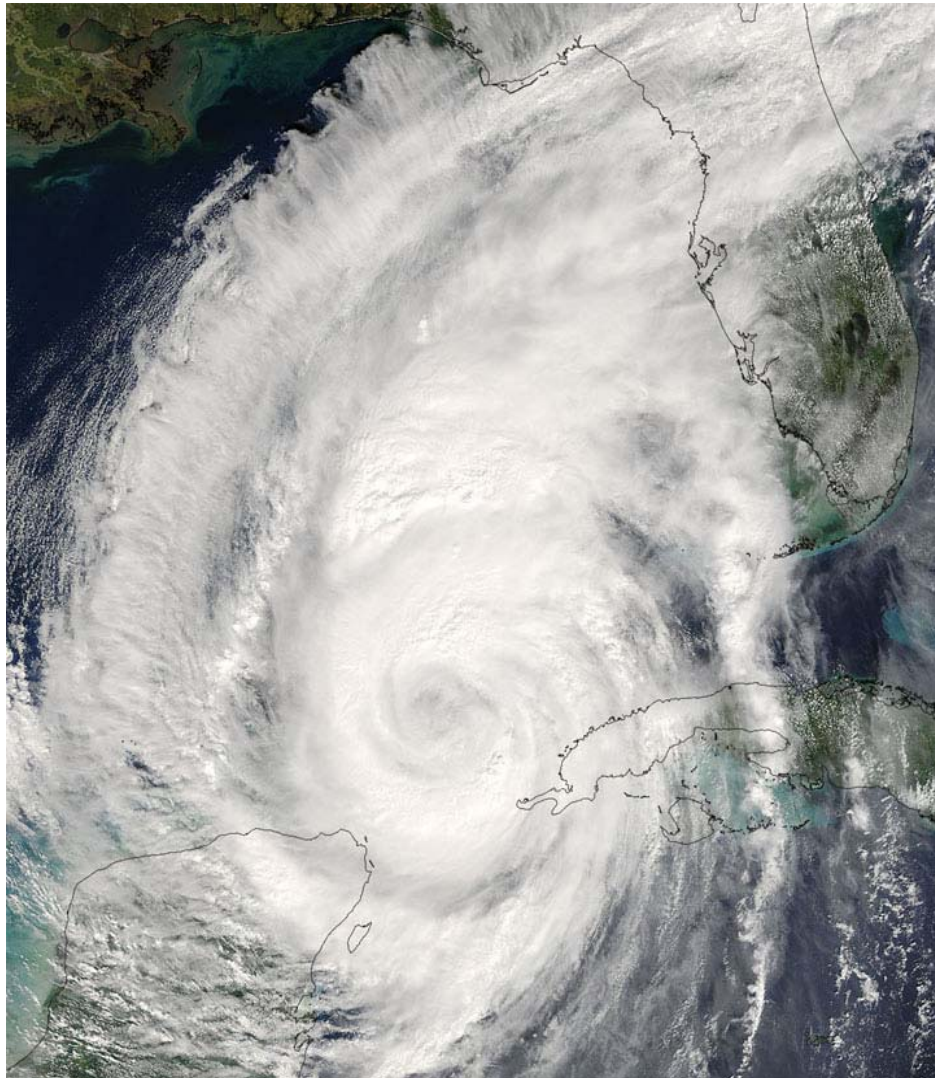


# *Hurricane Wilma*

## POST-STORM BEACH CONDITIONS AND COASTAL IMPACT REPORT



**Florida Department of Environmental Protection  
Division of Water Resource Management  
Bureau of Beaches and Coastal Systems  
January 2006**

## Foreword

The Bureau of Beaches and Coastal Systems of the Florida Department of Environmental Protection is responsible for protection and management of Florida's sandy beaches fronting the Gulf of Mexico, the Atlantic Ocean and the Straits of Florida, and the regulation of coastal development adjacent to those coastal beaches. The monitoring and assessment of hurricane impacts to Florida's beaches and coastal construction and the preparation of post-storm recovery responses and management strategies are important elements of the Bureau's responsibilities.

This report provides documentation of the impact of Hurricane Wilma on the southwestern and eastern coasts and beaches of Florida. The report also provides preliminary recommendations for post-storm response activities. This report was prepared by the Coastal Engineering Section for the Bureau of Beaches and Coastal Systems. The report was written by Ralph Clark, P.E., P.L.S., and James LaGrone, Coastal Engineer, with major contributions by Jennifer Koch, Coastal Geologist. Field data of beach and dune erosion and structural damage were obtained by Ralph Clark, James LaGrone, Jennifer Koch, Guy Weeks, Steve West, Jennifer Cowart, Ryan Murray, and Bobbie Nelson. Aerial videography and oblique aerial photography were supplied by Stacey B. Roberts of PBS&J and Camera Copters, Inc. Ground and aerial photography of Fort Jefferson and Everglades National Park were provided by the National Park Service.

STATE OF FLORIDA, DEPARTMENT  
OF ENVIRONMENTAL PROTECTION



Michael R. Barnett, P.E., Chief  
Bureau of Beaches and Coastal Systems

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## Hurricane Wilma

October 15-25, 2005

Hurricane Wilma, the twelfth hurricane of the 2005 hurricane season for the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico, spawned as a tropical depression over the western Caribbean Sea on Saturday, October 15. In its initial advisory, the National Weather Service, Tropical Prediction Center (National Hurricane Center, Miami, Florida) located this depression near latitude 17.6 degrees north, longitude 78.8 degrees west, or about 85 miles southwest of Montego Bay, Jamaica. Movement was west near 3 miles per hour (mph). Figure 1 illustrates the track history of Hurricane Wilma combined with satellite imagery. This composite was developed by the Cooperative Institute of Meteorological Satellite Studies (CIMSS) at the University of Wisconsin - Madison.

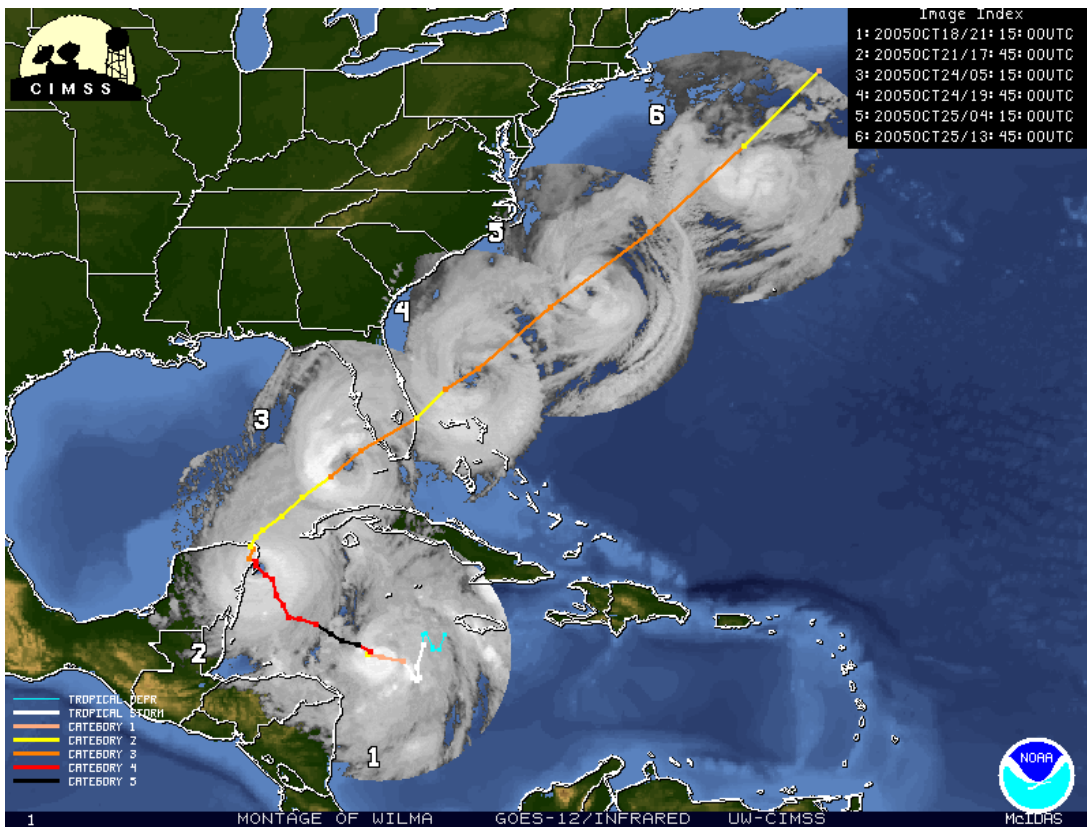


Figure 1. Hurricane Wilma storm track with landfall on southwest Florida coast (Source: CIMSS/Univ. of Wisconsin-Madison via NOAA / NCEP / TPC).

