SECTION 2: HAZARD IDENTIFICATION AND VULNERABILITY ANALYSIS

This section represents a hazard and vulnerability analysis, through a comprehensive HVA assessment commissioned by the County Division of Emergency Management, completed in 2021. As part of the LMS2024 revision, the LMS HVA Sub-Committee reviewed the following plans, studies, reports, and technical information, and provided updated information to be added to Section 2:

- Florida State Hazard Mitigation Plan (2023)
- *2016 Palm Beach County Supplemental Summary*, Statewide Regional Evacuation Study, Palm Beach County Appendix (technical data update report on demographics, regional hazard analysis, and regional vulnerability and population analysis)
- *The Favorability of Florida's Geology to Sinkhole Formation* (June 2017)
- State of Florida Mitigation Goals and Capabilities (2018 draft)
- Florida Repetitive Loss Strategy (2017 draft)

All other documents used in the creation of the comprehensive HVA assessment in 2021 are listed in Appendix A.

This section addresses, in part, the following FEMA requirements:

Requirement: §201.6(b)(3): The plan must include review and incorporation, if appropriate, of existing plans, studies, reports, and technical information were reviewed.

Requirement: §201.6(c)(2): The plan shall include a *risk assessment* that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

Requirement §201.6(c)(2)(i): The risk assessment shall include a description of the type of all natural hazards that can affect the jurisdiction.

Requirement §201.6(c)(2)(i): The risk assessment must include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan must include information on previous occurrences of hazard events and on the probability of future hazard events.

Requirement §201.6(c)(2)(ii): The risk assessment must include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description must include an overall summary of each hazard and its impact on the community. The risk assessment must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.

Requirement §201.6(c)(2)(ii): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities in the identified hazard areas; an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate; providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

2.1 Hazard Identification

Section 2.1 and Table 2.1 list the general hazards that PBC is vulnerable to and indicates their projected impact potential across the entire spectrum of community exposure and services. **Section 2.1, Hazard Identification** describes these hazards in detail and discusses countywide exposures. **Section 2.2, Vulnerability Assessment** discusses specific vulnerabilities faced by the individual governmental entities, County and municipal, forming the PBC community. Vulnerability, probability, and risk assessments for the County and municipal jurisdictions, and a countywide impact analysis are contained in Appendix A. **Section 2.3, Risk Assessment** describes the elements considered in the risk assessment process. Hazard & Risk Assessment Maps and potential loss values for PBC and each jurisdiction are located in Appendix G and Section 2B. The majority of hazards in PBC affect most areas of the county equally. However, there are a few that maybe more concentrated in one (1) area of the county. For example, a Herbert Hoover Dike Breach would cause more severe damage to the western communities. For the purpose of this document, the County has been divided into four (4) geographical areas: Northern Palm Beach, Southern Palm Beach, Western Palm Beach, and Coastal PBC.

For most of the hazards identified and defined, a historical list of occurrences, as well as significantly impactful occurrences regardless of date, are listed in chronological order for the past ten (10) years.

In addition, the charts will show probability of occurrence and impact. These are rated as low – under 5% chance of occurring, medium – 5% to 15% chance of occurring, or high – greater than 15% chance. These rating correspond with the information in the charts.

Each disaster affects PBC differently based on the severity and scope of the disaster and where it occurred within the County. While impacts to structures, infrastructure, people, and the environment will be addressed within each individual hazard, in most cases unless the disaster is significant (major or catastrophic) in duration and destruction, impact will be minimal and can be handled with resources within the County. If not specifically discussed within the hazard, it is assumed that there would be minimal or no impact to the to the County.

The charts in Appendix A will provide additional information on impacts.

Disasters are classified by the magnitude of their effect. The recognized classification system is as follows:

- Minor Disaster - Any disaster that is likely to be within the response capabilities of local government and results in only minimal need for state or federal assistance. The damage level to life and property is minimal and can be controlled and contained with resources within the municipality, or county in which they occurred.
- Major Disaster - As defined under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C 5122) a major disaster is any natural catastrophe (earthquakes, explosion, fire, flood, high water, hostile actions, hurricanes, landslide, mudslide, storms, tidal wave, tornado, wind-driven water, snowstorms, or drought), or, regardless of cause, any fire, flood, or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant disaster assistance under this Act to supplement the effort and available resources of States, tribes, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby.
- Catastrophic Disaster – A disaster event that results in large numbers of deaths and injuries; causes extreme damage or destruction of facilities that provide and sustain human needs; produces an overwhelming demand on the state and local response resources and mechanisms: causes a severe long-term effect on general economic activity; and severely affects state; local, and private sector capabilities to begin and sustain response activities.

The hazards identified in **Table 2.1** and discussed in **Section 2.1** are organized based on their maximum projected impact potential. This means that hazards capable of producing the maximum community-wide impact, such as hurricanes and floods, are discussed first. This does not mean other identified hazards are less important or less worthy of mitigation. It simply means that their potential to affect the total community has been assessed to be less impactful.

Table 2.1 *Identification and Projected Impact Potential for Hazards*

Hazard Category	Excessive Wind	Excessive Water	Damaging Hail	Soil/Beach Erosion	Electric Power Outage	Surface & Air Transportation	Navigable Waterway Impairment	Potable Water System Loss or Disruption	Sewer System Outage	Telecommunications System Outage	Human Health & Safety	Psychological Hardship	Economic Disruption	Disruption of Community Services	Agricultural//Fishery Damages	Damage to Critical Environmental Resources	Damage to Identified Historical Resources	Fire	Toxic Releases	Stormwater Drainage Impairment
	Projected Impact Potential																			
NATURAL																				
Flood		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hurricanes/Tropical Storms	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Severe Thunder-storms/ Lightning	✓	✓	✓		✓	✓				✓	✓	✓	✓					✓		✓
Sea Level Rise		✓		✓		✓	✓	✓					✓	✓	✓	✓	✓			✓
Soil/Beach Erosion				✓			✓						✓			✓				✓
Tornadoes	✓				✓	✓				✓	✓	✓	✓							
Wildfires/Urban Interface Zone					✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓	
Pandemic/Com-municable Diseases											✓	✓	✓	✓						
Drought													✓		✓	✓		✓		
Agricultural Pests & Diseases											✓	✓	✓		✓	✓				
Muck Fires						✓					✓		✓		✓	✓		✓	✓	
Seismic Hazards						✓													✓	
Geologic Hazards						✓	✓	✓					✓						✓	
Extreme Temperatures					✓						✓	✓	✓		✓	✓		✓		

Hazard Category	Excessive Wind	Excessive Water	Damaging Hail	Soil/Beach Erosion	Electric Power Outage	Surface & Air Transportation	Navigable Waterway Impairment	Potable Water System Loss or Disruption	Sewer System Outage	Telecommunications System Outage	Human Health & Safety	Psychological Hardship	Economic Disruption	Disruption of Community Services	Agricultural//Fishery Damages	Damage to Critical Environmental Resources	Damage to Identified Historical Resources	Fire	Toxic Releases	Stormwater Drainage Impairment
	Projected Impact Potential																			
TECHNOLOGICAL																				
Dam/Dike Failures		✓					✓		✓		✓	✓	✓	✓	✓	✓				✓
Hazardous Materials Accidents						✓					✓	✓	✓					✓	✓	
Radiological Incidents (Nuclear Power Plant)						✓	✓				✓	✓	✓	✓	✓		✓			✓
Communication Failures											✓			✓	✓					
Transportation System Accidents						✓	✓				✓		✓	✓				✓		
Wellfield Contaminations								✓	✓		✓	✓	✓	✓						
Power Failure (Outages)					✓	✓		✓	✓	✓	✓	✓	✓	✓						
Coastal Oil Spills											✓	✓	✓	✓		✓				
HUMAN-CAUSED																				
Civil Disturbances						✓					✓	✓	✓	✓			✓			
Domestic Security					✓	✓		✓		✓	✓	✓	✓			✓	✓	✓	✓	
Workplace/School Violence											✓	✓	✓	✓						
Harmful Algal Blooms								✓			✓	✓	✓		✓	✓	✓		✓	
Mass Migration Crises											✓	✓	✓	✓						

2.1.1 Natural Hazards

Climate Change

According to NOAA's National Centers for Environmental Information (NCEI), 2023 was the warmest year in NOAA's 174-year climate record. With the planet warming, the threats and impacts of climate change will need to be assessed and addressed. As of this writing, the County's Office of Resilience, through a Resilient Florida grant, is leading a vulnerability assessment (VA) that will assess climate threat impacts on the County's assets for the County's unincorporated and western areas and will develop a County-wide implementation strategy, identify resiliency priority projects, and create greenhouse gas reduction options that could achieve net zero emissions. The finished VA, covering seven (7) threats related to climate change, will not be completed before submission of this revision.

2.1.1.1 Flooding

Frequencies from flooding associated with rain events other than tropical storms and hurricanes are more difficult to estimate. Eastern Florida shows an annual dry cycle stretching from early November through mid-May. During this part of the year, monthly rainfall rarely exceeds 2.5 to 4.0 inches per month. The wet season, beginning in mid-May and running through late October, shows monthly rainfall levels in the area to be 6.0 to 8.5 inches. Heaviest rainfall usually occurs in June and September. In PBC, the eastern or coastal section of the County receives more rain than the western section, however, all of PBC can be affected by flooding. This rainfall pattern coupled with the hurricane season (June through November) makes PBC particularly vulnerable to flooding associated with late season tropical storms and hurricanes because they typically occur when the water table is high and the ground is saturated. Based strictly on the historic flooding events presented below, the probability of even a minor flooding event somewhere in PBC over the past 10 years tends to lean towards at least once annually. More information is available through the DEM webpage accessible at: http://pbcgov.com/flood.

Historical Flooding Events

Flood of fall 1947 – This flood is generally considered to be the most severe flood recorded in southern Florida. Heavy rainfall, including the rains from two (2) hurricanes, occurred over a period of five (5) months. Many parts of PBC were flooded for months and there was extensive damage to dairy pastures and agriculture in general. Such a flooding event would be much more significant today because of the increase in land development.

Flood of October 1952 – This flood was preceded by five (5) months of heavier than normal rainfall, which included a tropical storm in October. June through October rainfall was approximately 48 inches. Damage was heaviest in the beef cattle industry, with extensive losses of improved pasture land that required supplemental feeding of cattle. Vegetable growers and dairy farmers also suffered significant losses as a result of this flood.

Rains of January 1957 – On January 21, 1957, PBC received 9 to 21 inches of rainfall within a 24-hour period. There was severe flooding in the vegetable garden areas of the County and much crop damage. Some fields had to be pumped out. Local crop damage was estimated at $1,000,000.

Flood of June 1959 – Heavy rains fell across most of central Florida from June 17th to 21st. These rains were associated with and followed a tropical depression, and caused extensive flooding in poorly drained, low-lying agricultural areas and some residential sections. Considerable pasture land and some citrus land in PBC were inundated. Some highways also sustained damage from these flood waters.

Rains of October 1966 – On October 22, 1966, heavy rains ranging from eight (8) to ten (10) inches over a 24-hour period destroyed approximately 4,200 acres of vegetable crops.

Rains of March 1982 – On March 28-29, 1982, PBC was subjected to a severe coastal storm with heavy rains and high winds. Lantana measured 16 inches of rain over a 24-hour period. High seas sunk a Haitian freighter and a total of 11 people were drowned.

The Great Thanksgiving Holiday East Coast Storm of 1984 – A strong low-pressure system developed east of Florida and coupled with a high-pressure system to produce an extremely strong pressure gradient leading to gale force winds and high seas along the entire Florida east coast. Heavy rains fell over most of central Florida, and this surface runoff, coupled with the wind packing of seawater along the coast resulted in extensive coastal erosion and flooding. Many coastal structures were damaged or destroyed, including several in PBC.

Flood of January 1989 – On January 21-22, 1989, PBC experienced a gale with subtropical storm characteristics that caused extensive beach erosion and dropped four (4) to six (6) inches of rain across the County. This caused ponding of water in low-lying areas. Several homes and a motel were damaged. Road flooding caused several accidents.

The Unnamed Storm of October 1995 – Almost exactly one (1) year after the Hurricane Gordon flooding incident in 1994, a stalled frontal system dropped over 15 inches of rain on PBC over a period of 29 hours. In the intervening year between these two (2) events, some communities in PBC had conducted a number of mitigation projects and initiatives designed to improve drainage and prevent flooding in known flood prone areas. These mitigation projects and initiatives undoubtedly reduced the extent of flooding and flood related damages during the 1995 flooding event, nevertheless, the County did experience significant flooding again in 1995.

Unnamed Storm of January 1999 – On Saturday, January 2, 1999, a cold front stalled over the northern part of PBC. Warm, moist air from the Bahamas became entrained in this frontal system and produced a localized, intense rain event in northern PBC. Initial reports indicated 21 inches of rain in a 12-hour period. This later turned out to be an erroneous reading from the recording instrument involved; however, it is generally recognized that between 18 and 22 inches of rain fell in the northern third of the County over a 12- to 18- hour period. Flooding was even more extensive than in the 1995 event, but it is interesting to note that many areas where flooding mitigation projects had been implemented remained dry or showed a minimum of damage compared to areas where planned mitigation had not yet been implemented. Hardest hit were the Riviera Beach and Lake Park jurisdictions with a total of over $6,000,000 damage between them. Flooding was extensive along Northlake Boulevard. Erosion caused the collapse of a portion of I-95 that was under construction.

Record Rainfall June - July 2002 – On July 14, 2002, a record 27 consecutive days of rain concluded. The combined June - July rainfall total was six (6) inches below the all-time record. June rainfall was 20.16" (12.5% above normal). The County experienced five (5) days of one (1) inch or more rain. The water level in Lake Okeechobee rose to 12.57 feet. Because this rainy period was preceded by an extended dry period and rains were spread over several days, flooding was limited to street flooding.

Hurricane Frances September 4, 2004 – A maximum storm-total rainfall amount of 12.56 inches was measured at West Palm Beach International Airport with 10.26 inches occurring in a 24-hour period. Unofficial storm-total rainfalls included 9.56 inches at Boynton Beach, eight (8) inches at Deerfield Beach and 7.18 inches at the Hillsboro Canal. Widespread storm-total amounts of three (3) to five (5) inches occurred in southeast and interior south Florida with southwest Florida averaging one (1) to three (3) inches. Rainfall flooding was mostly minor except for a few locations in PBC, which had up to three (3) feet of standing water. A section of I-95 in PBC was closed due to a large sinkhole. Within the confines of the Herbert Hoover Dike, water levels on Lake Okeechobee fluctuated up to five (5) feet above and below normal.

Hurricane Jeanne September 25, 2004 – A South Florida Water Management District (SFWMD) gauge measured a maximum storm-total rainfall amount of 10.22 inches over the eastern portion of Lake Okeechobee. A SFWMD gauge about four (4) miles west of West Palm Beach International Airport measured 9.10 inches with 8.79 inches of that occurring in a 24-hour period. At Moore Haven, 5.99 inches of rain was measured. Widespread storm-total amounts of one (1) to four (4) inches occurred in most of southeast and interior south Florida with Miami-Dade County and Collier County averaging one-half (1/2) to one (1) inch. Mostly minor rainfall flooding was observed except locally in Palm Beach Gardens, Jupiter and in the farmlands of western PBC where it was more severe. Within the confines of the Herbert Hoover Dike, water levels on Lake Okeechobee fluctuated up to seven (7) feet above and below normal causing severe flooding of some marinas.

Flood of June 5, 2005 – Eight (8) inches of rain in three (3) hours caused flooding in streets and businesses in Boca Raton and in Highland Beach. Cars were stalled and Federal Highway was closed for a nine-block section from NE 20 to NE 29 Street.

Hurricane Wilma October 24, 2005 – Rainfall amounts across South Florida generally ranged from two (2) to four (4) inches across southern sections of the peninsula to four (4) to six (6) inches across western Collier County and around Lake Okeechobee, with a maximum amount of 7.21 inches in Clewiston. There was scattered street flooding.

Flood of December 14, 2006 – A slow-moving low-pressure trough caused very heavy rains and significant flooding over parts of PBC. West Palm Beach International Airport received a total of 8.21 inches of rain ending at 7 PM on December 15. Other locations in Central and Southern PBC received between six (6) and eight (8) inches of rain. Northern Broward County received lesser amounts in the two (2) to three (3) inch range. Several streets and roads were closed in the city of West Palm Beach, with water reaching up to three (3) feet deep in some areas. Hardest hit was the neighborhood of Pineapple Park. Many vehicles were stranded in the deep water, with local police receiving about 120 calls for assistance. No significant damage was reported to property despite water entering homes and businesses. Florida Power and Light reported 20,000 customers without power during the afternoon and early evening hours. Shelters were opened for people left homeless by the floods, but only five (5) people arrived as of 8:20 PM.

Flood of January 22, 2008 – Intense rains affected Boynton Beach and the northwest section of Delray Beach during the late afternoon and evening hours of January 22. Maximum observed rainfall amounts were between four (4) and six (6) inches in Boynton Beach, although Doppler radar estimated as much as ten inches of rain fell in just over three (3) hours. Numerous reports of flooding were reported. A trained spotter reported water getting into houses in the corridor west of Federal Highway and east of Congress Avenue between Boynton Beach Boulevard and Woolbright Road. Water rose to as high as two (2) feet along sections of Congress Avenue. Significant flooding was reported at the parking lot of Boynton Beach mall. The I-95 on-ramp at Gateway Boulevard as well as sections of Boynton Beach Boulevard were closed due to the water depth. Dozens of vehicles stalled. Forty (40) traffic accidents were reported due to the rain and standing water. The combination of a mid and upper-level trough moving east across South Florida and a developing warm frontal boundary provided the necessary atmospheric conditions for intense rains and flooding in the Boynton Beach area on January 22.

March 22, 2008 – Heavy rain across the Wellington area produced multiple reports of knee-deep water in yards and across roadways. Heavy rain across central portions of PBC including the Wellington area produced flooded roads and water approaching a structure.

May 24, 2008 – Flooding reported at the intersection of Linton Boulevard and Congress Avenue making the intersection impassable. Flooding also reported along Nassau Street with water intruding into some homes. Flood waters were near two (2) feet deep at some locations. A shortwave moved across South Florida during the afternoon hours allowing multiple severe thunderstorms to develop across southeast Florida. A total of 8,200 customers lost power due to the severe thunderstorms in the three-county area of Palm Beach, Broward and Miami-Dade counties.

March 21, 2009 – A warm front lifted north through South Florida during the day of March 21. Unstable air south of the front combined with warm temperatures to produce strong and severe thunderstorms over PBC. About 5,000 customers lost power. Significant flooding was reported in the Palm Beach Gardens and North Palm Beach areas. Flooding was most severe in the area of Pearl Street and Riverside Drive, and along US 1 near PGA Boulevard. Water reached the windows of cars in some cases. The flooding along US 1 was exacerbated by construction on the highway.

August 14, 2010 – Strong and slow-moving thunderstorms produced flooding in the Jupiter area due to light atmospheric flow and copious moisture. A spotter reported severe street flooding in Jupiter and the closing of Central Boulevard and Indian Creek Parkway. Rainfall of 2.75 inches reported within 45 minutes.

October 28, 2011 – A weak frontal boundary across South Florida, in combination with a flow of deep tropical moisture from the western Caribbean Sea associated with the remnant of Hurricane Rina, led to periods of very heavy rain and significant flooding lasting the better part of four (4) days. An estimated 2,000 customers lost power across South Florida due to the rain. Rainfall amounts of six (6) to nine (9) inches fell over southeastern PBC in less than six (6) hours, leading to numerous reports of flooded streets and some road closures. No reports were received of water entering structures.

August 26, 2012 – Tropical Storm Isaac moved west-northwest across the Florida Straits south of the Florida Keys on August 26. The northern edge of the wind and rain area associated with Isaac affected the South Florida peninsula throughout the day on the 26th. Isaac continued on a west-northwest track into the Gulf of Mexico on the 27th with winds, rain and flooding continuing over parts of South Florida. Moderate to severe flooding affected a large portion of metro PBC west of the Florida Turnpike. Hardest hit communities include The Acreage, Royal Palm Beach, Loxahatchee and Wellington. Canals were overtopped and communities were stranded by high water for several days after the rains stopped. Few homes suffered water damage, but major damage was sustained to infrastructure, including roads and water management structures. Rainfall amounts as high as 16 inches were measured in Royal Palm Beach and Loxahatchee, with estimates in excess of 18 inches in a two-day period.

August 27, 2012 – Flooding persisted over the western communities of PBC through the end of August as a result of torrential rains from Tropical Storm Isaac, which occurred on August 26 and 27.

It is important to note that many of the areas that experienced heavy flooding in both the 1994, 1995, and 2012 rainfall events were not in designated flood zones. For those areas where the Flood Insurance Rate Maps (FIRM) did indicate a flooding hazard, these two events both exceeded the 100-year storm levels and occurred back-to-back. The 1999 event was extremely localized, but rainfall exceeded all previous records in specific areas, and was beyond the design capacity of virtually all drainage systems in the County.

Often when these types of intense rainfall events occur, streams and drainage ditches tend to reach peak flood flow concurrently with tidal water conditions associated with coastal storm surge. This greatly increases the probability of flooding in the low-lying areas of the coastal zone. Areas along the Intracoastal Waterway are particularly susceptible to flooding under these conditions. The most flood prone areas in the eastern portion of PBC poorly drained soils, a high water table, and relatively flat terrain; all of which contribute to their flooding problems. Flat terrain and heavily wooded areas aggravate flood problems by preventing rapid drainage in some areas.

January 9, 2014 – During the night of Thursday, January 9, 2014, several mesoscale meteorological factors combined to produce torrential rainfall across portions of coastal PBC over a rather short period. From roughly 8:00 p.m. until midnight, several locations received over 12 inches of rain in just those few hours, with one (1) mesonet site just west-southwest of Hypoluxo receiving an astonishing 22.21 inches during the same time frame according to National Oceanic and Atmospheric Administration (NOAA).

In addition, heavy rains continue for 12 hours causing major flooding in the Kings Point area, at Atlantic Avenue and Jog Road in suburban Delray Beach.
Estimated rainfall totals in that area were almost 12 inches, according to the SFWMD. A number of homes sustained minor damages and a presidential declaration was sought but not granted due to the damage not meeting federal threshold guidelines.

October 21, 2014 – During the afternoon hours, portions of coastal PBC were inundated with flooding rains for the second time this year. Although this event was not near to the magnitude of the flood event in January, it did produce copious amounts of rainfall over a short period. Many roads were blocked which left motorists stranded. Portions of metro PBC received anywhere from one (1) to three (3) inches of rainfall while some coastal locales received nearly 10 inches. The worst impacted areas were between downtown West Palm Beach and Riviera Beach where many roads became flooded and impassable.

March 24, 2016 – A combination of daytime heating, deep moisture, and a passing upper-level system led to numerous afternoon showers and thunderstorms across South Florida, especially across the east coast metro areas. Heavy rainfall from training storms also brought flooding across southern PBC. Heavy rainfall fell across northern Broward and southern Palm Beach counties during the afternoon hours. Flooded roadways were reported in Boca Raton, including portions of US1//Federal Highway. Numerous cars were stalled along flooded roadways. Flood damages were sustained to several buildings including the library on the camps of Florida Atlantic University in Boca Raton. Flood damages were also sustained to the Boca Raton city hall where water came in through damages to the roof during the heavy rainfall and lead to a couple of inches of water in the first-floor main hallway. Water damage was also reported in the Town Center at Boca Raton. Rainfall amounts measured around five (5) to six (6) inches of rain in six (6) hours across the region.

June 3-9, 2017 – A disturbance meandered across the Gulf of Mexico and led to nearly a week of heavy rainfall across South Florida. The storm set a record rainfall in PBC, breaking the 1904 record set in West Palm Beach with 4.18 inches of rain. During the entire week, over 8.54 inches of rain fell, but only caused street flooding. The county did not experience flooding inside houses, as the flood control measures were successful in handling the rain amounts, although street flooding was common during this time.

Hurricane Irma September 10-11, 2017 – Hurricane Irma, while causing millions of dollars of damage to the State of Florida as it tracked through the Florida Keys, north across the Gulf coast, and then across the state towards Jacksonville, surprisingly did not cause an issue with flooding damage in PBC. It is acknowledged that mitigation efforts over the years are likely reducing the amount of flooding during these fast-moving rain events, and only wind damage was sustained.

Hurricane Nicole November 8-11, 2022 – Hurricane Nicole was a sprawling late-season Category 1 hurricane in November 2022. The fourteenth named storm and eighth hurricane of the 2022 Atlantic hurricane season. On November 10, it made landfall twice in Florida, south of Vero Beach and then northwest of Cedar Key, after briefly emerging over the Gulf of Mexico. Nicole then weakened to a depression while moving over the Florida Panhandle, and then was absorbed into a mid-latitude trough and cold front over extreme eastern Tennessee the following day. While this storm did not directly affect PBC, the County, and its municipalities were activated because of the proximity of the storm. Some minor flooding occurred on the barrier islands but no major incidents. Beach erosion was notable after this storm.

Flood Water Sources and Frequency of Occurrence

Sources of flood waters in PBC include:

- The Atlantic Ocean
- The Intracoastal Waterway
- Lake Okeechobee
- The West Palm Beach Canal
- The Hillsboro Canal
- The North New River Canal
- The Miami Canal

Major water retention areas include:

- Corbett Wildlife Management Area
- Loxahatchee Wildlife Refuge and WCA No. 2
- The Rotenberger/Holey Land Area

Floodplains designated on the FIRM are based on the 1% annual flood chance or the 100-year flood event. The 500-year flood event with a 0.2 % annual chance of occurrence is used to designate other areas of the community, which may have some vulnerability to flooding. Additional flood information is addressed in **Section 2.2.1.1**. The PBC Flood Insurance Rate Maps were updated and went into effect October 5, 2017.

As a relatively flat, low lying, heavily developed coastal county that experiences frequent intense rain events and periodic tropical storms, PBC is especially susceptible to flooding. Flooding in the County has historically taken one (1) of the following forms:

1. Flash flooding resulting in the rapid buildup of flood waters from intense localized precipitation that exceeds drainage capacities.
2. General flooding resulting from a buildup of water levels over time.
3. Water body overflows resulting from excessive rainfall or water management actions.

4. Coastal surge flooding driven by storm-force winds.
5. Dike breaches or overtopping related to major rain and tropical storm events.

Causes of Local Flooding

Significant factors contributing to inland flooding include rainfall intensity, rainfall frequency, rainfall duration, surface conditions, topography, and inadequate natural drainage.

The County’s torrential rains, low and flat terrain, and large number of inland water bodies, conspire to create a significant probability for inland flooding. An additional, increasingly significant, contributing factor is rapid water runoff associated with the vast areas of impervious surfaces created by new development, creating flood prone areas where they did not previously exist.

In urban areas, grates and drains can become overtaxed or blocked with debris, leaving no space for excess water to enter drainage and sewer systems. According to the SFWMD, “Many new residents to PBC are alarmed when they see standing water in streets or driveway swales. In other places, that could be a cause for concern, but in our region, it's something you can expect to see after a soaking summer shower.”

The County averages over 60 inches of rain a year and more than 130 rain days, with most of it coming between the months of June and November. Most developed areas are clustered along the coasts or near large waterways. Virtually flat, with most areas at or only slightly above sea level, even moderate rains can accumulate quickly.

The Water Management Challenge

Rainfall has been critical to South Florida’s history, feeding its natural wetlands and refreshing surface-water and groundwater reservoirs. Its water management issues differ from those of most other areas in the country. Where most areas are concerned with protecting “scarce” water resources, South Florida’s challenge is managing an overabundance of surface water. In order to drain and manage the excess water, hundreds of miles of canals, dikes, and levees have been built. Water management policies have created agricultural, tourism, and real estate industries whose success has fueled the state's population growth and taxed the seemingly abundant water supply. To consider sustainable population growth, environmental protection, and an adequate, safe water supply, water management, water resource and infrastructure decisions should include review of data that reflects projected future conditions such as higher volume rainfall events, increased SLR, and salinity issues related to water supply sources located in proximity to the coast.

The area’s high hydrologic variation, low physical relief, and limited storage and conveyance capacities, make water management challenging. A delicate balance must be struck, dealing with extremes: flooding versus drought and open land versus crowded urban areas. Actions range from enforcing water restrictions during dry periods to precautionary or emergency flood management during wet periods and storm events. With annual rainfall averaging over 60 inches (but varying widely), more than 50% occurring in four (4) months (June to September), and with the rainy season necessitating the movement of water away from populated areas for flood control, and the storage of excess water necessary to meet population needs and demands during dry periods, water management is a complex challenge.

County Elevations

Terrain throughout the County is relatively level. The mean elevation is 15 feet above sea level. Ocean coastal beachfront gradually slopes up to a dune line with top elevations of 12 to 23 feet. From the dune line there is a gradual downward slope to lake and inland waterway frontage with a width of a few hundred feet to a half mile. From there, land slopes upward to a coastal ridge then downward to elevations of five (5) to twelve feet in a drainage valley. Further inland, elevations remain relatively stable.

Primary Surface Water Areas

Lake Okeechobee, the largest freshwater lake after the great lakes, is South Florida's primary water reservoir. Approximately 250 square miles of the lake are within the geographical boundaries of PBC. Other sizeable bodies of water include Lake Mangonia (540 acres) and Clear Lake (401 acres) in West Palm Beach and Lake Osborne (356 acres) in southern Lake Worth Beach and northern Lantana. The West Palm Beach Canal connects Lake Okeechobee and Lake Worth Beach. A vast network of canals is interconnected with the West Palm Beach Canal. A system of lakes runs north and south within eight (8) miles of the east coast. The Loxahatchee River system is located in the northern section of the county and is interconnected with the Loxahatchee Slough.

The map on the following page shows the relative distribution of primary surface water areas within PBC.

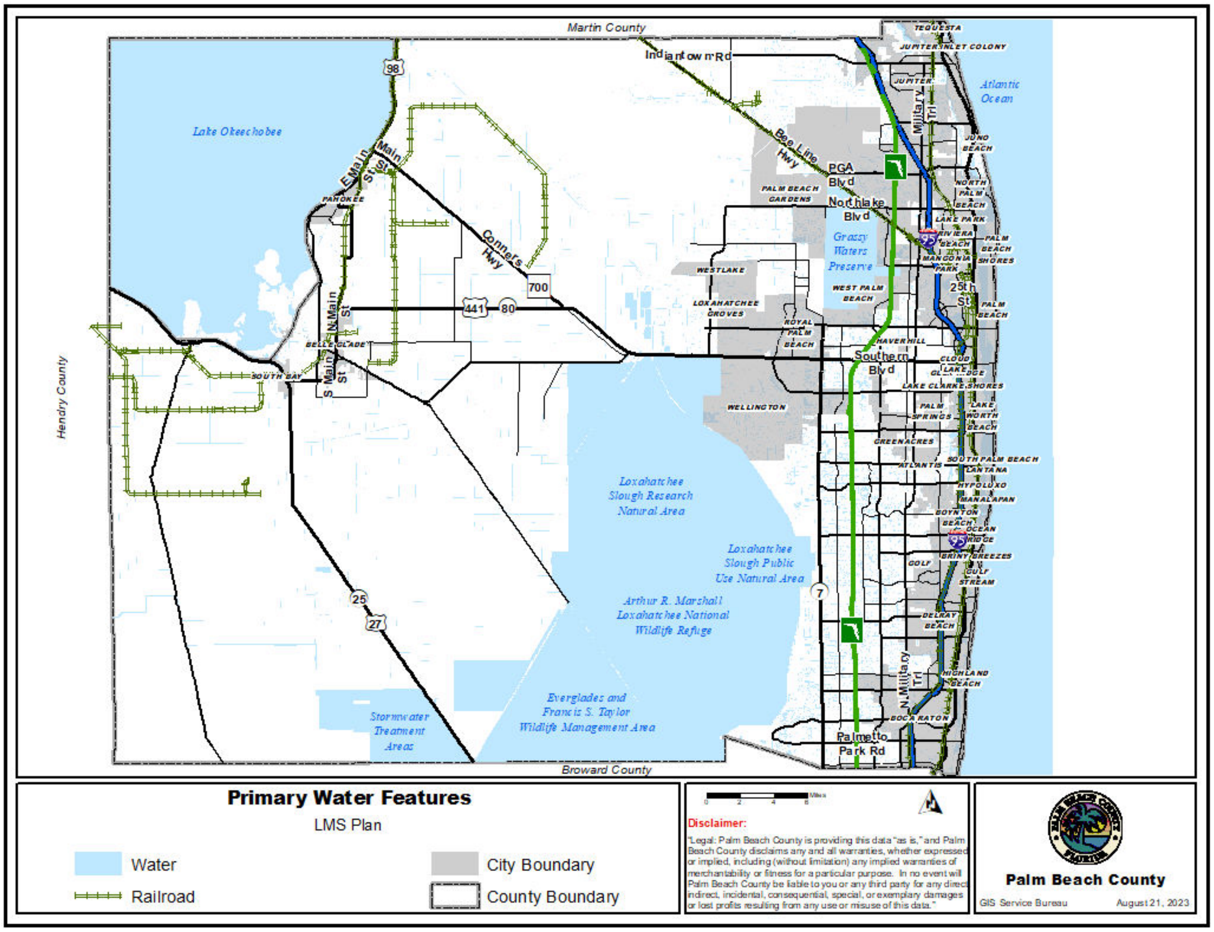


Figure 2.1: Surface Water Areas in PBC

Natural & Beneficial Flood Water Storage Areas

The following areas, designated as "Environmentally Sensitive lands" are undisturbed areas of PBC that act as natural storage areas for flood waters, reduce the possibility of flooding nearby residences, and help to recharge the groundwater aquifer.

