sediment volume retained in the inlet flood and ebb shoal system.

Little information is available on New Pass to the south of Lover's Key. Olsen estimated in 1987 that the New Pass flood shoal contains 300,000 cy, and the ebb shoal contains 420,000 cy. They also stated that the construction of Estero Blvd Causeway construction has led to enlargement of the shoals.

2.3 Previous Coastal Engineering Projects and Construction

2.3.1 Coastal Structures

Various privately sponsored coastal structures have been constructed along the Gulf Beach of EI since the 1950s, including 87 stone groins, 4 timber groins, 2 combined stone/timber groins, and approximately 3800 ft of mostly concrete seawall (USACE, 1969). Godshalk and Assoc. (1988) state that generally these structures have failed to provide protection to the beach and reduce erosion. Terminal groins have been temporarily effective. Seawalls and bulkheads have been effective at protecting infrastructure, but not at maintaining a beach fronting them.

In 1988 Godshalk and Assoc. observed that a low, continuous seawall approximately 14,000 ft in length 2-3 ft high exists approximately between R-180 and R-198. The beach width in front of the seawall varies but in some areas it is quite narrow. Low rock and woodpile groins have been placed in a few areas but are ineffective. A seawall exists at the very southern end of the island facing Big Carlos Pass and no coastal structures are at the northern tip of the island adjacent to Matanzas Pass. Recent construction in 2011 and early 2012 constructed a terminal groin on north end of island at Matanzas pass, details of the terminal groin are discussed in Section 2.3.6.

Table 3. Summary of structures along Estero Island as of 1988; reproduced from Godshalk and Assoc. (1988b).

Estero Island	R180 to R-194	Seawall/Bulkhead	14,000
	R-194	Groin (remnants)	-
	R-195 to R-198	Bulkhead	3,020
	R-197	Nine Rock groins	500
	R-198 toR-199	Groins (Remnants)	1,000
	R-208 to R-210	Bulkhead / groins	1,480

2.3.2 Matanzas Dredging and Placement

Matanzas Pass captures the northward transport from the northern end of EI. Because of this the pass has been dredged periodically to maintain navigation, and to provide a source for beach nourishment. In 1959, USACE recommended dredging Matanzas Pass (House Document 183, 86th congress, 1st session 1959), and recommended the channel be dredged at 12 ft x 150 ft transitioning to 11 ft deep and 125 ft wide inside the pass. The same document estimated northerly transport of sand into Matanzas Pass at 22,000 cy/yr

Since then, Matanzas Pass was been dredged at least 6 times between 1961 and 1986 by the USACE, again in 1996 by Lee County, and the more recently in 2001 where 180,000 cy of material were removed and nourished (Humiston and Moore, 2008). Historical disposal for the maintenance dredging has been approximately 200 ft north of R-178 to approx. 500 ft south of R-180 on Estero Island.

Originally, the beach nourishment was placed too far north causing large scale accretion at the northern end and erosion immediately to the south. Dredging/BN in 1996 addressed this by shifting the disposal area further south.

Table 4. Summary of dredging of Matanzas Pass.

Date	Volume [cy]	Project	Placement	Borrow Source
2/1961 to 3/1961	265,000	Dredge & Beach Nourishment	R-178.2 to R-180.5	Matanzas
8/1961 to 11/1961	52,000	Dredge & Beach Nourishment	R-178.2 to R-180.5	Matanzas
1972	110,000	Dredge & Beach Nourishment	R-178.2 to R-180.5	Matanzas
11/1979 to 4/1980	192,000	Dredge & Beach Nourishment	R-178.2 to R-180.5	Matanzas
10/1982 to 10/1983	71,000	Dredge & Beach Nourishment	R-178.2 to R-180.5	Matanzas
11/1985 to 6/1986	96,000	Dredge & Beach Nourishment	R-178.2 to R-180.5	Matanzas
4/1996 to 5/1996	188,712	Dredge & Beach Nourishment	R-179.1 to R-183.7	Matanzas
2001	187,800	Dredge & Beach Nourishment	R-178.2 to R-185.5	Matanzas
2009	229,313	Dredge & Nearshore Placement	R-182 to R-187A	Matanzas

2.3.3 Nearshore placement

In October 2009, Matanzas Pass was dredged and the material composed primarily of fine sand was placed approximately 600 ft offshore of EI 1.5 miles southeast of Matanzas Pass in the form of an artificial berm designed to be 6,000 ft long, 400 ft wide, 3 ft high with slopes of 20H:1V composed of 229,313 cy. Researchers from the University of South Florida have monitored the morphology of the berm; two years of monitoring results are available in Brutsche (2011) and Brutsche and Wang (2012).

Over the first two years of monitoring, this material moved onshore an average of 300 ft and increase in elevation. In addition, sediment sampling over time observed coarser material moving onshore while finer and muddy sediment tended to move offshore.

2.3.4 Lover's Key

A beach nourishment was conducted in the fall of 2004 along 1.2 miles of Lovers Key, which consisted of placing 590,000 cy of sand between approximately R215 and R220 (FDEP, 2008). The borrow source was an offshore site; the exact location was not able to be determined.

2.3.5 Big Carlos Pass

Big Carlos Pass ebb shoal was utilized as a borrow source for a beach nourishment along Bonita Beach in June 2004, where approximately 143,000 cy of sand was placed between R226 to R230 (FDEP, 2008). The impacts of this dredging should be carefully studied, and the future use of Big Carlos Pass ebb shoal as a sand source must be analyzed in detail considering the possible implications to adjacent shorelines as improper dredging of ebb shoals can lead to erosion on adjacent shorelines and/or unintended morphology of the pass itself.

2.3.6 2011/12 Beach Nourishment

A large-scale beach nourishment was recently constructed on the north end of EI funded by the USACE and local governments. This construction is the result of the USACE (1969) Beach Erosion Control Study, the follow-up USACE 2001 General Re-evaluation Report, and subsequent updates to the design. The design and modification over time are briefly summarized here.

The 1969 design criteria included berm widths of at least 50 ft at +4 ft MLW (+4 ft is reached with 5yr return storm); 15:1 slope subaqueous, 35:1 MLW to dunes, adding a 5-yr advance supply of sand to berm; 4.6 mi of nourishment from north; a total volume of 325,000 cy, and renourishment at 120k cy/yr with a renourishment cycle at 3 years. They also proposed a terminal groin at Matanzas Pass with a crest elevation of +4 ft and stone sized to be stable for a wave height of 6 ft.

Olsen (1987) estimated nourishment for EI (in reaches R180-185, R192-198, R207.5-210) for a volume of 1.2 million cy at a cost of $5,000,000, with maintenance (renourishment) at 600,000 cy every 6.1 years, annualized to 98,000 cy/yr at $761,000 per yr.

Humiston and Moore (1997) reviewed island wide beach restoration history and considered a new beach nourishment from R177-199 (4.2 mi) and R207-210 (0.6 mi), with a volume of 1.4 million cy, two 200 ft terminal groins at north end of EI and one at the south end of the island. The total cost was estimated at $9,000,000 with maintenance at 10 yr intervals for an annualized maintenance cost of $546,000 per yr.