At 5:00 a.m. on Monday, October 17, the National Hurricane Center's (NHC) seventh advisory upgraded the depression to a tropical storm naming it Wilma and locating the center of circulation near latitude 17.2 degrees north, longitude 79.7 degrees west, or about 175 miles southeast of Grand Cayman. Movement was southwest near 3 mph. Wilma became the 21<sup>st</sup> tropical storm of the season and tied the record set in 1933 for the number of tropical storms forming in one season.

Throughout Monday, October 17, Tropical Storm Wilma slowly strengthened and moved southwest in the western Caribbean Sea. At 11:00 a.m., Tuesday, October 18, the NHC's 12<sup>th</sup> advisory upgraded Wilma to a hurricane locating it about latitude 16.5 degrees north, longitude 80.6 degrees west, or about 195 miles south-southeast of Grand Cayman, and about 200 miles east-northeast of Cabo Gracias a Dios on the Nicaragua/Honduras border of Central America. Wilma was moving northwest near 7 mph with maximum sustained winds near 75 mph.

Hurricane Wilma continued to strengthen and at 11:00 p.m., Tuesday, October 18, the NHC's 14<sup>th</sup> advisory upgraded Wilma to a category two hurricane. At this time Wilma was located near latitude 16.8 degrees north, longitude 82.1 degrees west, or about 185 miles south-southwest of Grand Cayman, and about 405 miles southeast of Isla de Cozumel, Mexico. Movement was west-northwest near 8 mph and maximum sustained winds were near 110 mph. A NOAA weather buoy in the western Caribbean Sea reported a sustained wind of 50 mph and a peak gust of 58 mph.

Wilma continued to intensify throughout the night, reaching category four intensity with maximum sustained winds near 150 mph near midnight. With further intensification during the early morning, Wilma reached category five hurricane intensity with maximum sustained winds near 185 mph. A U.S. Air Force reconnaissance airplane reported a minimum central barometric pressure of 882 millibars, which is the lowest minimum pressure ever measured in the Atlantic basin. At 11:00 a.m., Wednesday, October 19<sup>th</sup>, the NHC's 17<sup>th</sup> advisory located Wilma near latitude 17.4 degrees north, longitude 83.2 degrees west, or about 325 miles southeast of Cozumel. Movement was west-northwest near 7 mph and maximum sustained winds were near 185 mph. The government of Mexico issued a hurricane warning for the states of Quintana Roo and Yucatan on the Yucatan Peninsula.

Wilma slightly weakened Wednesday evening and Thursday morning. At 4:00 p.m., Thursday, October 20, the NHC's 22<sup>nd</sup> advisory located Wilma near latitude 18.9 degrees north, longitude 85.7 degrees west, or about 135 miles southeast of Cozumel. Movement was northwest near 6 mph and maximum sustained winds were near 150 mph. Wilma was still an extremely dangerous category four hurricane and warnings were extended eastward along Quintana Roo from Tulum to Chetumal.

Throughout the evening Wilma moved closer to the state of Quintana Roo, Mexico. A NOAA weather buoy located about 75 miles east of the eye of Wilma measured maximum sustained winds of 71.6 mph and a peak gust of 91.7 mph. A maximum significant wave height was measured at 36.1 feet. At 10:00 a.m., Friday, October 21<sup>st</sup>, the NHC's 25<sup>th</sup> advisory located Wilma near latitude 20.2 degrees north, longitude 86.5 degrees west, or about 35 miles southeast of Cozumel. Movement was northwest near 5 mph and maximum sustained winds were near 150 mph. The northwestern eye wall had already moved over Cozumel.

Near 4:00 p.m., the eye of Wilma crossed near the north end of the island of Cozumel and an automated weather station measured a minimum pressure of 927.4 millibars or 27.39 inches of mercury. Another automated weather station in Cancun measured a wind gust of 133 mph before contact with the station was lost. Throughout Friday evening the

winds and waves of Wilma battered the Quintana Roo coast of Mexico along the beaches of the Maya Riviera. At 4:00 a.m., Saturday, October 22<sup>nd</sup>, the NHC's 28<sup>th</sup> advisory located Wilma near latitude 20.9 degrees north, longitude 87.2 degrees west, or about 25 miles southwest of Cancun. The large eye of Wilma passed over Playa del Carmen and the hurricane became stationary with its unrelenting energy affecting the northern coast of Quintana Roo. Maximum sustained winds decreased to about 125 mph.

Throughout Saturday, October 22<sup>nd</sup>, Wilma slowly drifted north just inland of the coast of northern Quintana Roo. At 11:00 p.m., a hurricane warning was issued for south Florida and the Florida Keys as Wilma drifted north off the coast of Quintana Roo at Cabo Catoche and into the Yucatan Strait with maximum sustained winds of 100 mph. Throughout Sunday, October 23<sup>rd</sup>, Wilma crossed the Yucatan Strait and extreme southeastern Gulf of Mexico with an accelerating northeast forward speed and a steady increase in strength. At 11:00 p.m., the NHC's 35<sup>th</sup> advisory located Wilma near latitude 24.4 degrees north, longitude 83.7 degrees west, or about 120 miles west of Key West, Florida, and 170 miles southwest of Naples, Florida. Wilma was moving northeast near 18 mph with maximum sustained winds near 115 mph, making Wilma a major category three hurricane.

Throughout Monday morning, October 24<sup>th</sup>, Wilma tracked northeast into southwest Florida, impacting the north coast of Cuba and the Florida Keys with an eight to ten-foot storm surge. Wilma made landfall near Cape Romano in Collier County, Florida, bringing its approximately 10-foot storm surge into the Ten Thousand Islands region of Collier County and the Florida Everglades National Park segment of coast in Monroe County. At 7:00 a.m., the NHC's advisory number 36A located Wilma near latitude 26.1 degrees north, longitude 81.4 degrees west, or about 10 miles north of Everglades City, Florida. Wilma was moving northeast near 23 mph with maximum sustained winds near 120 mph, making Wilma a category three (major) hurricane crossing south Florida. A wind gust of 95 mph was measured at Everglades City, where the lowest barometric pressure recorded over land was 28.12 inches of mercury. From other recording stations some peak wind gusts include: 127 mph at Fowey Rocks, 123 mph at Cudjoe Key, 121 mph at Naples, 111 mph at Miami, 100 mph at Ft. Myers Beach, and 101 mph at Sombrero Key. Maximum sustained winds reached 101 mph at Fowey Rocks, 87 mph at Sombrero Key, and 79 mph at the Naples Pier.

Near noon Monday, October 24<sup>th</sup>, the large eye of Wilma (60 nautical miles in diameter) moved off the coast of southeast Florida north of West Palm Beach with maximum sustained winds of 105 mph. Wilma quickly re-intensified back over the warm waters of the Gulf Stream. At 2:30 p.m., the NHC's 38<sup>th</sup> advisory located Wilma near latitude 28.1 degrees north, longitude 78.8 degrees west, or about 125 miles northeast of West Palm Beach. Movement was northeast near 29 mph and maximum sustained winds were near 115 mph, making Wilma a category three hurricane once again. A maximum sustained wind of 96 mph and a peak gust of 119 mph were recorded at Settlement Point, Grand Bahama Island. Maximum significant wave heights were obtained from the NOAA buoy 20 nautical miles east of Cape Canaveral at 19.7 feet, and from the NOAA buoy 120 nautical miles east of Cape Canaveral at 33.5 feet. At the NOAA buoy located 40 nautical miles east of St. Augustine, Florida, maximum significant wave heights reached 14.4 feet.

Throughout Monday evening and Tuesday, October 25<sup>th</sup>, Wilma raced northeastward across the North Atlantic Ocean, traveling at speeds reaching 53 mph as it merged with a strong cold front and became a large extratropical storm that moved across the ocean and away from North America.