Table 2.2 *Environmentally Sensitive Lands/Natural Water Storage Areas in PBC*

NAME	TOTAL ACRES
Acreage Pines Natural Area	115.61
Arthur R. Marshall Loxahatchee National Wildlife Refuge	143,953.77
Blazing Star Preserve	24.14
C-18 Triangle Natural Area	138.7
C-51 and L-8 Reservoir	1,263.73

Carlin Park	120.31
Coral Cove Park	31.42
Cypress Creek Natural Area	2,083.12
Cypress Creek/Loxahatchee	3547
Cypress Knee Slough Preserve	29.31
Delaware Scrub Natural Area	15.8
Delray Oaks Natural Area	24.5
DuBois Park	18.69
Dupuis Reserve	21891.61
East Coast Buffer	20,757.95
East Conservation Area	195.93
Everglades Agricultural Area	52,125.5
Everglades and Francis S. Taylor Wildlife Management Area	671,831
Florida Atlantic University Ecological Site	91.6
Frenchman's Forest	173.15
Gentle Ben Flowage Easement	334.81
Gopher Tortoise Preserve (City of Boca Raton)	8.8
Grassy Waters Preserve	12,800
Green Cay Nature Center and Wetlands	100
Gumbo Limbo Environmental Complex	20
Herbert Hoover Dike	774.8
High Ridge Scrub Natural Area	39.26
Holey Land Wildlife Management Area	35,350
Hungryland Slough Natural Area	2,895.29
Hungryland/SFWMD Parcels	7,859.99
Hypoluxo Scrub Natural Area	96.71
Indian Mounds	436.25
J. W. Corbett to Loxahatchee NWR Connector	35
J. W. Corbett Wildlife Management Area	60,348
Jackson Riverfront Pines Natural Area	3.01
John C.& Mariana Jones/Hungryland Wildlife & Environmental Area	12,735
John D. MacArthur Beach State Park	437.57
Jonathan Dickinson State Park	11,458.68
Juno Dunes Natural Area	577.7
Juno Park	18.2
Jupiter Beach Park	46.49
Jupiter Inlet Lighthouse Outstanding Natural Area	126.28
Jupiter Mangroves Natural Area	0.92
Jupiter Ridge Natural Area	271.32

Lake Harbor Tract	632
Lake Okeechobee Connector	7.73
Lake Park Scrub Natural Area	54.93
Leon M. Weekes Environmental Preserve	12
Limestone Creek Natural Area	51.62
Loggerhead Park	17.26
Loxahatchee Slough Natural Area	12,838.32
Loxahatchee Slough Public Use Natural Area	640
Loxahatchee Slough Research Natural Area	2,560
Lynn University Scrub	11.46
Morikami Museum and Japanese Gardens	188.53
North Jupiter Flatwoods Natural Area	146
North Ocean Ridge Mangroves Natural Area	8.69
Ocean Ridge Hammock Park	8.54
Ocean Ridge Natural Area	12.35
Okeeheelee Park North	900
Okeeheelee Park South	812
Pahokee Marina and Campground	30
Paw-Paw Preserve	3
Pine Glades Natural Area	6,641.98
Pine Jog Environmental Education Center	150
Pond Cypress Natural Area	1,736.18
Pondhawk Natural Area	78.7
Radnor	153.7
Red Reef Park	67
Riverbend Park	680
Rosemary Ridge Preserve	7.29
Rosemary Scrub Natural Area	13.59
Rotenberger Wildlife Management Area	29,297
Royal Palm Beach Pines Natural Area	773.23
Seacrest Scrub Natural Area	53.69
Serenoa Glade Preserve	9
Snook Islands Natural Area	117.65
South Beach Park	24.77
South County Regional Park	314.46
South Inlet Park	11.1
Spanish River Park	94.4
Stormwater Treatment Areas	47,605.32
Strazzulla Tract	2701
Sweetbay Natural Area	1094

Wellington/Acme Marsh	363.61
Winding Waters Natural Area	550.01
Yamato Scrub Natural Area	216.7
TOTAL AREA (in acres)	1,176,895.73

The map below shows these natural and beneficial flood water storage areas:

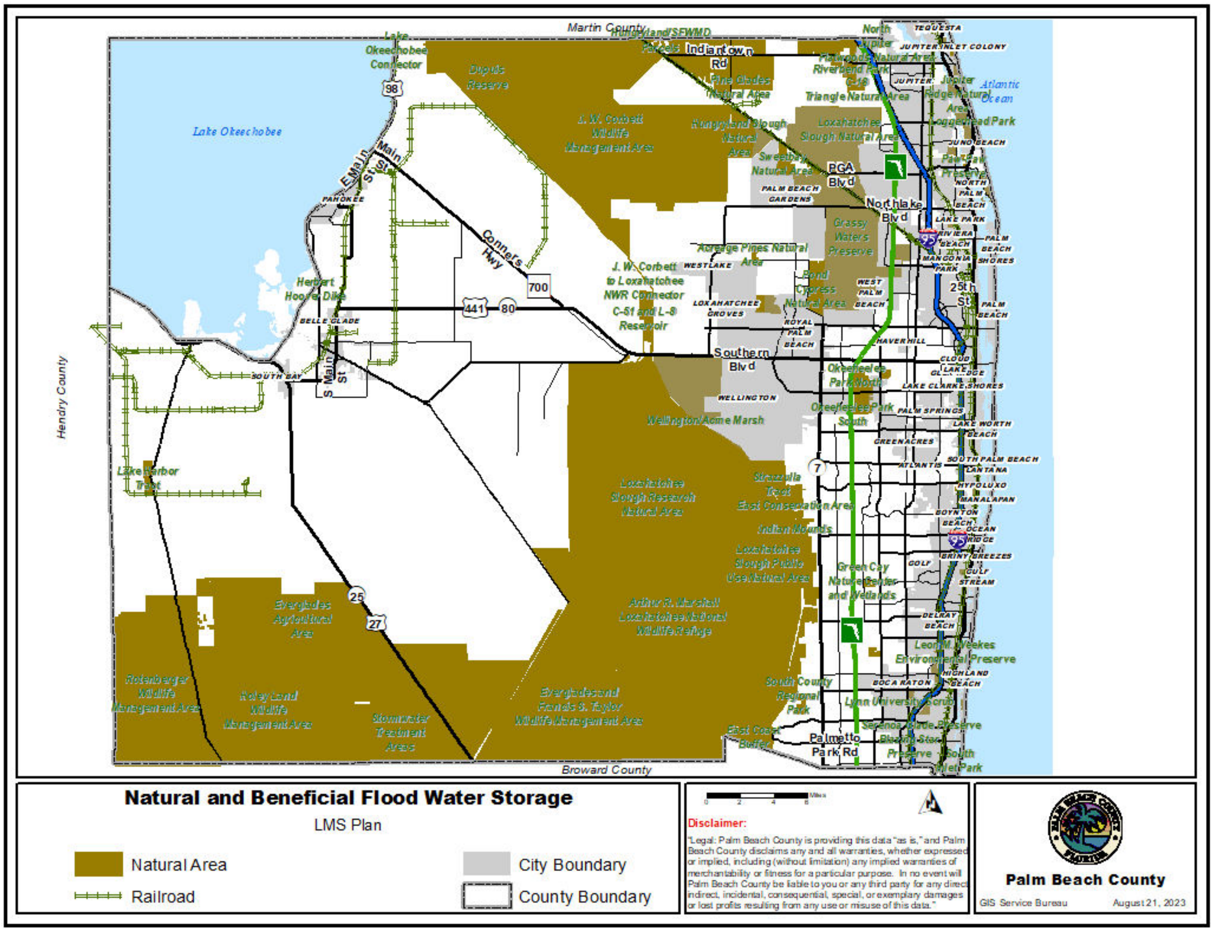


Figure 2.2: Natural and Beneficial Flood Water Storage

Flood Prone Areas

Flood prone areas are widely scattered throughout the county. Areas close to inland bodies of water and lower elevation areas in the northern and southern sections of the county are particularly susceptible to inland flooding.

The map below depicts Special Flood Hazard Areas within the county designated by FEMA as having a 1% chance of inundation in any given year. While some areas of the county might believe they are immune from flooding based upon recent history, published elevations, and/or designations on FIRMS, virtually the entire county has proven to be susceptible to short-term localized flooding when extraordinary rain events have exceeded the capacity of natural runoff and absorption.

A review of recent flood events suggests that PBC significantly surpasses the national average of 25% of flooding occurring outside of Special Flood Hazard Areas (SFHA). Even a significant number of county properties designated as "repetitive flood loss list" by the NFIP lie outside SFHAs. The map below shows the SFHAs in PBC.

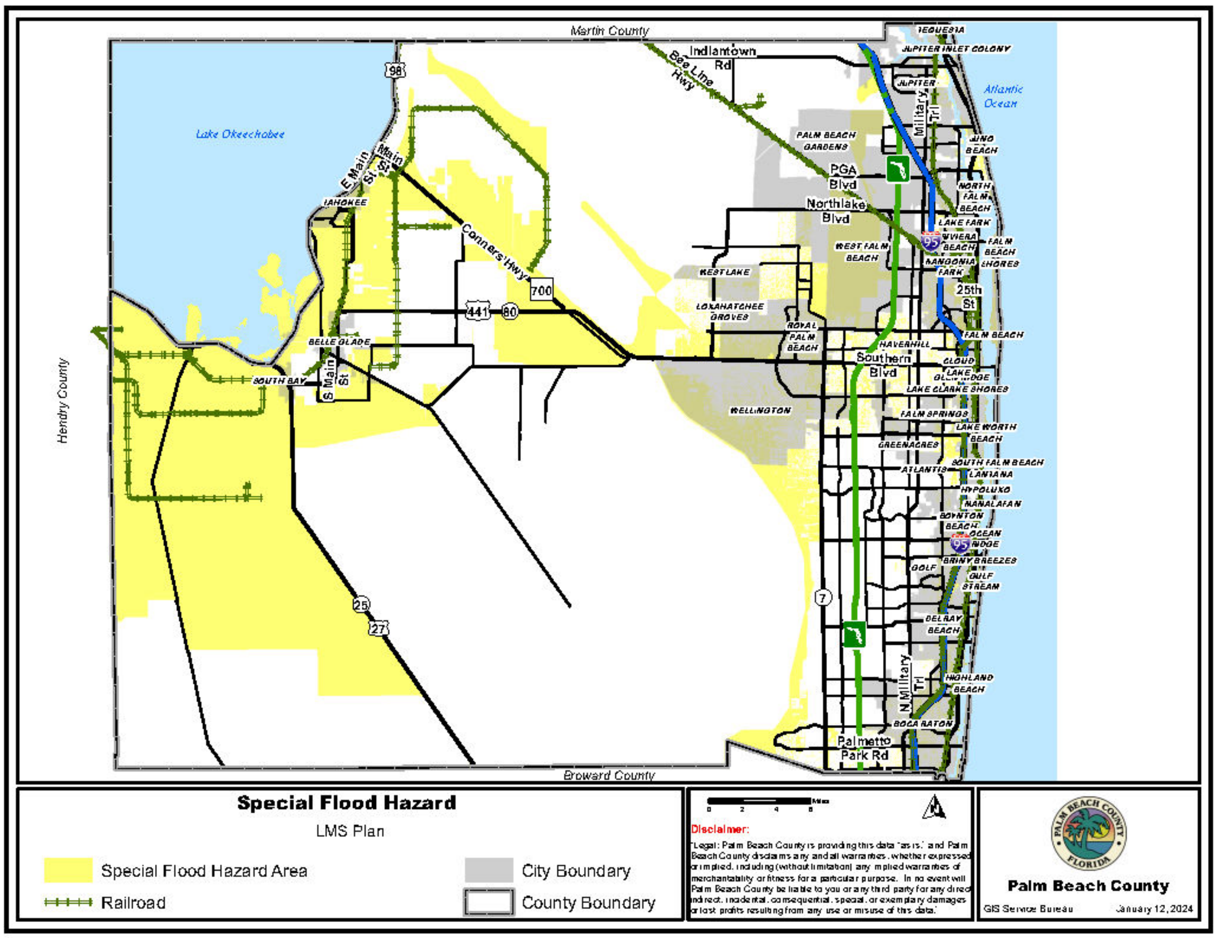


Figure 2.3: *Special Flood Hazard Areas*

Historically, the PBC rainfall area has the highest annual rainfall in South Florida, followed by Broward County and Miami-Dade. The county's east coast communities receive higher rainfall levels than the inland and western areas. Even during drought years, there have been instances where the coastal rainfall in eastern areas of the county were close to the average. Because there are no large impoundments in the eastern coastal rainfall areas, runoff has to be discharged into the Atlantic Ocean.

Flood Control

Flood control in PBC is dependent on a complex, integrated system of canals, waterways and flood control devices operated by the South Florida Water Management District, 20 drainage districts, and thousands of privately owned canals, retention/detention lakes and ponds.

The county's drainage system is designed to handle excess surface water in three (3) stages. The "neighborhood or tertiary drainage systems" (made up of community lakes, ponds, street and yard drainage grates or culverts, ditches, and canals) flow into the "local or secondary drainage system" (made up canals, structures, pumping stations, and storage areas) and then into the "primary flood control system" (consisting of South Florida Water Management District canals and natural waterways and rivers), ultimately reaching the Atlantic Ocean.

Table 2.3 *Water Control Districts serving PBC*

South Florida Water Management District	
Acme Improvement District	Pahokee Drainage District
East Beach Water Control District	Pelican Lake WCD
East Shore Water Control District	Pine Tree WCD
Gladeview Drainage District	Ritta WCD
Highland Glades Drainage District	Seminole WCD
Indian Trail Improvement District	Shawano Drainage District
Lake Worth Drainage District	South Florida Conservancy District
Loxahatchee Groves WCD	South Indian River WCD
North Palm Beach Heights WCD	South Shore Drainage District
Northern PBC Improvement District	WPB Water Catchment Area

South Florida Water Management District (SFWMD), an LMS member, has identified “areas of interest” within PBC, which are those places where frequent flash flooding and minor flooding events have been known to occur based upon reports that have been received and logged into a database over many years. The South Florida Flood Information Resource is being developed to provide the region with a repository to consolidate flood occurrence information. The map below illustrates the SFWMD Flood Repository which includes frequently flooded areas.

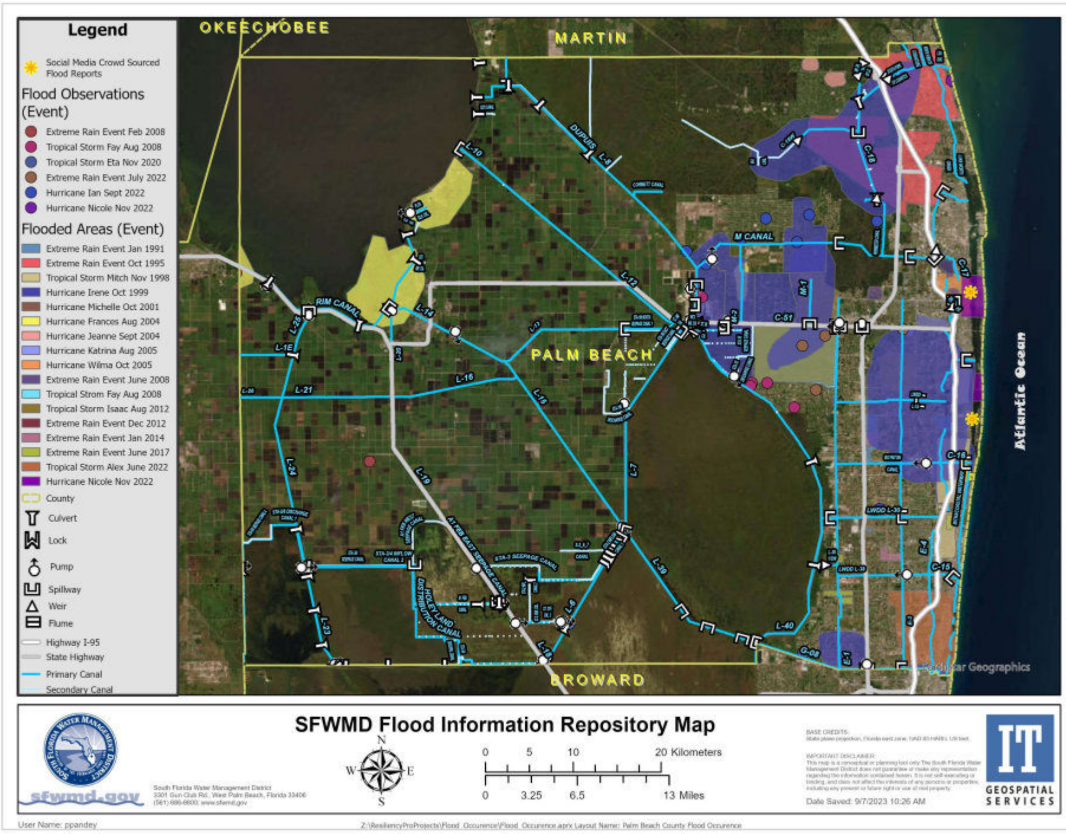


Figure 2.4: *SFWMD Flood Repository Map*

Drainage System Maintenance

The County's drainage systems consist of a combination of natural drainage ways and channels, engineered channels, storm sewers and ditches, and detention/retention basins contiguous to drainage systems. These systems can easily lose their carrying capacity with debris accumulation, sedimentation buildup and/or vegetation growth, becoming ineffective for flood prevention. Extensive maintenance is necessary to ensure flood preparedness.

Responsibility for inspection and maintenance of drainage systems falls to a variety of organizations depending on the type of system involved:

- SFWMD and the various water control districts provide oversight for the routine inspection of the drainage systems under their purview, and for debris clearance and other maintenance activities.
- Storm drain maintenance falls within the purview of the County's Road & Bridge Division, municipal public works departments, and the State Department of Transportation.

- Inspection, clearance, and maintenance of privately owned systems are the responsibilities of property owners and associations.

In rare instances, environmental regulations may prohibit removing natural debris and new growth from some drainage ways.

Maintenance activities most commonly include ongoing monitoring, debris and sediment removal, and the correction of problem sites and damaged systems by field crews. Quite often, maintenance actions are prompted by citizen complaints and reports. Given the sheer size of the County, the vigilance of citizens is a critical element in identifying potential drainage problems. The County has ongoing programs for structural and permanent changes to channels or basins (e.g. enlargement of openings, installation of grates to catch debris, installation of hard bank protection, construction of new retention basins, etc.) to reduce flooding and maintenance problems. Coastal communities commonly undertake a variety of maintenance measures including dune and mangrove preservation, bluff stabilization, and beach nourishment to protect coastal buildings, property, and coastal water bodies from flooding and erosion.

The county and municipalities work continuously to improve and maintain their stormwater management systems. Some of these projects are self-funded and others depend on grant support. Drainage improvement projects are among the most prevalent flood mitigation strategies reflected on the County's Local Mitigation Strategy Prioritized Project List (PPL).

2.1.1.2 Hurricanes/Tropical Storms

For many years, the risk of significant loss of life and property due to hurricanes seemed small. Many, if not the majority, of existing homes and businesses along the U.S. Atlantic and Gulf Coasts were constructed during the 1970s and 1980s, a period of relatively inactive hurricane formation. Most of the people currently living and working in coastal areas have never experienced the impact of a major hurricane. Hurricanes that affected Florida during the 1970s and 80s were infrequent and of relatively low intensity. Homeowners, business interests, and government officials grew to regard hurricane risk as manageable by private insurance supplemented occasionally by federal disaster funding and subsidized flood insurance. The hurricane risk did not seem sufficient to warrant increased investment in mitigation. Two (2) major hurricanes, Hugo in 1989 and Andrew in 1992, forced a reevaluation of this risk assessment. While experts sometimes disagree on the annual cost of hurricane damage, many sources agree that Hurricane Andrew was one of the most costly hurricane events ever to affect the U.S. Insured losses from Hurricane Andrew topped $17 billion and most sources agree that the total cost of Hurricane Andrew exceeded $25 billion.

Florida is the most vulnerable state in the nation to the impacts of hurricanes and tropical storms. Southcentral Florida is particularly exposed to the dangers presented by hurricanes, due to its topography. The region is largely a flat, low-lying plain. The potential for property damage and human casualties in PBC has increased due to rapid growth over the last few decades, particularly along the coastline. Population risk has also been exacerbated by some complacency due to the recent period of reduced hurricane frequency. With Hurricanes Matthew (2016) and

Irma (2017) striking close to PBC, renewed interest in hurricane safety and mitigation has been produced, as hurricanes may affect any jurisdiction within PBC.

Hurricanes are tropical cyclones with winds that exceed 74 mph and blow counterclockwise around their centers in the Northern Hemisphere. They are essentially heat pumping mechanisms that transfer the sun's heat energy from the tropical to the temperate and polar regions. Hurricanes are formed from thunderstorms that form over tropical oceans with surface temperatures warmer than 81° Fahrenheit (26.5° Celsius). The ambient heat in the sea's surface and moisture in the rising air column set up a low-pressure center and convective conditions that allow formation of self-sustaining circular wind patterns. Under the right conditions, these winds may continue to intensify until they reach hurricane strength. This heat and moisture from the warm ocean water is the energy source of a hurricane. Hurricanes weaken rapidly when deprived of their energy source by traveling over land or entering cooler waters.

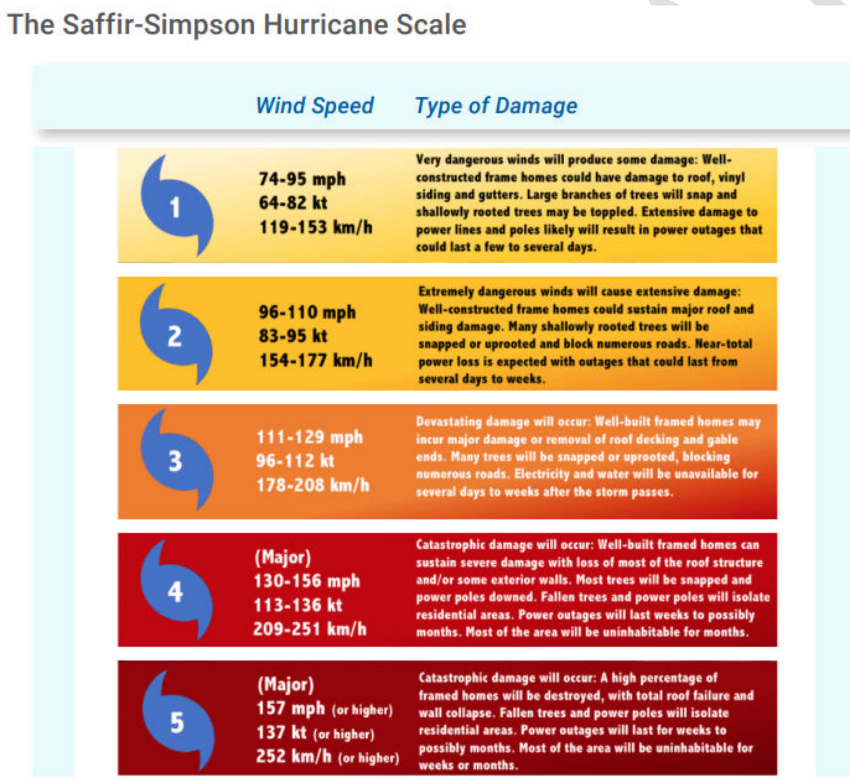


Figure 2.5 Saffir-Simpson Hurricane Scale

Since 1886, 59 storms of hurricane intensity have passed within 125 miles of PBC. This represents an average of one (1) hurricane every two years. The number of direct hits on the southeastern Florida coastline between 1899 and 2019 has been as follows:

- Category 1 Storms: 9 storms
- Category 2 Storms: 3 storms
- Category 3 Storms: 17 storms

- Category 4 Storms: 16 storms
- Category 5 Storms: 9 storms

A storm surge is a large dome of water often 50 to 100 miles wide and rising anywhere from four (4) to five (5) feet in a Category 1 hurricane up to 20 feet in a Category 5 storm. The storm surge arrives ahead of the storm's actual landfall and the more intense the hurricane, the sooner the surge arrives. Water rise can be very rapid, posing a serious threat to those who have waited to evacuate flood prone areas. A storm surge is a wave that has outrun its generating source and become a long period swell. The surge is always highest in the right-front quadrant of the direction the hurricane is moving in. As the storm approaches shore, the greatest storm surge will be to the north of the hurricane eye.

Such a surge of high water topped by waves driven by hurricane force winds can be devastating to coastal regions. The stronger the hurricane and the shallower the offshore water, the higher the surge will be. In addition, if the storm surge arrives at the same time as the high tide, the water height will be even greater. The storm tide is the combination of the storm surge and the normal astronomical tide.

Damage during hurricanes may also result from tornadoes, inland flooding, and heavy rainfall that usually accompany these storms. Hurricane Andrew, a relatively "dry" hurricane, dumped ten inches of rain on south Florida and left many buildings extensively water damaged. Rain water may seep into gaps in roof sheathing and saturate insulation and ceiling drywall, in some cases causing ceilings to collapse.

Aside from direct property damage, the potential for crop damage and economic disruption from hurricanes and tropical storms is significant. Tropical Storm Mitch dropped as much as ten (10) inches of rain in some south Florida areas, which resulted in approximately $20 million in direct crop damage in PBC. The largest monetary loss, however, was sustained by the sugar cane mills in the western part of the County, where contracted part-time help and union workers must be paid whether or not the mills run. The six (6) mills in PBC and the one (1) in Hendry combined lost about $500,000 a day in wages. The mills remained down until the fields dried out.

There are 671 listed farm proprietors with approximately 8,000 employees and a total annual payroll of $12,894,000 in PBC. It also has approximately 627,924 acres of farmland currently valued at $2,417,525.

Historic Hurricane/Tropical Storm Events

Hurricane of September 1928 – This hurricane made Florida landfall near the Town of Palm Beach as a strong Category 4 hurricane with one of the lowest barometric pressures ever recorded in this area (928.9 millibars/27.42 in). This was the 5th most intense hurricane ever to make landfall in U.S. territory. It reached Lake Okeechobee with very little diminished intensity and moved across the northern shoreline. This sent a massive storm surge southward flooding lower areas on the southern and western edge of the lake. In excess of, 2,500 people were killed during this storm's passage. Nearly all the loss of life was in the Okeechobee area and was caused by overflowing of the lake along its southwestern shore. While all of central Florida was affected by this killer storm, PBC mainly experienced wind damage and flooding from the associated rains.

Hurricane of August 1949 – This Category 2/Category 4 hurricane made landfall in Florida between Delray Beach and Palm Beach with winds of 120 mph and a barometric pressure of 954.0 millibars (28.17 in). As it moved inland, its center passed over the northern part of Lake Okeechobee, but the levees in that area held and no major flooding occurred. Damages were estimated at $45 million. Tides of 11.2 ft. at Fort Pierce, 8.5 ft. at Stuart, and 6.9 ft. at Lake Worth Beach were reported. Stuart sustained severe damages from this storm. Statewide, over 500 people lost their homes as a result of this storm.

Hurricane Donna of September 1960 – Hurricane Donna was the sixth most intense U.S. Hurricane at landfall. This storm crossed the Florida Keys into the Gulf of Mexico then turned back toward the northeast and struck the Florida mainland just south of Naples. It then turned north moved across Ft. Myers, where it turned again to the northeast, moved across the state, and exited Florida at just north of Daytona Beach. Rainfall ranged from five (5) to ten inches in an 80- to 100-mile wide belt following this storm's track. Lakes and streams overflowed their banks and forced the evacuation of many homes throughout central Florida. The high water closed many roads and inundated considerable agricultural land. At least 12 people were killed statewide and more than 1,794 were injured.

Hurricane Agnes of June 1972 – Hurricane Agnes moved through the Gulf of Mexico off Florida's west coast. While it never struck central Florida mainland, it spawned the worst severe weather outbreak in Florida history. The outer rain bands covered virtually the entire peninsula and spawned numerous tornadoes. There were six (6) people killed and 40 injured in Okeechobee, one (1) killed and seven (7) injured in La Belle, 40 injured at Big Coppit Key, two (2) injured at Bassinger, three (3) injured in Haines City, four (4) at Crystal Springs, 11 in Malabar, and 12 in Cape Canaveral. Most of those injured lived in manufactured housing. Damage estimates totaled $5 million to public property and $26 million to private property.

Tropical Storm Gordon of October 1994 – Following a similar track to hurricane Donna of 1960, tropical storm Gordon crossed the Florida Keys into the Gulf of Mexico then turned back to the northeast and struck the mainland Florida Peninsula near Fort Myers on October 12, 1994. It moved across the state and exited Florida into the Atlantic just north of Vero Beach on October 16. Although the maximum sustained winds reported from Gordon were only 52 mph, the storm caused eight (8) deaths and 42 injuries.

The County had experienced a period of extensive growth during the 1970s and 1980s. Most of this growth took place in the form of residential and commercial land development in the eastern portion of PBC close to the Intracoastal Waterway and the beaches. The rain event associated with Tropical Storm Gordon in October of 1994 was the most significant rain event to occur after this period of development. Essentially, the County received 17+ inches of rain over a 2-day period. Rainfall was not evenly disbursed over the whole County.

Statewide damages associated with Gordon totaled over $400 million. Agricultural interests sustained $275 million in damages primarily from the widespread flooding. Vegetable and citrus crops were hit particularly hard. Exacerbating the flooding associated with Tropical Storm Gordon was the fact that prior to October 1994 had been a very wet year for PBC. Rainfall recorded through September of that year had reached 74 inches before the Gordon event occurred. Altogether, PBC received approximately 100 inches of rain in 1994, making that year the wettest year since 1912.

Hurricane Irene of October 1999 – Hurricane Irene weakened to Tropical Storm force winds by the time it tracked north through the Everglades, but it menaced South Florida and PBC with incessant rains and its sluggish pace. In the end, it dropped 10-20 inches of rain throughout the County, causing extensive flooding in some areas. By Friday evening (October 15), 125,000 homes in PBC were without power.

Hurricane Frances of September 4, 2004 – Hurricane Frances formed from a tropical depression in the deep tropical Atlantic on August 25, about 1400 miles east of the Lesser Antilles and reached hurricane strength on August 26. Frances became a Category 4 Hurricane on August 28, while about 700 miles east of the Lesser Antilles. Frances then moved generally west-northwest and weakened to a Category 2 hurricane while crossing the northwest Bahamas. After stalling for about 12 hours on September 4 in the Florida Straits between Grand Bahama Island and the southeast Florida coast, the center of the nearly 70-mile diameter eye crossed the Florida coast near Sewalls Point at 1 A.M. EDT September 5, with the southern eyewall affecting the extreme northeast portion of PBC. Frances moved farther inland just north of Lake Okeechobee and weakened to a tropical storm before crossing the entire Florida Peninsula and exiting into the Gulf of Mexico just north of Tampa. It made a second landfall as a tropical storm in the eastern Florida Panhandle.

