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Hillsboro Inlet and the Lighthouse: One Hundred and Fifteen Years of Change

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ABSTRACT

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Hillsboro Inlet is one of many natural inlets along the Florida Atlantic Coast. The first documented map of Hillsboro Inlet in its present location was made in 1884. The inlet changed in 1890 with completion of the Florida East Coast Canal. The Hillsboro Lighthouse was constructed in 1905–1907. Early maps, photo records and written documentation have been used to describe the changes in 115 years. Gradual stabilization of the inlet by manmade structures from 1925 to 1966 are described. Dredging since 1983 has provided 100 percent sand bypassing. Future planned changes to deepen the inlet channel from 8 feet to 20 feet are described.

ADDITIONAL INDEX WORDS: *Dredging, sand bypassing, inlet stabilization, taxing district.*

SURVEY OF HILLSBORO INLET 1884

The first definitive record of Hillsboro Inlet was made in 1884 by a U.S. Coast and Geodetic Survey team. They spent several months recording a wild and desolate coastline. The purpose was to investigate the possible installation of a lighthouse to reduce the danger to mariners. Fortunately a bony ridge of calcium carbonate and cemented sand was located on the northern side of the Hillsboro Inlet, and this was where a lighthouse was located.

The coastline in this area shows many barrier islands, some separated from the mainland by wide bays such as Lake Worth in Palm Beach, and Biscayne Bay in Miami. At Hillsboro Inlet there was an island to the north with a shallow narrow river, and swamps to the south. The coast had no fresh water, no food, and an abundance of flies, panthers and alligators. Many shipwrecked sailors starved to death before rescue. Records of the period describe a foliage of Palmetto scrub, with a sandy soil. Fish, sea turtles and sharks were plentiful offshore.

TIDAL PRISM IN 1884

The early tidal prism was very small. The 1884 map shows flow south of the inlet cut off by sandbars. Other records indicate there was a shallow river to the north which was not navigable until after the Florida East Coast Canal dredging was completed in 1890. The map shows extensive sandbars at the north end of the inlet. The tidal change at Hillsboro Inlet measured by electronic gauges in September 1994 were as high as one meter (3.3 feet). In November 1994 measurements averaged a more normal 0.6 meters (2 feet) (COASTAL SYSTEMS INTERNATIONAL, INC., 1995).

The tidal area shown on the 1884 map was measured at 360,000 square meters. The present tidal flow has been calculated at 11,000,000 cubic meters per day through the Hillsboro Inlet. The present flow is about 15 to 20 times as great as the tidal flow of 1884 (COASTAL SYSTEMS INTERNATIONAL, INC., 1995).

FLORIDA EAST COAST CANAL 1890

Shortly after the 1884 survey the tidal prism changed significantly. By 1890 a shallow canal was dredged from Lake Worth (Palm Beach) to Biscayne Bay (Miami). The canal was only 1.5 meters deep (five feet) by 15 meters wide (50 feet), but it connected a chain of interior lakes and streams into a continuous waterway which by 1914 was 550 kilometers long (340.3 miles).

The 1890 tidal prism drained about five miles north of the inlet, and five miles to the south, and the heavier flow scoured a deep channel past the lighthouse. The East Coast Canal plan was deeply flawed, since there was never enough marine traffic to support the construction costs. Construction of Flagler's Florida East Coast Railroad to Miami in 1896 made the canal obsolete, and it never raised enough tolls to cover construction costs. The canal went bankrupt and became a Federal project during the 1930's.

LAND FOR THE HILLSBORO LIGHTHOUSE

In 1905 the Lighthouse Service documented the plan for the Hillsboro Station in "Plate 38" of the contract plans (Fig-

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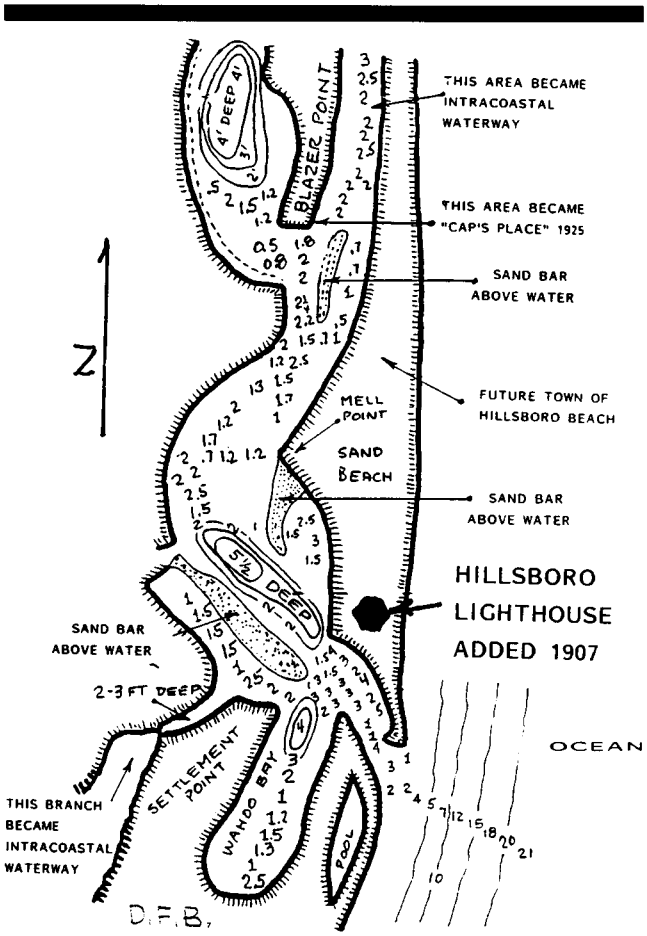

Figure 1. Re-drawn by D.F. Butler from part of 1884 map titled "Lakes Boca Ratone and Wyman, Hillsboro River and Inlet".

ure 2). The map includes a cross-section of the land showing a high elevation where the keepers' homes were located at 5.2 meters (17 feet) above mean low water.