## Post-storm Beach Conditions and Coastal Impact Summary and Overview

Figure 2 presents the track of Hurricane Wilma and its proximity to the coasts of south Florida. Hurricane Wilma crossed the southeast Gulf of Mexico from the southwest and made landfall in Collier County as a category three hurricane before exiting Palm Beach County into the Atlantic Ocean.

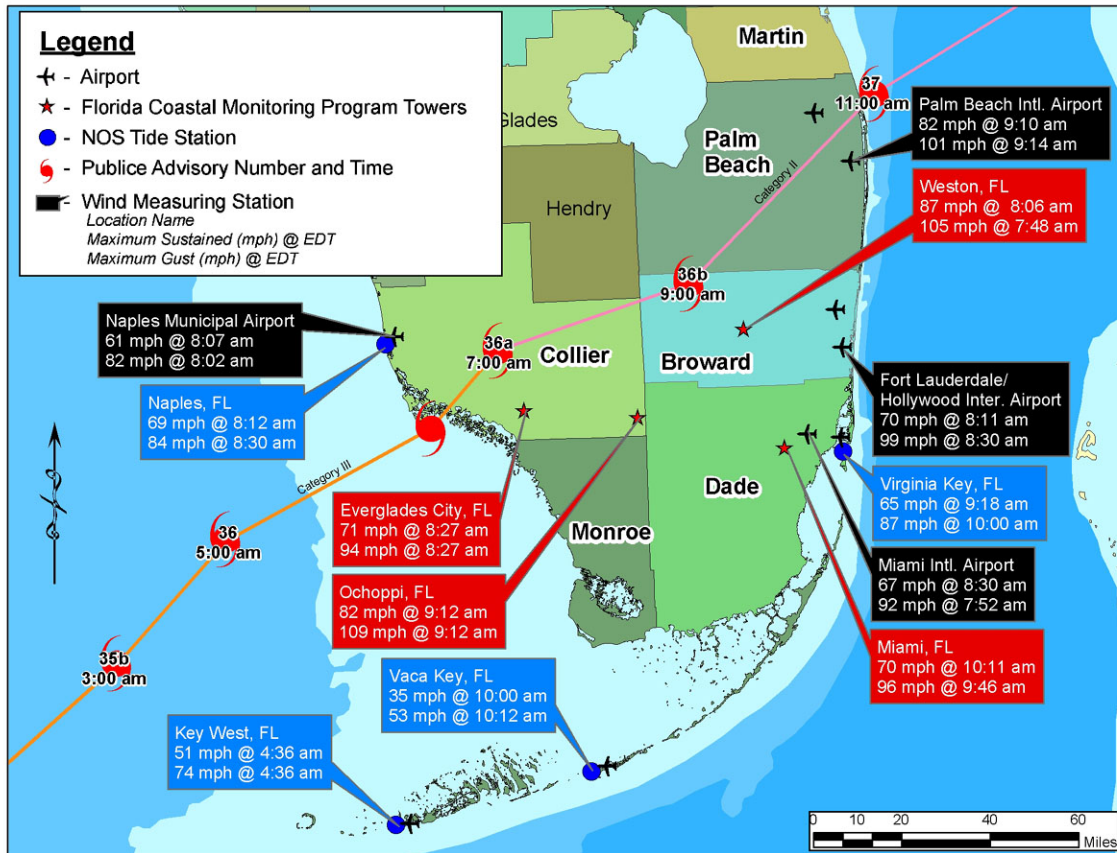


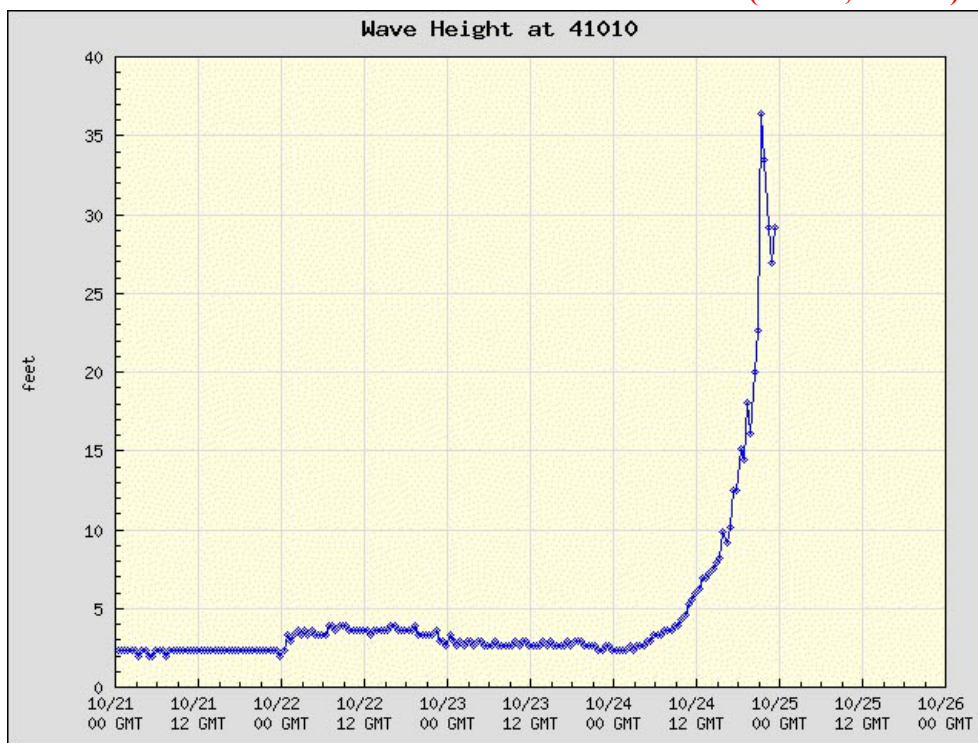
Figure 2. Hurricane Wilma track and wind data on Monday, October 24<sup>th</sup>, 2005 (EDT).

The winds of Hurricane Wilma are graphically presented in the wind swath map shown in Figure 3. Wave data recorded at the East Cape Canaveral Buoy is graphically shown in Figure 4. The data was prepared and provided by the Hurricane Research Division (HRD) at the Atlantic Oceanographic and Meteorological Laboratory (AOML) of the National Oceanographic and Atmospheric Administration, on Virginia Key. Storm tide data are available at the Key West and Virginia Key NOAA tide stations during Hurricane Wilma (Figure 5 & 6).



**Pending Graphic**

**Figure 3. Surface wind fields associated with Hurricane Wilma (NOAA, AOML).**



**Figure 4. Wave data at East Cape Canaveral Buoy (NOAA, NBDC).**

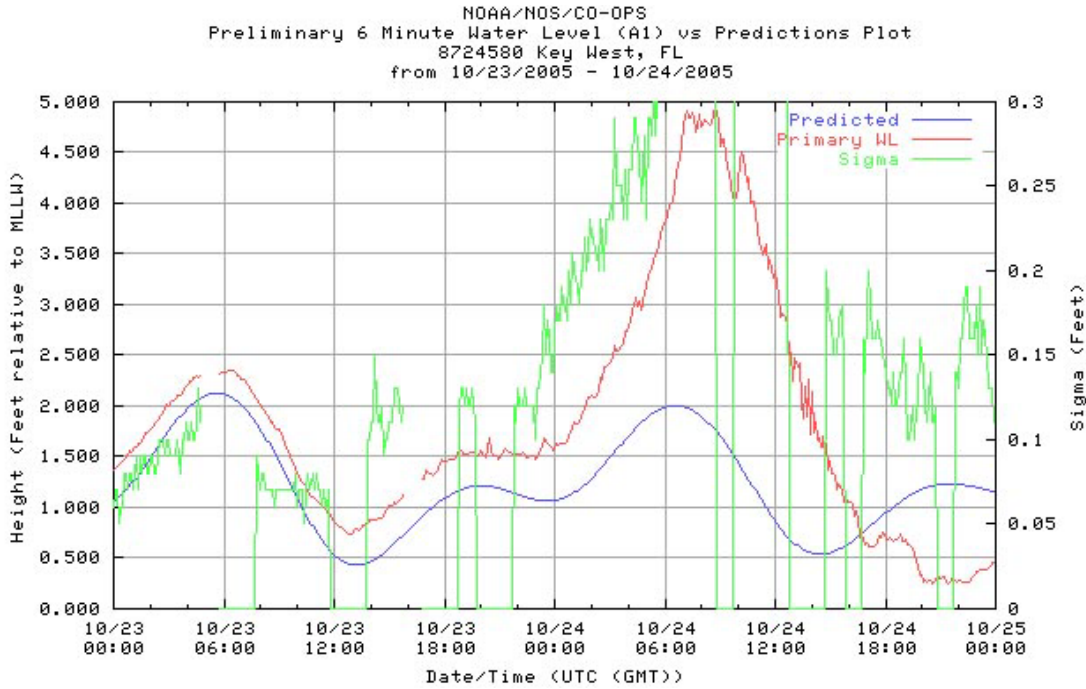


Figure 5. Key West NOAA tide station during Hurricane Wilma.