Sustained tropical storm-force winds likely occurred in all six (6) south Florida counties. Although no sustained hurricane-force winds were officially observed in any of the six (6) south Florida counties, a National Weather Service (NWS) instrument on the eastern shore of Lake Okeechobee at Port Mayaca, just across the PBC border, measured a sustained wind of 85 mph. At West Palm Beach International Airport, the highest sustained wind was 64 mph with a peak gust of 82 mph and the lowest observed barometric pressure was 972 millibars. A SFWMD instrument measured a peak wind gust of 92 mph over the eastern portion of Lake Okeechobee. The estimated peak wind gust in the Palm Beach metro area was 91 mph at Jupiter Inlet with a peak wind gust of 87 mph measured by a Coastal-Marine Automated Network (C-MAN) station at Lake Worth Beach Pier. In Glades County near the western shore of Lake Okeechobee, the highest measured sustained wind was 60 mph with a peak gust of 90 mph. In Clewiston, a sustained wind of 60 mph with a gust of 80 mph was estimated.

A maximum storm-total rainfall amount of 12.56 inches was measured at Palm Beach International Airport with 10.26 inches of that occurring in a 24-hour period. Unofficial storm-total rainfalls included 9.56 inches at Boynton Beach, eight (8) inches at Deerfield Beach and 7.18 inches at Hillsboro Canal. Widespread storm-total amounts of three (3) to five (5) inches occurred in southeast and interior south Florida with southwest Florida averaging one (1) to three

(3) inches. Rainfall flooding was mostly minor except for a few locations in PBC, which had up to three (3) feet of standing water. A section of I-95 in PBC was closed due to a large sinkhole. The maximum storm surge was estimated to have ranged from two (2) to four (4) feet along the northeast Palm Beach Coast to one (1) to two (2) feet along the northeast Broward Coast.

Within the confines of the Herbert Hoover Dike, water levels on Lake Okeechobee fluctuated up to five (5) feet above and below normal. Coastal beach erosion was moderate in Palm Beach and portions of Broward counties.

There were no confirmed tornadoes. There were no known direct deaths, but at least nine (9) people died in the aftermath. Six (6) of these deaths occurred in PBC, mainly as the result of vehicle-related accidents or from drowning. An unknown number of injuries occurred. Property damage at the coast occurred mainly to marinas, piers, seawalls, bridges and docks, as well as to boats. Inland structure damage included 15,000 houses and 2,400 businesses in PBC. Wind damage to house roofs, mobile homes, trees, power lines, signs, screened enclosures and outbuildings occurred over much of southeast Florida including areas near Lake Okeechobee but was greatest in PBC. A preliminary damage estimate for Frances in south Florida was $620 million, including $500 million in Palm Beach, $80 million in Broward, and $24 million in Miami-Dade. Crop damage in PBC was estimated at an additional $70 million to sugar cane and vegetables and additional heavy losses occurred to nurseries. Florida Power and Light reported power outages for 659,000 customers in Palm Beach, 590,000 in Broward, 422,000 in Miami-Dade, 29,200 in Collier, 2,500 in Hendry and 1,700 in Collier. An estimated 17,000 persons sought refuge in public shelters in PBC and nearly 7,000 in Broward County.

Hurricane Jeanne of September 25, 2004 – Just three (3) weeks after Hurricane Frances, Hurricane Jeanne struck the same area of southeast Florida. Hurricane Jeanne formed from a tropical depression just east of the Leeward Islands on September 12. She moved across Puerto Rico and Hispaniola then turned north into the Atlantic and became a hurricane on September 20th. Jeanne made a clockwise loop for three (3) days in the Atlantic north of Hispaniola before moving west-northwest. It strengthened to a Category 2 Hurricane while over the northwest Bahamas and then made landfall around 11 P.M., September 25 near the south end of Hutchinson Island, nearly coincident with the landfall point of Hurricane Frances just three (3) weeks before. The 40-mile diameter eye was not quite as large as Frances, but the southern eyewall again affected northeast PBC. After landfall, Jeanne initially moved along a track similar to Frances, just north of Lake Okeechobee as it weakened to a tropical storm then turned to the northwest and moved over the northwest Florida Peninsula.

Although slightly smaller and stronger than Hurricane Frances, winds and pressures over southeast Florida were remarkably similar to Frances. Unfortunately, the Automated Surface Observing System (ASOS) at Palm Beach International Airport stopped sending data during the height of the hurricane. Sustained tropical storm-force winds likely occurred over most of Palm Beach and northeast Glades counties and portions of Broward, Hendry, and Collier counties. Although no sustained hurricane-force winds were officially observed in any of the six (6) south Florida counties, portions of northern PBC mostly likely experienced them. A SFWMD instrument in the Martin County portion of Lake Okeechobee measured a 15-minute sustained wind of 79 mph with a peak gust of 105 mph. In metropolitan Palm Beach, the highest official sustained wind speed was 60 mph with a peak gust of 94 mph from the C-MAN station at Lake Worth Beach Pier. An unofficial peak wind gust of 125 mph was measured in West Palm Beach at the Solid Waste Treatment Plant. Near Clewiston, the highest measured sustained wind was 21 mph with a peak wind gust of 72 mph from a SFWMD instrument. The lowest barometric pressure of 960.4 millibars was measured at a SFWMD site in the Martin County portion of Lake Okeechobee.

A SFWMD gauge measured a maximum storm-total rainfall amount of 10.22 inches over the eastern portion of Lake Okeechobee. A SFWMD gauge about four (4) miles west of West Palm Beach International Airport measured 9.10 inches with 8.79 inches of that occurring in a 24-hour period. At Moore Haven, 5.99 inches of rain was measured. Mostly minor rainfall flooding was observed except in Palm Beach Gardens, Jupiter and in the farmlands of western PBC where it was more severe.

The estimated maximum storm surge ranged from two (2) to four (4) feet along the northeast Palm Beach Coast to one (1) to two (2) feet along the northeast Broward Coast. Within the confines of the Herbert Hoover Dike, water levels on Lake Okeechobee fluctuated up to seven (7) feet above and below normal causing severe flooding of some marinas. Beach erosion was moderate in Palm Beach.

There were no confirmed tornadoes. There were no known direct deaths, but four (4) persons died in the aftermath. An unknown number of injuries occurred. Storm surge and winds at the coast caused damage to condominiums, marinas, piers, seawalls, bridges and docks, as well as to boats and a few coastal roadways. Inland wind damage to building roofs, mobile homes, trees, power lines, signs, and outbuildings occurred mainly over PBC and portions of eastern Glades and Hendry counties. Preliminary damage estimates for Jeanne in southeast Florida were $220 million, including $260 million in PBC, $50 million in Broward and $10 million in Miami-Dade. Agricultural Damage in PBC was estimated at $20 million. Florida Power and Light reported outages occurred to 591,200 customers in PBC, 165,900 in Broward, 25,100 in Miami-Dade, 5,200 in Collier, 2,000 in Hendry and 1,500 in Glades. An estimated 12,524 persons sought refuge in public shelters in PBC.

Hurricane Wilma October 24, 2005 – Wilma was a classic October hurricane, which struck South Florida as a Category 2 hurricane on October 24, 2005. Wilma developed from a tropical depression near Jamaica, a typical source region for October tropical cyclones, on the afternoon of October 15. It became the 21st named storm of the season during the morning hours of October 17, which tied the record for the most named storms in one (1) season originally set back in 1922. Wilma underwent a rapid intensification cycle, which began on October 18 and ended in the early morning hours of October 19, with a central pressure decrease of 88 millibars in only 12 hours. The central pressure reached 882 millibars, making Wilma the most intense hurricane ever in the Atlantic Basin, lower than Hurricane Gilbert in September 1988. Wilma went on to make landfall on Cozumel Island just off the Yucatan Peninsula as a strong Category 4 hurricane on October 21, then drifted erratically over the Yucatan Peninsula through the evening October 22. Wilma began to move off the northeast coast of the Yucatan Peninsula on the night of the 22nd, then gradually accelerated northeast over the southern Gulf of Mexico toward South Florida as a strong mid and upper-level trough over the central United States moved south and forced a southwesterly steering flow.

The hurricane made landfall as a Category 2 storm shortly before 7:00 a.m. Monday October 24 on the southwest Florida coast between Everglades City and Cape Romano with maximum sustained winds of 125 mph and an estimated minimum central pressure of 950 millibars. Wilma exhibited a very large 55- to 65-mile-wide eye while crossing the state, and the eye covered large portions of South Florida, including the eastern two-thirds of Collier County, extreme northwestern Miami-Dade County, the southern and eastern third of Hendry County, most of Broward County, and all of PBC. The eye also clipped the southeastern shore of Lake Okeechobee. The eye wall affected virtually all of South Florida. Around 10:20 a.m., a SFWMD meteorological station located at the south end of Lake Okeechobee reported sustained winds of 102 mph. The highest recorded gusts were in the 100-120 mph range. The winds on the back (south/west) side of the eye wall were as strong, if not stronger, than those on the front (north/east) side. This goes against the common, but sometimes erroneous, belief that the strongest winds in a hurricane are always in the right-front quadrant of the storm. This occurred over much of South Florida, except for central and southern Miami-Dade County, which barely missed the southwestern portion of the eye wall and likely contributed to the heavier damage across Broward and Palm Beach counties compared to slightly lesser damage across much of Miami-Dade and Collier counties.

Wilma moved rapidly northeast across the state, with an average forward speed of 25 mph. Wilma exited the east coast over northeastern PBC near Palm Beach Gardens around 11:00 a.m. on Monday October 24 as a Category 2 hurricane with maximum sustained winds of around 105 mph. It traversed the southern peninsula in about four (4) hours. Rainfall amounts across South Florida generally ranged from two (2) to four (4) inches across southern sections of the peninsula to four (4) to six (6) inches across western Collier County and around Lake Okeechobee, with a maximum amount of 7.21 inches in Clewiston, Downtown Miami and Northeast Miami.

In Collier, Miami-Dade, Broward, and Palm Beach Counties, the winds killed five (5) people. Total damage estimates from all the effects ranged from $9 to $12 billion. Extensive damage to crops was reported, with an estimated $222 million in crop damage for Miami-Dade County alone. Damage was widespread, with large trees and power lines down virtually everywhere, causing over two (2) million customers to lose power. Structural damage was heaviest in Broward and Palm Beach counties where roof damage and downed or split power poles were noted in some areas. High-rise buildings suffered considerable damage, mainly in the form of broken windows. This was observed mainly along the southeast metro areas. An F1 tornado caused snapped power poles, uprooted large trees, and significant damage to mobile homes. Small swaths of greater damage elsewhere in South Florida have not been attributed to tornadoes but were instead likely caused by "mini-swirls", small vortices within the eye wall.

Tropical Storm Fay of August 15-22, 2008 – The center of Tropical Storm Fay moved across Key West early in the evening of August 18, and into the mainland of South Florida at Cape Romano shortly before 5:00 a.m. the next day. Minimum central pressure was 989 millibars at landfall but continued to decrease after landfall to 986 millibars at Moore Haven on the southwest shore of Lake Okeechobee.

Maximum sustained winds were estimated to be around 60 mph at landfall, however as the storm tracked across the western Everglades and Southwest Florida the radar presentation continued to organize and winds increased to around 65 mph around Moore Haven. A maximum wind gust of 79 mph was recorded on a South Florida Water Management gauge on Lake Okeechobee as the storm passed. Wind gusts of tropical storm force were felt area-wide, with sustained tropical storm force winds experienced over portions of mainland Monroe, Collier, Hendry and Glades counties as well as the immediate coastal sections of Miami-Dade, Broward, and Palm Beach Counties. Wind damage was most significant in the areas affected by tropical storm force sustained winds, primarily around Lake Okeechobee and interior sections of southwest Florida, with only minor wind damage elsewhere.

The storm caused over $10 million in beach erosion along PBC's coastline. A maximum rainfall total of 16.17 inches was reported with this event at Moore Haven in Glades County. Flooding from these rains produced total damage estimates of $280,000, primarily in Glades and Hendry counties. Rainfall elsewhere ranged from three (3) to six (6) inches in southeast Florida, and six (6) to eight (8) inches in southwest Florida, with isolated amounts up to ten inches in coastal PBC. All the associated effects of Tropical Storm Fay in South Florida resulted in one (1) fatality, four (4) injured, and $2.949 million in property damage. Two (2) tornadoes produced $1.25 million in damage but caused no injuries or fatalities. The one (1) fatality and three (3) of the injuries were indirectly caused by Fay, with a traffic accident in PBC. The direct injury occurred when a kite surfer on Fort Lauderdale Beach lost control during a squall and was slammed into a building along A1A. Fay caused tropical storm force winds, significant rainfall flooding in some areas and two (2) confirmed tornadoes.

Hurricane Irene of August 25–26, 2011 – Hurricane Irene passed over the western Bahamas about 170 miles east of the Florida coast. The western fringes of Irene affected southeast Florida with high surf and winds bordering on tropical storm force. Winds to marginal tropical storm force and high surf affected the PBC coast as the outer fringes of Hurricane Irene passed over the area. Sustained winds to 26 knots with gusts to 46 knots were measured near the coast from Jupiter through Boynton Beach associated with intermittent squalls. Wind damage was limited to a few uprooted trees and knocked down tree branches, causing minor power outages. High surf pounded the coast during the day, causing damage to Lake Worth Beach Pier totaling $2,000 and injuring eight (8) people at Boynton Inlet when a large wave crashed onto the jetty while onlookers were present. Maximum storm surge at Lake Worth Beach Pier was 1.28 feet with a maximum tide of 1.55 feet.

Tropical Storm Debby of June 22-27, 2012 – The outer bands from Tropical Storm Debby located in the Northeast Gulf of Mexico continued to move over South Florida. Severe thunderstorms developed during the late morning into the afternoon with severe wind gusts and eight (8) tornadoes occurring over a span of four (4) hours in Lake Worth Beach, Okeechobee Boulevard and east of I-95, a warehouse district just south of Okeechobee Boulevard, Tamarind Avenue, and Banyan Boulevard. Additional details related to the tornadoes is discussed below.

Hurricane Isaac of August 26, 2012 – The center of Tropical Storm Isaac moved over the Florida Straits south of the Florida Keys on Sunday, August 26, passing just south of Key West. Rain bands and winds on the north side of the circulation of Isaac affected Southeast Florida throughout the day of the 26th and part of the 27th. Highest winds over land were recorded along and near the southeast Florida coast where the highest sustained winds ranged from 40-45 mph, with 25-30 mph sustained winds over most inland areas as well as over southwest Florida. Highest wind gusts ranged from 50-60 mph over most land areas to as high as 65 mph along the Atlantic coast and just offshore. Three-day rainfall totals ending at 8:00 a.m. August 28 ranged from five (5) to seven (7) inches across southeast Florida to two (2) to five (5) inches over interior and southwest Florida. The primary exception was over northern metro Broward County and much of PBC where eight (8) to twelve (12) inches fell, with maximum amounts up to 15-18 inches from west of Boynton Beach to Wellington, The Acreage, Royal Palm Beach, and Loxahatchee. These areas of highest rainfall amounts experienced severe flooding with communities cut off for several days after the storm. Maximum storm tide values were observed at 4.9 feet at Naples, with estimates of five (5) to seven (7) feet along the southern Collier County coast from Goodland to Everglades City. Highest estimated inundation values of up to two (2) feet above ground level were noted in Goodland and Everglades City. Major beach erosion was also observed along the Collier County beaches, with moderate beach erosion along the Atlantic beaches. All of the associated effects of Isaac in south Florida resulted in about $17.2 million in property damage. Specifically, Isaac's inland floodwaters resulted in about $10 million in damages, mostly in Palm Beach and Broward counties. Flooding caused by storm tides along the coast in Collier County resulted in about $400 thousand in damage. Damage from beach erosion in Collier and Broward counties was estimated at $6 million. Wind damage was estimated at $750,000. Approximately 112,000 customers lost power during the storm in South Florida.

Hurricane Sandy of October 25-26, 2012 – Hurricane Sandy began to affect the PBC coast and its adjacent Atlantic waters with tropical storm force winds during the evening of October 25 as it moved slowly north across the northwest Bahamas. Tropical storm force wind gusts were first observed along the coastal PBC region by early in the evening of October 25. Several Weather Flow sensors along and near the PBC coast recorded Tropical Storm Force wind gusts during the evening of October 25, with a peak wind gust of 67 mph observed at Jupiter. However, as Hurricane Sandy continued to move slowly north and then northeast over the Atlantic waters north of the Bahamas through October 28, the main effect along the PBC coast were large northeast swells generated by the storm, which pummeled the Southeast Florida coast with significant beach erosion and coastal flooding. Large breaking waves of possibly over 20 feet were estimated along the coast. As a result, major coastal flooding occurred with the most significant impacts experienced from central Palm Beach north, including the Manalapan area where beachfront structures were threatened by water intrusion. In all, there was an estimated $14 million in damage sustained in PBC. A total of 44,270 customers lost power. A maximum storm tide of 5.2 feet above mean lower low water (MLLW) was observed at Lake Worth Beach Pier on October 28 at 7:12 a.m. along with a maximum storm surge of 2.28 feet on October 28 at 2:26 a.m. Similar tide and surge levels were measured at the highest daily high tide during this period, generally between 7:00 and 9:00 a.m.

Tropical Storm Andrea of June 5-7, 2013 – During the early evening of June 5, 2013, Tropical Storm Andrea formed in the east-central Gulf of Mexico becoming the first named storm of the 2013 tropical season, and over the next 48 hours, Andrea would pummel portions of south Florida with heavy rainfall and major flooding. Andrea even spawned three (3) tornadoes including an EF-1 tornado that tore through portions of northeast PBC. Although Andrea never made landfall in south Florida, it had far-reaching impacts that mainly affected the east coastal areas. During the early morning hours of June 6, convective rain bands well to the southeast of the storm center streamed across the south Florida area spawning three (3) tornadoes. The first occurred just after 3:00 a.m. and affected the town of Belle Glade in PBC. Only minor damage to trees and power lines was sustained from this tornado and was rated as an EF-0. Just a few hours later, another tornado ripped through The Acreage community in north central PBC.

Hurricane Matthew of October 7, 2016 – Hurricane Matthew moved north along the east coast, previously hitting Cuba and Haiti, it moved into Florida as a much weaker hurricane than before. Matthew never made landfall, as the eye barely missed Cape Canaveral. Matthew killed twelve people in the state, produced flooding and high winds, and knocked out power to 1.1 million people. Despite significant preparations, PBC was not directly impacted.

Hurricane Irma of September 10-11, 2017 – Tropical Storm Irma formed on August 30 and intensified into a Category 5 cyclone on September 5. Irma attained its peak intensity with winds of 185 mph later that day and maintained Category 5 intensity when it made landfall in Cuba on September 9. Land interaction disrupted the storm temporarily, but once again it strengthened to a Category 4 storm with winds of 130 mph when it made landfall in Cudjoe Key of the Florida Keys early on September 10. A few hours later, it struck Marco Island, Florida, with winds of 115 mph. Irma steadily weakened as it continued north and west. It was the strongest hurricane in terms of wind speed to hit Florida since Charley in 2004, and the most intense in terms of pressure since Andrew in 1992. Irma killed at least 82 people in Florida. Preliminary damage estimates for PBC were over 145 million dollars in damage. According to Florida Power and Light, 680,799 PBC customers lost power, and more than 20% of the County's customers remained without power four (4) days after the storm.

With peak winds of 185 mph, Irma was the strongest Atlantic storm outside of the Gulf of Mexico or Caribbean Sea on record and is the 11th most intense hurricane on record in the Atlantic basin. Maintaining peak intensity for 37 consecutive hours, Irma is the only tropical cyclone on record worldwide to have had winds that intense for such a long duration. Surprisingly, very little flood damage was reported, and almost all damage was wind related.

Tropical Storm Philippe of October 22, 2017 – Philippe made landfall over the Everglades in southwest Florida with winds of 45 mph. Effects were relatively minor in Florida, although Philippe brought moderate rain and spawned a few weak tornadoes, including one (1) in West Palm Beach. Some localized flooding was reported, mostly on streets with very few homes affected.

Hurricane Dorian August 24, 2019 – Hurricane Dorian was an extremely powerful and catastrophic Category 5 Atlantic hurricane, which became the most intense tropical cyclone on record to strike the Bahamas and tied for the strongest landfall in the Atlantic basin. The 2019 cyclone is regarded as the worst natural disaster in the Bahamas' recorded history. While this storm did not directly affect PBC, the County, and its municipalities were activated because of the proximity of the storm.

Both residents and government entities were able to provide support and relief efforts to the islands of the Bahamas. Because of the proximity, residents helped bring donations gathered throughout South Florida over to the islands to help those affected by the storm. Palm Beach County Emergency Management opened a shelter for those evacuating the Bahamas. The County sheltered approximately 120 civilians.

Hurricane Ian September 23-30, 2022 – Hurricane Ian was a deadly and extremely destructive Category 5 Atlantic hurricane, which was the third-costliest weather disaster on record, the deadliest hurricane to strike the state of Florida since the 1935 Labor Day hurricane, and the strongest hurricane to make landfall in Florida since Michael in 2018. While this storm did not make direct landfall in PBC, the County, and its municipalities were activated because of the proximity of the storm. Because of the location of landfall, numerous tornadoes made touchdown throughout the county.

The County Emergency Management Division as well as employees from multiple municipalities sent mutual aid and supplies over to the affected areas on the West Coast of Florida. This included EOC personnel, first responders, and donations.

Hurricane Nicole November 8-11, 2022 – Hurricane Nicole was a sprawling late-season Category 1 hurricane in November 2022. The fourteenth named storm and eighth hurricane of the 2022 Atlantic hurricane season. On November 10, it made landfall twice in Florida, south of Vero Beach and then northwest of Cedar Key, after briefly emerging over the Gulf of Mexico. Nicole then weakened to a depression while moving over the Florida Panhandle, and then was absorbed into a mid-latitude trough and cold front over extreme eastern Tennessee the following day. While this storm did not make direct landfall in PBC, the County, and its municipalities were activated because of the proximity of the storm. Some minor flooding occurred on the barrier islands but no major incidents. Beach erosion was notable after this storm.

2.1.1.3 Severe Thunderstorms/Lightning

Severe Thunderstorms

A severe thunderstorm is a rain shower during which one or more of the following phenomena: one (1) inch hail or greater, winds gusting in excess of 57.5 mph, and/or a tornado. Severe weather can include lightning, tornadoes, damaging straight-line winds, and large hail. Most individual thunderstorms only last several minutes; however some can last several hours.

A supercell is a long-lived thunderstorm that has a persistent rotating updraft. This rotation maintains the energy release of the thunderstorm over a much longer time than typical, pulse-type thunderstorms, which occur in the summer months. Supercell thunderstorms are responsible for producing most of the severe weather, such as large hail and tornadoes (NOAA). Downbursts are also occasionally associated with severe thunderstorms. A downburst is a strong downdraft resulting in an outward burst of damaging winds on or near the ground. Downburst winds can produce damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can even occur with showers too weak to produce thunder (NOAA). Strong squall lines can also produce widespread severe weather, primarily very strong winds and/or microbursts.

Florida has more thunderstorm activity than any other US state. PBC residents are quite familiar with thunderstorms and the severe weather they can bring. When a severe thunderstorm approaches, the NWS will issue alerts. Two (2) possible alerts are:

- Severe Thunderstorm Watch - Conditions are favorable for the development of severe thunderstorms.
- Severe Thunderstorm Warning - Severe weather is imminent or occurring in the area.

Thunder is created when lightning passes through the air. The lightning discharge heats the air rapidly and causes it to expand. The temperature of the air in the lightning channel may reach as high as 50,000 degrees Fahrenheit, five (5) times hotter than the surface of the sun. Immediately after the flash, the air cools and contracts. Lightning occurs with all thunderstorms and is very dangerous. Most lightning strikes are cloud to cloud but some are cloud to ground. These are the ones that kill approximately 93 peoper per year in the U.S.

Lightening

Lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground. In the early stages of development, air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground. When opposite charges build up sufficiently, the insulating capacity of the air breaks down causing a rapid discharge of electricity that we know as lightning. The flash of lightning equalizes the charge regions in the atmosphere until the opposite charges build up again (NOAA, 2023).

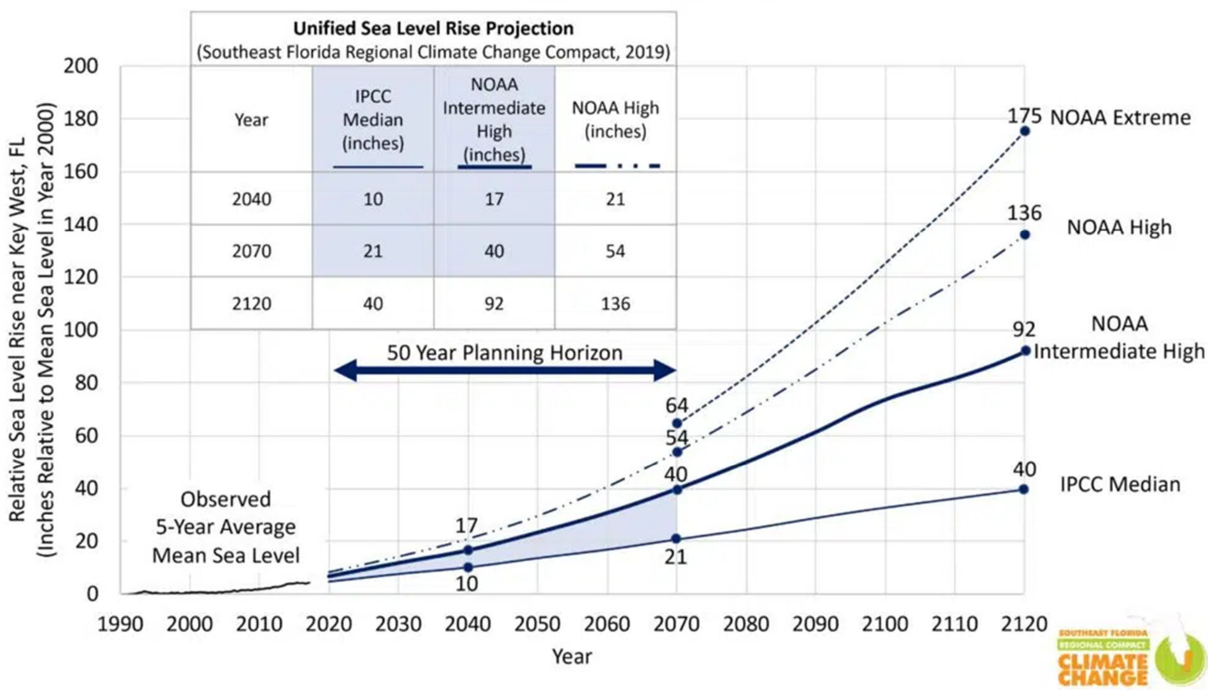
The risk of being struck by lightning is low, but the consequences of being struck are serious. According to the National Lightning Safety Council, Florida ranks #1 in lightning related deaths with 51 deaths statewide from 2013 to 2022. Florida is considered the “lightning capital” of the country with more than 2,000 lightning injuries over the past 50 years. The peak months for lightning strikes in Florida are June, July, and August, but no month is safe from lightning danger, and all of PBC is equally vulnerable to this hazard.

According to NOAA’s storm events database, from January 2019 – August 2023, PBC experienced 60 thunderstorm events with winds gusts over 50 knts (<57 miles per hour). The highest wind gust during this time was 68 knts (78.3 miles per hour) on April 6, 2022, in Palm Beach Gardens in the northern part of the County.

2.1.1.4 Sea Level Rise

Sea level rise is defined as a mean rise in sea level. Since 1870, global sea level has risen by about eight (8) inches. Nationally, sea level has risen 6.5 inches since 1950, and the rate of increase is accelerating with sea levels now rising by an average of one (1) inch every five (5) years (NOAA Tides and Currents). As coastal populations increase, vulnerability of those populations to sea level rise increases as well.

The curves below represent the 2019 Unified Sea Level Rise Projection. In the short term, sea level rise is projected to be 10 to 17 inches by 2040 and 21 to 54 inches by 2070 (above the 2000 mean sea level). In the long term, sea level rise is projected to be 40 to 136 inches by 2120. For critical infrastructure projects with design lives in excess of 50 years, use of the upper curve is recommended with planning values of 54 inches in 2070 and 136 inches in 2120. Projected sea level rise, especially by 2070 and beyond, has a significant range of variation as a result of uncertainty in future greenhouse gas emissions and their geophysical effects, the incomplete quantitative understanding of all geophysical processes that might affect the rate of sea level rise in climate models, and the limitations of current climate models to predict the future. For these reasons, the Sea Level Rise Work Group of the Southeast Florida Regional Climate Change Compact has produced a guidance document describing recommended planning applications of the Unified Sea Level Rise Projection (see https://southeastfloridaclimatecompact.org).



*These projections are referenced to mean sea level at the Key West tide gauge. The projection includes four global curves adapted for regional application: the median of the IPCC scenario as the lowest boundary (thin, solid blue curve), the NOAA Intermediate High curve as the upper boundary for the short term for use until 2070 (thick, solid blue line), the NOAA High curve as the uppermost boundary for medium- and long-term use (.. _ .. blue curve), and the new NOAA Extreme curve (dashed curve). The table lists the projection values at years 2040, 2070, and 2120.

Figure 2.6 : Unified Sea Level Rise Projection

The Southeast Florida Regional Climate Change Compact defines the consequences associated with sea level rise to include the following direct physical impacts:

- Coastal inundation of inland areas
- Increased frequency of flooding in vulnerable coastal areas
- Increased flooding in interior areas resulting from impairment of the region's stormwater infrastructure (i.e., impacts to gravity drainage systems, saltwater intrusion into the aquifer and local water supply wells, and contamination of the land and ocean with pollutants and debris and hazardous materials released by flooding)

Consequences of sea level rise also include socio-economic impacts such as displacement, decreases in property values and tax base, increases in insurance costs, loss of services, and impaired access to infrastructure.

Sea Level Rise is a relatively new hazard for the County and much of the Atlantic Coast resulting in increasing flooding frequency in coastal communities. High tide flooding which results in public inconveniences, often termed "nuisance flooding" or "sunny-day flooding," is increasing in frequency as sea level rises. Additionally, perigean spring tides, or tidal events which occur when a new or full moon are closest to the earth, are especially concerning to the public in South Florida. These tides, also known as "king tides," occur once or twice a year and produce slightly larger tidal ranges. In South Florida, we often see the effects of tidal flooding during the fall (September–December) with the highest tide of year usually occurring in October. For example, according to the NOAA tide table below for the Lake Worth Beach Pier, highest predicted tides of 2023 were as follows:

Table 2.4 *NOAA 2023 Tide Table, Lake Worth Beach Pier*

Date Range	Highest Date	Prediction (Ft)
September 29 – October 2, 2023	September 30, 2023	3.96
October 27 – 31, 2023	October 29, 2023	4.05
November 26 - 27, 2023	November 26, 2023	3.8

When heavy rains or coastal storms coincide with high tide conditions, flooding can be exacerbated. Low-lying, coastal communities in PBC are most vulnerable to tidal flooding, and that risk is expected to increase as sea levels rise. Impacts include reduced access/egress to dwellings, businesses, parking lots and marinas; loss of business revenue; damage to vegetation and vehicles; and potential property damage.

2.1.1.5 Soil/Beach Erosion

Soil Erosion

Soil erosion is the deterioration of soil by the physical movement of soil particles from a given site. Wind, water, animals, and the use of tools by humans may all be reasons for erosion. The two (2) most powerful erosion agents are wind and water; but in most cases these are damaging only after humans, animals, insects, diseases, or fire have removed or depleted natural vegetation. Accelerated erosion caused by human activity is the most serious form of soil erosion because the rate is so rapid that surface soil may sometimes be blown or washed away right down to the bedrock. While there is no scale of determination, magnitude of soil erosion affect may be determined by economic impact given to the area, agriculture type, or land development.

