COASTAL CONSTRUCTION CONTROL LINE
REVIEW AND REESTABLISHMENT STUDY
FOR BAY COUNTY

Sponsored By

Bureau of Beaches and Coastal Systems
Division of Environmental Resource Permitting

Submitted By

Beaches and Shores Resource Center
Institute of Science and Public Affairs
Florida State University
Tallahassee, Florida 32306

July 1996

TABLE OF CONTENTS

LIST OF FIGURE

COASTAL CONSTRUCTION CONTROL LINE REVIEW AND REESTABLISHMENT STUDY FOR BAY COUNTY, FLORIDA

I. INTRODUCTION

Chapter 161.053, Florida Statutes, enacted by the 1971 session of the State Legislature, provides that the Department of Environmental Protection shall set a Coastal Construction Control Line along the Gulf and Atlantic shores of the State. The law provides that the setting of this line shall be based on data resulting from comprehensive engineering and topographic surveys, erosion trends, predictable storm tides, wave runup, the vegetation line, and other technical data. This law also provides that the established control lines shall be subject to review at the discretion of the Department of Environmental Protection (DEP) or at the written request of officials of affected counties or municipalities. Since 1971, all twenty-four counties which have sandy beaches have had a setback (or control) line established.

The 1978 session of the State Legislature amended the statute which changed the Coastal Construction Setback Line to Coastal Construction Control Line and permitted counties and municipalities to adopt coastal zoning and building codes in lieu of the state administered Coastal Construction Control Line Program.

Under a contract between the Division of Environmental Resource Permitting, Florida Department of Environmental Protection, and the Beaches and Shores Resource Center of the Florida State University's Institute of Science and Public Affairs, Bay County becomes the twenty-first county to have the review studies as required by Florida Statutes 161.053. This report presents the procedure and results of the required studies.

II. BACKGROUND AND DESCRIPTION

Bay County is located in the central part of the Florida panhandle. The study area consists of the coastal area of Bay County from the west county line to east county line, a total distance of about 44 miles. The locality is shown on NOAA's Nautical Charts Nos. 11385, 11388, 11389, 11391, 11393 and Figure 1 of this report.

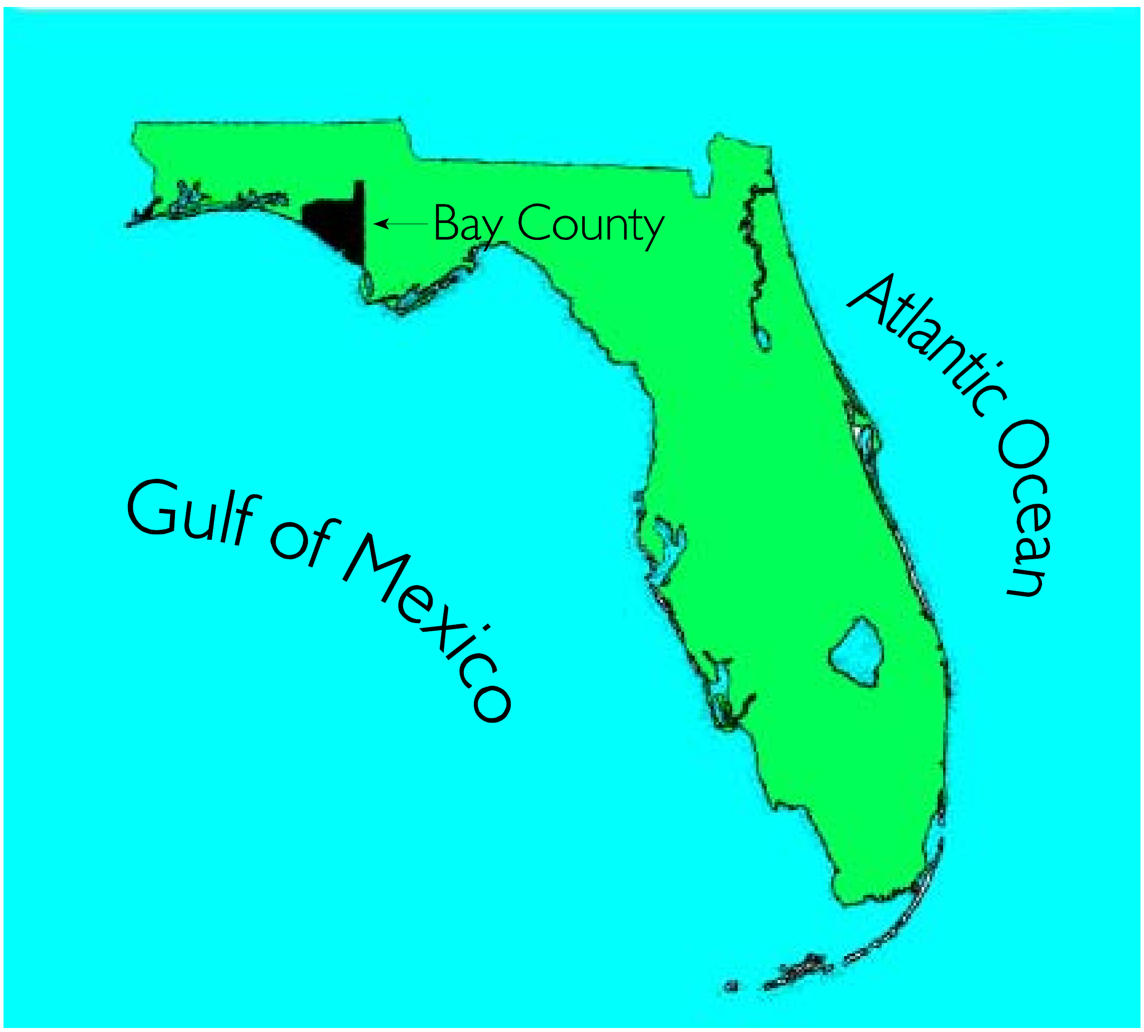


Figure 1 Location Map of Bay County

The county's coastline is characterized by mainland beaches along western and eastern extremes and a barrier island section in the center which almost closes the natural entrance into St. Andrews Bay and its several extensions, West Bay, North Bay and East Bay. Some parts of Shell Island and Crooked Island in the barrier island section are exceptionally low and narrow, exhibiting evidence of washover deposit accumulations in the sound. Crooked Island and the eastern part of Shell Island are under the jurisdiction of Tyndall Air Force Base. The Florida Department of Environmental Protection has not surveyed profiles or established monuments on these segments of Federal land, therefore, the following descriptions apply to only 33 of the 44 miles comprising the Bay County coastline.

A more detailed description of the study area can be obtained from References (1) and (2)*.

---

*Numbers in parentheses indicate the references listed at the end of this report.

III. CONTROL LINE FACTORS

The location of a control line (CL) from a coastal engineering point of view depends upon certain physical conditions. Factors to be considered in a broad sense are shoreline stability (fluctuations, erosion trends) and topography concerning storm/hurricane surges and wave action.

The first step in a study is to investigate the area in question to determine the need, if any, for a review (or study) of the control line. When the need is established, as it has been in Bay County, all available data should be collected; and a topographic and hydrographic survey of the area should be carried out if no recent surveys are available.

The general case in Florida will show a lack of historical and good statistical data. Therefore, much reliance must be made on the recent topo-hydro studies correlated with the measured and predicted physical parameters of the area.

The following sections describe some study factors for the control line investigation.

1. Field Program

A monumented baseline was placed along the 33 mile shoreline of Bay County coastal area, from the western county line to the eastern county line, except the 11 mile segments of federal land. Monumented stations approximately 1,000 ft. apart were placed on the baseline in 1970 and have, since then, been maintained (see Figure 2). Beach profiles from the top of the dune (where existing) to a wading depth were surveyed in December 1972-October 1973, February-March 1992 and in March-May 1995. Offshore soundings at every third monument from the beach to a depth over 30 ft. were made with the surveys of 1971. Offshore soundings to a point about 3,000 to 6,000 ft. offshore (about 20 to 60 ft. in depth) were made at every monument on the baseline for the control line surveys of 1995. Figure 2 shows the location of the beach profiles (R-1, R-2, etc.) and some typical beach profiles surveyed in 1995 are shown in Appendix A. Exhibit B presents the complete set of beach profiles surveyed in March-May 1995. Visual information and photographic ground coverage were also carried out during each survey period and on special occasions.

