

SECTION I

INTRODUCTION

AUTHORITY

1. This post-hurricane report on meteorological data and storm damages resulting from Hurricane Frederic has been prepared by the US Army Corps of Engineers, Mobile District, under the authority contained in Public Law 84-99. The information contained in this report was compiled pursuant to instructions contained in Engineer Regulation number ER 500-1-1, dated 9 January 1978, as revised by Change 1, dated 12 December 1978.

PURPOSE AND SCOPE

2. Because of the widespread area affected and the magnitude of the wind and water damages experienced in the Mobile District as a result of Hurricane Frederic on 12-13 September 1979, the preparation of a post-hurricane report was warranted. This report presents a complete assessment of the hurricane's damaging effect, the meteorological and hydrological characteristics of the storm, emergency activities and post disaster actions.

3. The region most severely effected by the hurricane includes the coastal areas of Mobile and Baldwin Counties, Alabama, Jackson and Harrison Counties, Mississippi and Escambia and Santa Rosa Counties, Florida. Massive damage was inflicted by the wind and the storm surge in the resort areas of Dauphin Island and Gulf Shores along the Alabama Gulf Coast. The hurricane force winds caused extensive damage to the homes and businesses in the urban areas of Mobile, Alabama and Pascagoula, Mississippi which were in the immediate area of landfall. Special emphasis is placed on this area of greatest destruction. Extensive wind damage was also reported in the inland counties of Alabama and Mississippi along a band about 200 miles wide for a distance of about 150 miles from the Gulf Coast north to the vicinity of Meridian,

SECTION III

AREAS AFFECTED IN THE MOBILE DISTRICT

GENERAL

22. Hurricane Frederic moved inland across Mobile County near the Alabama-Mississippi State Line. Hurricane force winds were reported in Hancock County, Mississippi, about 90 miles west of Mobile. Pensacola, about 70 miles east of Mobile, reported winds of 96 m.p.h., and it is estimated that hurricane force winds extended about 20 miles east of Pensacola. Frederic retained its hurricane intensity for approximately 150 miles inland to the vicinity of Meridian, Mississippi; thereafter, it was downgraded to a tropical storm. Its major path of destruction from rain, winds and tornadoes was approximately 250 miles wide and 150 miles deep, with the heaviest destruction occurring around the eye in Mobile and Baldwin Counties, Alabama, and Jackson County, Mississippi.

23. The Governors of Alabama, Mississippi, and Florida requested that President Carter declare selected counties disaster areas as a result of the damages inflicted by Frederic. On 14 September 1979, President Carter issued a "Presidential Disaster Declaration" which approved 30 counties in Mississippi, Alabama, and Florida as disaster areas eligible for Federal assistance under Public Law 93-288. The disaster area in Florida included Escambia, Santa Rosa, Okaloosa, Walton and Bay Counties. In Alabama, the counties included Mobile, Baldwin, Escambia, Washington, Clark, Monroe, Conecuh, Choctaw, Covington, Geneva and Marengo. Affected Mississippi counties were Jackson, Harrison, Hancock, George, Stone, Pearl River, Greene, Perry, Forrest, Wayne, Jones, Covington, Clarke, and Lauderdale. Lamar and Jasper Counties, Mississippi, were approved for individual assistance only. The total disaster area, which is depicted on plate 4 included 32 counties in three states.

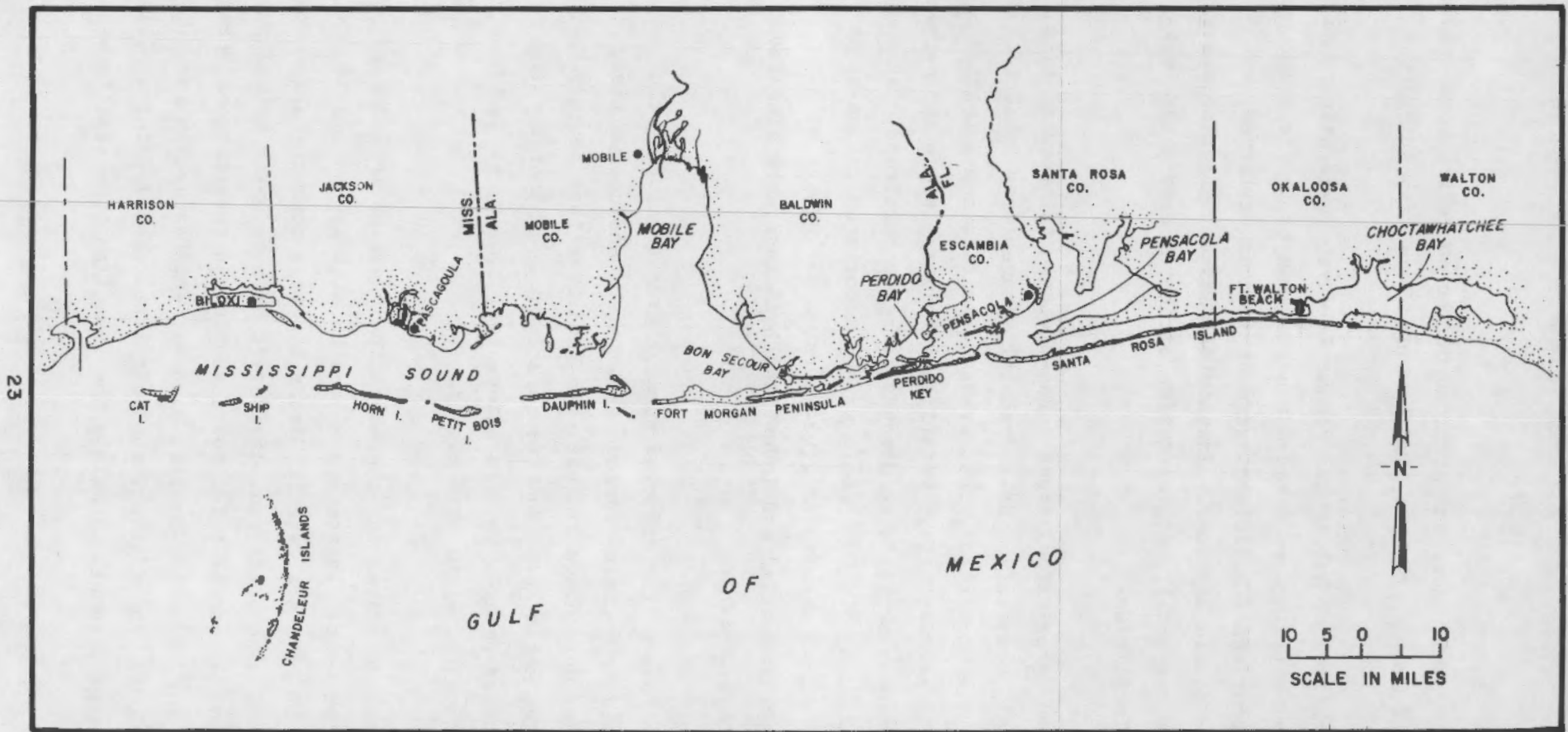


FIGURE 2 GULF COASTAL AREA AFFECTED BY HURRICANE FREDERIC.

STORM SURGE

57. As the storm struck the coast, the storm surge was greatest in its north-eastern quadrant, which swept along the Alabama Gulf Coast near the Alabama-Florida State line. On Dauphin Island the astronomical low tide occurred at 1:05 p.m. on 12 September, and the high tide occurred at 1:53 a.m. on 13 September. The tide variation from low to high was about 1.1 feet. At that location, the hurricane struck with its greatest force at about 8:00 p.m. on 12 September. On the Alabama beaches in Baldwin County, from Fort Morgan (at Mobile Bay) east to Alabama Point (at Perdido Pass), storm surge high water elevations ranged from 10 feet to more than 15 feet above National Geodetic Vertical Datum, NGVD (formerly mean sea level). One of the higher water marks (HWM) was measured at 15.79 feet, along a driftline at the northwest corner of the main building at Gulf State Park, Gulf Shores, Alabama.

