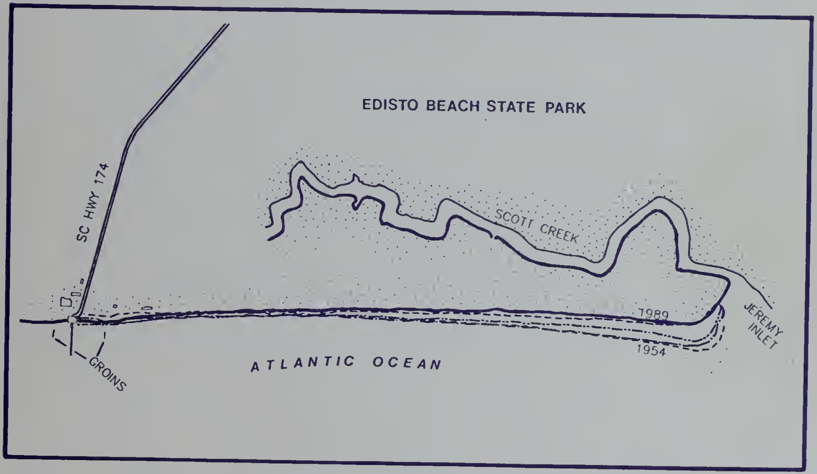
FEASIBILITY STUDY

EROSION ASSESSMENT AND BEACH RESTORATION ALTERNATIVES FOR EDISTO BEACH STATE PARK



Historical Shorelines

Prepared for:

South Carolina Department of Parks,
Recreation and Tourism

COASTAL SCIENCE & ENGINEERING, INC.

FEASIBILITY STUDY

EROSION ASSESSMENT AND BEACH RESTORATION ALTERNATIVES FOR EDISTO BEACH STATE PARK, SOUTH CAROLINA

Prepared for:

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INTRODUCTION

This report outlines findings and recommendations regarding beach restoration alternatives for Edisto Beach State Park, South Carolina. It is prepared in connection with an erosion assessment study of Hunting Island and Edisto Beach State Parks by Coastal Science & Engineering, Inc. (CSE), under contract to the South Carolina Department of Parks, Recreation and Tourism (PRT). Recommendations herein are limited to Edisto Beach State Park.

The report outlines key findings of previous studies, new surveys accomplished, and an updated analysis of erosion rates. Because of previous studies covering the area, including a 1987 shorefront management plan for all of Edisto Beach by Cubit Engineering, Ltd. (CUBIT), lengthy discussions of old data have been omitted. Instead, the emphasis of the present report is on alternatives. There are several reports on Edisto Beach's erosion problem dating back to 1949, and reviewers of this report and its recommendations are directed to the original reports annotated in Table 1 for further background information.

Edisto Beach State Park has experienced erosion over the past 50 years, although the rate has been moderate. Park facilities have been able to accommodate erosion, partly because only ±3,200 ft of shoreline north of Collins Restaurant comprise the campground and the remaining ±4,500 ft are an undeveloped barrier spit ending at Jeremy Inlet. Erosion increases from south to north along the state park. A system of groins, beginning about 400 ft north of the Collins Restaurant where Route 174 turns down the beach, has helped to reduce the erosion rate at the south end of the park. Despite the presence of groins every 600 ft or so along the remainder of Edisto Beach, erosion is the predominant trend for over one mile south of the park. A nourishment project was constructed in 1954 along the beach section south of the park using sediment from the back side of the island. There is no evidence that the park directly benefitted from the 1954 project because of the predominance of southerly sand transport along the coast in the area; however, the park erosion rates for the period 1954-1957 were less than normal as detailed later in the report.

The question of whether remedial measures, such as nourishment or shore-protection structures, are justified is a management decision. The present report is intended to address the technical and longevity requirements of shore protection and outlines several alternatives for Edisto Beach State Park. Costs of each alternative may then be weighed against recreational benefits (the anticipated primary impact), improved storm-damage reduction, and reduction of land loss.

PREVIOUS STUDIES & BEACH RESTORATION PROJECTS

The majority of erosion studies of Edisto Beach were prepared by the U.S. Army Corps of Engineers (USACE) (Table 1). Others were prepared by the University of South Carolina (USC) and CSE as part of statewide beach erosion reports. The most detailed report to date is the Edisto Island shorefront management plan prepared in 1987 for the South Carolina Coastal Council (SCCC) by CUBIT. The USACE completed the most recent report, *Reconnaissance Report for Edisto Beach, South Carolina,"* in April 1990. The reconnaissance report covers the beach south of the park and presents recommendations for a 407,200 cubic yard (cy) nourishment project extending 1.5 miles south from the Collins Restaurant.

With the exception of the USC (1975) report, all previous studies confirm a trend of increasing erosion in a northerly direction over the northern two-thirds of the Edisto oceanfront. This trend is offset by long-term accretion at the southern tip of the island. Volumetric erosion within the state park beach was first estimated at 55,000 cubic yards per year (cy/yr) by the USACE (1969). Other long-term volumetric erosion estimates for the park have been lower, including CUBIT's 1987 estimate of 20,700 cy/yr (long term).

The only prior protective measure within the state park shoreline was construction of a groin 400 ft north of Collins Restaurant (former ocean pier site). The first groin at the site was built of palmetto logs in 1948 as part of the groin field built by the South Carolina Highway Department (SCHD) to protect Route 174 and cottages south of the park. At some time in the 1950s or early 1960s, the original groin was replaced by a composite groin made of timber piles and rock extending 165 ft. Groin spacing south of the park is approximately 600 ft. In 1954, the SCHD dredged ±830,000 cy from Scott Creek at the back side of the island. Marsh sediments, including sand and mud, were placed as nourishment material between groin 3 and groin 12 (numbered north to south) with the intent to build up the beach and provide extra protection. According to the USACE (1969), this project moved the shoreline up to 210 ft seaward along the discharge area, or an average of 55 ft considered over the entire system. There is no published record of the nourishment cost in 1954.

It has been concluded by USC (Stephen et al., 1975), CUBIT (1987), and USACE (1990) that the Edisto Beach groin field has been effective in reducing the rate of erosion. CUBIT (1981, 1987) provided detailed analyses of the groin field and made specific recommendations for maintenance or upgrading of the structures. Repairs were completed in 1989 and 1990, generally following Cubit's recommendations (S.L. Smith, pers. comm.).

Recent Planning

In July 1989, PRT submitted a request to the SCCC for beach nourishment funds under the state's Beach Management Trust Fund authorized by the legislature that year (PRT, 1989). PRT's request was for a 3,300 ft project (USACE stations 0+00 to 33+00) totaling ±231,612 cy. Project cost was estimated at $1,040,904 based on approximately $4.50/cy. No borrow site was designated, but PRT proposed an investigation if and when funds were awarded. The request included an estimate of 23.4 years design life for the project based on average erosion of 3.0 cy/ft/yr.

Just prior to Hurricane *Hugo* in September 1989, the SCCC allocated $50,000 toward further studies of Edisto Beach (SCCC memorandum dated September 15, 1989). These funds were withdrawn following *Hugo* (September 21) because of emergency nourishment projects in the Grand Strand. Officials from the Town of Edisto and PRT are in the process of developing a new funding request for nourishment pending the outcome of the present study and recent work by the USACE.

TABLE 1. Annotated listing of selected reports on Edisto Beach erosion.

CSE = Coastal Science & Engineering, Inc.
CUBIT = Cubit Engineering, Ltd.
SCCC = South Carolina Coastal Council
SCWMRD = South Carolina Wildlife & Marine Resources Division
SCSG = South Carolina Sea Grant Consortium
USC = University of South Carolina
USACE = U.S. Army Corps of Engineers

Date Agency	Title of Report	•Key Findings

1949
USACE

Cooperative Beach Erosion Study — State of South Carolina

- •First erosion report available recommends continued study of the use of palmettos log groins and calls for 20 groins along a 12,000-ft reach at 600-ft spacing.
- •Reports 1940 hurricane cut back sand dunes 30-120 ft, destroyed 51 beach cottages and damaged 125 others.
- •Park cottages had been moved to mainland prior to the study.
- •Reports shells common on Edisto Beach for over 60 years; peaty clay outcrops near MSL on "most beaches."
- •Reports winter of 1947-1948 produced strong northeast winds and extensive erosion; northeasters considered to have greater cumulative effect than hurricanes.
- •Reports 1851-1949 erosion rate averaged 450 ft (-4.6 ft/yr).
- •Reports storm of record in 1893 with an 11.5 ft mean low water (MLW) surge.
- •Reports park beach contains a usable area of 20 acres having elevations greater than 12 ft MLW.
- •Reports the following grain-size data:

Location	Mean Size (mm)	
	W/Shell	WO/Shell
State Park	0.21	0.18
Collins Pier	0.24	0.19
South of pier (1,600 ft)	0.64	0.55

- •Recommends beach nourishment using a "plentiful supply" of suitable material along a tidal stream in rear of the island and south of the entrance highway.

1965
USACE

Hurricane Survey, Edisto and Hunting Island Beaches, South Carolina

- •Reports Hurricane *Gracie* (1959) produced $80,000 damages.
- •Estimates average annual storm damages (1893-1963) of $9,800/yr.
- •Reports 450 houses existing and a year-round population of 40.
- •Value of real estate and infrastructure estimated at $3,600,000.
- •Report assumes most severe hurricane would cause $3,600,000 in damages (i.e., 100 percent).
- •Reports local interests do not desire any hurricane protection.
- •Presents a generic beach/dune protection system with dimensions to 15 ft MSL, 25-ft crest width, and 1 on 20 beach slope.

1969
USACE

Edisto Beach, Charleston County, South Carolina
(detailed project report on beach erosion control)

- •Provides first estimate of volumetric erosion within the park at 55,000 cy/yr; based on one square foot, "beach area loss" equals 1 cy volumetric erosion (loss of 1.3 acres/yr).
- •Formulates a nourishment project for the park at 248,000 cy (initial) and 82,500 cy (renourishment at 3-year intervals).

TABLE 1. (continued) Annotated listing of selected reports on Edisto Beach erosion.

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Date Agency	Title of Report	•Key Findings
(cont.)		•Reports B/C ratio for formulated project at 0.9 to 1.0 consequently does not recommend authorization. •Reports 169,000 users during 1968. •Reports regional erosion trend (1854-1956) of decreasing erosion from Botany Island (-34 ft/yr) to Jeremy Inlet (-9.6 ft/yr) to Collins Pier (-2.6 ft/yr); accretion averaged +14.3 ft/yr at the south end of the beach. •Reports higher erosion rates in nourished section after the 1954 project (est. 40,000 cy/yr from the section). •Reports beach profile slopes at north end (1 on 22) and south end (1 on 6). •Provides prediction of 25-year future shorelines (1992) and loss of 20 acres of marsh between 1966 and 1992. •Reports median grain diameter of beach and inshore sediments is 2.8ϕ (0.144 mm). •Proposes eight groins, 340-400 ft long at two-times groin-length intervals for the park area. •Establishes stationing from groin 2 (existing is 0+00 south of Collins Pier) to Jeremy Inlet (~77+00). •Proposes lower Scott Creek north of Route 174 along the back beach as a borrow site for nourishment.
1975 USC	**Beach Erosion Inventory of Charleston County, South Carolina** (Stephen et al., 1975)	•Reports general stability of Edisto Beach for the period 1949-1973 based on vertical aerial photographs. •Reports erosion rates at Jeremy Inlet (-5.4 ft/yr), park campsite area (-2.0 to -4.1 ft/yr), area one-half mile south of Collins Pier (-0.7 ft/yr), and south end of beach (-14.4 ft/yr). •Reports the erosion trend at the south end of Edisto Beach for 1949-1973 is opposite the long-term trend reported by USACE and others. [CSE note: Short-term erosion at the south end during the 1970s probably contributed to damage during Hurricane *David* in September 1979. During the 1980s, this part of Edisto Beach accreted by several hundred feet.]
1978 SCWMRD	**Sand Transport at Edisto Beach, Colleton County, South Carolina** (Stapor, 1978)	•Reports long-term accretion at south end of beach for 1856-1957 period based on nautical charts; confirms USACE findings. •Monitored currents and detected net southerly flow.

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Date Agency | **Title of Report** | **•Key Findings**

1987
CUB

Shorefront Management Plan, Edisto Island, South Carolina

- Most detailed evaluation of Edisto Beach to date; also drew from previous CUB studies of Edisto in 1981 and 1984.
- Reports erosion rates (smoothed) for 1920-1983 as follows for park:

Location	Profile	Ft/Yr
Jeremy Inlet	16	-3.4
	15	-3.3
2,000 ft north of north campsite	14	-2.9
North edge of campsite	13	-2.5
Campsite 13	12	-2.3
South end of park	11	-1.9

- Reports long-term accretion at south end at 6.1 ft/yr (131 years) with higher rates prior to 1920.
- Ran dune erosion model for various return period storms and predicted ±32 ft of erosion or 8.7 cy/ft erosion during a 25-year storm.
- Reports sediments vary from coarse (~1.0 mm) to fine (0.18 mm) from north to south.
- Recommends beach nourishment from Marianne Street (groin 18) to Jeremy Inlet as follows: 197,000 cy at $4-5/cy (5-6 year renourishment cycle).
- Reports long-term erosion at park estimated at 20,700 cy/yr.
- For the period 1981-1987 when comparative profiles are available, reports 50,300 cy/yr along the town beach versus 10,300 cy/yr (long-term record for the town beach). No comparative profiles available within the park.
- Recommends groin maintenance for groins 1-23 and repair of seaward end with graded "riprap"; also extend groins to MLW and repair from south to north.
- Report provided basis for interim baselines and setback lines.

1987
PRT

Letter Dated January 26, 1987, to USACE

- Formal request for emergency assistance following the 1987 New Year's Day northeaster.
- Provides an estimate of 47,000 cy of sand lost along the park during the storm.

1988
CSE

Analysis of Beach Survey Data Along the South Carolina Coast
October 1987 — August 1988 (Eiser et al. 1988)

- Reports 14 cy/ft erosion (average) between June 1987 and June 1988 (dunes to -5 ft NGVD contour) using profiles BP 1-16 established by CUB.
- Mean unit-width volumes ranged from 84 cy/ft to 98 cy/ft.
- Reports 11.4 cy/ft erosion for same period at the north end of the campsite; unit-width volume there was 54.1 cy/ft to 65.5 cy/ft during the period or about 66 percent of average for Edisto Beach.
- Reports 21 cy/ft erosion for the period at campsite 13 when unit volumes ranged from 88.6 cy/ft to 109.4 cy/ft.

TABLE 1. (continued) Annotated listing of selected reports on Edisto Beach erosion.

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Date Agency	Title of Report	•Key Findings
1989 PRT	**Beach Renourishment Proposal, Edisto Beach State Park**	•Request for funding presented to the SCCC outlining a 231,612 cy nourishment project extending from USACE station 0+00 (groin) to station 33+00. •Design calls for approximately 100 ft berm at +10 ft MSL and 1 on 25 slope along beach face. •No borrow site designated. •First costs estimated at $1,040,904 (±$4.50/cy). •Reports visitation in fiscal 1985-1986 was 235,258 people.
1990 USACE	**Edisto Beach, South Carolina — Reconnaissance Report**	•Report covers Town of Edisto only. •Recommends beach nourishment project for 1.5 mile reach south of Collins Restaurant at 407,200 cy with eight-year renourishment cycle of ±139,200 cy. •Recommends ebb shoals at south end of island be investigated further for use as a borrow site; other potential borrow areas are the boat channel (1954 borrow area) and inland deposits at The Neck. •Estimates that without the project, average annual structural damage will be $521,000 and about 0.25 acres per year will be lost; with the project, average annual structural damage reduces to $224,000. •Nourishment design section calls for 20 ft berm at elevation +9 ft NGVD and beach slope of 1 on 20. •Estimates cost of project at $1,986,400 including mobilization ($462,000), sand placement ($2.75/cy), contingencies ($274,000), and engineering ($180,600). •Requires 50 percent cost share with town for development of feasibility study (estimated total cost $550,000) before proceeding with project.

SCOPE OF SERVICES & WORK ACCOMPLISHED

CSE's services and work accomplished through August 1990 include:

1) Data review.
2) Field surveys (topographic and geotechnical).
3) Engineering analysis.
4) Preparation of alternative plans.

Data Review

In addition to the reports annotated in Table 1, CSE used the data sources listed in Table 2 to analyze shoreline changes and volumetric erosion rates. These included original surveys by the USACE in connection with their 1969 report on Edisto Beach erosion, recent surveys by the SCCC, and historical vertical photographs from the U.S. Department of Agriculture. CSE supplemented these data with a resurvey of SCCC profiles in April. For purposes of comparison, USACE stations situated close to SCCC beach survey markers were emphasized in our analysis. The USACE established a baseline in 1966 for early surveys; unfortunately, control was lost except for one starting point (0+00) at groin 2 near Collins Restaurant. Linear distances along the shoreline were recoverable but displacement landward or seaward could not be determined accurately from original field notes or related to the present shoreline. To approximate volumetric changes since 1966, recent SCCC profile lines were juxtaposed with the nearest USACE profile line and overlain at positions that correlated with shoreline positions developed from historical aerial photography.

Historical aerial photographs (approximately 1 inch = 400-ft scale) were analyzed using base maps prepared by Greenhorn and O'Mara and Wilbur Smith Associates (circa 1983) for control points and photo rectification. Vegetation lines and the dry-sand/wet-sand contact line (approximate high watermark) were digitized in AutoCad^{TM} format for the years 1954 to 1989 (Table 2). Shoreline change rates were computed from digitized shorelines at nine points approximately corresponding to the present location of SCCC beach survey stations and/or earlier USACE stations. For time periods not covered in the above analyses, we took the results of previous studies by the USACE and CUBIT at face value. These results extend the time period of interest back to 1851 for certain erosion rates.

TABLE 2. Data sources used in the present study to update shoreline changes and volumetric erosion rates.