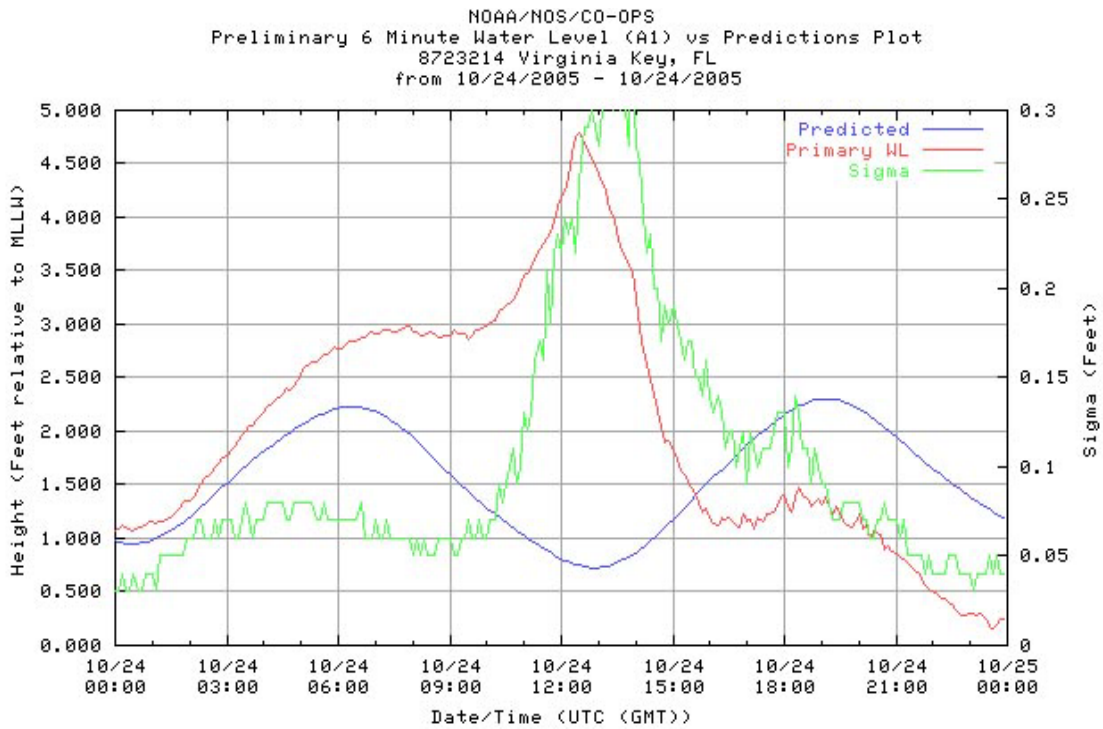


Figure 6. Virginia Key NOAA tide station during Hurricane Wilma.

The impact of Hurricane Wilma caused the following beach erosion conditions (Table 1). The erosion conditions summarized in Table 1 utilize the qualitative scale shown in Figure 7.

*Table 1. Beach and Dune Erosion Summary – Post-Wilma*

<b><u>County</u></b>	<b><u>Erosion Condition</u></b>
<b>Pinellas</b>	I (Minor)
<b>Manatee</b>	I (Minor)
<b>Sarasota</b>	I (Minor)
<b>Charlotte</b>	I (Minor)
<b>Lee</b>	I (Minor)
<b>Collier</b>	
Lely Barefoot Beach (R1-R9)	I (Minor)
Barefoot Beach State Preserve (R9-R16)	I-II (Minor)
Delnor-Wiggins Pass State Park (R17-R22.3)	I (Minor)
Vanderbilt Beach (R22.3-R29)	I (Minor)
Pelican Bay (R29-R41.6)	I-II (Minor)
Pelican Bay (R40-R40.65)	III (Moderate)
Park Shore (R41.6-R56)	I-II (Minor)
Park Shore (R56– R57.5)	III (Moderate)
Naples (R57.75-R73)	I-II (Minor)
South Naples (R73-R89.3)	III (Moderate)
Keewaydin Island (R90-R122)	I-II (Minor)
South end Keewaydin Is. (R122.5-V2.1)	Accretion
Sea Oat Island (V3-V7)	II (Minor)
Coconut Island	IV (Major)
Marco Island, Hideaway Beach (V10-V16)	I-II (Minor)
Marco Island, Tiger Tail Beach (R130-R137)	II-III (Moderate)
Marco Island (R137-R147.5)	I-II (Minor)
South end of Marco Island (R147.5-R148.8)	III-IV (Major)
Kice Island (V20-V23)	I (Minor)
Kice Island (V23-V32)	II-III (Moderate)
Morgan Island (V33-V43)	II-III (Moderate)
Ten Thousand Islands	II (Minor)

**Monroe**

Islamorada, Lower Matecumbe Key	III (Moderate)
Long Key State Park	III-IV (Major)
Grassy Key	III-IV (Major)
Curry Hammocks State Park	III-IV (Major)
Coco Plum Beach	II-IV (Major)
Key Colony – private beaches	II-III (Moderate)
Key Colony, Sunset Beach	III-IV (Major)
Vaca Key, Sombrero Beach	II-III (Moderate)
Little Duck Key, Missouri Key, Ohio Key	III (Moderate)
Bahia Honda State Park	II-IV (Major)
West Summerland Key	III-IV (Major)
Long Beach, Big Pine Key	III-IV (Major)
Newfound Harbor Keys	III-IV (Major)
Sugarloaf Beach, Sugarloaf Key	III-IV (Major)
Boca Chica Key	III-IV (Major)
Key West, Smathers Beach	II (Minor)
Key West, Berg & Kitsos Beach	III-IV (Major)
Key West, Rest Beach	IV (Major)
Key West, Higgs Beach	I (Minor)
Key West, South Beach	I (Minor)
U.S. Navy, Truman Annex	I (Minor)
Fort Zachary Taylor State Park	II-IV (Major)
Woman Key	no report
Boca Grande Key	no report
Marquesas Keys	no report
Garden Key, Ft. Jefferson	IV (Major)
Loggerhead Key, Dry Tortugas	no report
Cape Sable	IV (Major)
Key McLaughlin	IV (Major)
Everglades Sloughs Debouchure	IV (Major)

**Dade**

North Dade County, R1-R74	I (Minor)
Virginia Key, R79-R87	I (Minor)
Key Biscayne, R90-R111.5	I (Minor)
Cape Florida State Park, R111.5-R114	II (Minor)

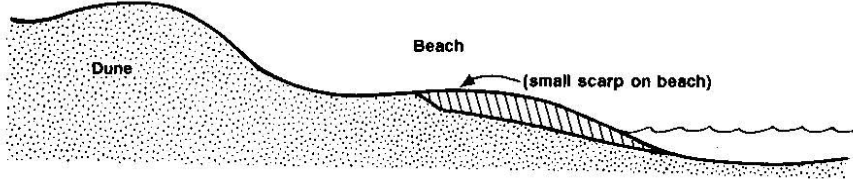
**Broward**

R1-R4	I (Minor)
R4-R6.8	II (Minor)
R6.8-R11.6	III (Moderate)
R12-R19.5	I-II (Minor)
R20-R24	Accretion
R25-R34	I (Minor)
R35-R64.2	II (Minor)
R65-R81.1	I (Minor)
R82-R84.4	Accretion
R85-R98	II-III (Moderate)
R98-R121	I (Minor)
R121-128	I-II (Minor)