Stereoscopic aerial coverage of the coastal area were carried out in August 1973, November 1975, November 1979 and October 1995. For the present study, the May 1991 stereoscopic aerial plan photographs were used for the purposes of graphic presentation of the study area and the relocated control line. Elevation contours generated from the controlled aerial plan photographs of 1979 have been used as reference in the study. Exhibit C shows the complete set of the controlled aerial plan photographs of May 1991 for the study area at a scale of 1" = 100'.

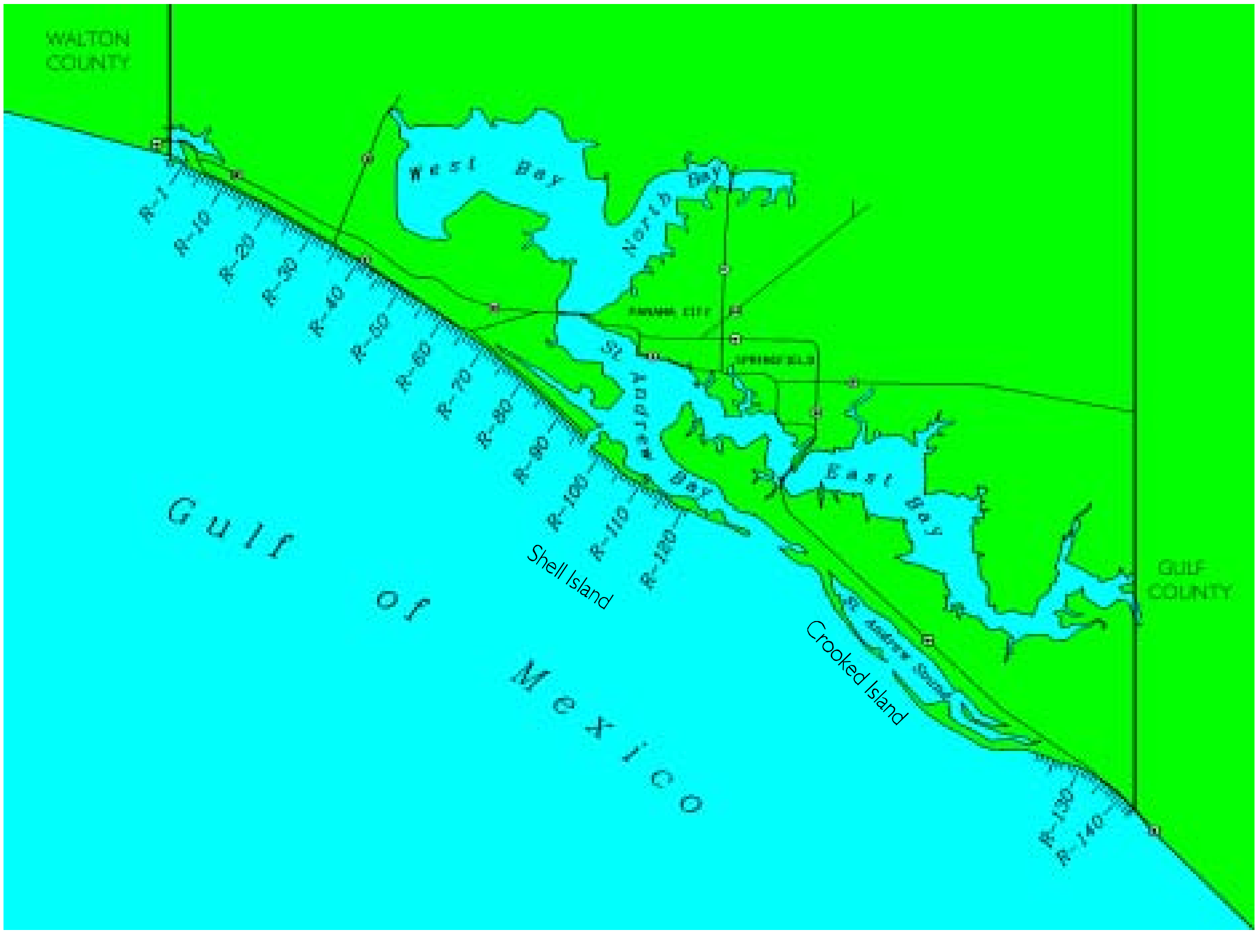


Figure 2   Location Map of Study Area and Range Lines for Bay County

2. <u>Shoreline History</u>

There is little available historical sounding data of the study area. In the past, this area of the Florida coastline has been considered one of the most beautiful, stable areas in the state. It was blessed with beautiful dune formations, clean white sand and apparent coastline stability with a rather low frequency of storm tide flooding because of the high dune structure. However, development of the coastline in this area has progressed at an ever increasing pace. Coastal development provides "reference points" on the dynamic shoreline whereby shoreline fluctuations become readily apparent. The beach fluctuations are not so readily apparent in undeveloped coastal areas - especially where wide high dunes are present.

Unfortunately, the beaches in Florida have had a history of erosion and many coastal structures are now in serious danger. The problem has been increasingly apparent at Bay County over the past years as occasional above normal tides and wave conditions have caused considerable damage to coastal structures and dune formation. The serious erosion problem came to near disastrous proportions in October of 1970 when slightly above average tides associated with moderate to heavy wave action caused considerable damage to coastal structures and scarp erosion to the dunes.

Erosion rates, however important, do not always indicate the short-term fluctuations that occur on the beach. These fluctuations can be quite large in magnitude over a short-term as a result of certain tide-wave conditions. A shoreline which may have an apparent long-term <u>trend</u> of stability can suffer quite severe erosion with subsequent accretion--erosion, etc. These cycles are dependent on tide-wave conditions, however, severe damage (i.e. , loss of vegetation, structures, etc.) may result during these fluctuations.

A. <u>Long-Term Shoreline Changes</u>

Except for a 1.7-mile reach from R-40 to R-49, which appears to be stable, all of Bay County's shoreline is experiencing erosion (3). The historical erosion rate is about 2.1 ft/yr from R-1 to R-40. From R-50 to St. Andrews Inlet at R-97, the erosion rate increases to a maximum of 8 ft/yr at R-90 and R-91. Erosion of the segment from R-63 to R-97 is associated with the 1934 construction of the St. Andrews Inlet. From 1934 to 1988 about 12.8 million cubic yards of sand had been dredged from the inlet, of which only 1.04 million cubic yards had been bypassed to the west and the remainder deposited offshore (1, 4, 5). The erosion has been held largely in check in recent years as a result of placement of the inlet dredging material on the beaches at St. Andrews State Recreation Areas.

Shell Island from R-98 to R-107 is eroding at increasing rates from 1.74 ft/yr at R-98 to 6.41 ft/yr at R-107. Clark (6) reports the erosion to be noncritical due to the lack of coastal development.

From R-127 to R-144 the beach fronting the town of Mexico Beach is experiencing critical erosion, resulting from the impact of the Mexico Beach Canal entrance (6). However, bypass placement of sand from the canal entrance by local officials along the Mexico Beach shoreline has helped stabilized the shoreline.

B. <u>Short-Term Shoreline Changes</u>

Hurricane Eloise in September 1975 caused great damage and erosion on the beaches in Bay County. About 801,000 cubic yards beach-dune material above MSL was eroded. The 10-ft. contour retreated an average of about 23.5 ft. as a result of the erosion (7).