I. Vertical Aerial Photographs (U.S. Department of Agriculture)

Date	Enlarged Scale
May 1954	1 in = 400 ft
Dec 1957	1 in = 400 ft
Mar 1973	1 in = 800 ft
Feb 1984	1 in = 800 ft
Feb 1989	1 in = 400 ft

II. Beach Surveys

Date	Agency
July 1986	USACE
October 1988	SCCC
April 1990	CSE

Locality	SCCC Station	Corresponding USACE Station
Collins Restaurant Groin 2	2200	0+00
	N/A	2+50
	N/A	11+50
	2210	22+50
	2230	29+50
	N/A	40+75
	2250	50+75
	2270	62+25
Near Jeremy Inlet	N/A	72+25

III. Other Quantitative Erosion Surveys Referenced

USACE (1949)	Stephen et al. (1975)	CUBIT (1987)
USACE (1969)	Stapor (1978)	Eiser et al. (1988)

Field Surveys

In addition to general inspections of the site, CSE reoccupied five existing SCCC stations within the park and surveyed beach profiles to -5 ft NGVD (low-tide wading depth) in April. During June, CSE mobilized a 45-ft catamaran survey vessel by subcontract and obtained five cores at potential borrow sites offshore of Edisto Beach. Two cores were obtained directly offshore from the Collins Restaurant, and three cores were obtained around the north shoal of the South Edisto River ebb-tidal delta. Cores average eight feet long.

Engineering Analyses and Preparation of Alternative Plans

The above-mentioned data were analyzed to compute sand budgets for the period 1966 to present, evaluate sediment compatibility of selected core samples, and develop alternative beach-fill sections. The primary alternatives evaluated were:

1) **Do nothing** – prediction of future trends in 10 years and 25 years if no remedial measures are implemented.
2) **Moderate-scale beach nourishment** – predicated on a design life around 10 years.
3) **Beach nourishment with sand-retaining structures** – predicated on a design life for the fill around 10 years and for structures around 25 years.

GEOTECHNICAL DATA

Five vibracores were obtained in June off Edisto Beach (Fig. 1) to determine if there were any potential borrow areas immediately offshore of the park. Two cores, ED-1 and ED-2, were collected 1,800 ft and 3,800 ft offshore from the Collins Restaurant (south end of the park), respectively. Cores ED-3, ED-4, and ED-5 were collected around the north shoal of south Edisto Inlet ebb-tidal delta. Hard-packed sand and shell, indicative of swash platforms subject to breaking wave energy, were encountered in the latter cores. As a result, penetration was limited for two of them. Past experience at Seabrook indicates swash platforms of ebb-tidal deltas often contain excellent, clean, sandy or shelly material perched on the antecedent shoreface or drowned river beds (CSE, 1989). Cores ED-3 and ED-5 both fit this description and are believed to overlie additional clean sand for beach nourishment. Core ED-4 was obtained in deeper water at the margin of the channel (Fig. 1) and encountered mud at several intervals over the 11-ft core.

An inland borrow site was also considered for investigation early in the feasibility study. Discussions with PRT officials indicated some land off the beach within the park on Edisto Island might be available for excavation of ponds. If so, material could be trucked to the beach in a manner similar to the Myrtle Beach nourishment project (Kana and Jones, 1988). Athena Technologies, Inc., investigated a comparable 20-acre upland borrow site in "The Neck" area about one mile northwest of the park. On the basis of 14 sand samples taken from cores for comparison with native beach sands, it was concluded by the USACE (1990) that overfill ratios on this material would be exceedingly high, at 10 to 1, or worse. While better sediment may occur somewhere on park property other than "The Neck," we elected to emphasize the offshore search during this stage of the project. Cursory inspections and familiarity with the sediments in ebb-tidal delta shoals suggested the offshore material might have a better chance of matching the present beach sediments than inland park deposits.

Table 3 lists the cores, length recovered, Loran coordinates, and approximate water depth at the site when the cores were taken. Each two-inch-diameter core was opened, logged, photographed, and split for sampling and archiving. Sediment samples (composites) were taken from representative sections exhibiting similar lithologies (texture, sediment size, and type). Six sediment samples were processed by wet and dry sieving to determine size gradations and mud content. Table 4 includes summary grain-size results. Appendix I contains the set of core logs and grain-size statistics.

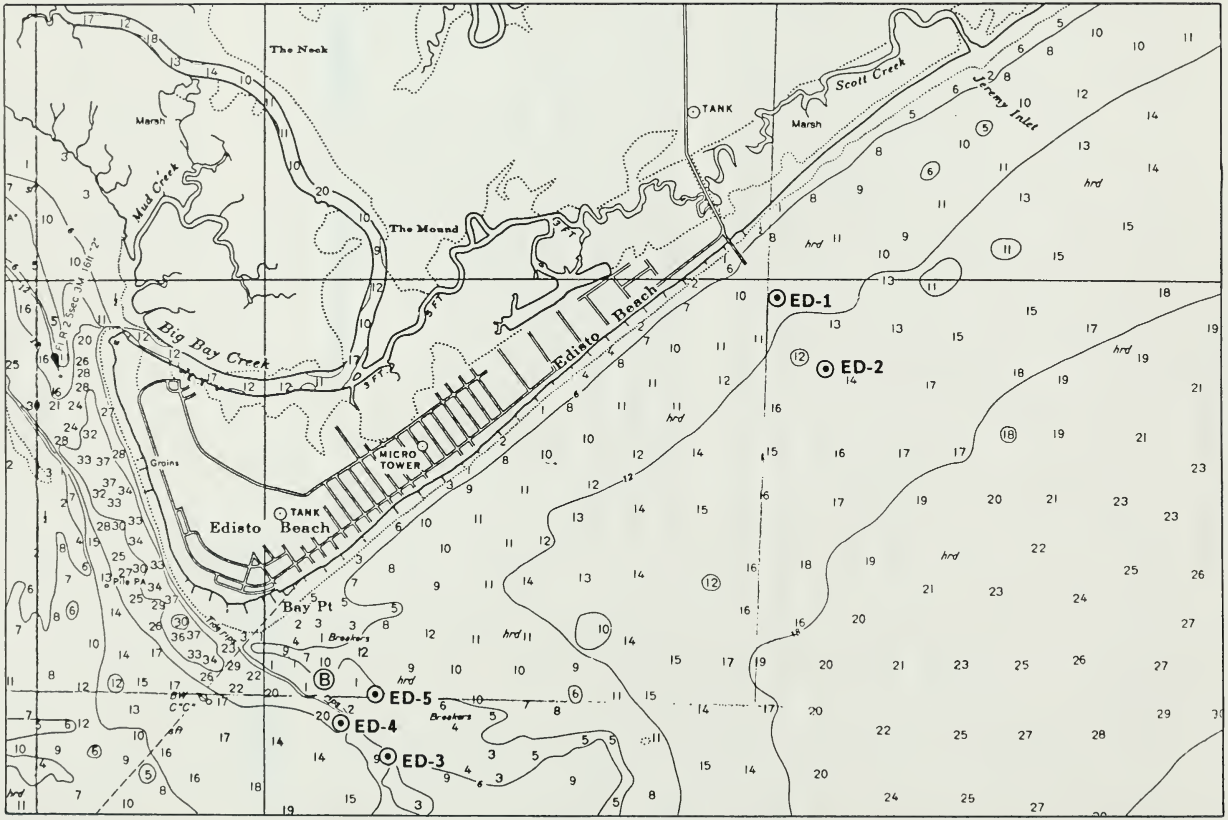

FIGURE 1. Location of five vibracores obtained offshore of Edisto Beach in April 1990. See Table 3 for Loran coordinates. Soundings are from NOS Chart No. 11517; mean low water datum.

TABLE 3. Offshore vibracores obtained off Edisto Beach in June 1990. [*Water depth at the time core was taken.]

Core I.D.	Water Depth* (ft)	1990 Coring Date	Time Cored	Recovered Core Length	Loran Coordinates	
ED-1	17	6-11	0700	9' 9"	60841.0	45583.0
ED-2	20	6-11	0700	12'4"	60950.1	45581.2
ED-3	12	6-11	1030	4' 0"	60869.8	45588.5
ED-4	17	6-12	0645	11' 0"	60871.3	45588.0
ED-5	10	6-12	0730	3' 3"	60869.2	45587.7

TABLE 4. Summary of graphic (Folk and Ward, 1957) grain-size statistics for offshore sediment samples from Edisto Beach, South Carolina. See Appendix I for detailed statistics and moment measures of grain size.

MS = moderately sorted
MWS = moderately well sorted
PS = poorly sorted
WS = well sorted
VWS = very well sorted

CS = coarse skewed
FS = fine skewed
NS = near symmetrical
SCS = strongly coarse skewed
SFS = strongly fine skewed

Sample ID	Core Depth Sampled (ft)	Mean Grain Size			Standard Deviation	Skewness
		Phi(ϕ)	mm	Class		
ED-2-1	0-2.5	2.22	0.21	Fine sand	0.62 (MWS)	-0.27 (CS)
ED-2-2	2.5-bottom	2.53	0.17	Fine sand	0.33 (VWS)	+0.30 (SFS)
ED-3-1	Entire	1.37	0.39	Medium sand	1.27 (PS)	-0.11 (CS)
ED-4-1	0-4	1.08	0.47	Medium sand	1.24 (PS)	-0.04 (NS)
ED-4-2	4-6	1.53	0.35	Medium sand	1.18 (PS)	-0.55 (SCS)
ED-5-1	Entire	0.97	0.51	Coarse sand	1.08 (PS)	-0.12 (FS)

Sample ID	Depth Samples (ft)	Pre-Acid Weight (gm)	Post-Acid Weight (gm)	Percent $CaCO_3$
Percentage of carbonate, shell material in a selected sample from Edisto Beach				
ED-2	0-2.5	159.5	83.9	47

From Table 4 and Appendix I, it can be seen the cores directly offshore from the Collins Restaurant are predominantly fine sand with a significant mud content estimated at around 15-20 percent over the length of recovery. Mean grain size of the sand fraction was 0.17 to 0.21 mm for ED-2. Both ED-1 and ED-2 contained mud zones in the form of alternating sand and mud lenses (flaser bedding) which is indicative of cyclic sedimentation. The relatively high proportion of mud and fine sand size for these deposits makes them less suitable for nourishment at the park, given the coarse grain sizes that predominate at the north end of Edisto Beach (Table 1).

By contrast, cores taken on the shoal at the south end of the island were dominantly medium to coarse sand and poorly sorted. Mud content was negligible in cores ED-3 and ED-5, both of which had limited penetration because of the extreme compaction of sediments. Core ED-4, along the channel margin in deeper water, encountered over 15 percent mud. It is believed the upper 10 ft of shoal to depths of about -15 ft MLW will be dominated by clean sand and shell, given the high wave energy over shallow depths. This pattern generally occurs over swash platforms of ebb-tidal deltas along the South Carolina coast. However, additional cores are recommended for confirming the shoal for borrow material. The results are sufficiently promising and follow expected trends to tentatively favor the south shoal as a borrow area for nourishment along Edisto Beach.

An overfill ratio was calculated using the James method (CERC, 1984) for native sands sampled by the USACE (1969) and the most favorable deposits obtained from cores (Table 5). The native composite was determined for beach samples only (elevations +10 ft to -2 ft MSL) and yielded a coarser mean grain size than used by the USACE in their 1969 analysis (0.65 mm versus 0.14 mm). The earlier analysis included offshore samples which skewed the data toward finer composite grain sizes. Table 5 shows the "best case" result is an acceptable R_A of 1.1 (ratio of borrow material volume required to produce equivalent performance of native material if used for nourishment). All other borrow samples would result in higher overfill ratios.

A more detailed analysis of native and borrow sands would be required before proceeding with nourishment at Edisto Beach, particularly because of the wide range of sediment types and sizes found on the beach. It is clear, however, that finer grained sediment found directly offshore of the state park would not be as suitable for restoring the dry-sand beach because of the tendency to reside at a gentler slope than exists at present along the beach. This is also true of the inland sediment sampled in "The

Neck" (USACE, 1990). Such material could be used to nourish the underwater and low-tide portions of the beach profile, but would be unstable along the dry-sand beach unless exceedingly large nourishment quantities are applied. While limited in scope, the present geotechnical results of the south shoal are sufficiently promising to recommend a more concentrated sand search in future phases of the project. Additionally, in the event ponds are proposed for excavation within park boundaries, we recommend that consideration be given to disposing any sandy material on the beach. If the sandy sediments are finer than the native beach, they can still be used to widen the low-tide beach. Sand from inland should also be considered for possible use following storm emergencies or for routine maintenance of the nourished beach.

TABLE 5. Estimate of overfill ratios for potential borrow sands at Edisto Beach. [M = mean; S = standard deviation]

	Elevation (MSL)				Composite
	+10	+8	+5	-2	
Native Beach Grain Size in Phi (ϕ) Units [Source: USACE, 1969]					
ϕ_{16}	-0.4	-1.0	-1.4	-1.0	-
ϕ_{84}	2.3	2.2	2.0	2.4	-
$M\phi_n$	0.95	0.60	0.30	0.70	0.64 (0.65 mm)
$S\phi_n$	1.35	1.60	1.70	1.70	1.60
Borrow Area Grain Size in Phi (ϕ) Units [Source: Present Study]					
	ED-3		**ED-5**		**Composite**
ϕ_{16}	-0.06		-0.10		0
ϕ_{84}	2.72		2.16		-
$M\phi_b$	1.33		1.03		1.18 (0.45 mm)
$S\phi_b$	1.39		1.13		1.26

$$\frac{M\phi_b - M\phi_n}{S\phi_n} = \frac{-0.54}{1.60} = -0.34$$

$$\frac{S\phi_b}{S\phi_n} = \frac{1.26}{1.60} = 0.79$$

R_A = overfill ratio (CERC, 1984) = 1.1 (graphically)

SHORELINE CHANGES

The USACE (1969) provided the first detailed analysis of shoreline changes along Edisto Beach State Park, using historical surveys by the U.S. Coast & Geodetic Survey (USCGS). Figure 2 (taken from their report) shows a clear trend of increasing erosion from south to north for the period 1855 to 1955. Transect E, situated close to Jeremy Inlet, had an average annual erosion rate of 9.6 ft, whereas section F eroded at 2.7 ft/yr during the period. It can be seen in Figure 2 the erosion rate increased after 1920, reaching upwards of 15.7 ft/yr at Jeremy Inlet (1920 to 1955) and 2.9 ft/yr near the Collins Restaurant site. Transects E-4, E-5, and E-6 along the primary campsite reach eroded 6.6 ft/yr to 10.9 ft/yr between 1920 and 1955, based on USCGS charts. While these rates are representative of the erosion trends for Edisto Beach State Park, they should be considered less reliable than beach profiles.

We believe many of the old surveys plot the MHW contour as a variable point, depending on how the survey party interpreted the waterline. The high watermark may have been taken as the upper limit of wave action at the time of the survey regardless of tide stage or wave action, or it may have been marked at a debris line along the dry-sand beach. Either way, the delineated high watermark can fluctuate over 100 ft on a gently sloping profile, depending on how it is interpreted in the field. The true mean high watermark is actually an absolute elevation tied to the high-tide stillwater level which, along ocean beaches, will fall midway down the beach face **below** the normal limit of wave action. It is not a point along the profile that is readily and consistently identified during field surveys.

In the course of the USACE's (1969) erosion analysis, beach profile lines were established along the park, numbered from groin 2 (station 0+00) to Jeremy Inlet (approximately station 78+00). In 1987, the SCCC established six monuments for periodic beach surveys numbered 2200 to 2290. Note station 2290 was not found during the present surveys. The relationship between the two sets of control points is shown in Figure 3. The SCCC monuments are related to state plane coordinates and are recoverable if lost. The USACE ranges were related to a temporary baseline and several pins in trees along the property. CSE reviewed original field notes provided by the USACE but was unable to reconstruct the USACE baseline and accurately juxtapose it with the SCCC monuments. However, we approximated the two baselines using historical shorelines developed from vertical aerial photographs.

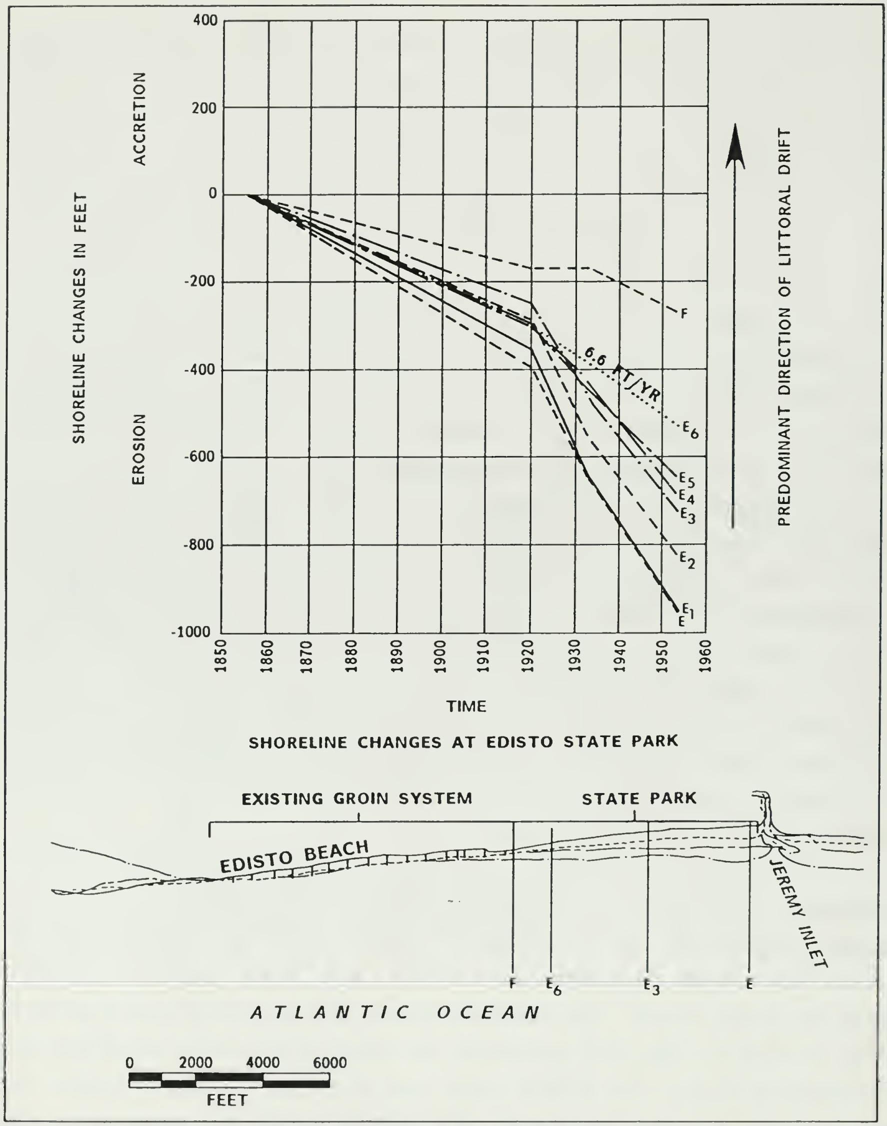

FIGURE 2. Historical erosion trend for Edisto Beach State Park for 1855 to 1955 developed by the USACE from USCGS charts (after USACE, 1969).

