Hillsborough County Multi-jurisdictional **Local Mitigation Strategy**

2020 Plan Update

IN COORDINATION WITH

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Version 1.1 - February 2022
Replaces Version 1.0 from April 25, 2020

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Document Revision History

The 2020 Plan Update to the Hillsborough County Multi-jurisdictional Local Mitigation Strategy went through the following approvals and has been updated as indicated within the revision history table below:

4/25/2020: Plan receives Approval Pending Adoption letter from Florida Division of Emergency Management (FDEM)

7/27/2020: Date of Plan Approval per the Federal Emergency Management Agency (FEMA)

8/19/2020: FEMA and FDEM letters formally approve all jurisdictions through 7/27/2025. The letter acknowledges Hillsborough County, City of Tampa, and City of Plant City as also being compliant from 7/27/2020 through 7/27/2025).

6/16/2020: City of Temple Terrace Resolution

7/15/2020: Hillsborough County Resolution

7/27/2020: City of Plant City Resolution

8/06/2020: City of Tampa Resolution

Revision Index	Summary of Changes	Date Approved by LMS Working Group
1.0	Original Document	4/25/2020
1.1	New hazard profiles added to address Emergency Management Accreditation compliance: - Coastal Oil Spill - Port Vessel Collision - Utility Failure - Special Events - Cyber Terrorism renamed to Cyber Incident Hazards recategorized from Natural and Technological to Natural, Technological, and Human/Societal Appendix H: Updated language for Governance (approved by LMS Working Group at 11/17/20 meeting)	11/4/2021

EXECUTIVE SUMMARY

Introduction

Under Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) enacted under the Disaster Mitigation Act of 2000 (DMA2K), Hillsborough County is required to have a Federal Emergency Management Agency (FEMA)-approved hazard mitigation plan in order to be eligible for federal hazard mitigation funding. The purpose of the County Hazard Mitigation Plan, more commonly called the Local Mitigation Strategy (LMS) in Florida communities, is to reduce death, injuries, and property losses caused by natural hazards in Hillsborough County. The 2020 Plan identifies hazards based on the history of disasters within the county and lists goals, directives, strategies, and actions for reducing future losses. Implementation of planned, pre-identified, and cost-effective mitigation measures not only helps to reduce losses to lives, property, and the environment but it also streamlines the disaster recovery process. This is a 5-year update of the countywide LMS that was last approved in July of 2015. While the document may refer to specific historical events for context, the plan update focuses on changes to the communities and their vulnerabilities over the last 5 years and provides an update to capabilities, programs, and actions that the participants intend to utilize to reduce exposure or consequences from the identified hazards. Hazard mitigation is most effective when based on an inclusive, comprehensive, long-term plan that is developed before a disaster occurs.

The LMS serves several purposes, including providing an explanation of how Hillsborough County and its three municipalities identify strategies to implement an effective, comprehensive countywide Local Mitigation Strategy. The communities participating in this plan include the Unincorporated County and all its municipalities:

- Hillsborough, Unincorporated
- Plant City, City of
- Tampa, City of
- Temple Terrace, City of

The 2020 Plan is coordinated through appropriate state, local, and regional agencies as well as non-governmental interest groups. This plan, and its future revisions, will provide guidance in merging the planning efforts of all local governments, the private sector, and non-profit organizations within Hillsborough County into one viable, comprehensive, mitigation program.

The scope of the LMS is broad. The plan explains the way in which the communities implement mitigation activities within the county in coordination with local agencies. Additionally, as required by statute, the Risk Assessment portion of the LMS identifies natural hazards as well as technological and human-caused hazards. The Risk Assessment portion analyzes vulnerability of the county in countywide terms as well as results and capabilities at the municipal level.

The purpose of the 2020 LMS is to:

- Reduce risk to people, property, and the critical infrastructure.
- Increase public awareness and education about the plan and planning process.

- Maintain grant eligibility for participating jurisdictions.
- Update the plan in accordance with Community Rating System (CRS) requirements.
- Maintain compliance with state and federal legislative requirements for local hazard mitigation plans.
- Complete an update of information in the plan to demonstrate progress and reflect current conditions.

Hillsborough County is vulnerable to both natural hazards and technological and human-caused hazards. The most common hazards to Florida are wildfires and floods; however, hurricanes have historically inflicted catastrophic destruction.

Planning Process and Plan Maintenance Section

There are 10 primary steps that comprise the LMS planning process. The process defines not only who should be involved, but how the process is going to work, and provides an understanding of how the process facilitates the production of the final product.

- Step 1: The Planning Organization – The development of a mitigation strategy requires the involvement of representatives from the public, private, and governmental sectors.
- Step 2: Involving the Public – An important component of the mitigation planning process involves public participation.
- Step 3: Coordination – Coordinate activities within the county and to bring back perspectives of their constituency.
- Step 4: Assessing the Hazard – Conduct and maintain a hazard identification and vulnerability assessment.
- Step 5: Assessing the Problem – Quantify the impact of the hazards identified in the previous step on the community.
- Step 6: Goals and Directives – Revisit goals and directives and make adjustments as appropriate.
- Step 7: Possible Activities: Mitigation Opportunities and Initiatives – Identification of potential mitigation opportunities and initiatives.
- Step 8: An Action Plan – Directives were identified for each goal to specifically identity action items and are reflected in six categories of mitigation activities.
- Step 9: Adoption of the Strategy – Officially adopt the LMS.
- Step 10: Implementation, Evaluation, and Revision – The LMS is intended to be a dynamic document that will be updated regularly.

The LMS Working Group (WG) consists of representatives of the jurisdictions, private sector, and non-profits as well as any members of the public as all meetings are advertised on the county's website and calendar.

The county's first LMS was developed in the late 1990s. The plan was then updated in 2004, 2009, and 2015. This is the fourth update of the plan and the focus of the update was on adding new risk assessments, refining directives, and refreshing the project list.

The 2020 LMS update began in March 2019. Many of the entities involved had related efforts occurring simultaneously and so one of the key activities was the integration of these studies into the plan. Two of the most relevant projects include:

- The Community Vulnerability Study – Contracted by Hillsborough County and being performed by the University of South Florida. The effort focuses on future flood conditions and evaluates public health implications for flood-related hazards.
- Community Rating System (CRS) Updates – The CRS program, which evaluates floodplain management activities for jurisdictions, is a very involved program that requires specific analysis, code assessments, and public information activities (among actions) to be performed annually. Where applicable, the CRS work of the cities and their subcontractors has been incorporated under the direction of the LMS WG.

After the 2020 LMS Plan Update underwent final revisions, and the plan was completed to the satisfaction of the State Hazard Mitigation Office (SHMO) which reviews the Plan for compliance on behalf of the Federal Emergency Management Agency, the plan was officially adopted by Hillsborough County via a memorandum signed by the Chief Executive Officer (CEO) as the County's Authorized Representative. The 2020 LMS update was approved via resolution on 07/15/2020. The plan was authorized by FEMA and will be in effect from July 27, 2020 until July 27, 2025. Each jurisdiction also approved the Plan within their community as identified in "Chapter 2 – Planning Process" (with full resolutions available in Appendix F).

Mitigation Strategy Section

The LMS details goals and directives for achieving loss reduction in Hillsborough County. The four goals are listed below.

1. Improved Human Environment – with directives focusing on social vulnerability, public education, collaboration with community networks, warning and evacuation procedures, improving resilience of businesses, and public health
2. Improved Built Environment – focusing on resilient structures and sustainable infrastructure, watershed management, and flood reduction techniques
3. Improved Natural Environment – which emphasizes protection of natural habitats, management of the natural floodplain, and natural infrastructure solutions
4. Resiliently Designed Environments – includes directives that promote countywide consistency for higher standards, consideration of higher risk thresholds for hazard assessments, and education of residents and businesses on impacts from climate variability

Additional information on the LMS goals and directives as well as specific mitigation measures can be found in this section.

Hillsborough County has policies, programs, and capabilities designed to help mitigate the impacts of hazard events. Each community has its own policies, programs, and capabilities. These depend on factors such as the size of the geographic area, its population, or the amount of funding available through local resources. Regardless of size or wealth, each community has a unique core set of policies, programs, and capabilities at its disposal related to hazard reduction and mitigation including building codes, land use plans, and regulations, which are discussed in this section.

Risk Assessment Section

The risk assessment for Hillsborough County was intentionally structured to align with the State of Florida Enhanced Hazard Mitigation Plan (SHMP) and provides the factual basis for developing a mitigation strategy for the county. This section profiles the natural, human-caused, and technological hazards that could possibly affect Hillsborough communities. This risk assessment is used not only for the LMS, but also supports the County's Comprehensive Emergency Management Plan (CEMP). Each natural hazard profile includes a discussion of the geographic areas affected, the historical occurrences in the county, an impact analysis, the probability, and the vulnerability and loss estimation by county critical facilities, and a discussion of overall vulnerability. Alternatively, the human-caused and technological hazards include similar topics of discussion, but not all aspects are able to be quantified. This is because of the limited data available and the imprecise nature of the human-caused and technological hazards.

The risk assessment identifies 28 hazards based on an examination of past disasters, probability of occurrence, possible impacts, and vulnerability. The hazards include:

Natural Hazards

- Flood
- Tropical Cyclone
- Severe Storm
- Tornado
- Wildfire
- Erosion
- Extreme Heat
- Drought
- Suspect Soil
- Winter Storm and Freeze
- Seismic Event
- Tsunami

Technological Hazards

- Transportation Incident
- Infrastructure Disruption
- HazMat Incident
- Space Weather Incident
- Dam/Levee Failure
- Agricultural Disruption
- Disease Outbreak and Biologic Incident
- Food and Waterborne Disease Outbreak
- Coastal Oil Spill
- Port Vessel Collision

- Utility Failure

Human/Societal Hazards

- Civil Disturbance
- Cyber Incident
- Mass Migration
- Terrorism
- Special Events

Potential Funding Sources Section

The county uses a variety of programs and funds to achieve its mitigation goals, including federal grant programs such as HMGP, Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance (FMA), and the state grant Hurricane Loss Mitigation Program (HLMP). Various grants and programs are discussed throughout this section.

Appendices

Many documents are included with the LMS as appendices. These appendices are referenced throughout the plan and support the plan.

- Appendix A: Planning Process Documentation
- Appendix B: Risk Assessment Tables
- Appendix C: Additional Natural Hazard Planning Documents
- Appendix D: Mitigation Projects
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INTRODUCTION

Purpose

The Local Mitigation Strategy (LMS) offers innovative approaches for combining resources and coordinating government leadership with the private sector. Mitigation strategies, the cornerstone to risk reduction, offer an opportunity for each sector of our community to plan and prepare for a safer future. Mitigation is an ongoing effort to lessen the impacts disasters have on people and property.

History tells the many stories of disasters that caused tragic losses of life and property. As tragic as these losses are, the probability of even greater catastrophic loss in the future is real. As the population continues to grow and the necessary infrastructure is erected, the impact of a disaster multiplies. The LMS provides a conceptual framework to reduce these losses by breaking the cycle of 'disaster event – rebuild – disaster event – rebuild'.

During the late nineties Hillsborough County and its municipalities developed a multijurisdictional LMS and, in 2004, updated it as required by the Disaster Mitigation Act of 2000. Currently, the Code of Federal Regulations, 44 CFR §201.6 - Local Mitigation Plans (eCFR.gov, 2014) requires that the Local Mitigation Strategy be reviewed and revised every five years. This revision must reflect any changes in priorities, the progress in local mitigation efforts and development, and be submitted to the Florida Department of Emergency Management for approval for continuation of state and federal grant funding.

Hillsborough County's diligence in continually improving and updating its LMS provides the community with the information and tools available to increase its resiliency to the disruptions caused by disasters. Another benefit is the potential reduction in the associated cost of disasters. The cost of recovery and rebuilding due to the devastation caused by a disaster is much greater than the cost of planning and preparing before disaster strikes (Berginnis, 2014).

The goal of the Hillsborough County LMS is to establish and maintain an ongoing process that continually assess potential disasters, develops corresponding mitigation techniques, and incorporates preparedness and response into the consciousness of the entire community. To date, Hillsborough County's LMS process has produced the assessed vulnerabilities of the community to a variety of hazards, identified a comprehensive list of plans, programs, and projects to decrease the magnitude of those vulnerabilities, and prioritized the implementation of respective initiatives. This 'all-hazards' LMS will continue to be referenced through the Comprehensive Emergency Management Plan (CEMP), the local Comprehensive Plan, the Hillsborough County Land Development Code, the Floodplain Management Plan, the Hillsborough County Construction Code (Ord.13-31) and the unified Post-Disaster Redevelopment Plan (PDRP).

What is Hazard Mitigation?

Mitigation is defined as "sustained action that reduces or eliminates long-term risk to people and property from natural hazards and their effects" (FEMA, National Mitigation Strategy, 1996). This definition distinguishes actions that have a long-term impact from those that are more closely associated

Definition: Hazard Mitigation

What exactly is hazard mitigation?

According to the website of the Federal Emergency Management Agency (FEMA), "Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. Mitigation is taking action now—by analyzing, reducing, or insuring against risk—to reduce impacts of future disasters.

Mitigation requires an understanding of local risks and current capabilities and a commitment to investing in long-term community well-being."

(https://www.fema.gov/hazard-mitigation-planning-frequently-asked-questions).

According to the Code of Federal Regulations, "hazard mitigation means any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards" (44 CFR 201.2).

with preparedness and immediate response to and short-term recovery from a specific event although this on-going process does encompass processes that address the time before and during a disaster.

The intent of mitigation is to focus on actions that produce repetitive benefits over time, not on those actions that might be considered emergency planning or emergency services. The primary purpose of hazard mitigation is to safeguard communities so, when they experience a disaster, they suffer the least damaging effects possible with the ideal outcome of eliminating negative effects from the impact of a disaster.

Another important benefit of effective mitigation techniques is that current dollars spent on mitigation will significantly reduce the demand for large amounts of future dollars when disasters strike. Current mitigation expenditures will also reduce the economic disaster that often accompanies the hazard event through destruction of property, loss or interruption of jobs, and closing or disabling of businesses. This process describes the ongoing effort at the Federal, State, Local, and individual levels to lessen the impact of disasters upon families, homes, communities, and economy (Federal Emergency Management Agency, Strategic Plan, 1996).

Mitigation should be used as the means to decrease demands for disaster response and recovery resources. By reducing the principal causes of injuries and deaths; it enables a quicker lifesaving response and long-term economic recovery because the community infrastructure remains intact. Additionally, it reduces the societal impacts of disaster because it results in less disruption of the social environment. In essence, mitigation is the foundation of sustainable community development.

Through the application of mitigation technologies and practices, society can lessen or eliminate the negative consequences of disasters. For example, mitigation measures can be the strengthening of homes so that belongings are better protected from floods, hurricanes, and other hazards. Strategies can be used to reinforce businesses and industries to lessen or avoid damages to their facilities possibly allowing them to remain operational.

Mitigation technologies can be used to strengthen hospitals, fire stations, and other critical service facilities so that they can remain operational or reopen more quickly after an event. In addition, mitigation measures can help reduce disaster losses and suffering so that there is less demand for money and resources in the aftermath.

In practice, mitigation can take many forms. Actions include the following:

- Promote sound land-use planning based on known hazards
- Work closely with the insurance industry
- Retrofit structures to withstand disasters where an increased risk is present
- Provide opportunities to build to higher standards to reduce structural vulnerability
- Develop, adopt, and enforce effective standards in high-risk areas
- Engineer infrastructure to withstand greater risks
- Develop and implement a hazard mitigation plan that illustrates strategies to reduce vulnerability to hazards

Mitigation is a principal foundation of our community-based Local Mitigation Strategy and is centered on people helping people with the goal of reducing the number of victims, property loss, and environmental damage.

Regulations

The Disaster Mitigation Act of 2000 (DMA2K) became law October 30, 2000. The act amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) (Public Law 93-288, as amended).

Federal statutes and regulations applicable to Local Mitigation Planning include the following:

- Disaster Mitigation Act of 2000 (42 U.S. Code 5121)
- Stafford Act
    - Title III – Major Disaster and Emergency Assistance Administration
        - Section 322 – Mitigation Planning (42 U.S. Code 5165)
            - (a) Requirement of Mitigation Plan
            - (b) Local and Tribal Plans
            - (e) Increased Federal Share for Hazard Mitigation Measures
- Stafford Act
    - Title IV – Major Disaster Assistance Programs
        - Section 404 – Hazard Mitigation (42 U.S. Code 5170(c))
            - (c) Program Administration by States
- 44 Code of Federal Regulations 201 – Mitigation Planning
    - §201.6 Local Mitigation Plans
- 44 Code of Federal Regulations 13 – Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments
    - Subpart B – Pre-Award Requirements
        - §13.10 Forms for Applying for Grants

Florida statutes and regulations applicable to state and county mitigation planning include the following:

- Florida Statute 252
    - Florida Administrative Code 27P-22

- Florida Statute 252.3655

Other applicable standards include the Emergency Management Accreditation Program (EMAP) Standards. Hillsborough County is EMAP Accredited and the Hillsborough County LMS is compliant with the EMAP Standards. The applicable Standards include:

- 4.1: Hazard Identification, Risk Assessment and Consequence Analysis
- 4.2: Hazard Mitigation

Assurances

Hillsborough County will comply, and assures it will continue to comply, with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding in compliance with 44 CFR 13.11(c) as a subgrantee through the State of Florida. This includes managing and administering FEMA funding locally in accordance with applicable Federal statutes and regulations.

The county also assures it will amend the Local Mitigation Strategy in accordance to 44 CFR. This includes amending the plan whenever necessary to reflect changes in state or Federal laws and statutes.

County Profile

Natural Features and Topography

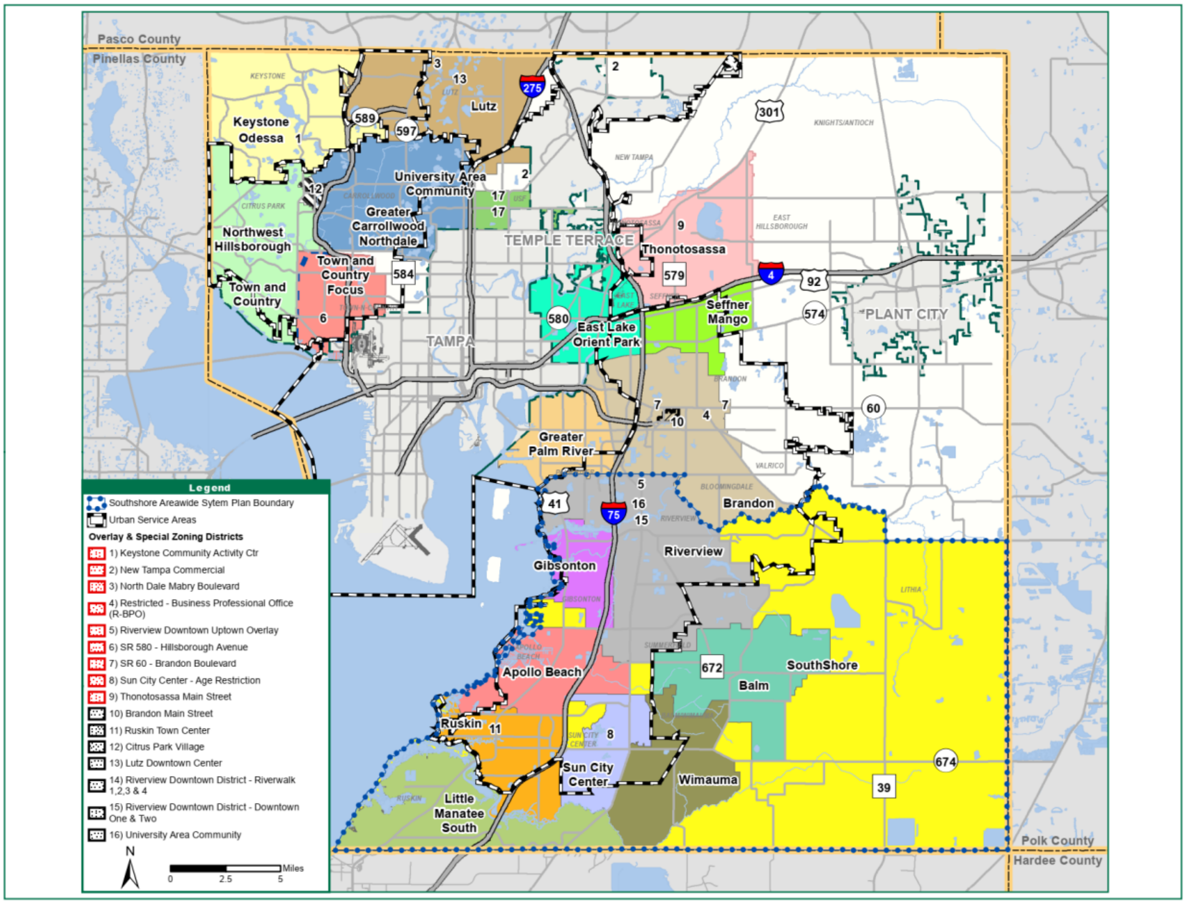
Hillsborough County is located in west-central Florida bordered by Pasco County to the north, Manatee County to the south, Polk County to the east, and on the west by Pinellas County and Tampa Bay. The 39.2 miles of coastline in Tampa Bay is home to an estuary, a place where fresh water and salt water meet and mix to form a unique habitat. At high tide, Tampa Bay which is Florida's largest estuary, represents 398 square miles of Hillsborough County total 1,266.4 square miles. These many miles are composed of 1,051 miles of land and 215.4 miles of water broken down into 39.7 inland miles, 155.9 coastal miles, and 19.8 territorial miles. Hillsborough County's topography ranges from sea level to approximately 160 feet in the Keystone area of northwestern Hillsborough County.

Hillsborough County is the economic hub of the Tampa Bay metropolitan region. Its diverse industries include: the chief financial district in downtown Tampa, the Port of Tampa - the largest seaport in the state based on tonnage, beaches and theme parks that provide tourists year-round destinations, both private and public colleges and universities, respected medical and medical research facilities, and a thriving agricultural sector. The agricultural industry is strong and produces strawberries, tomatoes, grapefruit, oranges, squash, tangerines, watermelons, cattle, dairy products, broilers, and eggs in addition to an aquaculture industry which produces such products as aquarium fish and aquatic plants.

As the county continues to grow and thrive, however, it remains vulnerable to a wide range of natural, technological, and human hazards. Natural hazards include hurricanes, floods, tornadoes, storm surge, lightning, high winds, sinkholes, wildfires, and drought. Technological hazards include electrical failures, sewer failures, radiologic exposures, cyber incidents, and chemical exposures. Human-made hazards include terrorism, mass casualties, bomb threats, hostage situations, and workplace violence. Hillsborough County and its population of more than one million residents need to prepare of all of them.

Identifying both the physical and the cultural geographic features of a region is vital in order to understand and prepare for the impact of the various types of hazards. This section builds a profile of Hillsborough County in an effort to identify, understand, and make available information to its citizens to be used to prepare Hillsborough County's residents to mitigate, respond, and recover from various types of hazards.

Figure 1.1: Map of Hillsborough County



Hillsborough County comprises four jurisdictions, three of which are incorporated including Tampa, Plant City, and Temple Terrace. Of the three, Tampa is the largest in both size and population followed by Plant City and then Temple Terrace.

The physical features of the county were described in the Conservation and Aquifer Recharge Element of the county's Comprehensive Plan as follows: "…by virtue of its subtropical climate and variable hydrology and geology, [Hillsborough County] supports a rich and diverse complement of natural resources." There are three major rivers in the county: Hillsborough River, Alafia River, and Little Manatee River. The features of these rivers were described in the Conservation and Aquifer Recharge Element as follows: "The Hillsborough River begins in the Green Swamp and then flows southwestward draining 690 square miles before emptying into McKay and Hillsborough Bay. The Alafia begins in Polk County and flows westward. It drains a 420 square mile basin and also enters Hillsborough Bay. The Little Manatee River begins in southeast Hillsborough County and northeast Manatee County and flows west to Tampa Bay, draining 225 square miles."

Figure 1.2: Hillsborough County Wetlands and Waterways

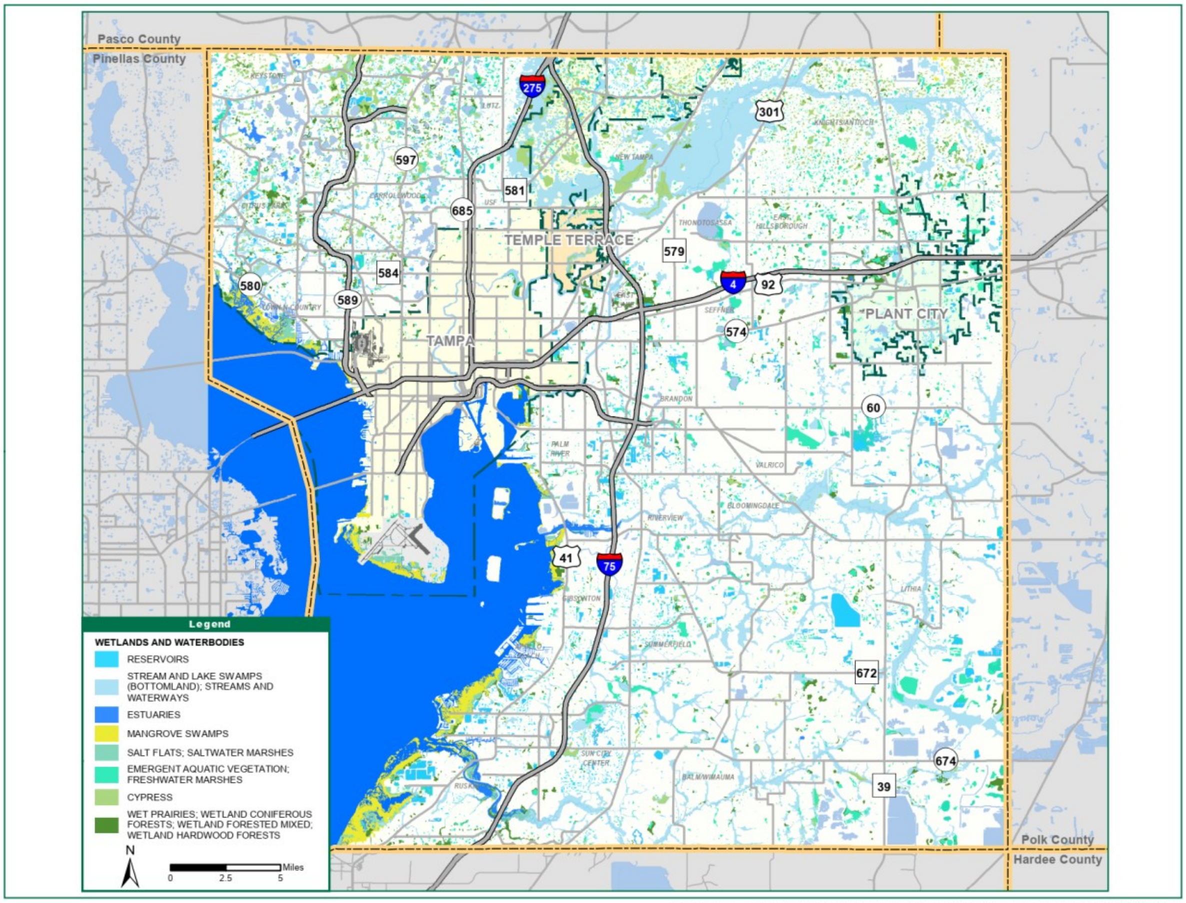


Table 1.1: Waterways Map Features, Hillsborough County

Alafia River	Alderman Creek	Archie Creek	Baker Creek	Bell Creek
Big Ditch	Blackwater Creek	Boggy Creek	Brusshy Creek	Bullfrog Creek
Campbell Branch	Chito Branch	Cockroach Creek	Curiosity Creek	Cypress Creek
Dug Creek	English Creek	Fish Creek	Fishhawk Creek	Flint Creek
Halls Branch	Hillsborough River	Hollomans Branch	Howard Prairie Brook	Howell Branch
Hurrah Creek	Indian Creek	Itchepackesassa	Keystone Lake	Lake Thonotosassa
Little Bullfrog Creek	Little Fishhawk Creek	Little Manatee River	Mizelle Creek	New River
North Prong Alafia River	Owens Branch	Pemberton Creek	Rocky Creek	Sherrys Brook
South Prong Alafia River	Spartman Branch	Sweetwater Creek	Thirtymile Creek	Turkey Creek
West Branch	Wolf Branch			

Source: Florida Center for Instructional Technology, Tampa, FL: University of South Florida, 2008.

Note: The Floridian aquifer, the largest potable water aquifer in Florida and one of the most productive aquifers in the world (Ground Water Atlas of the United States, 1990) (for citation http://pubs.usgs.gov/ha/ha730/ch_g/G-text6.html) with rich deposits of phosphate rock, lies under the county. It was also noted in the Conservation and Aquifer Recharge Element that the karst topography of the County has created a mosaic of solution sinks and depressions.

Demographics

The 2010 Census determined that Hillsborough County's population was 1,229,226. In 2019, the University of Florida's Bureau of Economic and Business Research (BEBR) estimated the county's population to be 1,444,870 making it the fourth most populous county in Florida. In terms of future growth, BEBR estimated the County's population will increase to 1,950,504 by 2045.

The 2010 Census found the population for Hillsborough County's four jurisdictions to be 24,541 in Temple Terrace, 34,721 in Plant City and 335,709 in Tampa and 834,255 in unincorporated Hillsborough County. In 2019, the jurisdictional populations were estimated to be as follows:

Table 1.2: Area, Population, and Density by Jurisdiction

Jurisdiction	Area (per sq. mi.)	2019 Population	Persons (per sq. mi.)
Plant City	28	39,478	1,410
Tampa	177	390,473	2,206
Temple Terrace	7	26,669	3,810
Unincorporated County	1,004	988250	99
Hillsborough County Total	**1,216**	**1,444,870**	**1,188**

Source: U.S. Census Bureau, Census 2010 Summary File 1 for Florida; Population Estimates prepared by University of Florida's Bureau of Economic and Business Research (BEBR)

According to the 2013-2017 American Community Survey 5-year Estimates, Hillsborough County racial composition is the following:

- White alone: 70.9% (958,208)
- Black or African American alone: 16.6% (224,284)
- Another Race: 12.5% (168,595)
- Hispanic or Latino (off any race): 27.4% (370,827)

Table 1.3: Racial Composition by Jurisdiction (Estimates)

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
Total Population	1,351,087	37,459	368,087	25,853	919,688
White	958,208	25,091	240,097	17,097	675,923
Black or African American	224,284	5,735	89,032	5,726	123,791
American Indian & Alaska Native	4,080	79	1,128	42	2,831
Asian	53,446	1,064	15,506	1,233	35,643
Native Hawaiian	206	0	75	0	131
Some Other Race	65,344	4,662	9,481	745	50,456
Two or More Races	44,807	797	12,615	978	30,417

Source: U.S. Census Bureau, Table DP05, 2013-2017 American Community Survey 5-year Estimates.

Note: Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. In addition to sampling variability, the ACS estimates are subject to non-sampling error.

Table 1.4: Hispanic or Latino by Specific Region

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
Total Population	1,351,087	37,459	368,087	25,853	919,688
Hispanic or Latin	370,827	11,355	92,494	4,446	262,532
Mexican	73,093	6,980	12,066	451	53,596
Puerto Rican	112,874	2,262	28,444	1,863	80,305
Cuban	86,313	625	27,087	865	57,736
Other Hispanic	98,547	1,488	24,897	1,267	70,895

Source: U.S. Census Bureau, Table DP05, 2013-2017 American Community Survey 5-year Estimates.

Note: Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. In addition to sampling variability, the ACS estimates are subject to non-sampling error.

Table 1.5: Age Distribution by Gender: Total and by Each Jurisdiction

	Total Males	Total Females	Plant City Males	Plant City Females	Tampa Males	Tampa Females	Temple Terrace Males	Temple Terrace Females	Unincorporated Males	Unincorporated Females
Total	658,639	692,448	18,235	19,224	177,778	190,309	12,466	13,387	450,160	469,528
<5	44,074	41,834	1,319	1,353	11,720	11,246	550	983	30,485	28,252
5-9	43,556	43,343	1,392	1,469	11,200	11,060	763	827	30,201	29,987
10-14	44,913	41,252	1,326	1,222	11,060	10,434	925	502	31,602	29,094
15-19	44,565	42,802	1,203	1,445	12,369	13,904	744	722	30,249	26,731
20-24	45,402	46,758	1,466	1,011	13,166	14,893	1,231	1,655	29,539	29,199
25-29	51,674	53,268	1,112	1,389	15,765	16,728	1,451	1,225	33,346	33,926
30-34	47,798	49,667	1,331	1,238	13,079	14,583	804	823	32,584	33,023
35-39	44,386	46,653	1,433	1,174	11,923	13,192	770	716	30,260	31,571
40-44	45,318	46,886	1,195	1,569	12,132	12,023	729	753	31,262	32,541
45-49	45,403	46,820	1,237	1,655	12,609	12,742	475	755	31,082	31,668
50-54	45,840	47,620	1,076	1,166	12,899	12,562	772	877	31,093	33,015
55-59	40,378	43,608	951	943	11,132	11,229	780	984	27,515	30,452
60-64	35,257	39,987	868	1,013	9,379	10,178	738	764	24,272	28,032
65-69	29,618	33,096	980	727	7,748	8,089	830	656	20,060	23,624
70-74	20,248	24,667	496	754	4,705	6,116	308	369	14,739	17,428
75-79	13,419	17,458	409	474	3,163	4,362	216	351	9,631	12,271
80-84	9,031	12,574	264	351	1,809	3,523	173	187	6,785	8,513
85+	7,759	14,155	177	271	1,920	3,445	207	238	5,455	10,201

Source: U.S. Census Bureau, Table DP05, 2013-2017 American Community Survey 5-year Estimates.

Note: Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. In addition to sampling variability, the ACS estimates are subject to non-sampling error.

According to the 5-year American Community Survey, data collected in 505,845 households countywide between 2013 and 2017 identified select information regarding income and benefits in 2017 inflation-adjusted dollars (American Community Survey [ACS], Table DP03, 2017). In Hillsborough County:

- Median household income is $53,742
- Median family income is $65,730
- Median non-family income is $35,847
- Average per capita income (dollar) is $29,806

Table 1.6: Households by Income by Jurisdiction (Estimates)

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
Total Households	505,845	13,176	147,250	9,960	335,459
Less than $10,000	36,551	1,041	14,640	809	20,061
$10,000 to $14,999	24,658	681	9,415	266	14,296
$15,000 to $24,999	52,445	1,375	16,957	760	33,353
$25,000 to $34,999	49,755	1,339	15,386	1,041	31,989

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
$35,000 to $49,999	71,522	2,389	19,129	1,299	48,705
$50,000 to $74,999	91,609	2,692	22,912	2,216	63,789
$75,000 to $99,999	60,430	1,375	14,475	1,126	43,454
$100,000 to $149,999	63,616	1,458	16,287	1,285	44,586
$150,000 to $199,999	26,712	454	7,269	635	18,354
$200,000 or more	28,547	372	10,780	523	16,872

Source: U.S. Census Bureau, Table DP05, 2013-2017 American Community Survey 5-year Estimates.

Note: Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. In addition to sampling variability, the ACS estimates are subject to non-sampling error.

Before concluding this section, it is important to note that in Hillsborough County there were 208,195 individuals living in poverty, as defined by the U.S. Census Bureau, 2013-2017 American Community Survey (ACS).

Table 1.7: Poverty Status by Type by Jurisdiction

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
All Ages	208,195	5,194	71,425	4,024	127,552
<18	64,783	1,889	22,510	1,103	39,281
18-64	123,532	2,739	41,597	2,667	76,529
65+	19,880	566	7,318	254	11,742
Families	36,932	1,009	12,077	619	23,227
Female Headed	19,402	502	7,227	423	11,250

Source: U.S. Census Bureau, Table DP05, 2013-2017 American Community Survey 5-year Estimates.

Note: Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. In addition to sampling variability, the ACS estimates are subject to non-sampling error.

Housing Mix

According to the 2013-2017 American Community Survey 5-year Estimates, there are 505,845 occupied housing units in Hillsborough County. Of the 505,845 occupied units, 293,143 were owner-occupied and 212,702 were renter-occupied. Additionally, there were 57,793 vacant units. The average household size was 2.70 for owner-occupied and 2.53 for renter-occupied.

Table 1.8: Households by Jurisdiction

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
Total housing units	563,638	14,673	165,678	11,181	372,106
Total occupied units	505,845	13,176	147,250	9,960	335,459
Total vacant units	57,793	1,497	18,428	1,221	36,647
Owner-occupied units	293,143	7,777	71,103	4,968	209,295
Population in owner-occupied units	792,897	21,902	182,641	12,849	575,505
Avg. household size of owner-occupied units	2.70	2.82	2.57	2.59	2.75
Renter-occupied units	212,702	5,399	76,147	4,992	126,164
Population in renter-occupied units	537,296	15,358	173,622	12,520	335,796
Avg. household size of renter-occupied units	2.53	2.84	2.28	2.51	2.66

Source: U.S. Census Bureau, Table DP05, 2013-2017 American Community Survey 5-year Estimates.

Note: Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. In addition to sampling variability, the ACS estimates are subject to non-sampling error.

The 2013-2017 American Community Survey 5-year Estimates shows of the 563,638 housing units countywide that 316,783, or 56 percent, were single-family detached and 39,915, or 7 percent, were mobile homes. The majority of housing was single-family detached in the jurisdictions as well.

Table 1.9: Housing Type by Jurisdiction

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
Total housing units	563,638	14,673	165,678	11,181	372,106
1-unit, detached	316,783	10,064	88,859	5,050	212,810
1-unit, attached	38,995	605	10,485	1,106	26,799
2 units	11,667	418	4,987	258	6,004
3 or 4 units	24,230	611	7,985	1,149	14,485
5 to 9 units	34,927	622	10,000	1,292	23,013
10 to 19 units	43,340	944	13,260	1,118	28,018
20 or more units	52,721	765	27,967	1,161	22,828
Mobile home	39,915	644	2,002	47	37,222

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
Boat, RV, van, etc.	1,060	0	133	0	927

Source: U.S. Census Bureau, Table DP05, 2013-2017 American Community Survey 5-year Estimates.

Note: Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. In addition to sampling variability, the ACS estimates are subject to non-sampling error.

The continued population growth in Hillsborough County was reflected in the distribution of housing units by the year they were built. Of the 563,638 total housing units, 253,040 were built since 1990, 293,350 were built from 1940 to 1989, and 17,248 were built before 1939.

Table 1.10: Year Structure Built by Jurisdiction (Estimate)

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
Total housing units	563,638	14,673	165,678	11,181	372,106
Built 2014 or later	8,232	128	2,039	70	5,995
Built 2010 to 2013	21,808	529	6,254	9	15,016
Built 2000 to 2009	126,360	2,851	31,524	1,687	90,298
Built 1990 to 1999	96,640	3,557	19,854	1,572	71,657
Built 1980 to 1989	108,413	2,771	19,575	3,143	82,924
Built 1970 to 1979	84,579	1,603	19,381	2,543	61,052
Built 1960 to 1969	47,507	887	17,707	849	28,064
Built 1950 to 1959	41,360	1,142	26,138	1,202	12,878
Built 1940 to 1949	11,491	501	8,696	44	2,250
Built 1939 or earlier	17,248	704	14,510	62	1,972

Source: U.S. Census Bureau, Table DP05, 2013-2017 American Community Survey 5-year Estimates.

Note: Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. In addition to sampling variability, the ACS estimates are subject to non-sampling error.

According to the 2013-2017 American Community Survey 5-year Estimates, the median value for the 293,143 owner-occupied housing units countywide was $179,500. The distribution of these units by value was a follows:

- <$50,000: 23,291
- $50,000 - 99,999: 41,936

- $100,000 - $149,999: 47,374
- $150,000 - $199,999: 51,843
- $200,000 - $299,999: 63,508
- $300,000 - $499,999: 43,558
- $500,000>: 21,633

Table 1.11: Property Values by Jurisdiction Owner-Occupied Housing Units

	Hillsborough County Total	Plant City	Tampa	Temple Terrace	Uninc. County
Total owner-occupied units	293,143	7,777	71,103	4,968	209,295
Less than $50,000	23,291	678	4,888	193	17,532
$50,000 to $99,999	41,936	1,615	12,221	896	27,204
$100,000 to $149,999	47,374	1,788	10,413	735	34,438
$150,000 to $199,999	51,843	1,510	9,531	814	39,988
$200,000 to $299,999	63,508	1,581	11,833	1,317	48,777
$300,000 to $499,999	43,558	490	12,295	708	30,065
$500,000 to $999,999	17,415	51	7,258	295	9,811
$1,000,000 or more	4,218	64	2,664	10	1,480

Source: U.S. Census Bureau, Table DP05, 2013-2017 American Community Survey 5-year Estimates.

Note: Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. In addition to sampling variability, the ACS estimates are subject to non-sampling error.

Business and Industry

Hillsborough County's geographic location and size plays a crucial role in the overall economic health and vitality of the Tampa Bay region. Using information from the 2013-2017 American Community Survey 5-year Estimates, the county reported a labor force of 699,502. The table below shows the number of employers and employees by industry for the first quarter of 2019 according to the Florida Labor Market Statistics, Quarterly Census of Employment and Wages Program.

Table 1.12: Number of Establishments and Employees by Industry

Industry	Employers	Total Wages	Average Monthly Employment	Average Quarterly Wage
Agriculture, Forestry, Fishing & Hunting	86	$7,770,973	927	$8,383
Mining	2	*	*	*
Utilities	12	$9,619,232	421	$22,830

Industry	Employers	Total Wages	Average Monthly Employment	Average Quarterly Wage
Construction	675	$62,868,897	5,615	$11,197
Manufacturing	210	$65,643,001	4,419	$14,855
Wholesale Trade	224	$53,942,563	2,874	$18,771
Retail Trade	949	$94,614,770	14,249	$6,640
Transportation and Warehousing	124	$36,965,090	3,417	$10,817
Information	118	$27,204,330	1,852	$14,687
Finance and Insurance	321	$64,723,026	3,886	$16,654
Real Estate and Rental and Leasing	358	$24,894,344	2,501	$9,955
Professional and Technical Services	989	$100,512,790	6,216	$16,169
Management of Companies and Enterprises	25	$9,313,365	504	$18,491
Administrative and Waste Services	693	$45,075,458	6,386	$7,058
Educational Services	122	$445,048,570	25,565	$17,409
Health Care and Social Assistance	880	$394,741,151	29,054	$13,587
Arts, Entertainment, and Recreation	105	$18,799,300	1,993	$9,434
Accommodation and Food Services	641	$59,837,632	14,035	$4,263
Other Services, Ex. Public Admin	641	$25,848,875	3,171	$8,152
Public Administration	100	$90,192,259	6,782	$13,299
Unclassified	61	$238,304	32	$7,525

Source: Florida Labor Market Statistics, Quarterly Census of Employment and Wages Program

The primary locations for industrial activity in Hillsborough County are historically associated with or in close proximity to the Port of Tampa or Tampa International Airport. Historically, office space was primarily concentrated in the Port, Westshore, and University areas and in the Central Business Districts of Tampa. Newer employment areas have grown to include, but are not limited to, the University area and the Brandon and Sable Park area. Other office development is also taking place in association with the I-75 and US 301 corridor. With the exception of the Mosaic facility on US 41 at the Alafia River, industries associated with phosphate mining are located in the eastern portions of the county.

There are an estimated 36,533 employer establishments located in Hillsborough County with a total employment of 587,224 according to Census Quick facts 2016. There are 130,887 non-employer establishments within the county.

While the Port of Tampa continues to have a concentration of heavy and light industrial activity, the character of the surrounding area near downtown Tampa has been undergoing a transformation. This area is no longer the site of warehousing, wholesale, and transportation activities. Rather, it is redeveloping with retail, office, residential, and tourist activities. Increased interest has been expressed in developing the area with more mixed use of residential and commercial uses.

Table 1.13: 2014 Major Employers in Hillsborough County

Rank	Employer Name	Industry	Employees
1	Hillsborough County School District	Education Services	25,776
2	University of South Florida	Education Services	16,693
3	MacDill Air Force Base	Public Administration	14,500
4	Hillsborough County Government	Public Administration	9,707
5	Tampa International Airport*	Air Transportation	7,500
6	Publix Supermarkets	Grocery Store	7,156

Rank	Employer Name	Industry	Employees
7	Tampa General Hospital	Healthcare & Social Assistance	6,550
8	St. Joseph's Hospital	Healthcare & Social Assistance	6,000
9	JPMorgan Chase & Co.	Finance & Insurance	5,000
10	City of Tampa	Public Administration	4,406
11	H. Lee Moffitt Cancer Center	Healthcare & Social Assistance	4,300
12	James A. Haley VA Medical Center	Healthcare & Social Assistance	4,240
13	Citi	Finance & Insurance	4,000
14	Busch Gardens	Arts, Entertainment & Recreation	3,800
15	Seminole Hard Rock Café	Arts, Entertainment & Recreation	3,000
16	Sweetbay/Winn-Dixie	Grocery Store	2,800
17	Florida Hospital	Healthcare & Social Assistance	2,500
18	Casper's Company	Accommodation and Food Services	2,500
19	Humana	Healthcare & Social Assistance	2,400
20	TECO Energy	Utility	2,300
21	USAA	Finance & Insurance	2,000
22	Progressive	Finance & Insurance	2,000

Source: Tampa Bay Business Journal.2014 Book of Lists, Tampa Bay Partnership, Tampa Hillsborough EDC, Hoover's, ReferenceUSA, and Company websites.

Note: The Tampa International Airport employment figure is limited to ancillary employment. Aviation Authority employment is represented in the Hillsborough County Government figure.

Future Land Use

Typical of a metropolitan area, the variety of land uses found in Hillsborough County range from highly urban areas such as Tampa, to the busy suburban areas such as Brandon and Citrus Park, to the picturesque rural areas of Wimauma and Keystone. Historically, Hillsborough County's principal activity centers have been located in: the business districts of downtown Tampa and the Westshore area, Old Carrollwood, The University of South Florida area, MacDill Air Force Base, The Port of Tampa, Tampa International Airport, downtown Plant City, and adjacent unincorporated areas. Over time, new development has occurred largely within the identified urban service areas of unincorporated Hillsborough County and the "New Tampa" area of north-central Hillsborough County.

Commonly, urban areas develop in and around activity centers and along the highway corridors which connect them. With development moving away from the county's urban core, former suburban and rural areas have become urban in nature. According to the Planning Commission, unincorporated areas of Hillsborough County experiencing increasing population growth include: Balm/Wimauma, Brandon, Carrollwood, Greater Sun City Center, Riverview, Westchase, and Town 'N Country.

Outside the county's urbanized central county area, the City of Plant City has been experiencing rapid growth as a result of spill-over from the development of the warehouse/wholesale industry in the City of Lakeland. The City of Temple Terrace has also experienced growth associated with both the expansion of the University of South Florida and the development occurring along the I-75 corridor. In addition to the growth and development in unincorporated Hillsborough County, redevelopment activity is evident in three municipalities: Tampa's residential development and its redevelopment in the Interbay and the Tampa Heights areas, and Temple Terrace's and Plant City's downtown redevelopment plans.

The Planning Commission for Tampa and Hillsborough's website is Hillsborough County's information center for log-range planning projects and plans. Meeting information, maps, and information on how to get involved can also be found on the site at:

http://www.planhillsborough.org/aboutus

The following three organizations work together to provide the information as listed on the website:

- The Planning Commission serves the citizens of Hillsborough County, City of Plant City, City of Temple Terrace, and the City of Tampa by providing a vision for improving the quality of life. It is an independent, consolidated planning agency, led by 10 citizen appointees from all 4 local jurisdictions, which along with a staff of professional planners, promotes and coordinates comprehensive long-range planning, growth management, transportation, and environmental protection.
- The Hillsborough County Metropolitan Planning Organization (MPO) is a transportation policy-making board composed of representatives from local governments and transportation agencies. According to federal and state laws, the Hillsborough County MPO is responsible for establishing a continuing, cooperative, and comprehensive transportation planning process for Hillsborough County. Key responsibilities are the creation of the twenty-year Long Range Transportation Plan (LRTP) and the five-year Transportation Improvement Program (TIP).
- The Hillsborough River Interlocal Planning Board, an organization consisting of three elected officials representing the geographic location of the river, is responsible for considering the present and future of the resources of the Hillsborough River. It is supported by the Hillsborough River Technical Advisory Council, composed of eight agency representatives and three citizen members. Mandated by state law, the River Board and Council developed a Master Plan for the Hillsborough River.

As Hillsborough County's population grows and expands, the need for expanding and improving mitigation techniques grows exponentially. The growth inland to both the north and east away from coastal flooding and velocity wave action is resulting in newer, more wind resistant construction. Development in the 100-year flood risk area as well as the redevelopment areas in downtown Tampa and the Interbay area must meet the strict National Flood Insurance Program floodplain management standards. Hillsborough County's wetlands are protected through new comprehensive plans and permitting processes. All these actions are resulting in more disaster-resistant communities. Just as critical, if not more so than disaster–resistant buildings and other mitigation techniques, is the necessity to have an informed and educated populace. As the county's and cities' first responders and resources continue to be challenged by growing demands, it is imperative that Hillsborough County citizens are knowledgeable and prepared to face and recover from disasters. By providing information and training to Hillsborough County residents', lives will be saved, property will be spared, and life will return to normal more rapidly after a disaster.

PLANNING PROCESS AND PLAN MAINTENANCE SECTION

History of the County LMS

The Local Mitigation Strategy (LMS) offers innovative approaches for combining resources and coordinating government leadership with the private sector. Mitigation strategies, the cornerstone to risk reduction, offer an opportunity for each sector of our community to plan and prepare for a safer future. Mitigation is an ongoing effort to lessen the impacts disasters have on people and property.

History tells the many stories of disasters that caused tragic losses of life and property. As tragic as these losses are the probability of even greater catastrophic loss in the future is real. As the population continues to grow and the necessary infrastructure is erected the impact of a disaster multiplies. The LMS provides a conceptual framework to reduce these losses by breaking the cycle of 'disaster event – rebuild – disaster event – rebuild'.

During the late nineties Hillsborough County and its municipalities developed a multijurisdictional LMS and in 2004 updated it as required by the Disaster Mitigation Act of 2000. Currently, the Code of Federal Regulations, 44 CFR §201.6 - Local Mitigation Plans (eCFR.gov, 2014) requires that the Local Mitigation Strategy be reviewed and revised every five years. This revision must reflect any changes in priorities, the progress in local mitigation efforts and development and be submitted to the Florida Department of Emergency Management for approval for continuation of state and federal grant funding.

Hillsborough County's diligence in continually improving and updating its LMS provides the community with the information and tools available to increase its resiliency to the disruptions caused by disasters. Another benefit is the potential reduction in the associated cost of disasters. The cost of recovery and rebuilding due to the devastation caused by a disaster is much greater than the cost of planning and preparing before disaster strikes (Berginnis, 2014).

The goal of the Hillsborough County LMS is to establish and maintain an ongoing process that continually assess potential disasters, develops corresponding mitigation techniques and incorporates preparedness and response into the consciousness of the entire community. To date Hillsborough County's LMS's process has produced the assessed vulnerabilities of the community to a variety of hazards, identified a comprehensive list of plans, programs and projects to decrease the magnitude of those vulnerabilities and prioritized the implementation of respective initiatives. This 'all-hazards' LMS will continue to be referenced through the Comprehensive Emergency Management Plan (CEMP), the local Comprehensive Plan, the Hillsborough County Land Development Code, the Floodplain Management Plan, the Hillsborough County Construction Code (Ord.13-31) and the unified Post-Disaster Redevelopment Plan (PDRP).

At the core of the unified multi-jurisdictional mitigation planning process for Hillsborough County is the coordination and partnership among governmental units, commercial enterprises (industry partners), and citizen groups. This partnership consists of respective groups and the cities Plant City, Temple Terrace and Tampa, as well as, unincorporated Hillsborough County. However, the success of the planning processes for all-hazards and floodplain management planning for the respective of communities within the county and with the National Flood Insurance Program Community Rating System does rely on the close involvement of public and private sector organizations and state and federal agencies. The University of South Florida (USF) provided analysis and review of drafts during the initial development the LMS's design. Neighboring jurisdictions were invited to attend planning meetings and sent drafts for review. Although not a comprehensive list, participants included: environmental organizations such as the Southwest Florida Water Management District (SWFWMD); community organizations including homeowners associations, the Citizen Corps Council (CCC), Community Emergency Response Team (CERT) and private industries included representatives from the insurance industry and the power utilities, Tampa Electric Company and Peoples Gas. Relief organizations and tribal groups were represented by the American Red Cross and the Seminole Tribe respectfully. Since its adoption in 2004 and the approved update in 2009, the updating of the LMS is an ongoing process and is revised on an annual basis pursuant to Florida Administrative Code (FAC) 27P-22.004 (4)(e). A requirement for incremental annual updates includes maintaining records of the meetings of the LMS Working Group (LMS WG). These records include details of many of the aspects that are incorporated in the required five-year update and include:

- subcommittee reports from private/quasi-public groups and non-profit/volunteer groups;
- updates on continuity planning and critical facilities and infrastructure;
- training announcements;
- proposed and completed projects;
- reports on modifications to the Land Development Code and Comprehensive Plans as they related to mitigation;
- discussions of available funding and grant application cycles.

A committee comprised of the LMS Chair and Vice-Chair, the Hazard Mitigation Officer for Hillsborough County; a professional engineer working in Hillsborough County Development Services, Transportation and Land Development Review Division; the senior planner with the Hazard Mitigation Section, the base planner for MacDill Air Force Base, a member of the University of South Florida College of Public Health, a staff member of USF Health Physicians Group and the LMS Coordinator held several meetings to review the recommendations and work plan to formulate a strategy on how to best proceed with the update. The LMS Coordinator created a task list from these discussions and organizations and personnel were identified to complete the initial revisions.

Initial revisions were performed or coordinated by the committee. The revised sections were sent to the LMS WG for comment, suggested revisions, deletions or additions. Each jurisdiction was represented and participated in the planning process and participated in the process. All suggestions, revisions and corrections were considered in the final document.

2020 Update

The update process formally began in 2019 with a kickoff meeting in March. The County's Hazard Mitigation Section opted to utilize the services of Atkins Global to supplement activities of the Local Mitigation Strategy Working Group and revise the full plan. Many of the entities involved had related efforts occurring simultaneously and so one of the key activities was the integration of these studies into the plan. Two of the most relevant projects include:

- The Community Vulnerability Study – Contracted by Hillsborough County and being performed by the University of South Florida. The effort focuses on future flood conditions and evaluates public health implications for flood-related hazards.
- Community Rating System (CRS) Updates – The CRS program, which evaluates floodplain management activities for jurisdictions, is a very involved program that requires specific analysis, code assessments, and public information activities (among actions) to be performed annually. Where applicable, the CRS work of the cities and their subcontractors has been incorporated under the direction of the LMS WG.

Throughout the update process, these projects were discussed at working group meetings so that their results could be shared with stakeholders and evaluated for inclusion in the new document. The sections below illustrate the full planning process in accordance with the 10-step process as required by Activity 510 (Floodplain Management Planning or FMP) of the 2017 Manual for the Community Rating System. The County and its jurisdictions utilize the LMS document to meet the FMP requirements under the CRS program.

STEP 1: THE PLANNING ORGANIZATION

The development of a mitigation strategy requires the involvement of representatives from the public, private, and governmental sectors. Therefore, every attempt has been made to include the following entities in the Working Group membership:

- Representatives from Hillsborough County and the three municipal planning and/or code enforcement or building departments, emergency management services, environmental protection and public information departments;
- State Agencies (Cooperative Extension Service, Department of Health, Florida Division of Emergency Management Regional Coordinator);
- Private utilities (Tampa Electric, etc.);
- Businesses, (Health Care, Business Contingency Planners, and the Hotel/Motel Industry, etc.);
- Educational (University of South Florida and Hillsborough County Public Schools);
- Civic Organizations;
- Southwest Water Management District;
- Tampa Bay Regional Planning Council;
- Volunteer organizations, (Community Emergency Response Teams, Regional COAD, Red Cross, Salvation Army, Hospice, Habitat for Humanity);
- Private non-profit organizations
- Surrounding county mitigation representatives (Pinellas, Manatee, Pasco counties) and CRS Coordinators, and
- Public including Hillsborough County Neighborhood Association, Citizen Advisory Committee members, County and municipal leadership programs.

Through the involvement of the members of the LMS Working Group, the LMS was developed in coordination with neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have development review authority, businesses, academia and other private and non-private interests. Pasco County, Pinellas County, and the TBRPC were part of the Working Group. Representatives are brought together to enhance the Hillsborough County LMS Working Group. These additional stakeholders, as well as the public are welcome to attend any meeting encouraging both a dynamic membership and participation of the Working Group. Meetings are noticed on County and municipal websites and online event calendars.

The LMS Working Group elects a Chairperson and Vice-Chairperson at its regular annual meeting in December or January of each year. The Working Group voted to meet at least every quarter in a central location with additional meetings to be scheduled as the workload dictates. In order to complete the 5-year update of the LMS in 2019-20, the LMS Working Group met most months from March 2019 to February 2020. The quarterly meeting schedule will resume in April 2020 augmented with conference calls to address comments and recommendations from the State Division of Emergency Management and FEMA. The meeting calendar is provided in Appendix A – Planning Process Documentation and reflects the Working Group work through the development and the revision of the LMS.

The Hillsborough LMS website is available as part of the County's website at the following location:

https://www.hillsboroughcounty.org/en/residents/public-safety/emergency-management/local-mitigation-strategy

It provides links to the plan documents and requests for public input. In addition, in the past, it has served as a valuable tool in updating and, in some cases, creating new sections of the Plan. Through the SharePoint section of the website, members have updated their projects and accomplishments, the departmental responsibilities, and local goals, policies, land development regulations, and mitigation programs. During the 2020 LMS Plan Five-Year update process, a Google drive was created, and its link shared with the Working Group and the stakeholders. This allowed the Working Group members to review, update, and help create new sections of the Plan. It also enabled them to weigh-in on the development of the strategy and provide recommendations and comments on the risk assessment, goals and directives, mitigation initiatives, and public awareness programs.

Hillsborough County has previously contracted with the Tampa Bay Regional Planning Council (TBRPC) when assistance is required to update the study. TBRPC provided additional staff support for the 2004 and 2009 5-year comprehensive updates, as well as the 2015 update. For the 2020 update, Hillsborough County contracted with Atkins, an engineering and design firm headquartered in the Tampa Bay Area.

The representatives commit their time and available resources to develop a mitigation strategy that would protect life, property, and the environment as well as contribute to the economic well-being of the County. The implication of the Hazard Mitigation Planning and Hazard Mitigation Grant Program (HMGP) Interim Final Rule is that each of the jurisdictions and representatives on the Working Group must show participation in the planning process to qualify for HMGP, Pre-Disaster Mitigation Program (PDM) and Flood Mitigation Assistance Program (FMAP) funding. The definition of participation as determined by the Working Group is attendance at a minimum of 50% of the scheduled meetings during the year. The 2019 meeting schedule is abnormal in that there are more meetings to accommodate the development of the plan update. Each member signs in at each meeting for documentation purposes.

STEP 2: INVOLVING THE PUBLIC

Public participation was an important component of Hillsborough County's mitigation planning process. Individual citizen and community-based input provides the entire planning team with a greater understanding of local concerns and increases the likelihood of successfully implementing mitigation actions by developing community "buy-in" from those directly affected by the decisions of public officials. As citizens become more involved in decisions that affect their safety, they are more likely to gain a greater appreciation of the hazards present in their community and take the steps necessary to reduce their impact. Public awareness is a key component of any community's overall mitigation strategy aimed at making a home, neighborhood, school, business or entire city safer from the potential effects of hazards.

Public involvement in the development of the Hillsborough County LMS Update was sought using three methods: (1) public meetings were held and were advertised in local media; (2) public survey instruments were made available in hard copy and online; and (3) the draft Plan deliverables were made available on county LMS website along with contact information for providing input.

The general public was provided two opportunities to be involved in the development of the County plan (in addition to optional participation in working group meetings): (1) four meetings held during the drafting stage of the Plan; and (2) upon completion of a final draft Plan, but prior to official Plan approval and adoption. Since Hillsborough County is a large county of over 1,000 square miles in area, it was identified that there should be four meetings with each one covering a different region of the project area.

- May 13, 2019 – Jan Kaminis Plan Regional Library: City of Tampa and Central Area of the County
- May 14, 2019 – Maureen B. Gauzza Library: Northwest Area of the County
- May 15, 2019 – Bruton Memorial Library: Plant City and Eastern Area of the County
- May 16, 2019 – Southshore Regional Service Center: Southern Area of the County

All meetings were advertised on the county website, the local newspaper, the electronic county calendar, additional websites, and through social media avenues. After each of these meetings, members provided valuable input to the plan which was ultimately incorporated. Additional information on these meetings can be found in Appendix A. In addition, during the planning process, a public participation survey (see Appendix A) was made available at the meetings and distributed through Hillsborough County social media sites and email. A total of 41 survey responses were received, which provided valuable input for the Working Group to consider in the development of the plan update. Selected survey results are presented below:

- All of jurisdictions except the City of Temple Terrace were represented in the respondents and were all primarily residents of the area.
- Respondents ranked Flooding, Hurricane/Tropical Storm, and Severe Thunderstorm/ Winds/ Tornado as the highest threats to their neighborhood.
- All of the respondents had homeowner or renter's insurance policies and over 50 percent have flood insurance policies as well.

- Approximately 70 percent of the respondents stated that following a substantial disaster, they would prefer to repair/rebuild in the same location to higher standards and understand that they would have to comply with the current standards.
- Over 40 percent of the respondents have already taken measures to reduce risk by strengthening the openings in and around their homes.
- Preparedness, Coordination and Response Actions and Infrastructure Projects were ranked as the most important activities for communities to pursue in reducing risks.
- The respondents learned about the public meetings mostly through outdoor signage.

During the plan maintenance process, the County will continue to use and refine the public engagement tools and methods described above to improve public awareness about mitigation, reach out to a wider audience, and increase participation in the County's mitigation efforts.

STEP 3: COORDINATION

The LMS Working Group representatives have responsibility to not only participate in the committee and its subcommittees, but to also reach out in their community to share significant information and messages, to coordinate activities within the County and to bring back perspectives of their constituency. The intent is for the representatives to contact agencies, organizations and their residents to collect information related to hazards and mitigation activities, provide information regarding the LMS and its update as well as offer these agencies and organizations an opportunity to be involved in the planning effort. The documents shared through Google drive for the 2020 LMS plan update and the discussions at the working group meetings helped to share information regarding existing plans, studies, and data belonging to different jurisdictions that are relevant to LMS. These discussions helped refine the Goals and Directives within the LMS plan as a part of the five-year update. These discussions also emphasized the need to adopt language in related plans that encourage consistency in vulnerability metrics and mitigation measures throughout the County. (See Appendix A for more detailed information.) Local plans, such as comprehensive plans, capital improvement plans, economic development plans, etc., were also reviewed to inform the mitigation update process and may be updated in the future following the update of the risk assessment and strategy development. These plans are listed in Section 3 – Mitigation Strategy.

The preparation for the 2020 LMS update began in early 2019 at an LMS meeting, and, shortly after, the contractor, Atkins, was procured to update the plan. Throughout 2019, the LMS WG met numerous times and went through the entire process of assessing the hazards, analyzing the risks, and updating the appropriate mitigation actions. The plan was reviewed and updated to reflect progress in county mitigation efforts and changes in priorities. The schedule of the LMS meetings is included below along with the agencies and departments that participated on the LMS WG.

Table 2.1: List of LMS WG Meetings

Date	LMS Working Group Meetings
March 26, 2019	• Begin the Update Process
August 22, 2019	• Risk Assessment Process and Public Outreach Results
September 17, 2019	• Strategy and Potential Projects

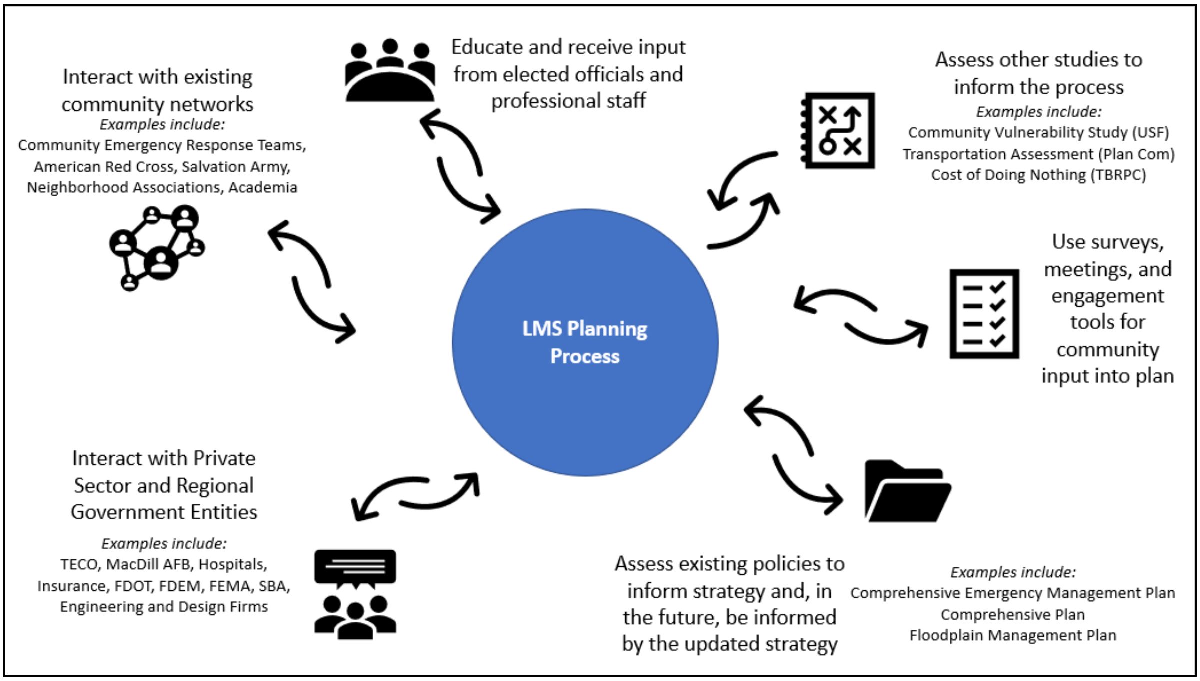
Date	LMS Working Group Meetings
November 5, 2019	• Strategy and Potential Projects (2nd session)
December 10, 2019	• Goals and Objectives
January 15, 2020	• Strategy, Governance, and Risk Communication
February 6, 2020	• Draft Documents and Remaining Plan Update Priorities

The LMS WG consists of 130 stakeholders from many different agencies and backgrounds. The list fluctuates frequently as entities come in and out of the planning process and staff change jobs or roles within the community. The bulleted list below identifies the count of stakeholder by each type of entity, and also lists some of the key agencies in that category. While not all members participate at local meetings or events, they are invited and are provided correspondence via email. The composition of the larger, informational LMS WG is as follows:

- Local Government: **56** members. These are employees of the 4 participating jurisdictions.
- Regional Entity: **15** participants. These members represent agencies such as, Hillsborough County City County Planning Commission, Florida State Fair, Tampa Bay Water, Tampa Bay Regional Planning Council, Tampa General Hospital, Environmental Planning Commission, and the Tampa Port Authority.
- State Entity: **9** members. These members are part of agencies such as Florida Dept. of Transportation, Florida Division of Emergency Management, Southwest Florida Water Management District, and the Florida Department of Health.
- Federal Entity: **3** members, representing the Department of Homeland Security.
- Non-Profit Entity: **5** members, including representatives of the American Red Cross, the Federal Alliance for Safe Homes, and the Florida Floodplain Members Association
- Business Entity: **18** members with most being local engineering companies. Tampa Electric Company also has multiple representatives and is included in this category.
- Academic Institution: **6** members of the University of South Florida, including representatives of the Colleges of Health and Geography as well as the Emergency Management Office and the Florida Center for Community Design and Research
- Neighboring Jurisdictions: **5** members, including representatives from the counties of Pasco and Manatee, as well as a community in Pinellas County.
- Tribal Entity: **1** member, representing the Seminole Tribe of Florida. The Seminole Tribe has their own mitigation plan and did not participate in the planning process.
- Private Citizen: **12** members. The citizens participate in LMS WG meetings by phone and in person depending upon their availability.

During the overall LMS Planning Process and numerous meetings of the LMS WG, the relationships between community networks, the private sector, and regional government entities were fostered to include other studies and inform the process and strategy development. The county LMS Planning Process elements and integration are clearly outlined in Figure 2.1 below.

Figure 2.1 Hillsborough County LMS Planning Process



STEP 4: ASSESSING THE HAZARD

One of the most important tasks required of the LMS Working Group is to conduct and maintain a hazard identification and vulnerability assessment. The information provided by the assessment is the foundation on which decisions about future mitigation initiatives are based. An analysis of both natural and technological hazards is on-going as new information and technology evolves and events occur. The hazard identification and vulnerability assessment data is gathered from FEMA, National Oceanographic and Atmospheric Administration (NOAA) and the National Weather Service, the Tampa Bay Regional Planning Council (TBRPC); the National Hurricane Center SLOSH (Sea Lake Overland Surge in Hurricanes) model; the Laser Infrared Detection and Ranging system (LIDAR); the municipalities and their departments; and Hillsborough County departments of Emergency Management, Planning, Building, Information Systems, Public Works, Utilities, and Developmental Review Services. The Hazard Identification and Risk Assessment relied heavily on GIS planning tools to identify vulnerable areas, populations, and recognize geographic vulnerabilities of critical facilities and key infrastructure.

STEP 5: ASSESSING THE PROBLEM

This previous step assessed the hazards facing the community. This step quantifies the impact of those hazards on the community. The LMS Committee collected population and demographic data from the 2017 American Community Survey (ACS) data, critical infrastructure and facilities inventories, flood insurance data, building type/valuation from the property appraiser data, historical damage and an estimation of potential future events.

This section also described the areas within the floodplain that provide natural functions including wetlands, riparian areas, sensitive areas and habitat. This was tied to the community goals and policies reflected in the local government comprehensive plans which provide a description of the development, redevelopment and population trends.

Additionally, the update process integrated vulnerability assessments from concurrent projects, including the Community Vulnerability Study which assesses future flood hazards and public health being performed by the University of South Florida; the Transportation Vulnerability Assessment being performed on a regional basis by local planning commissions and the Tampa Bay Regional Planning Council, and flood loss assessments performed by local jurisdictions in support of the Community Rating System program.

During the September 2019 meeting of the LMG WG on Strategy and Potential Projects, a presentation of the overall effort from USF on the Community Vulnerability Study and the mitigation approaches for flood was given. A discussion amongst the LMS WG ensued and the possible mitigation ideas were extracted to be included in the overall mitigation strategy within the plan.

STEP 6: GOALS AND DIRECTIVES

In 2019, the Working Group decided to take a fresh look at their goals and directives. This resulted in reframing their goals to four, topical areas and then identifying how existing and new projects could help address these goals or their supporting directives when mitigating hazard vulnerabilities. The four areas were as follows:

1) **Improved Human Environment** – with directives focusing on social vulnerability, public education, collaboration with community networks, warning and evacuation procedures, improving resilience of businesses, and public health;
2) **Improved Built Environment** – focusing on resilient structures and sustainable infrastructure, watershed management, and flood reduction techniques;
3) **Improved Natural Environment** – which emphasizes protection of natural habitats, management of the natural floodplain, and natural infrastructure solutions
4) **Resiliently Designed Environments** – includes directives that promote countywide consistency for higher standards, consideration of higher risk thresholds for hazard assessments, and education of residents and businesses on impacts from climate variability.

The County considered the FEMA suggestion that the proposed directives also support the following categories identified in the CRS Manual:

- Prevention
- Property Protection
- Natural Resource Protection
- Emergency Services
- Structural Flood Protection
- Public Information

Further information regarding the goals and directives is available later in this document as part of Section 3 – Mitigation Strategy Section.

STEP 7: POSSIBLE ACTIVITIES: MITIGATION OPPORTUNITIES AND INITIATIVES

The process of developing the local mitigation strategy culminated in the identification of potential mitigation opportunities and initiatives. As the original strategy was developed in 1998, there have been multiple updates to the proposed project list to address the county's natural hazard vulnerabilities. Some of these projects have persisted on the list for multiple cycles and thus the LMSWG endeavored to clean the list to what projects are most likely to be implemented if the funding and technical feasibility can be achieved.

Each Working Group member is required to review, evaluate, and analyze his or her current policies and ordinances regarding mitigation. The information is then shared and compared with the other members of the Working Group. This allows for the exchange of good ideas, accomplishments, and past experiences both successful and unsuccessful. The process also identifies any inconsistencies between communities. The most successful policies limit public expenditures in areas subject to repetitive damage from disasters; protect critical facilities and infrastructure; preserve, restore and enhance natural resources that can mitigate hazards; encourage economic diversification as protection from the loss of any one asset; encourage structural retrofitting, property acquisition and relocation; and identify procedures to expedite post-disaster recovery and permitting. Because of the education gained from this process, the Working Group is better prepared to determine the future mitigation initiatives that should be or need to be pursued. Some of the needed mitigation initiatives require unified intergovernmental coordination and participation. Other initiatives can be accomplished on an individual community basis.

STEP 8: AN ACTION PLAN

Directives were identified for each Goal to specifically identify action items and are reflected in six categories of mitigation activities:

- **Preventive –** activities which keep vulnerability from getting worse. The use and development of vulnerable areas through planning, land acquisition or regulation. This includes hazard vulnerability mapping and data; open space preservation; floodplain regulations, coastal setbacks; planning and zoning; Stormwater management; drainage system maintenance and building codes.
- **Property protection –** activities which are usually undertaken by property owners or the community on a parcel by parcel basis, including relocation, acquisition, building elevation, retrofitting, sewer backup protection and insurance.
- **Natural resource protection –** activities which preserve or restore natural areas or the natural function of the floodplain and watershed areas. These activities include wetlands protection erosion and sediment control, natural area preservation or restoration, water quality improvement, coastal barrier protection, and environmental corridors.
- **Emergency services** - activities taken during any emergency to minimize its impact. This includes hazard threat recognition, warning, response operations, critical facilities protection, and post disaster mitigation actions.

- **Structural projects** – are those traditionally engineering/maintenance projects that protect vulnerable populations and structures including seawalls, levees, Stormwater/drainage improvements or maintenance, access restrictions, etc.
- **Public Information** – activities which advise property owners and visitors about hazards, ways to protect people and property from the hazards. These include maps, outreach projects, real estate disclosure, technical assistance and education.

As noted in planning step 6 above, these directives are presented in Section 3 – Mitigation Strategy. In the original version of the table, each directive was cross-referenced to the six categories above. After multiple meetings to narrow the focus area of the directives, it was decided to leave the mitigation technique categories out as those are better related to the unique actions that each jurisdiction or stakeholder may choose to implement in support of the directives.

Hillsborough County and each of the three participating municipalities submit a list of their prioritized mitigation initiatives. The initiatives are then placed on a consolidated county-wide list, which is divided into the six categories relevant to specific goals and directives. These mitigation actions were then evaluated using the STAPLEE method. This technique identifies the following local conditions: Social, Technical, Administrative, Political, Legal, Economic and Environmental. Actions are also evaluated using other criteria:

- Compatibility with the Local Mitigation Strategy
- Compatibility with Local Government Comprehensive Plans
- Estimate of benefits from the project

A spreadsheet was exchanged with working group participants at meetings and via email. All stakeholders were asked to update the status of existing projects to either active (will have estimated implementation date and status) or archived (complete, deleted, or unknown). Completed or deleted projects were updated with an explanation as to what had changed. New projects were self-scored by the applicant, then reviewed by the LMS WG's scoring committee, and then presented to the LMS WG to provide any clarification on details before being accepted by the group. The potential projects were evaluated with two specific sets of criteria. One component was the project evaluation worksheet that detailed the project description, the proposed mitigation measure, and then weighed the measure for alignment with goals and objectives within the LMS strategy and related policies. The other component for project evaluation is assessing the social cost-benefit factor which provides an equation to weigh the project's expected benefit relative to the proportion of the municipality (or entity) that it serves. This provides a level of equity for smaller jurisdictions who may have smaller-scaled projects that provide a greater proportional benefit to their community. Ultimately, the two components are used in conjunction to prioritize projects that are cost-beneficial, technically feasible, and environmentally sound. Each applicant will typically present an overview of the proposed measure and their scoring during an LMS meeting where the membership can ask further questions about the project and its evaluation before it gets approved and added to the active list of projects. Within Appendix D – Mitigations Projects, there are two tables per each jurisdiction: (1) Active projects (the new or deferred projects) and (2) Archived projects (those that are completed, deleted, or unknown).

Using the LMS planning process to examine opportunities to make Hillsborough County more disaster resistant, the LMS WG identified 18 directives that align with the revised goals. Section 3 – Mitigation Strategy covers these specific directives by defining the intent/actions for that directive as well as a proposed metric for how it will be measured. As this is a new approach developed during the 5-year update, these directives will be more fully integrated into activities of the LMS WG and adjusted as necessary to best support the communities.

STEP 9: ADOPTION OF THE STRATEGY

After the 2020 LMS underwent final revisions, and the plan was completed to the Florida Division of Emergency Management's satisfaction (and thus the Federal Emergency Management Agency per agreement with FDEM), the plan was officially adopted by Hillsborough County via a memorandum signed by the Chief Executive Officer as the County's Authorized Representative, on 07/15/2020. Each municipality adopted the updated plan and the exact dates are provided in Appendix F – Plan Adoption. The 2020 Plan will be effective from July 27, 2020 until July 27, 2025.

The following documentation can be found in *Appendix F: Plan Adoption*.

- Hillsborough County, Unincorporated County – Resolution R20-053, Adopted 07/15/20
- Plant City, City of – Resolution 134-2020, Adopted 07/27/20
- Tampa, City of – Resolution 2020-470, Adopted 08/06/20
- Temple Terrace, City of – Resolution 67-20, Adopted 06/16/20

STEP 10: IMPLEMENTATION, EVALUATION, AND REVISION

The Hillsborough County Local Mitigation Strategy serves as a guide for hazard mitigation activities on a county-wide basis. The strategy is intended to be a dynamic document that will be updated regularly.

Consistent with federal and state requirements, the LMS Working Group will meet to update and review the effectiveness of the local mitigation strategy at least three times a year and will submit annual LMS updates to the Florida Division of Emergency Management no later than the last working weekday of each January. This update follows an annual review of the plan by the LMS Committee. The LMS Chair will be responsible for monitoring the plan on an ongoing basis. If by email or other communication, the LMS Chair receives information to warrant a meeting, then a special meeting will be called to discuss the changes. Any Working Group member also may request a special meeting. Hillsborough County Engineering and Operations Department and the LMS Chair will coordinate scheduling and notification of Working Group meetings. A minimum of thirty (30) days advance notice will be given for annual meetings. As much advance notice as possible will be given for regular and special meetings including conference calls or online webinars.

On an ongoing basis, new initiatives will be considered by the Working Group for inclusion into the strategy. Completed initiatives, termed Accomplishments, will be removed from the Initiatives List and detailed in the Accomplishments Listing. The new initiatives will be added as they are identified, ranked and approved by the Working Group. Every five years, or after any major change, the strategy will be resubmitted to municipal councils/commissions and to the Board of County Commissioners for re-adoption.

The plan maintenance is part of a continuing assessment of current policies, programs and plans by local governments as part of the adopted growth management initiatives, floodplain management strategies and countywide emergency management plans. Updates to the critical facilities, repetitive flood loss or hazards analysis will be reflected on all maps as required.

Timeframe and Agenda for Local Mitigation Strategies Working Group Meetings: the following describes the process by which the Local Mitigation Strategies Working Group (LMS WG) will maintain the Local Mitigation Strategy (LMS).

- Meetings will be noticed. The community will continue public participation in the plan maintenance process by noticing LMS WG meetings on the County's events calendar and by sending notices to the LMS WG members with the date, time and location of meetings. Information regarding the LMS will be furnished at expos and neighborhood conferences and on the Hillsborough County website (http://www.hillsboroughcounty.org/). Both the private and public members of the LMS WG will provide notice of meetings or information to: local governments, planning commission, community organizations and agencies. Information will be disseminated at neighborhood meetings, CERT training and other outreach activities.

- The Local Mitigation Strategy Working Group will meet at least three times a year to review the Local Mitigation Strategy and submit annual updates to the Florida Division of Emergency Management no later than the last work day of January as required by Florida Administrative Code (FAC) 27P-22.004 (4)(e).

  At a minimum, annual updates shall address:
  - changes to the hazard assessment
  - changes to the project priority list
  - changes to the critical facilities list
  - changes to the repetitive loss list
  - revision to maps

- To guide the update process, the LMS WG will consider the following questions:
  - Have there been any new mandates from federal, state, or local agencies that require changes to the Local Mitigation Strategy? Have there been any new or changing laws, policies or regulations?
  - Are there any societal developments or significant changes in the community that must be added to the current LMS? Does the LMS still reflect the concerns of the community? Are the demographics the same? Has there been any growth or development in hazard areas?
  - Have there been any changes in funding sources or requirements?
  - Are there any recent technological developments that should be reviewed for inclusion in the LMS document?
  - Should the LMS be updated to include any new forms of hazards or areas of vulnerability within our community?

  - Have there been any changes in the Comprehensive Plans or any other form of standard operating procedure?
  - Have any of the mitigation opportunities been implemented? Are the priorities for implementation the same?
  - What are the recommendations or lessons learned from any major incidents that have occurred during the past year?
  - What specific pre-disaster mitigation projects can be identified from the Post Disaster Redevelopment Plan (PDRP)? What new projects from the PDRP can be included as part of the LMS?

- The LMS Coordinator, under the direction of the Technical Services Director, Engineering and Operations Department, is assigned the responsibility of monitoring and coordinating annual tasks associated with the implementation of the plan. The LMS Coordinator will be responsible for: scheduling meetings, collaborating on the agendas, maintenance of meeting minutes, monitoring the plan, maintaining the list of completed projects, documenting new approved projects, collecting comments and/or answering questions related to the LMS, maintaining an official copy of the LMS, having the annual update approved, and forwarding the annual update to the State.

- Specific sections updated annually are the list of critical facilities and the repetitive flood loss property list. Each jurisdiction will be responsible for submitting this information to the Chairman of the LMS Working Group no later than October 31 of each year.

- Additional meetings of the LMS WG should be convened after any significant event such as a hurricane, tornado, flooding or a severe hazardous materials spill where a review of the event, responses and effectiveness of current mitigation techniques could serve as a means to formulate more effective responses, mitigation strategies, and techniques.

Five-Year Update

In addition to these annual progress reports and reviews, the LMS will be updated every five years, in accordance with 44 CFR 201.4. The five-year updates are labor intensive and can take over a year to complete. Each section of the 2020 LMS will be reviewed and updated accordingly. Every five years, or after any significant change, the LMS will be resubmitted to the Hillsborough County Board of County Commissioners, the City of Tampa City Council, the City of Plant City City Council, and the City of Temple Terrace City Council for re-adoption.

Since 2007, the LMS WG has met three times a year as a minimum, usually in March, June or July and October. During the year prior to the expiration of the LMS, a committee with representation from all four jurisdictions and other community members and organizations wishing to participate will be formed to review the LMS and make recommendations for revisions to the LMS WG. Neighboring communities, community stakeholders, and the public will be notified that an update to the 5-year planning process is beginning. The committee will meet on a monthly basis, or as needed, and all meetings will be noticed as open to the public. All LMS WG members will be invited and encouraged to attend. At these meetings the

LMS WG will evaluate and update the LMS with recommendations approved by the Steering Committee. During the final meeting of the year the LMSWG will evaluate the actions of the year and incorporate them into the document as required for the yearly update and submit it to the state.

MITIGATION STRATEGY SECTION

Local Hazard Mitigation Plan Requirements
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources, and its ability to expand on and improve these existing policies and programs? [44 CFR §201.6(c)(3)]
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? [44 CFR §201.6(c)(3)(ii)]
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? [44 CFR §201.6(c)(3)(i)]
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? [44 CFR §201.6(c)(4)(ii)]

Mitigation Strategy

The purpose of the local mitigation strategy is to develop a "blueprint" or guide intended to:

Provide a unified and consistent course of action needed to eliminate or reduce the impact of disasters that threaten Hillsborough County and its municipalities.

This strategy was originally developed in late nineties in accordance with the Florida Department of Community Affairs publication, *The Local Mitigation Strategy: A Guidebook for Florida Cities and Counties*, and other applicable guidance promoted by the Department of Community Affairs (DCA), the Florida Division of Emergency Management (DEM) and the Federal Emergency Management Agency (FEMA).

The content of this section discusses how the county and its municipalities develop and prioritize actions in coordination with countywide goals and directives.

Goals and Directives

Goals and directives help capture the overall purpose of the plan and assist with determining possible new directions for hazard mitigation efforts. Setting goals and directives ensures that the county is headed in the right direction when it comes to hazard mitigation planning by providing ways in which success can be measured. The goals and directives below are intended to reduce long-term vulnerabilities. It is important that both the goals and directives are reviewed regularly for continuing relevance to the county hazard mitigation strategy.

Overview

The overarching purpose for the county LMS is "to minimize the effects of any potential natural or man-made disasters on the community and its infrastructure;" however, using the new hazards and vulnerability analyses, goals were crafted along with specific directives to fully recognize the overall intentions of the county. The table below outlines the new goals and directives for the county.

The priority changes for the County as a whole shifted somewhat to focus area goals underneath the overall goal of the LMS which is to establish and maintain an ongoing process that continually assesses potential disasters, develops corresponding mitigation techniques, and incorporates preparedness and response into the consciousness of the entire community.

There were **18 focused directives developed across the 4 objective areas**. For each directive, a description of the activity was created as well as a type of metric to begin measuring progress.

The four objective areas are:

1. **Improved Human Environment *(People and Businesses)*** **–** Provide guidance on activities that protect and improve the quality of life and standard of living for residents and businesses. Specific actions are intended to focus on education, safety, health, and finances that reduce social vulnerability and improve business retention.
2. **Improved Built Environment *(Housing, Commercial Facilities, and Infrastructure)*** – Provide guidance on activities that improve levels of service through risk assessments, assess benefits of development/retrofits in low-risk areas, and consider higher standards.
3. **Improved Natural Environment *(Land, Vegetation, Animals)*** – Provide guidance on activities that promote natural and beneficial functions of floodplains, consider natural protection measures, and support healthy air and water quality for people and animals.
4. **Resiliently Designed Environments *(Strengthened Human, Built, and Natural Environments)*** **–** Provide guidance on activities that integrate lessons learned and best practices, while considering current and future hazard vulnerabilities, to provide a more disaster-resilient community.

The table below *(Table 3.1: Hillsborough County Goals and Directives)* clearly outlines the County's focused goals, their associated directives, and the related strategic measures for each directive. These priorities were identified and discussed during a series of meetings of the LMS Working Group in January and February of 2020. The finalized list of new directives was approved by the LMS Working Group for inclusion in the update.

Table 3.1: Hillsborough County Goals and Directives

Directive Number	Goal Number	Goal Name	Strategic Directive (for community organizations, such as jurisdictions, NGOs, and non-profits)	Strategic Measures
1.1	1	Improved Human Environment	Provide guidance to promote education of residents and businesses of their vulnerability to hazards.	% of community vulnerable to high-priority hazards reached
1.2	1	Improved Human Environment	Provide within areas of community needs, guidance regarding emergency response, warnings and related activities.	% of Residents and businesses understand what warnings mean and how to take appropriate actions
1.3	1	Improved Human Environment	Through the integrated community networks provide guidance to identify information on community health resources available within socially vulnerable areas.	% of vulnerable houses beyond or greater than 1 mile from closest health resource
1.4	1	Improved Human Environment	Promote awareness of locational vulnerability to businesses and facilities in order to become more sustainable to disasters.	% of businesses/ Land Use codes vulnerable to high-priority hazards reached
1.5	1	Improved Human Environment	Promote small business/facility owners to have continuity plan and reserves.	% of businesses vulnerable to high-priority hazards reached

Directive Number	Goal Number	Goal Name	Strategic Directive (for community organizations, such as jurisdictions, NGOs, and non-profits)	Strategic Measures
1.6	1	Improved Human Environment	Promote flood insurance as an effective method of risk transfer.	% of respective jurisdictions with policies
2.1	2	Improved Built Environment	Provide a higher prioritized rank to LMS projects that will mitigate impacts within areas that have had, and will continue to have, significant flood impacts to human, natural and built environments.	Zero repetitive structures in the county
2.2	2	Improved Built Environment	Provide guidance using LMS Strategies for vulnerable areas to community stakeholders to consider natural-beneficial functions, higher standards for design, resilient structures and sustainable infrastructure.	New codes with higher standards adopted
2.3	2	Improved Built Environment	Provide guidance to community entities about mitigation initiatives that considered repetitive-loss analyses and lead to healthier, sustainable, resilient, safer and secure areas.	Zero repetitive structures in the county with consideration given to the matrix of hazards
2.4	2	Improved Built Environment	Assistance in guidance for watershed management plans and maintenance for storm water systems.	Community budgets

Directive Number	Goal Number	Goal Name	Strategic Directive (for community organizations, such as jurisdictions, NGOs, and non-profits)	Strategic Measures
3.1	3	Improved Natural Environment	Provide guidance to community stakeholders about mitigation initiatives to protect the coastal areas of the community against erosion.	% of vulnerable coastline protected
3.2	3	Improved Natural Environment	Promote regulations that restrict and manage development activity in the floodplain.	% of floodplain protected
3.3	3	Improved Natural Environment	Promote regulations that protect natural habitats that sustain all species.	Code language
3.4	3	Improved Natural Environment	Identify mitigation initiatives that may be used to integrate the use of natural habitats with man-made maintenance activities.	Number of mitigation initiatives used
4.1	4	Resiliently Designed Environments	Identify mitigation initiatives that may be used in coordination with land-use management practices to reduce density in high-risk areas.	Track density in high-risk areas
4.2	4	Resiliently Designed Environments	Promote the education of residents and businesses on the changing vulnerabilities due to climate variability.	Outreach programs and materials

Directive Number	Goal Number	Goal Name	Strategic Directive (for community organizations, such as jurisdictions, NGOs, and non-profits)	Strategic Measures
4.3	4	Resiliently Designed Environments	Identify benefits of higher-risk thresholds to community stakeholders when assessing hazard vulnerability (i.e. a 500-yr storm as a baseline vs 100-yr).	Code language
4.4	4	Resiliently Designed Environments	Promote countywide consistency for higher standards (similar risk thresholds and planning horizons).	Code language

Specific Mitigation Measures

Mitigation tools and techniques fall into three broad categories: (1) **structural techniques** including design and construction; (2) **environmental interventions** and (3) **non-structural interventions**. Structural mitigation projects include strengthening of vulnerable structures and public facilities to withstand wind, fire and other forces, elevation of structures to protect them from flood damage, construction of storm water control facilities and drainage improvements. Environmental intervention refers to actions that reduce the vulnerability of communities by armoring them against the elements. This term includes beach restoration and stabilization projects. Non-structural mitigation refers to policies for avoiding hazard impacts, applying zoning restrictions, land acquisition in the floodplain, promoting citizen awareness and public education initiatives.

Each jurisdiction identified mitigation actions which fell into one of six (6) specific measures:

A. Prevention:

Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and storm water management regulation.

B. Property Protection:

Actions that involve the modification of existing building or infrastructure to protect them from a hazard or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and impact-resistant glass.

C. Public Education and Awareness:

Actions to inform and educate citizens, elected officials and property owners about potential risks from hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.

D. Natural Resource Protection:

Actions that, in addition to minimizing hazard losses also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.

E. Structural Projects:

These are actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls, floodwalls, seawalls, retaining walls, and safe rooms. The implementation of a mitigation program is a key component in the achievement of a “sustainable community”, one in which citizens, businesses, and institutions are protected from the disruptions and impacts of disasters. In an urbanized metropolitan county such as Hillsborough County, coordination among and between levels of government is critical to the success of the program.

F. Emergency Services:

These actions support and provide emergency services in response to an emergency or disaster in the county. It may include early warning systems, sirens, or equipment for actual response.

The LMS Project List for Hillsborough County and its municipalities can be found in Appendix D. During the 2020 LMS Update, all stakeholders were asked to update the status of existing projects to either active or archived. Active projects all have an estimated implementation date and status, and archived projects were either completed, deleted, or are unknown and have an explanation as to what has changed. New projects were self-scored by the applicant, then reviewed by the LMS WG's scoring committed, and then presented to the LMS WG to provide any clarification on details before being accepted by the group. There are two tables per each jurisdiction: (1) Active Projects (the new or deferred projects) and (2) Archived Projects (those projects that are completed, deleted, or unknown).

Local Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of a local jurisdiction to implement a comprehensive mitigation strategy and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs, or projects. As in any planning process, it is important to try to establish which goals, directives, and/or actions are feasible based on an understanding of the organizational capacity of those agencies or departments tasked with their implementation. A capability assessment helps to determine which mitigation actions are practice and likely to be implement over time given a local government's planning and regulatory framework, level of administrative and technical support, amount of fiscal resources, and current political climate.

A capability assessment has two primary components: 1) an inventory of a local jurisdiction's relevant plans, ordinances, or programs already in place and 2) an analysis of its capacity to carry them out. Careful examination of local capabilities will detect any existing gaps, shortfalls, or weaknesses with ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. A capability assessment also highlights the positive mitigation measures already in place or being implemented at the local government level, which should continue to be supported and enhanced through future mitigation efforts.

The capability assessment completed for Hillsborough County serves as a critical planning step and an integral part of the foundation for designing an effective hazard mitigation strategy. Coupled with the Risk Assessment, the Capability Assessment helps identify and target meaningful mitigation actions for incorporation in the Mitigation Strategy portion of the LMS. It not only helps establish the goals and directives for the county to pursue under this Plan but also ensures that those goals and directives are realistically achievable under given local conditions.

Conducting the Capability Assessment

In order to facilitate the inventory and analysis of local government capabilities within participating jurisdictions of Hillsborough County, a detailed Capability Assessment Survey was distributed. The survey questionnaire requested information on a variety of "capability indicators" such as existing local plans, policies, programs, or ordinances that contribute to and/or hinder the jurisdictions' ability to implement hazard mitigation actions. Other indicators included information related to the jurisdictions' fiscal, administrative, and technical capabilities, such as access to local budgetary and personnel resources for mitigation purposes. Survey respondents were also asked to comment on the current political climate with respect to hazard mitigation, an important consideration for any local planning or decision-making process.

At a minimum, survey results provide an extensive inventory of existing local plans, ordinances, programs, and resources in place or under development in addition to their overall effect on hazard loss reduction. However, the survey instrument can also serve to identify gaps, weaknesses, or conflicts that the local jurisdictions can recast as opportunities for specific actions to be proposed as part of the hazard mitigation strategy.

Planning and Regulatory Capability

Planning and regulatory capability is based on the implementation of plans, ordinances, and programs that demonstrate a local jurisdiction's commitment to guiding and managing growth, development, and redevelopment in a responsible manner while maintaining the general welfare of the community. It includes emergency response and mitigation planning, comprehensive land use planning, and transportation planning; the enforcement of zoning or subdivision ordinances and building codes that regulate how land is developed and structures are built; as well as protecting environmental, historic, and cultural resources in the community. Although some conflicts can arise, these planning initiatives generally present significant opportunities to integrate hazard mitigation principles and practices into the local decision-making process.

This assessment is designed to provide a general overview of the key planning and regulatory tools and programs that are in place or under development for Hillsborough County along with their potential effect on loss reduction. This information will help identify opportunities to address existing gaps, weaknesses, or conflicts with other initiatives in addition to integrating the implementation of this Plan with existing planning mechanisms where appropriate. There is a circular relationship between many of these plans as they occur at different points in time and are nuanced within each jurisdiction. The plans both inform and are informed by the LMS document as well as the planning process in which the government stakeholders participate. The data that informs these local plans (and the LMS) often lives in geospatial tools outside of the plan documents themselves and are refreshed more currently than the policy documents. The most direct links between the actual LMS document and local codes occur through the Comprehensive Emergency Management Plan (CEMP) and each jurisdiction's Comprehensive Land Use Plan. The CEMP utilizes the risk assessment portion of the LMS to support it, and all jurisdictions coordinate emergency management activities with the county. The Comprehensive Plans have individual elements, some of which are provided guidance by the LMS (or more broadly stated in some local plans as "hazard mitigation activities"). For example, many communities have a Conservation and Coastal Management Element in which ecologic and coastal hazard mitigation concerns within the jurisdiction are addressed.

The table below provides a summary of the relevant local plans, ordinances, and programs already in place or under development for Hillsborough County. An "X" indicates that the given item is currently in place and being implemented. An "*" indicates that the given item is currently being developed for future implementation. A green-filled box indicates that the item strongly supports loss reduction and a blue-filled box indicates that the item supports loss reduction but is not a primary tool. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Hillsborough County LMS.

Table 3.2: Relevant Plans, Ordinances, and Programs

Planning/Regulatory Tool	Unincorporated County	Plant City	Tampa	Temple Terrace
Hazard Mitigation Plan	X	X	X	X
Threat and Hazard Identification and Risk Assessment (THIRA)	X		X	X
Comprehensive Land Use Plan	X	X	X	X
Floodplain Management Plan/Flood Mitigation Plan	X		X	X
Open Space Management Plan (Parks & Rec/Greenway Plan)	X	X	X	X
Stormwater Management Plan/Ordinance	X	X	X	X
Natural Resource Protection Plan	X	X	X	X
Flood Response Plan	X			X
Emergency Operations Plan	X	X	X	X
Emergency Management Accreditation Program (EMAP Accreditation)	X		X	X
Continuity of Operations Plan	X		X	X
Evacuation Plan	X		X	X
Disaster Recovery Plan	X			X
Capital Improvements Plan	X	X	X	X
Economic Development Plan	X			X
Historic Preservation Plan			X	X
Flood Damage Prevention Ordinance	X	X	X	X
Zoning Ordinance	X	X	X	X
Subdivision Ordinance	X	X	X	X
Post-Disaster Redevelopment/ Reconstruction Plan/Ordinance	X	X	X	X
Building Code	X	X	X	X
Fire Code	X	X	X	X

Planning/Regulatory Tool	Unincorporated County	Plant City	Tampa	Temple Terrace
National Flood Insurance Program (NFIP)	X	X	X	X
NFIP Community Rating System (CRS Program)	X	X	X	X

Emergency Management

Hazard mitigation is widely recognized as one of the four primary phases of emergency management. The three other phases include preparedness, response, and recovery. In reality, each phase is interconnected with hazard mitigation. Opportunities to reduce potential losses through mitigation practices are most often implemented before disaster strikes, such as elevation of flood prone structures or through the continuous enforcement of policies that prevent and regulate development that is vulnerable to hazards due to its location, design, or other characteristics. Mitigation opportunities will also be presented during immediate preparedness or response activities, such as installing storm shutters in advance of a hurricane, and certainly during the long-term recovery and redevelopment process following a hazard event.

Planning for each phase is a critical part of a comprehensive emergency management program and a key to the successful implementation of hazard mitigation actions. As a result, the Capability Assessment Survey asked several questions across a range of emergency management plans in order to assess the participating jurisdictions' willingness to plan and their level of technical planning proficiency.

The following describes the various types of emergency management plans surveyed.

Hazard Mitigation Plan: A hazard mitigation plan represents a community's blueprint for how it intends to reduce the impact of natural and human-caused hazards on people and the built environment. The essential elements of a hazard mitigation plan include a risk assessment, capability assessment, and mitigation strategy.

Threat and Hazard Identification and Risk Assessment (THIRA): A THIRA is a comprehensive risk assessment process that helps a community understand its risks and estimate capability requirements. Outputs of the THIRA process can inform a variety of disaster preparedness and emergency management efforts, including emergency operations planning, mutual aid agreements, and hazard mitigation planning.

Disaster Recovery Plan: A disaster recovery plan serves to guide the physical, social, environmental, and economic recovery and reconstruction process following a disaster. In many instances, hazard mitigation principles and practices are incorporated into local disaster recovery plans with the intent of capitalizing on opportunities to break the cycle of repetitive disaster losses. Disaster recovery plans can also lead to the preparation of disaster redevelopment policies and ordinances to be enacted following a hazard event.

Emergency Operations Plan: An emergency operations plan outlines the responsibilities and the means by which resources are deployed during and following an emergency or disaster. The State of Florida requires that every county develop and maintain a compliant Comprehensive Emergency Management

Plan (CEMP). This plan addresses the threats to which a county or a region are exposed and how the local governing agency plans to respond to them.

Continuity of Operations Plan: A continuity of operations plan establishes a chain of command, line of succession, and plans for backup or alternate emergency facilities in case of an extreme emergency or disaster event.

Flood Response Plan: A flood response plan establishes procedures for responding to a flood emergency including coordinating and facilitating resources to minimize the impacts of flood.

Emergency Management Accreditation Program (EMAP): EMAP is the voluntary standards, assessment, and accreditation program for disaster preparedness programs. It provides emergency management programs the opportunity to be recognized for compliance with industry standards, to demonstrate accountability, and to focus attention on areas and issues where resources are needed.

Post-Disaster Redevelopment Plan: The Post Disaster Redevelopment Plan (PDRP) identifies policies, operational strategies, and roles and responsibilities for implementation that will guide decisions affecting long-term recovery and redevelopment of a community after a disaster. The PDRP emphasizes seizing opportunities for hazard mitigation and community improvements consistent with the goals of the local comprehensive plan and with full participation of its citizens. Amendments to Chapter 163, F.S. in 2015 (commonly known as Perils of Flood requirements) further clarified that the redevelopment component requirements.

General Planning

The implementation of hazard mitigation activities often involves agencies and individuals beyond the emergency management profession. Stakeholders may include local planners, public works officials, economic development specialists, and others. In many instances, concurrent local planning efforts will help to achieve or complement hazard mitigation goals, even though they are not designed as such. Therefore, the Capability Assessment Survey also asked questions regarding general planning capabilities and the degree to which hazard mitigation is integrated into other ongoing planning efforts in Hillsborough County.

The following describes the various types of general planning tools surveyed.

Comprehensive Land Use Plan: A comprehensive land use plan establishes the overall vision for what a community wants to be and serves as a guide for future governmental decision making. Typically, a comprehensive plan contains sections on demographic conditions, land use, transportation elements, and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, directives, and actions.

Capital Improvements Plan: A capital improvements plan guides the scheduling of spending on public improvements. A capital improvements plan can serve as an important mechanism for guiding future development away from identified hazard areas. Limiting public spending in hazardous areas is one of the most effective long-term mitigation actions available to local governments.

Historic Preservation Plan: A historic preservation plan is intended to preserve historic structures or districts within a community. An often-overlooked aspect of the historic preservation plan is the assessment of buildings and sites located in areas subject to natural hazards and the identification of ways to reduce future damages. This may involve retrofitting or relocation techniques that account for the need to protect buildings that do not meet current building standards or are within a historic district that cannot easily be relocated out of harm's way.

Zoning Ordinance: Zoning represents the primary means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the public health, safety, and welfare of those in a given jurisdiction that maintains zoning authority. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, a zoning ordinance can serve as a powerful tool when applied in identified hazard areas.

Subdivision Ordinance: A subdivision ordinance is intended to regulate the development of residential, commercial, industrial, or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Subdivision design that accounts for natural hazards can dramatically reduce the exposure of future development.

Building Codes, Permitting, and Inspections: Building codes regulate construction standards. In many communities, permits and inspections are required for new construction. Decisions regarding the adoption of building codes (that account for hazard risk), the type of permitting process required both before and after a disaster, and the enforcement of inspection protocols all affect the level of hazard risk faced by a community. The Florida Building Code (FBC) is a statewide building construction regulatory system that places emphasis on uniformity and accountability in order to ensure building strength in the events of natural disasters. The building code is implemented and enforced locally by individual counties. This delegation allows for greater state coverage, but also presents challenges as some smaller counties do not have the staff and resources that other counties might have. All construction in the state must adhere to the FBC. This allows local jurisdictions to ensure structures are more resistant to certain types of natural disasters, especially to wind and flood events.

Floodplain Management

Flooding represents the greatest natural hazard facing the nation. At the same time, the tools available to reduce the impacts associated with flooding are among the most developed when compared to other hazard-specific mitigation techniques. In addition to approaches that cut across hazards such as education, outreach, and the training of local officials, the National Flood Insurance Program (NFIP) contains specific regulatory measures that enable government officials to determine where and how growth occurs relative to flood hazards. Participation in the NFIP is voluntary for local governments; however, program participation is strongly encouraged by FEMA as a first step for implementing and sustaining an effective hazard mitigation program. It is therefore used as part of this assessment as a key indicator for measuring local capability.

In order for a county or municipality to participate in the NFIP, they must adopt a local flood damage prevention ordinance that requires jurisdictions to follow established minimum building standards in the floodplain. These standards require that all new buildings and substantial improvements to existing buildings will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties.

A key service provided by the NFIP is the mapping of identified flood hazard areas. Once completed, the Flood Insurance Rate Maps (FIRMs) are used to assess flood hazard risk, regulate construction practices, and set flood insurance rates. FIRMs are an important source of information to educate residents, government officials, and the private sector about the likelihood of flooding in their community.

NFIP policy and claim information for each participating jurisdiction in Hillsborough County can be found in the Risk Assessment Section. Each of the jurisdictions that is participating in the development of this plan that also participates in the NFIP is committed to maintaining and enforcing its floodplain management ordinance and regulating new development in floodplains.

All of jurisdictions in Hillsborough County are participants in the NFIP and will continue to comply with all required provisions of the program and will work to adequately comply in the future utilizing a number of strategies. In an effort to ensure continued compliance with the NFIP, each community will:

- Continue to enforce their adopted Floodplain Management Ordinance requirements, which include regulating all new development and substantial improvements in Special Flood and Coastal High Hazard Areas (SFHAs and CHHAs)
- Continue to maintain all records pertaining to floodplain development, which shall be available for public inspection
- Continue to notify the public when there are proposed changes to the floodplain ordinance or Flood Insurance Rate Maps (FIRMs)
- Maintain the maps and changes identified through Letters of Map Amendments, Revisions, or Changes
- Continue to promote flood insurance for all properties
- Continue the Community Rating System (CRS) outreach programs

Community Rating System: An additional indicator of floodplain management capability is the active participation of local jurisdictions in the Community Rating System (CRS). The CRS is an incentive-based program that encourages counties and municipalities to undertake defined flood mitigation activities that go beyond the minimum requirements of the NFIP by adding extra local measures to provide protection from flooding. All of the 18 creditable CRS mitigation activities are assigned a range of point values. As points are accumulated and reach identified thresholds, communities can apply for an improved CRS class rating. Class ratings, which range from 10 to 1, are tied to flood insurance premium reductions as shown in the table below. As class ratings improve (the lower the number the better), the percent reduction in flood insurance premiums for NFIP policyholders in that community increases.

Table 3.3: CRS Premium Discounts by Class

CRS Class	Premium Reduction SFHA*	Premium Reduction Non-SFHA†
1	45%	10%
2	40%	10%
3	35%	10%
4	30%	10%
5	25%	10%
6	20%	10%
7	15%	5%
8	10%	5%

CRS Class	Premium Reduction SFHA*	Premium Reduction Non-SFHA†
9	5%	%5
10	0	0

*Special Flood Hazard Areas (SFHAs) – all A and V Zones (except AR and A99 Zones)
†Non-Special Flood Hazard Areas (non-SFHAs) – Zones B, C, X, D; all AR and A99 Zones are treated as non-SFHAs
Note: Premium reductions are subject to change.
Source: FEMA

Community participation in the CRS is voluntary. Any community that is in full compliance with the rules and regulations of the NFIP may apply to FEMA for a CRS classification better than class 10. The CRS application process has been greatly simplified over the past several years based on community comments. Changes were made with the intent to make the CRS more user-friendly and make extensive technical assistance available for communities who request it.

Table 3.4: Hillsborough County CRS Communities and Classes

Location	CRS Class
Tampa	5
Temple Terrance	6
Plant City	8
Unincorporated	5

Both the NFIP and the CRS program allow county-level mitigation programs to address repetitive loss (RL) properties.

The following describes the other types of floodplain management tools surveyed.

Flood Damage Prevention Ordinance: A flood damage prevention ordinance establishes minimum building standards in the floodplain with the intent to minimize public and private losses due to flood conditions.

Floodplain Management Plan: A floodplain management plan (or a flood mitigation plan) provides a framework for action regarding corrective and preventative measures to reduce flood-related impacts.

Open Space Management Plan: An open space management plan is designed to preserve, protect, and restore largely undeveloped lands in their natural state and to expand or connect areas in the public domain such as parks, greenways, and other outdoor recreation areas. In many instances, open space management practices are consistent with the goals of reducing hazard losses, such as the preservation of wetlands or other flood-prone areas in their natural state in perpetuity.

Stormwater Management Plan: A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding.

Administrative and Technical Capability

The ability of a local government to develop and implement mitigation projects, policies, and programs is directly tied to its ability to direct staff time and resources for that purpose. Administrative capability can be evaluated by determining how mitigation-related activities are assigned to local departments and if there are adequate personnel resources to complete these activities. The degree of intergovernmental coordination among departments will also affect administrative capability for the implementation and success of proposed mitigation activities.

Technical capability can generally be evaluated by assessing the level of knowledge and technical expertise of local government employees, such as personnel skilled in using Geographic Information Systems (GIS) to analyze and assess community hazard vulnerability. The Capability Assessment Survey was used to capture information on administrative and technical capability through the identification of available staff and personnel resources.

The table below provides a summary of the Capability Assessment Survey results for Hillsborough County with regard to relevant staff and personnel resources. An "X" indicates the presence of a staff member(s) in that jurisdiction with the specified knowledge or skill.

Table 3.5: Relevant Staff/Personnel Resources

Staff/Personnel Resources	Unincorporated County	Plant City	Tampa	Temple Terrace
Planners with knowledge of land development/land management practices	X	X	X	X
Engineers or professionals trained in construction practices related to buildings and/or infrastructure	X	X	X	X
Planners or engineers with an understanding of natural and/or human-caused hazards	X	X	X	X
Emergency Manager	X		X	X
Floodplain Manager	X	X	X	X
Land Surveyors	X		X	
Scientists familiar with the hazards of the community	X			
Staff with education or expertise to assess the community's vulnerability to hazards	X	X	X	X
Personnel skilled in GIS and/or Hazus	X	X	X	X
Resource development staff or grant writers	X		X	

Fiscal Capability

The ability of a local government to take action is often closely associated with the amount of money available to implement policies and projects. This may take the form of outside grant funding awards or locally-based revenue and financing. The costs associated with mitigation policy and project implementation vary widely. In some cases, policies are tied primarily to staff time or administrative costs associated with the creation and monitoring of a given program. In other cases, direct expenses are linked to an actual project, such as the acquisition of flood-prone homes, which can require a substantial commitment from local, state, and federal funding sources.

The Capability Assessment Survey was used to capture information on the county's fiscal capability through the identification of locally-available financial resources.

The table below provides a summary of the Capability Assessment Survey results for Hillsborough County with regard to relevant staff and personnel resources. An "X" indicates that the given fiscal resource has previously been used or is available to use to implement hazard mitigation actions. An "*" indicates that the given item is currently being developed as financial resources for hazard mitigation purposes.

Table 3.6: Relevant Fiscal Resources

Fiscal Tool/Resource	Unincorporated County	Plant City	Tampa	Temple Terrace
Capital Improvement Programming	X	X	X	X
Community Development Block Grants (CDBG)	X	X	X	X
Special Purpose Taxes (or taxing districts)	X			
Gas/Electric Utility Fees				
Water/Sewer Fees				X
Stormwater Utility Fees	X			
Development Impact Fees	X			X
General Obligation, Revenue, and/or Special Tax Bonds				
Partnering Arrangements or Intergovernmental	X	X	X	X

Political Capability

One of the most difficult capabilities to evaluate involves the political will of a jurisdiction to enact meaningful policies and projects designed to reduce the impact of future hazard events. Hazard mitigation may not be a local priority or may conflict with or be seen as an impediment to other goals of the community, such as growth and economic development. Therefore, the local political climate must be considered in designing mitigation strategies as it could be the most difficult hurdle to overcome in accomplishing their adoption and implementation.

The Capability Assessment Survey was used to capture information on political capability of Hillsborough County and its municipalities. Survey respondents were asked to identify some general examples of local political capability, such as guiding development away from identified hazard areas, restricting public investments or capital improvements within hazard areas, or enforcing local development standards that go beyond minimum state or federal requirements (e.g., building codes, floodplain management, etc.).

Some survey responses provided examples of development regulations that go beyond minimum state or federal requirements. The responses included information on the enforcement of ordinances and building standards as well.

The table below provides a summary of the results for Hillsborough County with regard to political capability. An “X” indicates the expected degree of political support by local elected officials in terms of adopting/funding information.

