

APPENDIX A STORM HISTORY



1930's – 1980's

The 1930s had a number of significant storms, including the March 1931 nor'easter, and the "Long Island Express" hurricane in 1938. The March 1931 nor'easter occurred during a full moon, and is the storm that created Moriches Inlet. Prior to 1931 nor'easter, the only sustained inlet in the study area was Fire Island Inlet.

The 1938 hurricane had wind gusts up to 135 miles per hour (mph), and made landfall in the vicinity of Moriches Inlet, at a time nearly coinciding with a high tide. The results of this hurricane were devastating. Wave heights between 15 to 30 feet swept the beaches along the entire south shore of Long Island. The ocean broke through the barrier island in hundreds of places inundating the normally dry land. The storm resulted in 11 new openings of the barrier islands in the study area. The storm left 50 people dead and over 1,000 homes destroyed. Damages to property on Long Island were estimated at \$87 million.

Despite the impact, in the years following the 1938 hurricane, there was increased human investment along the shoreline. Suffolk County and New York State stabilized Moriches Inlet with stone jetties and dredged the inlet for improved navigation access. Building after World War II resulted in extensive development along the western bay shorelines. The NPS indicates that the number of houses and business on Fire Island increased from 1,260 to 2,400 from 1955 to 1962.

The next period of intense storm activity was in the period of the mid 50's and early 60's. Notable storms impacting the area during this period include the November 1950 Nor'easter, the November 1953 nor'easter, Hurricane Carol in 1954, Hurricane Donna in 1960, and the Ash Wednesday Nor'easter of 1962, also known as the "5-High Storm". These storms had a considerable effect on the area and resulted in a continued human response to the problem.

The 1962 Ash Wednesday storm was particularly damaging to the study area because it lasted through five consecutive high tides causing severe beach and dune erosion. Each successive high tide was able to reach further inland or into back-bay areas as the beaches and sand dunes eroded and washed away. The storm destroyed 96 barrier beach homes. Many houses not destroyed during the storm were left hanging on the edge of the eroded dunes.

A new 300 foot wide inlet was formed through the barrier beach. Additional smaller inlets in the barrier island were also formed. The local authorities worked quickly to repair the breaches, using two dredges provided by the county; it took approximately one week to close the major breach working 24 hours each day.

The storm activity in the mid-1950s was also the impetus for the original FIMP Study. The study concluded with the 1958 Survey Report that was authorized for construction by Congress. This time period also saw continued development along the shoreline and additional man-made shore protection and inlet stabilization structures built. Groins were constructed by State and local interests in the areas of Ocean Beach on Fire Island. Numerous local and homeowner projects were also constructed, as evidenced by the small groins, bulkheads, and dunes sometimes reinforced with stone, concrete and cars, which are intermittently exposed today.

The 1970's and 80's were a period of relative calm. Although a Nor'easter in January 1980 resulted in a breach of the barrier island, just to the east of Moriches Inlet, which remained open for 13 months, until closed in February 1981 at a cost of \$12 Million. It should be noted that the



breach that occurred just to the east of Moriches Inlet in 1980 was in approximately the same location as the breach that occurred during the 2012 Hurricane Sandy.

Hurricane Gloria impacted the study area in 1985, but made landfall at low-tide, sparing Long Island from severe flooding, and resulting in mostly wind damage. Still, 48 houses were reported as destroyed in the Study Area with peak wind gusts of 100 mph.

1990's – 2000's

The next series of events impacting the project area included Hurricane Bob in 1991, the Halloween Nor'easter of 1991 (dubbed the "Perfect Storm"), the December 1992 Nor'easter, and the March 1993 "Storm of the Century". Hurricane Bob (1991) and the Halloween Nor'easter (1991) caused widespread coastal flooding in low lying areas and dune washovers along the project area.

The December 1992 Nor'easter resulted in significant damages along barrier islands and back-bays. Overwashes of the island were also observed along western Fire Island, at Smith Point County Park, Old Inlet. On the mainland at Mastic Beach the water reached 2 to 4 feet deep in the streets as a result of back-bay flooding from the breaches.