Undisturbed by humans, soil is usually covered by shrubs and trees, by dead and decaying leaves or by a thick mat of grass. Whatever the vegetation, it protects the soil when rain falls or wind blows. Root systems of plants hold the soil together. Even in drought, the roots of native grasses, which extend several feet into the ground, help tie down the soil and keep it from blowing away. With its covering of vegetation stripped away, soil is vulnerable to damage. Whether the plant cover is disturbed by cultivation, grazing, deforestation, burning, or bulldozing, the soil is bare to the erosive action of wind and water, greatly increases the rate of natural erosion. Losses of soil take place much faster than new soil can be created resulting in a deficit spending of topsoil begins.

Beyond coastal PBC, soil erosion has become less prevalent as sustained land zoning ordinances, regulated land development, wildfire mitigation efforts, university agricultural extension information practices, and long matured agricultural conservation efforts contribute greatly a diminished hazard.

Beach Erosion

Wind, waves, and longshore currents are the driving forces behind coastal erosion. This removal and deposition of sand permanently changes beach shape and structure. Most beaches, if left alone to natural processes, experience natural shoreline retreat. As houses, highways, seawalls, and other structures are constructed upon or close to the beach, the natural shoreline retreat processes are interrupted. The beach jams against these man-made obstacles and narrows considerably as the built-up structures prevent the beach from moving naturally inland. When buildings are constructed close to the shoreline, coastal property soon becomes threatened by erosion. The need for shore protection often results in "hardening" the coast with a structure such as a seawall or revetment.

A seawall is a large, concrete wall designed to protect buildings or other man-made structures from beach erosion. A revetment is a cheaper option constructed with "rip rap" such as large boulders, concrete rubble, or even old tires. Although these structures may serve to protect beachfront property for a while, the resulting disruption of the natural coastal processes has consequences for all beaches in the area. Seawalls inhibit the natural ability of the beach to adjust its slope to the ever-changing ocean wave conditions. Large waves wash up against the seawall and rebound back out to sea carrying large quantities of beach sand with them. With each storm the beach narrows, sand is lost to deeper water, and the longshore current scours the base of the wall. Eventually large waves impact the seawall with such force that a bigger structure becomes necessary to continue to resist the forces of the ocean (Pilkey and Dixon, 1996).

The County, under the Department of Environmental Resources Management, has a shoreline enhancement and restoration program that anticipates the magnitude of beach soil erosion and shoreline areas and takes pro-active measures to protect the coastal areas. The plan is also adaptable to respond to disasters that may impact the shoreline.

The County's 46 miles of ocean shoreline has been subjected to coastal erosion for many years due to the stabilization of inlets, residential and commercial development, and natural forces. The coastal strand ecosystem is one of the most threatened natural systems in Florida due to over-development.

Presently, 33.6 of the County's 46 miles are listed as critically eroded by Florida's Department of Environmental Protection as of July 2023. They also list two (2) non-critically eroded areas (0.9 mile) and one (1) critically eroded inlet shoreline area (0.8 mile). While there is no one solution to beach erosion, several methods are utilized by PBC - each with its own merits and drawbacks. The first approach is to facilitate sand transfer at the inlets in order to restore the natural flow of sand. The second approach includes protecting the existing dunes and beaches and restoring the portions of shoreline that are already degraded. The last approach includes evaluating erosion control structures for use along beaches that may not qualify for a traditional beach fill project or may experience an erosional hot spot.

All approaches include environmental monitoring of the resources to ensure that our effort to restore sand is accomplished in a manner that protects the natural environment to the greatest extent possible. Through the Shoreline Enhancement & Restoration Program, the County is able to provide publicly accessible beaches, support the tourist-based economy, restore beach habitat and protect upland property. Funding for this capital improvement program is derived from a portion of "bed tax" fees administered through the Tourist Development Council, as well as funds from the state, the federal government and municipal partners. Modifications to natural tidal inlets and the creation and stabilization of artificial inlets affect the natural littoral transport of sediments. Therefore, efforts to maintain the natural sediment movement in and around all four (4) inlets in PBC are encouraged. Transfer of material from the north side of an inlet to the south prevents beach quality sand from being lost to the interior of an inlet or from becoming impounded within near shore shoals.

In 2011, the County constructed a new sand transfer plant (STP) and rehabilitated the north and south jetties. The STP is operated by the County and transfers approximately 70,000 cubic yards of material per year to the beaches south of the Inlet. The County also dredges the Inlet's interior sand trap approximately every six (6) years. Sand from the trap is pumped into the nearshore along the beach south of the Inlet.

Since the dissolution of the South Lake Worth Inlet District in 1996, the County has been responsible for the management of the South Lake Worth Inlet (Boynton Inlet) and the development of the Inlet's Management Plan.

PBC utilized a spatial impact for a hazard analysis by which the amount of geographic area is affected by either or both soil and beach erosion vulnerabilities and offset impacts may be felt by the municipality stakeholders.

- Very Low – Minimal geographic area affected,
- Low – Up to 25% of total area or jurisdiction affected,
- Medium – 26%-50% of total area or jurisdiction affected,
- High – 51% or more of total area or jurisdiction affected.

Historic Erosion Events

Hurricanes Frances & Jeanne (September 2004) – Both Hurricanes Frances and Jeanne in 2004 equaled or exceeded the 100-year return period for storm surge in St Lucie, Indian River and southern Brevard Counties when they made landfall on the Martin County shoreline. The highest measured surge level for Category 2 Hurricane Frances was 11.8' (NGVD). The highest surge level for Category 2 Hurricane Jeanne was 10.8' (NGVD). Surge levels in PBC were significantly lower. Both storms caused significant beach erosion along the coastline of PBC.

Tropical Storm Noel November 2007 – Between November 1 and November 4, 2007, high surf associated with Tropical Storm Noel battered the PBC coast. Hardest hit spots were beaches in Jupiter, Singer Island, and South Palm Beach/Lantana, where severe to locally extreme beach erosion occurred. A steel sea wall protecting the Condado condominium complex in Singer Island collapsed, causing cracks to form in the outer walls of the building. In some areas, the dune line was completely eroded, leaving oceanfront buildings sitting precariously on top of 15-foot cliffs looking straight down to the water. A sea wall at the Imperial House condominiums in South Palm Beach collapsed from the pounding surf, and the east portion of the building was evacuated. South of Lantana to Boca Raton, erosion was reported as moderate to severe. Total damage for the County (minus beach restoration costs) was estimated at $4 million. No tide measurements were available from PBC, but storm tide was estimated to have been as high as two (2) to three (3) feet over northern PBC. A strong pressure gradient between high pressure over the Mid-Atlantic States and Tropical Storm Noel over Hispaniola and eastern Cuba caused a prolonged period of strong easterly winds over Southeast Florida and the adjacent waters. As Noel moved north across the western Bahamas, the strong winds continued across southeast Florida. The event caused severe beach erosion, coastal flooding, and minor wind damage. The event began in the last week of October.

Hurricane Sandy of October 25, 2012 – The main impact of Hurricane Sandy to the Palm Beach coast was large northeast swells generated by the storm, which pummeled the Southeast Florida coast with significant beach erosion and coastal flooding. Large breaking waves of possibly over 20 feet were estimated along the coast. As a result, major coastal flooding occurred with the most significant impacts experienced from central Palm Beach north, including the Manalapan area where beachfront structures were threatened by water intrusion. In all, there was an estimated $14 million in damage sustained in PBC. A maximum storm tide of 5.2 feet above mean lower low water (MLLW) was observed at Lake Worth Beach Pier on October 28 at 7:12 a.m. along with a maximum storm surge of 2.28 feet on October 28th at 2:26 a.m. Similar tide and surge levels were measured at the highest daily high tide during this period, generally between 7:00 and 9:00 a.m.

Hurricane Irma of September 10-11, 2017 – Hurricane Irma, which centered over southwest Florida when it made landfall, caused an estimated $44 million dollars in damages from lost sand in PBC, according to County sources (http://cbs12.com/weather/hurricane-stories/hurricane-irma-causes-major-erosion-in-palm-beach-county). The hurricane removed enough sand from the area's 46-mile coastline to fill 380 Olympic-sized swimming pools. A nourishment project completed years ago was undone by the force of the waves and wind from Hurricane Irma. Some sand was also lost in the Town of Palm Beach as well.

Hurricane Nicole November 8-11, 2022 – Hurricane Nicole was a sprawling late-season Category 1 hurricane in November 2022. While beach erosion was notable after this storm, there was less beach erosion than expected in Palm Beach County, due to the wind direction and low tide at the time of Nicole's arrival. Recent dune projects also contributed to the lack of significant beach erosion.

2.1.1.6 Tornadoes

According to NOAA, Florida ranks third in the United States in the average number of tornado strikes, and first in number of tornadoes per square mile according to Florida State University's Florida Climate Center. However, Florida tornadoes are generally weaker than those striking the Plains and other southern states.

Tornadoes are classified using the Enhanced Fujita (EF) Scale as follows:

Scale	Wind speed		Relative frequency	Potential damage	
	mph	km/h			
EF0	65–85	105–137	53.5%	Minor damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.	
EF1	86–110	138–178	31.6%	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.	
EF2	111–135	179–218	10.7%	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.	
EF3	136–165	219–266	3.4%	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.	
EF4	166–200	267–322	0.7%	Extreme damage to near-total destruction. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.	
EF5	>200	>322	<0.1%	Massive Damage. Strong frame houses leveled off foundations and swept away; steel-reinforced concrete structures critically damaged; high-rise buildings have severe structural deformation. Incredible phenomena will occur.	

Figure 2.7: Enhanced Fujita Scale

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. It is generated by a thunderstorm (or sometimes as a result of a hurricane) and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. The damage from a tornado is a result of the high wind velocity and wind-blown debris. The most common type of tornado, the relatively weak and short-lived type, occurs in the warm season with June being the peak month. The strongest, most deadly tornadoes occur in the cool season, from December through April. All of PBC can be affected by a tornado.

According to the Tornado History Project, of the 191 tornadoes seen in PBC between 1950 and January 2023, 130 were classified as F0 tornadoes (68%), 50 (26%) were classified as F1, 10 (5%) were classified as F2, and 1 (0.5%) was classified as an F3 tornado. One (1) death and 102 injuries have been attributed to tornadoes in the County in this period, with total estimated damages of more than 150 million dollars.

When a tornado threatens, only a short amount of time is available for life-or-death decisions. The NWS issues two (2) types of alerts:

- A Tornado Watch means that conditions are favorable for tornadoes to develop.
- A Tornado Warning means that a tornado has actually been sighted.

Historic Tornado Events

August 7, 2002 – On August 7, 2002, there was a Tornado Watch issued by the NWS. Two (2) tornadoes touched down later that evening in the northern part of PBC. Jupiter suffered damage to a shopping plaza. No injuries were reported. A second tornado touched down in unincorporated PBC in a mobile home park causing major damage in some areas. The tornado moved in the direction of east southeast toward Interstate 95. The tornado caused considerable damage to an industrial park located in unincorporated PBC/Riviera Beach. The tornado continued in the same direction damaging several neighborhoods in Riviera Beach. It continued through additional neighborhoods in Riviera Beach just north of Blue Heron Boulevard. The damage path was narrower until it lifted or dissipated near the intersection of Blue Heron Boulevard and Old Dixie Highway.

From all of the evidence considered, including some damage that was very close to F2 damage, National Weather Service Weather Forecast Office (WFO) Miami classified the unincorporated PBC-Riviera Beach tornado as F1 on the Fujita scale, meaning that winds were approximately 72 to 112 mph. The worst damage was apparently caused by winds near the upper end of that range. Miami WFO meteorologists determined that the main path of the tornado was approximately 1/6-mile (200 yards) wide at its widest point and about four (4) miles long. There were no deaths, but 28 individuals suffered minor injuries. There were 22 dwellings destroyed and 226 suffered damage. The damage has been estimated to be $70 to $80 million dollars.

August 19, 2008, Wellington Tornado – At about 1:20 a.m. on August 19, a tornado associated with a spiral band of strong thunderstorms rotating around the circulation of Tropical Storm Fay moved through the Village of Wellington. The tornado began near Polo Mark Middle School near the intersection of Lake Worth Road and Isles View Drive and ended just southwest of Wellington High School. The tornado had an approximate damage path of 2.75 miles from the southeast to the northwest and was around 100 yards wide at its widest point but averaged 70 to 80 yards in width.

The tornado moved through a number of equine farms and polo grounds as well as two (2) subdivisions in Wellington. The most significant damage was to Palm Beach Equine Clinic, where stables were de-roofed, power poles snapped, and many trees fell in crisscrossing patterns. The Equine Veterinary lost more than 95% of its roof tiles; a heavy trailer was tossed about 40 yards from its previous location northwest of the International Polo Club; and an apartment home near Folkstone Circle lost about 70% of its roof tiles. There were no deaths or injuries to people or animals.

March 21, 2009, Palm Beach Gardens Tornado – A warm front lifted north through South Florida during the day of March 21. Unstable air south of the front combined with warm temperatures produced strong and severe thunderstorms over PBC. A total of about 5,000 customers lost power. A tornado touched down in Palm Beach Gardens in the Ballenisles Golf Country Club near Holly and Seagrape Drives. The tornado moved southeast, across Military Trail and Lilac Street, and lifted near Palm Beach Gardens High School. Minor roof damage was noted to a few residential buildings, as well as uprooted trees and a damaged fence near Palm Beach Gardens High School. Final tornado rating was EF0 based on an Emergency Management survey and analysis of damage photos.

March 21, 2009, Glen Ridge Tornado – A second tornado touchdown occurred in West Palm Beach near Palm Beach Lakes Boulevard and Australian Avenue. This is the same storm that produced the tornado in Palm Beach Gardens, but eyewitness reports and photographs indicate a likely second tornado touchdown in the West Palm Beach area. Damage was minor (EF0) consisting of downed traffic signals, broken tree branches, and a flipped bus bench.

August 7, 2010 – A small and short-lived tornado moved through the West Boca area, with numerous reports received of trees down, overturned patio furniture, streetlights knocked down, some roofing shingles blown off houses, and downed power lines from around the intersection of Powerline Road and SW 18th Street to the Boca Point Golf Course. No major structural damage was reported. No damage assessment was performed by PBC officials, due to the minor nature of the damage.

April 12, 2010 – A brief tornado occurred two (2) miles northeast of Belle Glade. The PBC Sheriff's office reported a tornado two (2) miles northeast of the PBC Sheriff's Office substation along state road 80; however, no damages or injuries occurred.

January 25, 2011 – A small and brief tornado touched down in the Cameo Woods development of Boca Raton near the intersection of Camino Real and Military Trail. Damage was exclusively to vegetation, including an uprooted large avocado tree and several large branches snapped off or broken. About 20 trees in total were damaged by the tornado. Estimated wind speeds were in the 70-75 mph range, indicative of an EF0 tornado.

June 24, 2012 – The outer bands from Tropical Storm Debby included severe thunderstorms with severe wind gusts and eight (8) tornadoes occurring over a span of four (4) hours. This event spawned the greatest number of tornadoes in one day over the southern Florida peninsula since October 14, 1964, when Hurricane Isbell also spawned eight (8) tornadoes. All of the tornadoes were of EF0 intensity.

A brief tornado in Lake Worth Beach touched down and damage was confined to a few homes on North A Street and 15th Avenue, between US 1 and I-95. Damage was minor and consisted primarily of vegetation and debris from a nearby park.

The first report of damage was to a carport south of Okeechobee Boulevard and east of I-95. The tornado traveled through a warehouse district just south of Okeechobee Boulevard and east of Australian Avenue, damaging roofs and doors to a warehouse building. The tornado then crossed Okeechobee Boulevard and traveled between Australian and Tamarind Avenues, damaging trees and knocking down a large metal gate at the West Palm Beach train station. A railroad-crossing arm was broken at Tamarind Avenue and Banyan Boulevard. The tornado followed a discontinuous path of 1.2 miles and its width of probably no more than 20 yards. Maximum winds were likely in the upper end of EF0 scale (75-85 mph), with most areas along the path probably experiencing low end EF0 winds (65-75 mph).

June 6, 2013 – Convective rain bands associated with Tropical Storm Andrea streamed across South Florida spawning three (3) tornadoes that affected PBC. The first (EF-0) affected the town of Belle Glade with minor damage to trees and power lines. Another tornado (EF-1 with maximum sustained winds of 100 mph) ripped through The Acreage community damaging several homes and snapped trees and power lines as it tracked across a residential area just west of 130th Avenue between 69th Street and 87th Street. Most damage was to roofs; the garage door of one (1) home was damaged leading to the roof being completely punctured above the garage. A few vehicles were also moved from their original locations and a 30-foot boat was flipped on its side. There was one (1) serious injury from this tornado when an 85-year-old woman was struck by flying debris from a large oak tree that broke through her bedroom window. A third (EF-0) tornado touched down across inland Broward County just east of U.S. Highway 27 about six (6) miles north of Alligator Alley and tracked north, likely crossing over into southern PBC.

January 28, 2016 – A line of strong storms moved onto the Gulf Coast just after 5:00 a.m. and moved across the South Central Florida peninsula. A small area of rotation quickly developed at the northern end of the line as it approached the PBC coast. A brief EF-0 tornado touched down in Delray Beach and Boynton Beach.

January 23, 2017 – A strong squall line intensified well ahead of a cold front over the eastern Gulf of Mexico during the early morning hours of January 23. The line produced tornadoes in Palm Beach and Miami-Dade counties. Tornado damage was first noted in the Mirabella neighborhood of Palm Beach Gardens west of the Florida Turnpike between PGA Boulevard and Donald Ross Road, then followed a somewhat discontinuous path ENE across Palm Beach Gardens to Juno Beach where it moved offshore at the Juno Beach Pier.

At Dwyer High School, the tornadic winds as well as flying debris broke windows, damaged a softball field and caused a small hole in the ceiling over a classroom in the school's main building. It continued into Juno Beach Condo Mobile Home Park where eight (8) units sustained damage. The tornado moved offshore at the Juno Beach Pier around 1:49 a.m. where a wind gust of 87 mph was recorded at Juno Beach Pier at 1:50 a.m. The roof was lifted off of one (1) lifeguard stand near the pier, and wood railings were damaged at the north side of the pier.

May 14, 2018 – A severe thunderstorm along a band of convection spawned a brief EF-0 tornado over The Acreage in Palm Beach County touched down. The tornado lasted approximately 4 minutes and was 1.5 miles long. Damage consisted primarily of snapped tree branches, uprooted trees, downed fences, and power lines along the tornado's path. Several homes suffered minor roof damage in the form of shingles being blown off. Two homes sustained damage to side doors, and one home had a set of windowpanes blown out. Several sheds were damaged, a few horse stables lost their covering, and a chicken coop was destroyed. The estimated peak wind was in the 75-80 mph range.

July 25, 2019 – Deep tropical moisture with light wind flow across the region. A stalled front across north central Florida and a mid-upper-level shortwave moving through the region with cold temperatures aloft. 500 mb temperatures were around -8C, which allowed for some robust convection to be able to develop across the east coast metro. Storms produced hail across Miami-Dade and a brief tornado in Palm Beach County.

An NWS storm survey team found tree damage consistent with a weak Ef-0 tornado in the Haverhill area including Haverhill Park along Club Road. Damage consisted of downed tree limbs and a broken mailbox.

April 17, 2020 – A warm front moving north across South Florida, along with a warm and moist local atmosphere, provided support for the development of thunderstorms. Several outflow boundary collisions from nearby storms helped produce a short-lived Palm Beach County tornado.

The NWS storm survey team found damage consistent with an EF-0 tornado in the San Castle neighborhood in Palm Beach County. This area is east of I-95 tucked right between the Boynton Beach and Hypoluxo city limits. Track began near Miner Road and Summit Road, and tracked N-NE between Summit and Grove Road, with the heaviest damage along Brown Road. The track then shifted east of Summit Road from Wilkinson Road to Overlook Road where it lifted near Monroe Boulevard. Damage consisted of multiple downed tree limbs and minor damage to home roofs and fences.

September 27, 2022 – A strong tornado affected portions of Boca Raton and unincorporated Delray Beach on the evening of September 27th, 2022. The beginning of the identified damage was at the Florida Atlantic University Campus in Boca Raton, where siding was torn off of a building. Doppler radar showed evidence of strong rotation along the track; however, damage reports are unavailable for the remainder of the Boca Raton portion of the track. EF-0 damage was noted at the American Heritage School just south of Linton Blvd where trees were uprooted, and fences were damaged. The tornado intensified after crossing Linton Blvd and entered the Kings Point community. Considerable damage to condominium buildings, trees, and vehicles was noted. EF-1 and EF-2 damage was common in Kings Point. The roof was completely lifted off of a small two-story building complex, with an adjacent larger two-story building complex having about 25% of its roof lifted. Several palm trees were snapped in the middle, and one of the snapped palm trees crashed into a second-story unit and tore a large hole into the wall. A few cars were flipped and moved, and many large tree branches were snapped at the top of the tree canopies. In Kings Point, 2 people were injured in their homes when their roofs collapsed. One person was rescued from her bathroom after her roof collapsed. A total of about 30 people were evacuated. Just north of the Kings Point community, large tree branches were broken off trees at a Home Depot parking lot at Jog Road and Atlantic Avenue. The tornado continued north of Atlantic Avenue and entered the Villages of Oriole where EF-1 damage was observed to a few homes, mainly in the form of roof uplift and loss of roof covering/shingles. The tornado lifted in the area of Jog Road.

A tornado began in Wellington just north of Greenbriar Park, causing EF-0 to EF-1 damage in the form of torn roof tiles and many broken tree branches in the Wanderer's Golf Course community. The tornado moved northwest into the Lakefield West and Meadow Wood of the Landings communities, causing minor roof damage before crossing Flying Cow Ranch Road and moving over open land south of Southern Boulevard. Damage totals are estimated based on at least 2 dozen homes sustaining roof damage. The tornado crossed Southern Boulevard near Lion Country Safari Road, causing significant tree damage, then passed just west of Lion Country Safari into Loxahatchee where tree trunks were snapped in the Buck Ridge Trail and Hanover Circle area. The last reported damage was fencing damage at Hanover Circle and Duellant Road.
A brief tornado moved through western sections of Loxahatchee at around the same time that another tornado was occurring in the same general area west of Lion Country Safari. The tornado started near Dellwood Road and produced EF1 tree damage as well as roof damage to a single-family home. The last damage point available was along Capet Creek Court where significant damage to the roof of a stable was observed.

April 29, 2023 – Following ample sunshine, mesoscale boundary collisions created afternoon and evening showers and strong thunderstorms across South Florida, especially around Lake Okeechobee and Palm Beach County. A cell merger that began in Palm Beach Gardens was able to take advantage of a favorable environment for tornadoes and spawned an EF-2 tornado in Palm Beach County.

The tornado began in eastern Palm Beach Gardens, just east of Interstate 95, and moved northeast across A1A, passing just south of the Palm Beach Gardens Medical Center. As it moved through the Sanctuary Cove community, it crossed State Road 786 (PGA Boulevard) near the intersection with US-1. After a short trek up US-1, the tornado dissipated before reaching Juno Beach. Light tree damage consistent with an EF-0 was noted near the determined starting point of the tornado. The tornado strengthened quickly to an EF1 as it moved through the Gardens East apartment complex. Significant tree damage ranging from uprooted trees to snapped trunks were noted in this community. The tornado then moved through the Sandalwood Estates |community off of Burns road. Quite a bit of tree debris was scattered throughout this community, with several large trees completely uprooted. One notable damage indicator was a greater than 3-inch diameter branch that pierced the metal roof of a |residence. A countless number of large branches were stripped from trees throughout the community with a few snapped trunks near the worst of the damage in this area. The tornado then moved through the Rainwood community where a home suffered broken windows and had many shingles removed. Similar tree damage continued into this neighborhood.||When the tornado crossed Prosperity Farms Road and entered the Sanctuary Cove community, this was where it strengthened to EF-2 intensity reaching an estimated peak wind of 130 mph. Some of the most substantial structural damage was noted here with collapsed roofs, broken windows, removed roofing material, and debarking of trees. The EF2 tornado then cross the North Palm Beach Waterway where it completely destroyed a manufactured home along the canal bank. As the tornado moved NNE, it crossed into the Point at Palm Beach Gardens community where it created minor structural damage to the complex but had some of its most photographed moments as cars were displaced, flipped, and stacked on each other. The tornado then moved through the City Centre where considerable tree, light post, and street sign damage was noted. As it crossed PGA Blvd the tornado destroyed a dry cleaners business, collapsed large light posts, and even caused a concrete electrical pole to lean. The last notable damage was still at EF2 strength when the tornado crossed US 1 and caused two cars to be flipped and displaced on the opposite side of US 1. Several videos of the |incident were witnessed, as well as one from inside the vehicle, and the survey crew was able to interview one of the drivers. The tornado quickly lifted after crossing US 1 where it caused minor tree damage in a shopping center.

2.1.1.7 Wildfires/Urban Interface Zone

The Wildland/Urban Interface is defined as the area where human development meets or intermingles with undeveloped wildland or vegetative fuels that are both fire-dependent and fire-prone (FEMA, 2022). As residential areas expand into relatively untouched wildlands, people living in these communities are increasingly threatened by wildfires.

There are three (3) different classes of wildland fires. A surface fire is the most common type and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire is usually started by lightning and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildland fires are usually identified by dense smoke that fills the area for miles around.

Rural and large tracts of unimproved lands are susceptible to brush and forest fires capable of threatening life, safety, and property loss in adjacent developed areas if not effectively controlled. Wildfires are caused by numerous sources including arson, carelessness by smokers, individuals burning debris, operating equipment that throws sparks, and children playing with matches. However, the largest number of fires is caused by lightning strikes, which coincides with the height of the thunderstorm season. A major wildland fire can leave a large amount of scorched and barren land, and these areas may not return to pre-fire conditions for decades. If the wildland fire destroys the ground cover, other potential hazards, such as erosion, may develop (FEMA, 2022).

Structures in the wildland/urban interface zone are vulnerable to ignition in three (3) different ways: radiation, convection, and firebrands (National Wildland/Urban Interface Fire Protection Program). Radiating heat from a wildfire can cause ignition by exposure to the structure. The chances of ignition increase as the size of the flames increases, surface area exposed to flames increases, length of exposure time increases, and distance between the structure and the flames decreases. Another source of ignition by wildfire is convection. Ignition of a structure by convection requires the flame to come in contact with the structure. Contact with the convection column is generally not hot enough to ignite a structure. Clearing to prevent flame contact with the structure must include any materials capable of producing even small flames. Wind and steep slopes will tilt the flame and the convection column uphill increasing the chance of igniting a structure. Structures extending out over a slope have the greatest likelihood of ignition from convection.

Firebrands also pose a threat to structures in the wildland/urban interface. A firebrand is a piece of burning material that detaches from a fire due to strong convection drafts in the burning zone. They can be carried a long distance [approximately one (1) mile] by fire drafts and winds. The chance of these firebrands igniting a structure depends on the size of the firebrand, how long it burns after contact, and the materials, design, and construction of the structure.

The LMS Revisions Sub-Committee based wildfire (above) and Muck Fire (below) impacts on a severity scale based on the magnitude of the hazard and the on-going mitigation measures in place to counteract those hazards. The severity describes how intense a hazard may be felt and comprised of its impacts, as well as any mitigation actions to offset the impacts.

- Magnitude – the degree to which impacts may be felt or a measured intensity: Human Impacts – Possibility of death or injury to the population.
    - Very Low – Minimal possibility of death or injury.
    - Low – Less than 2 deaths or 10 injuries reported or expected.
    - Medium – Between 2 – 5 deaths or 10 – 25 injuries reported or expected.
    - High – More than 5 deaths or 25 injuries reported or expected.

- Property Impacts – Physical losses and damages to property, buildings, or other critical infrastructure.
    - Very Low – Minimal possibility of physical loss and/or damage.
    - Low – Physical losses and/or damages are reported or expected to be less than $10,000.
    - Medium – Physical losses and/or damages are reported or expected to be between $10,000 and $1,000,000.
    - High – Physical losses and/or damages are reported or expected to be greater than $1,000,000.

- Spatial Impacts – Amount of geographic area affected.
    - Very Low – Minimal geographic area affected.
    - Low – Up to 25% of total area or jurisdiction affected.
    - Medium – 26%-50% of total area or jurisdiction affected.

  - High – 50% or more of total area or jurisdiction affected.

- Economic Impacts (Interruption of businesses, infrastructure, or government services).
  - Very Low – Minimal interruption of services or no more than 12 hours.
  - Low – Interruption of services between 1 – 3 days.
  - Medium – Interruption of services between 3 – 7 days.
  - High – Interruption of services greater than 7 days.

Historic Wildfire Events

April 15, 1999 – Just north of PBC in Port St. Lucie, a wildfire consumed 42 homes in 24 hours. Every fire unit in St. Lucie County and assistance from Indian River, Martin, Palm Beach, Broward, and Okeechobee Counties and units from two (2) Division of Forestry Districts, two (2) helicopters, and a Type 1 Air Tanker contained the fire after 26 hours. Due to the near perfect wildfire conditions, the fire suppression units were unable to keep up with these rapidly moving fires. The estimated damage was $4.2 million. Over 5,000 people were evacuated, most self-evacuated from the area.

April 10, 2002 – A brush fire occurred in a heavily wooded area just east of the Acreage on the north side of Northlake Boulevard. Fueled by high winds, and low humidity, the fire eventually burned approximately 450 acres, destroyed a number of vehicles and trailers stored on the property, and required several days to fully extinguish. A helicopter was called in to aid in extinguishing the wildfire. The helicopter made a total of 58 water drops. A loss of $250,000 of timber was lost in relation to the wildfire.

The five (5) federal agencies managing forest fire response and planning for almost 10 million acres in Florida are the United States Forest Service, the Bureau of Land Management, Bureau of Indian Affairs, the National Park Service, and the United States Fish and Wildlife Services. There are other State agencies that have a significant number of wildfires but conduct a lot of prescribed fires, namely the Florida Forest Service. They determine the magnitude of size, intensity, acreage, and potential for evacuations. The county has over 587,649 acres of vegetation and trees that could be potentially destroyed or damaged in an uncontrolled muck or wildfire. The majority of these areas are in the western and southwestern part portion of county. These acres are under contract with the Florida Department of Agriculture and Consumer Services (FDACS) to be protected in case of fire in coordination with Palm Beach Country Fire Rescue.

2.1.1.8 Pandemic/Communicable Diseases

Infectious diseases emerging throughout history have included some of the most feared plagues of the past. New infections continue to emerge today, while many of the old plagues are still with us. As demonstrated by influenza pandemics, under suitable circumstances, a new infection first appearing anywhere in the world could travel across entire continents within days or weeks (Morse, 1996). Due to the potential of complex health and medical conditions that can threaten the general population, Florida's vulnerability to a pandemic is continually monitored. With millions of tourists arriving and departing the state annually, disease and exposure (airborne, vector, and ingestion) are constantly evaluated and analyzed.

Primarily as a result of the entrance of undocumented noncitizens into south Florida, and the large number of small wildlife, previously controlled or eradicated diseases have surfaced. Health officials closely monitor this potential threat to the public health. The emphasis upon preventive medical measures such as school inoculation, pet licensing, rodent/insect eradication, water purification, sanitary waste disposal, health inspections, and public health education mitigate this potential disaster.

Another potential threat to south Florida's population is food contamination. Frequent news stories document that *E.coli* and botulism breakouts throughout the country are not that uncommon.

While this plan addresses all potential pandemic diseases, those that have actually affected PBC will be addressed in that disease discussion.

Avian (Bird Flu) H5N1

Although there are many forms of bird flu, the form that has most recently concerned health officials is the H5N1 flu virus carried by wild birds. While wild birds seldom get sick from the virus, they can easily pass the virus to farm birds such as chickens, ducks, and turkeys being raised for food. There have been very few rare cases of H5N1 being transmitted to humans, mostly in Asia. The Centers for Disease Control (CDC) recommends if you work closely with birds such as poultry farms, and develop conjunctivitis or flu-like symptoms, to seek medical attention to rule out H5N1.

Swine Flu A (H1N1)

One way an antigenic shift can occur is through pigs. Pigs can be infected with both avian and human influenza viruses. If pigs become infected with viruses from different species at the same time, it is possible for genes of the viruses to mix and create a new virus for which humans have no natural immunity. This is termed by the CDC as a "variant" virus.