The distance from the lighthouse to the intersection of the Atlantic Ocean and the inlet measured 122 meters (400 feet) in 1905. The length of the sand-bar to the south had increased to 173 meters (563 feet) by 1915.

The area of the "ridge covered with tropical growth" was 4,745 square meters in 1905 (51,000 square feet). The total area at low tide was 9,070 square meters (97,600 square feet). Only the inclusion of the "Ledge of rock exposed at low water" would bring the area to the three acres listed in early documents (U.S. LIGHTHOUSE SERVICE, 1904).

BUILDING OF HILLSBORO LIGHTHOUSE

Between 1905 and 1907 an iron skeleton lighthouse was erected on the northern side of Hillsboro Inlet (Figure 3). The land was excavated to the bedrock, and concrete foundations were cast and locked to the rock with bolts.

The engineering was well done with hurricane wind load calculations before construction. The tower was designed with steel tension and compression members, in a horizontal, vertical and diagonal pattern so no matter what direction the storm winds blew there were ample iron members to carry the loads. The keepers climbed stairs inside a nine-foot diameter central tower to reach the lens 135 feet above the Atlantic Ocean.

The lens was the latest French Fresnel "clamshell" design nine feet in diameter with 344 pieces of cast and polished optical glass. Illumination was by vaporized kerosene burning inside a mantle giving a white flash equivalent to 550,000 candlepower through the lens.

LIFE AT HILLSBORO LIGHT STATION

The Hillsboro Lighthouse station was a very self-contained community. The Supply Ship arrived every six months, and landed about 1,600 kilograms of kerosene in square tin cans (3,600 pounds). The ship was a floating storehouse which even included a lending library. The three keepers and families were supplied with dry and canned food. Operating supplies such as paint, rope, and brooms were ferried to the wharf, and wheeled to the storehouse close to the dock. Then the quiet isolation returned. Fish and game were plentiful, and keepers were encouraged to grow food in small farms. Fresh water came from rainwater off the roofs of the buildings (Figure 4).

HILLSBORO INLET LIGHT STATION 1915

A detailed map of the "Hillsboro Inlet Light Station, Florida" was drawn in September 1915 (Figure 5). It showed substantial changes in the land around the lighthouse. Huge shoals were exposed at mean low water, and land area had more than doubled to 19,600 square meters (4.8 acres). The distance from the lighthouse to the point of sand between the Ocean and Inlet at low water had increased from 122 meters in 1905 to 179 meters in 1915. The "high ground" shown on the map was 7,834 square meters (2 acres). The land appeared stable, with the significant accretion on the ocean side.

The strong 550,000 candlepower flash of light from the tower was visible on the very dark coastline about 23 kilometers (14 miles) at sea, and shipwrecks were greatly reduced. Everything seemed to be going according to plan.

THE HURRICANE OF 1926

The land area at the Station varied tremendously during the 1920's. The Ocean started eroding the high ground steadily, and the area decreased from 7,800 square meters in 1915 to 5,500 square meters in the summer of 1926. Then a devastating September 6, 1926 hurricane all but destroyed the station. The barometric pressure dropped to 27.61 at Miami, with wind velocities recorded of 220 kilometers per hour (132 MPH). Structures along the beach were demolished, and trees were sandblasted bare of bark, and paint was sandblasted down to bare metal on some automobiles exposed to the storm (OFFICE OF THE SUPT. OF LIGHTHOUSES, SIXTH DISTRICT, CHARLESTON S.C., 1929). The keeper on duty at Hillsboro was up in the tower for 36 hours, and he saw the roof of the boat-house fly all the way across the inlet. The