Bay County beaches were severely eroded again by Hurricane Opal in October 1995. Panama City Beaches (R-6 - R-97) suffered 888,000 cubic yards of dune erosion and 776,100 cubic yards of beach erosion. Mexico Beach (R-127 - R-144) experienced about 28,700 cubic yards of dune erosion and 131,000 cubic yards of beach erosion (8).

3. <u>Littoral Forces</u>

A. <u>Tides</u> - Tide records in this area, both collected in previous studies and during the present study show the tides are chiefly diurnal. Tide tables of the National Ocean Service show the mean diurnal tidal ranges at the channel entrance to St. Andrew Bay and at Panama City are 1.3 ft. and 1.4 ft., respectively.

B. Winds - The most comprehensive wind speed and direction data in the offshore area was compiled by the U.S. Naval Weather Service Command (SSMO). According to its publication, 55.1% of the wind speed is between 7 and 16 knots. Most frequent wind directions are east (18.2%) and north (17.6%).

C. Waves - In accordance with the wind direction, a higher percentage of waves are from the east (23.5%). Waves with heights between 1 and 2 ft. are the most frequent ones (33.3%). Waves higher than 6 ft. have a frequency of 13.2%. The average deep water wave height is 3.9 ft. The prevailing wave periods are less than 6 sec. (59.5%). Periods of 6 sec. to 7 sec. and 8 sec. to 9 sec. waves have a percentage frequency of 25.0% and 6.7%, respectively. Here, only sea waves generated by local winds in the vicinity of the observer are summarized.

D. Longshore current and littoral transport - The main current affecting the surf zone is the longshore current created by waves breaking at an angle to the shore. The magnitude of the longshore current depends on the breaking wave characteristics, breaking angle and local bottom and shore configurations.

The longshore currents are responsible for sand transport along the coast. For the study area, the net littoral transport is generally westward as the predominant waves are from the east and is estimated to be about 65,000 cubic yards per year. This estimate seems to be in agreement with the field evidence as indicated by the lack of strong erosion and accretion at the west and east side of the gulf entrance to the St. Andrew Bay (1).

E. Storms/Hurricanes - During the impact of storms/hurricanes, the wind, wave, current and littoral transport patterns are drastically altered from that described in B, C, and D above for normal conditions. Severe erosion and damage (i.e., loss of vegetation, and structures, etc.) caused by the greatly increased water level and wind and wave forces can take place in a very short period of time. The rise or fall of the astronomical tide aids or reduces the wave action on the dune or beach face and can be an important factor in flooding and beach-dune erosion during the events of storms/hurricanes.

A number of damaging storms/hurricanes have affected the study area in the past. Among them were the hurricanes of 1975 (Eloise), 1985 (Kate) and 1995 (Opal). In addition to storms/hurricanes, there were extratropical storms (northeasters) which were more frequent, causing structure damage and beach erosion that were generally not well documented. Among them the most severe ones were the northeasters of October 1970.

4. Storm Surge and Wave Setup

In addition to the astronomical tide, storms/hurricanes and waves are capable of creating extreme high water levels, especially on shallow coastal areas.

Storm surge is the vertical rise in the still water level near the coast caused by reduction of atmospheric pressure and wind stresses on the water surface. Wave setup is the superelevation of the water surface above storm surge level due to onshore mass transport of the water by wave action alone. There exist only a very limited number of reliable records of water levels on the open coast during major hurricanes which have occurred in the past. In the study of storm tides in Florida (9), the Coastal and Oceanographic Engineering Department of the University of Florida has analyzed the normal yearly high tides and high water levels caused by storms/hurricanes and expressed the results as frequency of occurrence for a certain water level to be equaled or exceeded. In that study, all available normal yearly high tide and storm surge data along the coast of Florida before 1959 were analyzed and correlated to provide the tidal level-frequency information for the open coast of Florida. The National Oceanic and Atmospheric Administration (NOAA) and the Federal Emergency Management Agency (FEMA) has done numerical modeling of storm surge in Bay County. For the present study, refined joint probability numerical modeling of hurricanes has been carried out to obtain sufficient details of the storm tide frequency in Bay County. In the joint probability numerical modeling, the hurricane parameters, astronomical tide, dynamic wave setup and Coriolis force are all taken into consideration to obtain the combined total storm tide frequencies. Two separate reports (10, 11) present all the details in the analysis. Figure 3 shows the combined total storm tide frequencies resulting from the numerical analysis (11) at three locations along the Bay County shoreline. The sites of the three locations, i.e., west profile, middle profile, and east profile are depicted in Figure 4.

Another factor which may cause an increase in water level but is not included in the analysis is the effect of rainfall. Since tropical storms/hurricanes are often associated with excessive rainfall, an increase in storm tide levels may occur in coastal areas in the neighborhood of creeks, rivers and inlets/passes.