58. A wave height was measured at elevation 16.93 feet NGVD, and its associated wave runup of 23.88 feet, on the coast about three miles west of Perdido Bay.

59. High water elevations on the Gulf Coast of Perdido Key, Florida were about 11 to 15 feet. On the north side of the key in Big Lagoon, at Gulf Beach Bridge, which crosses the Gulf Intracoastal Waterway, a high water elevation of about 7 feet was observed. The gage at the bridge was destroyed during the hurricane.

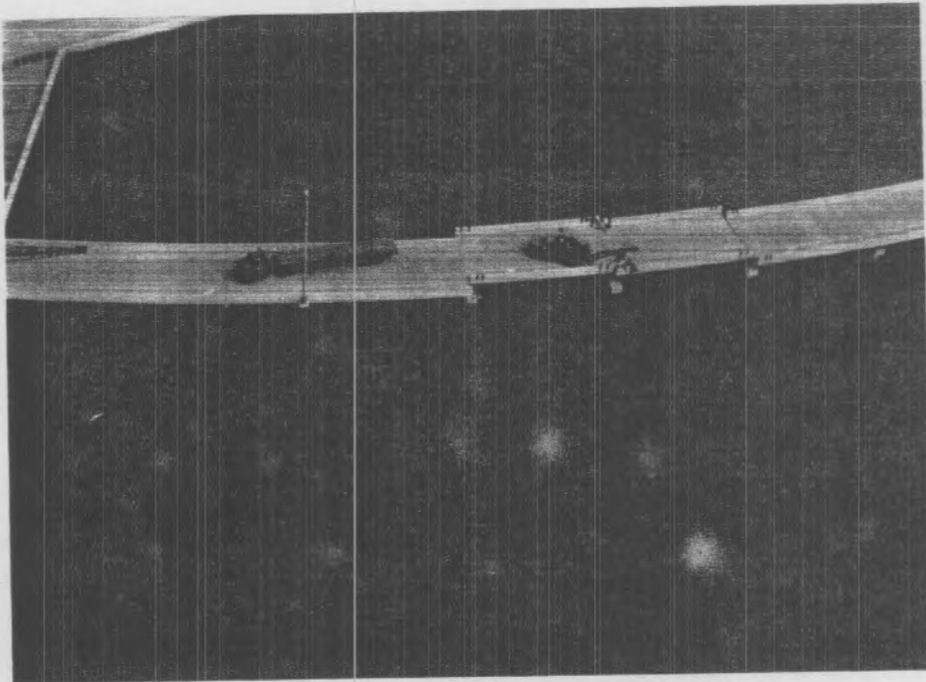
60. The high water elevations in Pensacola Bay at the City of Pensacola averaged 6 feet. At Gulf Breeze the high water marks were 6 to 7 feet. High water marks on the Gulf (south) side of Santa Rosa Island from Fort Pickens to Navarre, were from 11 to 15 feet. On the Santa Rosa Sound (north) side of Santa Rosa Island in the same general area, the high water elevations ranged from 6 to 7 feet. The gage at Destin, Florida, recorded a high water elevation of 3.28 ft, and the gage at Panama City, Florida, had a high of 3.86 feet NGVD.

61. On Dauphin Island, Alabama, high water elevations ranged from 9 feet on the eastern end near Fort Gaines, to over 13 feet NGVD on the Gulf (south)

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VIEW OF DESTRUCTION AT WOODY'S MOTEL LOCATED ON BATTLESHIP PARKWAY (U.S. HIGHWAY 90 & 98), WHICH CROSSES MOBILE RIVER DELTA IN BALDWIN COUNTY, ALA.



SPAN OF I-10 EASTBOUND ENTRANCE RAMP AT HWY. U.S. 90 WAS LIFTED AND DISPLACED OVER SIX FEET FROM ITS FOUNDATION.



ONLY THE SIGN REMAINS OF THE ONCE POPULAR ROUSSOS RESTAURANT. DEBRIS IS SCATTERED ACROSS THE LOCATION WHERE THE EATERY ONCE STOOD ON BATTLESHIP PARKWAY.

67. The Pascagoula, Mississippi gage recorded a high water elevation of 5.78 feet. The high water elevation at the same location was 6.4 feet NGVD during Hurricane Betsy (September 1965), and 8.5 feet during Hurricane Camille (August 1969).

68. The Gulfport, Mississippi gage recorded a high water elevation of only 2.98 feet. Even though Gulfport sustained hurricane force winds, the predominate winds were from the north resulting in a negative tide. A tabulation of high water data and a high water profile of the Gulf Coast affected by Hurricane Frederic are shown on plate 8.

69. The Gulf coastal region within the Mobile District's jurisdiction is vulnerable to wind and wave effects from meteorological disturbances affecting the northern Gulf of Mexico. Significant storms may occur either as a result of frontal systems or tropical storms up to the magnitude of hurricanes. The track of significant storms affecting the Mobile District is shown on plate 9. A summary of significant barometric pressure and wind speed data from 1901 through 1979 is contained in table 11.

HURRICANE NAMES

70. In early years, especially before 1900, unusually violent hurricanes of the Atlantic Ocean, Caribbean Sea and Gulf of Mexico were named after the particular saint's day on which they occurred. Hurricanes were later referred to by the date or the year in which they occurred e.g., in Mobile, Alabama the "1906 Hurricane" caused many deaths. As early as the years of World War II, (1941-1944) hurricanes were unofficially given feminine names. In 1950 the US Weather Bureau began to name hurricanes using the phonetic alphabet. This practice continued until 1953, when hurricanes began to be officially designated by feminine names, following a practice first established in "Storm" a 1941 novel by George R. Stewart. In 1979 the National Weather Service initiated a policy of alternating masculine and feminine names to designate storms which occurred in the Atlantic Ocean and Gulf of Mexico region. A year earlier the policy of alternating names had begun for storms in the Pacific Ocean.

SECTION VI
HURRICANE EFFECTS ON BEACHES AND DUNES

BEACH AND DUNE EROSION

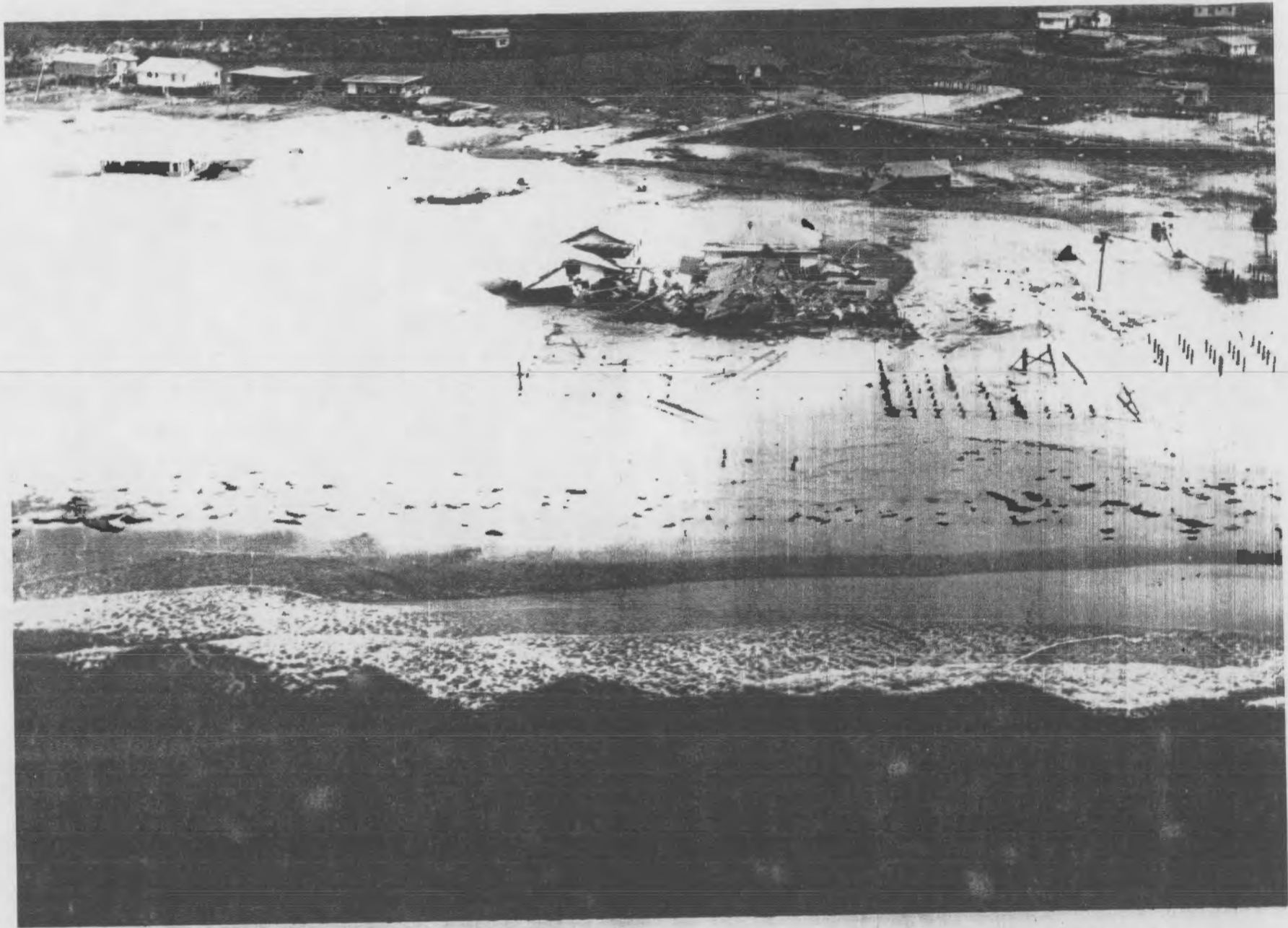
79. Varying degrees of beach and dune erosion occurred along the Gulf coasts of Florida, Alabama, and Mississippi. The most extensive erosion and flooding as a result of storm surge was in Baldwin County, Alabama and Escambia County, Florida.

