### **CHAPTER 88**

### ESTABLISHMENT OF A COASTAL SETBACK LINE IN FLORIDA

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### ABSTRACT

The Florida Legislature passed a law in 1971 requiring the establishment of coastal construction setback lines on a county basis along the sand beaches of the State of Florida fronting on the Atlantic Ocean and the Gulf of Mexico.

Florida's beach areas (valued in \$ billions) are being developed at an accelerated rate, however the coastline is in a general state of serious erosion. These factors combine to make implementation of the above law extremely urgent.

The Coastal and Oceanographic Department of the University of Florida has a contract with the Florida Department of Natural Resources to furnish a comprehensive engineering study of the various coastal counties of Florida in order to provide the technical information and make recommendations for the establishment of such setback lines.

A typical coastal county study is described. The study included historical data related to shoreline stability, field measurements, computations and evaluation of all pertinent factors. Some factors considered were dune elevations, foreshore-offshore slopes, erosion trends, storm surge, vegetation bluff line, wave setup, uprush, coastal structures and upland development.

Analysis of the pertinent factors resulted in formulation of criteria that were applied in recommendation of the setback line. The criteria-application is described along with adoption procedures as required by law.

### INTRODUCTION

Chapter 161.053, Florida Statutes, enacted by the 1971 session of the State Legislature, provides that the Department of Natural Resources (Governor and Cabinet) shall set a Coastal Construction Setback Line along the Gulf and Atlantic shores of the State. This law prohibits any construction, excavation, damage to dunes or vegetation and driving of vehicles on dunes, <u>seaward of the established setback line</u>.

The purpose of this law is the protection of upland properties and the control of beach erosion by preservation of the natural beach-dune system.

This law states that the setting of this line shall be based on data resulting from comprehensive engineering and topographic-hydrographic surveys, erosion trends, predictable storm tides, wave runup, the vegetation bluff line, and other technical data.

Subsequently, the Department of Natural Resources, through the Bureau of Beaches and Shores, entered into a contract with the Coastal and Oceanographic Engineering Department of the University of Florida's College of Engineering for the required studies and surveys.

### II. PROBLEM BACKGROUND

Florida's coastline has been considered one of the most beautiful recreational areas in the world. It has over 800 miles of sand beaches fronting the Atlantic Ocean and the Gulf of Mexico. It has beautiful dune formations, clean white sand and a sub-tropical climate which attracts over 25 million tourists per year.

Its sandy beaches backed by dunes constitute a natural defense against the sea. The beach area is highly dynamic, and seasonal fluctuations of the shoreline are a normal occurrence. However, Florida is subjected to winter northeast storm and tropical hurricanes, and abnormal assaults on the coastline may result in severe erosion or wild fluctuations. Sand dunes are nature's "insurance" in these instances. Although showing the scars of battle (scarps), nature usually provides a healing or rebuilding time before the next abnormal onslaught. In undeveloped beach areas bounded by natural dunes, the shoreline fluctuations are not readily apparent to the casual observer. Thus, parts of Florida's coastline have been considered relatively free of beach erosion and fluctuations. However, coastal development by man encroaching on the dynamic beach area provides "reference point" whereby natural shoreline fluctuations and beach erosion becomes readily apparent.

Recent history (geologically speaking) has shown that Florida's shorelines are in a general state of natural erosion (submergence), due mainly to a rise in sea level. But man's actions have and still are the biggest contributing factor to the State's shoreline problems.

Development of the coastline has progressed at an ever increasing pace. Unfortunately, with a complete lack of or poor zoning laws, man has encroached on the beaches and in the process has hampered or destroyed nature's defense against the sea. In fact, development has, in many instances, magnified erosive forces (vertical seawalls), inhibited natural rebuilding processes and placed older existing structures, once relatively safe, in jeopardy. Sections of the natural dune line have been removed and/or flattened and in many instances, structures have been erected in front of existing dunes. Large portions of the coastline and development worth billions of dollars are now subjected to flooding by storm tides as a result of these practices. The "improvement" and construction of several inlets around the coastline has further aggravated shoreline problems.