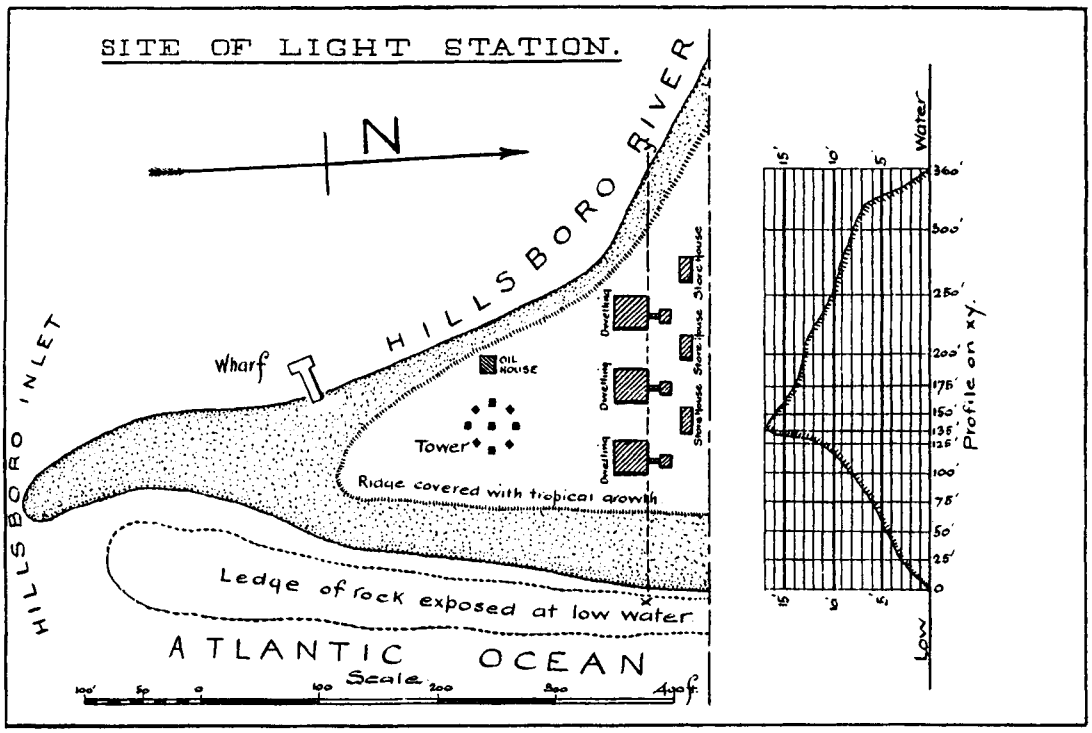

Figure 2. U.S. Lighthouse service contract plans (plate 38) 1904.

tower shook so badly he thought it was going to collapse. Much of the beach and the "high ground" of palmetto scrub south of the lighthouse was washed away. Late 1926 photographs show four feet of the concrete lighthouse foundations exposed.

Area of the "high ground" was recorded on a map, and area calculations indicate only 4,160 square kilometers was left after the storm. This was only one acre in size, only ½ the 7,834 square meter area of 1915 (OFFICE OF THE LIGHTHOUSE INSPECTOR, 1915; OFFICE OF THE SUPT. OF LIGHTHOUSES, SIXTH DISTRICT, CHARLESTON S.C., 1929).

EMERGENCY WOODEN GROINS

The disastrous hurricane of 1926 required emergency action to stabilize the land. Six wooden groins were added along the beach in late 1926 and were very effective in trapping the littoral drift down the beach from the north. This drift now averages 115,600 cubic meters of sand per year and the groins trapped a lot of sand quickly. The low tide area had decreased to about 11,600 square meters after the 1926 hurricane (2.9 acres). Despite severe damage to the wooden groins in 1928 the low tide area had doubled in size to 24,000 square meters by May 1929 (5.9 acres) (OFFICE OF THE SUPT. OF LIGHTHOUSES, SIXTH DISTRICT, CHARLESTON S.C., 1929; SASSO *et al.*, 1997).

STABILIZING HILLSBORO LIGHT STATION

Wooden groins were only a temporary solution, for a second hurricane in September 1928 partially destroyed the structures. There were three Florida lighthouses nearby which had collapsed after being undermined by ocean storms. Two were at Key West 320 kilometers (200 miles) to the south, and one at Ponce Inlet 400 kilometers (250 miles) to the north. The decision was to add a 80 meter breakwater (260 ft) made of Georgia granite. The structure was massive, 5.5 meters (18 ft) wide by 2 meters (6 ft) high, with stones typically weighing 2,000 kilograms apiece.

The design was highly effective, and the station area at low tide stabilized at 23,200 square meters. This amounted to 5.7 acres, well above the three acre area purchased in 1901. The area of high ground remained very small, and it took many years of accretion on the ocean side to regain the 8,200 square meter (2 acre) size of 1915.

HILLSBORO INLET IN 1930

During 1930 another large-scale map was made of the Hillsboro station showing the drastic loss of "high ground" near the lighthouse. The map has been re-drawn to a smaller scale (Figure 6). The lantern was still fueled with kerosene in 1930 and the oil house was in daily use. The dock, storage shed near the dock and the boat house all were destroyed by the hurricanes. A dock was essential, and later photographs show a new dock built during the 1930's. During the depression years Hillsboro inlet remained fairly stable on the spit of land by the lighthouse, but very unstable on the southern side of the inlet. At times there was deep water available to the wharf at the Light Station. At other times supplies had to be landed on the beach. Each hurricane moved thousands