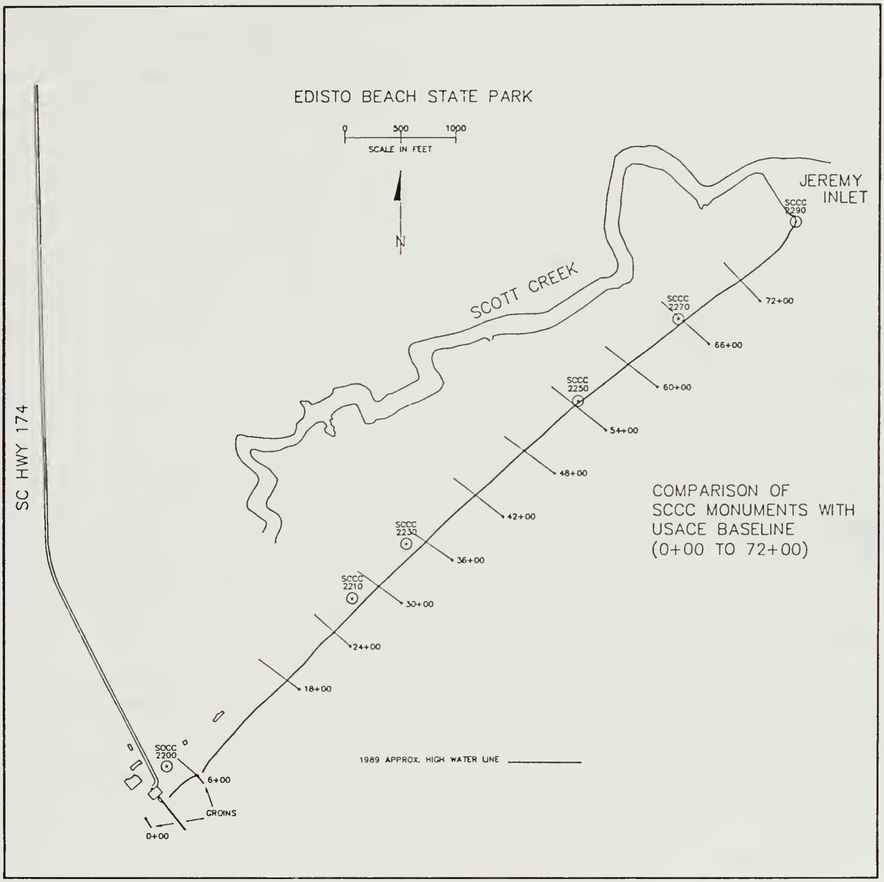

FIGURE 3. Relationship of SCCC beach profile monuments and the USACE (1969) baseline along Edisto Beach State Park.

Figures 4 and 5 show the results of CSE's aerial photo analysis, covering the period 1954 to 1989. U.S. Department of Agriculture vertical aerial photographs were enlarged to a scale of 1 inch equals 400 ft or 1 inch equals 800 ft (Table 2), and two shorelines were digitized for each date. Base maps of the park prepared by Greenhorn and O'Mara (circa 1983) and Wilbur Smith Associates (date unknown) were used to identify common control points on the maps and photographs. Photo scales were corrected to the map scale; then the shorelines were digitized in AutoCAD^{TM} format. Two shorelines were chosen from the photos: seawardmost vegetation line (Fig. 4) and the dry-sand/wet-sand contact line (Fig. 5). The vegetation line tends to represent the upper limit of tide and wave action during the year, whereas the dry-sand/wet-sand line approximates MHW and is herein referred to as the high watermark.

Nine transects were selected along the shoreline for computing erosion rates. The points correspond approximately to USACE transects and SCCC monuments. Table 6 summarizes the shoreline change rates for the past 35 years. The average trend has been slight accretion at the south end of the park and erosion of 6-8 ft/yr at the north end of the park. Note the long-term trend smooths considerable variation among the time periods covered by the data. For example, the period May 1954 to December 1957 was generally accretional throughout the project area. This probably reflects accretion from the 1954 nourishment project, either through direct feeding of sand to the north or the "groin effect" whereby southerly sand flow from Eddingsville Beach becomes trapped temporarily by the artificial bulge produced by nourishment south of groin 3. Accretion rates for the 3.6 year period after nourishment ranges upwards of 28 ft/yr near the Collins Restaurant. Along the campsites, accretion was of the order 3 ft/yr (vegetation line) to 13 ft/yr (high watermark).

The accretion trend of 1954 to 1957 reversed in the 1960s and accelerated in the 1970s and early 1980s (Fig. 6). Hurricane *David* in 1979 contributed to the higher erosion rates which, along the north campsites, reached ±4 ft/yr (vegetation line) to 7 ft/yr (high watermark). The trends for 1984 to 1989 are ambiguous with high erosion rates indicated at the vegetation line (e.g., -5.5 ft/yr at station 2230) but accretion at the high watermark (e.g., +1.2 ft/yr at 2230). This illustrates the problem of using one shoreline contour to monitor erosion. The retreat of the vegetation line during the past five years reflects the 1987 New Year's Day storm which cut back the dunes about 40 ft along much of the South Carolina coast (CSE unpublished data). While the vegetation line retreated, the dry-sand beach gained as reflected in the seaward movement given in Table 6.

The 35-year results of the shoreline analysis for 1954 to 1989 confirm the trend and approximate the erosion rates obtained by the USACE (1969) for the 1855 to 1955 period. Therefore, these can be considered a realistic and consistent result for planning purposes. CUBIT (1987) adopted long-term erosion rates in the park area of -3.4 ft/yr to -1.9 ft/yr for planning purposes based on review of USACE and aerial photography. Despite the difference in magnitude, the trend of increasing erosion to the north was confirmed in the CUBIT study. Further, more reliance should be placed on volumetric changes from beach profiles because of the subjectivity involved in aerial photo interpretation and the difficulty of converting linear erosion rates to volumetric quantities.

TABLE 6. Average annual historical shoreline change rates averaged from USDA historical aerial photographs. Given in Appendix II are the raw data on which these annualized rates are based. [(-) erosion; (+) accretion; ND = no data]

Locality	SCCC Station	USACE Station	Average Annual Change (ft/yr)				
			1954-57 (3.6 yrs)	1957-73 (15.2 yrs)	1973-84 (10.9 yrs)	1984-89 (5.0 yrs)	1954-89 (34.7 yrs)
VEGETATION LINE							
Groin 2, Collins Restaurant	2200	0+00	+10.7	+4.7	ND	ND	ND
		2+50	+28.4	+0.4	-3.8	+0.7	+2.0
		11+50	+18.6	-0.6	-2.0	-3.2	+0.6
	2210	22+50	+3.0	-1.5	-2.8	-4.0	-1.8
North end of campsite	2230	29+50	+4.2	-1.1	-3.7	-5.5	-2.0
		40+75	+1.7	-2.0	-5.4	-8.9	-3.9
	2250	50+75	-3.0	-3.5	-6.4	-11.6	-4.9
	2270	62+25	-4.3	-5.8	-9.5	-8.0	-7.1
New Jeremy Inlet		72+25	-10.9	-4.8	-16.6	-1.3	-8.5
HIGH WATERMARK							
Groin 2, Collins Restaurant	2200	0+00	+25.3	-4.2	-2.8	0.0	+3.6
		2+50	+20.6	+1.6	-2.0	+0.8	+2.3
		11+50	+20.9	+1.7	-5.4	+8.6	+2.5
	2210	22+50	+13.1	+0.9	-6.8	+5.9	+0.5
North end of campsite	2230	29+50	+11.4	+0.9	-6.9	+1.2	-0.4
		40+75	+10.8	-0.8	-9.1	-5.2	-2.8
	2250	50+75	+9.8	-0.8	-11.1	-10.0	-4.3
	2270	62+25	+6.2	-1.9	-14.4	-3.7	-5.2
New Jeremy Inlet		72+25	-0.9	-5.2	-14.5	-11.7	-6.7

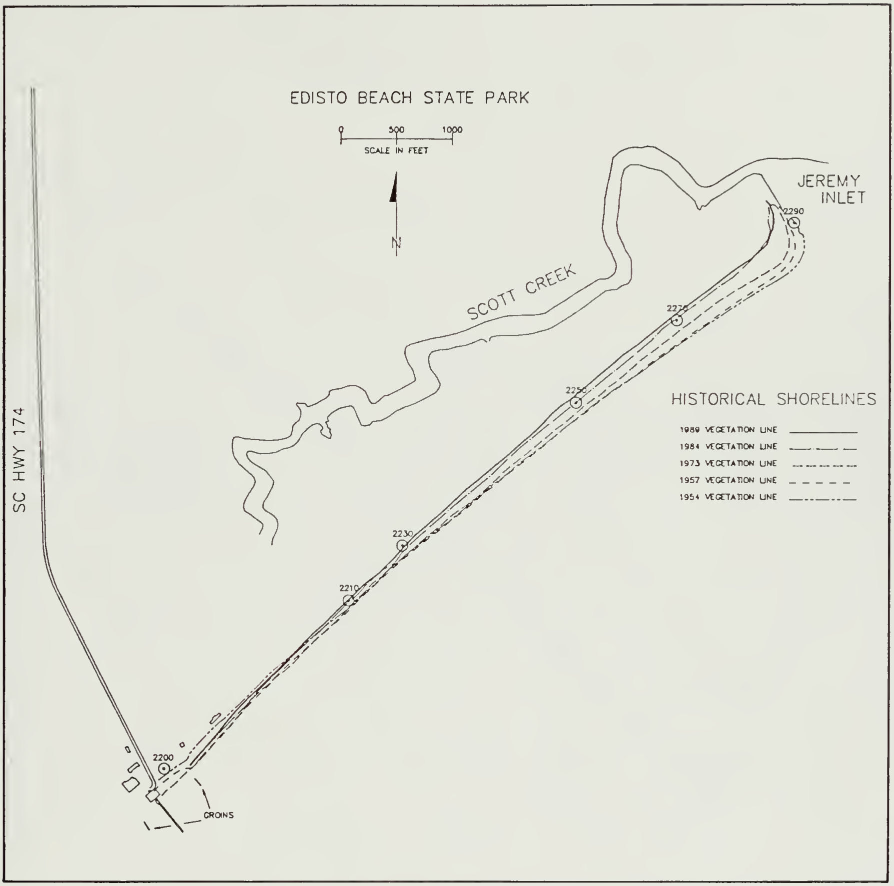

FIGURE 4. Historical shorelines (seaward vegetation line) between May 1954 and February 1989 developed by computer from USDA vertical aerial photos.

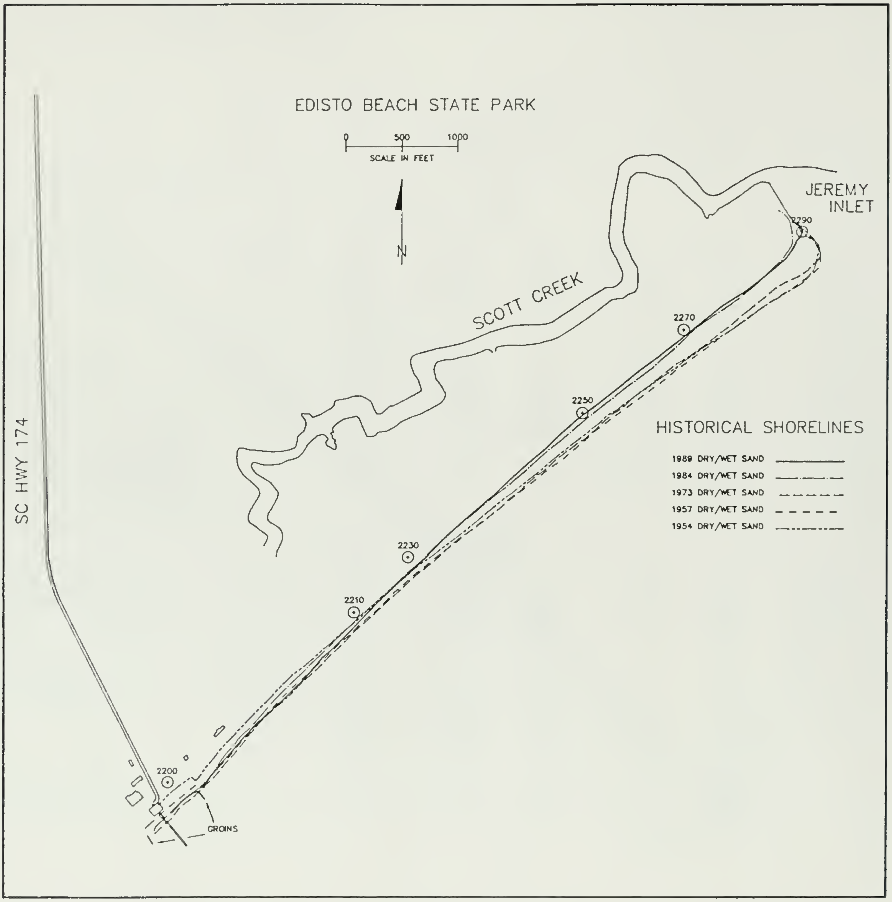

FIGURE 5. Historical high watermarks (dry-sand/wet-sand contact on aerial photos) for the period 1954 to 1989.

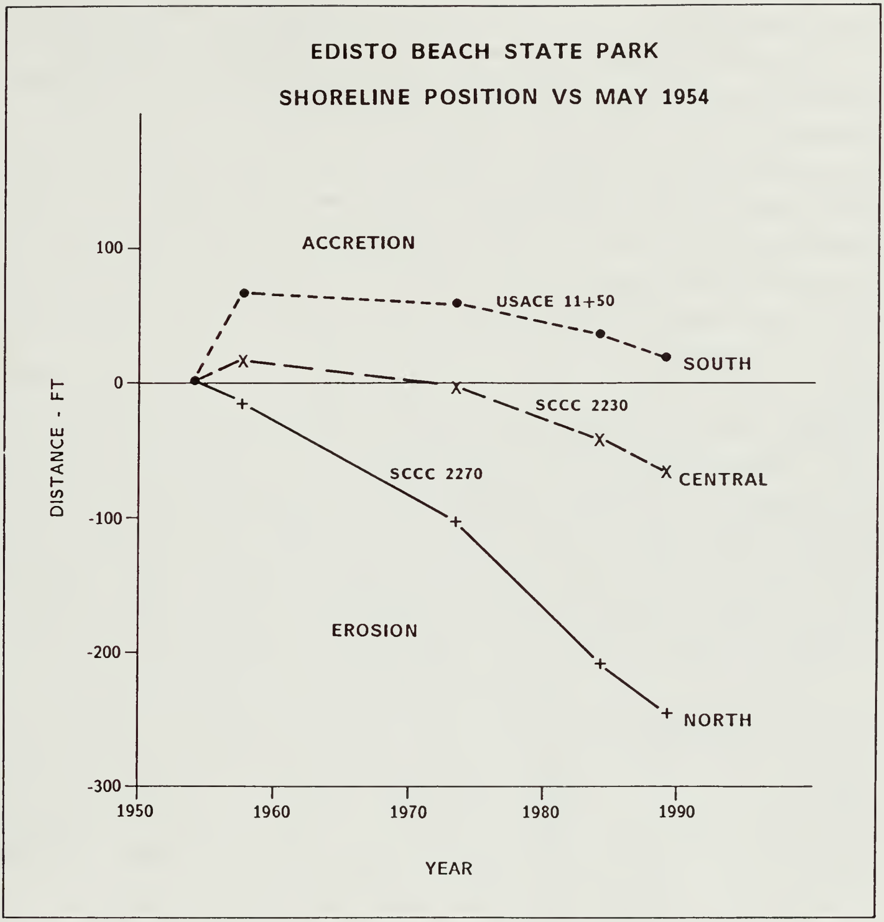

FIGURE 6. Graph of shoreline change (seawardmost vegetation line) for representative stations along Edisto Beach State Park developed from aerial photographs.

Volumetric Changes

Beach profiles are available from a USACE survey in 1966 (USACE. 1969. and unpublished survey notes). Other profiles in the area were obtained by CUBIT(1987). covering March 1987. and the SCCC. covering October 1988.

CSE selected USACE profiles that were situated close to the five recoverable SCCC monuments and juxtaposed them for direct comparison. This type of juxtaposition was not attempted for the CUBIT 1987 data. Because of lost control for the 1966 baseline. comparative profiles had to be matched at an upper beach contour that correlated with the shoreline position changes developed from aerial photographs. This is an approximate procedure. but one that provides a better estimation of long-term volumetric changes compared with simple extrapolation from linear shoreline movement. Once juxtaposed. profiles from 1966. 1988. and the present survey (April 1990) could be compared directly. Table 7 provides a summary of sand volume data at each station. The standard procedure for South Carolina profile data is to measure the unit volume (cy/ft) between the most landward foredune within the data set and the -5 ft NGVD contour (i.e.. low-tide wading depth). Because of low dunes in the area. the upper contour used in the volume analysis was +7.5 ft or +9.5 ft NGVD at the north end of the park rather than +10 ft NGVD. the conventional starting point.

The only truly reliable volume comparisons is the short time period. October 1988 to April 1990 (1.5 years). Average annual losses vary widely from 1.5 cy/ft/yr accretion at station 2200 to -7.9 cy/ft/yr at 2210 for this period. The overall weighted average change is -3.3 cy/ft/yr. This would correspond to a total volumetric loss of approximately -25.400 cy/yr along the 7.700 ft park length. an estimate that is about 50 percent of the USACE's (1969) estimate. Results for the longer period (1966-1990) show average annual losses of 1.5 to 3.5 cy/ft/yr along most of the park.