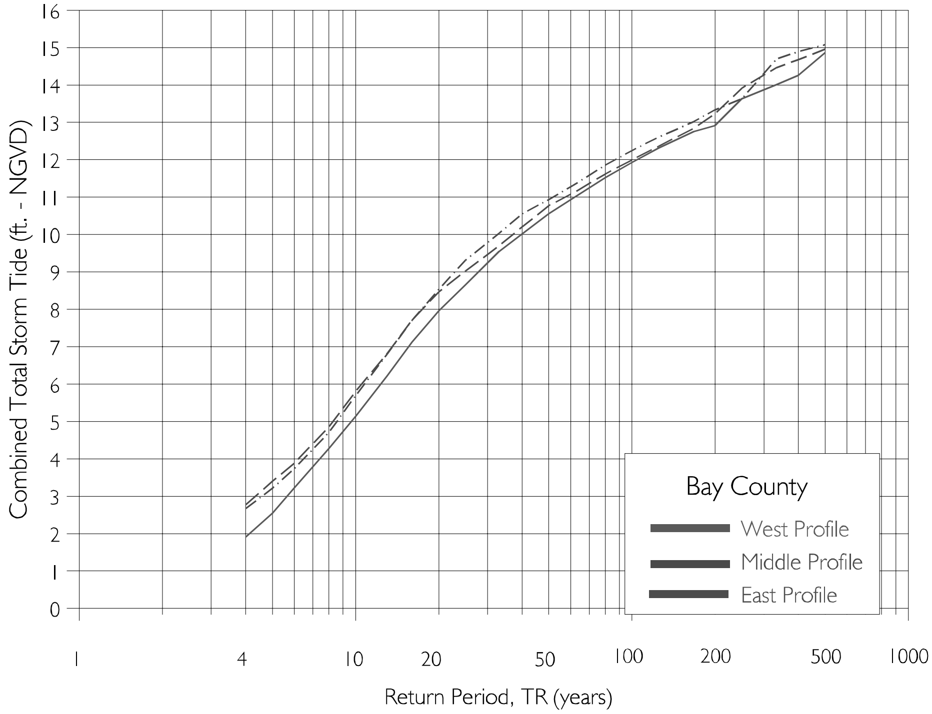


Figure 3 Combined Total Storm Tide Frequencies for Bay County

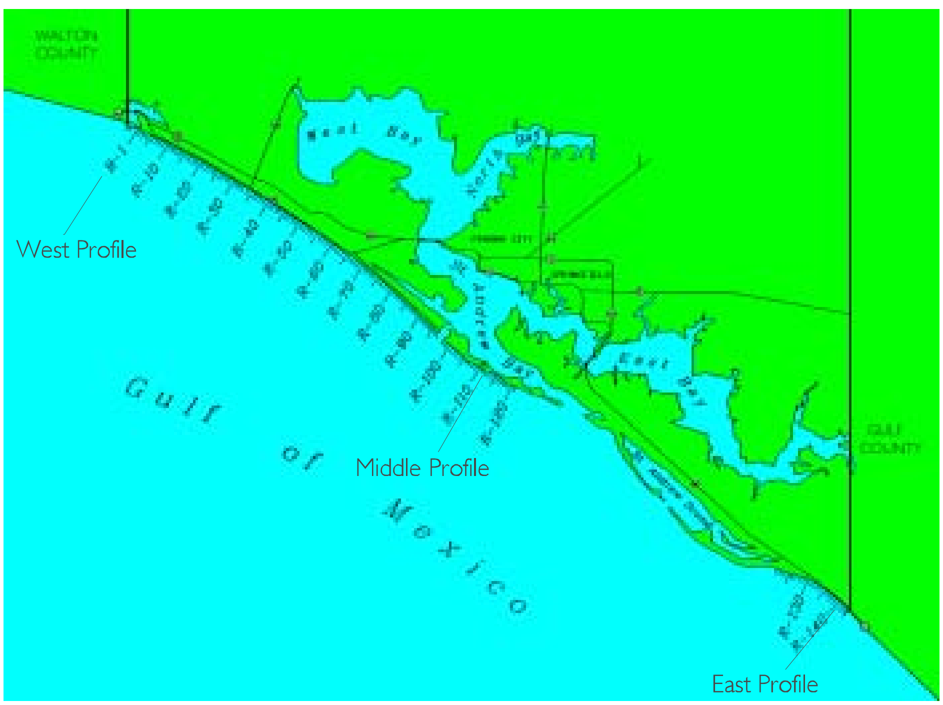


Figure 4 Location Storm Tide Simulation Profiles

IV. CONTROL LINE CRITERIA

In making the analysis for the control line (CL), the objectives were: to prevent beach encroachment that would endanger the existing beach-dune system, and to help prevent existing and future structures from being unreasonably subject to great or irreparable harm.

In the analysis, the following criteria were considered when placing the control line:

1. One hundred year frequency combined total storm tide level of 11.9 to 12.2 as shown in Figure 3 are adopted for calculating:
   - A. Beach-dune erosion limits by a numerical model based on the findings of Reference (12). The model takes into account the storm tide characteristics in the erosion process and was calibrated against the measured beach-dune erosion caused by Hurricane Eloise of September 1975 in Walton County (7) before applying it to the computation of erosion limits associated with the 100 year frequency storm tide for Bay County. The calibration of the erosion model against erosion caused by Hurricane Eloise of 1975 was necessary because of the existence of extensive erosion data on that hurricane.
   - B. Wave action effects associated with the combined total storm tide for the flooded coastal area (where existing) according to the procedures prepared by the National Academy of Sciences (13,14).
   - C. Wave runup on a composite slope (15).
2. The calculated erosion limits and wave action effects together with the historical data and topo-hydrographic information gathered from the surveys and field inspections are finally utilized to arrive at a suitable CL.

In short, the CL analysis considered the following factors: the most recently measured topographic factors which include dune elevations, foreshore slopes, offshore slopes, beach widths, adjacent profiles, upland development and vegetation-bluff lines and the newly developed or measured dynamic factors which include storm tide elevations and erosion, erosion trends, wave action effects, and fluctuations of the beach profiles.

V. DISCUSSION OF ANALYSIS AND REASONING OF RECOMMENDED CONTROL LINE

Shore history, as outlined in previous sections and references, indicates that the beach erosion has been a problem in Bay County. The presence of St. Andrews Inlet and Mexico Beach Inlet greatly contribute to the problem. It is a well known fact that tidal inlets intersecting a sandy shoreline affect the stability of adjacent beaches - especially if the inlets are "improved" by the construction of jetties which interferes with the natural sand bypassing of the inlet.

Coastal development has been substantial in the Panama City Beach area westward to near Phillips Inlet. Impactive and imprudent development has destroyed most of the barrier dune system of western Bay County and rendered the area vulnerable to storm surge flooding, erosion and wave damage (16). Hurricanes of 1975 (Eloise), 1985 (Kate) and 1995 (Opal) have all caused erosion and destruction to the county's coastal area. It is, therefore, obvious that coastal development in Bay County carries a high "risk factor". So, it cannot be emphasized too strongly that future development should be carefully planned and engineered to minimize the risks as much as possible. Figure 5 shows the structure damage (at 1975 dollar value) versus structure location in relation to the control line in Bay County. The data are taken from a study made by Shows (17) after Hurricane Eloise of 1975. The figure shows clearly that damage per structure increases sharply seaward from the control line, levels off at the CL, and reduces gradually landward.

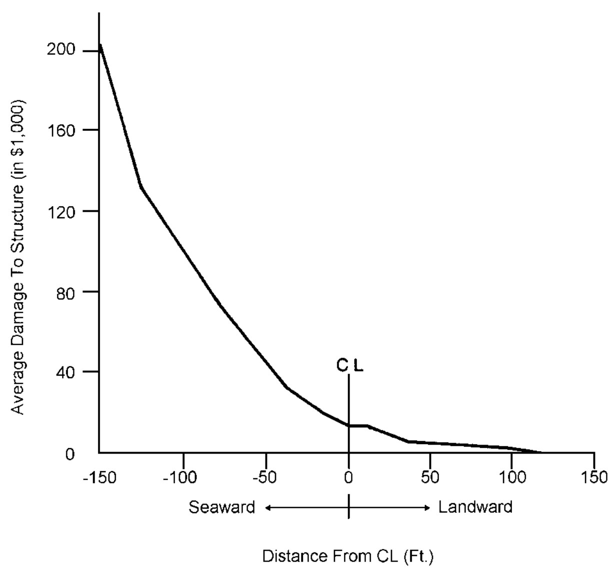


Figure 5 Damage to Structure in Relation to its location with Control Line (resulting from study of 540 structures in Bay County after Hurricane Eloise, By Shows, 1976)

It is possible to develop the shoreline in a manner which will enhance rather than destroy its natural beauty. Every effort must be made to protect, preserve and encourage growth of dunes. Beaches must not be encroached upon to avoid accelerated erosion and adverse effect on adjacent property. In view of the results from the refined analysis in this study, the damage from erosion and flooding by a hundred year frequency hurricane must be recognized. It is for these reasons that the present control line location is recommended. However, it should be strongly pointed out that 'COMPLIANCE WITH THE RECOMMENDED CONTROL LINE DOES NOT IMPLY THAT STRUCTURES WILL BE SAFE OR EVEN RISK FREE'. Property owners and developers are again strongly urged to seek the assistance of design professionals who are familiar with ocean/gulf-front construction so that they may have safe structures which will have a minimum adverse effect on the beach area.

VI. CONTROL LINE DESCRIPTION

As required by law and mentioned in Section III, a monumented baseline was placed and surveyed along the Gulf shoreline of Bay County in 1970 and has, since then, been maintained. Each concrete monument has a 3½ inch diameter brass cap on top. The cap is identified as a Florida Department of Environmental Protection Monument and has a range line designation (R-1, etc.). The monuments run southeast along the Gulf shoreline and are placed approximately 1,000 ft. apart. The western-most monument at the west end of the county is designated as Range One (R-1) and the remaining monuments are numbered consecutively to R-144.

The monuments have been surveyed by a registered land surveyor and each monument is referenced to the State System of Plane Coordinates. Location of the monuments are also shown on Exhibit C (Aerial Plan).

The recommended coastal construction control line (CL) is shown in Exhibit C as a broad line. Exhibit C is controlled aerial plan photographs, taken on May, 1991 along the shoreline of Bay County.

The aerial plan photographs are reproduced at a scale of 1 inch equals to 100 ft.

Upon adoption of the control line (CL), the line will be referenced to the monumented baseline and described using the State System of Plane Coordinates.

REFERENCES

1. U. S. Army Corps of Engineers, "National Shoreline Study - Regional Inventory Report," South Atlantic Division, Atlanta, Georgia, August 1971.

2. University of West Florida, "Florida Beach Management Study," Final Report Submitted to the Florida Department of Natural Resources, Division of Beaches and Shores, Tallahassee, Florida, 1984.