As a consequence of man's encroachment, destructive actions and magnification of erosive forces we now find that Florida has a <u>serious</u> beach erosion problem. A forewarning of this problem was pointed out in a 1962 publication<sup>1</sup> of the Coastal Engineering Laboratory of the University of Florida. The problem has been increasingly apparent as further development, above normal tides and wave conditions, have caused extensive damage to coastal structures and dune formations.

### III. SETBACK LINE INVESTIGATION

The location of a setback line 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 as related to storm/hurricane tides and wave action. To properly evaluate shoreline stability, there is a need for historical data of long duration.

The first step in a study is to survey the area in question to determine the need, if any, for a setback line. If the need is established, all available historical data should be collected, and a topographic and hydrographic survey of the area should be carried out.

### Study Area

Based on existing shoreline conditions, and at the request of local officials, the Bureau of Beaches and Shores designated Martin County as the first county in which the required studies would be made. The study area consists of 22 miles of Atlantic Ocean beachfront dissected by St. Lucie Inlet, a major tidal inlet. The area consists of barrier islands, namely Hutchinson Island between the north Martin County line and St. Lucie Inlet and Jupiter Island from St. Lucie Inlet to the Palm Beach County Line. The locality is shown on USC & GS charts Nos. 846, 1247, 1248 and Figure 1 of this report.

Martin County has a long history of beach erosion and/or storm damage to its Atlantic Coastline. Jupiter Island has been noted for severe beach erosion problems and Hutchinson Island has suffered from erosion and damage especially during hurricanes and northeast storms.

Testimony and exhibits presented at a prestudy public hearing in Stuart on October 6, 1971 described some of the erosion and damage problems that have occurred in the past.

Of particular interest was the account of the August-September 1949 hurricane as reported in the <u>Stuart News</u>. It described how Martin County's "first ocean front tourist colony," at Jensen Beach was reduced to a pile of rubble. The colony was described as 5 deluxe, reinforced concrete cottages.

Also described at the hearing was the severe erosion south of the inlet, a breakthrough to the bay at Pecks Lake and a history of the development of St. Lucie Inlet.

A comprehensive report of the coastline problem in Martin County has been issued by the Department of the Army, Jacksonville District, Corps of Engineers dated September 16, 1968. The report entitled, <u>Beach Erosion Control Study</u> on Martin County, Florida, with its detailed descriptions and historical data was a valuable aid in the study. The above data and public hearing, confirmed the need of a setback line in Martin County.

### 2. Field Programs

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

A comprehensive field investigation of the study area was carried out as follows: As required in the law, monumented stations approximately 900 ft. apart were placed parallel to the shoreline (127 stations) from the northern county line along the coast to the southern county line, a distance of approximately twenty-two miles. (Figs. 2 and 3). Each station was carefully





FLORIDA SETBACK LINE





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FIGURE 3 PROFILE STATIONS

surveyed in and tied to the State Plane Coordinate System.

Beach profiles from the back of the dune (where existing) to a wading depth were completed from each station. Profiles were repeated after two winter storms to determine profile fluctuations.

An automatic tide recorder was placed in operation on an ocean pier and recorded continuously during the study.

Using targeted stations as control, stereoscopic aerial coverage of the study area was flown and mylar reproductions at a scale of 1" = 100' were obtained.

Approximately 40 offshore soundings from the beach to a depth of about 30 ft. were completed.

Intensive ground coverage was carried out taking special note of beach material and composition, rock strata, vegetation-bluff-scarp lines, wave uprush, dune stability (blowout-gaps, etc.), existing coastal structures and their behavior, present construction and upland development. All of this data was carefully recorded and supplemented with photographs.

### IV. PERTINENT FACTORS

### 1. Erosion Trends

Historical data are extremely valuable in determining the shoreline trend and erosion-accretion rates for use in determining a setback line location. Fortunately, there are sounding data of 1882, 1928-1930, 1946 and 1964 for Martin County. Much use was also made of historical aerial photographs, local news stories, local land surveys and public testimony. Long term trends, however, 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. During the recent surveys, areas of the county shoreline which have an apparent long term trend of stability were, noticed to suffer quite severe erosion with subsequent accretion-erosion cycles. These cycles are dependent on wave conditions, however, severe damage (i.e. loss of vegetation, structures, etc.) may result during these fluctuations.