80. The State of Florida, Department of Natural Resources, prepared a report dated 19 September 1979 and entitled, "Summary Field Inspection Report of Beach and Coastal Construction Storm Damage Resulting from Hurricane Frederic In the Florida Panhandle, September 13, 1979." The report described the hurricane's effect on beaches and dunes and the varying degrees of damage to structures along the beach from Bay County west to and including Escambia County, Florida. Much of the following data relative to Florida beaches was taken from the report.

81. Bay County, Florida. In the vicinity of Mexico Beach there was minor beach and dune erosion. Maximum dune recession was about 15 feet horizontally and 2 feet vertically.

82. The beaches in the vicinity of Panama City had minor to moderate beach and dune erosion. Maximum dune erosion was about 50 feet horizontally and 7 feet vertically. Volumetric losses were estimated at about 10 cubic yards per yard of beach.

83. Philips Inlet remained open to normal tidal exchange. It has been reported that most of the emergency beach sand restoration put in place after Hurricane Eloise (1975) which had been slowly eroding since its installation, was washed away by Hurricane Frederic. The restoration had extended about 18.5 miles, from the west jetty at Panama City Harbor Entrance, west to Philips Inlet.



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TYPICAL EXAMPLE OF DESTRUCTION OF BEACH HOUSES ALONG GULF COAST IN BALDWIN COUNTY, ALA.



HIGHWAY BRIDGE CROSSING INLET AT LITTLE LAGOON IN BALDWIN COUNTY, ALA. - SEVERAL SPANS COMPLETELY DESTROYED AND ROAD AND BRIDGE APPROACHES WASHED AWAY.



VIEW OF GULF SHORES, ALA. WATER DAMAGE TO HOMES AND BUSINESSES WAS EXTENSIVE. NOTE HOUSE MOVED BY STORM SURGE INTO ROADWAY.

91. Baldwin County, Alabama. For a distance of about 6 miles along the beach west from Perdido Bay there was extensive dune erosion. The shoreline receded about 80 feet and the dune line about 100 feet from the waterline. The dunes eroded about 5 feet vertically down to an elevation of about 5 feet NGVD.

92. There was a substantial breach and tidal breakthrough into Shelby Lakes, as a result of the storm surge. A section of the road between the lake and the gulf was completely washed away. A sand closure was constructed, within a few days, to protect the fresh water lake from further mixing with salt water from the gulf.

93. For about the next 12 miles west to the vicinity of the western end of Little Lagoon, there was extensive dune damage. Dunes in the area are approximately 150 feet wide and are located about 150 feet from the water line. They thin out and become discrete mounds near Little Lagoon. Many of these dunes were eroded 5 to 8 feet and the shoreline receded about 100 feet.

94. From Little Lagoon west for about 6 miles the dunes had averaged 15 to 20 in elevation. There was extensive dune erosion of about 10 feet vertically. The dunes which had been about 100 feet from the waterline no longer exist and the sand is spread over a gentle sloping beach from about elevation 8 down to the waters edge over a distance of about 500 feet.

95. For the next 5 miles west, to Fort Morgan at Mobile Point, there was extensive dune erosion. However, the waterline remained about the same. The dunes which ranged from elevation 10 to 15 feet NGVD, and about 200 feet wide were eroded to about elevation 5 feet NGVD. The sand formed a long gentle slope over a distance of about 200 feet to a slight berm near the waters edge, about 50 feet wide and 3 feet high. The north shoreline of the peninsula along Mobile Bay eroded away in irregular fans. A large amount of sand was pushed over the salt marshes and covered over half of them.



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AERIAL VIEW OF DAUPHIN ISLAND, ALA. SHOWING MASSIVE DESTRUCTION OF BOATS AND STORAGE BUILDINGS AT MARINA, ALSO NOTE ROAD DAMAGE.



STORM SURGE CAUSED WASHOVER FANS PUSHING SAND ACROSS ROAD INTO MISSISSIPPI SOUND. VIEW OF DAUPHIN ISLAND, ALA. LOOKING SOUTH.



DAUPHIN ISLAND, ALA. LOOKING NORTHWEST. MANY HOMES RECEIVED WIND AND WATER DAMAGE.

100. Jackson County, Mississippi. The Mississippi coast is partially protected by a line of barrier islands. Only minor to moderate beach and dune erosion occurred on these islands. Although Petit Bois Island was completely breached in one location, it has about regained its original shape. The cut was about 100 yards wide and was located about 300 yards from the eastern end of the island. The shoreline on the south side of the island has become straighter as a result of the hurricane.

101. Due to the northern winds in the vicinity of Horn and Ship Islands, they received only minor beach erosion.

ASSESSMENT OF BEACH DAMAGE

102. The Mobile District Corps of Engineers, at the request of FEMA, made an assessment of damage to Alabama beaches. The extent of damage from Hurricane Frederic was determined by comparing "before and after" conditions of 30 miles of beaches at Gulf Shores, and 7 miles on Dauphin Island. The Florida Department of Transportation provided aerial photographs taken 14 September 1979, from which maps of Dauphin Island, Alabama and Gulf Shores, Alabama (from Fort Morgan to Alabama Point) were made. By comparing these photos with aerial photos taken 15 March 1979, the location of destroyed buildings was determined and noted on the maps with a symbol. There were about 18 structures destroyed on Dauphin Island. At Gulf Shores from Fort Morgan to Alabama Point there were about 475 structures completely destroyed as a result of the storm surge.

103. Aerial Photographs and Beach Profiles. "Before" conditions of Dauphin Island and Gulf Shores beaches were determined by photogrammetric techniques, since field data prior to the storm were nonexistent. Aerial photographs of Gulf Shores taken in the spring of 1979 and those of Dauphin Island taken in 1975 were utilized as the most recent available. "After" conditions were determined by the Corps of Engineers in October 1979 using conventional field survey methods to obtain beach profiles. Monument and baseline reference data, for these beach profiles, were placed on maps made from the aerial photographs. "Before" beach profiles were established from the photographs at the same location "after" beach profiles were made.