CEC (1998) recommended 1.4 million cy of nourishment from R175-199 (4.8 mi) and R207-210 (0.6 mi) with groins at north and south end of island for a total cost of $12,800,000. They provided a table summarizing the proposed nourishment actions to date, shown in Table 5.

Table 5. Summary of proposed nourishment actions on EI; reproduced from CEC (1998).

Project	USACOE 1970	USACOE Economic Update Report, 1995	Olsen, 1987	Humiston & Moore, 1997	ATM, 1997: & FDEP, 1998
Beach Fill Segments	R174.6-R199	R174.6-R199	R180-R185 R192-R198 R207.5-R210	R177-R199 R206-R210	R174.6-R199 R206-R210
Length of Beach Fill N. Segment: S. Segment: Total:	4.6 miles	4.6 miles	2.6 miles	4.2 miles 0.6 miles 4.8 miles	4.8 miles 0.6 miles 5.4 miles
Cubic Yards of Fill (initial) N. Segment: S. Segment: Total:	325,000 cy	944,850 cy	1,192,000 cy total	1,325,000 cy 75,000 cy 1,400,000 cy	1,325,000 cy 75,000 cy 1,400,000 cy
Structures	(1) 600'	(1) 600'	None	(2) 200' (1) 200'	(2) 200' (1) 200'
Initial Cost	$357,000	–	$5,062,552	$9,000,000	$12,120,000
Annualized Maintenance Fill	120,000 cy/yr	120,000 cy/yr	98,443 cy/yr	Approx. 90,000 cy/yr Total	Approx. 90,000 cy/yr Total
Annual Maintenance Cost	$130,000	--	$761,000	$546,000	$120,000

The USACE 2001 re-evaluation design recommended the following design features: 4.7 miles of beach nourishment (4.6 was originally authorized), berm elevation of +5 ft MLW and 40 ft wide (at MHW), construction slope of 10H:1V, existing beach slope estimated as 25H:1V above MLW and 35H:1V below MLW, limits from R-175 to R-198 with 1800 ft tapers that connect the beach fill to the existing shoreline. The nourishment volume is 790,800 cy including 244,400 cy of advance fill volume (546,400 cy design volume). The renourishment cycle is 3 years with 81,500 cy/yr annually required. An update described in CPE (2001a) modified the renourishment cycle to 8 yr intervals due to reduced erosion rate (attributed primarily to erroneous survey data) and due to a closer borrow site that reduced the sand cost resulting in increased possible volume of fill.

The terminal groin was proposed in vicinity of R-175.The optimum effective length of groin was 150 ft with an additional 90 ft necessary to link structure to existing berm crest (240 ft total). The design criteria resulted in a continuous groin height of +6 ft MLW (capable of sustaining a 4 ft wave with no overtopping and a 6 ft wave with minimal overtopping). The groin structure design specified 13,713 cf of armor stone, 3,325 cf of bedding stone, 7,968 cf of foundation stone, 10,080 sf of geotextile, and 2,500 sf of vinyl sheet pile. It is not clear if this is exactly what was constructed.

ATM (2007) Analyze changes from 2000 to 2005 to reassess the USACE 2001 plan. Between April 2000 and October 2005 the project area shoreline on the whole advanced 0.92 ft and gained 272,000 cy above depth of closure. Analysis indicated that these volumetric gains occurred primarily within the nearshore as the upper beach above MLW exhibited a net gain on the order of 2,000 cy. Overall the beach has remained stable or accretionary, but significant erosion areas are present within the project area. Erosion/accretion trends remained consistent with shoreline observations and consistent with shoreline trends for the area dating back to at least 1974. Historically, placement of dredged material within the vicinity of the pier has helped address the impacts of the northern hotspot. This placement however, has occurred over a localized area and the constructed shoreline has receded at an above average rate due to diffusion losses of material to adjacent (non-nourished) areas. Shoreline data collected since the USACE 2001 study suggests that the volume of material required to meet the project's goals may be less than projected within the current plan, but any major modifications to USACE plans are not warranted. ATM recommended minor modifications to reduce volume by 124,000 cy (12% reduction)

Based on reports from Lee County, sand placement and terminal groin construction was completed on 12/19/2011. Approximately 402,805 cy were placed within the project area (Boutelle, 2012). Sand was placed approximately 400 ft north of R-175 to R-181.5. Lee County estimates that Matanzas Pass requires maintenance dredging every 5 years.

3 Assessment of Available Data

3.1 Aerial Photos

Aerial photos are important data sources as they provide a means of extracting the shoreline position over time, and also provide visual evidence of morphology. Humiston and Moore (1997) identified available aerial photos from the USDA and FDOT. Lee County provided CHE with a copy of all available digitized aerial photos in their database. Table 6 summarizes all identified aerial photos of the vicinity. Sufficient aerial photography exists to develop an understanding of shoreline change rates.

It should be noted that while aerial photography is an important tool in establishing and analyzing morphological trends, using aerial photographs requires careful attention to reduce subjectivity of visual interpretation of the photos, and a detailed error analysis must be performed on the results as any position data (such as shoreline location) obtained from photos can be high. The error associated using aerial photography to define the shoreline position is a function of errors in rectification, seasonal variability, hydrodynamic conditions at the time of photography (water surface elevation), the subjectivity of the interpretation of the high water line, and photograph quality. It is common to have an error in shoreline position from a single photo in the range of ± 30 ft (Crowell *et al.*, 1991; Moore, 2000). This error typically increases as photo quality decreases and age increases.

Table 6. Aerial photographs identified for the Estero Island area.

YEAR	Exact Date	Source	Geo-Referenced	Resolution	Coverage
1944	4/13/1944	NARA	NO	unknown	ALL
1953	unknown	Lee County	Yes	0.5 m	ALL
1953	2/9/1953	NARA	NO	unknown	ALL
1958	1/18/1958	USDA	NO	unknown	north and south
1958	3/15/1958	USDA	NO	unknown	central
1968	11/22/1968	Lee County	NO	tbd - good quality	ALL
1968	3/18/1968	FDOT	NO	unknown	ALL
1970	2/14/1970	USDA	NO	unknown	north
1970	2/26/1970	USDA	NO	unknown	South
1972	3/9/1972	Lee County	NO	tbd - good quality	ALL
1972	3/3/1972	FDOT	NO	unknown	ALL
1975	10/22/1975	Lee County	NO	tbd - good quality	ALL
1975	10/22/1975	FDOT	NO	unknown	South
1975	10/24/1975	FDOT	NO	unknown	North and Central
1977	4/9/1977	USDA	NO	unknown	ALL
1979	3/7/1979	Lee County	NO	tbd - good quality	ALL
1979	3/7/1979	FDOT	NO	unknown	Central and South
1979	3/13/1979	FDOT	NO	unknown	North
1980	12/13/1980	USDA	NO	unknown	ALL
1985	3/3/1985	USDA	NO	unknown	ALL
1986	2/26/1986	Lee County	NO	tbd - good quality	ALL
1986	2/25/1986	FDOT	NO	unknown	ALL
1990	1/14/1990	Lee County	NO	tbd - good quality	ALL
1990	1/14/1990	FDOT	NO	unknown	ALL
1994	3/15/1994	USDA	NO	unknown	North
1995	1/27/1995	USDA	NO	unknown	South
1996	2/5/1996	Lee County	NO	tbd - good quality	ALL
1996	2/5/1996	FDOT	NO	unknown	North and Central
1996	3/13/1996	FDOT	NO	unknown	Central and South
2002	4/1/2002	Lee County	Yes	0.5 ft	ALL
2004	unknown	Lee County	Yes	1 m	Partial (Estero)
2005	1/18/2005	Lee County	Yes	0.5 ft	ALL
2007	8/22/07 - 11/11/07	Lee County	Yes	0.5 ft	ALL
2008	1/1/2008	Lee County	Yes	0.5 ft	ALL
2011	unknown	Lee County	Yes	0.32 ft	ALL