Table 3.7: Local Political Support

Level of Support	Unincorporated County	Plant City	Tampa	Temple Terrace
Limited	X			
Moderate			X	
High				
Unknown		X		X

Local Implementation

It is important to note, LMS goals and directives are already implemented through some of these programs or documents listed earlier in Table 3.2, which guide policy approaches, regulatory processes, and day-to-day operations within Hillsborough County. Mitigation is incorporated into these existing mechanisms as described below, and areas where greater attention is required to strengthen regulatory frameworks and better integrate other similar processes are discussed.

In the past, the County and its municipalities have utilized the LMS and embedded floodplain management practices to inform their planning efforts for their CRS program to maintain their class status. Communities have also utilized the risk assessment to inform the planning processes for their individual comprehensive plans, particularly policies related to land use, environmental resources, and public infrastructure.

Further, LMS’s risk assessment continues to inform the County’s Comprehensive Emergency Management Plan to guide emergency management mitigation, response, and recovery. The LMS strategy process has also supported collaborative efforts such as the Post-Disaster Recovery Plan, where LMS WG members (private and public sector representatives) have served as leads for Technical Advisory Committees.

Hillsborough County and the cities of Plant City, Tampa, and Temple Terrace work to maintain continuity among local growth management and emergency management plans, land development regulations, building codes, and other ordinances and programs. Special emphasis needs to be placed on the ongoing cooperative action between county and city governments, businesses and industry, and other segments of the community. The county is working to further unify county processes through the coordination of programs within county government and through interagency coordination with all local governments and businesses within the county.

All jurisdictions utilize the LMS and embedded floodplain management practices to inform their planning efforts for their CRS program to maintain their class status. Each jurisdiction independently reviews the strategy to determine what elements will inform the planning processes for their individual comprehensive plans. The floodplain management information within the LMS strategies, as well as the best practices conveyed during regular meetings of the LMS WG, are used to guide the floodplain management policies and how those policies are applied locally for development and permitting.

Furthermore, the new LMS will inform the jurisdictions regarding future policy directives for emergency management response and recovery as well as informing the communities on how to utilize resources appropriately. Communities are evaluating how the LMS can factor into the assessment of appropriate infrastructure projects to implement based on the risk assessment and the outlined mitigation actions to pursue with their CIP and grant resources.

The LMS goals and objectives also form a critical part of the Coastal Management Element within Hillsborough County's Comprehensive Plan. Policies, Goals, and Objectives address a variety of mitigation approaches and strategies; including, encouraging non-structural or nature-based mitigation approaches; guiding density and development by enacting policies that encourage infill and development outside of the coastal high hazard and storm surge areas; and require the maintenance of critical planning and operational documents that support mitigation and risk-reduction. Mitigation-focused policies also supports restricting public infrastructures expenditures that subsidize redevelopment in the Coastal Storm Area; developing and maintaining the LMS, Comprehensive Emergency Management Plan (CEMP) and the Post-Disaster Redevelopment Plan (PDRP).

In addition to the Comprehensive Plan, the LMS goals are closely tied with Hillsborough County's CEMP. The principles and procedures defined within the county's CEMP were developed with input and expertise from County departments, municipal emergency management coordinators as well as the LMS Working Group. The CEMP is the operations plan for Hillsborough County that guides the response to a disaster. It establishes a framework through which Hillsborough County and its municipalities prepare for, respond to, recover from, and mitigate the impacts of a wide variety of disasters. While Hillsborough County's CEMP is an operations-based plan that addresses emergency protective actions such as evacuation, sheltering and recovery procedures, the LMS serves as the guiding document for all the mitigation priorities. The county's CEMP integrates the response and recovery activities with the LMS functions.

A full comparison, alignment, and assimilation was done between the CEMP and the updated risk assessment of the LMS. An analysis of the identified hazards within the county's previous LMS, the Office of Emergency Management's (OEM) hazards within in the newly revised CEMP, and the State Hazard Mitigation Plan's list of hazards was compared and incorporated into the new LMS plan through a crosswalk process. OEM provided feedback on the hazards and the necessity to include very specific hazards for the geographic area and historical events within the county. Adjustments were made accordingly to both plans for complete integration.

Hillsborough County's PDRP is another such document that supports and implements mitigation goals. Developed in 2010, the PDRP identifies mitigation as one of its core post-disaster functions that is critical to how we approach land use changes in damaged areas, rebuild, restore the environment and infrastructure following a disaster. Following the adoption of the LMS, the PDRP will incorporate the 2020 LMS Goals and Objectives to revise and expand on the actions defined in the PDRP.

The Comprehensive Plan, PDRP, and CEMP discussed above, are the overarching policy, procedure or operational documents that help implement the LMS goals and objectives. While the risk assessment and LMS Goals inform the policies, metrics, and operational strategies within these plans, the analysis, policies and procedures developed as a part of these planning documents also inform the LMS goals. This is accomplished through the involvement of stakeholders from the municipalities representing multiple disciplines within the LMS Working Group. In addition to these plans and programs, there are other ongoing or upcoming initiatives that are equally comprehensive in scope and hold a lot of potential in implementing mitigation. These include, Hillsborough County's Community Vulnerability Assessment project, Sustainability and Resiliency Action Plan, and the Health in All Policies Initiative. These initiatives can help - advance our understanding of vulnerability from a new perspective; address risk reduction using new approaches; develop co-beneficial strategies and performance measures; strategically attain targeted goals; and reach out to new interested groups and mitigation partners. As a next step, we are looking for opportunities to integrate mitigation goals in these initiatives and vice versa.

Regulatory Review: Local governments employ regulatory procedures that manage growth through the development review process. These regulations are principally associated with mitigating the impacts of development associated with floodplains/ floodways (includes the establishment of base-flood elevations or identification of flood proofing), wetlands and coastal high-hazard areas. The current regulatory framework continues to address certain issues and techniques that may assist in furthering hazard mitigation initiatives that are listed below. Some of these topic issues include items that may be better established first through policy within the Comprehensive Plan and then drafting and modifying regulations in order for consideration to be provided through development-review and building-permitting functions.

At a minimum the following items should be addressed:

- Watershed alteration
- Alternatives to redevelopment in high hazard areas
- Development review and building permitting processes that incorporate hazard mitigation alternatives
- Potential flooding from hurricane storm surges and associated wind and wave action
- Redevelopment of, or the prohibition of, non-conforming uses after a disaster (an economic analysis may be required)
- Development/redevelopment in areas associated with repetitive losses due to natural disasters
- Storm surge/severe winds of greater magnitude storms

Plans and Policy Implementation: The adopted Local Government Comprehensive Plans are used to guide growth in each of the jurisdictions based upon factors such as development limitations, public service provision, and environmental resource protection. Additionally, the county and municipalities have adopted other plans for use in mitigating hazards and in the development review process.

These plans are principally associated with mitigation development by:

- Limiting development density through limiting public service provision (indicated through development areas) for various areas within the county – some of which are associated with hazard-prone areas
- Prioritizing areas for protection and implementing a preservation or conservation value
- Minimizing (non-mitigated) development within high-hazard coastal areas
- Identifying the need to retrofit and improve stormwater systems
- Maintaining adequate level of service capacities associated with public infrastructure and services
- Implementing procedures of the Comprehensive Emergency Management Plan (CEMP)

At a minimum, the following additional items should be addressed:

- Redevelopment of existing properties after a disaster to ensure mitigation strategies that would minimize the number of non-conforming uses are considered
- Modify the Comprehensive Plan to recognize strategies approved within the LMS, per Florida Administrative Code 163.3177 (Chapter 163, Florida Statutes) and Post-Disaster Redevelopment Plan (PDRP)
- Update the Comprehensive Emergency Management Plan (CEMP) to use hazard mitigating strategies as identified through the LMS and PDRP
- Establish a policy direction that encourages removal of septic tanks or hazardous sites from high hazard areas throughout the county after a catastrophic event
- Establish policy direction to ensure evacuation shelters are addressed per the direction of the CEMP

Program Implementation: The county has implemented programs that are effective in mitigating hazards, which mostly address the hazards associated with flooding at this time. Some plans are not unified or integrated. One of the principal purposes of the LMS is to unify these programs and "identify areas for strengthening" to ensure implementation of the LMS. Plans principally associated with mitigating development that are becoming better integrated are:

- Post Disaster Redevelopment Plan (PDRP)
- Greenways and environmental lands acquisition – some areas identified for acquisition may serve a dual purpose (recreation/preservation and hazard mitigation)
- National Flood Insurance Program (NFIP) and the Community Rating System (CRS) criteria that provides for the provision of flood insurance
- Floodplain management and stormwater drainage programs – these programs have been established to minimize and mitigate flooding hazards

At a minimum, the following items should be continued:

- Development of more monitoring systems to measure flood levels
- Expansion of acquisition programs to acquire more hazard-prone areas
- Review of allowances made for non-conforming uses to rebuild
- Update the Comprehensive Emergency Management Plan (CEMP) to include a definition of critical facilities as defined within the LMS

- Review repetitive loss cases to better examine historical patterns of repetitive damage to determine whether the policy should be expanded or modified to other areas
- Coordinate repetitive loss flood insurance "payouts" from the Federal government to ensure payments are not for non-conforming structures
- Establish a permanent funding source for mitigation projects within the Capital Improvements Program
- Identify alternatives (and incentives) in building techniques for development within high hazard areas
- Identify all potential hazards in the review of new development

Conclusions on Local Capability

The overall capability to implement hazard mitigation actions varies among the participating jurisdictions. Larger jurisdictions typically have higher planning and regulatory capability, more staff and technical resources, as well as greater fiscal capability compared to smaller jurisdictions.

One of the reasons for conducting a Capability Assessment is to examine local capabilities to detect any existing gaps or weaknesses within ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. These gaps or weaknesses have been identified for each jurisdiction in the tables found throughout this section. The participating jurisdictions used the Capability Assessment as part of the basis for the Mitigation Measures that are identified in this LMS; therefore, each jurisdiction addresses their ability to expand on and improve their existing capabilities through the identification of their Mitigation Measures.

<u>Linking the Capability Assessment with the Risk Assessment and the Mitigation Strategy</u>

The conclusions of the Risk Assessment and Capability Assessment serve as the foundation for the development of a meaningful hazard mitigation strategy. During the process of identifying specific mitigation actions to pursue, the LMS Working Group considered not only each jurisdiction's level of hazard risk but also their existing capability to minimize or eliminate that risk.

RISK ASSESSMENT SECTION

Local Hazard Mitigation Plan Requirements in this section are:
B1. Does the Plan include a description of the type, location, and extent of all-natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))

Introduction

In order to minimize the losses suffered from disasters it is important to have an understanding of the types of hazards and severity of these events that have the potential to affect Hillsborough County. Although the losses cannot be completely eliminated much can be done to reduce the negative impact of a disaster. The Hazard Identification and Risk Assessment (HIRA) is a tool used to gain the understanding needed to identify hazards, understand their potential severity and plan strategies to lessen the intensity, or mitigate, the damage due to the forces of and aftermath of a disaster.

The hazards analysis for the Hillsborough County Local Mitigation Strategy (LMS) provides a basis for developing a strategic approach to mitigating risk county-wide. These mitigation strategies are used by the county to develop and maintain the LMS program which is designed to determine and prioritize these mitigation initiatives.

This section profiles the natural, public health, and technological hazards that could potentially affect each jurisdiction within the county including the City of Tampa, Temple Terrace, Plant City, and unincorporated Hillsborough County. Each natural hazard profile includes an overall summary of the risk analysis, overview of the hazard, discussion of the geographic areas affected, the historical occurrences affecting the county, the probability, and an impact analysis that includes an overview of impacts to the built environment, ecological impacts, and population and social vulnerabilities. Alternatively, the public health and technological hazards include similar topics of discussion, but not all aspects are able to be quantified due to limitations in available data and the imprecise nature of these events.

Consistent with Federal and State Plans and the County Comprehensive Emergency Management Plan (CEMP), the Hillsborough County LMS reflects an "All-Hazards" approach to mitigation. Consequently, research focuses on identifying technological, societal and natural hazards that may affect the county. Information was compiled by the LMS Working Group, Atkins Global, the University of South Florida, Hillsborough County Emergency Management, county and municipal planning departments with data provided from the Port Tampa, National Weather Service, Tampa Electric (TECO), State of Florida Department of Transportation (DOT), Tampa International Airport, U.S. Geological Survey, National Climatic Data Center, the Tampa Bay Regional Planning Council, and other sources.

2020 Update

Significant research was required to update the 12 natural hazard profiles, the 11 technological hazards, and the 5 human/societal hazards. References and sources are included as footnotes in the hazard profiles, but the main sources of data included:

- Declared Events
- NOAA
- Hazus-MH
- FEMA
- CDC
- U.S. Census Bureau

Current Status and Future Maintenance

As of 2020, this risk assessment is the most current and detailed hazard analysis for Hillsborough County. The information has been analyzed using the most current data sets available at the time of revision and update. As this risk assessment is continually updated, this information will be used to further refine the current state mitigation strategies.

Identified Hazards

The plan addresses those natural hazards as required by the Federal Emergency Management Agency (FEMA) and the State of Florida. Based on meteorological, geological, and topological research it was determined that four of these hazards (volcanic eruptions, seismic events, tsunamis, and landslides) do not pose any significant threat to Hillsborough County. Volcanic eruptions and landslides present no threat to Hillsborough County, while seismic events and tsunamis are of minimal concern. Therefore, volcanic eruptions and landslides will not have a profile in the 2020 plan update.

The list below shows the natural hazards that are profiled in this risk assessment.

- Flood
- Tropical Cyclone
- Severe Storm
- Tornado
- Wildfire
- Erosion
- Extreme Heat
- Drought
- Suspect Soil
- Winter Storm and Freeze
- Seismic Event
- Tsunami

Because this risk assessment serves as the single risk assessment for the Hillsborough County, other hazards have been included to meet requirements. EMAP and other planning mechanisms require that the CEMP and LMS identify the same hazards. To avoid duplication of effort, the Hillsborough County LMS risk assessment serves as the CEMP risk assessment, as well as the risk assessment for any other emergency management plans. The technological and human hazards included in this risk assessment are listed below.

- Transportation Incident
- Infrastructure Disruption
- HazMat Incident
- Space Weather Incident
- Dam/Levee Failure
- Agricultural Disruption
- Disease Outbreak and Biologic Incident
- Food and Waterborne Disease Outbreak
- Coastal Oil Spill
- Port Vessel Collision
- Utility Failure
- Civil Disturbance
- Cyber Incident
- Mass Migration
- Terrorism
- Special Events

These 28 hazards were identified based on examination of past disasters, probability of occurrence, possible impacts, and vulnerability.

Hazard Profiles

The hazard profiles all follow the same outline, and the sections and a short description of the intent of the section is listed in the table below.

Table 4.1: Hazard Profile Description

Hazard Profile Section	Description
Hazard Description and Background	This section includes a basic overview of the hazard, such as causes, various types of the hazard, the measurements of the hazard, advisories for the hazard and any other pertinent information. There are also statements about the overall frequency and magnitude determinations that were made regarding the hazard. Each hazard description includes a section titled "Potential Impacts of Climate Change," where the potential impacts of climate change on that hazard are discussed. If there are no known potential impacts of climate change for a given hazard, there is a statement in place of the discussion.
Geographic Areas Affected by Hazard	This section discusses the areas of the county that are likely to be impacted by the hazard. There may also be references to where the hazard has occurred in the past.
Historical Occurrences of Hazard	This section lists significant occurrences of the hazard overall. There is also a list of every Major Disaster Declaration in the county for the hazard, if there are any.

Hazard Profile Section	Description
Probability of Future Occurrence of Hazard	This section includes a description of the likelihood of the hazard occurring in the future. There is probabilistic data from Hazus-MH. Annual probability is also determined by averaging the number of occurrences within a specified timeframe. There is also a statement about the determined overall probability of the hazard.
Hazard Impact Analysis	This section lists impacts that are possible due to the hazard occurring in the county. They are categorized into impacts affecting: ● Public; ● First Responders; ● Continuity of Operations (including continued delivery of services); ● Property, Facilities, Infrastructure; ● Environment; • Economic condition of the jurisdiction; and • Public Confidence in the Jurisdiction's Governance. The impacts were categorized this way to align more easily with EMAP Standard requirements. Additional impacts to the built environment, ecological impacts, and population and social impacts are also described for several of the water-related and public-health related hazards.
Vulnerability Analysis and Loss Estimation by Jurisdiction	Natural Hazards: This section includes a discussion of the overall vulnerability and an estimation of losses possible. This information is gathered from various sources, discussed below. Technological Hazards: This section includes a discussion of overall vulnerability. Where possible, loss estimation information is provided. There are also examples of the cost of incidents in the past to provide a baseline of losses possible.
Hazard Summary Matrix	There is a statement about the ranking system below, as well as a statement about the overall vulnerability of the respective hazard in each profile. These statements are followed by the Hazard Summary Matrix. Overview: A few sentences from the hazard description. Probability: Rankings of the likelihood of the hazard occurring. Impact Analysis: Rankings of the hazard's general impact on people, property, and critical facilities. Spatial Extent: Ranking of the area of the county that will be affected by the hazard. Warning Time: Amount of time generally available before an impending hazard event. Duration: Length of time a typical hazard event will last. PRI Score: Numerical value that indicates degree of risk for the hazard. *More details on how this is calculated can be found below. Overall Vulnerability: Overall risk ranking based on PRI scores.

An important addition to this version of the LMS was to address hazard impacts to the built environment, ecological impacts, and the impacts to population and social vulnerabilities, when possible. Continuing to address the needs and challenges of vulnerable populations in Hillsborough County is essential in mitigation activities designed to increase the likelihood of improving public health objectives, prevent disaster-related economic costs, build resilience, and reduce unnecessary loss of life. Vulnerable populations include, but are not limited to, populations living in low-income areas, senior citizens, special needs populations, non-English speaking households, and residents living in manufactured homes.

Data Sources

Significant research was required to update the 12 natural hazard profiles, the 11 technological hazards, and the 5 human hazards. References and sources are included as footnotes in the hazard profiles, but the main sources of data included the sources below.

Hazus-MH

Hazus-MH is a nationally applicable standardized methodology that contains models for estimating potential losses from floods and hurricanes. HAZUS-MH uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. This helps users to visualize the spatial relationship between populations and other more permanently fixed geographic assets or resources for the specific hazard being modeled. HAZUS-MH is used for preparedness, response, recovery, and mitigation and is useful in the risk assessment step in the mitigation planning process.

Hazus-MH 4.0 uses 2010 Census data for population and general building stock information, which is aggregated to the Census Track and Block (wind and flood, respectively). Furthermore, the Flood model incorporates a dasymetric model which more accurately represents where the population is located based on land use and land cover.

FEMA

The FEMA website provides information about each federal declaration that has been made for Florida, including emergency declarations, major disaster declarations, and fire management assistance declarations.

The Risk Mapping, Assessment and Planning (RiskMAP) program aims to identify flood risk and promote informed planning and development practices to help reduce risk. The GIS portion of the RiskMAP program was used to develop the *Flood Hazard Profile* and analyses.

NOAA/NWS/NHC

The National Oceanic and Atmospheric Administration (NOAA) is a large agency with many purposes. The National Weather Service (NWS) is part of NOAA and both agencies provided information via their websites that is included in the natural hazard profiles.

The National Hurricane Center (NHC) is within NOAA/NWS and works to issue the best watches, warnings, forecasts, and analyses, as well as increase the understanding of tropical weather. Much of the *Tropical Cyclone Hazard Profile* stems from information on this website. The NHC is located on the Florida International University in Miami, Florida.

National Centers for Environmental Information (NCEI)

The NCEI Storm Events Database contains records which document three things: the occurrence of storms and other significant weather phenomena with sufficient intensity to cause loss of life, injuries, significant property damage, and disruption to commerce; rare or unusual weather phenomena that generates media attention; and other significant meteorological events, such as record maximum or minimum temperatures. The database was used to search for data from January 1950 through December 2018. Event types recorded include coastal flood, cold/wind chill, drought, excessive heat, extreme cold/wind chill, flash flood, flood, frost/freeze, hail, heat, heavy rain, high wind, lightning, sleet, storm surge/tide, strong wind, thunderstorm wind, tornado, tropical depression, tropical storm, wildfire, winter storm, and winter weather.

National Climate Assessment

The National Climate Assessment is a summary document of the overall impact of climate change on the United States currently and futuristically. It is a culmination of work from a large pool of experts along with the Federal Advisory Committee. This document explores the effects of climate changes on the various sectors such as water, ecosystems, human health, energy, transportation, agriculture, and forests throughout the regions of the country.

United States Drought Monitor

Since 1999, the U.S. Drought Monitor is a map that is released weekly showing the parts of the country that are experiencing drought. The map depicts the drought through five different classifications and is hosted by the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln, NOAA, and the U.S. Department of Agriculture.

Southern Wildfire Risk Assessment

The Southern Wildfire Risk Assessment (SWRA) works with various other agencies to provide wildfire information for southern U.S. states, including identifying areas that are prone to wildfires. The SWRA Portal (SWRAP) also works to create awareness and to support mitigation planning. This information was used to develop GIS information for the *Wildfire Hazard Profile*.

USGS

United States Geological Survey (USGS) provides the United States with reliable scientific information to describe and understand the Earth and to minimize the loss of life and property from natural disasters. Information from USGS is included in several hazard profiles, including the *Suspect Soil Hazard Profile*.

CDC

Centers for Disease Control and Prevention's (CDC) Social Vulnerability Index (SVI) uses 15 U.S. census variables at tract level to help local officials identify communities that may need support in preparing for hazards or recovering from disaster. Social vulnerability refers to the resilience of communities when confronted by external stresses on human health, stresses such as natural or human-caused disasters, or disease outbreaks. Reducing social vulnerability can decrease both human suffering and economic loss.

Florida State Agencies

Information from State of Florida agencies, such as Division of Emergency Management (FDEM), Florida Department of Transportation (FDOT) Department of Environmental Protection (FDEP), and Department of Agriculture and Consumer Services (FDACS) was used to develop the hazard profiles and the GIS data shown.

Priority Risk Index

In order to draw some meaningful planning conclusions on hazard risk for Hillsborough County, the results of the hazard profiling process were used to generate county-wide hazard classifications according to a "Priority Risk Index" (PRI). The purpose of the PRI is to categorize and prioritize all potential hazards for Hillsborough County as high, moderate, or low risk. Combined with the asset inventory and quantitative vulnerability assessment provided, the summary hazard classifications generated through the use of the PRI allows for the prioritization of those high hazard risks for mitigation planning purposes and, more specifically, the identification of hazard mitigation opportunities for Hillsborough County to consider as part of their proposed mitigation strategy.

The prioritization and categorization of identified hazards for Hillsborough County is based principally on the PRI, a tool used to measure the degree of risk for identified hazards in a particular planning area. The PRI is used to assist the Hillsborough County LMS Working Group in gaining consensus on the determination of those hazards that pose the most significant threat to the county based on a variety of factors. The PRI is not scientifically based but is rather meant to be utilized as an objective planning tool for classifying and prioritizing hazard risks in Hillsborough County based on standardized criteria.

The application of the PRI results in numerical values that allow identified hazards to be ranked against one another (the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard (probability, impact, spatial extent, warning time, and duration). Each degree of risk has been assigned a valued (1 to 4) and an agreed upon weighting factor as summarized in the table below.[1] To calculate the PRI value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final PRI value as demonstrated in the example equation below:

PRI VALUE = [(PROBABILITY x .30) + (IMPACT x .30) + (SPATIAL EXTENT x .20) + (WARNING TIME x .10) + (DURATION x .10)]

According to the weighting scheme and point system applied, the highest possible value for any hazard is 4.0. When the scheme is applied for Hillsborough County, the highest PRI value is 3.3 (flood). Prior to being finalized, PRI values for each identified hazard were reviewed and accepted by the members of the Hillsborough County LMS Working Group.

[1] The Hillsborough County LMS Working Group, based upon any unique concerns or factors for the planning area, may adjust the PRI weighting scheme during future plan updates.

Table 4.2: Priority Risk Index for Hillsborough County

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.	1	30%
	Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.	3	
	Catastrophic	High number of deaths/injuries possible. More than 50% of property in affected are damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	4	
Spatial Extent	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
Warning Time	> 24 hours	Self explanatory	1	10%
	12 to 24 hours	Self explanatory	2	
	6 to 12 hours	Self explanatory	3	
	< 6 hours	Self explanatory	4	
Duration	< 6 hours	Self explanatory	1	10%
	< 24 hours	Self explanatory	2	
	< 1 week	Self explanatory	3	
	> 1 week	Self explanatory	4	

The table below summarizes the degree of risk assigned to each category for all identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the LMS Working Group. The results were then used in calculating PRI values and making final determinations for the risk assessment.

Table 4.3: Summary of PRI Results for Hillsborough County

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Natural Hazards						
Flood	Highly Likely	Critical	Moderate	6 to 12 hours	< 1 week	**3.3**
Tropical Cyclone – Minor (TD to Cat 2)	Likely	Critical	Large	> 24 hours	< 1 week	**3.0**
Tropical Cyclone – Major (Cat 3 to 5)	Possible	Catastrophic	Large	> 24 hours	< 1 week	**3.0**
Severe Storm	Highly Likely	Critical	Moderate	6 to 12 hours	< 6 hours	**3.1**
Tornado	Likely	Critical	Small	< 6 hours	< 6 hours	**2.7**
Wildfire	Likely	Limited	Moderate	< 6 hours	< 1 week	**2.8**
Erosion	Likely	Limited	Moderate	> 24 hours	> 1 week	**2.6**
Extreme Heat	Likely	Minor	Large	> 24 hours	> 1 week	**2.5**
Drought	Likely	Minor	Large	> 24 hours	> 1 week	**2.5**
Suspect Soil	Likely	Limited	Small	< 6 hours	< 24 hours	**2.5**
Winter Storm and Freeze	Possible	Minor	Large	> 24 hours	< 1 week	**2.1**
Seismic Events	Possible	Minor	Moderate	< 6 hours	< 6 hours	**2.0**
Tsunami	Unlikely	Limited	Small	< 6 hours	< 6 hours	**1.8**
Technological Hazards						
Transportation Incident	Possible	Critical	Moderate	< 6 hours	< 1 week	**2.8**
Infrastructure Disruption	Possible	Limited	Moderate	< 6 hours	< 1 week	**2.5**
HazMat Incident	Possible	Critical	Moderate	< 6 hours	> 1 week	**2.9**
Space Weather	Unlikely	Catastrophic	Large	< 6 hours	< 6 hours	**2.8**
Dam/Levee Failure	Unlikely	Critical	Moderate	< 6 hours	< 6 hours	**2.3**
Agricultural Disruption	Likely	Limited	Large	< 6 hours	> 1 week	**3.1**
Disease Outbreak and Biologic Incident	Likely	Limited	Small	> 24 hours	< 1 week	**2.3**
Food and Waterborne Disease Outbreak	Likely	Limited	Small	> 24 hours	< 1 week	**2.3**
Coastal Oil Spill	Possible	Critical	Moderate	< 6 hours	> 1 week	**2.9**
Port Vessel Collision	Possible	Critical	Moderate	< 6 hours	< 1 week	**2.8**
Utility Failure	Possible	Limited	Moderate	< 6 hours	< 1 week	**2.5**
Human/Societal Hazards						
Civil Disturbance	Possible	Critical	Moderate	< 6 hours	< 1 week	**2.8**
Cyber Incident	Possible	Limited	Moderate	< 6 hours	< 1 week	**2.5**
Mass Migration	Unlikely	Minor	Moderate	> 24 hours	> 1 week	**1.7**
Terrorism	Possible	Critical	Moderate	< 6 hours	> 1 week	**2.9**
Special Events	Possible	Critical	Moderate	< 6 hours	> 1 week	**2.9**

The conclusions drawn from the hazard profiling process for Hillsborough County, including the PRI results and input from the LMS Working Group, resulted in the classification of risk for each identified hazard according to three categories: high risk, moderate risk, and low risk. For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Hillsborough County. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately and is described in the individual hazard profiles below. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

Table 4.4: Hazards Vulnerability by Jurisdiction

Hazard	Hillsborough County	Plant City	Tampa	Temple Terrace
Natural Hazards				
Flood	High	High	High	High
Tropical Cyclone – Minor (TD to Cat 2)	High	High	High	High
Tropical Cyclone – Major (Cat 3 to 5)	High	High	High	High
Severe Storm	High	High	High	High
Tornado	Moderate	Moderate	Moderate	Moderate
Wildfire	Moderate	High	Moderate	Moderate
Erosion	Moderate	Low	High	Low
Extreme Heat	Moderate	Moderate	Moderate	Moderate
Drought	Moderate	Moderate	Moderate	Moderate
Suspect Soil	Moderate	Moderate	Moderate	Moderate
Winter Storm and Freeze	Low	Low	Low	Low
Seismic Events	Low	Low	Low	Low
Tsunami	Low	Low	Low	Low
Technological Hazards				
Transportation Incident	High	High	High	High
Infrastructure Disruption	Moderate	Moderate	Moderate	Moderate
HazMat Incident	High	High	High	High
Space Weather	High	High	High	High
Dam/Levee Failure	Moderate	Moderate	Moderate	Moderate
Agricultural Disruption	High	High	High	High
Disease Outbreak and Biologic Incident	Moderate	Moderate	Moderate	Moderate
Food and Waterborne Disease Outbreak	Moderate	Moderate	Moderate	Moderate
Coastal Oil Spill	Moderate	Low	Moderate	Low
Port Vessel Collision	Moderate	Low	Moderate	Low
Utility Failure	Moderate	Moderate	Moderate	Moderate
Societal/Human				
Civil Disturbance	High	High	High	High
Cyber Incident	Moderate	Moderate	Moderate	Moderate
Mass Migration	Low	Low	Low	Low
Terrorism	High	High	High	High
Special Events	Moderate	Moderate	Moderate	Low

Hillsborough County Asset Inventory

An inventory of geo-referenced assets within Hillsborough County and its jurisdictions was compiled in order to identify and characterize those properties potentially at risk to the identified hazards. By understanding the type and number of assets that exist and where they are located in relation to known hazard areas, the relative risk and vulnerability for such assets can be assessed. Under this assessment, two categories of physical assets were created and then further assessed through GIS analysis. These are presented below.

Physical and Improved Assets

The two categories of physical assets consist of:

1. Improved Property: Includes all improved properties in Hillsborough County according to local parcel data provided by the county. The information has been expressed in terms of the number of parcels and total assessed value of improvements (buildings) that may be exposed to the identified hazards. In addition, building footprint data was available for all jurisdictions and it was used to improve the overall assessment by providing an accurate assessment of how many buildings are located in hazard areas.

2. Critical Facilities: Critical facilities vary by jurisdiction and the critical facilities provided by the county are used in this section. It should be noted that this listing is not all-inclusive for assets located in the county, and it is anticipated that it may be expanded or adjusted during future plan updates as more geo-referenced data becomes available for use in GIS analysis. Critical facilities for each jurisdiction were determined based on jurisdictional boundaries and not necessarily by jurisdictional ownership.

The following tables provide a detailed listing of the geo-referenced assets that have been identified for inclusion in the vulnerability assessment by Hillsborough County.

Table 4.5: Improved Property in Hillsborough County

Location	Number of Parcels	Number of Buildings	Improved Value
Plant City	12,846	50,138	$1,954,413,458
Tampa	134,949	541,988	$34,502,914,550
Temple Terrace	8,526	37,318	$1,468,374,034
Unincorporated	345,351	1,314,570	$62,478,258,857
HILLSBOROUGH COUNTY TOTAL	**501,672**	**1,944,014**	**$100,403,960,899**

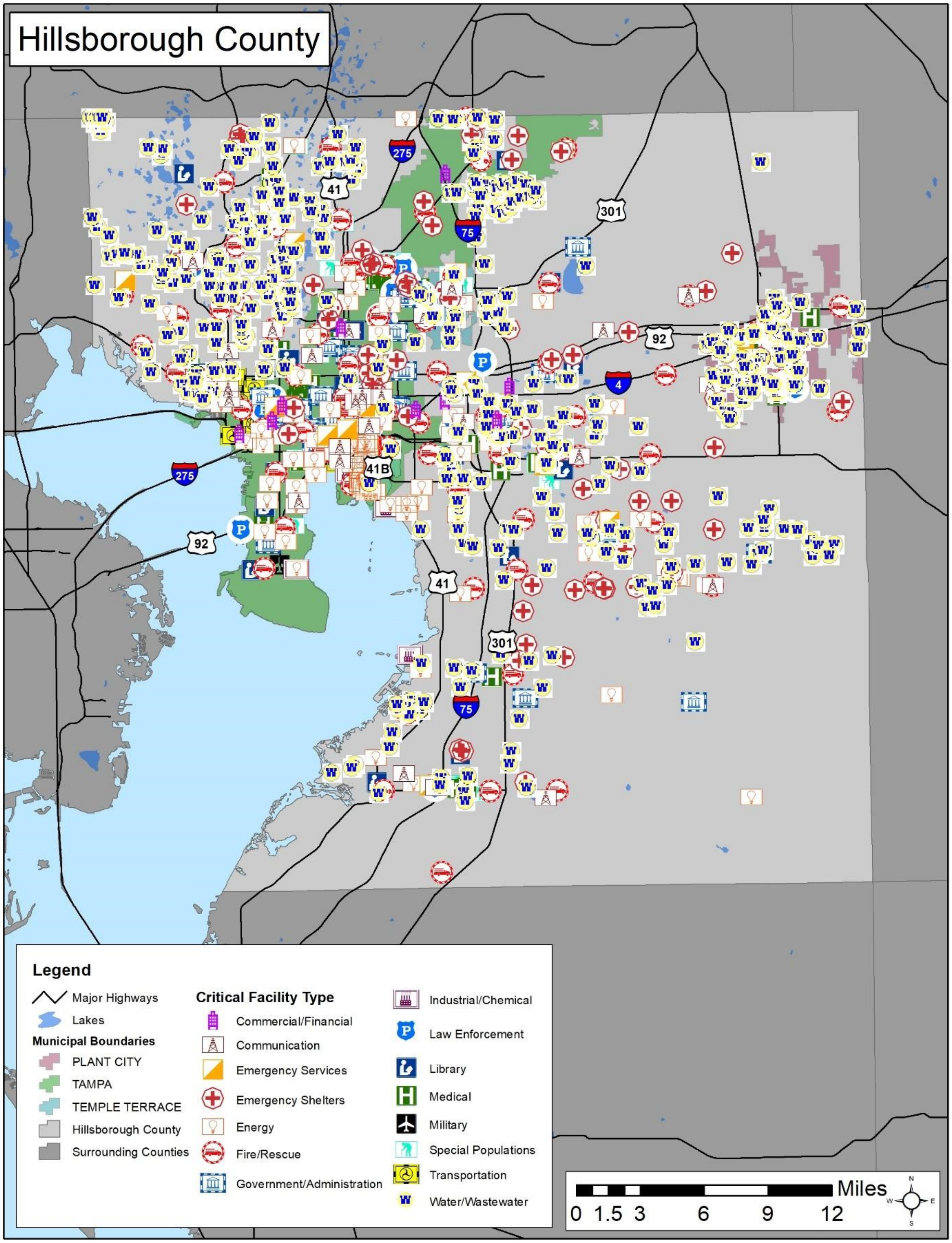
The table below summarizes the emergency service, hazardous material, health, communication, and other critical facilities located in Hillsborough County. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens.

Table 4.6: Critical Facility Inventory in Hillsborough County

Location	Number of Critical Facilities
Plant City	75
Tampa	213
Temple Terrace	23
Unincorporated	513
HILLSBOROUGH COUNTY TOTAL	**824**

These facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. The maps below illustrate the location of critical facilities in the county by type.

Figure 4.1: Critical Facilities in Hillsborough County – Critical Facilities



Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Hillsborough County that are potentially at risk to these hazards.

The following maps illustrate population density by census block as it was reported by the U.S. Census in 2010 as well as other indicators of social vulnerability.

Figure 4.2: Population Density in Hillsborough County

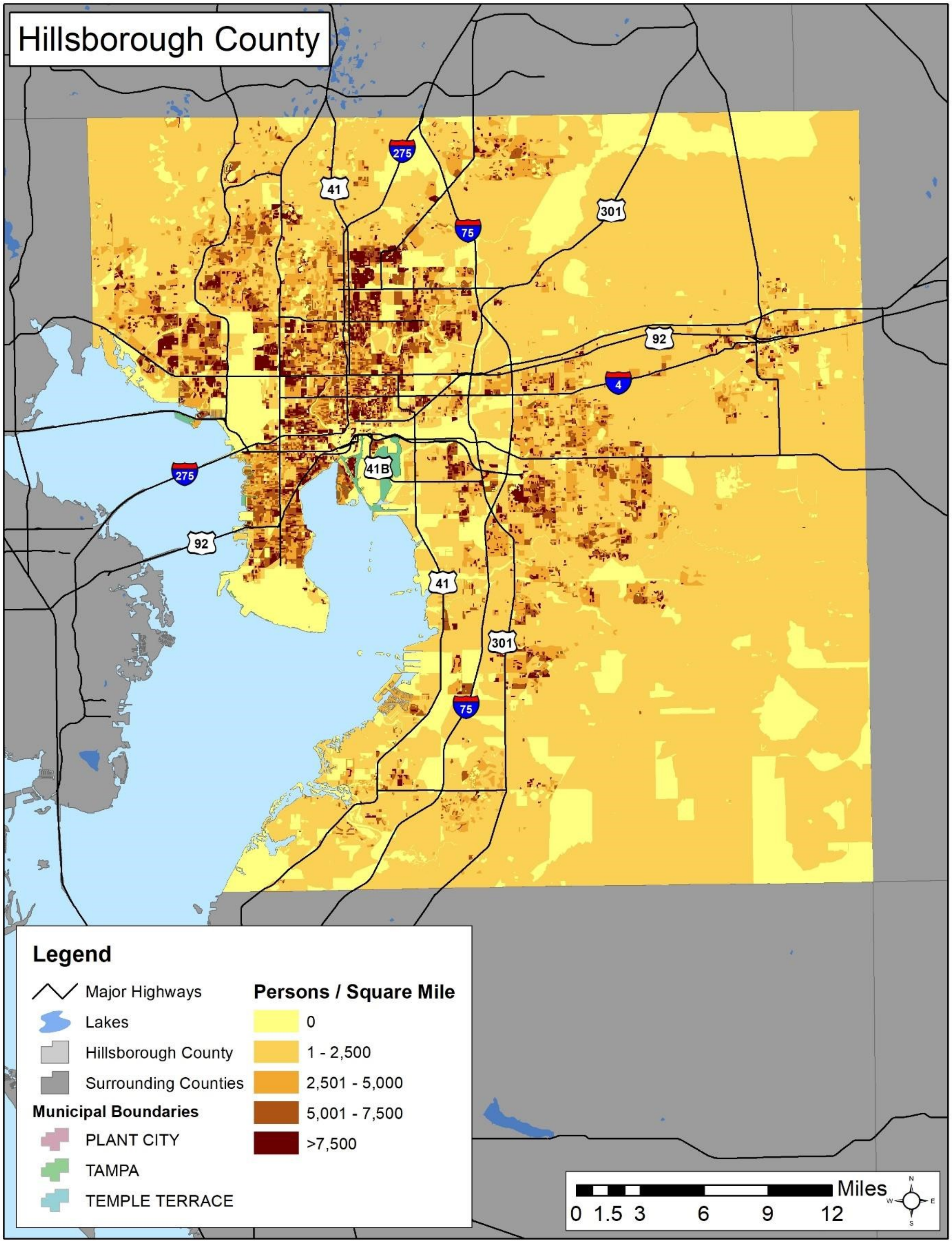


Figure 4.3: Social Vulnerability in Hillsborough County – Total

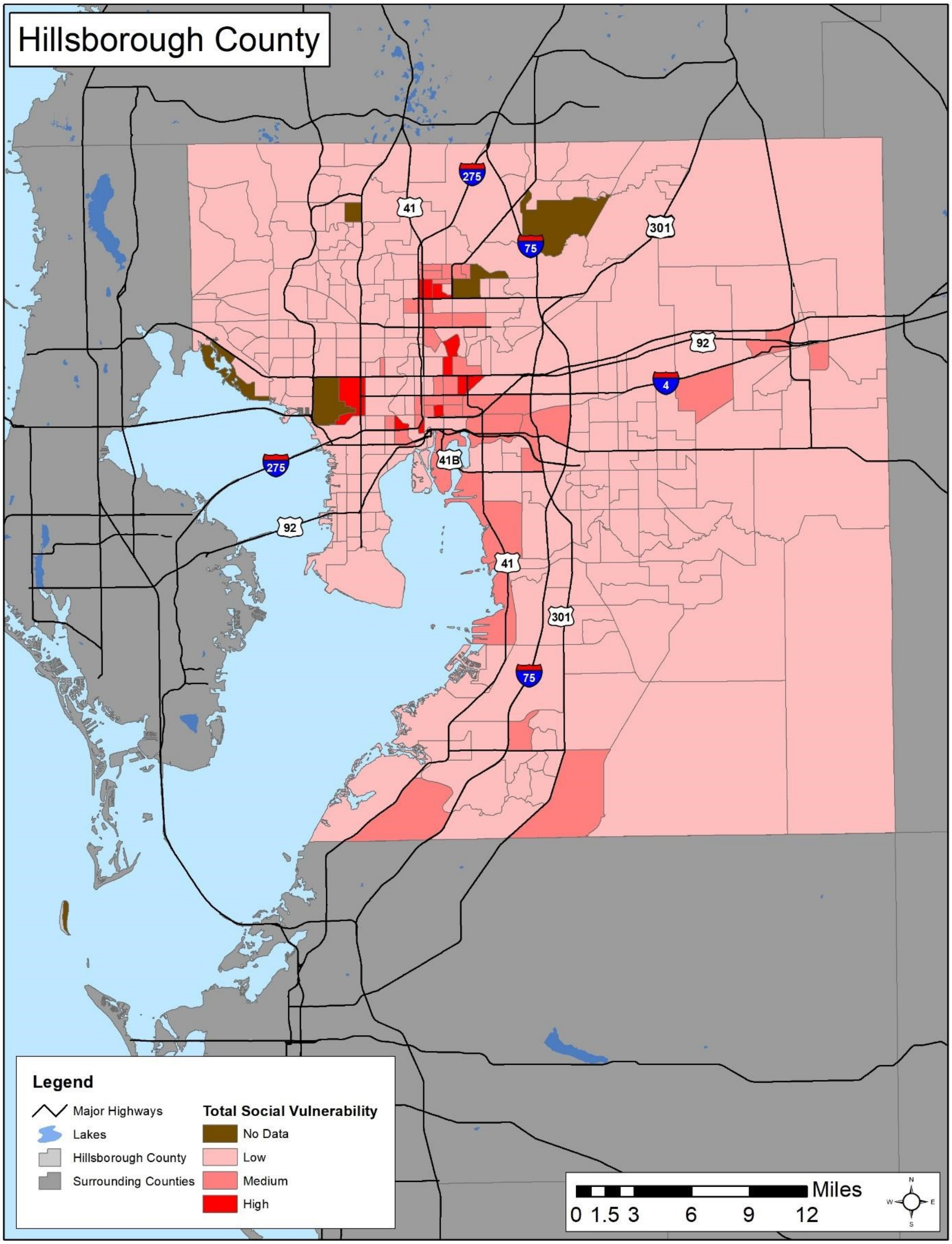


Figure 4.4: Social Vulnerability in Hillsborough County – Disabled

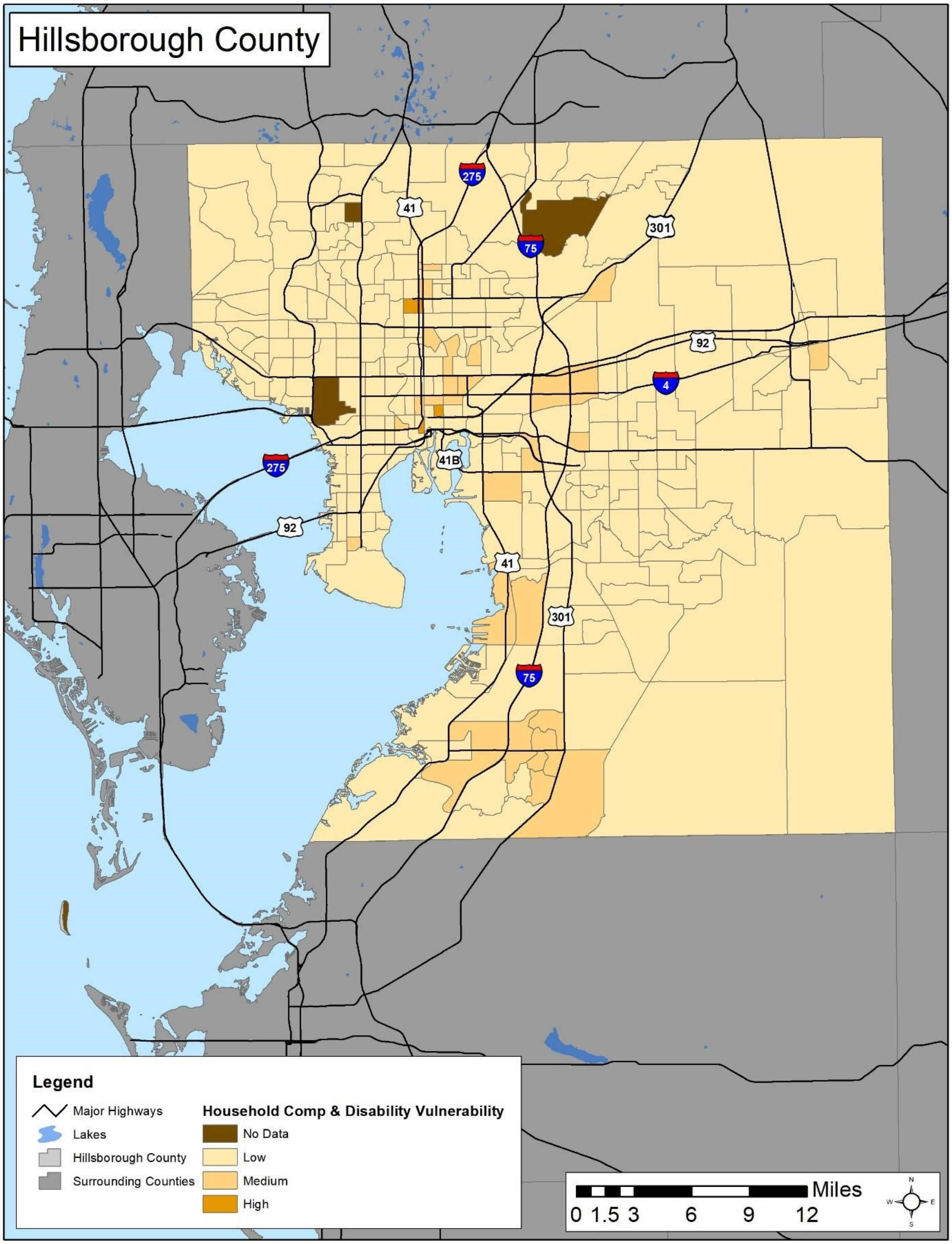


Figure 4.5: Social Vulnerability in Hillsborough County – Low Income/Poverty

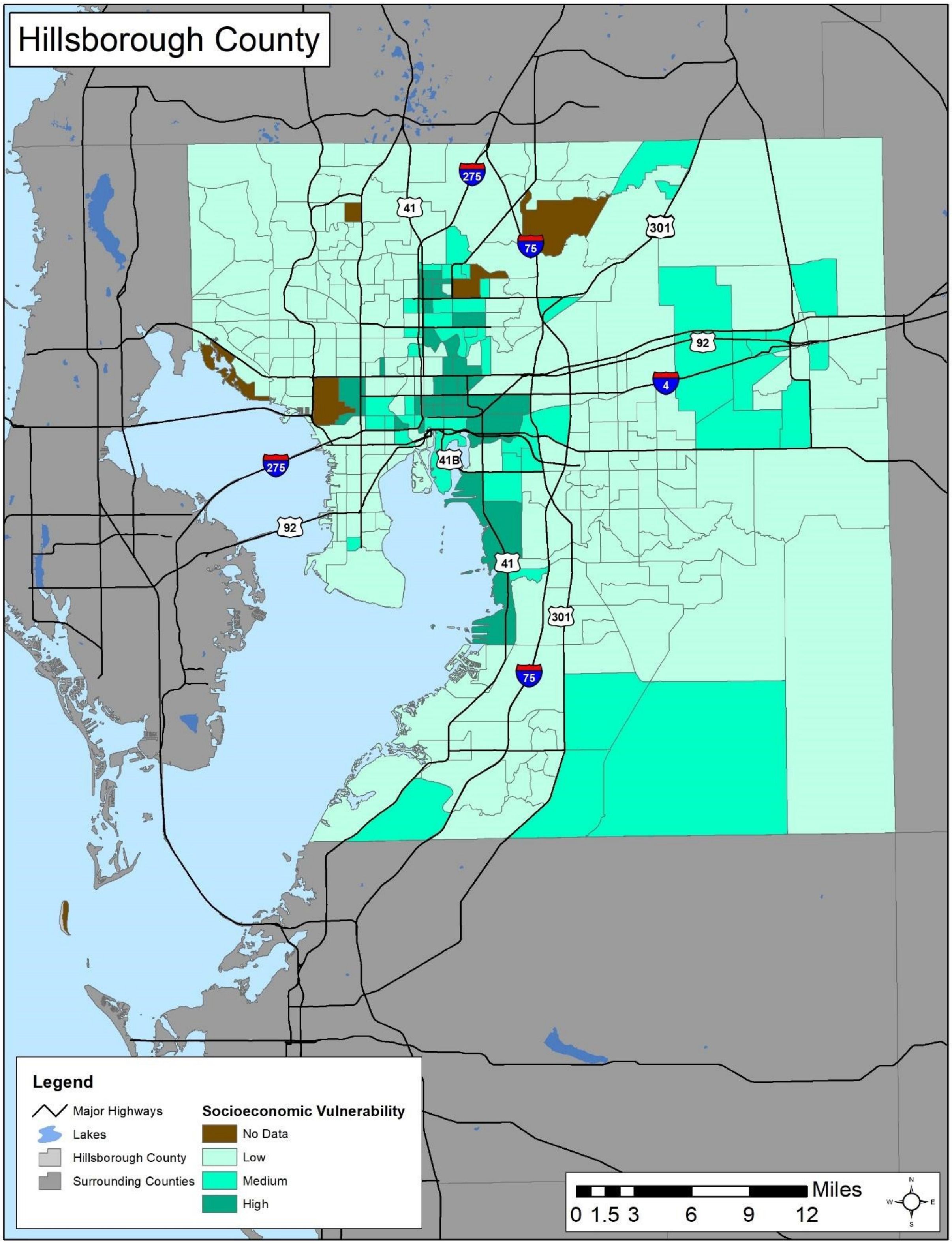


Figure 4.6: Social Vulnerability in Hillsborough County – Minority Language

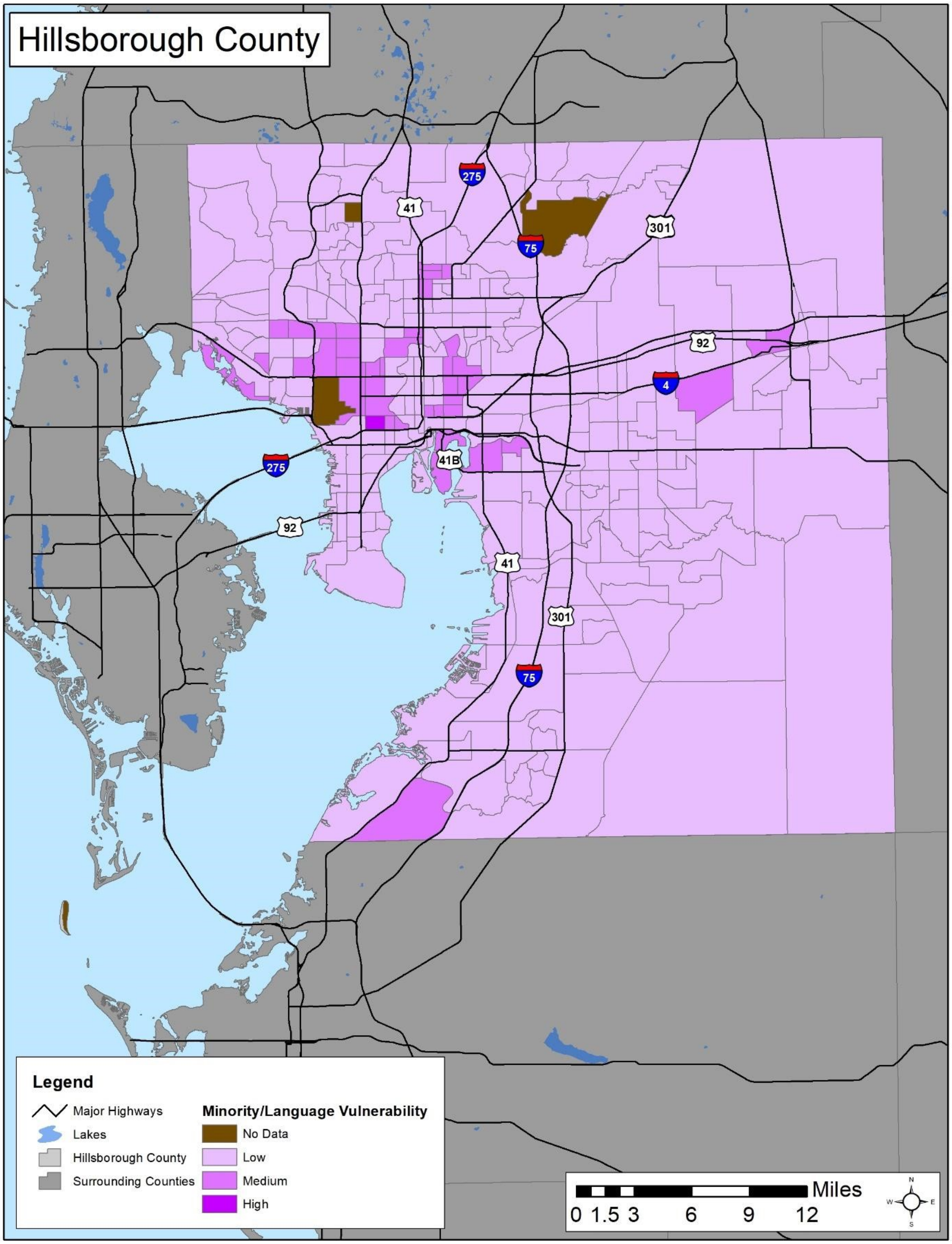
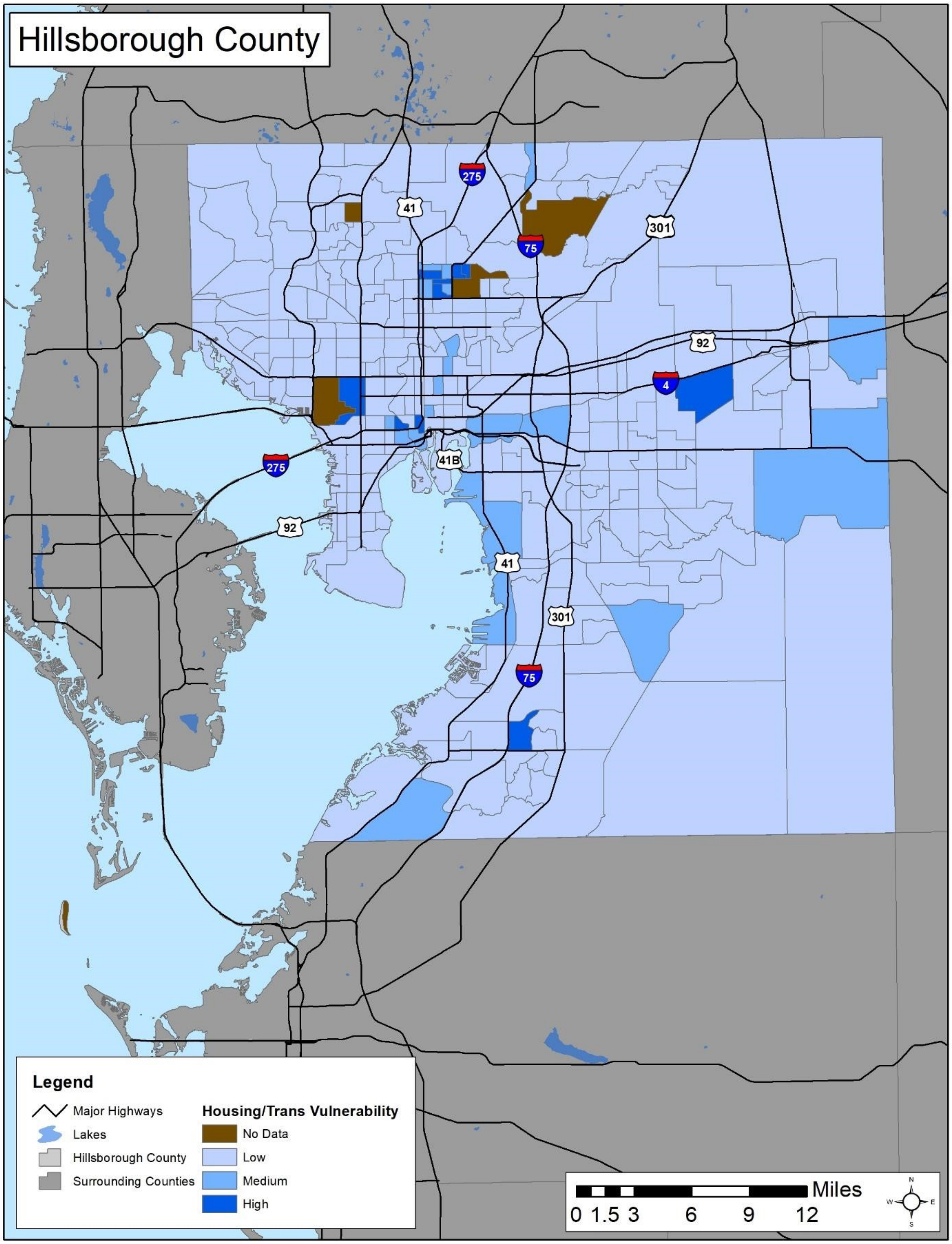


Figure 4.7: Social Vulnerability in Hillsborough County – Transient/Homeless



Development Trends and Changes in Vulnerability

Since the previous LMS was approved, Hillsborough County has experienced growth and development across the county. The table below shows the number of building units constructed since 2014 according to the U.S. Census American Community Survey.

Table 4.7: Building Counts for Hillsborough County

Location	Total Housing Units (2017)	Units Built 2014 or Later	% of Building Stock Built Post-2014
Plant City	14,673	128	0.9%
Tampa	165,678	2,039	1.2%
Temple Terrace	11,181	70	0.6%
Unincorporated	372,106	5,995	1.6%
HILLSBOROUGH COUNTY TOTAL	**563,638**	**8,232**	**1.5%**

The table below shows population estimates for the county from 2014 to 2017 based on the U.S. Census Bureau American Community Survey 5-Year Estimates.

Table 4.8: Population Growth for Hillsborough County

Location	Population Estimates				% change 2014-2017
	2014	2015	2016	2017	
Plant City	35,866	36,382	36,830	37,459	4.4%
Tampa	348,934	355,603	361,477	368,087	5.5%
Temple Terrace	25,098	25,354	25,654	25,853	3.0%
Unincorporated	869,770	885,545	899,098	919,688	5.7%
HILLSBOROUGH COUNTY TOTAL	**1,279,668**	**1,302,884**	**1,323,059**	**1,351,087**	**5.6%**

Based on the data above, there has been some residential development in the county since 2014. However, Tampa and the unincorporated county have experienced higher rates of development compared to the rest of the county, resulting in an increased number of structures that are vulnerable to the potential impacts of the identified hazards. Additionally, there has been population growth in Hillsborough County. Again, Tampa and the unincorporated county experienced higher rates of growth compared to the rest of the county. However, since the population has increased across the county, there is now a greater number of people exposed to the identified hazards. Therefore, population growth has impacted the county's vulnerability since the previous hazard mitigation plan was approved, and there has been a moderate increase in the overall vulnerability as well as a more significant increase in certain areas and communities. As Hillsborough County grows, the development within coastal and riverine areas become more populated and the consequences of storms and other hazards impact more people and the consequences are more severe.

It is also important to note that as development increases in the future, greater populations and more structures and infrastructure will be exposed to potential hazards if development occurs in the floodplains or other high-risk areas.

Flood Hazard Profile

1. Flood Description

A flood or flooding refers to the general or temporary conditions of partial or complete inundation of normally dry land area from the overflow of inland or tidal water and surface water runoff from any source. Floodplains are defined as any land areas susceptible to being inundated by water from any flooding source. While many people underestimate the severity of floods, loss of life and property from flooding are real threats in Hillsborough County. Flood stages are the water elevations at which varying levels of damage to personal property occurs. Locally heavy precipitation may produce flooding in areas other than delineated floodplains or along recognized drainage channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding.

Types of Flooding

In Hillsborough County, several variations of flooding occur due to the effects of severe thunderstorms, tropical storms and hurricanes, seasonal rain, climate change, and other weather-related conditions. This hazard profile will focus on two broad categories of flooding, inland flooding and coastal flooding.

- Inland Flooding
    - Riverine Reach
    - Flash Floods
- Coastal Flooding
    - Tidal Flooding

The greatest flood threat comes from storm surge which can cause widespread damage throughout coastal areas, estuaries, and areas adjacent to rivers. Localized flooding from rainfall can adversely affect many coastal and inland sections of the county as well, including low-lying areas along the Hillsborough, Alafia, and Little Manatee Rivers.

There are three major hazards that need to be taken into consideration that are produced by flooding: *inland flooding, coastal flooding, and storm surge*.

Inland or Riverine Flooding: Hillsborough County's low-lying topography combined with its subtropical climate makes it highly vulnerable to inland or riverine flooding. Riverine flooding occurs when the flow of runoff is greater than the carrying capacities of the natural drainage systems. Flood damage is proportional to the volume and the velocity of the water. High volumes of water can move heavy objects and undermine roads and bridges. Flooding can occur as a result of precipitation upstream without any precipitation occurring near the flooded areas.

Flash floods present more significant safety risks than other riverine floods because of the rapid onset, the high-water velocity, the debris load, and the potential for channel scour. In addition, more than one flood crest may result from a series of fast-moving storms. Sudden destruction of structures and the washout of access routes may result in the loss of life.

Although rural flooding is dangerous to fewer people and may be less costly than urban flooding, it can cause great damage to agricultural operations. The U.S. Geological Survey has established a system of monitoring stations to retrieve data about streamflow conditions. This system works in real time for flood warnings and for short-term trends. The system is accessible at the following website: http://waterdata.usgs.gov/fl/nwis/rt.

- Riverine Reach: The influence of river flooding on river stage gradually decreases with proximity to the Gulf, and the influence of tides and storm surges on river stage gradually increases the flood levels in bodies of water. Tides affect river stages at low and medium flows in the upper tidal reach and at all flows in the lower tidal reach. In the lower part of the lower tidal reach, stages during storm surges are higher than river flood stages. Soils are present in all riverine wetland forests, but the most nutrient-rich swamps are dry during low-flow periods. Most surface soils in the deepest riverine swamps, upper and lower tidal swamps and lower tidal mixed forests are continuously saturated mucks.

- Upper Tidal Reach: Upper tidal mixed forests are found on low levees or in transitional areas between swamps and higher forest types. Upper tidal swamps are present at elevations below median monthly high stage and usually have surface soils that are permanently saturated mucks.

- Lower Tidal Reach: The lower tidal reach is a floodplain is found on elevations that do not receive regular tidal inundation or frequent river flooding but have a high-water table and are briefly inundated by storm surges several times a decade. Lower tidal mixed forests include swamps with numerous small reaches and are found on deep muck soils that are below the elevation of the median daily or monthly high stages.

- Flash Flooding: As Hillsborough County's population has rapidly increased since 1960, so has the profile of the landscape. Rapid urbanization has manifested itself in the form of increased impervious surface areas such as asphalt roads, concrete areas, sidewalks, and structures. This increase has led to a much higher level of flash flooding during heavy rainstorms and flooding events. The design of urban drainage systems in the past has concentrated on disposing of storm water as rapidly and efficiently as possible in a concentrated area. However, stormwater is often collected and transported elsewhere without a comprehensive strategy for dealing with it as a system. As a result, drainage in urbanized areas of Hillsborough County is often a piecemeal solution and needs improvements in the comprehensive design.

Coastal Flooding: Coastal flooding is usually the result of a severe weather system such as a severe thunderstorm, hurricane, or tropical storm with high winds. Water driven ashore by the wind, known as storm surge, is the main cause of coastal flooding.

- Tidal Flooding: A tide is the periodic rise and fall of a body of water resulting from gravitational interactions between the sun, moon, and earth.[2] Tides are very predictable and most coastal areas experience two high tides and two low tides every day. High tides occur about every 12 hours and

[2] http://tidesandcurrents.noaa.gov/glossary.html

25 minutes and it takes about half that time (6 hours and 12.5 minutes) for the tie to go from high to low or low to high.[3]

- King Tides: are higher than normal ties and usually occur in the autumn months from September to November. These tides tend to be 6 inches or more above the average high tide of that area. Similar to regular high and low tides, king tides are predictable and usually last for 5-7 days.[4] King tides can cause flooding or streets and even structures. It is also important to note that weather conditions and concurrent rainfall can exacerbate the effects of king tides.

- Storm Surge: The damaging effects to structures in beach areas are caused by a combination of higher levels of storm surge, winds, waves, rains, erosion, and battering by debris. Sea walls, jetties, and the beach areas are affected by coastal flooding, and the loss over a period of time becomes costly. Loss of life and property damage are often more severe because a storm surge involved velocity wave action and accompanying winds.

  The output of the National Oceanic and Atmospheric Administration (NOAA) storm surge prediction model (SLOSH) shows that storm surge height of 28 feet or more above sea level could impact certain Hillsborough coastal and riverine areas under a worst-case Category 5 hurricane. Local topography, bay and river orientation, depth of the sea bottom, astronomical tides, as well as other physical features are taken into account in a predefined grid referred to as a "SLOSH basin."

  The bay and river orientation in Hillsborough County, depth of the sea bottom, astronomical tides, as well as other physical features are taken into account to determine storm surge levels and the impact it may have on the built environment, ecology, and population of Hillsborough County. Storm surge is discussed in depth in the *Tropical Cyclone Hazard Profile*.

National Weather Service Advisories

The National Weather Service (NWS) is tasked with providing weather forecasts and warnings of hazardous weather to agencies and the public for the purposes of protection, safety, and general information. If severe weather is detected, alerts are issued, and the Emergency Alert System may activate and broadcast the alert, mainly for severe thunderstorms or tornadoes.

Table 4.9: National Weather Service Advisories and Thresholds for Flooding[5]

[3] http://oceanservice.noaa.gov/education/kits/tides/tides05_lunarday.html
[4] http://www.southeastfloridaclimatecompact.org/wp-content/uploads/2016/06/KingTideToolkit.pdf
[5] https://www.weather.gov/safety/flood-watch-warning

National Weather Service Advisories	
Flooding or Flash Flooding	
Flood Advisory	Normally issued as an Urban and Small Stream Flood Advisory, this is issued when the flooding is not expected to be severe enough to warrant a flood warning, but it may cause inconvenience and could threaten life or property if caution is not exercised. Examples include nuisance flooding of low-lying areas and areas of poor drainage and minor flooding of roadways.
Flood or Flash Flood Watch	Issued when conditions are favorable for a specific hazardous weather event, including flooding, to occur, meaning flooding is possible.
Flood Warning	Issued when conditions are favorable for a specific hazardous weather event, including flooding, to occur, meaning flooding is possible.
Areal Flood Warning	Issued for flooding that occurs more gradually, normally from prolonged and persistent moderate to heavy rainfall.
Flash Flood Warning	Issued when a flash flood is imminent or occurring, referring to a sudden violent flood that can take minutes to hours to develop. It is even possible to experience a flash flood in areas not receiving rain.
River Flood Warning	Issued when a river is forecast to go above its designated flood stage at the forecast point.
Coastal Flood Advisory/ Watch/Warning	Issued when flooding along the coast of the Atlantic Ocean, Pacific Ocean, or the Gulf of Mexico is possible. The flooding must be due to water being forced from the nearby body of water onto land, and not from rainfall.

Floodplains

According to FEMA, a floodplain is any land area susceptible to being inundated by floodwaters, from any source. The USGS further defines a floodplain as the relatively flat lowland that borders a river and is usually dry but is subject to flooding.[6]

To establish floodplains, FEMA adopted the base flood elevation, which is the level of a flood that has a 1% probability of occurring in any given year. This level of flood is referred to as the base flood, the 1% flood, or the 100-year flood. The area that would be inundated by a base flood is called the 100-year floodplain. This is often misunderstood because many assume such a flood would only occur once every 100 years; however, as explained, the “100” number is referring to the 1% chance of the flood reaching that specified floodplain. The same theory is applied to understand the 500-year floodplain; it has a 0.2% chance of occurring each year.

FEMA has identified and mapped areas of flood risk on Flood Insurance Rate Maps and the zones are called Special Flood Hazard Areas (SFHA). The 100-year floodplain is considered a high-risk area and is denoted as Zone A. The 500-year floodplain is shown by the notation Zone C or Zone X. The areas between the 100 and 500-year floodplains are shown using Zone B and Zone X. Additionally, high risk coastal areas are denoted as Zone V. This information is shown in the table below.

[6] https://pubs.usgs.gov/fs/FS-229-96/

Table 4.10: FEMA Flood Zone Designations[7]

Zone	Description
Low to Moderate Risk Areas	
C and X (unshaded)	Area of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level. Zone C may have ponding and local drainage problems that don't warrant a detailed study or designation as a base floodplain. Zone X is the area determined to be outside the 500-year flood and protected by levee from 100-year flood.
B and X (shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile.
High Risk Areas	
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones.
AE	The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.
A1 - 30	These are known as numbered A Zones (e.g., A7 or A14). This is the base floodplain where the FIRM shows a BFE (old format).
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
AO	River or stream flood hazard areas, and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.
High Risk Coastal Area	
V	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.
VE, V1 - 30	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.

[7] https://www.fema.gov/flood-zones

Zone	Description
Undetermined Risk Areas	
D	Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.

Mitigation measures are taken to reduce the flood risk in the floodplain; however, development is not prohibited. Management of floodplains is accomplished through building codes, local ordinances, and zoning regulations to mitigate the damage from floodwaters. The floodway is the channel of a watercourse and those portions of the adjoining floodplain that needs to be kept open to provide for the passage of a base flood. The floodway fringe is the portion of the floodplain which when fully developed should not result in more than a one-foot rise in flood levels.

Floodplains cover a very large area in Hillsborough County. Pressure from developers to build, and the potential tax revenues from developments, make it difficult to keep floodplains undeveloped and makes floodplain management challenging. This lack of control coupled with inadequate information available regarding the extent of floodplains and flood prone areas typically leads to unsound development on floodplain land. Floodplains offer many benefits to communities by providing natural flood and erosion control, natural water filtration processes, habitats for plant and animal communities, as well as recreational areas and scientific field-study. Acting as natural flood storage areas, floodplains decrease the destructive force of floodwaters downstream by reducing the velocity of floodwaters. Though floodplain vegetation is partly responsible for slowing the rush of floodwaters, it also serves other valuable functions such as reducing soil erosion, trapping floodwater sediment that increases soil fertility by providing nutrients to environments, and reducing sediment load downstream.

The chemical filtration processes and biological activity that occur within a floodplain can also help reduce flood-generated pollution from agricultural and urban runoff and sewage overflow. Floodplains preserve and recharge groundwater supplies and provide opportunities for recreation, education, and scientific study. Urban expansion may encourage development in floodplains that would otherwise be reserved for these benefits.

National Flood Insurance Program and Repetitive Loss Properties

In 2019 flood maps for Hillsborough County, also known as Flood Insurance Rate Maps, provided by the Federal Emergency Management Agency (FEMA) were updated to reflect areas of potential inundation. In general, the map updates will result in one of the following for property owners in the affected area:

- For properties removed from the high-risk areas, the flood risk is reduced but not removed.
- Properties newly identified to be at high-risk will experience potential changes in insurance requirements and costs and new building requirements.
- Properties in high-risk areas may see their risk increase more.

These are a useful tool for assessing a flood risk for a property and are a factor in flood insurance and building requirements. Most homeowners' insurance does not cover flood damage. Flood maps are changed for coastal areas, generally west of Interstate 75 in southern Hillsborough County, south of

Interstate 275 and Tampa International Airport in Tampa, south of Linebaugh Avenue in Tampa, and near the lower Hillsborough, Alafia, and Little Manatee rivers.[8]

One of the consequences of flooding is repetitive loss. A repetitive loss property is one for which two or more losses of at least $1,000 each have been paid by the National Flood Insurance Program (NFIP) over a rolling 10-year period. Hillsborough County is a NFIP "C" Community (ten or more repetitive losses).

As of July 2019, all jurisdictions and the unincorporated areas of Hillsborough County participate in the NFIP. Furthermore, there are 64,526 NFIP polices in Hillsborough County, with flood insurance coverage totaling nearly $17.9 billion. According to the Policy and Claim Statistics for Flood Insurance page on the FEMA website (https://www.fema.gov/policy-claim-statistics-flood-insurance), there have been 7,302 claims countywide in Hillsborough County since Hillsborough County joined the NFIP on 16 June 1980, with the total paid equaling approximately $72.3 million. Furthermore, the county pays $49.5 million in insurance premiums each year to the NFIP, proving that Hillsborough County is also important to the NFIP program. For more information about the NFIP, please see the *Mitigation Strategy Section*.

Table 4.11: Hillsborough County NFIP Policies by Jurisdiction, as of July 31, 2019

Jurisdiction	Number of Policies	Total Coverage (in Thousands)	Total Written Premium and Federal Policy Fee (FPF)
Plant City	526	$139,004	$442,455
Tampa	27,143	$7,523,678	$23,559,300
Temple Terrace	526	$154,338	$223,455
Unincorporated	36,362	$9,984,358	$25,169,619
HILLSBOROUGH COUNTY TOTAL	**64,526**	**$17,801,377**	**$49,434,829**

Table 4.12: Hillsborough County NFIP Claims by Jurisdiction, 1980-2019

Jurisdiction	Total Number of Claims	Total Paid in Claims
Plant City	24	$104,432
Tampa	3,793	$39,726,862
Temple Terrace	42	$199,198
Unincorporated	3,443	$32,335,338
HILLSBOROUGH COUNTY TOTAL	**7,302**	**$72,365,829**

Repetitive Loss (RL) properties are the focus of strong mitigation programs. Mitigation RL and Severe Repetitive Loss (SRL) properties is strategic, because if there are properties that are known to flood, targeting them to mitigate will prevent flooding and losses in likely properties and give a high return on investment.

[8] www.hillsboroughcounty.org/en/residents/property-owners-and-renters/homeowners-and-neighborhoods/find-my-flood-zone?gt=1#/

This table summarizes the losses incurred by RL properties in Hillsborough County. In total, there are 441 RL properties in the county that have experienced 1,294 losses resulting in over $25.0 million in claims payments.

Table 4.13: Hillsborough County Repetitive Loss Properties Summary

Jurisdiction	Number of RL Properties	Number of Losses	Building Payments	Contents Payments	Total Payments
Plant City	1	2	$10,018.06	$741.80	$10,759.86
Tampa	223	645	$9,809,858.79	$3,730,591.90	$13,540,450.69
Temple Terrace	1	3	$27,611.30	$6,909.01	$34,520.31
Unincorporated	216	644	$8,324,436.97	$3,090,593.13	$11,415,030.10
HILLSBOROUGH COUNTY TOTAL	**441**	**1,294**	**$18,171,925.12**	**$6,828,835.84**	**$25,000,760.96**

This table shows the type of RL properties located in Hillsborough County. In total, there are 410 residential RL properties, 26 commercial RL properties, and 5 other types of RL properties in the county.

Table 4.14: Hillsborough County Repetitive Loss Properties by Type

Jurisdiction	Residential	Commercial	Other	Total
Plant City	1	0	0	1
Tampa	199	19	5	223
Temple Terrace	1	0	0	1
Unincorporated	209	7	0	216
HILLSBOROUGH COUNTY TOTAL	**410**	**26**	**5**	**441**

Furthermore, the NFIP's Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result of CRS, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS:

- Reduce flood losses
- Facilitate accurate insurance rating
- Promote the awareness of flood insurance

Hillsborough County, Tampa, and Temple Terrace are part of the Community Rating System and is explained further within Section 3 – Mitigation Strategy.

<u>Sea Level Rise</u>

Hillsborough County is vulnerable to sea level rise given its extensive shoreline and low elevation. If sea levels do rise, several consequences including the salinization of freshwater sources, land loss, and increases in storms and flooding could be observed. Rising sea level affects the salinity of both surface water and ground water through salt-water intrusion. Shallow coastal aquifers such as those in Hillsborough County are at risk to this salt-water intrusion process.

As sea levels rise, water inundates and erodes coastal wetland ecosystems such as mangroves and salt marshes. Higher water levels wash away wetlands and flood previously dry land. These coastal wetland ecosystems are crucial to absorbing the impact of tropical storms and provide a breeding ground for a significant proportion of sea life. Sea level rise would increase the vulnerability of coastal areas to flooding during storm. During a tropical storm or hurricane, storm surge would build up on top of a higher base of water resulting in damages that are more significant.

Additionally, shore erosion increases storm vulnerability by removing the dunes and beaches that otherwise provide a buffer between coastal property and storm waves and surge. Lastly, sea level rise would result in an increase in coastal flooding from rainstorms because low areas drain more slowly as sea levels rise.

In the Hillsborough County Metropolitan Planning Organization (MPO) Vulnerability Assessment and Adaptation Pilot Project (2014) they concluded that, given projections for more frequent and intense extreme rainfall events[9] coupled with forecasts for increasing urbanization (exacerbating runoff), events that exceed the current 100-year floodplain will occur, on average, with greater frequency (i.e., the average annual probability of exceedance will be greater than 1%).[10] Due to these increasing flood risks, it is important to prepare and plan for future conditions when designing flood mitigation strategies. For more information regarding the effects of climate change on flooding and sea level rise for 2045, the Hillsborough County Community Vulnerability Study provides maps and an analysis of impacts to effected areas.[11]

<u>Potential Effects of Climate Change on Flooding</u>

Climate driven long-term trends of rising sea levels, increasing storm intensity, and consequent severe compound flooding events are degrading coastal ecosystems and threatening residents that live in coastal and riverine areas.

Inland and Riverine Flooding

A warmer atmosphere holds more water vapor and, therefore, can result in heavier and more long-lasting rainfall events.[12] A possible global pattern is for arid areas to become drier and moist areas to become wetter. Where precipitation is enhanced, strong storms are expected to become stronger with the result that rainfall events with a given recurrence frequency, e.g. the 25-year storm, will happen more often.[13]

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[9] See, Florida State University's 2013 research project entitled "Integrating Climate Change into the SHMP" (Deyle, Butler, and Stevens) which cites expectations for increased rainfall frequency and intensity due to climate change.
[10] http://www.planhillsborough.org/wp-content/uploads/2013/10/NoAppendix_Hillsborough-MPO_FHWA-Pilot-Final-Report.pdf
[11] http://www.planhillsborough.org/hillsborough-county-community-vulnerability-study/?fbclid=IwAR0hHfyX2tmKttDcuWLZLGEbsMb0_DxRaBlzRSt-8aOAlx1hErGQp0VFnYA
[12] Peterson, T.C. et al. (2012). Explaining extreme events of 2011 from a climate perspective. American Meteorological Society, July, p. 1044; http://journals.ametsoc.org/doi/full/10.1175/BAMS-D-12-00021.1.
[13] Knutson et al. (2010). Simulated reduction in Atlantic hurricane frequency under twenty-first-century warming conditions. Nature Geoscience, 1(6), 161.

Coastal Flooding

A warmer atmosphere may influence three drivers of coastal flooding: rainfall intensity and frequency, storm surge intensity, and sea level. Rising sea levels would raise the base for coastal floods and storm surge resulting in greater flood depths within existing flood hazard zones; as well as landward expansion of coastal and tidal rivers and stream floodplains and storm surge zones in areas with relatively flat topography. The relationship between a given increase in sea level and the resulting expansion of a coastal flood hazard or storm surge zone depends on the slope of local coastal topography as well as the type of geologic substrate (sand, clay, gravel, rock, etc.), and the presence and type of vegetation. The boundaries of coastal flood zones will expand more rapidly as the rate of sea level rise increases.

If frequency of higher intensity tropical cyclones increases coastal (see the *Tropical Cyclone Hazard Profile*) coastal communities will experience the storm surge flooding associated with those stronger storms more often (category 4 and 5 hurricanes). However, storm surge height is not solely determined by hurricane intensity. It also is a function of the size and speed of the storm, the geometry and bathymetry of the coast, and the process by which the storm develops prior to landfall.[27] The effects of climate change on tropical storm size (radius of maximum wind and outer radius) have not yet been studied thoroughly.

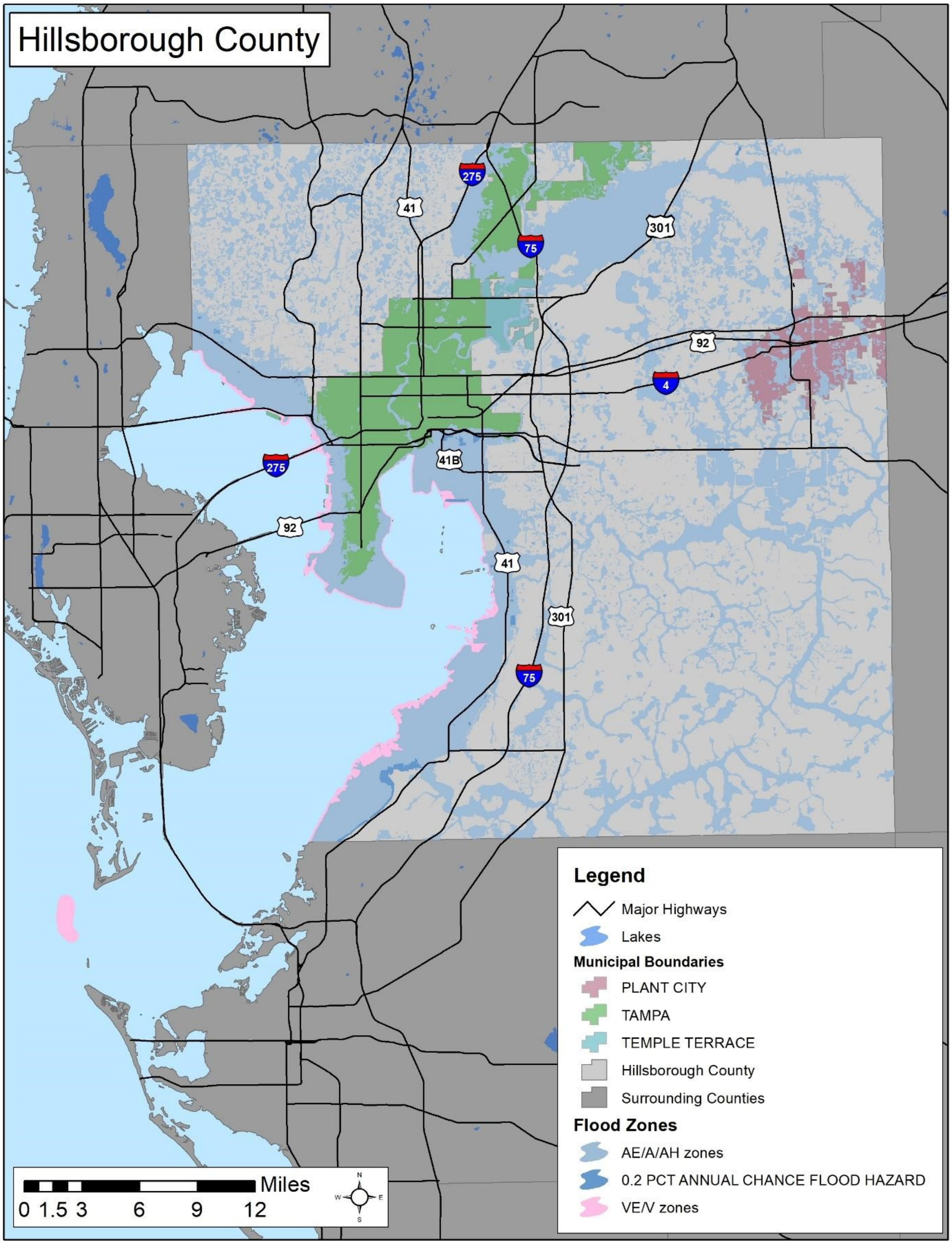
2. Geographic Areas Affected by Flood

The entire state of Florida is particularly susceptible to flooding due to the large amounts of coastline, significant drainage systems, and the relatively low elevations. Many other factors contribute to flooding in Florida and therefore help to define the geographic area impacted by flooding. Areas along waterways, including lakes, rivers, streams and wetlands, are particularly susceptible to flooding due to heavy storms and rain or storm surge.

A geographic assessment of the flooding hazard in Hillsborough County was obtained using FEMA DFIRM floodplain data. This data is available for vulnerable counties in the state and it outlines the areas in the 100-year and the 500-year floodplains, with 1% annual probability and 0.2% probability of floods, respectively.

Below is a map showing the 100-year floodplain (including VE zones which are subject to additional hazards due to storm-induced velocity wave action) and the 500-year floodplain. The 500-year floodplain includes the areas in the 100-year floodplain, plus additional areas, which are shown in darker blue.

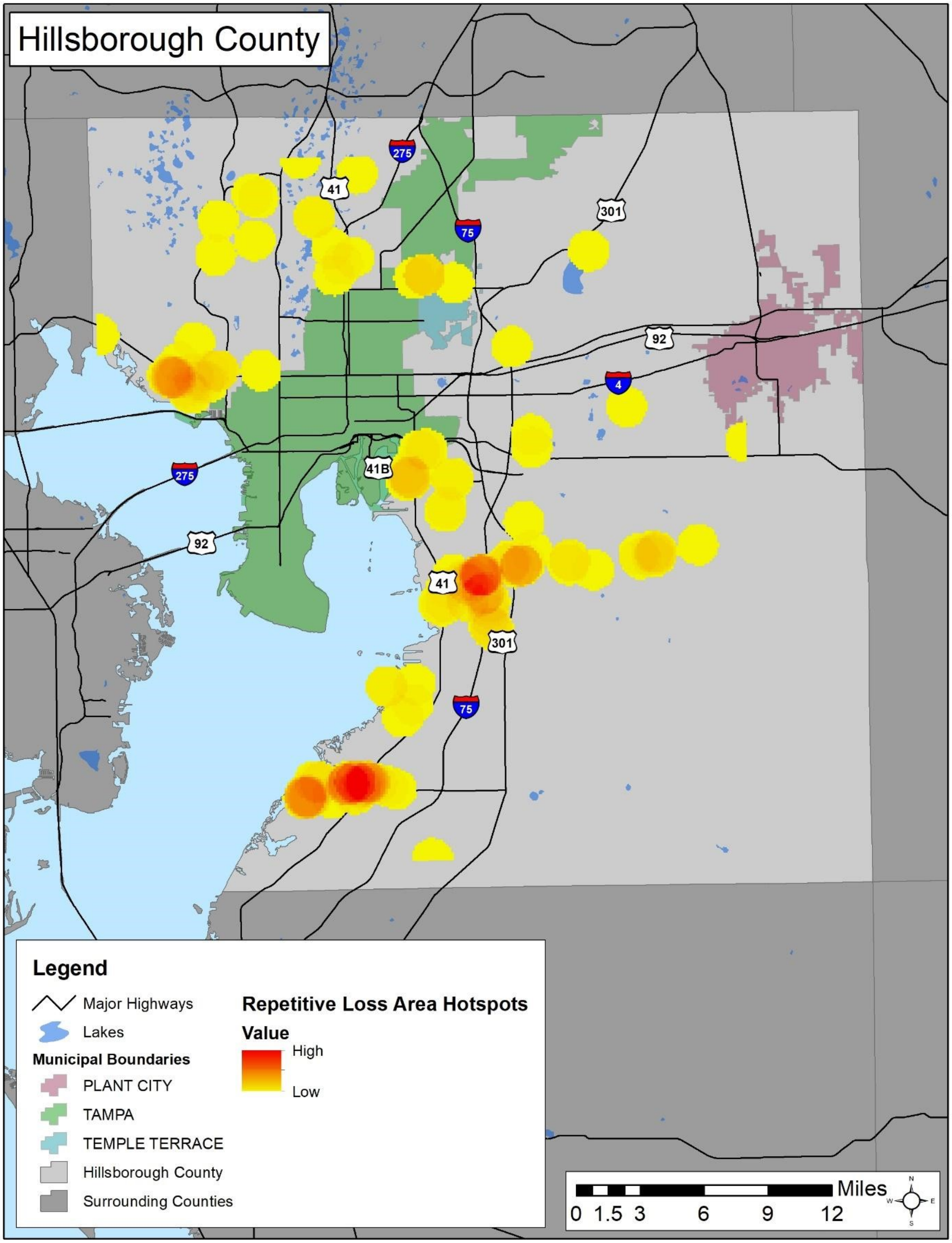
Figure 4.8: Areas at Risk for Flooding, 100- and 500-year Floodplains



Businesses and structures in the downtown Tampa area are vulnerable to flooding due to their location on the bay. Many major businesses that are located in coastal areas are susceptible to flooding including the Port Tampa Bay, Tampa International Airport (TIA), Tampa General Hospital, the Westshore business district, and retail stores and restaurants located along these waterways and coastal areas of Hillsborough County. New areas of development include Water Street, Sparkman Warf and the Downtown Tampa Riverwalk, along with other large areas of development in Westshore are at risk to the effects of coastal flooding.

The following map shows the location of repetitive loss (RL) properties in Hillsborough County by illustrating RL property density. This highlights areas that are susceptible to repetitive flooding and are at risk to flood hazards.

Figure 4.9: Repetitive Loss Property Density



Sea Level Rise

The maps below delineate the geographic areas that are vulnerable to potential sea level rise. They illustrate projected 1-foot, 4-foot, 7-foot, and 10-foot sea level rise as well as the depth of flooding associated with that amount of sea level rise.

Figure 4.10: Projected Flooding with 1-foot Sea Level Rise

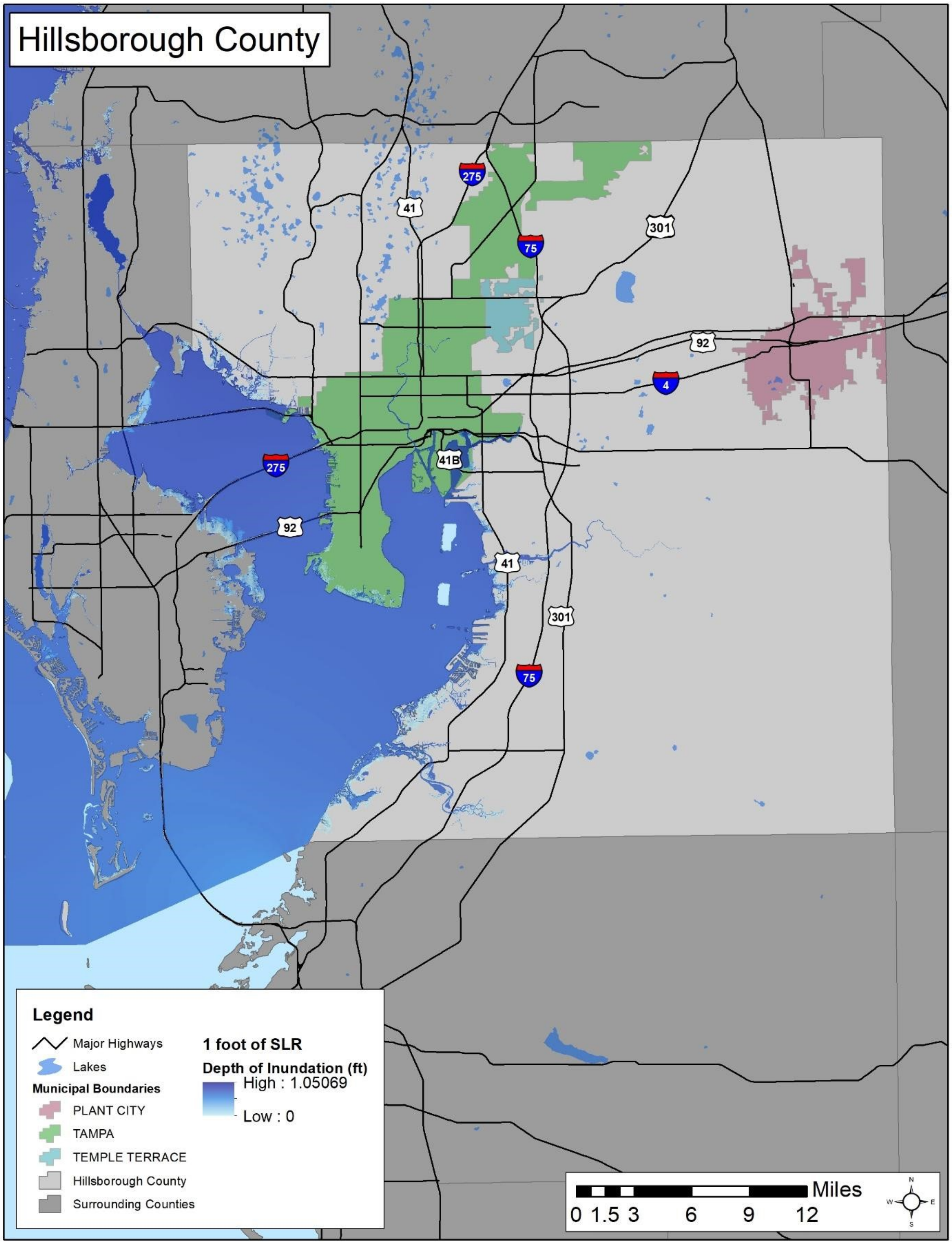


Figure 4.11: Projected Flooding with 4-foot Sea Level Rise

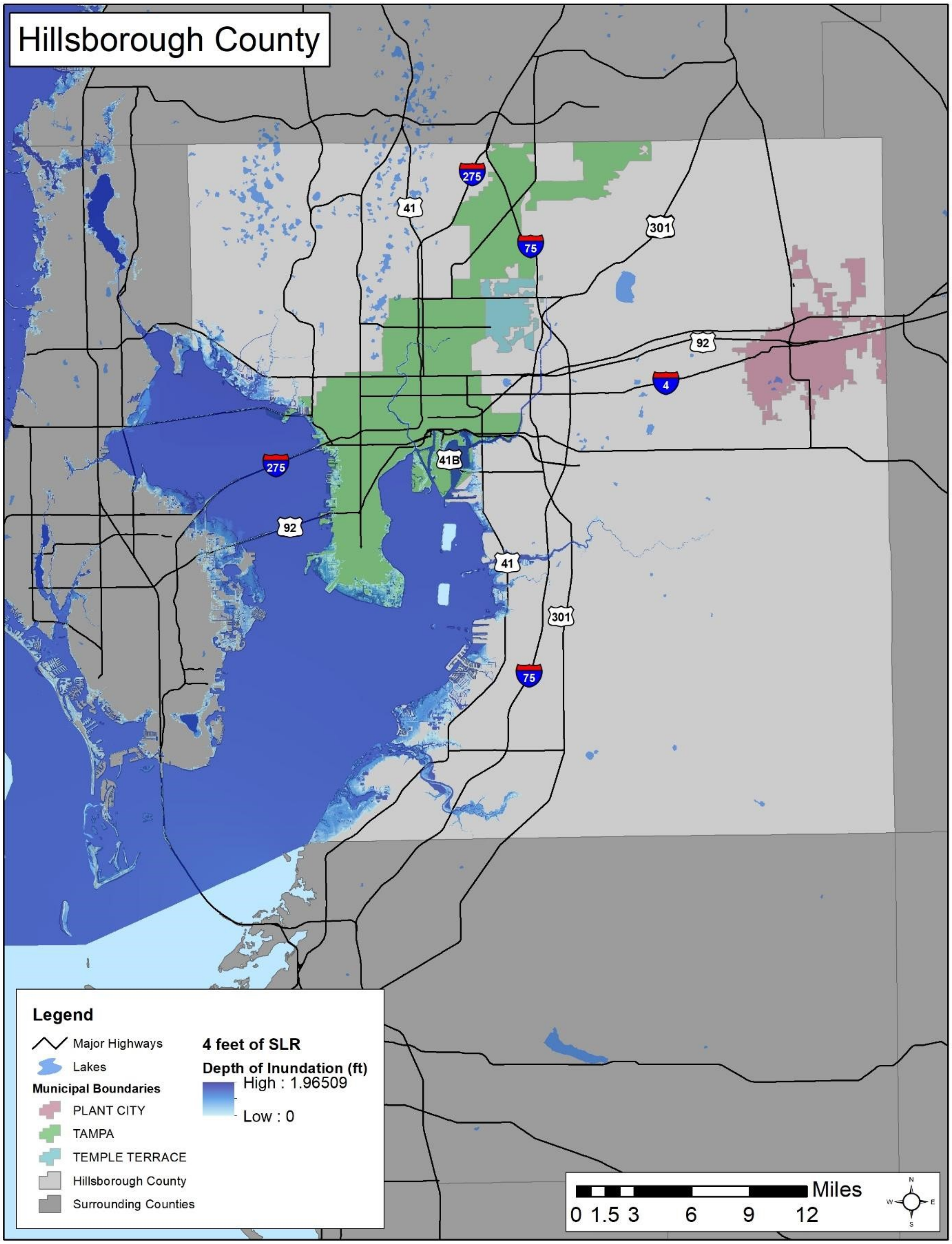


Figure 4.12: Projected Flooding with 7-foot Sea Level Rise

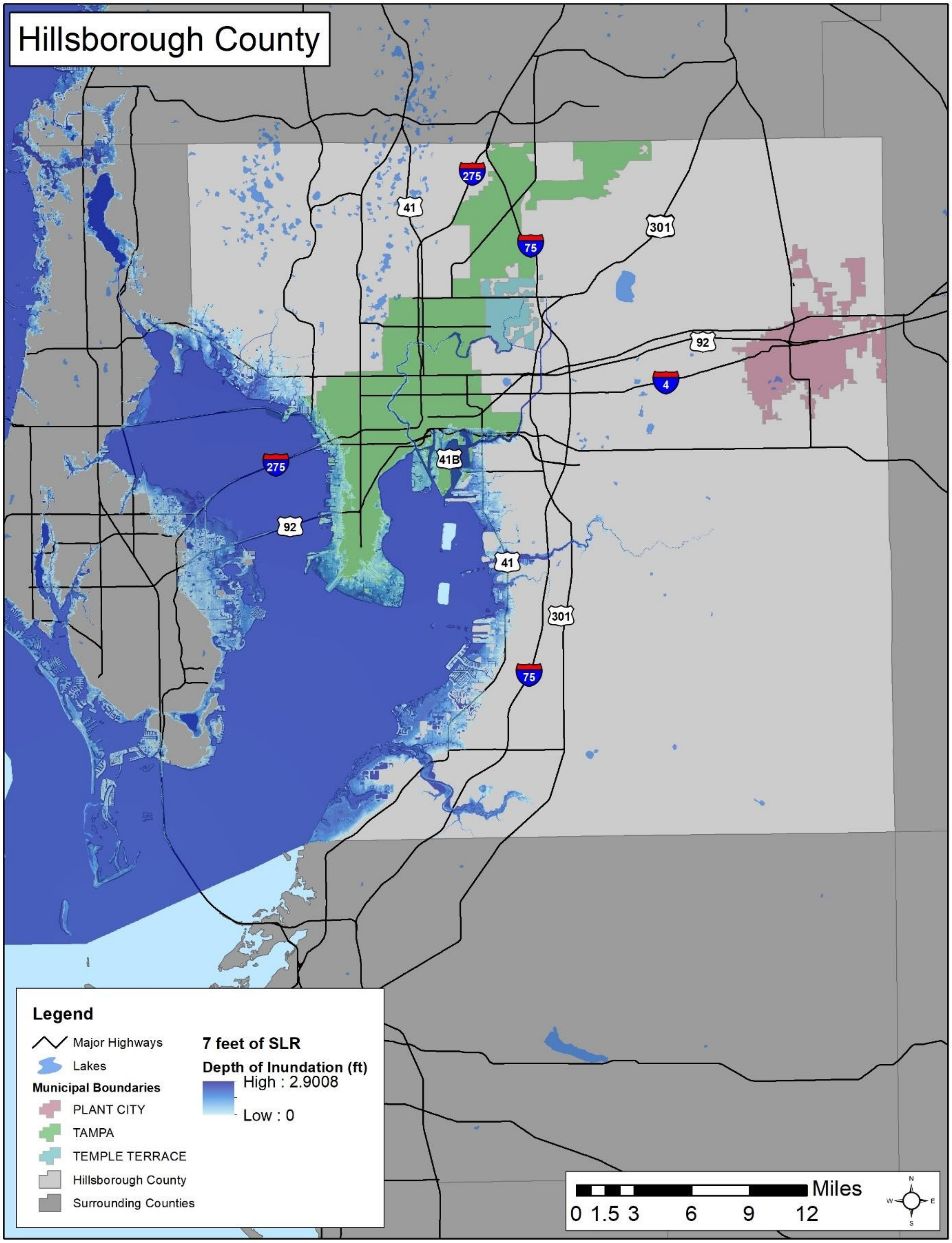
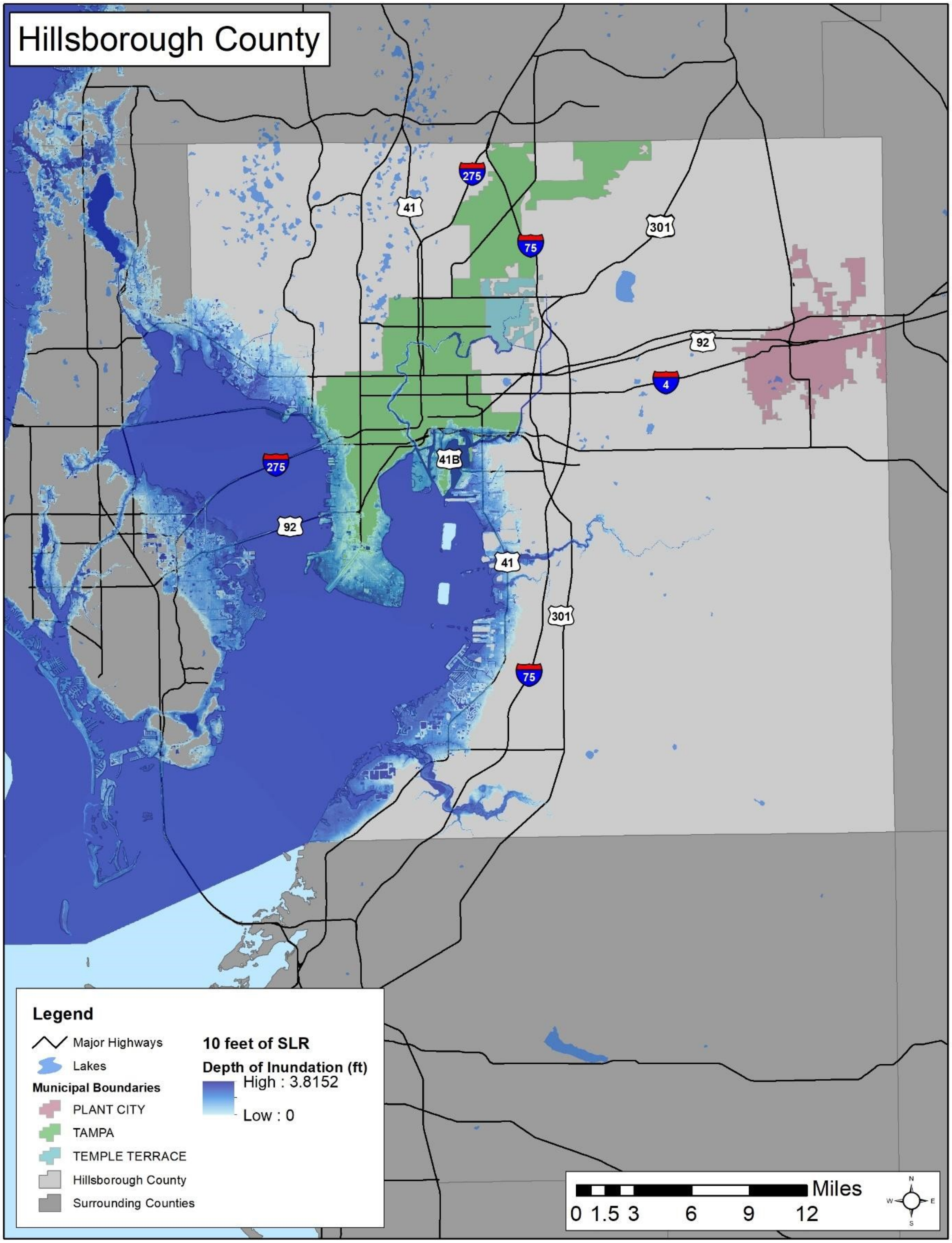


Figure 4.13: Projected Flooding with 10-foot Sea Level Rise



3. Historical Occurrences of Flood

Inland and Coastal Flooding

Historically, floods have been a factor in over 80% of all Presidential-declared disasters.[14] The National Strategy for reducing flood damages has evolved from a reliance almost solely on structural flood control projects to a more comprehensive approach that emphasizes non-structural measures such as local land-use planning and zoning, building codes, and acquisition or relocation of flood-prone buildings.

Due to its unique geographical location and configuration Florida is prone to flooding. Hillsborough County experienced excessive flooding in September 1988 when I-4 near Plant City was cut off for several days and numerous residences in the county were flooded. Rainfall caused by the El Nino weather system caused extensive flooding throughout the county over an extended period of time during the time frame from late 1997 through the spring of 1998. In addition, substantial flooding was caused by Hurricane Frances and Jeanne in 2004. Localized flooding from strong thunderstorms is quite common during the summer rainy seasons and occurs on basically an annual basis.

Hillsborough County has experienced a number of damaging flood events in recent history. Below is a table highlighting the most significant events.

Table 4.15: Significant Flood Occurrences in Hillsborough County

Date	Information
September 6, 2004	Widespread heavy rain associated with Hurricane Frances across west central Florida lead to record flooding on many of the rivers. In Hillsborough County, the Hillsborough County River at Morris Bridge (flood Stage 32 feet) reached its all-time high of 34.38 feet on the 8th, the Alafia River at Lithia (flood stage 13 feet) reached the 5th highest stage at 22.33 feet on the 7th, and the Little Manatee River at Wimauma (flood stage 11 feet) reach 17.09 feet on the 7th.
September 26, 2004	Widespread heavy rain combined with saturated ground and swollen rivers to cause river flooding across west central Florida and lead to record flooding on one of those rivers. In Hillsborough County, the Alafia River at Lithia (flood stage 13 feet) reached 19.19 feet on the 28th, and the Little Manatee River at Wimauma (flood stage 11 feet) reach 14.60 feet on the 28th.
October 1, 2004	Widespread heavy rain from the hurricanes in September combined with saturated ground and swollen rivers continued to cause river flooding across west central Florida. In HC, the Alafia River at Lithia reached 19.19 feet on September 28th and fell below flood stage on October 3rd. The Little Manatee River at Wimauma reach 14.60 feet on September 28th and fell below flood stage on October 1st.
February 3, 2006	The combination of tropical moisture flowing into a line of thunderstorms and an approaching upper-level disturbance allowed a train of intense thunderstorms to repeatedly cross over parts of the Tampa Bay area. Between 8 and more than 11 inches of rain fell in roughly a five-hour period in a five-mile-wide stripe extending from Madeira Beach northeast through Pinellas Park, then across Old Tampa Bay to west Tampa, including Tampa International Airport. The area of heaviest rain was so concentrated that downtown St. Petersburg, less than 10 miles away, recorded less than an inch of rain during

14 http://nesec.org/flood/

Date	Information
	the same period. The torrential rains caused flash flooding in the areas where more than 8 inches fell. The flash flooding prompted the mayor of St. Petersburg to term the event a "hundred-year flood". In Lealman, an entire mobile home community was evacuated, and at least 60 of the homes were flooded. A partial roof collapse was reported at a big box store in St. Petersburg. Water pouring into the store washed out several cash register stands and injured one employee as they were washed into the parking lot. Another roof collapsed at Treasure Island. Hundreds of vehicles were stranded by the flood waters. Hillsborough County Rain Reports: Tampa International Airport: 8.24 inches, Citrus Park: 6.90 inches, Thonotosassa: 4.35 inches
September 1, 2009	A trough of low pressure was dissipating across the area with high pressure ridging across southern Florida. This kept west to southwest winds in place across the local area and allowed for numerous thunderstorms with heavy rains and a tornado. The river stage on the Little Manatee River near Wimauma reached 14.15 feet during the evening of July 2nd. Flood stage is 11 feet. The flooding was a result of two days of heavy rain. The total rainfall at the National Weather Service in Ruskin from June 30 through July 1 was 4.53 inches. Fire Rescue reported Owens Road was washed away in the area of the river and numerous roads were inaccessible due to flooding. The damage amount listed is a rough estimate of the road damage.
August 6, 2012	Deep layer moisture allowed sea breeze thunderstorms to develop over west central and southwest Florida, dumping heavy rain with minor flooding. One of these storms produced severe hail. Broadcast media reported roads closed due to flooding near Linebaugh Avenue and Nebraska Avenue. Additionally, one or two inches of water flooded some ground floor units at the Richmond Hill Apartment Complex at the same intersection. Road closures also occurred at 113th Avenue and 15th Street intersection due to a foot of standing water. Near Florida Avenue and Busch Boulevard at the Floriland Business Center, around 30 cars were stuck in standing water from the heavy rain.
May 2, 2014	A nearly stationary cold front helped generate a squall line that dumped heavy rain over much of West Central Florida. In part of Hillsborough County, training storms produced 6-10 inches of rain, leading to flash flooding. Long durations of heavy rain fell over northern Tampa and the surrounding areas, with radar storm total precipitation estimates of 6-10 inches being confirmed by mesonet rain gauges in the area. Water levels rose quickly in the areas of heaviest rain, shutting down roads, stranding cars, and entering houses. Hillsborough County Emergency Management reported water entering a house near 56th Street and Fowler Avenue, significant flooding on Fowler Avenue between North 50th and North 56th Streets blocking the entrance to USF, general flooding on North 22nd Street between Busch Boulevard and Fowler Avenue, and flooding at Bougainvillea Avenue and North 30th Street.
September 28, 2014	A stalled frontal boundary produced localized areas of heavy rain which caused minor flooding in low-lying areas as well as along some area rivers. Flooding of several manufactured homes begins on 32nd and 33rd street in Ruskin when the gauge on the Little Manatee River at Wimauma reaches 14.5 feet. Moderate flooding continued until October 3 and the maximum crest was

Date	Information
	14.67 ft. About 10 other homes were cutoff as roads were inundated. This area floods one to five times a year and residents move vehicles and other valuables out of the area when flooding is expected.
October 1, 2014	Heavy rains from a stalled frontal boundary in late September caused moderate flooding along the Little Manatee River near Wimauma from September 28 until October 3. Flooding of several manufactured homes begins on 32nd and 3rd street in Ruskin when the gauge on the Little Manatee River at Wimauma reaches 14.5 feet. The maximum crest was 14.67 ft. About 10 other homes were cutoff as roads were inundated. This area floods one to five times a year and residents move vehicles and other valuables out of the area when flooding is expected. Damage of $30,000 was reported in September as moderate flooding began on the 28th.
June 10, 2015	Heavy rain across the area lead to several inches of water with multiple sites reported over 6 inches of rain from the storm. Hillsborough County Sheriff's Office reported flooding on Hanna Avenue at 56th Street, with several stalled vehicles on the roadway. Trained spotters reported cars floating down the road near the intersection of Ferdinand Avenue and Tacon Street in Palma Ceia, and on MacDill Air Force Base it was estimated that approximately 90 percent of the roads were flooded. Florida Department of Emergency Management reported that heavy rain and flooding closed the bridge to Davis Island. As a result, Tampa General Hospital was on bypass for over an hour due to the fact that emergency vehicles could not get to or from the hospital. Damage was roughly estimated to be $200,000, mostly from flooded cars.
August 1, 2015	Multiple days of heavy rain caused widespread road closures across the Tampa area. Dozens of roads were flooded including the major thoroughfares of Armenia Avenue, Dale Mabry Highway, Gandy Boulevard, Westshore Boulevard, Veteran's Expressway, US 41, and State Road 60. The flooding resulted in 117 road cave-ins across Tampa, 99 homes and 66 businesses were impacted by the flooding, and 9 City of Tampa vehicles were damaged. Additionally, a large tree was uprooted due to the saturated ground and fell on a car just west of Bayshore Boulevard on South Gandy Boulevard. Further north across parts of Temple Terrace, including the University of South Florida, there was additional damage from flooding. The university sustained $137K in damages while 101 homes in the Temple Terrace were impacted, 88 homes and 7 mobile homes sustained major damage.