TABLE 20

ESTIMATED EROSION DAMAGE AND RESTORATION COST OF FOREDUNE SYSTEM
ON ALABAMA AND FLORIDA BEACHES

<u>LOCATION</u>	<u>BEACH LENGTH (MILES)</u>	<u>EROSION (CUBIC) (YARDS)</u>	<u>COST/ @ \$2.30/cubic yard</u>
<u>Alabama</u>			
Gulf Shores, Baldwin County	30	2,900,000	\$6,670,000
Dauphin Island, Mobile County	7	748,000	<u>1,720,000</u>
		Alabama Total	\$8,390,000
<u>Florida</u>			
Perdido Key, Escambia County	6.1	317,000	\$729,000
Santa Rosa Island, Escambia County	16.5	2,253,000	<u>5,181,000</u>
		Florida Total	<u>\$5,910,000</u>
		Two State Total	\$14,300,000

FLOOD DAMAGE IN COASTAL COUNTIES

115. Florida storm damage data were compiled in a report prepared by the Florida Department of Natural Resources³. The following damage data, relative to Escambia County, Florida, was extracted from that report.

116. Navarre Beach, Santa Rosa Island.

- a. Navarre Pier received damage to outer "T" section from wave action.
- b. Holiday Inn received extensive flood damage.
- c. Sixty-seven residential structures were impacted by wind and storm surge. Of these structures 10 sustained minor flooding and 6 sustained extensive flooding.

117. Pensacola Beach, Santa Rosa Island.

- a. One hundred and twenty-eight structures fronting the gulf beaches were impacted by the storm as a result of high wind and storm surge. Of these, 33 sustained damage from high water and wave action; 3 were totally destroyed; 36 sustained minor flooding, and 49 sustained extensive flooding.
- b. The Pensacola Beach fishing pier was severely damaged and a major portion destroyed by storm waves.

118. Perdido Key, Florida. About 200 homes were affected by flooding on Perdido Key. Of these buildings about 15% were destroyed and 40% received major damage.

³ "Summary Field Inspection Report of Beach and Coastal Construction Storm Damage Resulting from Hurricane Frederic in the Florida Panhandle, September 13, 1979", dated September 19, 1979, by State of Florida, Department of Natural Resources.



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VIEW OF DAMAGE AT THE "HANGOUT," A POPULAR GULF SHORES BEACH ATTRACTION. CHUNKS OF SAND, ASPHALT AND OTHER DEBRIS IN FOREGROUND COVER AN AREA WHICH WAS A SMOOTH PAVED THOROUGHFARE BEFORE HURRICANE FREDERIC.



GULF SHORES HIGHWAY WAS CARPETED WITH DEBRIS
WASHED FROM ADJACENT RESIDENCES AND BUSINESSES.



ALABAMA STATE RETAIL ALCOHOLIC BEVERAGE STORE
WAS TOTALLY DESTROYED BY HURRICANE FREDERIC.

123. Mobile Bay, Alabama.

a. About 30 structures on Battleship Parkway were destroyed or severely damaged by floodwater. The structures were built along the highway which was constructed on a causeway crossing the northern end of Mobile Bay.

b. Many homes and businesses received flood damage in the coastal towns of Bayou La Batre and Coden in Mobile County.

124. The Federal Insurance Association (FIA) provided flood insurance payments for claims to structures damaged as a result of flooding caused by the hurricane.

WIND STORM DAMAGE IN COASTAL AREAS

125. Besides flood damage, a considerable amount of wind storm damage occurred in the coastal areas. The Insurance Underwriting Association paid claims to those individuals who had a policy with a member company, and who owned a structure located within designated coastal limits which sustained wind storm damage. Several of the large insurance companies are not members of the association.

126. The Alabama Insurance Underwriting Association paid about 2,100 claims amounting to about \$26,000,000; 40% in Mobile County and 50% in Baldwin County. In both counties the claims were 90% residential and 10% commercial. In Mobile County the claim coverage area is generally beach area south of the L&N Railroad. In Baldwin County the claim coverage area extends from near Spanish Fort south along Mobile Bay and east along the gulf coast from about one mile south of Foley to the gulf.

127. The Mississippi Insurance Underwriters Association paid about 2,425 claims amounting to about \$4,500,000; about 80% in Jackson County and 20% in Harrison County. The area of coverage includes the entire area of the coastal counties. Residential claims were about 75% and commercial claims 25% of the total number of claims.

or received major damage, with losses amounting to about \$4,600,000. Nine other commercial structures sustained minor damages amounting to \$1,400,000. The Dauphin Island Sea Lab facilities sustained major damage to 6 buildings, minor damage to 18 buildings, and two buildings were destroyed. The total damages to the Sea Lab facilities amounted to about \$1,107,000. Damage to the Isle Dauphine Country Club and golf course was about \$320,000. Damage to the water and sewer facilities on Dauphin Island amounted to about \$450,000. Roads on the island sustained damages amounting to approximately \$900,000. The replacement cost of a new bridge from the mainland to Dauphin Island and the demolition and removal of the remains of the old damaged bridge, is estimated to cost about 37 million dollars. The total damages on Dauphin Island, including the cost of the new bridge, are about 59 million dollars.

DAMAGE CATEGORIES

130. Damage data were divided into eleven major categories. The estimates for each category, where applicable, were divided into direct damages and indirect losses. Direct damages are those sustained as a result of physical damage to the structure and its contents, such as merchandise and equipment. Indirect losses include cost of such items as production loss, shutdown cost, subsistence and cleanup. Each of the major categories contains items of similar nature. A listing of the Damage Categories and the property items contained in each category is shown in table 22.

RESIDENTIAL DAMAGES

131. Structures in the residential category include homes, mobile homes, apartments, condominiums, and farm dwellings. Lightweight wood frame structures and mobile homes were especially vulnerable to damage from the hurricane force winds.

132. The American Red Cross conducted a damage assessment survey in the disaster area following the hurricane. Table 23 shows a summary of the

SECTION XI

ENVIRONMENTAL ASSESSMENT

GENERAL

247. The impacts of Hurricane Frederic on the natural environment were extensive and some of them will affect various ecosystems for several years. Normal physical alteration of coastal environments is a natural process which occurs slowly. A hurricane, however, compresses decades of physical change into a few hours, or perhaps a day, so that the changes are dramatically evident.

248. Pertinent Federal, State and local experts were contacted to gather data on the storm's impacts and to obtain their views on the short- and long-term effects of the hurricane. The US Fish and Wildlife Service, the National Marine Fisheries Service, the Alabama Department of Conservation and Natural Resources, the Mississippi Department of Wildlife Conservation, and the Gulf Coast Research Laboratory were major organizations contacted. Unfortunately, most of these organizations were too involved with immediate survival needs and clean-up and repair operations to devote appreciable time and effort to evaluate the environmental impacts of the hurricane. Consequently, most of this evaluation is based on aerial photography produced on 15 August 1977 and on field observation and professional analysis of the environmental staff of the Mobile District, Corps of Engineers.

COASTAL CHANGES

249. The most extensive change along the coast was the transport of sea water and beach sand northward. The primary dune system was moved inland and flattened from Pensacola Beach, Florida, to Horn Island, Mississippi. Storm seas damaged dune systems over a much broader area than the storm front. Wash overs of high seas caused damage to the beach systems even along the Chandeleur Islands, Louisiana.

the 1980 growing season, the subsequent loss of trees may exceed the number lost during the hurricane.