3.2 Shoreline Data

Shoreline data is used to determine shoreline change rates and can be a means of estimating volume change rates, both of which are important in developing a quantitative understanding of morphology. Shorelines can be derived from either digitization of aerial photography or from direct surveying. Humiston and Moore (1997) summarized available shoreline from 1858 to 1982, shown in Table 7. More recent shoreline data is available from the USACE 2001 and subsequent reanalysis studies (CEC 2005; ATM 2007). This data along with the available aerial photos are sufficient to develop an understanding of shoreline change rates.

Table 7. Summary of available shoreline data for Estero Island; reproduced from Humiston and Moore (1997).

YEAR	SOURCE	COVERAGE
1858	USC&GS	R-178 to R-190
1885	USC&GS	R-190 to R-208
1927	USC&GS	R-177 to R-210
1951	USGS	R-176 to R-210
1960	USC&GS	R-176 to R-210
1972	NOS, USGS	R-201 to R-210
1974	DNR	R-176 to R-210
1979	NOS	R-176 to R-210
1982	DNR	R-175 to R-210

Table 2-1: Estero Island MHW Shorelines from the DEP Lee County Historical Shoreline Map

3.3 Bathymetry and Topography

Numerous bathymetric and topographic surveys have been conducted in the Estero Island vicinity since the initial USACE 1969 study. In 1974, the Florida DNR established a baseline monument system along the shoreline spaced approximately 1,000 ft apart. Since establishment, beach profile survey data has been collected at these monuments. Beach profiles collected at every monument in 1974, 1982 and 1989 by FDNR. The 1974 and 1989 surveys were conducted as part of a county-wide study by the FDNR for the establishment and subsequent re-establishment of a coastal construction control line. Corresponding offshore profiles were taken by sonar from beach to approx 3000 ft offshore at every third monument for the 1974 survey. The 1989 survey included offshore soundings at every monument from the beach to approx. 3,000 to 9,000 ft offshore.

More recent bathymetry has been collected for the USACE 2001, 2005, pre-construction in 2011 and post-construction in 2012. These data have not been inspected for extents. Several studies have been performed analyzing volume change rates over the past half century. Future studies should continue the assessment of volume changes, and will require new bathymetric survey data be collected for that purpose.

No comprehensive detailed survey data has been identified for the passes adjacent to Estero Island (Matanzas, Big Carlos, and others). Bathymetry is available in Matanzas Pass but typically only covers the navigation channel. In addition, bathymetric data is generally unavailable for Estero Bay. Bathymetric data is available in the form of navigation charts and through the NOAA National Ocean Service's GEODAS data clearinghouse (http://www.ngdc.noaa.gov/mgg/geodas/geodas.html). Comprehensive coverage is available, but the data is typically old and not adequate for use in hydrodynamic modeling in inlets due to the dynamic nature of the passes. If hydrodynamic modeling is required for future study, it is recommended to collected data in Matanzas and Big Carlos Pass and their shoals.

It is recommended to collect complete single realizations of the topographic and bathymetric conditions of Estero Island, Lover's Key, Matanzas Pass, and Big Carlos Pass, where the complete survey is conducted over a short period of time. This allows for a complete picture of the conditions to be determined, and reduces the need for interpretation of morphology between survey time periods, which increases the reliability of engineering assessment of project conditions (e.g., winter versus summer profiles; impacts of storms; coastal construction projects).

3.4 Hydrodynamic Data

No detailed hydrodynamic data such as direct measurements of currents in passes, wave heights, or similar have been identified. Estimates of current velocities have been provided, but the basis for the estimated values are unknown. If hydrodynamic modeling is required (circulation and/or morphologic modeling), some hydrodynamic data are recommended to be acquired to increase the accuracy of the modeling results through calibration and validation.

3.5 Geotechnical

Extensive geotechnical data has been collected in the vicinity of Estero Island for beach nourishment material in support of the USAC 1969 and 2001 studies. Several possible borrow sources have been identified for future nourishment efforts, and unless they become financially or environmentally unfeasible to dredge, appear to be sufficient for future nourishment activities. Therefore, no new geotechnical data is recommended to be collected for study in the near future unless other conditions warrant. However, if a new nourishment project is to be constructed, a detailed geotechnical investigation of the exact borrow site should be conducted.

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Estero Island Coastal Management Plan - Plan Approach

Recommendations for Coastal Management Plan Work

October 8, 2012

1 INTRODUCTION

This Technical Memorandum summarizes the results of work conducted by Coast & Harbor Engineering, Inc. (CHE) under Task 3 of the Scope of Work in accordance with the Town of Fort Myers Beach (TFMB) Professional Services Agreement dated 2/21/2012 for RFQ-11-01-CD for the Estero Island Coastal Management Plan Phase 1 - Coastal Management Plan Approach. The objective of this Technical Memorandum is to prepare a detailed approach and work items for the development of a Coastal Management Plan

2 BACKGROUND

The town of Fort Myers Beach is located on Estero Island, which is a barrier island approximately 7 miles long separating Estero Bay from the Gulf of Mexico. The island varies in width from about 400 feet at the north end to about 3,800 feet at the south end. The island is bounded by Matanzas Pass and San Carlos Bay to the north and Big Carlos Pass and Lovers Key to the south with Sanibel and Captiva Islands located northwest of Estero Island. The town is a highly developed resort community with a mixture of residential, commercial, hotel and public beach with many structures built close to the present shoreline.

Erosion of the Estero Island beach has long been an issue of concern for the residents of Fort Myers Beach. The 1969 Beach Erosion Control Study for Lee County conducted by the U.S. Army Corps of Engineers (USACE, 1969) was the first major study to address the issue of beach erosion and recommended that Estero Island be eligible for a federally sponsored beach nourishment project, which was authorized in 1970. Momentum towards constructing the nourishment project did not begin until the 1990's with the designation of the Island's beach as critically eroded by the Florida Department of Environmental Protection. Several supplemental studies of erosion on Estero Island have since been undertaken, including a general reevaluation report (GRR) in 2001 by the USACE (2001) and an independent project review in 2007.