Date	Information
	 *The scene following 08/01/15 flooding event at the Westshore Blvd. exit on I-275, Photo courtesy of WFLA Channel 8*
August 27, 2017	Heavy rain fell across southern Hillsborough County on the 27th and continued into the 28th. Six to nine inches of rain were reported over 48 hours, with the highest totals in and around Apollo Beach. Hillsborough County Emergency Management reported several homes and cars were inundated by flood water in Apollo Beach on the evening of the 27th. Four people needed to be rescued from flooded vehicles on Gulf and Sea Boulevard.
September 10-12, 2017	Heavy rains from Hurricane Irma caused the Little Manatee River at Wimauma to rise above flood stage on the 10th, with flooding continuing through the 16th. The water level crested at 17.69 feet on the 12th, 0.69 feet above the major flooding threshold. The flood waters entered several mobile homes on 32nd and 33rd streets in Ruskin. Flood damage to homes was estimated at $2 million. In coastal portions of Hillsborough County, the highest winds reported from Hurricane Irma was a gust to 79 knots at the WeatherFlow station XEGM at Egmont Key. Rainfall was generally around 5 inches or greater, with the highest rain total being 16.18 inches at the CWOP site D3252 in Tampa. The wind resulted in damage to numerous homes, as well as knocking over trees and power lines. Hillsborough County Emergency Management reported that 41 homes or businesses were destroyed, 130 sustained major damage, 166 had minor damage, and an additional 93 were affected by hurricane Irma throughout Hillsborough County. The track of Irma resulted in a much stronger negative surge north of the eye, causing extremely low water levels. A couple of manatees got beached in the mud, and there was a lot of media coverage showing people walking out into the dry part of the bay to rescue them. No significant damage was reported from either the negative surge or the weak positive surge. The total damage from Irma in Hillsborough County was estimated at $19.95 million, including $17.86 million in individual assistance claims and $2.09 million in public assistance claims, of which, $7 million was estimated to be caused by wind damage in coastal portions of Hillsborough County. Three indirect fatalities were reported in Hillsborough County from Hurricane Irma. A 55 year old man in Town N' Country was trimming a damaged tree with a chainsaw

Date	Information
	when a branch fell on the chainsaw, causing it to kick upward and strike him in the neck. A 60 year old man fell from a ladder in Tampa while cutting branches and died on the 14th. A 61 year old man also died on the 14th while cleaning up yard debris when a branch knocked the ladder out from under him, causing him to fall to the ground. In inland portions of Hillsborough County, winds from Hurricane Irma were estimated to be around 60-70 knots based on surrounding observations. Rainfall was generally around 6 inches or greater, with the highest rain total 7.62 inches at the COOP site PLCF1 in Plant City. The wind resulted in damage to numerous homes, as well as knocking over trees and power lines. Hillsborough County Emergency Management reported that 41 homes or businesses were destroyed, 130 sustained major damage, 166 had minor damage, and an additional 93 were affected by hurricane Irma throughout Hillsborough County. Heavy rains across the area also resulted in widespread river flooding, with rising water levels damaging houses on the Hillsborough River, the Alafia River, and the Little Manatee River in Hillsborough County. The total damage from Irma in Hillsborough County was estimated at $19.95 million, including $17.86 million in individual assistance claims and $2.09 million in public assistance claims, of which, $6.95 million was estimated to be caused by wind damage in inland portions of Hillsborough County. Additionally, crop damage to citrus plants in Hillsborough County was roughly estimated at $28.5 million.
May 17, 2018	Heavy rain fell in northeastern Hillsborough County, with some sites reporting over 7 inches of rain. This led to street flooding along Highway 60 near Plant City, resulting in two vehicles ending up in the ditch and becoming partially submerged. Broadcast media relayed pictures of two vehicles in a flooded ditch along Highway 60 south of Plant City. The water was up to the hood of both cars. Nearby rain gauges reported as much as 7 inches of rain.  *Photo courtesy of the Tampa Police Department*

Additionally, there have been several FEMA major disaster declarations in Hillsborough County that are specifically related to flooding events. Please note that some of these events are also listed under Severe

Storms and Tornadoes. Also, there are some events that are categorized by FEMA as tropical storms or hurricanes and not flooding, even though the event may have caused significant flooding.

Table 4.16: FEMA Major Disaster Declarations in Hillsborough County, Flood, 1953-2019[15]

Disaster Number	Date	Name/Description
DR-586	May 15, 1979	SEVERE STORMS, TORNADOES & FLOODING
DR-607	September 29, 1979	SEVERE STORMS & FLOODING
DR-966	October 3–4, 1979	SEVERE STORMS, TORNADOES & FLOODING
DR-982	March 12–16, 1993	TORNADOES, FLOODING, HIGH WINDS & TIDES, FREEZING
DR-1195	December 25, 1997–April 24, 1998	SEVERE STORMS, HIGH WINDS, TORNADOES, AND FLOODING

According to the NCEI Storm Events Database, there were 69 reports of flood in Hillsborough County from 1996 to 2019.[16] These flood events are only inclusive of those reported by NCEI from 1996 through October 2019. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.17: Summary of Flood Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
Plant City	3	1	1	$8,528,604	$370,809
Tampa	40	0	1	$14,117,708	$588,238
Temple Terrace	0	0	0	$0	$0
Unincorporated	26	0	0	$10,459,739	$435,822
HILLSBOROUGH COUNTY TOTAL	69	1	2	$33,106,051	$1,394,869

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in December 2019.

Table 4.18: Historical Flood Occurrences in Hillsborough County

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
Plant City						
PLANT CITY	9/26/1997	Flood	0	0	$79,707	$0

[15] www.fema.gov/api/open/v1/DisasterDeclarationsSummaries.csv

[16] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Coastal+Flood&eventType=%28C%29+Flash+Flood&eventType=%28Z%29+Flood&beginDate_mm=07&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=07&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
PLANT CITY	9/26/1997	Flash Flood	1	1	$8,448,897	$797
PLANT CITY	6/20/2000	Flood	0	0	$0	$0
Tampa						
TAMPA	2/2/1996	Flood	0	0	$0	$0
TAMPA	6/12/1996	Flood	0	0	$0	$0
TAMPA	8/12/1996	Flood	0	0	$0	$0
TAMPA	10/31/1997	Flood	0	0	$15,902	$0
TAMPA	12/10/1997	Flood	0	0	$159,314	$0
TAMPA	12/13/1997	Flood	0	0	$1,274,515	$0
TAMPA	12/13/1997	Flood	0	0	$159,314	$0
TAMPA	12/13/1997	Flood	0	0	$1,752,458	$0
TAMPA	12/27/1997	Flood	0	0	$955,886	$0
TAMPA	12/27/1997	Flood	0	0	$398,286	$0
TAMPA	12/27/1997	Flood	0	0	$63,726	$0
TAMPA	12/28/1997	Flood	0	0	$238,971	$0
TAMPA	1/1/1998	Flood	0	0	$0	$0
TAMPA	1/1/1998	Flood	0	0	$159,019	$0
TAMPA	1/23/1998	Flood	0	0	$79,509	$0
TAMPA	2/16/1998	Flood	0	0	$476,172	$0
TAMPA	2/16/1998	Flood	0	0	$634,896	$0
TAMPA	2/17/1998	Flood	0	0	$15,872	$0
TAMPA	2/28/1998	Flood	0	0	$79,362	$0
TAMPA	3/1/1998	Flood	0	0	$31,686	$0
TAMPA	3/1/1998	Flood	0	0	$0	$0
TAMPA	3/19/1998	Flood	0	0	$1,188,228	$0
TAMPA	3/19/1998	Flood	0	0	$594,114	$0
TAMPA	3/20/1998	Flood	0	0	$79,215	$0
TAMPA	7/19/1998	Flood	0	0	$15,746	$0
TAMPA	7/20/1998	Flood	0	0	$15,746	$0
TAMPA	9/20/1998	Flood	0	0	$117,806	$0
TAMPA	9/20/1998	Flood	0	0	$78,537	$0
TAMPA	9/11/1999	Flood	0	0	$30,610	$0
TAMPA	6/13/2000	Flood	0	0	$298,114	$0
TAMPA	6/13/2000	Flood	0	0	$0	$0
TAMPA	7/15/2000	Flood	0	0	$0	$0
TAMPA	8/10/2000	Flood	0	0	$74,356	$0
TAMPA	8/12/2000	Flood	0	0	$148,712	$0
TAMPA	5/16/2002	Flood	0	0	$0	$0
TAMPA	6/24/2002	Flash Flood	0	0	$0	$0
TAMPA	12/13/2002	Flood	0	0	$0	$0
TAMPA	12/24/2002	Flood	0	0	$0	$0
(TPA)TAMPA INTL ARPT	2/3/2006	Flash Flood	0	1	$129,328	$0

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
OLD PORT TAMPA PORTS SITE	8/1/2015	Flood	0	0	$4,852,310	$0
Temple Terrace						
NONE REPORTED	--	--	--	--	--	--
Unincorporated						
NORTHERN	6/26/1996	Flood	0	0	$0	$0
RUSKIN	10/31/1997	Flood	0	0	$508,859	$0
SUN CITY	11/13/1997	Flood	0	0	$39,779	$0
COUNTYWIDE	12/13/1997	Flash Flood	0	0	$2,389,715	$0
COUNTYWIDE	2/2/1998	Flood	0	0	$15,872	$0
COUNTYWIDE	2/16/1998	Flood	0	0	$47,617	$634,896
COUNTYWIDE	2/19/1998	Flood	0	0	$63,490	$0
CITRUS PARK	7/10/1998	Flash Flood	0	0	$78,730	$0
RIVERVIEW	6/25/2000	Flood	0	0	$0	$0
LUTZ	8/26/2000	Flood	0	0	$74,356	$0
APOLLO BEACH	9/17/2000	Flash Flood	0	0	$73,971	$0
RUSKIN	9/14/2001	Flash Flood	0	0	$288,249	$0
BRANDON	5/30/2002	Flood	0	0	$0	$0
SOUTH PORTION	12/31/2002	Flash Flood	0	0	$142,053	$0
VALRICO	6/19/2003	Flash Flood	0	0	$0	$0
BALM	7/1/2009	Flood	0	0	$89,496	$0
SULPHUR SPGS	8/6/2012	Flood	0	0	$0	$0
NOWATNEY	5/2/2014	Flash Flood	0	0	$54,009	$0
GULF CITY	9/28/2014	Flood	0	0	$32,387	$0
GULF CITY	10/1/2014	Flood	0	0	$0	$0
REMLAP	6/10/2015	Flood	0	0	$215,367	$0
SUNSHINE SKYWAY PORTS SITE	8/27/2017	Flood	0	0	$78,499	$0
GULF CITY	9/10/2017	Flood	0	0	$2,082,287	$0
BLOOMINGDALE	9/11/2017	Flood	0	0	$2,082,287	$0
CLARKWILD	9/12/2017	Flood	0	0	$2,082,287	$0
TRAPNELL	5/17/2018	Flood	0	0	$20,428	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

4. Probability of Future Flood

Based on historical knowledge and an understanding of floodplains, it is believed that Hillsborough County will continue to experience flooding events on an annual basis. Specific probability is difficult to determine; however, 100-year and 500-year estimates help provide a baseline understanding. It is likely that Hillsborough County will continue to be impacted by flooding in the future due to any number of causes annually.

The map included in the Geographic Areas Affected by Flood section shows the areas with a 1% annual probability of a flood, or the 100-year flood, as well as the areas with a 0.2% chance and annual probability of a flood, or the 500-year flood.

Below is a figure depicting the flash flood risk in Florida. The potential of flash floods is difficult to predict.

In 2003, subject matter experts developed the Flash Flood Potential Index (FFPI), which used the following equation where M represents Slope, L refers to Land Cover or Use, S represents Soil Type or Texture, and V equals the Vegetation Cover or Forest Density:

FFPI = (M+L+S+V)/N

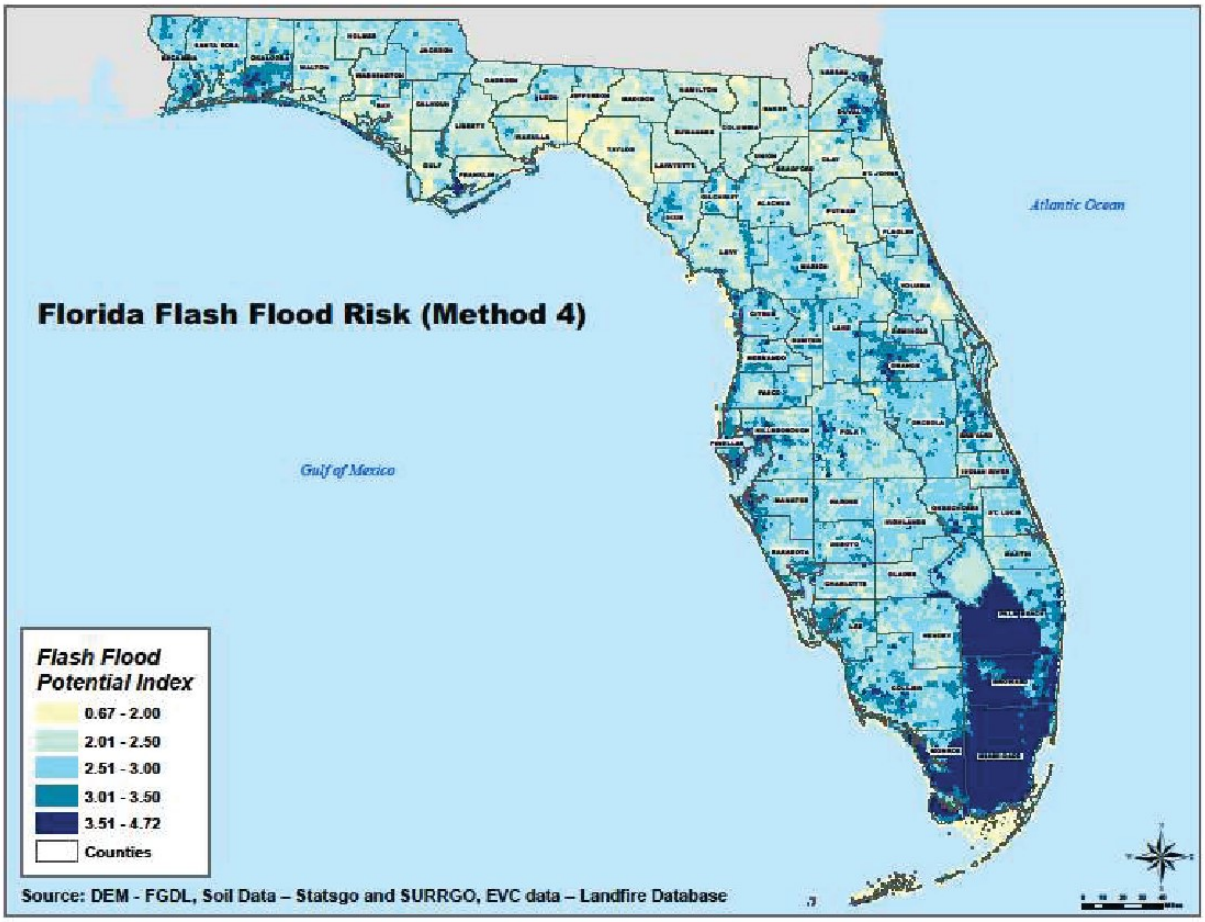
Since 2003, this equation has been refined into four scenarios to more accurately represent specific areas and conditions. For the figure below, the equation used is referred to as Model 4:

FFPI = (2*M+S+2*LV)/5

There have been numerous other storms which have affected the area causing protective actions and damage. It is considered that the occurrence of a hurricane in the Tampa Bay area on an annual basis is high. The coastal regions of the United States are associated with intense winds from tropical storms and thunderstorms. It is not uncommon to have winds exceed 100 mph within these areas. Florida, including Tampa Bay, is susceptible to winds of greater than 100 mph on a regular basis.

More information about the FFPI can be found here: https://www.cbrfc.noaa.gov/papers/ffp_wpap.pdf.

Figure 4.14: Florida Flash Flood Risk



This map shows the areas of the state that are at risk for flash flooding based on various ground measures such as land use, soil type, vegetation cover, and the slope of the area. It indicates that most areas in Hillsborough County have a flash flood potential that ranges between 2.01 and 4.72.

Flooding varies within the county. Based on the preceding table, the Tampa-Hillsborough area may have a major flood event on the average of once a year. It has been determined that structures that are within the 100-year flood elevation have a 26% chance of being flooding in any given year.[17] The actual risk of flooding varies on the height of the "finished floor" elevation. Because of the varied background associated with construction within the county, some structures flood at a two-year interval (a severe flooding problem).

FEMA has quantified the probability of flooding through the preparation of Flood Insurance Rate Maps under NFIP. Made available to all jurisdictions, these maps delineate the 100-year floodplain. In using the maps, it is important to note that it is probable that no one storm will inundate all the areas within the flood zone and that areas outside the identified 100-year floodplain may be flooded.

[17] https://www.fema.gov/pdf/floodplain/nfip_sg_unit_3.pdf

The Federal Emergency Management Agency released preliminary updates in 2019 to flood maps for the coastal areas of Hillsborough County which have led to changes in the probability of risk and insurance rates. The changes are believed to impact as many as 60,000 people between the city of Tampa and Hillsborough County.[18] The map changes generally impact the areas west of I-75 in southern Hillsborough County, south of I-275 and Tampa International Airport in Tampa, south of Linebaugh Avenue in Town 'N Country, and near the lower Hillsborough, Alafia, and Little Manatee rivers.

Through detailed hydrodynamic computer modeling the Hillsborough County Stormwater Management Program has identified areas of flood risk throughout the seventeen County watersheds for storms events associated with return periods from mean annual to 100- years.[19] Return periods translate directly into probability of occurrence. At each location the watershed models are capable of providing the expected flow and water surface elevation associated with each event. The determination of projected flood depth varies with location and type of flooding throughout the county. This is based on the three distinctive types of flooding that can occur including coastal, riverine and inland flooding.

Probability Based on Historical Occurrences

An analysis of flood reports from 1996 to 2019 in Hillsborough County from the NCEI Storm Events Database indicates that there will be no one coastal floods, less than one flash flood, and two to three floods each year in Hillsborough County.

Table 4.19: NCEI Flood Reports 1996–2019[20]

Type of Severe Storm	NCEI Reports	Average per Year
Coastal Flood	0	0
Flash Flood	10	< 1
Flood	59	2.5
TOTAL	**69**	**2.9**

Based on historical information, this hazard was determined to have a probability level of highly likely (100% annual probability).

5. Flood Impact Analysis

All communities in Hillsborough County could receive the following impacts due to flooding. Variable climate impacts are likely to worsen exposure for coastal communities, but inland communities could also be impacted by more frequent, and higher volume precipitation events.

[18] https://www.hillsboroughcounty.org/en/newsroom/2019/03/19/coastal-flood-maps-are-changing-for-hillsborough-county

[19] http://www.planhillsborough.org/wp-content/uploads/2013/10/NoAppendix_Hillsborough-MPO_FHWA- Pilot-Final-Report.pdf

[20] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Coastal+Flood&eventType=%28C%29+Flash+Flood&eventType=%28Z%29+Flood&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

- Public
    - Injury/death
        - Car accidents because of flood waters, high winds, panic, traffic jams because of evacuations, no power after storm
        - Not receiving emergency response during storm –emergency medical services
        - Drowning in flood waters
        - Vehicle accidents
        - Exposure to hazardous materials
        - Illness from contaminated water
    - Traffic
        - Panic to evacuation
        - Accidents from driving through flooded roads –car washed away, water deeper than expected
    - Damage to property
        - Issues with damage to uninsured property
        - Mold damage causing the need for expensive mold remediation actions
        - Cost to replace damaged and destroyed items, such as furniture, flooring, etc.
        - Cost and labor to repair damaged homes and other structures to make the house inhabitable
        - If the property was uninsured, the cost falls upon the property owner
        - Hotel room fees or having to live in a shelter until damage is repaired or home is replaced
        - Damaged or washed-away vehicles
- Responders
    - Injury/death
    - Responding during flooding, traversing flooded roads
    - Drowning
    - Dangerous rescue missions, from roofs, unstable buildings, stranded cars
    - Exposure to hazardous materials or wastewater
    - Power outage dangers, such as being electrocuted by live downed wires
- Continuity of Operations (including continued delivery of services)
    - Floodwaters may damage buildings, electrical systems, paperwork, etc. making continued operations difficult or impossible
    - Floodwaters may hinder access to buildings (roads or sidewalks) preventing employees and the public from entering a building
- Property, Facilities, Infrastructure
    - Property damage
        - Floodwaters can damage property or carry heavy debris that could cause damage
    - Infrastructure damage
        - If water overwhelms the drainage systems, it can backup and cause damage to

  - Drains or even result in wastewater release
  - Cost of repairing damage to property such as buildings
  - Cost of replacing items damaged such as furniture on the first floor of a flooded home
  - Crop damage or loss
  - Damage to transportation infrastructure, like a road being washed out or a bridge collapsing, and/or closure of major transportation networks
  - Inability to control wastewater
  - Release of hazardous materials
- Environment
  - Release of hazardous materials or wastewater could damage environment
  - Damage to habitat for plants and animals
  - Inundation of agricultural areas could destroy crops
  - Event-generated debris impacting waterway navigation and submerged wetland habitats
  - Eroded river banks
  - Loss or damage to habitat for animals because of flooding
  - Crop damage or loss
- Economic Condition
  - Damaged and destroyed businesses leading to long-term closures and possibly permanent closures
  - Delayed re-opening of businesses because of utility issues, road blockages, etc.
  - Crop damage or loss from flooding leads to decline in agricultural revenues
- Public Confidence in Jurisdiction's Governance
  - If floodwaters do not recede quickly, it appears as though the water utilities and government are not able to manage water properly, which calls into question the capability of the government
  - If public or government offices must close because of restricted access due to floodwaters, people may think the government is not able to handle emergency events and lose confidence in their capabilities

Impact Summary

All of Hillsborough County is susceptible to flooding, however, there are key geographic areas that are particularly susceptible to flooding including low lying areas, neighborhoods near water and downstream from dams, dry creek beds, drainage ditches, and urban areas with lack of impervious surfaces. Coastal communities across Hillsborough County are increasingly at risk from compound flooding, water quality degradation, water-borne pathogens, coastal erosion, and ecosystem loss.

Flood maps, also known as Flood Insurance Rate Maps, provided by the Federal Emergency Management Agency (FEMA) are a useful tool for assessing a property's flood risk.[21] In 2019, FEMA released updates to the coastal flood maps. These new zone designations may impact insurance and building requirements for homes and businesses in areas where flooding may occur. Most homeowners' insurances do not cover flood damage. Changes impact the areas west of I-75 in southern Hillsborough County, south of I-275 and

[21] https://www.hillsboroughcounty.org/en/residents/public-safety/flood-maps

Tampa International Airport in Tampa, south of Linebaugh Avenue in Town 'N Country, and near the lower Hillsborough, Alafia, and Little Manatee rivers.[22]

Impact to the Built Environment

The entire built environment may be vulnerable to flooding events including coastal, flash flooding, and inland flooding due to increased rainfall-induced flooding and/or storm surge. Although improvements have and will be made, floods will continue to occur.

In general, the map updates will result in one of the following for property owners in the affected area:

- For properties removed from the high-risk areas, the flood risk is reduced but not removed.
- Properties newly identified to be at high-risk will experience potential changes in insurance requirements and costs and new building requirements.
- Properties in high-risk areas may see their risk increase more.

The amount of flooding should be reduced as drainage improvements are made and homes built prior to the county's implementation of the National Flood Insurance Program (NFIP) are upgraded or removed. For example, drainage infrastructure determines how long contaminated flood waters may linger in neighborhoods and urban areas. Filthy water can contain numerous diseases, snakes and flesh-eating bacteria.

The entire built environment may be vulnerable to flooding especially in low lying, storm surge evacuation zones, areas close to canals and structures that were built prior to floodplain regulations, have below-grade crawl spaces, and are mobile homes that are improperly anchored to a foundation. Structures in areas where there has been repetitive losses and no mitigation efforts established may also be at a higher risk to flooding. Areas of concern for repetitive loss in the year 2045 include Westshore, Davis Island, along the Alafia River and Bull Frog Creek, with minor issues along the Hillsborough River and TNC.[23] The low-lying areas of Hillsborough County are considered especially vulnerable to flooding. Still, in recent years heavy development has occurred in many of the flood prone areas in the county and the high population density make these areas even more vulnerable. Keep in mind, past flooding events do not necessarily indicate future flooding problems.

The various types of flooding can result in different impacts to the built environment. For example, flash flooding is especially dangerous to life and property because it is often unexpected and can carry large amounts of debris. Flowing flood waters cause erosion, carry damaging debris, and can even carry away people, cars, and unanchored structures. Flooding that does not subside quickly can cause lasting damage to buildings and pose a health concerns to the affected population. Stagnant water leads to mold in buildings and creates an ideal environment in which mosquitoes can breed.

<u>Residential Structures</u>

[22] https://www.hillsboroughcounty.org/en/newsroom/2019/03/19/coastal-flood-maps-are-changing-for-hillsborough-county.
[23] http://www.planhillsborough.org/hillsborough-county-community-vulnerability-study/?fbclid=IwAR0hHfyX2tmKttDcuWLZLGEbsMb0_DxRaBlzRSt-8aOAlx1hErGQp0VFnYA

In Hillsborough County there is an estimated 133,370 housing units located in the floodplain with 9.39% of these buildings constructed before 1960. There are an estimated total renter-occupied population of 50,127 in Hillsborough County with an estimated 3,943 total subsidized rental housing units.[24]

Impact to Critical Infrastructure

With inland and coastal flooding, high flood levels along with potential wave action may destroy sections of bridges and roadways. It is speculated that the Tampa Bay bridges that connect Hillsborough to Pinellas County would be in jeopardy under severe weather conditions.[25] Infrastructure such as bridges and roads that pass over culverts are also susceptible to flood related damages. Flooded roads can lead to property damage, prevent residents from being able to evacuate, and hinder access to emergency services.

Fire stations, hospitals, schools, and emergency shelters are critical facilities that play a central role in disaster response and recovery. Understanding which facilities are susceptible to flooding, and the degree of that exposure, can help reduce or eliminate service interruptions and costly redevelopment. There are 19 hospitals in Hillsborough County with a total bed capacity of 4,593 beds[26] and 70 fire stations (23 Tampa Fire Rescue, 44 Hillsborough County Fire Rescue, 1 Plant City Fire Rescue Department, and 2 Temple Terrace Fire Department) in Hillsborough County. Furthermore, there are 252 public schools (31 high schools, 33 magnet schools, 43 middle schools, 137 elementary schools, 8 K-8 schools), 53 charter schools, 63 private schools, 12 universities, and 12 colleges[27] in which 45 are utilized as emergency shelters during tropical storms to ensure residents that are susceptible to coastal flooding have a safe area to stay on an "as-needed" basis. The capacity of these pre-identified shelters will hold an estimated 42,900 residents with 16 shelters meeting all Americans with Disabilities Act (ADA) requirements.

Water control structures help provide flood protection, manage lake water levels and prevent salt water from flowing up freshwater streams and creeks. There are thirty-three of these structures located across Hillsborough County designed to help mitigation and manage flooding.[28]

Wastewater facilities and storage of hazardous materials should be protected from flooding as spread of waste can exacerbate damage of the flood and cause additional environmental damage and public health impacts.

Ecological Impacts of Flooding

Flooding causes severe coastal erosion and damage to natural and man-made waterways. Coastal areas and areas along canals and rivers are more vulnerable to storm surge and flash flooding. Saltwater inundation can occur inland through the canals and waterways along the coast, having a far-reaching ecological impact on the flora and fauna inland.[29] As Hillsborough County continues to grow, with a projected population of 2,007,100 by 2045, the factors of flood protection become more complicated.[30]

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[24] https://furmancenter.org/floodzonedata/map.

[25] https://www.jstor.org/stable/4124819?seq=14#metadata_info_tab_contents

[26] Florida Hospital Association (FHS), 2019. http://www.fha.org/reports-and-resources/hospital-directory.aspx

[27] http://www.sdhc.k12.fl.us/schools/

[28] www.tampabay.wateratlas.usf.edu/upload/documents/water-control-structures-hillsborough-2011.pdf.

[29] Williams, V. (2010) Identifying the economic effects of salt water intrusion after Hurricane Katrina. Journal of Sustainable Development, https://doi.org/10.5539/jsd.v3n1p29

[30] http://www.planhillsborough.org/wp-content/uploads/2019/06/BOCC_May7_2019_Final-version.pdf

These factors include an increase in the amount of impervious surfaces and loss of natural water storage areas that will then effect new development downstream.

Watershed urbanization involves a change in the natural habitat which is dredged, filled, and paved to support urban development. These changes have the potential to exacerbate issues related to flooding due to increased water volume in the area (peak discharges) being two to five times higher than pre-development levels. A moderately developed watershed may produce 50% more runoff volume than a forested watershed during the same storm.[31] Increased urban development in Hillsborough County has led to the removal of natural upland and wetland habitats which increases the construction of roads, parking lots, sidewalks, rooftops, and other impervious surfaces. Furthermore, canals being built or maintained through dredging, penetrate the aquifer allows salt water intrusion into this source of drinking water for Hillsborough County. Salt water intrusion impacts soil quality and building construction as well.

Diminished Littoral Zones

Littoral zones are an important aspect to lake health and water quality, functioning as a barrier and purifier for water quality issues such as runoff pollution and algal blooms.[32] With flooding in freshwater sources such as lakes, this littoral zone will become less prevalent and less diverse. With abnormally fluctuating water levels, littoral zones diminish and homogenize due to changes in survival rates of both terrestrial and aquatic organisms surrounding a lake. As well, this effect will be seen more severely in man-made hydrologic reservoirs as the water levels here fluctuate more.[33] Scouring can also be more intense when this littoral zone is reduced, leading to complications with near-water construction.

Impervious Surfaces

There was a 26.36% net increase in impervious surface area in Hillsborough County due to development between 1996 and 2010. During this time 28.57 miles^2 of agricultural land was developed and 35.41 miles^2 of scrub, woody wetlands, and emergency wetlands were developed as well.

Impervious surfaces due to development are an environmental concern because, with their construction, a chain of events is initiated that modifies the air quality and water resources. The pavement materials seal the soil surface, eliminating rainwater infiltration and natural groundwater recharge. These surfaces shed rainwater rather than allowing it to soak into the ground, thus decreasing groundwater recharge.[34] Groundwater recharge is needed to replenish aquifer drinking water; while it percolates to the aquifer, an additional water filtration occurs that helps to increase water quality. When the water is not able to percolate, such as in urban, paved areas, it instead flows rapidly into rivers and other bodies of water where it will travel out to the ocean. This allows chemicals, agricultural waste, oil, and nutrients such as those from fertilizers to enter into environments where they can have a profound effect on the health of the ecosystem and the residents of Hillsborough County. As a result, algal blooms can occur due to the increase in nutrients, oysters and other estuarine animals can perish due to the sudden drop in salinity, and varied flora and fauna can suffer in the watershed due to the pesticide and chemical runoff.

[31] https://tbeptech.org/TBEP_TECH_PUBS/2009/TBEP_06_09_Habitat_Master_Plan_Update_Report_July_2010.pdf
[32] https://www.colliercountyfl.gov/your-government/divisions-f-r/natural-resources/littoral-zones#Important
[33] Tamar Zohary & Ilia Ostrovsky (2011) Ecological impacts of excessive water level fluctuations in stratified freshwater lakes, Inland Waters, 1:1, 47-59, DOI: 10.5268/IW-1.1.406
[34] https://pubs.usgs.gov/circ/1348/

Furthermore, when impervious surfaces cover areas where water naturally seeps into underground water sources, or aquifers, they reduce the amount of water available to recharge wells and springs. During storms, excess water that could not seep into the ground flows across impervious surfaces where it can gather harmful pollutants (e.g., oil and fertilizer) and deposit them into surrounding waters and farther downstream. As impervious surfaces increase, so do stormwater runoff volumes, the velocity of stormwater flows, and pollutant levels in runoff.[35]

Wetlands

Wetlands help protect our natural ecosystems by providing a wide range of hydrological and ecological benefits, including flood protection and erosion control (i.e., green infrastructure), filtration of toxins and nutrients from runoff, recharge and discharge of groundwater resources, and vital habitat for a multitude of plant and wildlife species. Additionally, wetlands are important natural resources for recreation and education and provide economic commodities such as fish, rice, timber, and peat.[36]

Approximately 206,288 acres (31%) of Hillsborough County's land area are wetlands located in the floodplain. Wetlands located in coastal and riverine floodplains can protect people and their property, community infrastructure, and agricultural investments from floods. Wetlands act as natural sponges, holding floodwaters and lowering flood heights. Wetlands Improve Water Quality Runoff associated with concrete, asphalt, rooftops, and other impervious surfaces is a leading cause of water pollution. Wetlands near developed and agricultural areas trap pollutants and excess nutrients in surface runoff, keeping water bodies cleaner. This natural filtering helps prevent water use restrictions, such as beach and shellfish closures, and reduces the need for costly treatment systems.[37]

Social and Population Impacts from Flooding

Understanding the current demographic and socioeconomic characteristics of a population provides context to understanding vulnerabilities within communities and neighborhoods across Hillsborough County. Examining potential future problems that may impact populations in these at-risk areas allow for the development and implementation of structural and non-structural mitigation measures aimed to protect those more susceptible to the effects of flooding. This knowledge can increase the ability of local planners and the population to prepare before an event, remain safe during an event and better plan for rehabilitation in the aftermath.

For those residents of Hillsborough County who live along the coast, the Hillsborough, Alafia, and Little Manatee River, within the 100-year Special Flood Hazard Area, or urban neighborhoods living with the flooding is a way of life. While the chances of flooding are not a common event, should it occur, the flooding conditions can range from nuisance to catastrophic. In review of the National Climatic Center database and the National Weather Service Hydrologic Prediction Service websites widespread heavy rain associated with Hurricane Irma in 2017 across west central Florida lead to record flooding on many of the rivers and widespread flooding throughout Hillsborough County.

Historically, flooding has caused a substantial amount of property damage. As more people move to Hillsborough County and more development takes place the potential for flood-related damages,

[35] Schueler, T. R., 1994. The importance of imperviousness. Watershed Protection Techniques, 1(3): 100-111.
[36] EPA, 2010. Protection of Environment. 40 C.F.R. pt. 232.2
[37] https://coast.noaa.gov/snapshots/.

increases each year. From approximately 1.23 million residents in 2010 to approximately 1.4 million in 2018, there has been an estimated 16.9% increase in population growth in Hillsborough County.[38] As for the population living in a floodplain, in 2000 there were 231,624 residents living in a floodplain and in 2016 this number increased to 305,524.[39] Hillsborough County was estimated to have the third largest floodplain population change from 2000-2016 with a 32% increase (estimated 73,900 residents). According to the Bureau of Economic and Business Research (2018), an upward estimate of 1.04 million new residents are projected to migrate to the area by 2045 which will likely result in an even larger increase in residents living in the floodplain.[40]

The more homes and people located in a floodplain, the greater the potential for harm from flooding. Impacts are likely to be even greater when additional risk factors (age, income, capabilities) are involved, since people at greatest flood risk may have difficulty evacuating or taking action to reduce potential damage.

People who live in areas prone to flooding and whom may be uninsured or underinsured are at greatest risk. The cost of insurance may be prohibitive and people who live outside of a flood zone may believe they are not at risk. People who rent properties may not be aware of their flood risk as it may not be disclosed by the owner or they may not know the history of the area.

Socio-economic Status

According to the U.S. Bureau of Labor Statistics (BLS), the unemployment rate for Hillsborough County was 3.4% in June 2019.[41] Approximately 15.5% of individual residents in Hillsborough County are living below the poverty line.[42] These segments of the population, due to their unstable economic situations, are likely to seek assistance, may not have adequate health or renter/homeowner's insurance, or may end up homeless after a major flooding event.

Older Adults

According to U.S. Census Bureau (2018), 14.3% of the Hillsborough County population is over the age of 65. These are a portion of the population that may be more vulnerable due to financial barriers, lack of social networks and transportation, or due to health reasons. Many retirees live on fixed incomes and may not have resources for home mitigation measures, to maintain their home to reduce the impacts of rain or flooding, ability to afford homeowner's insurance, or evacuate due to a flooding event.

They may need additional assistance to help retrofit or mitigate the effects of tropical storms and hurricanes to their homes or need assistance for evacuating due to a variety of chronic health problems including cognitive impairments and diminished mobility.

[38] https://www.census.gov/quickfacts/fact/table/hillsboroughcountyflorida/PST120218

[39] https://www.governing.com/gov-data/census/flood-plains-zone-local-population-growth-data.html#methodology.

[40] https://www.bebr.ufl.edu/sites/default/files/Research%20Reports/projections_2018.pdf

[41] U.S. Bureau of Labor Statistics, Unemployment Rate in Hillsborough County, FL [FLHILL7URN], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/FLHILL7URN

[42] https://www.census.gov/quickfacts/fact/table/hillsboroughcountyflorida/PST120218

Between 2010 and 2045, Hillsborough County will experience considerable growth in its older population. In 2045, the population aged 65 and over is projected to be 342,382, over double the estimated population of 145,237 residents in 2010.[43] The aging of the population will have wide-ranging implications for Hillsborough County, presenting challenges to policy makers and for emergency planners.

Table 4.20: Hillsborough County Population Age, 2018 estimates

Population (years of age)	Estimate	Percent
Total	**1,436,888**	**100%**
Under 5	89,087	6.2%
5 to 17	323,300	22.5%
18 to 64	819,026	57%
65 and over	205,475	14.3%

Source: U.S. Census Bureau, 2018 estimates.[44]

Housing and Transportation

Vulnerability is not just a product of building codes; however, social vulnerability plays an important role in understanding risk. Identifying mobile home parks with exceptional social cohesion serves as a model for those where social capital appears to be lacking, and in that way improve the disaster preparedness of those areas.

There are 479 mobile home parks and over 33,270 manufactured homes registered in Hillsborough County.[45] Residents in mobile home communities usually own their homes and pay monthly rent to park on the property within the mobile home park. The arrangement is popular among retirees as well as low-income families looking for an affordable housing option.

By drawing from various levels of flood plain data for Hillsborough County and cross referencing it with the location of our mobile home parks, identifying which manufactured home parks are at the greatest risk for future storm surge and flooding events has been conducted. Long-term risks exist for those who live closest to the coastline along Tampa Bay in South County, as well as Town 'N Country with regards to storm surge, flooding and anticipated sea-level rise. Furthermore, there is a concern for residents of manufactured home parks that lay within the watersheds of some of our largest rivers (specifically the Alafia and Hillsborough rivers) that may lead to risk of in-land flooding during tropical storm and hurricane events. In the event of a flood, many of these home parks could see significant destruction of personal property and displacement of their residents.

High-density residential areas in that are susceptible to potential storm surge include Town 'N Country, South Tampa, Davis Island, Apollo Beach, and Ruskin. Tampa ranked in the top 10 among large metropolitan areas with severe shortages of rental homes affordable to low-income households.[46]

[43] https://www.bebr.ufl.edu/sites/default/files/Research%20Reports/projections_2019_asrh.pdf

[44] https://www.census.gov/quickfacts/fact/table/hillsboroughcountyflorida/PST120218

[45] US Census Bureau. (2017). Physical housing characteristics for occupied housing units, 2013-2017 ACS 5-year estimates. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF.

[46] https://reports.nlihc.org/oor/florida

Health Vulnerabilities

Populations of concern in Hillsborough County include individuals that have health concerns that need to be considered when looking at homes that have been impacted by flooding. Many individuals may be electricity dependent (i.e., ventilators, oxygen concentrators, CPAP and other sleep apnea devices, dialysis machines, take medications needing refrigeration) and have functional needs that pose a challenge to their safety and well-being. Healthcare facilities could experience extended periods of disruption after a disaster and mitigating against potential risks, developing comprehensive plans for their facility, and having adequate resources on hand is essential.

As mentioned, populations over the age of 65 may be more susceptible to health concerns that may impact their ability to evacuate or mitigate against flood damages. Between 2010 and 2045, Hillsborough County will experience considerable growth in its older population. In 2045, the population aged 65 and over is projected to be 342,382, over double the estimated population of 145,237 residents in 2010.[47]

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Historical Losses

The NCEI Storm Events Database information, presented in the Historical Occurrences section above, also contained property and crop damage dollar amounts, which is shown in the table below. This information, combined with values of structures in hazard areas and with projected losses from HAZUS-MH, can provide a more complete analysis than using only one data source.

Table 4.21: Flood Events in Hillsborough County, by Type, (1996–2019)

Type of Event	Number of Events	Deaths	Injuries	Property Damage (2019 dollars)	Crop Damage (2019 dollars)
Coastal Flood	0	0	0	$0	$0
Flash Flood	10	1	2	$11,604,951	$797
Flood	59	0	0	$21,501,099	$634,896
TOTAL	**69**	**1**	**2**	**$33,106,051**	**$635,693**

The information can be analyzed to provide the average amount of property and crop damage that is likely each year. This information is shown in the chart below.

Table 4.22: NCEI Floods, 1996–2019

NCEI Storm Event (hazard)	Average Floods per Year	Annualized Property Loss (2019 dollars)	Annualized Crop Loss (2019 dollars)
All Types of Floods	2.9	$1,394,869	$26,489

According to the analysis, Hillsborough County is historically vulnerable to almost $1.4 million in property damages and over $26,000 in crop damages from roughly 3 flood events each year.

[47] https://www.bebr.ufl.edu/sites/default/files/Research%20Reports/projections_2019_asrh.pdf

Exposure

To estimate exposure of improved property to flood, the approximate number of parcels and their associated improved valued located in the floodplains was determined using GIS analysis.

Table 4.23: Estimated Exposure of Improved Property to Flood

Location	Buildings and Parcels in Flood Risk Area								
	100-year floodplain			500-year floodplain			VE-Zone		
	No. of Parcels	No. of Bldgs	Improved Value	No. of Parcels	No. of Bldgs	Improved Value	No. of Parcels	No. of Bldgs	Improved Value
Plant City	1,321	5,795	$268,504,115	0	0	$0	0	0	$0
Tampa	17,250	94,567	$8,269,429,507	631	2,630	$309,743,684	296	2,108	$456,653,617
Temple Terrace	155	1,641	$112,810,881	0	0	$0	0	0	$0
Unincorp.	35,660	170,018	$10,150,891,321	663	4,316	$287,817,520	148	422	$97,272,945
HILLSBOROUGH COUNTY TOTAL	**54,386**	**272,021**	**$18,801,635,824**	**1,294**	**6,946**	**$597,561,204**	**444**	**2,530**	**$553,926,562**

To estimate the county population's exposure to flood, the floodplains were intersected with census block data. As a result, these population estimates are going to be an overestimate of risk since the entire census block's population count will be included even if only a portion of the census block's area is located in a floodplain. However, these estimates still give an idea of the county population's risk to flood.

Table 4.24: Estimated Exposure of Population to Flood

Location	Population in Flood Risk Area		
	100-year floodplain	500-year floodplain	VE-Zone
Plant City	13,230	0	0
Tampa	82,678	272	4,446
Temple Terrace	950	0	0
Unincorporated	583,398	78	4,570
HILLSBOROUGH COUNTY TOTAL	**680,256**	**350**	**9,016**

Sea Level Rise

To estimate exposure of improved property to sea level rise, the approximate number of parcels and their associated improved valued located in the areas vulnerable to 1-foot, 4-foot, 7-foot, and 10-foot increments of sea level rise was determined using GIS analysis.

Table 4.25: Estimated Exposure of Improved Property to Sea Level Rise Risk Areas

Sea Level Rise Depth	Buildings and Parcels in Sea Level Rise Risk Areas								
	Hillsborough County Total			Tampa			Unincorporated		
	No. of Parcels	No. of Buildings	Improved Value	No. of Parcels	No. of Buildings	Improved Value	No. of Parcels	No. of Buildings	Improved Value
1 ft	222	328	$573,778,642	79	154	$549,539,169	143	174	$24,239,473
4 ft	5,175	16,734	$3,217,564,867	2,535	8,882	$2,479,303,272	2,640	7,852	$738,261,595
7 ft	25,578	122,658	$9,769,745,629	12,049	61,415	$6,472,799,678	13,529	61,243	$3,296,945,951
10 ft	46,302	236,604	$15,099,195,981	19,809	104,771	$8,802,750,321	26,493	131,833	$6,296,445,660

Sea Level Rise Depth	Buildings and Parcels in Sea Level Rise Risk Areas								
	Hillsborough County Total			Tampa			Unincorporated		
	No. of Parcels	No. of Buildings	Improved Value	No. of Parcels	No. of Buildings	Improved Value	No. of Parcels	No. of Buildings	Improved Value

*Plant City and Temple Terrace have no buildings or parcels located in sea level rise risk areas, so they are not included in this table.

To estimate the county population's exposure to potential sea level rise, the areas vulnerable to 1-foot, 4-foot, 7-foot, and 10-foot increments of sea level rise were intersected with census block data. As a result, these population estimates are going to be an overestimate of risk since the entire census block's population count will be included even if only a portion of the census block's area is located in an inundation area. However, these estimates still give an idea of the county population's risk to sea level rise.

Table 4.26: Estimated Exposure of Population to Sea Level Rise Risk Areas

Sea Level Rise Depth	Population in Sea Level Rise Risk Areas											
	1-foot			4-foot			7-foot			10-foot		
	County Total	Tampa	Uninc.	County Total	Tampa	Uninc.	County Total	Tampa	Uninc.	County Total	Tampa	Uninc.
0 to 1 ft	2,351	125	2,226	11,426	3,778	7,648	58,639	27,788	30,851	58,095	27,168	30,927
1 to 2 ft	0	0	0	4,307	486	3,821	13,805	3,144	10,661	58,777	26,798	31,979
2 to 3 ft	0	0	0	0	0	0	4,526	751	3,775	11,504	2,025	9,479
3 to 4 ft	0	0	0	0	0	0	0	0	0	8,782	966	7,816
4 to 5 ft	0	0	0	0	0	0	0	0	0	0	0	0

*Plant City and Temple Terrace have no population located in sea level rise risk areas, so they are not included in this table.

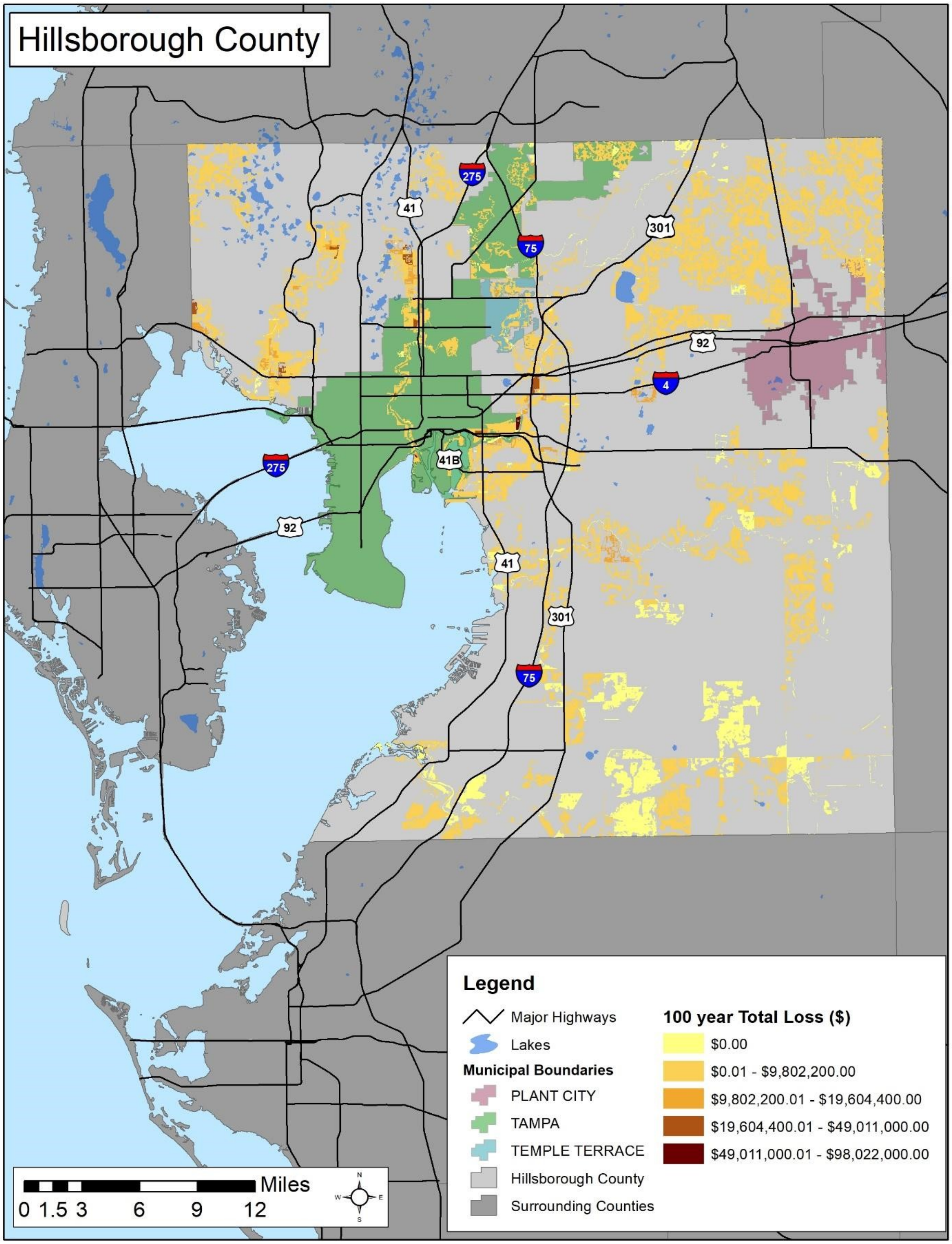
Hazus-MH

Hazus-MH was used to estimate the direct economic loss for the county from a 100-year flood as shown below. This analysis includes losses to buildings, contents, inventory, relocation, capital, wages, and rental income.

Table 4.27: Direct Economic Loss from 100-year Flood

	100-year Flood Event
Building Loss	$728,234,000
Contents Loss	$781,301,000
Inventory Loss	$22,009,000
Relocation Loss	$400,327,000
Capital Related Loss	$416,697,000
Wage Loss	$581,714,000
Rental Income Loss	$181,688,000
TOTAL LOSS	**$3,111,970,000**

Figure 4.15: Direct Economic Loss 100-year Return Period



<u>Coastal Flooding</u>

Please refer to the *Tropical Cyclone Hazard Profile* for vulnerability and loss estimates by jurisdiction due to coastal flooding and storm surge.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

To estimate exposure to flood for the critical facility analysis, floodplains were intersected with critical facility locations. Digital Flood Insurance Rate Map (DFIRM) date was used to delineate the effective and preliminary floodplains. The table below summarizes the critical facilities in the county that are located within an identified floodplain.

Table 4.28: Exposure of Critical Facilities to Flood Risk Areas

Location	Number of Critical Facilities in Flood Risk Area		
	100-year floodplain	500-year floodplain	VE-Zone
Plant City	16	0	0
Tampa	48	4	0
Temple Terrace	1	0	0
Unincorporated	109	1	0
HILLSBOROUGH COUNTY TOTAL	**174**	**5**	**0**

Sea Level Rise

Additional analysis was done to estimate the exposure of critical facilities to sea level rise. Areas vulnerable to potential 1-foot, 4-foot, 7-foot, and 10-foot increments of sea level rise were intersected with the critical facility locations. The table below summarizes the critical facilities in the county that are located within a potential sea level rise inundation area.

Table 4.29: Exposure of Critical Facilities to Sea Level Rise Risk Areas

Location	Number of Critical Facilities in Sea Level Rise Risk Area			
	1-foot	4-foot	7-foot	10-foot
Plant City	0	0	0	0
Tampa	3	7	30	48
Temple Terrace	0	0	0	0
Unincorporated	2	7	35	45
HILLSBOROUGH COUNTY TOTAL	**5**	**14**	**65**	**93**

All of the critical facilities and their associated risk can be found in Appendix B.

Please refer to the *Tropical Cyclone Hazard Profile* for vulnerability and loss estimations of critical facilities due to coastal flooding and storm surge.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 3.3.

<table>
<tr><th colspan="5">Flood</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">A flood or flooding refers to the general or temporary conditions of partial or complete inundation of normally dry land areas from the overflow of inland or tidal water and of surface water runoff from any source. While many people underestimate the severity of floods, loss of life and property from flooding are real threats in Florida. Florida experiences several different kinds of floods due to the effects of severe thunderstorms, hurricanes, seasonal rains and other weather-related events.</td><td>HIGH</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Highly Likely</td><td>Critical</td><td>Moderate</td><td>6 to 12 hrs</td><td>< 1 week</td><td>3.3</td></tr>
</table>

Tropical Cyclone Hazard Profile

1. Tropical Cyclone Description

Tropical storms and hurricanes are characterized by strong winds and rain, tidal and in-land flooding, high waves, and have the potential to spawn severe thunderstorms, lighting, and tornadoes. These weather events, generally known as tropical cyclones, are an organized system of rotating clouds and thunderstorms that originate over tropical or subtropical waters and has a closed low-level circulation. These storms form when a developing center of low pressure moves over warm water and the pressure drops in the center of the storm. As the pressure drops, the system becomes more organized and the winds begin to rotate around the low pressure, pulling in the warm and moist ocean air. This is what causes the wind and rain associated with a tropical cyclone. As the storm system rotates faster, an eye forms in the center. Higher-pressure air from above flows down into the eye.

Tropical cyclones act as a safety valve that limits the build-up of heat and energy in tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the poleward latitudes.

Tropical cyclones rotate counterclockwise in the Northern Hemisphere moving normally from east to west with an average diameter of 200 to 400 miles across. If all of the conditions are favorable (warm ocean water and favorable high-altitude winds), the system could strengthen to become categorized as a tropical storm or hurricane. The following are descriptions of the four general levels of development for tropical cyclones:

- **Tropical Depression—**The formative stages of a tropical cyclone in which the maximum sustained surface winds are 38 mph (33 knots) or less.
- **Tropical Storm—**A tropical cyclone in which the maximum sustained surface winds range from 39 to 73 mph (34 to 63 knots).
- **Hurricane—**A tropical cyclone with maximum sustained winds of 74 mph (64 knots) or higher.
- **Major Hurricane—**A tropical cyclone in which the maximum sustained surface winds is at least 111 mph (96 knots) or higher, corresponding to a Category 3, 4, or 5 on the Saffir-Simpson Hurricane Wind Scale.

Hurricanes are further ranked by wind speed from Category 1 to 5, with 5 being catastrophic. The Saffir-Simpson Hurricane Wind Scale is shown in the table below.

Special Consideration: *While this document will profile Tropical Cyclone as one hazard, the communities within Hillsborough County have operational and planning documents that discretize the hazard into Minor (Tropical Depression through Category 2 Storm) and Major (Category 3 and higher events). Table 4.4 at the beginning of the Risk Assessment Section identifies this relative to each jurisdiction.*

Table 4.30: Saffir-Simpson Hurricane Wind Scale[48]

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74–95 mph	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96–110 mph	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111–129 mph	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes
4 (major)	130–156 mph	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or Higher	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

There are four major hazards that need to be taken into consideration that are produced by tropical storms and hurricanes: *storm surge, high winds, large rainfall, and rip currents*.

- ***Storm Surge***: Storm surge is the rise in water level in coastal areas caused by the wind and pressure forces of a hurricane. Generally speaking, the more intense the hurricane, the higher the surge will be. The output of the National Oceanic and Atmospheric Administration (NOAA) storm surge prediction model (SLOSH) shows that storm surge height of 28 feet or more above sea level could impact certain Hillsborough coastal and riverine areas under a worst-case Category 5 hurricane.

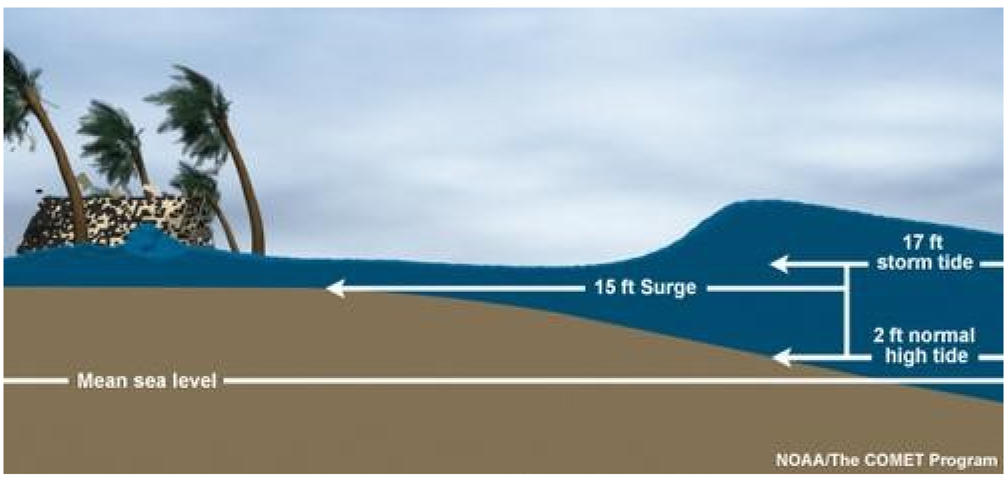
  The National Hurricane Center forecasts storm surge using the SLOSH model, which stands for Sea, Lake, and Overland Surges from Hurricanes. The model is accurate to within 20 percent. The inputs include the central pressure of a tropical cyclone, storm size, the forward motion, its track, and maximum sustained winds. Local topography, bay and river orientation, depth of the sea

[48] http://www.nhc.noaa.gov/aboutsshws.php

bottom, astronomical tides, as well as other physical features are taken into account in a predefined grid referred to as a "SLOSH basin." To allow for track or forecast uncertainties, usually several model runs with varying input parameters are generated to create a map of MOMs, or Maximum of Maximums.[49]

In 2010, the National Hurricane Center separated storm surge from the Saffir-Simpson Hurricane Wind Scale because it did not accurately describe storm surge. For example, a Category 1 hurricane could have devastating storm surge, while a Category 5 hurricane could have minimal storm surge. The Gulf Coast of Florida has a long, gently sloping shelf and shallow water depths, leading to higher storm surge than the Atlantic Coast of Florida but there are smaller waves. The bay and river orientation in Hillsborough County, depth of the sea bottom, astronomical tides, as well as other physical features are taken into account to determine storm surge levels and the impact it may have on the built environment, ecology, and population of Hillsborough County.

Figure 4.16: Storm Surge Explanation



- ***High Winds***: The high winds of a hurricane also present significant dangers and hazardous conditions to the populace and cause severe damage to the built environment and ecology, as well as a substantial amount of debris. This hazard especially applies to structures unable to withstand the stress and uplift forces from hurricane force winds ranging from 74 to more than 155 miles per hour. Structures most vulnerable to hurricane force winds tend to be manufactured homes and substandard housing that is not built to current building codes. Debris, including signage, pieces of structures not properly secured, flying glass from structures and high-rise buildings, and even shallow rooted trees, are often carried by the high winds which causes further damage and roadway obstructions. Majority of wind damage caused from hurricanes has been a result of down bursts, which are strong downdrafts causing damaging winds on or near the ground.
- ***Tornadoes***: Tornadoes are a threat during tropical cyclones and have been associated with the majority that have affected Florida. Tornadoes tend to develop on the northwest edge relative to

[49] http://www.nhc.noaa.gov/surge/slosh.php

the forward motion of the hurricanes. These tornadoes are usually short lived and relatively weak. For more information regarding tornadoes, please see the *Tornado Hazard Profile*.

- ***Large Rainfall***: Rainfall varies with hurricane size, forward speed, and other meteorological factors. Residents must be aware of rainfall can cause flash flooding and flooding on rivers and streams that can persist for several days after the storm. This flooding is actually the biggest threat from tropical cyclones for people who live in inland in low-lying areas and along rivers or canals that serve as a major drainage system. The Rainfall amounts are related to the speed and size of a tropical cyclone, not the intensity of the storm. Slower moving and larger tropical cyclones have a longer and larger capacity to produce more rainfall in an area leading to increased flooding. For more information regarding flooding, please see the *Flood Hazard Profile*.
- ***Rip Currents***: The strong winds associated with tropical cyclones can cause rip currents, which are a significant threat to mariners, coastal residents and visitors. Rip currents are channeled currents of water flowing away from shore and can easily pull strong swimmers into the open water. These rip currents can occur before and after a tropical storm or hurricane even when the county is still a large distance from the storm system.

The National Weather Service produces Rip Current Outlooks to alert beach goers to the risk of rip currents at a particular beach or waterway. There are three levels of outlooks:[50]

  - Low Risk: The risk for rip currents is low; however, life-threatening rip currents often occur in the vicinity of jetties, reefs, and piers.
  - Moderate Risk: Life threatening rip currents are possible in the surf zone.
  - High Risk: Life threatening rip currents are likely in the surf zone.

National Hurricane Center Advisories

The NOAA National Hurricane Center (NHC) is responsible for tracking and predicting tropical weather systems. Whenever a tropical cyclone forms, they issue advisories every six hours until the storm is over. Public advisories are issued more often when the storm is expected to form into a tropical storm or hurricane. Below are the advisories and thresholds that the NHC can issue during a Tropical Cyclone event.

Table 4.31: National Hurricane Center Advisories and Thresholds during a Tropical Cyclone.[51]

National Hurricane Center Advisories	
Tropical Storm	
Tropical Storm Watch	Issued when sustained winds of 39 to 73 mph are possible in the specified area within 48 hours in association with a tropical cyclone. These watches are issued 48 hours in advance of the anticipated onset of tropical storm force winds because preparedness activities become difficult and unsafe once winds reach tropical storm force.
Tropical Storm Warning	Issued when sustained winds of 39 to 73 mph are expected in the specified area within 36 hours in association with a tropical cyclone. These warnings

50 https://www.weather.gov/media/srh/tropical/TropicalCyclones11.pdf
51 http://www.nhc.noaa.gov/aboutgloss.shtml

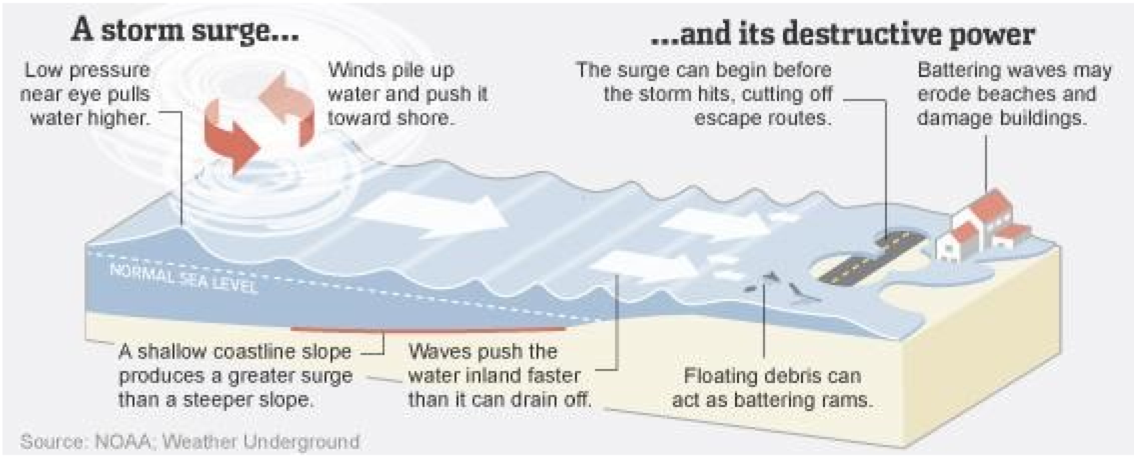
National Hurricane Center Advisories	
	are issued 36 hours in advance of the anticipated onset of tropical storm force winds because preparedness activities become difficult and unsafe once winds reach tropical storm force.
Potential Tropical Storm	Until 2017, the National Hurricane Center was only able to issue warnings when a storm was already formed. This is a problem because sometimes forecasting is certain enough to know that a disturbance will turn into a storm closer to landfall, but by the time a warning is sent out when a storm is close to land, it will be too late for protective actions. To remedy this issue, the NHC will now have the option to issue Potential Tropical Cyclone Warnings for areas of disturbance that are expected to develop into a tropical storm or hurricane and impact land within 48 hours.
Hurricane	
Hurricane Watch	Issued when 74 mph winds or higher are possible in the specified area within 48 hours in association with a tropical cyclone. Because preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours in advance of the anticipated onset of tropical storm force winds.
Hurricane Warning	Issued when 74 mph winds or higher are expected in the specified area within 36 hours in association with a tropical cyclone. Because preparedness activities become difficult once winds reach tropical storm force, the hurricane warning is issued 36 hours in advance of the anticipated onset of tropical storm force winds
Storm Surge	
Storm Surge Watch	Issued when there is the possibility of life-threatening inundation from rising water moving inland from the shoreline in the specified area, generally within 48 hours, in association with an ongoing or potential tropical cyclone.
Storm Surge Warning	Issued when the danger of life-threatening inundation from rising water moving inland from the shoreline in the specified area, generally within 36 hours, in association with an ongoing or potential tropical cyclone.
Storm Surge Watches and Warnings may be issued earlier based on timing forecasts and may be issued for locations adjacent to expected life-threatening inundation areas.	

Causes of Fatalities in Tropical Cyclone Storms

There are two categories of causes of fatalities in tropical storms or hurricanes, direct and indirect. A direct death means that the fatality is attributable to forces of the storm, such as water or wind. An indirect death means that the fatality resulted from actions before, during, and after the storm.

In a study from the National Hurricane Center, from 1963 to 2012, there are an average of 40 to 50 direct deaths from tropical storms or hurricanes each year. According to the study, 90% of the deaths are due to water, either storm surge, freshwater flooding, or rainfall. Of course, there is a large storm-to-storm and year-to-year variability associated with that average.[52]

Figure 4.17: Explanation of Storm Surge in Areas with a Shallow Coastline Slope and the Potential Effects on Coastal Communities



The study also examined indirect deaths and found that there is an average of 30 to 40 indirect fatalities from tropical storms or hurricanes each year. Additionally, those over age 70 were found to be 8 times as likely to be victims than those under age 21. The study found four primary contributing factors to indirect deaths, some of which occur in combination. The leading cause of indirect deaths is cardiovascular complications; in fact, one third of all indirect deaths are attributed to cardiovascular complications. The next factor is complications during evacuations, either during the evacuation or when the victim reaches the destination. Vehicle accidents are also a contributing factor to indirect deaths. Examples of vehicle accidents include hydroplaning, traffic lights out, and downed trees. Finally, indirect deaths are sometimes caused by power related complications, such as the improper use of generators leading to carbon monoxide poisoning or structure fires, electrocutions, and losing power to life sustaining medical equipment.[53]

Potential Effects of Climate Change on Tropical Cyclone

A warmer atmosphere could influence two of the factors that affect the generation and strength of tropical cyclones: (1) increased thermal energy resulting from higher sea surface temperatures (SST) and (2) increased vertical wind shear.[54] It is believed that these effects are likely to counteract each other to some degree, however, the exact role of increasing SST remains to be determined.

[52] http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-12-00074.1
[53] http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-15-00042.1
[54] Grinsted et al. (2013). Projected Atlantic hurricane surge threat from rising temperatures. Proceedings of the National Academy of Sciences, 110(14), 5369, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3619316/.

Tropical cyclone intensity, as measured by power dissipation indices[55] may increase directly as a function of SST, or intensity may be a function of the difference between SST in the cyclone development region and mean global tropical SST.[56] Vertical wind shear disturbs the structure of a tropical cyclone and, therefore, increased shear can lead to system weakening.

Tropical cyclone intensities globally will likely increase on average. As temperatures rise, it is predicted that a larger proportion of hurricanes will reach Category 4 and 5 strengths, however, it is believed that frequency of all tropical cyclones will either decrease or see little change.[57] Keep in mind, tropical cyclone intensity is one of the principal determinants of storm surge height; thus, the net effects of climate change on tropical cyclone intensity will also affect the magnitude of coastal flooding associated with these storms.[58] The vulnerability of coastal regions to storm-surge flooding and higher coastal inundation levels is expected to increase with future sea-level rise and coastal development. This change would imply an even larger percentage increase in the potential destruction of a storm and impact on populations along rivers and coastal areas of Hillsborough County.

As stated in the *Flood Hazard Profile*, higher rainfall intensity is likely due to anthropogenic warming and accompanying atmospheric moisture increases. This means that rainfall correlated with tropical storms and hurricanes will likely increase in the future. Modeling studies on average project an increase of 10-15% for rainfall rates due to global warming.[59] Additionally, tropical cyclone tracks and, consequently, the number of systems that make landfall in Florida could be influenced by atmospheric steering currents and climate phenomena such as the El Niño-Southern Oscillation, North Atlantic Oscillation, Atlantic Meridional Mode, and Madden-Julian Oscillation.[60]

2. Geographic Areas Affected by Tropical Cyclone

The average diameter of tropical force winds extends out 300-400 miles, and hurricane force winds average 100 miles.[61] This means all areas of Hillsborough County are subject to the effects of tropical cyclones, however, some areas are more vulnerable than others. Maps throughout this section illustrate the areas of Hillsborough County that are and can be impacted by tropical storms and hurricanes at different levels over time. Tropical cyclones are random in distribution, so there is not specific area in the county that is more at risk than another. The figure below depicts all the tropical cyclones to affect

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[55] Power dissipation indices are "an aggregate compound of tropical cyclone frequency, duration, and intensity that measures total energy consumption by tropical cyclones," Seneviratne et al., 2012, p. 159. https://www.ipcc.ch/pdf/special-reports/srex/SREX-Chap3_FINAL.pdf.

[56] Seneviratne et al. (2012). Changes in climate extremes and their impacts on the natural physical environment. In Field et al. (Eds.), Managing the risks of extreme events and disasters to advance climate change adaptation, p. 159. https://www.ipcc.ch/pdf/special-reports/srex/SREXFull_Report.pdf.

[57] NOAA Geophysical Fluid Dynamics Laboratory [GFDL]. (2019). Global warming and hurricanes: An overview of current research results. https://www.gfdl.noaa.gov/global-warming-and-hurricanes.

[58] Kossin et al. (2010). A globally consistent reanalysis of hurricane variability and trends. Geophysical Research Letters, 34, 4. doi: 10.1029/2006GL028836.

[59] NOAA GFDL. (2019). Global warming and hurricanes: An overview of current research results. https://www.gfdl.noaa.gov/global-warming-and-hurricanes.

[60] Grossmann, I. & Morgan, M. (2011). Tropical cyclones, climate change, and scientific uncertainty: What do we know, what does it mean, and what should be done? *Climate Change*, 108: 543-579. Doi 10.1007/s10584-011-0020-1.

[61] http://www.hurricanescience.org/science/science/hurricanestructure/

Hillsborough County from 1852 to 2017. This graphic shows that all areas of the county can be affected by tropical cyclones.[62] However, the coastal areas and along the rivers are more vulnerable to the effects that a tropical cyclone can produce due to urban development, location, population density, and the storm surge that can occur.

The additional maps that follow delineate areas that are vulnerable to the storm surge that can be produced by tropical cyclones.

[62] https://coast.noaa.gov/hurricanes/

Figure 4.18: Historical Tropical Cyclone Tracks, Hillsborough County, 1852 to 2017

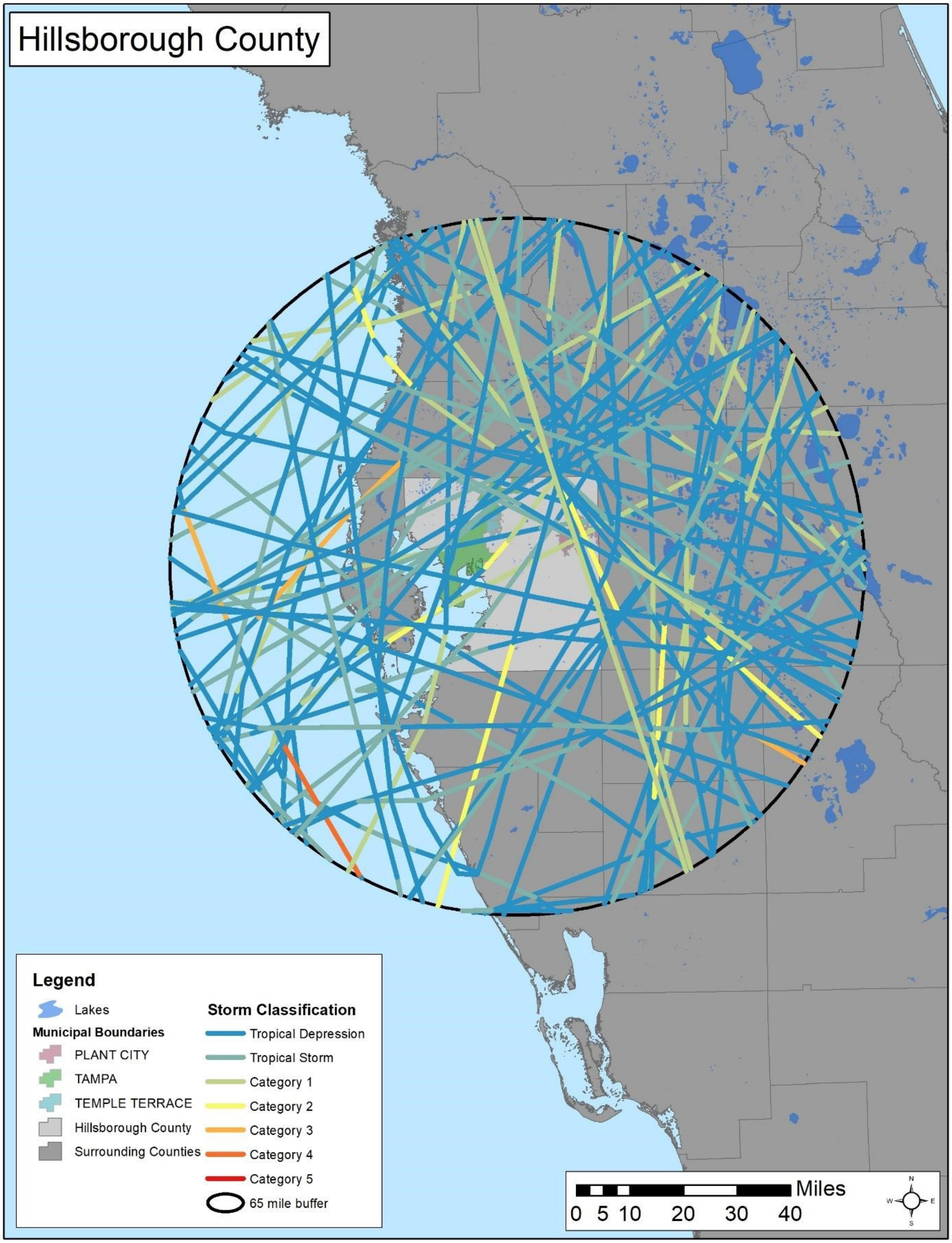


Figure 4.19: Storm Surge Zones – Category 1 Depth

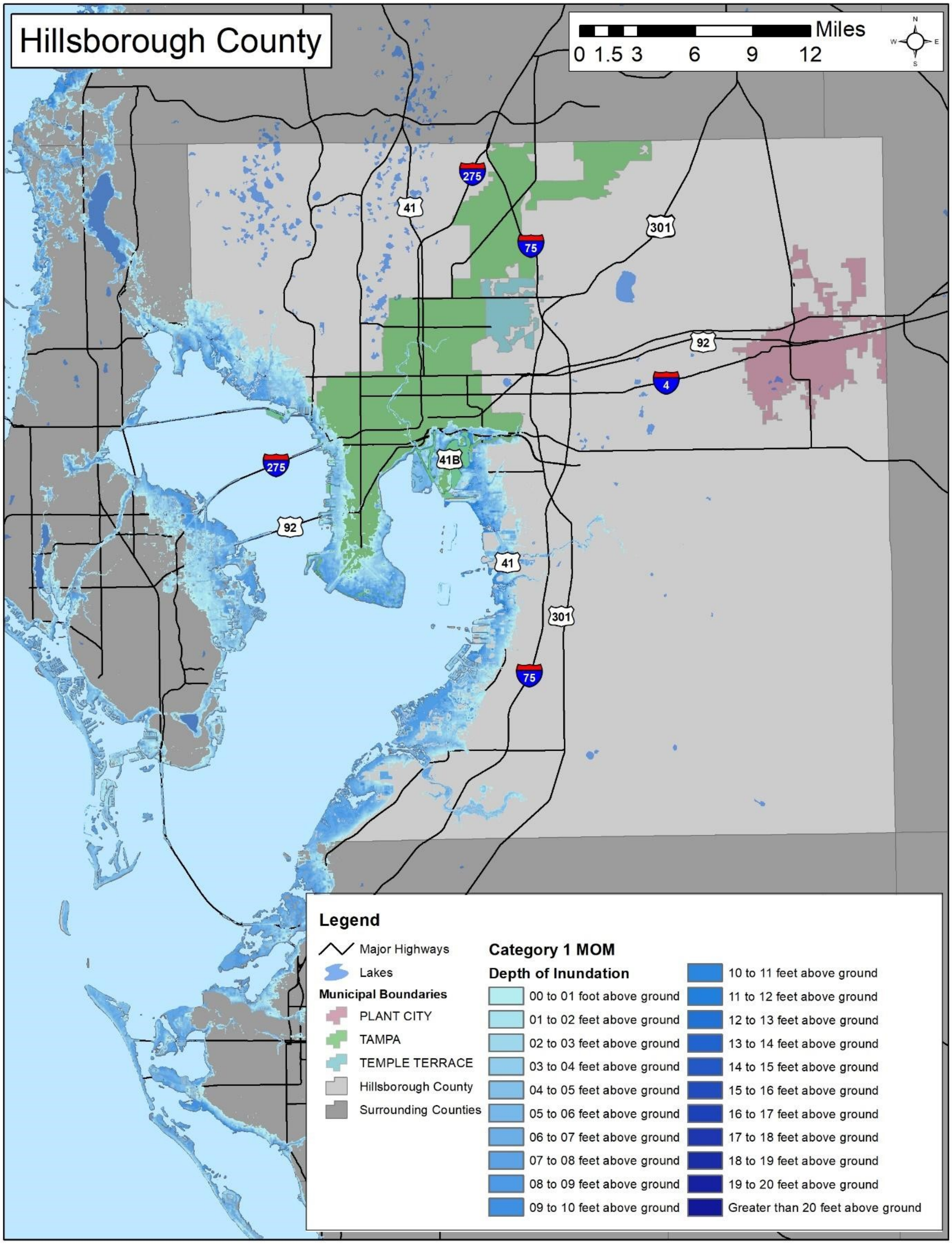


Figure 4.20: Storm Surge Zones – Category 2 Depth

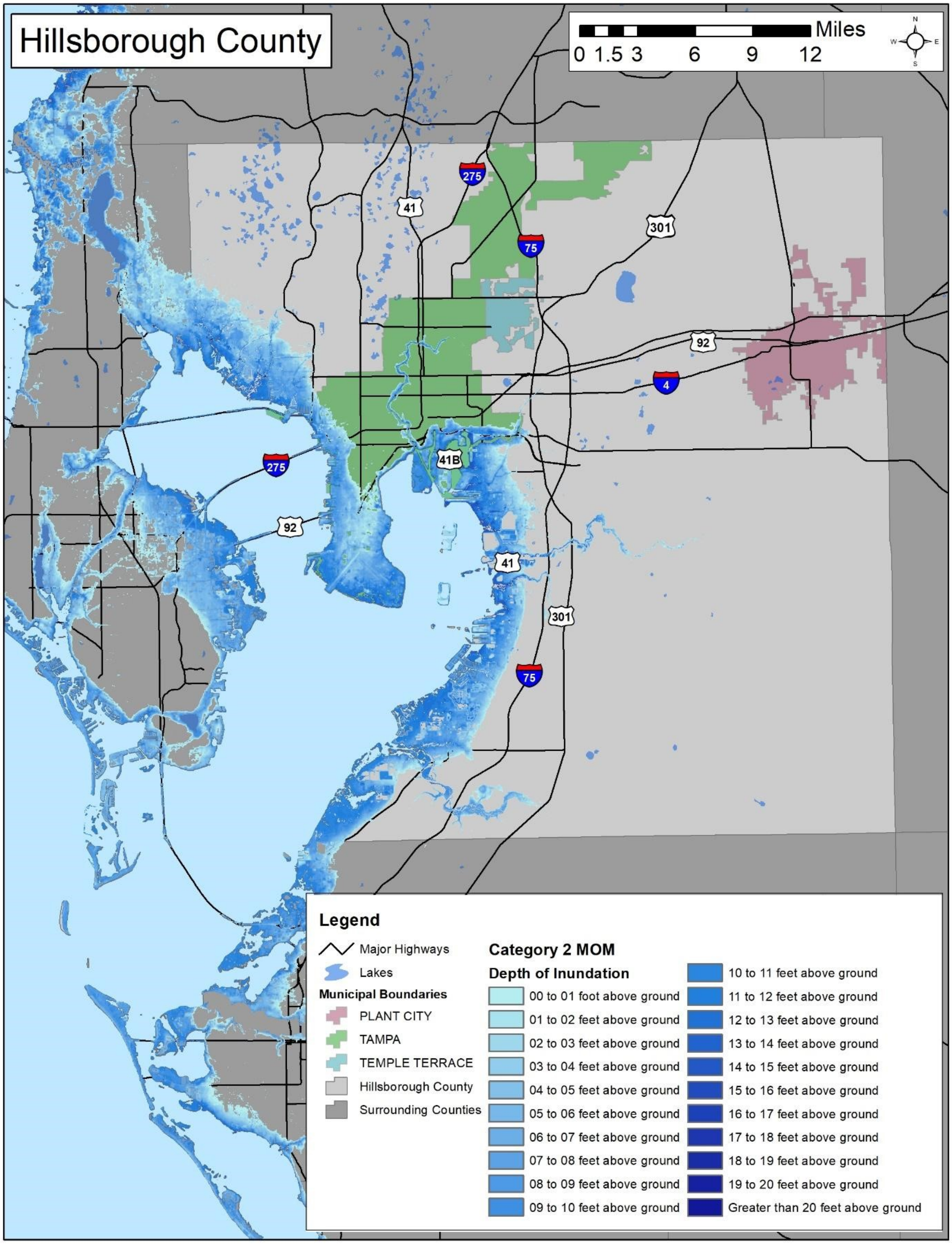


Figure 4.21: Storm Surge Zones – Category 3 Depth

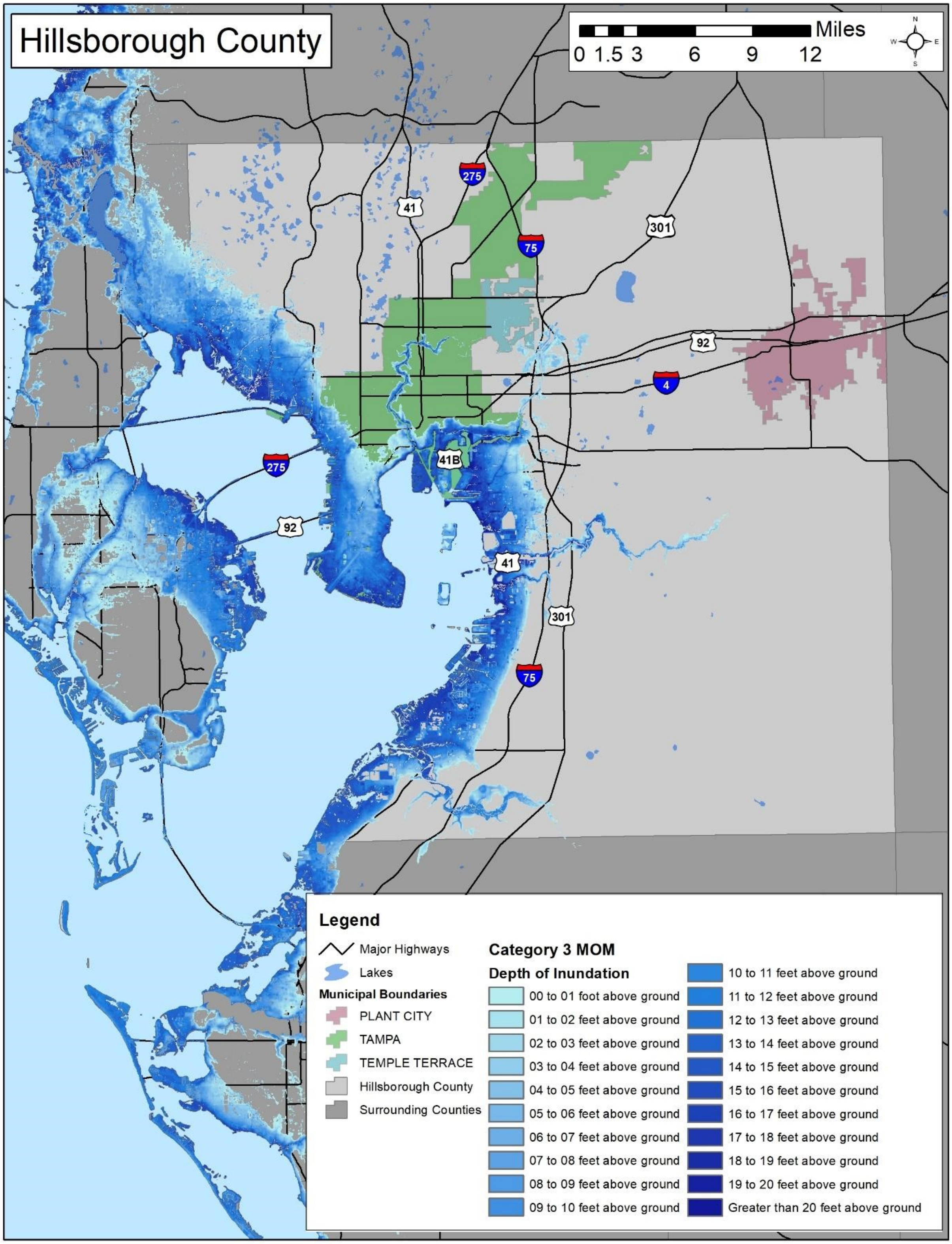


Figure 4.22: Storm Surge Zones – Category 4 Depth

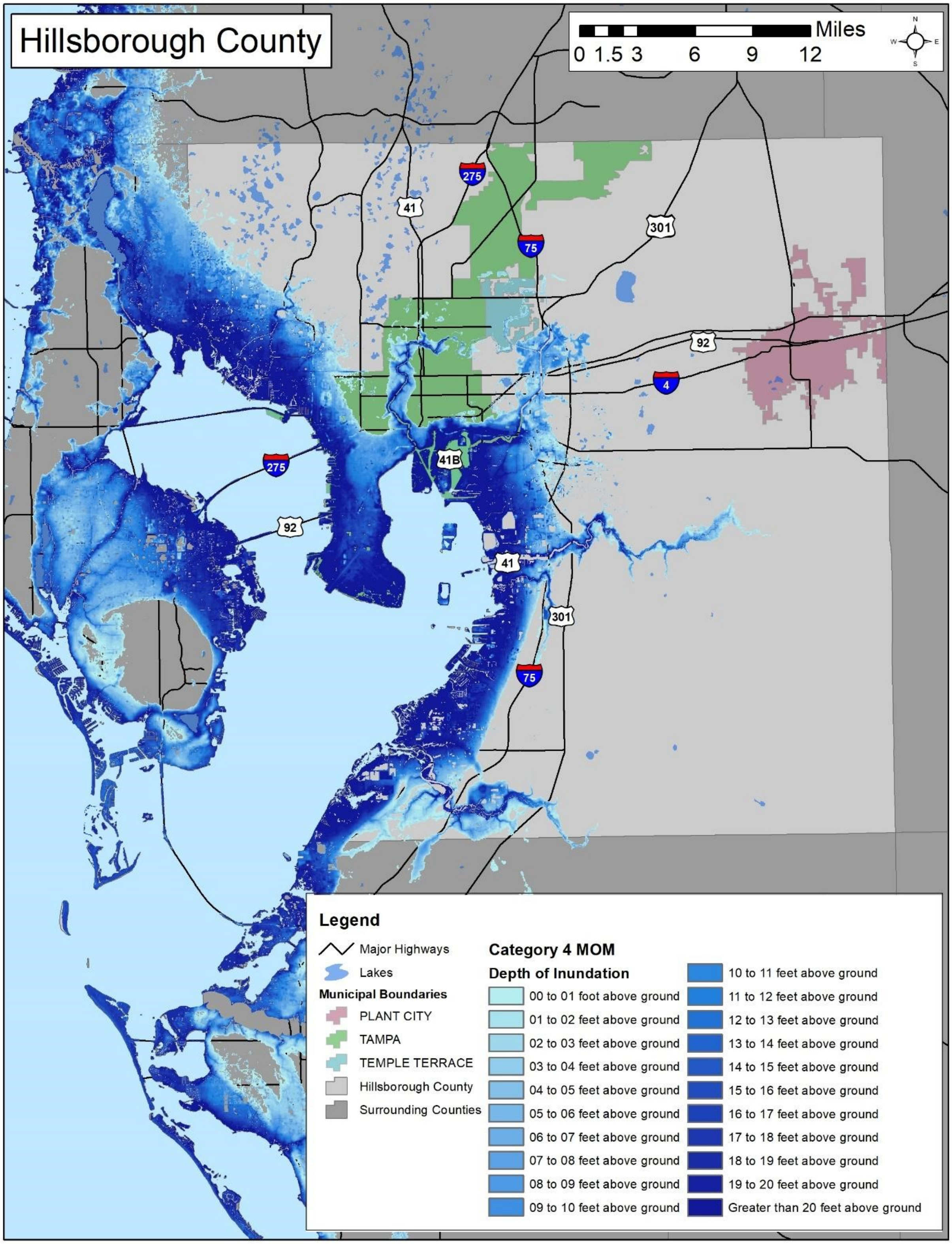
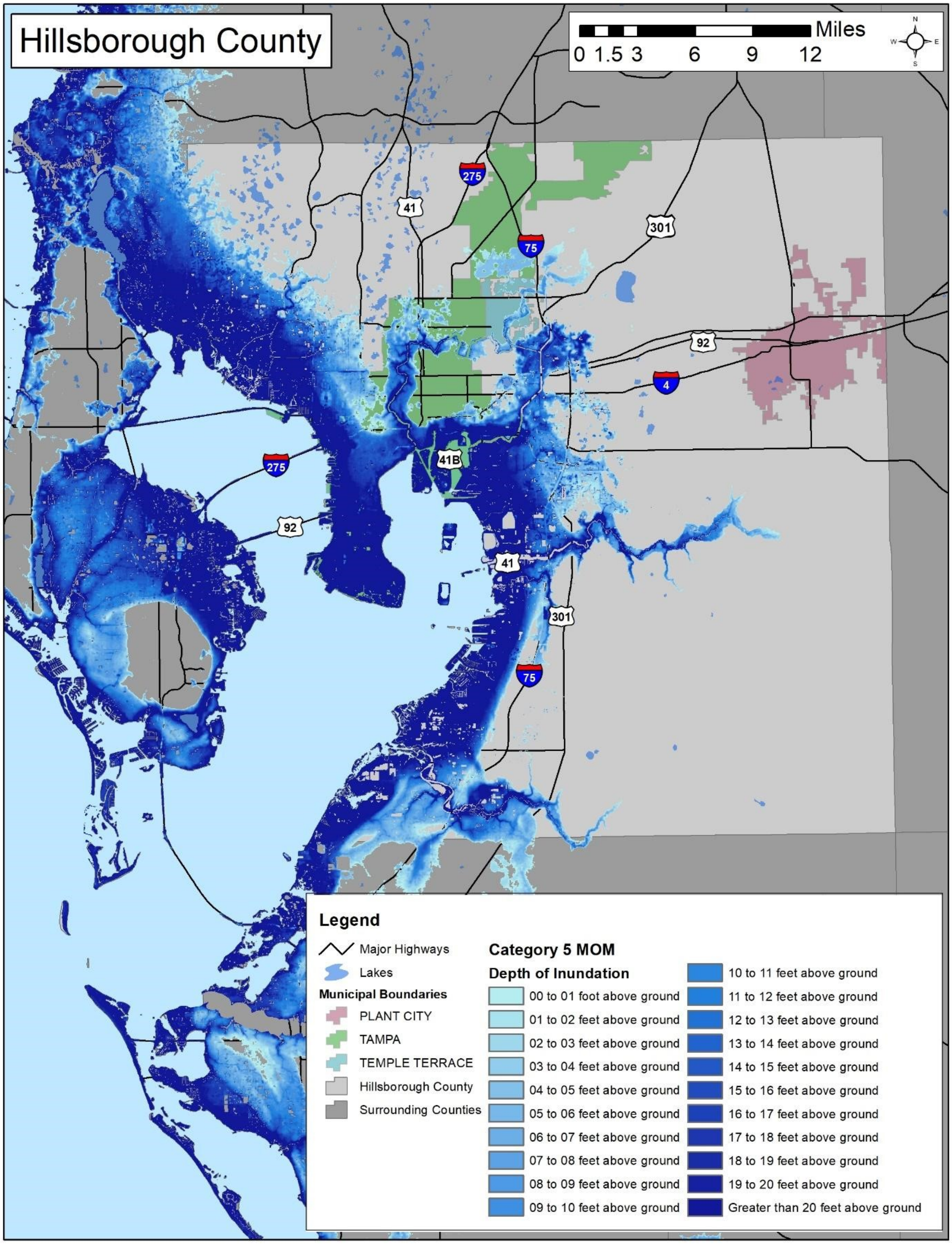


Figure 4.23: Storm Surge Zones – Category 5 Depth

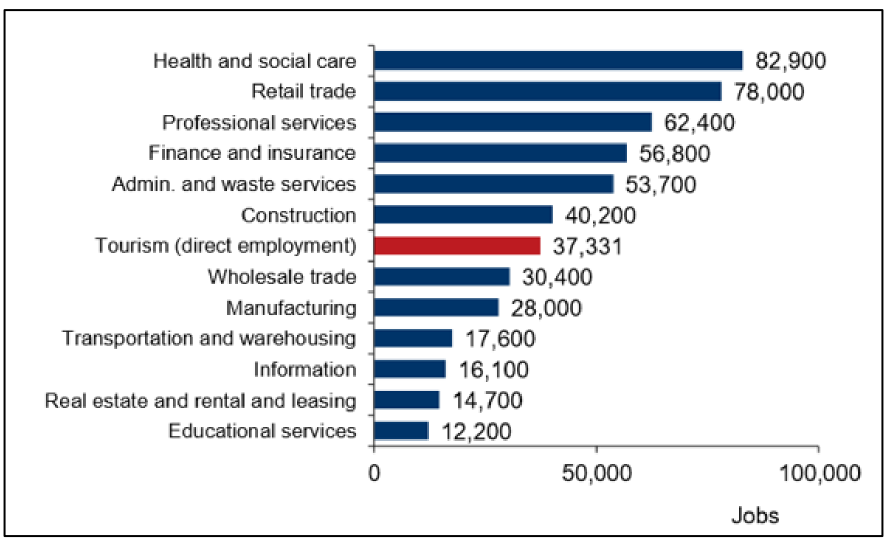


The vulnerability of Hillsborough County to potential hazards from hurricanes and tropical storms is analyzed prior to each approaching storm and monitored. The population at risk and the potential for property or economic damages is based on the specific characteristics of the threatening hurricane. The principle tool for analyzing the expected hazards from potential hurricanes that may affect the Tampa Bay Region is the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) numerical storm surge model. Based on these models, coastal areas are most vulnerable to the greatest storm surge, high winds and rainfall impacts; however, the entire county is vulnerable to at least high rains and winds.

All coastal areas (158 mi. shoreline) of the 1,051 square mile Hillsborough County, and the flood plains along the three county rivers (Hillsborough, Alafia, and Little Manatee), are considered hazard areas for hurricane storm surge. These areas include Ruskin, Apollo Beach, Gibsonton, Progress Village, South Tampa, the MacDill Air Force Base (AFB), Westshore, Town 'N Country, and the Downtown Tampa area including Ybor City, Davis Island, Channelside, and Harbor Island are most at-risk to storm surge. Populations along the Alafia, Hillsborough, and Little Manatee River floodplains are at highest risk of in-land flooding, storm-surge, rainfall impacts and high wind during a hurricane. These communities are located in the Level A and B evacuation zones near coastal areas of Hillsborough County.

In the event of a Category 5 Hurricane, industries that will experience the highest number of employee loss include health and social care, retail trade, professional services, finance and insurance, administrative and waste services, tourism (direct employment).[63] Hillsborough County has the 8th largest school district in the nation and serves as the region's largest employer. Whereas, the MacDill Air Force Base is region's second-largest employer which a major tropical cyclone would have devastating impact on the local economy and workforce due to its location in South Tampa on the Tampa Bay. There are more than 15,000 military personnel with an annual economic impact of $4.9 billion to the region.[64]

Figure 4.24: Employment in Hillsborough County, 2018.



Source: U.S. Bureau of Labor Statistics (BLS), 2018.

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63 U.S. Bureau of Labor Statistics (2018). https://www.bls.gov/.

64 https://assets.simpleviewinc.com/simpleview/image/upload/v1/clients/tampabay/Tampa_Bay_Fast_Facts_2019_5e0877cc-4985-490e-a817-a93d28b1d66f.pdf

Businesses and structures in the downtown Tampa area are vulnerable to hurricanes due to their location on the bay. Many major businesses that are located in coastal areas are susceptible to hurricanes including the Port Tampa Bay, Tampa International Airport (TIA), Tampa General Hospital, the Westshore business district, and retail stores and restaurants located along these waterways and coastal areas of Hillsborough County. New areas of development include Water Street, Sparkman Wharf and the Downtown Tampa Riverwalk, along with other large areas of development in Westshore are at risk to the effects of tropical storms and hurricanes.

In 2017, 23 million people visited Hillsborough County with expenditures totaling $5.9 billion. Tourism supports more than 48,000 local jobs and $2 billion in wages.[65] The majority of hotels in Tampa Bay have seen an incline in occupancy rates and revenue over the past years as tourism increases in the area. In April 2019, Hillsborough County hotels overall had a high 82.4% occupancy rate and increase of revenue to $244,804,472.[66]

Table 4.32: Major Events in Hillsborough County during Hurricane Season, June 1st – November 30th

Month	Major Events and Festivals
June	Busch Gardens® Tampa Bay "Summer Nights"
	Adventure Island "Island Nights"
July	Freedom Fest
	Tampa Bay Comic Con
August/ September	Tampa Bay Food & Wine Festival
	Tampa Bay Boat Show
	Tampa Bay MegaCon
October	NSRA Southeast Street Rod Nationals
	Tampa Bay Gay & Lesbian International Film Festival
	Oktoberfest Tampa
	Brews by the Bay
	Tampa Pig Jig
	Creatures of the Night at ZooTampa
	Ybor City March of the Pumpkin King
	Howl-O-Scream at Busch Gardens® Tampa Bay
November	Ruskin Seafood & Arts Festival

3. Historical Occurrences of Tropical Cyclone

Due to its unique geographical location and configuration, Florida is the most hurricane-prone state in the country. Hurricanes and tropical storms are the greatest natural disaster threat to Hillsborough County.

The table below lists the significant tropical storms and hurricanes that affected Hillsborough County.

65 https://assets.simpleviewinc.com/simpleview/image/upload/v1/clients/tampabay/Tampa_Bay_Fast_Facts_2019_5e0877cc-4985-490e-a817-a93d28b1d66f.pdf

66 https://www.bizjournals.com/tampabay/news/2019/04/26/tampa-and-hillsborough-hotel-revenue-and-occupancy.html

Table 4.33: Significant Tropical Cyclone Occurrences in Hillsborough County

Date	Information
October 1921	The hurricane of record for the 20th century in Tampa Bay was in October 1921 when a Category 3 hurricane passed within 30 miles of Tampa. Storm surge and abnormally high tides caused damage to several areas of Hillsborough County. Strong winds damaged trees and structures, and the agricultural industry suffered a significant loss. Six deaths were attributed to this hurricane and approximately $1 million dollars in damage.
September – October 1948	Two other hurricanes of note hit Tampa Bay within two and a half weeks of each other in September- October 1948 causing 10 and 15 feet of storm surge.
Hurricane Easy, September 1950	Hurricane Easy hit northwest of Tampa with 125 mph winds and tides reaching 6.5 feet.
Hurricane Gladys, October 1968	Hurricane Gladys came ashore to the north of Hillsborough County with hurricane force winds briefly affecting the area at 80 mph leading to storm surges of roughly 6 feet in the area and 3 deaths reported.
Hurricane Elena, September 1985	Elena threatened the area and caused the Tampa Bay region to conduct a major evacuation of over 500,000 people. The four bridges leading into Pinellas County were closed soon after Elena began threatening the county. Gandy Bridge was closed due to the eastbound span being struck by two barges during the storm. While the Sunshine Skyway and Courtney Campbell Parkway were closed due to debris and erosion on the highway, and the Howard Frankland Bridge was closed due to debris.
Tropical Storm Josephine, October 1996	The county sustained substantial flooding with storm tides (storm surge plus astronomical tide) to range from 4 to 6 feet in Hillsborough County.
Hurricane Georges, September-October 1998	Although Hurricane Georges caused a mandatory evacuation of coastal areas and manufactured homes, it caused minimal damage.
1995 – 2001 Hurricane Seasons	The following Tropical Storms and Hurricanes led to voluntary evacuation advisories with minimal to no damage due to the storm not directly hitting Hillsborough County: ● Tropical Storm Erin, August 1995 ● Hurricane Floyd, September 1999 ● Tropical Storm Harvey, September 1999 ● Hurricane Irene, October 1999 ● Hurricane Gordon, September 2000 ● Hurricane Gabrielle, 2001
2004 Hurricane Season	There were several tropical cyclones to affect Florida in the 2004 hurricane season, unprecedented in modern times. Hurricanes Charley, Frances, Ivan, and Jeanne as well as Tropical Storm Bonnie all hit Florida within a 48-day span –the most tropical activity in one state in 120 years. All four of these hurricanes either threatened or came close to striking Hillsborough County. The impact to Hillsborough County is as follows: ● Hurricane Charley made landfall as a Category 4 on the southwestern coast of Florida south of Tampa Bay, however, it was initially projected to directly impact Hillsborough County;

<table>
<tr><th>Date</th><th>Information</th></tr>
<tr><td></td><td>Hurricane Ivan was projected to directly hit Hillsborough County but passed to the west and made landfall as a Category 4 hurricane on the northern Gulf Coast;
Hurricane Frances made landfall on the east coast of Florida as a Category 2 hurricane and traversed through the county after crossing the state of Florida;
Hurricane Jeanne, which made landfall in central Florida east coast as a Category 3 hurricane traveled through Hillsborough County.
Hurricanes Frances and Jeanne caused substantial damage in Hillsborough County with flooding, extensive amount of debris and significant power outages, though no winds were recorded in the hurricane force category.</td></tr>
<tr><td>Hurricane Wilma, October 2005</td><td>Hurricane Wilma produced tropical force winds for much of southwest and west central Florida. Damages due to peak winds reaching 51 mph in Hillsborough County led to damages related to downed tree limbs and localized flooding. There were 381 insurance claims that totaled $127,000.</td></tr>
<tr><td>Tropical Storm Alberto, June 2006</td><td>A peak wind gust of 56 mph (49 knots) was recorded at the MacDill AFB with storm surge levels reaching 3.28 feet at McKay Bay and 2.75 feet at Old Port Tampa. The overspray from the surge combined with fresh water flooding closed parts of Bayshore Blvd.</td></tr>
<tr><td>Tropical Storm Debby, July 2012</td><td>Tropical Storm Debby caused significant damage and interruption from flood and wind. Storm surge from Debby flooded Bayshore Boulevard, a major artery between downtown Tampa and MacDill AFB. High winds associated with Debby caused the Sunshine Skyway Bridge (a major thoroughfare at the mouth of Tampa Bay) to be closed for several days, causing significant transportation interruption and detours. Although the Skyway Bridge is in Manatee County, south of Hillsborough County, detour traffic to the county was pushed to Hillsborough County surface roads and three cross bay bridges.

Tropical Storm Debby created isolated significant inland flooding situations; whereby, some structures within the University of South Florida area did receive flooding. Flooding within this area to storms less than the one-percent storm will be minimized in the future due to a stormwater project that was completed after 2012.</td></tr>
<tr><td>Hurricane Isaac, September 2012</td><td>Hurricane Isaac was anticipated to come into close proximity to Tampa Bay during the Republican National Convention (RNC) which was being held in the area at this time. Despite impacts to Hillsborough County being minor, the start of the RNC was postponed to ensure the safety of delegates, guests, members of the media attending the RNC, and citizens of the Tampa Bay area that would be engaged with the event.</td></tr>
<tr><td>Tropical Storm Andrea, June 2013</td><td>During Tropical Storm Andrea, approximately 3,000 “properties” were slightly affected by coastal storm surge. However, no structures were identified as having flood water within structures.</td></tr>
<tr><td>Tropical Storm Erika, September 2015</td><td>Tropical Storm (TS) Erika made landfall after an historic month of flooding (52" inches of rain in 2015 when normal was 21"). The storm crossed the northern end of Florida on September 2 after dropping rain in the southern half of the</td></tr>
</table>

Date	Information
	state. The Hillsborough County Emergency Operation Center (EOC) was activated and a state of emergency was actually declared on September 28 because the state was already water saturated.
Tropical Storm Colin, June 2016	Tropical Storm Colin developed over the Gulf of Mexico on June 5th. Maximum storm tide was around 3 to 7 feet MLLW in the afternoon of June 6th with a calculated highest storm surge ranged from around 2.5 to 4.5 feet during the evening. Widespread areas of 6 to 10 inches of rain fell over the area, The Skyway Bridge section of Interstate 275 connecting Manatee and Pinellas Counties across the Tampa Bay was closed by the Florida Department of Transportation for about 25 hours beginning late morning on June 6th. The Coast Guard closed the Port of Tampa due to high winds and was opened up again less than 24 hours later. Additionally, Hillsborough County Emergency Management reported numerous trees and 93,000 power outages in Tampa Bay at peak due to winds. Public Works removed approximately 30 trees from roadways. One of the trees landed on a home and removed the front of the home from the rest of the building, displacing a resident.
Hurricane Hermine, September 2016	Hurricane Hermine made landfall in the Florida Panhandle as a Category 1 Hurricane on September 2. In coastal Hillsborough County, the highest wind gust recorded was 58 MPH on the morning of September 2nd at Old Port Tampa. Storm total rainfall ranged from 6 to 10 inches, with the highest value recorded of 9.11 inches. Hillsborough County Emergency Management found 8 homes sustained minor damage, 7 homes had major damage, and 9 homes were destroyed. Damage was estimated at $800,000, mostly from wind damage. The Sunshine Skyway Bridge across the mouth of the Tampa Bay was closed for just over 24 hours beginning on the afternoon of the 1st due to the high wind speeds. Numerous power outages were also reported, with around 39,000 people without power in Pinellas and Hillsborough County on the evening of the 1st. The power outage affected the local wastewater treatment plant and greater than 900,000 gallons of partially treated wastewater dumped into the Hillsborough Bay. Heavy rainfall caused extensive flooding. A federal disaster was declared on September 28 and Hillsborough County became eligible for individual assistance. The total damage estimate for the storm was approximately $857,000.00.
Hurricane Matthew, October 2016	On October 3 the Governor declared a state of emergency for all Florida counties and activated the National Guard. On October 6 the President declared a federal state of emergency for jurisdictions in the path of the storm. In the Tampa Bay area, schools across the region cancelled classes in anticipation of widespread impact. While Matthew did not directly impact Florida, it did cause over 1 Million in power outages and has been blamed for 12 deaths statewide.
Hurricane Irma	In the morning of September 5th, less than 300 miles east of the Leeward Islands, Irma became a Category 5 hurricane with maximum sustained winds of 175 mph. Due to this potentially catastrophic hurricane heading toward Florida, Hillsborough County Office of Emergency Management initiated preparations and activated the Emergency Operations Center (EOC).

Date	Information
	The track of Irma resulted in a much stronger negative surge north of the eye, causing extremely low water levels. A couple of manatees got beached in the mud, and there was a lot of media coverage showing people walking out into the dry part of the bay to rescue them. In coastal portions of Hillsborough County, the highest winds reported from Hurricane Irma was gusts upwards of 91 mph (79 knots) with rainfall around 5 inches or greater, with the highest rain total being 16.18 inches. The wind resulted in damage to numerous homes, as well as knocking over trees and power lines. Hillsborough County Emergency Management reported that 41 homes or businesses were destroyed, 130 sustained major damage, 166 had minor damage, and an additional 93 were affected by hurricane Irma throughout Hillsborough County. The total damage from Irma in Hillsborough County was estimated at $19.95 million, including $17.86 million in individual assistance claims and $2.09 million in public assistance claims, of which, $7 million was estimated to be caused by wind damage in coastal portions of Hillsborough County. Additionally, crop damage to citrus plants in Hillsborough County was roughly estimated at $28.5 million. In Hillsborough, up to 265,000 customers were left without electricity – about 36%. In Hillsborough County wind gusts peaked at 91 mph, all rivers were at major flood stage, 60 shelters were opened for 30,000 people, and four points of distribution were opened to distribute food, water and ice. Heavy rains across the area also resulted in widespread river flooding, with rising water levels damaging houses on the Hillsborough River, the Alafia River, and the Little Manatee River. Flood damage to homes was estimated at $2 million. Water levels were above the major flooding threshold along the Little Manatee River at Wimauma (0.69 feet), Alafia River at Lithia (3.79 feet), and Hillsborough River at Morris Bridge (0.66 feet). The flood waters entered several mobile homes on 32nd and 33rd streets in Ruskin along the Little Manatee River, in homes near Lithia Pinecrest Road near the Alafia River, and mobile homes in the Pine Ridge Estates neighborhood along the Hillsborough River. Three indirect fatalities were reported in Hillsborough County from Hurricane Irma that occurred while the individuals were clearing debris.
Hurricane Dorian, September 2019	Hurricane Dorian was expected to make landfall on the east coast of Florida and travel across the state through the Tampa Bay area. Hillsborough County activated their EOC and began planning for evacuations and shelter operations. Schools in the area closed and sandbags were distributed. The system, however, slowed down over the Bahamas and began heading north along the east coast resulting in no direct effects from Dorian to the area.

Additionally, there have been 10 FEMA major disaster declarations in Hillsborough County that are related to tropical cyclone events.

Table 4.34: FEMA Major Disaster Declarations in Hillsborough County, Tropical Cyclone, 1953–2019[67]

Disaster Number	Date	Name/Description
DR-252	November 7, 1968	HURRICANE GLADYS
DR-337	June 23, 1972	TROPICAL STORM AGNES
DR-743	August 29–September 2, 1985	HURRICANE ELENA
DR-1141	October 7–21, 1996	TROPICAL STORM JOSEPHINE
DR-1539	August 11–30, 2004	TROPICAL STORM BONNIE AND HURRICANE CHARLEY
DR-1545	September 3–October 8, 2004	HURRICANE FRANCES
DR-1561	September 24–November 17, 2004	HURRICANE JEANNE
DR-4068	June 23–26, 2012	TROPICAL STORM DEBBY
DR-4280	August 31–September 11, 2016	HURRICANE HERMINE
DR-4337	September 4–October 18, 2017	HURRICANE IRMA

According to the NCEI Storm Events Database, there were 8 reports of tropical cyclone in Hillsborough County from 2016 to 2019.[68] These tropical cyclone events are only inclusive of those reported by NCEI from 1996 through October 2019, and events are only reported at the county level. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.35: Summary of Tropical Cyclone Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
HILLSBOROUGH COUNTY TOTAL	**8**	**0**	**0**	**$15,428,776**	**$3,857,194**

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in December 2019.

Table 4.36: Historical Tropical Cyclone Occurrences in Hillsborough County

[67] www.fema.gov/api/open/v1/DisasterDeclarationsSummaries.csv

[68] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Hurricane+%28Typhoon%29&eventType=%28Z%29+Tropical+Depression&eventType=%28Z%29+Tropical+Storm&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
Hillsborough County						
INLAND HILLSBOROUGH (ZONE)	6/6/2016	Tropical Storm	0	0	$0	$0
COASTAL HILLSBOROUGH (ZONE)	6/6/2016	Tropical Storm	0	0	$53,310	$0
COASTAL HILLSBOROUGH (ZONE)	9/1/2016	Tropical Storm	0	0	$851,513	$0
INLAND HILLSBOROUGH (ZONE)	9/1/2016	Tropical Storm	0	0	$0	$0
COASTAL HILLSBOROUGH (ZONE)	10/7/2016	Tropical Storm	0	0	$0	$0
INLAND HILLSBOROUGH (ZONE)	7/31/2017	Tropical Storm	0	0	$0	$0
INLAND HILLSBOROUGH (ZONE)	9/10/2017	Hurricane	0	0	$7,235,947	$29,672,590
COASTAL HILLSBOROUGH (ZONE)	9/10/2017	Hurricane	0	0	$7,288,005	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

Storm Surge

According to the NCEI Storm Events Database, there were 2 reports of storm surge in Hillsborough County from 1998 to 2019.[69] These storm surge events are only inclusive of those reported by NCEI from 1996 through October 2019, and events are only reported at the county level. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.37: Summary of Storm Surge Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
HILLSBOROUGH COUNTY TOTAL	**2**	**0**	**0**	**$0**	**$0**

[69] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Storm+Surge%2FTide&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in December 2019.