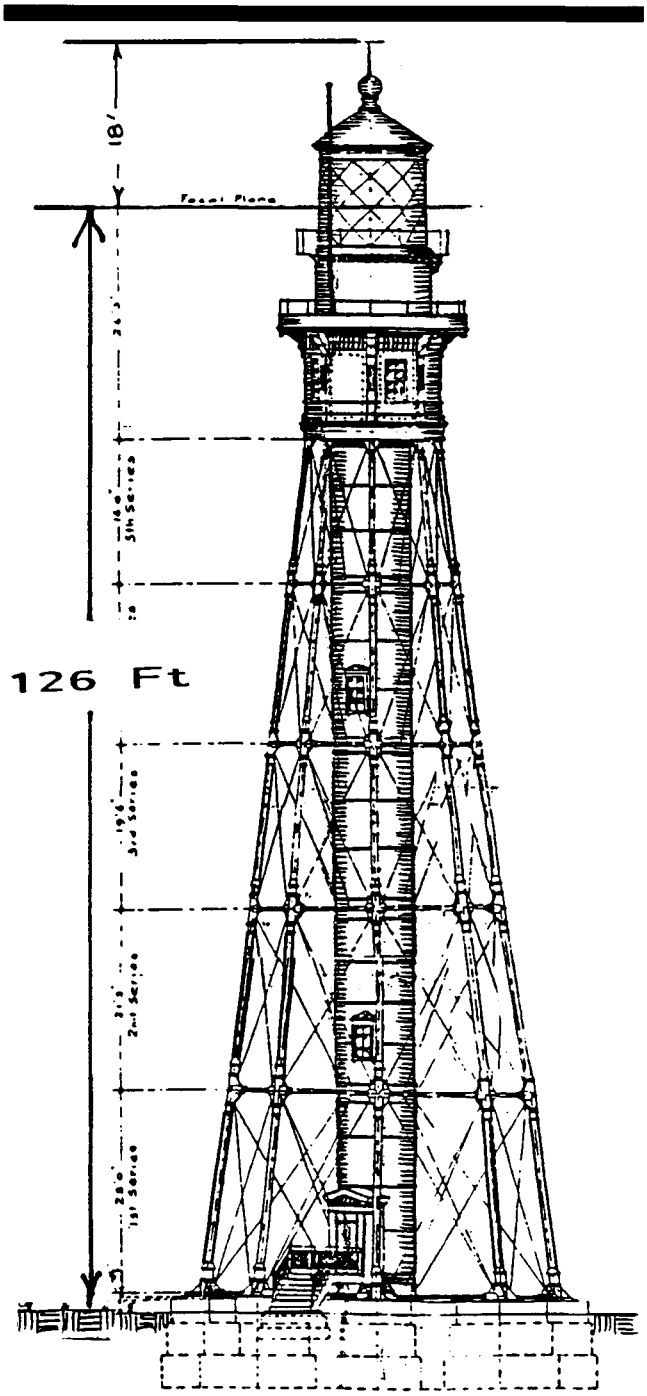

Figure 3. David F. Butler's 1904 plans for Hillsboro Lighthouse (4).

of tons of sand into fanciful new configurations. The next big storm changed the sand patterns again.

HILLSBORO INLET DURING THE 1930's

The long breakwater stabilized the land by the Hillsboro Lighthouse, but the land on the west side of the channel moved with every big storm. A typical configuration of the 1930–1945 period is shown in Figure 7. The inlet was characterized by:

1. Shallow channels filled with sand bars
2. Shoals in the area of the "first reef" running south from the lighthouse
3. Periodic inlet closings requiring hand-digging to reopen. Boat captains and crews often did the digging, but several photographs show convicts with shovels at this work.

CHANGES DURING WORLD WAR II

There were great changes in the area near Hillsboro Inlet during World War II. A chain of airfields was built along the coast from Key West to Jacksonville. Thousands of young men saw Florida for the first time, and many came back on vacations or to settle down. Farming was a major industry with over 25,000 acres (101,175,000 m^2) in winter crops in the town of Pompano.

In early 1947 "Local Interests" developed reports and plans to improve Hillsboro Inlet. C.W. MacMillan, a registered Engineer, drew a detailed map showing a natural inlet (Figure 8). This map shows the configuration just before the disastrous September 1947 hurricane (MacMillan, 1947).

THE WET HURRICANE OF 1947

The 1947 hurricane was very wet, and to compound the drainage problems a ship wrecked in the harbor just south of the bridge during the storm. Hillsboro Inlet with all the shoals could not handle the runoff, and fields remained flooded for weeks. One thousand cattle drowned, and coast roads were impassable. A huge sand bar formed over the shipwreck just south of the bridge. The Army Corps of Engineers arranged for about 76,000 cubic meters to be dredged from the harbor, and used to fill in the bay east of the bridge. A straight concrete bulkhead was added. This created the present straight channel from the bridge to the lighthouse. A 1948 map (Figure 9) was drawn after these improvements had been completed (MacMillan, 1948).

HILLSBORO INLET DURING THE 1950'S

By the winter of 1950–1951 the channel had decreased from 30 meter (100 ft) width to 7.5 meters (25 ft). There were times when convicts were used to dig the inlet open by hand, and in the spring of 1951 the local Inlet Improvements Association cut an opening through the sand bar using a drag line. At the same time a retaining wall was constructed of vertical piling and horizontal planks opposite the lighthouse in an attempt to control the erosion on the south side of the inlet. By 1957 a long sand bar had formed from the lighthouse to the location of the old 1947 wreck, closing the channel on the lighthouse side. The new channel was a curved shape on the west side of Hillsboro Bay. This is shown in an illustration drawn from a 1957 aerial photograph (Figure 10) (Butler, 1993).

A commercial fishing fleet was located at the docks just south of the bridge. Land had been platted, and homes were filling in the area west of Hillsboro Inlet. Wahoo Bay, south

Figure 4. U.S. Lighthouse Service 1907 photograph of completed.