According to the CDC, estimating the number of individual flu cases in the United States is very challenging because many people with flu don't seek medical care and only a small number of those that do seek care are tested. More people who are hospitalized or die of flu-related causes are tested and reported, but under-reporting of hospitalizations and deaths occur as well. For this reason, CDC monitors influenza activity levels, trends, and virus characteristics through a nationwide surveillance system and uses statistical modeling to estimate the burden of flu illness (including hospitalizations and deaths) in the United States.

Influenza viruses that normally circulate in pigs are called "variant" viruses when they are found in people. Influenza A H3N2 variant viruses (also known as "H3N2v" viruses) with the matrix (M) gene from the 2009 H1N1 pandemic virus were first detected in people in July 2011. The viruses were first identified in U.S. pigs in 2010. In 2011, 12 cases of H3N2v infection were detected in the United States (Indiana, Iowa, Maine, Pennsylvania, and West Virginia). In 2012, 309 cases of H3N2v infection across 12 states were detected. In 2013, 19 cases of H3N2v across five (5) states were detected.

The CDC assessment from 2017 states that it is possible that sporadic infections and even localized outbreaks among people with this virus may occur. While there is no evidence at this time that sustained human-to-human transmission has occurred, all influenza viruses have the capacity to change. It is possible that this virus may change and become widespread in people. Illness associated with H3N2v infection so far has been mostly mild with symptoms similar to those of seasonal flu. Like seasonal flu, however, serious illness, resulting in hospitalization and death is possible.

There have been no documented cases of any of the H1N1 or variants in the state of Florida since 2011.

MERS-CoV

MERS-CoV is a novel corona virus causing severe acute respiratory illness. Corona viruses are transmitted by close person-to-person contact. Corona viruses are thought to be transmitted most readily by respiratory droplets produced when an infected person coughs or sneezes or through living with or caring with someone who has a confirmed case of MERS. The virus can also spread when a person touches a surface or object contaminated with infectious droplets and then touches his or her mouth, nose, or eye(s). Signs and symptoms of MERS-CoV are fever, cough, and shortness of breath. The death rate is 30-40% of all people who have reported with MERS.

West Nile Virus

The PBC Health Department reported cases of the West Nile Virus in 2002, 2002, 2010, and 2011. This disease is transmitted by mosquitoes. Health notifications were given throughout the County both years to alert and caution the public. Individuals were advised to take precautions when outdoors and to try to avoid being outside after dusk.

The West Nile Virus is an arthropod-borne virus (arbovirus) most commonly spread through infected mosquitoes. In a very small number of cases, the virus has been transmitted through blood transfusions, organ transplants, and from mother to baby during pregnancy, delivery, or breastfeeding. Most people (70-80%) who contract West Nile Virus never develop symptoms. Those with symptoms include a fever with headache, body aches, joint pains, vomiting, diarrhea, or rash. Some severe symptoms (less than 1% will exhibit) are serious neurologic illness such as encephalitis or meningitis.

SARS

Severe Acute Respiratory Syndrome (SARS) is a viral respiratory illness caused by a corona virus, called SARS-associated corona virus (SARS-CoV). It is transmitted by close person-to-person contact. The virus that causes SARS is thought to be most readily spread by respiratory droplets produced when an infected person coughs or sneezes, or when a person touches a surface or object contaminated with infectious droplets and then touches his/her nose, mouth, or eyes. Signs and symptoms of SARS generally begins with a high fever (greater than 100.4 degrees Fahrenheit) and may include headache, overall feeling of discomfort, and body aches. Some people will also have mild respiratory symptoms.

Malaria

Malaria is a parasite (*P.faliciparum, P.vivax, P.malariae,* and *P.ovale*) that infects humans primarily after being bitten by an infected mosquito. It also can be transmitted from infected mothers to their babies during pregnancy or during delivery, and in rare cases, through blood transfusions. Malaria was eradicated from the US in the early 1950's, and nearly all cases today in the US are from recent overseas travelers. On June 26, 2023, the Florida Department of Health issued a statewide mosquito-borne illness advisory following the detection of seven (7) local cases of malaria in Sarasota County.

Symptoms of malaria include fever and flu-like illness, including chills, headache, muscle aches, and tiredness. Nausea, vomiting, and diarrhea may also occur. For most people, symptoms begin ten (10) days to four (4) weeks after infection, although a person may feel ill as early as eight (8) days or as late as one (1) year later.

Dengue

Dengue fever is caused by any of four (4) closely related viruses, or serotypes of dengue 1-4. Dengue is transmitted by the bite of infected mosquitoes (*Aedes aegypti* and *Aedes albopictus*) which are found throughout the world, including PBC. Signs and symptoms include severe headache, high fever, severe eye pain (behind the eyes), muscle, bone, and joint pain, low white cell count, mild bleeding manifestation (e.g., nose or gum bleed, petechiae, or easy bruising), and rash. In 2022, there were 750 travel-associated and 57 locally transmitted cases of Dengue in the state.

Dengue hemorrhagic fever is a similar illness but also occurring with hemorrhagic manifestations. A person can be infected separately by all four (4) dengue fever serotypes, and research has shown that infection by more than one increases the chances of developing dengue hemorrhagic fever.

Ebola

Ebola Virus Disease is a rare and deadly disease most commonly affecting people and nonhuman primates (monkeys, gorillas, and chimpanzees). It is caused by an infection of one (1) of five (5) known Ebola virus species, four (4) of which can cause disease in people: Ebola virus, Sudan virus, Tai Forest virus, Bundibugyo virus, and Reston virus (only nonhuman primates and pigs, not humans). Ebola spreads to people through direct contact with bodily fluids of a person who is sick or who has died from the virus. It enters through broken skin or mucous membranes in the eyes, nose, or mouth. In 2014, the Ebola virus drew national attention with one (1) suspected case in the County. DEM worked with Florida Health and other key stakeholders to develop the Port of Entry sections of this plan that would mitigate against passengers coming into PBC affected with any communicable disease. As of March 29, 2016, the World Health Organization terminated the Public Health Emergency of International Concern for the Ebola outbreak in West Africa. There have been no cases in the US since before that time.

Zika

Zika is a virus which spreads to people primarily through the bite of an infected *Aedes* species mosquito. It can also be passed through sex from a person who has Zika to his or her sex partners, and it can be spread from a pregnant woman to her fetus. In 2015, Zika was not a nationally reportable disease however, nine (9) cases, representing 15% of all US cases of symptomatic infections, occurred in the State of Florida. In 2016, Florida reported 1,115 cases, representing 22% of all US cases of infections. In 2017, this number dropped significantly to 110 cases, and in 2018 dropped again to 14. As of this writing, there have been no reported cases in Florida in 2019. This is due to efforts by local, state, federal, health, and government officials identifying outbreaks and using mitigation strategies (i.e. mosquito spraying) to reduce the chances of infected mosquitoes transmitting the virus.

The County has a very active mosquito spraying program which has likely limited the spread of Zika from the *Aedes* species mosquito.

Coronavirus

Covid-19 also known as the coronavirus disease, originated in late 2019 in China. It is caused by the SARS-Cov-2 virus. The disease quickly spread globally, leading to a pandemic. Covid-19 has had a significant impact on public health, economies, and daily life. Efforts to control the spread of the virus have included lockdowns, social distancing, mask wearing, and vaccination campaigns. It is transmitted by close person-to-person contact. The virus that causes Covid-19 is thought to be most readily spread by respiratory droplets produced when an infected person coughs or sneezes, or when a person touches a surface or object contaminated with infectious droplets and then touches his/her nose, mouth, or eyes. Signs and symptoms of Covid-19 generally begins with a high fever (greater than 100.4 degrees Fahrenheit) and may include headache, overall feeling of discomfort, and body aches. Some people will also have mild respiratory symptoms.

PBC bases Pandemic Diseases on a probability scale of occurrence. This scale takes into effect the likelihood that PBC will be impacted by disease hazards within a given period of time or the return rate of a hazard and is based on the historical data, estimated return periods, recurrence, or chance of occurrence.

Very Low	Although the hazard is noted, no previous occurrence has been recorded; or less than a 0.1% chance of occurrence; or a 100-year event or greater.

Low	The hazard has occurred 10 years or more ago; or greater than 0.1% to 1.0% chance of occurrence; or a 100-year event.
Medium	The hazard has occurred in the past 6 to 10 years; or greater than 1.0% to 2.0% chance of occurrence; or a 50-year event.
High	The hazard to occurred in the past 1-5 years; or greater than 2.0% chance of occurrence; or less than a 50-year event.

2.1.1.9 Drought

Drought is a normal, recurrent feature of climate, although many perceive it as a rare and random event. In fact, each year some part of the U.S. has severe or extreme drought. Even in Florida, where annual rainfall averages about 54 to 56 inches, drought is a regular part of the climate. Although drought is generally defined as a "deficiency of precipitation over an extended period of time (usually a season or more) resulting in a water shortage. Droughts can lead to a wide range of environmental, social, and economic impacts. Droughts are second to hurricanes in terms of damage costs when they occur (Drought.gov 2023).

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area producing physical drought. This complexity exists because water is essential to our ability to produce goods and provide services (National Drought Mitigation Center, 1998).

A few examples of direct impacts of drought are reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitats. Social impacts include public safety; health issues; conflicts between water users; reduced quality of life; and inequities in the distribution of impacts and disaster relief. Income loss is another indicator used in assessing the impacts of drought; reduced income for farmers has a ripple effect throughout the region's economy (National Drought Mitigation Center, 1998).

The impact is so diffuse that it is difficult to come up with financial estimates of damages. However, FEMA estimates $6-8 billion in losses as the annual average. The worst drought in recent history occurred in 1987-1989, and the National Climatic Data Center reports the estimated cost as $40 billion (National Drought Mitigation Center, 1998).

In PBC, the primary sources of water are Lake Okeechobee, watershed areas, and the County's wellfields. Normally, excess water from an interconnected series of lakes, rivers, canals, and marshes flows into Lake Okeechobee via the Kissimmee River. When this cycle is disrupted by periods of drought, one of the potentially most damaging effects is substantial crop loss in the western agriculture areas of the County. In addition to obvious losses in yields in both crop and livestock production, drought in PBC is associated with increases in insect infestations, plant disease, and wind erosion. The incidence of wildfires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk.

The county averages between 50 and 60 inches of rain per year, with annual rainfall varying up to 20 inches above or below the annual average. The SFWMD and County staff manage the County's water resources. A countywide, uniform, forceful, contingency plan is in place to effectively restrict the use of water that complements the District's water management efforts during periods of critical water shortage.

The worst drought on record for PBC was from November 2000 to February 2001. Lake Okeechobee dropped from 18 feet after Hurricane Irene in October of 1999 to nine (9) feet by May of 2001. Lake Okeechobee's average is about 12 feet. The year 2000 was also the driest year on record for the State of Florida.

The graph below shows periods of drought for PBC from January 2000 through January 2024. The y-axis is the percentage of PBC covered by drought conditions, and the colors indicate the drought levels as defined by the US Drought Monitor in the legend below the graph. According to this data, exceptional drought occurred in the County in the winters of 2001 and 2011, extreme drought conditions occurring in 2007 and 2009, and 2023 as one of the driest driest years recorded.

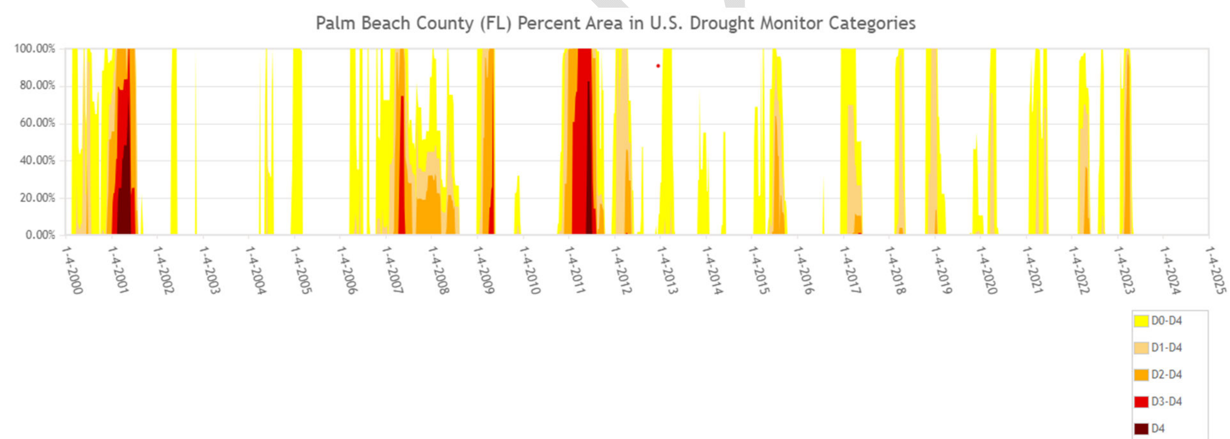


Figure 2.8: PBC Droughts January 2000 through January 2024

Historic Drought Events

The following are significant droughts that have affected PBC since 1970 but did not result in major negative impacts to the county.

1980 – 1982 Drought – The 1980–1982 Drought was one of the most severe droughts ever in South Florida. A more than 20-inch rainfall deficit over two (2) years resulted in the decline of the Lake Okeechobee stage from 17.46 feet NGVD on January 1, 1980, to 9.79 feet NGVD on July 21, 1981. The 7.7-foot drop in water level was attributed to a decrease in rainfall and increases in evaporation and water use. The drought for the Lower East Coast and Water Conservation Areas was relieved in 1981 by Tropical Storm Dennis.

1988 – 1989 Drought – South Florida experienced a severe drought from September 1988 to August 1989, during which there was a 21-inch rainfall deficit in the Everglades Agricultural Area and the Lower East Coast. The Lake Okeechobee water level declined from 15.95 feet NGVD on September 1, 1988, to 11.06 feet NGVD on August 8, 1989. During the same period, record storage depletion was reported for Lake Okeechobee and the Water Conservation Area.

1990 Drought – The 1990 drought was a continuation of the 1988–1989 drought. From June 1989 through May 1990, a nine-inch rainfall deficit occurred District-wide and was most severe in Everglades National Park. Lake Okeechobee supply-side management and water restrictions were implemented to conserve lake water. The Lake Okeechobee water level declined from 12.25 feet NGVD on January 1, 1990, to 10.47 feet NGVD on June 21, 1990.

2000 - 2001 Drought – A new low water level record of 8.97 feet NGVD was set for Lake Okeechobee on May 24, 2001, during the 2000–2001 drought in South Florida. This is considered the worst drought on record for PBC, and also the driest year on record for the State of Florida.

2007 Drought – A severe drought affected the region from late 2006 through 2007, following back-to-back years of unprecedented hurricane activity and higher-than-normal rainfall. On July 2, 2007, water levels in Lake Okeechobee reached an all-time record low of 8.82 feet, eclipsing the mark of 8.97 feet set during the 2001 drought. Rainfall directly over the lake was low enough to qualify the 2007 drought as a 1-in-100-year event. Only 40 inches of rain fell on the region in an 18-month period, about half the average. More than 200 days passed without water flowing from the Kissimmee River into Lake Okeechobee. This also marked the first time SFWMD experienced a situation where all three (3) major water storage areas of the system – the Upper Kissimmee Chain of Lakes, Lake Okeechobee, and the Water Conservation Areas – simultaneously had substantially below normal water levels approaching record lows.

A combination of voluntary and mandatory water use restrictions were enacted by the SFWMD in early 2007. Widespread drought conditions continued into late 2007, particularly in the Lake Okeechobee watershed.

A wetter than normal spring and summer of 2008 finally interrupted the extended drought. Water use restrictions continued into 2009 and beyond, in order to balance longer-term regional water availability and supply needs.

August 2011 Drought – Rainfall amounts in August ranged from four (4) to six (6) inches over parts of interior southwest Florida to over ten (10) inches over parts of southeast Florida. Overall, rainfall averaged near to above average over most areas, leading to gradually improving drought conditions. Lake Okeechobee remained over two (2) feet below the normal level for this time of year. Underground water levels remained below normal over much of south Florida, especially over the metro east coast sections.

2.1.1.10 Agricultural Pests and Diseases

According to FDACS, Florida ranks 15th amoung all states in number of farms and 30th in land farms. Florida agriculture generated farm cash receipts totaling $7.41 billion in 2020. All crops accounted for 80.3% of total cash receipts. The market value of agricultural products sold, including food and marketing practices and value-added products was $901 million in 2017. The USDA's Ag Census will be updated later in 2024. The industry is susceptible to many hazards including freezes, droughts, and exotic pests or diseases. Agricultural crops grown throughout the state and every region are vulnerable to the effects of an exotic pest or disease infestations.

According to PBC Cooperative Extension, the County is one of the 10 largest agricultural counties in the United States and leads the state of Florida in total agricultural sales with an estimated $1.397 billion in 2019-2020. Palm Beach County leads the nation in the production of sugarcane, fresh sweet corn, and sweet bell peppers. It leads the State in the production of rice, lettuce, radishes, Chinese vegetables, specialty leaf, and celery. The main threats to the PBC agriculture industry are Citrus Canker, HLB (greening disease), the Mediterranean Fruit Fly (Medfly), and sugarcane pests.

However, as it relates to PBC, we have not experienced or had any issues as it relates to Agricultural Pest and Disease over the past 20 years.

Citrus Canker

Citrus Canker was found in PBC in numerous locations in 2002. The FDACS reported cases of orange and grapefruit trees infected in the southern and northern parts of the County. Citrus Canker is a bacterial disease that causes premature leaf and fruit drop. It affects all types of citruses, including oranges, sour oranges, grapefruit, tangerines, lemons, and limes. Symptoms found on leaves and fruit are brown, raised lesions surrounded by an oily, water-soaked area and a yellow ring or halo.

There is no known chemical compound that will destroy the Citrus Canker bacteria. In order to eradicate the disease, infected trees must be cut down and disposed of properly. In 2002, legal cases over the cutting down of infected and exposed trees began when citrus canker was discovered in PBC. The FDACS wanted to search a 70-square-mile area of PBC for diseased trees. It is a highly contagious disease that can be spread rapidly by windborne rain, lawnmowers and other landscaping equipment, animals and birds, people carrying the infection on their hands or clothing, and moving infected or exposed plants or plant parts. There is great potential to affect Florida's $785 million citrus industry.

Huanglongbing (HLB)/Citrus Greening Disease

Huanglongbing (HLB), also known as citrus greening or yellow dragon disease, is one of the most serious citrus diseases in the world. It is widespread in Asia, Africa, and the Saudi Arabian Peninsula. In July 2004 it was reported in Brazil, and in August 2005 it was found for the first time in the U.S. in south Miami-Dade County. Huanglongbing is a bacterial disease that attacks the vascular system of plants. Once infected, there is no cure for the disease, and in areas where the disease is endemic, citrus trees decline and die within a few years. There are three (3) known forms: Asian, African and Brazilian. The HLB bacteria is transmitted primarily by insect vectors (Asian citrus psyllids) but can also be spread through plant grafting and movement of infected plant material. Even though the pathogens are bacteria, the disease does not spread by casual contamination of personnel and tools or by wind and rain. Though citrus is the primary plant host for HLB, other citrus relatives can also get the disease. Common HLB host plants include the Chinese box orange (Severinia buxifolia) and the curry leaf (Murraya koenigii). While HLB disease and the Asian psyllid share many of the same host plants, some host plants are specific to the disease and others to the psyllid.

The entire State is under Federal quarantine for citrus greening and Asian citrus psyllid. Federal law restricts the movement of live citrus plants, plant parts, budwood, or cuttings outside of Florida. Subsequent U.S. detections of the disease have occurred in numerous citrus-producing States and U.S. Territories.

The map on the following page from FDACS indicates instances of citrus canker and citrus greening in South Florida, including PBC.

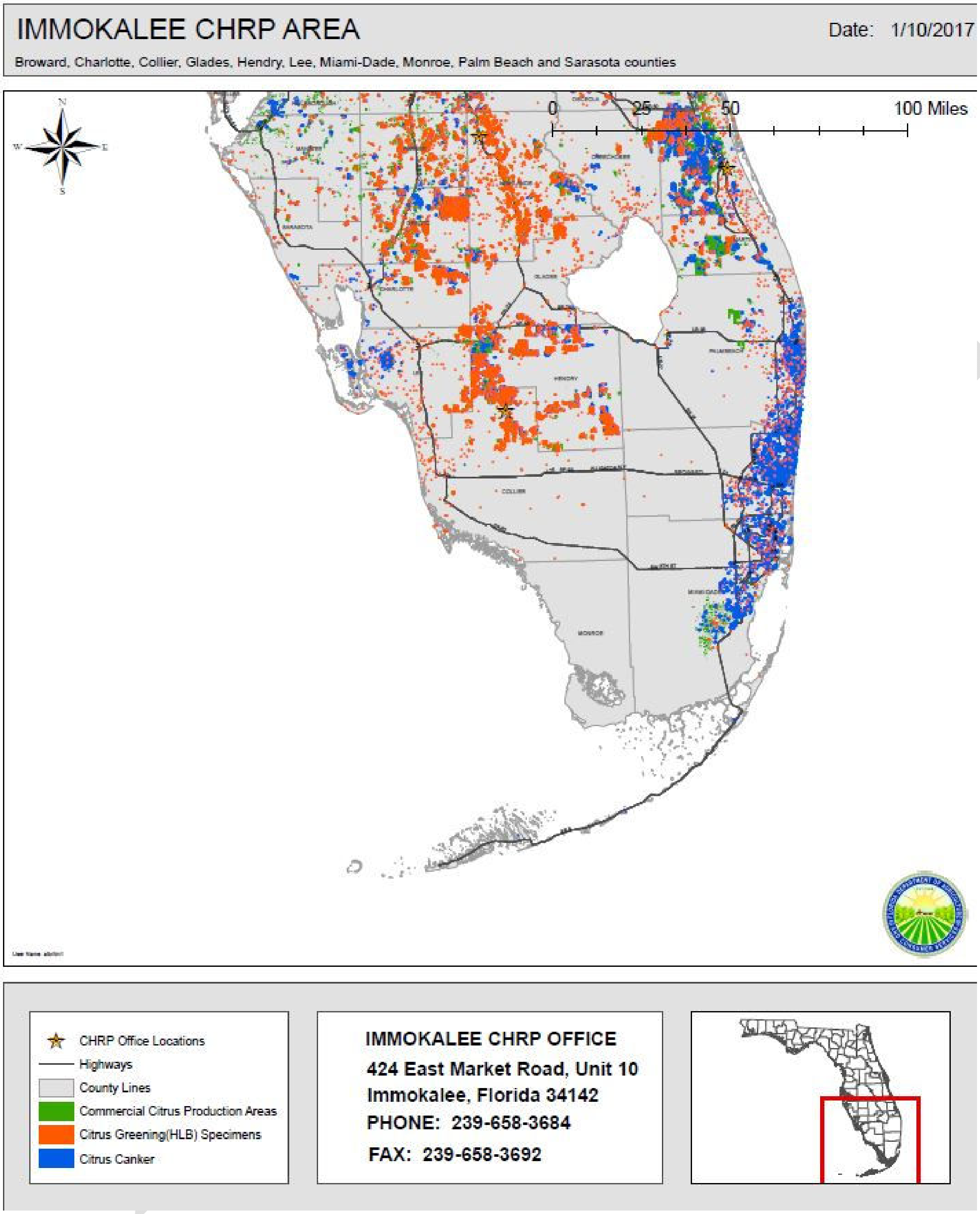


Figure 2.9: Citrus Canker and Citrus Greening in South Florida

Mediterranean Fruit Fly (Medfly)

Another possible threat to PBC's agriculture industry has been the Medfly. It is one of the world's most destructive pests and infests more than 250 different plants that are important for U.S. food producers, homeowners, and wildlife. It had been considered one of the greatest pest threats to Florida's $785 million citrus industry, as well as endangering many other economically significant crops. For example, a Medfly outbreak in 1997 cost an estimated $26 million to eradicate. Florida growers were not permitted to ship numerous fruit and vegetable crops to many foreign and domestic markets. The movement of fruits and vegetables, even within the state if affected, would be disrupted, which could lead to higher prices in the supermarket.

Adult Medflies are up to 1/4 inch long, black with yellow abdomens, and have yellow marks on their thoraxes. Their wings are banded with yellow. The female Medfly damages produce by laying eggs in the host fruit or vegetable. The resulting larvae feed on the pulp, rendering the produce unfit for human consumption. In addition to citrus, Medflies will feed on hundreds of other commercial, backyard fruit, and vegetable crops.

Because Medflies are not strong fliers, the pest is spread by the transport of larval-infested fruit. The major threats come from travelers, the U.S. mail, and commercial fruit smugglers. Several steps had been taken to prevent new infestations. State and federal officials working with postal authorities, continue to inspect packages suspected of potentially carrying infested fruit.

Eradication efforts and close inspections have allowed the USDA to report no known Medfly infestations in PBC nor Florida in over 20 years. https://www.invasivespeciesinfo.gov/profile/mediterranean-fruit-fly

The USDA continues to apply Integrated Pest Management to determine the magnitude of pest infestations and crop diseases. It applies an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties.

The PBC LMS Committees have tried to provide the most comprehensive information possible for each potential hazard. In some instances, the information was incomplete or there was only partially available data. Our Committees will continue its research, seek out further analytical tools or databases, and include new information in the LMS whenever possible as part of its annual monitoring.

We based the Medfly hazard on a probability scale of occurrence. This scale takes into effect the likelihood that PBC will be impacted by the hazard within a given period of time or the return rate of a hazard, and is based on the historical data, estimated return periods, recurrence, or chance of occurrence.

Very Low	Although the hazard is noted, no previous occurrence has been recorded; or less than a 0.1% chance of occurrence; or a 100-year event or greater.
Low	The hazard has occurred 10 years or more ago; or greater than 0.1% to 1.0% chance of occurrence; or a 100-year event.

Medium	The hazard has occurred in the past 6 to 10 years; or greater than 1.0% to 2.0% chance of occurrence; or a 50-year event.
High	The hazard to occurred in the past 1-5 years; or greater than 2.0% chance of occurrence; or less than a 50-year event.

Sugarcane Pests and Diseases

Florida is the nation's largest producer of cane sugar accounting for one in every five teaspoons consumed. The Florida sugar industry has a $2 billion economic impact and generates tens of thousands of jobs. Most of the commercial sugarcane industry is located in South Florida around the southern tip of Lake Okeechobee. Palm Beach County accounts for approximately 75% of the commercial sugarcane acreage. The remainder is grown in the adjacent counties of Hendry, Glades, and Martin. The crop is harvested from late-October through mid-April.

As a tropical grass, sugarcane has evolved to resist many pests that are common in semi-tropical environments, but there are still key pests for the crop. These pests include sugarcane borer, white grubs, wireworms, yellow sugarcane aphid, and lesser cornstalk borer on the sugarcane grown on sand. Insect problems vary during the growing season and from one season to the next because of varying factors such as the weather and cultural practices.

There are a number of sugarcane diseases known throughout the world. However, very few have affected Florida sugarcane historically. Until 2008, no fungicides were used in this crop and varietal resistance to brown rust kept this disease under economic thresholds. However, orange rust was found in Florida in 2007, and again, varietal adjustments and several cultivars use fungicides to maintain economically acceptable yields.

We also based the Sugarcane Pests and Diseases hazard on a similar probability scale of occurrence as the Medfly. This scale takes into effect the likelihood that PBC will be impacted by the hazard within a given period of time or the return rate of a hazard and is based on the historical data, estimated return periods, recurrence, or chance of occurrence.

Very Low	Although the hazard is noted, no previous occurrence has been recorded; or less than a 0.1% chance of occurrence; or a 100-year event or greater.
Low	The hazard has occurred 10 years or more ago; or greater than 0.1% to 1.0% chance of occurrence; or a 100-year event.
Medium	The hazard has occurred in the past 6 to 10 years; or greater than 1.0% to 2.0% chance of occurrence; or a 50-year event.
High	The hazard to occurred in the past 1-5 years; or greater than 2.0%

	chance of occurrence; or less than a 50-year event.

There have been no measurable outbreaks recorded for PBC or surrounding counties.

2.1.1.11 Muck Fires

A muck fire is a fire that consumes all the organic material of the forest floor and burns into the underlying soil. It differs from a surface fire by being invulnerable to wind. If the fire gets deep into the ground, it could smolder for several years. In a surface fire, the flames are visible and burning is accelerated by wind, whereas in a muck fire, wind is not generally a serious factor (Canadian Soil Information System, 1996). Another extraordinary fact about muck fires has to do with their release of carbon dioxide. A peat bog that is on fire can release more carbon dioxide into the atmosphere than all the power stations and car engines emit in Western Europe in one year (New Scientist, 1997). This type of fire could have a significant impact on the overall climate. Much like wildfires, we based this hazard on a severity scale as indicated above.

Muck fires are not a frequent threat to Florida. However, during a drought in the 1980s, fires in the Everglades consumed the rich, dried out muck that had once been the bottom of the swamp. These fires burned deep into the ground and required specialized, non-traditional firefighting techniques.

A muck fire occurred in June of 1999. There were about 20,000 acres of muck, brush, and sawgrass on fire in the Rotenberger Wildlife Management Area located in Southwestern PBC.

In May 2008, a muck fire, spawned by an extended drought, scorched the dried edges of Lake Okeechobee between Moore Haven and Clewiston covering an area of over 5,800 acres.

In PBC, most of the muck area is owned by the sugar cane industry and not owned by the county. The corporation conducts controlled burns each year to over 300,000 acres of muck area to prepare the land for seasonal growth. These areas are monitored very closely. The National Park Service or the Florida Forest Service may determine the magnitude of size, intensity, acreage, and potential for evacuations. If a muck fired occurred that required Country resources, they would be provided with coordination.

2.1.1.12 Seismic Hazards

Tsunamis

Recent, widely published, research by British and American scientists warned of potential catastrophic destruction of coastal areas of the Atlantic, including the Florida east coast, by mega tsunami waves generated by a future volcanic collapse in the Canary Islands. The research predicted a gigantic wave would traverse the Atlantic at jet aircraft speeds and devastate the Florida coast as far as 10 miles inland. Such an event would present a tremendous warning challenge and a virtually impossible evacuation response. Subsequent research by the Tsunami Society, a body of scientists solely dedicated to the study of tsunamis, has concluded the threat has been grossly overstated. The society challenged many of the assumptions made relative to the probability and magnitude of a collapse on La Palma and the characteristics of waves should such a collapse occur. The Society notes that there have been no such mega-tsunami events in the Atlantic or Pacific oceans in recorded history.

The threat of a tsunamis impacting PBC is considered to be extremely low (approximately 5% or less per century). Tsunamis are most often generated by earthquake-induced movement of the ocean floor. Landslides, volcanic eruptions, and even meteorites can also generate a tsunami. They are often incorrectly referred to as tidal waves, but a tsunami is actually a series of waves that can travel at speeds averaging 450 (and up to 600) miles per hour in the open ocean. In the open ocean, tsunamis are not felt by ships because the wavelength is hundreds of miles long, while the amplitude is only a few feet. This would also make them unnoticeable from the air. As tsunami waves approach a coast, their speed decreases, and their amplitude increases. Unusual wave heights have been known to be over 100 feet high. However, waves that are 10 to 20 feet high can be very destructive and cause many deaths or injuries.

There have been no reported or recorded Tsunamis in PBC history.

Earthquakes

Florida is not located near tectonic plate boundaries and has the fewest earthquakes of any state. However, several minor shocks have occurred in recorded time, causing little if any damage. PBC has not been susceptible to earthquake activity. Therefore, earthquakes will not be fully profiled in the LMS.

A 4.4 magnitude earthquake struck 99 miles south, southeast from Key West on July 29, 2017.

A 7.7 magnitude earthquake occurred off the coast of Jamaica and was felt on the east coast of South Florida on January 28, 2020. Several buildings in Miami had to be evacuated.

A magnitude 4.7 earthquake occurred 143 miles south southwest from Key West on June 29, 2021.