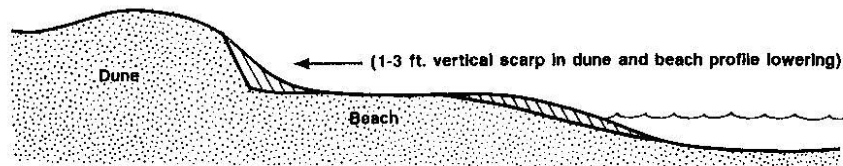
<b>Palm Beach</b>	
R1-R14	I (Minor)
R14-R15.5	III (Moderate)
R16-R58	I (Minor)
R58-R59	II (Minor)
R60-R65	III (Moderate)
R65-R227	Stable
<b>Martin</b>	
R1-R27	I (Minor)
R27	III (Moderate)
R28-R30	I (Minor)
R30-R31	II-III (Moderate)
R31-R40	I-II (Minor)
R40-R42.5	Accretion
R42.5-R93	I (Minor)
R93-R96	II (Minor)
R96-R127	I (Minor)
<b>St. Lucie</b>	
R1-R80	I (Minor)
R80-R84	III (Moderate)
R84-R99	I (Minor)
R99-R115	II-III (Moderate)
<b>Indian River</b>	
R1-R29	I (Minor)
R29-R38	II (Minor)
R38-R40	I (Minor)
R40-R46	II (Minor)
R46-R55	III (Moderate)
R55-R101	I (Minor)
R101-R107	II (Minor)
R107-R119	I (Minor)
<b>Brevard</b>	
R1-R219	I (Minor)
R158.5	III (Moderate)
<b>Volusia</b>	
R1-R115	I (Minor)
R115-R145	II-III (Moderate)
R145-R148	I (Minor)
R148-R158.5	II (Minor)
R158.5-R176	III-IV (Major)
R176-R188	II (Minor)
R188-R207	Accretion
<b>Flagler</b>	I (Minor)
<b>St. Johns</b>	I (Minor)
<b>Duval</b>	I (Minor)
<b>Nassau</b>	I (Minor)

## BEACH AND DUNE EROSION CONDITIONS

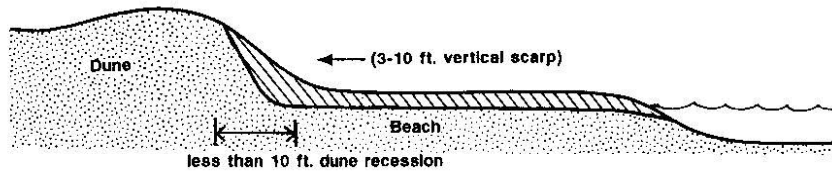
### CONDITION I: MINOR BEACH EROSION



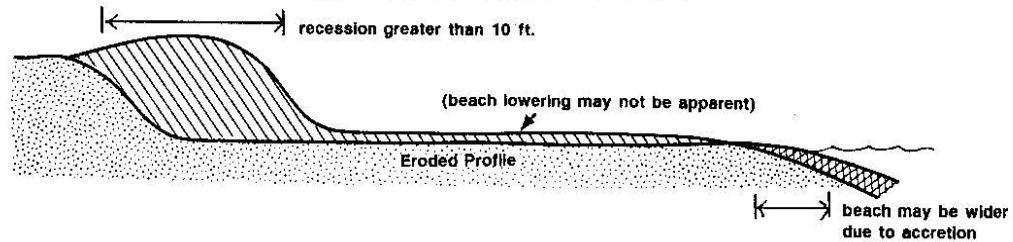
### CONDITION II: MINOR DUNE AND BEACH EROSION



### CONDITION III: MODERATE DUNE EROSION AND BEACH PROFILE LOWERING



### CONDITION IV: MAJOR DUNE EROSION



OR:

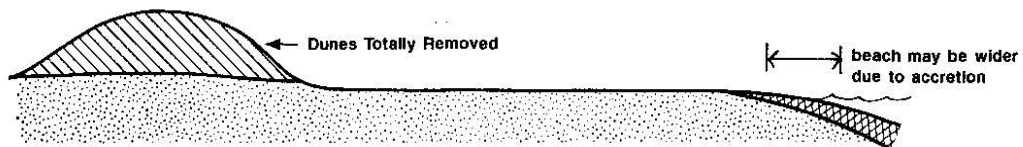


Figure 7. Beach and dune erosion conditions (Clark, 1980).

Pages 12 through 95 provide discussions of Hurricane Wilma's storm effects, erosion conditions, and damage to the coastal counties of South Florida.

## Collier County

Collier County is located on Florida's southwest Gulf of Mexico coast, and has 34.1 miles of beaches extending southward from Lee County to the southwest tip of Cape Romano (Figure 8). Collier County includes the following beach communities and major parks: Lowdermilk Park, Barefoot Beach State Preserve, Delnor-Wiggins Pass State Park, Vanderbilt Beach, Park Shore, Naples, Marco Island, and Everglades National Park. The net direction of longshore transport along the Collier County coast is to the south. This coast is characterized by low to moderate wave energy (Tanner, 1960) and narrow, relatively steep beaches. Collier County's beaches are generally subdivided to include the northern, generally mainland coast, the central segment of barrier islands, and the southern segment of mangrove forested islands.



Figure 8. Collier County location map.

The segment of coast comprising the northern 16.5 miles of Collier County's beaches (R1-R89) is similar to a mainland coast. The tidal bays backing the coastal barriers lose their physiographic continuity south of Wiggins Pass (R16), and to the south are a line of small, discontinuous "back-beach" water bodies and dredged channels (Balsillie and Clark, 1992). There are four coastal inlets along northern Collier County, including from north to south, Wiggins Pass, Clam Pass, Doctors Pass, and Gordon Pass. To the south of Gordon Pass (R89), the coast is characterized by five gulf fronting barrier islands: Keewaydin Island, Sea Oat Island, Marco Island, Kice Island, and Morgan Island. These Collier County barriers are separated by five coastal inlets including, Little Marco Pass, Capri Pass, Big Marco Pass, Caxambas Pass, and Blind Pass. There are also two unnamed inlets that bisect Morgan Island, as well as Morgan Pass between Morgan Island and Cape Romano. In southern Collier County south of Cape Romano, are the northern approximately 12 miles of the Ten Thousand Islands. The gulf fronting islands of this large group of mangrove forested islands are the result of vermetid reefs that have trapped both silicate and carbonate sands that have been transported across Gullivan Bay from shoals south of Cape Romano (Shier, 1969). The islands of this group within Collier County that have significant sand beaches include: Turtle Key, Gullivan Key, White Horse Key, Panther Key, and Round Key.

Prior to the 2005 hurricane season, there were five critically eroded beach areas (10.2 miles), five noncritically eroded beach areas (9.5 miles), and one critically eroded inlet shoreline area (0.8 mile) in Collier County. A 1.6-mile segment (R22.3-R30.5) that is critically eroded exists in northern Collier County threatening development interests in Vanderbilt Beach. This area is substantially armored with bulkheads and has a beach restoration project. The City of Naples has two segments that are critically eroded threatening development interests north and south of Doctors Pass. North of Doctors Pass (R50.65-R57.5) is a 1.3-mile segment that is critically eroded. Between Doctors Pass and Gordon Pass (R57.8-R89) is a 5.6-mile segment that is critically eroded. Most of Naples is armored with bulkheads and revetments and these two critically eroded segments have a continuous beach restoration project.

South of Gordon Pass (R90-R111) is a 3.9-mile stretch that is noncritically eroded along the northern half of Keewaydin Island. Between Little Marco Pass and Capri Pass, Sea Oat Island has 0.9 mile beach that is noncritically eroded. Also, Coconut Island (M1-M2) has 0.1 mile that is noncritically eroded between Capri Pass and Big Marco Pass. Marco Island has three areas that are critically eroded threatening development interests. The north shore of Marco Island (H3-H11) fronting on Big Marco Pass has 0.8 mile of inlet shoreline that is critically eroded. The central gulf beach of Marco Island (R134.5-R139) has 0.8 mile that is critically eroded and the southern stretch of beach (R143-R148) has 0.9 mile that is critically eroded. All three critically eroded areas on Marco Island have beach restoration projects. The north shore of Marco Island (Hideaway Beach) also has a recently constructed boulder T-groin field and the southwest tip of Marco Island has offshore detached rock breakwaters. The two southern barriers in Collier County between Caxambas Pass and Cape Romano have been designated noncritically eroded (2.5 miles of Kice Island and 2.1 miles of Morgan Island).