2. Wind-Waves-Tide

It is important to obtain long term records of wind, waves and tides because of their direct bearing on the coastline stability. This is especially true for the short term trends or fluctuations of the beaches. Florida's coastline suffers from severe northeastern storms on an annual basis. These storms although "normal", can in many instances, if long enough in duration, cause considerably more beach erosion and coastline damage than many hurricanes. The following data was obtained for the Martin County area.

<u>Tides</u> - Tide records in this area, collected from previous studies and currently furnished by a tide recorder at Seminole Shores pier on Hutchinson Island, show that the tide is semi-diurnal with a rather large daily inequality. Tide tables of the U.S. Coast and Geodetic Survey list the average tidal range for the ocean tide off Martin County as 2.6 ft. and the average spring tidal range as 3.0 ft. The actual mean sea level (MSL) is 1.08 ft. above mean low water (MLW) and 1.83 ft. below mean high water (MHW) (furnished by the Army Corps of Engineers, Jacksonville District).

<u>Winds</u> - The most comprehensive offshore wind speed and direction data in this area are compiled by the U. S. Naval Weather Service Command. According to this publication, 85.5% of the time the wind speed is between 4 and 21 knots. Wind direction frequencies are rather evenly distributed among the eastern semicircle with slightly higher frequency from east (21.7%) and northeast (16.7%).

<u>Waves</u> - In accordance with the wind direction, higher percentage of waves are from the east (22.4%) and northeast (17.2%). Waves with a height between 3 and 6 ft. are the most frequent (48.4%). Waves higher than 6 ft. have a frequency of 12.9%. The prevailing wave periods are between 3 and 4 sec. (30.7%), 1 and 2 sec. (26.0%) and 5 and 6 sec. (17.9%).

### 3. Longshore Current and Littoral Drift

The currents which affect the open coast are the longshore currents created by breaking waves 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 littoral transport is generally southward during the period September through February, northward from June through August and directions uncertain during the rest of the months. The predominant or net littoral drift is from north to south and is estimated to be about 200,000 to 250,000 cu. yds. a year inside the 20 ft. contour.

#### Storm Surge and Wave Setup

In addition to the astronomic 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 wind stresses on the water surface. No reliable records are available of water levels on the open coast during major hurricanes which have occurred in the past few decades. In a study of storm tides in Florida<sup>2</sup>, the Department of Coastal and Dceanographic Engineering, University of Florida has analyzed the normal yearly high tides and high water levels caused by 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 and storm tide data before 1959 along the coast of Florida were analyzed and correlated to provide the tidal level-frequency information for the open coast of Florida. Unfortunately there were a lack of data for the study area. Thus the interpolated storm surge frequencies given in that report may be less reliable than the new information furnished by National Oceanic and Atmospheric Administration (NOAA). For this reason, it is chosen to adopt the NOAA's information and frequency.



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For comparison the interpolated surge elevation-frequency curve in the Univerversity of Florida's report is also shown in Figure 4 which indicates a much higher trend. In view of the documented<sup>3</sup> surge of 8.5 ft. (MSL) in St. Lucie River caused by the August 1949 hurricane, the curve with higher surge trend may prove to be valid, however, the newly compiled curve by NOAA was used for this study.

Wave setup is the superelevation of the water surface over normal surge elevation due to onshore mass transport of the water by wave action alone. There is no record of wave setup for this area. During a "Standard Hurricane" such as Hurricane Audrey (1960), the wave setup is estimated to be about 2.0 ft. in the study area.

Another factor which may cause an increase in water level is the effect of rainfall. Since hurricanes are often associated with excessive rainfall, an increase in storm tidal levels may occur in coastal areas in the neighborhood of creeks, rivers and inlets.

The water level rise due to reduced atmospheric pressure associated with a hurrican is considered to be included in the original storm tide data.

### 5. Wave Uprush

Wave uprush is the rush of water up onto the beach following the breaking of a wave. How high or how far the uprush will reach depends on the wave characteristics and the steepness and roughness of the beach surface. Due to the fact that each beach profile is highly irregular in shape and widely varying in elevation from place to place, the wave uprush is expected to vary accordingly. Since a setback line should not be exposed to direct wave attack of a certain frequency, the uprush would be a minimum elevation (or distance) beyond which the setback line should be located. While not much field data are available, laboratory test results have been utilized to assist in uprush computations. For a complicated beach surface with changing slopes, the composite slope method<sup>4</sup> has proven to be applicable. Laboratory tests<sup>5</sup> also showed rough surfaces could reduce uprush considerably.