The construction of the beach nourishment project was completed in early 2012. This was the first major beach nourishment on Estero Island other than periodic placement of sand on the beach from dredging of the Matanzas Pass. Due to concerns of its residents, the Town opted out of a cost sharing agreement with Lee County and the federal government which reduced the nourishment project from the originally planned extent of the northern 4.6 miles of Estero Island consisting of over 1,000,000 cubic yards of sand to approximately 1 mile of approximately 390,000 cubic yards of sand. Furthermore, numerous individual property owners along the revised nourishment length initially refused to sign easements allowing placement of the sand which would have resulted in a fragmented placement of sand fill along islands north end beach. One hole was constructed and remains today; others were avoided by shortening the extents of the nourishment project.

3 OBJECTIVE

The objective of the work in Phase 2 is to develop a Coastal Management Plan (CMP) for Estero Island. The CMP will lay out future work with the objective of stabilizing the shoreline and reducing the impact of erosion on Island infrastructure. The CMP will be designed with a detailed understanding of coastal processes controlling the morphology of the island and will work with these processes to develop the optimum solution.

The major work in the CMP is to determine the physical processes controlling the Estero Island shoreline erosion and ranking these processes relative to their contribution to erosion. This will be accomplished by (1) assessing existing knowledge from Lee County, FDEP and the Corps of Engineers, the Town, as well as other local coastal communities, (2) collecting new data where necessary to supplement the existing data base, and (3) engineering analysis and numerical modeling to quantify the coastal processes and test hypotheses on the causes of morphology and erosion. The CMP will also include the evaluation and determination of the performance and impacts of man-made structures on the coastal processes and morphology of the island's Gulf shoreline.

Based on an understanding of the natural and anthropogenic processes that control shoreline morphology, a set of engineered solutions (alternatives) will be developed with the goal of protecting and preserving the structural integrity of the barrier island shoreline. The performance of the alternative solutions will be evaluated with state-of-the-art coastal analysis tools. Preferred alternatives will be selected based on their performance in meeting the project goals and with the input of all project partners. The study should conclude with a preliminary design of the preferred project elements and a prioritization of their implementation.

The deliverable the Coastal Management Plan should consist of a detailed discussion of the morphology of Estero Island, coastal processes acting on the Island, a review of man-made coastal projects along Estero Island and their impact on the Island's morphology, discussion of the development of alternative solutions, the evaluation of the alternatives, and the selection of the preferred alternatives, and a preliminary design of the preferred alternatives.

The following sections describe the proposed methodology and work that should be accomplished.

4 DATA COLLECTION PLAN

This task is required to develop a reliable database of physical data and available knowledge on coastal processes relevant to the Estero Island shoreline that will be used as the basis for the engineering analysis and numerical modeling. The data collection effort includes compilation of existing (historical) data collected in Phase 1 (already completed) and new field data collection. Existing data applicable for the analysis and numerical modeling will be utilized as much as possible to minimize the new data collection program. Existing data has been identified during Phase 1 and knowledge of that data has been used in developing this work plan.

4.1 New Field Data Collection

A new, detailed field data collection program has been developed based on results of the Phase 1 – Coastal Management Plan Approach. Data to be collected includes historical aerial photos, oceanographic data (bathymetric and topographic surveys, current velocities, and waves) and geotechnical data.

4.1.1 Historic Aerial Photos

Historical aerial photos were compiled during Phase 1. A thorough record of historical aerial photos are available and have been compiled; many of the older photos will require rectification.

4.1.2 Bathymetric and Topographic Surveys

Historic topographic and bathymetric survey data are available from recent beach nourishment work and related studies. This data should be compiled and processed.

New bathymetric and topographic data collection should be conducted according to the standards of the Corps of Engineers manual EM110-2-1003 and should be of sufficient quality and detail for further engineering analysis and numerical modeling. The new data collection effort will maximize the use of the existing survey data. Where recent surveys have been conducted and an assessment shows that significant morphology is not likely to have occurred, the recent surveys shall be used in place of new data collection. The new data will overlap the existing data to maximize its use in historical morphological analyses. Offshore bathymetric data will be required to capture the detailed bathymetry offshore that governs wave transformation. Detailed beach transects should be collected along the length of Estero Island and Lovers Key. In addition, detailed bathymetric surveys should be conducted in Matanzas Pass, Big Carlos Pass, and New Pass, covering the pass itself as well as the flood and ebb shoals. Coarse bathymetric data of Estero Bay should be collected to supplement existing (but dated) bathymetry; this data is required for accurate hydrodynamic modeling. The data collection program should be presented to the TFMB for review and approval prior to execution.

4.1.3 Hydrodynamic Data Collection

Hydrodynamic data collection include measuring water surface elevation, current velocities, at several (likely two) sites using Acoustic Doppler Profilers (ADP), and waves using a directional wave gages (S4 gage or similar) at one location. The gages will be deployed with bottom-mounted stations or on existing piles if possible. The locations of the stations will be selected in coordination with the TFMB and chosen to obtain representative and reliable results. The measuring stations and the measuring frequency will be specified in a detailed data collection program. The hydrodynamic data should cover at least a one month period.

4.1.4 Geotechnical data collection

All existing sediment, geotechnical, and geophysical data were collected during the Phase 1 study. A thorough record of existing geotechnical data exists for the project vicinity to characterize the geotechnical properties of Estero Island, and no new geotechnical data collection on the island is needed.

Several borrow source investigations have been conducted, and the borrow source identified for the 2011/2012 beach nourishment project was stated to have sufficient quantity for future projects. Therefore, a new field investigation to identify a borrow source is not proposed. However, a desktop investigation should be conducted to identify if another potential borrow source could be utilized that may be more cost effective (such as the ebb shoal of Big Carlos Pass).

5 COASTAL ENGINEERING ANALYSIS PLAN

The objective of the engineering analysis is to develop and understanding of the island morphology and identify the causes of erosion and accretion along Estero Island to develop a basis for alternative development, selection, and evaluation.

5.1 Coastal and Morphological Processes Analysis

Hypotheses on the morphological processes and causes controlling shoreline accretion and erosion along Estero Island should be identified based on review of previous studies from Phase 1, analysis of relevant physical data and coastal processes, and experience with similar projects in the area. Engineering analysis will be required to validate previous findings with new data.

Coastal processes such as waves, winds, water levels, and sediment transport should be analyzed with analytical, empirical, and numerical modeling methods. Statistics of winds, waves, and water levels (storm surge) should be developed based on relevant up-to-date data. A shoreline change analysis should be conducted using available historical shorelines and aerial photos. New and historic bathymetric data should be used to developed volume changes and the relationship between shoreline change and volume change along the island.

A sediment budget should be developed for the Estero Island shoreline. Sediment sources and sinks including coastal processes, the effect of Matanzas Pass and Big Carlos Pass as well as man-made influences in the Estero Island littoral cell will be analyzed and incorporated into the sediment budget. The sediment budget will be used to explore trends in the patterns of sediment transport and transport pathways, and how it relates to erosion along the Estero Island shoreline.