Table 4.38: Historical Storm Surge Occurrences in Hillsborough County

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
Hillsborough County						
APOLLO BEACH	1/2/1998	Storm Surge/Tide	0	0	$0	$0
APOLLO BEACH	1/2/1999	Storm Surge/Tide	0	0	$0	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

4. Probability of Future Tropical Cyclone

Since tropical cyclones are random in distribution, it is impossible to forecast whether Hillsborough County will experience a tropical storm or hurricane. However, due to the high frequency of tropical cyclones that have affected Florida in the past, it is reasonable to assume that Florida will experience tropical cyclones in the future. However, minor tropical cyclones (tropical depressions, tropical storms, Category 1, and Category 2) occur more frequently than major tropical cyclones (Category 3, Category 4, and Category 5).

There have been numerous other storms which have affected the area causing protective actions and damage. It is considered that the occurrence of a hurricane in the Tampa Bay area on an annual basis is high. The coastal regions of the United States are associated with intense winds from tropical storms and thunderstorms. It is not uncommon to have winds exceed 100 mph within these areas. Florida, including Tampa Bay, is susceptible to winds of greater than 100 mph on a regular basis.

Probability Based on Historical Occurrences

An analysis of tropical cyclone reports from 1996 to 2019 in Hillsborough County from the NCEI Storm Events Database indicates that there will be one to two tropical storms, less than one hurricane, and less than one storm surge event each year in Hillsborough County.

Table 4.39: NCEI Tropical Cyclone Reports 1996–2019[70]

Type of Tropical Cyclone	NCEI Reports	Average per Year
Tropical Storm	6	1.5
Hurricane	2	< 1
Storm Surge	2	< 1

[70] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Hurricane+%28Typhoon%29&eventType=%28Z%29+Tropical+Depression&eventType=%28Z%29+Tropical+Storm&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Type of Tropical Cyclone	NCEI Reports	Average per Year
TOTAL	**10**	**2.3**

Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability) for minor tropical cyclones (tropical depressions to Category 2 storms) and a probability level of possible (1 to 10% annual probability) for major tropical cyclones (Category 3 to Category 5 storms).

5. Tropical Cyclone Impact Analysis

Portions of the City of Tampa and Unincorporated Hillsborough County face potential storm surge conditions in addition to winds. The inland portions of those jurisdictions as well as Plant City and Temple Terrace could be devasted by wind impacts. All jurisdictions could receive some or all of the following impacts due to tropical cyclones.

- Public
    - Injury/death
        - Car accidents because of flood waters, high winds, panic, traffic jams because of evacuations, no power after storm
        - Not receiving emergency response during storm –emergency medical services
        - Delayed emergency response because of blocked roads, etc.
        - Drowning in flood waters
        - Hit or crushed by debris
        - Stranded on roof because of flooding
        - Exposure to hazardous materials
        - Illness from contaminated water
        - Pet and other animal deaths from all of the above
    - Damage to Home or Property
        - Power loss or damage to power connections on home
        - Mold damage causing the need for expensive mold remediation actions
        - Cost to replace damaged and destroyed items, such as furniture, flooring, etc.
        - Cost and labor to repair damaged homes and other structures to make the house inhabitable
        - If the property was uninsured, the cost falls upon the property owner
        - Hotel room fees or having to live in a shelter until damage is repaired or home is replaced
        - Damaged or washed-away vehicles
        - Lost wages because no way to get to work if roads are blocked or if car was damaged in storm or if employer experienced damage
        - Possibly forced to evacuate
            - Cost to travel
            - Cost to stay at hotel
            - Loss of wages if out of town

      - Loss of food if you cannot go back to get it
    - Power outage
      - Cost of generators and gas to run the generators
        - Risk of accidental fire or carbon monoxide poisoning is high
      - Loss of food in refrigerator and freezer
      - Difficulties travelling anywhere because of outages at traffic lights
      - Cost of purchasing disaster supplies such as flashlights
      - Hotel room fees or having to live in a shelter until power is restored
      - Lost wages because employer is experiencing power outage
    - Emotional or psychological toll of surviving
      - If a friend or family member dies in storm, individual may feel great sense of guilt or stress
      - If major damage occurs for an individual, they will likely experience stress and anxiety dealing with evacuating, staying in shelters, working to get insurance payments, working to get government assistance, etc.
      - Being forced to leave or forfeit a pet in an unsafe area during or after a tropical cyclone
- Responders
  - Injury/death
    - Responding during tropical storms is unsafe
    - Responding immediately after tropical storms is unsafe because of debris, unstable transportation infrastructure, unstable structures
    - Rescuing people from unstable buildings or by boat
    - Exposure to hazardous materials
  - Stress caused by severity of tasks such as rescuing people
  - Feelings of guilt for not being able to save people
  - Witnessing gruesome scenes of injured or dead
- Continuity of Operations (including continued delivery of services)
  - Loss of revenue if businesses cannot operate during or after event
  - Loss of wages if your employer's organization is damaged or destroyed and you cannot work o Utility failures such as electric or gas may prevent businesses from opening even if there is no damage
  - Utility failures may impede or prevent government offices from continuing daily services
  - Severe damage and interruption to transportation systems and infrastructure like roads and bridges, communication systems, power, water, wastewater, etc.
- Property, Facilities, Infrastructure
  - Damaged or destroyed property, such as homes and other buildings
    - Roofing is particularly susceptible to damage from high winds
    - The first floor of many buildings, plus all the items on that floor, are susceptible to severe damage from flooding
  - Cost of repairing damage to property such as buildings
  - Cost of replacing items damaged such as furniture on the first floor of a flooded home

- Crop damage or loss
- Damage to transportation infrastructure, like a road being washed out or a bridge collapsing, and/or closure of major transportation networks
- Inability to get clean water
- Inability to control wastewater
- Release of hazardous materials

- Environment
  - Beach and dune erosion
  - Downed trees
  - Eroded river banks
  - Release of hazardous materials can contaminate or damage the environment
  - Loss or damage to habitat for animals because of flooding or high winds
  - Crop damage or loss
  - Event-generated marine debris impacting waterway navigation and submerged wetland habitats
- Economic Condition
  - Damaged and destroyed businesses leading to long-term closures and possibly permanent closures
  - Delayed re-opening of businesses because of utility issues, road blockages, etc.
  - Crop damage or loss from flooding and high winds
  - Absenteeism from work
  - Loss of tourism because of coastal erosion or damaged hotels and attractions
- Public Confidence in Jurisdiction's Governance
  - Evacuations not ordered in time lead to decrease in public confidence
  - Shelters not opened or having little information
  - Warnings not communicated effectively
  - Communicating too much
  - Over exaggeration of possible storm impacts, especially if the storm does not have expected impacts

Impact Summary

Using the 2016 Hurricane Evacuation Zones some of the major commercial, industrial, and residential areas impacted would include:

a. **Category 1 Storm**: Rocky Point; the western, southern, and eastern edges of the Interbay Peninsula including portions of MacDill Air Force Base, Davis Island, Harbor Island; Hookers Point, Port Sutton, Riverview, Gibsonton, Big Bend, Apollo Beach, Ruskin, and portions of the Hillsborough, Alafia, and Little Manatee Rivers floodplain.

b. **Category 3 Storm**: same as a Category 1 storm; plus, portions of Town N' Country, the Westshore business district including a portion of the western-most runway of Tampa International Airport; two-thirds of the Interbay Peninsula including all of MacDill Air Force Base, the eastern and western sides of the Hillsborough River to the Dam including Downtown Tampa and U.S. 41 south of Palm River.

i. **Category 5 Storm**: same as a Category 3 storm; plus expanded portions of Town N' Country; the three runways and portions of the terminal at Tampa International Airport, all of the Interbay Peninsula south of Henderson Avenue; area between Hillsborough Avenue and the U.S. 301/I-75 interchange; area east of the By-pass Canal, south of 7th Avenue, and north of the Crosstown Expressway, areas between U.S. 41 and I-75, and expanded areas of the Hillsborough, Alafia, and Little Manatee River floodplains.

Impact to the Built Environment

The entire built environment may be vulnerable to hurricanes and tropical storms due to wind, rain and/or storm surge damages. The Saffir-Simpson Hurricane Wind Scale does not address the potential for other hurricane-related impacts (i.e., storm surge, rainfall-induced floods, and tornadoes) simply wind-caused damage that are dependent on local building codes in effect and how well and how long they have been enforced. For example, building codes enacted during the 2000s in Florida are likely to reduce the damage to newer structures. Hurricane wind damage is dependent on factors such as duration of winds, change of wind direction, and age of structures.

Homes and businesses that were built under older building codes and standards, or structures that do not have impact resistant features or protection that can be installed, may be more vulnerable to wind damage. Most of the damage from strong winds is caused not by the wind itself, but from the debris it carries. Therefore, one of the best ways to mitigate for wind hazards is to minimize the amount of debris that can become airborne. Property maintenance regulations should be adopted and enforced because areas near trash piles, junkyards, and unkempt properties are vulnerable to damage from airborne debris. Buildings that are improperly constructed or maintained, high rise buildings, and manufactured homes may be more susceptible to wind events and contribute to airborne debris.

Impact to Manufactured Homes and RV

Water and wind both pose a threat to manufactured homes leading to higher risk to infrastructure and even those that are secured by the required steel bands are less resilient than homes that have an established foundation. Manufactured homes are required to be elevated and anchored to a vertical, engineer-certified system allowing some mitigation for minor flood prevention.[71]

Manufactured homes have a reputation for being poorly designed and are therefore unsafe in hurricane force winds and storm surge. Only a fraction of mobile homes are strapped down with the kind of hardened braces meant to withstand hurricane fierce winds and minor flooding. Upgrading and retrofitting an older mobile home is uneconomical. This has resulted in the development of new safety regulations with regards to construction practices. There are three distinct generations of mobile homes based on their year of manufacture which have been identified as: Pre-1976, 1976 to 1994, and Post-1994.[72] Units that were manufactured before 1976 do not have manufacturing design standards, whereas

[71] Florida Manufactured Homes Association (FMHA, 2018). Hurricanes & Manufactured Homes: Four Myths Busted. Retrieved at http://www.fmha.org/.

[72] Schreiber, S. (2005). Mobile Homes and Hurricanes: The Crisis in Florida. Association of Collegiate Schools of Architecture (ACSA). Retrieved from http://www.acsa-arch.org/.

those between 1976-1994 were built under HUD's Manufactured Home Construction and Safety Standards (MHCSS; 24 CFR 3280) and its Model Manufactured Home Installation Standards (24 CFR 3285). After Hurricane Andrew, the standards then changed and all Post-1994 generations of manufactured homes have incorporated stricter design and manufacturing standards including wind load standards based on American Society of Civil Engineers (ASCE) specifications. Despite these changes to current code, it is estimated that a large portion of mobile homes are not installed to current code.

Impact to Critical Infrastructure

Power lines are at risk of toppling or having trees fall on them during wind storms resulting in loss of power, risk of fire, and injury if someone comes in contact with a downed line. Uprooted trees can cause damage to underground and overhead utilities. Hurricanes and tropical storms may also cause flying debris that cause additional damages.

With surge heights anticipated to reach bridge causeway levels, pounding by waves may destroy sections of bridges as seen during hurricanes Ivan in 2004 and Katrina in 2005. From these examples, it is speculated that the Tampa Bay bridges would be in jeopardy under severe hurricane conditions.[73]

Essential Facility Inventory

There are 19 hospitals in Hillsborough County with a total bed capacity of 4,593 beds.[74] There are 252 public schools[75] (31 high schools, 33 magnet schools, 43 middle schools, 137 elementary schools, 8 K-8 schools), 53 charter schools, 63 private schools, 12 universities, and 12 colleges. There are 70 fire stations (23 Tampa Fire Rescue, 44 Hillsborough County Fire Rescue, 1 Plant City Fire Rescue Department, and 2 Temple Terrace Fire Department), and 3 emergency operation facilities (Hillsborough County EOC, City of Tampa EOC, and the University of South Florida EOC).

Table 4.40: Hospitals and Bed Capacity in Hillsborough County

Hospital	Beds
AdventHealth Carrolwood	103
AdventHealth Tampa	536
Brandon Regional Hospital	422
H. Lee Moffitt Cancer Center & Research Institute	206
James A. Haley Veterans' Hospital	353
Kindred Hospital Bay Area – Tampa	73
Kindred Hospital Central Tampa	102
Memorial Hospital of Tampa	183
Shriners Hospital for Children – Tampa	60
South Bay Hospital	138
South Florida Baptist Hospital	147
St. Joseph's Children's Hospital	186
St. Joseph's Hospital Behavioral Health Center	60
St. Joseph's Hospital, Inc.	437

[73] https://www.jstor.org/stable/4124819?seq=14#metadata_info_tab_contents
[74] Florida Hospital Association (FHS), 2019. http://www.fha.org/reports-and-resources/hospital-directory.aspx
[75] http://www.sdhc.k12.fl.us/schools/

Hospital	Beds
St. Joseph's Hospital – North	108
St. Joseph's Hospital – South	114
St. Joseph's Women's Hospital	157
Tampa Community Hospital	201
Tampa General Hospital	1007
19 Total Hospitals in Hillsborough County	**4,593 Total Beds**

Source: Florida Hospital Association (FHA), 2019. [76]

Impact to Hotels and Motels in Hillsborough County

The majority of hotels in Tampa Bay have seen an incline in occupancy rates and revenue over the past years as tourism increases in the area. In April 2019, Hillsborough County hotels overall had a high 82.4 percent occupancy rate and increase of revenue to $244,804,472.[77] Many hotels in the county are located in coastal areas including Downtown Tampa and Westshore near Tampa International Airport in predominantly evacuation Zones A and B. This causes associated concerns for the added population needing to evacuate, housing post-disaster, recovery personnel having housing, and for employees to be able to return to work. Furthermore, this could have devastating effect on our tourism industry post-disaster.

In 2018, there was an estimated 23.6 million visitors in Hillsborough County with over 6 million hotel room nights booked. There are 53,446 jobs sustained by tourism and over $944 million in taxes sustained by tourism with $206 million of which accrues to local government. The $206 million in local taxes generated would be enough to fully fund the Hillsborough County Police Department ($160m).[78] Protecting and engaging the hotel industry in mitigation planning would be important to protect visitors and the local economy.

Ecological Impacts of Tropical Cyclone

Tropical cyclones cause severe coastal erosion and flooding or wind damage to natural and agricultural assets. Crops are more susceptible to wind damage as strong winds can break plants and ruin crops.

Coastal areas and areas along canals and rivers are more vulnerable to storm surge. Saltwater inundation can occur inland through the canals and waterways along the coast, having a far-reaching ecological impact on the flora and fauna inland.[79] Furthermore, canals being built or maintained through dredging, penetrate the aquifer allows salt water intrusion into this source of drinking water for Hillsborough County. Salt water intrusion impacts soil quality and building construction as well.

Natural Systems to Reduce Stormwater Runoff

[76] Florida Hospital Association (FHS), 2019. http://www.fha.org/reports-and-resources/hospital-directory.aspx

[77] https://www.bizjournals.com/tampabay/news/2019/04/26/tampa-and-hillsborough-hotel-revenue-and-occupancy.html

[78] Tourism Economics. The Economic Impact of Tourism on Hillsborough County, 2018. https://assets.simpleviewinc.com/simpleview/image/upload/v1/clients/tampabay/Tourism_Economics_2018_Economic_Impact_c6fa7ef7-42fd-4b93-9c88-2bf382d02e9e.pdf

[79] Williams, V. (2010) Identifying the economic effects of salt water intrusion after Hurricane Katrina. Journal of Sustainable Development, https://doi.org/10.5539/jsd.v3n1p29

Impervious surfaces due to development are an environmental concern because, with their construction, a chain of events is initiated that modifies the air quality and water resources. The pavement materials seal the soil surface, eliminating rainwater infiltration and natural groundwater recharge. There was a 26.36% net increase in impervious surface area in Hillsborough County due to development between 1996 and 2010. During this time 28.57 miles^2 of agricultural land was developed and 35.41 miles^2 of scrub, woody wetlands, and emergency wetlands were developed as well.

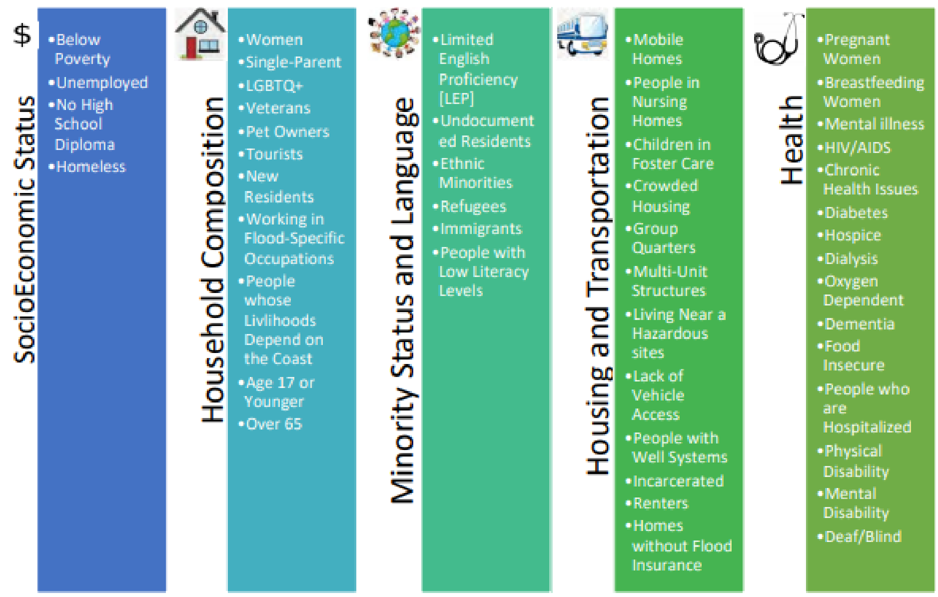
Social and Population Impacts from Tropical Cyclone

Understanding the current demographic and socioeconomic characteristics of a population provides context to understanding vulnerabilities within communities and neighborhoods across Hillsborough County. Examining potential future problems that may impact populations in these at-risk areas allow for the development and implementation of structural and non-structural mitigation measures aimed to protect those more susceptible to the effects of tropical storms and hurricanes. This knowledge can increase the ability of local planners and the population to prepare before an event, remain safe during an event and better plan for rehabilitation in the aftermath.

Population and social vulnerability need to be taken into consideration to ensure planners mitigation measures are taking into consideration social inequalities that may lead to some groups being more susceptible to the impacts of hazards, as well as hinder their ability to mitigate risk in a way that will make them more resilient to the effects of a natural or technological disaster. According to academic researchers Cutter & Emrich (2006), "this susceptibility is not only a function of the demographic characteristics of the population (age, gender, wealth, etc.), but also more complex constructs such as health care provision, social capital, and access to lifelines (e.g., emergency response personnel, goods, services).[80] In this section, population and social vulnerability is examined in regards to tropical storms and hurricanes. Some of the key finding and considerations focus on populations that have been identified across the five themes outlined in the *2019 Hillsborough County Community Vulnerability Study* including (1) socioeconomic status, (2) household composition, (3) minority status and language, (4) housing and transportation, and (5) health vulnerabilities of Hillsborough County residents.[81]

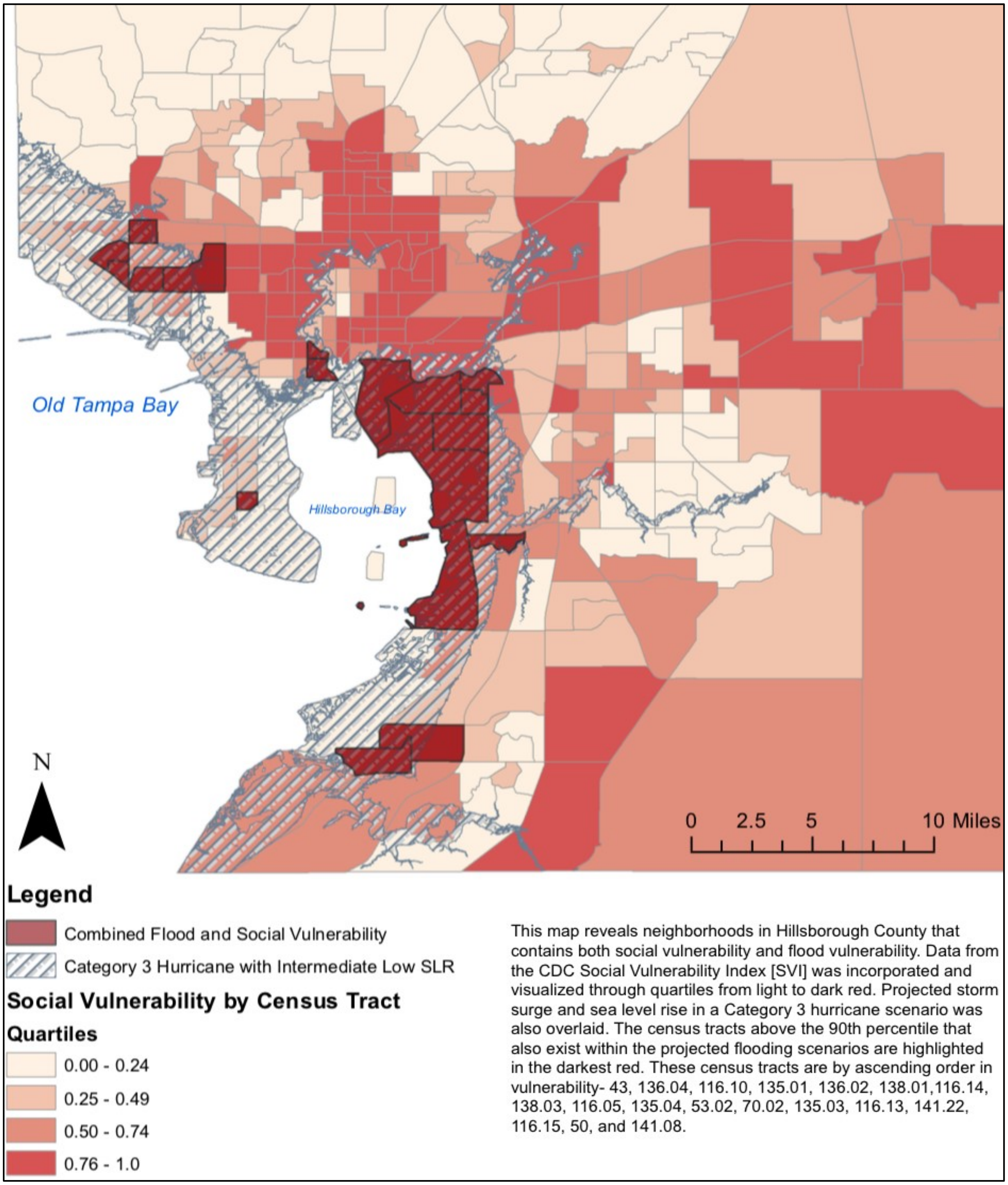
[80] Cutter, S. & Emrich, C. (2006). Moral Hazard, Social Catastrophe: The Changing Face of Vulnerability Along the Hurricane Coasts. Annals of The American Academy of Political and Social Science, 604. 102-112. doi:10.1177/0002716205285515.
[81] http://www.planhillsborough.org/hillsborough-county-community-vulnerability-study/

Figure 4.25: List of Vulnerable Populations Broken Down into Five Categories



Source: 2019 Hillsborough County Community Vulnerability Study adapted by the Center for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI).

Figure 4.26: Hillsborough Counties Neighborhoods with High Social Vulnerability and Flooding, and Category 3 Hurricane with Intermediate Low Sea Level Rise Projections



Poverty and Homelessness

According to the U.S. Bureau of Labor Statistics (BLS), the unemployment rate for Hillsborough County was 3.4% in June 2019.[82] Approximately 15.5% of individual residents in Hillsborough County are living below the poverty line.[83] These segments of the population, due to their unstable economic situations, are likely to seek assistance, may not have adequate health or homeowner's insurance, or may end up homeless after a major hurricane event.

New Residents

Historically, hurricanes and tropical storms have caused the greatest amount of property damage and as more people move to Hillsborough County and more development takes place the potential for hurricane-related deaths and damages, increases each year. From approximately 1.23 million residents in 2010 to approximately 1.4 million in 2018, there has been an estimated 16.9% increase in population growth in Hillsborough County.[84] According to the Bureau of Economic and Business Research (2018), an upward estimate of 1.04 million new residents are projected to migrate to the area by 2045.[85]

Older Adults

According to U.S. Census Bureau (2018), 14.3% of the Hillsborough County population is over the age of 65. These are a portion of the population that may be more vulnerable due to financial barriers, lack of social networks and transportation, or due to health reasons. Many retirees live on fixed incomes and may not have resources for home mitigation measures and to ensure they have the supplies necessary to be prepared.

They may need additional assistance to help retrofit or mitigate the effects of tropical storms and hurricanes to their homes or need assistance for evacuating due to a variety of chronic health problems including cognitive impairments and diminished mobility.

Between 2010 and 2045, Hillsborough County will experience considerable growth in its older population. In 2045, the population aged 65 and over is projected to be 342,382, over double the estimated population of 145,237 residents in 2010.[86] The aging of the population will have wide-ranging implications for Hillsborough County, presenting challenges to policy makers and for emergency planners.

Table 4.41: Hillsborough County Population Age, 2018 estimates

Population (years of age)	Estimate	Percent
Total	**1,436,888**	**100%**
Under 5	89,087	6.2%
5 to 17	323,300	22.5%
18 to 64	819,026	57%

[82] U.S. Bureau of Labor Statistics, Unemployment Rate in Hillsborough County, FL [FLHILL7URN], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/FLHILL7URN

[83] https://www.census.gov/quickfacts/fact/table/hillsboroughcountyflorida/PST120218

[84] https://www.census.gov/quickfacts/fact/table/hillsboroughcountyflorida/PST120218

[85] https://www.bebr.ufl.edu/sites/default/files/Research%20Reports/projections_2018.pdf

[86] https://www.bebr.ufl.edu/sites/default/files/Research%20Reports/projections_2019_asrh.pdf

Population (years of age)	Estimate	Percent
65 and over	205,475	14.3%

Source: U.S. Census Bureau, 2018 estimates.[87]

Housing and Transportation

Housing and transportation are a major concern due to the damaging effects of a tropical cyclone on the built environment. Mobile/manufactured home residents and persons who may not have adequate resources to protect their homes or access to evacuation resources are at greatest risk to tropical storms and hurricanes. Prolonged power outages and gas shortages cause additional challenges to businesses and service providers and can disproportionately impact persons whom rely upon regular home services such as medical services or food delivery. Furthermore, debris can block evacuation and emergency services access routes. The extent of debris and infrastructure outages and restoration times can complicate and increase response and recovery timelines.

Vulnerability is not just a product of building codes; however, social vulnerability plays an important role in understanding risk. Identifying mobile home parks with exceptional social cohesion serves as a model for those where social capital appears to be lacking, and in that way improve the disaster preparedness of those areas.

There are 479 mobile home parks and over 33,270 manufactured homes registered in Hillsborough County.[88] Residents in mobile home communities usually own their homes and pay monthly rent to park on the property within the mobile home park. The arrangement is popular among retirees as well as low-income families looking for an affordable housing option.

By drawing from various levels of flood plain data for Hillsborough County and cross referencing it with the location of our mobile home parks, identifying which manufactured home parks are at the greatest risk for future storm surge and flooding events has been conducted. Long-term risks exist for those who live closest to the coastline along Tampa Bay in South County, as well as, Town 'N Country with regards to storm surge, flooding and anticipated sea-level rise. Furthermore, there is a concern for residents of manufactured home parks that lay within the watersheds of some of our largest rivers (specifically the Alafia and Hillsborough rivers) that may lead to risk of in-land flooding during tropical storm and hurricane events. In the event of a flood, many of these home parks could see significant destruction of personal property and displacement of their residents.

High-density residential areas in that are susceptible to potential storm surge include Town 'N Country, South Tampa, Davis Island, Apollo Beach, and Ruskin. Tampa ranked in the top 10 among large metropolitan areas with severe shortages of rental homes affordable to low-income households.[89]

[87] https://www.census.gov/quickfacts/fact/table/hillsboroughcountyflorida/PST120218

[88] US Census Bureau. (2017). Physical housing characteristics for occupied housing units, 2013-2017 ACS 5-year estimates. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF.

[89] https://reports.nlihc.org/oor/florida

Health Vulnerabilities

Populations of concern in Hillsborough County include individuals that have health concerns that need to be considered whether they decide to evacuate or stay in their home during a tropical cyclone. Many individuals may be electricity dependent (i.e., ventilators, oxygen concentrators, CPAP and other sleep apnea devices, dialysis machines, take medications needing refrigeration) and have functional needs that pose a challenge to their safety and well-being. Healthcare facilities could experience extended periods of disruption after a disaster and mitigating against potential risks, developing comprehensive plans for their facility, and having adequate resources on hand is essential.

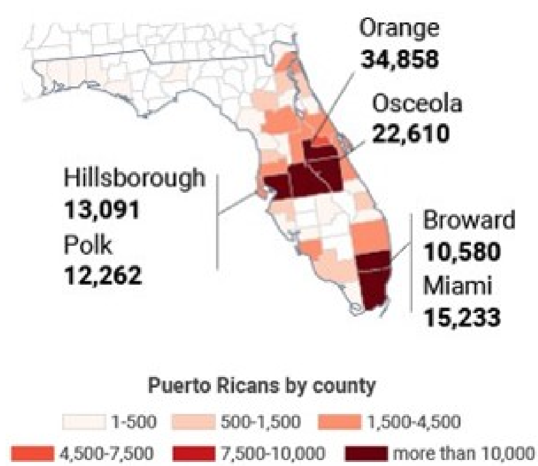
As mentioned, populations over the age of 65 may be more susceptible to health concerns that may impact their ability to evacuate or mitigate against tropical storms and hurricanes. Between 2010 and 2045, Hillsborough County will experience considerable growth in its older population. In 2045, the population aged 65 and over is projected to be 342,382, over double the estimated population of 145,237 residents in 2010.[90] The aging of the population will require the county to identify additional facilities to serve as Special Needs Shelters and retrofit their facilities to meet requirements necessary to serve as a SNS. In 2019, there were 1,858 special needs shelter pre-registrants from across Hillsborough County.

Population Migration

Migration of persons affected by catastrophic hurricanes from other areas of Florida and the Caribbean may have an effect on Hillsborough County. For example, nearly 400,000 Puerto Ricans left the island following Hurricane Maria between October 2017 and February 2018 with Florida receiving about 150,000 between these months. Hillsborough County had an influx of new residents from Puerto Rico migrating due to the conditions on the island following the impact of this hurricane. There was an estimated migration of 13,091 Puerto Ricans to Hillsborough County between October 2017 and February 2018 following Hurricane Maria.

Table 4.42: Estimated Population of Puerto Ricans in Florida by County.[91]

Counties in Florida Receiving Puerto Rican Population	Total
Orange	34,858
Osceola	22,610
Miami-Dade	15,233
Hillsborough	13,091
Polk	12,262
Broward	10,580
Seminole	7,430



In 2018, Hurricane Michael lead to an exodus of residents from the Florida Panhandle to other communities that had adequate rental housing and job opportunities. Following Hurricane Dorian (2019),

[90] https://www.bebr.ufl.edu/sites/default/files/Research%20Reports/projections_2019_asrh.pdf

[91] https://www.citylab.com/environment/2018/05/watch-puerto-ricos-hurricane-migration-via-mobile-phone-data/559889/

residents from the Bahamas began to seek refuge on other adjacent islands or communities in Florida. The usefulness of monitoring geo-referenced data from Hillsborough County School enrollment numbers can help support disaster relief efforts, especially when it comes to developing accurate emergency planning and determining when and where the affected population is relocating following a major disaster in other areas of the state and if the Caribbean islands are affected by a major hurricane.

Tropical cyclones can have a severely negative impact on the local economy due to loss of employment and the closure of local businesses that had major impacted from the storm if business continuity and mitigation measures are not implemented. It can take an estimated four to eight years for the economy to recover without outside stimulus to support reconstruction and recovery.[92]

Impact on Visitors and Tourism in Hillsborough County

Many hotels in Hillsborough County are located along coastal areas and rivers that would be in an evacuation Zone A or B. In the event of a major hurricane, visitors and evacuees that are staying in hotels or motels may need to seek refuge elsewhere if the location is in vulnerable to storm surge. Visitors and tourists may not be familiar with the area or what to do to prepare for a hurricane making them more vulnerable.

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Due to Hillsborough County's geographic location, the entire county is vulnerable to damage from tropical cyclones. As the population of the county increases, so does the number of those who have not experienced the impact of a tropical cyclone or major hurricane.

The vulnerability of the county to hurricanes varies with the progression of the hurricane season. Early and late in the season (June and October), the region of maximum hurricane activity is in the Gulf of Mexico and the western Caribbean. Most of those systems that move into Florida approach the state from the south or southwest, entering the keys or along the west coast. Mid-season (August and most of September), tropical cyclones develop off the coast of Africa. These systems are known as Cape Verde Storms and approach the state from the east or southeast.

Historic Losses

The NCEI Storm Events Database information, presented in the Historical Occurrences section above, also contained property and crop damage dollar amounts, which is shown in the table below. This information, combined with values of structures in hazard areas and with projected losses from HAZUS-MH, can provide a more complete analysis than using only one data source.

Table 4.43: Tropical Cyclone Events in Hillsborough County, by Type, (1996–2019)[93]

Type of Event	Number of Events	Deaths	Injuries	Property Damage (2019 dollars)	Crop Damage (2019 dollars)
Tropical Storm	6	0	0	$904,824	$0

[92] https://www.hillsboroughcounty.org/library/hillsborough/media-center/documents/emergency-management/21--pdrp-economic-analysis-of-a-hurricane.pdf.

[93] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Hurricane+%28Typhoon%29&eventType=%28Z%29+Storm+Surge%2FTide&eventType=%28Z%29+Tropical+Depression&eventType=%28Z%29+Tropi

Type of Event	Number of Events	Deaths	Injuries	Property Damage (2019 dollars)	Crop Damage (2019 dollars)
Hurricane	2	0	0	$14,523,952	$29,672,590
Storm Surge	2	0	0	$0	$0
TOTAL	**10**	**0**	**0**	**$15,428,776**	**$29,672,590**

The information can be analyzed to provide the average amount of property and crop damage that is likely each year. This information is shown in the chart below.

Table 4.44: NCEI Tropical Cyclones, 1996–2019[94]

NCEI Storm Event (hazard)	Average Tropical Cyclones per Year	Annualized Property Loss (2019 dollars)	Annualized Crop Loss (2019 dollars)
All Types of Tropical Cyclones	0.5	$3,857,194	$7,418,148

According to the analysis, Hillsborough County is historically vulnerable to over $15.4 million in property damages and almost $29.7 million in crop damages from approximately 0.5 tropical cyclone events each year.

Exposure

Storm Surge

To estimate exposure of improved property to storm surge, the approximate number of parcels and their associated improved valued located in hurricane risk areas was determined using GIS analysis. The risk areas utilized are the hurricane storm surge areas associated with various category hurricanes.

Table 4.45: Estimated Exposure of Improved Property to Hurricane Risk Areas – Hurricane Storm Surge (Category 1, 2, and 3)

	Buildings and Parcels in Hurricane Risk Areas								
	Category 1			Category 2			Category 3		
	No. of Parcels	No. of Bldgs	Improved Value	No. of Parcels	No. of Bldgs	Improved Value	No. of Parcels	No. of Bldgs	Improved Value
Plant City	0	0	$0	0	0	$0	0	0	$0
Tampa	16,742	90,330	$8,033,881,470	29,347	150,731	$11,323,436,395	40,805	203,776	$15,337,917,609
Temple Terrace	0	0	$0	0	0	$0	13	64	$5,711,749

cal+Storm&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

[94] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Hurricane+%28Typhoon%29&eventType=%28Z%29+Storm+Surge%2FTide&eventType=%28Z%29+Tropical+Depression&eventType=%28Z%29+Tropical+Storm&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

	Buildings and Parcels in Hurricane Risk Areas								
	Category 1			Category 2			Category 3		
	No. of Parcels	No. of Bldgs	Improved Value	No. of Parcels	No. of Bldgs	Improved Value	No. of Parcels	No. of Bldgs	Improved Value
Unincorporated	22,164	112,272	$5,540,717,831	36,743	181,390	$8,335,977,473	51,731	251,939	$11,932,866,392
HILLSBOROUGH COUNTY TOTAL	**38,906**	**202,602**	**$13,574,599,301**	**66,090**	**332,121**	**$19,659,413,868**	**92,549**	**455,779**	**$27,276,495,750**

Table 4.46: Estimated Exposure of Improved Property to Hurricane Risk Areas – Hurricane Storm Surge Total (Category 4 and 5)

	Buildings and Parcels in Hurricane Risk Areas					
	Category 4			Category 5		
	No. of Parcels	No. of Buildings	Improved Value	No. of Parcels	No. of Buildings	Improved Value
Plant City	0	0	$0	0	0	$0
Tampa	55,032	267,692	$19,163,983,026	67,880	329,489	$21,480,617,775
Temple Terrace	204	1,597	$98,880,587	840	6,211	$256,987,200
Unincorporated	72,626	351,844	$17,795,460,314	98,450	474,995	$23,000,185,780
HILLSBOROUGH COUNTY TOTAL	**127,862**	**621,133**	**$37,058,323,927**	**167,170**	**810,695**	**$44,737,790,755**

To estimate the county population's exposure to storm surge, areas of risk were intersected with census block data. As a result, these population estimates are going to be an overestimate of risk since the entire census block's population count will be included even if only a portion of the census block's area is located in a hurricane storm surge area. However, these estimates still give an idea of the county population's risk to storm surge.

Table 4.47: Estimated Exposure of Population to Hurricane Risk Areas – Hurricane Storm Surge (Category 1, 2, and 3)

Storm Surge Depth	Population in Hurricane Risk Areas											
	Category 1				Category 2				Category 3			
	County Total	Tampa	Temple Terrace	Uninc.	County Total	Tampa	Temple Terrace	Uninc.	County Total	Tampa	Temple Terrace	Uninc
0 to 1 ft	14,559	7,199	0	7,360	11,942	4,655	0	7,287	11,638	6,530	0	5,108
1 to 2 ft	20,638	8,847	0	11,791	12,610	6,729	0	5,881	14,248	5,835	0	8,413
2 to 3 ft	21,502	9,790	0	11,712	17,401	7,847	0	9,554	17,701	9,099	0	8,602
3 to 4 ft	20,213	7,735	0	12,478	15,563	6,847	0	8,716	12,038	5,219	8	6,811
4 to 5 ft	13,346	7,938	0	5,408	17,870	8,646	0	9,224	12,319	4,082	0	8,237
5 to 8 ft	16,384	5,239	0	11,145	66,300	27,554	0	38,746	44,978	20,235	0	24,743
8 to 11 ft	502	117	0	385	41,232	18,439	0	22,793	53,771	22,262	0	31,509
11 to 14 ft	0	0	0	0	6,340	1,262	0	5,078	64,851	27,184	0	37,667
> 14 ft	0	0	0	0	84	0	0	84	28,047	12,378	0	15,669

*Plant City has no population located in storm surge risk areas, so it is not included in this table.

Table 4.48: Estimated Exposure of Population to Hurricane Risk Areas – Hurricane Storm Surge (Category 4 and 5)

Storm Surge Depth	Population in Hurricane Risk Areas							
	Category 4				Category 5			
	County Total	Tampa	Temple Terrace	Uninc.	County Total	Tampa	Temple Terrace	Uninc.
0 to 1 ft	14,124	3,535	125	10,464	18,113	7,290	350	10,473
1 to 2 ft	9,912	5,020	31	4,861	19,950	6,349	55	13,546
2 to 3 ft	10,371	4,168	0	6,203	15,157	5,376	328	9,453
3 to 4 ft	8,934	4,779	0	4,155	16,552	3,660	301	12,591
4 to 5 ft	11,812	3,530	436	7,846	15,830	4,366	85	11,379
5 to 8 ft	34,729	12,343	0	22,386	44,362	11,862	224	32,276
8 to 11 ft	42,414	22,899	8	19,507	32,319	11,546	156	20,617
11 to 14 ft	43,609	19,025	0	24,584	38,419	14,868	436	23,115
> 14 ft	184,519	78,374	0	106,145	279,469	123,892	8	155,569

*Plant City has no population located in storm surge risk areas, so it is not included in this table.

<u>Hazus-MH</u>

Wind

Hazus-MH was used to estimate the number of damaged buildings from a 100-year and 500-year hurricane event for the county as shown in the figures below. This analysis includes the number of buildings that sustain at least moderate loss and at least severe loss from hurricane winds.

Figure 4.27: At Least Moderate Loss, 100-year Return Period

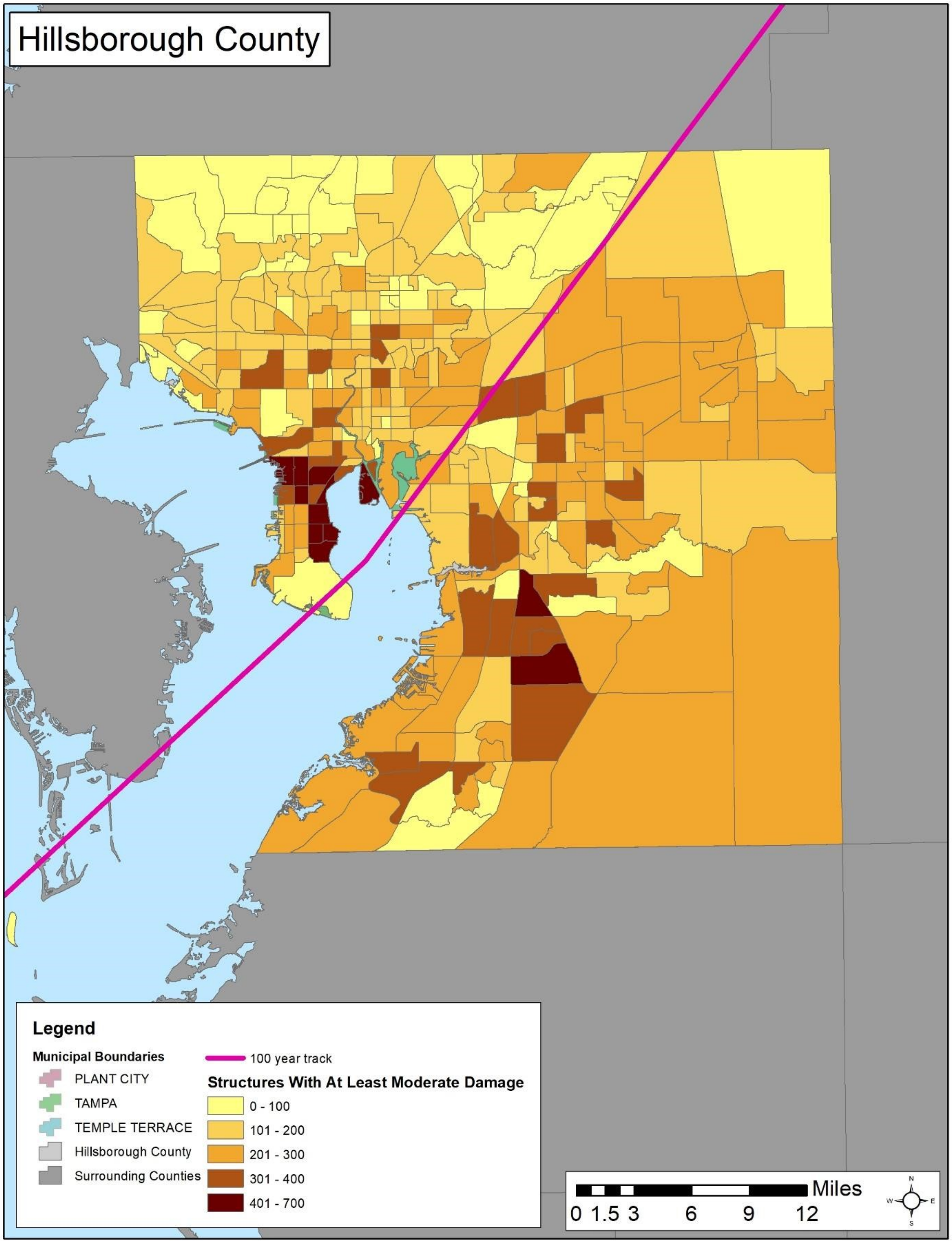


Figure 4.28: At Least Moderate Loss, 500-year Return Period

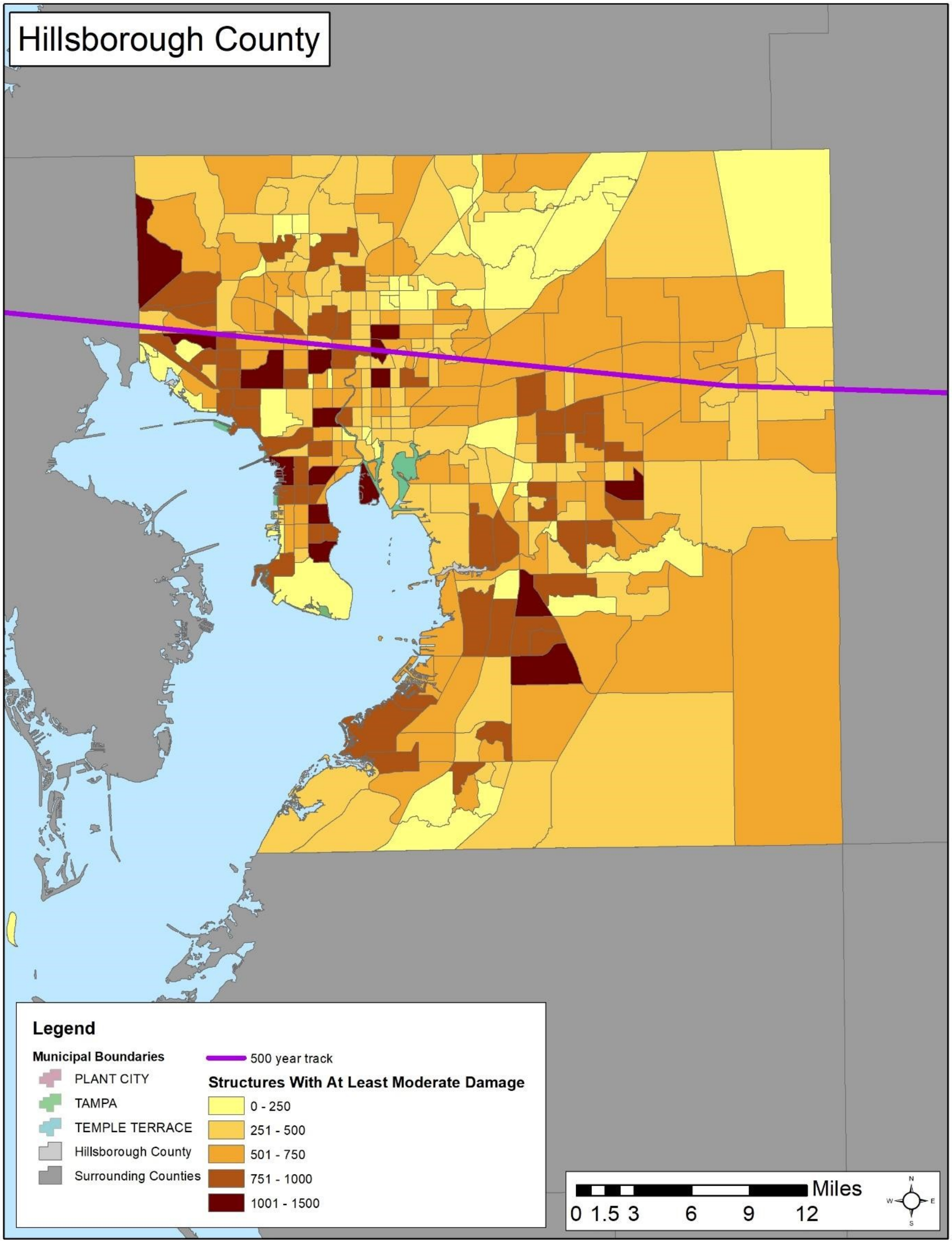


Figure 4.29: At Least Severe Loss, 100-year Return Period

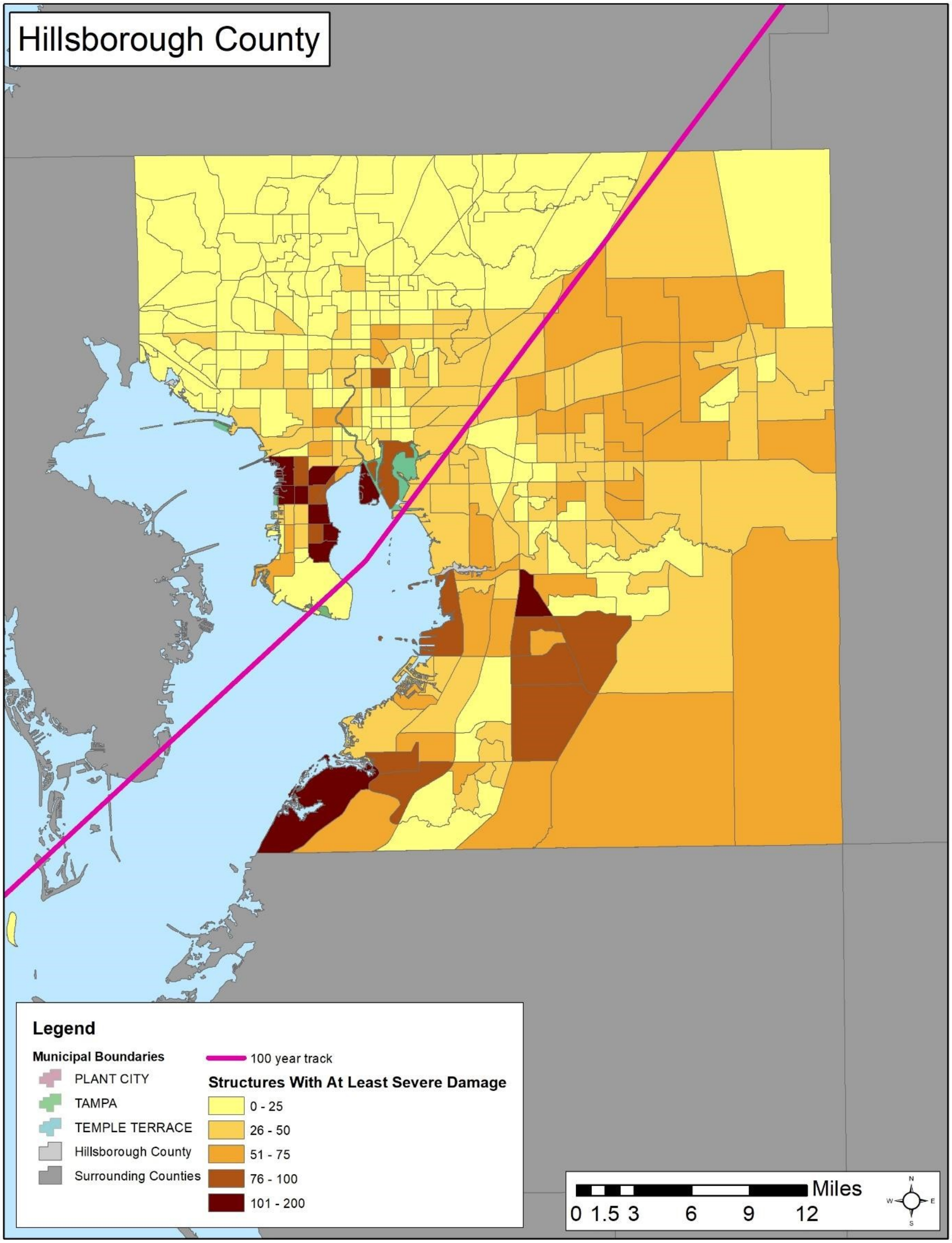
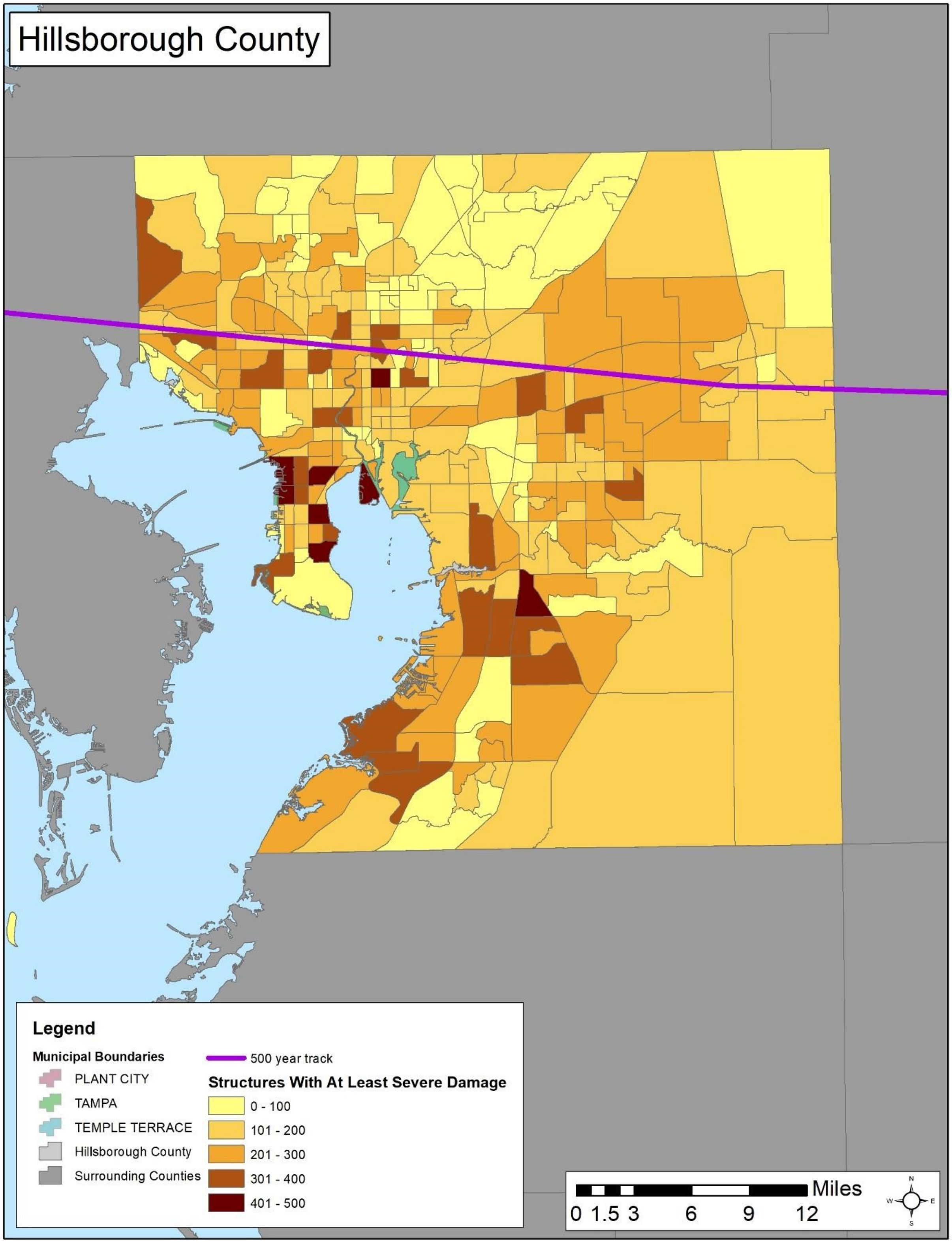


Figure 4.30: At Least Severe Loss, 500-year Return Period

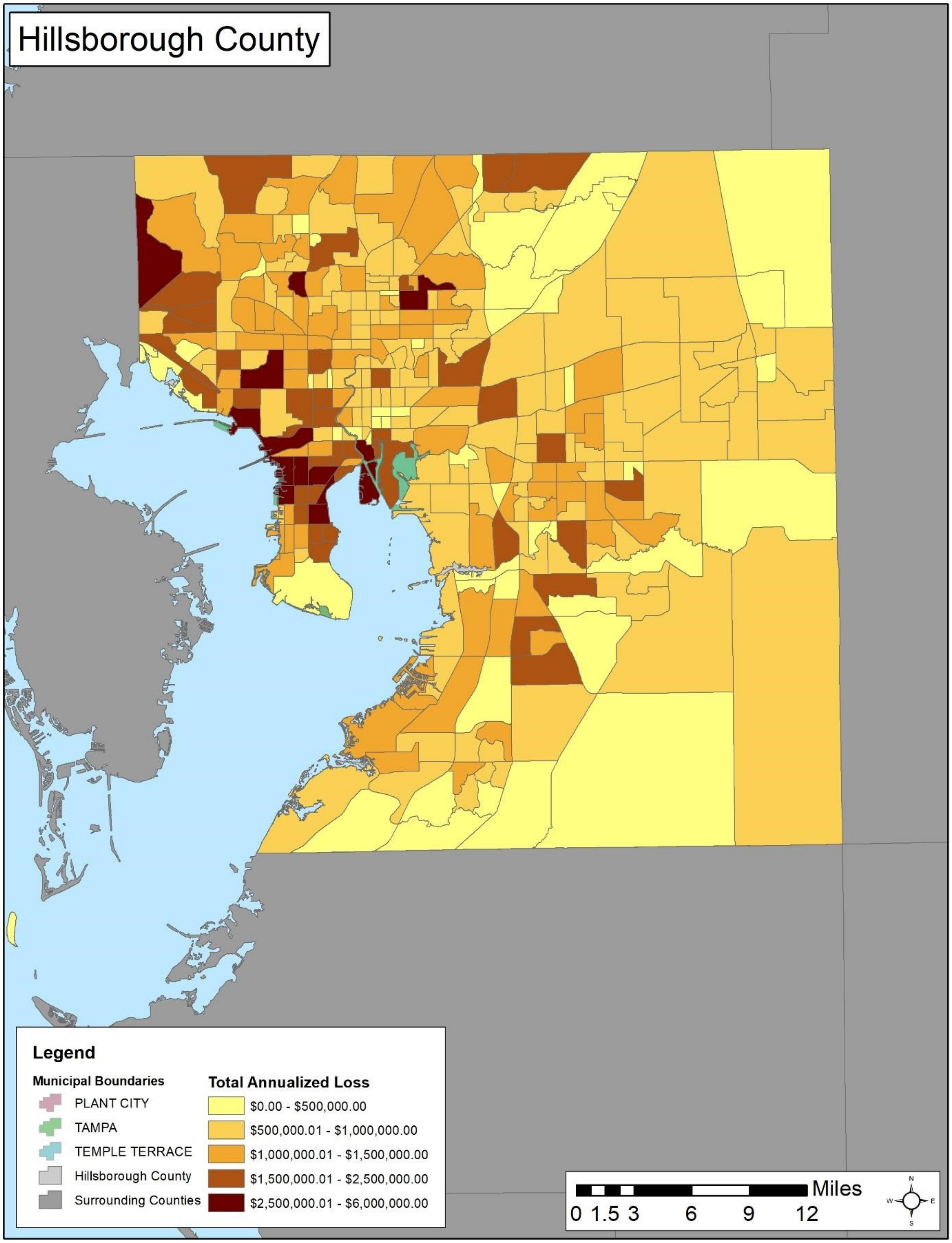


Hazus-MH was also used to estimate the annualized loss from a hurricane event for the county as shown below. This analysis includes annual losses to buildings, contents, inventory, relocation, capital, wages, and rental income from hurricane winds.

Table 4.49: Annualized Direct Economic Losses from Hurricane Event Wind

	Hurricane Event
Building Loss	$218,145,000
Contents Loss	$70,431,000
Inventory Loss	$992,000
Relocation Loss	$26,707,000
Capital Related Loss	$4,330,000
Wage Loss	$5,077,000
Rental Income Loss	$11,839,000
TOTAL LOSS	**$337,522,000**

Figure 4.31: Total Annualized Loss



7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Since all counties within Florida are vulnerable to the effects of tropical cyclones, all of the Hillsborough County critical facilities are vulnerable to potentially damaging storm surge and hurricane force winds.

To estimate exposure to storm surge for the critical facility analysis, hurricane storm surge areas were intersected with critical facility locations. The table below summarize the critical facilities in the county that are located within a hurricane risk area.

Table 4.50: Exposure of Critical Facilities to Hurricane Risk Areas – Hurricane Storm Surge

Location	Number of Critical Facilities in Hurricane Risk Area				
	Category 1 Storm Surge	Category 2 Storm Surge	Category 3 Storm Surge	Category 4 Storm Surge	Category 5 Storm Surge
Plant City	0	0	0	0	0
Tampa	46	64	80	108	135
Temple Terrace	0	0	0	0	3
Unincorporated	43	63	85	124	161
HILLSBOROUGH COUNTY TOTAL	**89**	**127**	**165**	**232**	**299**

All of the critical facilities and their associated risk can be found in Appendix B.

While all county facilities are vulnerable to tropical cyclones, it is clear that there are coastal areas with significant numbers of critical facilities within storm surge zones.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 3.0.

TROPICAL CYCLONE					Overall Vulnerability
Overview					
A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation. A tropical storm is one such system that has a maximum sustained surface wind speed of 34-73mph, while a hurricane has sustained winds of 74 mph or greater. Florida is at risk of experiencing these tropical systems due to subtropical climate and exposed position within large bodies of water. Residents in all sections of the county are potentially vulnerable to the effects a tropical cyclone but due to high levels of development and concentrated numbers of civilians, the coastlines are vulnerable to greater impacts.					HIGH
MINOR (TROPICAL DEPRESSION TO CATEGORY 2)					
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Likely	Critical	Large	> 24 hrs	< 1 week	3.0
MAJOR (CATEGORY 3 TO CATEGORY 5)					
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Possible	Catastrophic	Large	> 24 hrs	< 1 week	3.0

Severe Storm Hazard Profile

1. Severe Storms Description

In this profile, Severe Storms refers to thunderstorms having one or more of these effects: lightning, hailstorms, flooding, and straight-line winds. Tornadoes will be profiled in a separate hazard profile.

Thunderstorms are very prevalent in Hillsborough County and the state of Florida leads the country with the number of thunderstorms that occur. However, these storm systems are shorter in duration than those that develop over the western states. Thunderstorms in Florida routinely last approximately 30 minutes and rarely affect an area greater than 15 miles. However, multiple storms can develop together and act as an integrated system.

A thunderstorm forms when moist, unstable air is lifted vertically into the atmosphere. The lifting of this air results in condensation and the release of latent heat. The process to initiate vertical lifting can be caused by:

- Unequal warming of the surface of the Earth;
- Orographic lifting due to topographic obstruction of airflow; or
- Dynamic lifting because of the presence of a frontal zone.

A typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Despite their small size, all thunderstorms are dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe.[95]

The three key elements of a thunderstorm are wind, water, and lightning. The National Weather Service (NWS) considers a thunderstorm severe if it produces hail at least one inch in diameter, winds of 58 mph or stronger, or a tornado.

Thunderstorms also vary in type, depending on size and organization. Below are the different types of thunderstorms:[96]

- Ordinary cell thunderstorms only have one cell. These storms may also be referred to as single cell thunderstorms or pulse thunderstorms.
- Multi-cell cluster thunderstorms are organized in clusters of two to four short lived cells.
- Multi-cell line thunderstorms form in a line that extends, sometimes for hundreds of miles and can persist for hours. These are called squall lines and hey can be continuous or include contiguous precipitation.
    - Long-lived squall lines are called derechos and can cause severe damage with fast straight-line winds.
- Supercell thunderstorms are very dangerous storms with long-lived strong tornadoes and damaging wind, hail, and flash floods.

[95] https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/
[96] http://climatecenter.fsu.edu/topics/thunderstorms

Table 4.51: Thunderstorm Classification

Types Characteristics	Single Cell Storm	Multi-Cell Cluster	Multi-Cell Line (Squall Line)	Super-Cell
Severe Weather Occurs as:	Brief isolated downburst, small hail, heavy rain, weak tornadoes	Downbursts, moderate size hail, flash floods, weak tornadoes	Downbursts, small-moderate sized hail, occasional flash floods, weak tornadoes	Strong downbursts, large hail, occasional flash floods, weak-violent tornadoes
Severe Event Predictability	Low	Moderate	Moderate	High (Once identified as Super-Cell)
Danger to Public	Low	Moderate	Moderate	Extreme
Danger to Aviation	Low	Moderate to High	Moderate to High	Extreme

Source: National Oceanic and Atmospheric Agency (NOAA); Compiled by Hillsborough County.

There are four major hazards that need to be taken into consideration that are produced by thunderstorms: *lightning, heavy rainfall, straight-line winds, tornados, and hail*.

- ***Lightning***: Lightning is a rapid discharge of electricity in the atmosphere between clouds, the air, or the ground. Thunder is the sound of this rapid discharge and can be heard up to 25 miles away. Lightning tends to strike tall objects such as trees but can also strike in an open field. Thunderstorms always include lightning because lightning is what causes the sound of thunder.[97]
- ***Heavy Rain:*** Heavy rains are defined as intense large amount of rainfall in a short period. Because of this, flash floods often occur during slow moving thunderstorms. Other factors, such as the topography of the area, the soil conditions, and the ground cover can also affect flash flooding resulting from heavy rains. For example, if the ground is already waterlogged, new rainfall cannot filter into the ground and has no place to go, causing a flood.
  As stated in the *Flood Hazard Profile*, flash flooding is a significant concern because of the rapid onset, the high-water velocity, the debris load, and the potential for channel scour. In addition, more than one flood crest may result from a series of fast-moving storms with heavy rainfall. Sudden destruction of structures and the washout of access routes may result in the loss of life. Furthermore, the rapid urbanization within the state of Florida has manifested itself in the form of increased impervious surface areas which leads to less natural drainage and more flash flooding resulting from heavy rains.
- ***Straight-line Winds:*** Severe Storms often include strong winds that are called "straight-line" winds and are different than the winds in tornadoes. These damaging winds exceed 50–60 mph and can reach up to 100 mph. Damage from these winds is more common than damage form

[97] http://www.nssl.noaa.gov/education/svr wx101 /lightning/

tornadoes in the continental United States. Straight- line winds form as a result of outflow from a thunderstorm downdraft.[98]

- *Downburst Winds*: Strong "downbursts" (winds) are concentrated, straight-line winds created by falling rain and sinking air that exceed 125 mph.
- *Microburst Winds*: A separate wind phenomenon is the "microburst, which are narrowly-concentrated downdrafts that can exceed speeds of 150 mph.

- ***Tornados:*** A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. Tornado wind speed normally ranges from 65 mph to over 200 mph. The maximum winds in tornadoes are often confined to extremely small areas and vary tremendously over very short distances, even within the funnel itself. For more information regarding tornadoes, please see the *Tornado Hazard Profile*.
- ***Hail:*** Hail is frozen precipitation that can occur during a thunderstorm. Hail forms when raindrops freeze into balls of ice and usually range in size from 1/4 inch in diameter to 4 1/2 inches in diameter. Damage from hail increases with the size of the hail and can cause damage to vehicles, aircraft, and homes, and can be fatal to people and livestock. However, Florida thunderstorms do not often include hail because the hailstones usually melt before they reach the ground because of the generally warm temperatures in the state.[99]

Table 4.52: TORRO Hailstorm Intensity Scale

	Intensity Category	Typical Hail Diameter (mm)*	Probably Kinetic Energy J-m^2	Typical Damage Impacts
H0	Hard Hail	5	0-20	No damage
H1	Potentially Damaging	5-15	>20	Slight damage to plants and crops
H2	Significant	10-20	>100	Significant damage to fruit, crops, and vegetation
H3	Severe	20-30	>300	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	25-40	>500	Widespread glass damage, vehicle bodywork damage
H5	Destructive	30-50	>800	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	40-60		Bodies of grounded aircrafts dented, brick walls pitted
H7	Destructive	50-75		Severe roof damage, risk of serious injuries
H8	Destructive	60-90		Severest recorded in the British Isles; Severe damage to aircraft bodywork

[98] http://www.nssl.noaa.gov/education/svr wx101 /wind/
[99] http://www.nssl.noaa.gov/education/svr wx101 /hail/

	Intensity Category	Typical Hail Diameter (mm)*	Probably Kinetic Energy J-m^2	Typical Damage Impacts
H9	Super Hailstorms	75-100		Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	>100		Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: http://www.torro.org.uk/hscale.php

Approximate range (typical maximum size in bold), since other factors (e.g. number and density of hailstones, hail fall speed and surface wind speeds) affect severity The *TORRO Hailstorm Intensity Scale* (H0 to H10) in relation to typical damage and hail size codes. Size codes are presented in following table.

Table 4.53: Hail Size and Diameter in Relation to TORRO Hailstorm Intensity Scale

Size Code	Maximum Diameter (mm)	Description
H0	5-9	Pea
H1	10-15	Mothball
H2	16-20	Marble, grape
H3	21-30	Walnut
H4	31-40	Pigeon’s egg > Squash ball
H5	41-50	Golf ball > Pullet’s egg
H6	51-60	Hen’s egg
H7	61-75	Tennis ball > Cricket ball
H8	76-90	Large Orange > Softball
H9	91-100	Grapefruit
H10	>100	Melon

National Weather Service Advisories

The National Weather Service (NWS) is tasked with providing weather forecasts and warnings of hazardous weather to agencies and the public for the purposes of protection, safety, and general information. If severe weather is detected, alerts are issued, and the Emergency Alert System may activate and broadcast the alert, mainly for severe thunderstorms or tornados.

Table 4.54: National Weather Service Advisories and Thresholds

National Weather Service Advisories	
Severe Thunderstorm	
Severe Thunderstorm Watch	Issued when conditions are favorable for severe thunderstorms to develop.
Severe Thunderstorm Warning	Issued when severe thunderstorms are occurring or are imminent.

National Weather Service Advisories	
Tornado	
Tornado Watch	Issued when conditions are favorable for severe thunderstorms and tornadoes to develop.
Tornado Warning	Issued when a tornado is sighted or imminent.
Flash Flooding	
Flash Flood Watch	Issued when conditions are favorable for a specific hazardous weather event, including flooding, to occur, meaning flooding is possible.
Flash Flood Warning	Issued when a flash flood is imminent or occurring, referring to a sudden violent flood that can take minutes to hours to develop. It is even possible to experience a flash flood in areas not receiving rain.

Causes of Fatalities in Severe Storms

All aspects of Severe Storms are life-threatening. NOAA tracks weather related fatalities and lighting itself contributes to the most deaths from thunderstorms in Florida. Other causes include flooding, tornadoes, and winds.[100] Lightning is often called the underrated killer. In an average year, more people die from lightning nationwide than from all hurricanes and tornadoes combined. Lightning may strike people directly or it can cause death and injury from fires it initiates.

Various factors contribute to lightning fatalities including the willingness to cancel or postpone activities, the ability to know when a storm is approaching or developing, the ability to get to a safe place quickly, and the vulnerability of the actual activity.

Potential Effects of Climate Change on Severe Storms

With higher temperatures and humidity there will be an increase in atmospheric instability associated with the generation of severe thunderstorms and tornadoes. According to NASA, climate change can directly impact the frequency and intensity of thunderstorms. Modeling data predicts that in the Southeast portion of the United States, there will be more days per year with severe thunderstorms. Since severe thunderstorms lead to hazardous conditions and property damage, it can be concluded that those outcomes will increase with increasing number of severe thunderstorms.[101]

However, some believe vertical wind shear could also decrease, resulting in fewer or weaker severe thunderstorms and tornadoes.[102] However, decreases in vertical wind shear are most likely to occur when convective available potential energy (CAPE) is high in spring and summer months, which could result in more frequent severe storms. Furthermore, days with high CAPE are also likely to occur during times of the year with strong low-level wind shear, increasing the likelihood of the most severe storm events, including tornadoes.[103]

[100] http://www.nws.noaa.gov/om/hazstats.shtml#
[101] https://climate.nasa.gov/news/897/severe-thunderstorms-and-climate-change/
[102] Seneviratne et al. (2012). Changes in climate extremes and their impacts on the natural physical environment. In Field et al. (Eds.), Managing the risks of extreme events and disasters to advance climate change adaptation, p.159. https://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf.
[103] Diffenbaugh et al. (2013), http://www.pnas.org/content/110/41/16361.full.

Overall, there has been an increase in the number of severe storm and tornado reports over the last 50 years. However, it is believed that this increase may be attributed to the technology improvements that allow for better identification and reporting of such storms.

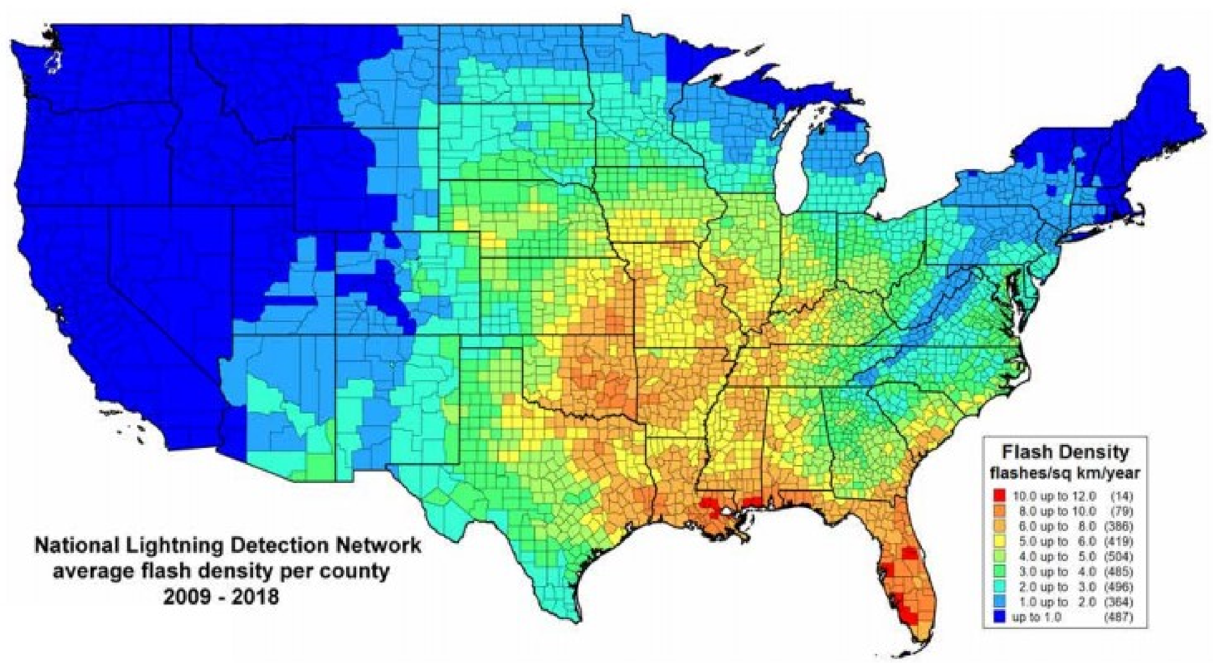
2. Geographic Areas Affected by Severe Storms

Severe thunderstorms can occur anywhere in the county. As the number of structures and the population increases, the probability that a severe storm will cause property damage or human casualties also increases. Florida experiences more thunderstorms each year than any other state in the United States. The combination of heat, humidity and sea breezes on both the Gulf and Atlantic coasts makes the perfect breeding ground for thunderstorms over the Florida Peninsula. The dense population and the amount of people that spend a great deal of time outdoors year-round, more people are struck and killed by lightning in Florida than any other state. On average, Florida has 3,500 cloud to ground lightning flashes per day and 1.2 million flashes per year occur.[104]

Lightning

The following map shows cloud-to-ground flash density in the United States for counties. Hillsborough is one of 14 counties in the United States that has the highest flash density between 10 to 12 flashes per square mile each year.[105]

Figure 4.32: U.S. Average Cloud-to-Ground Flash Density per County, 2009–2018

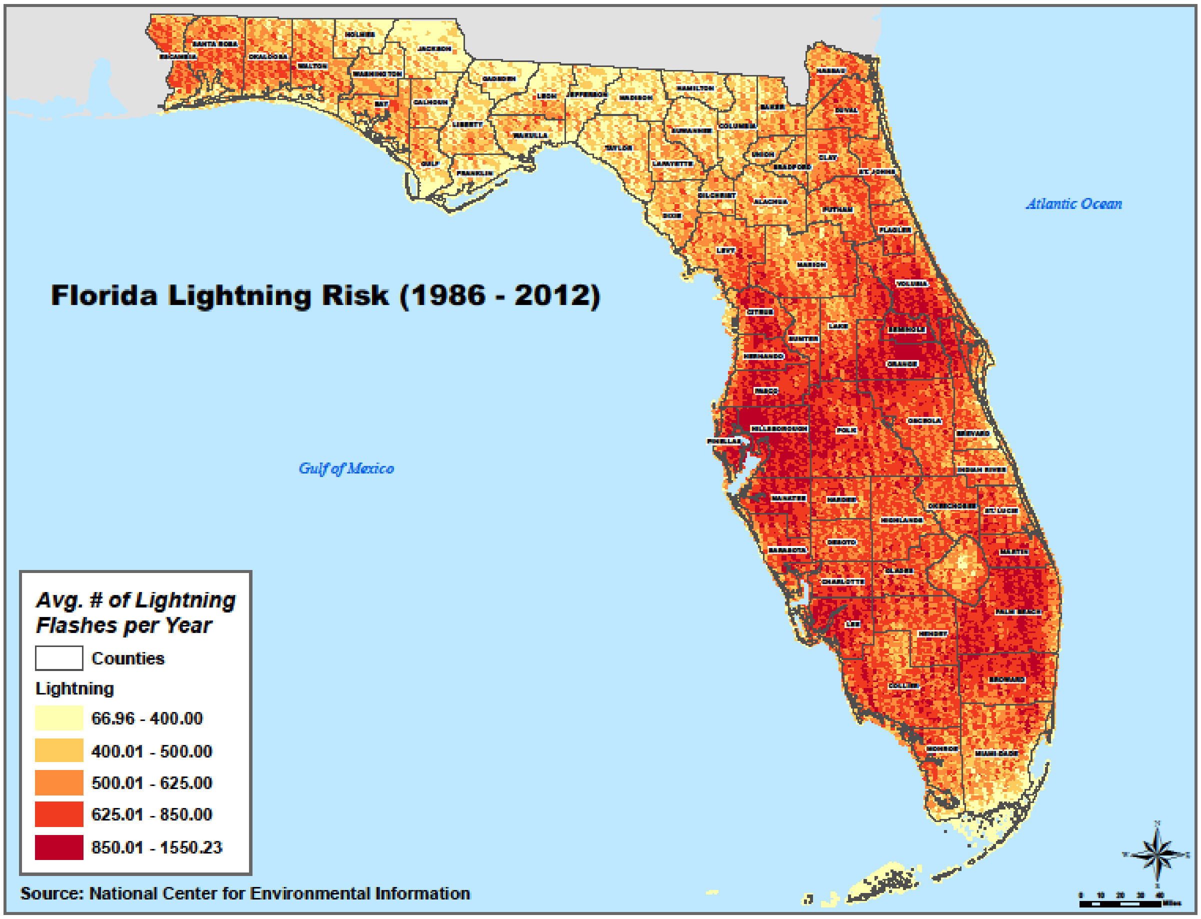


Source: Vaisala, 2018 Annual Lightning Report.

[104] www.accuweather.com/en/weather-news/why-florida-ranks-highest-for-lightning-fatalities-in-the-us/350561
[105] Vaisala, 2018 Annual Lightning Report. https://www.vaisala.com/sites/default/files/documents/2018%20 Annual%20Lightning%20Report_1.pdf

Below is a map depicting the average number of lightning flashes per year based on historical data from 1986 to 2012.

Figure 4.33: Florida Lightning Risk, 1986–2012



According to the data, Hillsborough County is expected to have between 625 and 1550 lightning flashes per year. However, lighting occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Hillsborough County is uniformly exposed to lightning.

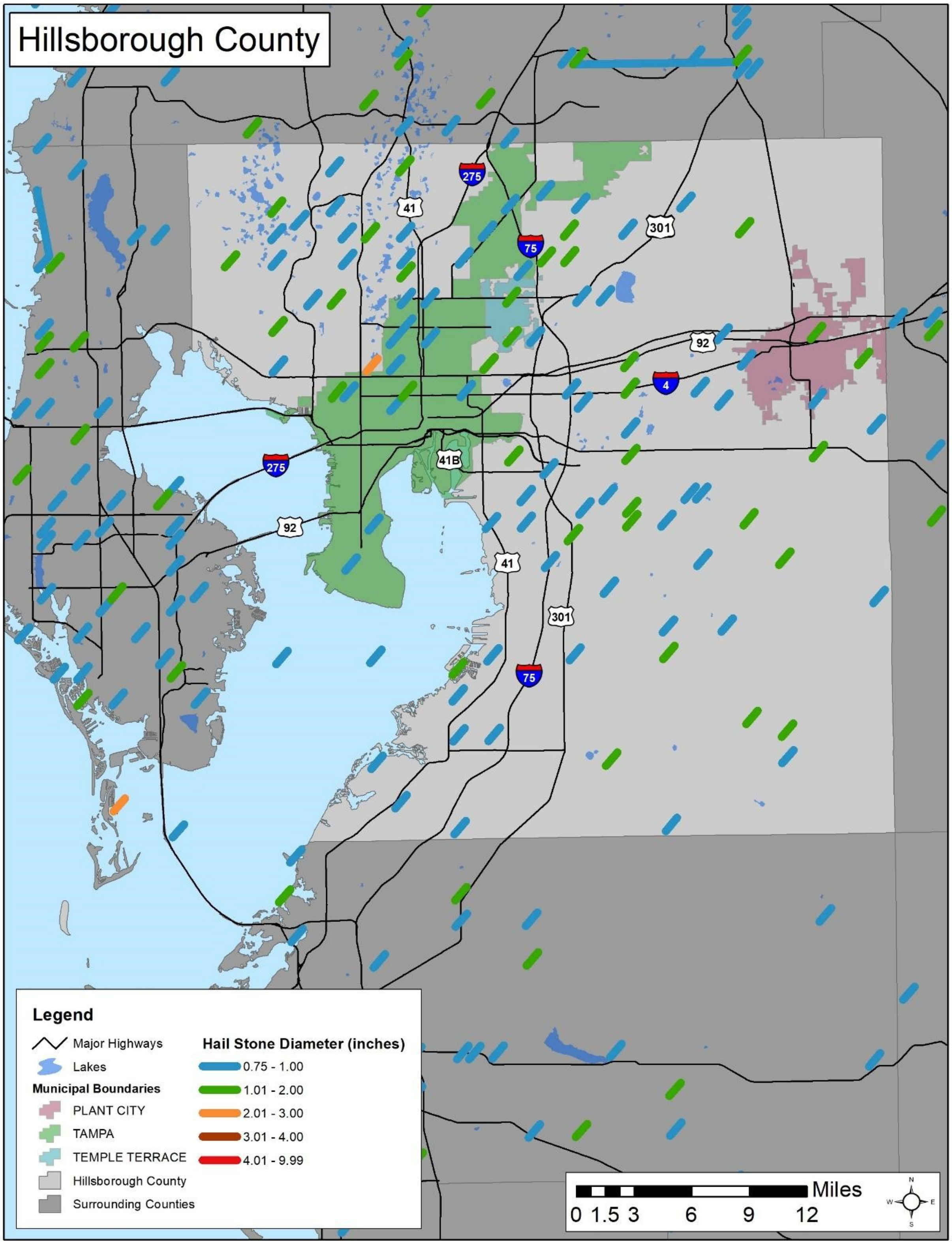
<u>Heavy Rain</u>

Heavy rain is produced by severe storms, so their locations and spatial extents coincide. It is assumed that Hillsborough County is uniformly exposed to severe thunderstorms; therefore, all areas of the county are equally exposed to heavy rain which may be produced by such storms.

<u>Hail</u>

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Hillsborough County is uniformly exposed to severe thunderstorms; therefore, all areas of the county are equally exposed to hail which may be produced by such storms. With that in mind, the map below shows the location of hail events that have impacted Hillsborough County based on historical data from 1955 to 2017.

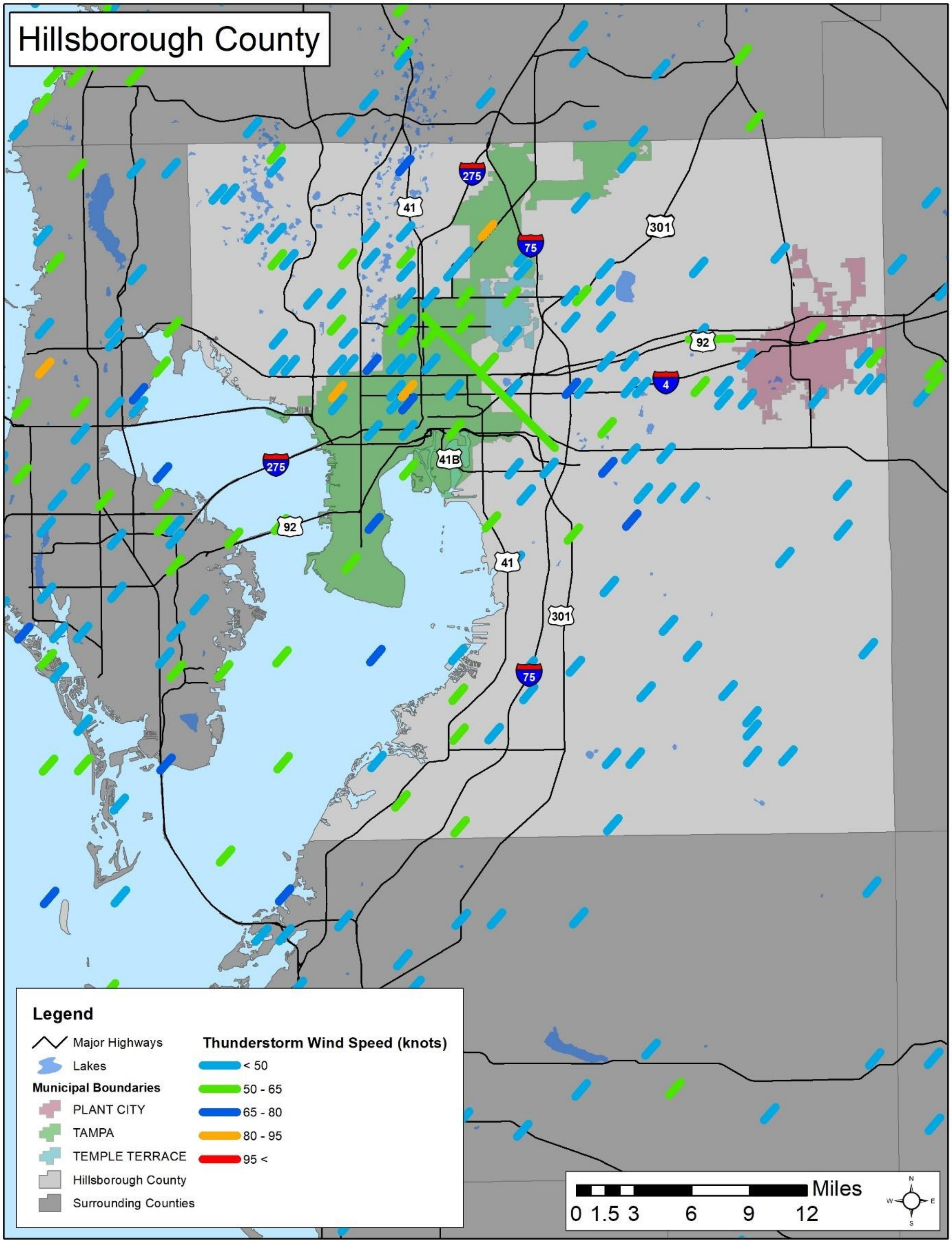
Figure 4.34: Hillsborough County Hail Events, 1955–2017



Wind

A thunderstorm and its accompanying hazards, including wind, are atmospheric hazards and thus have no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States, However, thunderstorms are most common in central and southern states, such as Florida, because atmospheric conditions in those regions are favorable to for generating these powerful storms. It is assumed that all of Hillsborough County is equally susceptible to the wind hazard. With that in mind, the map below shows the location of wind events that have impact Hillsborough County based on historical data from 1955 to 2017.

Figure 4.35: Hillsborough County Wind Events, 1955–2017



3. Historical Occurrences of Severe Storms

The table below lists the significant severe storms that affected Hillsborough County.

Table 4.55: Significant Severe Storm Occurrences in Hillsborough County[106]

Date	Description
May 5, 1998	Thunderstorm Wind – Thunderstorm winds measured at 85 mph damaged nine parked aircraft and nine hanger doors at the Peter O. Knight Airport on Davis Island. At least 27 drydocked sailboats and five moored power boats were damaged by the thunderstorm wind at a marina on Davis Island.
June 21, 1998	Thunderstorm Wind – Thunderstorm winds snapped a large 500-pound, 15-inch oak branch which fell atop and killed a 71-year-old female while she walked along a sidewalk near the 6300 block of State Road 39 in Plant City.
August 26, 2000	Thunderstorm Wind – The broadcast media reported that thunderstorm winds produced widespread damage from near Plant City west to Thonotosassa. Thunderstorm winds destroyed two hangers and damaged eight small planes five miles north northwest of Plant City. Also, several large trees and power lines were downed by thunderstorm winds along U.S. Highway 301 near Hillsborough State Park. In Thonotosassa, thunderstorm winds overturned a trailer on Five Acre Road.
July 4, 2001	Lightning - Eight people were injured, while taking cover in a tent, when lightning struck a nearby tree and the tents central metal support rod, on Beer Can Island in Hillsborough Bay. An adult, holding the center metal support rod of the tent, was seriously injured from the lightning strike.
June 16, 2003	Heavy Rain – Several buildings sustained minor water damage and five parked cars were half under water in a parking lot on the University of South Florida campus.
October 2, 2007	Heavy Rain – Rainfall of 3.79 inches was measured at the USGS river gaging station. Radar estimated rainfall of 6 to 8 inches from Fort Lonesome to Duette in Manatee County. The excess water filled ditches, but no homes received damage due to rising water. The Little manatee River 4.2 miles southwest of Wimauma rose 5 feet between 8 PM EDT to 2 AM EDT with a maximum stage of 11.97 feet at 2 PM on October 3rd. Flood stage is 11 feet and only minor flooding was reported.
February 5, 2010	Thunderstorm Wind – 13 people were injured when estimated 60 mph thunderstorm winds ripped the tethers of a 600-square-foot food tent at the Florida State Fair, causing the tent to collapse. In addition, the winds blew over some tables and blew the cover off of an ATM machine.
December 21, 2014	Lightning – The Florida State Watch Office relayed a report from Tampa Fire Rescue of a lightning strike across the street from Raymond James Stadium shortly after the conclusion of the Buccaneers football game. Lightning

[106] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Heavy+Rain&eventType=%28C%29+Lightning&eventType=%28Z%29+Strong+Wind&eventType=%28C%29+Thunderstorm+Wind&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Date	Description
	detection networks show that this was one of the first lightning strikes in the area. Seven people were transported to a nearby hospital with another four taking themselves to the hospital for treatment. One person was said to be in critical condition while being transported to a nearby hospital. Minor damage occurred to the car the victims were around as well.
July 5, 2017	Thunderstorm Wind – A large tree fell onto a van, temporarily trapping one person inside, and injuring 2 people.
December 21, 2018	Thunderstorm Wind – The Sunshine Skyway Bridge was closed from around 9 am to 5 pm on December 21 due to 78 mph wind gusts at the road surface which is about 200 feet above the water.

Additionally, there have been 5 FEMA major disaster declarations in Hillsborough County that are related to severe storms.

Table 4.56: FEMA Major Disaster Declarations in Hillsborough County, Severe Storm, 1953–2019[107]

Disaster Number	Date	Name/Description
DR-586	May 15, 1979	SEVERE STORMS, TORNADOES & FLOODING
DR-607	September 29, 1979	SEVERE STORMS & FLOODING
DR-966	October 3–4, 1992	SEVERE STORMS, TORNADOES & FLOODING
DR-982	March 12–16, 1993	TORNADOES, FLOODING, HIGH WINDS & TIDES, FREEZING
DR-1195	December 25, 1997–April 24, 1998	SEVERE STORMS, HIGH WINDS, TORNADOES, AND FLOODING

While severe storms may seem to be a lesser threat to life safety than a hurricane, severe storms can be fatal. From 1955 to 2019, severe storms killed 10 people, 9 people died from lightning strikes and 1 person died from wind.[108] (It is important to note that the wind-related fatalities could have been from other storms, not only thunderstorms.)

Lightning

Florida is ranked number 2 in the U.S. regarding the number of lightning strikes. However, lightning-related deaths are the highest in the nation in the state of Florida with 49 deaths from 2009 to 2018.

Table 4.57: Number of Lightning Fatalities by State, 2009-2018[109]

State	Fatalities 2009-2018	Rank of Fatalities
Florida	49	1

[107] www.fema.gov/api/open/v1/DisasterDeclarationsSummaries.csv

[108] Note that the wind related fatalities could have been the result of other types of severe weather, such as hurricanes.

[109] http://lightningsafetycouncil.org/Deaths%20by%20State%20Table.pdf

State	Fatalities 2009-2018	Rank of Fatalities
Texas	20	2
Alabama	16	3
Arizona	14	4
North Carolina	14	5
Missouri	12	6
Colorado	10	7
Louisiana	10	8
Georgia	9	9
New Jersey	7	10

According to the NCEI Storm Events Database, there were 103 reports of lightning in Hillsborough County from 1996 to 2019.[110] These lightning events are only inclusive of those reported by NCEI from 1996 through October 2019. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.58: Summary of Lightning Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
Plant City	4	0	7	$1,386,324	$57,764
Tampa	40	3	32	$2,174,057	$90,586
Temple Terrace	6	2	1	$133,320	$7,017
Unincorporated	53	4	26	$3,638,420	$158,192
HILLSBOROUGH COUNTY TOTAL	**103**	**9**	**66**	**$7,332,121**	**$313,558**

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in December 2019.

Table 4.59: Historical Lightning Occurrences in Hillsborough County

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
Plant City						
PLANT CITY	7/4/1996	Lightning	0	4	$0	$0
PLANT CITY	8/11/1997	Lightning	0	1	$0	$0
PLANT CITY	9/26/1997	Lightning	0	2	$0	$0
PLANT CITY	8/3/2006	Lightning	0	0	$1,386,324	$0

[110] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Lightning&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
Tampa						
TAMPA	6/17/1996	Lightning	0	1	$0	$0
TAMPA	7/30/1996	Lightning	0	0	$6,547	$0
TAMPA	8/17/1996	Lightning	0	0	$408,414	$0
TAMPA	6/22/1997	Lightning	0	1	$0	$0
TAMPA	6/24/1997	Lightning	0	0	$16,031	$0
TAMPA	7/4/1997	Lightning	0	0	$80,054	$0
TAMPA	7/8/1997	Lightning	0	0	$4,803	$0
TAMPA	7/12/1997	Lightning	1	1	$0	$0
TAMPA	7/24/1997	Lightning	0	1	$0	$0
TAMPA	8/22/1997	Lightning	0	0	$79,905	$0
TAMPA	9/26/1997	Lightning	0	0	$7,971	$0
TAMPA	6/21/1998	Lightning	0	1	$0	$0
TAMPA	7/6/1998	Lightning	0	0	$0	$0
(MCF)MC DILL AFB	5/12/1999	Lightning	0	3	$0	$0
TAMPA	6/3/1999	Lightning	0	0	$1,546	$0
TAMPA	6/30/1999	Lightning	0	0	$309,235	$0
TAMPA	8/1/1999	Lightning	1	0	$0	$0
TAMPA	8/18/1999	Lightning	0	0	$1,538	$0
TAMPA	6/19/2000	Lightning	0	0	$149,057	$0
TAMPA	6/23/2000	Lightning	1	1	$0	$0
TAMPA	7/8/2000	Lightning	0	1	$0	$0
TAMPA	6/5/2001	Lightning	0	2	$0	$0
TAMPA	6/24/2001	Lightning	0	2	$0	$0
TAMPA	8/31/2001	Lightning	0	1	$0	$0
TAMPA	7/1/2002	Lightning	0	0	$85,610	$0
TAMPA	8/6/2002	Lightning	0	1	$0	$0
TAMPA INTL ARPT	6/9/2003	Lightning	0	1	$0	$0
SOUTH TAMPA	7/8/2003	Lightning	0	0	$279,471	$0
TAMPA	8/7/2003	Lightning	0	1	$0	$0
TAMPA INTL ARPT	11/6/2003	Lightning	0	1	$0	$0
TAMPA	8/25/2004	Lightning	0	0	$162,728	$0
TAMPA	6/19/2006	Lightning	0	0	$25,330	$0
TAMPA INTL ARPT	7/11/2006	Lightning	0	0	$63,139	$0
(TPA)TAMPA INTL ARPT	8/7/2007	Lightning	0	0	$463,479	$0
TAMPA INTERNATIONAL AIRPORT	8/2/2010	Lightning	0	1	$0	$0
TAMPA	6/26/2013	Lightning	0	0	$1,101	$0

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
TAMPA	5/26/2014	Lightning	0	0	$10,802	$0
TPA P O KNIGHT ARPT	5/29/2014	Lightning	0	0	$16,203	$0
MACDILL AIR FORCE BASE	7/16/2014	Lightning	0	1	$0	$0
(TPA)TAMPA INTL ARPT	12/21/2014	Lightning	0	11	$1,094	$0
Temple Terrace						
TEMPLE TERRACE	8/10/2001	Lightning	1	0	$0	$0
TEMPLE TERRACE	6/29/2002	Lightning	1	0	$0	$0
TEMPLE TERRACE	8/17/2002	Lightning	0	0	$28,442	$0
TEMPLE TERRACE	5/19/2003	Lightning	0	0	$35,010	$0
TEMPLE TERRACE	7/13/2003	Lightning	0	0	$69,868	$0
TEMPLE TERRACE	7/19/2006	Lightning	0	1	$0	$0
Unincorporated						
BRANDON	9/26/1997	Lightning	0	3	$15,941	$0
MANGO	6/19/1998	Lightning	0	1	$0	$0
SEFFNER	6/19/1998	Lightning	0	1	$0	$0
BRANDON	6/30/1998	Lightning	1	0	$0	$0
LUTZ	7/5/1998	Lightning	0	0	$157,460	$0
THONOTOSASSA	6/13/1999	Lightning	0	1	$0	$0
RUSKIN	7/7/1999	Lightning	0	0	$9,866	$0
RUSKIN	7/9/1999	Lightning	0	0	$15,415	$0
RIVERVIEW	7/9/1999	Lightning	0	0	$3,083	$0
BRANDON	6/7/2000	Lightning	0	0	$2,981	$0
RUSKIN	7/15/2000	Lightning	1	0	$0	$0
LUTZ	8/5/2000	Lightning	0	1	$0	$0
LUTZ	6/27/2001	Lightning	0	1	$0	$0
APOLLO BEACH	7/4/2001	Lightning	0	8	$1,448	$0
BRANDON	8/10/2001	Lightning	0	1	$0	$0
THONOTOSASSA	8/21/2001	Lightning	0	1	$0	$0
BRANDON	12/31/2002	Lightning	0	1	$0	$0
APPOLLO BEACH	8/1/2003	Lightning	0	1	$0	$0
VALRICO	6/27/2004	Lightning	0	1	$0	$0
BRANDON	8/18/2004	Lightning	0	1	$0	$0
GIBSONTON	7/8/2006	Lightning	0	2	$0	$0
LUTZ	7/11/2006	Lightning	0	0	$252,554	$0
BRANDON	7/20/2007	Lightning	0	1	$0	$0
BRANDON	10/24/2007	Lightning	0	1	$0	$0
GOLDSTEIN	6/9/2008	Lightning	0	0	$11,744	$0
BEACH PARK	7/6/2008	Lightning	0	0	$5,841	$0
RATTLESNAKE	7/6/2008	Lightning	0	0	$175,238	$0
LITHIA	6/17/2009	Lightning	0	0	$23,828	$0

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
EAST LAKE-ORIENT PARK	7/14/2010	Lightning	0	0	$1,768	$0
LITHIA	7/29/2010	Lightning	0	0	$35,362	$0
WIMAUMA	8/1/2010	Lightning	0	0	$512,036	$0
SULPHUR SPGS	11/4/2010	Lightning	0	0	$11,745	$0
SULPHUR SPGS	7/8/2011	Lightning	0	0	$0	$0
SULPHUR SPGS	9/10/2011	Lightning	1	0	$0	$0
HARNEY	8/13/2012	Lightning	0	0	$429,444	$0
BOYETTE	4/4/2013	Lightning	0	0	$221	$0
BRANDON	8/3/2013	Lightning	0	0	$10,988	$0
BRANDON ARPT	8/22/2013	Lightning	0	0	$1,099	$0
RUSKIN	9/6/2013	Lightning	0	0	$27,437	$0
CARROLLWOOD	2/12/2014	Lightning	0	0	$10,945	$0
PLEASANT GROVE	5/14/2014	Lightning	1	0	$0	$0
CARROLLWOOD	6/9/2014	Lightning	0	0	$862,535	$0
NOWATNEY	7/16/2014	Lightning	0	0	$107,859	$0
BLOOMINGDALE	7/21/2014	Lightning	0	0	$270	$0
EDISON	3/26/2015	Lightning	0	0	$43,533	$0
GOLDSTEIN	5/23/2015	Lightning	0	0	$21,612	$0
TARPON	5/4/2016	Lightning	0	0	$53,485	$0
THONOTOSASSA	7/11/2016	Lightning	0	0	$106,793	$0
SUN CITY CENTER	7/21/2017	Lightning	0	0	$20,996	$0
NOWATNEY	9/1/2017	Lightning	0	0	$52,057	$0
RATTLESNAKE	7/5/2018	Lightning	0	0	$101,971	$0
BRANDON	7/19/2019	Lightning	0	0	$500,785	$0
THONOTOSASSA	7/20/2019	Lightning	0	0	$50,079	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

Heavy Rain

According to the NCEI Storm Events Database, there were 35 reports of heavy rain in Hillsborough County from 1997 to 2019.[111] These heavy rain events are only inclusive of those reported by NCEI from 1996 through October 2019. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.60: Summary of Heavy Rain Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
Plant City	0	0	0	$0	$0

[111] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Heavy+Rain&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
Tampa	9	0	0	$1,356	$59
Temple Terrace	1	0	0	$13,989	$823
Unincorporated	25	0	0	$0	$0
HILLSBOROUGH COUNTY TOTAL	**35**	**0**	**0**	**$15,345**	**$882**

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in December 2019.

Table 4.61: Historical Heavy Rain Occurrences in Hillsborough County

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
Plant City						
NONE REPORTED	--	--	--	--	--	--
Tampa						
TAMPA	4/26/1997	Heavy Rain	0	0	$0	$0
TAMPA	8/16/2003	Heavy Rain	0	0	$0	$0
TAMPA	8/25/2004	Heavy Rain	0	0	$1,356	$0
TAMPA	6/28/2005	Heavy Rain	0	0	$0	$0
(MCF)MC DILL AFB	6/1/2007	Heavy Rain	0	0	$0	$0
TAMPA	7/6/2008	Heavy Rain	0	0	$0	$0
TAMPA	7/18/2008	Heavy Rain	0	0	$0	$0
TPA P O KNIGHT ARPT	7/18/2008	Heavy Rain	0	0	$0	$0
(TPA)TAMPA INTL ARPT	7/1/2009	Heavy Rain	0	0	$0	$0
Temple Terrace						
TEMPLE TERRACE	6/16/2003	Heavy Rain	0	0	$13,989	$0
Unincorporated						
BRANDON	4/17/2002	Heavy Rain	0	0	$0	$0
THONOTOSASSA	2/25/2004	Heavy Rain	0	0	$0	$0
THONOTOSASSA	9/4/2004	Heavy Rain	0	0	$0	$0
RUSKIN	6/10/2006	Heavy Rain	0	0	$0	$0
WIMAUMA	10/2/2007	Heavy Rain	0	0	$0	$0
CITRUS PARK	7/15/2008	Heavy Rain	0	0	$0	$0
LAKE MAGDALENE	7/15/2008	Heavy Rain	0	0	$0	$0
SWEETWATER CREEK	7/15/2008	Heavy Rain	0	0	$0	$0
LAKE MAGDALENE	7/15/2008	Heavy Rain	0	0	$0	$0

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
ORIENT PARK	7/17/2008	Heavy Rain	0	0	$0	$0
ORIENT PARK	7/17/2008	Heavy Rain	0	0	$0	$0
CITRUS PARK	9/17/2008	Heavy Rain	0	0	$0	$0
BEACH PARK	9/11/2009	Heavy Rain	0	0	$0	$0
LUTZ	3/11/2010	Heavy Rain	0	0	$0	$0
SUN CITY CENTER	9/1/2011	Heavy Rain	0	0	$0	$0
NOWATNEY	6/24/2012	Heavy Rain	0	0	$0	$0
RATTLESNAKE	9/27/2014	Heavy Rain	0	0	$0	$0
CHAPMAN	9/27/2014	Heavy Rain	0	0	$0	$0
TRAPNELL	9/27/2014	Heavy Rain	0	0	$0	$0
HOPEWELL	9/27/2014	Heavy Rain	0	0	$0	$0
RUSKIN	9/27/2014	Heavy Rain	0	0	$0	$0
CITRUS PARK	9/27/2014	Heavy Rain	0	0	$0	$0
DURANT	9/27/2014	Heavy Rain	0	0	$0	$0
SUN CITY CENTER	9/27/2014	Heavy Rain	0	0	$0	$0
CITRUS PARK	8/3/2015	Heavy Rain	0	0	$0	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

Hail

According to the NCEI Storm Events Database, there were 280 reports of hail in Hillsborough County from 1958 to 2019.[112] These hail events are only inclusive of those reported by NCEI from 1955 through October 2019. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.62: Summary of Hail Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
Plant City	12	0	0	$0	$0
Tampa	53	0	0	$460,515	$17,056
Temple Terrace	17	0	0	$0	$0
Unincorporated	198	0	0	$1,375,498	$22,185
HILLSBOROUGH COUNTY TOTAL	**280**	**0**	**0**	**$1,836,013**	**$39,242**

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in December 2019.