3. Balsillie, J. H., O'Neal, T.T. and Kelly, W. J., "Long-term shoreline change rates for Bay County, Florida," Florida Department of Natural Resources, Beaches and Shores Special Report No. 86-2, 1986.

4. Hine, A. C., Mearns, D. L., Davis, R. A. Jr. and Bland, M., "Impact of Florida's Gulf Coast Inlets on the Coastal Sand Budget," University of South Florida, 1986.

5. Leadon, M. E., "Use of Inlet Sand for Beach Nourishment in Florida," Coastal Zone '83, 1983.

6. Clark, R. R., "Beach Conditions in Florida : a statewide inventory and identification of the beach erosion problem areas in Florida," Florida Department of Natural resources, Beaches and Shores technical and Design Memorandum No. 89-1, 1989.

7. Chiu, T. Y., "Beach and Dune Response to Hurricane Eloise of September 1975," Proc. Coastal Sediment '77, 5th Symposium of the Waterway, Port, Coastal And Ocean Division, ASCE, pp. 116-134, Charleston, South Carolina, November 1977.

8. Florida Department of Environmental Protection, "Hurricane Opal - Poststorm Beach and Dune Recovery Strategic Management Plan for the Panhandle Coast of Florida," March 1996.

9. Bruun, P., Chiu, T. Y., Gerritsen, F., and Morgan, W. H., "Storm Tide Study in Florida as Related to Coastal Topography," Bulletin Series No 109, Florida Engineering and Industrial Experiment Station, University of Florida, 1962.

10. Dean, R. G., Chiu, T. Y. and Wang, S. Y. "Combined Total Storm Tide Frequency Analysis for Bay County, Florida," Beaches and Shores Resource Center, Florida State University, Tallahassee, Florida, September 1994.

11. Dean, R. G., Chiu, T. Y. and Wang, S. Y. "Revised - Combined Total Storm Tide Frequency Analysis for Bay County, Florida," Beaches and Shores Resource Center, Florida State University, Tallahassee, Florida, May, 1996.

12. Kriebel, D. L. and Dean, R. G., "Beach and Dune Response to Severe Storms," Proceedings of the 19th International Conference on Coastal Engineering, Vol. II, pp. 1584-1599, Houston, Texas, September 1984.

13. "Methodology for Calculating Wave Action Effects Associated with Storm Surges,"National Academy of Sciences, Washington D.C., 1977.

14. "Users Manual for Wave Height Analysis to Accompany Methodology for Calculating Wave Action Effects Associated with Storm Surges," Federal Emergency Management Agency, Federal Insurance Administration, June 1980.

15. Saville, T., Jr., "Wave Run-Up on Composite Slopes," Proc. of the 6th Conference on Coastal Engineering, Council of Wave Research, University of California, 1958.

16. Florida Department of Natural Resources, "Florida's Beach Restoration Plan for Planning Districts I, II and V," Chapter IV, February 1990.

17. Shows, E.W., "Florida's Coastal Setback Line - An Effort to Regulate Beach Front Development," Coastal Zone Management Journal, Vol. 4, Number ½, pp. 151-164, Crane, Russak and Company, Inc., 1978.

APPENDIX A

TYPICAL BEACH PROFILES

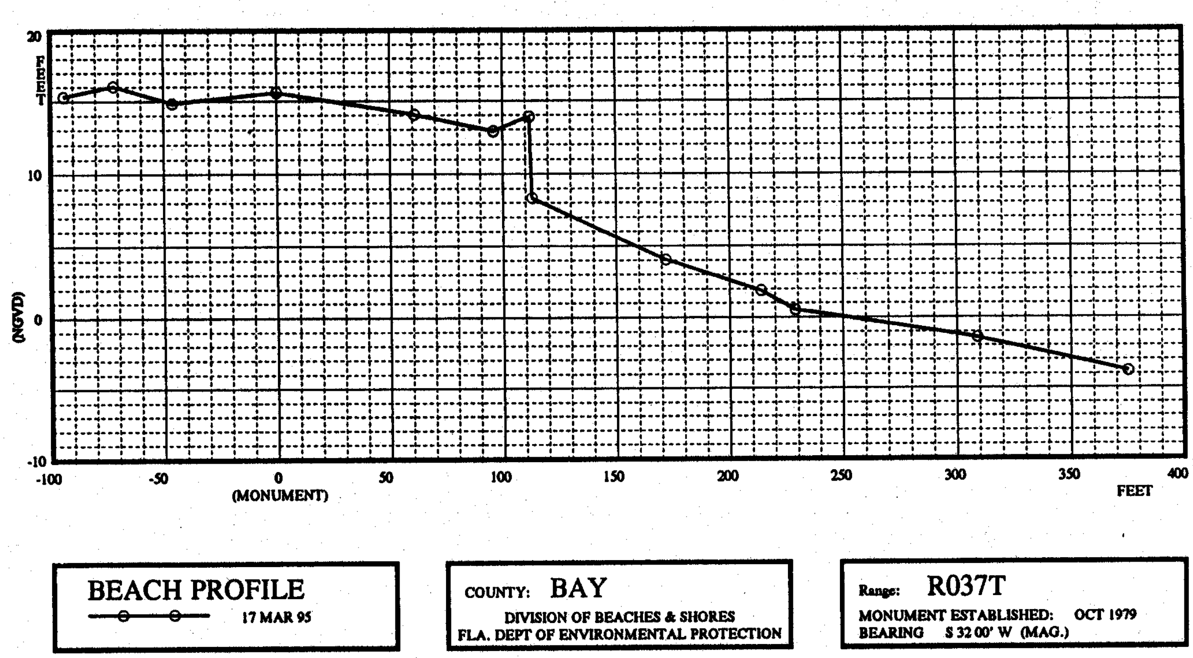


Figure A1 Beach Profile at Range No. 37 (R-37T)