2.1.1.13 Geologic Hazards

Sinkholes and Subsidence

Sinkholes are a common feature of Florida's landscape. They are only one (1) of many kinds of karst landforms, which include caves, disappearing streams, springs, and underground drainage systems, all of which occur in Florida. Karst is a generic term, which refers to the characteristic terrain produced by erosion processes associated with the chemical weathering and dissolution of limestone or dolomite, the two most common carbonate rocks in Florida. Dissolution of carbonate rocks begins when they are exposed to acidic water. Most rainwater is slightly acidic and usually becomes more acidic as it moves through decaying plant debris. Limestone in Florida is porous, allowing the acidic water to percolate through it, dissolving some and carrying it away in solution. Over time, this persistent erosion process has created extensive underground voids and drainage systems in much of the carbonate rocks throughout the state. Collapse of overlying sediments into the underground cavities produces sinkholes (Florida Geological Survey, 1998). Sink holes vary in size, length and depth.

We based Geological Hazards on a probability scale of occurrence. This scale takes into effect the likelihood that PBC will be impacted by this hazard within a given period of time or the return rate of a hazard and is based on the historical data, estimated return periods, recurrence, or chance of occurrence.

Very Low	Although the hazard is noted, no previous occurrence has been recorded; or less than a 0.1% chance of occurrence; or a 100-year event or greater.
Low	The hazard has occurred 10 years or more ago; or greater than 0.1% to 1.0% chance of occurrence; or a 100-year event.
Medium	The hazard has occurred in the past 6 to 10 years; or greater than 1.0% to 2.0% chance of occurrence; or a 50-year event.
High	The hazard to occurred in the past 1-5 years; or greater than 2.0% chance of occurrence; or less than a 50-year event.

2.1.1.14 Extreme Temperatures

Freezing Temperatures

According to the FDACS, a moderate freeze may be expected in the state every one (1) to two (2) years on average, and severe freezes every 15 to 20 years. Florida has experienced a number of severe or disastrous freezes, where the majority of the winter crops are lost. According to the Florida Climate Center, there have been 12 significant “impact freezes” in the state since 1894, the most recent being in 1996, when a Presidential Disaster Declaration was issued for crop losses exceeding $90 billion dollars. During this event, there was an extensive loss of citrus trees with the majority not being replanted. Freezes pose a major hazard to the agriculture industry in PBC on a recurring basis and are a significant threat to the economic vitality of the County’s agriculture industry. The county has experienced seven (7) significant freezes between 1970 and the present.

Freezing conditions primarily affect agriculture and homeless people in PBC. While PBC enjoys warm weather throughout the year, freezing does occur, primarily in the months late December and January. During the nighttime hours, temperatures can dip to as low as 35 degrees, but this normally is not sustained for more than three (3) hours before the temperatures rises above 40 degrees. The County’s *Cold Weather Shelter Plan* may be implemented when the nighttime temperature is forecast to fall to ≤40˚F and/or ≤45˚F during forecast precipitation and/or the wind chill factor is ≤35˚F for periods of four (4) consecutive hours or more in PBC. In the past five (5) years, the shelters have only been activated four (4) times for one (1) day each and once for two (2) days. . When conditions are predicted to fall below thresholds, the Duty Officer is alerted by the County Warning Point.

Historic Freeze Events

1977 Freeze – Climaxing one of the coldest winters ever recorded in the eastern United States, a severe cold outbreak of arctic air swept into Florida January 18 through 21, 1977. Snow was reported as far south as Homestead and a severe freeze affected all of the State's citrus and vegetable crops.

In South Florida agricultural areas, the freeze was one of the most severe of this century. Temperatures were below freezing for l0 to l4 hours, and 28°F or colder for four (4) to eight (8) hours. An unusually heavy frost accompanied these freezing temperatures and extended to the coast. West Palm Beach recorded an all-time low of 27°F. Some farmers in the area reported temperatures near 20°F. A USDA report indicated the following crop losses statewide: Citrus 25%, vegetables 95-l00%, commercial flowers 50-75%, permanent pastureland 50%, sugar cane 40%. It is estimated the 1977 freeze cost the Florida economy $2 billion (1977 dollars).

1989 Freeze – Tens of millions of dollars, if not hundreds of millions of dollars, in losses are possible. A second freeze occurred two (2) weeks later causing some additional crop damage but was not as severe.

2009 Freeze – When agricultural damages from a January 2009 freeze were assessed, 70 million citrus trees and tens of thousands of acres of fresh fruits and vegetables were in regions where temperatures remained below 20°F for several hours for two (2) consecutive days. In the Glades area, freezing temperatures lasted as long as 12 hours. Early estimates indicated that the bean crop was destroyed and as much as 85% of the corn crop was lost. Sugar cane also took a hit, but damage was not known until harvest time. This event was the most destructive since the 1989 freeze. Tens of millions of dollars, if not hundreds of millions of dollars, in losses are possible. A second freeze occurred two (2) weeks later causing some additional crop damage, but was not as severe.

January 2010 Freeze – A historic cold snap of both duration and magnitude began on New Year’s Night when the first of two (2) arctic cold fronts moved through south Florida. After a brief warm-up on Friday, January 8, a stronger arctic front moved through during the pre-dawn hours of Saturday, January 9. Several daily low and low maximum temperature records were either tied or broken during this period. West Palm Beach had an average 12-day temperature of 49.9 degrees between Jan 2 and Jan 13, the lowest on record for any 12-day period (previous record 50.9 degrees set from January 16-27, 1977). Impacts were significant, particularly to the agricultural industry with statewide estimated crop losses in the $500 million range. Heavily agricultural areas west and southwest of Lake Okeechobee, primarily over Glades, Hendry, and inland Collier counties, registered anywhere from five (5) to seven (7) days of freezing temperatures.

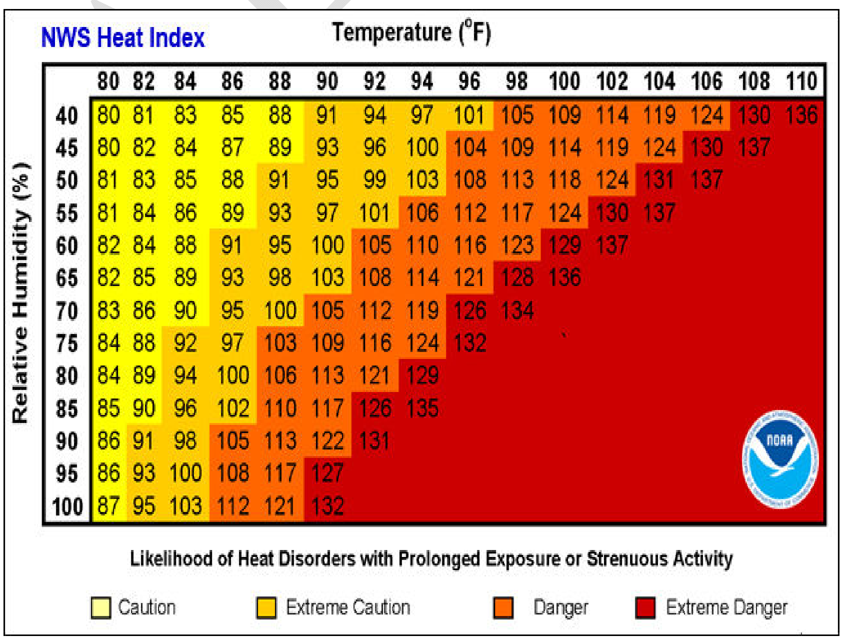
March 2014 Freeze – A cold late-season air mass settled over South Florida, causing temperatures to drop to near or slightly below freezing on the morning of March 4th across the Lake Okeechobee and interior areas of southern Florida. Temperatures in the low to mid 30s in western PBC led to frost formation during the early morning hours of March 4, leading to some crop damage. Damage was mainly to corn, with less than 20% of the crop damaged. Crop damage is estimated and based on total number of acres damaged which was approximately 3,000-4,000 acres. Unofficial temperature readings in some of the fields were as low as the mid-20s, but these values were likely not representative of the larger area. PBC estimated crop losses were over $3 million dollars.

Extreme Heat

Extreme heat is defined as a period of high heat and humidity with temperatures above 90 degrees for at least two to three days. Extreme heat events occur across the state each year. During the summer months of 2021, there were five (5) heat-related deaths and 242 heat-related emergency room visits in the County. (Florida Department of Health Tracking Data)

Heat Index

The Heat Index is a measure of how hot the temperature feels when humidity is factored in with the actual temperature. In the Heat Index chart shown below, the red area indicates extreme danger. Alerts will be issued when the heat index is expected to exceed 105-110 degrees Fahrenheit for at least two consecutive days.


NWS Heat Index — Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Figure 2.10: National Weather Service (NWS) Heat Index

Table 2.5: National Weather Service Heat-Related Advisories

Excessive Heat Warning—Take Action	An Excessive Heat Warning is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Warning is when the maximum heat index temperature is expected to be 105° or higher for at least 2 days and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas not used to extreme heat conditions. If you don't take precautions immediately when conditions are extreme, you may become seriously ill or even die
Excessive Heat Watches—Be Prepared!	Heat watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. A Watch is used when the risk of a heat wave has increased but its occurrence and timing is still uncertain.
Heat Advisory—Take Action!	A Heat Advisory is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Advisory is when the maximum heat index temperature is expected to be 100° or higher for at least 2 days, and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas that are not used to dangerous heat conditions. Take precautions to avoid heat illness. If you don't take precautions, you may become seriously ill or even die.
Excessive Heat Outlooks—Be Aware!	The outlooks are issued when the potential exists for an excessive heat event in the next 3-7 days. An Outlook provides information to those who need considerable lead-time to prepare for the event.

Human bodies dissipate heat in one of three ways: by varying the rate and depth of blood circulation; by losing water through the skin and sweat glands; and by panting. As the blood is heated to above 98.6°F, the heart begins to pump more blood, blood vessels dilate to accommodate the increased flow, and the bundles of tiny capillaries penetrating through the upper layers of skin are put into operation. The body's blood is circulated closer to the surface, and excess heat is released into the cooler atmosphere. Water diffuses through the skin as perspiration. The skin handles about 90% of the body's heat dissipating function.

Heat disorders generally have to do with a reduction or collapse of the body's ability to cool itself by circulatory changes and sweating, or a chemical (salt) imbalance caused by too much sweating. When the body cannot cool itself or when it cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat-related illness may develop. Studies indicate that, other factors being equal, the severity of heat disorders tend to increase with age. Heat cramps in a 17-year-old may be heat exhaustion in someone 40 and heat stroke in a person over 60.

When the temperature gets extremely high, the NWS has increased its efforts to alert the public as well as the appropriate authorities by issuing Special Weather Statements. Residents should heed these warnings to prevent heat related medical complications. As a result of the latest research findings, the NWS has devised the "Heat Index" (HI). The HI, given in degrees Fahrenheit, is an accurate measure of how hot it feels when relative humidity is added to the actual air temperature. The NWS will initiate alert procedures when the HI is expected to exceed 105°F for at least two (2) consecutive days. Possible heat disorders related to the corresponding HI are listed below.

Data from the Palm Beach International Airport weather station, acquired from the Florida Climate Center, indicate that between July 1938 and December 2023, there were 137 days with maximum temperatures above 95 degrees Fahrenheit, of which 19 were above 97 degrees. The highest temperature ever recorded at the station was on July 21, 1942, at 101 degrees Fahrenheit.

In most cases, extreme heat affects those who do not have the ability to stay inside during extreme heat. The county does not have a significant population of people that experience heat related injuries. Although the County does have a sheltering program, shelters have never activated shelters due to heat. This below chart represents the averages and potential extreme temperatures of the County.

Table 2.6: *Palm Beach County Monthly Averages (Degrees Fahrenheit)*

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Avg Temp	66°	68°	71°	75°	79°	82°	83°	83°	82°	79°	73°	69°
Record High	89°	90°	95°	99°	99°	100°	101°	99°	97°	95°	92°	90°
Record Low	26°	27°	26°	38°	45°	60°	64°	65°	61°	46°	36°	24°
Avg Rain	3.5"	2.6"	3.3"	3.7"	4.9"	8.5"	5.6"	8.7"	8.0"	5.9"	3.6"	3.5"

2.1.2 Technological Hazards

2.1.2.1 Dam/Dike Failures

According to the National Inventory of Dams and the National Levee Database, Palm Beach County has 10 dams, 22 levee systems, and 1 dike partially within the County (as of July 2023). A dam is any artificial barrier, which impounds or diverts water on a temporary or long-term basis. Dams can be constructed of concrete or masonry in a variety of ways or can be constructed of natural or waste materials in the form of an embankment. There are many types of dams but the most common include embankment, gravity, buttress, and arch, with 98 percent of dams in Florida being earthen embankment dams. While one of the most important benefits of dams is flood control and water storage, other benefits include electric generation and renewable energy, irrigation, navigation, and recreation. Another benefit of the dam reservoirs is to improve water quality and remove nutrients.

The below table lists the dams, hazard potential classification, and if there is an active emergency action plan.

Table 2.7 *Palm Beach County Dam Classification*

Dam	Hazard Potential Classification	Emergency Action Plan
C-18	Low	No
C-51	Low	No
Corbett Levee	Low	No
G-92	Low	No
Herbert Hoover Dike	High	Yes
S-40	Significant	No
S-41	Significant	No
S-46	Significant	No
S-44	High	No
S-155	Significant	No

Levees are typically earthen embankments that are designed to control, divert, or contain the flow of water to reduce flood risk.

A dike has water only on one (1) side, whereas a dam has water on both sides. The main purpose of a dike is to protect the land behind it from flooding. Dikes may form naturally through large rocks and sediment, but are more often constructed. The Herbert Hoover Dike (HHD) surrounds Lake Okeechobee, consisting of 143 miles of earthen dam, levee, hurricane gates, and other water control structures.

Dam/levee/dike failure poses a threat to population and property in several areas of PBC. All are earthen structures and are state, regionally, locally, or privately controlled. The most significant risk related to dam/levee failure is flooding due to substantial rainfall and its eastward migration to final discharge in the Indian River Lagoon. Structural and non-structural techniques to slow and contain this runoff incorporate several drainage systems, some dating back to 1919. Rainfall in excess of designed capacities could cause erosion of constructed drainage facilities and flooding of many areas including primary roadway evacuation routes (CEMP, 2020).

2.1.2.2 Hazardous Materials Accidents

Hazardous materials accidents can occur anywhere there is a road, rail line, pipeline, or fixed facility storing hazardous materials. Virtually the entire state is at risk to an unpredictable accident of some type. Most accidents are small spills and leaks, but some result in injuries, property damage, environmental contamination, and other consequences. These materials can be poisonous, corrosive, flammable, radioactive, or pose other hazards and are regulated by the Department of Transportation. According to the U.S. Department of Transportation's data from 2020 to 2023, there have been over 96,000 hazardous materials incidents nationwide with the majority occurring during unloading (over 44,000). There were 60 injuries requiring hospitalization and 18 fatalities.

Emergencies involving hazardous materials can be expected to range from a minor accident with no off-site effects to a major accident that may result in an off-site release of hazardous or toxic materials. The overall objective of chemical emergency response planning and preparedness is to minimize exposure for a wide range of accidents that could produce off-site levels of contamination in excess of Levels of Concern (LOC) established by the U.S. Environmental Protection Agency. Minimizing this exposure will reduce the consequences of an emergency to people in the area near to facilities, which manufacture, store, or process hazardous materials (TCRPC).

Large volumes of hazardous materials are transported to and through the county by railroad, highway, air, water, and pipeline daily. Within PBC, there are a number of both public and private fixed facilities, which produce or use hazardous materials. Coordinating procedures for hazardous material response are found within the County's *Hazardous Materials Hazard Specific Plan*.

In addition to the County's *Hazardous Materials Hazard Specific Plan*, as well as other hazardous materials plans, Local Emergency Planning Committee (LEPC) officials have prepared a plan for use in responding to and recovering from a release of hazardous or toxic materials. This plan addresses the range of potential emergency situations and the appropriate measures to be implemented to minimize exposure through inhalation, ingestion, or direct exposure.

Mishandling and improper disposal or storage of medical wastes and low-level radioactive products from medical use are also a hazard to PBC. For example, a few years ago an incident occurred in New Jersey when improper disposal of medical wastes resulted in some of the used products ending up on Atlantic Ocean beaches.

Since 2020 three (3) facilities in Palm Beach County have reported chemical emergencies which have meet the Environmental Protection Agency's (EPA) Emergency Planning Right-to-Know Act (EPCRA) criteria (section 304) for release of toxic inhalation chemicals:

- Pre-cooler incident March, 2023 - Belle Glade
    - A malfunction in an anhydrous ammonia based agricultural cooling system triggered the release of Chlorine dioxide into the atmosphere. A total of 25 patients were transported to local area hospitals for evaluation & treatment of minor exposure.

- Ice rink incident October, 2023 – Boca Raton
    - A malfunction in an anhydrous ammonia based cooling system used for ice skating triggered the release of anhydrous ammonia into the atmosphere. No injuries were reported.

- Water Treatment Plant incident May, 2022 - Palm Beach Gardens
    - A mechanical failure in a tank valve at a water treatment plant, caused the release of sulfuric acid to spill into the tank's secondary containment system. No injuries were reported.

While notable, none of the incidents cited required the use of additional resources (to be ordered), additional operational periods, or activation of the emergency operations center in the course of the response. They could therefore be classified according the national incident management system (NIMS) as type 4 incidents, e.g. local, non-routine.

2.1.2.3 Radiological Incidents (Nuclear Power Plant Accidents)

While an actual release of radioactive material is extremely unlikely and the immediate threat to life extremely low, vulnerability to a nuclear plant disaster could consist of long-range health effects with temporary and permanent displacement of populations from affected areas. The potential danger from an accident at a nuclear power plant is exposure to radiation. This exposure could come from the release of radioactive material from the plant into the environment, usually characterized by a plume (cloud-like) formation. The area the radioactive release might affect is determined by the amount released from the plant, wind direction, and speed and weather conditions (e.g., rain, etc.) which would quickly drive the radioactive material into the ground, causing increased deposition of radionuclides, which would result in widespread agricultural contamination and the negative consequences thereof.

The levels of response to the release of radioactive materials are as follows:

- Notification of Unusual Event - The event poses no threat to plant employees, but emergency officials are notified. No action by the public is necessary.
- Alert - An event has occurred that could reduce the plant's level of safety, but back- up systems still work. Emergency agencies are notified and kept informed, but no action by the public is necessary.
- Site Area Emergency - The event involves major problems with the plant's safety and has progressed to the point that a release of some radioactivity into the air or water is possible but is not expected to exceed Environmental Protection Agency Protective Action Guidelines (PAGs). Thus, no action by the public is necessary.
- General Emergency - The event has caused a loss of safety systems. If such an event occurs, radiation could be released that would penetrate the site boundary. State and local authorities will take action to protect the residents living near the plant. The alert and notification system will be sounded. People in the affected areas could be advised to evacuate, or in some situations, to shelter in place. When the sirens are sounded, radio and television alert will have site-specific information and instructions.

Thirty of the 67 counties in the State of Florida are involved in preparedness planning for a commercial nuclear power plant emergency.

The St. Lucie nuclear power plant is located on Hutchinson Island approximately four (4) miles east-northeast of the City of Port St. Lucie, approximately 5.5 miles north of Martin County/St. Lucie County boundary line. This facility is owned and operated by the Florida Power & Light Company. The county is located more than 20 miles from the plant and is well outside the ten (10) mile Emergency Planning Zone/potential plume area, so there is not a risk to direct radiation exposure. Therefore, PBC would provide assistance to St. Lucie and Martin Counties in the unlikely chance of an accident at the plant. The County municipalities located in part or whole within 50 miles of the power plant (Tequesta, Jupiter Inlet Colony, Jupiter, Juno Beach, Palm Beach Gardens, North Palm Beach, Lake Park, Riviera Beach, Mangonia Park, West Palm Beach, Palm Beach, Pahokee, Royal Palm Beach, Haverhill, Glen Ridge, Wellington, Palm Springs, Greenacres and Lake Clarke Shores) fall within the ‘Ingestion Pathway Zone’ meaning if there is a major release at the power plant, radioactive contamination could be deposited as far as 50 miles affecting food and water supplies.

The purpose of the County radiological emergency preparedness program is to prepare to receive, offer Potassium Iodide to, decontaminate (if necessary), and offer shelter to potentially contaminated evacuees from an accident at the St. Lucie nuclear power plant. A radiological emergency response plan has been developed and is exercised following federal regulations in order for federal officials to have reasonable assurance that adequate protective measures can be taken in the event of a nuclear power plant emergency.

2.1.2.4 Communication Failures

Perhaps the most common cause of communications failures during disasters is the physical damage to devices or components that make up a network infrastructure. Hurricane-force winds, floodwaters, terroristic or cyber activity can all create physical disturbances that have the power to do significant damage to cities and the vulnerable communications equipment that's responsible for supporting these areas.

Disruptions caused by physical damage have the potential to be incredibly costly and time consuming to restore, as they require maintenance or sometimes replacement of complex network hardware to re-establish communications. This is especially problematic if major installations such as cell towers or fiber-optic cables are involved. If a cell tower is severely damaged or even knocked down, it not only causes major disruptions in the area's wireless communications but is extremely expensive to replace and will remain a significant problem until the service provider is able to get a repair crew into the affected area.

Likewise, damage to fiber-optic cables can be an even greater challenge to repair. Because the cables are concealed underground, large portions of earth and roadway may need to be excavated just to pinpoint the exact location of the damage.

Wireless links are also susceptible to disruption or damage during disasters, as different wavelength signals can be cut off by heavy rain, or high winds. The transmitter itself can also receive damage or be knocked out of alignment with its receiver. While these issues are sometimes cheaper and less difficult to correct than damage to wired infrastructure, it nonetheless remains a serious obstacle to rescue efforts if knocked offline during a disaster.

2.1.2.5 Transportation System Accidents

Florida has a large transportation network consisting of major highways, airports, marine ports, and passenger railroads. The heavily populated areas of PBC are particularly vulnerable to serious accidents, which are capable of producing mass casualties. With the linear configuration of several major highways in PBC, such as Interstate highways and the Florida Turnpike, major transportation accidents could occur in a relatively rural area, severely stressing the capabilities of local resources to respond effectively. A notorious regional example is the crash in the Everglades of the Value Jet Flight 592 on May 11, 1996, which resulted in 110 fatalities and cost millions of dollars to respond, severely taxing the financial and public safety resources of Miami-Dade County. Similarly, a major transportation accident could involve a large number of tourists and visitors from other countries, given Florida's popularity as a vacation destination, further complicating the emergency response to such an event.

Since 2020 three (3) facilities in Palm Beach County have reported chemical emergencies which have meet the Environmental Protection Agency's (EPA) Emergency Planning Right-to-Know Act (EPCRA) criteria (section 304) for release of toxic inhalation chemicals:

- Pre-cooler incident March, 2023 - Belle Glade

    - A malfunction in an anhydrous ammonia based agricultural cooling system triggered the release of Chlorine dioxide into the atmosphere. A total of 25 patients were transported to local area hospitals for evaluation & treatment of minor exposure.

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While notable, none of the incidents cited required the use of additional resources (to be ordered), additional operational periods, or activation of the emergency operations center in the course of the response. They could therefore be classified according the national incident management system (NIMS) as type 4 incidents, e.g. local, non-routine.

2.1.2.6 Wellfield Contaminations

As communities become more aware of both the potential health risks and the economic effects of ground water contamination, they are beginning to look increasingly toward preventative efforts. Even when no immediate hazard appears to exist, a community should be concerned about protecting its drinking water supply for three (3) reasons:

- To reduce potential risks to the health of the community,
- To avoid the costs of cleaning up contamination and providing alternative water supplies,
- To prevent the negative economic impacts on community development that ground water contamination can cause.

The development of wellfield protection programs is a major preventative approach for the protection of community drinking water supplies. Wellfield protection is a means of safeguarding public water supply wells by preventing contaminants from entering the area that contributes water to the well or wellfield over a period of time. Management plans are developed for the wellfield protection area that include inventorying potential sources of groundwater contamination, monitoring for the presence of specific contaminants, and managing existing and proposed land and water uses that pose a threat to groundwater quality.

Ground water is a vitally important natural resource. It is a source of drinking water for more than half of the U.S. population and more than 95 % of the rural population. In addition, ground water is a support system for sensitive ecosystems, such as wetlands or wildlife habitats.

Between 1971 and 1985, there were 245 ground water related outbreaks of disease nationwide, resulting in more than 52,000 individuals being affected by associated illnesses (Browning). While most of these diseases were short-term digestive disorders caused by bacteria and viruses, hazardous chemicals found in wells nationwide also pose risks to public health.

The 1986 Amendments to the Federal Safe Drinking Water Act require states to implement wellfield protection programs for public water wells. Prevention strategies include maintaining the isolation distances from potential contamination sources, reporting to the state violations of the isolation distance to the state and asking a local governmental unit to regulate these sources.

Cleaning up contaminated ground water can be technically difficult, extremely expensive, and sometimes cannot be done. Contaminated ground water also affects the community by discouraging new businesses or residents from locating in that community.

2.1.2.7 Power Failure (Outages)

In the U.S., from July 2 to August 10, 1996, the Western States Utility Power Grid reported widespread power outages that affected millions of customers in several western states and adjacent areas of Canada and Mexico. These problems resulted from a variety of related causes, including sagging lines due to hot weather, flashovers from transmission lines to nearby trees, and incorrect relay settings. According to the electric utility industry's trade association, the potential for such disturbances is expected to increase with the profound changes now sweeping the electric utility industry.

On August 14, 2002, the largest power outage occurred in the Northeast and Midwest states. The power outage started around 2:00 p.m. in the afternoon and was out in some places until August 18. There were major cities without power for an extended period of time. Some of the cities included: New York, Cleveland, Detroit, Buffalo, and Toronto. The power outage affected millions of people across states and Canada. The source of the outage is unclear at this time. The entire northeast power grid was affected.

In February 2021, the state of Texas experienced a major power crisis as a result of three (3) severe winter storms that swept across the nation. The storms caused the worst energy infrastructure failure in Texas state history. Residents experienced water, food, and heat shortages. For several days, more than 4.5 million homes and businesses were left without power. Approximately 246 people were killed directly or indirectly with some estimates citing over 70 killed as a result of the power failure.

In PBC, the major causes of a power failure are lightning and trees. Lightning strikes and trees falling onto power lines can shut down power for hundreds of people. Other factors that can cause a power failure are:

- Age of facility (transmission and distribution).
- Community growth.
- High winds.

The location of power lines underground or above ground also has significance. Lines underground have the advantage of being less vulnerable to tree foliage; however, they are still at risk from other underground hazards such as tree roots.

To address times when generating capacity is tight or falls below consumer demand due to state or local emergencies, the Florida Electrical Emergency Contingency Plan was developed. Alerts have been created to give early warning of potential electricity shortfalls and bring utilities, emergency management officials, and the general public to a state of preparedness. The Contingency Plan has four (4) stages (Florida Reliability Coordinating Council):

- **Generating Capacity Advisory** – A Generating Capacity Advisory is primarily for information purposes. It starts utility tracking activities, and it initiates inter-utility and inter-agency communication. No action by the public is required. General information may be distributed to consumers to forewarn them of conditions if necessary.
- **Generating Capacity Alert** – A Generating Capacity Alert starts actions to increase reserves. Available emergency supply options will be explored. When reserves fall below the size of the largest generating unit in the state, loss of that size unit to an unexpected mechanical failure could lead to blackouts somewhere since insufficient backup is available.
- **Generating Capacity Emergency** – A Generating Capacity Emergency occurs when blackouts are inevitable somewhere in Florida. Every available means of balancing supply and demand will be exhausted. Rolling blackouts, manually activated by utilities are a last resort to avoid system overload and possible equipment damage. Frequent status reports are provided to agencies and the media. The Division of Emergency Management will consider using the Emergency Broadcast System to inform citizens of events and to direct them to available shelters if conditions warranted. Recognizing the consequences of a loss of electricity, individual utility emergency plans include provisions for special facilities critical to the safety and welfare of citizens.
- **System Load Restoration** – System Load Restoration is instituted when rolling blackouts have been terminated and power supply is adequate. It is the recovery stage, and efforts are made to provide frequent system status reports.

2.1.2.8 Coastal Oil Spills

As a major industrial nation, the United States produces, distributes, and consumes large quantities of oil. Petroleum-based oil is used as a major power source to fuel factories and various modes of transportation and in many everyday products, such as plastics, nylon, paints, tires, cosmetics, and detergents. At every point in the production, distribution, and consumption process, oil is invariably stored in tanks. With billions of gallons of oil being stored throughout the country, the potential for an oil spill is significant, and the effects of spilled oil can pose serious threats to the environment.

In addition to petroleum-based oil, the U.S. consumes millions of gallons of non-petroleum oils, such as silicone and mineral-based oils, and animal and vegetable oils. Like petroleum products, these non-petroleum oils are often stored in tanks that have the potential to spill, causing environmental damages that are just as serious as those caused by petroleum-based oils. To address the potential environmental threat posed by petroleum and non-petroleum oils, the U.S. Environmental Protection Agency has established a program designed to prevent oil spills. The program has reduced the number of spills to less than 1 % of the total volume handled each year (Environmental Protection Agency, 1998). Spilled oil poses serious threats to fresh water and marine environments, affecting surface resources and a wide range of subsurface organisms. Most oils tend to spread horizontally into a smooth and slippery surface, called a slick, on top of the water. However, once the oil reaches the shoreline it can escape downward into sand, making it difficult to clean up and reducing its ability to degrade. Spilled oil can harm the environment in several ways, including the physical damages that directly impact wildlife and their habitats (such as coating birds or mammals with a layer of oil) and the toxicity of the oil itself, which can poison exposed organisms.

Not only would an oil spill adversely affect the environment, but also the economy would suffer due to a decrease in tourism. Depending on the severity of the spill, the economy could suffer mild, short-term effects to devastating, long-term effects.

The County has 46 miles of Atlantic Ocean coastline that is subject to contamination caused by an oil spill. By Executive Order, the responsibility for preparing response plans for coastal oil spills is designated to the Department of Environmental Protection, Division of Florida Marine Patrol. There are two (2) active oil field regions in Florida: in Escambia and Santa Rosa counties in the Panhandle, and Collier, Hendry, and Lee counties in southwest Florida.

On April 20, 2010, an explosion on the Deepwater Horizon/BP MC252 drilling platform in the Gulf of Mexico killed 11 workers and caused the rig to sink. As a result, oil began leaking into the Gulf creating one of the largest spills in American history. During the next 87 days an estimated 4.9 million barrels (210 million gallons) of oil were released. While the spill did not affect the waterways or coastal communities of PBC, it did put DEM and other supporting agencies throughout the County on alert. Extensive plans were coordinated to prepare for a potential containment and oil clean up response.

2.1.3 Human-Caused Hazards

2.1.3.1 Civil Disturbances

As in any other area, PBC is subject to civil disturbances in the form of riots, mob violence, and a breakdown of law and order in a localized area. Although they can occur at any time, civil disturbances are often preceded by periods of increased tension caused by questionable social and/or political events such as controversial jury trials or law enforcement actions. Police services are responsible for the restoration of law and order in any specific area of the County.

With the election of President Donald Trump in 2016, and his properties located in PBC, there was a marked escalation of protests and civil disturbances. These were most evident in the winter months when the president spent many weekends at his home in the Town of Palm Beach. Agencies throughout PBC spent a great deal of time and resources to ensure the safety of the

President and his family when they were in the area, as well as the safety of protesters in the areas surrounding his home in Palm Beach. The PBC LMS HVA Sub-Committee recognized the increased likelihood of civil disturbances in the analyses of probabilities located in Appendix A. Additionally, Presidential visits, while bringing civil disturbance issues, are also, by nature, domestic security hazards. Therefore, the planning process for Presidential visits is contained in the PBC *Domestic Security Plan*.

May 31- June 6, 2020 – The national protests initially started after the murder of George Floyd during his arrest by Minneapolis police officers on May 25, 2020. The Palm Beach County protests started in downtown West Palm Beach on May 31 and eventually turned into a march that shut down I-95 in both directions. Law enforcement was able to reopen the interstate. A tense standoff with protestors started in the evening and turned into crowds vandalizing the Palm Beach County Courthouse and area businesses. More protests endured the following days in Belle Glade, Boca Raton, Boynton Beach, Delray Beach, and Lake Worth Beach. For the most part, these protests were peaceful.