[112] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Hail&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Table 4.63: Historical Hail Occurrences in Hillsborough County

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
Plant City							
PLANT CITY	3/25/1993	Hail	1.25 in.	0	0	$0	$0
PLANT CITY	3/25/1993	Hail	0.75 in.	0	0	$0	$0
PLANT CITY	5/12/1995	Hail	1.00 in.	0	0	$0	$0
PLANT CITY	5/5/1998	Hail	0.88 in.	0	0	$0	$0
PLANT CITY	8/16/1998	Hail	0.75 in.	0	0	$0	$0
PLANT CITY	6/20/2000	Hail	1.00 in.	0	0	$0	$0
PLANT CITY	8/9/2000	Hail	1.00 in.	0	0	$0	$0
PLANT CITY	6/14/2001	Hail	1.75 in.	0	0	$0	$0
PLANT CITY	6/14/2001	Hail	1.00 in.	0	0	$0	$0
PLANT CITY	8/1/2003	Hail	1.00 in.	0	0	$0	$0
PLANT CITY	6/17/2011	Hail	0.88 in.	0	0	$0	$0
PLANT CITY	8/14/2012	Hail	0.88 in.	0	0	$0	$0
Tampa							
N TAMPA	3/24/1993	Hail	1.00 in.	0	0	$0	$0
TAMPA	8/10/1993	Hail	1.00 in.	0	0	$0	$0
TAMPA	9/13/1993	Hail	1.00 in.	0	0	$0	$0
N TAMPA	7/17/1994	Hail	1.00 in.	0	0	$0	$0
TAMPA	7/18/1994	Hail	0.75 in.	0	0	$8,658	$0
TAMPA	9/9/1994	Hail	0.88 in.	0	0	$0	$0
TAMPA	5/3/1996	Hail	0.75 in.	0	0	$0	$0
TAMPA	5/4/1996	Hail	1.50 in.	0	0	$0	$25,106,655
TAMPA	6/7/1996	Hail	1.00 in.	0	0	$0	$0
TAMPA	6/7/1996	Hail	0.75 in.	0	0	$0	$0
TAMPA	6/26/1996	Hail	0.75 in.	0	0	$0	$0
TAMPA	8/18/1996	Hail	0.75 in.	0	0	$0	$0
TAMPA	9/9/1996	Hail	0.88 in.	0	0	$0	$0
TAMPA	4/23/1997	Hail	0.75 in.	0	0	$0	$0
TAMPA	5/23/1997	Hail	1.75 in.	0	0	$0	$0
TAMPA	5/23/1997	Hail	0.75 in.	0	0	$0	$0
TAMPA	6/25/1997	Hail	1.00 in.	0	0	$0	$0
TAMPA	7/15/1997	Hail	0.75 in.	0	0	$0	$0
TAMPA	7/16/1997	Hail	0.75 in.	0	0	$0	$0
TAMPA	7/17/1997	Hail	0.75 in.	0	0	$0	$0
TAMPA	7/24/1997	Hail	1.00 in.	0	0	$0	$0
TAMPA	8/16/1997	Hail	0.75 in.	0	0	$0	$0
TAMPA	8/16/1997	Hail	0.88 in.	0	0	$0	$0
TAMPA	3/9/1998	Hail	0.75 in.	0	0	$79,215	$0
TAMPA	6/21/1998	Hail	0.75 in.	0	0	$0	$0
TAMPA	6/21/1998	Hail	0.75 in.	0	0	$0	$0
TAMPA	8/9/1998	Hail	0.75 in.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
TAMPA	9/6/1998	Hail	1.00 in.	0	0	$0	$0
TAMPA	5/10/1999	Hail	1.75 in.	0	0	$0	$0
TAMPA	5/10/1999	Hail	0.75 in.	0	0	$0	$0
TAMPA	5/10/1999	Hail	1.75 in.	0	0	$0	$0
TAMPA	5/14/1999	Hail	0.75 in.	0	0	$0	$0
TAMPA	6/30/1999	Hail	0.75 in.	0	0	$0	$0
TAMPA	7/7/1999	Hail	0.75 in.	0	0	$0	$0
TAMPA	8/1/1999	Hail	0.75 in.	0	0	$0	$0
TAMPA	6/13/2000	Hail	1.00 in.	0	0	$372,642	$0
TAMPA	7/21/2000	Hail	1.00 in.	0	0	$0	$0
TAMPA	6/4/2001	Hail	0.75 in.	0	0	$0	$0
TAMPA	6/4/2001	Hail	1.00 in.	0	0	$0	$0
TAMPA	4/3/2002	Hail	0.75 in.	0	0	$0	$0
TAMPA	7/25/2002	Hail	0.75 in.	0	0	$0	$0
TAMPA	7/25/2002	Hail	1.00 in.	0	0	$0	$0
TAMPA	8/19/2002	Hail	0.75 in.	0	0	$0	$0
TAMPA	8/2/2003	Hail	0.88 in.	0	0	$0	$0
TAMPA	8/25/2004	Hail	0.88 in.	0	0	$0	$0
TAMPA	8/5/2005	Hail	0.88 in.	0	0	$0	$0
TAMPA	7/20/2006	Hail	0.88 in.	0	0	$0	$0
TAMPA	4/11/2007	Hail	0.88 in.	0	0	$0	$0
TAMPA	7/16/2007	Hail	0.88 in.	0	0	$0	$0
TAMPA	7/16/2007	Hail	0.75 in.	0	0	$0	$0
TAMPA	6/25/2008	Hail	1.00 in.	0	0	$0	$0
TAMPA	7/6/2008	Hail	0.88 in.	0	0	$0	$0
(TPA)TAMPA INTL ARPT	5/28/2014	Hail	0.75 in.	0	0	$0	$0
Temple Terrace							
TEMPLE TERRACE	8/17/1998	Hail	0.75 in.	0	0	$0	$0
TEMPLE TERRACE	8/1/2000	Hail	0.88 in.	0	0	$0	$0
TEMPLE TERRACE	8/26/2000	Hail	0.75 in.	0	0	$0	$0
TEMPLE TERRACE	8/10/2001	Hail	1.75 in.	0	0	$0	$0
TEMPLE TERRACE	8/21/2001	Hail	2.00 in.	0	0	$0	$0
TEMPLE TERRACE	5/31/2002	Hail	1.75 in.	0	0	$0	$0
TEMPLE TERRACE	3/27/2003	Hail	1.75 in.	0	0	$0	$0
TEMPLE TERRACE	3/27/2003	Hail	1.75 in.	0	0	$0	$0
TEMPLE TERRACE	6/16/2003	Hail	1.00 in.	0	0	$0	$0
TEMPLE TERRACE	6/8/2004	Hail	0.75 in.	0	0	$0	$0
TEMPLE TERRACE	6/24/2004	Hail	1.00 in.	0	0	$0	$0
TEMPLE TERRACE	7/15/2005	Hail	1.00 in.	0	0	$0	$0
TEMPLE TERRACE	7/23/2008	Hail	0.75 in.	0	0	$0	$0
TEMPLE TERRACE	6/6/2011	Hail	1.00 in.	0	0	$0	$0
TEMPLE TERRACE	8/21/2012	Hail	0.88 in.	0	0	$0	$0
TEMPLE TERRACE	5/11/2015	Hail	1.00 in.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
TEMPLE TERRACE	7/10/2017	Hail	1.25 in.	0	0	$0	$0
Unincorporated							
HILLSBOROUGH CO.	4/15/1958	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	9/8/1959	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/23/1960	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/2/1960	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	8/8/1960	Hail	2.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/8/1961	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/5/1961	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/23/1961	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/25/1961	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/5/1962	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/13/1962	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/28/1963	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/30/1963	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/10/1964	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/28/1964	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	9/2/1964	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/26/1965	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/16/1966	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/13/1966	Hail	1.25 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/29/1967	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	2/23/1968	Hail	1.25 in.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	5/4/1968	Hail	1.50 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/16/1968	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/28/1968	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/28/1968	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/4/1969	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/4/1969	Hail	1.50 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/6/1969	Hail	2.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/7/1969	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/8/1969	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	2/8/1971	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/11/1971	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/10/1971	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/9/1971	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/13/1972	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	8/4/1972	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	4/4/1973	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/30/1973	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/20/1973	Hail	1.25 in.	0	0	$0	$0
HILLSBOROUGH CO.	8/6/1973	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	8/22/1973	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/14/1974	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/15/1974	Hail	1.75 in.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	6/14/1974	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/14/1974	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	3/25/1975	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/9/1977	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/2/1978	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	10/5/1978	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/14/1979	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/15/1979	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/30/1979	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/7/1979	Hail	1.50 in.	0	0	$0	$0
HILLSBOROUGH CO.	8/10/1979	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/15/1980	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/19/1981	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/6/1981	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/8/1981	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	3/24/1983	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/23/1983	Hail	1.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/18/1989	Hail	1.25 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/6/1990	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/9/1990	Hail	1.25 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/9/1990	Hail	1.50 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/11/1990	Hail	1.00 in.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	7/21/1990	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/17/1991	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/30/1991	Hail	1.50 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/24/1991	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	2/5/1992	Hail	0.88 in.	0	0	$0	$0
HILLSBOROUGH CO.	2/5/1992	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	7/21/1992	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	8/5/1992	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	8/7/1992	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	9/1/1992	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	9/1/1992	Hail	1.00 in.	0	0	$0	$0
HILLSBOROUGH CO.	9/2/1992	Hail	1.00 in.	0	0	$0	$0
RUSKIN	2/22/1993	Hail	0.75 in.	0	0	$0	$0
THONOTOSASSA	8/26/1993	Hail	1.00 in.	0	0	$0	$0
CARROLLWOOD	9/5/1993	Hail	0.88 in.	0	0	$0	$0
APOLLO BEACH	6/29/1994	Hail	1.50 in.	0	0	$0	$0
VALRICO	6/29/1994	Hail	1.00 in.	0	0	$0	$0
LITHIA	5/4/1995	Hail	1.75 in.	0	0	$0	$0
VALRICO	5/4/1995	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	5/12/1995	Hail	0.75 in.	0	0	$0	$0
HILLSBOROUGH CO.	6/11/1995	Hail	0.75 in.	0	0	$0	$0
RIVERVIEW	3/30/1996	Hail	1.00 in.	0	0	$0	$0
RIVERVIEW	3/30/1996	Hail	0.75 in.	0	0	$0	$0
RIVERVIEW	3/30/1996	Hail	1.75 in.	0	0	$123,783	$0
VALRICO	3/30/1996	Hail	1.75 in.	0	0	$330,089	$0
BRANDON	3/30/1996	Hail	1.75 in.	0	0	$148,540	$0
RIVERVIEW	5/3/1996	Hail	0.75 in.	0	0	$0	$0
BRANDON	5/3/1996	Hail	0.75 in.	0	0	$0	$0
RUSKIN	2/16/1998	Hail	0.75 in.	0	0	$0	$0
SUN CITY	2/16/1998	Hail	1.00 in.	0	0	$0	$0
RUSKIN	2/16/1998	Hail	1.00 in.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
RUSKIN	3/1/1998	Hail	1.00 in.	0	0	$0	$0
BRANDON	5/4/1998	Hail	1.75 in.	0	0	$0	$0
BRANDON	5/5/1998	Hail	0.88 in.	0	0	$0	$0
BRANDON	6/24/1998	Hail	0.75 in.	0	0	$0	$0
BRANDON	9/30/1998	Hail	0.88 in.	0	0	$0	$0
BRANDON	5/10/1999	Hail	0.88 in.	0	0	$0	$0
BRANDON	5/10/1999	Hail	1.75 in.	0	0	$773,087	$0
WIMAUMA	5/12/1999	Hail	0.75 in.	0	0	$0	$0
BRANDON	5/19/1999	Hail	0.88 in.	0	0	$0	$0
BRANDON	5/19/1999	Hail	0.75 in.	0	0	$0	$0
MANGO	5/19/1999	Hail	1.00 in.	0	0	$0	$0
APOLLO BEACH	5/21/1999	Hail	1.00 in.	0	0	$0	$0
RIVERVIEW	5/21/1999	Hail	1.00 in.	0	0	$0	$0
RIVERVIEW	5/22/1999	Hail	0.75 in.	0	0	$0	$0
BRANDON	5/22/1999	Hail	0.75 in.	0	0	$0	$0
VALRICO	6/3/1999	Hail	1.00 in.	0	0	$0	$0
WIMAUMA	6/3/1999	Hail	0.75 in.	0	0	$0	$0
BRANDON	6/4/1999	Hail	0.75 in.	0	0	$0	$0
BRANDON	6/9/1999	Hail	0.88 in.	0	0	$0	$0
BRANDON	7/7/1999	Hail	0.75 in.	0	0	$0	$0
RUSKIN	7/13/1999	Hail	0.75 in.	0	0	$0	$0
DOVER	7/14/1999	Hail	0.88 in.	0	0	$0	$0
MANGO	6/7/2000	Hail	0.88 in.	0	0	$0	$0
RIVERVIEW	6/13/2000	Hail	0.75 in.	0	0	$0	$0
BRANDON	7/21/2000	Hail	0.88 in.	0	0	$0	$0
SUN CITY	8/26/2000	Hail	0.75 in.	0	0	$0	$0
THONOTOSASSA	3/31/2001	Hail	0.75 in.	0	0	$0	$0
SEFFNER	3/31/2001	Hail	1.50 in.	0	0	$0	$0
LITHIA	6/14/2001	Hail	1.00 in.	0	0	$0	$0
THONOTOSASSA	6/15/2001	Hail	1.00 in.	0	0	$0	$0
RUSKIN	6/18/2001	Hail	0.75 in.	0	0	$0	$0
WIMAUMA	6/21/2001	Hail	1.00 in.	0	0	$0	$0
RIVERVIEW	6/21/2001	Hail	0.75 in.	0	0	$0	$0
BRANDON	4/17/2002	Hail	1.00 in.	0	0	$0	$0
VALRICO	5/30/2002	Hail	1.00 in.	0	0	$0	$0
VALRICO	5/30/2002	Hail	0.75 in.	0	0	$0	$0
BRANDON	5/30/2002	Hail	0.88 in.	0	0	$0	$0
CITRUS PARK	7/25/2002	Hail	1.75 in.	0	0	$0	$0
SEFFNER	7/29/2002	Hail	0.75 in.	0	0	$0	$0
RIVERVIEW	3/14/2003	Hail	0.75 in.	0	0	$0	$0
LUTZ	5/18/2003	Hail	2.00 in.	0	0	$0	$0
LUTZ	5/19/2003	Hail	1.00 in.	0	0	$0	$0
CARROLLWOOD	7/18/2003	Hail	1.00 in.	0	0	$0	$0
VALRICO	7/30/2003	Hail	1.00 in.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
SUN CITY CENTER	8/1/2003	Hail	1.00 in.	0	0	$0	$0
RIVERVIEW	6/4/2004	Hail	1.00 in.	0	0	$0	$0
THONOTOSASSA	6/6/2004	Hail	0.88 in.	0	0	$0	$0
CARROLLWOOD	7/5/2004	Hail	0.75 in.	0	0	$0	$0
BLOOMINGDALE	5/17/2005	Hail	0.88 in.	0	0	$0	$0
MANGO	5/13/2007	Hail	0.75 in.	0	0	$0	$0
CARROLLWOOD	8/24/2007	Hail	0.75 in.	0	0	$0	$0
BRANDON	9/12/2007	Hail	0.75 in.	0	0	$0	$0
BRANDON	9/12/2007	Hail	1.25 in.	0	0	$0	$0
LAKE FERN	1/22/2008	Hail	0.75 in.	0	0	$0	$0
LAKE FERN	1/22/2008	Hail	1.00 in.	0	0	$0	$0
LUTZ	6/9/2008	Hail	0.75 in.	0	0	$0	$0
THONOTOSASSA	6/12/2008	Hail	1.00 in.	0	0	$0	$0
TARPON	6/21/2008	Hail	0.88 in.	0	0	$0	$0
BEACH PARK	6/25/2008	Hail	0.75 in.	0	0	$0	$0
PINECREST	6/25/2008	Hail	0.88 in.	0	0	$0	$0
GOLDSTEIN	6/25/2008	Hail	0.88 in.	0	0	$0	$0
PINECREST	6/25/2008	Hail	0.88 in.	0	0	$0	$0
GROVE PARK ESTATES	6/25/2008	Hail	0.88 in.	0	0	$0	$0
GOLDSTEIN	6/25/2008	Hail	0.88 in.	0	0	$0	$0
GOLDSTEIN	6/25/2008	Hail	0.88 in.	0	0	$0	$0
CARROLLWOOD	6/25/2008	Hail	1.00 in.	0	0	$0	$0
FOREST HILLS	6/25/2008	Hail	0.88 in.	0	0	$0	$0
CARROLLWOOD	6/25/2008	Hail	0.88 in.	0	0	$0	$0
CLARKWILD	7/1/2008	Hail	1.00 in.	0	0	$0	$0
THONOTOSASSA	7/1/2008	Hail	0.75 in.	0	0	$0	$0
BEACH PARK	7/6/2008	Hail	1.00 in.	0	0	$0	$0
BEACH PARK	7/6/2008	Hail	1.75 in.	0	0	$0	$0
GROVE PARK ESTATES	7/6/2008	Hail	0.88 in.	0	0	$0	$0
ROCKY CREEK	7/22/2008	Hail	0.75 in.	0	0	$0	$0
MORICZVILLE	3/29/2009	Hail	0.75 in.	0	0	$0	$0
ORIENT PARK	5/13/2009	Hail	1.00 in.	0	0	$0	$0
BRANCHTON	6/2/2009	Hail	0.75 in.	0	0	$0	$0
LUTZ	6/17/2009	Hail	0.88 in.	0	0	$0	$0
LUTZ	6/17/2009	Hail	1.00 in.	0	0	$0	$0
LUTZ	6/17/2009	Hail	1.00 in.	0	0	$0	$0
RIVERVIEW	6/18/2009	Hail	0.75 in.	0	0	$0	$0
LAKE FERN	6/16/2010	Hail	1.00 in.	0	0	$0	$0
ORIENT PARK	7/28/2010	Hail	1.00 in.	0	0	$0	$0
CORONET	6/10/2012	Hail	1.00 in.	0	0	$0	$0
ENON CHURCH	6/14/2012	Hail	1.00 in.	0	0	$0	$0
TARPON	7/9/2012	Hail	0.88 in.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
TARPON	7/10/2012	Hail	1.25 in.	0	0	$0	$0
SAFFOLD	5/1/2013	Hail	1.00 in.	0	0	$0	$0
THONOTOSASSA	8/20/2013	Hail	0.75 in.	0	0	$0	$0
TARPON	5/25/2014	Hail	0.88 in.	0	0	$0	$0
LAKE MAGDALENE	5/26/2014	Hail	0.75 in.	0	0	$0	$0
CARROLLWOOD	5/29/2014	Hail	1.00 in.	0	0	$0	$0
SUN CITY CENTER	6/27/2014	Hail	1.00 in.	0	0	$0	$0
VALRICO	7/1/2014	Hail	0.88 in.	0	0	$0	$0
CORONET	7/11/2014	Hail	0.88 in.	0	0	$0	$0
LITHIA	7/21/2014	Hail	1.00 in.	0	0	$0	$0
GOLDSTEIN	5/12/2015	Hail	1.00 in.	0	0	$0	$0
BRANDON ARPT	6/18/2015	Hail	0.88 in.	0	0	$0	$0
CORONET	9/26/2016	Hail	0.88 in.	0	0	$0	$0
BOYETTE	5/3/2017	Hail	0.88 in.	0	0	$0	$0
LITHIA	9/13/2018	Hail	0.75 in.	0	0	$0	$0
LIMONA	7/18/2019	Hail	0.75 in.	0	0	$0	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

Studies conducted by NOAA and the NWS are continually refining the ability to determine the extent and maximum size of hail that could impact specific areas including Hillsborough County. Analysis of historical records available through the NCEI Storm Events database revealed, between the years 1958 and 2019, the largest size hail recorded was approximately 2.75 inches in diameter. However, it is possible that future hail size could exceed this.

Wind

According to the NCEI Storm Events Database, there were 458 reports of thunderstorm/high wind in Hillsborough County from 1955 to 2019.[113] These wind events are only inclusive of those reported by NCEI from 1955 through October 2019. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.64: Summary of Wind Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
Plant City	17	1	0	$931,423	$37,257
Tampa	122	0	26	$5,015,305	$185,752
Temple Terrace	15	0	0	$305,643	$13,893
Unincorporated	304	0	10	$13,047,049	$200,724

[113] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+High+Wind&eventType=%28Z%29+Strong+Wind&eventType=%28C%29+Thunderstorm+Wind&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
HILLSBOROUGH COUNTY TOTAL	**458**	**1**	**36**	**$19,299,420**	**$437,626**

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in December 2019.

Table 4.65: Historical Wind Occurrences in Hillsborough County

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
Plant City							
PLANT CITY	5/4/1995	T-storm Wind	50 kts.	0	0	$0	$0
PLANT CITY	5/4/1995	T-storm Wind	0 kts.	0	0	$1,688	$0
PLANT CITY	8/10/1997	T-storm Wind	--	0	0	$3,196	$0
PLANT CITY	12/27/1997	T-storm Wind	--	0	0	$6,373	$0
PLANT CITY	6/21/1998	T-storm Wind	--	1	0	$1,577	$0
PLANT CITY	8/16/1998	T-storm Wind	--	0	0	$7,863	$0
PLANT CITY	7/26/1999	T-storm Wind	--	0	0	$7,708	$0
PLANT CITY	6/7/2000	T-storm Wind	--	0	0	$2,981	$0
PLANT CITY	6/24/2000	T-storm Wind	--	0	0	$37,264	$0
PLANT CITY	8/9/2000	T-storm Wind	57 kts.	0	0	$0	$0
PLANT CITY	8/26/2000	T-storm Wind	--	0	0	$743,559	$0
PLANT CITY	6/17/2001	T-storm Wind	--	0	0	$72,184	$0
PLANT CITY	7/25/2002	T-storm Wind	50 kts.	0	0	$0	$0
PLANT CITY	7/22/2003	T-storm Wind	55 kts.	0	0	$0	$0
PLANT CITY	7/21/2007	T-storm Wind	50 kts.	0	0	$6,168	$0
PLANT CITY	7/15/2010	T-storm Wind	52 kts.	0	0	$35,362	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
PLANT CTY HILSBRO AR	7/17/2013	T-storm Wind	40 kts.	0	0	$5,500	$0
Tampa							
TAMPA	9/5/1993	T-storm Wind	0 kts.	0	0	$0	$0
TAMPA	9/5/1993	T-storm Wind	0 kts.	0	0	$88,551	$0
N TAMPA	9/5/1993	T-storm Wind	0 kts.	0	0	$8,855	$0
TAMPA	7/18/1994	T-storm Wind	0 kts.	0	0	$8,658	$0
TPA	5/12/1995	T-storm Wind	0 kts.	0	0	$8,442	$0
TPA	5/12/1995	T-storm Wind	0 kts.	0	0	$8,442	$0
TAMPA	6/10/1995	T-storm Wind	50 kts.	0	0	$0	$0
TPA	7/8/1995	T-storm Wind	0 kts.	0	0	$3,370	$0
TAMPA	7/8/1995	T-storm Wind	40 kts.	0	0	$16,851	$0
TAMPA	8/15/1995	T-storm Wind	0 kts.	0	0	$840	$0
TAMPA	8/15/1995	T-storm Wind	0 kts.	0	0	$504	$0
TAMPA	8/19/1995	T-storm Wind	36 kts.	0	0	$1,681	$0
TAMPA	11/11/1995	T-storm Wind	0 kts.	0	0	$3,346	$0
TAMPA	5/3/1996	T-storm Wind	--	0	0	$8,205	$0
TAMPA	5/4/1996	T-storm Wind	--	0	0	$32,819	$0
TAMPA	5/29/1996	T-storm Wind	--	0	0	$196,915	$0
TAMPA	5/29/1996	T-storm Wind	--	0	0	$16,410	$0
TAMPA	6/7/1996	T-storm Wind	--	0	0	$4,920	$0
TAMPA	6/25/1996	T-storm Wind	--	0	0	$6,560	$0
TAMPA	6/26/1996	T-storm Wind	--	0	0	$3,280	$0
TAMPA	6/26/1996	T-storm Wind	--	0	0	$1,640	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
TAMPA	6/26/1996	T-storm Wind	--	0	0	$16,399	$0
TAMPA	6/26/1996	T-storm Wind	49 kts.	0	0	$0	$0
TAMPA	8/8/1996	T-storm Wind	--	0	0	$8,168	$0
TAMPA	8/17/1996	T-storm Wind	--	0	0	$8,168	$0
TAMPA	8/18/1996	T-storm Wind	--	0	0	$24,505	$0
TAMPA	9/21/1996	T-storm Wind	--	0	0	$1,628	$0
TAMPA	9/29/1996	T-storm Wind	--	0	0	$16,285	$0
TAMPA	1/9/1997	T-storm Wind	--	0	0	$16,152	$0
TAMPA	1/29/1997	T-storm Wind	--	0	0	$4,846	$0
TAMPA	4/23/1997	T-storm Wind	50 kts.	0	0	$0	$0
TAMPA	4/26/1997	T-storm Wind	--	0	0	$0	$0
TAMPA	5/23/1997	T-storm Wind	--	0	0	$32,102	$0
TAMPA	5/28/1997	T-storm Wind	--	0	0	$8,025	$0
TAMPA	6/21/1997	T-storm Wind	--	0	0	$1,603	$0
TAMPA	6/24/1997	T-storm Wind	--	0	0	$3,206	$0
TAMPA	6/24/1997	T-storm Wind	--	0	0	$8,015	$0
TAMPA	6/26/1997	T-storm Wind	57 kts.	0	0	$0	$0
TAMPA	6/26/1997	T-storm Wind	75 kts.	0	0	$0	$0
TAMPA	7/4/1997	T-storm Wind	--	0	0	$120,081	$0
TAMPA	7/4/1997	T-storm Wind	--	0	9	$8,005	$0
TAMPA	7/5/1997	T-storm Wind	--	0	0	$8,005	$0
TAMPA	7/8/1997	T-storm Wind	--	0	0	$3,202	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
TAMPA	7/8/1997	T-storm Wind	--	0	0	$40,027	$0
TAMPA	7/12/1997	T-storm Wind	--	0	0	$1,601	$0
TAMPA	7/17/1997	T-storm Wind	--	0	0	$1,601	$0
TAMPA	7/30/1997	T-storm Wind	--	0	0	$40,027	$0
TAMPA	10/2/1997	T-storm Wind	--	0	0	$0	$0
TAMPA	10/27/1997	T-storm Wind	--	0	0	$159,019	$0
TAMPA	10/31/1997	T-storm Wind	52 kts.	0	0	$1,590	$0
TAMPA	2/2/1998	T-storm Wind	--	0	0	$158,724	$0
TAMPA	2/16/1998	T-storm Wind	52 kts.	0	0	$0	$0
TAMPA	2/19/1998	T-storm Wind	--	0	0	$7,936	$0
TAMPA	3/9/1998	T-storm Wind	--	0	0	$79,215	$0
TAMPA	3/9/1998	T-storm Wind	--	0	0	$1,584,303	$0
TAMPA	5/5/1998	T-storm Wind	74 kts.	0	0	$789,232	$0
TAMPA	8/7/1998	T-storm Wind	--	0	0	$15,727	$0
TAMPA	8/9/1998	T-storm Wind	--	0	0	$78,633	$0
TAMPA	8/16/1998	T-storm Wind	--	0	0	$1,573	$0
TAMPA	8/20/1998	T-storm Wind	--	0	0	$7,863	$0
TAMPA	8/20/1998	T-storm Wind	--	0	0	$23,590	$0
TAMPA	9/6/1998	T-storm Wind	--	0	0	$7,854	$0
TAMPA	9/30/1998	T-storm Wind	--	0	0	$23,561	$0
TAMPA	3/14/1999	T-storm Wind	--	0	0	$1,557	$0
TAMPA	3/14/1999	T-storm Wind	--	0	0	$23,361	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
TAMPA	3/14/1999	T-storm Wind	--	0	0	$77,871	$0
TAMPA	3/14/1999	T-storm Wind	--	0	0	$46,723	$0
TAMPA	5/10/1999	T-storm Wind	--	0	0	$0	$0
TAMPA	5/14/1999	T-storm Wind	50 kts.	0	0	$0	$0
TAMPA	5/14/1999	T-storm Wind	--	0	0	$7,731	$0
TAMPA	5/14/1999	T-storm Wind	--	0	0	$77,309	$0
TAMPA	5/14/1999	T-storm Wind	--	0	0	$1,546	$0
TAMPA	6/4/1999	T-storm Wind	--	0	0	$15,462	$0
TAMPA	6/30/1999	T-storm Wind	--	0	0	$0	$0
TAMPA	6/13/2000	T-storm Wind	--	0	0	$74,528	$0
TAMPA INTL ARPT	6/25/2000	T-storm Wind	--	0	0	$37,264	$0
TAMPA	7/21/2000	T-storm Wind	--	0	0	$7,436	$0
TAMPA	7/26/2000	T-storm Wind	--	0	0	$74,356	$0
TAMPA	7/28/2000	T-storm Wind	--	0	0	$37,178	$0
TAMPA	7/29/2000	T-storm Wind	--	0	0	$74,356	$0
TAMPA	8/6/2000	T-storm Wind	--	0	0	$37,178	$0
TAMPA	8/12/2000	T-storm Wind	--	0	0	$14,871	$0
TAMPA	8/12/2000	T-storm Wind	--	0	0	$74,356	$0
TAMPA	8/12/2000	T-storm Wind	--	0	0	$7,436	$0
TAMPA	8/12/2000	T-storm Wind	--	0	0	$2,974	$0
TAMPA	6/4/2001	T-storm Wind	--	0	0	$7,218	$0
TAMPA	7/21/2001	T-storm Wind	--	0	0	$36,194	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
TAMPA	8/7/2001	T-storm Wind	--	0	0	$108,581	$0
TAMPA INTL ARPT	7/4/2003	T-storm Wind	50 kts.	0	2	$41,921	$0
TAMPA	8/16/2003	T-storm Wind	50 kts.	0	0	$13,921	$0
(TPA)TAMPA INTL ARPT	2/24/2004	T-storm Wind	52 kts.	0	0	$55,204	$0
TAMPA	6/7/2004	T-storm Wind	50 kts.	0	0	$0	$0
TAMPA	6/13/2004	T-storm Wind	50 kts.	0	0	$0	$0
TAMPA	3/14/2005	T-storm Wind	57 kts.	0	0	$79,764	$0
(MCF)MC DILL AFB	6/27/2005	T-storm Wind	53 kts.	0	0	$0	$0
TAMPA	8/5/2005	T-storm Wind	55 kts.	0	0	$26,168	$0
MC DILL	8/6/2005	T-storm Wind	54 kts.	0	0	$0	$0
TAMPA	9/21/2005	T-storm Wind	53 kts.	0	0	$0	$0
TAMPA	7/3/2006	T-storm Wind	50 kts.	0	0	$12,628	$0
TAMPA	7/11/2006	T-storm Wind	53 kts.	0	0	$12,628	$0
TAMPA INTERNATIONAL AIRPORT	6/8/2007	T-storm Wind	50 kts.	0	0	$6,167	$0
TAMPA VANDENBERG ARP	2/5/2010	T-storm Wind	52 kts.	0	13	$1,186	$0
(MCF)MC DILL AFB	6/21/2010	T-storm Wind	61 kts.	0	0	$0	$0
TPA P O KNIGHT ARPT	1/25/2011	T-storm Wind	52 kts.	0	0	$0	$0
(MCF)MC DILL AFB	3/31/2011	T-storm Wind	53 kts.	0	0	$0	$0
OLD PORT TAMPA PORTS SITE	5/14/2011	T-storm Wind	66 kts.	0	0	$0	$0
SOUTH TAMPA	7/10/2012	T-storm Wind	56 kts.	0	0	$168,247	$0
TPA P O KNIGHT ARPT	8/20/2012	T-storm Wind	39 kts.	0	0	$1,115	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
CRUISE TERMINAL 2 PORT SITE	2/26/2013	T-storm Wind	62 kts.	0	0	$0	$0
TPA P O KNIGHT ARPT	2/26/2013	T-storm Wind	52 kts.	0	0	$0	$0
TAMPA	7/4/2013	T-storm Wind	50 kts.	0	0	$0	$0
(TPA)TAMPA INTL ARPT	8/9/2013	T-storm Wind	52 kts.	0	0	$1,099	$0
OLD PORT TAMPA PORTS SITE	5/28/2014	T-storm Wind	50 kts.	0	0	$0	$0
(MCF)MC DILL AFB	8/24/2014	T-storm Wind	53 kts.	0	0	$0	$0
TPA P O KNIGHT ARPT	5/12/2015	T-storm Wind	52 kts.	0	0	$0	$0
SOUTH TAMPA	6/26/2016	T-storm Wind	50 kts.	0	0	$2,132	$0
SOUTH TAMPA	6/26/2016	T-storm Wind	50 kts.	0	0	$5,331	$0
OLD PORT TAMPA PORTS SITE	1/22/2017	T-storm Wind	51 kts.	0	0	$0	$0
TAMPA	7/5/2017	T-storm Wind	50 kts.	0	2	$5,249	$0
TPA P O KNIGHT ARPT	7/5/2017	T-storm Wind	50 kts.	0	0	$6,299	$0
TPA P O KNIGHT ARPT	4/19/2019	T-storm Wind	51 kts.	0	0	$0	$0
TAMPA	7/4/2019	T-storm Wind	50 kts.	0	0	$0	$0
Temple Terrace							
TEMPLE TERRACE	2/17/1998	T-storm Wind	--	0	0	$7,936	$0
TEMPLE TERRACE	8/17/1998	T-storm Wind	--	0	0	$15,727	$0
TEMPLE TERRACE	9/30/1998	T-storm Wind	--	0	0	$31,415	$0
TEMPLE TERRACE	5/29/1999	T-storm Wind	--	0	0	$7,731	$0
TEMPLE TERRACE	8/1/2000	T-storm Wind	--	0	0	$14,871	$0
TEMPLE TERRACE	8/26/2000	T-storm Wind	--	0	0	$22,307	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
TEMPLE TERRACE	9/19/2000	T-storm Wind	--	0	0	$147,941	$0
TEMPLE TERRACE	8/21/2001	T-storm Wind	--	0	0	$36,194	$0
TEMPLE TERRACE	6/16/2003	T-storm Wind	55 kts.	0	0	$0	$0
TEMPLE TERRACE	6/16/2003	T-storm Wind	50 kts.	0	0	$20,983	$0
TEMPLE TERRACE	6/24/2004	T-storm Wind	50 kts.	0	0	$0	$0
TEMPLE TERRACE	6/25/2004	T-storm Wind	50 kts.	0	0	$0	$0
TEMPLE TERRACE	6/28/2004	T-storm Wind	60 kts.	0	0	$0	$0
TEMPLE TERRACE	5/13/2009	T-storm Wind	52 kts.	0	0	$0	$0
TEMPLE TERRACE	7/5/2015	T-storm Wind	45 kts.	0	0	$538	$0
Unincorporated							
HILLSBOROUGH CO.	7/28/1955	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	4/10/1956	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	11/27/1959	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/22/1960	T-storm Wind	89 kts.	0	0	$0	$0
HILLSBOROUGH CO.	2/25/1961	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/14/1961	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/24/1961	T-storm Wind	50 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/25/1961	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/10/1963	T-storm Wind	58 kts.	0	0	$0	$0
HILLSBOROUGH CO.	2/7/1964	T-storm Wind	51 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/2/1964	T-storm Wind	55 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/20/1964	T-storm Wind	52 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/23/1964	T-storm Wind	0 kts.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	6/25/1964	T-storm Wind	68 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/28/1964	T-storm Wind	66 kts.	0	0	$0	$0
HILLSBOROUGH CO.	2/24/1965	T-storm Wind	50 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/5/1965	T-storm Wind	64 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/4/1965	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/4/1965	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/4/1965	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/23/1965	T-storm Wind	62 kts.	0	0	$0	$0
HILLSBOROUGH CO.	4/28/1966	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/24/1966	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/7/1966	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/1/1967	T-storm Wind	73 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/23/1968	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/30/1968	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/27/1968	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	10/18/1968	T-storm Wind	60 kts.	0	0	$0	$0
HILLSBOROUGH CO.	10/18/1968	T-storm Wind	55 kts.	0	0	$0	$0
HILLSBOROUGH CO.	11/9/1968	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	2/15/1969	T-storm Wind	65 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/3/1969	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/20/1969	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/6/1969	T-storm Wind	57 kts.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	6/7/1969	T-storm Wind	55 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/14/1969	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/19/1969	T-storm Wind	50 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/31/1969	T-storm Wind	57 kts.	0	0	$0	$0
HILLSBOROUGH CO.	9/5/1970	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	9/7/1970	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	2/8/1971	T-storm Wind	60 kts.	0	0	$0	$0
HILLSBOROUGH CO.	3/3/1971	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	4/26/1971	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	9/1/1971	T-storm Wind	73 kts.	0	0	$0	$0
HILLSBOROUGH CO.	9/6/1971	T-storm Wind	52 kts.	0	0	$0	$0
HILLSBOROUGH CO.	11/29/1971	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	2/7/1972	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	3/17/1973	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	4/7/1973	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	4/26/1973	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/15/1973	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	2/19/1974	T-storm Wind	50 kts.	0	0	$0	$0
HILLSBOROUGH CO.	3/23/1974	T-storm Wind	60 kts.	0	0	$0	$0
HILLSBOROUGH CO.	3/29/1974	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/29/1974	T-storm Wind	55 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/5/1975	T-storm Wind	0 kts.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	7/21/1976	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	9/6/1976	T-storm Wind	56 kts.	0	0	$0	$0
HILLSBOROUGH CO.	9/7/1976	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/15/1977	T-storm Wind	53 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/20/1977	T-storm Wind	50 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/19/1978	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/19/1978	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/19/1978	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/19/1978	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/25/1978	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/19/1978	T-storm Wind	60 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/19/1978	T-storm Wind	61 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/15/1978	T-storm Wind	51 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/24/1978	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	12/24/1978	T-storm Wind	56 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/2/1979	T-storm Wind	50 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/8/1979	T-storm Wind	85 kts.	0	0	$0	$0
HILLSBOROUGH CO.	4/20/1980	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/15/1980	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/9/1980	T-storm Wind	53 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/18/1981	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/18/1981	T-storm Wind	0 kts.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	7/6/1981	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/8/1981	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/14/1982	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/23/1982	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/23/1983	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	9/14/1983	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	4/8/1984	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	4/9/1984	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/4/1985	T-storm Wind	50 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/4/1985	T-storm Wind	58 kts.	0	0	$0	$0
HILLSBOROUGH CO.	3/14/1986	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	3/16/1986	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/6/1987	T-storm Wind	55 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/21/1987	T-storm Wind	55 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/24/1988	T-storm Wind	55 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/12/1989	T-storm Wind	50 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/22/1989	T-storm Wind	80 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/15/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/27/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/6/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/7/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/1/1990	T-storm Wind	0 kts.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	7/7/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/7/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/10/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/17/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/18/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/20/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/20/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/10/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/12/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/18/1990	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/19/1991	T-storm Wind	0 kts.	0	1	$0	$0
HILLSBOROUGH CO.	3/3/1991	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	3/3/1991	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	5/16/1991	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/25/1991	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/13/1991	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/13/1991	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/17/1991	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/17/1991	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/5/1991	T-storm Wind	0 kts.	0	3	$0	$0
HILLSBOROUGH CO.	9/18/1991	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	2/5/1992	T-storm Wind	0 kts.	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	2/25/1992	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	2/25/1992	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	3/30/1992	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	6/7/1992	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/15/1992	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	7/21/1992	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/2/1992	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/6/1992	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	9/1/1992	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	9/2/1992	T-storm Wind	55 kts.	0	0	$0	$0
HILLSBOROUGH CO.	1/16/1993	T-storm Wind	0 kts.	0	0	$9,010	$0
HILLSBOROUGH CO.	1/16/1993	T-storm Wind	0 kts.	0	0	$90,103	$0
HILLSBOROUGH CO.	1/16/1993	T-storm Wind	0 kts.	0	0	$9,010	$0
HILLSBOROUGH CO.	2/11/1993	T-storm Wind	0 kts.	0	0	$8,979	$0
HILLSBOROUGH CO.	3/3/1993	T-storm Wind	0 kts.	0	0	$894,756	$0
HILLSBOROUGH CO.	3/3/1993	T-storm Wind	0 kts.	0	0	$89,476	$0
HILLSBOROUGH CO.	3/3/1993	T-storm Wind	56 kts.	0	0	$0	$0
HILLSBOROUGH CO.	3/13/1993	T-storm Wind	83 kts.	0	0	$0	$0
COASTAL HILLSBOROUGH (ZONE)	3/13/1993	T-storm Wind	65 kts.	0	0	$0	$0
COASTAL HILLSBOROUGH (ZONE)	3/13/1993	T-storm Wind	0 kts.	0	0	$8,947,563	$0
INLAND HILLSBOROUGH (ZONE)	8/3/1993	T-storm Wind	0 kts.	0	0	$8,873	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
DOVER	9/15/1993	T-storm Wind	0 kts.	0	0	$8,855	$0
HILLSBOROUGH CO.	10/30/1993	T-storm Wind	0 kts.	0	0	$88,186	$0
HILLSBOROUGH CO.	6/16/1994	T-storm Wind	0 kts.	0	4	$868,155	$0
HILLSBOROUGH CO.	6/27/1994	T-storm Wind	0 kts.	0	0	$868	$0
HILLSBOROUGH CO.	6/29/1994	T-storm Wind	0 kts.	0	0	$868	$0
HILLSBOROUGH CO.	6/30/1994	T-storm Wind	0 kts.	0	0	$868	$0
HILLSBOROUGH CO.	7/7/1994	T-storm Wind	0 kts.	0	0	$866	$0
COASTAL HILLSBOROUGH (ZONE)	7/11/1994	T-storm Wind	0 kts.	0	0	$0	$0
COASTAL HILLSBOROUGH (ZONE)	7/13/1994	T-storm Wind	0 kts.	0	0	$0	$0
INLAND HILLSBOROUGH (ZONE)	7/16/1994	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/10/1994	T-storm Wind	0 kts.	0	0	$0	$0
BUSHNELL	8/18/1994	T-storm Wind	0 kts.	0	0	$862	$0
ZEPHYRHILLS	8/18/1994	T-storm Wind	0 kts.	0	0	$862	$0
HILLSBOROUGH CO.	8/24/1994	T-storm Wind	0 kts.	0	0	$0	$0
HILLSBOROUGH CO.	8/28/1994	T-storm Wind	0 kts.	0	0	$0	$0
BRANDON	10/30/1994	T-storm Wind	0 kts.	0	0	$85,944	$0
BRANDON	2/4/1995	T-storm Wind	45 kts.	0	0	$170	$0
CARROLLWOOD	3/31/1995	T-storm Wind	0 kts.	0	0	$25,460	$0
ST. PETE	8/15/1995	T-storm Wind	67 kts.	0	0	$0	$0
ST. PETE	8/15/1995	T-storm Wind	52 kts.	0	0	$0	$0
RIVERVIEW	5/3/1996	T-storm Wind	--	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
BRANDON	4/23/1997	T-storm Wind	--	0	0	$8,020	$0
BRANDON	2/3/1998	T-storm Wind	--	0	0	$47,617	$0
RUSKIN	2/20/1998	T-storm Wind	--	0	0	$79,362	$0
LUTZ	6/21/1998	T-storm Wind	--	0	0	$3,153	$0
RUSKIN	6/22/1998	T-storm Wind	--	0	0	$157,653	$0
BRANDON	6/23/1998	T-storm Wind	--	0	0	$15,765	$0
BRANDON	7/12/1998	T-storm Wind	--	0	0	$23,619	$0
BRANDON	7/26/1998	T-storm Wind	--	0	0	$15,746	$0
BRANDON	9/5/1998	T-storm Wind	--	0	0	$3,141	$0
RUSKIN	9/6/1998	T-storm Wind	--	0	0	$3,141	$0
APOLLO BEACH	1/2/1999	T-storm Wind	50 kts.	0	0	$15,641	$0
BRANDON	5/10/1999	T-storm Wind	--	0	0	$77,309	$0
BALM	5/22/1999	T-storm Wind	--	0	0	$1,000	$0
WIMAUMA	6/4/1999	T-storm Wind	--	0	0	$3,092	$0
THONOTOSASSA	6/9/1999	T-storm Wind	--	0	0	$7,731	$0
RIVERVIEW	6/15/1999	T-storm Wind	--	0	0	$3,092	$0
RIVERVIEW	6/15/1999	T-storm Wind	--	0	0	$15,462	$0
RIVERVIEW	7/9/1999	T-storm Wind	57 kts.	0	0	$7,708	$0
LITHIA	6/7/2000	T-storm Wind	--	0	0	$14,906	$0
WIMAUMA	6/12/2000	T-storm Wind	--	0	0	$0	$0
RIVERVIEW	6/13/2000	T-storm Wind	--	0	0	$1,491	$0
BRANDON	7/4/2000	T-storm Wind	--	0	0	$44,614	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
BRANDON	8/6/2000	T-storm Wind	--	0	0	$29,742	$0
DOVER	8/9/2000	T-storm Wind	--	0	0	$37,178	$0
RUSKIN	8/12/2000	T-storm Wind	--	0	0	$22,307	$0
SUN CITY	8/26/2000	T-storm Wind	52 kts.	0	0	$29,742	$0
RUSKIN	5/3/2001	T-storm Wind	--	0	0	$72,306	$0
THONOTOSASSA	6/15/2001	T-storm Wind	60 kts.	0	0	$216,551	$0
BRANDON	6/19/2001	T-storm Wind	52 kts.	0	0	$36,092	$0
WIMAUMA	6/21/2001	T-storm Wind	--	0	0	$4,331	$0
SUN CITY CENTER	6/21/2001	T-storm Wind	--	0	0	$72,184	$0
RIVERVIEW	6/27/2001	T-storm Wind	--	0	0	$28,873	$0
TURKEY CREEK	7/10/2001	T-storm Wind	--	0	0	$72,387	$0
THONOTOSASSA	7/14/2001	T-storm Wind	--	0	0	$72,387	$0
LITHIA	8/31/2001	T-storm Wind	--	0	0	$36,194	$0
CITRUS PARK	9/6/2001	T-storm Wind	--	0	0	$7,206	$0
BRANDON	4/17/2002	T-storm Wind	--	0	0	$2,858	$0
VALRICO	6/29/2002	T-storm Wind	50 kts.	0	0	$7,142	$0
SUN CITY	7/29/2002	T-storm Wind	50 kts.	0	0	$0	$0
RIVERVIEW	3/17/2003	T-storm Wind	52 kts.	0	0	$13,951	$6,975
RUSKIN	4/25/2003	T-storm Wind	55 kts.	0	0	$0	$0
LUTZ	5/19/2003	T-storm Wind	50 kts.	0	0	$0	$0
WIMAUMA	6/3/2003	T-storm Wind	50 kts.	0	0	$13,989	$0
CARROLLWOOD	6/13/2003	T-storm Wind	50 kts.	0	0	$0	$6,994

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
THONOTOSASSA	6/16/2003	T-storm Wind	50 kts.	0	2	$0	$0
CITRUS PARK	6/16/2003	T-storm Wind	50 kts.	0	0	$0	$0
CITRUS PARK	6/16/2003	T-storm Wind	50 kts.	0	0	$0	$0
CARROLLWOOD	6/16/2003	T-storm Wind	50 kts.	0	0	$0	$0
VALRICO	7/25/2003	T-storm Wind	50 kts.	0	0	$0	$0
BRANDON	7/30/2003	T-storm Wind	50 kts.	0	0	$0	$0
BRANDON	2/24/2004	T-storm Wind	39 kts.	0	0	$20,701	$6,900
LUTZ	6/24/2004	T-storm Wind	50 kts.	0	0	$0	$0
SEFFNER	6/27/2004	T-storm Wind	50 kts.	0	0	$0	$0
SUN CITY CENTER	4/7/2005	T-storm Wind	60 kts.	0	0	$6,603	$0
SUN CITY CENTER	4/7/2005	T-storm Wind	50 kts.	0	0	$6,603	$0
LAKE FERN	4/14/2009	T-storm Wind	59 kts.	0	0	$0	$0
LUTZ	5/24/2009	T-storm Wind	43 kts.	0	0	$63,085	$0
RIVERVIEW	6/18/2009	T-storm Wind	52 kts.	0	0	$35,742	$0
SEFFNER	7/1/2009	T-storm Wind	43 kts.	0	0	$11,933	$0
PROGRESS VLG	7/19/2009	T-storm Wind	52 kts.	0	0	$4,773	$0
CLARKWILD	1/22/2010	T-storm Wind	43 kts.	0	0	$3,558	$0
VALRICO	6/21/2010	T-storm Wind	43 kts.	0	0	$2,358	$0
LEMANON CHURCH	7/15/2010	T-storm Wind	52 kts.	0	0	$11,787	$0
PALM RIVER	7/28/2010	T-storm Wind	56 kts.	0	0	$17,681	$0
GARY	7/28/2010	T-storm Wind	58 kts.	0	0	$0	$0
PALM RIVER	7/28/2010	T-storm Wind	56 kts.	0	0	$8,840	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
ORIENT PARK	7/28/2010	T-storm Wind	52 kts.	0	0	$11,787	$0
ADAMSVILLE	1/25/2011	T-storm Wind	52 kts.	0	0	$5,834	$0
THONOTOSASSA	3/31/2011	T-storm Wind	52 kts.	0	0	$0	$0
SULPHUR SPGS	5/14/2011	T-storm Wind	52 kts.	0	0	$7,961	$0
SAFFOLD	3/4/2012	T-storm Wind	45 kts.	0	0	$5,601	$0
CARROLLWOOD	7/21/2012	T-storm Wind	50 kts.	0	0	$5,608	$0
BOYETTE	9/18/2012	T-storm Wind	35 kts.	0	0	$1,110	$0
SEFFNER	5/20/2013	T-storm Wind	45 kts.	0	0	$5,516	$0
REMLAP	7/4/2013	T-storm Wind	40 kts.	0	0	$2,200	$0
BLOOMINGDALE	7/5/2013	T-storm Wind	40 kts.	0	0	$2,200	$0
TARPON	7/17/2013	T-storm Wind	40 kts.	0	0	$2,200	$0
SEFFNER	7/17/2013	T-storm Wind	40 kts.	0	0	$5,500	$0
BRANDON	7/17/2013	T-storm Wind	40 kts.	0	0	$11,001	$0
RATTLESNAKE	7/17/2013	T-storm Wind	40 kts.	0	0	$2,200	$0
ROCKY CREEK	8/9/2013	T-storm Wind	50 kts.	0	0	$3,296	$0
PINECREST	8/9/2013	T-storm Wind	52 kts.	0	0	$8,790	$0
GROVE PARK ESTATES	8/9/2013	T-storm Wind	52 kts.	0	0	$0	$0
COSME	8/19/2013	T-storm Wind	52 kts.	0	0	$0	$0
SEFFNER	8/20/2013	T-storm Wind	50 kts.	0	0	$2,198	$0
SEFFNER	8/20/2013	T-storm Wind	50 kts.	0	0	$0	$0
TOWN N COUNTRY	8/20/2013	T-storm Wind	50 kts.	0	0	$0	$0
PALM RIVER	3/17/2014	T-storm Wind	40 kts.	0	0	$1,088	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
GOLDSTEIN	3/17/2014	T-storm Wind	40 kts.	0	0	$2,175	$0
ADAMSVILLE	3/17/2014	T-storm Wind	40 kts.	0	0	$1,088	$0
RIVERVIEW	3/17/2014	T-storm Wind	50 kts.	0	0	$1,088	$0
BRANDON ARPT	3/17/2014	T-storm Wind	50 kts.	0	0	$1,088	$0
VALRICO	3/17/2014	T-storm Wind	50 kts.	0	0	$1,088	$0
SNOWS CORNER	3/17/2014	T-storm Wind	50 kts.	0	0	$1,088	$0
GROVE PARK ESTATES	5/25/2014	T-storm Wind	50 kts.	0	0	$5,401	$0
LAKE MAGDALENE	5/26/2014	T-storm Wind	40 kts.	0	0	$1,080	$0
LITHIA	5/28/2014	T-storm Wind	50 kts.	0	0	$5,401	$0
VALRICO	5/29/2014	T-storm Wind	40 kts.	0	0	$108	$0
BEACH PARK	6/17/2014	T-storm Wind	35 kts.	0	0	$539	$0
SUN CITY CENTER	6/27/2014	T-storm Wind	50 kts.	0	0	$10,782	$0
HILLSBOROUGH RIVER STATE	7/20/2014	T-storm Wind	40 kts.	0	0	$5,393	$0
BOYETTE	7/21/2014	T-storm Wind	50 kts.	0	0	$539	$0
LITHIA	7/21/2014	T-storm Wind	45 kts.	0	0	$539	$0
RIVERVIEW	7/21/2014	T-storm Wind	50 kts.	0	0	$10,786	$0
BOYETTE	7/21/2014	T-storm Wind	45 kts.	0	0	$539	$0
BLOOMINGDALE	7/21/2014	T-storm Wind	45 kts.	0	0	$5,393	$0
TOWN N COUNTRY	8/22/2014	T-storm Wind	40 kts.	0	0	$10,804	$0
BEACH PARK	8/24/2014	T-storm Wind	40 kts.	0	0	$2,161	$0
BRANDON ARPT	4/20/2015	T-storm Wind	50 kts.	0	0	$543	$0
BRANDON ARPT	6/18/2015	T-storm Wind	50 kts.	0	0	$2,154	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
EAST LAKE-ORIENT PARK	7/3/2015	T-storm Wind	50 kts.	0	0	$21,535	$0
EAST LAKE-ORIENT PARK	7/3/2015	T-storm Wind	50 kts.	0	0	$10,768	$0
RIVERVIEW	7/11/2015	T-storm Wind	51 kts.	0	0	$0	$0
GIBSONTON	7/11/2015	T-storm Wind	50 kts.	0	0	$1,077	$0
GIBSONTON	7/11/2015	T-storm Wind	50 kts.	0	0	$1,077	$0
RATTLESNAKE	1/22/2016	T-storm Wind	50 kts.	0	0	$5,423	$0
COASTAL HILLSBOROUGH (ZONE)	1/23/2016	Strong Wind	45 kts.	0	0	$1,085	$0
BLOOMINGDALE	5/4/2016	T-storm Wind	50 kts.	0	0	$1,070	$0
SWEETWATER CREEK	7/12/2016	T-storm Wind	40 kts.	0	0	$0	$0
ADAMSVILLE	1/22/2017	T-storm Wind	45 kts.	0	0	$1,058	$0
MANGO HILLS	1/22/2017	T-storm Wind	40 kts.	0	0	$3,175	$0
PALM RIVER	5/4/2017	T-storm Wind	35 kts.	0	0	$5,250	$0
NOWATNEY	5/20/2017	T-storm Wind	43 kts.	0	0	$52,501	$0
MANGO HILLS	5/24/2017	T-storm Wind	50 kts.	0	0	$2,625	$0
CITRUS PARK	6/11/2017	T-storm Wind	40 kts.	0	0	$5,245	$0
EAST LAKE-ORIENT PARK	7/10/2017	T-storm Wind	45 kts.	0	0	$5,249	$0
PALM RIVER	7/10/2017	T-storm Wind	45 kts.	0	0	$20,996	$0
EDGEMONT KEY COMPS SITE	4/15/2018	T-storm Wind	51 kts.	0	0	$0	$0
COSME	7/23/2018	T-storm Wind	50 kts.	0	0	$10,197	$0
NOWATNEY	7/23/2018	T-storm Wind	50 kts.	0	0	$10,197	$0
RUSKIN	9/6/2018	T-storm Wind	40 kts.	0	0	$15,269	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
COASTAL HILLSBOROUGH (ZONE)	12/21/2018	High Wind	68 kts.	0	0	$0	$0
INLAND HILLSBOROUGH (ZONE)	4/19/2019	Strong Wind	48 kts.	0	0	$20,112	$0
WEST PARK	4/19/2019	T-storm Wind	45 kts.	0	0	$10,056	$0
CLARKWILD	4/19/2019	T-storm Wind	50 kts.	0	0	$5,028	$0
MANGO HILLS	4/19/2019	T-storm Wind	50 kts.	0	0	$10,056	$0
TARPON	5/5/2019	T-storm Wind	54 kts.	0	0	$0	$0
BRANDON	5/5/2019	T-storm Wind	50 kts.	0	0	$15,052	$0
TARPON	7/4/2019	T-storm Wind	40 kts.	0	0	$1,002	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

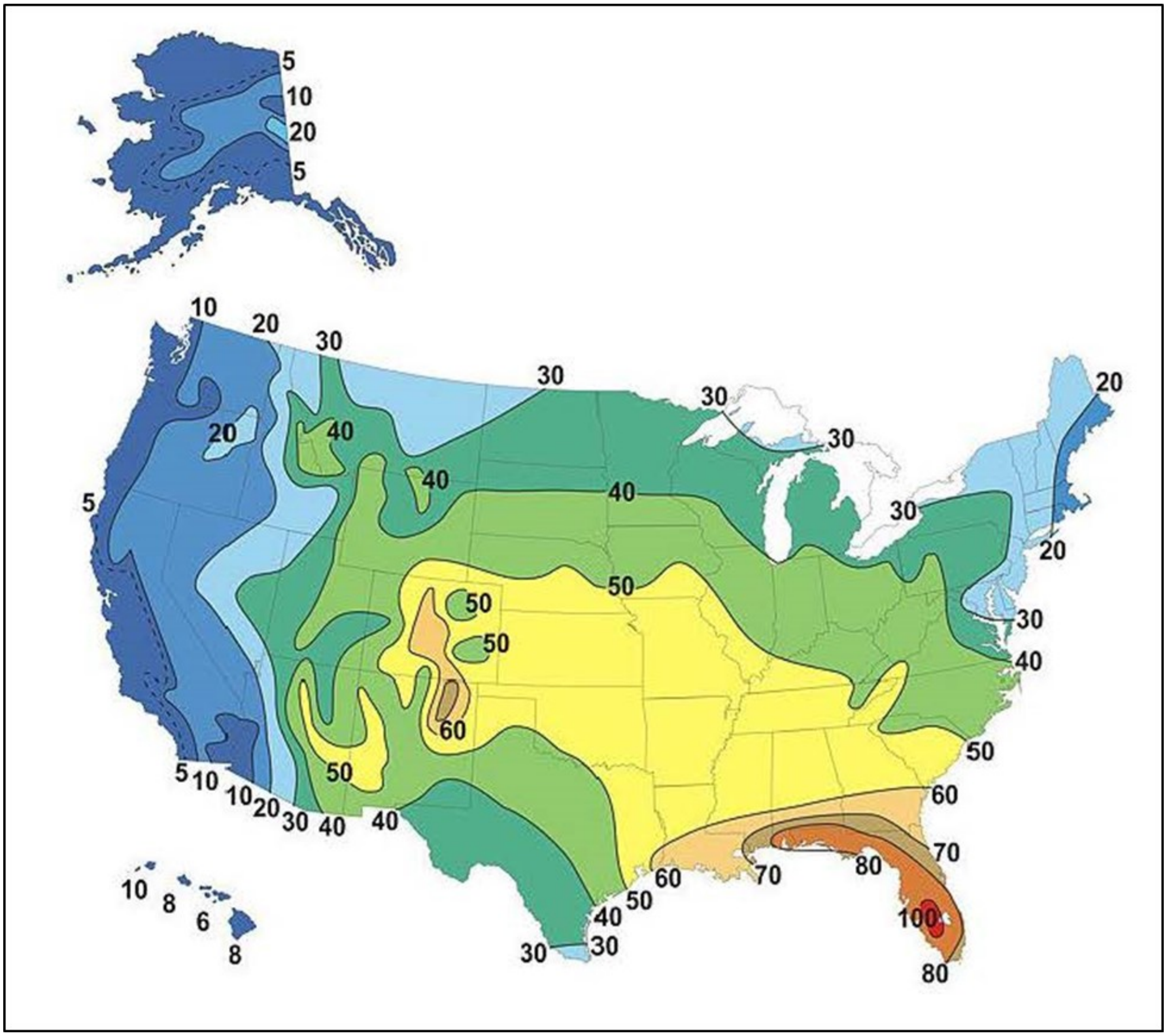
4. Probability of Future Severe Storms

The probability of a thunderstorm occurring depends on atmospheric and climatic conditions. Based on historical analysis, severe storms will continue to effect Hillsborough County. Hillsborough County experiences 80 to 90 days of thunderstorms through the year and the state of Florida has about 1.4 million lightning strikes on an annual basis making Florida first in the United States for lightning strikes per square mile.[114] Due to these annual occurrences, lightning is one of the prevalent hazards in the county. Severe thunderstorms can occur at any time within the Tampa Bay area, but mostly between the period from early summer through late fall. The greater the number of thunderstorms and/or their duration, the higher the number of lightning and hail occurrences.

Approximately 17 hail storm incidents have been document by the NOAA National Climatic Data Center in the years 2013-2018. These are the documented incidents but being that hail can occur at the micro-level scale and affect areas as small as a single neighborhood and even single residence, it is presumed that many more instances of hail occurred and will occur in the area that may not have been officially documented. NWS utilizes the *Probability for Severe Hail (POSH)* and most recently the *Maximum Expected Hail Size (MESH)* methods to predict hail size.

[114] www.nssl.noaa.gov/education/svrwx10/thunderstorms and www.floridadisaster.org/hazards/thunderstorms/

Figure 4.36: Average Number of Thunderstorm Days, United States[115]



Probability Based on Historical Occurrences

An analysis of severe storm reports from 1955 to 2019 in Hillsborough County from the NCEI Storm Events Database indicates that there will be approximately 4 lightning events, 2 heavy rain events, 5 hail events, and 7 wind events each year in Hillsborough County.

Table 4.66: NCEI Severe Storm Reports for Hillsborough County, 1955–2019[116]

Type of Severe Storm	NCEI Reports	Average per Year
Lightning	103	4.3

[115] http://www.srh.noaa.gov/jetstream/tstorms/tstorms_intro.html

[116] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Hail&eventType=%28C%29+Heavy+Rain&eventType=%28Z%29+High+Wind&eventType=%28C%29+Lightning&eventType=%28Z%29+Strong+Wind&eventType=%28C%29+Thunderstorm+Wind&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&end

Type of Severe Storm	NCEI Reports	Average per Year
Heavy Rain	35	1.5
Hail	280	4.5
Wind	458	7.0
TOTAL	**876**	**17.3**

Based on historical information, this hazard was determined to have a probability level of highly likely (100% annual probability).

5. Severe Storms Impact Analysis

All jurisdictions could receive the following impacts due to severe storms. Variances in how much damage these storms generate within each community would be dependent upon severity of storms, maintenance of vegetation and infrastructure, and strength of residential and commercial structures.

- Public
  - Injury or death from being struck by lightning
  - Injury or death from hail
  - Injury or death from flying debris
  - Injury or death from tornadoes and not having adequate shelter
  - Car accident
  - Indirect death
  - Survivors guilt if their house was not damaged from a severe storm or tornado and other neighbors died
- Responders
  - Responding during a severe storm can be very dangerous because of heavy rains, strong winds, hail, lightning, tornadoes
  - Downed powerlines posing a threat to first responders
    - Potential medical call without knowledge of threat
    - Maintaining personal safety when securing area
    - Live wires can catch palm trees, fields, or structures on fire in which first responders may have difficulty using water sources to respond to the event before the power is shut off
- Continuity of Operations (including continued delivery of services)
  - Thunderstorms often cause power outages from wind damage to power lines or lightning damage to power stations or other electrical infrastructure
  - Delays in air transportation
- Property, Facilities, Infrastructure

Date_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

- Damage to property, including homes and businesses, can occur from strong winds, flooding, or tornadoes. The damage can range from minor roof damage to total structure loss.
- Damage to critical facilities, such as transformer stations, etc., from fallen trees and limbs, causing a power outage
- Power outages leading to traffic signals being out

- Environment
  - Damage to environment, from strong winds, flooding, and tornadoes
  - There may be severe damage to vegetation in localized areas from a tornado
  - Severe soil erosion
- Economic Condition
  - Power outages cause lost revenue and lost wages for businesses and employees
  - Damage to agriculture especially due to hail or flooding
- Public Confidence in Jurisdiction's Governance
  - Power outages for extended periods give the appearance that the jurisdiction does not know how to restore power
  - Large volumes of rain may overwhelm storm drains causing localized flooding in which residents may blame local government or expect immediate response to mitigate from future occurrences

Impact to the Built Environment

Since severe storms are a hazard that do not have geographically definable boundaries, it was excluded from spatial analysis through GIS. However, because severe storms are considered atmospheric, they have the potential to affect all buildings and all populations in Hillsborough County.

Severe storms do not always impact structures, but impacts could include flooding from heavy rain, wind, tornadoes, hail, and lighting. Because of the Florida Building Code, and the speed of most winds during severe storms, most structures do not sustain damage. This is because most buildings are built to withstand hurricane force winds and severe storms often do not have high wind speeds. Tornadoes however, may cause damage to structures. Hail is unlikely to cause damage because of the fact that, oftentimes, hail does not impact the county. Lightning impacts on structures are minimal, however, homes and businesses throughout Hillsborough County are at risk of fire due to lightning strikes igniting debris and materials that have been struck directly.

Homes and businesses that were built under older building codes and standards, or structures that do not have impact resistant features or protection that can be installed may be more vulnerable to wind damage. The impact from hail is typically recognized as property damage including that to vehicles suffering from hail impact as well as the roofs of structures; both commercial and residential. Structures can be significantly damaged if the hail diameter is large enough.

Impact to Manufactured Homes and RV

Since wind and water both pose a threat to manufactured homes, severe thunderstorms pose a threat to the infrastructure and even those that are secured by the required steel bands are less resilient than homes that have an established foundation. Manufactured homes are required to be elevated and anchored to a vertical, engineer-certified system allowing some mitigation for minor flood prevention.[117]

There are three distinct generations of mobile homes based on their year of manufacture which have been identified as: Pre-1976, 1976 to 1994, and Post-1994.[118] Units that were manufactured before 1976 do not have manufacturing design standards, whereas those between 1976-1994 were built under HUD's Manufactured Home Construction and Safety Standards (MHCSS; 24 CFR 3280) and its Model Manufactured Home Installation Standards (24 CFR 3285). All Post-1994 generations of manufactured homes have incorporated stricter design and manufacturing standards including wind load standards based on American Society of Civil Engineers (ASCE) specifications. Despite these changes to current code, it is estimated that a large portion of mobile homes are not installed to current code in Hillsborough County.

Ecological Impacts of Severe Storms

Hail damage to the agricultural industry of Hillsborough County is always a potential threat. While historically in the last five years there has been no documented event with hail large enough on the TORRO scale to cause large scale crop damage, the potential for future impact to the agricultural industry does exist and there are reports of large-scale economic impacts on the agricultural industry due to hailstorms in past. Severe thunderstorm winds, rain, hail, and tornadoes cause damage to natural and agricultural assets. Crops are more susceptible to wind damage as strong winds can break plants and ruin crops.

Natural Systems to Reduce Stormwater Runoff

Impervious surfaces due to development are an environmental concern because, with their construction, a chain of events is initiated that modifies the air quality and water resources. The pavement materials seal the soil surface, eliminating rainwater infiltration and natural groundwater recharge. There was a 26.36% net increase in impervious surface area in Hillsborough County due to development between 1996 and 2010. During this time 28.57 miles^2 of agricultural land was developed and 35.41 miles^2 of scrub, woody wetlands, and emergency wetlands were developed as well.

These natural systems reduce the occurrence of flash flooding and damages that are cause by these summer thunderstorms that occur during the summer months in Hillsborough County. Important mitigation measures in the area will be to discourage development in flood-prone areas and encourage any future development to incorporate green infrastructure and design practices to protect the natural systems, such as wetlands, that help to buffer against floods.

Social and Population Impacts from Severe Storms

People could be impacted by severe storms in a number of ways. Lightning can result in death or severe injury if a person is struck, heavy rain can result in rising floodwaters that can lead to drowning or other serious injury, injuries from hail are rare but they can be severe, wind can cause trees to fall and potentially

[117] Florida Manufactured Homes Association (FMHA, 2018). Hurricanes & Manufactured Homes: Four Myths Busted. Retrieved at http://www.fmha.org/.
[118] Schreiber, S. (2005). Mobile Homes and Hurricanes: The Crisis in Florida. Association of Collegiate Schools of Architecture (ACSA). Retrieved from http://www.acsa-arch.org/.

result in injuries or death, and a tornado can directly damage and destroy buildings and vehicles with occupants inside as well as create flying windborne debris that can cause serious injuries or loss of life.

From 2006 through 2018, 396 people were struck and killed by lightning in the United States. Almost two thirds of the deaths occurred to people who had been enjoying outdoor leisure activities, there were a total of 38 fishing deaths, 23 beach deaths, 19 camping deaths, and 17 boating deaths. Males accounted for 80% of all fatalities, and more than 90% of the deaths in the fishing, sports, and work categories.[119]

The impact of lightning on Hillsborough County is significant. While not always directly measurable by personal injury or financial loss, the fact Hillsborough County lies in one of the most concentrated areas for lightning strikes in the world leads to effects outside of meteorological documentation. The practice of safety in lightning avoidance is a major mitigation measure for residents in the area as this hazard can result in construction delays, cancelled outdoor events, and possible revenue loss based on these interruptions and cancellations due to thunderstorm generated lightning. Estimations based upon previous meteorological records reveal that lighting strikes can reach 1,000 per hour in the peak of a severe summer thunderstorm. Although not all of these are cloud-to-ground lightning, the impact can still be severe.

<u>Recreational Activities</u>

Residents and visitors of Hillsborough County part-taking in many outside activities leading to increased vulnerability to lightning and hail that may occur during a thunderstorm. High risk areas include baseball, football, soccer fields, recreational areas, lakes, boats, docks and beaches where populations are exposed to lightning strikes and/or are directly impacted by hail.

Attendees at Raymond James Stadium, George M. Steinbrenner Field, Plant Field, Al Lopez Field, Larry Sanders Progress Village Sports Complex, Lowry Park Zoo, Busch Gardens Amusement Park, MIDFLORIDA Credit Union Amphitheatre, Florida State Fair Grounds, the Tampa Riverwalk, Sparkman's Wharf, and Curtis Hixon Waterfront Park are at higher risk and are advised to seek shelter when lightning strikes are within close proximity. Special events that occur annually in the community include numerous music festivals/concerts, races including marathons/half marathons, the Florida State Fair, Strawberry Festival in Plant City, and the Gasparilla Day Parade and the Gasparilla Children's Parade. Whereas, various recreational activities that are common in Hillsborough County include fishing, kayaking, biking, skateboarding, swimming, riding motorcycles and golfing that could pose a risk to those engaging in these activities when a severe thunderstorm and lightning occurs.

Various factors contribute to lightning fatalities including the willingness to cancel or postpone activities, the ability to know when a storm is approaching or developing, the ability to get to a safe place quickly, and the vulnerability of the actual activity.

<u>Health Vulnerabilities</u>

Populations of concern in Hillsborough County include individuals that have health concerns that need to be taken into consideration regarding power outages that could occur due to a severe thunderstorm. Many individuals may be electricity dependent (i.e., ventilators, oxygen concentrators, CPAP and other

[119] https://www.weather.gov/media/safety/Analysis06-18.pdf

sleep apnea devices, dialysis machines, take medications needing refrigeration) and have functional needs that pose a challenge to their safety and well-being.

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Historical Losses

The NCEI Storm Events Database information, presented in the Historical Occurrences section above, also contained property and crop damage dollar amounts, which is shown in the table below.

Table 4.67: Severe Storm Events in Hillsborough County, by Type, (1955–2019)[120]

Type of Event	Number of Events	Deaths	Injuries	Property Damage (2019 dollars)	Crop Damage (2019 dollars)
Lightning	103	9	66	$7,332,121	$0
Heavy Rain	35	0	0	$15,345	$0
Hail	280	0	0	$1,836,013	$25,106,655
Wind	458	1	36	$19,299,420	$20,870
TOTAL	**876**	**10**	**102**	**$28,482,899**	**$25,127,525**

The information can be analyzed to provide the average amount of property and crop damage that is likely each year. This information is shown in the chart below.

Table 4.68: NCEI Severe Storms, 1955–2019

NCEI Storm Event (hazard)	Average Severe Storms per Year	Annualized Property Loss (2019 dollars)	Annualized Crop Loss (2019 dollars)
All Types of Severe Storm	17.3	$791,307	$930,197

According to the analysis, Hillsborough County is historically vulnerable to almost $800,000 in property damages and approximately $930,000 in crop damages from roughly 17 severe storm events each year.

Exposure

Since severe storm is a hazard that does not have geographically definable boundaries, it was excluded from spatial analysis through GIS. However, because severe storms are considered atmospheric, they have the potential to affect all buildings and all populations in Hillsborough County.

Severe storms do not always impact structures, but impacts could include flooding from heavy rain, wind, hail, and lighting. Please refer to the *Flood Hazard Profile* for the 100-year and 500-year floodplain vulnerability and loss estimations. Because of the Florida Building Code, and the speed of most winds during severe storms, most structures do not sustain damage. This is because most buildings are built to

[120] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Hail&eventType=%28C%29+Heavy+Rain&eventType=%28Z%29+High+Wind&eventType=%28C%29+Lightning&eventType=%28Z%29+Strong+Wind&eventType=%28C%29+Thunderstorm+Wind&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

withstand hurricane force winds and severe storms often do not have high wind speeds. Hail is unlikely to cause damage because of the fact that, oftentimes, hail does not impact the county. Lightning impacts on structures are minimal.

People could be impacted by severe storms in a number of ways. Lightning can result in death or severe injury if a person is struck, heavy rain can result in rising floodwaters that can lead to drowning or other serious injury, injuries from hail are rare but they can be severe, and wind can cause trees to fall and potentially result in injuries or death.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Severe storms can strike anywhere in Hillsborough County; therefore, all of the county critical facilities are equally vulnerable and at risk. However, severe storms do not always impact structures. The impacts of severe storms to structures, including critical facilities, are listed above under Exposure.

All of the critical facilities and their associated risk can be found in Appendix B.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 3.1.

SEVERE STORM					Overall Vulnerability
Overview					
The three key elements of a thunderstorm are wind, water, and lightning. The National Weather Service (NWS) considers a thunderstorm severe if it produces hail at least one inch in diameter, winds of 58 mph or stronger, or a tornado. Lightning, flash floods, hail, straight line winds, and tornadoes are some of the hazards related to severe storms. Afternoon thunderstorms are typical summer-time occurrences that can become severe storms and can occur in any part of the county.					HIGH
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Highly Likely	Critical	Large	6 to 12 hrs	< 1 week	3.1

Tornado Hazard Profile

1. Tornado Description

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. Tornado wind speed normally ranges from 65 mph to over 200 mph. The maximum winds in tornadoes are often confined to extremely small areas and vary tremendously over very short distances, even within the funnel itself. Additionally, these storms typically travel around 10 to 20 mph, but can move at more than 60 mph. Tornadoes can occur at any time of the year and at any time of day.

Tornadoes develop under three scenarios: (1) along or ahead of a squall line ahead of an advancing cold front moving from the north; (2) in connection with thunderstorm squall lines during hot, humid weather; and (3) within a tropical cyclone.

The most common, and often the most dangerous, tornadoes come from a supercell thunderstorm. Non-supercell tornadoes form because of spinning air already near the ground, caused by wind shear. These include a gustnado, a whirl of debris with no condensation funnel; a landspout, a narrow condensation funnel that develops while the thunderstorm is still growing; and a waterspout, a landspout that occurs over water.

Florida has two tornado seasons, the spring and summer. The deadly spring season is from February through April and is characterized by powerful tornadoes associated with squall lines. The summer tornado season runs from June until September and has the highest frequencies of storm generation, with usual intensities of EF0 or EF1 on the Enhanced Fujita Scale. This includes those tornadoes associated with land-falling tropical cyclones.

Tornadoes are measured by their intensity or their wind speed, and their area, using the Enhanced Fujita (EF) Scale. The scale ranges from EF 0, with minor damages from winds ranging 65–85 mph, to EF 5 with severe damages from winds in excess of 200 mph.

Table 4.69: Enhanced Fujita Scale[121]

EF Number	Estimated 3-second gust (mph)	Typical Damage
0 (Gale)	65–85	Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; damaged sign boards.
1 (Weak)	86–110	Surfaces peeled off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads.
2 (Strong)	111–135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
3 (Severe)	136–165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forests uprooted Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.

[121] http://climatecenter.fsu.edu/topics/tornadoes

EF Number	Estimated 3-second gust (mph)	Typical Damage
4 (Devastating)	166–200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
5 (Incredible)	200+	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.

Advisories

Below are the advisories that the NWS issues regarding tornado hazards:

- Tornado Watch: issued when conditions are favorable for severe thunderstorms and tornadoes to develop.
- Tornado Warning: issued when a tornado is sighted or imminent.

Causes of Fatalities in Tornadoes

The most common cause of death and injury due to a tornado is being hit by flying/falling debris and being picked up or blown by a tornado. Most deaths and injuries happen to people who are unaware and uninformed of the possibility of severe weather and tornadoes.

Potential Effects of Climate Change on Tornadoes

Higher temperatures and humidity may increase atmospheric instability associated with the generation of severe thunderstorms and tornadoes. However, vertical wind shear could also decrease, resulting in fewer or weaker severe thunderstorms and tornadoes.[122] However, decreases in vertical wind shear are most likely to occur when convective available potential energy (CAPE) is high in spring and summer months, which could result in more frequent severe storms. Furthermore, days with high CAPE are also likely to occur during times of the year with strong low-level wind shear, increasing the likelihood of the most severe storm events, including tornadoes.[123]

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[122] Seneviratne et al. (2012). *Changes in climate extremes and their impacts on the natural physical environment.* In Field et al. (Eds.), *Managing the risks of extreme events and disasters to advance climate change adaptation,* p. 159. https://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf., pp. 151–155; National Oceanic and Atmospheric Administration (NOAA) (2013). *Tornadoes, climate variability, and climate change. State of the science fact sheet.* http://nrc.noaa.gov/sites/nrc/Documents/SoS%20Fact%20Sheets/SoS_%20Fact_Sheet_Tornado%20and%20Climate_FINAL_Sept2017.pdf?ver=2017-12-05-115742-360., pp. 1–2. Diffenbaugh, et al. (2013). *Robust increases in severe thunderstorm environments in response to greenhouse forcing.* Proceedings of National Academy of Sciences. doi/10.1073/pnas. 1307758110., http://www.pnas.org/content/110/41/16361.full.

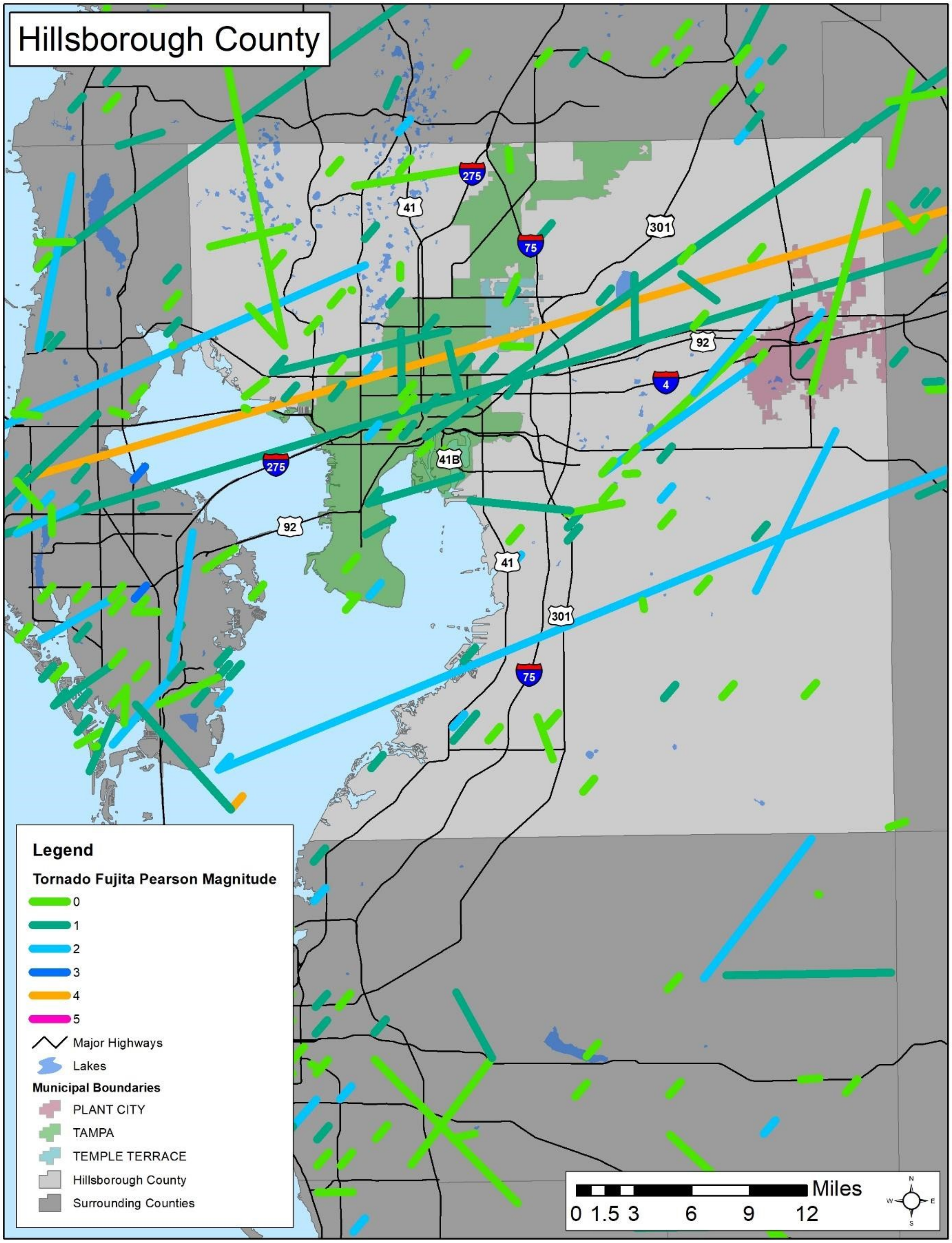
[123] Diffenbaugh et al. (2013), http://www.pnas.org/content/110/41/16361.full., p. 1.

There has been an increase in the number of tornado reports over the last 50 years. However, it is believed that this increase is attributed to the technology improvements that allow for better identification and reporting of such storms.

2. Geographic Areas Affected by Tornado

Tornadoes occur throughout the state of Florida and thus are possible in Hillsborough County. The National Weather Service ranks the Tampa Bay area as one of the highest areas in Florida for the occurrence of tornadoes. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random, and it is not possible to predict specific areas that are more susceptible to tornado strives over time. Therefore, it is assumed that the county is uniformly exposed to this hazard. With that in mind, the map below shows tornado track data for many of the major tornado events that have impacted Hillsborough County based on historical occurrences of tornadoes from 1950 to 2017. While no definitive pattern emerges from this data, some areas that have been impacted in the past may be potentially more susceptible in the future.

Figure 4.37: Hillsborough County Tornado Events, 1950–2017



From this map, it is possible to understand that lower strength tornadoes, EF-0 through EF-2, are common across Hillsborough County, while stronger tornadoes like EF-3, EF-4, and EF-5 tornados in Hillsborough are uncommon. According to this data, an EF-5 tornado has not occurred in Hillsborough County from 1950 to 2018.

3. Historical Occurrences of Tornado

The table below lists significant tornadoes that affected Hillsborough County.

Table 4.70: Significant Tornado Occurrences in Hillsborough County

Date	Information
October 3, 1992	One of the most deadly tornado events in central Florida history occurred on October 3, 1992 when four people died and more than $100 million in property damage occurred. NOAA estimated approximately $14 million dollars in damage from severe wind events between 1987 and 1996 within Hillsborough County. The damage was the result of 22 tornadoes and 112 downbursts. These occurrences resulted in one death and 16 injuries.
November 11, 1995	A weak tornado (F0), 150 feet wide along a path of 1.2 miles combined with a microburst to move east over rural portions of southern Hillsborough County. The tornado touched near the Sundance community along U.S. Highway 301 and Surona Road. The F0 tornado touched down and severely damaged one doublewide mobile home and produced minor damage to five other mobile homes. Two persons sustained minor injuries. A shed and a chain link fence were also destroyed. Power lines along with several large trees were downed. The tornado lifted and dissipated near Seminole Trail and Oakwood Drive.
March 31, 2011	Several tornadoes and areas of damaging winds occurred across the greater Tampa Bay area. Twenty-nine residences and businesses suffered minor damage and six structures suffered major damage in the area around Interbay Boulevard. The area around the Tampa Port Authority and Progress Village suffered extensive damage from an EF1 tornado. Numerous roofs were blown off and 40 feet long storage containers were overturned around the Tampa Port Authority. There were 118 homes and businesses with minor damage in Progress Village, and 40 that sustained major damage. In addition, 245 homes are being assisted with tree damage in the Progress Village area.
June 29, 2018	Scattered thunderstorms moved east through the Tampa Bay area throughout the late morning and early afternoon hours. One storm developed a brief tornado as it interacted with an outflow boundary, damaging the roof of an apartment in Tampa. Broadcast media reported on moderate roof damage to a 2-story apartment building, where a portion of a roof was removed. Little, if any, surrounding damage was observed. A weak radar rotation was observed in the vicinity at the same time, indicating that the damage was likely caused by a tornado.

Additionally, there have been 4 FEMA major disaster declarations for tornadoes in Hillsborough County.

Table 4.71: FEMA Major Disaster Declarations in Hillsborough County, Tornado, 1953–2019[124]

Disaster Number	Date	Name/Description
DR-586	May 15, 1979	SEVERE STORMS, TORNADOES & FLOODING
DR-966	October 3–4, 1992	SEVERE STORMS, TORNADOES & FLOODING
DR-982	March 12–16, 1993	TORNADOES, FLOODING, HIGH WINDS & TIDES, FREEZING
DR-1195	December 25, 1997–April 24, 1998	SEVERE STORMS, HIGH WINDS, TORNADOES, AND FLOODING

According to the NCEI Storm Events Database, there were 144 reports of tornado in Hillsborough County from 1951 to 2019.[125] These tornado events are only inclusive of those reported by NCEI from 1950 through October 2019. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.72: Summary of Tornado Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
Plant City	4	0	0	$593,564	$24,732
Tampa	27	1	4	$5,492,451	$211,248
Temple Terrace	0	0	0	$0	$0
Unincorporated	113	0	120	$81,663,265	$1,183,526
HILLSBOROUGH COUNTY TOTAL	144	1	124	$87,749,280	$1,419,506

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in December 2019.

Table 4.73: Historical Tornado Occurrences in Hillsborough County

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
Plant City							
PLANT CITY	10/7/1996	Tornado	F0	0	0	$0	0
PLANT CITY	10/7/1996	Tornado	F0	0	0	$1,623	0
PLANT CITY	10/27/1997	Tornado	F1	0	0	$198,773	0
PLANT CITY	8/6/1998	Tornado	F0	0	0	$393,167	0

[124] www.fema.gov/api/open/v1/DisasterDeclarationsSummaries.csv

[125] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Tornado&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
Tampa							
TAMPA	6/14/1994	Tornado	F0	0	0	$0	$0
N TAMPA	6/27/1994	Tornado	F0	0	0	$0	$0
TAMPA	6/27/1994	Tornado	F1	0	0	$868,155	$0
TAMPA	8/25/1995	Tornado	F0	0	0	$0	$0
TAMPA	11/11/1995	Tornado	F0	0	2	$40,152	$0
TAMPA	10/7/1996	Tornado	F0	0	0	$8,117	$0
TAMPA	10/7/1996	Tornado	F0	0	0	$1,623	$0
TAMPA	10/7/1996	Tornado	F0	0	0	$16,233	$0
TAMPA	12/7/1996	Tornado	F2	1	0	$162,026	$0
TAMPA	4/23/1997	Tornado	F0	0	0	$8,020	$0
TAMPA	4/28/1997	Tornado	F0	0	1	$802,041	$0
TAMPA	7/5/1997	Tornado	F0	0	0	$160,108	$0
TAMPA	10/27/1997	Tornado	F0	0	0	$159,019	$0
TAMPA	10/31/1997	Tornado	F0	0	0	$15,902	$0
TAMPA	1/23/1998	Tornado	F0	0	0	$119,264	$0
TAMPA	9/25/1998	Tornado	F0	0	0	$0	$0
TAMPA	1/2/1999	Tornado	F1	0	1	$234,608	$0
TAMPA	1/2/1999	Tornado	F1	0	0	$150,000	$0
TAMPA	5/18/1999	Tornado	F1	0	0	$425,198	$0
TAMPA INTL ARPT	6/25/2000	Tornado	F0	0	0	$149,057	$0
TAMPA INTL ARPT	6/5/2002	Tornado	F0	0	0	$214,264	$0
PORT TAMPA	7/9/2005	Tornado	F0	0	0	$0	$0
PORT OF TAMPA PORTS SITE	3/31/2011	Tornado	EF1	0	0	$1,816,908	$0
LUTZ TAMPA DOWNS ARP	6/24/2012	Tornado	EF0	0	0	$100,784	$0
CRUISE TERMINAL 2 PORT SITE	8/27/2012	Tornado	EF0	0	0	$2,231	$0
TPA P O KNIGHT ARPT	2/26/2013	Tornado	EF0	0	0	$38,740	$0
(MCF)MC DILL AFB	10/8/2013	Tornado	EF0	0	0	$0	$0
Temple Terrace							
NONE REPORTED	--	--		--	--	--	--
Unincorporated							
HILLSBOROUGH CO.	7/22/1951	Tornado	F2	0	0	$24,804	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	1/9/1953	Tornado	F2	0	12	$241,517	$0
HILLSBOROUGH CO.	12/11/1957	Tornado	F0	0	0	$271	$0
HILLSBOROUGH CO.	1/21/1958	Tornado	F0	0	0	$270	$0
HILLSBOROUGH CO.	4/15/1958	Tornado	F1	0	0	$267	$0
HILLSBOROUGH CO.	5/21/1959	Tornado	F1	0	0	$22,153	$0
HILLSBOROUGH CO.	2/18/1960	Tornado	F1	0	0	$218,515	$0
HILLSBOROUGH CO.	3/16/1960	Tornado	F1	0	0	$262	$0
HILLSBOROUGH CO.	3/16/1960	Tornado	F0	0	0	$2,185,153	$0
HILLSBOROUGH CO.	3/17/1960	Tornado	F0	0	0	$262	$0
HILLSBOROUGH CO.	6/19/1960	Tornado	F1	0	0	$21,704	$0
HILLSBOROUGH CO.	9/29/1960	Tornado	F1	0	0	$2,170	$0
HILLSBOROUGH CO.	2/25/1961	Tornado	F1	0	0	$21,558	$0
HILLSBOROUGH CO.	11/23/1961	Tornado	F1	0	0	$21,415	$0
HILLSBOROUGH CO.	2/19/1963	Tornado	F2	0	0	$2,113,273	$0
HILLSBOROUGH CO.	7/28/1963	Tornado	F2	0	0	$20,926	$0
HILLSBOROUGH CO.	6/11/1964	Tornado	F0	0	0	$20,724	$0
HILLSBOROUGH CO.	7/2/1964	Tornado	F2	0	6	$206,571	$0
HILLSBOROUGH CO.	7/14/1967	Tornado	F1	0	0	$19,235	$0
HILLSBOROUGH CO.	11/9/1968	Tornado	F1	0	1	$1,814,788	$0
HILLSBOROUGH CO.	11/9/1968	Tornado	F1	0	3	$1,814,788	$0
HILLSBOROUGH CO.	6/4/1969	Tornado	F0	0	0	$17,553	$0
HILLSBOROUGH CO.	6/6/1969	Tornado	F0	0	0	$0	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	7/1/1969	Tornado	F1	0	0	$1,746	$0
HILLSBOROUGH CO.	7/2/1969	Tornado	F2	0	2	$17,457	$0
HILLSBOROUGH CO.	12/10/1969	Tornado	F2	0	0	$170,407	$0
HILLSBOROUGH CO.	1/6/1970	Tornado	F1	0	2	$169,956	$0
HILLSBOROUGH CO.	1/6/1970	Tornado	F2	0	3	$169,956	$0
HILLSBOROUGH CO.	1/6/1970	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	3/3/1971	Tornado	F0	0	0	$16,061	$0
HILLSBOROUGH CO.	3/3/1971	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	4/15/1971	Tornado	F0	0	0	$16,021	$0
HILLSBOROUGH CO.	7/2/1971	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	7/10/1971	Tornado	F1	0	0	$157,846	$0
HILLSBOROUGH CO.	7/20/1971	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	7/28/1971	Tornado	F1	0	0	$0	$0
HILLSBOROUGH CO.	8/2/1971	Tornado	F1	0	0	$189	$0
HILLSBOROUGH CO.	10/17/1971	Tornado	F1	0	0	$157,075	$0
HILLSBOROUGH CO.	2/7/1972	Tornado	F1	0	0	$155,553	$0
HILLSBOROUGH CO.	3/31/1972	Tornado	F2	0	4	$1,551,775	$0
HILLSBOROUGH CO.	3/31/1972	Tornado	F2	0	0	$155,178	$0
HILLSBOROUGH CO.	1/22/1973	Tornado	F1	0	8	$150,806	$0
HILLSBOROUGH CO.	10/31/1973	Tornado	F2	0	8	$14,088,487	$0
HILLSBOROUGH CO.	2/19/1974	Tornado	F1	0	53	$13,610,911	$0
HILLSBOROUGH CO.	2/19/1974	Tornado	F1	0	0	$13,610,911	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	6/10/1974	Tornado	F0	0	0	$13,111	$0
HILLSBOROUGH CO.	8/26/1974	Tornado	F0	0	0	$12,849	$0
HILLSBOROUGH CO.	5/27/1975	Tornado	F0	0	0	$120,758	$0
HILLSBOROUGH CO.	6/3/1975	Tornado	F1	0	0	$11,986	$0
HILLSBOROUGH CO.	7/29/1975	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	8/8/1975	Tornado	F1	0	0	$118,312	$0
HILLSBOROUGH CO.	9/3/1975	Tornado	F1	0	0	$117,662	$0
HILLSBOROUGH CO.	5/23/1976	Tornado	F1	0	2	$11,370,531	$0
HILLSBOROUGH CO.	6/4/1976	Tornado	F1	0	0	$113,105	$0
HILLSBOROUGH CO.	6/28/1976	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	1/8/1978	Tornado	F2	0	2	$1,027,896	$0
HILLSBOROUGH CO.	1/19/1978	Tornado	F0	0	0	$10,279	$0
HILLSBOROUGH CO.	5/26/1978	Tornado	F0	0	0	$9,960	$0
HILLSBOROUGH CO.	7/12/1978	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	7/26/1978	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	5/8/1979	Tornado	F1	0	1	$898,510	$0
HILLSBOROUGH CO.	5/8/1979	Tornado	F0	0	0	$899	$0
HILLSBOROUGH CO.	5/8/1979	Tornado	F1	0	0	$898,510	$0
HILLSBOROUGH CO.	5/8/1979	Tornado	F0	0	0	$898,510	$0
HILLSBOROUGH CO.	5/8/1979	Tornado	F0	0	0	$898,510	$0
HILLSBOROUGH CO.	5/8/1979	Tornado	F0	0	1	$898,510	$0
HILLSBOROUGH CO.	5/8/1979	Tornado	F0	0	0	$898,510	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	5/8/1979	Tornado	F0	0	0	$898,510	$0
HILLSBOROUGH CO.	5/8/1979	Tornado	F0	0	0	$89,851	$0
HILLSBOROUGH CO.	5/8/1979	Tornado	F0	0	0	$108	$0
HILLSBOROUGH CO.	8/19/1980	Tornado	F1	0	6	$771,230	$0
HILLSBOROUGH CO.	2/2/1981	Tornado	F1	0	0	$730,870	$0
HILLSBOROUGH CO.	6/13/1981	Tornado	F1	0	0	$70,909	$0
HILLSBOROUGH CO.	6/25/1981	Tornado	F0	0	0	$70,909	$0
HILLSBOROUGH CO.	7/30/1981	Tornado	F1	0	0	$701,348	$0
HILLSBOROUGH CO.	7/8/1982	Tornado	F1	0	0	$65,891	$0
HILLSBOROUGH CO.	2/2/1983	Tornado	F2	0	2	$656,216	$0
HILLSBOROUGH CO.	6/8/1983	Tornado	F1	0	2	$645,663	$0
HILLSBOROUGH CO.	9/8/1983	Tornado	F0	0	0	$637,969	$0
HILLSBOROUGH CO.	6/11/1984	Tornado	F0	0	0	$61,951	$0
HILLSBOROUGH CO.	7/25/1985	Tornado	F0	0	0	$596	$0
HILLSBOROUGH CO.	10/31/1985	Tornado	F1	0	0	$591,017	$0
HILLSBOROUGH CO.	8/30/1988	Tornado	F1	0	0	$539,861	$0
HILLSBOROUGH CO.	9/12/1989	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	6/22/1990	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	7/16/1990	Tornado	F0	0	0	$49,266	$0
HILLSBOROUGH CO.	1/19/1991	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	3/3/1991	Tornado	F0	0	0	$476	$0
HILLSBOROUGH CO.	4/25/1991	Tornado	F0	0	0	$4,752	$0

	Date	Type	Magnitude	Deaths	Injuries	Property Damage*	Crop Damage*
HILLSBOROUGH CO.	4/25/1991	Tornado	F1	0	0	$475,174	$0
HILLSBOROUGH CO.	10/3/1992	Tornado	F1	0	2	$45,306	$0
HILLSBOROUGH CO.	11/5/1992	Tornado	F0	0	0	$0	$0
HILLSBOROUGH CO.	1/8/1993	Tornado	F0	0	0	$90,103	$0
RUSKIN	7/13/1999	Tornado	F0	0	0	$38,538	$0
BRANDON	7/14/2000	Tornado	F0	0	0	$0	$0
THONOTOSASSA	6/15/2001	Tornado	F0	0	0	$28,873	$0
THONOTOSASSA	7/8/2003	Tornado	F1	0	0	$27,947	$0
BRANDON	7/9/2005	Tornado	F0	0	0	$52,605	$0
MANGO	7/9/2005	Tornado	F0	0	0	$0	$0
HARNEY	5/13/2009	Tornado	EF0	0	0	$90,122	$0
CARROLLWOOD	6/30/2009	Tornado	EF0	0	0	$23,828	$0
RIVERVIEW	7/1/2009	Tornado	EF0	0	0	$5,966	$0
ROCKY CREEK	7/27/2009	Tornado	EF0	0	0	$0	$0
CITRUS PARK	3/31/2011	Tornado	EF0	0	0	$0	$0
CHAPMAN	3/31/2011	Tornado	EF0	0	0	$22,999	$0
RATTLESNAKE	3/31/2011	Tornado	EF1	0	0	$2,610,367	$0
SUN CITY CENTER	6/6/2013	Tornado	EF0	0	0	$39,618	$0
ROCKY CREEK	3/6/2014	Tornado	EF0	0	0	$0	$0
BOYETTE	5/30/2014	Tornado	EF0	0	0	$54,009	$0
FORT LONESOME	2/24/2016	Tornado	EF0	0	0	$0	$0
GULF CITY	4/23/2018	Tornado	EF0	0	0	$51,283	$0
HARNEY	6/29/2018	Tornado	EF0	0	0	$101,978	$0
BALM	12/9/2018	Tornado	EF1	0	0	$10,229	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

4. Probability of Future Occurrences of Tornado

Based on historical analysis, tornadoes will continue to effect Hillsborough County.

Hillsborough County is likely to experience at least 1 tornado warning each year. Furthermore, as shown in the Historical Occurrences section, most tornadoes in Florida are likely to be of smaller strength, usually between an EF-0 and an EF-2. Additionally, tornadoes are most likely in Florida in the spring and between 4pm and 9pm.

Probability Based on Historical Occurrences

An analysis of tornado reports from 1950 to 2019 in Hillsborough County from the NCEI Storm Events Database indicates that there will be approximately 2 tornado events each year in Hillsborough County.

Table 4.74: NCEI Tornado Reports for Hillsborough County, 1950–2019[126]

	NCEI Reports	Average per Year
Tornado	144	2.1

Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability).

5. Tornado Impact Analysis

All jurisdictions could receive the impacts listed below due to tornadoes. Variances in how much damage these storms generate within each community would be dependent upon the magnitude of the tornado and the strength of residential and commercial structures.

- Public
  - Injury or death from flying debris
  - Injury or death from tornadoes and not having adequate shelter
  - Car accident
  - Indirect death
  - Survivors guilt if their house was not damaged from a tornado and many neighbors died
- Responders
  - Responding during a tornado can be very dangerous because of strong winds and flying debris
- Continuity of Operations (including continued delivery of services)
  - Tornadoes often cause power outages from wind damage to power lines
- Property, Facilities, Infrastructure
  - Damage to property, including homes and businesses, can occur from tornadoes. The damage can range from minor roof damage to total structure loss.
  - Damage to critical facilities, such as transformer stations, etc., from fallen trees and limbs, causing a power outage
- Environment
  - Damage to environment, from tornadoes
  - There may be severe damage to vegetation in localized areas from a tornado
- Economic Condition
  - Power outages cause lost revenue and lost wages for businesses and employees
- Public Confidence in the Jurisdiction's Governance
  - Power outages for extended periods give the appearance that the jurisdiction does not know how to restore power

[126] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Tornado&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Historical Losses

The NCEI Storm Events Database information, presented in the Historical Occurrences section above, also contained property and crop damage dollar amounts, which is shown in the table below.

Table 4.75: Tornado Events in Hillsborough County (1950–2019)[127]

Type of Event	Number of Events	Deaths	Injuries	Property Damage (2019 dollars)	Crop Damage (2019 dollars)
Tornado	144	1	124	$87,749,280	$0

The information can be analyzed to provide the average amount of property and crop damage that is likely each year. This information is shown in the chart below.

Table 4.76: NCEI Tornadoes, 1950–2019

NCEI Storm Event (hazard)	Average Severe Storms per Year	Annualized Property Loss (2019 dollars)	Annualized Crop Loss (2019 dollars)
Tornado	2.1	$1,419,506	$0

According to the analysis, Hillsborough County is historically vulnerable to over $1.4 million in property damages and approximately $0 in crop damages from roughly 2 tornado events each year.

Exposure

Since tornado is a hazard that does not have geographically definable boundaries, it was excluded from spatial analysis through GIS. However, because tornadoes are considered atmospheric, they have the potential to affect all buildings and all populations in Hillsborough County.

Tornadoes do not always impact structures, but they may cause damage from high wind, falling trees and limbs, and flying debris. Substantial damage could incur to government facilities, hospitals, and residential areas. The damage to infrastructure could include lost power, water, sewer, gas, and communications leading to hindered emergency response and access to these vital services. This could then lead to increased public health concerns due to poor sanitation, access to clean water, increased susceptibility to foodborne illness, food spoilage and exposure to hazardous materials. Roadways and bridges could be damaged or blocked due to debris, while many people would lose their homes leading to the displacement of the population from their primary residence.

People could be impacted by tornadoes in a number of ways. Wind can cause trees to fall and potentially result in injuries or death, and a tornado can directly damage and destroy buildings and vehicles with occupants inside as well as create flying windborne debris that can cause serious injuries or loss of life.

[127] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Tornado&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Mobile homes in the area are particularly at risk due to those structures not offering the same level of protection a single family, site-built home can provide. Mobile homes, mostly occupied by lower income residents, are some of the most vulnerable populations in Hillsborough County. Populations that reside in mobile homes make up a high percentage of fatalities following a tornado, in comparison to traditional site-build houses. A large number of mobile homes are located in East Hillsborough County including Zephyrhills, Brandon, Valrico, Thonotosassa, Seffner, Mango, Valrico, Plant City, Progress Village, Riverview, Sun City, and Ruskin. In addition, very few homes in the Tampa Bay area have basements or other underground parts of the dwelling where residents could seek shelter.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Tornadoes can strike anywhere in Hillsborough County; therefore, all of the county critical facilities are equally vulnerable and at risk. However, tornadoes do not always impact structures. The impacts of tornadoes to structures, including critical facilities, are listed above under Exposure.

All of the critical facilities and their associated risk can be found in Appendix B.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.7.

TORNADO					Overall Vulnerability
Overview					
A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. Tornado wind speed normally ranges from 65 mph to over 200 mph. The maximum winds in tornadoes are often confined to extremely small areas and vary tremendously over very short distances, even within the funnel itself. Additionally, these storms typically travel around 10 to 20 mph, but can move at more than 60 mph. Tornadoes can occur at any time of the year and at any time of day.					MODERATE
Probability	**Impact**	**Spatial Extent**	**Warning Time**	**Duration**	**PRI Score**
Likely	**Critical**	**Small**	**< 6 hrs**	**< 6 hrs**	**2.7**

Wildfire Hazard Profile

1. Wildfire Description

Wildfire, or wildland fire, is a fire that was started by lightning or by humans in an area with vegetation. Wildfires occur in Florida every year and at all times of the year and are part of the natural cycle of Florida's fire-adapted ecosystems. Wildfires can cause major environmental, social, and economic damages because of the possible loss of life, property, wildlife habitats, and timber. Fortunately, many of these fires are quickly suppressed before they can damage or destroy property, homes, and lives.

Causes

Wildfires can be caused by humans or occur naturally. Based on analysis of statistics from 2006 to 2016 in Florida, about 70–80% of wildfires are caused by humans, including arson, burning debris, or accidents. Furthermore, 20–30% of wildfires are caused by lightning (Florida forest service report). These statistics are similar to nationwide statistics from the National Park Service data.

Wildfire prevention and public awareness campaigns such as Smokey Bear and Firewise Communities have helped to greatly reduce the number of human-caused wildfires in Florida. Other measures used to help reduce the number and severity of wildfires includes NWS advisories, prescribed burns, and county burn bans.

Although wildfires can cause severe damage, there can be benefits from this hazard. Sometimes, burns are "prescribed" by fire managers, meaning they are intentionally lit under carefully controlled conditions. The Florida Forest Service authorizes an average of 2 million acres to be burned each year in these prescribed burns. Benefits of prescribed burns include insect pest control, removal of exotic species, addition of nutrients to the soil for trees and other vegetation, removal of undergrowth to allow sunlight to reach the forest floor, and removal of extra fuel sources so when an un-prescribed burn occurs, there is less fuel for it to grow.[128] [129]

While there are many possible causes of wildfires, all spread in one of three patterns:

- Surface Fires: burn along the forest floor consuming the litter layer and small branches on or near the ground.
- Ground Fires: smolder or creep slowly underground. These fires usually occur during periods of prolonged drought and may burn for weeks or months until sufficient rainfall extinguishes the fire, or it runs out of fuel.
- Crown Fires: spread rapidly by the wind, moving through the tops of the trees.

The type and amount of fuel, as well as its burning qualities and level of moisture, affect wildfire potential and behavior. The continuity of fuels, expressed in both horizontal and vertical components, is also a factor because it expresses the pattern of vegetative growth and open areas. Topography is important because it affects the movement of air (and thus the fire) over the ground surface. The slope and shape

[128] http://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Wildland-Fire
[129] https://www.nps.gov/fire/wildland-fire/learning-center/fire-in-depth/fire-spread.cfm

of terrain can change the rate of speed at which the fire travels. Temperature, humidity, and wind (both short- and long-term) affect the severity and duration of wildfires.

Environmental short-term loss caused by a wildland fire can include the destruction of wildlife habitat and watersheds. Long-term effects include reduced access to affected recreational areas, destruction of cultural and economic resources and community infrastructure, and vulnerability to flooding due to the destruction of watersheds.

Wildland Urban Interface (WUI) Fires

Population movement trends in the United States have resulted in rapid development in the outlying fringes of metropolitan areas and in the rural areas with attractive recreational and aesthetic amenities, such as forests. This demographic change is increasing the size of the WUI, defined as the area where structures and other human development meet or intermingle with undeveloped wildland. The WUI creates an environment for fire to move readily between vegetation fuels, such as brush or forests; and structural fuels, such as houses and buildings. Homes and other flammable structures can become fuel for WUI fires. There are three categories of WUI fires:

- Mixed Interface fires: contain structures that are scattered throughout rural areas. Usually, there are isolated homes surrounded by larger or smaller areas of land.
- Occluded Interface fires: are characterized by isolated (either large or small) areas within an urban area. An example may be a city park surrounded by urban homes trying to preserve some contact with a natural setting.
- Class Interface fires: are where homes, especially those crowded onto smaller lots in new subdivisions, press along the wildland vegetation along a broad front. Vast adjacent wildland areas can propagate a massive flame front during a wildfire, and numerous homes are put at risk by a single fire.

The WUI is largely the result of development in areas once considered wildlands where people desire to live in a more natural setting. Natural landscaping, which allows natural vegetation to grow and accumulate near homes, is a hazardous trend and does not mitigate the risk of fire reaching into a homeowner's land. Many subdivision layouts are designed with numerous dead-end streets and cul-de-sacs, creating access issues for firefighting services and equipment. In addition, many of these areas do not have wet hydrants or other sources of water for firefighting.

Advisories

There are three advisories that the NWS can issue for wildfires:[130]

- Fire Weather Watch: indicates weather conditions could result in critical fire weather conditions in the next 72 hours.
- Red Flag Warning: indicates ongoing or imminent critical fire weather in the next 24 hours.
- Extreme Fire Behavior: implies that a wildfire is either moving fast, has prolific crowning or spotting, has fire whirls, or has a strong convection column.

[130] http://www.nws.noaa.gov/om/fire/ww.shtml

Measures

The data used to determine vulnerability to wildfire in Hillsborough County is based on GIS data called the Southern Wildfire Risk Assessment (SWRA). This data is available on the Southern Wildfire Risk Assessment website and can be downloaded and imported into ArcGIS. A specific layer, known as "Wildland Urban Interface Risk Index" (WUIRI) was used to determine vulnerability of people and property. The WUIRI is presented on a scale of 0 to -9. It combines data on housing density with the data on the impact and likelihood of a wildfire occurring in a specific area. The primary purpose of the data is to highlight areas of concern that may be conducive to mitigation actions. Due to the assumptions made, it is not a true probability. However, it does provide a comparison of risk throughout the region.

Potential Effects of Climate Change on Wildfire

The increased frequency or intensity of extreme heat or drought events, due to the augmenting of existing fuel flammability, could affect wildfire behavior.[131] Changes in vegetation types could also alter fuel mixtures. Reducing moisture of living vegetation, soils, and decomposing organic matter during drought or extreme heat events is associated with increased incidence of wildfires. Furthermore, changes over time in vegetation types could change the mixture and flammability of fuels. As these transitions occur, wildfire occurrences and severity could increase with the introduction of more flammable vegetation types or decrease with the introduction of more fire-resistant species.[132] As the *Flood Hazard Profile* discussed that arid areas may become drier and moist areas to become wetter. Florida has weather patterns that lead to both dry and wet periods each year. Climate change may cause one or the other, or both to increase in occurrences and magnitude.

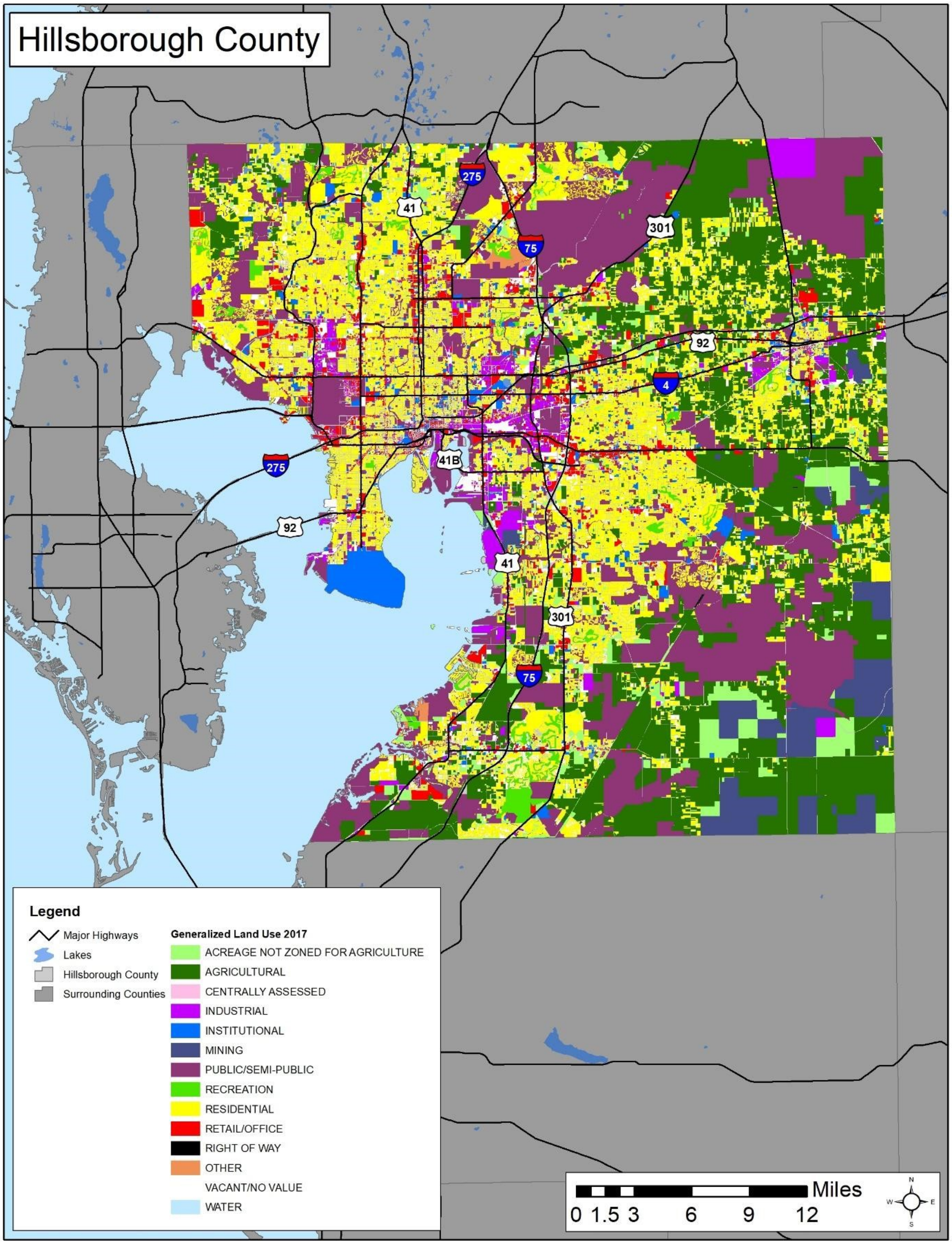
2. Geographic Areas Affected by Wildfire

The land use map below shows areas in Hillsborough County that may be prone to wildfire. All of the jurisdictions, Hillsborough County, the City of Plant City, the City of Tampa, and the City of Temple Terrace, are susceptible to wildfires and the potential impacts. Woodlands and timberlands are clearly vulnerable to wildfires. Additionally, droughts increase vulnerability in swamps, wetlands, and agricultural lands. These types of land are vulnerable because they contain materials that are easily combustible fuel.

[131] Murray et al. (2012). *Case studies*, (https://www.ipcc.ch/pdf/special-reports/srex/SREX-Chap9_FINAL.pdf). In Field et al. (Eds.), *Managing the risks of extreme events and disasters to advance climate change adaptation; A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*, pp. 487–542. https://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf., p. 519*;* Walsh and Wuebbles (2013).; *Our changing climate*. In, *Draft national climate assessment* (pp. 25–103). *http://ncadac.globalchange.gov/download/NCAJan11-2013-publicreviewdraft-fulldraft.pdf*

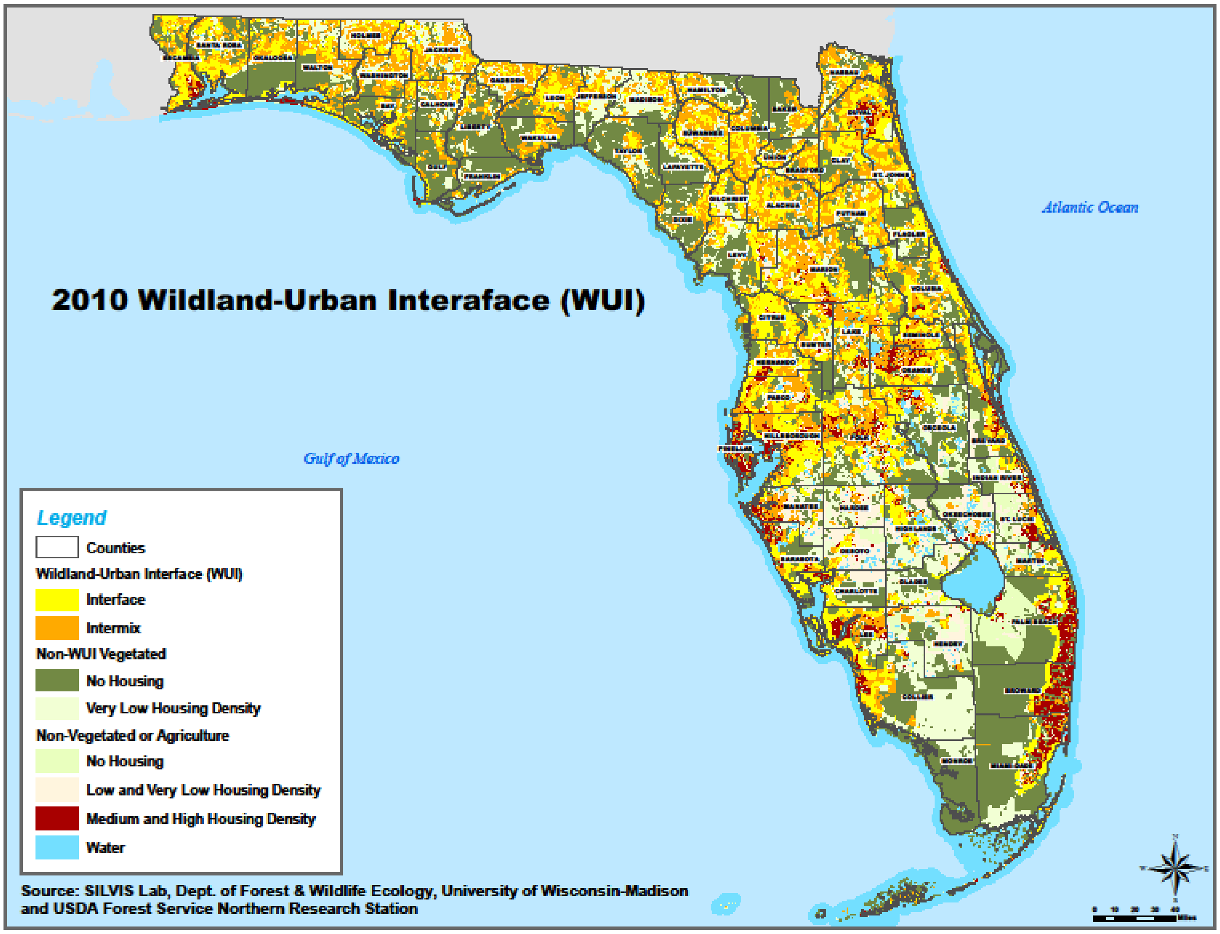
[132] Groffman and Kareiva (2013); http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.431.5893&rep=rep1&type=pdf; Walsh and Wuebbles (2013), https://www.globalchange.gov/sites/globalchange/files/NCAJan11-2013-publicreviewdraft-chap2-climate.pdf

Figure 4.38: Hillsborough County Land Use



As explained before, the WUI areas of the state have increased. WUI areas are vulnerable to wildfires and can cause significant property damage. The WUI of the United States was mapped in 2010, showing WU interface areas and the intermix areas, as well as areas that were Non-WUI and vegetated, and areas that were Non-Vegetated or Agriculture. The 2010 data and analysis are the most recent of this kind.

Figure 4.39: Wildland-Urban Interface (WUI) 2010



This map allows visualization of the WU Interface and Intermix. It is clear that between very urban areas, such as the Tampa Bay region or the south east coast, shown in red, and vegetation areas, shown in green, there are areas that are known as WU Interface and Intermix, shown in yellow and orange.