For purposes of nourishment planning. the volume loss rates presented in Table 7 provide a first-cut estimate of replacement quantities required each year. To this must be added any quantities to restore the profile to some minimum standard. Unit volumes for central South Carolina ocean beaches (+10 ft to -5 ft NGVD) typically range from 80 cy/ft to 120 cy/ft (Eiser et al.. 1988). Edisto's unit volumes tend to be lower than normal because the beach slope is steeper. This is due to the presence of coarse sand and shell material which allows faster percolation of wave uprush and promotes formation of steeper berms. Review of Table 7 indicates unit volumes in 1966 were generally much higher (regardless of juxtaposition errors). Therefore. an alternative measure of nourishment requirements can be derived from differences in unit volumes compared with an ideal volume for each profile. Assuming 80 cy/ft as an arbitrary ideal, it can be seen the park beach had a deficit averaging about 30 cy/ft in April 1990 (Table 7). Based on experience from other South Carolina nourishment projects, we know the deficit must also factor in a quantity beyond low-tide wading depth. Using a 60:40 ratio for the intertidal to subtidal sand deficit, the total deficit in this example would be 50 cy/ft. We believe this provides an order of magnitude estimate of the initial nourishment requirement for the principal recreation area of the park. Average annual losses can be estimated from the results in Table 7.

USACE (1969) Erosion Prediction

In 1969, the USACE prepared a prediction of the 25-year future beach profile (to year 1992) along the park. This was based on analysis of historical shorelines and the set of profiles collected in July 1966. CSE plotted the USACE future profiles against the April 1990 survey to determine how close the 1992 prediction was to present conditions. Figure 7 contains results from stations 2210 and 2270. Because of problems in juxtaposing the two data sets, the comparison is approximate. We do know from aerial photography that the backshore vegetation line at these two stations has not retreated as much as was predicted by the USACE.

It appears the major difference in response of the beach during the past 25 years has been the tendency for a steeper beach face to develop than was predicted and for the erosion rate to be less. Station 2210 at the south end of the park has likely benefited from the groin field and is upwards of 100 ft further seaward than was predicted along the upper beach. Station 2270 has also retreated less than predicted, but its profile slope is closer to the expected trend. Note in Figure 7b the decrease in dune elevation as the section becomes a washover along the backshore. Shoreline retreat at station 2270 also appears to be ±100 ft less than predicted.

TABLE 7. Unit-volume losses along beach profiles as surveyed from +10 ft, +9.5 ft*, or +7.5 ft** NGVD (dunes/highland scarps) to -5 ft NGVD (low-tide wading depth). The 1966 USACE data set was approximately juxtaposed with the closest SCCC monument by matching an upper beach contour that produces a linear change corresponding to the erosion rates in Table 6. The 1988 and 1990 data were obtained from the same control points established by the SCCC.

Locality	SCCC Station	Equivalent USACE Station	Representative Shoreline Length (ft)	Unit-Volume (cy/ft)			Net Change (cy/ft) Jul'66-Apr'90 (24.7 yrs)	Average Annual Change (cy/ft/yr)	
				Jul'66	Oct'88	Apr'90		Oct'88-Apr'90 (1.5 yrs)	1966-90 (24.7 yrs)
South end	2200	0+00	1,125	52.8	60.2	62.5	+9.7	+1.5	+0.4
	2210	22+50	1,475	84.1	58.4	46.6	-37.5	-7.9	-1.5
Central	2230*	29+50	1,412	83.2	49.7	45.6	-37.6	-2.7	-1.5
	2250**	50+75	1,638	105.9	58.6	51.2	-54.7	-4.9	-2.2
North End	2270**	62+25	2,050	117.8	59.1	56.5	-61.3	-1.7	-2.5
		Total	**7,700**					**-3.3**	**Weighted Average**

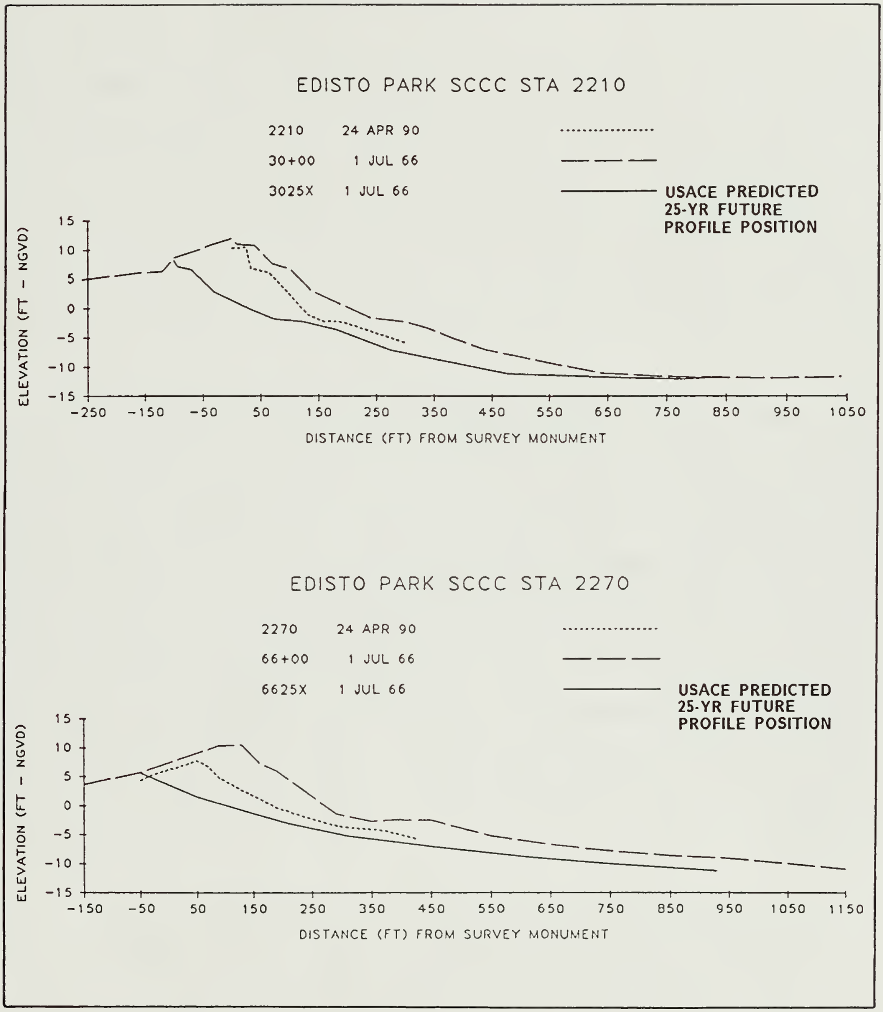

FIGURE 7. Comparative profiles developed by the USACE (1969) providing a prediction of the 25-year (1992) future shoreline profile. The April 1990 survey was approximately juxtaposed by matching backshore contours at positions documented by aerial photo analysis. Profile 2210 (A) at the south end of the park shows a steeper beach face in 1990 than predicted in 1969. This may be due to an increase in shell content. Profile 2270 (B) at the north end of the park shows about 100 ft less retreat than predicted and a lowering of the foredune as the beach goes into the washover mode.

CONCEPTUAL MODEL OF EROSION

Edisto Beach State Park is situated over three miles north of South Edisto River and St. Helena Sound, and 15 miles south of North Edisto Inlet, the two inlets which fundamentally control the supply of sand in the area. Jeremy Inlet at the north end of the park is too small to control long-term shoreline trends, but undoubtedly plays a part in yearly changes by episodically bypassing sand from north to south. In comparison to Hunting Island, Edisto Beach State Park's erosion is steadier and exhibits a consistent trend, increasing toward Jeremy Inlet. Based on previous studies, analyses of shoreline changes, and experience in other areas, we believe the following factors are the primary causes of erosion along the park.

Sand Trapping by North and South Edisto Inlets. Considered over many decades, the major inlets control the sand budget for Edisto. Both inlets are among the largest along the South Carolina coast with ebb-tidal deltas extending several miles into the ocean. A deep channel at North Edisto Inlet prevents sand bypassing from north to south and accounts for long-term accretion on Seabrook (CSE, 1989). The seaward extension of the ebb delta reduces wave energy from the northeast along Botany Bay and north Eddingsville Beach. This allows waves from the south to predominate and produce a net sand transport to the north. Most of the sand lost from Botany Island during the past 100 years is believed to have shifted into North Edisto Inlet and its offshore shoals. Eddingsville Beach (between Frampton and Jeremy Inlets) has also experienced extensive erosion, estimated at about 15 ft/yr (Stephen et al., 1975). Geomorphic trends suggest sand leaves Eddingsville Beach to the north as well as the south.

Edisto Beach is influenced in an opposite sense by the shoals of St. Helena Sound. Extending offshore, they intercept some wave energy from the south and enhance the dominance of waves from the north. This is readily seen by the buildup at the south end of Edisto Beach. The park is situated midway between the Eddingsville and Edisto system and serves as a reach through which north- to south-flowing sand moves. Based on the increasing erosion trend to the north, it is apparent that somewhat more sand leaves the north end of the park than the south end each year, producing a varying rate of loss along the beach.

Accelerated Erosion Rates in the Washover Mode. Eddingsville Beach and the north end of Edisto Beach State Park lack dunes and the elevation of these beaches is only 1 to 2 ft above the peak tide and wave limit normally experienced each year. When storm surges occur, they quickly overtop the beach and tend to drive sediment landward into the nearby marsh. The beach becomes a **washover** and any sand deposited in the marsh is lost from the normal littoral zone. Along beaches with high dunes, sand will be eroded offshore during storms but generally stays within the littoral system. In time, most of the eroded sand will shift back to the beach. A balance of offshore/onshore transport is critical to maintaining low erosion rates and a stable shoreline. The beach profile of Eddingsville inhibits onshore/offshore transport and promotes overwash. The high rates of erosion along Eddingsville influence the north end of the park because Jeremy Inlet does little to trap sands or dramatically change the trend as is often the case with large tidal inlets.

Lack of Sand From Updrift. The park depends on a supply of sand from Eddingsville Beach. However, erosion has shifted the beach into the marsh and reduced the supply of sand to the longshore transport system. Much of Eddingsville's beach profile now consists of outcrops of marsh muds. This limits the quantity that is deposited at Jeremy Inlet or is bypassed to the park. Lacking an adequate supply, breaking waves feed on the existing supply along the park beach.

Sand Trapping by the Groin Field. The park benefits from the groin field because it has reduced the rate at which sand leaves the park to the south. This is apparent from the lower erosion rates (and for some periods, accretion) at USACE stations 0+00 to 11+50. Without the groin field, erosion along the campsite area would be much higher.

While the factors given above are not analyzed quantitatively, we use them as a basis for predicting trends and formulating alternatives that take site-specific processes into account. Quantitative beach surveys are available to estimate short-term erosion rates, but a regional framework is useful to refine shore-protection plans and develop cost-effective solutions that work with the natural processes as much as possible. The next section presents several beach restoration alternatives for Edisto Beach State Park based on the findings herein.

BEACH RESTORATION ALTERNATIVES

I. DO NOTHING

The **do-nothing** alternative assumes a continuation of erosion if no nourishment or shore-protection structures are added along Edisto Beach State Park. Our best estimate of future erosion is given in Table 8. This erosion estimate yields an increasing rate from south to north in accordance with the historic trend. It is based principally on the shoreline change rates for the period 1957-1989 (31.8 years). We selected this time period as most representative of long-term rates because it begins several years after nourishment and follows construction of the groin field. Therefore, it is reasonably indicative of prevailing conditions. The 1954-1957 historical shoreline changes at the park were probably indirectly affected by the 1954 nourishment project south of the Collins Restaurant.

Using the adopted long-term erosion rates in Table 8, we have projected 10-year and 25-year future shorelines (vegetation line) landward of the present shoreline (Fig. 8). At station 2270 near Jeremy Inlet, the 10-year shoreline is predicted to shift ±80 ft landward; the 25-year shoreline would be approximately 200 ft landward. Erosion of this magnitude would produce loss of marsh both from shoreline recession and the overwash of sand (into the marsh) that precedes erosion. At station 2210 near the north end of the campsites, the 10-year and 25-year future shorelines are predicted to be 25 ft and 62 ft, respectively, landward of the present, based on average erosion of 2.5 ft/yr.

TABLE 8. Long-term erosion rates (vegetation line change) assumed under the do-nothing alternative. [*See Table 6 for other shoreline change data.]

	USACE Station	Historical Trend 1957-1989*		Adopted Future Trend This Study (ft/yr)
		Net (ft)	Average Annual (ft/yr)	
South	2+50	-32.2	-1.0	-1.5
	11+50	-47.0	-1.5	-1.5
	22+50	-72.6	-2.3	-2.5
	29+50	-84.9	-2.6	-2.5
	40+75	-134.5	-4.2	-4.5
	50+75	-181.2	-5.7	-6.0
	62+25	-231.9	-7.2	-7.5
North	72+25	-259.9	-8.1	-8.5

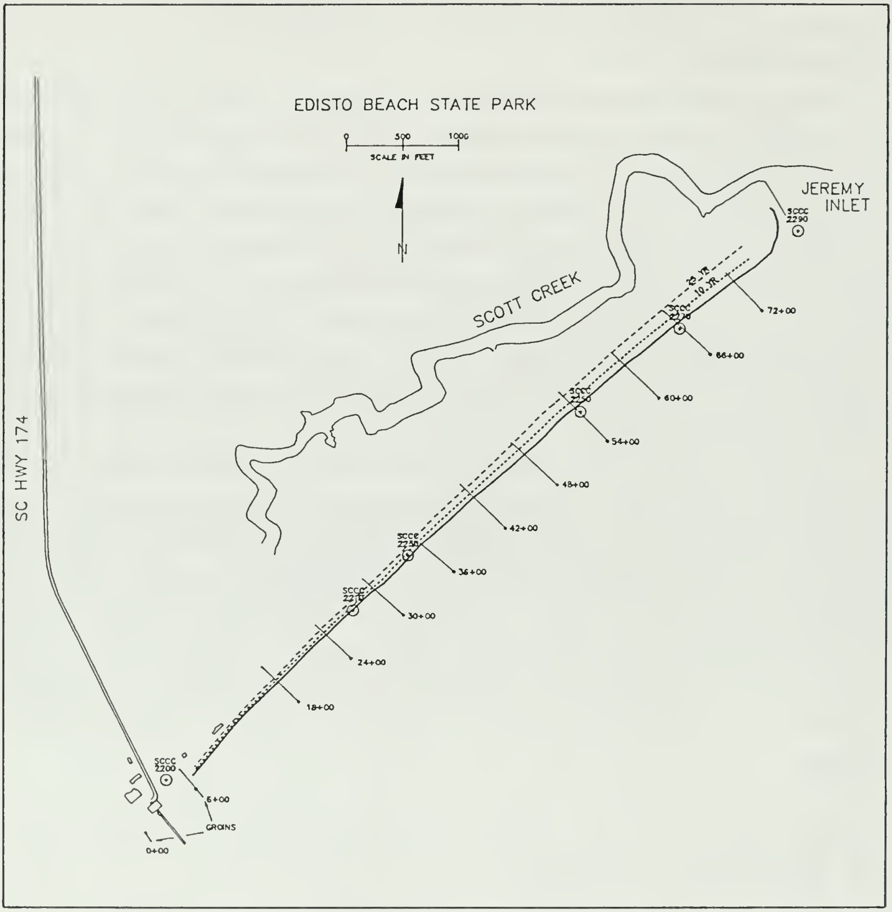

FIGURE 8. Predicted 10-year and 25-year future shorelines assuming no beach restoration attempts and average annual erosion as given in Table 8.

Under the **do-nothing** alternative, we estimate the following losses will occur:

Impact		10-Year Scenario	25-Year Scenario
Shoreline retreat:	at SCCC 2210	25 ft	62 ft
	at SCCC 2270	80 ft	200 ft
Highland acreage lost:	(USACE 0+00 to 32+00)	1.5 acres	3.7 acres
	(32+00 to 77+00)	Negligible	Negligible
Marsh acreage lost (32+00 to 77+00)		6.2 acres	15.5 acres
Dry-sand beach (limited at present)		Negligible	Negligible
Wet-sand beach		0	0
Infrastructure - campsites		Yes	Yes

It can be seen that even with erosion, the dry-sand/wet-sand beach may be maintained with little change in area because it will simply be displaced landward. The present beach condition is such that the dry beach is already degraded by erosion and along the primary campsite section of the park, it is negligible. The dry beach widens toward the Collins Restaurant. The quality of the south beach will be degraded in the future because of erosion of highland vegetation that will leave stumps and infrastructure along the beach. This will introduce some maintenance costs if safe beach recreation is to be maintained.

Perhaps the biggest cost of erosion over ten years will be loss of highland (1.5 acres out of about 20 acres that exist at present) and loss of salt marsh north of the campsite. We estimate the direct costs roughly as follows for the ten-year scenario:

Item	Unit Cost	No. of Units	Total Cost
Infrastructure relocation and repair	$50,000	1	$50,000
Land clearing/grading and debris disposal	$4,500/acre	1.5 acres	6,750
		Total	$56,750

To the above totals may be added values for land loss, reduced recreation use from a narrow beach, and loss of marsh--values of which are best determined by PRT officials.

II. BEACH NOURISHMENT ALTERNATIVE

For purposes of developing a **beach nourishment** alternative, we assumed a design life of ten years which is an arbitrary but realistic time frame to predict trends, evaluate performance, and fund a project. Design life as defined here is the estimated time for a nourishment project to erode to existing conditions. As such, it differs from designs intended to withstand certain storm occurrences without damage to backshore facilities. This is an important difference because even large sand volumes placed on the beach will not prevent rare surges from inundating the land, as we saw after Hurricane *Hugo*. Surge protection requires both a stable beach and foredunes well above the expected storm tide.

The ten-year nourishment requirement for Edisto Beach State Park is based on five factors:

1) Historical volumetric losses.
2) Initial nourishment to replace the existing sand deficit.
3) Anticipated use of the park as a feeder beach to the south end of Edisto Beach.
4) The need for more protection at the south end of the park where highland infrastructure and campsites exist.
5) The need for a supply updrift of the campsites to replace losses as sand shifts south.

Because the north end of the park is a natural area that is likely to be maintained in its existing condition despite future erosion (i.e., through displacement of the washover beach into the marsh), we have assumed part of the area may be left as is.

With variable erosion rates from south to north, we developed a nourishment plan that calls for variable rates of fill section by section, while meeting the five criteria given above. Table 9 and Figure 9 outline a plan that in our opinion achieves a ten-year design life (as previously defined) along the south end of the park (campsite area to station 32+00).