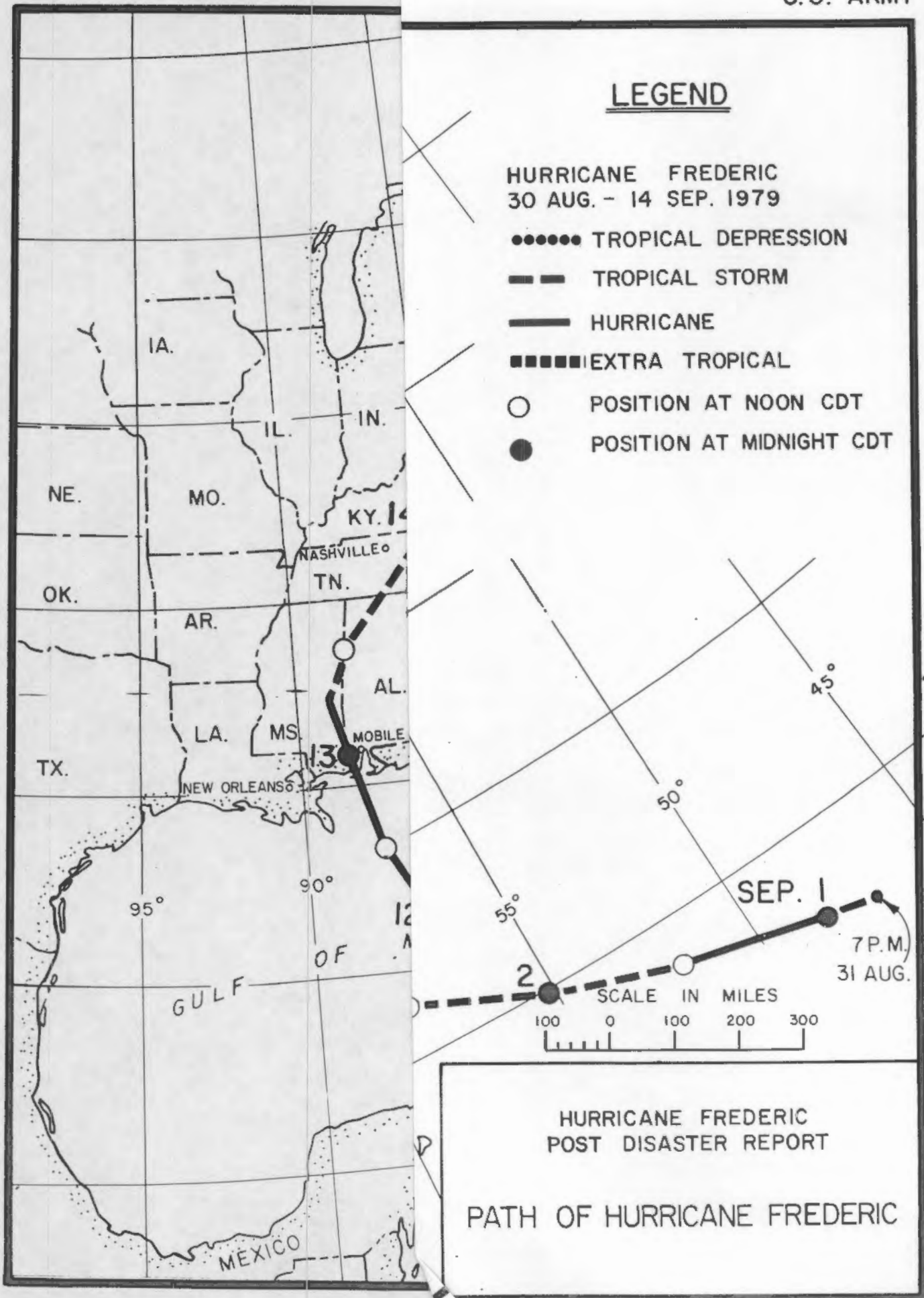
256. No figures exist on the loss of wildlife, but in the coastal counties indications are that many animals were killed by the storm. Bird species that did not leave the area were killed by windblown debris. Arboreal animals, such as squirrels, were also killed in great numbers and immediately after the storm were more vulnerable to predators, especially house cats. Other game animals such as rabbits, deer, quail, dove, and turkey were also killed in significant numbers. Fortunately for both man and wildlife, Hurricane Frederic did not bring the torrential rains and flooding that usually accompany major coastal storms.

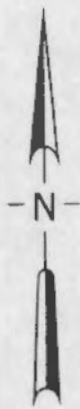
257. During the weeks following the storm, wildlife had an abundance of ground cover but a significant loss of den trees. The reduced animal populations should have somewhat reduced competition for dens and food, giving the survivors some relief. The unseasonal budding of trees and shrubs immediately after the storm provided an abundant food source for browsing animals such as deer. However, acorns, pecans, hickory nuts, and other mast were blown from the trees before they matured and were not available to deer, turkey, squirrels, etc., as fall and winter food. This loss will extend through the winter of 1980 since most nut producing trees will not form nuts again until 1981.

258. Animals that utilize hollow trees such as wood ducks, squirrels, and raccoons, will probably experience a shortage of den sites through 1980 but by 1981 damaged hardwood trees should produce an increase of hollows for den sites.

LONG-TERM IMPACTS

259. If one assumes that a hurricane hits a section of our coast as often as once every 100 years, then 100 hurricanes and numerous lesser storms have hit



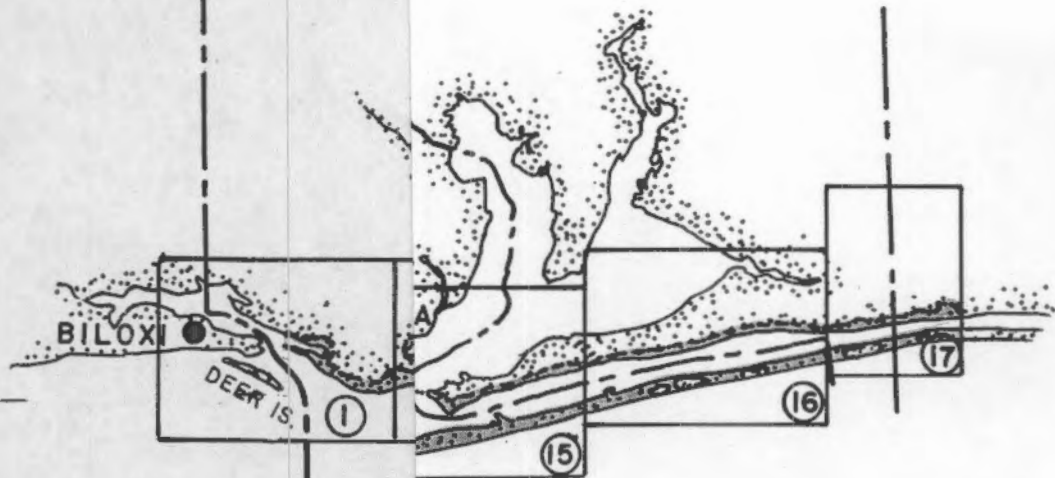


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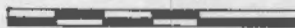
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HURRICANE FREDERIC
POST DISASTER REPORT

ATED AREA - INDEX MAP

S ALABAMA, AND FLORIDA COAST

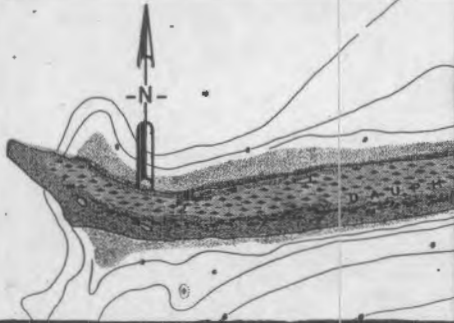
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HURRICANE FREDERIC,
 POST DISASTER REPORT
TAIL OF INUNDATED AREA
 ALABAMA COAST