2.1.3.2 Domestic Security

Terrorism

The FBI defines terrorism as, "the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of political or societal objectives." A terrorist incident could involve the use of a Weapon of Mass Destruction (WMD) that would threaten lives, property and environmental resources by using explosives or incendiary devices and/or by contamination with chemical, biological, and/or radiological materials.

It is recognized that the state has many critical and high-profile facilities, high concentrations of population and other potentially attractive venues for terrorist activity that are inherently vulnerable to a variety of terrorist methods. Governmental/political, transportation, commercial, infrastructure, cultural, academic, research, military, athletic, and other activities and facilities constitute ideal targets for terrorist attacks, which may cause catastrophic levels of property and environmental damage, injury and loss of life. Furthermore, some extremist groups are known to be present within Florida. Terrorist attacks may take the form of the hazards described in this section. When incidents of these types are executed for criminal purposes, such as induced dam or levee failures, hazardous materials could be used to injure or kill or biological weapons could be used to create a pandemic. Terrorists have the potential to create disasters, which threaten the safety of a large number of citizens.

In the recent years, terrorist acts have become a reality for the nation. The County is not immune from acts of terrorism. The 2001 World Trade Center bombing was the largest terrorist attack the United States has ever experienced. After the World Trade Center attack, it was learned that the (terrorists) pilots took flight lessons in PBC and many of the perpetrators resided in the County. In addition, Anthrax, which was dispersed via the postal system in late 2001, claimed the lives of five (5) US citizens including one (1) person from PBC. It was determined that he became infected with the disease at his place of employment, American Media Incorporated (AMI), in Boca Raton. A second employee became infected and survived.

In the past two (2) decades, terrorism has had a significant influence on the daily lives of Americans. The consistent attacks abroad and intermittent attacks within the United States have made most communities more conscious of the growing risks and vulnerabilities in a free environment. The advancement of technologies has made our communities more vulnerable to the impacts from these hazards. It should be noted that the impact of a terrorist attack can extend well beyond the immediate targeted facility. The effects of terrorism include:

- Direct Result: Injury, illness, or death,
- Psychological Reactions: fear, anxiety, stress, shock, revulsion, long-term emotional effects, post-traumatic stress,
- Economic, Political, and Social Impacts.

The terrorism incident at the Pulse Night Club in Orlando on June 12, 2016, is a prime example of other acts of terrorism that are emerging in society today. A heavily armed man entered the nightclub and killed 49 victims and injured over 50 more. While no incidents of terrorism to this scale have occurred in PBC, the regional Fusion Center and local law enforcement work together on a daily basis to be on alert for signs of impending terrorist activity in the South Florida region.

Terrorism, Sabotage, and Cyber Attacks

With the growth of a computer-literate population, increasing numbers of people possess the skills necessary to attempt such a cyber-attack. The resources to conduct a cyber-attack are now easily accessible everywhere. A personal computer and an internet service provider anywhere in the world are enough to cause a great deal of harm.

Cyberspace is particularly difficult to secure due to a number of factors: the ability of malicious actors to operate from anywhere in the world, the linkages between cyberspace and physical systems, and the difficulty of reducing vulnerabilities and consequences in complex cyber networks. Implementing safe cybersecurity best practices is important for individuals as well as organizations of all sizes. Basic "cyber hygiene" can drastically improve online safety. Cybersecurity basics apply to both individuals and organizations. For both government and private entities, developing and implementing tailored cybersecurity plans and processes is key to protecting and maintaining operations. As information technology becomes increasingly integrated with all aspects of our society, there is increased risk for wide scale or high-consequence events that could cause harm or disrupt services upon which our economy and the daily lives of millions of Americans depend (CISA, 2024).

Sophisticated cyber actors and nation-states exploit vulnerabilities to steal information and money and are developing capabilities to disrupt, destroy, or threaten the delivery of essential services. Defending against these attacks is essential to maintaining the nation's security. Protecting cyber space is the responsibility of individuals; families; small and large businesses; and state, local, tribal, territorial, and federal governments. By preventing attacks or mitigating the spread of an attack as quickly as possible, cyber threat actors lose their power. Any cyber-attack, no matter how small, is a threat to our national security and must be identified, managed, and shut down. Every mitigated risk or prevented attack strengthens the cybersecurity of the nation (CISA, 2024).

Threats include:

- Human error,
- Insider use of authorized access for unauthorized disruptive purposes,
- Recreational hackers – with or without hostile intent,
- Criminal activity – for financial gain, to steal information or services, organized crime.
- Industrial espionage,
- Terrorism – including various disruptive operations,
- National Intelligence – information warfare, intended disruption of military operations.

As the internet becomes more and more important, the loss of its services, whether by accident or intent, becomes a greater hardship for those relying on this form of communication. The outcomes of such activities may take the form of disruption of air traffic controls, train switches, banking transfers, police investigations, commercial transactions, defense plans, power line controls, and other essential functions. Computer failures could affect emergency communications as well as routing civilian applications, such as telephone service, brokerage transactions, credit card payments, Social Security payments, pharmacy transactions, airline schedules, etc.

There have been multiple cyber-attacks in recent years involving the theft of citizen's private information such as bank account numbers, social security numbers, etc. The PBC LMS HVA Sub-Committee recognizes the potential impacts. In their most recent update to the hazard profile of the LMS, they advised that the threat will only become greater as we continue to transition the bulk of our financial transactions over to online platforms.

2.1.3.3 Workplace/School Violence

A workplace/school violence incident could occur without warning in a number of settings. The workplace will be defined as a place of business or government offices where commerce occurs. Schools are educational settings which can be both public and private. Acts of violence in the workplace are handled by municipal or county law enforcement, dependent upon jurisdictional boundaries. Palm Beach County School District Police Department would have a large role in the response to an act of violence in a school.

Due to the current international climate and following the rising trend of active shooter/assailant incidents, public safety agencies have remained at a level of heightened awareness. The number of active shooter/assailant incidents are on the rise with less use of traditional weaponry, making it difficult for law enforcement agencies to detect would-be attackers.

In 2014, the Federal Bureau of Investigation (FBI) published a study and defined an active shooter as, “an individual actively engaged in killing or attempting to kill people in a populated area” (Blair, P., Schweit, W., 2014). The County will adopt the FBI’s definition of an active shooter/assailant with one adjustment to the verbiage. Within this plan, the word “shooter” will be accompanied by the word “assailant”, as "active shooter/assailant" to coincide with an international trend of the word “assailant", stated in the aforementioned FBI report. “Assailant” was defined by the report as “those (who) commit violence in the workplace or schools, using weapons other than firearms to commit killings or attempted killings.” (Blair, P., Schweit, W., 2014). These weapons include but is not limited to the use of knives, hatchets, vehicles, explosives, and blunt objects (e.g., baseball bats, metal pipes).

The school violence incident at the Marjory Stoneman Douglas High School in Parkland, Florida (Broward County) on February 14, 2018, resulted in 17 deaths and 14 injuries. This further emphasizes the importance of planning for these types of incidents. Due to the nature of the incident being in an adjacent county to PBC, special attention will be paid to the outcomes identified in the after-action report to assist in continued planning in the unfortunate event such an incident occurs in PBC. Planning for such an incident is not limited to the incident itself, but should include planning for memorials/vigils, reunification and survivor care, as well as many other considerations. The *Workplace/School Violence HSP* addresses the County’s response to such an incident.

2.1.3.4 Harmful Algal Blooms

Algae are a group of plants that can be found in all types of waters, including salt water, fresh water, and brackish water (a mix of salt and freshwater). Algae that live in the water can be grouped into two categories: seaweed and phytoplankton. Seaweed are large plants made up of many cells. Phytoplankton are small, single-celled plants. Both seaweed and phytoplankton can rapidly grow out of control or “bloom” when water is warm, slow-moving, and full of nutrients such as nitrogen and phosphorus. These “blooms” can be harmful to people, animals, or the environment if they produce toxins, become too dense, deplete oxygen in the water, or release harmful gases as they decay. Most harmful blooms that make people and animals sick are caused by phytoplankton. They can also discolor water, contaminate drinking water, and form huge, smelly piles on beaches. Collectively, these events are referred to as harmful algal blooms, or HABs.

HABs occur naturally. However, human activities that disturb ecosystems play a role in increasing the frequency and intensity of occurrence. Increased nutrient loadings and pollution, food web alterations, introduced species, water flow modifications, and climate change all play a role. For example, overfishing the waters near coral reefs removes the primary algae-eaters from the environment, allowing populations of fleshy algae to explode. In areas with large human populations, pollution often exacerbates the problem by stimulating these algae. Fleshy algae on reefs release copious amounts of nutrients known as dissolved organic carbon that microbes eat. These microbes then endanger corals by depleting oxygen from the environment or by introducing diseases. As the reefs die, the algae have even more space to take over leading to further coral mortality. Millions of people around the world depend on coral reefs for productive fisheries. Reefs play an important role in global environmental health. HABs have caused an estimated 1$ billion in losses over the last several decades to coastal economies in the United States that rely on recreation, tourism, and seafood harvesting.

Natural Causes

Although all coastal states experience HABs, different organisms live in different places and cause different problems. Factors such as the structure of the coast, runoff, oceanography, and the presence of other organisms can change the scope and severity of HAB impacts. Some HABs appear in the aftermath of natural phenomena like sluggish water circulation, unusually high-water temperatures, and extreme weather events like hurricanes, floods, and drought.

Anthropogenic Causes

Eutrophication, also known as nutrient pollution, describes the excess accumulation of nutrients (primarily nitrogen and phosphorus) in bodies of water. Like people, plants need nutrients. However, excessive amounts can become a problem. Although nutrients occur naturally, most of the nutrients in our waterways come from human activities like agricultural practices, fossil fuel emissions, landscaping, and stormwater and wastewater runoff. Nutrient pollution can exacerbate algae blooms leading to more severe blooms that occur more frequently.

Blue-Green Algae (Cyanobacteria)

Cyanobacteria, commonly referred to as blue-green algae, are a type of phytoplankton common to Florida's freshwater environments. Cyanobacteria can make the water different colors including green, blue, red, or brown and look like foam, scum, mats, or paint floating on the water's surface.

Exposure to blue-green algae blooms can cause negative health effects to both people and animals. Cyanotoxins can be released into the air from splashing in the water or from boat wakes. Direct contact or breathing airborne droplets containing high levels of algae toxins when swimming or showering can cause irritation of the skin, eyes, nose, and throat. Sometimes, high exposures of toxin can affect the liver and nervous system.

Bloom Monitoring

NOAA issues forecasts to monitor bloom conditions and the potential for impacts. The Harmful Algal Bloom Forecasting Branch (HAB FB) of the National Centers for Coastal Ocean Science (NCCOS) produces several remote sensing products to aid resource managers and public health officials in responding to fresh and saltwater HABs. NOAA currently uses a combination of satellite imagery and water samples of the algae (specifically Karenia brevis) collected from the field by local partners to forecast the location and intensity of red tide events. Additionally, this allows them to test potentially affected shellfish beds more precisely and for shorter periods of time and, if necessary, post advisories in coastal areas where there is a direct health risk. More information about monitoring can be found below in *Location*.

In 1999, the Florida Fish and Wildlife Conservation Commission (FWC) established the Harmful Algal Bloom Task Force. Due to a lack of funding, the Task Force became inactive for over 15 years. In 2019, Governor DeSantis reorganized the group as the Red Tide Task Force to "focus on causes of Red Tide" and find solutions and empower our brightest minds to help protect our environment" said DeSantis in a press conference announcing the reorganization. The Task Force will also work with Mote Marine Laboratory's Florida Red Tide Mitigation and Technology Development Initiative.

Similarly, Governor DeSantis signed Executive Order 19-12 titled Achieving More Now for Florida's Environment, establishing the Blue-Green Algae Task Force. The Task Force is made up of five (5) members from various academic institutions who are charged with focusing on expediting progress toward reducing the adverse impacts of blue-green algae blooms now and over the next five (5) years (starting in 2019).

Emerging Technology

Private industry is working on new and exciting projects and searching for ways to mitigate and remove harmful algal blooms. For example, AECOM recently conducted the first ever field-scale algae to biocrude oil demonstration project in the U.S. The project utilized Hydrothermal Processing which transforms recovered algae biomass (wet waste) into carbon neutral energy, biocrude oil, and Renewable Natural Gas (RNG) to help reduce our dependence on fossil fuels. This process applies immense heat and pressure, similar to how crude oil is formed naturally, but does so in 30 minutes instead of millions of years. The result is a carbon neutral biofuel that functions like its fossil counterparts. It was proven highly effective and demonstrated how innovative technologies can be used to deliver a sustainable solution to HABs with little to no waste.

Another algae mitigation strategy is algae extraction using Hydronucleation Flotation Technology (HFT). This process separates and extracts algae from the water and returns clean clarified water to its source, safely and sustainably. By physically removing algae without damaging the cells, the key nutrients that fuel algae growth (phosphorus and nitrogen) are also removed, along with any carbon and algae toxins that might be present. Minimizing these nutrients can reduce and potentially eliminate the threat of future HABs.

Location

In Florida, HABs can be found in and along saltwater, freshwater, and brackish water bodies, especially south of Lake Okeechobee. While these events are most frequent in coastal regions of southwest Florida, they occur to a lesser extent throughout the Gulf region. Some of the more susceptible water bodies in Florida include Lake Okeechobee, the St. Lucie and Caloosahatchee estuaries, St. Johns River, Biscayne Bay, Florida Bay, Apalachicola Bay, and others. Additionally, harmful algae can easily thrive in still bodies of water. HABs are most common in late summer or early fall months. However, other events like hurricanes can spark a bloom due to the stormwater and pollution runoff.

NOAA's NCCOS monitors conditions daily and issues regular forecasts for red tide blooms in the Gulf of Mexico and East Coast of Florida. NCCOS has a number of products that forecast and monitor HABs that can be found on the website here. These products also include a compilation of products from other sources including current conditions, respiratory forecast, intensification forecast, satellite imagery, beach conditions reporting system (MOTE Marine Lab), and State of Florida observations (FWC). The FWC red tide map can be viewed on their website here.

The Florida Department of Environmental Protection (FDEP) has an Algal Bloom Sampling Status Dashboard that shows cyanobacteria (blue-green algae) samplings from across Florida. The interactive dashboard features information and real-time sampling updates from FDEP, South Florida Water Management District (WMD), Southwest Florida WMD, FWC, and Lee County. Additional entities can join sampling efforts as needed. Along with the dashboard, FDEP creates and disseminates weekly updates that includes reported HABs, sites, and other information that can also be found on the dashboard. Subscribe to the weekly updates here.

Historic Algal Bloom Events

2013 Lake Okeechobee Release: Heavy rains in the summer of 2013 resulted in high water levels for Lake Okeechobee. To avoid jeopardizing the integrity of the Herbert Hoover Dike, U.S. Army Corps of Engineers (USACE) released large volumes of polluted water from the lake into the region’s rivers and estuaries including the St. Lucie River estuary to the east, Caloosahatchee River estuary to the west, St. Johns River to the north, and Biscayne Bay to the south. The bloom caused 100% of the oysters and 120 manatees in the St. Lucie River to die, leading to restoration efforts along the estuary. This event led to some lawmakers forming the Select Committee on Indian River Lagoon and Lake Okeechobee Basin, and a report outlining actions and $220 million in proposed funding initiatives.

2016 Blue-Green Algae Bloom – In May 2016, 33 square miles (85 km2) of the southern portion of Lake Okeechobee were affected by an algae bloom. The bloom grew large early in the season and affected more people than usual, presenting far beyond the confines of the lake. Lake discharges through the St. Lucie Canal caused impacts throughout the estuary and east to Stuart where the water runs into the Atlantic Ocean. Water samples collected from the lake and from the river near Stuart tested positive for high levels of toxins produced by the algae. On June 29th, the Governor declared a state of emergency in Martin and St. Lucie counties after the blooms appeared in local waterways. The state of emergency allowed state and local government agencies to reduce the flow of water into Lake Okeechobee and directed FDEP and FWC to take action. A study by NOAA showed that impacts along the Treasure Coast cost the local economy $237 million in lost sales and 3,000 jobs.

2018 Blue-Green Algae Event – While blue-green algae are naturally occurring in Lake Okeechobee, they can become harmful if found in large concentrations. In 2018, NOAA first observed a blue-green algae bloom in Lake Okeechobee by satellite imagery in June, caused by surrounding nutrient influx, record-setting rainfall, and resuspension of sediments caused by Hurricane Irma. By mid-July, 90% of the lake was covered in blue-green algae. Following heavy periods of rainfall, USACE performed water releases into the St. Lucie and Caloosahatchee estuaries, including about 83 billion gallons of water discharged to the St. Lucie allowing disastrous algae bloom conditions to cripple the Caloosahatchee River. The overall event across the three (3) locations lasted for several months and caused "mats" of algae with an unpleasant smell along the water's surface, massive fish kills, and mitigating behavior by the public. On July 9, 2018, the Governor issued Executive Order 18-191 declaring a state of emergency for Glades, Hendry, Lee, Martin, Okeechobee, Palm Beach, and St. Lucie counties. The declared counties received $3 million [split between the seven (7) counties] for cleanup and disposal efforts. To learn more about the economic and socio-economic impacts of this event, see the following University of Florida report.

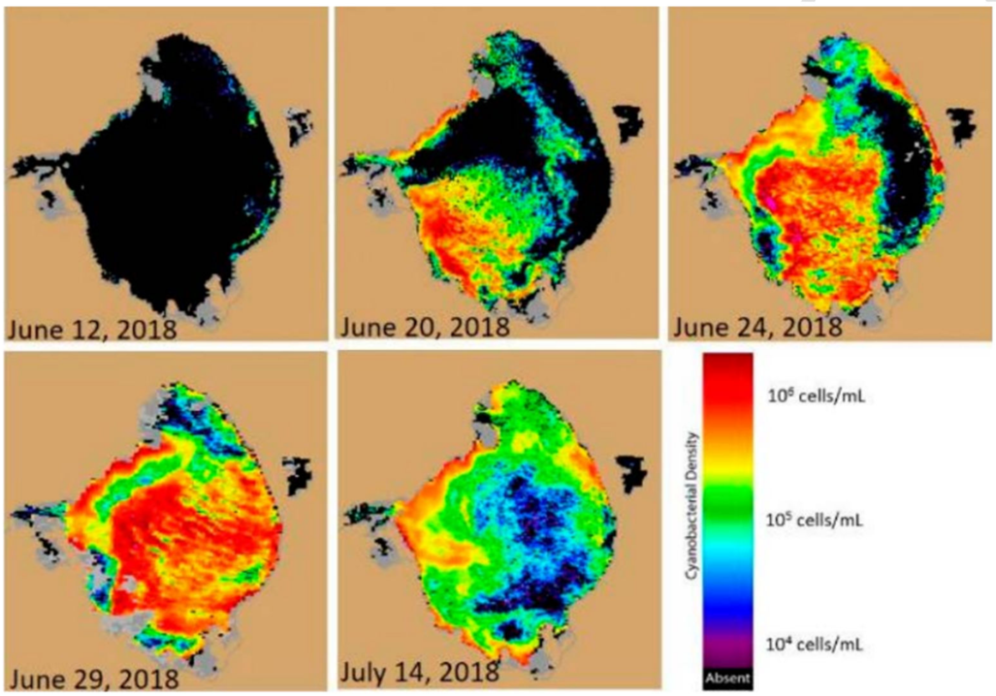

Figure 2.11: HAB Socio-Economic Impact (University of Florida)

2022 Hurricane Ian Concerns – Within a month after Hurricane Ian, medium levels of red tide were documented along the Gulf Coast outside of Sarasota. The bloom spread from Collier County to Pinellas County, causing thousands of pounds of dead fish to wash ashore and threatening manatee populations in Sarasota and Charlotte counties. While the storm did not directly cause the bloom because red tide is typical for that time of year, it likely pushed the red tide inland. The hurricane also destroyed man-made reefs as far as 30 miles away from the coast of Southwest Florida. Beginning in January 2023, USACE began releasing water from Lake Okeechobee into the St. Lucie Estuary for the first time in nearly two (2) years. The releases were due to water levels after Hurricane Ian. The absence of releases has led to ecological rehabilitation for the estuary, including clearer water and seagrass restoration. As releases continue, there are concerns of blue-green algae impacts along the estuaries, but no blooms were detected ahead of the summer months.

2.1.3.5 Mass Migration Crises

Florida's location, as the nearest United States land mass bordering the Caribbean, basin makes it a chosen point of entry for many migrants attempting to enter the country illegally. A major consequence of a mass arrival of undocumented noncitizens could be disruptive to the routine functioning of the impacted community, resulting in significant expenditures that are related to the situation. An example of this threat occurred in 1994, when the state responded to two (2) mass migration incidents. In May 1994, there was an unexpected migration of approximately 100 Haitian refugees. In August 1994, there was an influx of 700 Cubans. These events are typically preceded by periods of increasing tension abroad, which can be detected and monitored. Enforcement of immigration laws is a federal responsibility. However, it is anticipated that joint jurisdictional support of any operation will be required from the state and local governments.

The Atlantic shore of PBC is the frequent scene of the arrival of undocumented noncitizens, commonly Haitian or Cuban. The County has both the history and potential for the unannounced arrival of a large number of undocumented noncitizens. Until relieved of the responsibility by the state and federal governments, PBC must be capable of providing mass refugee care to include shelter, food, water, transportation, medical, police protection, and other social services. The County's *Mass Migration Hazard Specific Plan* addresses the response to this hazard should it occur in PBC.

The LMS HVA Sub-Committee recognizes that natural hazards (such as hurricanes) have the potential to influence other hazards such as Mass Migration. An example of this is the influx of American citizens from Puerto Rico into Florida following the devastation from Hurricane Maria in September of 2017. While not illegal, the burden of such a sudden migration of persons from one area of the U.S. to another can severely strain local and state resources.

2.2 Vulnerability Assessment

The County is diversified. While all PBC residents are exposed to the hazards identified in Table 2.1 to some degree, geographic location and other factors greatly affect individual vulnerabilities and probabilities relating to specific hazards illustrated in Appendix A for the County and each jurisdiction. Factors influencing vulnerability include community location, type of construction, demographics, and cultural characteristics. Appendix A tables summarize individual community vulnerability within PBC. Appendix A tables also relate the probability of future hazard events for each identified hazard within PBC. Appendix B includes mitigation initiatives to reduce the impacts of each jurisdiction risks for PBC in reference to the individual hazards identified in **Section 2.1** Additional maps will be located in Appendix G. These maps will be illustrated by hazard addressing critical facilities having the potential to be affected by hazard. The critical facilities will have a potential dollar loss figure.

With the assistance of the DEM, the LMS conducted impact analyses to assess the potential for detrimental impacts from all identified natural, technological, and human-caused hazards.

Results of these analyses are summarized below. Impacts were categorized into the following groupings:

- Health and safety of the resident population in the affected area,
- Health and safety of incident responders,
- Impacts on the continuity of government and non-government operations,
- Impacts to property, facilities and infrastructure,
- Impacts to the critical community services,
- Impacts to the environment,
- Economic and financial impacts,
- Impacts on regulatory and contractual obligations,
- Impacts negatively affecting the PBC's reputation, image, and/or ability to attract public and commercial interests.

Most hazards in PBC affect the entire county equally. However, there are some that may be more likely in one area. For example, a Herbert Hoover Dike breach would cause more damage to the western communities. For the purpose of this document, the County has been divided into four (4) geographical areas: Northern PBC, Southern PBC, Western PBC, and Coastal PBC.

In addition, the charts show probability of occurrence and impact. These will be rated as low = under 5% chance of occurring, medium, 5% - 15% chances of occurring, or High, greater than 15%. These rating responds with the information of the charts presented.

- An impact rating of "Low" for any hazard type means the hazard is not likely to have any measurable or lasting detrimental impact of a particular type and consequences will likely be rectified promptly with locally available resources. Chances here are less than 5%.
- An impact rating of "Medium" means there will likely be a measurable detrimental impact which may require some time to rectify and may require outside resources and/or assistance. The chances here are between 5% - 15%. As such, the hazard is considered a threat to the whole community of PBC.
- An impact rating of "High" means the impact will likely be severe and of longer duration, and require substantial time, resources, and/or outside assistance to rectify. The chances are greater than 15%. As such, the hazard is considered a threat to the whole community of PBC.
- Multiple ratings indicate detrimental impacts might easily vary within the range indicated.

2.2.1 Natural Hazards

2.2.1.1 Flooding

While damages caused by storm surge and dike failure can be extensive and costly, historical physical damages from inland structural flooding have been relatively minor and isolated. As a predominantly localized event, inland flooding does not pose a significant threat to the ability of the county, municipalities, and businesses to carry on normal operations.

People, structures, and infrastructure located within floodplains and areas with poor drainage are most susceptible inland flooding, particularly to flash flooding. However, flash flooding can and does affect all areas of the county. Continued development will certainly contribute to an increased frequency of runoff flooding.

For the most part, flooding depths are not sufficient to inundate large residential and commercial areas. Developed parcels tend to be elevated to a level limiting significant water intrusion from water build-up. Where water does intrude structures, damage can be costly for individual property owners. Beyond physical water damage, perhaps the greater issue is the potential for mold infestation which can create health problems for occupants and lead to costly cleanup and repairs.

Flooding can cause damage to cars and outdoor equipment, contaminate water systems, and interrupt water treatment. Sewage overflow raises health concerns.

Significant expanses of street flooding are common, can be costly in terms of loss of function for extended periods of time, and can create dangerous, even potentially deadly, driving conditions.

Post storm accidents, especially electrocutions, are not uncommon as people wander into flood waters where live wires or generators are present.

Flooding in PBC results from one (1) or a combination of both of the following meteorological events:

- Tidal surge associated with northeasters, hurricanes, and tropical storms,
- Overflow from streams and swamps associated with rain runoff.
- Coastal inundations from lakes and basins.

Major rainfall events occur in association with hurricanes, tropical storms, and thunderstorms associated with frontal systems.

When these types of intense rainfall events occur, streams and drainage ditches tend to reach peak flood flow concurrently with tidal water conditions associated with coastal storm surge. This greatly increases the probability of flooding in the low-lying areas of the coastal zone. Areas along the PBC coast are particularly susceptible to flooding under these conditions. The most flood prone areas in the eastern portion of the County feature poorly drained soils, a high water table, and relatively flat terrain, all of which contribute to their flooding problems. Flat, swampy terrain and heavily wooded areas in the western part of PBC aggravate flood problems by preventing rapid drainage in some areas.

In response to mounting losses from flooding nationwide, the United States Congress initiated the NFIP in 1968. The program is administered through FEMA. Under this program, FEMA produces FIRM maps which show areas subject to various levels of flooding under different conditions. This flood risk information is based on historic, meteorological, hydrologic, and hydraulic data, as well as open-space conditions, flood control works, and development.

Appendix G presents a generalized picture of the flood prone areas in PBC based on the 2017 version of the FIRM maps.

In addition to the FIRM maps there are two (2) numerical models, which predict the effects of storm surge in PBC. The older model, developed by NOAA, is called the Sea, Lake, and Overland Surges from Hurricanes model. Appendix G also illustrates the areas of PBC vulnerable to this type of flooding.

The State of Florida acquired another model for predicting hurricane storm surge as well as wind and property damage. This model, The Arbiter of Storms (TAOS) model, predicts storm surge height and wind field intensity for Category 1 through Category 5 hurricanes. Appendix G illustrates the areas of PBC subject to flooding during a Category 5 Hurricane. It is important to remember that the TAOS model projections are based on a Maximum of Maximums or absolute worst-case scenario. For this analysis, we have considered the TAOS model projections as reflecting total, worst-case exposure for PBC.

2.2.1.2 Hurricanes/Tropical Storms

From 1920 through 1959, a total of 58 hurricanes struck the U.S. mainland, 25 of which were Category 2 or higher (major storms). Between 1960 and 1989, 42 hurricanes struck the U.S. of which only 16 were Category 2 or stronger. Most hurricane experts feel we are entering a period of increased hurricane formation similar to the levels seen in the 1920s and 1940s. Current hurricane risk calculations are complicated by climatic factors suggesting the potential for even greater hurricane frequency and severity in the world's entire hurricane spawning grounds. Since 1995, there have been 220 Atlantic hurricanes, 15 of which occurred in 2005 alone. The below chart quantifies the activity in the Atlantic by classification. Climate change may cause changes in storm frequency and the precipitation rates associated with storms. A modest 0.9-degree Fahrenheit (0.5 degree centigrade) increase in the mean global temperature will add 20 days to the annual hurricane season and increase the chances of a storm-making landfall on the U.S. mainland by 22%. The warmer ocean surface will also allow storms to increase in intensity, survive in higher latitudes, and develop storm tracts that could shift farther north, producing more U.S. landfalls.

Table 2.8 *Atlantic Ocean Cyclone Activity Since 1995*

Atlantic Tropical Cyclone Activity					
Year	Hurricanes	Tropical Storms	Subtropical Storms	Topical Depressions	Total Per Year
1995	11	8	0	2	21
1996	9	4			13
1997	3	5	1		9

1998	10	4			14
1999	8	4	4		16
2000	8	6	1	4	19
2001	9	6		2	17
2002	4	8		2	14
2003	7	10		4	21
2004	9	5	1	1	16
2005	15	12	2	2	31
2006	5	5			10
2007	6	8	1	2	17
2008	8	8		1	17
2009	3	6		2	11
2010	12	7		2	21
2011	7	12		1	20
2012	10	9			19
2013	2	11	1	1	15
2014	6	2		1	9
2015	4	7		1	12
2016	7	8		1	16
2017	10	7		1	18
2018	8	7		1	16
2019	6	10	2	2	20
2020	14	15	1	1	31
2021	7	13	1		21
2022	9	6		2	17
2023	3	9	1		13
Total Per Classification	220	222	16	36	494

Severe (Category 4 or 5 on the Saffir-Simpson scale) hurricanes strike the U.S. on the average of three (3) every five (5) years (0.60 per year) (see http://www.aoml.noaa.gov/hrd/tcfaq/E19.html). Annually, hurricanes are estimated to cause approximately $1.2 billion in damages. The proximity of dense population to the Atlantic Ocean, as well as the generally low coastal elevations, significantly increases the County's vulnerability. The potential for property damage and human casualties in PBC has increased over the last several decades primarily because of the rapid growth this county has experienced since 1970, particularly along the vulnerable coastline areas.

Hurricane damage is caused by two factors:

- High winds.
- Storm surge (discussed under "Flooding").

Wind that produces most of the property damage associated with hurricanes. The greatest threat to life is from flooding and storm surge. Although hurricane winds can exert tremendous pressure against a structure, a large percentage of hurricane damage is caused not by flying debris. Tree limbs, signs and signposts, roof tiles, metal siding, and other lose objects can become airborne penetrating the outer shells of buildings destroying their structural integrity and allowing the hurricane winds to act against interior walls not designed to withstand such forces. Once a structure's integrity is breached, the driving rains associated with hurricanes can enter the structure and completely destroy its contents. Hurricane winds are unique in several ways. They are:

- More turbulent than winds in most other type storms.
- Sustained for a longer period of time (several hours) than any other type of atmospheric disturbance.
- Change slowly in direction, thus they are able to seek out the most critical angle of attack on a given structure.
- Generate large quantities of flying debris as the built environment is progressively damaged, thus amplifying their destructive power.

Hurricane gusts of wind can be expected to exceed the sustained wind velocity by 25 to 50 %. This means a hurricane with sustained winds of 150 mph will have wind gusts exceeding 200 mph. The wind's pressure against a fixed structure increases with the square of the velocity. For example, a 100-mph wind will exert a pressure of approximately 40 lbs. per square foot on a flat surface, while a 190-mph wind will exert a force of 122 lbs. per square foot on the same structure. In terms of a four (4) by eight (8) foot sheet of plywood nailed over a window, there would be 1,280 lbs. of pressure against this sheet in a 100-mph wind, and 2,904 lbs. or 1.95 tons of pressure against this sheet in a 190-mph wind.

The external and internal pressures generated against a structure vary greatly with increases in elevation, building shape, openings in the structures, and the surrounding buildings and terrain. Buildings at ground level experience some reductions in wind forces simply because of the drag exerted by the ground against the lowest levels of the air column. High-rise buildings, particularly those located along the beachfront, will receive the full strength of a hurricane's wind on their upper stories. Recent studies estimate that wind speed increases by approximately 27 % just 15 feet above ground level.