5.2 Numerical Modeling of Existing Conditions

Numerical modeling should be performed to validate hypotheses on forces controlling shoreline erosion and accretion and to develop a basis for evaluation of alternatives. Numerical modeling should include simulation of wind-wave growth and propagation, tide-generated and wave-generated currents, and sediment transport. The numerical models to be used for this task should include (but are not limited to):

- Wave transformation models such as SWAN, BOUSS-2D, or similar. Wave transformation models should be used to determine wave conditions approaching the shoreline, refraction on shoals and diffraction around structures (where applicable). The wave model(s) should be forced by regional and local wind, and will be able to predict wave height, period, direction and relevant transport parameters within areas of interest along Estero Island. The primary use of wave modeling is to drive longshore transport calculations for shoreline morphology and in computing storm conditions at the island.
- Tidal current flow models ADCIRC or similar should be used to evaluate circulation. The modeling domain and mesh will be developed and validated using all available survey and tide data and will include all areas of interest. This model should be used to develop an understanding of inlet processes which are required to develop a sediment budget, and is required to force sediment transport modeling.
- Sediment transport models CMS, SEDTRANS, LAGRSED, DELFT3D, or similar will be used for sediment transport analyses. During this modeling effort the erosion-

accretion processes resulting from tide-generated and wave-generated currents will be simulated and evaluated.

- Shoreline and beach response models like GENESIS and/or SBEACH (storm-induced profile evolution) models will be used to view shoreline response and evolution (if needed),
- In addition to numerical models, reliable empirical and semi-empirical relationships may be used to predict shoreline response related to the proposed alternatives/strategies. These methods may be used alone or in combination with numerical models.

Model selection and data input for numerical modeling and modeling scenarios should be coordinated with the TFMB. All models selected for simulations should be verified and calibrated (where applicable) by comparison with historical or newly collected field data.

The main factors controlling shoreline stability along the Estero Island shoreline should be determined based on the results of coastal processes analysis and numerical modeling. The identified factors should be tested and/or validated with numerical modeling. The results of this work should be presented in the appropriate section of the study report.

6 ALTERNATIVES DEVELOPMENT AND EVALUATION PLAN

A range of potential long-term solution alternatives/strategies should be developed for stabilization and restoration of the Estero Island shore. The alternatives should address the causes (controlling factors) of shoreline erosion. The potential alternatives may include the alternatives proposed previously and/or new alternatives based upon the understanding of the physical processes along the Estero Island shoreline developed in this study. The range of alternatives for the analysis should be coordinated with the Town prior to detailed analysis.

Modeling and analysis should be conducted to evaluate proposed alternatives ability to perform relative to the project goals. Numerical modeling may include the simulation of the processes as described in Section 5 with the alternatives incorporated into the modeling domains. The results of numerical modeling will provide the basis for evaluation of the alternatives and proposed strategies for stabilization and restoration of the Estero Island shoreline, and for developing recommendations regarding the preferred alternative(s).

Alternatives should be developed to a conceptual level, including plan view and cross section drawings sufficient for an alternative analysis. A conceptual-level cost analysis will should be performed for each alternative and should include initial construction costs and estimates of maintenance requirements related to the project lifetime.

In addition, estimates of future maintenance requirements for each alternative (i.e. structure damage, beach nourishment) should be developed. If required, analysis should be performed (including numerical modeling) to develop data to support evaluation of proposed alternative environmental impacts.

The results of the evaluation of the alternatives should be placed in an alternatives analysis matrix that will compare all alternatives performance, cost, maintenance, impacts to adjacent structures and shorelines, aesthetics, long term stability, and expected permitting difficulty.

Other evaluation criteria may be developed in coordination with the Town of Fort Myers Beach. Recommendations should be made on the preferred alternative.

A preferred alternative should be selected in coordination with the Town of Fort Myers Beach based on the results of the work in this Section.

7 PLAN FOR PRELIMINARY DESIGN OF PREFERRED ALTERNATIVE(S)

After the preferred alternative(s) have been selected, a preliminary design of the preferred alternative(s) should be developed. The preliminary design is recommended to be performed prior to submitting a permit application in order to meet all requirement for permitting and also to ensure that sufficient details are designed to allow for accurate permitting and cost estimating. The preliminary design includes the following work:

- Develop preliminary level engineering design criteria for the preferred alternative consisting of a typical cross section(s) and plan view(s).
- Preliminary design conducted on up to 3 preferred alternatives.
- Engineering analysis and computations conducted to develop cross sectional geometric requirements for the selected alternative.
- Conduct a preliminary review of potential material suppliers for each alternative. For beach nourishment alternatives, sand sources should be based on previously conducted beach nourishment projects in the area. A new detailed sand source investigation is not proposed for this work.
- Meet and discuss project alternatives with local contractors to obtain input on constructability and construction costs.
- Develop a quantity and construction cost estimate for the preferred alternatives.
- Identify future analysis, design, data collection and schedule requirements for the preferred alternative.
- Identify environmental and permitting requirements for the preferred alternatives.
- Develop a section of the final report summarizing preliminary engineering design work.
- Preliminary engineering plans should be developed as the basis for future permitting and final design phase work.

8 REPORTING AND COORDINATION PLAN

Reporting of project tasks and coordinating results, conclusions and possible alternatives with the Town of Fort Myers Beach should be an integral part of the Feasibility Study. Coordination should be constant and continue throughout study execution; the methodology for this work is presented below.

8.1 Preliminary Engineering Report

A preliminary engineering report (50%) will be prepared and presented to the Town of Fort Myers Beach; it should include results of the study under Data Collection and Coastal Engineering Analysis.

The preliminary engineering report should summarize the review of existing data and describe the new field data collected and present the results of the engineering analysis, preliminary numerical model selection and calibration (including approach and methodology) to identify and evaluate the hypothesis on forces controlling shoreline stability. Also, the report should include the engineering recommendations and alternative strategies for feasible shoreline stabilization and restoration measures. A preliminary cost estimate for each alternative, including initial construction costs and maintenance requirements, should be presented in the report.

8.2 Final Engineering Report

The final engineering report should be prepared to discuss the results of the entire study. The report should include, but is not limited to:

- Sufficient design details and cost estimates to allow the preparation of construction plans and specifications for the preferred alternative
- data collection descriptions, and copies of all existing and new data (if acquired) collected in hard copy and digital format
- Hypotheses and assumptions used for the study and methodology of the analysis
- Analysis and modeling results, including selection of the models, development of the modeling grids and boundary conditions, model calibration and validation, descriptions of modeling scenarios and input data, and modeling results.
- Description of all alternatives developed for analysis
- Description of the evaluation of alternatives and recommendation of preferred alternative
- Recommendations (drawings and parameters) regarding preferred alternative(s) and cost estimates for initial construction and maintenance requirements for the life-time of the project
- Preliminary design level plans sufficient for initiation of permitting consultation and initiation of final design.