### **Storm Effects and Erosion Conditions**

Hurricane Wilma made landfall at 6:30 am EDT (1030 UTC) with the geographic center of the eye passing near Cape Romano. The eye of Wilma was large (roughly 55 to 65 miles wide), and encompassed Keewaydin Island to the north and Sloughs Debouchure to the south. The radius of maximum winds was about 30 miles and placed Hurricane Wilma's category three intensity winds and storm surge into northern Monroe County (Figure 9). Collier County was spared a high storm surge, as the winds were generally offshore to alongshore as the storm approached and made landfall.

When the storm crossed into the Ten Thousand Islands area, the winds in Collier County shifted from a sustained northeast wind of 35 mph to a sustained northwest wind of 61 mph (Figure 10). On the coast, a peak wind gust of 84 mph was measured at the NOAA weather station on the Naples Pier. Marco Island reported a peak wind gust of 120 mph. Other Collier County stations with recorded peak wind gusts are as follows:

- Naples Airport — 121 mph
- Everglades City — 97 mph
- Collier County Emergency Operations Center (East Naples) — 125 mph

It was not until after Wilma made landfall that Collier County felt the impact of a storm surge. The highest storm surges for Collier County were reported at Marco Island (seven feet) and Everglades City (four feet), and occurred shortly after Hurricane Wilma's landfall (Figure 11).

Wilma caused minor to moderate beach and dune erosion (condition I to III) throughout Collier County. Isolated areas of moderate to major beach and dune erosion (condition III-IV) occurred at the northern side of several passes in the county. Specific beach conditions at major beach sites throughout Collier County are discussed as follows.

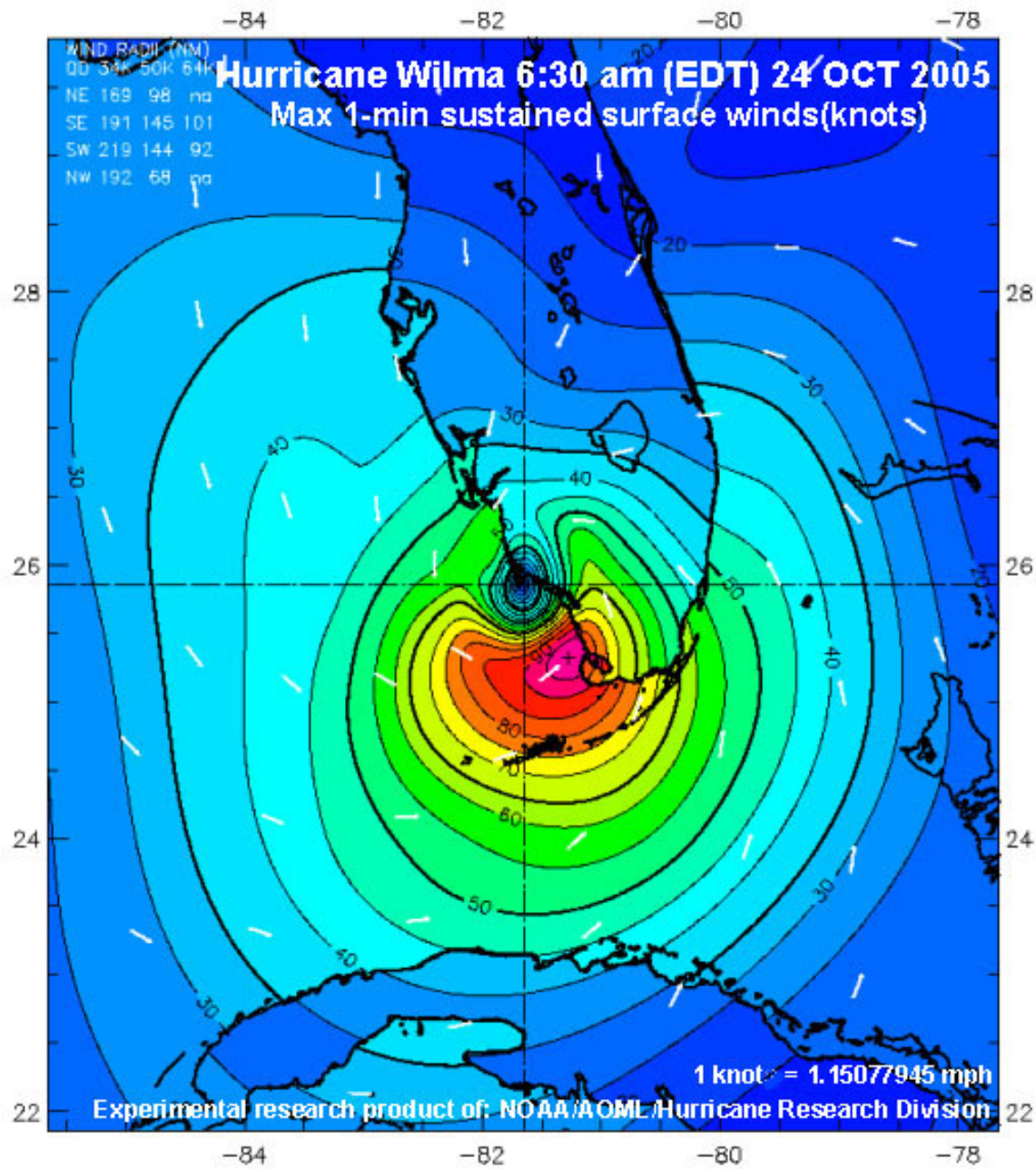


Figure 9. Sustained surface wind fields associated with Hurricane Wilma (NOAA, AOML).

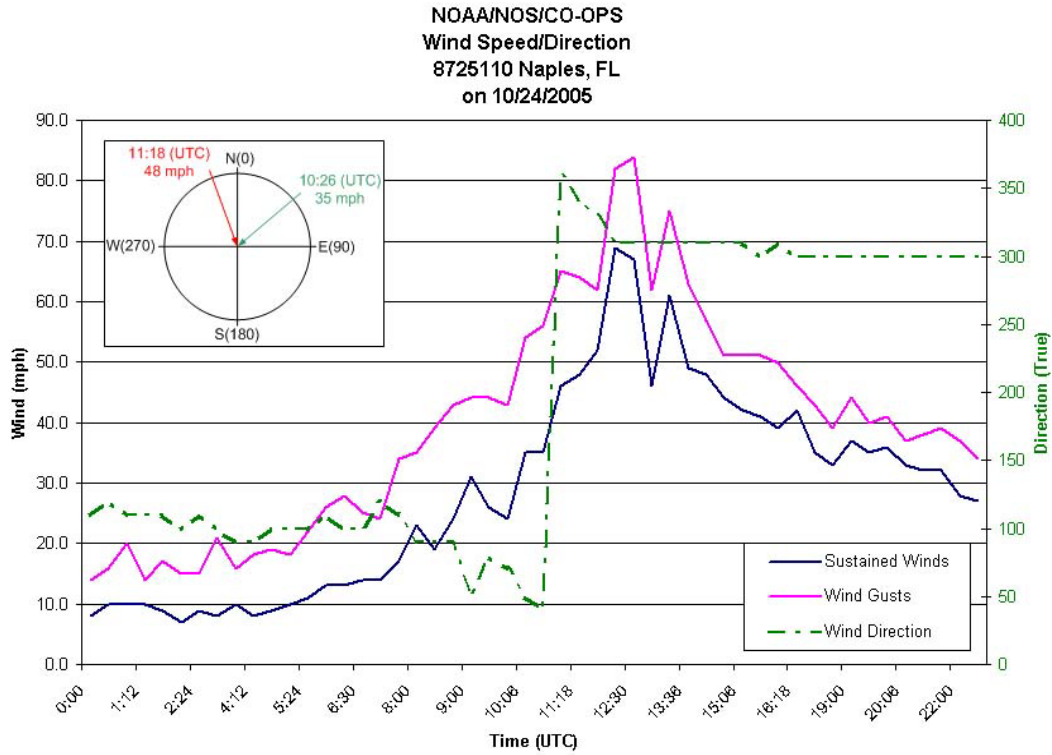


Figure 10. Wind chart for Hurricane Wilma from Naples, FL.