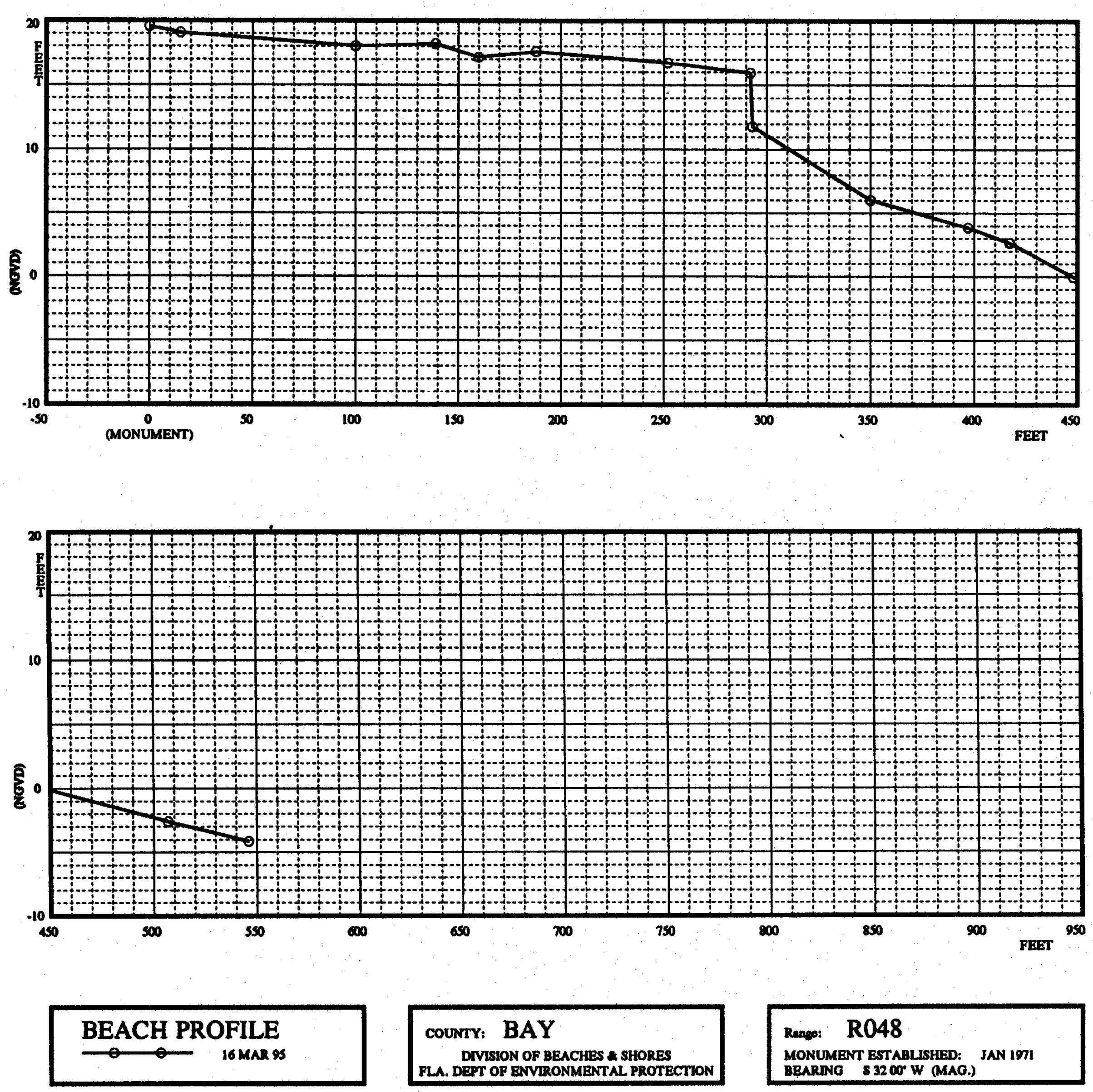
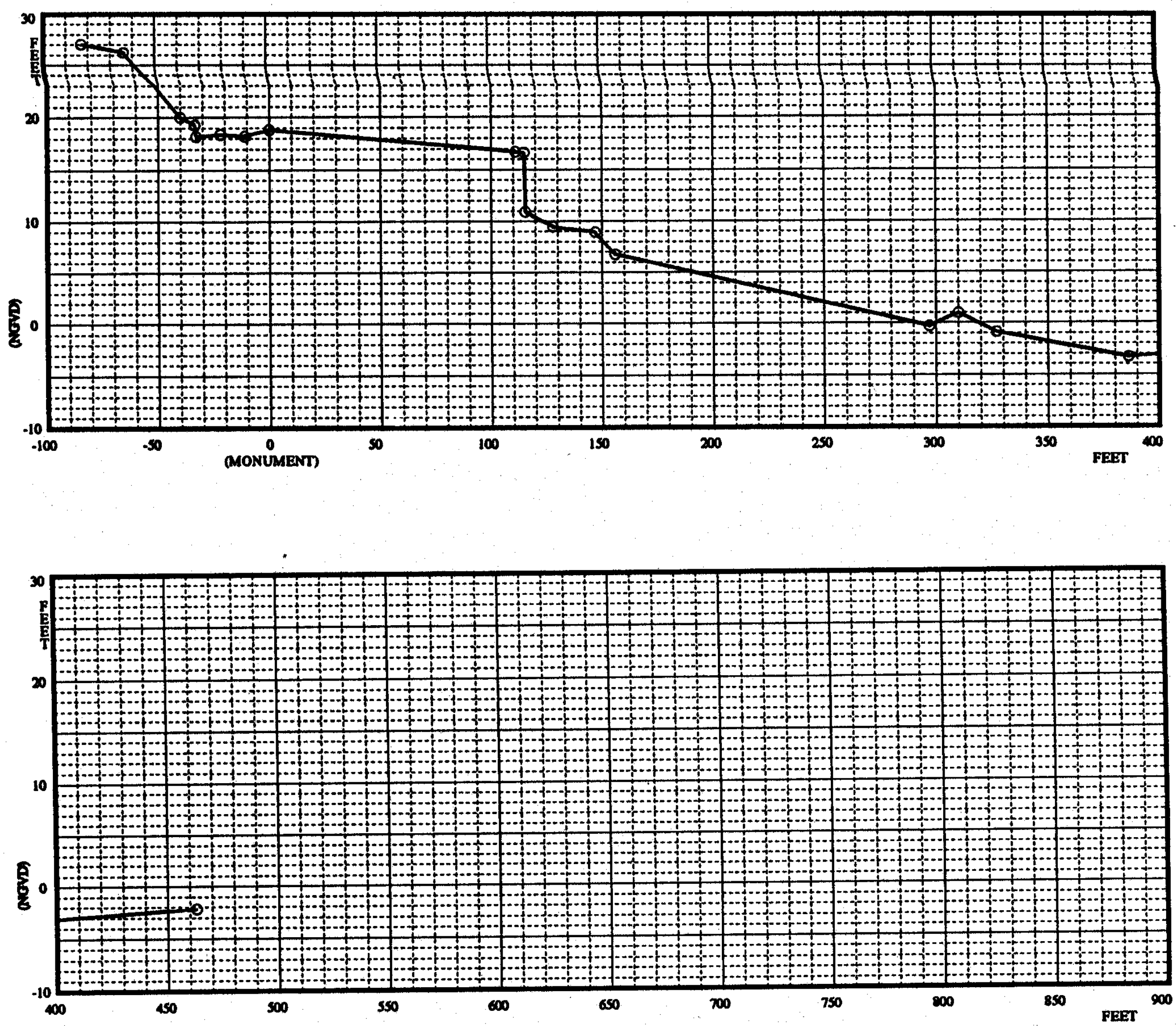


Figure A2 Beach Profile at Range No. 48 (R-48)



BEACH PROFILE
04 MAR 95

COUNTY: **BAY**
DIVISION OF BEACHES & SHORES
FLA. DEPT OF ENVIRONMENTAL PROTECTION

Range: **R054**
MONUMENT ESTABLISHED: JAN 1971
BEARING S 32 00' W (MAG.)

Figure A3 Beach Profile at Range No. 54 (R-54)

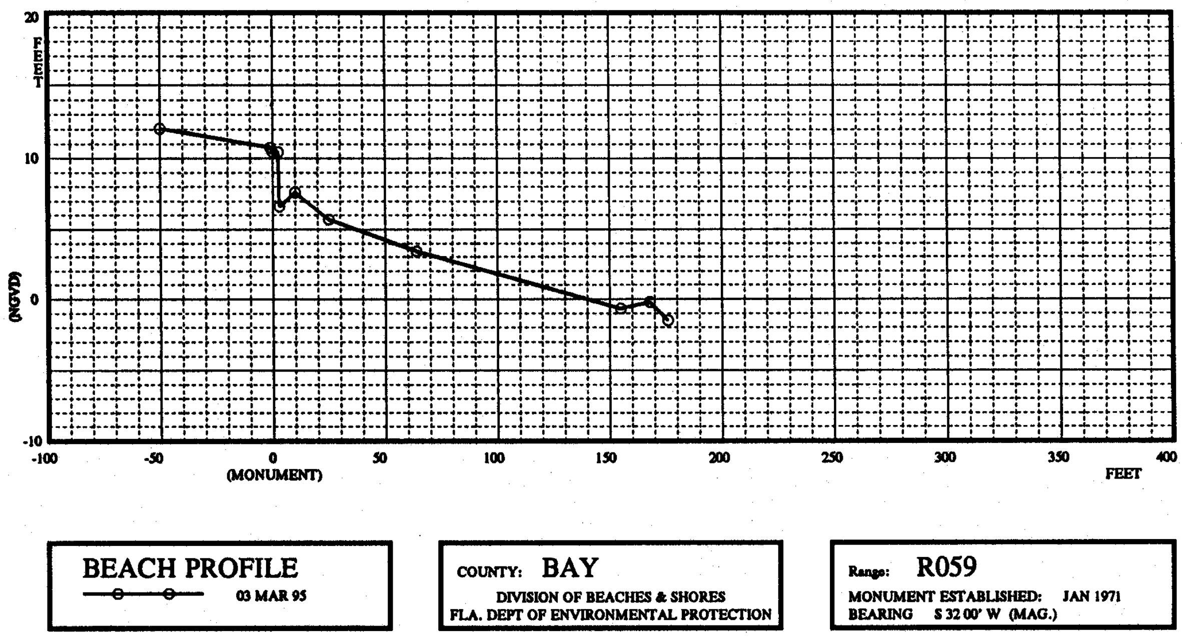


Figure A4 Beach Profile at Range No. 59 (R-59)