3. Historical Occurrences of Wildfire

The most naturally caused wildland fires typically occur in July due to lightning strikes and coincide with the height of the thunderstorm season. Human-caused fires, such as arson, debris or trash burning, or sparking equipment, can occur any time of year but usually occur during the same season as wildfires. The table below includes a brief narrative for significant wildfires in the county.

Table 4.77: Significant Wildfire Occurrences in Hillsborough County

Date	Description
March 5, 1999	Two firefighters were injured while suppressing an 80-acre wildfire in northwest Hillsborough County.
May 29, 2000	Sparks from a moving freight train ignited two separate wildfires that consumed nearly 600 acres of brush and scrub trees near County Road 37 and Keysville Road over rural eastern Hillsborough County.
May 2006	Interstate 75 was closed for six hours between Gibsonton Drive and Big Bend Road as 130 emergency workers fought the blaze with plows, helicopters, brush trucks and water tankers. Thousands of people were evacuated in developments east of the interstate when the fire jumped the road. A brush fire developed in Ruskin and eventually spread to 50 acres. The fire was reported by print media to have damaged a mobile home, several carnival food trucks, a warehouse, and a few old racing cars. Additionally, smoke from the fire shut down Interstate 75 between mile markers 229 and 240 for several hours.

Since 1999, FEMA has authorized several Fire Management (FM) disaster declarations. The 1999 wildfire season was so severe that in addition to the Fire Management assistance being authorized, an Emergency Declaration (EM) was made to assist with handling the fires. Below is a list of all the FM and EM designations, plus the single major disaster declaration (DR) that Hillsborough County has received from FEMA.

Table 4.78: FEMA Major Disaster Declarations in Hillsborough County, Wildfire, 1953–2019[133]

Disaster Number	Date	Name/Description
DR-1223	May 25–July 22, 1998	EXTREME FIRE HAZARD
FS-2259	April 13, 1999	FL-FIRES 04/13/99
EM-3139	April 15–May 25, 1999	FL-FIRES 04/15/99
FS-2300	May 22, 2000	LAKELAND DISTRICT FIRE
FS-2353	February 17, 2001	FL - LAKELAND COMPLEX FIRE

In addition to these FM designations, there has been one major disaster designation for a wildfire in Hillsborough County, named the Florida Extreme Fire Hazard, DR-1223, which occurred from May 25 until July 22, 1998.

According to the NCEI Storm Events Database, there were 2 reports of wildfire in Hillsborough County from 1999 to 2019.[134] These wildfire events are only inclusive of those reported by NCEI from 1996

[133] www.fema.gov/api/open/v1/DisasterDeclarationsSummaries.csv

[134] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Wildfire&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

through October 2019. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.79: Summary of Wildfire Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Property Damage (2019)*	Annualized Property Loss
Plant City	0	0	0	$0	$0
Tampa	1	0	2	$0	$0
Temple Terrace	0	0	0	$0	$0
Unincorporated	1	0	0	$0	$0
HILLSBOROUGH COUNTY TOTAL	**2**	**0**	**2**	**$0**	**$0**

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in December 2019.

Table 4.80: Historical Wildfire Occurrences in Hillsborough County

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
Plant City						
NONE REPORTED	--	--	--	--	--	--
Tampa						
TAMPA	3/5/1999	Wildfire	0	2	$0	$0
Temple Terrace						
NONE REPORTED	--	--	--	--	--	--
Unincorporated						
LITHIA	5/29/200	Wildfire	0	0	$0	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

Data from the State Fire Marshal Annual Reports was also reviewed to obtain additional information on historical wildfire events in the county. The table below summarizes the wildfires reported from 2006 to 2016.

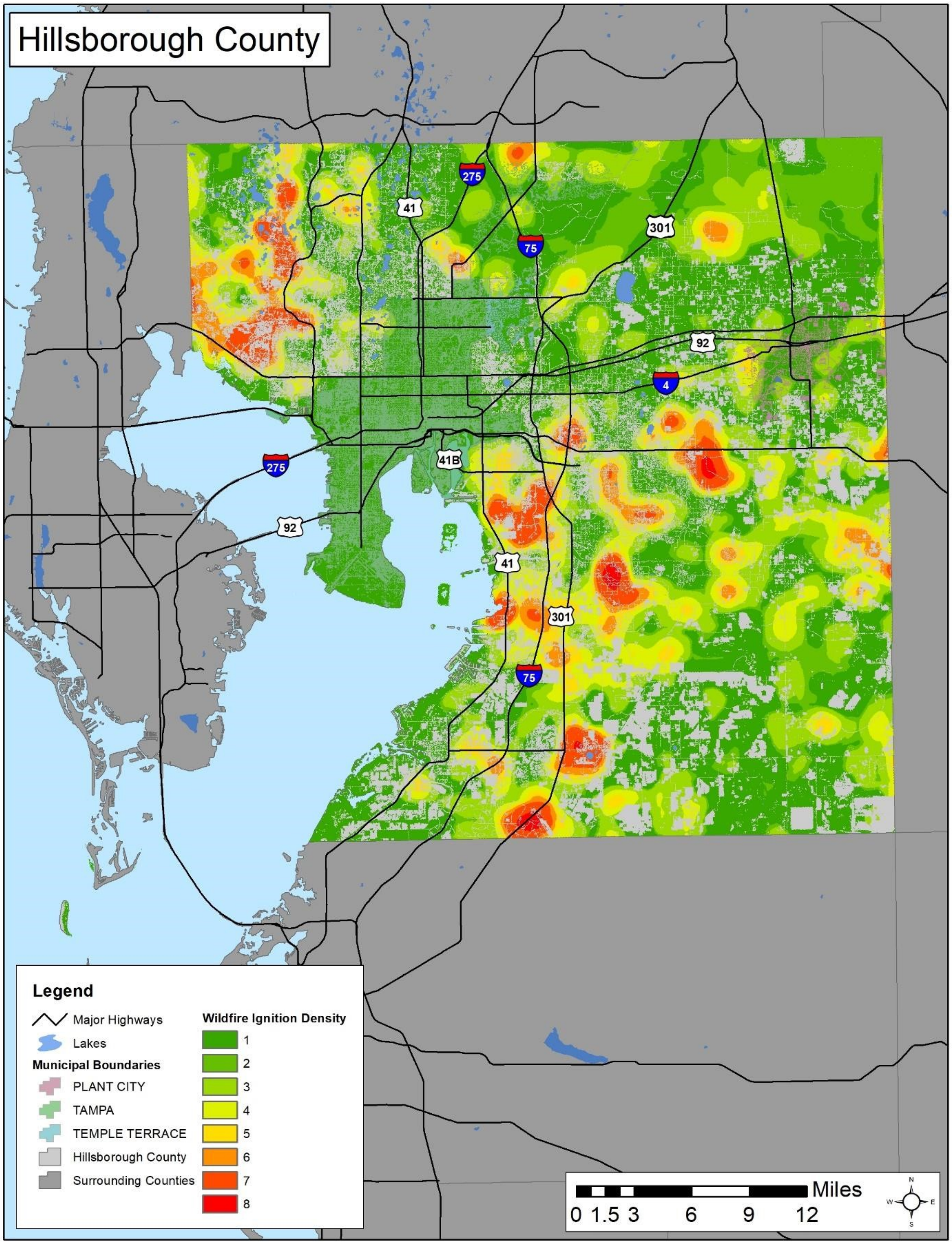
Table 4.81: Reported Wildfires in Hillsborough County, 2006–2016

Year	Number of Reported Wildfires	Acres Affected
2006	66	1,968.7
2007	42	1,085.6
2008	30	1,129.3
2009	58	3,752.8
2010	25	386.6
2011	44	1,368.4
2012	52	1,175.8

Year	Number of Reported Wildfires	Acres Affected
2013	29	290.6
2014	21	430.4
2015	17	71
2016	42	913
TOTAL	**426**	**12,572.2**

The wildfire ignition density shown in the figure below gives an indication of historic location in Hillsborough County. The wildfire ignition density is based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and the likelihood of a wildfire igniting in an area. Occurrence is derived by modeling historic wildfire ignition locations to create an average ignition rate map. This is measured in the number of fires per year per 1,000 acres.

Figure 4.40: Hillsborough County Wildfire Ignition Density, 2014



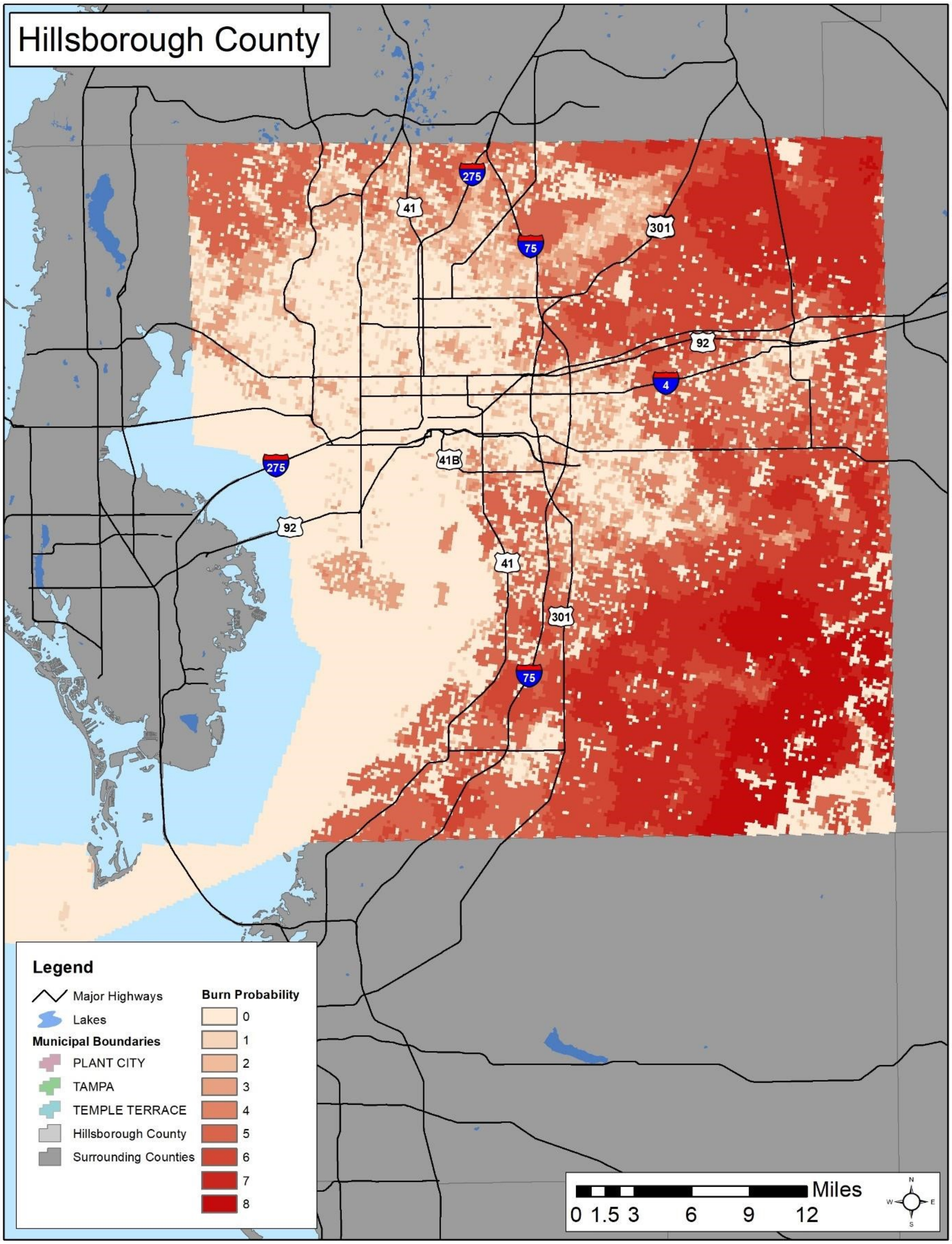
4. Probability of Future Occurrences of Wildfire

Below is a map showing the Burn Probability for Hillsborough County based on data from the Southern Wildfire Risk Assessment.

According to this burn probability map, there is some probability a wildfire will occur throughout the county, but they are most likely to occur in the northern, eastern, and southern portion. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the WUI will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas.

Florida has a year-round fire season with the most active time being April to July, with the largest number of lightning-caused fires occurring in July. The dry months, combined with low humidity and high wind, tend to have the highest number of fires reported. Approximately 80% of all wildfires in Florida occur within one mile of the WUI.

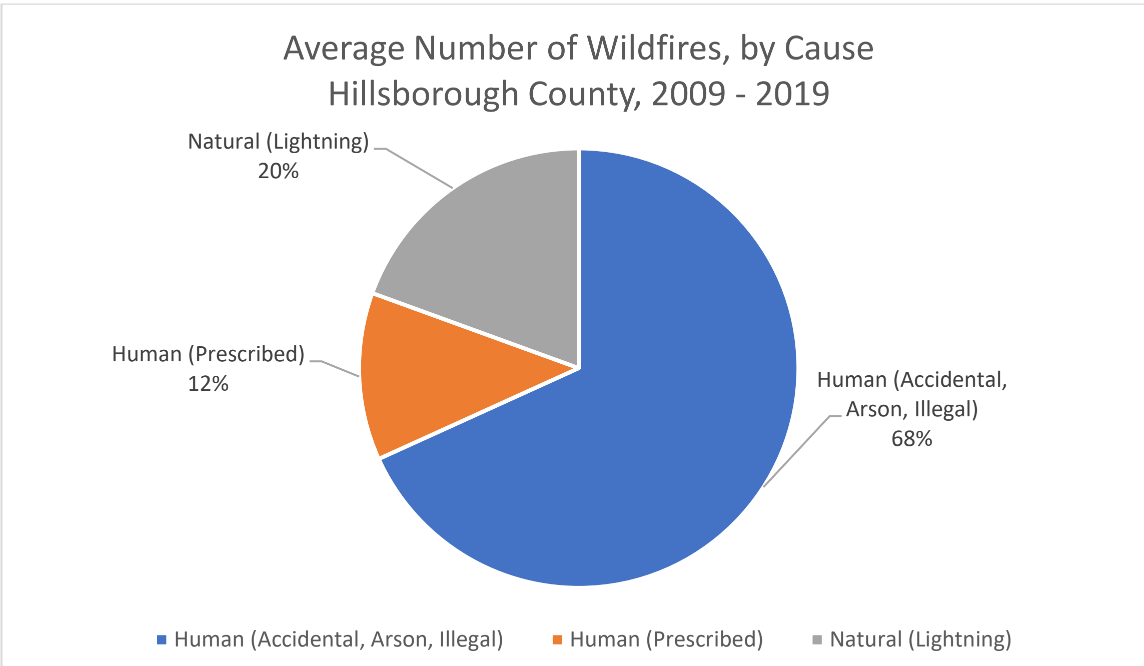
Figure 4.41: Hillsborough County Burn Probability



According to FFS and data about past wildfires in Hillsborough, there is an average of 36.5 wildfires each year, burning an average of 921 acres each year. Knowing this information, it is clear that it is possible wildfires occur in the county each year. Specifically, there was an average of 29 human-caused wildfires each year, burning an average of about 731 acres per year, and an average of 7 lightning-caused wildfires each year, burning an average of about 190 acres per year.[135]

The chart below shows data from FFS and indicates there is an annual probability that approximately 68% of wildfires in Hillsborough County will be human caused, 12% of wildfires will be prescribed burns, and 20% of wildfires will occur from natural causes, such as from lightning strikes.

Figure 4.42: Average Wildfires by Cause, Hillsborough County, 2009–2019[136]

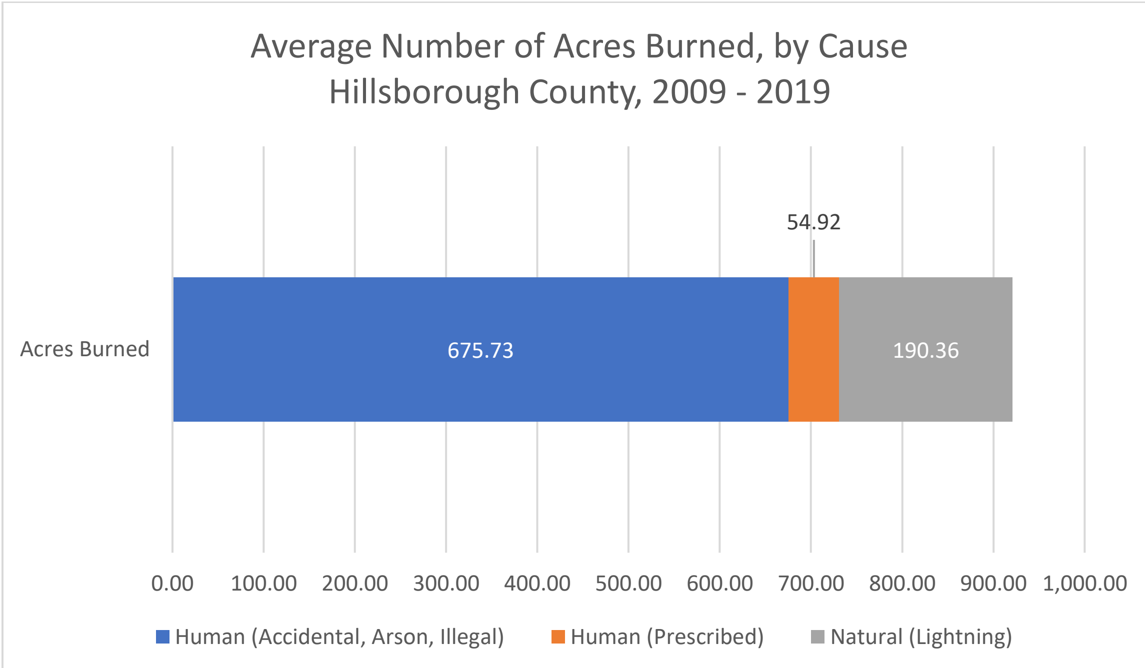


Furthermore, the chart below shows that there is an annual probability that approximately 921 acres will be burned by wildfire in Hillsborough County each year. Human caused (accidental, arson, illegal) accounts for about 73% of the acreage burned by wildfires, natural causes, such as lightning strikes, accounts for 21%, and human caused (prescribed) burns cause 6% of the acreage burned by wildfires each year.

[135] Florida Forest Service Report System, Fire by Causes, Hillsborough County 01/01/2009 through 12/31/2019. *Note: This data is an average of the wildfire occurrences from 2009 to 2019. It is important to note that this data does not include the fires that were managed by other agencies, such as the Department of Defense, U.S. Fish and Wildlife Service, the National Parks Service, and the Bureau of Indian Affairs, all federal or tribal agencies that assist the State of Florida with managing wildfires on non-state owned land.*

[136] Florida Forest Service Report System, Fire by Causes, Hillsborough County 01/01/2009 through 12/31/2019

Figure 4.43: Average Acres Burned by Cause, Hillsborough County, 2009–2019[137]



Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability).

5. Wildfire Impact Analysis

All jurisdictions could receive the impacts listed below due to wildfire. Wildfire impacts may be higher in Plant City where a higher proportion of the community is susceptible to wildfire than the other jurisdictions which are considered to have moderate impacts as noted in Table 4.4: Hazard Vulnerability by Jurisdiction.

- People
  - Injury or death from fire
  - Injury or death from smoke inhalation
  - Injury or death while evacuating
  - Vehicle accidents due to decreased visibility due to smoke
- Responders
  - Injury or death during wildfire suppression, especially during high wind conditions
  - Injury or death from vehicle accidents due to decreased visibility
  - Injury or death from evacuation and rescue missions
  - Injury or death from smoke inhalation
- Continuity of Operations (including continued delivery of services)
  - Inability to operate businesses if evacuations are ordered, leading to lost wages and revenue

[137] Florida Forest Service Report System, Fire by Causes, Hillsborough County 01/01/2009 through 12/31/2019

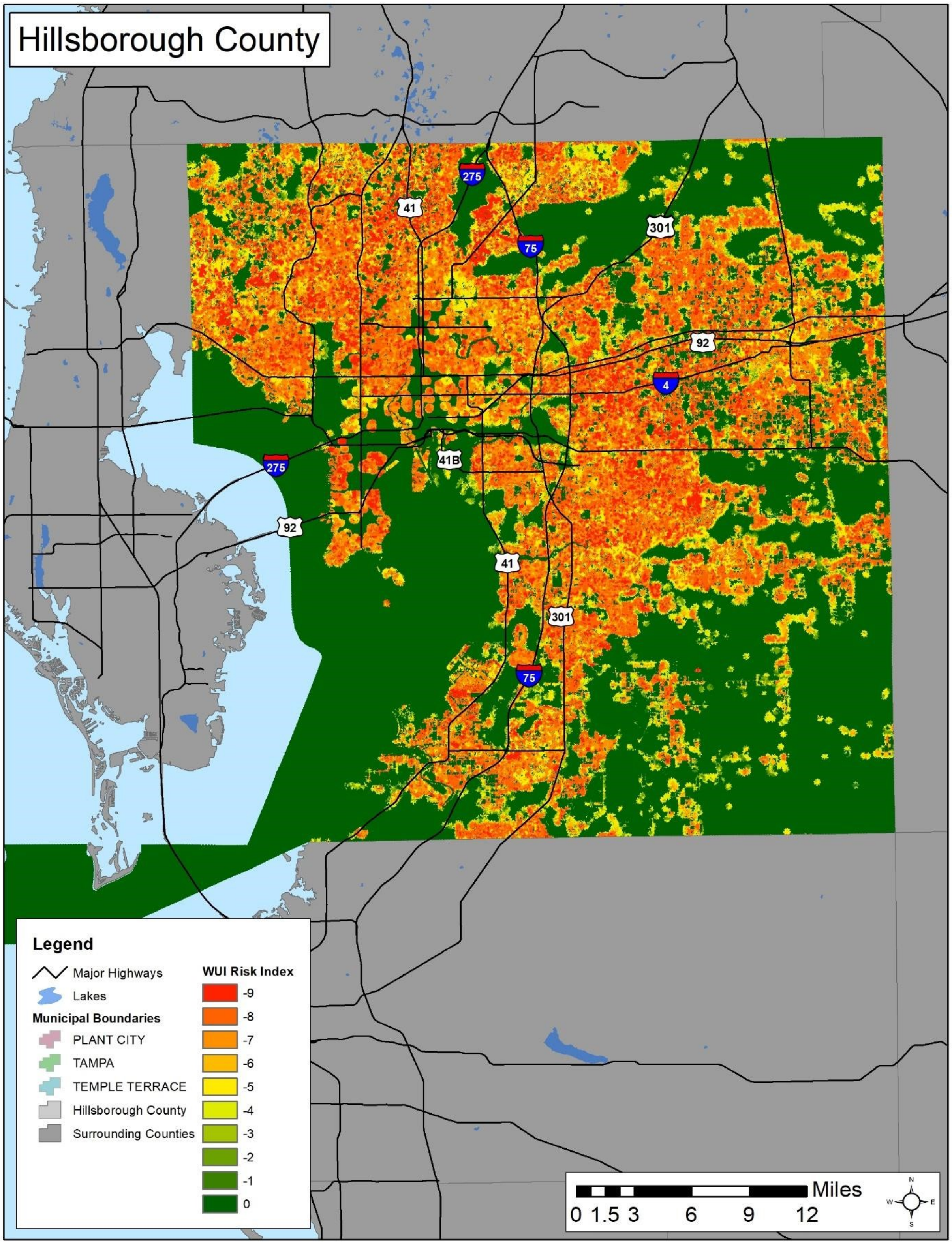
  - Employee absenteeism if employees are evacuated
  - Blocked transportation routes because of decreased visibility
- Property, Facilities, Infrastructure
  - Damage or loss to personal structures and businesses
  - Damage or loss to critical infrastructure such as schools, hospitals, government buildings, utilities, etc.
  - Damage or loss to agricultural crops and timber, which leads to loss of income and loss of revenue
- Environment
  - Damage or loss to large, forested areas
  - Damage or loss to habitats
- Economic Condition
  - Closure of businesses if in evacuation area leading to lost wages and revenue
  - Employee absenteeism leading to forced business closure which results in lost wages and lost revenue
  - Damage or loss to agricultural crops and timber, which leads to loss of income and loss of revenue
  - Loss of tourism if wildfires are in popular tourist areas
- Public Confidence in Jurisdiction’s Governance
  - Lost confidence if evacuations not ordered, messaged, and coordinated effectively
  - Lost confidence if many deaths from wildfires from those that did not evacuate

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

The Burn Probability map above shows that there is some burn probability across the county, but areas in the northern, eastern, and southern portion have the highest burn probability.

The map below is similar to the state of Florida WUI area map above and shows the risk for WUI fires. These maps are similar because they both highlight the WUI areas. The areas with a high WUI fire risk index are vulnerable because they are highly populated and near forested areas. Many areas throughout Hillsborough County have a WUI risk index between -5 and -9.

Figure 4.44: Wildland Urban Interface Risk Index



Historical Losses

According to NCEI Storm Events Database, the average (based on data from 2000 to 2019) annual property loss due to wildfires in Hillsborough County is $0.

Table 4.82: NCEI Wildfires, 2000–2019[138]

NCEI Storm Event (hazard)	Average Wildfires per Year	Annualized Property Loss (2019 dollars)	Annualized Crop Loss (2019 dollars)
Wildfires	< 1	$0	$0

Exposure

To estimate exposure of improved property to wildfire, the approximate number of parcels and their associated improved valued located in high wildfire risk areas was determined using GIS analysis. The WUI Risk Index data ranges from 0 to -9 with lower values being most severe. Areas with a WUI Risk Index of -5 was chosen to be displayed as areas of risk because this shows the upper echelon of the scale and the areas of highest risk. The map below delineates the areas with WUI Risk Index values less than -5, and the table below summarizes the buildings and parcels in the county that are located in the high wildfire risk areas.

[138] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Wildfire&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=09&endDate_dd=30&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Figure 4.45: Wildland Urban Interface Risk Index (< -5)

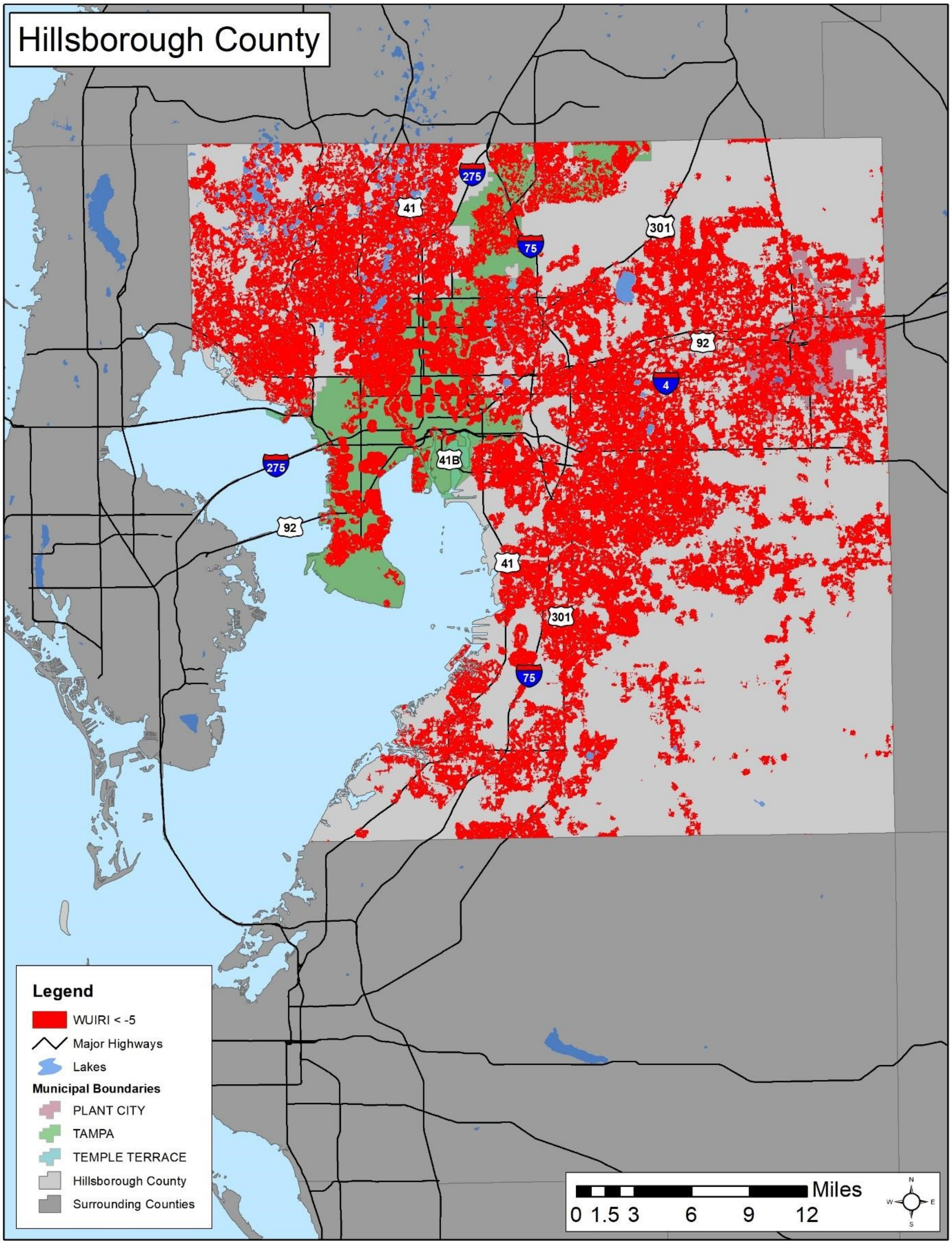


Table 4.83: Estimated Exposure of Improved Property to Wildfire

Location	Buildings and Parcels in High Wildfire Risk Area WUI Risk Index < -5		
	No. of Parcels	No. of Buildings	Improved Value
Plant City	93,21	41,448	$1,542,103,724
Tampa	70,716	345,770	$17,652,139,682
Temple Terrace	5,682	31,921	$1,129,143,752
Unincorporated	240,130	1,110,371	$46,106,835,685
HILLSBOROUGH COUNTY TOTAL	**325,849**	**1,529,510**	**$66,430,222,843**

To estimate the county population's exposure to wildfire, areas of risk were intersected with census block data. As a result, these population estimates are going to be an overestimate of risk since the entire census block's population count will be included even if only a portion of the census block's area is located in a risk area. However, these estimates still give an idea of the county population's risk to wildfire.

Table 4.84: Estimated Exposure of Population to Wildfire

Location	Population in High Wildfire Risk Area WUI Risk Index < -5
Plant City	23,493
Tampa	194,054
Temple Terrace	13,595
Unincorporated	671,724
HILLSBOROUGH COUNTY TOTAL	**902,866**

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

To estimate exposure to wildfire for the critical facility analysis, areas of risk were intersected with critical facility locations. The table below summarizes the critical facilities in the county that are located in high wildfire risk areas. The WUI Risk Index data ranges from 0 to -9 with lower values being most severe. Areas with a WUI Risk Index of -5 were chosen to be displayed as areas of risk because this shows the upper echelon of the scale and the areas of highest risk.

Table 4.85: Exposure of Critical Facilities to Wildfire Risk Areas

Location	Number of Critical Facilities in High Wildfire Risk Area WUI Risk Index < -5
Plant City	47
Tampa	86
Temple Terrace	14
Unincorporated	340
HILLSBOROUGH COUNTY TOTAL	**487**

All of the critical facilities and their associated risk can be found in Appendix B.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be moderate, with a PRI score of 2.8.

WILDFIRE					Overall Vulnerability
Overview					
Wildfire, or wildland fire, is a fire that was started by lightning or by humans in an area with vegetation. Wildfires occur in Florida every year and at all times of the year and are part of the natural cycle of Florida's fire-adapted ecosystems. Wildfires can cause major environmental, social, and economic damages because of the possible loss of life, property, wildlife habitats, and timber.					MODERATE
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Likely	Limited	Moderate	< 6 hrs	< 1 week	2.8

Erosion Hazard Profile

1. Erosion Description

Coastal or riverine erosion is the wearing away of land or the removal of beach or dune sediments by wind, water, wave action, tidal currents, wave currents, or drainage. Waves generated by storms cause erosion, which may take the form of long-term losses of sediment and rocks or merely in the temporary redistribution of coastal or riverine sediments. The study of erosion and sediment redistribution is called "coastal morphodynamics," which can also be described as the dynamic interaction between the shoreline, seabed, and water.

The ability of waves to cause erosion depends on a number of factors, which include:

- Erodibility of the beach, cliff, or rocks;
- Power of the waves to cross the beach;
- Lowering of the beach or shore platform through wave action; and
- Near shore bathymetry.

For example, waves must be strong enough to remove material from the debris lobe for erosion to occur. Additionally, beaches can help dissipate wave energy on the foreshore and can provide a measure of protection to cliffs, rocks, and other harder formations as well as any area upland.

Below is a table with the majority of the contribution factors to erosion. The factors are organized by first, second, and third orders depending on how the erosion occurs.

Table 4.86: Erosion Contribution Factors

First Order	Second Order	Third Order
• Geological structure and lithology: a) Hardness b) Height, etc. c) Fractures/faults d) Wave climate e) Prevailing wave direction f) Sub-aerial climate g) Weathering (frost, etc.) h) Stress relief swelling/ shrinkage i) Water-level change j) Groundwater fluctuations k) Tidal range l) Geomorphology	• Weathering and transport slope processes • Slope hydrology • Vegetation • Cliff foot erosion • Cliff foot sediment accumulation • Resistance of cliff foot sediment to attrition and transport	• Coastal land use • Resource extraction • Coastal management

As beaches are constantly moving, building up here and eroding there, in response to waves, winds, storms, and relative sea level rise, this issue requires long-term analysis and planning. The current beach-erosion problem has many causes, including the following items:

- The desire by many to live near the sea.
- A historically rapid rise in average ocean levels, now estimated to be rising at about 25–30 centimeters per century in much of the United States.
- The gradual sinking of coastal land (since the height of the land and the sea are both changing, the “relative sea level rise” is used to describe the rise of the ocean compared to the height of land in a particular location).
- Efforts to reduce erosion that have proved to be ineffective and instead increased it.

Some erosion changes are slow, inexorable, and usually gradual. However, the changes on a beach or river can happen overnight, especially during a storm. Even without storms, sediment may be lost to longshore drift (the currents that parallel coastlines), or sediment may be pulled to deeper water and lost to the coastal or riverine system. Coastal erosion may also be caused by the construction and maintenance of navigation inlets. There are over 60 inlets across Florida, many of which have been artificially deepened to accommodate commercial and recreational vessels. Jetties are also installed to prevent sediment from filling in these inlets. A consequence of this practice is that the jetties and inlets interrupt the natural flow of sediment along the beach, leading to an accumulation of sediment in the inlet and at the jetty on one side of the inlet and a loss of sediment to beaches on the other side of the inlet. There are many solutions to the major problem of beach erosion, including:

- <u>Beach re-nourishment</u>: Sand is purposefully deposited onto the beaches by humans; however, there is a very high cost associated with the solution.
- <u>Rebuild rivers</u>: Direct rivers back into places with a lack of sediment with the intention that the rivers will push the sediment back into place.
- <u>Breakwaters, sea walls, and groins</u>: While each location has different requirements that drive specific development and construction, these types of structural projects are intended to interfere with erosion. There are, however, some flaws and issues with these types of projects as they can trap as much sediment as they deposit with down-drift effects.
- <u>Limits on beach development</u>: Limit, restrict, or prohibit development on the impacted beaches.

Florida has 825 miles of sandy beach coastline fronting the Atlantic Ocean, the Gulf of Mexico, and the Straits of Florida. The beaches in Florida serve many critical purposes. For example, the beaches are home to several species of plants and animals that are dependent upon beaches, dunes, and nearshore waters for all or part of their lives. In fact, there are over 30 rare species within the state that inhabit the beach and adjacent habitats. These species have adapted to living in the beach’s harsh environment of salt spray, shifting and infertile sand, bright sunlight, and storms. Additionally, people visit Florida beaches at very high rates. Tourists and residents visit the beaches and coastal waters to relax, tan, swim, boat, fish, and dive.[139]

[139] http://www.dep.state.fl.us/beaches/

According to the Beach Management Funding Assistance Program (BMFA) within Florida Department of Environmental Protection (FDEP) (formerly the Beach Erosion Control Program), there are many stretches of shoreline that has been critically eroded. Critically eroded shoreline is defined as,

> *"a segment of the shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost. Critically eroded areas may also include peripheral segments or gaps between identified critically eroded areas which, although they may be stable or slightly erosional now, their inclusion is necessary for continuity of management of the coastal system or for the design integrity of adjacent beach management projects."*

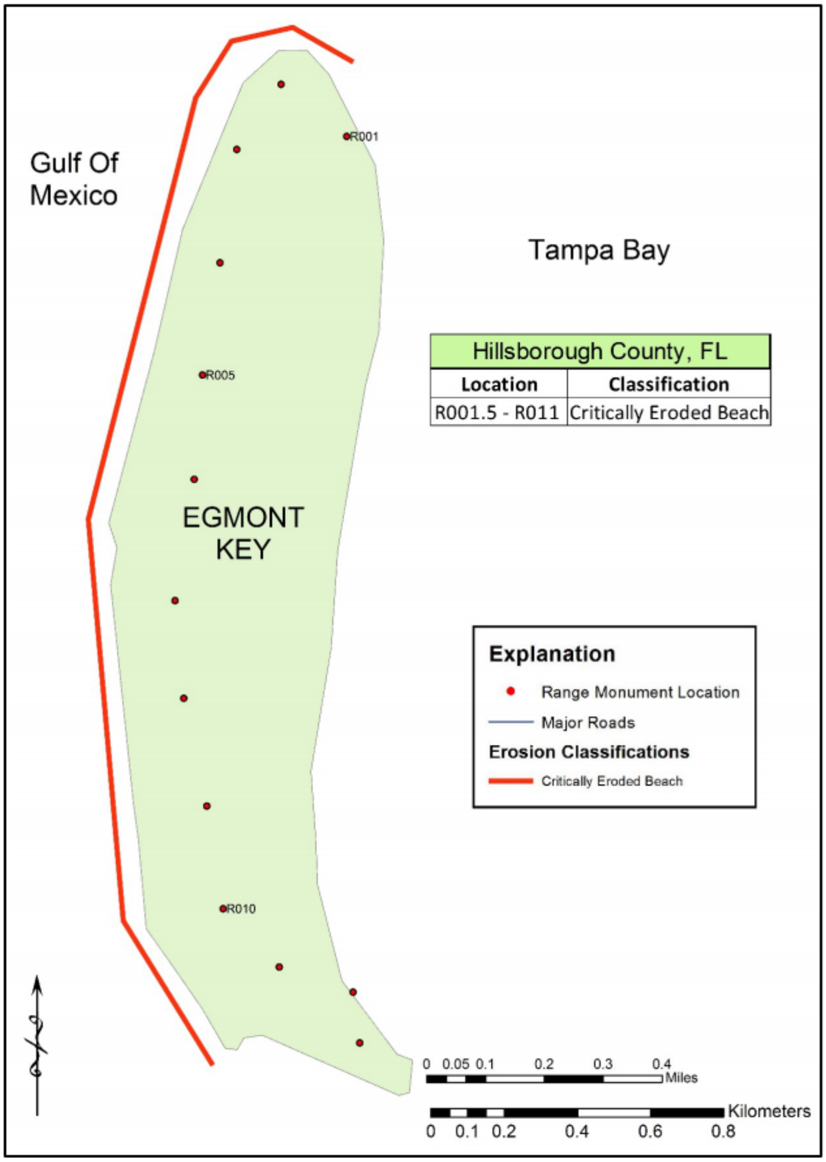
Therefore, critically eroded beaches are those in which there is a threat or loss of one of four specific interests: upland development, recreation, wildlife habitat, or important cultural resources. Non-critically eroded beaches are those in which there may be significant erosion conditions, but there is currently no public or private interest threatened.

In Hillsborough County, there is one coastal island, Egmont Key, at the entrance to Tamp Bay. The 2019 Critical Erosion Report from FDEP states that most of the length of Egmont Key (1.6 miles) is critically eroded, threatening recreational interests and important critical resources.[140]

This is shown below in the map.

[140] https://floridadep.gov/sites/default/files/FDEP-Critically-Eroded-Beaches-2019.pdf

Figure 4.46: Critical Eroded Shoreline, Hillsborough County, 2019[141]



Source: Florida Department of Environmental Protection, Critically Eroded Beaches in Florida, 2019

A St. Petersburg harbor maintenance dredging project in December 2000, provided the material for nourishment of the north end of Egmont Key for the protection of three Spanish-American War era batteries. Nourishment projects using Egmont Channel maintenance dredging material were also conducted in 2006 and 2015.

According to FDEP, roughly half of the designated critically eroded beaches in the state are currently managed with restoration efforts such as placement of beach fill material. While these areas are improved

[141] https://floridadep.gov/sites/default/files/FDEP-Critically-Eroded-Beaches-2019.pdf

from their eroded status, they are kept on the critically eroded list to ensure monitoring and continued eligibility for projects and funding.[142]

Beach Management Funding Assistance (BMFA) Program

The primary vehicle for implementing the beach management planning recommendations is the Florida Beach Erosion Control Program (BECP) within FDEP (formerly the Beach Erosion Control Program), a program established to work in concert with local, state, and federal governmental entities to achieve the protection, preservation, and restoration of the coastal sandy beach resources of the state. Under the program, financial assistance in an amount of up to 50% of project costs is available to Florida's county and municipal governments, community development districts, or special taxing districts for shore protection and preservation activities. Eligible activities include beach restoration and nourishment activities, project design and engineering studies, environmental studies and monitoring, inlet management planning, inlet sediment transfer, dune restoration and protection activities, and other beach erosion prevention-related activities consistent with the adopted Strategic Beach Management Plan.

Potential Effects of Climate Change on Erosion

Both increased rates of global eustatic sea level rise and increased frequency of higher intensity hurricanes may affect coastal erosion. As described in the *Flood Hazard Profile*, continued atmospheric warming could increase rates of global eustatic sea level rise. In the absence of offsetting changes in natural sediment supply, sand beaches will erode more rapidly as the rate of sea level rise increases. If the frequency of higher intensity hurricanes does increase (see *Tropical Cyclone Hazard Profile*), events will occur more often when sand eroded from beaches is transported to depths from which it will not be moved back on shore by swell waves. More frequent Category 4 and 5 hurricanes also would increase incidence of dune erosion and over wash where beach sediments are carried landward. These processes can damage structures, but where structures are not present, the over wash process can permit a beach and dune system to migrate landward.[143] Rising sea levels also threaten the survival of coastal wetlands when natural rates of sediment accretion and elevation increase are not fast enough to offset the rising sea.[144] However, wetlands also may be able to migrate landward with adequate sediment influx if there are no physical barriers to their movement.

2. Geographic Areas Affected by Erosion

In Hillsborough County, erosion along Tampa Bay and river shorelines is most noticeable after a significant rain and/or tidal surge event. Although this is a natural effect, shoreline development is at risk when erosion occurs at a rate greater than the natural rate of soil replenishment. The areas of greatest risks of erosion are found along the Hillsborough, Alafia, and Little Manatee Rivers, associated tributaries, and

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[142] https://floridadep.gov/sites/default/files/FDEP-Critically-Eroded-Beaches-2019.pdf

[143] *(Gutierrez et al. (2009). Ocean coasts. http://papers.risingsea.net/coastal-sensitivity-to-sea-level-rise-3-ocean-coasts.html; In Titus et al. (Eds.), Coastal sensitivity to sea-level rise: A focus on the mid-Atlantic region. http://downloads.globalchange.gov/sap/sap4-1/sap4-1-final-report-all.pdf.).*

[144] *(Cahoon et al. (2009). Coastal wetland sustainability. http://papers.risingsea.net/coastal-sensitivity-to-sea-level-rise-4-wetland-accretion.html; In Titus et al. (eds.), Coastal sensitivity to sea-level rise: A focus on the mid-Atlantic region.).*

velocity zone areas of the floodplain as well as the coastal areas in the Apollo Beach Nature Preserve and E.G. Simmons Park.

The Bureau of Beaches and Coastal Systems develops and publishes the Critically Eroded Beaches Report annually. The data from this report is gathered from a set of monitoring locations along the coast throughout the state. Data is collected from each of these stations and then compiled into a GIS database for modeling and analysis. The continual reporting and analysis are combined with the historical data for detailed records about the status of the state's beaches. Erosion is a constantly changing issue as development continues on the beaches and in the inlets. It can also be instantly changed by a large storm or a hurricane.

The June 2019 Critically Eroded Beaches in Florida Report[145] states that there are 1.6 miles of critically eroded beach in Hillsborough County. The map shown in the previous section depicts this information.

According to the Flood Insurance Study for Hillsborough County, the county has 158.27 miles of shoreline that could potentially experience erosion in a storm. In areas where mangrove stands front the bay, waves with heights of 3 feet or greater are dissipated within approximately 200 feet of the shoreline.[146]

3. Historical Occurrences of Erosion

DEP maintains a database of all the occurrences of erosion in the state with high quality reporting since the inception of the BMFA Program. There are constantly cases of beach erosion throughout the state.

The disastrous hurricane seasons of 2004–2005 had a severe impact on the state in terms of erosion, and DEP has published a number of reports about the specific details of these events. A number of these events are listed below.

Table 4.87: Florida Significant Erosion Contribution Events[147]

Year	Event
1972	Hurricane Agnes
1975	Hurricane Eloise
1979	Hurricanes David and Frederick
1984	Thanksgiving Day Nor'easter
1982	"no-name" storms
1985	Hurricanes Elena and Kate and Tropical Storms Bob and Juan
1992	Hurricane Andrew
1993	Winter storm
1995	Hurricanes Erin and Opal
1998	Hurricanes Earl and Georges
1999	Hurricanes Floyd and Irene
2004	Hurricanes Charley, Frances, Ivan, and Jeanne,
2005	Hurricanes Dennis, Katrina, Ophelia, Rita, and Wilma
2008	Tropical Storm Fay and Hurricane Gustav

[145] https://floridadep.gov/sites/default/files/FDEP-Critically-Eroded-Beaches-2019.pdf
[146] Flood Insurance Study, Hillsborough County, Florida and Incorporated Areas, Vol. 1 of 5
[147] https://floridadep.gov/sites/default/files/SBMP-Introduction_0.pdf

Year	Event
2012	Hurricane Isaac and Sandy and Tropical Storm Debby

In May of 2012, during Tropical Storm Debbie, and again in June 2013, during Tropical Storm Andrea, Bayshore Boulevard had water covering both the north and south lanes. In Hillsborough County, frequent wind gusts of up to 51 MPH were measured by the Automated Weather Observing System (AWOS) located at MacDill Air Force Base. Storm total rainfall of greater than 5 inches fell across the county, with the highest report of 11.91 inches at the CoCoRaHS site near Citrus Park. 74 buildings sustained damage with 6 being completely destroyed and damage to public buildings totaled $449,000. The tide gauge at Old Port Tampa measured a peak tide of 5.42 feet. Subtracting the predicted astronomical tide, the highest storm surge was calculated as 3.97 feet late in the evening of the 25th. The tide gauge at McKay Bay measured a peak tide of 4.43 feet MLLW. Subtracting the predicted astronomical tide, the highest storm surge was calculated as 4.07 feet. Storm surge water flooded Bay Shore Boulevard for three days.

Pursuant to the Flood Insurance Study for Hillsborough County published by the Federal Emergency Management Agency, the county has 17 major watershed basins with no less than 14 riverine systems that account for more than 700 linear miles of floodway that are potentially susceptible to erosion. No severe erosion has occurred within riverine systems due to any one hurricane.[148]

4. Probability of Future Occurrences of Erosion

The coastal and riverine areas in Hillsborough County will continue to shift and change over time, especially when faced with the current levels of development. This hazard will continue to affect the county, and there is considerable work being done regularly to mitigate potential damages. DEP maintains an active and on-going program to study this issue and mitigate damages as much as possible. This hazard will continue to affect the county in the future, especially in conjunction with hurricanes, winter storms, and coastal flooding, and considering the likelihood of future development in coastal and riverine areas. Erosion has occurred in Hillsborough County since the start of such record keeping. Additionally, flooding will continue to occur, whether it is due to tropical storms or sea level rise, or both. While it would be best to keep areas prone to erosion undeveloped, this is unlikely and future development in coastal and riverine areas will increase the probability of erosion affecting developed areas.

Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability).

5. Erosion Impact Analysis

The City of Tampa and the unincorporated coastline could feel high impacts due to coastal erosion. The County has a whole could suffer moderate impacts and the level of impacts would be much lower for Temple Terrace and Plant City due to being located further inland.

- Public
  - May lose property
  - May lose sandy beaches, dunes, or mangroves, which could lead to storm surge flooding

[148] Flood Insurance Study, Hillsborough County, Florida and Incorporated Areas, Vol. 1 of 5

  - Sandy beaches may have to close
- Responders
  - N/A
- Continuity of Operations (including continued delivery of services)
  - Businesses, critical infrastructure, government buildings, etc. may have operations hindered if erosion leads to damage to the structure
  - Operations may be hindered if roads to the structures are damaged from erosion
  - Continuity of transportation network may be interrupted because of erosion damage to roads
- Property, Facilities, Infrastructure
  - Structures may be damaged when erosion damages the ground
- Environment
  - Coastal and riverine areas, marshes, mangroves, sandy beaches etc. may be severely damaged from erosion which is a habitat for many species of plants and animals
  - If large portions of riverine and coastal areas and dunes are washed away from erosion, storm surge from the next storm could reach homes, businesses, roads, etc.
- Economic Condition
  - N/A
- Public's Confidence in Jurisdiction's Governance
  - If damage from erosion, such as damage to roads, is not quickly repaired, then the public may be frustrated with the jurisdiction's governance

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Historical Losses

After the 2004 tropical hurricane events, the Hillsborough County Parks, Recreation, and Conservation Department did request funding to assist with minor repairs (1,700 cubic yards of sand) associated with shore restoration of a park. Such minor losses could be expected in the future.

Exposure

The impact of coastal erosion will occur in two areas: coastal areas and riverine areas. In the coastal areas, significant impacts have been recognized at two county parks: the Apollo Beach Nature Preserve and E.G. Simmons. Each of these parks is part of a major reconstruction project to address previous natural impacts including erosion. Riverine areas are at risk to the impact of erosion with communities in unincorporated areas of East Hillsborough County including Plant City, Zephyrhills and Thonotosassa are at high risk. Communities in the south east portion of Hillsborough County are at risk as well including Apollo Beach, Riverview, and Gibsonton. Erosion principally affects structures through deteriorating the structural integrity of buildings by undermining the foundation or associated pilings/piers.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

The impacts of erosion to structures, including critical facilities, are listed above under Exposure.

All of the critical facilities and their associated risk can be found in Appendix B.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be moderate, with a PRI score of 2.6.

EROSION					Overall Vulnerability
Overview					
Erosion is the wearing away of land or the removal of beach or dune sediments by wind, water, wave action, tidal currents, wave currents, or drainage. Waves generated by storms cause erosion, which may take the form of long-term losses of sediment and rocks, or merely in the temporary redistribution of coastal or riverine sediments.					MODERATE
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Likely	Limited	Moderate	> 24 hrs	< 1 week	2.6

Extreme Heat Hazard Profile

1. Extreme Heat Description

Extreme heat is defined as extended period where the temperature and relative humidity combine for a dangerous heat index.[149] Extreme heat events occur across the state each year. This hazard is focused on the effects to the human population, while drought focuses more on environmental interests.

Heat Index

The Heat Index is a measure of how hot the temperature feels when humidity is factored in with the actual temperature. The Heat Index chart is below. The red area indicates extreme danger. The NWS will begin to issue alerts when the heat index is expected to exceed 105–110 degrees Fahrenheit for at least two consecutive days.[150]

Figure 4.47: Heat Index

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										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Advisories

The National Weather Service issues the following heat-related advisories:

- Excessive Heat Outlook: issued when the potential exists for an excessive heat event within the next 3 to 7 days.
- Heat Advisory: issued within 12 hours of extremely dangerous heat conditions.

149 https://www.weather.gov/safety/heat-index
150 https://www.weather.gov/safety/heat-index

- Excessive Heat Watch: issued when conditions are favorable for an excessive heat event within the next 24 to 72 hours; this is used when the risk of a heat wave has increased but the timing is still uncertain.
- Excessive Heat Warning: issued within 12 hours of extremely dangerous heat conditions.

Heat Related Illness

Extreme heat can cause death by making it difficult for a body to cool itself. Heat illnesses occur when the body temperature increases too quickly to cool itself or when too much fluid or salt is lost through dehydration or sweating. Older adults, young children, and those who are sick or overweight are more likely to succumb to extreme heat. Below are the different types of heat-related illnesses.[151]

Heat Cramps

Heat Cramps are the first sign of a heat illness and can lead to more serious illnesses. Symptoms of heat cramps include muscular pains and spasms, usually in the legs or abdomen.

Heat Exhaustion

Heat exhaustion follows heat cramps if the body is not able to cool itself. Symptoms include heavy sweating; weakness; cool, pale, clammy skin; a fast and weak pulse; dizziness; nausea or vomiting; and fainting.

Heat Stroke

Heat stroke usually occurs by ignoring the signs of heat exhaustion and is life threatening. Signs of heat stroke include extremely high body temperature, red skin, changes in consciousness, rapid and weak pulse, rapid shallow breathing, confusion, vomiting, and seizures. This occurs because the body becomes overwhelmed by heat and begins to stop functioning. There are two types of heat stroke, classical and exertional. Classical heat stroke occurs when an individual is unable to maintain thermal equilibrium due to medication, injury, chronic illness, or age. Exertional heat stroke occurs when young and healthy individuals are engaged in strenuous activity in hot and humid weather.

Additionally, other chronic illnesses may become exacerbated by heat-related illnesses. For example, those with cardiovascular disease and other heart conditions may not be able to tolerate the increased cardiac output associated with heat illnesses. People with mental health disorders and certain behavioral disorders, such as substance abuse, are at higher risk for morbidity and mortality during extreme heat events. Those with respiratory diseases and Type I and II diabetes are also at higher risk for morbidity and mortality with increased heat exposure.[152]

Potential Effects of Climate Change on Extreme Heat

Average global temperatures are expected to increase anywhere from 4 to 12 degrees Fahrenheit by the end of the 21st century.[153] Average global temperatures move in tandem with extreme temperatures,

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[151] https://www.weather.gov/safety/heat-illness

[152] http://flbrace.org/images/docs/heat-profile.pdf

[153] *(Karl et al. (Eds.). (2009). Global climate change impacts in the United States.* *https://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf*

suggesting that in the future extreme heat events will become more frequent and last longer with an overall warming trend.

According to analysis of 360 U.S. cities and the combination of several climate model projections, Florida will likely see an increase in days when the heat index is above 105 degrees Fahrenheit by 2050.[154] While it is likely that cycles of cool periods and warm periods will continue in the future, it is believed that the overall long-term trend is projected to be an increase in the number of extreme heat events.

2. Geographic Areas Affected by Extreme Heat

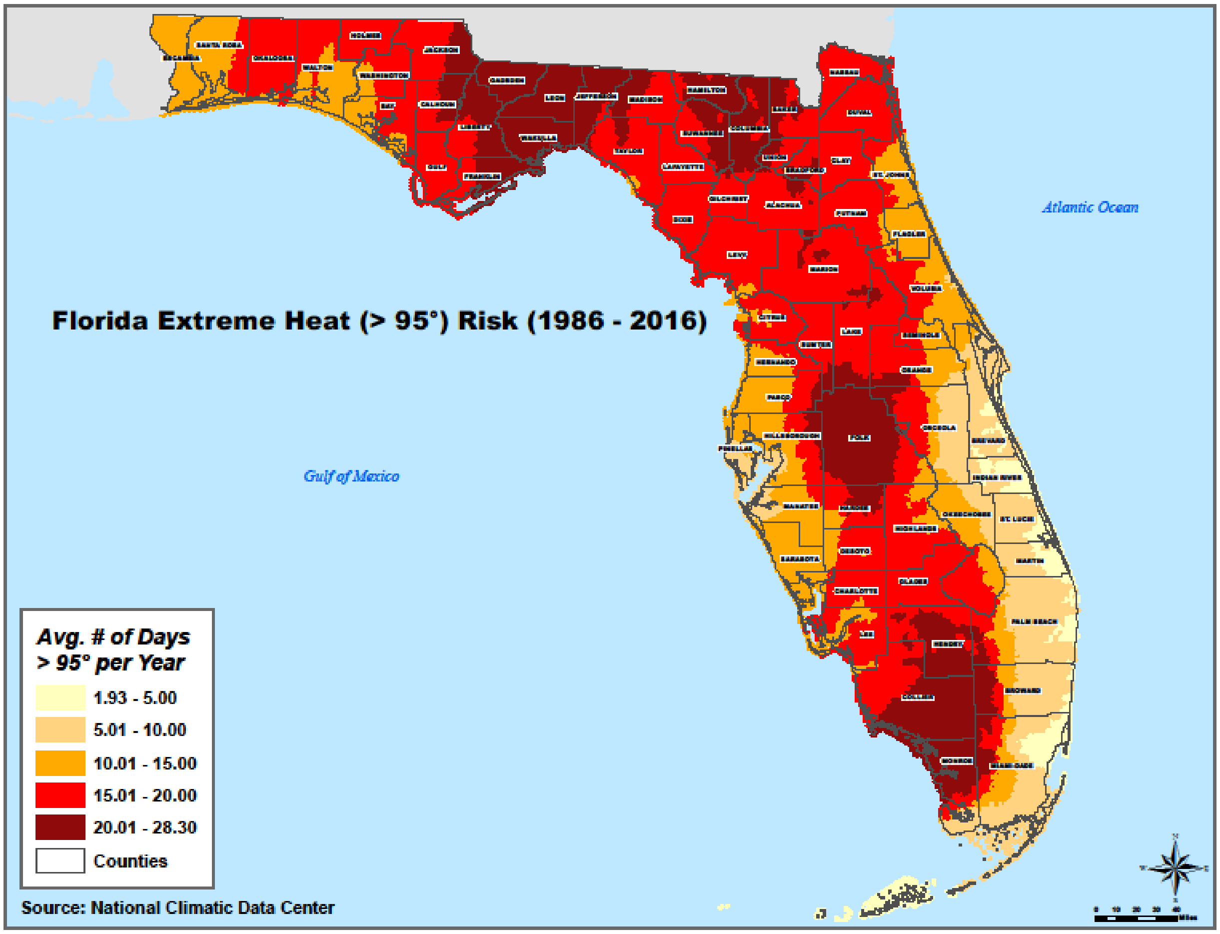
Due to the subtropical climate of Florida, the entire state has historically been vulnerable to extreme heat events. Because of the close proximity of large bodies of water, Florida typically experiences fewer days when the temperature reaches 100 degrees Fahrenheit or greater than many other states. However, the proximity to large bodies of water also increases the humidity, which decreases the body's ability to dissipate the heat.

Additionally, the expansion of urban development in large cities around the state has increased the magnitude of the urban heat island effect. A heat island occurs when concrete, asphalt, and heat absorbing buildings replace the natural environment.[155]

The map below shows the average number of days with temperatures above 95 degrees each year. From this map, it is evident that Hillsborough County experiences between 5 and 28 days of above 95-degree weather each year.

[154] *http://www.climatecentral.org/news/sizzling-summers-20515*
[155] http://flbrace.org/images/docs/heat-profile.pdf

Figure 4.48: Florida Extreme Heat (>95 degrees) Risk, 1986–2016



Extreme heat events typically impact a large area and cannot be defined to any geographic or political boundaries. The entirety of Hillsborough County is susceptible to extreme heat conditions. However, the eastern portion of the county, including Plant City, is more likely to experience a higher number of days above 95 degree weather due to its location further inland.

3. Historical Occurrences of Extreme Heat

Florida is known for its high humidity and heat, which combine to affect its population. However, the NCEI Storm Events Database has no record of extreme heat events reported in Hillsborough County from 1996 to October 2019.[156]

The table below describes various significant extreme heat incidents that have occurred in the state of Florida. Similar events are also likely in Hillsborough County.

[156] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Excessive+Heat&eventType=%28Z%29+Heat&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Table 4.88: Significant Extreme Heat Occurrences in Hillsborough County

Date	Description
June 1998	Several long stretches of record-breaking high temperatures, including in Melbourne, Orlando, and Daytona Beach. Temperatures resulted in 1 death.
July 2000	July was the hottest month that had been recorded in northwest Florida. Several cities had multiple days of 100 degrees or higher, including Pensacola, Milton, and Niceville.[157]
August 2008	On August 8, heat advisories were issued in Santa Rosa, Escambia, and Okaloosa Counties for high temperatures and humidities. The heat index values were between 110 and 115 degrees.[158]
July 2010	On July 28, a heat wave began in Florida's panhandle. There were above normal temperatures and high humidity producing a heat index above 110 degrees Fahrenheit in Dixie, Franklin, Jackson, Taylor, Leon, and Bay Counties. Heat index values exceeded 115 degrees in a few locations on occasion.[159]
November 2011	In Mid-November in South Florida, there was unseasonably warm and humid weather, with heat index values in the mid to upper 80 degrees.[160]
July 2016	Seven cities from across Florida reported their hottest July on record.[161]

As stated above, NOAA tracks deaths related to weather events by state. According to their data for Florida from 1995 to 2018, 1 person died from extreme heat in 1995, 1997, 2003, 2006, and 2010; 2 people died in 2009; and 4 people died in 1998.[162]

The tables below identify the history of maximum daily temperatures over 95 degrees in Hillsborough County based on the NCEI Climate Data Online collection of Local Climatological Data from 2010 to 2019.[163] Data is available for one location in the county that records daily maximum temperatures, and it is identified on the map that follows.

Table 4.89: Extended Periods of Maximum Daily Temperatures over 95°F in Hillsborough County, 2010–2019

Tampa International Airport		
Consecutive Days	Begin Date	End Date
Maximum Temperature >= 95°F		
6	7/17/210	7/22/2010
5	5/16/2017	5/20/2017
3	6/23/2010	6/25/1010
3	6/21/2011	6/23/2011
3	5/24/2012	5/26/2012
3	9/9/2016	9/11/2016

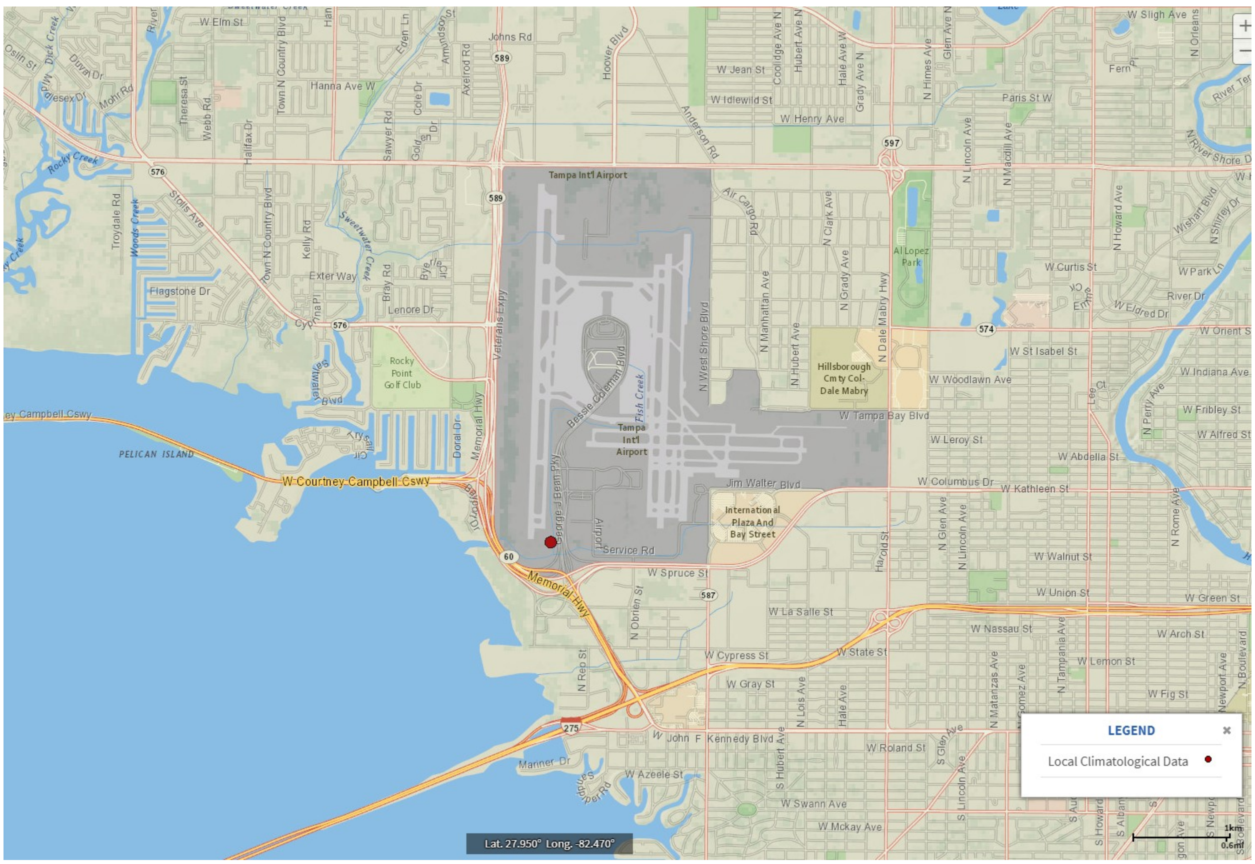
157 https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=348150
158 https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=54001
159 https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=253232
160 https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=354723
161 https://weather.com/news/weather/news/record-warm-south-july-2016
162 http://www.nws.noaa.gov/om/hazstats.shtml#
163 https://www.ncdc.noaa.gov/cdo-web/

Tampa International Airport		
Consecutive Days	**Begin Date**	**End Date**
3	8/21/2017	8/23/2017
3	9/10/2019	9/12/2019

Table 4.90: Total Number of Days with Maximum Temperatures over 95°F in Hillsborough County, 2010–2019

Tampa International Airport	
TOTAL NUMBER OF DAYS >= 95	90

Figure 4.49: NCEI Climate Data Online Local Climatological Data Station Locations in Hillsborough County



4. Probability of Future Occurrences of Extreme Heat

Extreme heat can occur throughout the state but typically occurs in the summer between the months of June and September. As shown in the map in the Geographic Areas section above, Hillsborough County is likely to experience between 5 and 28 days of temperatures above 95 degrees each year, and incidents of extreme heat are expected to continue in the county.

Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability).

5. Extreme Heat Impact Analysis

All jurisdictions could receive the impacts listed below due to extreme heat. Portions of these communities with high concentrations of senior residents and very young individuals could be the most at risk.

- Public
  - Injury or death from overexposure, especially to infants, children, the elderly, those who are overweight, those with chronic illnesses, and those who take certain medications
- Responders
  - Injury or death from overexertion in heat
- Continuity of Operations (including continued delivery of services)
  - Not likely to impact continuity of operations
- Property, Facilities, Infrastructure
  - Less efficient cooling systems or systems that must run constantly to effectively cool a building
- Environment
  - Faster evaporation
  - Damage to green spaces and agricultural lands
  - Death of plants and animals
- Economic Condition
  - Crop damage or loss
- Public Confidence in Jurisdiction's Governance
  - If people become ill or die from exposure to extreme heat, public may believe the government is not doing all that it can to help those in need, whether or not a cooling shelter was opened

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Historical Losses

Because there was no record of extreme heat events reported by the NCEI Storm Events Database in Hillsborough County, it is not possible to analyze historical losses for this hazard.

Exposure

Since extreme heat is a hazard that does not have geographically definable boundaries, it was excluded from spatial analysis through GIS. However, because extreme heat is considered atmospheric, it has the potential to affect all buildings and all populations in Hillsborough County.

Extreme heat usually does not cause significant damage to the built environment. Although structures themselves are not vulnerable to extreme heat, the areas or regions that the structures are located in may be susceptible to extreme heat. The efficiency at which a building operates may be affected (i.e., added load to building cooling systems) if the building is in an area vulnerable to extreme heat.

Extreme heat primarily affects the human population. Extreme heat can ultimately cause death, and most heat disorders occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. Specific high-risk groups typically experience a disproportionate number of health impacts from extreme heat conditions including low income, homeless, sick, elderly, individuals under the influence of drugs or alcohol, and special needs populations who have mobility restrictions, are oxygen dependent, or have mental impairments.

Age does not always equal vulnerability; however, it is a good proxy measure for vulnerability and there is a large population 65 years or older. Those at greatest risk of death in extreme heat conditions are urban-dwelling elderly without access to an airconditioned environment. For example, an elderly person that resides in a high-rise building may have difficulty evacuating following a power outage during a natural disaster; exposing them to this high-risk environment. Elderly populations are concentrated in the Sun City in the south portion of the county, and then in the Egypt Lake-Leto and Town 'n' Country communities of West Hillsborough County.

Those with special needs may show trends in geographic location in specific areas but are mostly scattered throughout the county with the map showing high concentrations of special needs populations residing along the east portion of Interstate 275 from downtown Tampa, north to Bearss Avenue.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Extreme heat can strike anywhere in Hillsborough County; therefore, all of the county critical facilities are equally vulnerable and at risk. However, extreme heat usually does not cause direct structural damage to critical facilities. Extreme heat impacts to structures, including to critical facilities, are listed above under Exposure.

All of the critical facilities and their associated risk can be found in Appendix B.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be moderate, with a PRI score of 2.5.

<table>
<tr><th colspan="5">EXTREME HEAT
Overview</th><th>Overall Vulnerability</th></tr>
<tr><td colspan="5">Extreme heat is defined as extended period where the temperature and relative humidity combine for a dangerous heat index.</td><td>MODERATE</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Likely</td><td>Minor</td><td>Large</td><td>> 24 hrs</td><td>> 1 week</td><td>2.5</td></tr>
</table>

Drought Hazard Profile

1. Drought Description

Drought is a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage. While droughts are a normal and recurring feature of our climate, sometimes they can endanger vegetation, animals, and even people. There are several types of droughts, which will be discussed below.[164]

- Meteorological droughts are based on the amount of dryness compared to normal for that region.
- Agricultural drought refers to agricultural concerns, such as precipitation shortages and reduced ground water.
- Hydrological drought refers to the hydrological effects from extended periods with precipitation deficits. These droughts take longer to occur than meteorological and agricultural droughts.
- Socioeconomic droughts occur when the demand for an economic good reliant upon water, such as fish or hydroelectric power, exceeds supply as a result of a weather-related water shortfall.

Many factors of precipitation determine whether the rains will relieve a drought. For example, the timing and effectiveness of the rains. There is also a balance between precipitation and evapotranspiration that must be maintained to avoid a drought. Evapotranspiration is the sum of evaporation and transpiration, which is the release of water from plant leaves. High temperatures, high winds, and low relative humidity are also factors that can intensify a drought.

The agricultural industry is particularly vulnerable to the impacts of a drought because the crops depend on stored soil water and surface water.

Drought Indices and Measurements

One method to interpret drought is the Palmer Drought Severity Index (PDSI), which is based on the supply and demand concept of the water balance equation, taking into account more than just the precipitation deficit at specific locations. The objective of the Palmer Drought Severity Index (PDSI), shown in the table below, is to provide measurements of moisture conditions that are standardized so that comparisons using the index can be made between locations and between months.

The PDSI is most effective in determining long-term drought, over a matter of several months, and is not as reliable with short-term forecasts. It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, minus 2 is moderate drought, minus 3 is severe drought, and minus 4 is extreme drought. The advantage of the PDSI is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions.

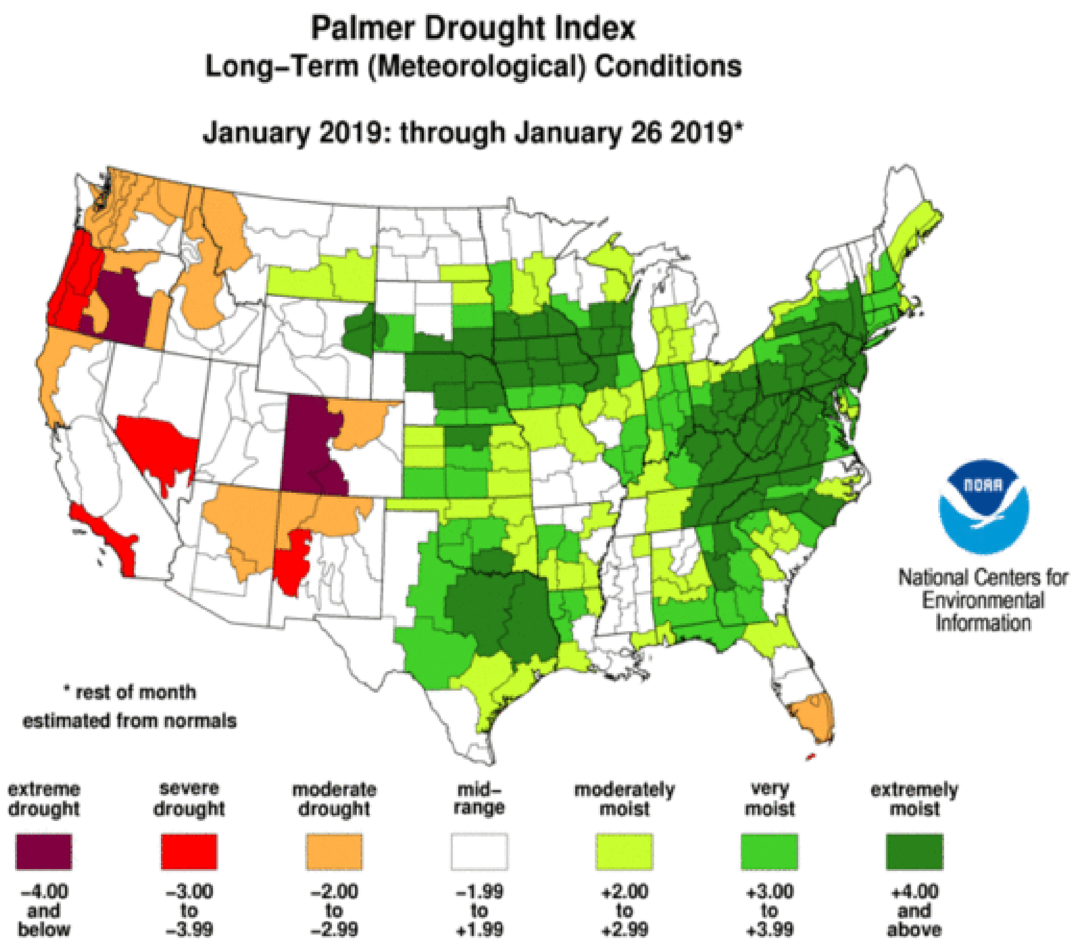
[164] https://www.nws.noaa.gov/om/csd/graphics/content/outreach/brochures/FactSheet_Drought.pdf

Table 4.91: Palmer Drought Severity Index[165]

Term	Extreme drought	Severe drought	Moderate drought	Mid-range	Moderately moist	Very moist	Extremely moist
Numerical description	-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above

Below is an example of the PDSI of the United States from January 2020.[166]

Figure 4.50: Florida PDSI, January 2020



Another method to interpret drought is with the Keetch Byran Drought Index (KBDI). It is a reference scale for estimating the dryness of the soil and duff layers. The index increases for each day without rain and

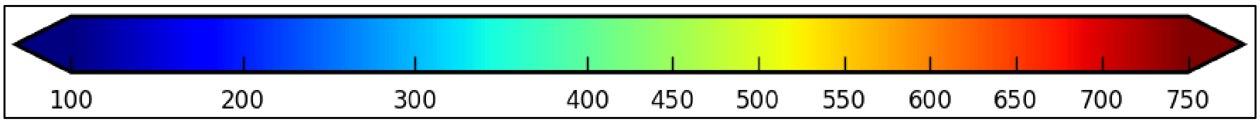
165 https://www.drought.gov/drought/data-maps-tools/current-conditions
166 https://www.ncdc.noaa.gov/temp-and-precip/drought/weekly-palmers/20191130

decreases when it rains and assumes there are 8 inches of saturated soil readily available to vegetation. The scale ranges from 0 (no moisture deficit) to 800.[167]

For different soil types, the depth of soil required to hold 8 inches of moisture varies (loam 30 inches, clay 25 inches, and sand 80 inches). A prolonged drought, meaning a high KBDI, can increase wildfire intensity because more fuel is available for combustion. In addition, the drying of organic material in the soil can lead to increased difficulty in fire suppression.

The index rating is displayed below.[168]

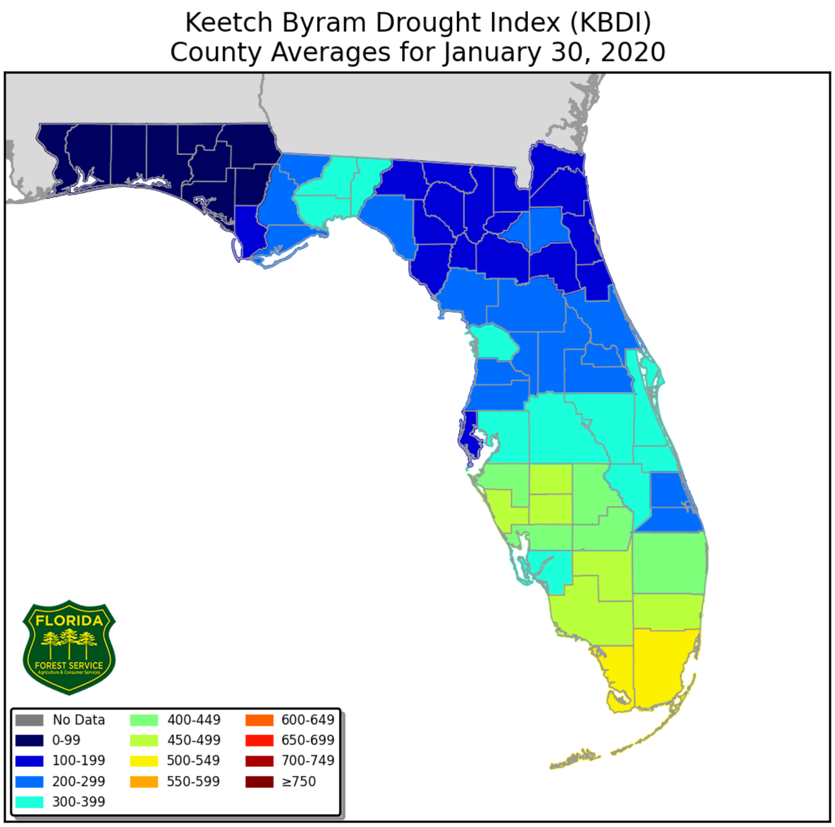
Figure 4.51: Keetch Byran Drought Index



Below is an example of the KBDI for Florida from January 30, 2020.

167 https://climatecenter.fsu.edu/
168 http://currentweather.freshfromflorida.com/kbdi_4km.html

Figure 4.52: Florida KBDI, January 2020[169]



There is also a U.S. Drought Monitor, which focuses on broad drought conditions across the entire United States. In this measurement, drought intensity is classified from D0 Abnormally Dry to D4 Exceptional Drought.

Table 4.92: United States Drought Monitor[170]

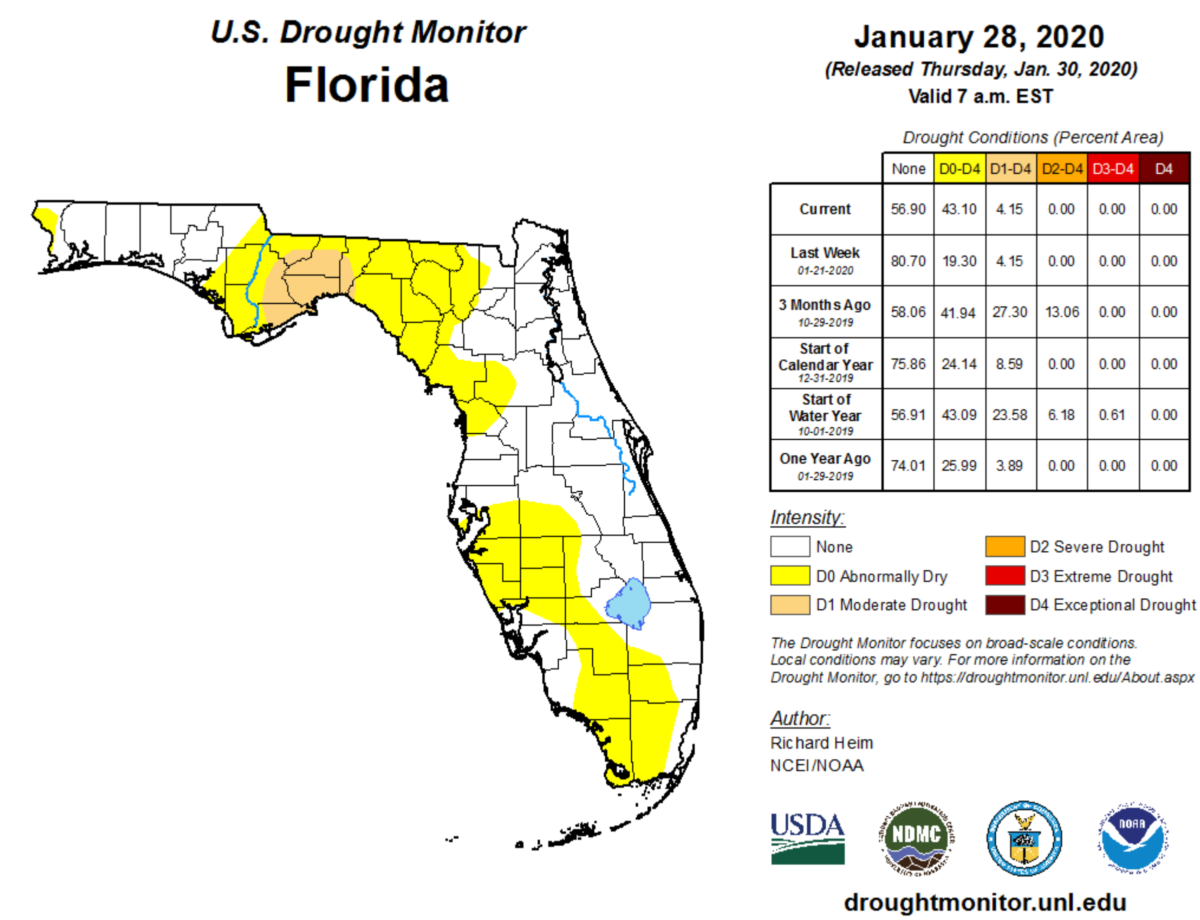
Category	Description	Possible Impacts
D0	Abnormally Dry	Going into drought: ● Short-term dryness slows planting and growth of crops or pastures Coming out of drought ● Some lingering water deficits ● Pastures or crops are not fully recovered
D1	Moderate Drought	● Some damage to crops, pastures ● Streams, reservoirs, or wells are low; some water shortages are developing or imminent ● Voluntary water-use restrictions requested
D2	Severe Drought	● Crop of pasture losses are likely

169 http://currentweather.freshfromflorida.com/kbdi_index.html
170 https://droughtmonitor.unl.edu/AboutUSDM/AbouttheData/DroughtClassification.aspx

Category	Description	Possible Impacts
		● Water shortages are common ● Water restrictions are imposed
D3	Extreme Drought	● Major crop or pasture losses ● Widespread water shortages or restrictions
D4	Exceptional Drought	● Exceptional and widespread crop or pasture losses ● Shortage of water in reservoirs, streams, and wells creating water emergencies

Below is an example of the drought monitor map for Florida from January 28, 2020.

Figure 4.53: Florida U.S. Drought Monitor, January 2020[171]



Potential Effects of Climate Change on Drought

Changes in rates of precipitation, evaporation, and transpiration may affect the duration and severity of drought events. A warmer climate would impact the hydrological cycle by increasing rates of evaporation leading to a decrease in runoff rates associated with rainfall events. Moreover, increased rates of

171 https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

evapotranspiration would exacerbate current droughts as existing soil moisture and plant moisture would likewise increase moisture in the atmosphere potentially leading to more frequent rainfall events. Regional effects are expected to range widely and are difficult to predict.[172] It is widely believed that an overall warming trend may intensify and prolong droughts as they occur due to increased rates of evapotranspiration associated with higher temperatures.[173]

The Intergovernmental Panel on Climate Change forecasts with medium confidence both an increase in heavy rainfall periods as well as an increase in the duration of relatively dry periods for North America, particularly in the subtropics, such as Florida.[174] South Florida, in particular, may see increased dry and hot periods between heavy rainfall events, exacerbating the risk for drought.[175] However, there is significant uncertainty associated with these projections given the numerous factors that contribute to climatic variability.[176]

As stated in the *Flood Hazard Profile*, the expected global pattern is for arid areas to become drier, meaning that droughts may occur more frequently and be more severe.

2. Geographic Areas Affected by Drought

The state of Florida experiences cyclical drought on a regular basis. Analyzing past events as well as the current drought conditions has proven that the conditions and severity of drought conditions has been variable over the years, affecting the east, north, south, and central regions randomly and somewhat equally.

The map below shows that Hillsborough County is likely to be impacted by drought and experiences up to 15 weeks of drought each year.

[172] *(Walsh and Wuebbles (2013). Our changing climate. In, Draft national climate assessment, pp. 25–103. https://www.globalchange.gov/sites/globalchange/files/NCAJan11-2013-publicreviewdraft-chap2-climate.pdf); p. 113.).*

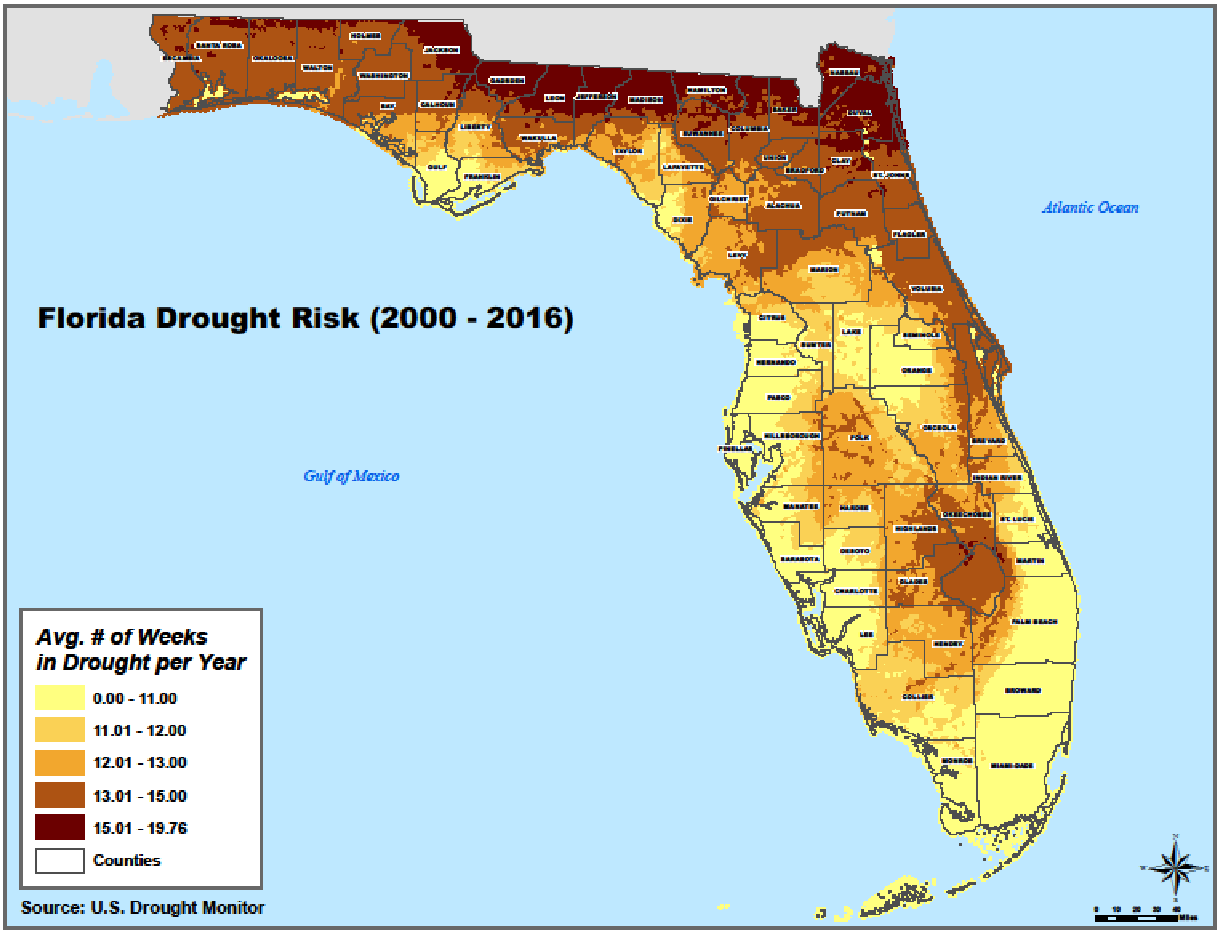
[173] *(Allen et al. (2012). Summary for policymakers. In Field et al. (Eds.), Managing the risks of extreme events and disasters to advance climate change adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, pp. 3–21., https://www.ipcc.ch/pdf/special-reports/srex/SREX_FD_SPM_final.pdf, p. 13).*

[174] *(Seneviratne et al. (2012). Changes in climate extremes and their impacts on the natural physical environment. https://www.ipcc.ch/pdf/special-reports/srex/SREX-Chap3_FINAL.pdf); In Field et al. (Eds.), Managing the risks of extreme events and disasters to advance climate change adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, pp. 109–230. https://www.ipcc.ch/pdf/special-reports/srex/SREX_FD_SPM_final.pdf, pp. 174–175.).*

[175] *(Karl et al. (Eds.) (2009). https://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf).*

[176] *(Seager et al. (2009). http://journals.ametsoc.org/doi/full/10.1175/2009JCLI2683.1).*

Figure 4.54: Florida Drought Risk, 2000–2016



3. Historical Occurrences of Drought

Florida experienced a destructive drought from 1998 to 2001 where farm crops were ruined, forest fires burned, and lake levels reached an all-time low. In 2006 to 2007, rainfall deficits were the largest observed since the mid-1950s, which led to severe wildfires in 2007.

While drought is a common occurrence in Florida, there has never been a Presidential Major Disaster Declaration for drought in the state. The NCEI Storm Events Database also has no record of drought events reported in Hillsborough County from 1996 to October 2019.[177]

The table below explains various significant drought events that have occurred in Florida.

[177] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Drought&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Table 4.93: Significant Drought Occurrences in Florida

Date	Description
1954–1956	The most extreme drought in Florida on record occurred during 1954–1956 when runoff was 8 inches below normal, causing extensive loss of crops and timber. The Panhandle and northern central regions of the state were in a drought for most of 1955 and the almost the entire state was in drought for most of 1956.[178]
1981–1982	Rainfall deficiencies caused the water levels in Lake Okeechobee to reach the lowest levels ever recorded. In mid-1981, the entire state was in moderate or severe drought, but most regions were out of drought by the end of the year.[179]
1998–2002	Lower than normal precipitation caused a severe long-term statewide drought in Florida lasting from 1998–2002. This drought was particularly severe over the 5-year period in the northwest, northeast, and southwest regions of Florida. The drought became so severe that in 2001, the following actions were taken: ● Three of Florida's five water management districts imposed mandatory cutbacks, strictly limiting water use. ● Several municipalities hiked water-sewer rates, meaning even customers who cut back were paying more. Restaurants in South Florida were ordered to stop serving water, except to diners who asked.[180]
2006–2007	Drought conditions began to develop in 2006 across Florida because of less than average rainfall. In 2007, the drought was so severe it was considered a one in 25-year drought. The drought affected most of the state. The 2007 wildfire season was very active because of the extreme drought classification.[181]
2010–2012	Drought conditions began in central Florida in late 2010 and continued into mid-2012. The drought affected most of the state, but the northern central and the Panhandle regions of the state were in "extreme drought" for several months.[182]
2016–2017	Drought conditions developed in late 2016 and persisted into mid 2017 leading to several wildfires across the state.[183]

Data from the U.S. Drought Monitor was used to ascertain historical drought conditions for Hillsborough County. (Data was only available at the county level, so each jurisdiction is not shown separately.) The U.S. Drought Monitor provides weekly updates on drought status by county. Drought conditions are classified on a scale of D0 to D4 as described previously in this section.

[178] https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/psi/195401-195612
[179] https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/psi/198001-198212
[180] https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/psi/199801-200212
[181] https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/psi/200601-200712
[182] https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/psi/201001-201212
[183] https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/psi/201601-201704

According to the U.S. Drought Monitor data from 2000 to 2019, the greatest magnitude of drought, D4 – exceptional drought, occurred in Hillsborough County in 2000 and 2001, and the county has experienced at least abnormally dry conditions every year except 2015. The table below shows the most severe drought classification for each year and the associated number of weeks reported at that category. It should be noted that the U.S. Drought Monitor also estimates what percentage of the county is in each classification of drought severity. For example, the most severe classification reported may be exceptional, but a majority of the county may actually be in a less severe condition.

Table 4.94: Historical Drought Occurrences in Hillsborough County[184]

Year	Most Severe Drought Condition		Number of Weeks
	Category	Description	
2000	D4	Exceptional Drought	3
2001	D4	Exceptional Drought	18
2002	D0	Abnormally Dry	24
2003	D0	Abnormally Dry	2
2004	D0	Abnormally Dry	2
2005	D0	Abnormally Dry	17
2006	D1	Moderate Drought	13
2007	D2	Severe Drought	3
2008	D2	Severe Drought	14
2009	D2	Severe Drought	10
2010	D1	Moderate Drought	5
2011	D2	Severe Drought	2
2012	D3	Extreme Drought	9
2013	D1	Moderate Drought	11
2014	D0	Abnormally Dry	4
2015	None	--	--
2016	D0	Abnormally Dry	2
2017	D3	Extreme Drought	3
2018	D0	Abnormally Dry	7
2019	D0	Abnormally Dry	7

4. Probability of Future Occurrences of Drought

Based on the previous occurrences of drought conditions in the county, future drought events occurring over the long term with some frequency are expected to continue. According to the Florida Drought Risk map shown above, Hillsborough County is likely to experience up to 15 weeks of drought each year. As Hillsborough County continues to develop with higher populations and higher water demands, these drought conditions and drier trends may begin to have a profound impact on the county and its residents.

Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability).

[184] https://droughtmonitor.unl.edu/Data/DataDownload/ComprehensiveStatistics.aspx

5. Drought Impact Analysis

All jurisdictions could receive the impacts listed below due to drought. As Hillsborough County continues to develop with higher populations and higher water demands, drought conditions and drier trends may begin to have a profound impact countywide on its residents.

- Public
  - Lack of water or water restrictions for personal use
  - Damage to property, such as grass and other vegetation dying from lack of water
- Responders
  - Lack of water to extinguish fires
- Continuity of Operations (including continued delivery of services)
  - Lack of water or water restrictions may impact the public use of water and wastewater utilities; the public may have to restrict their showering time and other water use in the restroom, restrict their water usage for cooking and drinking, and restrict from watering their gardens or lawns
- Property, Facilities, and Infrastructure
  - Facilities and infrastructure should not be affected by drought
  - Property, such as green spaces, gardens, crops, etc., may be damaged from lack of water
- Environment
  - Areas such as green spaces, gardens, and forests may be damaged from drought
- Economic Condition
  - Crop damage or loss from drought can severely impact farmers and the agricultural economy, which can in turn affect the economy of an area if it is dependent upon the sales of the crops, like how Florida relies upon the sales of citrus
  - Employment loss due to lower demand for services such as landscaping, lawn care, car wash, etc.
- Public Confidence in the Jurisdiction's Governance
  - The public may lose confidence in the jurisdiction's governance if there is not a plan in place to deal with lack of water or water restrictions

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Historical Losses

Because there was no record of drought events reported by the NCEI Storm Events Database in Hillsborough County, it is not possible to analyze historical losses for this hazard.

Exposure

Since drought is a hazard that does not have geographically definable boundaries, it was excluded from spatial analysis through GIS. However, because drought is considered atmospheric, it has the potential to affect all buildings and all populations in Hillsborough County.

Drought conditions typically do not cause significant damage to the built environment. Although structures themselves are not vulnerable to drought, the areas or regions that the structures are located in may be susceptible to drought. The efficiency at which a building operates may be affected (i.e., low water pressure) if the building is in a drought-stricken area. Furthermore, drought can also increase the likelihood of wildfires and lower water levels in canals and other surface waters which could inhibit the ability to fight fires in rural areas potentially increasing impacts to structures.

The agriculture sector is most vulnerable to drought because crops, pasturelands, and livestock can be impacted by lack of water due to short-term drought during critical times in the growth cycle and long-term drought over many years. The agricultural business of strawberry production would sustain one of the largest impacts of a drought in east Hillsborough County. Strawberries represent 46.6% of the county's annual agricultural sales while vegetable production is second accounting for 18%. Plant City would be most susceptible to agricultural loss. Significant impacts would also occur in fisheries located throughout East Hillsborough County including the Brandon, Riverview, and Gibsonton areas.

Drought conditions may also require water use restrictions and result in more water supply shortages. Availability of water during drought conditions is controlled largely by the topography, geology, hydrogeology, and hydrology of an area. Local conditions, such as the availability of a large impoundment for water storage, may affect drought vulnerability on a local scale.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Drought can strike anywhere in Hillsborough County; therefore, all of the county critical facilities are equally vulnerable and at risk. However, drought usually does not cause direct structural damage to critical facilities. Drought impacts to structures, including to critical facilities, are listed above under Exposure.

All of the critical facilities and their associated risk can be found in Appendix B.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be moderate, with a PRI score of 2.5.

<table>
<tr><th colspan="5">DROUGHT</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">Drought is a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage. While droughts are a normal and recurring feature of our climate, sometimes they can endanger vegetation, animals, and even people.</td><td>MODERATE</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Likely</td><td>Minor</td><td>Large</td><td>> 24 hrs</td><td>> 1 week</td><td>2.5</td></tr>
</table>

Suspect Soil Hazard Profile

1. Suspect Soil Description

Sinkholes are just one of many forms of ground collapse, or subsidence. Subsidence is the gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials. The principal causes of land subsidence are aquifer-system compaction, drainage of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost.[185]

Sinkholes are landforms created when overburden subsides or collapses into fissures or cavities in underlying carbonate rocks. Florida is underlain by several thousand feet of carbonate rock, limestone, and dolostone, with a variably thick mixture of sands, clays, shells, and other near-surface carbonate rock units, called overburden. Those several thousand feet of carbonate rocks are host to one of the world's most productive aquifers, the Floridian aquifer system. Erosional processes, physical and chemical, have created fissures and cavities within the rock. This has created Florida's karst topography, characterized by the presence of sinkholes, swallets, caves, submerged conduits, springs, and disappearing and reappearing streams. Sinkholes are unpredictable, as they can form rapidly, within minutes to hours, or slowly, within months to years.[186]

This profile will focus on the two common types of sinkholes in Florida, cover collapse sinkholes and cover subsidence sinkholes, because of their rate of formation and the risk they pose to human life and property. The profile will also address the location of muck soil since it is an organic soil, and subsidence can occur when wet organic materials are drained and exposed to air.

Cover Collapse Sinkholes

Cover-collapse sinkholes may develop quickly and cause significant damage. These sinkholes develop when the ceiling of an underground cavity can no longer support the overlying weight, resulting in an abrupt collapse of the overburden into the cavity, thereby forming a hole in the land surface.[187] This occurs because, over time, surface drainage, erosion, and deposition of materials develop a shallow bowl-shaped depression beneath the surface of the ground.

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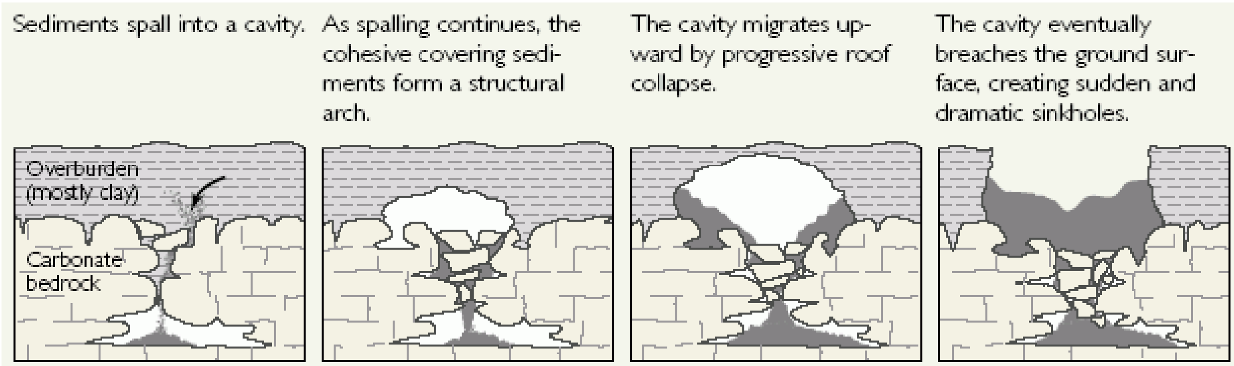
[185] https://www.usgs.gov/faqs/what-difference-between-a-sinkhole-and-land-subsidence?qt-news_science_products=0#qt-news_science_products

[186] Florida Department of Environmental Protection Florida Geological Survey. (2017). *The favorability of Florida's geology to sinkhole formation*. Page 4–7.

[187] Florida Department of Environmental Protection Florida Geological Survey. (2017). *The favorability of Florida's geology to sinkhole formation.* Page 5.

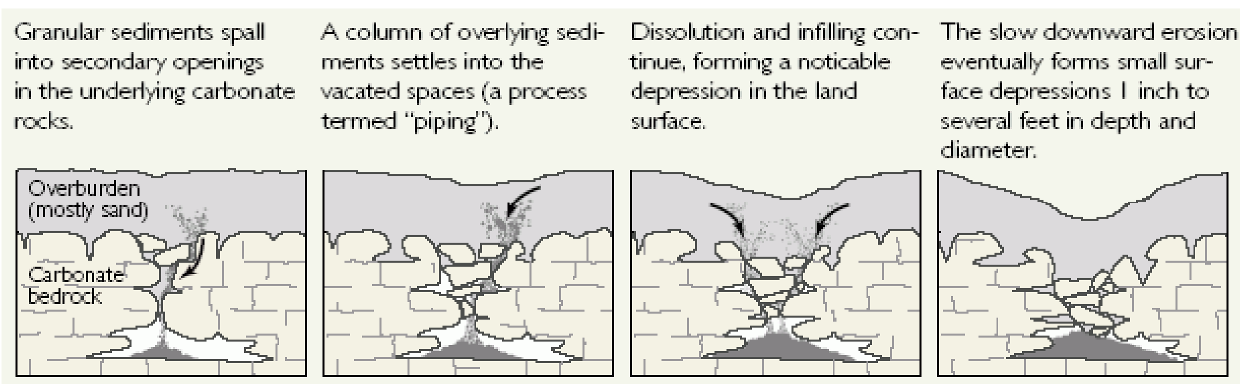
Figure 4.55: Cover Collapse Sinkholes[188]



Cover Subsidence Sinkholes

Cover-subsidence sinkholes develop more gradually, usually where the sediment is permeable and contains sand. The overburden slowly migrates down into the fissures and cavities in the underlying rock, which results in a depression in the land surface.[189]

Figure 4.56: Cover Subsidence Sinkholes[190]



Triggers

There are several triggers for sinkhole formation. For example, extended periods of drought can lead to sinkholes, especially if a heavy rain event occurs after an extended drought. Heavy rainfall can trigger sinkholes for several reasons. For example, heavy rainfall can add additional weight to overburden sediments above a cavity which could cause a failure of the cavity ceiling. Or heavy rainfall could collect in low-lying areas adding to the weight and accelerating infiltration at that location, which could cause failure of cavity ceilings. Additionally, heavy rainfall could saturate overburden sediments, making them soft, which could weaken the overburden sediments, causing failure of the cavity ceiling. According to geologists, sinkholes can also be attributed to anthropogenic triggers, such as significant groundwater withdrawal; terraforming, which is the alteration of the earth's surface without realizing the area has thin

188 https://water.usgs.gov/edu/sinkholes.html
189 Florida Department of Environmental Protection Florida Geological Survey. (2017). *The favorability of Florida's geology to sinkhole formation.* Page 4–7.
190 https://water.usgs.gov/edu/sinkholes.html

overburden sediments; some stormwater management practices; heavy infrastructure over critical areas; and well drilling and development.[191]

Potential Effects of Climate Change on Suspect Soil

Incidences of sinkholes increase either after severe storm events with associated flooding and soil saturation or during extended periods of drought.[192] With the potential for more prolonged and more intense periods of drought as well as greater intensity and frequency of rainfall and inland flooding *(*see *Flood Hazard Profile)*, it is likely that incidences of sinkholes will increase in the coming century in areas with karst geology or areas identified as favorable for sinkhole development.

Climate change is not expected to affect the occurrence of landslides in Florida.

2. Geographic Areas Affected by Suspect Soil

Sinkholes are common wherever there is limestone terrain. The following define areas of sinkhole occurrence in Florida:

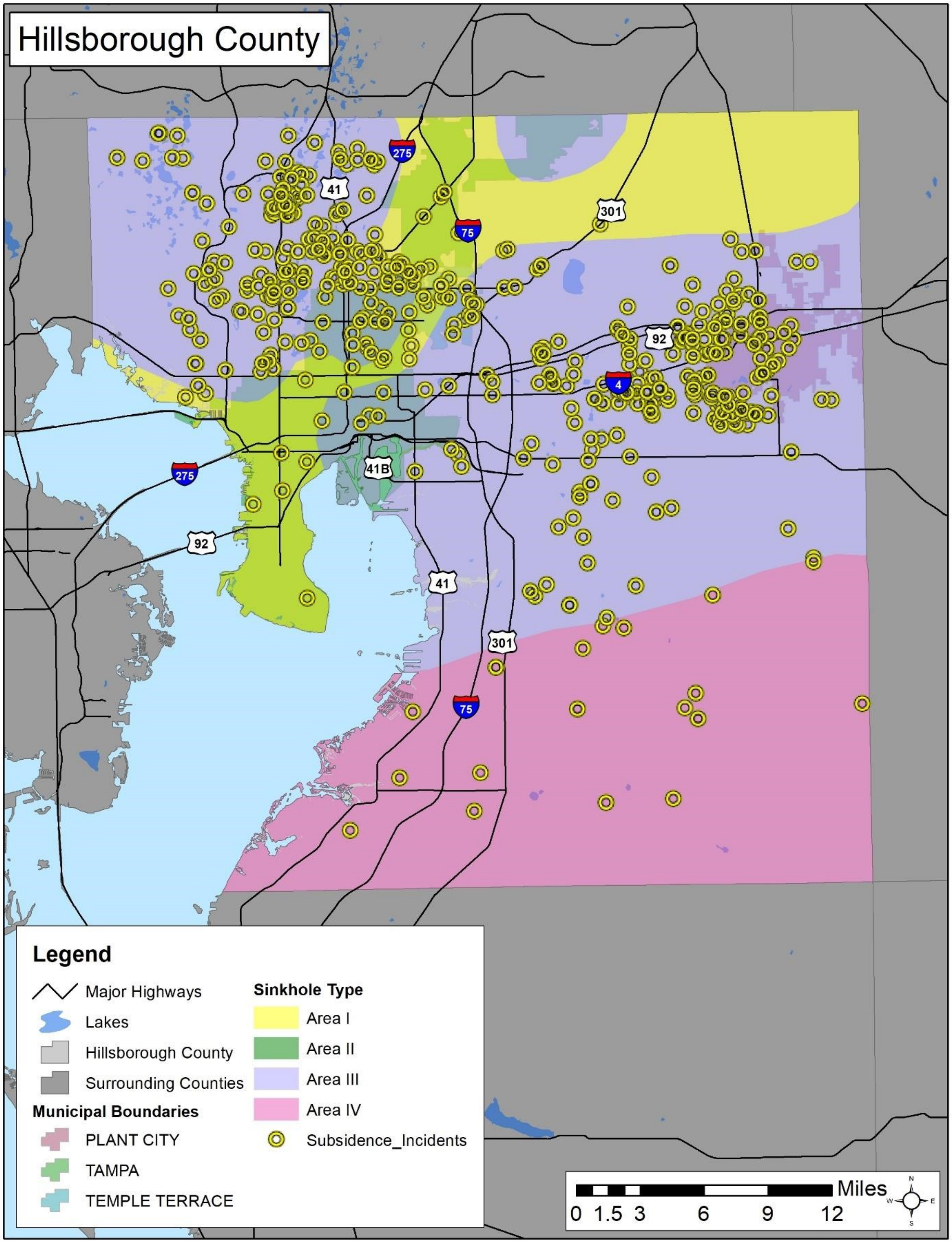
- Area I – Few sinkholes, generally shallow and broad that develop gradually.
- Area II – Few sinkholes, shallow and of small diameter that develop gradually.
- Area III – Sinkholes are most numerous, of varying size and develop abruptly.
- Area IV – Very few sinkholes but a large diameter and deep.

Area I, Area III, and Area IV of sinkhole occurrence are all present in Hillsborough County. The map below delineates the location of these areas as well as the location of documented sinkhole and subsidence incidents.

[191] Florida Department of Environmental Protection Florida Geological Survey. (2017). *The favorability of Florida's geology to sinkhole formation.* Page 11.

[192] Dragoni and Sukhija (2008) *Climate change and groundwater: A short review.* Geological Society, London, Special Publications, 288, 1-12; Hyatt and Jacobs (1996). *Distribution and morphology of sinkholes triggered by flooding following Tropical Storm Alberto at Albany, Georgia, USA.* Geomorphology, 17, 305-316.

Figure 4.57: Areas of Sinkhole Occurrence

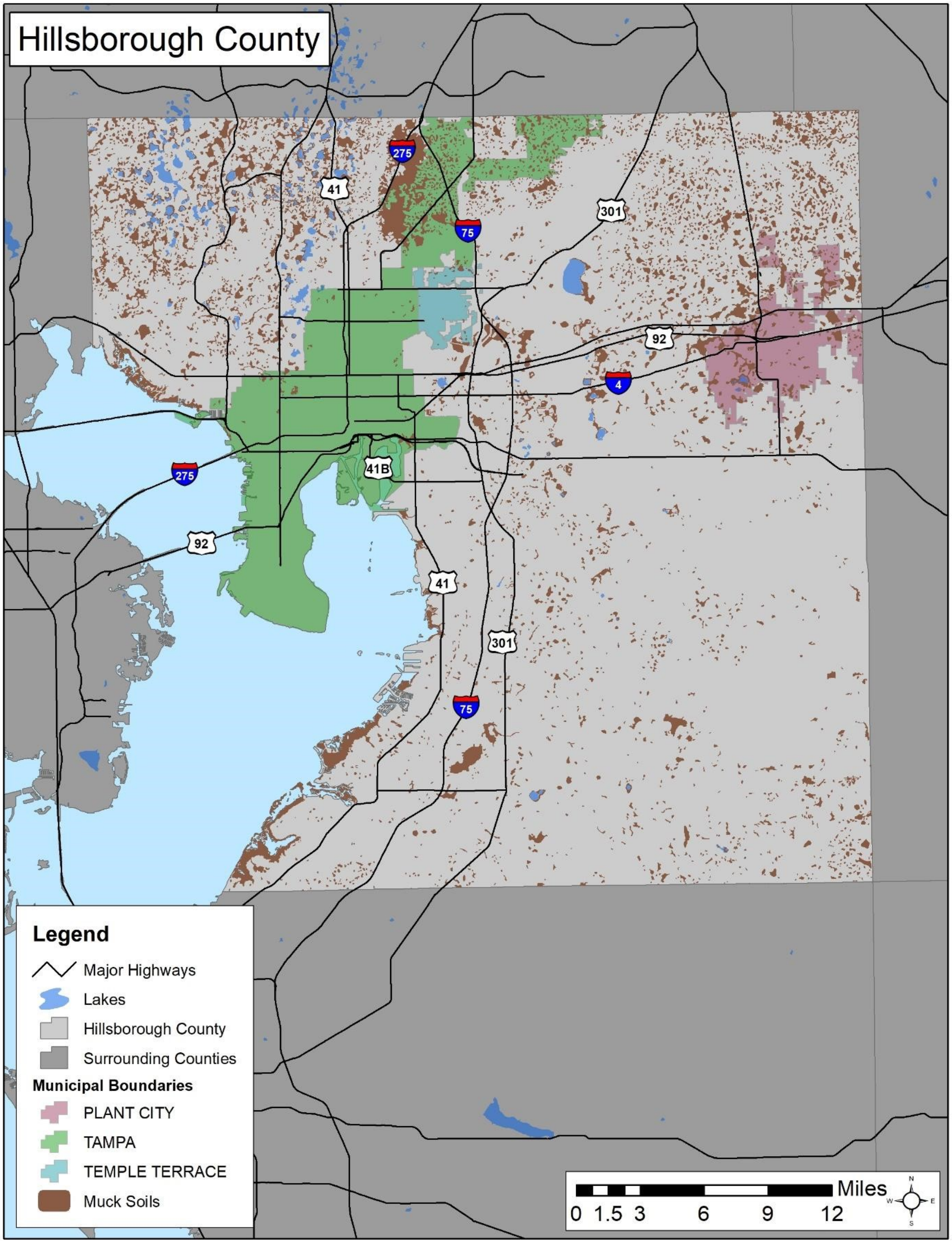


Muck soils generally form under saturated conditions in areas where oxidation of the organic matter is limited and organic matter subsequently accumulates. Some thick layers of organic material are buried by sediments so thick that the organic layers are not apparent after normal construction excavations.[193]

Muck soils are present throughout Hillsborough County. The map below delineates the location of these areas.