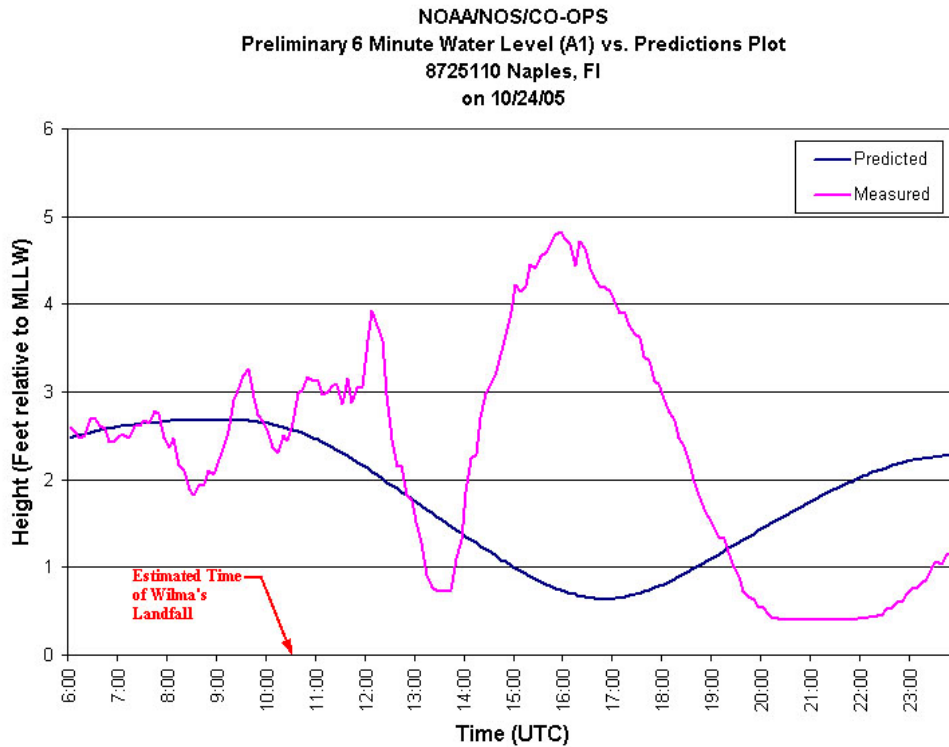


Figure 11. Tide chart for Hurricane Wilma from Naples, FL.

### County line to Wiggins Pass (R1-R16)

Minor beach erosion (condition I) prevailed along Lely Barefoot Beach (R1-R9) and Barefoot Beach State Preserve (R9-R16); however, a 2,000-foot segment (R14-R16) north of Wiggins Pass experienced minor beach and dune erosion (condition II). Along most of this segment, the storm surge with wave uprush did not reach the toe of the dune. Near the inlet, the storm surge and wave uprush eroded the dune and caused significant beach cusps and nearshore storm bars.

### Wiggins Pass to Clam Pass (R17-R41.6)

South of the inlet, along Delnor Wiggins State Park (R17-R22.3) and Vanderbilt Beach (R22.3-R29) the beaches sustained minor erosion (condition I). Along Pelican Bay (R29-R41.6) conditions ranged from minor beach erosion (condition I) to minor beach and dune erosion (condition II), except near Clam Pass (R40-R40.65) where moderate beach and dune erosion (condition III) was sustained (Photo 1). The beach north of Clam Pass had minor scarping due to the ebb flow of the storm surge coupled with storm water runoff.



Photo 1. Moderate beach and dune erosion at Pelican Bay (R40.5).

### Clam Pass to Doctors Pass (R41.6-R57.5)

In like manner to the northern two beach segments, minor erosion conditions prevailed along Park Shore and northern Naples with the exception of a small beach segment north of Doctors Pass. Minor beach erosion (condition I) was sustained from Clam Pass to R51, worsening to minor beach and dune erosion (condition II) towards Doctors Pass (R51-

R56). North of Doctors Pass (R56-R57.5) moderate beach and dune erosion (condition III) was sustained.

Doctors Pass to Gordon Pass (R57.75-R89.3)

Along the restored beaches of the City of Naples, minor erosion conditions prevailed. Minor beach erosion (condition I) was sustained from the south jetty of Doctors Pass (R57.75) to Lowdermilk Park (R60.4) increasing to minor beach and dune erosion (condition II) between the park and 500 feet north of Naples Pier (R74). Along the critically eroded and unrestored segment of beach south of Naples Pier, moderate beach and dune erosion (condition III) prevailed (Photo 2). Most of this area had vertical losses of the beach profile between one to three feet (Photos 3 and 4). Upland properties that did not have a seawall had overwash fans extending onto the uplands (Photo 5). Segments of the beach that had protruding seawalls had no visible dry beach following the storm.



Photo 2. Moderate beach and dune erosion south of Naples Pier.



Photo 3. Moderate beach erosion north of Gordon Pass (R89).



Photo 4. Aerial comparison of south Naples before and after Wilma.



Photo 5. Storm surge overwash, south Naples (R84.3).

#### Keewaydin Island (R90-R127; V1-V2.1)

South of Gordon Pass, the beaches along Keewaydin Island sustained minor erosion. Along the nourished and developed northern segment (R90-R96) of the island, minor beach erosion (condition I) was sustained, with the exception of a 650-foot segment (R92.3-R93) that sustained minor beach and dune erosion (condition II). Much of the remaining undeveloped central and southern portion of the island (R96-R122) also sustained minor beach and dune erosion (condition II) with dune breaches that conveyed overwash deposits into Bartell Bay. At the extreme south end of Keewaydin Island (R122.5-V2.1), nearshore storm bars and beach recovery berms were observed revealing the continued trend of accretion. The beach at the island's south end is observed to be wider than it was prior to Hurricane Wilma.

#### Sea Oat Island (V3-V7)

South of Little Marco Pass, Sea Oat Island sustained minor beach and dune erosion (condition II). The mid-section of Sea Oat Island experienced overwash and dune scarping with sediments either being transported landward into the interior mangrove forest or southward along the beach. Due to the increased longshore current associated with the waves of Hurricane Wilma, a shore parallel spit was created at the south tip of the island extending into Capri Pass.

### Coconut Island

Within Big Marco Pass, Coconut Island is essentially a supratidal ebb shoal. This small island sustained major beach and dune erosion (condition IV) as it was completely overtopped by Wilma's storm surge and truncated into two shoal segments. The island lost significant vertical elevation and all vegetation leaving only two small subaerial shoals at low tide (Photo 6).



Photo 6. Aerial comparison of Coconut Island before and after Wilma.



### Marco Island

Hideaway Beach, along the north shore of Marco Island fronting on Big Marco Pass, sustained generally minor beach and dune erosion (condition II) (Photo 7). Were it not for the recent beach restoration project and T-groin field, this beach would likely have seen greater erosional stresses to the shoreline. Sand Dollar Island, including Tiger Tail Beach, is a spit attached to the northwest end of Marco Island. Tiger Tail Beach (R130-R137) sustained minor to moderate beach and dune (condition II-III) and significant loss of vegetation. Wilma's storm surge overtopped the spit of Sand Dollar Island, and opened a breach near R131 (Photo 8). The remainder of Marco Island sustained minor beach erosion (condition I), except immediately north of Caxambas Pass. Moderate to major beach erosion (III-IV) was sustained between R147.5 and R148.8, including the loss of the beach seaward of a seawall and revetment (Photo 9).

### Caxambas Pass

The supratidal ebb shoal located in Caxambas Pass was overtopped by the storm surge and eroded at its terminal ends.

### Kice Island

South of Caxambas Pass, the undeveloped northern half of Kice Island (V20-V23) sustained minor beach erosion (condition I). The southern half of Kice Island (V23-V32) was overtopped and sustained minor to moderate beach and dune erosion (condition II-III). With the loss of sea turtle nesting habitat, this segment of beach is now critically eroded.



Photo 7. Minor dune erosion, Hideaway Beach (V15).