A computer program was developed to perform the calculations of uprush on each of the profiles by employing the composite slope method.<sup>4</sup> Field data could be directly fed into the computer which would compute the wave uprush under any given wave height and period superimposed on any water level. Many different water levels (surge frequencies) and combinations of wave periods could be computed in an extremely fast, efficient manner.

### 6. Topographical Conditions and Existing Structures

As mentioned in Section III-2, Field Program, intensive ground surveys were carried out. Factors such as beach composition, coastal structures, upland development, vegetation (types-density), visible erosion and/or dune damage are all important considerations. Controlled, vertical aerial photographs of the coastline were flown and proved to be extremely valuable. These aerials were reproduced on mylar sheets at a scale of 1" = 100' and showed the position of each permanent monument (profile station) as well as the state plane coordinate lines.

### V. SETBACK LINE ANALYSIS

In making the analysis for the setback line the objectives were two fold. To prevent beach encroachment that would endanger the natural beach-dune system and to prevent upland development from being unreasonably subjected to great or irreparable damage. The analysis considered these factors: topographic features, which included dune elevation, foreshore and offshore slopes, beach material and width, coastal structures, vegetation and bluff lines; the <u>dynamic features</u>, which included storm surge elevations, erosion rates, wave set up and uprush, tides and short term fluctuations of the beach profiles.

### 1. <u>Criteria</u>

For Martin County the guidelines and standards that were chosen for positioning the setback line are as follows:

A storm surge of 4.2 ft. MSL, 2.0 ft. wave setup and a 1.8 ft. MSL spring tide were combined in the determination of a still water level of 8.0 ft. MSL under storm conditions.

A wind wave of 6.5 ft. in height with a period of 8.0 sec. was chosen for computing the uprush by composite slope method<sup>4</sup> under the storm condition on each of the profiles. This will yield the information about how far landward the uprush may reach.

Long term erosion trends were compiled for each profile station and reduced to an annual average. Short term fluctuations were used to determine what order of magnitude may be expected on a 5 year frequency. Pertinent topographical features (materials, vegetation, etc.) were incorporated into these guidelines.

Existing coastal structures and upland development were studied for efficiency, durability, continuity and affect on adjacent properties.

### 2. Application

Using the above criteria, the uprush limits were plotted on the beach profile and aerial plans as a first approximation of the setback line.

A minimum distance of 40 ft. from the present dynamic beach face was used to provide for the extraordinary beach fluctuation. This distance was further adjusted to the annual erosion rate using a further setback of annual rate times 5 years.

A minimum distance of 25 ft. from the most seaward dune crest (if present) was used for protection of the dune system.

Adjustment of coastal structures - upland development was then applied where deemed necessary.

Further adjustment was made to avoid discontinuity, zig-zags or other irregularities which showed up on the plotted setback line.

Figures 5 to 8 show some typical profiles with the setback line (SBL), surge level (20 year frequency, see V.1.), and computed wave uprush.

### VI. ADOPTION OF SETBACK LINE

As required by law, a public hearing in Martin County was held prior to recommendation to the Governor and Cabinet for adoption of the line.

Prior to the public hearing, notice was given to all county residents and interested parties. Plans showing the recommended setback line along with reports and other supporting data were placed on public display well in advance of the hearing.

At the public hearing all arguments and evidence for support or in opposition to the recommended line were recorded for study by the staff of the Department of Natural Resources. As a result of the hearing, one adjustment to the line was made by the hearing officer.

The line was recommended to the Governor and Cabinet for adoption. Further arguments and evidence were presented at the time. The setback line was adopted by a unanimous vote.

A legal description of the adopted setback line was then recorded at the Martin County Clerk Office.

The law provides for variances of the setback line to be granted by the Oepartment of Natural Resources if such variances are fully justified. The law further provides that the setback line be reviewed at five year intervals or sooner if proven necessary.

### ACKNOWLEDGEMENTS

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## COASTAL ENGINEERING





# FLORIDA SETBACK LINE



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elevation in ft. (MSL)

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