[193] https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/16/nrcs143_019308.pdf

Figure 4.58: Location of Muck Soils



3. Historical Occurrences of Suspect Soil

Sinkholes, a common occurrence in many parts of Florida, have a history of occurring in Hillsborough County. Using the Alafia River as a reference point, Hillsborough County is roughly divided in half in terms of the possibility of sinkhole formation. North of the Alafia River, sinkhole formation increases in possibility whereas south of the river, sinkhole formation is rare.

There are several significant historical occurrences of sinkholes in Hillsborough County listed below.

Table 4.95: Significant Sinkhole Incidents in Hillsborough County[194]

Date	Event Description
November 10, 1987	At 5:15 PM, a 6-foot hole formed beneath a propane tank. Between 6:00 and 10:00 PM, the hole grew to 60-foot diameter and the home went in at 7:00 PM. At 4:00 AM, the porch broke off the home and fell into the hole. Water completely drained and rose slowly in the sinkhole. At 10:00 AM, new cracks formed along the side. The final size was 66-foot long, 60.5-foot wide, and 35-foot deep.
January 1, 1989	A 100-foot long, 100-foot wide, 15-foot deep sinkhole formed on the bottom of an excavation pit for a phosphate mine. The sinkhole drained the excavation pit of water and the pit was completely filled with water at the time of occurrence.
December 25, 1989	A 22.83-foot long, 23.17-foot wide, 6-foot deep sinkhole and a 8.58-foot long, 8.5-foot wide, 4-foot deep sinkhole both formed at a site located between two strawberry farms that were pumping for freeze protection.
July 20, 2003	A 20-foot long, 20-foot wide, 15-foot deep sinkhole impacted a residence on private property. Residents were evacuated and their car was swallowed by the sinkhole.
July 11, 2010	A 35-foot long, 35-foot wide, 35-foot deep sinkhole formed in the parking lot of Bordeaux Village Condos in Tampa swallowing a car. Residents of the condos were evacuated, the sinkhole was remediated, and the parking lot was repaired. However, the car was not recovered from the hole and further investigation of the building structure was required.
December 14, 2010	A 108-foot long, 108-foot wide, 60-foot deep sinkhole formed on the west slope of Section 9 of the Hillsborough County SE County Landfill in the Capacity Expansion Area (CEA). The landfill liner was breached releasing leachate into the ground.
March 2, 2013	A 50-foot long, 50-foot wide, 70-foot deep sinkhole developed under a home engulfing the bed in which a man was sleeping resulting in his death. The sinkhole reopened on August 19, 2015 with a diameter of 20 feet and unknown depth.
July 30, 2013	A 4-foot long, 1-foot wide, 2-foot deep sinkhole occurred over a wastewater asset. A solid waste truck went into the hole and was pulled out without any spills. TECO Gas broke the top of gravity main while directional drilling.
August 13, 2015	A sinkhole was reported under the foundation of a home in Valrico. Two homes have been evacuated with 10 people displaced.
January 8, 2018	A 10-foot long, 10-foot wide, 12-foot deep potential sinkhole was reported at the University of South Florida. The subsidence formed in a parking lot and

194 https://floridadep.gov/fgs/sinkholes/content/subsidence-incident-reports

Date	Event Description
	does not threaten any surface level structures. However, a stormwater pipe is visible in the subsidence.

Only a small percentage of sinkhole reports are determined to be actual sinkholes. Most are subsidence events, resulting from clay shrinkage or fill deterioration. However, most occurrences of subsidence are incorrectly identified as sinkholes.

The Florida Geological Survey maintains a database of sinkholes and subsidence incidents reported throughout the state. As of January 2020, this database reported 587 incidents for Hillsborough County, 136 of which resulted in property damage.[195] Due to the high number of occurrences, event details are only provided for those incidents with reported property damage. Many of the events with reported damage were related to freeze protection pumping.

Table 4.96: Summary of Sinkhole Occurrences in Hillsborough County

Location	Total Number of Occurrences	Number of Occurrences with Property Damage
Plant City	35	18
Tampa	125	51
Temple Terrace	10	2
Unincorporated	417	65
HILLSBOROUGH COUNTY TOTAL	**587**	**136**

Table 4.97: Historical Sinkhole Occurrences in Hillsborough County

	Data	Length (ft)	Width (ft)	Depth (ft)
Plant City				
PLANT CITY	12/29/1983	5	5	20
PLANT CITY	1/21/1985	12	12	17
PLANT CITY	1/21/1985	3	3	3
PLANT CITY	1/21/1985	20	15	15
PLANT CITY	1/21/1985	20	20	0
PLANT CITY	1/22/1985	5	5	0
PLANT CITY	1/23/1985	12	12	1.5
PLANT CITY	1/23/1985	0	0	0
PLANT CITY	5/29/1985	0	0	0
PLANT CITY	11/18/1988	12	12	12
PLANT CITY	2/25/1989	30	30	20
PLANT CITY	12/25/1989	8.58	8.5	4
PLANT CITY	12/25/1989	22.83	23.17	6
PLANT CITY	1/27/2012	5	5	5
PLANT CITY	6/30/2012	2	3	1
PLANT CITY	7/30/2012	5	5	0

[195] https://floridadep.gov/fgs/sinkholes/content/subsidence-incident-reports

	Data	Length (ft)	Width (ft)	Depth (ft)
PLANT CITY	6/26/2013	5	5	2
PLANT CITY	6/29/2013	1	1	0
Tampa				
TAMPA	1/23/1967	0	0	0
TAMPA	6/25/1973	15	15	0.83
TAMPA	12/30/1978	14	14	7.5
TAMPA	3/27/1979	10	10	5
TAMPA	5/8/1979	20	7	1
TAMPA	5/8/1979	5	5	3
TAMPA	5/8/1979	10	10	1
TAMPA	6/20/1979	0	0	0
TAMPA	9/25/1979	3	3	1
TAMPA	6/1/1981	0	0	0
TAMPA	3/25/1985	20	20	3
TAMPA	4/18/1985	15	15	2
TAMPA	4/12/1986	20	20	0
TAMPA	4/18/1986	50	50	5
TAMPA	4/29/1986	15	15	4
TAMPA	4/29/1986	10	10	2
TAMPA	5/1/1986	0	0	0
TAMPA	5/1/1986	0	0	0
TAMPA	6/1/1986	6	6	0
TAMPA	8/15/1986	10	15	1
TAMPA	5/18/1987	4	4	6
TAMPA	6/3/1987	55	38	1
TAMPA	1/25/1988	5	5	15
TAMPA	4/1/1988	5	5	18
TAMPA	6/29/1988	0	0	0
TAMPA	7/10/1988	3	3	3
TAMPA	8/15/1988	0	0	99.9
TAMPA	8/16/1988	12	12	8
TAMPA	2/25/1989	50	50	35
TAMPA	5/17/1989	7	7	1
TAMPA	5/24/1989	0	0	0
TAMPA	3/12/1990	15	10	10
TAMPA	3/16/1990	0	0	0
TAMPA	5/28/1990	30	30	1.5
TAMPA	1/19/1991	5	5	3
TAMPA	5/5/2003	0	0	28
TAMPA	7/20/2003	20	20	15
TAMPA	4/2/2004	40	40	30
TAMPA	7/11/2010	35	35	35
TAMPA	9/26/2011	0	0	0
TAMPA	6/26/2012	5	5	0
TAMPA	9/15/2012	2	2	1

	Data	Length (ft)	Width (ft)	Depth (ft)
TAMPA	9/15/2012	2	2	4
TAMPA	9/30/2012	2	1	0
TAMPA	6/10/2013	0	0	0
TAMPA	7/30/2013	4	1	2
TAMPA	8/13/2013	0	0	0
TAMPA	1/8/2018	10	10	12
TAMPA	8/22/2019	0	6	6
TAMPA	--	4	4	5
TAMPA	--	15	10	2
Temple Terrace				
TEMPLE TERRACE	8/1/1985	0	0	0
TEMPLE TERRACE	9/9/1988	20	15	10
Unincorporated				
ODESSA	1/1/1973	5	5	6
LUTZ	2/23/1973	0	0	0
HILLSBOROUGH COUNTY	8/9/1973	16	16	10
HILLSBOROUGH COUNTY	12/18/1973	0	0	0
HILLSBOROUGH COUNTY	4/7/1974	130	100	50
HILLSBOROUGH COUNTY	5/11/1974	30	30	5
SULPHUR SPRINGS	6/20/1975	20	25	10
HILLSBOROUGH COUNTY	12/1/1978	0	0	0
HILLSBOROUGH COUNTY	3/14/1980	6	6	0.08
HILLSBOROUGH COUNTY	5/5/1980	0	0	0
HILLSBOROUGH COUNTY	3/22/1981	0	0	0
BRANDON	10/22/1981	1	1	1
LUTZ	7/1/1983	0	0	0
HILLSBOROUGH COUNTY	7/20/1983	45	45	25
HILLSBOROUGH COUNTY	3/30/1984	5	5	8
SULPHUR SPRINGS	1/14/1985	15	15	42
DOVER	1/21/1985	11	10	5
DOVER	1/21/1985	36	30	9
HILLSBOROUGH COUNTY	1/21/1985	10	10	8

	Data	Length (ft)	Width (ft)	Depth (ft)
DOVER	1/21/1985	0	0	0
HILLSBOROUGH COUNTY	1/21/1985	35	30	15
DOVER	1/21/1985	23	23	10
HILLSBOROUGH COUNTY	1/21/1985	0	0	0
DOVER	1/21/1985	47	46	9.5
DOVER	1/21/1985	62	56	16
DOVER	1/21/1985	33	33	11.5
DOVER	1/21/1985	35	26	15
DOVER	1/21/1985	30	30	7
HILLSBOROUGH COUNTY	1/21/1985	5	5	0
DOVER	1/21/1985	13	8	6
DOVER	1/21/1985	32	30	1
DOVER	1/27/1985	10	10	5
LUTZ	3/13/1985	15	15	2
BRANDON	4/8/1985	0	0	0
BRANDON	6/1/1985	10	10	1.5
HILLSBOROUGH COUNTY	12/23/1985	15	15	7
BRANDON	9/1/1986	0	0	0
VALRICO	10/7/1987	2.5	2.5	1.5
ODESSA	11/10/1987	66	60.5	35
BRANDON	4/15/1988	3	3	8
NICHOLS	1/1/1989	100	100	15
HILLSBOROUGH COUNTY	4/1/1989	2	2	5
ODESSA	1/1/1990	15	15	6
RUSKIN	8/8/1990	30	30	1
LUTZ	11/12/1990	20	20	9
HILLSBOROUGH COUNTY	4/3/1991	9	9	6
HILLSBOROUGH COUNTY	10/7/2005	0	0	37
HILLSBOROUGH COUNTY	5/10/2007	7	0	5
BRANDON	4/8/2010	6	6	6
CARROLLWOOD	6/8/2010	8	6	6
RUSKIN	12/14/2010	108	108	60
HILLSBOROUGH COUNTY	6/26/2011	0	0	0
CITRUS PARK	4/19/2012	3	3	4
LUTZ	10/13/2012	15	15	5
SEFFNER	3/2/2013	50	50	70

	Data	Length (ft)	Width (ft)	Depth (ft)
SEFFNER	3/4/2013	15	15	8
SEFFNER	4/11/2013	0	0	0
RIVERVIEW	4/15/2013	1	1	6
SEFFNER	6/26/2013	0	0	0
HILLSBOROUGH COUNTY	8/13/2015	0	0	0
HILLSBOROUGH COUNTY	9/13/2016	6	4	0
HILLSBOROUGH COUNTY	6/26/2017	10	10	8
HILLSBOROUGH COUNTY	--	10	10	0
RIVERVIEW	--	0	1	5
BRANDON	--	0	0	0

4. Probability of Future Occurrences of Suspect Soil

There will continue to be incidences of sinkholes in Hillsborough County because, as explained above, Florida has terrain that is favorable to sinkholes.

Sinkholes can be triggered by natural and anthropogenic factors, such as heavy rain after an extended drought and groundwater withdrawal or well drilling. This means that heavy rainfall or high levels of groundwater withdrawal can increase the probability of sinkholes in an area.

Additionally, as Florida's population increases, the potential for individuals to be negatively impacted by a sinkhole increases because more people will live in locations that are favorable for sinkhole development.[196]

Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability).

5. Suspect Soil Impact Analysis

All jurisdictions could receive the impacts listed below due to suspect soils. As the county's population increases, the potential for individuals to be negatively impacted by suspect soils increases because more people will live in locations that are favorable for land subsidence.

- Public
  - May fall in or drive into a sinkhole
  - May be injured or killed from structure collapse because of sinkhole
- Responders
  - May be injured or killed when attempting rescue missions
- Continuity of Operations (including continued delivery of services)

[196] Florida Department of Environmental Protection Florida Geological Survey. (2017). *The favorability of Florida's geology to sinkhole formation.* Page 4.

  - If sinkhole affects structures or critical infrastructure, operations may be interrupted
- Property, Facilities, Infrastructure
  - Critical infrastructure, including structures and roads, may be affected or damaged causing disruption
- Environment
  - Sinkholes are part of the natural environment, but there may be damage to some natural spaces from a sinkhole; for example, a public park may be damaged and result in closure
- Economic Condition
  - Sinkhole damage repair can be very expensive, so a sinkhole may have a significant negative impact for the property owner; a sinkhole would likely not affect the economy of a community
- Public Confidence in Jurisdiction's Governance
  - If there is an increase in sinkhole occurrences and the government does not address the issue, the public may become concerned about what would happen if a sinkhole were to affect their property

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Exposure

To estimate exposure of improved property to sinkholes, the approximate number of parcels and their associated improved valued located in high sinkhole risk areas was determined using GIS analysis. Areas classified as Area III of sinkhole occurrence were chosen to be displayed as areas of risk because these areas are susceptible to the most numerous sinkholes of varying size and develop abruptly.

Table 4.98: Estimated Exposure of Improved Property to Sinkholes

Location	Buildings and Parcels in High Sinkhole Risk Area		
	No. of Parcels	No. of Buildings	Improved Value
Plant City	10,865	50,138	$1,775,231,425
Tampa	46,124	212,210	$11,123,231,997
Temple Terrace	2,579	15,410	$451,096,444
Unincorporated	216,777	1,051,650	$45,474,886,070
HILLSBOROUGH COUNTY TOTAL	**276,345**	**1,329,408**	**$58,824,445,936**

To estimate exposure of improved property to muck soils, the approximate number of parcels and their associated improved valued located in muck soil risk areas was determined using GIS analysis. The risk areas utilized are the areas that contain muck soils.

Table 4.99: Estimated Exposure of Improved Property to Muck Soils

Location	Buildings and Parcels in Muck Soil Risk Area		
	No. of Parcels	No. of Buildings	Improved Value
Plant City	966	1,804	$ 350,612,188
Tampa	2,515	4,800	$ 1,759,611,489

Location	Buildings and Parcels in Muck Soil Risk Area		
	No. of Parcels	No. of Buildings	Improved Value
Temple Terrace	65	165	$ 69,740,377
Unincorporated	30,062	42,622	$ 11,487,907,109
HILLSBOROUGH COUNTY TOTAL	**33,608**	**49,391**	**$13,667,871,163**

To estimate the county population's exposure to sinkhole, areas of risk were intersected with census block data. As a result, these population estimates are going to be an overestimate of risk since the entire census block's population count will be included even if only a portion of the census block's area is located in a risk area. However, these estimates still give an idea of the county population's risk to sinkhole.

Table 4.100: Estimated Exposure of Population to Sinkholes

Location	Population in High Sinkhole Risk Area
Plant City	29,020
Tampa	143,060
Temple Terrace	6,126
Unincorporated	724,587
HILLSBOROUGH COUNTY TOTAL	**902,793**

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

To estimate exposure to sinkholes for the critical facility analysis, areas of risk were intersected with critical facility locations. The table below summarizes the critical facilities in the county that are located in high sinkhole risk areas. Areas classified as Area III of sinkhole occurrence were chosen to be displayed as areas of risk because these areas are susceptible to the most numerous sinkholes of varying size and develop abruptly.

Table 4.101: Exposure of Critical Facilities to Sinkhole Risk Areas

Location	Number of Critical Facilities in High Sinkhole Risk Area
Plant City	75
Tampa	127
Temple Terrace	4
Unincorporated	405
HILLSBOROUGH COUNTY TOTAL	**611**

To estimate exposure to muck soils for the critical facility analysis, areas of risk were intersected with critical facility locations. The table below summarizes the critical facilities in the county that are located in muck soil risk areas.

Table 4.102: Exposure of Critical Facilities to Muck Soils

Location	Number of Critical Facilities in Muck Soil Risk Area
Plant City	1
Tampa	1
Temple Terrace	2
Unincorporated	24
HILLSBOROUGH COUNTY TOTAL	**28**

All of the critical facilities and their associated risk can be found in Appendix B.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be moderate, with a PRI score of 2.5.

SUSPECT SOIL					Overall Vulnerability
Overview					
Subsidence is the gradual settling or sudden sinking of the Earth's surface. Sinkholes are landforms created when overburden subsides or collapses into fissures or cavities in underlying carbonate rocks. Florida is underlain by several thousand feet of carbonate rock, limestone, and dolostone, with a variably thick mixture of sands, clays, shells, and other near surface carbonate rock units, called overburden. Muck soils are also susceptible to subsidence.					MODERATE
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Likely	Limited	Small	< 6 hrs	< 24 hrs	2.5

Winter Storm and Freeze Hazard Profile

1. Winter Storm and Freeze Description

Severe winter weather includes extreme cold, snowfall, ice storms, winter storms, and/or strong winds and affects every state in the continental United States. Areas where such weather is uncommon, such as Florida, may experience a greater impact on transportation, agriculture, and people from relatively small events compared to other states that experience winter weather more frequently.

Winter storm formation requires below-freezing temperatures, moisture, and lift to raise the moist air to form the clouds and cause precipitation. Lift is commonly provided by warm air colliding with cold air along a weather front. These storms move easterly or northeasterly and use both the southward plunge of cold air from Canada and the northward flow of moisture from the Gulf of Mexico to produce ice, snow, and sometimes blizzard conditions. These fronts may push deep into the interior regions, sometimes as far south as Florida. The National Weather Service will issue Frost Advisories, Wind Chill Advisories, Watches or Warnings, along with Freeze and Hard Freeze Watches and Warnings when cold weather threatens an area.

Frozen Precipitation: Snow, Sleet, and Freezing Rain

As a hazardous winter weather phenomenon, the National Weather Service (NWS) defines a winter storm a weather event with accumulating frozen precipitation such as snow, sleet, and/or freezing rain.

- Snowfall: steady fall of snow for several hours or more. Heavy snow is defined as either a snowfall accumulating to 4 inches in depth in 12 hours or less or snowfall accumulation to 6 inches or more in depth in 24 hours or less.
- Sleet: pellets of ice composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes. Heavy sleet is a relatively rare event defined as the accumulation of ice pellets covering the ground to a depth of 0.5 inch or more.

In states such as Florida, where even the smallest accumulations can cause impacts, lower thresholds are typically used to define significant winter storms and the issuance of Winter Storm Warnings. This is because of a lower capacity to respond to winter storm events.

In North Florida, a Winter Storm Warning is issued when greater than 1 inch of snow and/or sleet is expected to fall. For Central Florida, any snow or sleet amount over a 1/2 inch is considered a winter storm. An ice storm is when ice accumulates on the ground, vegetation, and power lines. Freezing rain falls as liquid rain but then freezes on contact with surfaces when the air temperature is below freezing. A Winter Storm Warning is issued in North Florida for ice accumulations over 1/4 inch. This amount is often when trees and power lines begin to feel the weight of the ice. Ice accumulations are usually accumulations of 0.25 inches or greater across the country; however, amounts as little as 0.1 inch in Florida have significant impact on transportation, special needs populations, and agriculture and livestock throughout the state.

These accumulations become heavy and can damage buildings and trees and even disrupt power and communications systems. A small amount of ice can be dangerous to pedestrians and motorists, with bridges being particularly dangerous because they freeze before other surfaces. A thin layer of ice can cause travel issues on untreated roadways.

Frost, Freeze, and Hard Freeze

Frost is the accumulation of small ice crystals on surfaces, similar to the accumulation of dew in the mornings. If a frost persists for long enough, it can lead to crop damage or loss. Frost is not a threat to the public but is a concern to the agricultural industry, particularly that of Florida's citrus growing season. Frost can occur when air temperatures fall below 36 degrees Fahrenheit, the wind is light, and there is sufficient moisture in the air. A freeze occurs when overnight temperatures reach at least 32 degrees Fahrenheit. A hard freeze occurs when the temperature falls below 28 degrees Fahrenheit for four hours or more. While most vegetation can survive a frost, very little vegetation can survive a hard freeze, and this is when the most damage to crops occurs. While cold fronts rarely bring snow or sleet to Florida, long lasting cold temperatures occur more often and can last for several days. Nighttime temperatures can drop below freezing for periods well in excess of 8 hours.

Nor'easter

A Nor'easter is a storm over the Atlantic coast, typically moving to the northeast, with northeasterly winds blowing from the ocean across the coast. According to the NWS, these storms can occur at any time of the year but are more common and stronger between September and April. These storms bring heavy rain, frozen precipitation, high winds, and rough surf, all of which may impact Florida. While Nor'easters do not typically bring winter weather, they have contributed to high winds, coastal erosion, and frozen precipitation in Florida.

Cold Illnesses

Frostbite is damage to skin and tissue caused by exposure to freezing temperatures, typically any temperature below 31F, and can occur in a matter of minutes when bare skin is exposed to extreme cold. Hypothermia occurs when the body loses the ability to regulate temperature. Both of these illnesses are very dangerous and can be life threatening if not treated immediately. Infants and elderly people are most at risk. When strong winds combine with cold temperatures, the heat loss from a person's skin can be accelerated. This is called the wind chill. The wind chill can make it feel like it is much colder outside than the actual temperature. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." During unexpected or prolonged cold periods in Florida, there are often issues with propane gas supplies, and electrical and natural gas systems are pushed to their limits to meet the record demands. Also, many residents of Florida have inadequate heating systems and turn to alternatives such as space heaters and wood fires that increase the likelihood of accidental house fires and deaths from carbon monoxide poisoning.[197]

Potential Effects of Climate Change on Winter Storms and Freezes

Climate change is not expected to increase occurrences or magnitude of winter storms and freezes in Florida. However, climate change does not mean that winter storms and freezes would not continue to

[197] http://www.nws.noaa.gov/om/winter/index/shtml

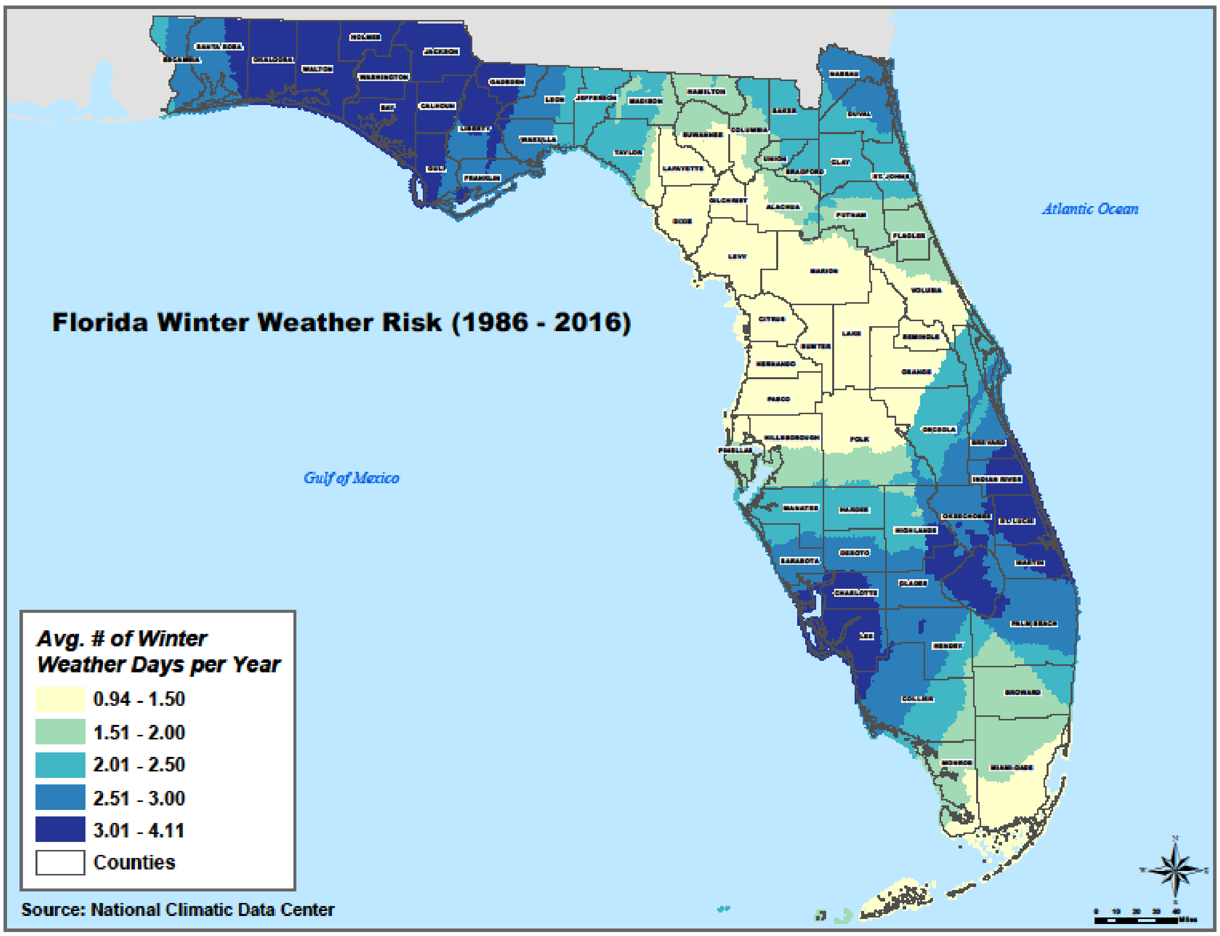
occur in Florida. Climate variability will continue to influence daily temperature variability, so isolated and prolonged winter storms and freeze events are not unlikely.[198]

Severe winter storms will not disappear. Specifically, isolated or prolonged winter freeze events in Florida will still occur.

2. Geographic Areas Affected by Winter Storm and Freeze

The northern portion of the state is affected by winter storm and freeze events more frequently than central and southern Florida. With that being said, central and southern Florida can still experience freeze events, and given the atmospheric nature of the hazard, the entirety of Hillsborough County has uniform exposure to winter storm and freeze events.

Figure 4.59: Winter Weather Risk, 1986–2016



According to this data, Hillsborough County is likely to receive less than 1 to 2 days of winter weather each year.

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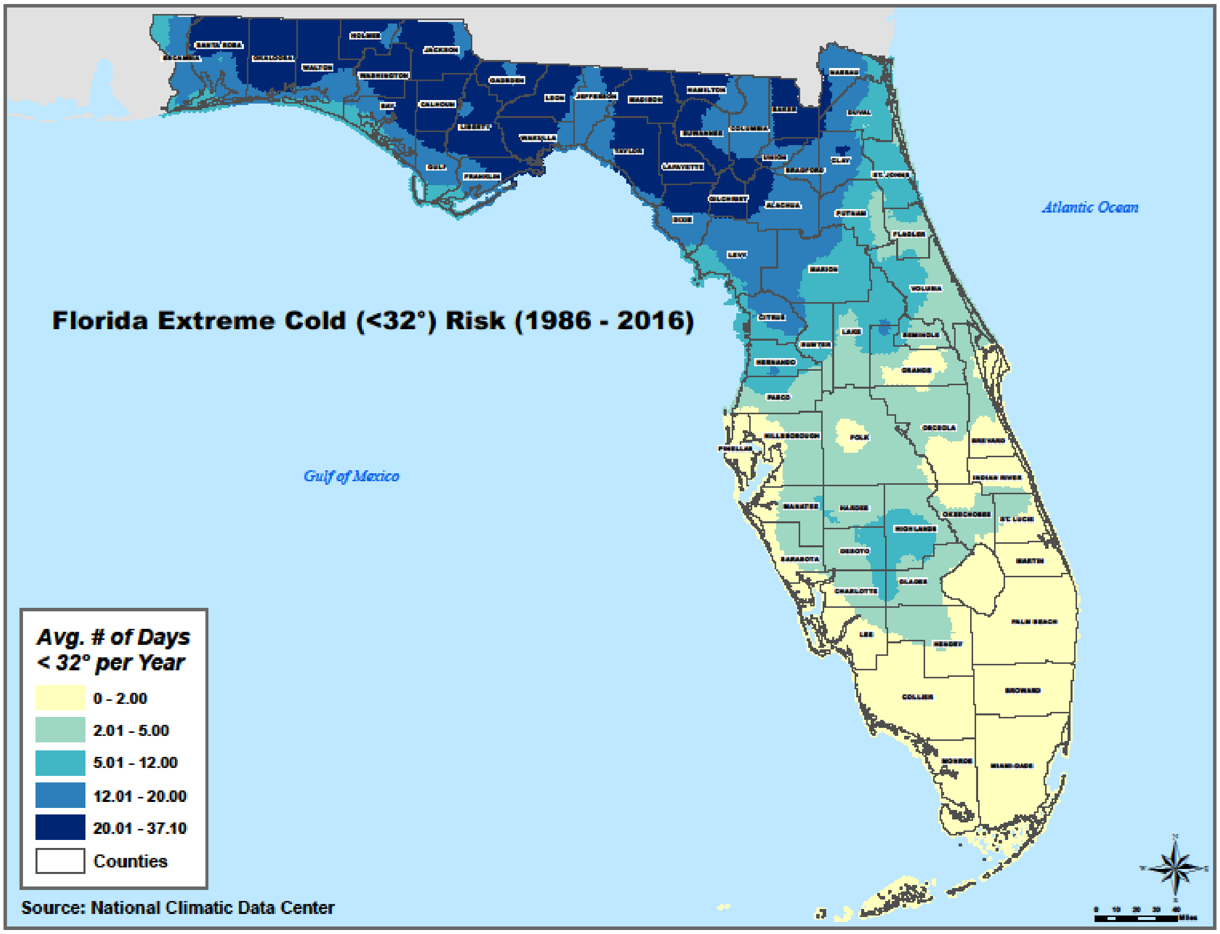
[198] *Ingram and Carter (2012). Southeast region technical report to the National Climate Assessment.* http://gyr.fortlauderdale.gov/home/showdocument?id=3153

Figure 4.60: Florida Extreme Cold (<32 degrees) Risk, 1986–2016



According to this data, Hillsborough County is likely to experience between 0 to 5 days of extreme cold, which is classified as less than 32 degrees, each year.

3. Historical Occurrences of Winter Storm and Freeze

Severe winter storms can affect the Tamp Bay area. Although Hillsborough County is not affected by snow, significant freezes have occurred. Winter storms may also be accompanied by other hazards such as coastal flooding, strong winds (tornadoes), wind-chill, and power outages. These effects can disrupt commerce and transportation and may result in the loss of life.

The table below lists the significant winter storm and freeze events that affected Hillsborough County.

Table 4.103: Significant Winter Weather and Freeze in Hillsborough County[199]

Date	Description
March 1993	The winter "No- Name" storm that affected Tampa Bay in March 1993 is considered one of the worst non-tropical storms in United States history.

[199] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Blizzard&eventType=%28Z%29+Cold%2FWind+Chill&eventType=%28Z%29+Extreme+Cold%2FWind+Chill&eventType=%28Z%29+Freezing+Fog&ev

Date	Description
	Equivalent to a Category 2 hurricane, it caused a significant amount of flooding and power outages within the Tampa Bay area and accounted for more than $2 billion of damage across the eastern United States.
2010	The record for the most days in which temperatures went below freezing was set in 2010. This period was also marked with an extreme amount of aquifer pumping, which was also considered to contribute to sinkholes that occurred during that same period.
January 18, 2018	A strong cold front moved southeast through the Florida Peninsula on the 17th, with strong cold air advection causing a hard freeze over large portions of the Nature Coast and west central Florida during the morning of the 18th. Another hard freeze occurred on the morning of the 19th as light winds and clear skies allowed for strong radiational cooling. The freeze caused unknown amounts of damage to citrus crops in Hernando, Pasco, Hillsborough, Polk, Manatee, Sarasota, Hardee, DeSoto, and Highlands Counties. There was also an unknown amount of damage to strawberry and crops in Hillsborough, Polk, Manatee, Sarasota, and Hardee County. In addition, the freeze also damaged landscaping across west central and southwest Florida. Temperatures dropped into the low to mid 20s across inland portions of Hillsborough County for several hours on the morning of the 18th, causing damage to citrus groves, strawberry crops, and landscaping. The coldest temperature reported was 22 degrees at the COOP site in Plant City.

Of the 20 FEMA-declared events in Hillsborough County from 1953 through 2019, there have been 5 events that involved severe winter weather. These events all related to freezing and to a large degree focused on the overall impact to the local economy. Below is a table of the major disaster declarations related to severe winter weather as designated by FEMA.

Table 4.104: FEMA Major Disaster Declarations in Hillsborough County, Winter Storm and Freeze, 1953–2019[200]

Disaster Number	Date	Name/Description
DR-526	January 31, 1977	SEVERE WINTER WEATHER – FREEZING
DR-732	March 18, 1985	SEVERE FREEZE
DR-851	December 23–25, 1989	SEVERE FREEZE
DR-982	March 12–16, 1993	TORNADOES, FLOODING, HIGH WINDS & TIDES, FREEZING
DR-1359	December 1, 2000–January 25, 2001	SEVERE FREEZE

entType=%28Z%29+Frost%2FFreeze&eventType=%28Z%29+Heavy+Snow&eventType=%28Z%29+Ice+Storm&eventType=%28Z%29+Sleet&eventType=%28Z%29+Winter+Storm&eventType=%28Z%29+Winter+Weather&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

[200] www.fema.gov/api/open/v1/DisasterDeclarationsSummaries.csv

According to the NCEI Storm Events Database, there was 1 report of winter storm and freeze in Hillsborough County from 2018 to 2019.[201] These winter storm and freeze events are only inclusive of those reported by NCEI from 1996 through October 2019, and events are only reported at the county level. It is likely that additional events have affected Hillsborough County. As additional local data becomes available, this hazard profile will be amended.

Table 4.105: Summary of Winter Storm and Freeze Occurrences in Hillsborough County

Location	Number of Occurrences	Deaths	Injuries	Crop Damage (2019)*	Annualized Crop Loss
HILLSBOROUGH COUNTY TOTAL	**1**	**0**	**0**	**$0**	**$0**

*Adjusted dollar values were calculated based on the Consumer Price Index for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. This data represents changes in the prices of all goods and services purchased for consumption by urban households. This monthly index value has been calculated every year since 1913. The 2019 dollar values were calculated based on buying power in April 2019.

Table 4.106: Historical Winter Storm and Freeze Occurrences in Hillsborough County

	Date	Type	Deaths	Injuries	Property Damage*	Crop Damage*
Hillsborough County						
INLAND HILLSBOROUGH (ZONE)	1/18/2018	Frost/Freeze	0	0	$0	$0

*Damage is reported in 2019 dollars. All damage may not have been reported.

4. Probability of Future Occurrences of Winter Storm and Freeze

Based on the historical evidence, it is anticipated that a freeze is possible in Hillsborough County. But there is no record of winter storm or winter weather events. In some years, no freezing temperatures occur, and snowfall is very rare.

Probability Based on Historical Occurrences

An analysis of winter storm and freeze reports from 1996 to 2019 in Hillsborough County from the NCEI Storm Events Database indicates that there will be no cold/extreme cold/wind chill or winter storm/winter weather events and less than one frost/freeze event each year in Hillsborough County.

[201] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Blizzard&eventType=%28Z%29+Cold%2FWind+Chill&eventType=%28Z%29+Extreme+Cold%2FWind+Chill&eventType=%28Z%29+Freezing+Fog&eventType=%28Z%29+Frost%2FFreeze&eventType=%28Z%29+Heavy+Snow&eventType=%28Z%29+Ice+Storm&eventType=%28Z%29+Sleet&eventType=%28Z%29+Winter+Storm&eventType=%28Z%29+Winter+Weather&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Table 4.107: NCEI Winter Storm and Freeze Reports 1996–2019[202]

Type of Severe Storm	NCEI Reports	Average per Year
Cold/Extreme Cold/Wind Chill	0	0
Frost/Freeze	1	< 1
Winter Storm/Winter Weather	0	0
TOTAL	**1**	**< 1**

Based on historical information, this hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Winter Storm and Freeze Impact Analysis

All jurisdictions could receive the following impacts due to winter storm and freeze.

- Public
  - Injury or death as well as possible property damage from car accidents because of ice on roads and bridges
  - Injury or death from exposure to cold weather, either because of being stranded outside or inside without proper heating systems
  - Deaths and injuries have resulted from accidents including automobile collisions due to poor driving conditions; emergency medical response can be severely hindered from the effects of a winter storm event; this is because Floridians are not accustomed to driving in winter weather conditions
- Responders
  - First responders are increasingly at risk as they respond to traffic incidents and calls for medical attention; they are vulnerable to the same transportation dangers as other citizens, but often have to go out in hazardous conditions when ordinary citizens would not
- Continuity of Operations (including continued delivery of services)
  - During a winter storm and the days that follow, many people do not travel due to the road conditions; the absenteeism of workers affects the overall continuity of operations of the government
- Property, Facilities, Infrastructure
  - Loss or damage of crops and agricultural revenue because of frost/freeze events
  - Roads and highways are most vulnerable to the effects of winter storms; roads frequently become iced over, resulting in accidents, injuries, deaths, and traffic congestion; roads

[202] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Blizzard&eventType=%28Z%29+Cold%2FWind+Chill&eventType=%28Z%29+Extreme+Cold%2FWind+Chill&eventType=%28Z%29+Freezing+Fog&eventType=%28Z%29+Frost%2FFreeze&eventType=%28Z%29+Heavy+Snow&eventType=%28Z%29+Ice+Storm&eventType=%28Z%29+Sleet&eventType=%28Z%29+Winter+Storm&eventType=%28Z%29+Winter+Weather&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

can be heavily damaged due to winter weather events; potholes and cracks can be found on roadways after a winter weather event, resulting in the need for repairs, causing further economic losses to the local area
  - Electrical transmission lines are highly vulnerable to severe winter weather; trees frequently fall due to the extra weight of ice accumulating on branches; trees falling on nearby power lines cause disruption of power service, which results in additional costs for repairs and maintenance
  - Other impacts resulting from winter storms include damage to plumbing, sewers, and waterlines as well as minor roof damage and house fires resulting from portable heaters
- Environment
  - Loss or damage to environment, including green spaces, habitats, and species because of cold weather, winter weather, and/or frost/freeze events
- Economic Condition
  - Loss or damage to crops because of freezes result in the loss of tens and sometimes hundreds of millions of dollars; this affects individual farmers and industries, such as the citrus industry in Florida
  - During a winter storm and the days that follow, many people do not travel due to the road conditions; the absenteeism of workers affects the economy
- Public Confidence in the Jurisdiction's Governance
  - A high number of motor vehicle accidents, school closures, power outages, or injuries and deaths may cause the public to believe that the government did not adequately prepare for the incident

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Historical Losses

The NCEI Storm Events Database information, presented in the Historical Occurrences section above, also contained property and crop damage dollar amounts, which is shown in the table below.

Table 4.108: Winter Storm and Freeze Events in Hillsborough County, by Type, (1996–2019)[203]

Type of Event	Number of Events	Deaths	Injuries	Property Damage (2019 dollars)	Crop Damage (2019 dollars)
Cold/Extreme Cold/Wind Chill	0	0	0	$0	$0
Frost/Freeze	1	0	0	$0	$0

[203] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Blizzard&eventType=%28Z%29+Cold%2FWind+Chill&eventType=%28Z%29+Extreme+Cold%2FWind+Chill&eventType=%28Z%29+Freezing+Fog&eventType=%28Z%29+Frost%2FFreeze&eventType=%28Z%29+Heavy+Snow&eventType=%28Z%29+Ice+Storm&eventType=%28Z%29+Sleet&eventType=%28Z%29+Winter+Storm&eventType=%28Z%29+Winter+Weather&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=10&endDate_dd=31&endDate_yyyy=2019&county=HILLSBOROUGH%3A57&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Type of Event	Number of Events	Deaths	Injuries	Property Damage (2019 dollars)	Crop Damage (2019 dollars)
Winter Storm/Winter Weather	0	0	0	$0	$0
TOTAL	**1**	**0**	**0**	**$0**	**$0**

The information can be analyzed to provide the average amount of property and crop damage that is likely each year. This information is shown in the chart below.

Table 4.109: NCEI Winter Storm and Freeze, 1996–2019

NCEI Storm Event (hazard)	Average Winter Storms and Freeze per Year	Annualized Property Loss (2019 dollars)	Annualized Crop Loss (2019 dollars)
All Types of Winter Storm and Freeze	< 1	$0	$0

According to the analysis, Hillsborough County is historically vulnerable to $0 in property damages and approximately $0 in crop damages from less than one frost or freeze event each year. Although no damages were reported by NCEI, significant freezes do have a significant impact to the agriculture industry in the county and agricultural losses have a direct impact on the local economy.

Exposure

Since winter storm and freeze is a hazard that does not have geographically definable boundaries, it was excluded from spatial analysis through GIS. However, because winter storms and freeze are considered atmospheric, they have the potential to affect all buildings and all populations in Hillsborough County.

Winter storms and freeze usually do not cause direct damage to structures in the county; however, extreme cold hazards include infrastructure damage to pipes, power lines, and roadways. And, although large-scale property damage is rare with these events, crop damage is much more likely and could significantly impact the local agriculture and livestock industry. Although Hillsborough County is not affected by snow, significant freezes have occurred with significant impact to the agricultural industry. A significant area of eastern Hillsborough County is agrarian including crops for strawberries and citrus. Portions of southern Hillsborough County contain tomato fields. All of these areas can be severely affected by just a few hours of below freezing temperatures.

The large agricultural businesses focusing on strawberry production would sustain one of the largest impacts primarily in east Hillsborough County. Plant City would be heavily impacted by the freezing temperatures leading to agricultural losses with direct impacts on the location economy. Strawberries represent 46.6% of the county's annual agricultural sales while vegetable production is second accounting for 18%. Significant impacts would also occur in fisheries located throughout East Hillsborough County including the Brandon, Riverview, and Gibsonton areas.

Winter storm and freeze can also have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages.

Furthermore, citizens may resort to using inappropriate heating devices that could lead to fire or an accumulation of toxic fumes. The population most vulnerable to winter storm and freeze is the elderly population, those medically dependent upon power, and the homeless population.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Winter storms and freeze can strike anywhere in Hillsborough County; therefore, all of the county's critical facilities are equally vulnerable and at risk. However, winter storms and freeze usually do not cause direct structural damage to critical facilities. Winter storm and freeze impacts to structures, including to critical facilities, are listed above under Exposure.

All of the critical facilities and their associated risk can be found in Appendix B.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be low, with a PRI score of 2.1.

WINTER STORM AND FREEZE					Overall Vulnerability
Overview					
Severe winter weather includes extreme cold, snowfall, ice storms, winter storms, and/or strong winds, and affects every state in the continental United States. Areas where such weather is uncommon, such as Florida, may experience a greater impact on transportation, agriculture, and people from relatively small events compared to other states that experience winter weather more frequently.					LOW
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Possible	Minor	Large	> 24 hrs	< 1 week	2.1

Seismic Event Hazard Profile

1. Seismic Event Description

A seismic event, or an earthquake, is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface that creates seismic waves. This shaking can cause buildings and bridges to collapse; disrupt gas, electric, and phone service; and sometimes trigger landslides and tsunamis or indirectly cause flash floods or fires.

Measures

Earthquakes are measured in two ways, by magnitude and by intensity. Magnitude is defined as one number, while intensity varies based on what is experienced in a specific location.

The magnitude is measured on the moment magnitude (Mw) scale and measures how much energy is released from a seismic event, such as the amount of rock movement and the area of the fault or fracture surface. The moment magnitude scale ranges from 0 to 10 and each increase in number is about 32 times greater than the previous number.

Table 4.110: Moment Magnitude Scale

Moment Magnitude Scale (Mw)	
10	
9	
	Great earthquake; near total destruction; massive loss of life
8	
	Major earthquake; severe economic impact; large loss of life
7	
	Strong earthquake; damage in the $ billions; loss of life
6	
	Moderate earthquake; Property damage
5	
	Light earthquake; some property damage
4	
	Minor earthquake; felt by humans
3	
2	
1	

The intensity of earthquakes is measured using the Modified Mercalli (MM) Intensity Scale, which attributes a number to the level of effects that people experience and the damages that are likely. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally total destruction. The scale is composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction and is designated by Roman numerals. It does not have a mathematical basis; instead, it is an arbitrary ranking based on observed effects.

The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude. Being far from the epicenter of an earthquake would mean people and structures experience a lower intensity, so the MM value would be lower. Whereas being close to the epicenter of an earthquake would have a higher MM value because people and structures would experience a higher intensity. Structural engineers usually contribute information for assigning intensity values of VIII or above. The Modified Mercalli Intensity Scale is shown below.

Table 4.111: Modified Mercalli Intensity Scale

Modified Mercalli Intensity Scale	
I.	Not felt except by a very few under especially favorable conditions.
II.	Felt only by a few persons at rest, especially on upper floors of buildings.
III.	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV.	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V.	Felt by nearly everyone, many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI.	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII.	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII.	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X.	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI.	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII.	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Potential Effect of Climate Change

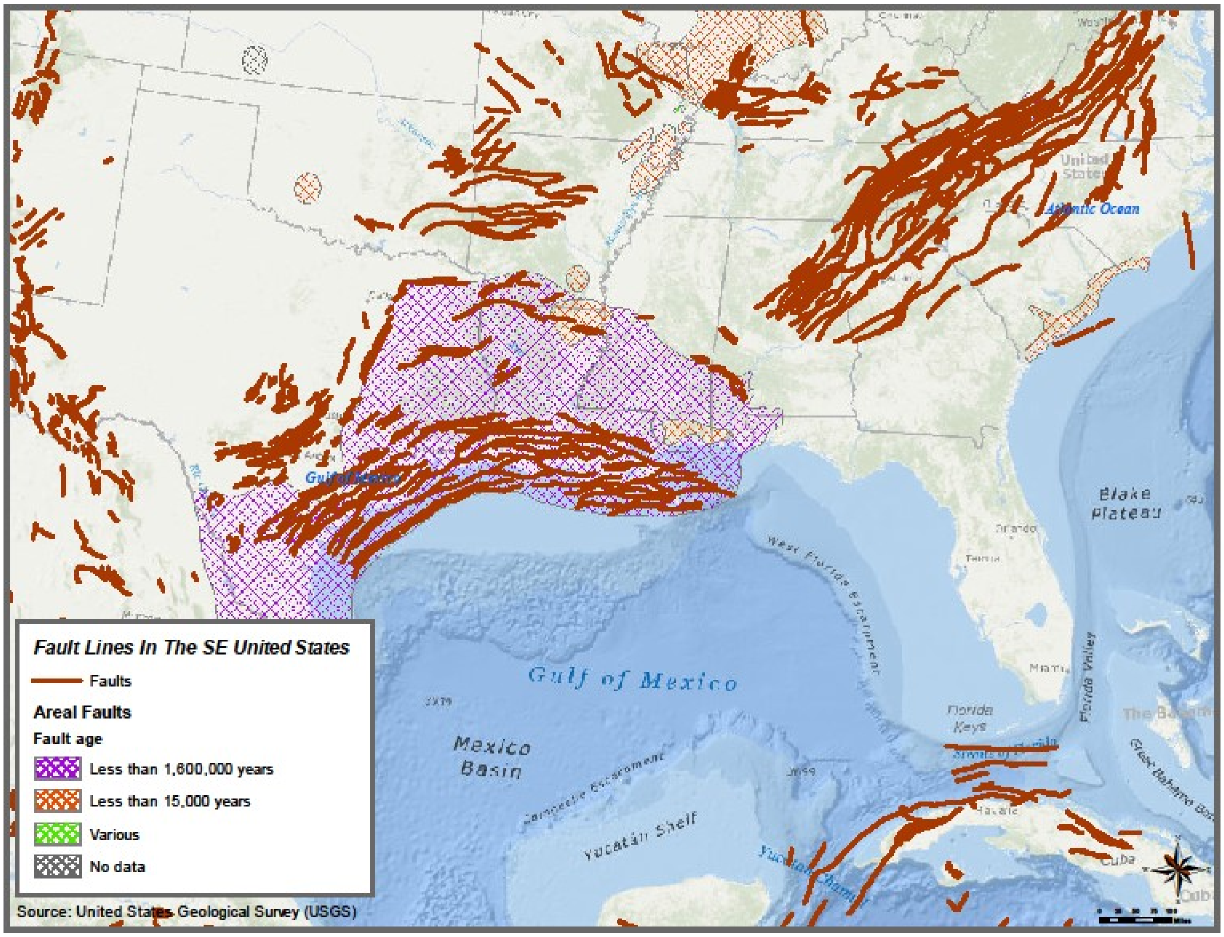
Climate change is not expected to affect the occurrence or magnitude of seismic events in Florida.

2. Geographic Areas Affected by Seismic Events

Seismic activity is rare in Florida and no earthquakes have had an epicenter in Florida. This is because there are no documented active faults in the State. Shaking felt in Florida comes from earthquakes either in the Gulf of Mexico, the Caribbean, or from the small fault line that is northeast of the State near Charleston, South Carolina.

Below is a map of fault lines in the southeast United States. The map shows that there are no known fault lines in Florida and that any seismic activity felt in Hillsborough County is likely from the faults to the north, west, or south.

Figure 4.61: Southeast United States Fault Lines



3. Historical Occurrences of Seismic Events

Earthquakes are very rare in Florida and there are no significant recorded incidents in the state. Additionally, many of the reports of earthquakes from before technological advancements have no proof and the original reports are lost.

Table 4.112: Florida Historical Occurrences, Seismic

Date	Description
August 31, 1886	Known as the “great earthquake,” a severe earthquake hit Charleston, South Carolina. It was so powerful that shaking was felt in St. Augustine and Tampa. There were also several aftershocks in the months after the quake that were felt in Florida.
January 5, 1945	Shaking was felt in Volusia County. Windows in a De Land courthouse shook violently.

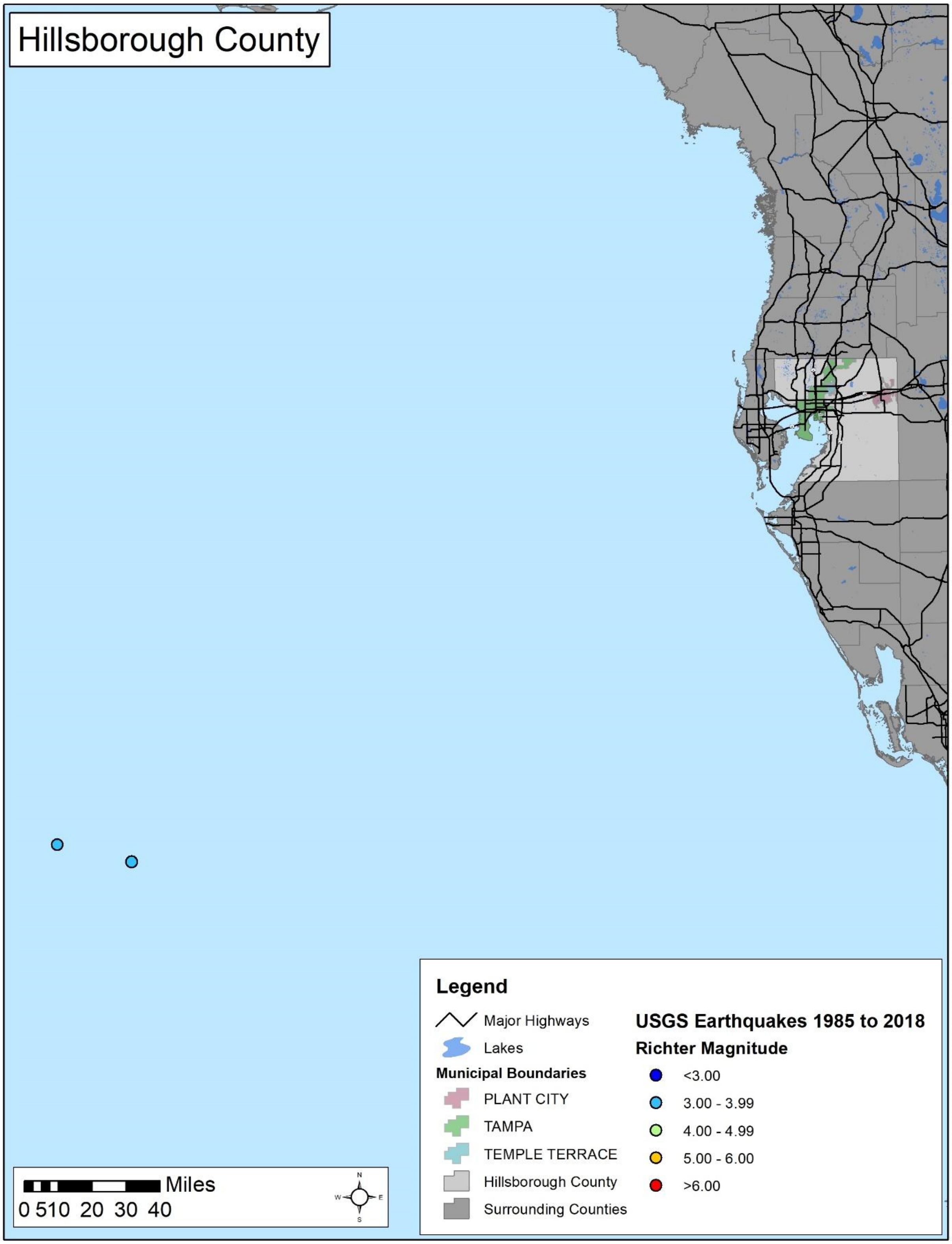
Date	Description
October 27, 1973	A shock was felt in Seminole, Volusia, Orange, and Brevard counties with a maximum intensity of MM V.
January 13, 1978	Two shocks were felt in Polk County, each lasting about 15 seconds and one minute apart. It rattled doors and windows, but there were no injuries or damages.
November 13, 1978	A shock was felt in northwest Florida. The seismic station estimated that it originated in the Atlantic Ocean.[204]
September 10, 2006	A strong quake was felt in Florida and other Gulf Coast states. USGS determined it was magnitude 6 quake originating in the Gulf of Mexico, 250 miles southwest of the Apalachicola area.[205]
July 16, 2016	Some felt small shakes in Florida and USGS rated it as a 3.7 magnitude. It was later discovered that the "quake" was actually an experimental explosion in the ocean by the U.S. Navy.[206]

Many reports of earthquakes felt in Florida are unsubstantiated and only known because of personal accounts of "tremblors." The 1886 Charleston, South Carolina earthquake was felt in Florida. There was a shock felt in 1978 and then no seismic activity in Florida until 2006 when a quake in the Gulf of Mexico was reportedly felt in Florida. Shaking in 2016 was thought to be a rare earthquake affecting Florida, but it was actually shaking felt from explosion tests by the U.S. Navy.

The map below shows earthquakes with epicenters that occurred near Hillsborough County between 1985 and 2018. No earthquakes occurred within the county boundaries during this period, but several did occur in the Gulf of Mexico.

[204] http://ufdc.ufl.edu/UF00001039/00001/13x
[205] http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/Forum/forum_oct2006.pdf
[206] https://earthquake.usgs.gov/earthquakes/eventpage/us20006f8n#executive

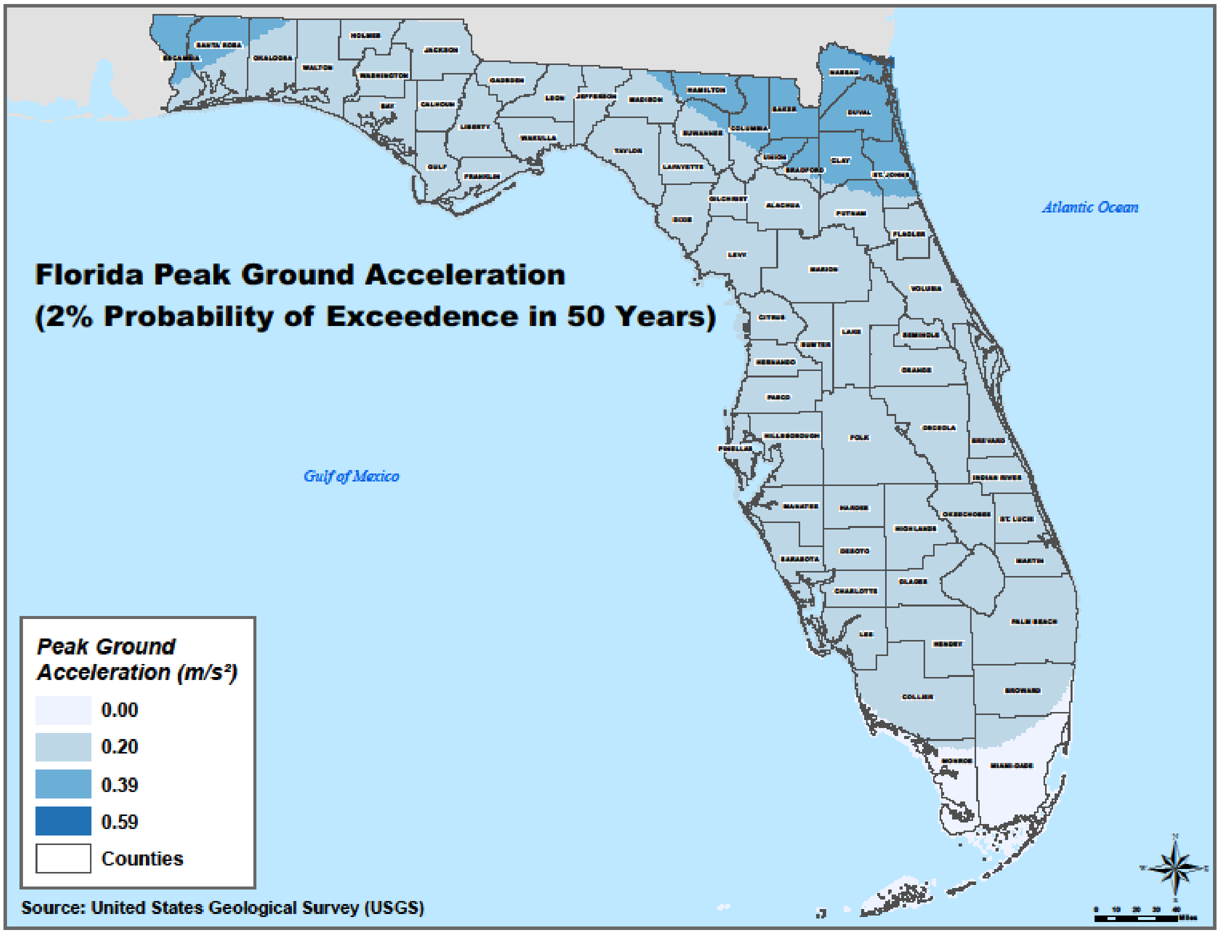
Figure 4.62: Historical Earthquake Epicenters, 1985–2018



4. Probability of Future Occurrences of Seismic Events

The probability is extremely low that a major earthquake will affect the state of Florida and cause significant damage. According to USGS, Florida is classified as a stable geological area, which means that damage from any shaking or tremors felt from an earthquake is expected to be minimal. The map below shows zones of peak ground acceleration as a percentage of gravitational acceleration. There is a two percent probability that the given acceleration range will be exceeded in a 50-year period. Peak ground acceleration refers to the maximum shaking that occurs at a specific location during an earthquake.

Figure 4.63: Florida Peak Ground Acceleration



Generally, a peak ground acceleration of 0.01 m/s^2 is felt by humans and a peak ground acceleration of 0.2 m/s^2 can cause people to lose their balance. As shown in the map above from USGS, most of the state, including Hillsborough County, would experience 0.20 m/s^2 peak ground acceleration in the event of an earthquake affecting Florida. To be clear, this does not mean that an earthquake that centered near Florida would be felt by all of Florida, but that shaking may be possible to feel.

Based on historical information, this hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Seismic Events Impact Analysis

All jurisdictions could receive the following impacts due to seismic events.

- Public
  - May feel slight shaking, but no injuries will result in shaking from an earthquake
- Responders
  - Unlikely to experience impacts
- Continuity of Operations (including continued delivery of services)
  - Unlikely to cause interruptions to operations
- Property, Facilities, Infrastructure
  - Some windows may be shattered from a large earthquake that sends shocks and shaking to Florida, but this is very unlikely
- Environment
  - Unlikely to impact the environment
- Economic Condition
  - Unlikely to impact the economy
- Public Confidence in Jurisdiction's Governance
  - Unlikely to impact the public confidence in the jurisdiction's governance

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

According to the peak ground acceleration map above, Hillsborough County has equally low vulnerability. But it is possible that the county may experience shaking during a future event centered near Florida.

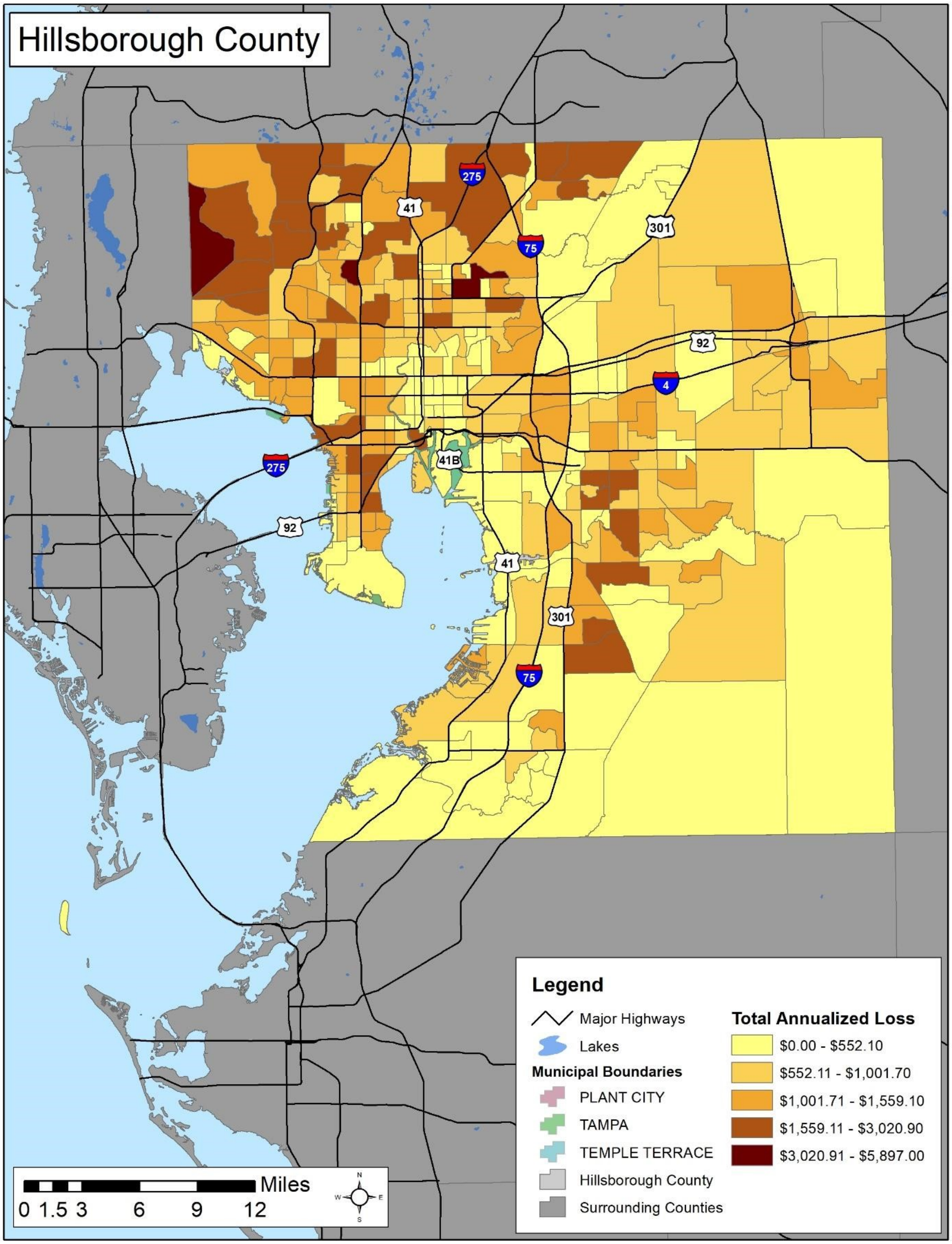
Hazus-MH

Hazus-MH was used to estimate the annualized loss for the county from a probabilistic earthquake scenario as shown below. Since the scenario is annualized, no building counts are provided. Losses reported include losses due to building damage (structural and non-structural), contents, inventory, relocation, capital, wages, and rental income.

Table 4.113: Estimated Annualized Loss for Probabilistic Earthquake Scenario

	Probabilistic Earthquake Scenario
Structural Damage	$74,000
Non-Structural Damage	$103,000
Contents Damage	$16,000
Inventory Loss	$0
Relocation Loss	$52,000
Capital Related Loss	$7,000
Wage Loss	$9,000
Rental Income Loss	$20,000
TOTAL LOSS	**282,000**

Figure 4.64: Seismic Annualized Losses



7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Similar to the jurisdiction vulnerability and loss estimates, critical facilities have a low vulnerability to seismic events and there are minimal to no losses expected.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be low, with a PRI score of 2.0.

<table>
<tr><th colspan="5">SEISMIC EVENTS</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">A seismic event, or an earthquake, is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface that creates seismic waves. This shaking can cause buildings and bridges to collapse; disrupt gas, electric, and phone service; and sometimes trigger landslides, and tsunamis or indirectly cause flash floods or fires.</td><td>LOW</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Possible</td><td>Minor</td><td>Moderate</td><td>< 6 hrs</td><td>< 6 hrs</td><td>2.0</td></tr>
</table>

Tsunami Hazard Profile

1. Tsunami Description

Tsunamis are among the most devastating of geologic disasters. Tsunamis are powerful waves created as a consequence of another non-meteorological hazard that is geologic in nature such as earthquakes, underwater landslides, volcanic eruptions, or other displacements of large amounts of water under the sea. As the waves travel towards land, they build up to higher heights as the depth of the ocean decreases and appear as walls of water or turbulent waves that resemble hurricane storm surge. The speed at which a tsunami travels depends on the ocean depth rather than the distance from the source of the wave. Deeper water generates greater speed, and the waves slow down when reaching shallow waters. Where the ocean is deep, tsunamis can travel at speeds up to 500 miles an hour. Tsunamis arrive on land with enormous force and recede with nearly equal force.

A tsunami is not a single wave but rather a series of waves often referred to as a “wave train.” There can be as many as 60 miles between peaks of each wave series, and waves can be as far as one hour apart.[207] Tsunamis have a much smaller amplitude (wave height) offshore and a very long wavelength (often hundreds of kilometers long), which is why they generally pass unnoticed at sea, forming only a passing "hump" in the ocean. The number of arrivals and the amplitudes of each wave will vary depending on the coastal properties, the exact travel direction, and other specifics of how the tsunami was generated. They will vary from place to place and event to event. In the largest tsunamis, surge can continue for many hours and more than a day.

Scientists cannot predict when and where the next tsunami will strike, but Tsunami Warning Centers know which earthquakes are likely to generate tsunamis and can issue messages when they think it is possible.

Tsunami Monitoring and Forecasting

There is often no advance warning of an approaching tsunami. However, since earthquakes are often a cause of tsunamis, an earthquake felt near a body of water may be considered an indication that a tsunami could shortly follow. The first part of a tsunami to reach land is a trough rather than a crest of the wave. The water along the shoreline may recede dramatically, exposing areas that are normally submerged. This can serve as an advance warning of the approaching crest of the tsunami although the warning only gives a very short time before the crest, which typically arrives seconds to minutes later.[208]

NOAA’s Pacific Marine Environmental Laboratory developed Deep-Ocean Assessment and Reporting of Tsunamis (DART) buoys to monitor tsunami systems in real time. These buoys are positioned at strategic locations throughout the ocean globally and play a critical role in tsunami forecasting. NOAA has two Tsunami Warning Centers:[209]

- The National Tsunami Warning Center in Palmer, Alaska, serves the continental United States, Alaska, Puerto Rico, Virgin Islands, and Canada

[207] http://news.nationalgeographic.com/news/2007/04/070402-tsunami.html
[208] http://www.tsunami.gov/?page=tsunamiFAQ
[209] http://www.tsunami.gov/?page=tsunamiFAQ

- The Pacific Tsunami Warning Center in Honolulu, Hawaii, directly serves the Hawaiian Islands and the U.S. Pacific territories and is the primary international forecast center for the warning systems of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization in the Pacific and the Caribbean and Adjacent Regions

NOAA's National Centers for Environmental Information (NCEI), formerly the National Geophysical Data Center (NGDC), is building high-resolution digital elevation models (DEMs) for select U.S. coastal regions. These combined bathymetric-topographic DEMs are used to support tsunami forecasting and modeling efforts at the NOAA Center for Tsunami Research, Pacific Marine Environmental Laboratory (PMEL). The DEMs are part of the Short-term Inundation Forecasting for Tsunamis (SIFT) system currently being developed by the PMEL for the NOAA tsunami warning centers and are used in the Method of Splitting Tsunami (MOST) model developed by the PMEL to simulate tsunami generation, propagation, and inundation.

Misnomers

Tsunamis are often referred to as tidal waves; however, oceanographers discourage this name because tides have little to do with these giant waves.[210]

There is another phenomenon often confused with tsunamis called rogue waves. There remains debate as to whether these waves are related to tsunamis. They are included in this section as the mitigation plans address the threat in the same relative manner. Rogue waves are unpredictable, and little is known about their formation, but they may be caused by regularly spaced ocean swells that are magnified by currents or the atmosphere.

Potential Effect of Climate Change

Climate change is not expected to affect the occurrence of tsunamis in Florida.

2. Geographic Areas Affected by Tsunami

Tsunami events occur most often in the Pacific Ocean, but they are a global phenomenon, and all are potentially dangerous though they may not damage every coastline they strike. Analyzing the past 150 years of tsunami records shows that the most frequent and destructive tsunamis to affect the United States have occurred along the coasts of California, Oregon, Washington, Alaska, and Hawaii.[211]

Overall, Florida has experienced few destructive tsunami or rogue wave events, but there were several small events.

There are two ways of identifying geographic locations that could be affected by a tsunami event. The first way is to consider the fact that there is scientific evidence that shows that there is the potential for a geological event, such as a massive landslide, to take place with Cumbre Vieja in the Canary Islands. If this event were to occur, a large-scale tsunami could affect the United States' eastern coastline, and it is expected that the eastern coastline of the state of Florida would suffer extensive damage and loss of life.

[210] http://oceanservice.noaa.gov/facts/tsunami.html
[211] http://nws.weather.gov/nthmp/documents/GoM-Final01regionalAssessment.pdf

Earthquakes are frequently the cause for tsunami events, and because there is no way of knowing exactly when and where future earthquake events might take place, it has been concluded that all geographic areas of Florida that border the Atlantic Ocean or Gulf of Mexico, including Hillsborough County, are at risk. However, sediment deposits in the Gulf of Mexico and Great Bahama Bank may lead to underwater landslide activity. The following vulnerabilities are organized by threat to the Atlantic Coast or Gulf Coast and Keys and list the potential causes of a tsunami that would put the state at risk:[212]

- Florida's Atlantic Coast
- Puerto Rico Trench
- Cumbre Vieja Volcano in Canary Islands
- Azores-Gibraltar Fracture Zone
- Florida's Gulf Coast and Keys
- Puerto Rico Trench (minor effect as wave wraps around islands)
- Large Meteorite into Gulf of Mexico

3. Historical Occurrences of Tsunami

There have been four reported tsunami events in the history of Florida. However, all four of these tsunamis occurred on the Atlantic Coast. Below are the causes of these tsunamis.[213]

- 1 was caused by an Atlantic Coast earthquake
- 1 was caused by a non-Atlantic earthquake
- 2 were caused by a Caribbean earthquake

While no known tsunamis have ever affected the Florida Gulf Coast, and Hillsborough County, a tsunami in that location is not impossible. Additionally, while tsunamis have historically affected the Caribbean many times, it is unlikely that those tsunamis will also affect Florida.

While it was not officially a "tsunami," there was a tsunami-like event on July 7, 1992 when a large "rogue wave" suddenly appeared along the coast in the Daytona area. The wave was reportedly about 10 feet above normal waves and stretched 27 miles long from Ormond Beach to New Smyrna Beach. There was 1 death, over 20 people injured, and damage to about 100 cars parked near the coastline. The best theory is that the wave was caused by winds from a storm front.[214]

4. Probability of Future Occurrences of Tsunami

Based on a historical analysis and the frequency of prior tsunami events from around the world, it can be concluded that the probability of future tsunami events affecting the state of Florida is low.

[212] http://www.rsmas.miami.edu/news-events/press-releases/2016/study-models-tsunami-risk-for-florida-and-cuba
[213] http://nws.weather.gov/nthmp/documents/Tsunami_Assessment_Final.pdf
[214] https://www.deseretnews.com/article/235629/ROGUE-WAVE-CRASHES-ASHORE-IN-FLORIDA.html

Since earthquakes cause most tsunamis and Florida is in a seismically stable region, there is a low probability that a tsunami will affect Florida. However, underwater landslides can also trigger tsunamis. Such landslides are unlikely but not impossible.[215]

Based on historical information, this hazard was determined to have a probability level of unlikely (less than 1% annual probability).

5. Tsunami Impact Analysis

The City of Tampa as well as the unincorporated county could suffer the impacts listed below due to tsunami. The cities of Temple Terrace and Plant City are inland and thus would be less likely to receive an impact.

- Public
  - There may be injury or death
- Responders
  - Rescue missions may be life threatening if buildings are not structurally stable or if rescuing from waters of unknown depth
- Continuity of Operations (including continued delivery of services)
  - If a structure were severely damaged or flooded, operations would be disrupted
- Property, Facilities, Infrastructure
  - If a major tsunami were to occur in Florida, many structures and critical infrastructure would be severely damaged from the force of the waters and from flooding effects
- Environment
  - The coast could be altered, including intra-coastal areas, beaches, mangroves, etc.
- Economic Condition
  - If a major tsunami were to occur in Florida, there would be many businesses damaged and forced to close, and employee absenteeism would also be a challenge
- Public Confidence in Jurisdiction's Governance
  - If a major tsunami were to occur in Florida and response and recovery efforts were not fast enough, the public may lose confidence in the jurisdiction's governance

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Exposure

Historically, large-scale tsunami events have not been a major threat to the state of Florida; however, that exposure has increased as more people move into areas of close proximity to the coast and more coastal development occurs.

Approximately 33% of the state's total population lives within 20 miles of the coast, and that number is increasing. The majority of the state's residents are not educated on the warning signs or effects of a tsunami and would be put at a higher risk of exposure should a large-scale event occur.

[215] http://dep.state.fl.us/geology/geologictopics/hazards/tsunamis.htm

Further analysis could not be conducted because, as explained above, tsunami data for Florida is not available because NOAA has not yet completed the models.

7. Vulnerability Analysis and Loss Estimation on Critical Facilities

As explained above, tsunami data for Florida is not available because NOAA has not yet completed the models. As such, the vulnerability of critical facilities could not be analyzed. However, it is possible that critical facilities located near the coast could potentially be impacted by a tsunami.

All of the critical facilities and their associated risk can be found in Appendix B.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be low, with a PRI score of 1.8.

TSUNAMI					Overall Vulnerability
Overview					
Tsunamis are powerful waves created as a consequence of another non-meteorological, geologic in nature, hazard such as earthquakes, underwater landslides, volcanic eruptions, or other displacements of large amounts of water under the sea. As the waves travel towards land, they build up to higher heights as the depth of the ocean decreases and appear as walls of water or turbulent waves that resemble hurricane storm surge.					LOW
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Unlikely	Limited	Small	< 6 hrs	< 6 hrs	1.8

Transportation Incident Hazard Profile

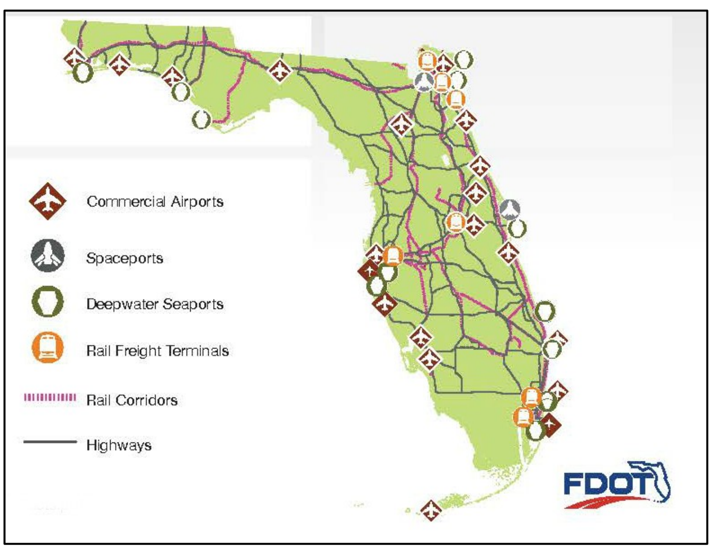
1. Transportation Incident Description

Transportation systems are designed to move people, goods, and services efficiently, economically, and safely from one point to another. As the movement of people, goods, and services increases due to population growth and technological innovation, the need to plan for events becomes increasingly important. As one of the critical infrastructure sectors, the Department of Homeland Security (DHS) categorizes the transportation sector into the following seven modes:[1]

- Aviation
- Highway and Motor Carrier
- Maritime
- Mass Transit and Passenger Rail
- Pipeline Systems
- Freight Rail
- Postal and Shipping

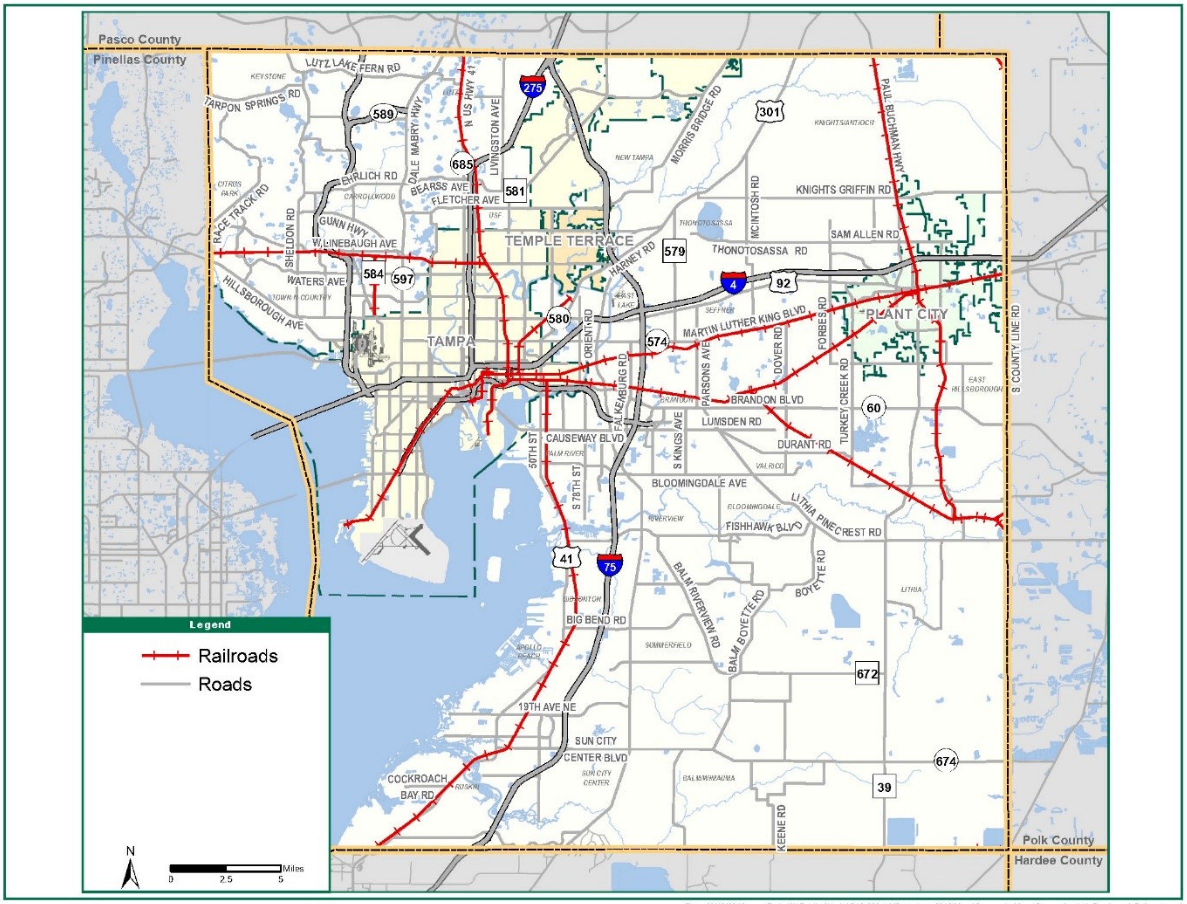
Florida has a large transportation network that consists of airports, major highways, passenger railroads, marine ports, and pipelines. These transportation systems provide lifeline services for communities and are vitally important for response and recovery operations. The vast network of public and private critical infrastructure owners and operators, the infrastructure and services they manage, and the extensive interdependencies among the transportation modes and other sectors indicate the need for coordinated planning to manage all hazards efficiently and effectively.

Figure 4.65: Florida Department of Transportation Network



[1] https://www.dhs.gov/sites/default/files/publications/nipp-ssp-transportation-systems-2015-508.pdf

Figure 4.66: Hillsborough County Transportation Routes



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The identification of critical transportation infrastructure requires consideration of federal, state, regional, and local jurisdictions; their interests; and a variety of hazards. At the national level, critical infrastructure in each of the four subsectors—aviation, maritime, surface, and postal and shipping—contribute to national security, economic stability, and public health and safety. At the regional, state, and local levels, the necessity of infrastructure is primarily determined by the business, lifestyle, and emergency needs of the community.

Risks to critical transportation infrastructure include natural disasters as well as man-made physical and cyber threats. Man-made threats include terrorism, vandalism, theft, technological failures, and accidents. Cyber threats to the sector are of concern because of the growing reliance on cyber-based control, navigation, tracking, positioning, and communications systems as well as the ease with which actors can exploit cyber systems serving transportation. While engineered hazards such as road curve geometry can be addressed through design, hazards such as terrorist attacks and extreme weather can be difficult to predict and mitigate.

Terrorism

Terrorist attacks, whether physical or cyber, can significantly disrupt vital transportation services and cause long-term sociological and economic consequences. The risk of a terrorist attack on transportation infrastructure is typically assessed using attack scenarios to evaluate the threats, vulnerabilities, and consequences. Transport vehicles are abundant, moving virtually unnoticed within industrial locations and major population centers, across borders, and in the case of mail and express package services, to nearly every household, business, and government office in the country. As seen on September 11, 2001, modes of transportation, such as airplanes, can be used as the weapons themselves. The very nature of the transportation enterprise is to be open, efficient, and accessible which can make it a target for terrorist attacks. For more on terrorism please see the *Terrorism Hazard Profile*.

Natural Disasters and Extreme Weather

Global transportation infrastructure today is confronted with significant vulnerabilities, including the evolving threats of our changing climate. Natural disaster risks to Hillsborough County transportation systems include wildfires, flooding, severe storms, tropical cyclones, and drought, all of which have the potential for widespread disruption of transportation services. Risks from natural disasters have a varying regional or local relevance because of prevailing weather patterns, geological trends, topographical features, and population density.

Heavy rainfall events can disrupt transportation services and damage infrastructure and facilities. During or following periods of heavy rainfall, inundation and washouts can block transportation routes, damage facilities, and interrupt power supplies. Tropical cyclones can damage critical infrastructure such as roads and bridges causing delays in critical response, services, and the ability to move throughout the state. Tornados have similar effects while also creating dangerous situations with people on the roads.

Fog

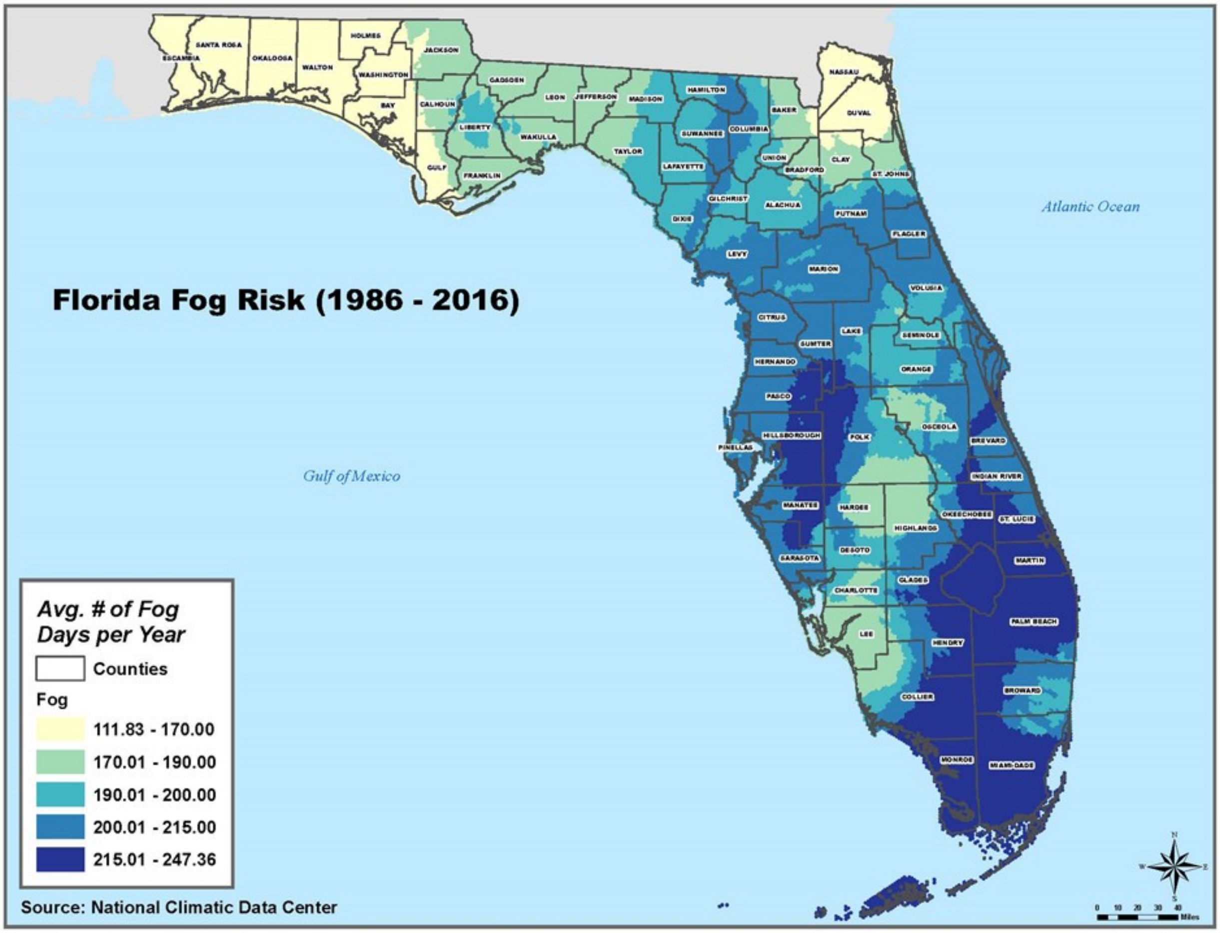
Fog is a cloud form at the surface of the earth made of tiny water droplets suspended in the air. The greatest problem with fog is visibility. Heavy fog is defined as visibility below one quarter of a mile. A Dense Fog Advisory means that dense fog has reduced visibility to 1/4 mile or less within the advisory area. These conditions make travel difficult.[2]

A Freezing Fog Advisory is when fog develops and surface temperatures are at or below freezing. The tiny liquid droplets in the fog can freeze instantly to any surface, including vehicles and road surfaces. Freezing fog makes driving, boating, flying, and other forms of transportation particularly hazardous. Visibilities are typically at or below one mile.

Fog, particularly when dense, can be hazardous to drivers, mariners, and aviators, contributing to numerous travel accidents every year. Restrictions in visibility resulting from fog can also impact takeoff and landing procedures and requirements for pilots and can be the cause of weather-related aviation delays.

[2] http://www.nws.noaa.gov/om/fog/ww.shtml

Figure 4.67: Florida Fog Risk, 1986–2016



<u>Aging Infrastructure</u>

The condition of Florida's transportation infrastructure is also a concern because of the advanced age and deterioration of many structures throughout the state's transportation network. Aging infrastructure threatens the resilience of these systems and can multiply risks from other factors such as man-made or natural disasters. The impact of a loss of a key asset, such as a bridge, poses an immediate threat and can have cascading impacts to passenger and freight movement as well as potentially large-scale impacts such as supply chain disruption.[3]

More than half of America's natural gas transmission pipelines were installed before 1970; the same holds true for pipelines that carry hazardous liquids such as gasoline, diesel, and jet fuel. Pipelines are just a fraction of the nation's vast network of transportation infrastructure — the roads, cables, wires, conduits, drains, satellites, and switches that enable the flow of everything from sewage to gas. The pipelines within Florida are owned by numerous private companies and have differing levels of condition, making the system vulnerable to accidents and failure. Meanwhile, the government-owned infrastructure — roads,

[3] http://knowledge.wharton.upenn.edu/article/americas-aging-infrastructure-what-to-fix-and-who-will-pay/

bridges, and mass transit — is under severe financial strain because maintenance costs have increased. Rail is predominantly, privately owned by the company CSX.

Cyber

Cyber-based technologies in transportation operations enable greater economies and efficiencies, improve customer service, enhance operational controls, and provide better security capabilities. Consequently, transportation companies are increasingly dependent on cyber systems for business, security, and operational functions. Cyber technologies upon which transportation services rely include positioning, navigation, tracking, shipment routing, industrial system controls, access controls, signaling, communications, and data and business management. These technologies are often interconnected through networks and remote access terminals, which may allow malicious actors easier access to key areas. For more information, please see the *Cyberterrorism Hazard Profile*.

Types of Transportation

The Florida Department of Transportation (FDOT) is the lead agency in committing to a safe transportation system that ensures the mobility of people and goods, enhances economic prosperity, and preserves the quality of the environment and communities. FDOT has implemented the Strategic Intermodal System (SIS), the state's highest priority for transportation investments. SIS also has a focus for implementing the Florida Transportation Plan (FTP) which is the state's long-term transportation vision and policy. SIS is a transportation system that:[4]

- is made up of facilities and services of statewide and interregional significance;
- contains all forms of transportation for moving both people and goods, including linkages that provide for smooth and efficient transfers between modes and major facilities; and
- integrates individual facilities, services, modes of transportation, and linkages into a single, integrated transportation network.

The system was established to efficiently serve the mobility needs of Florida citizens, businesses, and visitors and to help Florida become a worldwide economic leader, enhance economic prosperity and competitiveness, enrich quality of life, and reflect responsible environmental stewardship.

SIS is a network of high-priority transportation facilities including the state's largest and most significant commercial service airports, spaceports, deep-water seaports, freight rail terminals, passenger rail and intercity bus terminals, rail corridors, waterways, and highways. These state facilities carry more than 99% of all commercial air passengers and cargo, virtually all waterborne freight and cruise passengers, almost all rail freight, 89% of all interregional rail and bus passengers, 55% of total traffic, and more than 70% of all truck traffic on the state highway system.[5]

Aviation

Florida has long been the world's premier gateway to space, the air traffic hub of the Americas, a major hub for flight training, and home to leading manufacturers of all types of aircraft and aircraft components.

[4] http://www.fdot.gov/info/moredot/mvv.shtm
[5] http://www.fdot.gov/planning/sis/about.shtm

Florida is fortunate to be served by one of the most comprehensive and progressive airport systems in the country. Florida's aviation sector drives a large portion of the state's economy. In 2010, aviation made up more than 8.5% of Florida's Gross State Product (GSP). One of the largest drivers of the state's economy is international trade, with air cargo accounting for more than one third of Florida's international trade dollars. The second largest is tourism and over half of all visitors to the state arrive by air.

Florida has 21 commercial airports throughout the state, 107 general aviation airports and 12 military airfields. In 2015, 161 million airline passengers flew through Florida airports.[6] FDOT and the Federal Aviation Administration (FAA) coordinate efforts to ensure safe air travel and mitigate against potential hazards. In 2005, FDOT in cooperation with the FAA and Florida's Public Airports developed the Florida Aviation System Plan (FASP). They focused the plan on traditional aviation system planning elements, but also included an analysis of the intermodal aspects of the state transportation system. The FASP also includes a strategic planning element, identifying seven strategic goals considered essential.[7]

Air transportation hazards can include crashes and issues with the airplanes themselves but can also include potential hazards at the airport or within the surrounding areas. Causes and contributors to airplane accidents could include faulty parts and defects, operational or pilot error, system malfunctions, and outside forces such as extreme weather. Airports and the surrounding areas could also potentially cause additional hazards. One such hazard is bird strikes, and while unlikely to cause a crash, birds can cause flight delays and emergency landings.[8] Terrorist attacks could be targeted at major airports or involve the use of airplanes as a weapon. Degraded runways and equipment also pose a significant threat to the aviation infrastructure.[9]

Airplane crashes could lead to cascading hazards as a crash could lead to wildfires, dam or levee damage leading to flooding, roadway blockage and damage, and utility damage from downed power lines leading to outages and potential accidents. Air transportation hazards could also lead to damage or destruction of goods and freight and loss of life.[10]

Florida is also a premier aerospace and space location and is a top state for aerospace manufacturing. The industry companies excel in areas from aircraft parts and assembly, to intelligence, surveillance and reconnaissance, and missiles. Florida also offers tremendous space launch assets. Florida has 2 spaceports and conducted 17 spaceport launches in 2015.[11]

Highway and Motor Carrier

This mode of transportation includes highways, roadways, bridges, trucks, commercial freight vehicles, motor coaches, and school buses.[12] Florida has 122,659 miles of highway, over 273,000 miles of total public roadways, 12,262 bridges, and over 30 public transit systems. In fiscal year 2015, 207 billion automobile miles were traveled within the state. This includes private vehicles, passenger transportation,

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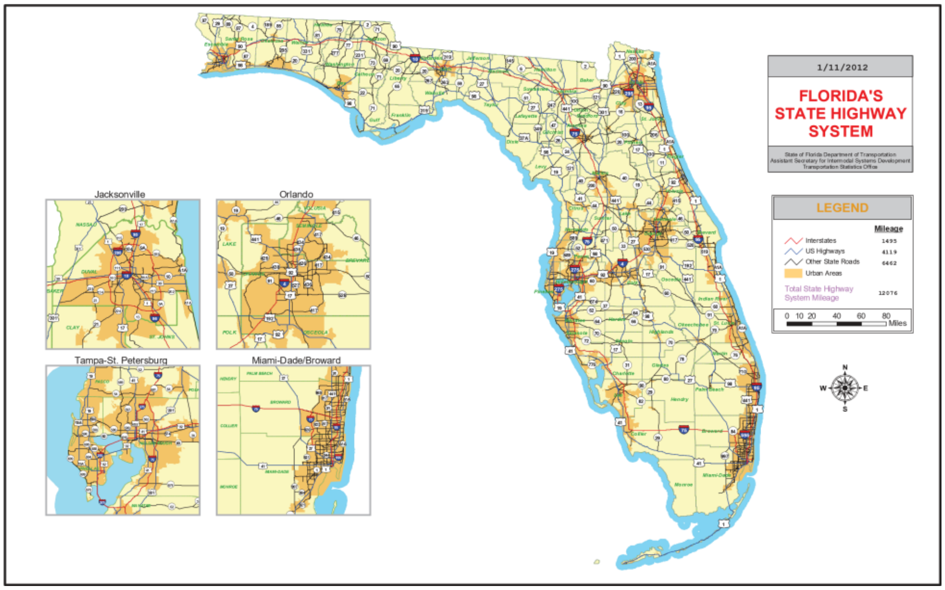
[6] https://www.faa.gov/
[7] http://www.fdot.gov/planning/fastfacts.pdf
[8] http://www.bne.com.au
[9] http://www.fdot.gov/aviation/planning.shtm
[10] http://www.fdot.gov/aviation/pdfs/Welcome%20to%20Fl%20Aviation112010.pdf
[11] https://www.nasa.gov/
[12] http://www.floridatransportationindicators.org/index.php?chart=13d

freight, and hazardous materials transportation. The public transit system had 271 million passengers in 2014.[13] Consequently, today's roadways are dangerously overcrowded, turning the focus to identifying serious roadway hazards.

Figure 4.68: Florida State Highway System



Accidents are the highest risk on roadways, and according to the Florida Department of Highway Safety and Motor Vehicles, there were 374,342 accidents with 2,939 fatalities in 2015.[14] Accidents involving freight could lead to loss of revenue for businesses and wages for drivers as well as affect the consumers waiting on the cargo being transported. Hazardous materials are routinely transported along Hillsborough's road system and can affect the environment and surrounding population in the event of a spill. For more information regarding the transportation of hazardous materials, please see the *HazMat Incident Hazard Profile*. Florida's 12,262 bridges within the state can malfunction or be degraded to the point of structural instability, causing not only roadway hazards but waterway hazards as well.[15]

Good, efficient roads make commuting feasible; however, aging roads can lead to hazards and accidents. The Federal Highway Administration's most recent survey points out that almost 20% of U.S. roads are in poor condition. This includes roads and bridges that need to be repaved, are crumbling, or have significant damage.[16]

[13] http://www.fdot.gov/planning/fastfacts.pdf
[14] https://flhsmv.gov/pdf/crashreports/crash_facts_2015.pdf
[15] http://www.smartmotorist.com/traffic-and-safety-guideline/roadway-hazards.html
[16] https://www.fhwa.dot.gov/

Maritime

Florida has a total water area of 4,308 square miles with more than 11,000 miles of rivers, streams and waterways.[17] The state has 1,197 statute miles of coastline and 2,276 statute miles of tidal shorelines. This includes 825 miles of beaches. The map below shows Florida's waterways.[18]

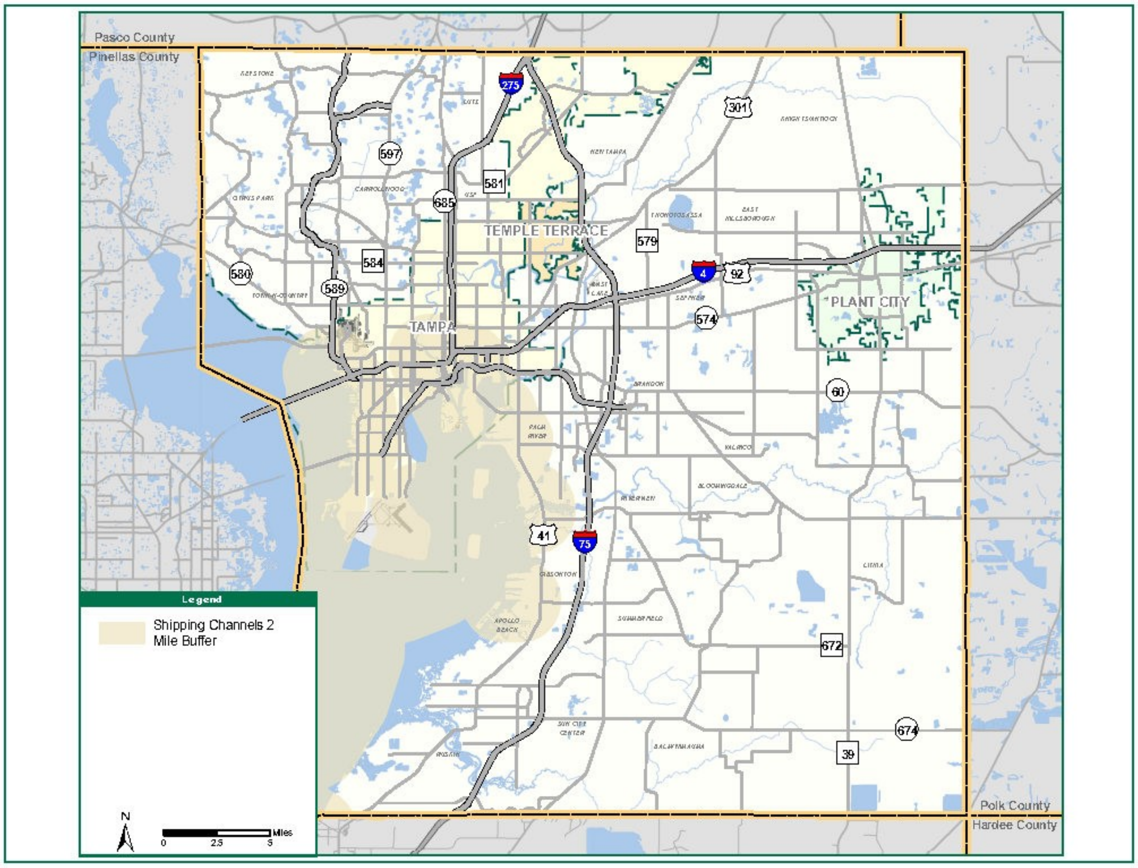
Figure 4.69: Florida Waterways

There are 15 seaports within the state that accommodate cruise lines, military ships, passenger and private vessels, and freight vessels.[19] Florida's 15 public seaports play a critical role in the lives of citizens and continue to drive Florida's economy. From what we wear to what we eat, from building materials to automobiles, almost everything we use in our daily lives flows through Florida ports. In 2015, 15.2 million cruise passengers made port in Florida and many more made port on private vessels. Currently, Florida seaports generate nearly 900,000 direct and indirect jobs and contribute $117.6 billion in economic value to the state through cargo and cruise activities. Florida maritime activities account for approximately 13% of Florida's GDP while contributing $4.2 billion in state and local taxes.

The Maritime Administration (MARAD) is the agency within the U.S. Department of Transportation regarding waterborne transportation. Its programs promote the use of waterborne transportation and its seamless integration with other segments of the transportation system, and the viability of the U.S. merchant marine. MARAD works in many areas involving ships and shipping, shipbuilding, port operations, vessel operations, national security, environment, and safety. [20]

[17] http://geology.com/lakes-rivers-water/florida.shtml
[18] http://www.stateofflorida.com/facts.aspx
[19] http://flaports.org/about/the-florida-system-of-seaports/
[20] https://www.marad.dot.gov/

Figure 4.65: Maritime Shipping Buffers



FDOT and The Maritime Administration (MARAD), along with Customs and Border Patrol (CBP),[21] monitor the maritime transportation system in Florida, including waterborne transportation, landside infrastructure, the shipbuilding and repair industry, and labor. They integrate the economy with a vast network of systems that moves large quantities of consumer goods, people, agricultural products, energy, and raw materials.

The United States Coast Guard (USCG) and CBP work together to ensure secure borders. U.S. Customs and Border Protection as part of their comprehensive effort to improve security at the nation's borders while enhancing legitimate travel, including private boaters, established the Local Boater Option (LBO). This means boaters can register with CPB, and then phone-in entry into the U.S. from a foreign country, instead of reporting in person. This reduces the number of undocumented individuals coming to Florida shores and works to reduce drug smuggling operations into the state. On an average day the USCG conducts search and rescue operations, saves lives and property in peril, conducts waterborne patrols of critical

[21] https://www.cbp.gov/

maritime infrastructure, seizes drugs, conducts security boarding in and around Florida ports, and interdicts undocumented migrants.[22]

Florida Fish and Wildlife Conservation Commission (FWC) oversees and coordinates statewide regulatory waterway markers to ensure compliance with the uniform marking system and to improve compliance of state boating and resource protection zones for the long-term well-being and benefit of all waterway users and the fish and wildlife resources. FWC regulates licenses and permits related to boating and fishing and manages waterways within the state.[23]

Mass Transit and Passenger Rail

Mass transit and passenger rail includes terminals, operational systems, and supporting infrastructure for passenger services by transit buses, trolleybuses, monorail, heavy rail—also known as subways or metros—light rail, passenger rail, and vanpool or rideshare.[24] Florida has a complex public transportation network with over 270 million public transit riders within the state annually.[25] Public transportation in Florida is a crucial part of the solution to the state's economic, energy, and environmental challenges – helping to bring a better quality of life and economic prosperity. In increasing numbers, people are using public transportation, and local communities are expanding public transit services. The Florida Public Transportation Association (FPTA) is one of the most active state transit associations in the nation. FPTA is a nonprofit association whose members include every major public transit agency in Florida as well as interested citizens and businesses.[26]

Florida has 2,908 main rail corridor miles, owned by 15 operating railroads and terminal or switching companies, as well as 81 miles owned by the State of Florida. The largest operator in the state is CSX Transportation, which owns more than 53% of the statewide track mileage.[27]

On average there is a train collision or derailment every two hours and a hazardous materials transportation incident every two weeks throughout the country. The Federal Railroad Administration (FRA) was created by the Department of Transportation Act of 1966 and is one of ten agencies within the U.S. Department of Transportation concerned with intermodal transportation. The FRA's mission is to enable the safe, reliable, and efficient movement of people and goods, now and in the future.[28]

Railroad hazards could include train collisions, derailments, accidents involving cars or pedestrians, rail worker accidents, and hazardous materials spills. Natural hazards also cause issues for railways including freezing tracks and malfunction with train car operations such as brakes. Dense fog could cause visual obstructions, animals on the tracks could lead to derailments, and all accidents can lead to the damage or destruction of freight, property, and loss of life. These accidents could also be caused by equipment failure, operator error, signal failure, and track damage or failure.[29]

[22] http://www.uscg.mil
[23] http://myfwc.com/
[24] https://www.dhs.gov/transportation-systems-sector
[25] http://www.fdot.gov/planning/fastfacts.pdf
[26] https://floridatransit.org/about-us
[27] https://www.fra.dot.gov/Page/P0002
[28] https://www.aar.org/data-center/railroads-states#state/FL
[29] http://www.fdot.gov/rail/PlanDevel/Documents/FinalInvestmentElement/G-Chapter2-FreightRail.pdf

Florida also has an extensive bus system with over 60,000 registered buses throughout the state.[30] Public transportation provides access to job opportunities for Floridian's as well as a transportation option to get to work, school, visit friends, or go to a doctor's office. Public transportation saves America about 4.2 billion gallons of gasoline each year. According to FPTA, Florida currently ranks third among all states in total gasoline consumption. The 4.2 billion gallons of gasoline saved by the transit industry represents Florida's entire gasoline consumption for about seven months.

Pipeline Systems

Energy pipelines are a fundamentally safe and efficient means of transporting materials key to the U.S. energy supply but, given that they often carry toxic, volatile, or flammable material, energy pipelines have the potential to cause injury and environmental damage.[31] There are a total of 34,019 miles of pipeline within Florida:[32]

- 552 miles Intrastate Natural Gas Transmission
- 4,510 miles Interstate Natural Gas Transmission
- 203 miles Propane
- 80 miles Liquid Hazardous Materials
- 43 miles Oil
- 36 miles Refined Petroleum Products
- 28,567 miles Natural Gas Distribution Systems

FDOT and the Pipeline and Hazardous Materials Safety Administration (PHMSA) work together to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to citizens' daily lives. To do this, PHMSA establishes national policy, sets and enforces standards, educates, and conducts research to prevent incidents. PHMSA also prepares the public and first responders to reduce consequences if an incident does occur.[33]

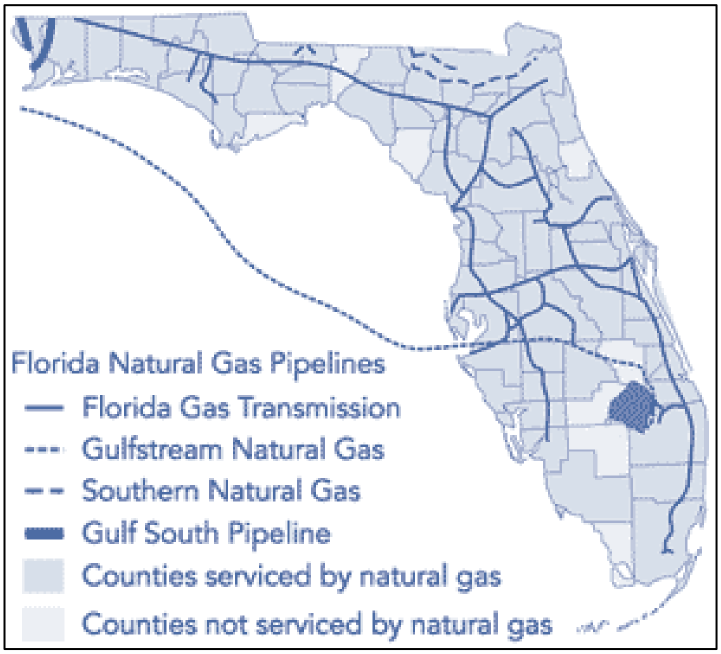
Increased urbanization is resulting in more people living and working closer to existing transmission pipelines. Growth in population, urbanization, and land development near transmission pipelines, together with the addition of new facilities to meet demands, may increase the likelihood of pipeline damage due to human activity and the exposure of people and property to pipeline failures. Compounding the potential risk is the age and gradual deterioration of the transmission pipeline system due to natural causes.[34]

Causes and contributors to pipeline failures include construction errors, material defects, internal and external corrosion, pressure buildups, operational errors, control system malfunctions, and outside force damage. Natural hazards such as sinkholes or land subsidence, earthquake or seismic activity, and flooding can all put pressure on existing pipelines resulting in bursts, spills, or leaks of natural gas, oil, and

[30] https://www.statista.com/statistics/196342/total-number-of-registered-buses-in-the-united-states-by-state/
[31] http://hazardmitigation.calema.ca.gov/plan/state_multi-hazard_mitigation_plan_shmp
[32] http://www.fdot.gov/planning/fastfacts.pdf
[33] https://www.phmsa.dot.gov/about/mission
[34] https://s3images.americangeosciences.org/agi/statefactsheets/FL_GeoscienceInYourState_AGI.pdf

hazardous substances. For more information on pipelines, also see the *HazMat Incident Hazard Profile*. The map below shows the major pipelines and the companies that own them.

Figure 4.65: Florida Natural Gas Pipelines

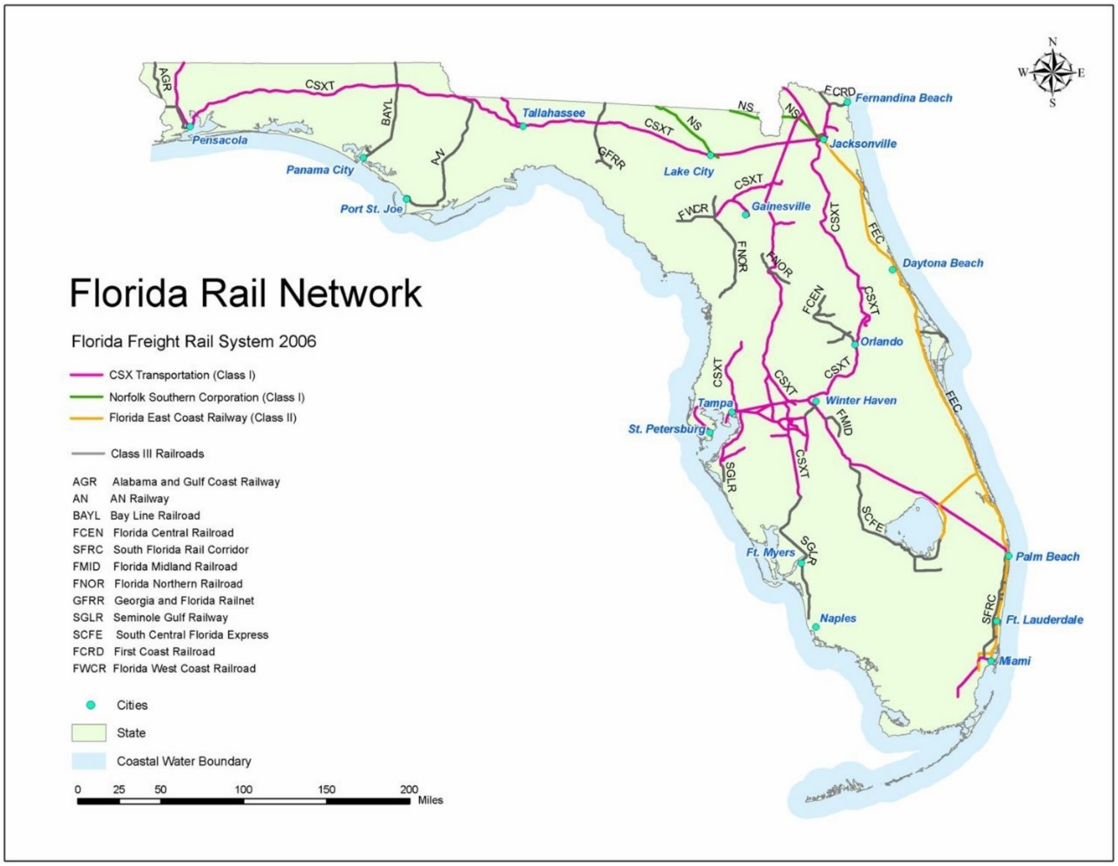


Freight Rail

Recognizing the increasing demand for rail services and the importance of rail in the state's overall mobility, Florida has been one of the nationwide leaders in promoting public-private partnerships and supporting the rail system. Of the 2,908 miles of rail lines in Florida, all but 81 miles are owned by the state's 15 freight railroads and the entire track is controlled by the freight railroads. Freight rail companies are the shippers that depend on rail to transport their goods in the global marketplace, to stock their shelves with the latest products for Florida residents and visitors, and to haul construction materials to keep pace with the rapid population growth.