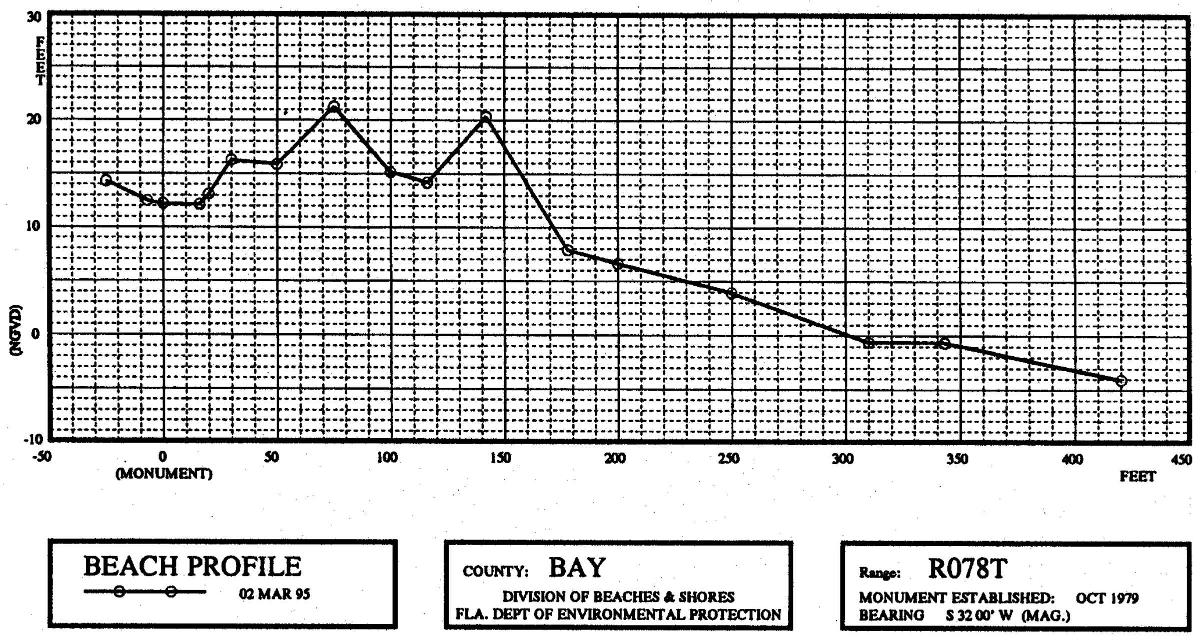


Figure A5 Beach Profile at Range No. 78 (R-78T)

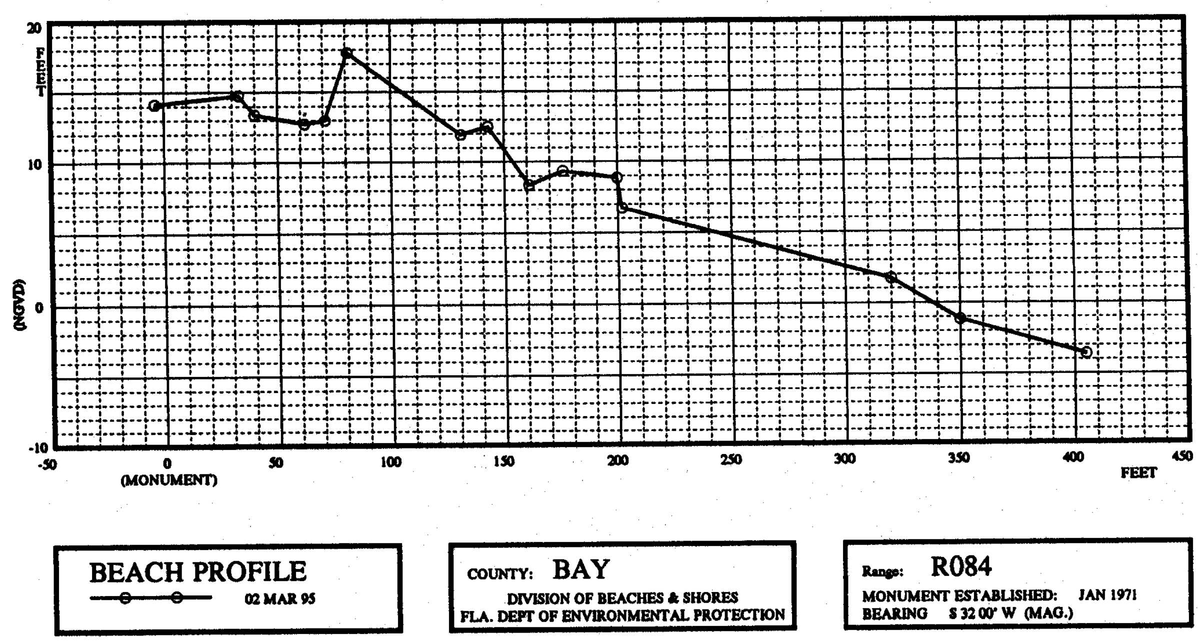


Figure A6 Beach Profile at Range No. 84 (R-84)

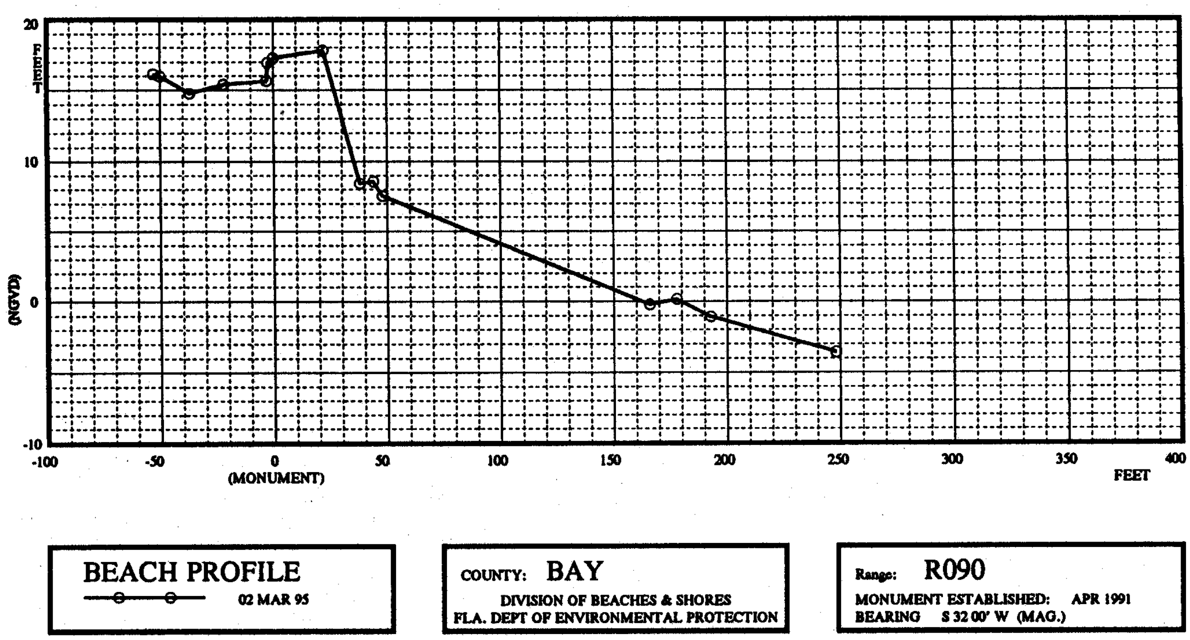


Figure A7 Beach Profile at Range No. 90 (R-90)