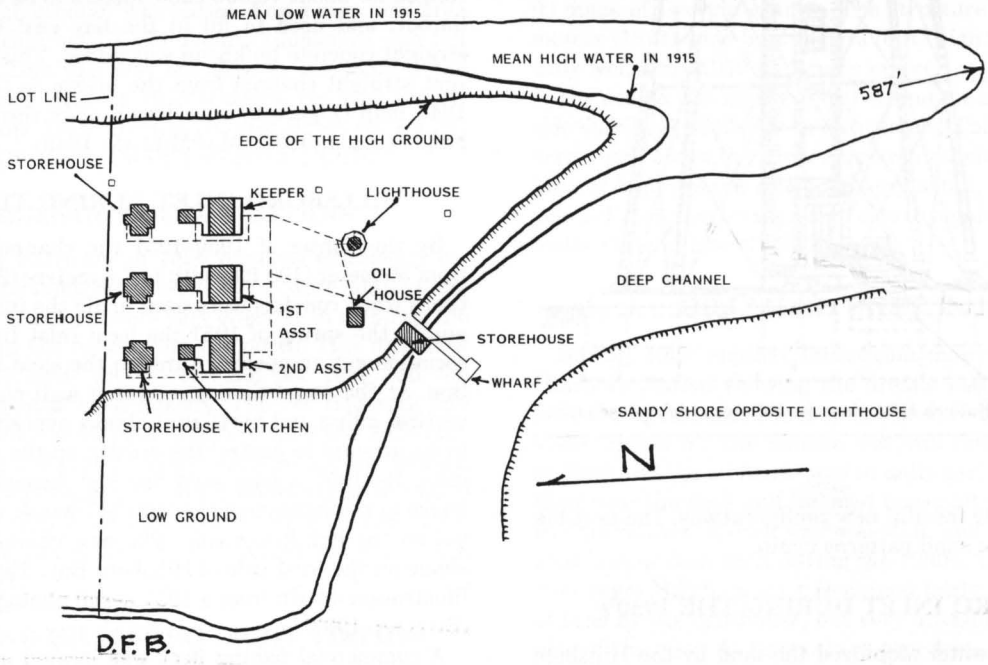

Figure 5. From map of Hillsboro Inlet Light Station Florida, Sept 14, 1915. Drawing C-14 Office of the Lighthouse Inspector Sixth District, Charleston, S.C.

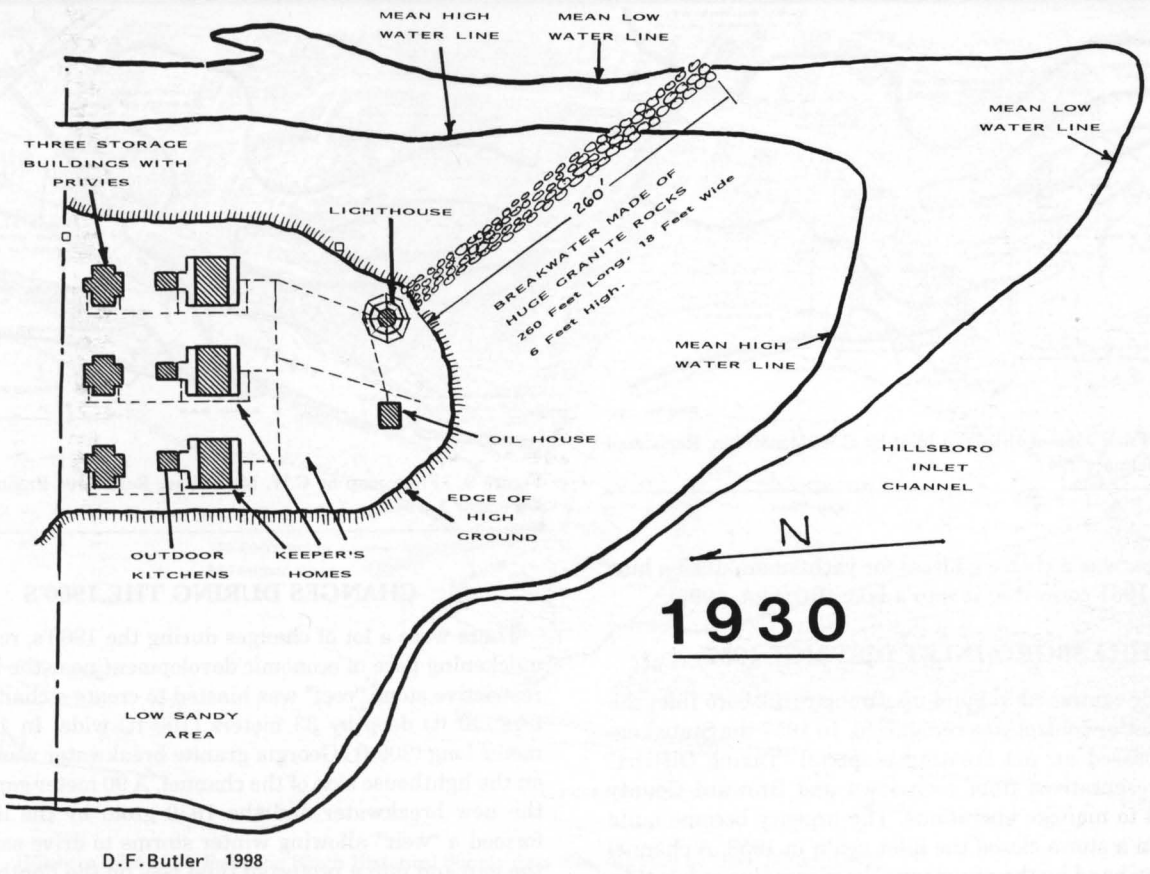

Figure 6. From Hillsboro Inlet Light-house, Florida Rock Jetty May 3, 1930. Drawing Number D-53 Office of the Supt. of Lighthouses, Sixth District, Charleston, S.C.

Figure 7. Pompano Beach Historical Society Archives.