8.3 Coordination

Coordination between the study author and the TFMB will be required during the course of the study. Coordination should be conducted using conference calls at least twice per month and meeting such as, but not limited to, (1) a kick-off meeting, (2) a meeting and presentation with Town staff and other interested parties to discuss the results of work under Section 4 and 5, and (3) a meeting and presentation with Town staff and other interested parties to discuss the results of work at the completion of the work.

9 References

US Army Corps of Engineers (1969) Beach Erosion Control Study on Lee County, Florida. Prepared by the US Army Corps of Engineers Jacksonville District July 29, 1969.

US Army Corps of Engineers (2001) Lee County, Florida Shore Protection Project (Gasparilla and Estero Islands) General Reevaluation Report with Final Environmental Impact Statement. Prepared by the US Army Corps of Engineers Jacksonville District.

Coast & Harbor Engineering, Inc
Ft Myers Beach - Coastal Management Plan
Engineering Fee Estimate
J. Carter

COAST & HARBOR ENGINEERING

CHE - STAFF HOUR SUMMARY | Date: October 8, 2012

Item	Senior Principal Engineer $191.52	Senior Coastal Engineer $175.83	Principal Engineer $156.30	Engineer VII $147.12	Engineer VI $122.55	Engineer IV $113.94	Engineer III $105.30	Senior Designer $96.63	GIS/ CADD $87.24	Admin $61.50	Total Hours	Sub-Contractor Costs	Direct Reimbursable Expense	Sub and Expense Markup	Subtotal Cost	Total Cost
TASK 1 - Development of Project Understanding																$ 3,238
Kickoff Meeting and Site Visit (2 engineers, 2 days)			1	8		8					17				$2,245	
Produce Memo of Understanding			1	2		4			1		8				$994	
TASK 2 - Existing and New Data Collection																$ 74,848
2.1 Existing Data Processing; coordination (aerials, survey, hydro, geotech)			2	14			28	4	36		84				$8,848	
2.2 Topo/Bathy Data Collection (Sub)											0	$35,000		10%	$38,500	
2.3 Hydrodynamic Data Collection [OPTIONAL] (sub)											0	$25,000		10%	$27,500	
TASK 3 - Coastal Engineering Analysis																$ 46,032
Coastal Empirical and Analytical Analyses	1		2	20		24	32		24		103				$11,644	
Numerical Modeling of Existing Conditions	1		4	20		40	140				205				$23,059	
Alternatives Development	1		1	6		4	4		4		20				$2,456	
Prepare Technical Memorandum section; Meeting on Alts	1		2	16		24	24		8		75		$50 n1	10%	$8,873	
TASK 4 - Alternatives Analysis and Evaluation																$ 29,942
Alternatives Analysis (modeling) and Evaluation	1		4	40		52	48				145				$17,681	
Prepare Technical Report			6	20		22	24		12		84		$50 n1	10%	$10,016	
Meeting to discuss Alternatives evaluation and recommendations			1	8		8					17				$2,245	
TASK 5 - Preliminary (30%) Design [OPTIONAL]																$ 38,909
Coastal Engineering Anlayses in support of prelim design			1	16		30	40				87				$10,140	
Preparation of Prelim Plans and Cost Estimate			8	40		40	32	16	60		196				$21,843	
Final 30% Design Report			4	16		4	8				32		$50 n1	10%	$4,332	
Meeting to discuss Prelim design			1	8		8			4		21				$2,594	
TASK 6 - Coordination and Quality Control																$ 7,674
Coordination Meetings (2x per month); teleconference			12	12							24				$3,641	
Project Indepedant Quality Control	8		16								24				$4,033	
Total Hours:	13	0	66	246	0	268	380	20	149	0	1,142					
Labor Cost:	$2,490	$0	$10,316	$36,192	$0	$30,536	$40,014	$1,933	$12,999	$0						
SubTotal Costs	2,490	0	10,316	36,192	0	30,536	40,014	1,933	12,999	0	$ 134,478	$ 60,000	$ 150	$ 6,015		
TOTAL PROJECT COST																$ 134,234
TOTAL PROJECT COST with Optional Tasks																$ 200,643

Notes:
- Mileage at $0.51 / mile
- Hotel Maximum at $85 + tax / night
- Round flight to site $450
- Rental Car: state rate; ~$50/day
- Per Diem: $42/day

n1: reproduction and courier
n2: travel for 2 engineers to site
n3: travel for 1 engineers to site
n4: field engineer
n5: travel for progress meetings

Hydro Sub-consultant Budget	$25,000
Survey Sub-consultant Budget	$35,000
Environmental Sub-Consultant	NA
CHE Labor Budget	$134,478
CHE Direct Costs	$150
CHE Markup on Subs	$6,015
Total	**$200,643**

3

4

COAST & HARBOR ENGINEERING

Estero Island Coastal Management Plan
Phase 2 – Coastal Management Plan
Scope of Work and Fee Estimate

Introduction and Objective

The following Scope of Work was developed by Coast & Harbor Engineering (CHE) upon request from the Town of Fort Myers Beach (Town). Based on communication with the Town staff, it is desired that a comprehensive long-term Coastal Management Plan (CMP) be developed which includes the review of engineered solutions that maximize the long-term stability of the beach for the Gulf shoreline of Estero Island from Matanzas Pass to Big Carlos Pass.

Work in this phase will develop the Coastal Management Plan (CMP) with the goal of creating a detailed plan and priorities for future work with the objective of stabilizing the shoreline and reducing the impact of erosion on Island infrastructure. This work includes determining the physical processes controlling the Estero Island shoreline erosion, and ranking these processes relative to their contribution to erosion (where possible) through the transfer and coordination of knowledge gained regarding coastal processes from Lee County, FDEP and the Corps of Engineers as well as other local coastal communities. Collected data, engineering analysis, and numerical modeling will be used to develop an understanding of the morphology of the shoreline and nearshore dynamics, allowing for the identification and quantification of the controlling forces. The CMP will also include the evaluation and determination of the performance and impacts of man-made structures on the coastal processes and morphology of the island's Gulf shoreline. Based on an understanding of the natural and anthropogenic processes that control shoreline morphology, a set of engineered solutions (alternatives) will be developed with the goal of protecting and preserving the structural integrity of the barrier island shoreline. The performance of the alternative solutions will be evaluated with state-of-the-art coastal analysis tools. Preferred alternatives will be selected based on their performance in meeting the project goals and with the input of all project partners. The study will conclude with a preliminary design of the preferred project elements and a prioritization of their implementation. The deliverable for this Phase will be the Coastal Management Plan consisting of a discussion of the morphology of Estero Island, coastal processes acting on the Island, a review of man-made coastal projects along Estero Island and their impact on the Island's morphology, discussion of the development of alternative solutions, the evaluation of the alternatives, and the selection of the preferred alternatives, and a preliminary design and cost estimate of the preferred alternatives.