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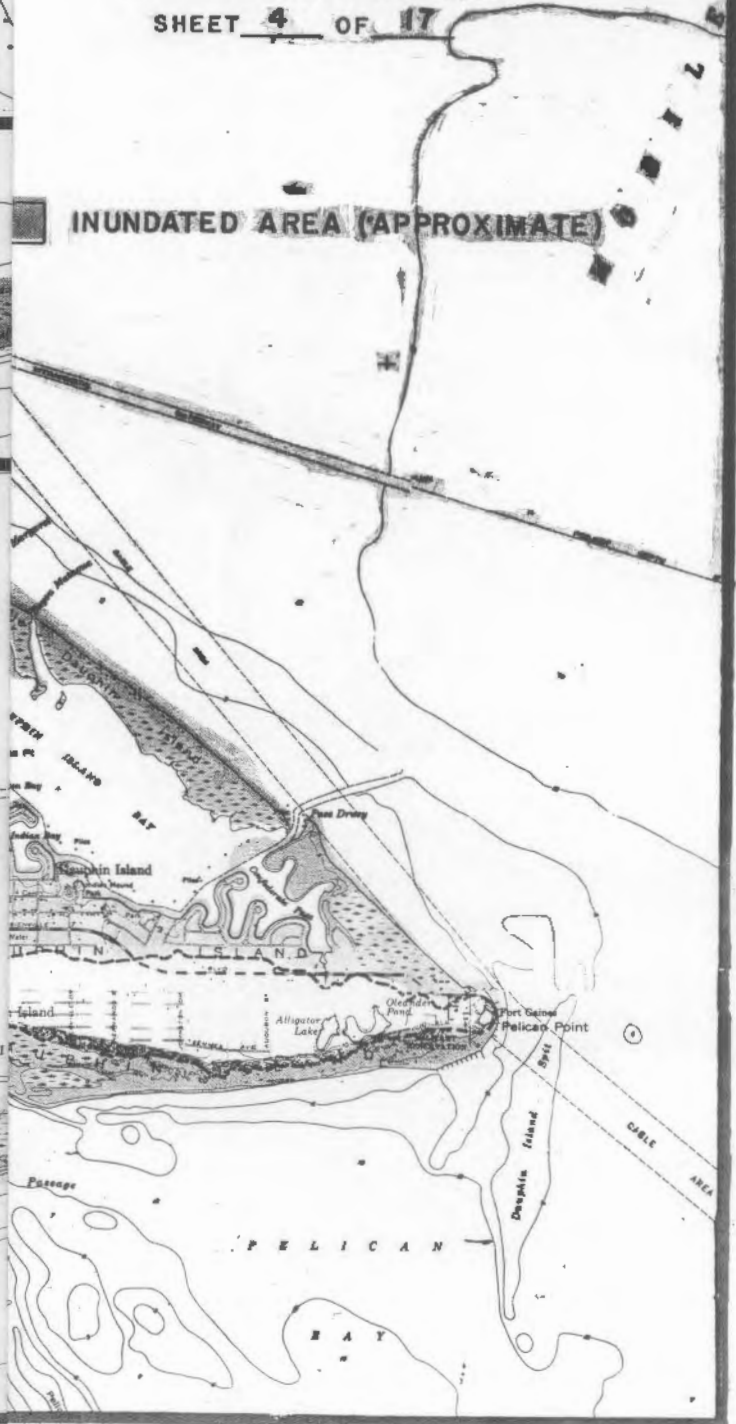
INUNDATED AREA (APPROXIMATE)