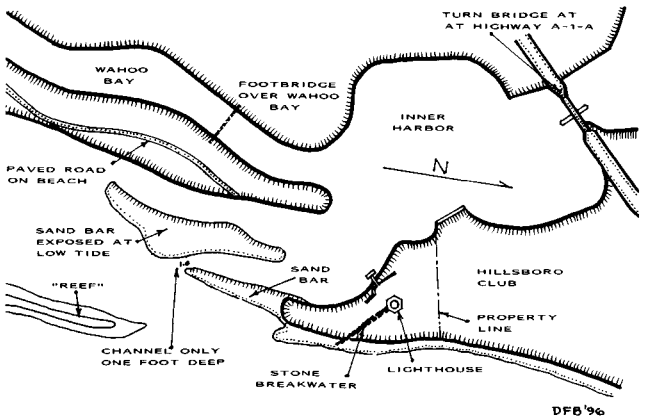

Figure 8. From Map of Hillsboro Inlet by C.W. MacMillan, Registered Engineer, January 1947.

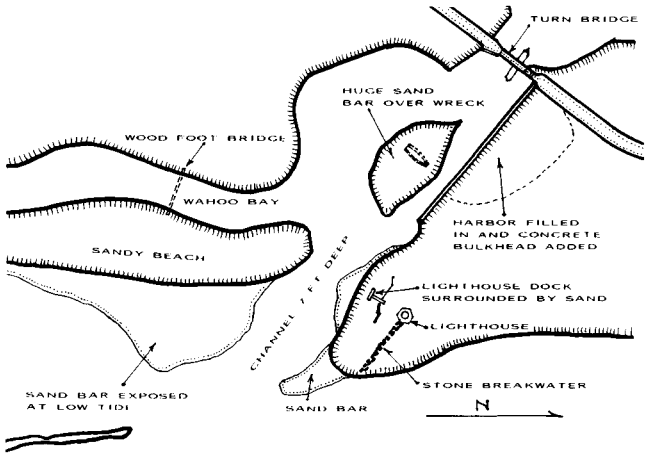

Figure 9. From map by C.W. MacMillan, Registered Engineer, drawn December 1, 1948.

of the inlet, was a choice address for yachtsman, until a hurricane in 1961 converted it into a lake (BUTLER, 1993).

HILLSBORO INLET DISTRICT 1957

As traffic continued to build up through Hillsboro Inlet the need for better control was recognized. In 1957 the State Legislature passed an Act creating a special "Taxing District" with representatives from each town and Broward County appointed to manage operations. The urgency became quite clear when a storm closed the inlet again in 1958. A channel was dug by hand by the commercial boat captains at low tide, and tidal action opened up the flow.

At first, rental equipment was used to dredge the inlet, but about 1964 a small used dredge was purchased. Dredges are rated by the diameter of the discharge line, and this was an eight inch (0.2 meter) dredge, working like an underwater vacuum cleaner. The equipment was marginal and there were many breakdowns, but the inlet has been kept open since 1958 (MCALLISTER and RYSAVY, 1990).

STABILIZING HILLSBORO INLET 1964

The addition of the 80 meter granite groin from the lighthouse to the beach in 1930 did much to stabilize the area close to the lighthouse. The western side of the channel continued to change with winter storms, and much worse, the channel kept filling with sand and periodically closing.

Attempts to stabilize the west side of the channel dated back to a wooden breakwater about 1924. Over the years the storms destroyed the wooden jetties, and new ones were built. After World War II, a tough jetty was built of interlocking sheet steel piling, and it was so tough parts still exist in 1999. Finally in 1964, a massive 122 meter (400 foot) jetty combining vertical reinforced concrete pilings with horizontal wooden beams and huge boulders of Georgia granite was installed. A detail of the south end is shown in Figure 11. This massive structure has stabilized the west side of the channel, and withstood the full fury of northeast storms and hurricanes for 35 years.

CHANGES DURING THE 1960'S

There were a lot of changes during the 1960's, reflecting a quickening pace of economic development near the inlet. The restrictive stone "reef" was blasted to create a channel 3 meters (10 ft) deep by 33 meters (100 ft) wide. In 1966 a 60 meter long (200 ft) Georgia granite breakwater was installed on the lighthouse side of the channel. A 90 meter gap between the new breakwater and the 1930 groin by the lighthouse formed a "weir" allowing winter storms to drive sand across the gap and into a protected tidal pool on the lighthouse side of the channel.

In 1966 a new bascule bridge was installed replacing the 1925 turning bridge. This opened up the restrictions at the bridge for better water flow. Careful studies by the Florida Engineering Experiment Station in 1963 and 1966 established that the new bridge design reduced peak water flow velocities by 0.3 meters per second (1 ft/sec). The peak velocities of 2 meters per second (6.5 ft/sec) in this area still scour a 5 meter (17 ft) depth under the bridge.

HYDRAULIC MODEL OF THE INLET

A very important technical study was the construction of a hydraulic model of Hillsboro Inlet at the University of Florida in 1966. This model with Dr. Per Bruun as the Senior Investigator required cooperative funding from the City of Pompano Beach, the University of Florida, and government agencies. It has provided a planning basis for developing the classical weir and the final configuration of the inlet. There have been four important man-made changes defining the present stable inlet configuration (BRUUN *et al.*, 1966):

1930	80 meter granite breakwater from lighthouse south to beach
1960's	Blasting the first reef formed a channel 3 meters deep by 33 meters wide at the mouth of Hillsboro Inlet
1964	122 meter granite breakwater defined the west side of the channel.