The ten-year beach nourishment plan would involve the following design criteria:

DESCRIPTION — BEACH NOURISHMENT ALTERNATIVE

Length / limits	5,000 ft / 0+00 to 50+00
Unit volume	30 cy/ft to 90 cy/ft variable
Total volume	300,000 cy
Berm elevation	+7.5 ft NGVD
Adjusted beach slope	1:30
Initial berm width	Variable ±50 ft to 100 ft for sections containing 60-90 cy/ft

The assumed beach slope is gentler than the existing profile above MLW (Table 10) under the assumption nourishment sand will be finer than existing because of fewer shells. Table 10 shows the composite slope of the existing beach varies from 1 on 11 above MHW to 1 on 36 below MLW, with the intertidal beach averaging 1 on 20. The unit quantities of fill will average 60 cy/ft or three times higher than the 1986-1987 Myrtle Beach nourishment project (Kana and Jones, 1988). Higher fill requirements at Edisto reflect the higher erosion rate. Figure 10 shows representative fill profiles at one beach section assuming a 1 on 30 slope.

TABLE 9. Beach nourishment alternative fill schedule. [*Taper section to unnourished area of park which is assumed to continue eroding. Sections 4 and 5 are designed as feeders to the south end of the park.]

Section	USACE Stations	Shoreline Length (ft)	Initial Volume (cy/ft)	Estimated Annual Losses (cy/ft/yr)	*10-Year Requirement (cy/ft)	Total Fill (cy)
1	0+00 to 10+00	1,000	20	1.0	30	30,000
2	10+00 to 20+00	1,000	40	2.0	60	60,000
3	20+00 to 35+00	1,500	40	5.0	90	135,000
4	35+00 to 45+00	1,000	0	6.0	60	60,000
5	45+00 to 50+00	500	0	3.0	30*	15,000
	Total	**5,000 ft**				**300,000 cy**

TABLE 10. Edisto Beach slopes based on 1988-1990 profile data.

Range	Station	Top to MHW	MHW to MLW	MLW to -5
6+00	2200	0.121	0.054	0.033
30+00	2210	0.084	0.058	0.034
36+00	2230	0.099	0.054	0.032
54+00	2250	0.071	0.038	0.023
66+00	2270	0.074	0.043	0.020
	Arithmetic Mean	0.090 (1:11)	0.049 (1:20)	0.028 (1:36)

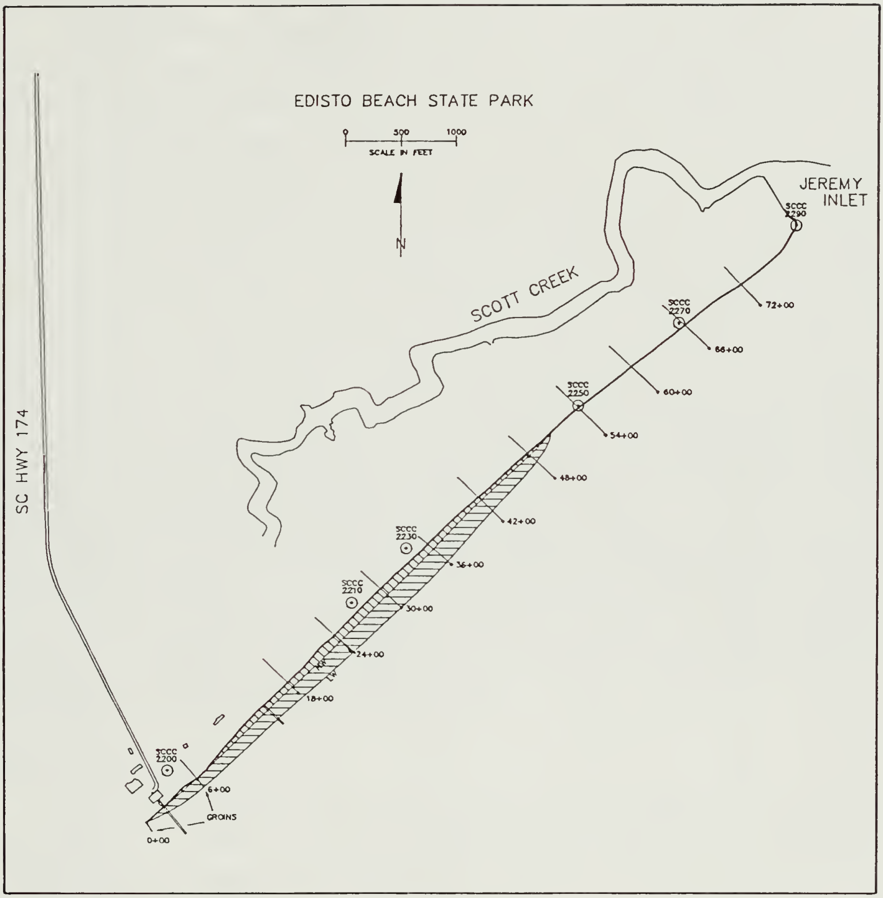

FIGURE 9. Beach nourishment alternative involving 300,000 cy along the primary campsite and recreation area. Fill north of 32+00 will provide a feeder beach to the south. The area north of 50+00 is assumed to continue eroding at historical rates.

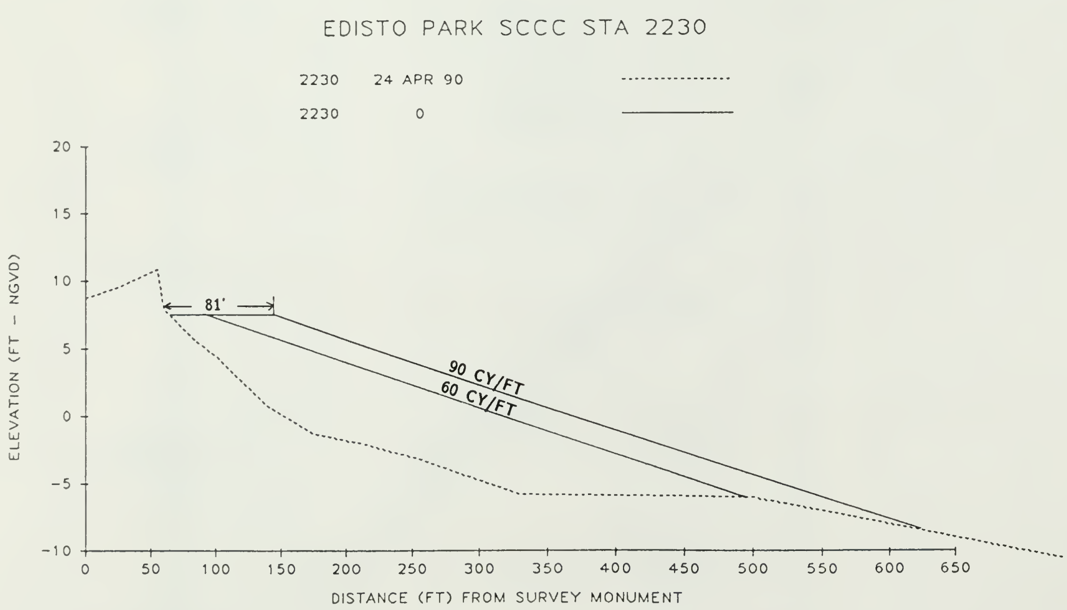

FIGURE 10. Representative fill quantities of 60 cy/ft and 90 cy/ft superimposed on SCCC 2230 to illustrate the impact of the ten-year nourishment project. Adjusted beach slope is assumed to be 1 on 30.

Borrow Source

Preliminary surveys of sand deposits offshore of Edisto Beach indicate the most suitable site is likely to be the north shoal of South Edisto Inlet. Additional geotechnical surveys and engineering analysis would be required to confirm this, but our conclusion follows the recent recommendation by USACE (1990). It is assumed here that the borrow area could be placed far enough offshore to leave a large shoal (>1,000 ft wide in the offshore direction) between the dredge and the shore. This would provide for continued wave attenuation over the shoals and sheltering of the south end of Edisto Beach. A more detailed study of wave propagation over the borrow area is required should the project be approved for the next phase of engineering. The principal drawback of this area is its +3-mile distance to the state park. If used as a borrow area, a large ocean-going dredge with upwards of 4-mile pipeline would be required. Pumping distances of this order are feasible and, in fact, less than the maximum distances for the 1990 Hilton Head project. However, costs of dredging increase as a function of distance from source to beach.

Offshore cores ED-3 and ED-5 contained beach-compatible sediment with a relatively low overfill ratio. For purposes of nourishment planning, the South Edisto shoal deposits are considered more acceptable than inland deposits previously identified by Athena Technologies (USACE, 1990). A borrow area 1,600 ft by 500 ft excavated to 10 ft deep would provide ±300,000 cy of sand.

Estimated Costs

Based on the dimensions of the fill, location of the proposed borrow area and recent cost data for similar projects, we estimate the costs of the ten-year nourishment alternative along the state park as follows:

TEN-YEAR BEACH NOURISHMENT ALTERNATIVE
CONSTRUCTION METHOD — HYDRAULIC DREDGE

Mobilization/demobilization — ocean-certified dredge	$350,000
Pumping/placement costs (300,000 cy @ $3.75/cy)	$1,125,000
Engineering/surveys/construction management @ ±7.5 percent	$ 110,000
Total Costs	**$1,585,000**

The above costs are based on recent bids for Seabrook (685,000 cy at $1,550,000 including mobilization, engineering, and construction) and Hilton Head Island (±2,500,000 cy at $9,700,000) (Kana, in review). Unit pumping costs for Seabrook were $1.90/cy based on distances of less than 5,000 ft from borrow site to shore. Unit pumping costs for Hilton Head were between $4.00-$4.50/cy based on pumping distances up to six miles. These cost estimates also assume no work along the town beach. If combined with a project by the town, mobilization costs could be shared and unit pumping costs might be lower, given economies for larger projects.

A project of the scale outlined herein would provide increased dry beach area (±7 acres upon initial fill adjustment plus additional acreage seaward of the berm crest) and could sustain losses of almost one acre per year before erosion reverts to the present shoreline. It would also provide a reasonably long time before renourishment is required, therefore minimizing disruption to recreation over the next decade. Like the 1954 project south of the park, however, it will not be a permanent solution much beyond ten years.

Cost-share criteria have been established by the SCCC whereby the State of South Carolina can pay up to 60 percent while the local entity pays 40 percent. Under this criteria then, the state share would be a maximum of (±)$951,000 and the PRT share would be a minimum of (±)$634,000 (40 percent).

III. NOURISHMENT WITH GROINS ALTERNATIVE

The third alternative considered involves a combination of nourishment with groins to reduce the rate of sand loss. The focus of this solution would be along the southern 3,200 ft of shoreline where the park campsites are situated. Groins have been intercepting sand transport and reducing erosion rates along the beach south of the park since the 1950s. Site-specific experience in this case shows groins are effective in lessening the erosion rate if not reversing it entirely. Evidence of reduced erosion can be seen at the south end of the park where groin 1 is situated (USACE station 6+00). Erosion rates at nearby profiles have been substantially lower than the north end of the park.

As a rule, groins are most effective when used over a length of shoreline extending to natural boundaries, such as tidal inlets or headlands. Where sand transport is predominantly in one direction, their effect is reasonably predictable with accretion occurring on the updrift side and erosion along the downdrift side. In areas where longshore transport reverses with the season or where natural transport splits in either direction, the effect of groins is less predictable.

Erosion along Edisto Beach State Park is clearly dominated by southerly sand transport; therefore, additional groins placed north of the existing groin field would intercept some of the sediment moving south. The extent of trapping is a function of groin height and length. For groins to trap all sediment moving in the littoral zone, they would have to be upwards of 1,000 ft long, extending beyond the normal limit of sand movement. Besides being costly, such an alternative would produce adverse impacts downdrift by denying those areas a supply of sand.

A compromise alternative would involve shorter structures and periodic nourishment. The optimal configuration depends on cost of each element. Shorter or lower groins cost less but reduce sand retention. A thorough analysis of these options is beyond the scope of work for the present study. However, using experience from other areas, rough design criteria for groins, and recent cost data, a representative plan was developed as shown in Figure 11.

Assumptions for the groin/nourishment alternative include:

1) Protection priority along the southern 3,200 ft of the park.
2) Initial nourishment to restore a ±50 ft dry-sand beach between structures.

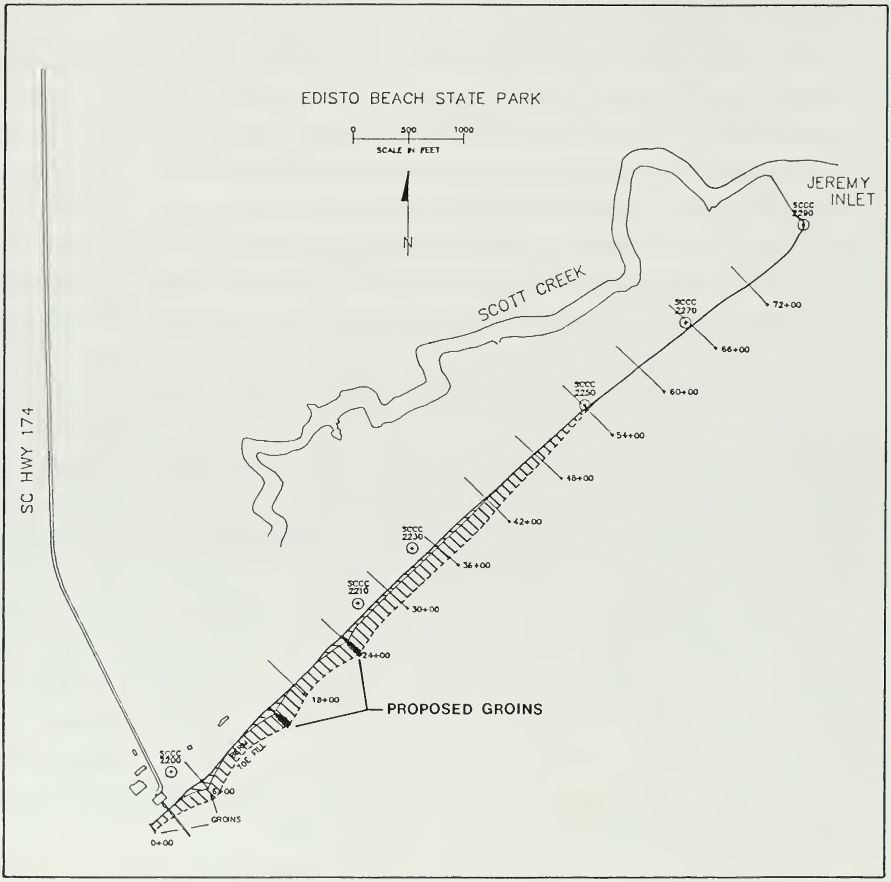

FIGURE 11. Nourishment and groin alternative designed to reduce the rate of sand loss from the principal campsite and recreation area of the park.

3) Length of groins based on approximate mid-tide mark after initial nourishment.
4) Erosion rate within the groin field reduces to ±50 percent of the estimated rate for the nourishment option.
5) Approximate design life of the nourished beach is 10 years.
6) Groins to withstand up to 25-year design waves and water levels with minimal damage.
7) Groins should be spaced to allow unimpeded recreation with a 100-ft buffer zone around each structure where swimming is prohibited.

The conceptual plan under this alternative includes two groins centered at USACE stations 15+00 and 24+00. Spacing would be 900 ft versus ±600 ft for the existing groin field. Each groin would be a ±250-ft-long, rubble-mound-type structure.

Beach nourishment would be required to restore the present deficit on the beach and provide for future erosion at some reduced rate. The plan in Figure 11 consists of the following:

DESCRIPTION — NOURISHMENT AND GROIN FIELD ALTERNATIVE

Groins — (2) @ 900-ft centers (USACE stations 15+00 to 24+00)
Primary swimming areas: stations 7+00 to 14+00, 16+00 to 23+00, and 25+00 to 32+00 (100-ft buffer zone adjacent to groins)
Typical dimensions: 250 ft long; crest at +9 ft NGVD (trunk); crest at +5 ft NGVD (head)
Structure type: rubble mound — 0.5-3.0 ton graded stone variable according to position and exposure along structures; side slopes of 1:2; crest width of 15 ft
Estimated tonnage per structure: 4,000

Nourishment (berm crest at 7.5 ft NGVD, width variable, adjusted slope of 1:30) — variable as follows:

0+00 to 6+00 at 20 cy/ft (taper)	12,000 cy
6+00 to 24+00 at 40 cy/ft	72,000 cy
24+00 to 40+00 at 60 cy/ft	96,000 cy
40+00 to 50+00 at 20 cy/ft (taper)	20,000 cy
Total Estimated Volume	**200,000 cy**

ESTIMATED COSTS

Groins — Unit costs/groin	
Rock (0.5-3.0 ton range) delivered and placed 4,000 tons @ $100/ton	$ 400,000
Filter material	6,500
Site preparation	10,000
Contingency (5%)	21,000
Subtotal — 1 Groin	$437,500
Subtotal — 2 Groins	**$875,000**
Nourishment	
Mobilization/demobilization	$ 350,000
Sand pumping (200,000 cy @ $4.50/cy)	900,000
Subtotal	**$1,250,000**
Total Project	
Groins	$ 875,000
Beach fill	1,250,000
Engineering/surveys/ construction management (±7.5%)	160,000
Total Estimated Costs	**$2,285,000**

The groin/nourishment alternative as outlined herein would be approximately 45 percent more costly than nourishment alone. However, it would have greater longevity along the campsite area because of the sand-retaining structures. The scale and materials of the groins envisioned here are more substantial than existing groins along Edisto Beach, averaging upwards of $1,750 per linear foot versus an estimated $500-$750 per linear foot for replacement of existing structures. Therefore, the groin cost estimate is conservative and should be refined during phase II with a thorough engineering analysis.

The beach fill estimate entails higher unit costs than alternative II under the assumption that a small-scale project on the order of 200,000 cy loses economies of scale. However, coordination of a project by PRT with a related project by the town would allow cost sharing of the mobilization charge and possibly lower unit pumping costs. By piggybacking two such projects, the potential savings for the park project would be $300,000 to $400,000. Other refinements of the groin design could potentially effect significant savings to get the project cost closer to the nourishment only alternative.