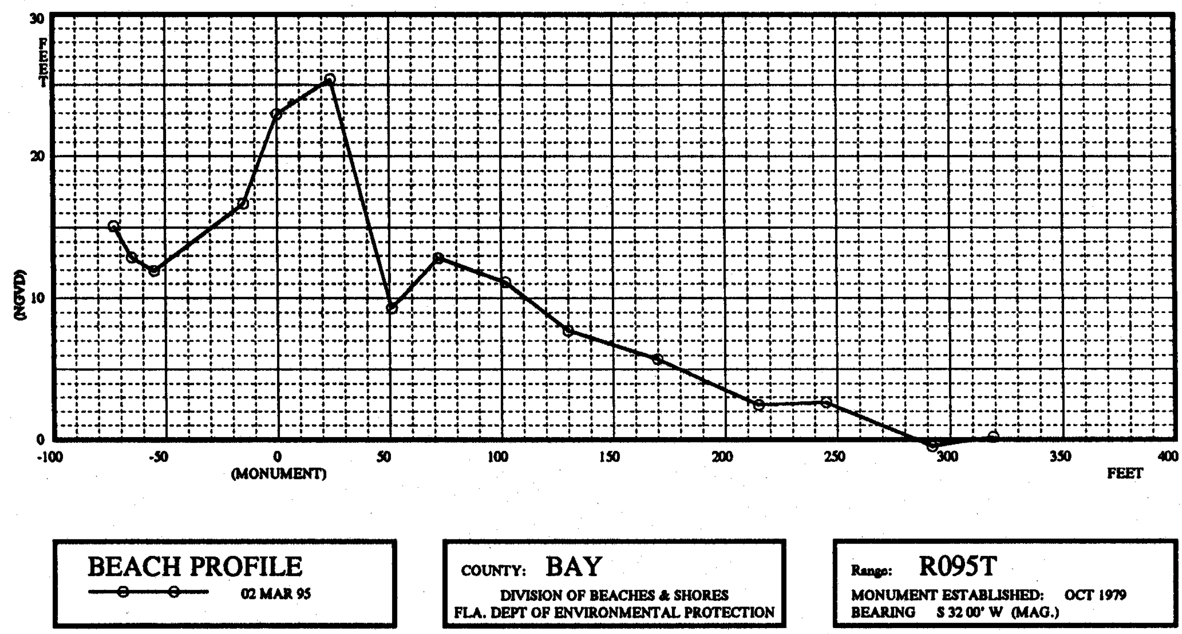


Figure A8 Beach Profile at Range No. 95 (R-95T)

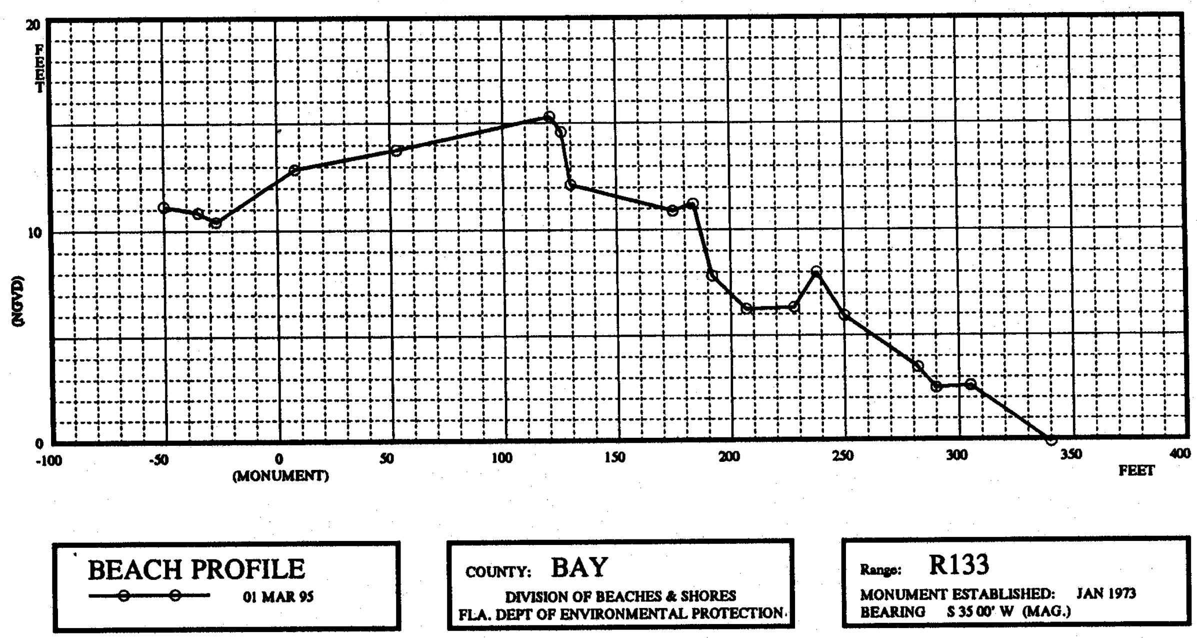


Figure A9 Beach Profile at Range No. 133 (R-133)

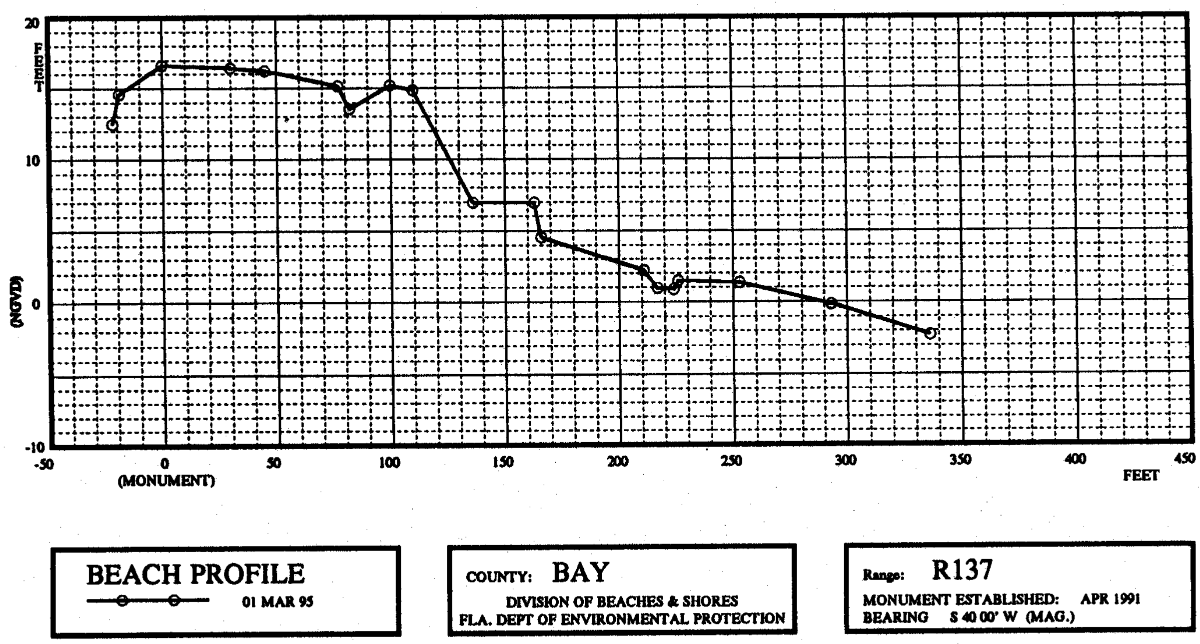


Figure A10 Beach Profile at Range No. 137 (R-137)