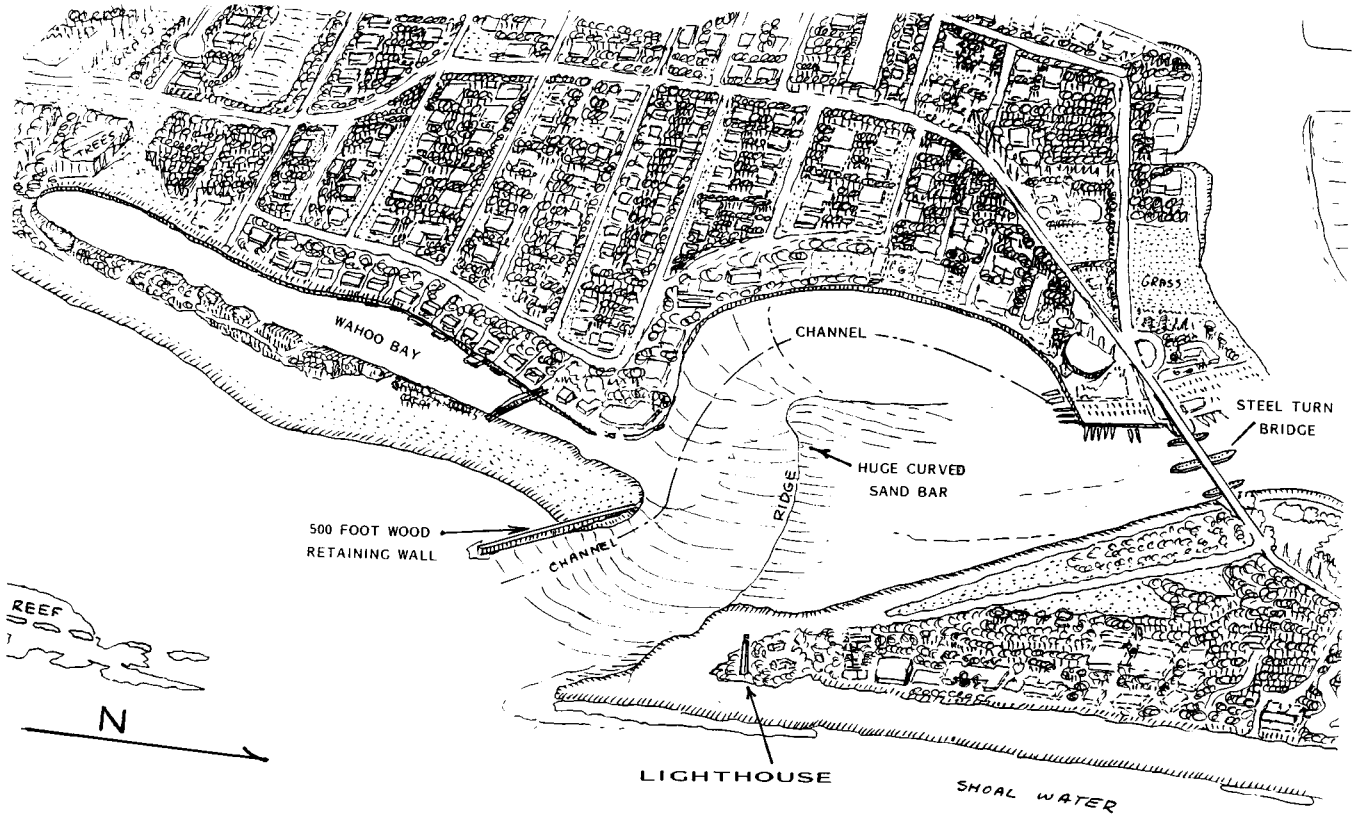

Figure 10. Hillsboro Inlet 1957, Pompano Beach Historical Society data files, drawing by Dave Butler, 1993.

1966 61 meter granite breakwater established the "weir" east of the channel.

MODERN HILLSBORO INLET

After authorization of the Hillsboro Inlet Taxing District in 1957 it took several years to secure appointees from the towns, and start collecting taxes. Dredging was done with rental equipment, and financial help was needed from Pompano Beach to keep the inlet open. Winter storms often dumped sand in the channel until only a usable depth of 1

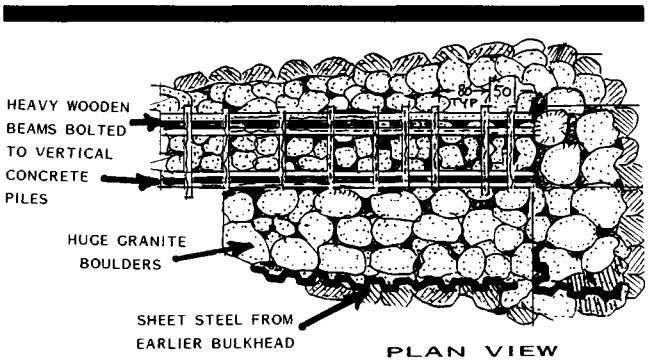

Figure 11. South end of 400 foot jetty (14).

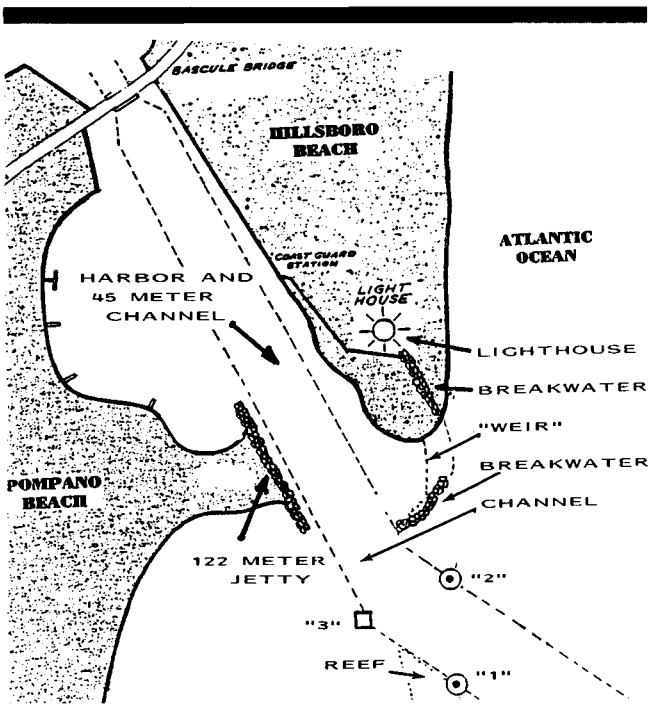

Figure 12. Modern Hillsboro Inlet.