**Tiger Tail Beach, May 4, 2005**



**Tiger Tail Beach, October 28, 2005**

Photo 8. Tiger Tail Beach before and after Wilma with a breach near R131.



Photo 9. South Marco Island beach erosion (R148).

### Morgan Island

South of Kice Island and Blind Pass, Morgan Island was overtopped and sustained minor to moderate beach and dune erosion (condition II-III). The storm surge overtopping breached previously closed channels and closed two previously open channels. Significant quantities of sediment were transported landward into the interior mangrove forest. The beach sustained an estimated vertical loss of two feet. Most of the mangrove trees that fronted the Gulf of Mexico were pushed back or uprooted by the storm surge and will likely result in the beach continuing to retreat. At the southwest tip of Cape Romano, Morgan Pass (previously closed) was breached (Photo 10).

### Ten Thousand Islands

The islands south of Cape Romano were impacted by an estimated four to seven-foot storm surge. Moderate beach and dune erosion (condition III) was generally sustained on the gulf fronting islands with sandy beaches, including Turtle Key, Gullivan Key, White Horse Key, Panther Key, and Round Key. Portions of previously emergent shoals within the Ten Thousand Islands have been eroded by the storm surge and are now submerged. Sand spits that previously connected mangrove islands have now been breached. The storm surge transported significant quantities of beach sediments landward into the interior mangrove exposing tree roots along the shoreline. Some of the sand relocated

during the storm was deposited on islands that previously had little to no beach before Hurricane Wilma impacted the area.



Photo 10. Cape Romano before and after Hurricane Wilma.

## **Storm Damage**

Light to moderate wind damages were sustained throughout Collier County, as generally only category one and category two hurricane intensity winds were experienced. The Collier County Building Department reports approximately 5,000 structures sustained wind related damage, with Chokoloskee and East Naples being the hardest hit areas. County-wide, 15 single-family dwellings, 35 multifamily dwellings, and 615 mobile homes were destroyed. An additional 276 mobile homes sustained major damage. An estimated 200 recreational vehicles were also destroyed on Chokoloskee Island.

An F1 tornado (on the Fujita tornado intensity scale) was also observed between U.S. Highway 41 and State Road 29, damaging utility lines and poles and uprooting trees prior to Wilma's landfall. Storm water flooding occurred throughout the county due to significant rainfall. The National Weather Service reported four to six inches of rain in western Collier County and six to eight inches in eastern Collier County.

The most significant damage was sustained on the coast at Chokoloskee, located at the southern-most point in Collier County landward of the Ten Thousand Islands. This was the only area where major structural damage was sustained due to both wind and storm surge. The storm surge in this area reached an estimated eight feet. Everglades City, to the north of Chokoloskee, also sustained significant wind damage and some storm surge flooding.

Collier County's recreational boating industry fared well, sustaining only roofing damage at various marinas throughout the county. However, Collier County's stone crab industry sustained significant crab trap losses.

Damages to coastal construction seaward of the established Collier County Coastal Construction Control Line are discussed as follows.

### County line to Wiggins Pass (R1-R16)

Along Lely Barefoot Beach six single-family dwellings and one multifamily dwelling sustained damage, including three dwellings which sustained major damage due to wind. Four screen porches were damaged.

### Wiggins Pass to Clam Pass (R17-R41)

Along Vanderbilt Beach (R22.3-R29) and Pelican Beach (R29-R40), one multifamily dwelling sustained major structural damage, and two multifamily dwellings and five single-family dwellings sustained major roofing damage due to wind (Photo 11). In addition, six high-rise condominiums and one single-family dwelling sustained minor cladding damage to windows and screened porches.



Photo 11. Wind damage to dwelling, Vanderbilt Beach (R24.1).

Clam Pass to Doctors Pass (R41.6-R57.3)

Minor wind damages were sustained along this segment of Park Shore and northern Naples.

Doctors Pass to Gordon Pass (R56.75-R89.3)

Along the gulf front of Naples, 27 major habitable structures sustained major roofing damage due to wind, including five single-family dwellings and 22 multifamily dwellings. In addition, three multifamily dwellings and one single-family dwelling sustained minor cladding damage to windows and screened porches. Fallen trees caused additional damages to buildings (Photo 12). Two ocean outfalls sustained major damage with their seaward pipe sections destroyed (Photo 13). Minor damages were also sustained to swimming pool enclosures (Photo 14). No major damages were observed to any of the numerous coastal or shore protection structures in Naples.



Photo 12. Fallen trees on Banyan Boulevard, Naples (R61.2).

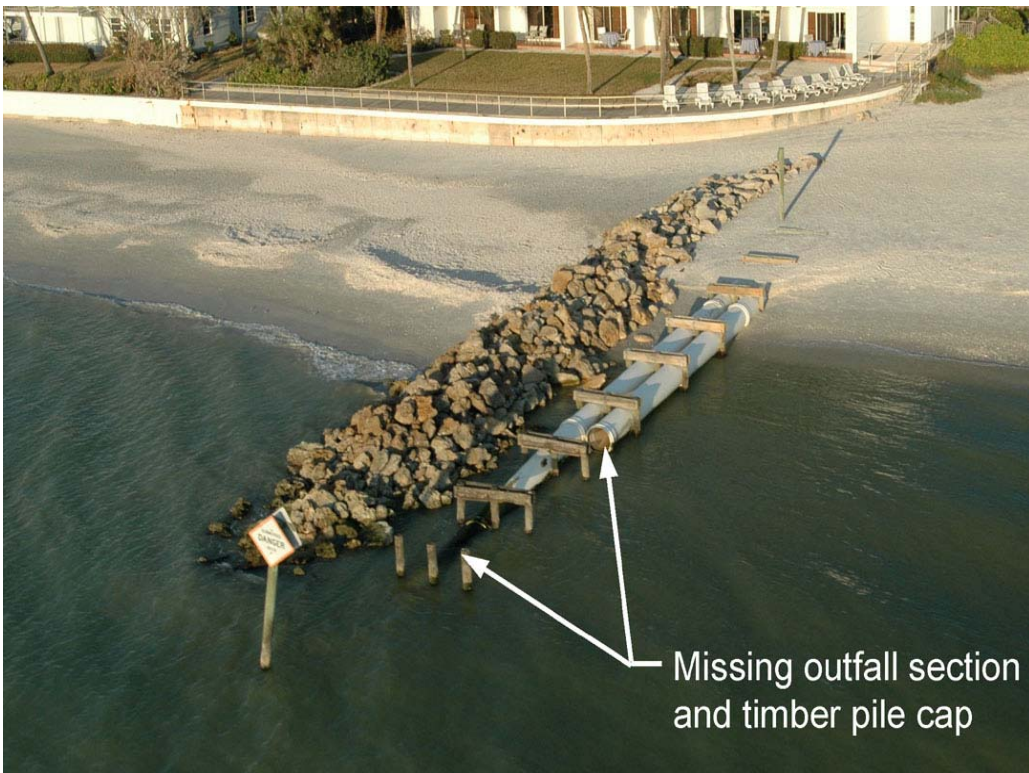


Photo 13. Damaged outfall pipes in Naples (R62.65).



Photo 14. Damaged screen enclosure, south Naples (R86.9).

### Marco Island

Widespread minor to moderate wind damage was sustained on Marco Island and a significant number of dwelling structures sustained major wind damage. Roughly 80 percent of the habitable structures on Marco Island sustained minor wind damage and two condominiums were rendered uninhabitable. At Hideaway Beach, five single-family dwellings and four multifamily dwellings sustained major roofing damage due to wind (Photo 15). In addition, three multifamily dwellings and four single-family dwellings sustained minor cladding damage to windows and screened porches. No damage was observed to any of the groins along Hideaway Beach.

Major roofing damage was also sustained to nine multifamily dwellings and four single-family dwellings at Tiger Tail Beach (Photo 16). Landward of Tiger Tail Beach numerous dwellings sustained major roofing damages within the Coastal Building Zone. Seaward of the Coastal Construction Control Line many of the high-rise condominiums along Marco Island sustained minor wind damages to the buildings' exterior cladding. Minor structures, including pool enclosures and screened porches, also sustained extensive wind damage.





Photo 15. Roofing damage to dwelling, Hideaway Beach (V14.7).



Photo 16. Extensive roofing damage, Tiger Tail Beach (R132.3).