In the event alternative III is selected but the Town of Edisto does not participate in a parallel project. we estimate the state/local cost share will be as follows: state (60 percent) – $1.371.000: PRT (40 percent) – $914.000.

COORDINATION WITH THE TOWN OF EDISTO

A recent study by the USACE (1990) recommends a ±407,000 cy nourishment project for a 1.5-mile reach along Edisto Beach beginning near Collins Restaurant. Estimated cost for the project is $1,986,400 plus $550,000 for a feasibility study. The reconnaissance report by the USACE is the first stage of a 3-5 year design process which entails feasibility studies, then final design before construction. Because the scale of the recommended project is relatively small, it meets USACE criteria for completion under their continuing authority. This facilitates federal approval and will speed up the design process because separate congressional authorization is not required. To qualify for funds, the local community must provide a matching share which will range from 35 percent to 50 percent for various study items and construction. The USACE has recommended their feasibility study be expanded to include the state park and coordinate beach restoration efforts.

A series of meetings were held in July and August 1990, involving the USACE, SCCC, Town of Edisto, and PRT officials, for purposes of reviewing the USACE findings on Edisto Beach and discussing costs and alternatives for joint sponsorship of projects. A focus of the discussion was on the requirement for 50 percent cost sharing between the town and USACE for the next phase of the project--feasibility study. Three options were outlined (Appendix III) whereby (1) the town (and if desired, PRT) could join with the USACE and develop the project according to the federal schedule, (2) the town and/or PRT could attempt to fund a project without federal assistance on a possibly faster time line, or (3) the town and/or PRT could attempt a smaller scale interim project as soon as practicable without federal assistance, then follow-up with long-term participation in the federal project.

In late August, the Town of Edisto, in consultation with the SCCC, elected to pursue an independent project without federal participation because of the uncertainty over long-term local funding required by the USACE and the need to perform remedial measures at the earliest time. It was also recommended by the SCCC that the town combine with PRT to develop a joint project. At the time of this writing (September 1990), both the town and PRT were planning to use the results of the USACE (1990) study and the present study to prepare a request for state funds for nourishment. State guidelines for cost sharing of such projects are up to 60 percent state funds matched by at least 40 percent local funds. As in the case of the Hunting Island project (CSE, 1990), PRT department funds applied to the project are treated as local funds. Because state funds have not yet been appropriated for the Edisto Beach projects, applications must be submitted for consideration in the next budget cycle. If approved in early 1991, the earliest either project could be constructed would be the winter of 1991-1992.

CSE has reviewed the USACE (1990) nourishment plan for the Town of Edisto and believes it can be combined with the park plan (either alternative II or alternative III) with minor changes. The level of effort and design criteria are comparable to alternative II outlined herein, and it would be feasible to construct both projects from the same mobilization because the pipeline for the park project must pass across the town project. In Tables 11 and 12, we assume the USACE project formulation is an appropriate level of effort and provide a combined cost estimate of the federal project with either alternative II or alternative III. The primary changes involve combining mobilization and engineering costs. By combining the town and park projects, sand placed along the park will provide a feeder beach to the town project, increasing its design life. Therefore, it is reasonable to assume the USACE eight-year design life estimate (i.e., complete erosion of the fill) would increase to at least ten years. As can be seen in Tables 11 and 12, the total cost of a combined project with alternative II would be on the order of $3.2 million and with alternative III would be about $3.8 million. Assuming the local share totals 40 percent and is split based on sand volume, PRT's local share for alternative II (nourishment only) would be (±)$537,600. Its share of requested state funds would be (±)$806,400 (alternative II) based on the ratio 58 percent sand volume to the town beaches and 42 percent to the park. By combining projects with the town, PRT could construct alternative II at a cost estimate of $1,344,000 versus $1,585,000--a savings of about $240,000.

If alternative III is chosen by PRT and the same procedure for cost sharing applies, PRT's local share would be $737,375 (groins plus nourishment). Its share of requested state funds would be $1,106,060 ($581,000 for nourishment and $525,000 for groins). This is based on ±67 percent of the nourishment volume going to the town project and ±33 percent going to the state park. Cost of the groins would be shared between the state (60 percent equals $525,000) and PRT (40 percent equals $350,000) under the schedule in Table 12. Total cost of alternative III (PRT plus state shares), if combined with the town project, would reduce from $2,285,000 to (±)$1,843,435--a difference of (±)$440,000.

The above cost shares are provided here for review and discussion only and are not to be considered final. Such determination must be made by PRT and Town of Edisto officials in consultation with the SCCC.

As a final note regarding coordination of projects, CSE recommends consideration be given to eventual participation in a federally sponsored project because of the significant long-term funding commitment by the USACE. While the design process may be longer, funding of up to 60 percent of the Edisto project by federal funds (R. Jackson, pers. comm., August 1990) will likely reduce long-term costs to the state and local government and PRT. We understand such participation would be possible after completion of a state/local project.

TABLE 11. Cost estimates for a combined ten-year nourishment project by PRT and the Town of Edisto based on **Alternative II** herein and the USACE (1990) plan. Note: The local cost shares have been arbitrarily split based on sand volume.

Mobilization/demobilization (USACE est.)		$ 462,000
Unit pumping costs		
407,200 cy at $2.75/cy (at town, USACE)		1,119,800
300,000 cy at $3.75/cy (at park, CSE)		1,125,000
Contingency (9%)		270,000
Engineering/surveys/construction management (±7.5%)		223,200
	Total	**$3,200,000**
Estimated Cost Shares		
State (60%)		$1,920,000*
Local (40%) ($1,280,000)		
Town of Edisto (58%)		742,400
State Park (42%)		537,600
	Total Costs	**$3,200,000**

*Pro rata shares for purposes of state funding requests, assuming the split is based on sand volume (58/42 percent) would be:

Town of Edisto	$1,113,600
PRT	806,400

TABLE 12. Cost estimates for a combined ten-year nourishment project with groins by PRT and the Town of Edisto based on **Alternative III** herein and the USACE (1990) plan. Note: The local cost shares have been arbitrarily split based on sand volume.

Mobilization/demobilization (USACE est.)		$ 462,000
Unit pumping costs		
407,200 cy at $2.75/cy (at town, USACE)		1,119,800
200,000 cy at $4.00/cy (at park, CSE)		800,000
Groins (2)		875,000
Contingency (9%)		293,200
Engineering/surveys/construction management (±7.5%)		265,000
	Total	**$3,815,000**
Estimated Cost Shares*		
State (60% = $2,289,000)		
Pro rata		
State park - groins (lump sum)		$ 525,000
State park - nourishment (x 0.3294)		581,060
Town of Edisto - nourishment (x 0.6706)		1,182,940
Local (40% = $1,526,000)		
Pro rata		
State park - groins		350,000
State park - nourishment		387,375
Town of Edisto - nourishment		788,625
	Total Costs	**$3,815,000**

*Assumes 60 percent of groins cost shared by the state.

ENVIRONMENTAL CONCERNS

No environmental assessment has been performed as part of the present feasibility study. Based on experienced with similar projects, however, the following impacts can be expected:

1) Disruption of bottom-dwelling communities at the borrow site.
2) Smothering of bottom-dwelling communities along the beach.
3) Temporary increases in suspended solids.
4) Disruption of nests along the upper beach or spawning habitat around the borrow area.
5) Disruption of commercial shrimping activities.

To the extent possible, these impacts should be minimized or avoided altogether. It has been shown that warmer months of the year produce higher impacts than winter months because (1) species density and diversity are higher, (2) certain species may be nesting, and (3) warmer waters have less capacity to hold dissolved oxygen. Therefore, if nourishment projects can be constructed in the winter months, certain specific environmental impacts can be reduced to a minimum, if not altogether avoided. Among them are turtle nesting along the backshore between May and November in South Carolina and bird nesting by least terns (threatened species) or other species in open supratidal areas during March-June. Construction in winter also avoids the commercial shrimping season between June and December.

Previous studies have shown that populations of benthic fauna (species living in the sediments) are upwards of ten times higher in summer than in winter (Knott et al., 1983; Reilly and Bellis, 1983; Nelson and Gorzelany, 1987; Lankford et al., 1988). If projects are constructed in winter, biological recovery of the borrow areas or beach will proceed more rapidly and in phase with the summer season (Lankford and Baca, 1989). Because of these generally accepted findings, we recommend the Edisto Beach project be constructed in the winter months, preferably during the months of January and February, with a total construction window extending from December to April. Such timing would then avoid the turtle nesting season, the bird nesting season, and most of the shrimping season altogether.

The months of January and February are favored because the weather is less changeable, being dominated by high-pressure systems and westerly (offshore) winds from the mainland. Northeasters occur in January and February but such systems are generally forecasted in sufficient detail to facilitate decisions regarding movement of offshore equipment to safe waters. Spring and fall tend to produce more variable and extreme weather patterns that can impact dredge operations. For all these reasons, a winter construction window is more favorable, in our opinion. Given the lack of funding authorization at present, it is apparent the earliest construction window meeting these guidelines would be winter 1991-1992.

Environmental impacts of the Edisto Beach State Park project will be assessed by state and federal regulatory agencies including the U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, South Carolina Wildlife and Marine Resources Division, South Carolina Department of Health and Environmental Control, and the South Carolina Coastal Council. Assuming the project is planned for construction in winter, the following concerns may be raised by these agencies:

1) **Impacts to bottom communities in the borrow areas.** Baseline benthic samples should be taken before construction to insure there are no hard bottom (i.e., rocky substrate) communities in the area and to quantify the species densities and diversity. Sandy subtidal borrow areas (such as the preliminary borrow area identified for further investigation) recover more rapidly than hard bottom (Saloman et al., 1982).
2) **Impacts to bottom communities along the beach.** Because Edisto Beach is eroding at a moderate rate, the existing community has already experienced stress. Previous South Carolina projects show that biological recovery along nourished beaches can be relatively rapid (e.g., Lankford et al., 1988; Baca and Lankford, 1988). Preproject baseline samples should be collected at several intertidal localities to verify existing faunal populations.
3) **Increased turbidity during construction.** This impact affects primary productivity (photosynthesis) but can be minimized by careful selection of a borrow area with low mud content and clean sand. Sand settles quickly and does not produce significant increases in turbidity the way mud does in suspension. The offshore shoal at the south end of Edisto Beach, designated as a possible borrow area, is believed to contain clean deposits of sand essentially free of mud. Additional borings have been recommended to confirm the quality and extent of

the deposit. We believe additional tests will confirm its suitability because it is situated within the ebb-tidal delta complex of South Edisto River, a feature which tends to be dominated by sand bodies rather than muddy deposits.

4) **Impacts to ghost crabs and vegetation that live and grow along the backshore.** Because Edisto Beach State Park is erosional, both vegetation and fauna such as ghost crabs have had to adapt already. Little dry-sand beach exists along the southern half of the park, and the northern half is an active washover beach.

RECOMMENDED PLAN

The results of a feasibility study of beach restoration alternatives for Edisto Beach State Park show beach nourishment having a ±10-year design life* will require placement of ±300,000 cy of sand at an estimated cost of $1,585,000 A more permanent solution involving placement of two groins with ±200,000 cy nourishment is estimated to cost $2,285,000. These cost estimates do not consider economies associated with a joint project involving the Town of Edisto. If a PRT project is combined with a town project, engineering and construction mobilization costs may be shared for an estimated savings of $240,000 (nourishment only) to $440,000 (nourishment with groins alternative).

Using a preliminary plan for nourishment of the town beach prepared by the U.S. Army Corps of Engineers (1990) and alternative II outlined herein, CSE estimates a combined project would cost $3,200,000 and entail ±707,000 cy. It would extend from station 50+00 (about 1 mile north of the Collins Restaurant and north of the Park campsite area) to a point approximately 1.5 miles south of the Park. The plan for the park provides for additional sand to feed the principal campsite area as well as the town beach through the natural process of southerly sand transport.

If costs for a combined nourishment project are shared on the basis of sand volumes (58 to 42 percent ratio) as well as the 60/40 percent state/local requirements established by the SCCC, the cost to each funding entity would be as follows:

State (60%)		$1,920,000
Local (40%) ($1,280,000):	Town of Edisto (58%)	742,400
	State Park (42%)	537,600
	Total Project	**$3,200,000**

The pro rata share of state funds, assuming the same ratio of sand volumes (58/42 percent) would be $1,113,600 for the Town of Edisto and $806,400 for PRT. Because of economies from combining the two projects, the total cost of the state park project (alternative II) would reduce to $1,344,000 under the above assumptions. The cost shares are provided as guidelines only because final shares should be negotiated between PRT officials and Town of Edisto officials in consultation with the SCCC.

[*Design life is defined here as the time required for the fill to completely erode at average annual rates, and the beach revert to its prenourishment condition.]

While CSE believes PRT should consider the long-range advantage of combining nourishment with groins (alternative III), nourishment alone will cost approximately $600,000 less over the ten-year period under the assumptions herein. Further, groins may be added to the project at a later date following monitoring of beach fill performance and additional engineering analysis.

A preliminary borrow site containing beach-quality sand is located within nearshore shoals at the south end of Edisto Beach. While further geotechnical investigations are required, cores taken during the present study confirm shoal areas exist about 0.5 to 1.0 mile offshore that contain compatible sand with low overfill ratios. In agreement with recommendations by the USACE (1990), additional borings should be taken to confirm quantities and qualities of material for nourishment.

In summary, CSE recommends the following nourishment plan for Edisto Beach State Park:

1) Beach fill of ±300,000 cy placed between the Collins Restaurant (USACE station 0+00) and one mile north of the park entrance (to USACE station 50+00).
2) Variable beach fill sections (30 cy/ft to 90 cy/ft) as outlined under alternative II to produce a ±50-100 ft dry-sand beach plus additional quantities to feed southerly sections of the park during the ±10-year life of the project.
3) No fill along the northern 0.5 mile section of the park.
4) Combine the park project with a ±407,000 cy beach nourishment project for the Town of Edisto as outlined by the USACE (1990), to share engineering and mobilization costs.
5) Request funds at the earliest time under the guidelines for cost sharing developed by the SCCC.
6) Construct the combined project in the winter of 1991-1992 (earliest feasible time).
7) Consider adding two groins as outlined under alternative III at a later date to effect a more permanent solution to erosion.

We suggest an equitable cost share between the town and PRT can be based on the nourishment volume which yields a ratio of 58 percent (town) and 42 percent (park) under the above plan. Assuming such a project also qualifies for state/local funding ratios of 60/40 percent, the funds required for the $1,344,000 park project are estimated as follows:

State share	$ 806,500
PRT (local) share	537,600
Total	$1,344,000

A combined project is estimated to yield savings of about $0.25 million to the park portion of the project and reduce total project costs to $3.2 million. If implemented, the project should be monitored by surveys on a regular basis to establish rates of sand loss and provide data for future nourishment designs.

ACKNOWLEDGMENTS

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REFERENCES

Baca, B.J., and T.E. Lankford. 1988. Myrtle Beach nourishment project: biological monitoring report — years 1, 2, 3. Prepared for the City of Myrtle Beach; Coastal Science & Engineering, Inc., Columbia, S.C., 50 pp.

CERC. 1984. *Shore Protection Manual.* U.S. Government Printing Office, Washington, D.C., 2 vols.

CSE. 1989. Beach restoration and shore protection alternatives along the south end of Seabrook Island. Feasibility Study for Seabrook Island POA; Coastal Science & Engineering, Inc., Columbia, S.C., 38 pp. + appendices.

CSE. 1990. Erosion assessment and beach restoration alternatives for Hunting Island, South Carolina. Feasibility Study for South Carolina Department of Parks, Recreation and Tourism. Coastal Science & Engineering, Inc., Columbia, S.C., 68 pp. + appendices.

CUBIT. 1981. Edisto Beach groin field evaluation. Prepared for Town of Edisto Beach; Cubit Engineering, Ltd., Charleston, S.C.

CUBIT. 1987. Shorefront management plan. Edisto Island: Jeremy Inlet to Big Bay Creek, South Carolina. Vol. I. Management Program. Vol. II. Supporting Studies. Prepared for South Carolina Coastal Council; Cubit Engineering, Ltd., Charleston, S.C., 2 volumes.

Eiser, W.C., T.W. Kana, and C.P. Jones. 1988. Analysis of beach survey data along the South Carolina coast: October 1987 — August 1988. Final Rept. to SCCC; Coastal Science & Engineering, Inc., Columbia, S.C., 78 pp. + appendices.

Folk, R.L., and W.C. Ward. 1957. Brazos River bar: a study in the significance of grain-size parameters. Jour. Sed. Petrology, Vol. 27, pp. 3-26.

Kana, T.W. (In review.) Conserving South Carolina's beaches through the 1990s. Manuscript prepared for South Carolina Coastal Council; Coastal Science & Engineering, Inc., Columbia, S.C., 30+ pp.

Kana, T.W., and C.P. Jones. 1988. Myrtle Beach nourishment project, beach monitoring report, 1987. Final Rept. to City of Myrtle Beach; Coastal Science & Engineering, Inc., Columbia, S.C., 77 pp. + appendices.

Knott, D.M., D.R. Calder, and R.F. Van Dolah. 1983. Macrobenthos of sandy beach and nearshore environments at Murrells Inlet, South Carolina, USA. Estuarine, Coastal and Shelf Science, Vol. 16, pp. 573-590.

Lankford, T.E., and B.J. Baca. 1989. Comparative environmental impacts of various forms of beach nourishment. In Proc. Coastal Zone '89, ASCE, New York, N.Y., pp. 2046-2059.

Lankford, T.E., B.J. Baca, and C.E. Nation. 1988. Biological monitoring of beach scraping at Pawleys Island, South Carolina. Final Rept. to Town of Pawleys Island; Coastal Science & Engineering, Inc., Columbia, S.C., 36 pp.

Nelson, W.G., and J.F. Gorzelany. 1983. Biological and physical monitoring of beach erosion control project, Indialantic/Melbourne Beach, Florida. Part II. Biological Monitoring. Unpublished Report, U.S. Army, Corps of Engineers District, Jacksonville, Florida, November.

PRT. 1989. Beach renourishment proposal: Edisto Beach State Park. Prepared for South Carolina Coastal Council. South Carolina Department of Parks, Recreation and Tourism, Division of Engineering and Planning, Columbia, 10 pp. + attachments.

Reilly, F.J., and V.J. Bellis. 1983. The ecological impact of beach nourishment with dredged materials on the intertidal zone at Bogue Banks, North Carolina. U.S. Army Corps of Engineers, CERC, Ft. Belvoir, Vir., Misc. Paper 83-3.