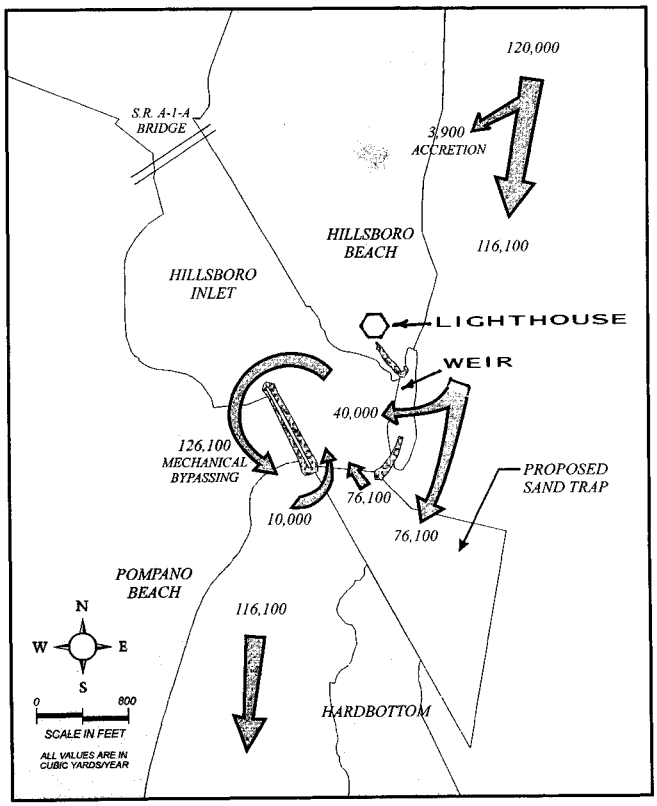

Figure 13. Predicted Hillsboro Inlet Sediment Budget.

meter (3 ft) remained. Vessels continued to be damaged in the shallow channel and the reef to the south.

In 1964 a small "sand sucker" dredge was purchased. This operated like an underwater vacuum cleaner with a rotating cutter head to form a slurry of sand, mud, and water which was sent through steel piping for 300 meters for discharge on the Pompano beach south of the inlet. The equipment was old and not very reliable, but served to keep the inlet open for twenty years.

In 1984 a much more powerful Ellicott dredge was purchased. This 1970 dredge has a 2 meter (6 ft) diameter centrifugal pump which is driven by a turbo-charged V-12 diesel engine and it can pump 270 cubic meters of sand per hour in a slurry (350 cubic yards/hour). This dredge and five-man crew have worked to maintain a 2.4 meter (8 ft) channel depth since 1984. Winter storms still cause major shoaling, normally on the north side of the channel. One 1996 storm dumped 50,000 metric tons of sand in the channel and harbor.

The present design of Hillsboro Inlet is shown in Figure 13. The quantities in this illustration are in cubic yards. The unique "weir" is shown just south of the lighthouse. According to 1995 measurements by Coastal Systems International 60,000 metric tons of sand travelled south along the Hillsboro Beach and crossed the weir into the sand trap by the lighthouse. The total sand removed each years averages 186,000 metric tons (116,100 cubic yards) (SASSO *et al.*, 1994; BRUUN *et al.*, 1978).

The sand removed is discharged on the Pompano beach where littoral drift carries it south to Fort Lauderdale beach.

LEGAL PROBLEMS AT HILLSBORO INLET

Legal problems at Hillsboro have centered on two areas. The present channel requires a 28 degree turn just past the breakwaters, and periodically vessels attempt to go straight, and end up on the exposed reef south of the channel. The other problem relates to the shallow channel. When the wind is from the northeast, and there is a flooding outgoing tide the interaction makes very steep waves with a short crest-to-crest distance. Vessels periodically hit bottom, and some are damaged. The District has not been found liable in any legal actions to date.

FUTURE PLANS FOR HILLSBORO INLET

The present channel at Hillsboro is maintained at 2.4 meters (8 ft) deep, and is no longer adequate as larger vessels regularly use the channel. The limiting factor is the cut through the hard bottom shoal right at the mouth of the inlet between the breakwaters which is only 3 meters deep. Future plans call for dredging the channel to a depth of 7.5 meters (25 ft) and eliminating the 28 degree "dog-leg" right at the mouth. In addition, a large triangular sand trap is planned which will absorb winter storm accretions and eliminate the shallow channel problems which now occur.

ACKNOWLEDGMENTS

This paper would not have been possible without the assistance of Mr. Frank Rysavy, Chairman of the Hillsboro Inlet District. Commander Dale Walker, Commandant, Civil Engineering, U.S. Coast Guard Seventh District Miami, has provided original construction documents and maps. Dr. Per Bruun has provided valuable historical and technical data. Mr. Harvey Sasso of Coastal Systems International has provided valuable maps and data.

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