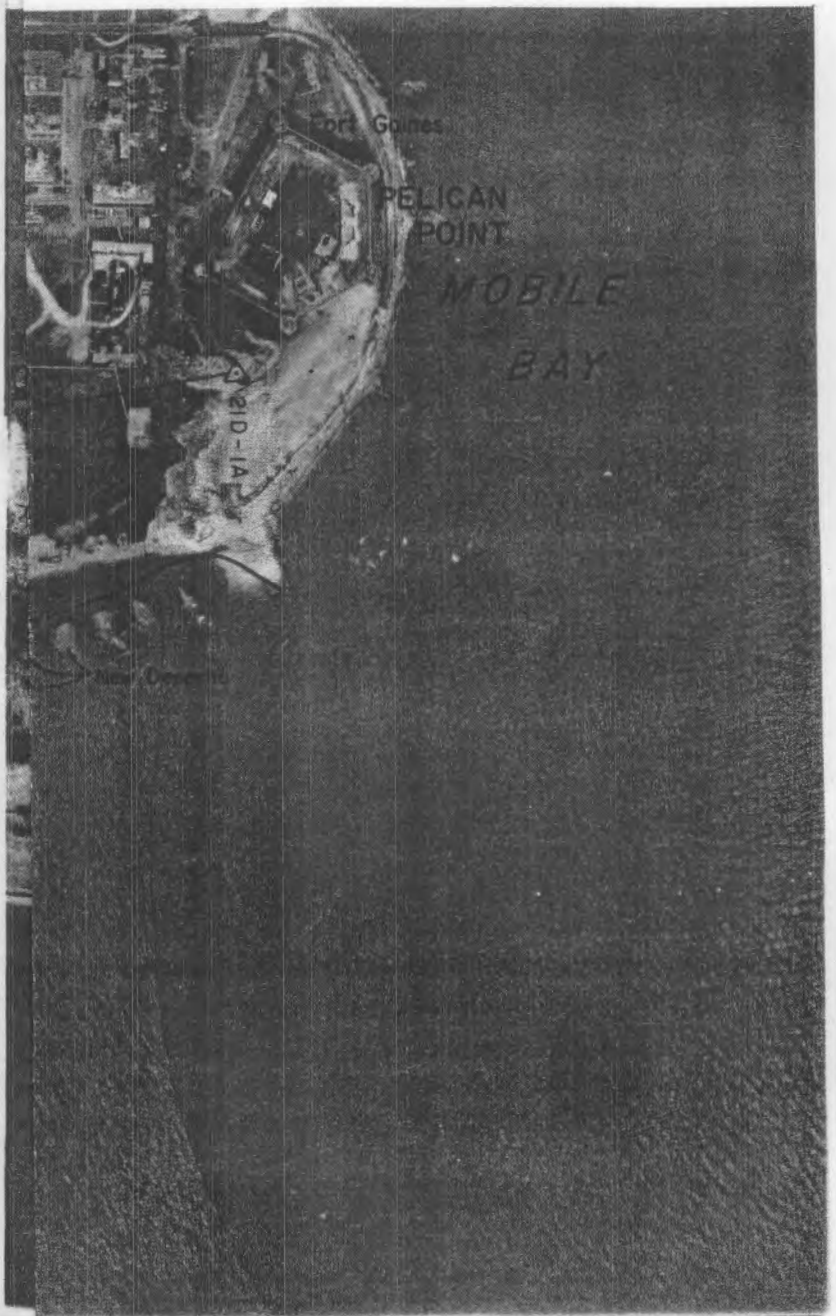


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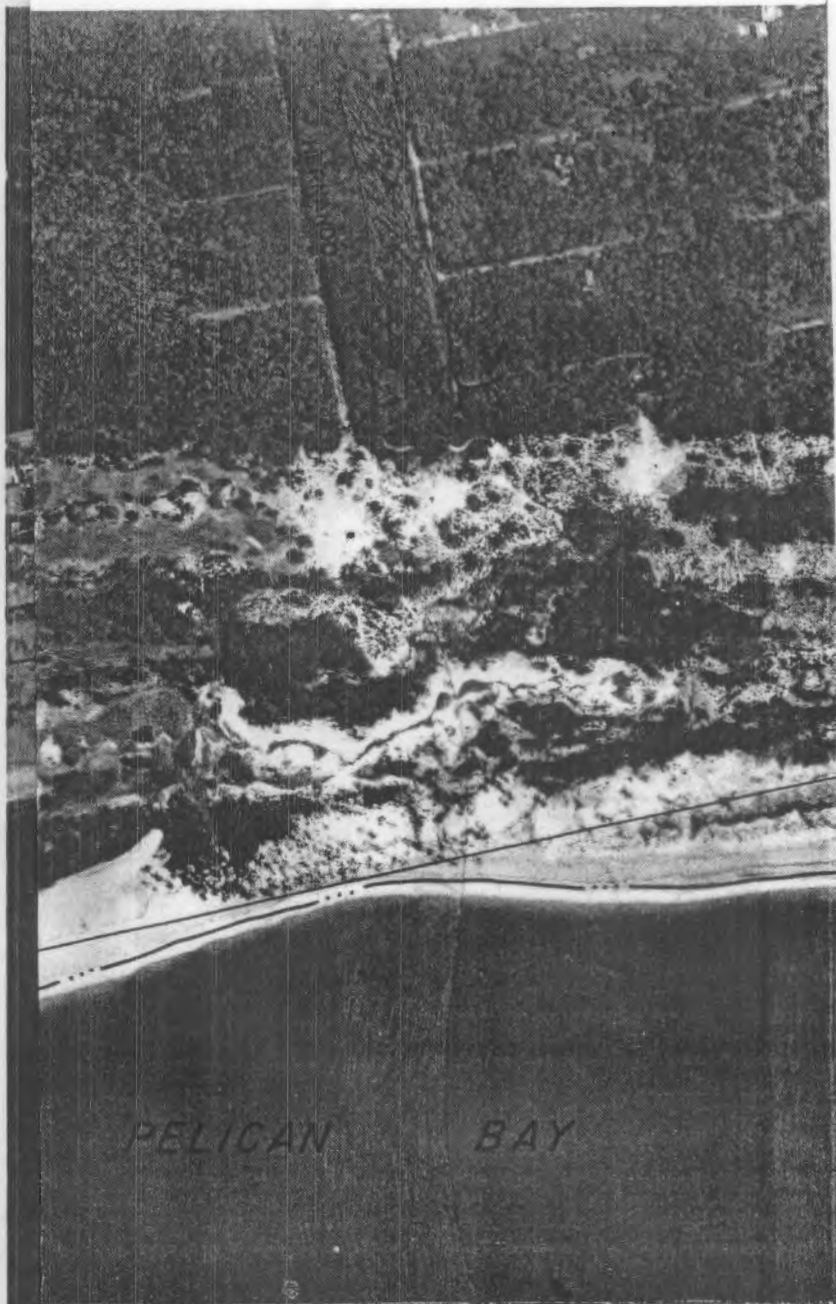
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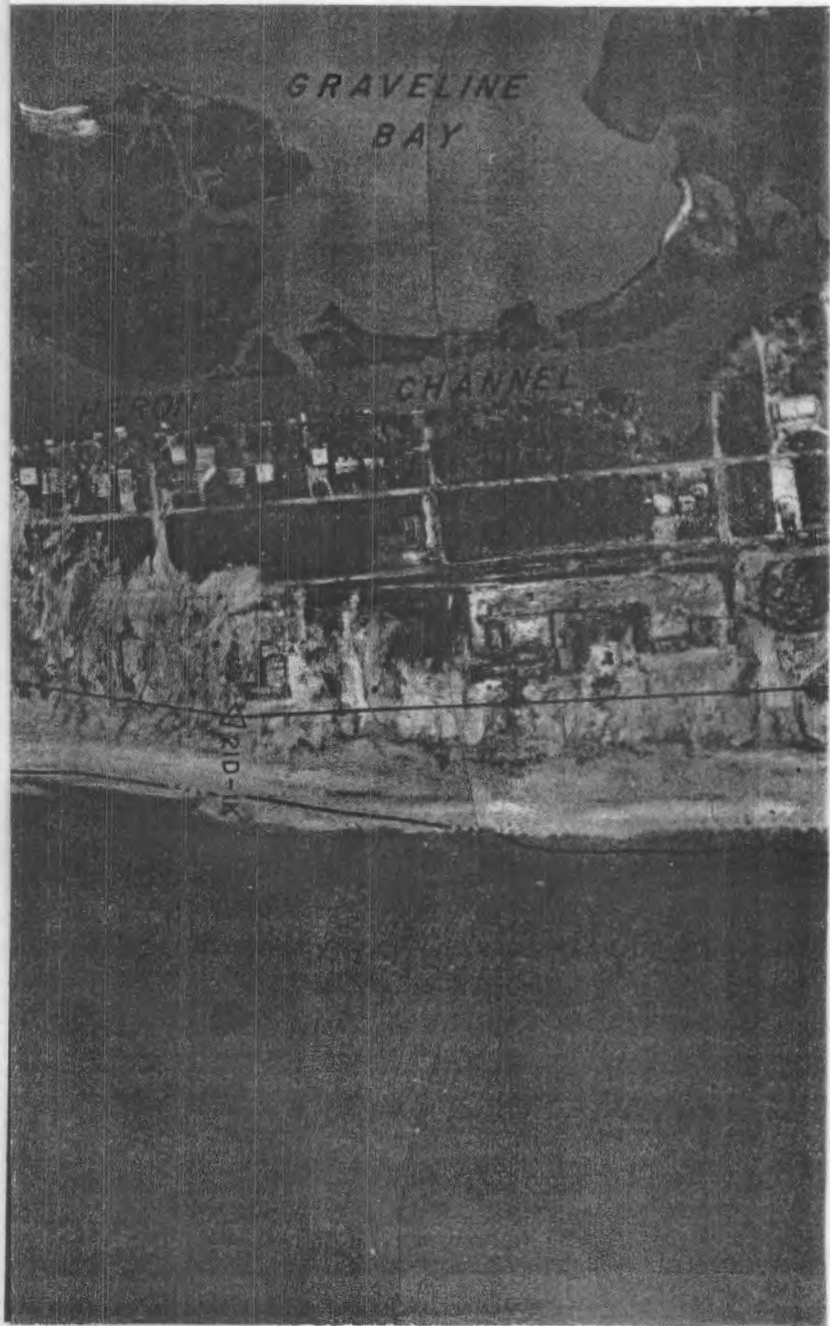
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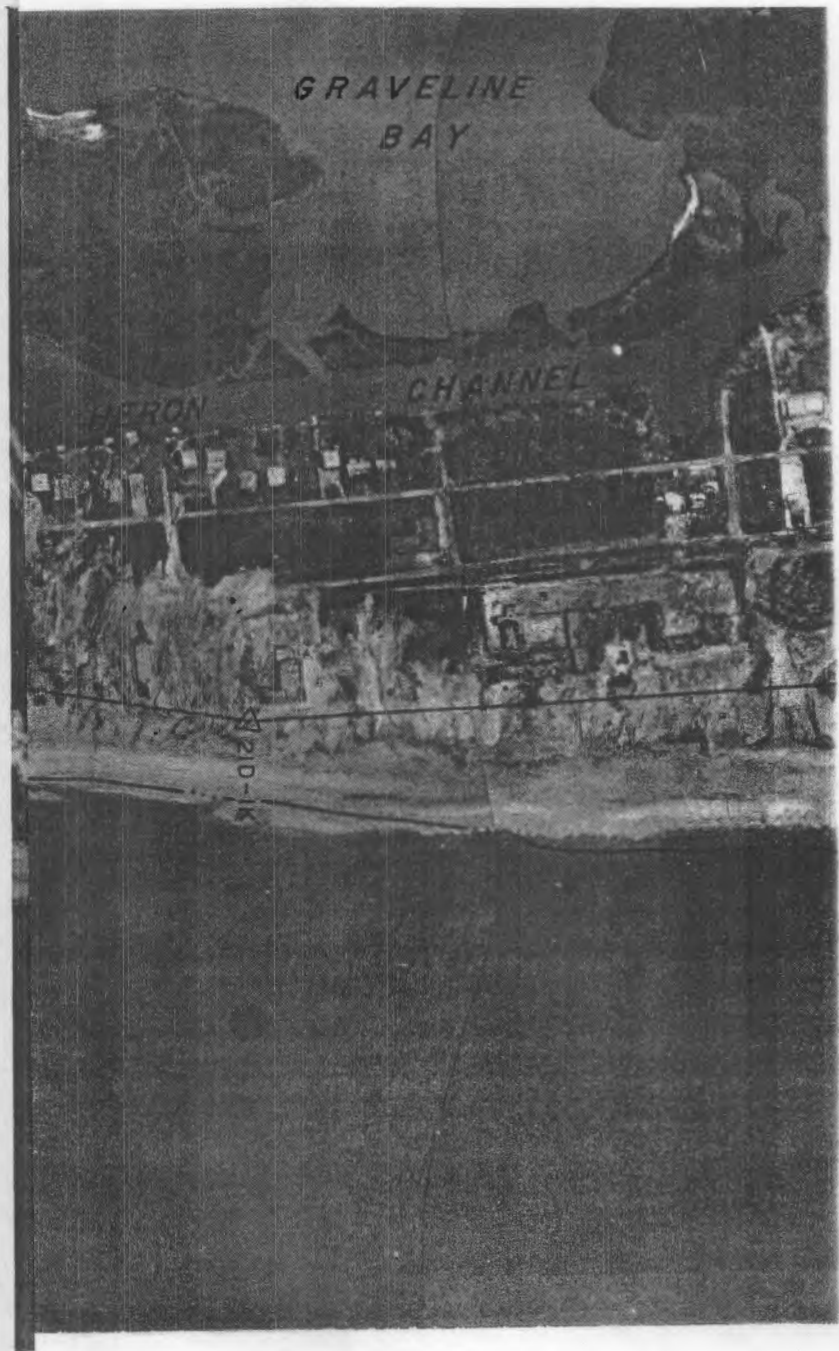
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PLATE 31