The March 1993 ("Storm of the Century") resulted in severe wave action that scoured the beaches along the entire barrier island. The dunes were overtopped, lowering the height of the dunes 15 to 20 feet. It was reported that homes were destroyed or severely damaged in several communities on Fire Island and in the back-bay. In 1996, a Breach Contingency Plan (BCP) was developed to allow for the rapid closure of barrier island breaches by quickly mobilizing federal, state, and municipal resources. The BCP was recommended based on the experiences at Westhampton where severe back-bay flooding was linked to the breach in the barrier island, in which it took 11 months to obtain the necessary approvals to close the breach. The BCP aims to reduce the time and cost to close future breaches. BCP was approved in 1996 and implemented under Advanced Measures (PL 84-99). If FIMI is constructed under an approved PL 113-2 HSLRR, the BCP would also be implemented under PL 84-99. Please note breach maintenance/closure costs associated with FIMI in this HSLRR are not associated with BCP as it presupposes the outcome of the overall FIMP GRR. However, economic analysis calculates damages avoided as a benefit of Future With Project conditions. The BCP is not a project feature for FIMI.

In the 2000s the following storms created significant threat to life and property as follows:

- August 10, 2002 — Tropical Storm Cristobal generates rip currents which drown three people on the coast of Long Island.
- September 21, 2003 — Hurricane Isabel affects the state with high winds and flooding. Damage in New York totals to \$90 million
- September 6, 2008 — Hurricane Hanna strikes Long Island as a tropical storm with wind gusts of 52 mph (84 km/h) at Shinnecock Inlet.
- August 22, 2009 — Offshore Hurricane Bill causes severe beach erosion and coastal damage on the southern shore of Long Island.



2010's

The most recent major storm events to impact the project area are Hurricane Irene (2011) and Hurricane Sandy (2012). Hurricane Irene caused minor coastal flooding along Fire Island as water levels reached 7.0 feet NAVD 88 at Sandy Hook, NJ. Measured wave heights 15 nautical miles offshore exceeded 25 feet during the peak of the storm.

Hurricane Sandy made landfall near Atlantic City, NJ on October 29th with wind speeds equivalent to a Category 1 hurricane. The orientation of Hurricane Sandy's wind field prior to landfall caused strong winds to blow across the continental shelf towards New York. Because the peak storm surge was in phase with the peak high tide, storm-induced flooding was exacerbated. Hurricane Sandy's unusually large diameter resulted in long fetch lengths generating extreme wave heights at the study area. These three factors (track, timing, and extraordinary size) resulted in record water levels and wave heights in the New York Bight. The maximum water level at Sandy Hook, NJ is estimated to have reached elevation 11.6 feet NAVD88 exceeding the previous record by over 4 feet (USACE, 2013).

A team from the USGS went to Fire Island before and after Hurricane Sandy to survey the beach and assess morphological changes. The following excerpt from their field report provides a summary of the impacts along Fire Island immediately after the storm (USGS, 2012):

"The impacts to the island were extensive. The majority of oceanfront homes in the communities within Fire Island National Seashore were damaged or destroyed. Enormous volumes of sand were carried from the beach and dunes to the central portion of the island, forming large overwash deposits, and the island was breached in multiple locations. With few exceptions, lower-relief dunes were overwashed and flattened. High dunes, which are more commonly found within undeveloped portions of the island, experienced severe erosion and overwash. The elevation of the beach was lowered and the dunes form vertical scarps where they survived."

An oblique aerial photo, Figure 1, taken after Hurricane Sandy at Otis G. Pike Wilderness Area looking east towards Smith Point County Park shows a typical overwash fan and the breach at Old Inlet. An example of dune scarping and berm lowering during Hurricane Sandy is shown in Figure 2 Pre- and post-Sandy aerial photos at Ocean Beach Figure 3 show an example of a location where the dunes were overwashed and flattened as well as the extensive damage to ocean front structures. Another example dune flattening and severe damage is provided in Figure 4 at Davis Park.

Two of the breaches, Smith Point County Park and Cupsogue (just east of Moriches Inlet), were closed shortly after the storm following the protocol established by the Breach Contingency Plan. A third breach at Old Inlet within the boundaries of the Otis G. Pike Wilderness Area on Fire Island has not been closed, and remains a relatively stable small tidal inlet. It continues to be monitored by the National Park Service, SOMAS, and USGS.





Figure 1: Post Sandy Photo of Breach at Old Inlet (looking east towards Smith Point County Park)



Figure 2: Post Sandy Photo Dune Erosion and Berm Lowering at Fire Island





Figure 3: Pre- and Post-Sandy Photo at Ocean Beach





Figure 4: Post-Hurricane Sandy Photo at Davis Park