Saloman, C.H., S.P. Naughton, and J.L. Taylor. 1982. Benthic community response to dredging borrow pits, Panama City Beach, Florida. U.S. Army Corps of Engineers, CERC, Ft. Belvoir, Vir., Misc. Rept. No. 82-3, 138 pp.

Stapor, F.W. 1978. Sand transport at Edisto Beach, Colleton County, South Carolina. Final Report, Marine Resources Research Institute, South Carolina Wildlife and Marine Resources Division (SCWMRD), Charleston.

Stephen, M.F., et al. 1975. Beach erosion inventory of Charleston County, South Carolina: a preliminary report. Tech. Rept. No. 4, South Carolina Sea Grant, prepared by University of South Carolina (USC), 79 pp.

USACE. 1949. Cooperative beach erosion study: State of South Carolina. Interim Report, U.S. Army Corps of Engineers, Charleston District, Serial No. 19, 23 pp. + appendices.

USACE. 1965. Hurricane survey: Edisto and Hunting Island beaches, South Carolina. Interim Report, U.S. Army Corps of Engineers, Charleston District, Serial No. 64, 13 pp. + appendices.

USACE. 1969. Edisto Beach, Charleston County, South Carolina. Detail Project Report on Beach Erosion Control. U.S. Army Corps of Engineers, Charleston District, Serial No. 43, 15 pp. + plates + appendices + attachments.

USACE. 1990. Edisto Beach, South Carolina. Reconnaissance Report for Storm Damage Reduction, April 1990. U.S. Army Corps of Engineers, Charleston District, South Atlantic Division, 25 pp. + appendix.

APPENDIX I

Geotechnical data obtained during the present study including five core logs from offshore vibracores and six sediment analyses for selected core sections. Note: No attempt was made to accurately determine the percent mud in these samples. Check core logs for qualitative description of mud content.

WELL LOG FORM

Well ID Ed-1

Well Depth From Ground Surface

Lithologic Description

Well Construction

Feet

(MSL Elevation) Ft.________

Date________

0 Shell lag

Clean fine sand

2 mixed shell & fine sand (slight mud content)

↓ ↓ ↓

mud content increasing w/ depth

4 ↓ ↓

sharp contact

mixed mud & fine sand (50/50) burrowed

trace organics

6 ↓ ↓

8 Interbedded mud & shell rich

muddy fine sand

shell lag - clean

10 base of core 9'9"

12 *shell layers lighter colored
as mud content increases
color darkens to dark
grey.

14

16

18

Well Development

Date________

Comments -

Water Samples

Date________

Sample ID________

Location Off-shore Edisto Beach - Pier

Date Drilled 11 June 1990

Client CSE

Geologist Walter J. Sexton

ATHENA TECHNOLOGIES INC

600 South Holly St., Columbia, SC 29205
(803) 771-6764

Well Depth From Ground Surface

Well ID ED-2

WELL LOG FORM

Lithologic Description

Well Construction

Feet

(MSL Elevation) Ft.

Date

0

muddy, sandy shell lag (grey)

shell rich-mixed (light grey to white) fine sand & possible early $CaCo_3$ cement

2

very well sorted fine sand - very low shell content nearly absent. Well preserved flaser beds ½" to ¼" (0.5 to 1.5 cm) thick. Flaser beds are mud. some show evidence of slipface migration mud less than 15%

4

6

8

10

12

Bottom of core 12'4"

14

16

18

Well Development

Date

Comments -

Water Samples

Date

Sample ID

Location Off-shore Edisto Beach - Pier

Date Drilled 11 June 1990

Client CSE

Geologist Walter J. Sexton

ATHENA TECHNOLOGIES INC

600 South Holly St., Columbia, S.C. 29205

(803) 771-6764

Well ID ED-3

WELL LOG FORM

Well Depth From Ground Surface

Lithologic Description

Well Construction

Feet **(MSL Elevation) Ft.**________

Date________

0 Shell rich mixed with
poorly sorted sands, fine, medium & coarse
very little if any mud - clean

2 tan

↓

________sharp contact

4 well sorted fine sand
some scattered large shells

trace organics

6 Bottom of core 4'

8

10

12

14

16

18

Well Development

Date ________

Comments -

Water Samples

Date ________

Sample ID ________

Location Shoal Complex s.end Edisto

Date Drilled 11 June 1990

Client CSE

Geologist Walter J. Sexton

ATHENA
TECHNOLOGIES INC
600 South Holly St., Columbia, S.C. 29205
(803) 771-6764

Well Depth From Ground Surface | **Well ID** ED-4

WELL LOG FORM

Lithologic Description | **Well Construction**

Feet **(MSL Elevation) Ft.**

Date

0

Mixed shell & sand ~50/50
more coarse sand than fine or medium
mud < 5%

2

shell rich zone mixed f. sand

mixed shell & sand - now
more f. sand and some mud
~10 to 15%

4

6

sharp contact

fine s. well sorted mixed
w/ mud, some mud ~30%
bioturbated

8

10

(med. grey)

muddy f. sand

12

Bottom of core 11"

14

16

18

Well Development

Date

Comments -

Water Samples

Date

Sample ID

Location Shoal Complex S. End Edisto

Date Drilled 12 June 1990

Client CSE

Geologist Walter J. Sexton

ATHENA TECHNOLOGIES INC
600 South Holly St., Columbia, S.C. 29205
(803) 771-6764

WELL LOG FORM

Well ID ED-5

Well Depth From Ground Surface	Lithologic Description	Well Construction
Feet	(MSL Elevation) Ft.	Date
0	mixed shell rich with poorly sorted sands	
2	f., m. & c. - little if any mud - some evidence	
	bottom of core 3'3"	
4		
6		
8		
10		
12		
14		
16		
18		

Well Development

Date

Comments -

Water Samples

Date

Sample ID

Location shoal Complex S. End Edisto

Date Drilled 12 June 1990

Client CSE

Geologist Walter J. Sexton

ATHENA
TECHNOLOGIES INC
600 South Holly St., Columbia, SC 29205
(803) 771-6764

```
SAMPLE NO.  DATE        MIDPOINT                WEIGHT     WEIGHT PERCENT  CLASS LIMITS   CUM PERCENT
                         (PHI)        (GRAM)                                  (PHI)
  ED2S-1     061190
Edisto Beach Core 2, 0-2.5'
                         -1.125          .100              .120          -1.000           .120
                          -.875          .300              .361           -.750           .481
                          -.625          .400              .481           -.500           .963
                          -.375          .400              .481           -.250          1.444
                          -.125          .600              .722            .000          2.166
                           .125         1.000             1.203            .250          3.369
                           .375         1.000             1.203            .500          4.573
                           .625          .800              .963            .750          5.535
                           .875         1.900             2.286           1.000          7.822
                          1.125         1.900             2.286           1.250         10.108
                          1.375         2.800             3.369           1.500         13.478
                          1.625         2.800             3.369           1.750         16.847
                          1.875         8.400            10.108           2.000         26.955
                          2.125        16.400            19.735           2.250         46.691
                          2.375        21.900            26.354           2.500         73.045
                          2.625        11.800            14.200           2.750         87.244
                          2.875         5.700             6.859           3.000         94.103
                          3.125         2.600             3.129           3.250         97.232
                          3.375         1.400             1.685           3.500         98.917
                          3.625          .800              .963           3.750         99.880
                          3.875          .100              .120           4.000        100.000

               TOTAL WEIGHT (GRAMS) =  83.100

PERCENT FINER THAN   4.00 PHI =     .60          PERCENT COARSER THAN  -1.00 PHI =     .36

MOMENT MEASURES:
      MEAN =  2.148    STANDARD DEVIATION =   .721    SKEWNESS   =  -.744     KURTOSIS =  3.408

DISPERSION =   .380    STANDARD DEVIATION =   .581     DEVIATION FROM NORMAL DISTR. = -19.46%

PERCENTILES:
   1.        5.       16.       25.       50.       75.       84.       95.       99.

 -.481      .611     1.687     1.952     2.281     2.534     2.693     3.072     3.522


GRAPHIC PHI PARAMETER          INMAN  (1952)          FOLK AND WARD (1957)

MEAN                               2.190                     2.220       FINE SAND

STANDARD DEVIATION                  .503                      .624       MODERATELY WELL SORTED

SKEWNESS(1)                        -.182                     -.270       COARSE-SKEWED

SKEWNESS(2)                        -.875

KURTOSIS                           1.447                     1.730       VERY LEPTOKURTIC
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```
SAMPLE NO.  DATE       MIDPOINT               WEIGHT     WEIGHT PERCENT  CLASS LIMITS   CUM PERCENT
                        (PHI)        (GRAM)                              (PHI)
  ED2S-2     061190
Edisto Beach Core 2, 2.5'- bottom
                        -1.125         .000          .000       -1.000           .000
                         -.875         .000          .000        -.750           .000
                         -.625         .100          .113        -.500           .113
                         -.375         .200          .226        -.250           .339
                         -.125         .200          .226         .000           .564
                          .125         .100          .113         .250           .677
                          .375         .100          .113         .500           .790
                          .625         .100          .113         .750           .903
                          .875         .100          .113        1.000          1.016
                         1.125         .100          .113        1.250          1.129
                         1.375         .300          .339        1.500          1.467
                         1.625         .400          .451        1.750          1.919
                         1.875        3.100         3.499        2.000          5.418
                         2.125        3.200         3.612        2.250          9.029
                         2.375       43.000        48.533        2.500         57.562
                         2.625       19.300        21.783        2.750         79.345
                         2.875        9.700        10.948        3.000         90.293
                         3.125        4.500         5.079        3.250         95.372
                         3.375        2.600         2.935        3.500         98.307
                         3.625        1.300         1.467        3.750         99.774
                         3.875         .200          .226        4.000        100.000

                TOTAL WEIGHT (GRAMS) =  88.600

PERCENT FINER THAN   4.00 PHI =    .89          PERCENT COARSER THAN  -1.00 PHI =    .11

MOMENT MEASURES:
     MEAN =  2.515    STANDARD DEVIATION =   .428    SKEWNESS    =  -.843    KURTOSIS = 12.861

DISPERSION =   .097    STANDARD DEVIATION =   .303    DEVIATION FROM NORMAL DISTR. = -29.37%

PERCENTILES:
   1.        5.        16.        25.        50.        75.        84.        95.        99.

  .965     1.970     2.286     2.332     2.461     2.700     2.856     3.232     3.618


GRAPHIC PHI PARAMETER          INMAN  (1952)         FOLK AND WARD (1957)

MEAN                              2.571                   2.534       FINE SAND

STANDARD DEVIATION                 .285                    .334       VERY WELL SORTED

SKEWNESS(1)                        .386                    .304       STRONGLY FINE-SKEWED

SKEWNESS(2)                        .490

KURTOSIS                          1.212                   1.405       LEPTOKURTIC
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SAMPLE NO.  DATE        MIDPOINT              WEIGHT     WEIGHT PERCENT  CLASS LIMITS   CUM PERCENT
                         (PHI)        (GRAM)                             (PHI)
  ED3-1      061190
Edisto Beach Core 3
                         -1.125        1.700        1.747        -1.000          1.747
                          -.875        2.600        2.672         -.750          4.419
                          -.625        4.200        4.317         -.500          8.736
                          -.375        3.600        3.700         -.250         12.436
                          -.125        4.500        4.625          .000         17.061
                           .125        6.200        6.372          .250         23.433
                           .375        5.500        5.653          .500         29.085
                           .625        4.200        4.317          .750         33.402
                           .875        7.500        7.708         1.000         41.110
                          1.125        4.400        4.522         1.250         45.632
                          1.375        5.500        5.653         1.500         51.285
                          1.625        2.700        2.775         1.750         54.060
                          1.875        3.600        3.700         2.000         57.760
                          2.125        4.600        4.728         2.250         62.487
                          2.375       10.300       10.586         2.500         73.073
                          2.625       12.300       12.641         2.750         85.714
                          2.875        8.200        8.428         3.000         94.142
                          3.125        3.900        4.008         3.250         98.150
                          3.375        1.300        1.336         3.500         99.486
                          3.625         .400         .411         3.750         99.897
                          3.875         .100         .103         4.000        100.000

               TOTAL WEIGHT (GRAMS) =  97.300

ERCENT FINER THAN   4.00 PHI =    .09          PERCENT COARSER THAN  -1.00 PHI =   9.31

OMENT MEASURES:
     MEAN =  1.392    STANDARD DEVIATION =  1.253    SKEWNESS   =  -.132     KURTOSIS = -1.177

ISPERSION =   .627    STANDARD DEVIATION =  1.025     DEVIATION FROM NORMAL DISTR. = -18.18%

ERCENTILES:
  1.        5.       16.       25.       50.       75.       84.       95.       99.

1.107     -.716     -.057      .319     1.443     2.538     2.716     3.054     3.409


RAPHIC PHI PARAMETER         INMAN  (1952)        FOLK AND WARD (1957)

EAN                              1.329                 1.367       MEDIUM SAND

TANDARD DEVIATION                1.387                 1.265       POORLY SORTED

KEWNESS(1)                       -.082                 -.114       COARSE-SKEWED

KEWNESS(2)                       -.198

URTOSIS                           .359                  .696       PLATYKURTIC
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```
SAMPLE NO.  DATE        MIDPOINT                WEIGHT     WEIGHT PERCENT   CLASS LIMITS   CUM PERCENT
                         (PHI)        (GRAM)                                  (PHI)
   ed4s-1    061190
Edisto Beach Core 4, S-1, 0-4'
                        -1.125         2.500         2.900        -1.000          2.900
                         -.875         3.400         3.944         -.750          6.845
                         -.625         4.400         5.104         -.500         11.949
                         -.375         3.900         4.524         -.250         16.473
                         -.125         4.800         5.568          .000         22.042
                          .125         6.500         7.541          .250         29.582
                          .375         5.200         6.032          .500         35.615
                          .625         3.900         4.524          .750         40.139
                          .875         6.500         7.541         1.000         47.680
                         1.125         4.700         5.452         1.250         53.132
                         1.375         6.600         7.657         1.500         60.789
                         1.625         4.000         4.640         1.750         65.429
                         1.875         5.000         5.800         2.000         71.230
                         2.125         5.500         6.381         2.250         77.610
                         2.375         7.900         9.165         2.500         86.775
                         2.625         5.700         6.613         2.750         93.387
                         2.875         3.200         3.712         3.000         97.100
                         3.125         1.600         1.856         3.250         98.956
                         3.375          .600          .696         3.500         99.652
                         3.625          .200          .232         3.750         99.884
                         3.875          .100          .116         4.000        100.000

                TOTAL WEIGHT (GRAMS) =  86.200

PERCENT FINER THAN   4.00 PHI =    .10         PERCENT COARSER THAN  -1.00 PHI =  16.62

MOMENT MEASURES:
     MEAN =  1.082    STANDARD DEVIATION =  1.194    SKEWNESS   =  -.035    KURTOSIS = -1.076

DISPERSION =   .645    STANDARD DEVIATION =  1.069     DEVIATION FROM NORMAL DISTR. = -10.41%

PERCENTILES:
   1.         5.         16.        25.        50.        75.        84.        95.        99.

-1.164     -.867      -.276      .098      1.106      2.148      2.424      2.859      3.266


GRAPHIC PHI PARAMETER          INMAN  (1952)          FOLK AND WARD (1957)

MEAN                               1.074                    1.085       MEDIUM SAND

STANDARD DEVIATION                 1.350                    1.240       POORLY SORTED

SKEWNESS(1)                        -.024                    -.042       NEAR SYMMETRICAL

SKEWNESS(2)                        -.082

KURTOSIS                            .380                     .745       PLATYKURTIC
```

```
SAMPLE NO.  DATE        MIDPOINT                WEIGHT     WEIGHT PERCENT   CLASS LIMITS   CUM PERCENT
                          (PHI)         (GRAM)                               (PHI)
   ed4s-2     061190
Edisto Beach Core 4, S-2, 4-6'
                         -1.125          1.900           2.303          -1.000           2.303
                          -.875          2.400           2.909           -.750           5.212
                          -.625          3.100           3.758           -.500           8.970
                          -.375          2.200           2.667           -.250          11.636
                          -.125          2.900           3.515            .000          15.152
                           .125          3.500           4.242            .250          19.394
                           .375          2.700           3.273            .500          22.667
                           .625          1.800           2.182            .750          24.848
                           .875          2.900           3.515           1.000          28.364
                          1.125          2.000           2.424           1.250          30.788
                          1.375          3.600           4.364           1.500          35.152
                          1.625          3.100           3.758           1.750          38.909
                          1.875          8.100           9.818           2.000          48.727
                          2.125         13.200          16.000           2.250          64.727
                          2.375         15.000          18.182           2.500          82.909
                          2.625          7.300           8.848           2.750          91.758
                          2.875          3.500           4.242           3.000          96.000
                          3.125          1.900           2.303           3.250          98.303
                          3.375          1.000           1.212           3.500          99.515
                          3.625           .300            .364           3.750          99.879
                          3.875           .100            .121           4.000         100.000

                TOTAL WEIGHT (GRAMS) =  82.500

PERCENT FINER THAN   4.00 PHI =    .20          PERCENT COARSER THAN  -1.00 PHI =  19.08

MOMENT MEASURES:
      MEAN =  1.562    STANDARD DEVIATION =  1.169    SKEWNESS   =  -.406    KURTOSIS =  -.471

DISPERSION =   .559    STANDARD DEVIATION =   .876     DEVIATION FROM NORMAL DISTR. = -25.03%

PERCENTILES:
   1.         5.        16.        25.        50.        75.        84.        95.        99.

-1.141     -.768      .050       .761      2.020      2.391      2.531      2.941      3.394


GRAPHIC PHI PARAMETER          INMAN  (1952)          FOLK AND WARD (1957)

MEAN                               1.290                   1.534       MEDIUM SAND

STANDARD DEVIATION                 1.240                   1.182       POORLY SORTED

SKEWNESS(1)                        -.588                   -.546       STRONGLY COARSE-SKEWED

SKEWNESS(2)                        -.753

KURTOSIS                            .495                    .932       MESOKURTIC
```

```
SAMPLE NO.  DATE         MIDPOINT                  WEIGHT     WEIGHT PERCENT   CLASS LIMITS   CUM PERCENT
                          (PHI)          (GRAM)                                   (PHI)
   ED5        061190
Edisto Beach Core 5, S-1
                          -1.125          1.800          1.556         -1.000           1.556
                           -.875          2.900          2.506          -.750           4.062
                           -.625          5.000          4.322          -.500           8.384
                           -.375          4.900          4.235          -.250          12.619
                           -.125          6.700          5.791           .000          18.410
                            .125         10.800          9.334           .250          27.744
                            .375         10.900          9.421           .500          37.165
                            .625          8.600          7.433           .750          44.598
                            .875         15.200         13.137          1.000          57.736
                           1.125          9.800          8.470          1.250          66.206
                           1.375         10.500          9.075          1.500          75.281
                           1.625          4.000          3.457          1.750          78.738
                           1.875          3.700          3.198          2.000          81.936
                           2.125          3.800          3.284          2.250          85.220
                           2.375          6.600          5.704          2.500          90.925
                           2.625          5.800          5.013          2.750          95.938
                           2.875          3.200          2.766          3.000          98.704
                           3.125          1.100           .951          3.250          99.654
                           3.375           .300           .259          3.500          99.914
                           3.625           .100           .086          3.750         100.000
                           3.875           .000           .000          4.000         100.000

               TOTAL WEIGHT (GRAMS) = 115.700

PERCENT FINER THAN   4.00 PHI =    .08          PERCENT COARSER THAN  -1.00 PHI =   6.69

MOMENT MEASURES:
      MEAN =   .913    STANDARD DEVIATION =  1.017    SKEWNESS    =    .122     KURTOSIS =  -.588

DISPERSION =   .588    STANDARD DEVIATION =   .936     DEVIATION FROM NORMAL DISTR. =  -7.90%

PERCENTILES:
   1.         5.        16.        25.        50.        75.        84.        95.        99.

-1.089     -.696     -.104       .177       .853      1.492      2.157      2.703      3.078


GRAPHIC PHI PARAMETER          INMAN  (1952)          FOLK AND WARD (1957)

MEAN                               1.027                        .969        COARSE SAND

STANDARD DEVIATION                 1.131                       1.080        POORLY SORTED

SKEWNESS(1)                         .154                        .121        FINE-SKEWED

SKEWNESS(2)                         .134

KURTOSIS                            .503                       1.059        MESOKURTIC
```

APPENDIX II

Beach erosion data covering the period 1954 to present including historical shoreline changes developed from vertical aerial photographs (U.S. Department of Agriculture), volumetric changes developed from USACE, SCCC, and CSE beach profiles, and representative beach profile plots.