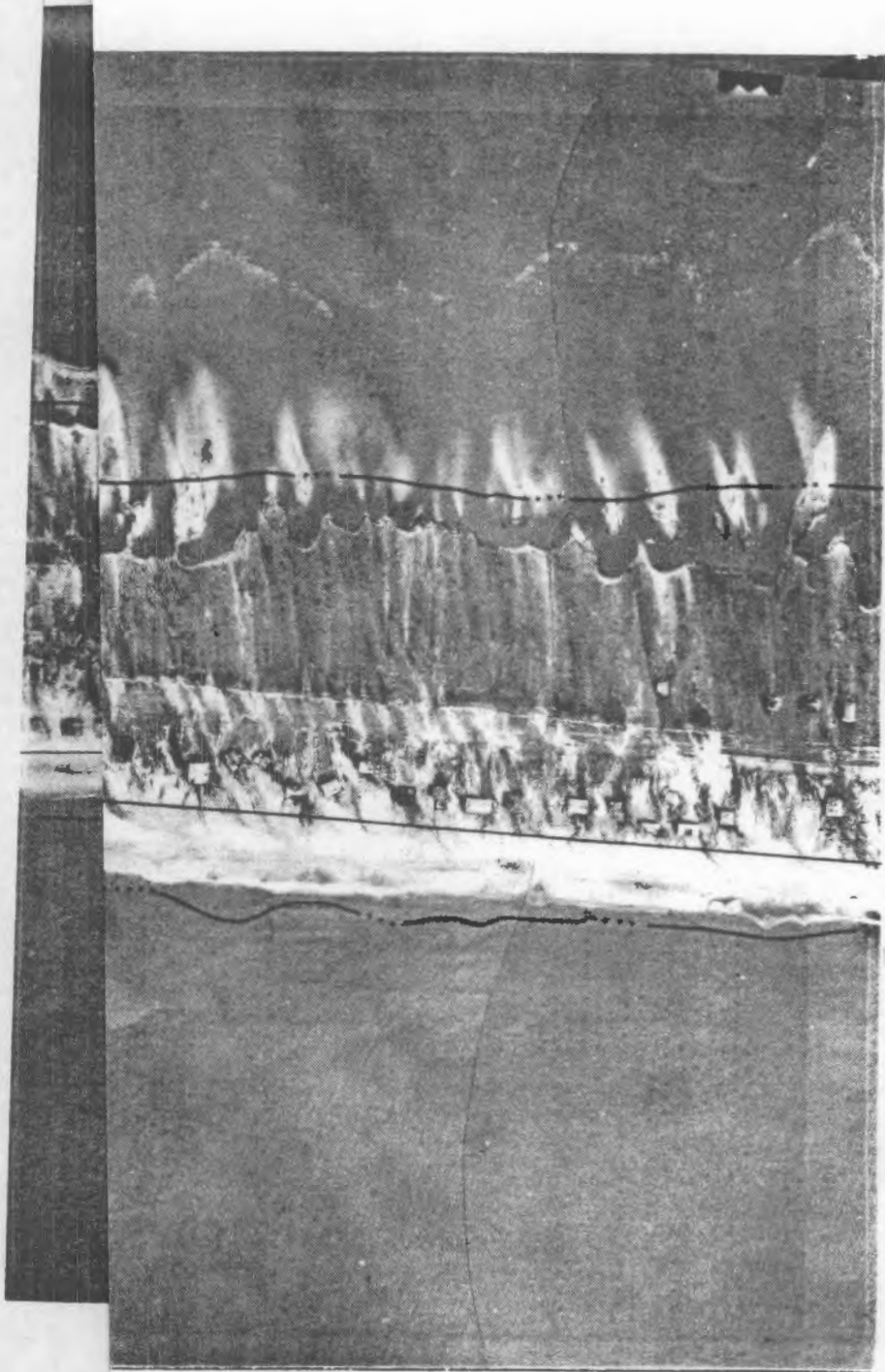
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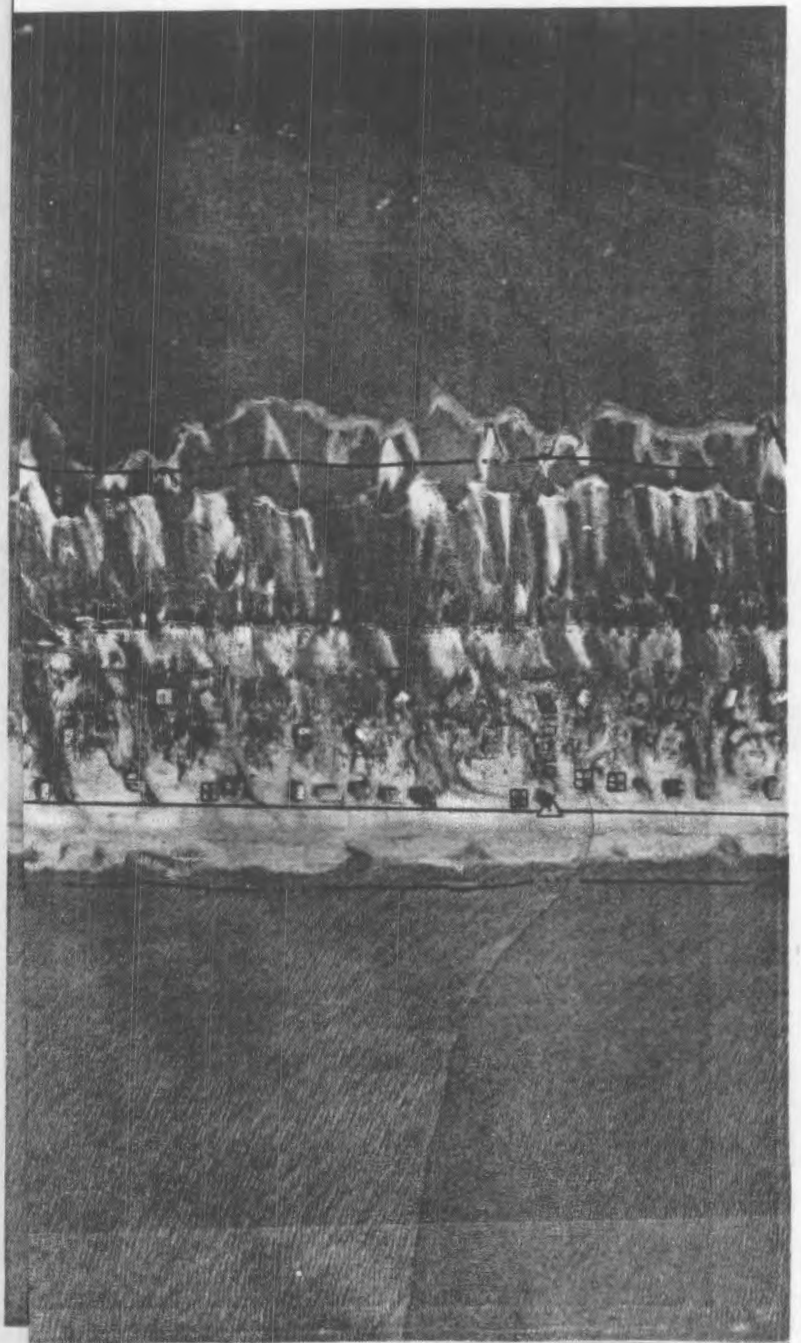
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