The wind stream generates uplift as it divides and flows around a structure. The stream following the longest path around a building, generally the path over the roof, speeds up to rejoin the wind streams following shorter paths, generally around the walls. This is the same phenomena that generate uplift on an aircraft's wings. The roof, in effect, becomes an airfoil that is attempting to take off from the rest of the building. Roof vortexes generally concentrate the wind's uplift force at the corners of a roof. These key points can experience uplift forces of two (2) to five (5) times greater than those exerted on other parts of the roof.

Once the envelope of the building has been breached through the loss of a window, door, or roof damage, wind pressure on internal surfaces becomes a critical factor. Openings may cause pressurizing or depressurizing of a building. Pressurizing pushes the walls out, while depressurizing will pull the walls in. Internal pressure coupled with external suction adds to the withdrawal force on sheathing fasteners. Damages from internal pressure fluctuations may range from blowouts of windows and doors to total building collapse due to structural failure.

During Hurricane Andrew in 1992, catastrophic failure of one and two-story wood-frame buildings in residential areas was observed more than catastrophic failures in any other type of building. Single-family residential construction is particularly vulnerable because less engineering oversight is applied to its design and construction. As opposed to hospitals and public buildings which are considered fully engineered, and office and industrial buildings which are considered "marginally engineered," residential construction is considered "non-engineered." Historically, the bulk of wind damage experienced nationwide has occurred to residential construction. Fully engineered construction usually performs well in high winds due to the attention given to connections and load paths.

Hurricane winds generate massive quantities of debris, which can easily exceed a community's entire solid waste capacity by three (3) times or more. Debris removal is an integral first step toward recovery, and as such must be a critical concern of all those tasked with emergency management and the restoration of community services. The TAOS model predicts the following quantities of debris for PBC given the following hurricane strengths:

Table 2.9 *The Arbitor of Storms (TAOS) Model*

Storm Strength	Debris Generated
Tropical Storm	156,142 cubic yards/acre
Category 1 Hurricane	1,049,571 cubic yards/acre
Category 2 Hurricane	2,182,522 cubic yards/acre
Category 3 Hurricane	7,421,401 cubic yards/acre
Category 4 Hurricane	16,289,149 cubic yards/acre
Category 5 Hurricane	44,874,888 cubic yards/acre

Both the Town of Palm Beach and City of West Palm Beach are old, historical communities on PBC's east coast. Their age alone makes them particularly vulnerable to hurricane damage. Both cities have old, historically significant structures whose loss would represent the loss of irreplaceable cultural resources. The age and construction type of much of the housing in West Palm Beach and to a lesser extent in many of the other coastal communities, suggests these communities would be hit very hard by a major storm.

2.2.1.3 Severe Thunderstorms/Lightning

Risk of severe thunderstorms and lightning is high in PBC, but many of the jurisdictions shown in Appendix A Table A-3 have only moderate vulnerabilities relative to these hazards. This variation in relative levels of vulnerability is again due primarily to construction practices and community characteristics. Working communities have a higher vulnerability to economic impacts from lightning than residential or retirement communities. All other factors being equal, residential and retirement communities have a historically higher vulnerability in terms of lightning fatalities.

2.2.1.4 Sea Level Rise

PBC completed an assessment of vulnerability due to sea level rise in a report entitled "Analysis of the Vulnerability of Southeast Florida to Sea Level Rise, Southeast Florida Regional Climate Change Compact Inundation, Mapping, and Vulnerability Assessment Work Group, August 2012." In this report, the County conducted an inundation analysis, identifying land at elevations below sea level, highlighted areas located near PBC's coastline and tidal waterways. The report concluded that limited physical infrastructure in PBC is at risk at the one (1), two (2) and three (3) foot sea level rise scenario. Initially low volume roads and parking areas may be impacted at one (1) foot and increase to up to 41 miles of roadways as the sea level continues to rise to three (3) feet. Property with a current taxable value of $396-557 million may become vulnerable at one (1) foot of sea level rise; properties valued at $3.6-4.5 billion may be vulnerable at three (3) feet of rise. One (1) school, one (1) landfill site, and one (1) hospital are estimated to be impacted at the higher three (3) foot sea level rise scenario.

An initiative conducted by Florida Department of Economic Opportunity in 2011 to analyze sea level rise integration utilized PBC as a pilot study (Statewide Post-Disaster Redevelopment Planning Initiative: Phase V). It concluded that while sea level rise was not addressed as an independent hazard category, other identified hazards may anticipate heightened impacts as the condition of sea level rise impacts over. Floods (Section 2.1.1.1), hurricanes (Section 2.1.1.2), and soil and beach erosion (Section 2.1.1.5) may be intensified due to the condition of sea level rise altering the traditional elements of the natural and man building environment. Section 2.1.1.1 details the conditions under which flooding occurs within the County and provides an overview of historical flooding events sea level rise will likely exacerbate flooding in flood prone areas, because flow rates in low lying areas may be further inhibited. The traditional flood conditions due to severe rain events will be impacted by sea level rise. Section 2.1.1.2 addresses these vulnerabilities associated with hurricanes. It details the overall vulnerability of the state and region due to its topography. Due to dense population along the coast, the potential for property damage and human casualties continues to increase. Florida not only has the most people at risk from hurricanes, but it also has the most coastal property exposed to these storms. While there continues to be debate, global climate change is likely to impact the development, intensity, and frequency of hurricanes in the world. Similarly, the condition of a higher sea level will increase the total inundation resulting from the storm surge. Section 2.1.1.5 addresses the vulnerability associated with beach and soil erosion stating that the natural forces of wind, waves, and longshore currents move the natural sand placement and change the beach shape and structure. However, this retreat is altered by man-made structures and creates a perceived need to protect the existing shoreline conditions. This condition will be vastly augmented by the increase of the sea level. Existing homes, businesses, roads, bridges, and other man-made structures will suffer more rapid beach erosion and eventual water intrusion.

Access to and from the barrier islands could be vulnerable due to bridges being inaccessible from local roadway inundation. Coastal marinas could also experience impacts. Natural habitats may also become increasingly vulnerable as water salinity levels and areas of inundation alter. Palm Beach County Assessment prioritizes saltwater ponds, saltwater marshes, and mangrove swamp as potential sensitive impacted habitats.

Generally, the areas in the southern parts of the County do not appear that they will suffer as much inundation in comparison with the central parts of the County, particularly along the Intracoastal Waterway. In the northern part of the County, large areas of projected inundation occur around existing natural waterways including the Loxahatchee River, Admiral's Cove, and Frenchman's Harbor. Most of the areas in PBC that are impacted by sea level rise are already fully developed or consist of natural lands. The rise in sea level will result in losses of land and structures, impact on utilities and infrastructure, and cause a reduction in value of real estate.

Areas within PBC that may be most problematic consist of those already below sea level. Cities in the northern portions of the County that are most inundated include Juno Beach and the coastal areas of North Palm Beach and Palm Beach. These areas are designated as natural areas. The land use designations are the residential, commercial, and recreational. Further analysis of this area may be necessary to determine if future land uses may be changed over time in order to decrease vulnerability to hurricane storm surge augmented by sea level rise. Land uses in the southern portions of the County include residential and commercial designations.

2.2.1.5 Soil/Beach Erosion

The County's vulnerability to coastal and beach erosion is moderate along its entire coastline. The most significant areas of beach erosion are the areas south of the stabilized inlets where the natural flow of laterally transported sand has been artificially interrupted. Many areas in PBC have been the subject of major beach re-nourishment projects sponsored jointly by the County and U.S. Army Corps of Engineers. Inland communities report some erosion problems along major canals and around water control structures.

2.2.1.6 Tornadoes

Historical data indicates the frequency of tornadoes in PBC is relatively low. However, the vulnerability does exist as proven in April of 2023 when PBC was affected by a tornado. Some individual communities have a higher vulnerability to this hazard due to the type of construction or numbers of mobile homes (manufactured housing units) within their boundaries.

2.2.2 Technological Hazards

2.2.2.1 Dam/Dike Failures

The county does have a major vulnerability to levee failure around the eastern boundary of Lake Okeechobee. Extensive diking of Lake Okeechobee has taken place since the hurricane of 1928 when about 2,500 people were killed from surge in western PBC. The county has the dubious distinction of having had the second highest number of fatalities (following Galveston, Texas) of any county in the United States. The U.S. Army Corps of Engineers maintains the levees around

Lake Okeechobee and they are considered to be sound. A levee failure with today's population would be a catastrophic disaster for PBC.

Herbert Hoover Dike Rehabilitation

The Herbert Hoover Dike (HHD) was completed in 1927 to protect PBC citizens from experiencing another flooding event similar to the occurrence in 1928. The flooding derived from the 1928 hurricane, which resulted in over 2,500 deaths and thousands more injured in the western portion of PBC. The dike protects from major flooding events occurring in the Belle Glade, Pahokee, and South Bay municipalities. Also, there is potential for flooding in The Village of Wellington, Royal Palm Beach, West Palm Beach, Palm Beach Gardens, and unincorporated PBC. The HHD is continuously monitored by the Army Corps of Engineers in partnership with the SFWMD.

In 2016, the U.S. Army Corps of Engineers finalized a key report that authorized additional rehabilitation work on the HHD that surrounds Lake Okeechobee in south Florida. The Corps' Jacksonville District received notification in 2017 that the dam safety modification report had been approved, marking the culmination of a four-year effort to conduct a risk assessment of the 143-mile earthen structure and develop alternatives for its rehabilitation.

The report, known as HHD Dam Safety Modification Study Environmental Impact Statement focused on extending embankment repairs over 28 miles on the south and west sides of the structure.

The approved repairs included installing 24 miles of seepage barrier, commonly known as a partial cutoff wall from Moore Haven to Lake Harbor (including the installation of 6.8 miles of seepage barrier between Lake Harbor and Belle Glade approved in a 2015 report). The Corps installed four (4) miles of cutoff wall near Lakeport. Armoring the embankment around the State Route 78 Bridge near the Harney Pond Canal and installation of a floodwall near water control structures on the Harney Pond and Indian Prairie Canals were also completed.

The rehabilitation efforts were estimated to be continue through 2025. However, the rehabilitation was completed in early 2023 at a cost of $1.6 billion.

A catastrophic failure of the HHD could pose a significant danger to the residents, local economies, and environment of PBC and South Florida. Completion of the HHD rehabilitation projects will serve to better protect the PBC communities of Belle Glade, Pahokee, and South Bay.

2.2.2.2 Hazardous Materials Accidents

A community's vulnerability to hazardous materials accidents depends on three (3) factors:

- Major transportation routes that pass through the community.
- Hazardous material generators located in or near the community.

- Resources in terms of people and property that are in an area of possible impact from a hazardous materials release.

Overall, unicorporated PBC has a low vulnerability to impacts from hazardous materials releases. There are relatively few existing major generators within the County that are generally away from major population centers.

Specific areas with higher vulnerability for hazardous materials accidents are along the transportation network (both highway and rail) that pass through the County. All the jurisdictions along the eastern sand ridge (Boca Raton, Delray Beach, Boynton Beach, Hypoluxo, Lantana, Lake Worth Beach, West Palm Beach, Riveria Beach, Lake Park, Palm Beach Gardens, Jupiter, and Tequesta) are extremely vulnerable to toxic material spills and releases from transportation system accidents, primarily rail. The Florida East Coast Railroad runs through all of these areas. Toxic material spills have occurred along the rail line. Given the right set of circumstances, such releases could produce significant detrimental effects on life and property in these communities.

2.2.2.3 Radiological Incidents (Nuclear Power Plant Accidents)

The Florida Power and Light St. Lucie Nuclear Power plant is located on south Hutchinson Island in St. Lucie County. In the U.S., federal regulations define two (2) distinct planning zones with regard to commercial nuclear power plant emergency planning. The Plume Exposure Pathway Emergency Planning Zone, commonly known as the EPZ, has a radius of 10 miles (16 km). The focus of the EPZ defines the geographic area for the management of protective actions related to the direct exposure to and inhalation of airborne radioactive contamination in citizens. The Ingestion Planning Zone, commonly known as the IPZ, has a radius of 50 miles (80 km). The focus of the IPZ is to define the geographic area for the management of protective actions related to the ingestion of food and liquid contaminated by radioactivity that may reach the food supply and surface-sourced drinking water reservoirs. Approximately 45% of PBC falls within the 50-mile radius IPZ for the St. Lucie Nuclear Power plant. This means that a significant portion of PBC is vulnerable to a nuclear power plant accident. Fortunately, the frequency with which actionable nuclear power plant accidents occur is extremely low. The overall risk to the citizens of PBC is therefore considered very low.

FEMA's Radiological Emergency Preparedness (REP) program provides clearly defined regulations relative to nuclear power plant emergency preparedness, response, and recovery. Drills are held routinely. Additionally, extensive documentation is required by the Nuclear Regulatory Commission and FEMA. Of greater risk to the citizens of PBC is the transport of fissionable material to and from the plant. Such material transfers are handled with a great deal of care and there has never been a significant accident during any such transfer. Again, while PBC's vulnerability to such accidents is high, the risk that this hazard will produce an impact within the community appears to be low. Some risks to PBC include:

- Potential physical injury (including long-term effects such as cancer).

- Loss of property (displacement from homes and agricultural lands).
- The county is within the 50-mile IPZ making contamination of food supplies and drinking water a possibility.
- Exaggerated media reporting could lead to heightened public alarm. Impacts to tourism industry are possible.

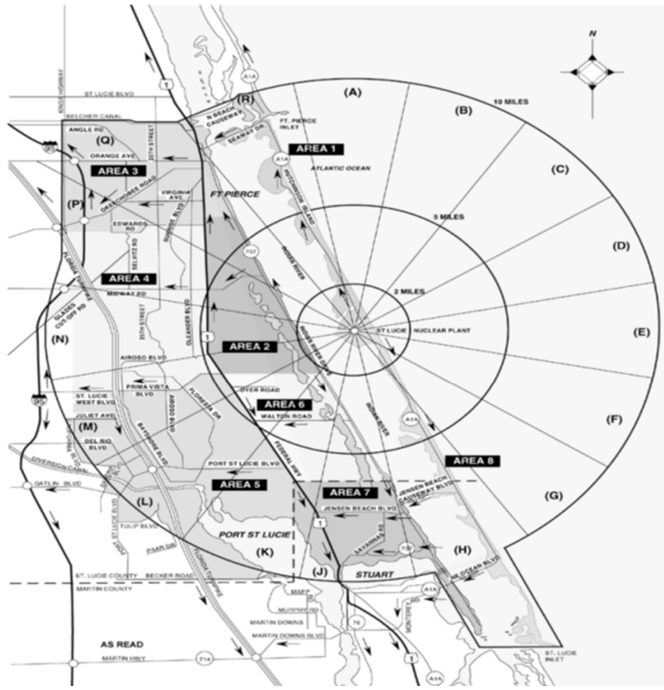

Figure 2.12: St. Lucie Nuclear Power Plant 10 Mile EPZ

In the event of an accidental release of radioactive materials from the St. Lucie Nuclear Plant, evacuation areas would depend on several metrological factors such as wind direction and wind speed. According to the 2020 Census data, there are approximately 245,144 people living within the 10-mile EPZ of the St Lucie Nuclear Power Plant. If an accident at the plant took place during tourist season, PBC could expect half of this population to evacuate into PBC (approximately 125,000 evacuees). The County must be prepared to shelter 10 % (12,500 people) of the evacuating population. All evacuees will be sheltered in Palm Beach, Indian River, and/or Brevard Counties.

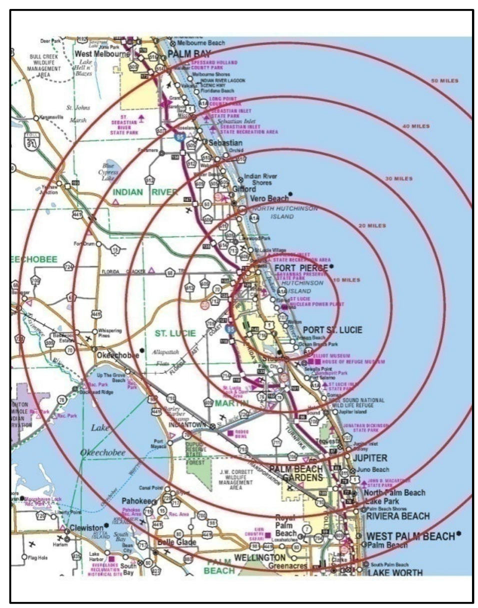

Figure 2.13: 50 Mile Ingestion Pathway Map for St. Lucie Nuclear Power Plant (Copyright © 2010 GIS Dolph Map LLC – Used with permission)

There are several safety design measures at the plant. Stringent federal safety standards govern plant operations (e.g. plants have multiple layers of protective barriers which are designed to withstand aircraft attack, tornados, severe accidents, and earthquakes). It is most likely that an accident would slowly progress from one (1) stage of emergency classification to the next over an extended period of time. A "fast breaker" accident is very unlikely. However, the plant can shut down operations within two (2) seconds if needed. Most likely, an accident would slowly progress providing time to warn the public and implement protective measures. In the case of a radioactive release, Florida Power and Light and the American Nuclear Insurers organization would reimburse evacuees for nuclear property damage and nuclear bodily injury in accordance with the Price Anderson Act which governs financial reimbursement in the event of a commercial nuclear power plant emergency.

In 1986, the United States Congress enacted the Emergency Planning and Community Right-to-Know Act (EPCRA). It imposed upon state and local governments planning and preparedness requirements for emergencies involving the release of hazardous materials. The role of the federal government in response to an emergency involving the release of hazardous materials is to support local and state emergency operations. Activation of the Federal Regional Response Team provides access to federal resources not available at the state and local levels. An on-scene coordinator is designated to manage federal resources and support.

2.2.2.4 Communication Failures

Communication failures have a greater potential to produce adverse economic impacts in business-based rather than retirement or residential communities. On the other hand, communication system failures in residential and retirement communities may put more human lives at risk. The County's vulnerability to communication system failures is generally considered moderate. Basically, PBC's vulnerability to this hazard is no greater or less than most other Florida coastal counties.

2.2.2.5 Transportation System Accidents

Palm Beach International Airport (PBI) is a major commercial air transportation hub, with extensive commercial passenger and freight business as well as a significant amount of private or general aviation activity as well. The airport is located directly to the south and west of the City of West Palm Beach and the runway approaches pass directly over both the Town of Palm Beach and the City of West Palm Beach. Aviation is an important element of the economy in PBC, and this activity raises the County's vulnerability to aviation associated accidents. Another busy airport for general aviation is the Lantana airport, which has been a source of many non-commercial incidents over the years.

Vulnerability to transportation system accidents is also associated with the highway and rail systems that run through PBC. Individual community and population center vulnerabilities to this hazard are entirely dependent upon location. The communities built on the eastern sand ridge of the County are most vulnerable. Major transportation hubs, rail yards, trucking centers, and the Port of Palm Beach all raise these communities' vulnerabilities to transportation system accidents and breakdowns. Transportation accidents have occasioned blockages on the major highways throughout PBC. The Town of Palm Beach and the City of West Palm Beach are also more vulnerable to plane crashes due to their location relative to PBI. The east-central portion of the County has a higher vulnerability to major highway accidents due to the presence of Interstate 95 and the Florida Turnpike.

Due to their locations along the rail line, the eastern cities have higher vulnerabilities to rail system accidents. The Brightline express train, with service from Miami to Orlando, has a potential top speed of 125 mph traveling at a much faster speed than other regional commuter trains. It is anticipated by the LMS HVA Sub-Committee that there will be additional people struck while ignoring rail crossing warning devices and to the high speeds that the public is not accustomed to in the area.

2.2.2.6 Wellfield Contaminations

Wellfield contamination has not been a major problem for most of PBC. There is some potential exposure to this hazard in the eastern portion of the County. However, the vulnerability to this hazard is considered low at this time.

2.2.2.7 Power Failures

Power failures have the same potential impacts in all PBC communities. The vulnerabilities of all communities to power failures are considered moderate. The power grid throughout PBC is diversified. There is no single choke point or distribution node whose failure would disrupt power distribution to the entire community.

2.2.2.8 Coastal Oil Spills

Many advanced response mechanisms are available for controlling oil spills and minimizing their impacts on human health and the environment. Mechanical containment or recovery is the primary line of defense against oil spills. This type of equipment includes a variety of booms, barriers, and skimmers. Natural and synthetic sorbent materials are used, as well, to capture and store the spilled oil until it can be disposed of properly. Chemical and biological methods can be combined with mechanical means for containing and cleaning up spills. Dispersants and gelling agents are most useful in helping to keep oil from reaching shorelines and other sensitive habitats. Physical methods are used to clean up shorelines. Wiping with sorbent materials, pressure washing, raking, and bulldozing can be used to assist natural environmental recovery processes. Scare tactics are used to protect birds and animals by keeping them away from oil spill areas.

2.2.3 Human-Caused Hazards

2.2.3.1 Civil Disturbances

The overall potential for civil disturbance in PBC is considered moderate. The municipalities of West Palm Beach, Delray Beach, Boynton Beach, Palm Beach, and Riviera Beach are considered to have relatively high vulnerability to this hazard. There has been significant civil unrest in certain areas of these cities in the past and a significant potential for such unrest remains. Within the past two (2) years, particularly with the election of the U.S. President who owns and frequents a home in PBC, the numbers of civil disturbance activities have increased significantly. However, they are most often considered peaceful in nature. This is expected to continue through 2020 and possibly 2024. The LMS HVA Sub-Committee has recognized and elevated the level of vulnerability to civil disturbance for the Town of Palm Beach due to the civil disturbances that they have in the area of the former President's Palm Beach home.

2.2.3.2 Domestic Security

Terrorism, Sabotage, and Cyber Attacks

The possibility for terrorism, sabotage, and cyber-attacks in PBC does exist. The County's vulnerability to this hazard is moderate and thus is considered a threat to the PBC community. The City of West Palm Beach has a slightly higher vulnerability to terrorism as it is the center of government and also by the role played by aviation in the local economy. This vulnerability is still considered only moderate. The Town of Palm Beach, as well as many other wealthy enclaves within PBC, has a slightly higher vulnerability to celebrity terrorism since so many well-known and wealthy personalities make their residence there. While this vulnerability exists, it is considered to be no greater than that faced by many other communities around the country where the rich and famous live.

The warm temperatures, onshore winds, high rate of sunshine (UV exposure), and rainfall in PBC make this area a less favorable target for biological or chemical terrorism than many other areas of the United States. The population here is dispersed when compared to major cities in the northeastern U.S. The transportation system infrastructure is highly dependent upon individual vehicles. Both of these features make PBC a less desirable target for transportation system or conventional type (bomb related) terrorist acts.

Crime/terrorism hazards will damage or impair the County's infrastructure, disrupt commerce, and possibly result in large-scale health emergencies, disease outbreaks, and/or epidemics. Public awareness of terrorist incidences worldwide has increased since 2001. The percentage of terrorist events resulting in fatalities continues to grow. As a metropolitan area and a key tourist/economic component of the U.S., PBC could be a possible target for terrorist activities. Government buildings, large market sectors, critical infrastructure, tourist attractions, and large-scale events are all prime targets for terrorist organizations. Additional vulnerabilities include:

- Transportation Systems – highways, railways, waterways, and airports are vital to the transportation of materials, goods, services, and people.
- Population – an attack on a large population is attractive to gain large media attention.
- Industry – large manufacturers and companies house hazardous materials. Disruption of these facilities can have an economic impact and cause physical damages to property and loss of lives due to the large volume of hazardous materials housed.
- Utilities – there is a large dependency on telecommunications, power, water, wastewater, and pipeline services for daily activities and operations.
- Government Buildings – an attack on government buildings is attractive in order to deliver a political statement.
- Entertainment/Recreation – anywhere that attracts large populations is an attractive target.

The Threat and Hazard Identification and Risk Assessment (THIRA) provides detailed information regarding the crime/terrorism hazards mentioned below that could affect PBC.

- Terrorism (see *Domestic Security HSP*)
- Bomb Threat Incident

- Cyber-Security Incident (see also *PBC Information Systems Services (ISS) Department Business Continuity and Disaster Recovery Plan* and *IT Security Policy Manual*).

2.2.3.3 Workplace/School Violence

While a workplace/school violence incident statistically ends within five (5) minutes, the consequences of the attack could last well beyond a single operating period (deemed to be 12 hours in duration per the CEMP) 70% of the time (Blair, P., Schweit, W., 2014), including many years, as these types of incidents create a detrimental psychological impact on the community. The County's vulnerability to this hazard is moderat. Therefore, this hazard is considered a threat to the PBC community.

A workplace/school violence incident tends to occur with the following actions:

1. An assault is acted upon by an active shooter/assailant.
2. Law enforcement moves into the scene to neutralize the assailant.
3. Fire rescue moves into the scene to assist wounded victims.
4. Victims are transported to health care facilities (e.g., hospitals).
5. Services are provided to victims and/or victims' families, such as victim and family mental health counseling.
6. Economic consequence management occurs.
7. Coordinated public messages and press releases are conducted.
8. Other numerous foreseen and unforeseen consequences may emerge.

Due to the majority of these type of incidents ending within five (5) minutes, planning will strongly focus on preparedness and mitigation, including the practice of educating the public on recommended actions they can take prior to an incident.

2.2.3.4 Harmful Algal Blooms

Blue Green Algae

Blue-green algae have had a significant impact on Palm Beach County's water bodies in recent years. In the summer of 2016, toxic blooms of blue-green algae affected Lake Okeechobee, which is connected to the St. Lucie Estuary and the Caloosahatchee River. These blooms led to the release of harmful toxins causing environmental and public health concerns. The blue-green algae blooms in PBC were primarily fueled by excess nutrient runoff, particularly from agricultural activities and urban areas. To mitigate the impact of blue-green algae blooms, various measures have been taken. These include improving water management practices, implementing stricter nutrient regulations, increasing monitoring efforts, and promoting public awareness about the importance of water quality and conservation. Efforts are ongoing to address the underlying causes of blue-green algae blooms and protect the health of Palm Beach County's water bodies.

2.2.3.5 Mass Migration Crises

Data on past mass migration and population movements, such as the Haitian influx and Cuban raft incidents of the 1980s, indicates that mass migration has never reached a crisis state for the local authorities in PBC. The county's vulnerability to this hazard is moderate, however, due to demographic features. Thus, mass migration is a threat to the public. The cities of West Palm Beach, Delray Beach, Boynton Beach, Rivera Beach, South Bay, Pahokee, and Belle Glade all have a slightly higher vulnerability to mass migration impacts due their larger populations of Latin American and Caribbean immigrants.

2.2.4 Vulnerability of Critical Facilities

Appendix G maps demonstrate the vulnerability of each hazard in relation to the County and each jurisdiction's location of critical facilities and/or infrastructure. Structures have been identified for each hazard with jurisdictional boundaries. An estimated dollar figure in relation to potential dollar losses has been identified and summarized in a narrative for each identified hazard by jurisdiction.

The County determined a criticality based on the relative importance of its various assets for the delivery of vital services, the protection of special populations, and other important functions. The types of critical facilities and infrastructure identified within these risk assessment maps are: schools, police stations, fire stations, specific government buildings, nursing homes, assisted living facilities, hospitals, shelters, Herbert Hoover Dike, Turnpike, I-95, water treatment facilities, utility stations, draw bridges, seaports, and airports. These facilities can be located on the risk assessment maps and a potential dollar loss will be correlated in the charts broken down by municipality and unincorporated PBC. The estimated costs are based upon information from the County Auditor's Office. The dollar figures specific to each hazard by municipality or unincorporated area express the potential human and economic impacts within PBC. Appendix M specifically addresses critical facilities in PBC.

2.3 Risk Assessment

In order to effectively plan hazard mitigation projects and allocate scarce financial resources, a community's vulnerability to a specific hazard must be coupled with other critical factors to perform a risk assessment.

Risk, or the probability of loss, depends on three (3) elements:

- Frequency – How frequently does a known hazard produce an impact within the community?
- Vulnerability – How vulnerable is a community to the impacts produced by a known hazard?
- Exposure – What is the community's exposure in terms of life and property to the impacts produced by a specific hazard?

Once these three (3) factors are established, the risk level faced by a community with regard to any specific hazard can be calculated using the Risk Triangle approach (Crichton, 1999).

In this approach, these three (3) factors become the sides of a triangle. The risk or probability of loss is represented by the triangle's area (Figure 2.14a). The larger the triangle's area, the higher the community's risk with respect to a given hazard. If a community wishes to reduce its potential for loss or risk of impacts from any given hazard, it can attack the problem by reducing any one of the three (3) elements forming the sides of this triangle, the frequency of a hazard's occurrence, the vulnerability of the community, or the exposure of the community.

For example, if a community wishes to reduce its exposure to hurricanes, it could move off of the barrier islands. This actually happened in the 1870s when an entire community on the North Carolina barrier islands moved to the mainland after suffering two (2) devastating hurricanes in three (3) years. By moving out of harm's way, a community drastically reduces its exposure and its potential for loss from a given natural hazard (Figure 2.14b).

In today's world, the potential to relocate an entire community off the barrier islands is, to say the least, remote. A community may, however, reduce its vulnerability to hurricanes by strengthening its buildings. If buildings are hardened, vulnerability is reduced and there is a corresponding reduction in a community's probability of loss (Figure 2.14c).

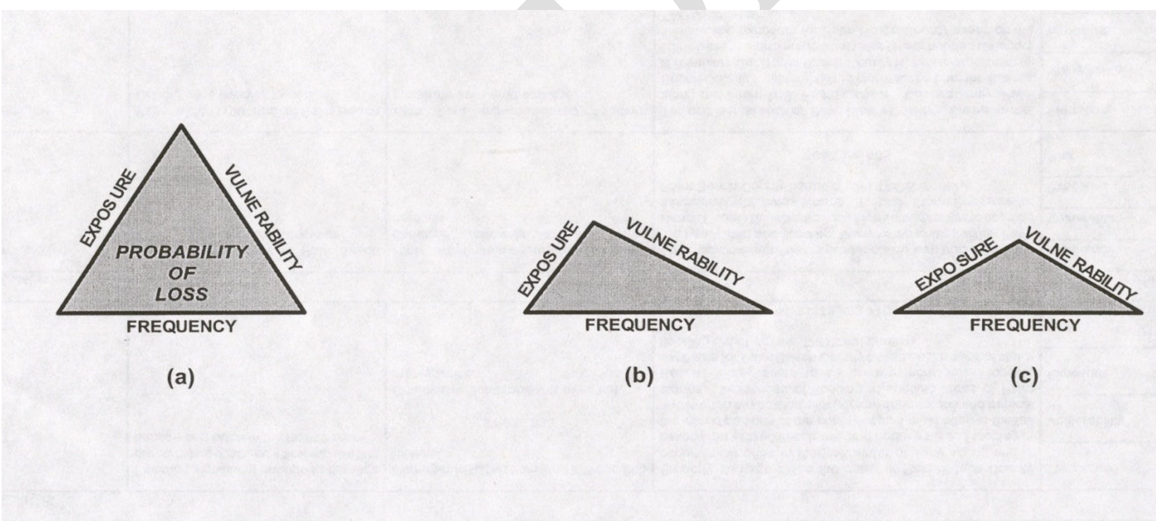

Figure 2.14: a, b, c Risk Triangles

In terms of natural hazards, there is very little, if anything, that can be done to change the frequency with which they produce impacts in a community. Mitigation planning relative to those hazards must therefore focus on reducing the community's vulnerability or exposure. In terms of technological and human-caused hazards, the most cost-effective type of mitigation is to limit or reduce the frequency with which such hazards actually occur. Appendix A tables summarize the County's potential for loss relative to each of the hazards identified. In addition, Appendix A will include a risk assessment by jurisdiction. The risk assessments will be illustrated by means of maps located in Appendix G by hazard. This is to give a clear image of potential risk throughout PBC, hazard specific, with potential dollar losses estimated tied to assessed property values. This assessment refers to Appendix B and Appendix G illustrating mitigation actions being addressed in the PBC comprehensive plans. The overall strategy is to mitigate to reduce damage of a potential hazard.

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