Assumptions

The following assumptions were made in the preparation of this Scope:

1. This Phase 2 Scope of Work does not include any permitting services.
2. Analysis performed for this phase of work is for the purpose of developing project understanding and for developing a preliminary design; additional analysis will be required during permitting and final design phases of the work.
3. Town will provide available relevant reports and data to CHE, if not already obtained from Phase 1 work.

Task 1. Development of Project Understanding

The goal of this task is to develop a detailed project understanding (objectives, deliverables, and schedule) with input from the Town and other project stakeholders. CHE will attend a project kickoff meeting in the Town of Fort Myers Beach to develop an understanding of the goals of the Coastal Management Plan. It is anticipated that the goals of this plan are:

1. Evaluate the historical natural and anthropogenic morphology, including historical construction activities, along the Estero Island Gulf Shorelines and adjacent Matanzas and Big Carlos passes in terms of their impact on the Estero Island shoreline.
2. Develop an understanding of coastal processes and forces that control short and long term shoreline morphology.
3. Develop a long-term engineering solution(s) and specific recommendations that maximize recreational beach stability for the Estero Island Gulf shoreline.
4. Develop a preliminary design of identified solutions(s), if required.

In addition to these goals, the meeting will also address project approach, deliverables, schedule, milestones, system of coordination, and project administration. The Project Team will discuss available and required project data and will familiarize itself with the data available from the Town and with the project site.

Task 1 Deliverable: A Memorandum of Project Understanding summarizing the project understanding including the project goals, schedule, and minutes from the kick off meeting and site visit.

Task 2. Existing and New Data Collection

This task is required to develop a comprehensive database of physical data and available knowledge on coastal processes relevant to the Estero Island shoreline that will be used as the basis for the coastal engineering analysis, alternatives analysis, and preliminary design. The data collection effort in Phase 1 included compilation of existing (historical) data; no new field data was collected. The existing data collected included a compilation of available data, reports, designs, permits, and publications from previous studies and designs sponsored by the Town of Fort Myers Beach, Lee County, U.S. Army Corps of Engineers, Florida Department of Environmental Protection, other state and federal agencies, as well as private consultants, that were submitted to municipalities or other public entities. The existing data on coastal processes were collected including waves, tides, currents, longshore sediment transport and sediment budgets, sand sources and related geophysical/geotechnical data, historical bathymetry and topography, and historical aerial photography.

Phase 1 identified that no new geotechnical or geophysical data are required, and also that a comprehensive topographic and bathymetric data collection effort as well as a hydrodynamic data collection effort are required. Therefore, this task includes new field topographic, bahtymetric, and hydrodynamic data collection as well as processing of the existing data collected during Phase 1 (geotechnical data and aerial photos) and processing of new data collected in this Phase.

Task 2.1. Existing Data Collection and Processing

Work performed in this task includes processing the data collected in Phase 1 and the new field data collected during this phase of the project. Data collected in Phase 1 that requires processing includes Geotechnical data on the island itself and of potential borrow sites, historical topographic and bathymetric surveys, and historical shoreline positions. In addition, most of the older aerial photos require rectification to be made useful. The new data to be collected that requires processing for use are the topographic and bathymetric surveys and the proposed hydrodynamic data (water surface elevation, current velocity, and waves).

Task 2.2. New Bathymetric and Topographic Survey

Bathymetric and topographic data collection will be conducted with regard to the standards of the Corps of Engineers manual EM110-2-1003 and will be of sufficient quality and detail for further engineering analysis and numerical modeling.

Topographic and bathymetric survey data is available from recent beach nourishment activity and ongoing monitoring at R-monuments. The new data collection effort will maximize the use of the existing survey data - the new data will overlap the existing data to maximize its use in historical morphological analyses. Detailed beach transects will be collected along the length of Estero Island and Lovers Key. In addition, detailed bathymetric surveys will be conducted in Matanzas Pass, Big Carlos Pass, and New Pass, covering the pass itself as well as the flood and ebb shoals. Coarse bathymetric data of Estero Bay will be collected to supplement existing (but dated) bathymetry; this data is required for accurate hydrodynamic modeling. The data collection program should be presented to the Town for review and approval prior to execution

Task 2.3. Hydrodynamic Data Collection [OPTIONAL]

Hydrodynamic data collection include measuring water surface elevation, current velocities, at several (likely two) sites using Acoustic Doppler Profilers (ADP), and waves using a directional wave gages (S4 gage or similar) at one location. The gages will be deployed with bottom-mounted stations or on existing piles if possible. The locations of the stations will be selected in coordination with the Town and chosen to obtain representative and reliable results. The measuring stations and the measuring frequency will be specified in a detailed data collection program. The hydrodynamic data should cover at least a two week period, with a one month period preferred.

Task 2 Deliverable:

- A section in the Task 3 and Task 4 technical memo summarizing the available existing and historical data, studies, reports, and any available knowledge on coastal processes relevant to the Estero Island shoreline as well as a description of the new data collected.
- Data will be delivered to the Town in digital format on a CD included with the Task 4 Technical Memo.

Task 3. Coastal Engineering Analysis and Development of Alternatives

The objective of the coastal engineering analysis is to develop an understanding of the island morphology and identify the causes of erosion and accretion along Estero Island to develop a basis for alternative development, selection, and evaluation.

Task 3.1 Coastal and Morphological Processes and Analysis

Hypotheses on the morphological processes and causes controlling shoreline accretion and erosion along Estero Island will be identified based on review of previous studies from Phase 1, analysis of relevant physical data and coastal processes, and experience with similar projects in the area. Engineering analysis will be required to validate previous findings with new data.

Coastal processes such as waves, winds, water levels, and sediment transport will be analyzed with analytical, empirical, and numerical modeling methods. Statistics of winds, waves, and water levels (storm surge) will be developed based on relevant up-to-date data. A shoreline change analysis will be conducted using available historical shorelines and aerial photos. New and historic bathymetric data will be used to developed volume changes and the relationship between shoreline change and volume change along the island.

A sediment budget will be developed for the Estero Island shoreline. Sediment sources and sinks including coastal processes, the effect of Matanzas Pass and Big Carlos Pass as well as man-made influences in the Estero Island littoral cell will be analyzed and incorporated into the sediment budget. The sediment budget will be used to explore trends in the patterns of sediment transport and transport pathways, and how it relates to erosion along the Estero Island shoreline.