APPENDIX II-1. Shoreline positions for 1957 to 1989 relative to 1954, based on analysis of vertical aerial photographs. [*No vegetation line visible. (-) landward/erosion, (+) seaward/accretion compared to 1954 shoreline. **Dry-sand/wet-sand contact; HWM = high watermark.]

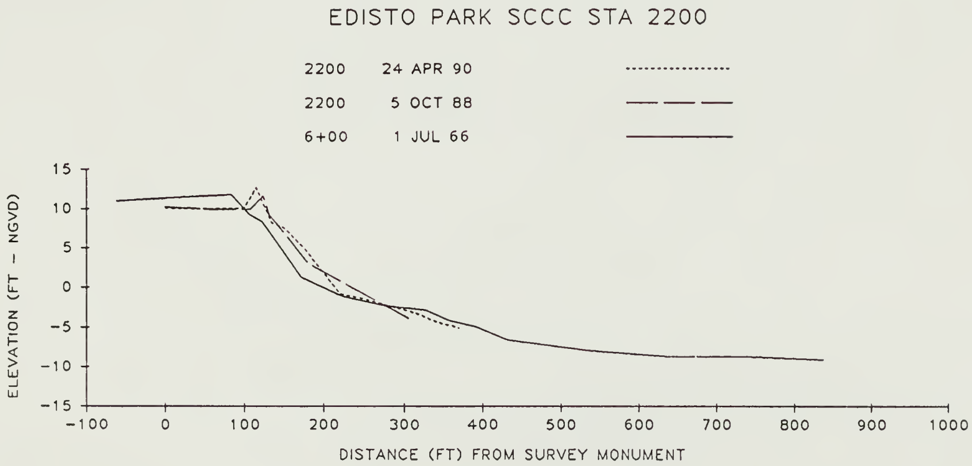
SCCC Station	COE Station	Distance to (ft)					Average Annual Shoreline Change for 1954-1989 (ft/yr)
		1954	1957	1973	1984	1989	
		SHORELINE POSITION (VEGETATION LINE)					
2200	0+00	0	38.6	110.6	*	*	*
	2+50	0	102.1	107.7	66.6	69.9	+2.0
	11+50	0	66.9	57.1	35.7	19.9	+0.6
2210	22+50	0	10.7	-11.5	-41.9	-61.9	-1.8
2230	29+50	0	15.1	-2.0	-42.4	-69.8	-2.0
	40+75	0	6.2	-24.3	-83.6	-128.3	-3.7
2250	50+75	0	10.7	-42.1	-112.3	-170.5	-4.9
2270	62+25	0	-15.4	-104.3	-207.5	-247.3	-7.1
	72+25	0	-39.0	-111.6	-292.3	-298.9	-8.5
		SHORELINE POSITION (HWM**)					
2200	0+00	0	91.2	155.2	124.9	124.9	+3.6
	2+50	0	74.3	99.1	77.5	81.6	+2.3
	11+50	0	75.4	101.7	43.1	86.2	+2.5
2210	22+50	0	47.1	60.5	-13.5	15.8	+0.5
2230	29+50	0	41.2	55.7	-19.6	-13.6	-0.4
	40+75	0	38.9	27.0	-72.7	-98.7	-2.8
2250	50+75	0	35.2	22.5	-98.8	-148.9	-4.3
2270	62+25	0	22.3	-7.2	-164.4	-183.0	-5.2
	72+25	0	-3.3	-82.4	-240.6	-234.5	-6.7

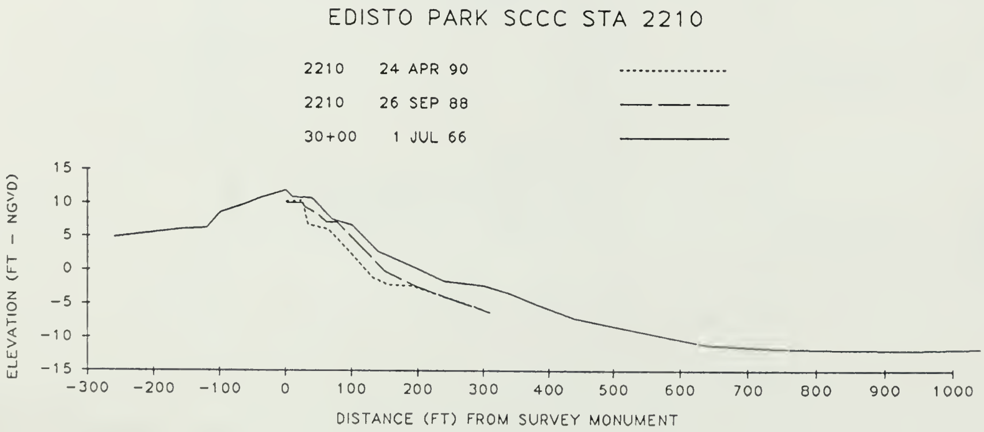
APPENDIX II-2. Beach volumes measured between the +10 ft* to -5 ft NGVD contours for representative survey dates. [*Volume calculation starts at +9.5 NGVD for station 2230 and at +7.5 ft NGVD for stations 2250 and 2270. Data from 1966 was approximatley juxtaposed with 1988-1990 profiles to yield a volume change comparison.]

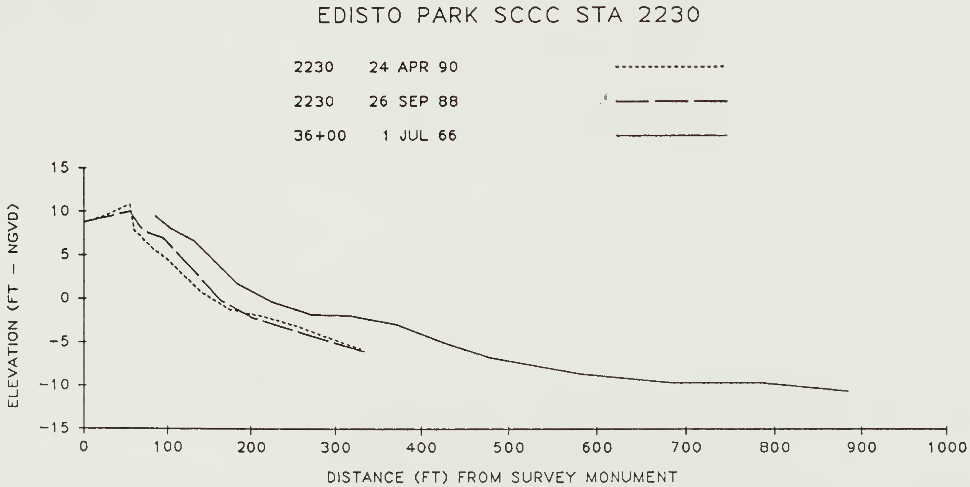
Station	Starting Distance (ft)	+10 ft to -5 ft NGVD Unit Volumes (cy/ft)			1966-1990 Difference (cy)
		1990	1988	1966	
2200	99.8	62.5	60.2	52.8	+9.7
2210	25.8	46.6	58.4	84.1	-37.5
2230	57.4	45.6	49.7	83.2	-37.6
2250	18.2	51.2	58.6	105.9	-54.7
2270	55.5	56.5	59.1	117.8	-61.3

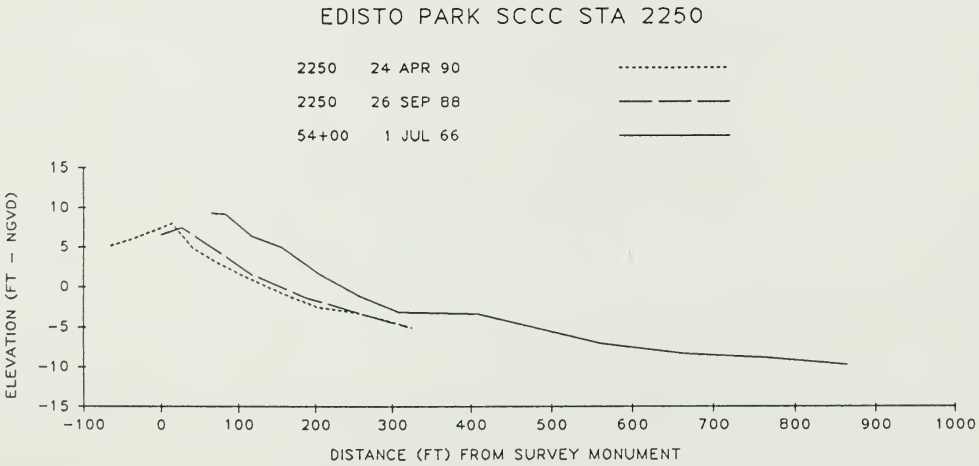
APPENDIX II-3. Sand budget for 1966-1990 (+10 ft* to -5 ft NGVD). [*Volume change computed from +9.5 ft NGVD (station 2230) or +7.5 ft NGVD (stations 2250 and 2270). (-) erosion]

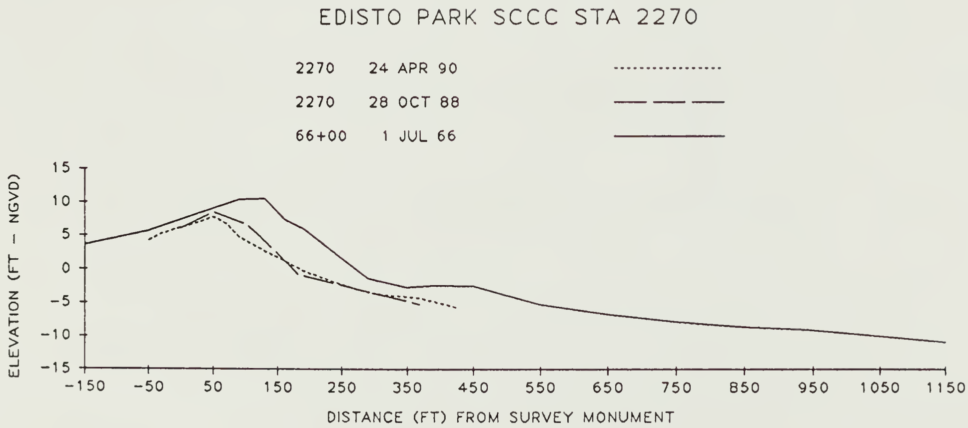
Station	Representative Length (ft)	Unit Change (cy/ft)	Net Change 24.7 Years (cy)
2200	1,125	+9.7	+10,910
2210	1,475	-37.5	-55,310
2230	1,412	-37.6	-53,090
2250	1,638	-54.7	-89,600
2270	2,050	-61.3	-125,670
	7,700	**-40.6**	**-312,760**
		(Average Annual Change = -12,660)	


EDISTO PARK SCCC STA 2200
2200 24 APR 90
2200 5 OCT 88
6+00 1 JUL 66
15
10
5
0
−5
−10
−15
ELEVATION (FT − NGVD)
−100
0
100
200
300
400
500
600
700
800
900
1000
DISTANCE (FT) FROM SURVEY MONUMENT


EDISTO PARK SCCC STA 2210
2210 24 APR 90
2210 26 SEP 88
30+00 1 JUL 66
ELEVATION (FT – NGVD)
15
10
5
0
–5
–10
–15
–300
–200
–100
0
100
200
300
400
500
600
700
800
900
1000
DISTANCE (FT) FROM SURVEY MONUMENT


EDISTO PARK SCCC STA 2230
2230 24 APR 90
2230 26 SEP 88
36+00 1 JUL 66
15
10
5
0
-5
-10
-15
ELEVATION (FT - NGVD)
0
100
200
300
400
500
600
700
800
900
1000
DISTANCE (FT) FROM SURVEY MONUMENT


EDISTO PARK SCCC STA 2250
2250 24 APR 90
2250 26 SEP 88
54+00 1 JUL 66
ELEVATION (FT – NGVD)
15
10
5
0
−5
−10
−15
−100
0
100
200
300
400
500
600
700
800
900
1000
DISTANCE (FT) FROM SURVEY MONUMENT


EDISTO PARK SCCC STA 2270
2270 24 APR 90
2270 28 OCT 88
66+00 1 JUL 66
ELEVATION (FT – NGVD)
15
10
5
0
-5
-10
-15
-150
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
DISTANCE (FT) FROM SURVEY MONUMENT

APPENDIX III

Memorandum (dated July 27, 1990) from a meeting involving the USACE, SCCC, Town of Edisto, and PRT in which alternatives were discussed for developing a joint nourishment project between the Town of Edisto and Edisto Beach State Park.

TO: Attendees and Interested Parties

Larry Smith, Town of Edisto
Richard Jackson, USACE
Ted Hauser, USACE
Larry Casbeer, USACE
Chris Brooks, SCCC
Steve Snyder, SCCC
Bill McMeekin, PRT
Timothy Kana, CSE

RE: Edisto Beach Nourishment Project

DATE: July 27, 1990

These are follow-up notes to the meeting held on July 26 at the Charleston District at which Edisto Beach nourishment alternatives were discussed. Richard Jackson led the discussion of the USACE's proposal for a (±)$2 million, ±400,000 cy project for the 1.5 mile section extending from the Collins Pavilion area south (excludes state park). This project will potentially provide 65 percent federal funds under the "Continuing Authority Program," is the first part of a long-range commitment including periodic renourishment, and does not require additional congressional authorization because of its size. The park may be added to the project but will likely receive a lower federal cost share (say 50 percent) because need would be based on recreation benefits rather than storm-damage reduction benefits, given the different type of development.

The next stage of the USACE planning process is a $550,000-$600,000 (est.) feasibility study which must be cost-shared 50-50 with the local sponsor(s). If the town (and park) elect to participate in the federal study and sign agreements in the next month or so, the earliest construction date would be winter 1993-1994.

The town and the SCCC expressed concern over the study cost; however, in-kind services may be offered by the local sponsors for credit toward their cost share. One example would be for the town to sponsor offshore borings, a $73,000 line item. A credit of $73,000 toward the town's cost share would be given by the USACE even if the work is performed at lower cost. It was recommended the town and attendees review the USACE study items and determine which might be performed (presumably at lower cost) by local sponsors for credit.

There was also concern over the time to construction because of immediate needs expressed by the town and park. Local funds in hand are presently limited to (±)$200,000 (LS). Request for funds under the Beach Management Trust Fund were made by the town and park last summer but were preempted by *Hugo* projects. There are reasonable prospects for funding under a new bond bill during the next legislative session.

Upon conclusion of the meeting, it was agreed the town and park have three options:

1) **USACE project/federal timeline**
   - Town and PRT sign 50-50 cost-share agreement for feasibility study.
   - Identify study items to be completed by local sponsor(s) for credit.
   - Anticipate first sand on the beach no sooner than 1993-1994.
   - Receive ±60 percent federal funds for life of the project.
   - Estimated cost to state/local government over ten years will be (±)$1-$2 million with about $2 million in matching federal funds.
2) **State/local project/accelerated timeline**
   - Apply existing funds toward surveys and ten-year design at scaled-down scope of services and possibly reduced engineering costs.
   - Request state bond funds in 1991.
   - Construct project in winter 1991-1992.
   - Estimated state/local cost will be $3-$4 million for ten-year project with no federal funds.
3) **Interim state/local project followed by USACE project**
   - Apply existing funds toward surveys and ±3 year design project.
   - Request state bond funds in 1991.
   - Construct small-scale (interim) project in winter 1991-1992.
   - Estimated cost $1 million (no federal credit) for three-year project (e.g., ±250,000 cy from an inland source) **plus** $250,000 (federal credit) to initiate USACE feasibility.
   - Sign agreement with USACE to continue project from thereon under the federal plan and anticipate earliest construction of permanent project in 1994-1995.
   - Estimated ten-year cost to state/local sponsors will be $2-$3 million with about $2 million in matching federal funds.

The cost estimates are admittedly very rough. They are based on an estimated ten-year need of ±650,000 cy at $5-$6/cy (including engineering) that covers the town and park areas (Kana, report in review with the SCCC).

Timothy W. Kana