Numerical modeling will be performed to validate hypotheses on forces controlling shoreline erosion and accretion and to develop a basis for evaluation of alternatives. Numerical modeling should include simulation of wind-wave growth and propagation, tide-generated and wave-generated currents, and sediment transport. All models selected for simulations will be verified and calibrated (where applicable) by comparison with historical or newly collected field data. The numerical models to be used for this task will likely include:

- Wave transformation models such as SWAN, BOUSS-2D, or similar. Wave transformation models will be used to determine wave conditions approaching the shoreline, refraction on shoals and diffraction around structures (where applicable). The wave model(s) should be forced by regional and local wind, and will be able to predict wave height, period, direction and relevant transport parameters within areas of interest along Estero Island. The primary use of wave modeling is to drive longshore transport calculations for shoreline morphology and in computing storm conditions at the island.
- Tidal current flow models such as ADCIRC or similar will be used to evaluate circulation. The modeling domain and mesh will be developed and validated using all available survey and tide data and will include all areas of interest. This model will be used to develop an understanding of inlet processes which are required to develop a sediment budget, and are required to force sediment transport modeling.
- Sediment transport models CMS, DELFT3D, SEDTRANS, or similar will be used for sediment transport analyses. During this modeling effort the erosion-accretion processes resulting from tide-generated and wave-generated currents will be simulated and evaluated.
- Shoreline and beach response models like GENESIS and/or SBEACH (storm-induced profile evolution) models will be used to view shoreline response and evolution (if needed).
- In addition to numerical models, reliable empirical and semi-empirical relationships may be used to predict shoreline response related to the proposed alternatives/strategies. These methods may be used alone or in combination with numerical models.

The main factors controlling shoreline stability along the Estero Island shoreline will be determined based on the results of coastal processes analysis and numerical modeling. The identified factors will be tested and/or validated with numerical modeling.

3.2 Development of Alternative Solutions

A range of potential long-term solution alternatives/strategies will be developed for stabilization and restoration of the Estero Island shoreline. The alternatives should address the causes (controlling factors) of shoreline erosion. The potential alternatives may include the alternatives proposed previously and/or new alternatives based upon the understanding of the physical processes along the Estero Island shoreline developed in this study.

The range of alternatives for the analysis will be coordinated with the Town prior to detailed analysis though a meeting to take place in Ft Myers Beach. During this meeting, criteria by which the proposed alternatives should be evaluated will be presented and discussed for use in the alternatives analysis.

Task 3 Deliverable: Technical memorandum describing existing and new data collection and processing, coastal processes acting at the site, factors controlling Estero Island morphology, and a discussion of the proposed alternative solutions and evaluation criteria. Delivered electronically via email in PDF format and as 2 hard copies.

Task 4. Alternatives Analysis and Evaluation

Modeling and analysis will be conducted to evaluate proposed alternatives ability to perform relative to the project goals and evaluation criteria developed in Task 3. Numerical modeling may include the simulation of the processes as described in Task 3 with the alternatives incorporated into the modeling domains. The results of numerical modeling and analysis will provide the basis for evaluation of the alternatives and proposed strategies for stabilization and restoration of the Estero Island shoreline, and for developing recommendations regarding the preferred alternative(s).

Alternatives will be developed to a conceptual level, including plan view and cross section drawings sufficient for an alternatives analysis. A conceptual-level cost analysis will be performed for each viable alternative and will include initial construction costs and estimates of maintenance requirements related to the project lifetime.

In addition, estimates of future maintenance requirements for each alternative (i.e. structure damage, beach nourishment) will be developed. If required, analysis will be performed (including numerical modeling) to develop data to support evaluation of proposed alternative environmental impacts.

The results of the evaluation of the alternatives will be placed in an alternatives analysis matrix that will compare all alternatives performance, cost, maintenance, impacts to adjacent structures and shorelines, aesthetics, long term stability, and expected permitting difficulty. Other evaluation criteria may be developed in coordination with the Town. CHE will recommend the preferred alternative. However, the preferred alternative (or alternatives) will be selected in coordination with the Town based on the results of the work in this Task to be used for preliminary design.

Task 4 Deliverable: Technical Report - delivered electronically via email in PDF format and as 2 hard copies - that compiles the describing the work performed in Tasks 1 through 4, including:

- Data collection descriptions and copies of all existing and new data (if acquired) collected in digital format
- Hypotheses and assumptions used for the study and methodology of the analysis
- Analysis and modeling results, including development of the modeling grids and boundary conditions, model calibration and validation, descriptions of modeling scenarios and input data, and modeling results.
- Description of all alternatives developed for analysis
- Description of the evaluation of alternatives and recommendation of preferred alternative
- Recommendations (drawings and parameters) regarding preferred alternative(s) and cost estimates for initial construction and maintenance requirements for the life-time of the project

Task 5. Preliminary (30%) Design [OPTIONAL]

After the preferred alternative(s) have been selected, a preliminary design of the preferred alternative(s) will be developed. The preliminary design is recommended to be performed prior to submitting a permit application in order to meet all requirements for permitting and also to ensure that sufficient details are designed to allow for accurate permitting and cost estimating. The preliminary design includes the following work:

- Develop preliminary level engineering design criteria for the preferred alternative consisting of a typical cross section(s) and plan view(s).
- Preliminary design conducted on up to 3 preferred alternatives.
- Engineering analysis and computations conducted to develop cross sectional geometric requirements for the selected alternative(s).
- Conduct a preliminary review of potential material suppliers for each alternative. For beach nourishment alternatives, sand sources will be based on previously conducted

beach nourishment projects in the area. A new detailed sand source investigation is not proposed for this work.

- Develop a quantity and construction cost estimate for the preferred alternative(s).
- Identify any future analysis, design, data collection and schedule requirements for the preferred alternative(s).
- Identify environmental and permitting requirements for the preferred alternative(s).
- Develop a section of the final report summarizing preliminary engineering design work.
- Preliminary engineering plans should be developed as the basis for future permitting and final design phase work. Note that additional work is expected to be required prior to preparing permit application and permit plans.

The preliminary engineering design report shall be prepared to discuss the results of the entire study. The report should include, but is not limited sufficient design details, conceptual construction approach, and cost estimates to act as the basis for the completion of a final design for the preferred alternative(s), and preliminary design level plans sufficient for initiation of permitting consultation and initiation of final design

Task 6. Coordination and Quality Control

Coordination between CHE and the Town will be required during the course of the study. Coordination should be conducted using conference calls at least twice per month. In addition, CHE will utilize an independent senior principal or senior engineer to review major project decisions and deliverable to ensure compliance with industry standards and to ensure the product is accurate and correct.

PHASE 2 – Coastal Management Plan

Project Schedule:

Task 1 – Development of Project Understanding .... *2 weeks from NTP*
Task 2 – Existing and New Data Collection .... *8 weeks from NTP*
Task 3 – Coastal Engineering Analysis and Development of Alternatives .... *14 weeks from NTP*
Task 4 –Alternatives Analysis and Evaluation .... *22 weeks from NTP*
Task 5 – Preliminary (30%) Design .... *26 weeks from NTP*
Task 6 – Reporting and Coordination .... *ongoing throughout project*

Total Time .... 22-26 Weeks

Cost Summary:

Task 1 – Development of Project Understanding .... *$ 3,238*
Task 2 – Existing and New Data Collection .... $ 47,348 to $ 74,848
Task 3 – Coastal Engineering Analysis and Development of Alternatives .... $ 46,032
Task 4 –Alternatives Analysis and Evaluation *$29,942*
Task 5 – Preliminary (30%) Design [OPTIONAL] .... *$ 38,909*
Task 6 –Coordination and Quality Control .... *$ 7,674*

Total Cost $134,234

Total Cost with Optional Tasks $200,635