There are 15 freight railroads operating in Florida. These railroads carried about 1.2 million carloads, 805,260 intermodal units (trailers and containers), and 119 million tons of freight, effectively removing almost 6 million heavy trucks from the roadways. The map below shows the freight rail companies in the state.

Figure 4.65: Florida Freight Rail Network



CSX Transportation (CSXT) is the only operator of a railroad system in Hillsborough County, which is only freight. The Federal Railroad Administration reports that there were four railroad incidents on CSXT facilities in the last 20 years. Two were minor accidents at railroad crossings and two were a track defect causing a minor derailment. The last incident occurred at the Tampa Port. There were no injuries or fatalities in any cases.

Phosphates and Fertilizers

Mineral deposits in West Central Florida make the state a world leader in the production of phosphate rock. With the exception of Hamilton County in northern Florida, the state's phosphates production is concentrated in Polk, Hillsborough, and Hardee counties. Florida accounts for just over half of the nation's production of phosphate fertilizers. The phosphates and fertilizers produced in Florida are shipped nationwide and to markets throughout the world, with China, India, Australia, and Brazil ranking among the leading foreign destinations.

Distribution and Retail

The distribution and retail trade industry is comprised of several key economic sectors – wholesale trade, retail trade, and transportation and warehousing. Florida's distribution and retail trade industry depends on the efficient movement of goods to keep costs down and to remain competitive. Rail is crucial for long hauls that bring goods into the state from distribution hubs such as Chicago, Atlanta, and Dallas-Fort

Worth, as well as from more distant gateways, including the west coast ports which are the leading point of entry for consumer items entering the United States from Asia.

Food and Agriculture

Rail plays a crucial role in Florida's food and agriculture industries. Perhaps the most famous freight rail shipments are the Tropicana "Orange Juice Trains," originating in Bradenton and Fort Pierce. The railcars are specially designed refrigerated boxcars, each capable of carrying four truckloads worth of product. Rail also plays a critical role in allowing Florida sugar to compete against foreign imports. U.S. Sugar uses rail to haul sugar cane from the fields into the processing plants.

Paper and Fiber

Much of Florida's Panhandle is forested, lying within the yellow pine growing region that stretches from East Texas to Georgia, one of the country's most prodigious areas for forestry. As such, Florida has a substantial paper and fiber industry that has been one of the pillars of the North Florida economy for decades. Rail remains popular for long hauls following the processing of timber into paper and wood products and also as the best option for hauling lumber long distances.

Automotive Distribution

The expanding population stimulates demand for retail sales of automobiles while the millions of tourists visiting the state on an annual basis depend on rental cars for mobility. The combination of retail sales and rental cars makes Florida the second largest market for new vehicles in the country, only surpassed by the much more populous state of California. Whether new or used, meeting Floridians demand for vehicles requires thousands of truck and rail trips annually as part of a system to transport vehicles to dealers and wholesalers

Energy

The transport of fuels (i.e., coal and petroleum) by rail is one of the leading inputs in the energy industry. Rail, joined by coal and petroleum commodity purchases, construction, and business services is a principal cost factor in electricity production that affects the overall price of energy. Rail is the primary mode of transportation to bring coal into Florida.

Construction

Rail is involved in the movement of many of the materials essential to the Florida construction industry, including metals, lumber, and cement. The largest tonnages though are for movement of aggregate rock such as crushed limestone from the Miami-Dade area to construction markets in Orlando, Jacksonville, and out-of-state markets.

Postal and Shipping

Postal and Shipping in the United States moves roughly 720 million letters and packages each day and includes large integrated carriers, regional and local courier services, mail services, mail management firms, and chartered and delivery services.

The United States Postal Service delivers more mail to more addresses in a larger geographical area than any other post in the world. The Postal Service delivers to more than 156 million addresses in every state, city and town in the country. Everyone living in the United States and its territories has access to postal products and services and pays the same for a First-Class postage stamp regardless of their location.

Climate Change and Transportation Infrastructure

A changing climate can modify the types and quantity of food we eat, where we live, the types of available jobs, and how people and goods move. The transportation infrastructure has potential vulnerabilities to rising sea levels, rising temperatures, more intense storms, and extreme drought. The table summarizes climate change factors and the effects they could have on transportation infrastructure.[35]

Table 4.114: Transportation Infrastructure Climate Change Impacts

Climate Change Factor	Transportation Effect
Increased storm frequency and severity • Higher drought probability • More extreme precipitation	• Maintenance costs will rise • Costs for erosion and flood control prevention will rise
Change in ocean temperature • Loss of ocean protection from storm surge and damage • Coral reef damage and losses	• Coastal infrastructure will be more vulnerable to extreme and severe weather events • Reduction in commercial fishing
Rising temperatures • More days with temperatures above 95 degrees • Increased risk of wildfire	• Transportation infrastructure degrading • Increased maintenance costs • Increased energy costs for transportation facilities
Rising sea levels and storm surges • Reduced amount of protective barrier islands and coastal wetlands • Loss of coastal land	• Coastal infrastructure degrading • Impacts to supply chains • Rail and road infrastructure damage

2. Geographic Areas Affected by Transportation Incidents

Transportation incidents can occur anywhere within the county. Areas of high traffic are particularly vulnerable to transportation hazards. Large urban areas with large populations and different forms of transportation are considered high traffic areas, meaning the risk is elevated. Due to the large number of railways, roadways, airports, pipelines, and seaports, the entire county is at risk for transportation hazards. Areas surrounding the airports and ports are even more susceptible. These hazards also involve the transportation of hazardous materials which carry their own risks and can be found in the *HazMat Incident Hazard Profile*. Numerous major roadway corridors service the county from the north, south, east, and west. Marine delivery routes border the county on the east. Several main railroad corridors service the county. Thus, the county is vulnerable to a transportation accident.

[35] https://ntl.bts.gov/lib/52000/52800/52855/Transportation_System_Resilience_Extreme_Weather_and_Climate_Change.pdf

Aviation

The crash of a large passenger aircraft into a densely populated area in either Tampa or unincorporated Hillsborough County represents the maximum threat in the western and central portions of the County.

Railroad/Waterway Incidents

An incident such as the MV Summit Venture in 1980 which struck the Skyway Bridge represents a serious threat impacting the transportation infrastructure (highway and port) and economy as well as injuries and loss of life. A derailment of a rail car carrying hazardous materials could also pose a significant threat to local neighborhoods and major transportation facilities.

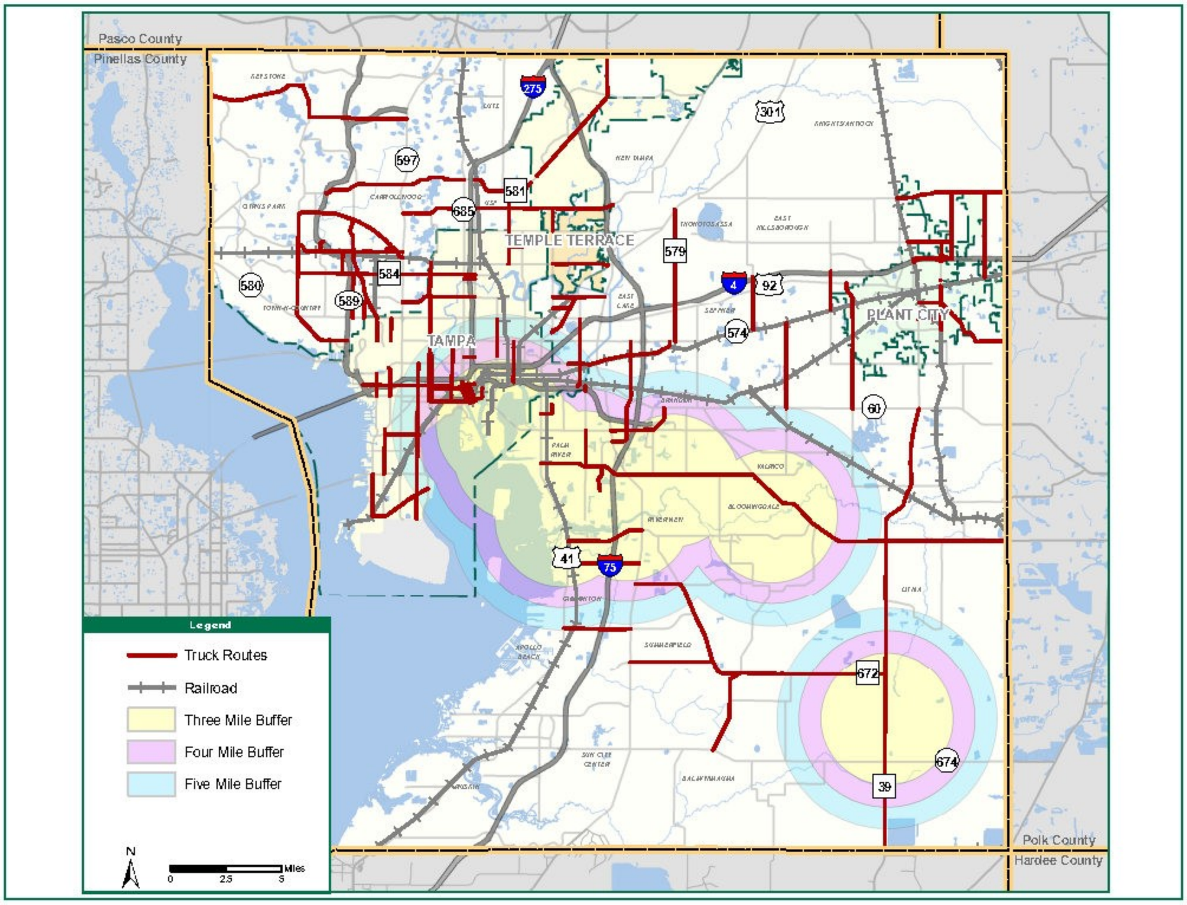
Hazardous Materials (Fixed Facilities)

The largest threat is from one of the anhydrous ammonia tanks operating at the port.

Hazardous Materials (Transportation)

Rail deliveries of anhydrous ammonia via ships to the port pose the largest threat, followed by rail deliveries of chlorine to one of the two water treatment plants in Tampa. The threats would exactly duplicate the Hazardous Materials (fixed facility) scenarios above, except that the location would be unknown. This incident could occur at any point along the rail delivery corridor throughout the northern half of the county.

Figure 4.65: Hillsborough County Hazardous Materials Transportation Buffers



3. Historical Occurrences of Transportation Incident

Due to the vast number of transportation routes, transportation incidents are fairly common. Below are some of the major incidents that have occurred in Hillsborough County.

The following are significant historical waterway accidents in the waterways in/near Hillsborough County:

- January 28, 1980: USCGC *Blackthorn*, a 180-foot seagoing buoy tender, and the tanker SS *Capricorn* collided near the Sunshine Skyway Bridge. The *Blackthorn* capsized and sank, killing 23 of her crew.
- May 9, 1980: The freighter MV *Summit Venture* collided with a support column of the Sunshine Skyway in a thunderstorm, causing a section of the bridge to collapse. Six cars, a truck, and a passenger bus fell into the water, killing 35 people.
- August 10, 1993: Two fuel barges and a phosphate freighter collided near the entrance to Tampa Bay, causing a spill of about 330,000 gallons of heavy fuel oil and 32,000 gallons of jet fuel, diesel, and gasoline

4. Probability of Future Transportation Incident

There is no sure way to predict future transportation incidents as most typically occur without warning. The probability of a major transportation event in the county is perceived to be high. The Florida Department of Transportation (FDOT) is part of an ongoing assessment of the state's vulnerability and coordinates efforts to prepare for, prevent, mitigate, respond to, and recover from transportation events that affect the state. In coordination with other transportation agencies such as the FAA, PHMSA, USCG, and CBP, FDOT ensures the safe travel and transportation of people and goods throughout the state.

This hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Transportation Incident Impact Analysis

- Public
  - Mass casualties
  - Injury or death
  - Delays
- Responders
  - Danger in reaching victims/survivors
  - Injury or death during rescue efforts
- Continuity of Operations (including continued delivery of services)
  - Normal transportation operations may not return to return to normal for a significant time due to repairs
  - Goods cannot be delivered or accepted
- Property, Facilities, Infrastructure
  - Potential damage to infrastructure and public transportation programs
  - Shutting down affected highways, railways, airports, etc.
- Environment
  - Hazardous material spills
  - Pipeline burst/leak
- Economic Condition
  - Cost for repairs and down time
  - Could cause loss in revenue or wages
    - Loss in shipping revenues
    - Loss of tourism
- Public Confidence in Jurisdiction's Governance
  - Citizens may lose trust in particular public transportation services
  - Tourists may reconsider visiting Florida

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Due to the nature and unpredictability of technological hazards, all property and infrastructure in the county are at risk to these events. Due to the significant tourism in the county all of the municipalities are at risk. Hillsborough is at a higher risk with large transportation hubs especially within the metropolitan area of Tampa such as the airports, port, and the three cruise terminals.

Major HazMat incidents can occur at any facility that produces, uses, or stores hazardous materials. These include chemical manifesting plants, laboratories, shipyards, railroad yards, warehouses, or chemical disposal areas. Illegal dumpsites can appear anywhere. Accidents involving the transportation of hazardous materials can occur at any time and severely impact the affected community. The shipping channel and port area would be most impacted by an ammonia transportation incident. The northern half of the county could be largely affected if there was a chlorine release during transport based on the delivery corridor route.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Due to the nature and unpredictability of technological hazards, all property and infrastructure in the county are at risk to these events. Large transportation hubs such as airports or ports are at a higher risk.

The county recognizes that critical facilities are vulnerable to transportation incidents, there is a lack of data to quantify the vulnerability of facilities to these hazards compared to natural hazards.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.8.

TRANSPORTATION INCIDENT					Overall Vulnerability
Overview					
Transportation systems are designed to move people, goods, and services efficiently, economically, and safely from one point to another. As the movement of people, goods, and services increases due to population growth and technological innovation, the need to plan for events becomes increasingly important. Hillsborough County has a large transportation network that consists of airports, major highways, passenger railroads, marine ports, and pipelines. These transportation systems provide lifeline services for communities and are vitally important for response and recovery operations. The vast network of public and private critical infrastructure owners and operators, the infrastructure and services they manage, and the extensive interdependencies among the transportation modes and other sectors indicate the need for coordinated planning to manage all hazards efficiently and effectively.					HIGH
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Possible	Critical	Moderate	< 6 hrs	< 1 week	2.8

Infrastructure Disruption Hazard Profile

1. Infrastructure Disruption Description

Infrastructure disruption can be divided into four types of events: utility outages, power outages, sanitary sewer disruption, and communication disruption.

Utility/Power Outage

A failure in the power distribution network can happen for varying reasons. Some possible examples include the physical failure of power lines due to hazards as discussed in the Critical Utilities sections throughout this document, as well as problems within the network itself including faults at a power station, shorts or overloading in a circuit(s), or physical damages at a substation.

There are three different types of power outages – transient faults, brownouts, and blackouts. A transient fault is a brief outage caused by a fault in a power line. The issue is corrected when the power flow clears the faulty part of the circuit, and power is returned. A brownout occurs when voltage falls to an inadequate level. A blackout occurs when there is a complete loss in the power supply. Blackouts are generally longer lasting outages than the previous two examples and may involve significant repairs. These outages can range from minutes to weeks or more depending on the significance of the failure in the network.

Sanitary Sewer Disruption

A disruption in the sanitary sewer system can result in hazardous environments that expose the built environment to waste products.

Communication Disruption

The widespread failure or disruption of communications systems is uncommon. In most cases, there are backup systems in place to keep communication lines flowing. Extreme situations or the presence of several significant hazards would be necessary for an incident that would affect multiple communications systems. Communications infrastructure is designed to withstand high winds and other weather elements; however, failure is always a possibility and must be planned for regardless of the unlikelihood. In Guilford County, one issue that can cause or exacerbate a communications system disruption is that numerous facilities in the county are constructed in a way that radio coverage is greatly diminished within the building. This kind of disruption can occur without a precipitating event and result in similar impacts to communication among response personnel.

Disruptions are more likely to occur than actual failures. Overloaded systems due to other hazards or disaster circumstances may cause temporary connectivity issues, especially in cell phone networks. The public, government, and business operations have become more reliant on cell phones for communicating. During large-scale events or emergencies when cell phone traffic is high, it can cause overload situations and disruptions could result.

2. Geographic Areas Affected by Infrastructure Disruption

Due to the unpredictable nature of where exactly an infrastructure disruption will occur, the entire county is considered to be equally susceptible to this hazard. However, it should be noted that in more urbanized areas, the effects of a disruption at a single location or facility would likely impact large numbers of people.

3. Historical Occurrences of Infrastructure Disruption

Most lengthy infrastructure disruptions have been due to tropical cyclone and severe storm events. Over Christmas weekend of 1989, extremely cold weather caused extended power outages throughout the county.

4. Probability of Future Infrastructure Disruption

There is no sure way to predict future infrastructure disruption as most incidents typically occur without warning. Infrastructure disruption is most likely to occur during an extreme weather event.

This hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Infrastructure Disruption Impact Analysis

- Public
  - Transportation tie-ups and accidents
  - Medical emergencies
  - Communications disruptions
- Responders
  - Issues related to transportation, medical equipment, extreme weather temperatures, and communications issues
  - Increased call volume
  - Impact to notification processes and increased response times
- Continuity of Operations (including continued delivery of services)
  - Power outages and communications disruptions
- Property, Facilities, Infrastructure
  - Loss of food/refrigeration
  - Medical equipment failure
  - Grounded flights and suspended operations
  - Transportation infrastructure failure
  - Loss of communications
- Environment
  - Minimal
  - Some disruptions may cause spillover effects from cascading events such as fires or sewer backups
- Economic Condition
  - Shut down businesses

    - Significant financial impacts
    - Event/commercial activity disruption
- Public Confidence in Jurisdiction's Governance
    - Disruptions for extended periods give the appearance that the jurisdiction does not know how to restore infrastructure

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Exposure

Due to the nature and unpredictability of technological hazards, all property and infrastructure in the county are at risk to these events. While an infrastructure disruption event could happen anywhere in the county, it should be noted that in more urbanized areas, the effects of a disruption at a single location or facility would likely impact larger numbers of people.

Some issues that need to be considered during a power outage include transportation tie-ups and accidents, medical emergencies, and communications disruptions. The transportation problems would likely be related to traffic lights and signals not working or from decreased visibility during the night. Medical emergencies could stem from homes not having power to operate heating and air conditioning systems, particularly during conditions of extreme temperatures. Also, medical equipment that relies on power could shut off, no longer providing a patient with treatment he or she requires. Communications issues could prevent the public from being able to call emergency services. Business disruptions could also impact services that the public wants or needs. Lastly, well pumps would not function without power unless on backup generator power.

Many residential structures do not have backup generators in place. If power fails, the residents of these homes may not be able to refrigerate their food, regulate medical equipment properly (such as oxygen), etc. until power is restored. Power outages can also sometimes lead to sparks that may rarely ignite fires or damage other components of the electric grid, causing extensive damage. Other utility failures may also cause damage when they go down, such as sewer systems. Shutdowns or damage to these systems can result in hazardous environments that expose the built environment to waste products.

In terms of transportation infrastructure, airports may have to ground flights and suspend operations as a result of a power outage until power can be restored. Extended outages may cause more significant impacts on flight patterns. Signals at railroad crossings may not work appropriately and in more severe cases, networks may be stopped until power is restored to prevent incidents.

Communications infrastructure may also be damaged or disrupted. Cellular telephone towers generally have backup power to function during power outages. However, depending on the presence of other hazards or lengthy outages, cell phone reception may be impacted. Internet connections that originate from or are linked to energy sources in affected areas will likely see effects from a power outage.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Infrastructure disruption can occur anywhere in Hillsborough County; therefore, all of the county critical facilities are equally vulnerable and at risk. The impact of infrastructure disruptions to structures, including critical facilities, are listed above under Exposure.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.5.

<table>
<tr><th colspan="5">INFRASTRUCTURE DISRUPTION</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">Infrastructure disruption can be divided into four types of events: utility outages, power outages, sanitary sewer disruption, and communication disruption.</td><td>MODERATE</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Possible</td><td>Limited</td><td>Moderate</td><td>< 6 hrs</td><td>< 1 week</td><td>2.5</td></tr>
</table>

Hazardous Materials Incident Hazard Profile

1. Hazardous Materials Incident Description

A hazardous material is any substance that poses a threat to humans, animals, or the environment. Hazardous materials, commonly referred to as HazMat, refers generally to hazardous substances, petroleum, natural gas, synthetic gas, and acutely toxic chemicals. Hazardous materials are defined and regulated in the United States primarily by laws and regulations administered by the EPA, OSHA, DOT, and the Nuclear Regulatory Commission (NRC).

The Occupational Safety and Health Administration (OSHA) further explains that HazMat is any substance or chemical that is a health hazard or physical hazard, including:

- chemicals which are carcinogens, toxic agents, irritants, corrosives, or sensitizers;
- agents which act on the hematopoietic system;
- agents which damage the lungs, skin, eyes, or mucus membranes;
- chemicals which are combustible, explosive, flammable, oxidizers, pyrophorics, unstable-reactive or water-reactive; and
- chemicals which in the course of normal handling, use, or storage may produce or release dusts, gases, fumes, vapors, mists, or smoke which may have any of the previously mentioned characteristics.

Hazardous materials typically fall into one of three categories: biological hazards, chemical hazards, or radiological hazards. All of these hazardous materials have both short-term and long-term effects based on the timing of detection and the response time to mitigate the effects of the hazard.[36]

Biological Hazards

Biological hazards are materials or incidents that involve exposure to a biological or living agent that causes harm. These agents include microorganisms, viruses, and any toxins originating from biological sources. Examples of biological hazards include anthrax, bloodborne pathogens, molds, Ebola, smallpox, and any medical waste that comes into contact with such microorganisms or viruses. Biological hazards are extremely contagious and pose a threat to any populations that are exposed. For more information on biological hazards, please refer to the *Disease Outbreak and Biologic Incident Hazard Profile*.

Chemical Hazards

Chemical hazards are hazards or incidents that involve exposure to chemicals that cause harm. Chemical HazMats include neurotoxins, immune agents, dermatologic agents, carcinogens, and other toxins. Chemical hazards can be introduced to populations through ingestion, inhalation, or physical contact. Chemicals enter the body through the eyes, skin, lungs, and digestive tract. Once in the body, the effect depends on the dosage and toxicity. The type of chemical, how it entered the body, and the susceptibility of the individual all affect the outcome of exposure. Once exposed to chemical substances, there can be acute (immediate) or chronic (long-term) health issues for the community. The effects of chemical hazards

[36] https://www.ihmm.org/about-ihmm/what-are-hazardous-materials

on an exposed population are not limited to the development of lesions and burns on skin and respiratory issues.

Radiological Hazards

Radiological hazards are hazards or incidents that involve exposure to materials that have encountered radioactive substances, thus making them contaminated. Exposure to radiological materials have both short-term and long-term effects; some short-term effects include radiation burns and radiation sickness, while long-term effects include radiation poisoning and radiation damage.[37]

With the passage of the Federal Emergency Planning and Community Right-To-Know Act (EPCRA) in 1986, FDEM began implementation of a statewide Hazardous Materials Emergency Planning Program. For the first time, passage of the EPCRA allowed emergency planners, responders, and the public access to facility-specific information regarding the identification, location, and quantity of particular hazardous materials at fixed sites.

The law requires facilities with certain threshold quantities of federally mandated substances to report annually to state and local emergency officials. In addition, facilities must immediately notify officials of any releases of harmful chemicals that have the potential to result in offsite consequences. This information is utilized to prepare emergency plans for HazMat incidents, to allow responders to receive training based on specific known threats, and to inform and educate the public regarding the chemicals present in their communities. The term extremely hazardous substance (EHS) is used in Title III of the Superfund Amendments and Reauthorization Act of 1986 to refer to those chemicals that could cause serious health effects following short-term exposure from accidental releases. Florida has more than 4,500 fixed facility locations that report the presence of an EHS in federally mandated threshold amounts.

The State Emergency Response Commission (SERC) is responsible for implementing the Federal Emergency Planning and Community Right-To-Know Act (EPCRA) provisions in Florida. The SERC, along with the Local Emergency Planning Committees (LEPCs), works to mitigate the effects of a release or spill of hazardous materials by collecting data on the storage of hazardous chemicals above planning quantities. The Technological Hazards Unit at the Florida Division of Emergency Management provides programmatic support for the SERC.[38]

Hazardous Waste

Hazardous waste is unwanted or discarded hazardous materials that may harm the health or wellbeing of people or the environment. As hazardous materials are produced, stored, and used, hazardous waste is created and must be disposed of. A hazardous waste site can be any place, whether a landfill or former industrial facility, where chemicals have made contact with the water, soil, or air. Ensuring that hazardous wastes (HW) are handled in accordance with federal and state rules and laws is the responsibility of the Compliance and Enforcement staff at DEP. This group interacts with the public and with the Resource Conservation and Recovery Act (RCRA) branch of the Federal EPA to develop policies and guidance, to

[37] http://www.floridahealth.gov/environmental-health/chemicals
[38] https://www.floridadisaster.org/hazmat/serc/

provide compliance assistance to the public and the regulated community, and to enforce the laws regulating the handling of hazardous waste.

Due to the unregulated process of dumping hazardous materials and waste, Congress signed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980. This became known as the “Superfund” Act and gave the Environmental Protection Agency (EPA) authority to clean up hazardous waste sites and spills. The Superfund Program, through the EPA, is responsible for cleaning some of the most contaminated areas in the United States and responds to emergencies involving the environment such as oil spills, hazardous material spills, and hazardous waste sites. To assist with this task the National Priorities List (NPL) was created which tracks the known releases or threatened releases of hazardous substances, pollutants, or contaminants. The NPL has four distinct categories:

- *Proposed* – The site has been contaminated by hazardous waste and is a candidate for cleanup. The site is not on the list yet.
- *Withdrawn* – The site poses no real or potential threat to the environment or community and was removed from the NPL.
- *Final* – These sites are currently on the list and pose a real or potential threat to the environment or community. The EPA will be part of the cleanup process.
- *Deleted* – These sites have been removed from the NPL because the cleanup goals were accomplished, and the area requires no further response.

As of July 2019, Florida has 54 final sites on the NPL and 1 proposed site.[39]

<u>Hazardous Waste Generators</u>

A generator is any person, organization, or agency who produces a hazardous waste as listed or characterized in Part 261 of Title 40 of the Code of Federal Regulations (CFR). Recognizing that generators produce waste in different quantities, the EPA established 3 categories of generators in the regulations. The volume of hazardous waste each generator produces in a calendar month determines which regulations apply to that generator.[40]

Conditionally Exempt Small Quantity Generators (CESQG’s) generate less than 220 pounds per month of hazardous waste or less than 2.2 pounds per month of acutely hazardous waste, such as some pesticides, toxins, or arsenic and cyanide compounds.

Small Quantity Generators (SQG) generate 220 to 2,200 pounds per month and have additional regulations including emergency planning and storage time limits.

Large Quantity Generators (LQG) generate 2,200 pounds or more of hazardous waste per month or 2.2 pounds or more per month of acutely hazardous waste.[41]

[39] https://www.epa.gov/fl/list-superfund-sites-florida
[40] https://www.epa.gov/hwgenerators/categories-hazardous-waste-generators
[41] https://floridadep.gov/waste/permitting-compliance-assistance/content/hazardous-waste-compliance-and-enforcement

Within the State of Florida there are 17,123 CESQG's, 3,547 SQG's, and 501 LQG's as well as 111 Hazardous Waste Transporters that are regulated and overseen by the Florida Department of Environmental Protection.[42]

Pipelines

There is a total of 34,019 miles of pipeline within Florida. The breakdown of pipeline types are as follows:

- 552 miles Intrastate Natural Gas Transmission
- 4,510 miles Interstate Natural Gas Transmission
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- 80 miles Liquid Hazardous Materials
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- 28,567 miles Natural Gas Distribution Systems

Energy pipelines are a fundamentally safe and efficient means of transporting materials key to the U.S. energy supply but, given that they often carry toxic, volatile, or flammable material, energy pipelines have the potential to cause injury and environmental damage.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) identifies "serious" and "significant" pipeline incidents. Serious incidents are those involving a fatality or injury requiring hospitalization. Significant incidents have the following conditions:

a) fatality or injury requiring hospitalization,
b) $50,000 or more in total costs,
c) highly volatile liquid releases of five or more barrels or other liquid releases of fifty barrels or more, and
d) liquid release that results in fire or explosion.

As of 2004, PHMSA does not include gas distribution incidents that are caused by nearby fire or explosion and impacts the pipelines.

According to PHMSA, in the state of Florida, there was one natural gas interstate transmission pipeline incident with no injuries in 2014 and six significant intrastate distribution pipeline incidents resulting in two injuries from 2014 through 2016. These incidents resulted in a total of $5,059,988 in property damages involving natural gas distribution systems incidents and $1,494,000 in property damages involving an interstate natural gas transmission pipeline.[43]

Historically, nationwide, the most common threats to energy pipelines have been accidents and seismic activity; however, more recently, DHS has warned that U.S. natural gas pipelines are targets of cyberattacks. DHS has been working with critical infrastructure owners and operators in the oil and natural gas sector to address a series of cyber intrusions targeting natural gas pipeline companies. Publicly

[42] https://fldeploc.dep.state.fl.us/www_rcra/reports/handler_sel.asp
[43] http://www.ncsl.org/research/energy/state-gas-pipelines-pipeline-accidents.aspx#Significant_Incidents

available information does not indicate the extent to which systems have been infiltrated, but cybersecurity officials warn that, with sufficient access, a hacker could potentially "manipulate pressure and other control system settings, potentially reaping explosions or other dangerous conditions." Additionally, sufficient access could shut down energy transit, significantly disrupting U.S. energy supply.

Within the state of Florida, the Department of Environmental Protection is the lead agency for the Emergency Support Function (ESF) that deals with HazMat and environmental affecting incidents. Florida Fish and Wildlife Conservation Committee (FWC) is an additional supporting agency that assists with HazMat incidents in the event that the material or incident in question is an environmental crime. The Department of Health (DOH) is a supporting agency for radiological incidents as well. The PHMSA is responsible for safety of interstate natural gas transmission lines, propane, and liquid transporting pipelines in Florida. The Florida Public Service Commission is responsible for natural gas safety of intrastate and distribution systems.

811 Call Before You Dig

Pipelines exist almost everywhere throughout the country, and Florida has an extensive pipeline and utility grid. One nationwide program that works to mitigate the risks associated with utility or pipeline damage is 811. According to data collected by the Common Ground Alliance (CGA), an underground utility line or pipeline is damaged once every six minutes nationwide. Before digging or excavating, residents or businesses can call 811 to ensure there are no buried utilities or pipelines on the property. Officials will be sent to locate these utilities and pipelines and mark the approximate location. This is a free service and used to ensure residents proceed without damaging any critical utilities or pipelines.[44]

<u>Oil Spill</u>

An oil spill is the release of crude oil, or liquid petroleum, into the environment. A hazard profile specific to Coastal Oil Spill is available later in this document.

2. Geographic Areas Affected by HazMat Incident

Hazardous material incidents can occur during the production, transportation, use, and storage of those hazardous materials and can happen anywhere within the county. As these materials are processed and stored, those in the immediate vicinity are at risk of toxic fumes, soil contamination, and water contamination. Even those communities removed from production or storage facilities are at risk given that hazardous materials are routinely and frequently transported via roadways, railways, pipelines, and waterways, concluding that all areas of the county are potentially at risk.

The Port of Tampa contains the largest concentration of hazardous materials in Hillsborough County. Included are such products as petroleum and ammonia. Although these products are stored within an industrial area, the port is located immediately adjacent to downtown Tampa and large residential concentrations on Harbour Island and Davis Island.

Port vessel collisions and on-water hazardous materials spills are most likely to occur in the shipping lanes serving the Tampa Port Authority.

[44] http://call811.com/

3. Historical Occurrences of HazMat Incidents

Hillsborough County is surrounded by water with hundreds of commercial and private marine vessels traveling its waterways daily. The Port of Tampa resides to the east of the county and is one of the busiest in the Gulf of Mexico, making the probability of a major spill more likely to occur. The last major incident occurred in August 1993 when three ships collided at the entrance to Tampa Bay causing a major fire and oil spill, which affected the southern third of the county significantly. More than 330,000 gallons of No. 6 oil were spilled following a three-vessel collision. This spill caused significant ecological and economic damage to local shorelines and beaches.

In July 1993, the U.S. Coast Guard responded to the worst hazardous materials incident in recent history involving the motor vessel OCELOT. In September 1995, the USCG also responded to a 5000-gallon diesel spill in the east Tampa Bay requiring multiple clean-up contractors. The spill would later prove to be the nation's fifth most resource intensive oil spill that year at a cost of $500,000.

On May 31, 2011, the DEP's Bureau of Emergency Response reported a mercury spill in a residential house in Tampa, Florida. DEP personnel observed at least two ounces of visible mercury within the residence. Mercury vapor readings with windows open in two rooms were 43,000 ng/m3 and 47,000 ng/m3 respectively (Lumex readings). Based on the readings, DEP advised the owners and their children to relocate until the hazards could be mitigated. The source of mercury is unknown and was discovered during home renovation activities.

On July 22, 2012, Kinder Morgan (Central Florida Pipeline) had an ongoing release of refined petroleum product from a 10-inch pipeline. Kinder Morgan shut off the pipeline and responded with state and local response agencies to locate the source and evaluate extent of impact. It was determined that the pipeline failed in a drainage ditch full of water. The ditch flows into a nearby creek which discharges into Tampa Bypass Canal and then into McKay Bay. Kinder Morgan estimated 750 barrels of refined product were released. About two miles of the creek, which includes ditches, creek, ponds, and wetlands were impacted.

The majority of the transportation hazardous materials events involve tanker trucks or trailers and certain types of bulk-cargo vehicles. Because of the number of miles traveled by these vehicles within the county daily transportation is a great area of potential hazardous materials spills. Additionally, rain, high winds and fires can worsen conditions surrounding these hazardous materials events.

For the City of Tampa, approximately 25.3% of the recorded incidents are related to a hazardous condition other than residential gas and fuel spill emergencies. Damage estimates associated with the hazardous conditions are not available. All calls for hazardous incidents within the City are funneled through the Tampa Fire Rescue Department.

4. Probability of Future HazMat Incident

Reports of hazardous material spills and releases, however, are increasingly commonplace. Thousands of new chemicals are developed each year and transported domestically and internationally creating the risk for accidents and spills. Small fuel spills occur in the waters surrounding Hillsborough on a daily basis.

Most are due to overfilling boat fuel tanks and a few due to boat sinking. Law enforcement agencies routinely receive reports of illegal oil dumping from the public.

Major chemicals spills can occur at any facility that produces, uses, or stores chemicals. These include chemical manifesting plants, laboratories, shipyards, railroad yards, warehouses, or chemical disposal areas. Illegal dumpsites can appear anywhere. Accidents involving the transportation of hazardous materials can occur at any time and severely impact the affected community. Recent evidence shows that hazardous materials incidents may be the most significant threat facing local jurisdictions.

This hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. HazMat Incident Impact Analysis

- Public
    - Loss of life or injury from contamination
    - Diseases may be exacerbated
- Responders
    - Loss of life or injury from contamination, explosions, cleanup, and destruction
    - Diseases
    - Cleanup and destruction at waste sites and incident sites
- Continuity of Operations (including continued delivery of services)
    - Lost material, such as gas, is unusable and could lead to shortages and price increases
- Property, Facilities, Infrastructure
    - Damage due to excavation and removal of soil and water
    - Inability to rebuild in affected areas
    - Services could be closed or blocked due to the contaminant
        - Roads
        - Trains
        - Airplanes
        - Bridges
        - Waterways
    - Long-term contamination at hazardous waste sites
- Environment
    - Death or illness to pets or wildlife near the spill
    - Damage to plants and wildlife
    - Airborne issues such as toxic fumes, gases, or vapors caused by chemicals
    - Water contamination
    - Soil contamination
    - Loss of critical or endangered species
    - Pollution
- Economic Condition
    - Business closures may lead to lost revenue and wages
    - Loss of tourism and income

    - Loss of product
    - Cost of cleanup and restoration
- Public Confidence in Jurisdiction's Governance
    - If the government does not communicate with the public, fear could ensue, leading to a fear of the government
    - If cleanup is slow, the public could believe the government does not know how to properly clean it up or that the accident was malicious

6. Vulnerability Analysis and Estimated Losses by Jurisdiction

Major Hazardous Materials incidents can occur at any facility that produces, uses, or stores hazardous materials. These include chemical manifesting plants, laboratories, shipyards, railroad yards, warehouses, or chemical disposal areas. Illegal dumpsites can appear anywhere. Accidents involving the transportation of hazardous materials can occur at any time and severely impact the affected community. The northern half of the county could be largely affected if there was a chlorine release during transport based on the delivery corridor route.

Hazardous materials releases pose short- and long-term toxicological threats to humans and to terrestrial and aquatic plants and wildlife. Toxic materials affect people through inhalation, ingestion and/or direct contact. As noted previously, should a hazardous material spill or accident occur in the Port of Tampa under favorable weather conditions, a significant number of people working, visiting, or living near the port could be adversely affected. As an active port, two factors are present which contribute to the need for vigilance. First, as a port, hazardous materials will always be present, either in transit or storage. Second, as a port, the potential for accidents is always present, either in the transfer of hazardous materials from ship-to-shore to storage or transfer from storage to overland transport. Given the amount of hazardous materials found at the port and its location should a spill or fire/explosion occur the impact on the surrounding community could be catastrophic.

7. Vulnerability Analysis and Estimated Losses of Critical Facilities

Hazardous Materials Incidents can, and do, occur anywhere and at any time. In most cases, they do not result in serious impacts to critical facilities. However, critical facilities that store or handle hazardous chemicals listed in the Environmental Protection Agency (EPA) Superfund Amendments and Reauthorization Act (SARA) Title III are most vulnerable.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.9.

<table>
<tr><th colspan="5">HAZMAT INCIDENT</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">A hazardous material is any substance that poses a threat to humans, animals, or the environment. Hazardous materials, commonly referred to as HazMat, refers generally to hazardous substances, petroleum, natural gas, synthetic gas, and acutely toxic chemicals. Hazardous materials are defined and regulated in the United States primarily by laws and regulations administered by the EPA, OSHA, DOT, and the Nuclear Regulatory Commission (NRC). Hazardous materials typically fall into one of three categories: biological hazards, chemical hazards, or radiological hazards.</td><td>HIGH</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Possible</td><td>Critical</td><td>Moderate</td><td>< 6 hrs</td><td>> 1 week</td><td>2.9</td></tr>
</table>

Space Weather Hazard Profile

1. Space Weather Description

Space weather is a broad term used to describe atmospheric events that have the potential to adversely affect conditions on Earth. Space weather events are caused by the interaction of Earth with emissions from the Sun. There are two causes of space weather events, coronal mass ejections (CMEs) and solar flares, which are different incidents that occur on the Sun. CMEs and solar flares can cause three different types of space weather events on Earth, geomagnetic storms, solar radiation storms, and radio blackouts.

When space weather does interact with Earth and its magnetic field, the technology on Earth can be disrupted, including that which operates critical infrastructure. For example, communications networks, satellite and airline operations, navigation systems, and the electric power grid could be disrupted, causing severe problems and damage.

According to the National Space Weather Strategy, published in October 2015, space weather poses a significant risk to the security of our country, including infrastructure and the economy. This is because our nation is becoming more and more dependent on technology, and the failure of one critical infrastructure facility or system could lead to failures in many other systems.[45]

The Space Weather Operations, Research and Mitigation (SWORM) Task Force was created in 2014 with the goal of uniting the national and homeland security field with the science and technology industry to formulate a cohesive vision to enhance national preparedness for space weather. The SWORM Task Force created two documents, the Space Weather Strategy and the Space Weather Action Plan,[46] to guide federal level actions to achieve the goal. Both documents build on recent efforts to reduce risks associated with natural hazards and improve resilience of essential facilities and systems. The Strategy contains goals and objectives and the Action Plan contains measurable actions to take to improve preparedness and resilience.

Causes

As stated before, space weather events are caused by two types of incidents on the surface of the Sun. These will be discussed below.

Coronal Mass Ejections

Coronal mass ejections (CMEs) are large eruptions of plasma and magnetic field structures in the Sun's atmosphere, which then travel through space at millions of miles per hour, eventually reaching Earth and affecting Earth's own magnetic field. When CMEs erupt from active regions on the Sun, they are often accompanied by large solar flares.

Solar Flares

Solar flares are sudden bursts of electromagnetic radiation, including x rays and ultraviolet light. The Sun continually streams out solar wind, which consists of charged particles, or plasma, travelling at high

[45] National Space Weather Strategy, National Science and Technology Council, October 2015
[46] National Space Weather Action Plan, National Science and Technology Council, October 2015

speeds. Solar wind carries the solar magnetic field into space where it interacts with magnetic fields of planets. When solar wind is very fast or turbulent, it can cause changes in the magnetic fields of planets; this is the basis of a geomagnetic storm. X-rays from solar flares affect Earth's ionosphere by causing a prompt loss of its ability to reflect long-range radio waves, which results in a radio blackout event. The plasma from solar flares can damage satellites and cause high-frequency radio blackouts in polar regions and the sun-facing side of Earth.

Space Weather Events

CMEs and solar flares can cause three different types of space weather events on Earth. These will be discussed below.

Geomagnetic Storms

Geomagnetic storms occur when CMEs affect Earth's magnetic field. Earth's magnetic field attempts to adjust to the large amounts of energy from the Sun carried in solar wind. CMEs from the Sun can disturb Earth's geomagnetic field for days, and several CMEs at once may cause prolonged disturbed periods. Geomagnetic storms usually last from a few hours to a few days, but stronger storms can last up to a week.

These storms induce currents that can have significant impacts on technological systems and critical infrastructure, including electrical transmission equipment. Electric power companies have procedures in place to mitigate the impact of geomagnetic storms. Strong geomagnetic storms are visible from Earth, in the form of aurora, which becomes brighter and moves closer to the equator during a storm.

Geomagnetic storms are measured on a scale from G1: Minor to G5: Extreme. The chart below from the National Oceanic and Atmosphere Administration (NOAA) describes the effects and frequency in detail.

Table 4.115: Geomagnetic Storm Scale

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
G5	Extreme	**Power systems:** Widespread voltage control problems and protective system problems can occur; some grid systems may experience complete collapse or blackouts. Transformers may experience damage. **Spacecraft operations:** May experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. **Other systems:** Pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).	Kp = 9	4 per cycle (4 days per cycle)

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
G4	Severe	**Power systems:** Possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. **Spacecraft operations:** May experience surface charging and tracking problems, corrections may be needed for orientation problems. **Other systems:** Induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).	Kp = 8	100 per cycle (60 days per cycle)
G3	Strong	**Power systems:** Voltage corrections may be required, false alarms triggered on some protection devices. **Spacecraft operations:** Surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. **Other systems:** Intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).	Kp = 7	200 per cycle (130 days per cycle)
G2	Moderate	**Power systems:** High-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. **Spacecraft operations:** Corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. **Other systems:** HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).	Kp = 6	600 per cycle (900 days per cycle)
G1	Minor	**Power systems:** Weak power grid fluctuations can occur. **Spacecraft operations:** Minor impact on satellite operations possible. **Other systems:** Migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).	Kp = 5	1700 per cycle (900 days per cycle)

Solar Radiation Storms

Solar radiation storms occur when there is a giant eruption from a sunspot region, causing large quantities of charged particles, or plasma, to accelerate through space and cover the near-Earth satellite environment with high-energy particles. These storms occur about 30 minutes to several hours after a solar flare, and they can last from a few hours to a few days. Sometimes these storms can penetrate down to Earth's surface.

Solar radiation storms cause the loss of high frequency (HF) radio communications in the polar region. Because of the increase in radiation, astronauts, as well as passengers and crew in aircraft at high altitudes and latitudes, are at risk of increased radiation exposure. Additionally, these storms can cause navigation position errors and damage to satellite systems.

Solar radiation storms are measured on a scale from S1: Minor to S5: Extreme. The chart below from NOAA describes the effects and frequency in detail.

Table 4.116: Solar Radiation Storm Scale

Scale	Description	Effect	Physical measure	Average Frequency
S5	Extreme	**Biological:** Unavoidable high radiation hazard to astronauts on EVA (extra-vehicular activity); passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** Satellites may be rendered useless, memory impacts can cause loss of control, may cause serious noise in image data, star-trackers may be unable to locate sources; permanent damage to solar panels possible. **Other systems:** Complete blackout of HF (high frequency) communications possible through the polar regions, and position errors make navigation operations extremely difficult.	10^5	Fewer than 1 per cycle
S4	Severe	**Biological:** Unavoidable radiation hazard to astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** May experience memory device problems and noise on imaging systems; star-tracker problems may cause orientation problems, and solar panel efficiency can be degraded. **Other systems:** Blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.	10^4	3 per cycle
S3	Strong	**Biological:** Radiation hazard avoidance recommended for astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** Single-event upsets, noise in imaging systems, and slight reduction of efficiency in solar panel are likely. **Other systems:** Degraded HF radio propagation through the polar regions and navigation position errors likely.	10^3	10 per cycle

Scale	Description	Effect	Physical measure	Average Frequency
S 2	Moderate	**Biological:** Passengers and crew in high-flying aircraft at high latitudes may be exposed to elevated radiation risk. **Satellite operations:** Infrequent single-event upsets possible. **Other systems:** Small effects on HF propagation through the polar regions and navigation at polar cap locations possibly affected.	10^2	25 per cycle
S1	Minor	**Biological:** None. **Satellite operations:** None. **Other systems:** Minor impacts on HF radio in the polar regions.	10	50 per cycle

Radio Blackouts

Radio blackouts are caused by the bursts of x-rays and ultra-violet radiation from solar flares. These x-ray and ultra-violet ray emissions that come along with solar flares ionize (by increasing electron densities) the sunlit side of Earth, which increases the amount of energy lost as radio waves pass through the region. These blackouts are the fastest and among the most common of space weather events to affect Earth. Earth is impacted after about eight minutes because the x-rays travel at the speed of light and it takes about eight minutes for the light from the Sun to reach Earth. This makes advance warning for these events difficult. These blackouts usually last for several minutes but can last up to a few hours.

High frequency (HF) communications ranging from 3 to 30 MHz can be disrupted by solar flares. Very high frequency (VHF) communications range from 30 to 300 MHz can be faded or have diminished reception because of solar flares. Similar to solar radiation storms, radio blackouts affect HF and VHF communications, polar regions, and the sunlit side of Earth, with impacts being primarily felt by aviation and marine industries.

Radio blackouts are measured from R1: Minor to R5: Extreme. The chart below from NOAA describes the effects and frequency in detail.

Table 4.117: Radio Blackout Scale

Scale	Description	Effect	Physical measure	Average Frequency
R5	Extreme	**HF Radio:** Complete HF (high frequency) radio blackout on the entire sunlit side of the Earth lasting for a number of hours. This results in no HF radio contact with mariners and en-route aviators in this sector. **Navigation:** Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours, causing loss in positioning. Increased satellite navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side.	X20	Less than 1 per cycle

Scale	Description	Effect	Physical measure	Average Frequency
R4	Severe	**HF Radio:** HF radio communication blackout on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. **Navigation:** Outages of low-frequency navigation signals cause increased error in positioning for one to two hours. Minor disruptions of satellite navigation possible on the sunlit side of Earth.	X10	8 per cycle (8 days per cycle)
R3	Strong	**HF Radio:** Wide area blackout of HF radio communication, loss of radio contact for about an hour on sunlit side of Earth. **Navigation:** Low-frequency navigation signals degraded for about an hour.	X1	175 per cycle (140 days per cycle)
R2	Moderate	**HF Radio:** Limited blackout of HF radio communication on sunlit side, loss of radio contact for tens of minutes. **Navigation:** Degradation of low-frequency navigation signals for tens of minutes.	M5	350 per cycle (300 days per cycle)
R1	Minor	**HF Radio:** Weak or minor degradation of HF radio communication on sunlit side, occasional loss of radio contact. **Navigation:** Low-frequency navigation signals degraded for brief intervals.	M1	2000 per cycle (950 days per cycle)

Protection

Earth's magnetosphere, ionosphere, and atmosphere protect us from the most hazardous effects of space weather. However, the amount of protection from space weather events depends on the location of impact. The polar regions are most affected because the magnetic field lines at the poles extend vertically downwards, allowing particles to spiral down the field lines and penetrate the atmosphere, increasing ionization. Extreme storms can produce disruptive and potentially damaging effects to medium and low Earth orbit satellites and lower mid-latitude terrestrial electric grids. Both satellite communications and ground-based utilities have mitigation measures that can be activated, such as temporarily ceasing non-essential maintenance operations, reducing the load on vulnerable equipment, increasing reactive reserve power, and taking steps to maximize system reliability.

Forecasting

Space weather can be predicted and forecasted. There are three levels of alerts that can be sent out for space weather: a watch, a warning, and an alert.

A watch is when the risk of a potentially hazardous space weather event has increased significantly, but its occurrence or timing is still uncertain. A space weather watch is intended to provide enough advance notice, usually a few hours or days, for protection plans to be implemented.

Warnings are sent out when a significant space weather event is occurring, imminent, or likely. These alerts are short term and there is a high confidence of occurrence. The warning is intended to give a lead time of a few minutes to a few hours.

An alert is sent out to indicate observed conditions, usually after a warning has been sent out, to inform that a space weather event has already started.

Solar Cycle

The solar cycle is a 9- to 14-year period, or an 11-year average, that the Sun goes through to release magnetic energy. The peak is the solar maximum, when there may be hundreds of sunspots visible at any time. The low is the solar minimum, when there can be many days in a row with no sunspots visible.

The first recorded solar cycle began in 1755. We are currently in cycle 24, which began in 2008; therefore, 2020 will be year 12 of the current cycle.[47]

2. Geographic Areas Affected by Space Weather

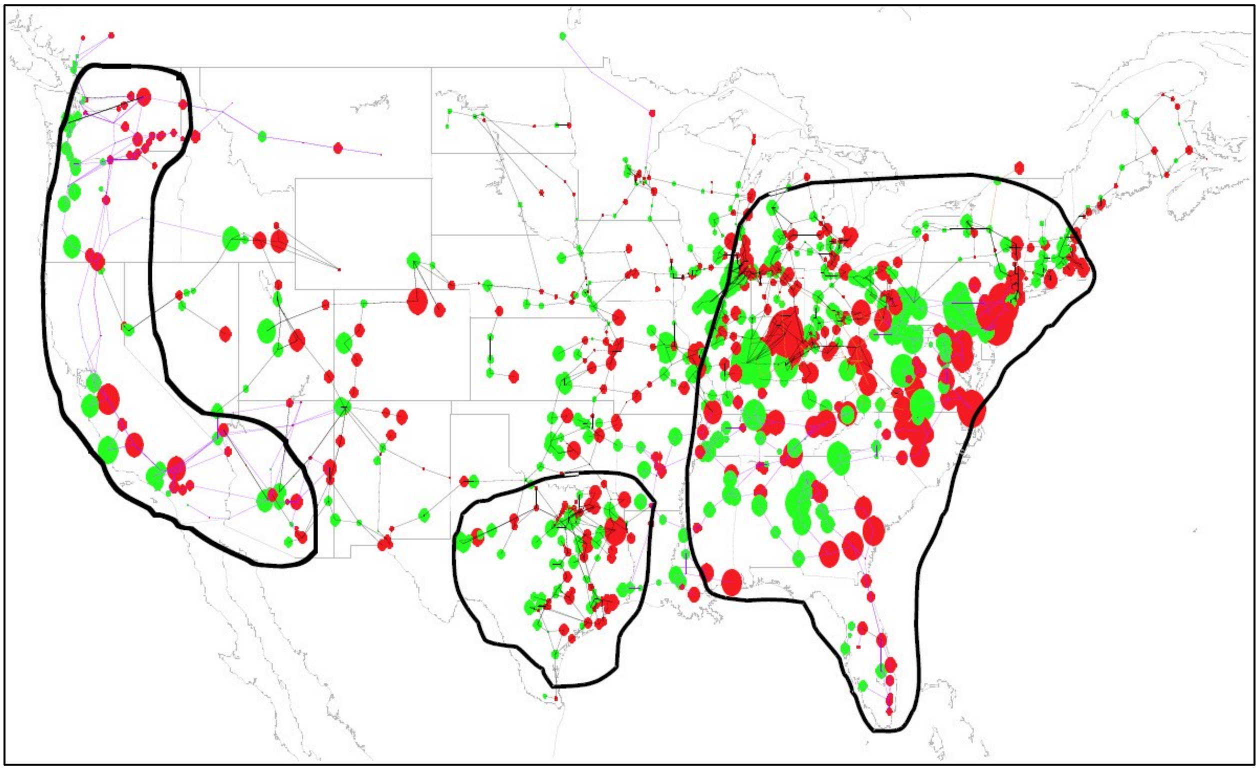
As mentioned in the section above, any region of Earth is susceptible to the effects of space weather. The sunlit side of Earth – whichever that happens to be at the time of impact – will have more effects than the unlit side of Earth. Additionally, there are stronger effects to communication systems and radiation exposure at higher altitudes and higher latitudes, such as at the polar regions.

The effects of space weather can affect more than the physical location of the impact. In fact, space weather could affect the whole of North America at the same time, and potentially become a global incident. For example, there may be cascading impacts. Because our power grids and communication systems are interconnected, an outage in one location could have far-reaching effects.

Florida has not been significantly affected by space weather since modern infrastructure began to be built in the 1950's. However, due to the high uncertainty of the location of geomagnetically induced impacts, extreme geomagnetic storms could produce electrical system disturbances and possibly widespread disruptions or blackouts. The following figures demonstrate that Florida is potentially vulnerable due to both ground connectivity and proximity to the ocean coastline.

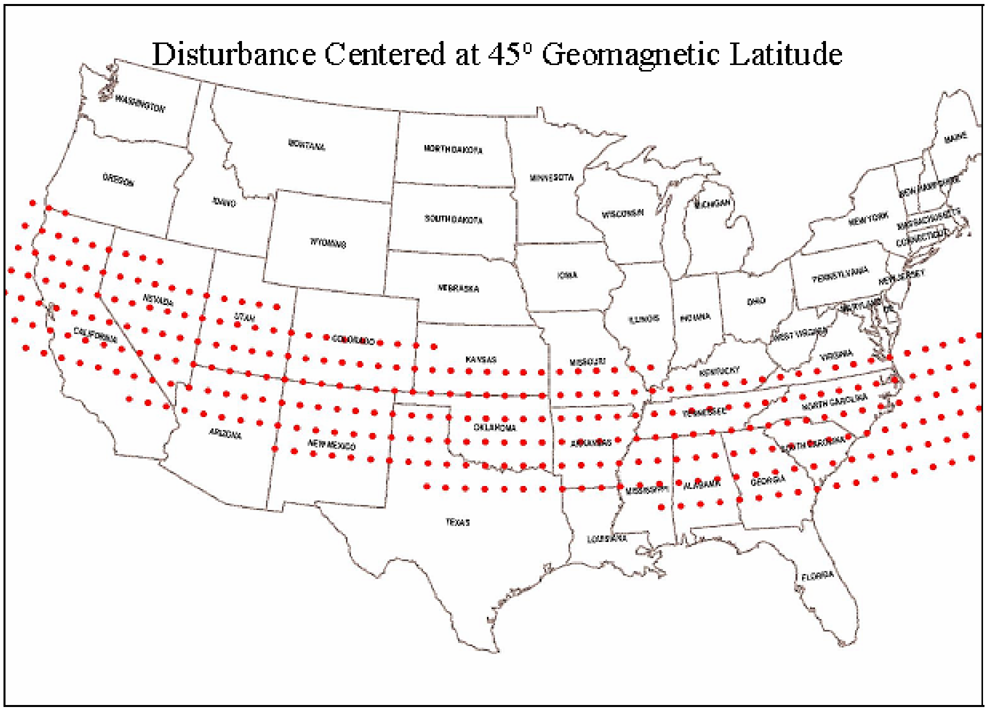
[47] http://www.nws.noaa.gov/om/space/index.shtml

Figure 4.65: United States Regions Susceptible to Electric System Collapse, 100-year Geomagnetic Storm 45 degree Latitude Scenario[48]



[48] https://www.ferc.gov/industries/electric/indus-act/reliability/cybersecurity/ferc_meta-r-319.pdf

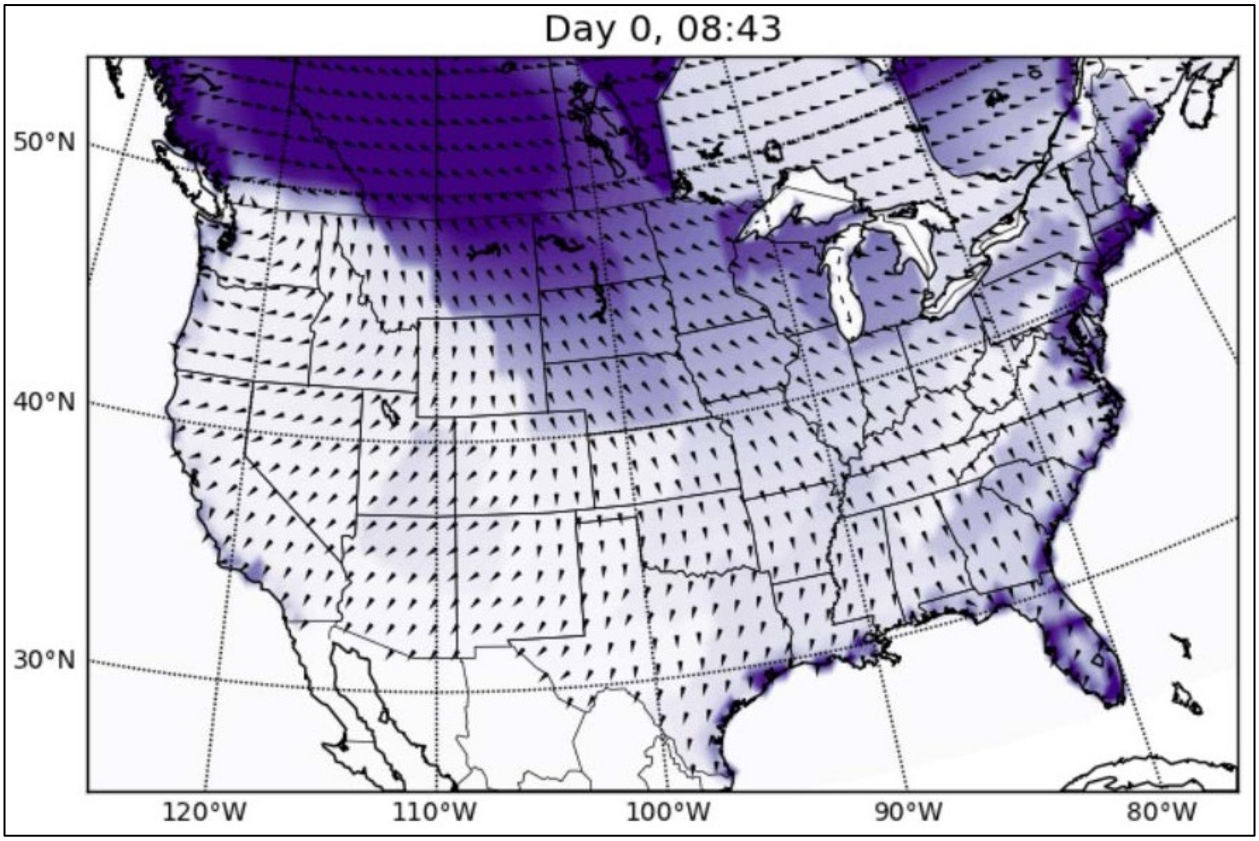
Figure 4.65: Disturbance Regions, Geomagnetic Storm, 45 degree Latitude[49]



Below is a figure depicting the electric field amplitudes (color-scale) and direction (barbs) during a simulated Carrington-level storm. Regions shaded in dark purple are experiencing the strongest surface electric fields at that time.

[49] https://www.ferc.gov/industries/electric/indus-act/reliability/cybersecurity/ferc_meta-r-319.pdf

Figure 4.65: Carrington Level Storm Electric Field Amplitudes Model[50]



3. Historical Occurrences of Space Weather

There has not been a space weather event to significantly affect Florida since our country began recording such incidents. However, space weather can affect any region at any time.

Table 4.118: Florida Historical Occurrences, Space Weather

Date	Description
September 1859	The strongest Geomagnetic Storm in recorded history, called the Carrington Event, occurred. Excess currents caused telegraph lines to fail. Technicians were shocked, and some telegraph equipment even caught fire. The Aurorae from this event were seen as far south as Cuba and Hawaii.
May 1921	A powerful geomagnetic storm called the New York Railroad Storm caused similar effects as the Carrington Event. There was interference in telegraph equipment, trans-Atlantic cable communications (telephone and telegraph), and railroad switching systems. Fires were also ignited in telegraph switchgear.
August 1972	A large solar flare disrupted long distance telephone communications across Illinois.

[50] Lloyd's/Atmospheric and Environmental Research, Solar Storm Risk to the North American Electric Grid, 2013, Figure 5, p 11

Date	Description
March 1989	A very powerful Geomagnetic Storm led to a major blackout in Canada, which left 6 million people without electricity for 9 hours. The storm disrupted electric power transmission from a generating station in Quebec and damaged power transformers in New Jersey.
October and November 2003	The Halloween geomagnetic storms were the strongest since March 1989. Both terrestrial electric utilities, aviation and spacecraft operations were affected by storms, but most were recoverable without incident. Temporary blackouts were reported in northern Europe. The November 20th storm also caused blackouts in northern Europe and South Africa. Several high-voltage transformers were damaged or destroyed in South Africa.
December 2005	X-rays from a solar storm disrupted satellite to ground communications and global positioning systems (GPS) navigation systems for 10 minutes.

4. Probability of Future Space Weather

Power outages due to space weather are rare; however, significant effects could occur.

The entire state of Florida and its population and infrastructure is susceptible to solar storms; however, the effect that minor solar events could have on the public, property, environment, and operations would be minimal. If a rare, major solar storm were to occur, there could be a much larger impact on the population, property, and operations. However, the environment would still not be affected.

This hazard was determined to have a probability level of unlikely (less than 1% annual probability).

Geomagnetic Storms

The frequency of geomagnetic storms depends on where Earth is in the average 11-year solar cycle, with most storms occurring around the solar maximum. The current solar cycle (cycle 24) maximum occurred from early 2012 to late 2014. These storms are also common in the declining phase, due to an increase in solar wind speeds. However, severe space weather can be observed at any time during the solar cycle.

Additionally, a CME may intensify a geomagnetic storm as it approaches the Earth. With sufficient time, a CME with a southward oriented magnetic field will cause geomagnetic storming by compressing and agitating Earth's magnetic field. Weak sub-storm to strong storming is common with hundreds of occurrences per solar cycle, less than 10-year long-term occurrence rates.

Storm intensity can also be measured in Disturbance storm time (*Dst*) with greater intensity represented by a more negative *Dst* value. Geomagnetic storms that cause the most significant disruptions and damage have Dst values of more than -300 nT[51], which may occur on Earth about 4 days per solar cycle. This means the probability of a storm with a Dst intensity value of about -450 nT occurs about once per solar cycle. A storm with an intensity similar to the March 1989 Great Storm may occur about one every 60 years, or about once per five solar cycles. Larger geomagnetic storms with intensities similar to the Carrington Event are rare and may occur about once every 250 years or more.

[51] nanotesla, unit of measurement

Furthermore, periods with very active sunspot groups, features such as corotating interaction regions can create an interstellar environment where unexpectedly intense and prolonged geomagnetic storming can occur.

The table below describes long-term geomagnetic storm occurrence and intensity.

Table 4.119: Space Weather Geomagnetic Storm Occurrence and Intensity Indicators

Space Weather Geomagnetic Storm Occurrence and Intensity					
Long-term Occurrence, years	**Storm Intensity Physical Measure Indicators**				
	Kyoto Equatorial *Dst* Index, nT	**Number of Storm Days per Cycle, days**	**Planetary K**	**NOAA Geomagnetic Storm Scale**	**Storm Intensity Description**
< 10	> -100	900	< 7	< 3	weak - moderate
	-100	130	7	3	strong
	-200	60	8/9-	4	severe
	-350	4	9	5	extreme
10 [52]	-451	1			
20 [5]	-501	< 1			Great Storms
30 [5]	-534				
50 [5]	-578				
60 [53]	-589				
100 [5]	-645				
200 [5]	-721				
250 [54]	-800				Carrington Class
500 [6]	-850				
1000 [6]	-925				
nT – nanotesla; Dst – Disturbance Storm Time					

The long-term geomagnetic occurrence rates illustrated above do not necessarily reflect the sun's potential to produce extreme storms at any time when active sunspot groups are present, even during lower than normal sunspot cycles. As an example, the STEREO A spacecraft orbits the sun at a location that is 1 AU distant from the sun, but with a view of the farside. At least twice during solar cycle 24, the sun produced major farside CME that would have likely impacted Earth if it had been in the path. The STEREO A spacecraft was able to directly observe the extreme interstellar conditions of a major CME in

[52] Table 2. Probable Storm Intensity S_T, *Long-term occurrence probabilities of intense geomagnetic storm events*, K. Tsubouchi and Y. Omura, Space Weather, Vol 5, 2007

[53] March 13/14, 1989 Great Geomagnetic Storm (Quebec Blackout)

[54] Estimates based on Figure 6. Probable storm intensity S_T as a function of year, *Long-term occurrence probabilities of intense geomagnetic storm events*, K. Tsubouchi and Y. Omura, Space Weather, Vol 5, 2007

July 2012 and July 2017. Academic publications indicate that the July 2012 storm could have rivaled the Carrington Event.

Solar Radiation Storms

Solar radiation storms can occur at any time during the solar cycle but are most common around solar maximum.

Radio Blackouts

Radio blackouts are caused by solar flares, which are quite common. In fact, minor events or R1 events, occur about 2,000 times each solar cycle.

5. Space Weather Impact Analysis

- Public
  - Traffic accidents caused by power outages
  - Power outages
    - Lost wages
    - Perishable food and medications
- Responders
  - N/A
- Continuity of Operations (including continued delivery of services)
  - Power outages may interrupt operations or delivery of services in government, private businesses, etc.
- Property, Facilities, Infrastructure
  - Damage to electrical lines, transformers, etc. may take several days or weeks to repair
  - Damage to lines may cause fires
  - Disruptions to computer systems, telephone systems, and other communications systems
  - Water and wastewater distribution systems
  - Public transportation systems
  - All electrical systems that do not have back up power
  - Heating/air conditioning and electrical lighting systems
  - Fuel distribution systems and fuel pipelines
- Environment
  - N/A
- Economic Condition
  - Extensive power outages would close businesses, causing them to lose revenue and employees to lose wages
  - High cost of repairing damage to utilities may put a burden on utility companies and they may have to raise rates
- Public Confidence in the Jurisdiction's Governance
  - May lose confidence in jurisdiction if communications or utilities are disrupted for an extended period of time

6. Vulnerability Analysis and Estimated Losses by Jurisdiction

In 2013, the state mitigation group, Mitigate Florida, identified space weather as an emerging threat. As of the 2018 update, there is no way to accurately assess risk and vulnerability of jurisdictions to space weather. This is because no one county or area in Florida is more vulnerable to space weather than another. Additionally, space weather impacts are not distributed geographically like natural hazard often are, but instead are based on the power grid. Because of this, there may be impacts in Florida from damage in another state caused by space weather.

7. Vulnerability Analysis and Estimated Losses of Critical Facilities

As explained above, Mitigate Florida identified solar storms as a potential emerging threat in 2013. According to current data, there is no way to assess risk and vulnerability of State Facilities to space weather. This is because no one area in Florida is more vulnerable than another to this hazard. Additionally, no state facilities are particularly more vulnerable than others to be affected by space weather because the geographic distribution of impacts would be based on the power grid.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.8.

<table>
<tr><th colspan="5">SPACE WEATHER</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">Space weather is a broad term used to describe atmospheric events that have the potential to adversely affect conditions on Earth. Space weather events are caused by the interaction of Earth with emissions from the Sun. There are two causes of space weather events, coronal mass ejections (CMEs) and solar flares, which are different incidents that occur on the Sun. CMEs and solar flares can cause three different types of space weather events on Earth, geomagnetic storms, solar radiation storms, and radio blackouts.</td><td>HIGH</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Unlikely</td><td>Catastrophic</td><td>Large</td><td>< 6 hrs</td><td>< 6 hrs</td><td>2.8</td></tr>
</table>

Dam/Levee Failure Hazard Profile

1. Dam/Levee Failure Description

The failure of a dam or dike may also result in a flood event. The amount of water impounded by a dam is measured in acre-feet; an acre-foot of water is the volume that covers an acre of land to a depth of one foot. Dam failures are not routine. Two factors influence the potential severity of full or partial dam failure: (1) The amount of water impounded, and (2) the density, type, and value of development downstream.

In 2007, the U.S. Army Corps of Engineers declared that the Herbert Hoover Dike was on the top of the list of nationwide dams in need of repair. Since 2001, USACE had provided over $870 million in rehabilitation funds for the dike.[55] The Herbert Hoover Dike is one of many dams in Florida, each of which are listed in the National Inventory of Dams and are assigned a high, significant, or low hazard classification based on potential for loss of life and damage to property if the dam fails. Classifications are updated based on development and changing demographics upstream and downstream.

Dam hazard is a term indicating the potential hazard to the downstream area resulting from failure or operational errors of the dam or facilities. The level of risk associated with dams is classified into three categories based on definitions from USACE:

- Low: A dam where failure or operational error results in no probable loss of human life and low economic and/or environmental loss. Losses are principally limited to the owner's property.
- Significant: A dam where failure or operational error results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or affect other concerns. These dams are often located in predominantly rural or agricultural areas but could be located in areas with more dense populations and significant infrastructure.
- High: A dam where failure or operational error will probably cause loss of human life.

A number of outside forces can cause dam failure, including prolonged periods of rain or flooding, landslides into reservoirs, failure of dams upstream, high winds, and earthquakes. Failure due to natural events such as earthquakes or tornadoes is significant because there is little to no advance warning. Improper design and maintenance, inadequate spillway capacity, internal erosion or "piping" within a dam, or a deliberate attack may also cause dam failure.[56]

National statistics show that overtopping of dams due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for 34% of all dam failures. Foundation defects, including settlement and slope instability, account for 30% of all failures. Piping and seepage cause 20% of national dam failures. This includes internal erosion caused by seepage, seepage and erosion along hydraulic structures, leakage through animal burrows, and cracks in the dam. The remaining 16% of failures are caused by other means, including the failure of conduits and valves.[57]

[55] http://www.saj.usace.army.mil/Missions/Civil-Works/Lake-Okeechobee/Herbert-Hoover-Dike/
[56] http://www.damsafety.org/news/?p=412f29c8-3fd8-4529-b5c9-8d47364c1f3e
[57] http://www.ecy.wa.gov/PROGRAMS/wr/dams/failure.html

When the term “dam” is used, it is normal to think only of structures associated with the impounding of rivers for use a drinking water reservoirs, the production of electricity, or flood control. In Florida, the term can take on an additional meaning, that of impounding clay settling ponds or phosphogypsum stacks associated with the mining and processing of phosphate. Both types of structures can be found within Hillsborough County. Dam/Levee failure is a collapse or breach in a dam or levee. While most dams have storage volumes small enough that failures have little or no repercussions, dams with large storage amounts can cause significant downstream flooding.

2. Geographic Areas Affected by Dam/Levee Failure

The National Inventory of Dams, a congressionally authorized database maintained by USACE, documents dams in the United States. According to the National Inventory of Dams, there are 96 dams in Hillsborough County as of January 2019. Of those, 9 are high hazard dams and 57 were significant hazard dams.[58]

The Florida DEP coordinates the Florida Dam Safety Program and maintains information for over 1,200 federal and non-federal dams in the state.[59] It has been determined that the river systems and the immediate areas around these dams are the zones with the highest vulnerability to flooding resulting from dam failure. Overall dam failure is a low priority with respect to flooding since the risks of coastal and inland flooding are much higher.

The specific locations of the dams are not provided in the plan due to security concerns.

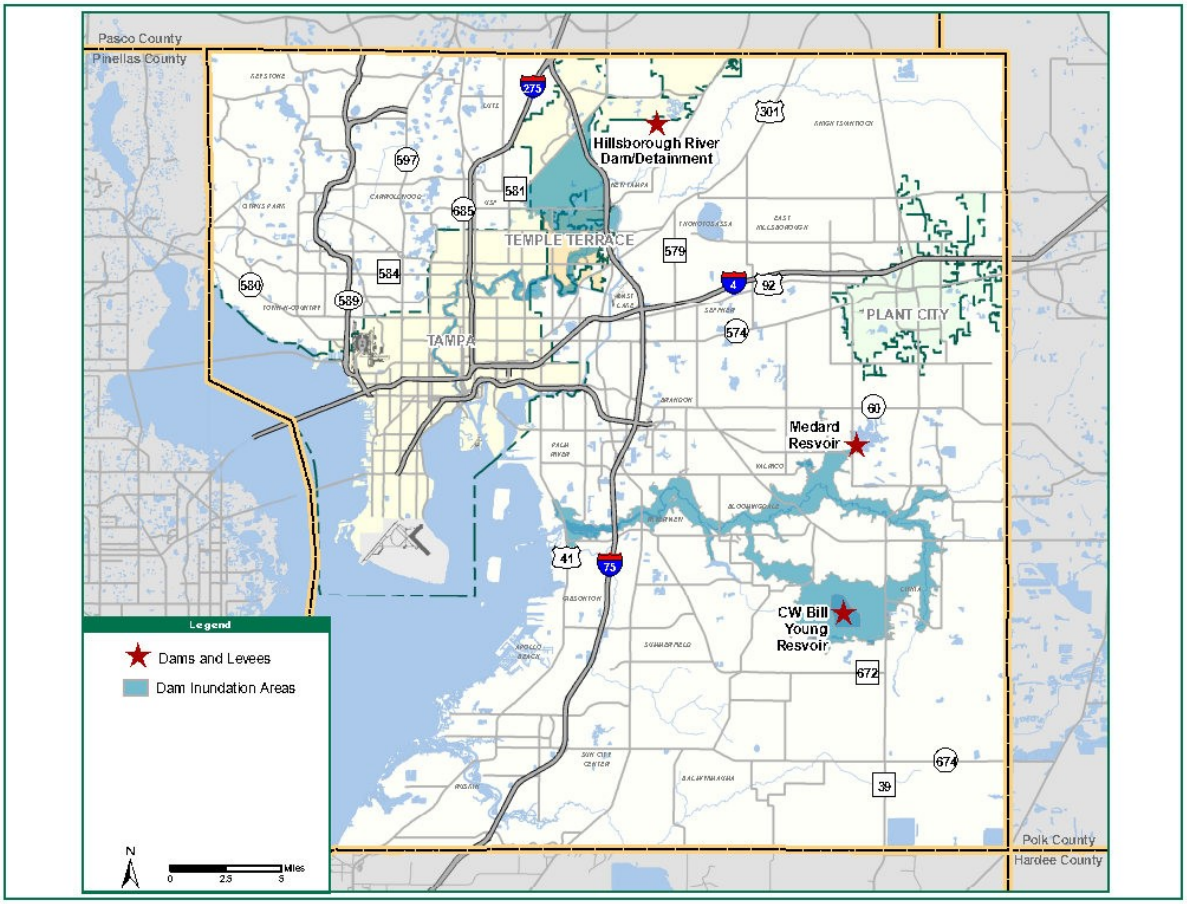
The City of Tampa’s Hillsborough River Reservoir is located east of 28th Street, just downstream from the City of Temple Terrace. The Reservoir is approximately 1,300 acres in size and contains up to 1.6 billion gallons of water. The Reservoir has served as the City of Tampa’s water source since the mid-1920s. In southeastern Hillsborough County, near CR 672 and SR 39 and south of the Alafia River, is the Tampa Bay Regional Reservoir. The Reservoir is being built by Tampa Bay Water to provide an additional source of potable water for the residents of the Tampa Bay area. The 1,100-acre Reservoir has a total volume of 15 billion gallons.

During the 1950s and 1960s residents along the Hillsborough River experienced several serious flood events. As a consequence, in the 1960s and 1970s, the Tampa Bypass Canal was constructed. Following the course of Palm River, the 14-mile waterway, with its flood-control structures, is intended to redirect rising waters from the Hillsborough River to McKay Bay. In addition to the Tampa Bypass Canal, flood control structures can be found along several of the creeks in the western portions of Hillsborough County. These creeks flow into the northern reaches of Tampa Bay.

Phosphate mining activities can be found in the eastern portions of the county. As noted above, phosphate mining and processing requires the need for water impoundments associated with clay settling ponds at the mining site and phosphogypsum stacks associated with the phosphate processing plant. Generally, phosphate processing plants are located in proximity to the mine sites. The exception to this is the Mosaic Riverview Plant located at the mouth of the Alafia River on Hillsborough Bay.

[58] https://nid.sec.usace.army.mil/ords/f?p=105:113:6944732769621::NO:113,2:P113_STATE,P113_COUNTY:FL,057
[59] https://floridadep.gov/water/engineering-hydrology-geology/content/florida-dam-safety-program

Figure 4.65: Hillsborough County Dam Inundation Areas



3. Historical Occurrences of Dam/Levee Failure

The construction and safety of dams and levees in Florida is governed by Chapters 62 and 373, FS. Through design and permitting there is little danger of failure from the Hillsborough River Reservoir, Tampa Bypass Canal or Tampa Bay Regional Reservoir. Unfortunately, the same cannot be said for clay settling ponds and phosphogypsum stacks. Since 1988, there have been four failures of such facilities either in or directly impacting Hillsborough County. The following is a summary of these events:

- 1988 and 1993 – Riverview, unincorporated Hillsborough County. Acidic water spill at the Mosaic Riverview (aka Gardinier) phosphate processing plant located at the mouth of the Alafia River.
- November 1994 – Hopewell, unincorporated Hillsborough County. Failure of a clay settling pond at the Hopewell Mine spilled approximately 1.9 million gallons of water into the Alafia River. In addition, some flooding occurred in the Keystone area.
- December 1997 – unincorporated Polk County. Failure of a phosphogypsum stack at Mulberry Phosphates resulted in 2.0 million gallons of phosphogypsum process water entering the Alafia River.

- September 5, 2004 – Riverview, Florida, a dike at the top of a 100-foot- high gypsum stack holding 150-million gallons of polluted water broke after waves driven by Hurricane Frances bashed the dike's southwest corner. Nearly 60 million gallons (227,000 m3) of acidic liquid spilled into Archie Creek that leads to Hillsborough Bay.

4. Probability of Future Dam/Levee Failure

There is no sure way to predict future dam/levee failure as most incidents typically occur without warning. Given the current dam inventory, historical data, and ongoing maintenance, a dam breach is unlikely. However, as it has been demonstrated in the past, regular monitoring is necessary to prevent these events.

This hazard was determined to have a probability level of unlikely (less than 1% annual probability).

5. Dam/Levee Failure Impact Analysis

- Public
  - Injury/death
    - Drowning
    - Vehicle accidents
    - Extended wait for emergency response
    - Become stranded on rooftop or trapped inside building or car
    - Exposure to hazardous materials or wastewater
  - Traffic
    - Panic to evacuation
    - Accidents from driving through flooded roads – car washed away, water deeper than expected
  - Damage to property
    - Mold infestation
    - Need to replace property damaged, furniture, clothes, etc.
    - Repairing damaged property
    - Issues with damage to uninsured property
- Responders
  - Injury/death
    - Responding to calls during flooding, traversing flooded roads
    - Drowning
    - Dangerous rescue missions, from roofs, unstable buildings, stranded cars
    - Exposure to hazardous materials or wastewater
    - Power outage dangers, such as being electrocuted by live downed wires
- Continuity of Operations (including continued delivery of services)
  - Floodwaters may damage buildings, electrical systems, paperwork, etc. making continued operations difficult or impossible

  - Floodwaters may hinder access to buildings (roads or sidewalks) preventing employees and the public from entering a building
- Property, Facilities, Infrastructure
  - Property damage
    - Floodwaters can damage property or carry heavy debris that could cause damage
  - Infrastructure damage
    - If water overwhelms the drainage systems, it can backup and cause damage to drains or even result in wastewater release
- Environment
  - Release of wastewater could damage environment
  - Damage to habitat for plants and animals
  - Inundation of agricultural areas could destroy crops
  - Event-generated debris impacting waterway navigation and submerged wetland habitats
- Economic Condition
  - Closure or delay of businesses because of flooded roads or water damage, leads to loss in revenue
  - Crop damage or loss leads to decline in agricultural revenues
- Public Confidence in Jurisdiction's Governance
  - If floodwaters do not recede quickly, it appears as though the water utilities and government are not able to manage water properly, which calls into question the capability of the government
  - If public or government offices have to close because of restricted access due to floodwaters, people may think the government is not able to handle emergency events and lose confidence in their capabilities

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Residents of Tampa living downstream of the Hillsborough River Reservoir are the most vulnerable should there be a dam failure. The exact number of residents which would be affected by such an event would be dependent upon the degree of the failure.

Concern with flooding was a major issue of residents and elected officials during the permitting of the Tampa Bay Regional Reservoir. The potential for such an event was deemed to be slight during the review of the Reservoirs Environmental Impact Statement by the U.S. Environmental Protection Agency and construction permit by the Florida Department of Environmental Protection.

Although it is possible, it is not probable that the failure of clay settling pond or phosphogypsum stack would adversely impact county residents. This determination can be made based on the general isolated nature of these operations. Still, as noted in the 1994 event, flooding of residences can occur. As a result of their general isolation it is not possible to determine the potential number of residents in the unincorporated county who could be affected. The major consequence of a failure event would be the resulting environmental damage should contaminated water reached a creek or river or infiltrate into the groundwater supply.

No further analysis will be completed on the vulnerability to dam/levee failure as more sophisticated dam breach plans (typically completed by the U.S. Army Corp of Engineers) have been completed for dams of concern in the county.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

No further analysis will be completed on vulnerability of critical facilities to dam/levee failure as more sophisticated dam breach plans (typically completed by the U.S. Army Corp of Engineers) have been completed for dams of concern in the county.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.3.

<table>
<tr><th colspan="5">DAM/LEVEE FAILURE</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">The failure of a dam or dike may also result in a flood event. The amount of water impounded by a dam is measured in acre-feet; an acre-foot of water is the volume that covers an acre of land to a depth of one foot. Dam failures are not routine. Two factors influence the potential severity of full or partial dam failure: (1) The amount of water impounded, and (2) the density, type, and value of development downstream.</td><td>MODERATE</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Unlikely</td><td>Critical</td><td>Moderate</td><td>< 6 hrs</td><td>< 6 hrs</td><td>2.3</td></tr>
</table>

Agricultural Disruption Hazard Profile

1. Agricultural Disruptions Description

The Presidential Policy Directive (PPD) on Critical Infrastructure Security and Resilience outlines the Food and Agricultural Sector as one of 16 complex critical infrastructure systems. Sectors that have been identified as critical infrastructure would be debilitating to the economy, public health, national security, and property. The Food and Agriculture Sector is almost entirely under private ownership and is composed of farms, restaurants, and registered food manufacturing, processing, and storage facilities.

The agricultural system in Hillsborough County is not only an important economic contributor in the state of Florida but could pose unique food safety concerns or lower food access, if disrupted. Having a robust food and agricultural sector with an active seaport and airport in the county provides many advantages yet presents a variety of unique risks to the agricultural systems. These factors need to be considered to ensure food and agricultural systems are secure and able to withstand and rapidly recover from all hazards. Agricultural disruptions are caused by accidental and intentional food contamination and disruptions, disease and pests, severe weather events (i.e., drought, floods, climate change), and cybersecurity threats.

The Food and Agricultural Sector accounts for roughly one-fifth of the nation's economic activity and has a number of dependencies[60] with many of the other critical infrastructure sectors including:

- Water and Wastewater Systems –for clean irrigation and processed water
- Transportation Systems –for movement of products and livestock
- Energy –to power the equipment needed for agriculture production and food processing
- Chemical –for fertilizers and pesticides used in the production of crops

Due to the complexity of agricultural systems, it may not be feasible to prevent disruptions all together, however, having in place early warning systems or surveillance by veterinarians, agricultural producers, and nationally coordinated disease surveillance programs is important to mitigate these potential threats.

The Florida Department of Agricultural and Consumer Services (FDACS), the Florida Department of Health (FDOH), and the Florida Department of Business and Professional Regulation (FDBPR) are the three primary state agencies tasked with preventing, preparing for, responding to, and ensuring recovery from food and feed emergencies in Florida. Furthermore, animal protection falls directly under Emergency Support Function (ESF) #17. The Florida State Agricultural Response Team was created by the FDACS to manage animal-related emergencies and provide support for ESF #17. Emergencies affecting crops are managed by a combination of these agencies depending on the exact nature of the emergency.[61]

The occurrence of disease in animal species are monitored by a network of private and state veterinarians. The USDA and World Organization for Animal Health (OIE) maintain a list of reportable infectious diseases,

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[60] https://www.dhs.gov/cisa/food-and-agriculture-sector
[61] https://flsart.org/aboutus/overview.jsp

known as transboundary disease (TBD) or foreign animal disease (FAD).[62] TBDs (sometimes referred to in the U.S. as FADs) are highly communicable pests and germs that responsible for high rates of disease and/or death in the affected animal populations. All veterinarians are trained to recognize and report these diseases and must maintain current accreditation (continuing education) in recognition of these diseases. When occurrences of these diseases are suspected, sample are sent to a National Animal Diagnostic Lab (NADL) network lab that is often called the *State Diagnostic Lab*.[63]

In Florida, that lab is the Bronson Animal Disease Diagnostic Lab located in Kissimmee, Florida. Similarly, agricultural workers in partnership with county and state coordinators for the Plant Protection and Quarantine program, monitor the crop systems for pest and disease occurrence.[64] Instances of suspected invasive disease or pests results in reporting/sample submission to the National Plant Diagnostic Network (NPDN). The University of Florida provides regional lab service for the southeastern United States.

Other monitoring and early warning systems include weather and drought monitoring systems, like the ones implemented by the National Oceanic and Atmospheric Administration (NOAA) and the Florida State University Climate Center. Projections of imminent periods of extreme weather may initiate a disaster declaration by either the state/local leadership, the presidential office, and/or the office of the Secretary of Agriculture.

Agricultural Industry in Hillsborough County

The subtropical climate of Hillsborough County provides a conducive environment for near year-round production of a variety of plant and animal commodities. Agriculture is an important small business industry with 96% of Hillsborough county farms being family-owned operations.[65] Hillsborough County has 2,466 farms, the 3rd largest number of farms of any county in the state of Florida and the 49th highest in the country. Diversity is one of the keys to the success of Hillsborough County agriculture which includes fruits, tree nuts, berries, swine products, and aquaculture (especially tropical fish).[66] In addition to major commodities, a variety of specialty crops contributed to the sale of $865 million of products in 2017. According to the U.S. Department of Agriculture (2017), Hillsborough County ranks the 4th largest producer of agricultural products in the state (out of 67 counties) and 189th in the United States (out of 3,079 counties). Hillsborough County is in the top 6% of agricultural counties in the country. In 2017, an estimated 239,358 acres were utilized for agriculture production; this represents approximately 37% of the county's land area.

Local agriculture generates additional local economic impact by supporting related businesses such as banking, real estate, legal services, transportation, packaging, equipment, seed, agricultural suppliers and services, and marketing firms. Most agriculture goods produced in Hillsborough County are sold outside of the county. According to a study completed in 2005, for every dollar of agricultural goods sold outside of the county, an estimated $l.86 is added to the local economy as a result of indirect and induced

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[62] World Organization for Animal Health. (2019). OIE-Listed diseases, infections, and infestations in force in 2019. *Animal Health in the World*. https://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2019/

[63] https://nifa.usda.gov/national-plant-and-animal-diagnostic-laboratory-networks

[64] https://www.aphis.usda.gov/aphis/ourfocus/planthealth/ppq-program-overview

[65] www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/ Florida/index.php

[66] U.S. Department of Agriculture. (2019, February 11). 2017 State and County Profiles. U.S. Agricultural Census (2017). National

benefits.[67] This study also calculated that agriculturalists contribute four times more in revenue (taxes, fees, transfer payments, etc.) to local government than they require in government services, effectively subsidizing government services for the urban residential population.

Table 4.120: Top Agricultural Commodities in Hillsborough County, 2017 [68]

Rank	Top Commodities by Value ($)	Top Commodities by Land Use (acres)
1	Strawberries ($477 million)	Forestry/Timber (117,560)
2	Vegetables ($150 million)	Beef Cattle/Pasture (76,859)
3	Ornamental Plants/Nursery ($125 million)	Vegetables (12,020)
4	Miscellaneous ($42 million)	Strawberries (11,367)
5	Aquaculture ($19 million)	Citrus (5,585)
6	Beef Cattle/Pasture ($14 million)	Hay (5,479)
7	Blueberries ($13 million)	Miscellaneous (3,045)
8	Sod ($6.7 million)	Ornamental Plants/Nursery (2,796)
9	Citrus ($6.2 million)	Sod (1,579)
10	Peaches ($3 million)	Blueberries (1,030)
Total	**$865,168,644**	**239,358**

Notes: This is the typical appearance of a strawberry field in Hillsborough County. This picture was taken with the permission of UF/IFAS. Source: UF/IFAS Hillsborough County Extension. (2019). Military Agricultural Tour (Presentation).

Strawberries

[67] UF/IFAS Hillsborough County Extension. (2019). Military Agricultural Tour (Presentation).
[68] www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/ Florida/index.php

The strawberry industry is, by far, the top agricultural industry in Hillsborough County valued at $477 million in sales, revenue, and other income. Strawberry production is a chemical intensive operation. Because of the great value of this crop, strawberries are exclusively grown on mulch with underlying soil that has been sterilized in some manner using fumigants that are applied approximately two weeks prior to planting. Following fumigation, the beds are covered in plastic white, silver, or black plastic. The primary planting period for strawberries in Florida is in September with an average harvest period running from late November into early April.

Vegetables and Nursery

Other fruits and vegetables, including tomatoes, melons, peppers, and so on, make up Hillsborough's second highest value industry. Nursery and ornamental plants make up the third. The exact appearance of these operations and practices vary depending on the specific crop requirements and best practice experience of the grower. Some fruits and vegetables can be seen growing in small or large open fields, while others require green houses. Nursery operations are most often carried out in planting trays or pots inside or outside of green houses.

Pasture/Beef

Pasture/beef production is the second highest valued livestock agriculture in Hillsborough. About half of all Hillsborough's agricultural land is dedicated to beef and pasture operations. All beef cattle live spend a large portion of their life on grazing on open pasture grazing and growing to size. Additionally, Florida's pastures, if properly developed, can serve as important green space for wildlife and native plant species, aquifer recharge, and carbon recovery. There is an effort in the cattle ranching community to incorporate best practices in conservation, renewable energy, and improved land development practices. Every year Florida has several regional winners that go on to compete for the National Cattlemen's Association Environmental Stewardship Award.

Notes: This picture is of a site visited during research and assessment. The facility featured both above ground tanks located in sheds with in-ground pools.

Aquaculture

Aquaculture is the process of growing animals or plants in controlled water environments. This industry, specifically tropical fish aquaculture, is the top livestock industry for Hillsborough County. Other forms of aquaculture that may be seen include aquatic plants, shellfish, turtles, and alligators, which may be included under livestock or miscellaneous agriculture codes by the property appraiser. This industry is carried out in small or large above ground tanks, commonly housed inside sheds, green houses, or screen enclosures for protection, and/or in pools seen in the image below. These operations involve a complex variety of systems including water transfer lines, salination systems, aeration systems, water treatment/purification, and small to large tank/pool areas.

Hazards that Lead to Agricultural Disruptions

Agricultural disruptions are not usually a cause for disaster declarations individually but can occur as part of a larger disaster declaration (e.g. hurricanes, flooding, tornado). Many of the same hazards that disrupt civil order and the built environment impact agriculture. Furthermore, agricultural disruption can produce many second order effects that has significant impacts on the local economy, ecology, and built environment.

Table 4.121: Hazards that Disrupt Agriculture and their Potential Impacts[69]

<table>
<tr><th>Hazard</th><th>Disruption/Impacts</th></tr>
<tr><td>Extreme Storm Events
(Hurricanes/Tropical Storms/ Thunderstorms/Tornadoes)</td><td rowspan="3">• Stress/damage to crops
• Fruit drop and/or down trees
• Injury/Death of agriculturally significant animals
• Increase plant/animal disease transmission (including zoonotic/toxic)
• Increased food and waterborne disease risk
• Structure and equipment damage
• Spoilage and/or rot of product
• Contamination of pasture/crops and soil with chemicals or germs
• Delay in planting/harvesting periods
• Increase agricultural draw on utilities and infrastructure
• Market vulnerability & cost fluctuations
• Injury/Death of agricultural workers, veterinary personnel, and related professions
• Mass Migration (movement to work; abandonment of local agriculture)</td></tr>
<tr><td>Extreme Heat Conditions
(Heat Wave/Drought/ Wild Fires)</td></tr>
<tr><td>Extreme Cold Conditions
(Frost/Freeze/Snow/Blizzard)</td></tr>
<tr><td>Sea Level Rise</td><td>• Stress/Damage to crops
• Spoilage and/or rot of product
• Alteration of soil quality
• Increase agricultural draw on utilities and infrastructure
• Market vulnerability and cost fluctuations</td></tr>
</table>

[69] U.S. Department of Homeland Security. (2019). Critical Infrastructure Sectors. Cyber + Infrastructure. https://www.dhs.gov/cisa/critical-infrastructure-sectors

Hazard	Disruption/Impacts
Plant and Animal Disease Outbreak/Biologic Incidents	• Stress/damage to crops • Fruit drop, spoilage and/or rot of product • Increased food & waterborne disease risk • Increased plant/animal disease transmission (including zoonotic/toxic) • Injury/Illness/Death of agricultural workers, veterinary personnel, and related professionals
Utility Failure	• Spoilage and/or rot of product • Delay in planting/harvesting • Market vulnerability & cost fluctuations • Increase agricultural draw on utilities and infrastructure • Mass Migration (movement to work; abandonment of local agriculture) • Increased food & waterborne disease
Transportation Incidents	• Stress/damage to crops • Spoilage and/or rot of product • Contamination of agricultural products with chemicals or germs • Injury/death of agricultural workers and related professions
Chemical/Radiologic Incidents	• Stress/damage to crops • Contamination of agricultural products with chemicals or radiation • Increased food & waterborne disease risk • Increase draw on utilities and infrastructure • Mass Migration (movement to work; abandonment of local agriculture) • Market vulnerability and cost fluctuations
Terrorism (Agroterrorism)	• Stress/damage to crops • Contamination of agricultural products with harmful agents • Increased food & waterborne disease risk • Increased zoonotic disease risk • Increase draw on utilities and infrastructure • Mass Migration (movement to work; abandonment of local agriculture) • Market vulnerability & cost fluctuations
Market Disruption	• Market vulnerability & cost fluctuations • Delay in planting/harvesting • Increase agricultural draw on utilities and infrastructure
Urban Sprawl	• Stress/damage to crops • Contamination of agricultural products with chemicals/germs • Increase food and waterborne disease risk • Increase zoonotic disease risk • Increase agricultural draw on utilities and infrastructure
Notes: Specific hazards for agricultural disruption can be divided into three broad categories: Natural (green), Technological (orange), and civil (red/gray).	

Potential Effects of Climate Change on Agricultural Disruptions

Climate change can disrupt food availability, reduce access to food, and affect food quality. For example, projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity.

Extreme weather events, especially droughts, heat waves, severe storms, and hurricanes, can be expected to continue into the future or potentially negatively impact the protection of the food chain. Current temperatures are optimal for many Florida crops with lower yield in hot seasons. Potential rising temperatures in the future will decrease annual crop yield, livestock productivity and water access. This will lower Florida's market strength. Increasing carbon dioxide levels may also decrease the nutritional content of many food crops.

Climate change is may change the ranges and behavior of agricultural pests and diseases. Rising temperatures and carbon dioxide levels may optimize growth of some invasive species and fungal diseases. Climate change and globalization is associated with a progressive northward movement of certain fungal and protozoal germs that may produce plant and animal disease outbreaks in new areas.

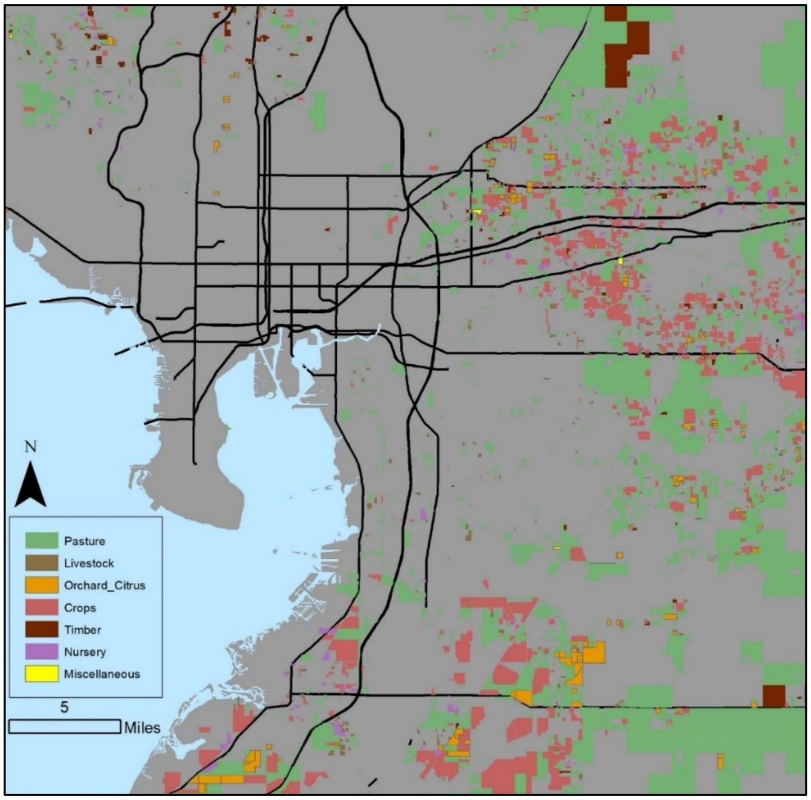
Sea level rise may be associated with salination of area water sources and aquifers. This can alter soil quality resulting in lowered yields or failed planting cycles.

2. Geographic Areas Affected by Agricultural Disruptions

Approximately 20-40% of the land mass in Hillsborough County has been dedicated to agriculture over the previous 5-year period. The majority of that land is located in unincorporated Hillsborough County and Plant City. Residential and increasingly urbanized areas exist between those agricultural properties. The land mass dedicated to agriculture in the county is declining from over 260,000 acres in 2012 to less than 240,000 acres in 2019. Over half of that land is dedicated to the forestry/timber and pasture/beef industries.

Despite this decline, agricultural land is very geographically dispersed throughout the county. Hazards that disrupt agriculture are often widespread throughout the county (e.g., hurricanes, wildfires, extreme heat/cold). It is important to note that the secondary effects of agricultural disruption may not be confined to the impacted farms. Secondary issues of food and waterborne disease outbreaks and quarantine zones may have countywide to national effects.

Figure 4.65: Agriculture in Hillsborough County, 2019



Source: Hillsborough County Property Appraiser, 2018.[70]

The above map shows the distribution of agricultural land in Hillsborough county in 2018 including pasture (including beef), livestock (i.e. poultry, fish, bees, dairy, feedlots), crops (field crops, berries, vegetables, berries, melons, other fruit), Orchard, Citrus, Nurseries (ornamental plants), timber, and miscellaneous (all other agriculture not captured above).

Nearly 80% of the agricultural land in Hillsborough County is located in the flood plain. Upland and coastal areas are similarly at risk for inundation flooding. Approximately 4% of agricultural land is at risk for category 1 hurricane storm surge and 11% agricultural land is at risk for category 5 hurricane storm surge. The most at-risk areas storm surge is in the southern portion of the county in and around Riverview, Gibsonton, Ruskin, and Sun City Center. A small area of at-risk land is also located in the northwestern corner of the county (north of Westchase), which is located in the Category 5 projected surge. Types of agricultural production at-risk in these areas include vegetables, pastures, nurseries, sod, and timber.

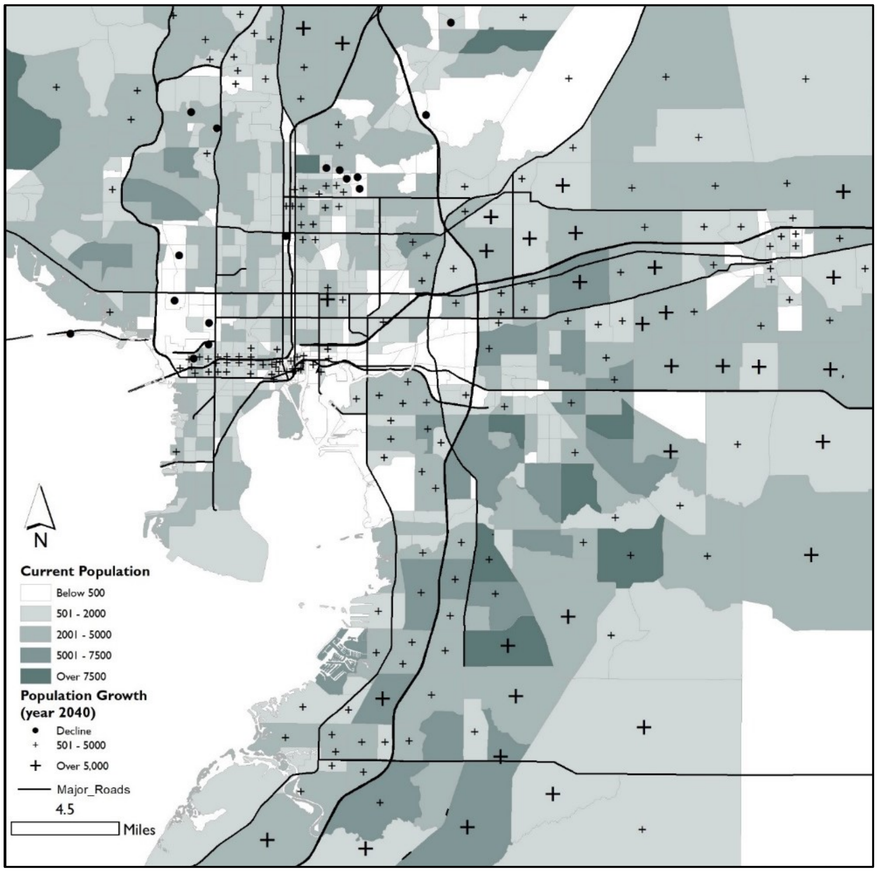
Urbanization in Hillsborough County

The most significant and frequent disruptors of agriculture cited by those in the industry is urban sprawl and market vulnerability. Agriculture is geographically dispersed throughout the eastern and southern areas of the county.

[70] Hillsborough County Property Appraiser. (2018). Hillsborough County Parcels. Hillsborough County Property Appraiser Downloadable Maps and Data. https://www.hcpafl.org/Downloads /Maps-Data

The current population and projected population growth in Hillsborough county are depicted in the map below with an indication of areas where the largest projected areas for growth correspond with current agriculture dense areas are occurring. Mixed land development among agricultural land creates a number of challenges including alteration of local water management, increased soil and land contamination, increased risk of zoonotic disease exposures, greater difficulty in biosecurity, and discontent or conflict between residents and the farm owners and workers.

Figure 4.65: Population Growth in Areas of High Agricultural Density in Hillsborough County



Source: Hillsborough County Planning Commission. (2019). 2045 Long Range Growth Forecasts.[71]

3. Historical Occurrences of Agricultural Disruptions

The historical occurrences below present a sampling of significant incidents or hazards that caused excessive risk or harm to the agricultural systems in Hillsborough county. The incidents profiled here have additional notable concurrent or secondary impacts.

Natural Disasters & Extreme Weather

Every year natural disasters, such as hurricanes, floods, fires, and tornadoes, challenge agricultural production. Since agriculture relies on the weather, climate, and water availability to thrive, it is easily

[71] Hillsborough County Planning Commission. (2019). 2045 Long Range Growth Forecasts (Socioeconomic Data). *Plan Hillsborough*. https://planhillsborough.org/2045-long-range-growth-forecasts/

impacted by natural events and disasters.[72] Flooding, severe thunderstorms, and tropical cyclones pose the greatest risk to agricultural disruptions in Hillsborough County.

Furthermore, temperature, precipitation, carbon dioxide, and water availability, directly impact the health and wellbeing of plants and livestock, as well as pasture and rangeland production. The potential impacts from extreme heat, drought, and freezes are relatively rare occurrences in Hillsborough county, however, climate change poses a major challenge as some of these events may become more common.[73]

Table 4.122: Description of Significant Freezes that Affected Hillsborough County, 1910 - 2018

Date	Information
Winter Freeze, January 2010	Freezing conditions (below 34°F) were seen for 11-12 days and a light snow fell in parts of Central Florida. One secondary effect of this event was a rash of sinkholes and karst events in the Plant City and Dover area. A disaster declaration was made for local farmers and disaster assessment teams were deployed to inspect properties for sinkhole damage.[74]
Drought, Spring/Summer 2017	Moderate to severe drought conditions experienced from April through June prompted a disaster declaration from the Secretary of Agriculture. Heavy rains in late June/July followed by the impacts of Hurricane Irma ended this drought period. The exact impacts/losses of this event could not be quantified due to the extreme and widespread impacts produced by Hurricane Irma.[75] [76]
Hurricane Irma, September 2017	In 2017, Hurricane Irma made landfall in southwest Florida as a Category 3 storm. Irma produced tropical storm to hurricane-force conditions in all 67 counties of Florida. The storm produced an estimated $2.5 billion in losses in the state, most of which (78.7%) were experienced in crop commodities.[77] Hillsborough county experienced category 1-2 hurricane conditions during Hurricane Irma and was in the top-ten counties that experiences the largest damage, resulting in $45,880,000 million worth of crop losses.[78] Strawberry growers experienced delays in planting and damage to already prepared and planted fields. Citrus growers that were unable to harvest their fruit prior to the storm experienced significant fruit drop, tree damage, and equipment and infrastructure damage. Similarly, vegetable growers and nursery owners experienced wind and water damage to crops and damage and destruction of light structure green houses, barns and sheds, irrigation, and equipment. Beef/Pasture and aquaculture are the two top livestock operations in Hillsborough. Statewide damage reports estimate up to $21,000 in losses per beef farm and up to $129,000 in losses per aquaculture operation.

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[72] https://www.epa.gov/agriculture/agriculture-and-natural-events-and-disasters
[73] https://www.dhs.gov/sites/default/files/publications/nipp-ssp-food-ag-2015-508.pdf
[74] https://www.swfwmd. state.fl.us/about/newsroom/news/hillsborough-and-polk-county-residents-affected-the-january-2010-freeze-can
[75] https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index
[76] http://blogs.ifas.ufl.edu/sarasotaco/2017/05/23/sarasota-florida-counties-get-drought-aid/
[77] https://www.fdacs.gov/content/download/77509 /file/FDACS%20Irma%20Agriculture%20Assessment.pdf
[78] https://fred.ifas.ufl.edu/destudio/t4/pdf/Economic%20Losses%20of%20Hurricane%20Irma%20on %20ag%20in%20Florida%20counties%2010-26-2018.pdf

Date	Information
	Loss areas included injured or deceased animals, lower gains (cattle), and damage to farm equipment and light structures including sheds and barns. In addition to financial losses, the storm displaced up to thousands of documented and undocumented seasonal and migrant workers. Most of which live in mobile homes and migrant housing established on or near the farms that are variable in their upkeep and ability to withstand hurricane force winds.[79]
Winter Freeze, January 2018	Conditions intermittently reached freezing or below freezing in Hillsborough County in January 2018. Despite this incident having a minimal effect on Hillsborough County, monitoring and mitigation measures were put into place. Freezes caused significant crop damage and crops that have fruits and vegetables that have been previously frozen are considered inedible and must be harvested for destruction.

Table 4.123: Economic Impact on Agricultural Crops in Hillsborough County due to Hurricane Irma, 2017

Field Crops	Citrus	Vegetables and other Fruits	Nursery and Timber	Total All Crops
$82,000	$6,277,000	$31,085,000	$8,436,000	$45,880,000

Plant and Animal Pests, Pathogens, and Invasive Species

Plant and animal disease outbreaks can lower overall production, destroy crops, and causes illness/death of livestock. Some diseases are common but can rapidly spread under certain conditions causing extreme disruption of agricultural systems. Plant and animal diseases can also have important public health risks. Some animal diseases may be zoonotic, meaning they are contagious between animals and humans (e.g. avian and swine flu). Additionally, some fungi are known to produce toxins that cause significant illness in humans (e.g. ergot poisoning and aflatoxin). As previously discussed, the state, county and USDA monitors for TBDs/FADs and invasive pests and germs pose significant political, economic, and public health consequences for local, state, and national agricultural systems.

Table 4.124: Pests and Diseases that affect Hillsborough County Agriculture[80]

Name	Description	Picture
Tetranychus urticae	These are some of the most damaging and persistent mite pests of strawberries. These are sucking mites that usually inhabit the undersides of leaves. Damage to leaves can significantly lower crop production.	

[79] http://flrecruiter.org/files/Effects_of_Hurricane_Irma_on_FL_Ag-Compilation.pdf
[80] U.S. Department of Agriculture. (2018, November 05). Animal Disease Information. Animal Health. https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information

Name	Description	Picture
Also known as the Two Spotted Spider Mite[81]		
Romalea microptera Also known as the Eastern Lubber Grasshopper	Because of its size and coloration, even one individual in a garden is conspicuous, but occasionally local populations explode to such an extent that the grasshoppers can seriously damage ornamentals, row crops, and citrus groves.	
Cochliomyia hominivorax Also known as New World Screwworm	New World screwworms are fly larvae (maggots) that can infest livestock and other warm-blooded animals, including people (rare). They feed on the animal's living flesh and, if not treated, infestations can be fatal.	
Foot and Mouth Disease virus	Foot and mouth disease (FMD) is a highly contagious viral disease that causes sores on the feet, mouth, and udders of cattle, pigs, and small ruminants. This disease is eradicated from the U.S. but is one of the most important TBDs worldwide.	
Wildlife Predation	There is a vast collection of wild birds and other animal species in Florida. Wild animals – including wild birds, raccoons, deer, and wild pigs – cause significant damage to strawberries and vegetable fields. Wild animals can also carry diseases that can cause serious illness in livestock. Wild birds are important pest in aquaculture.	
Notes: This table presents a sample of important pests and diseases for Hillsborough county's top agricultural industries. This is not a comprehisive listing of all pests and diseases.		

Table 4.125: Description of Plant and Animal Pests, Pathogens and Invasive Species that Pose a Threat to Hillsborough County, 2016-2018

Date	Information
New World Screwworm Outbreak, October 2016	New World Screwworm (*Cochliomyia hominivorax*) was detected in the Continental U.S. for the first time in over 30 years in Key Deer (South Florida). Screwworm is a transboundary pest listed in the USDA Grey Book for monitoring and was eradicated from the U.S. in 1966 using a method involving the release sterilized male flies into the environment. The "worm" is a fly maggot known for burrowing in large numbers into open wound of animals, causing significant damage to meat and pelts, leading to

[81] http://entomology.ifas.ufl.edu/liburd/fruitnvegipm/tssm.htm

Date	Information
	severe production losses including decreased weight gain and lowered milk production. The U.S. Fish and Wildlife Service estimates that 135 Key Deer were killed by the 2016 infestation, reducing the total population of this endangered species to 740. This is in addition to the costly response and risks to the Florida beef and dairy industry. The USDA states that the outbreak response involve release of 154 million sterile flies, 17,000 animal inspections, and about 700 hours of surveillance. This is the most significant FAD event to impact Florida in the previous 5 years.
Citrus Canker Outbreak, 2017-2018	In 2017-2018, following Hurricane Irma there was concern for an outbreak of citrus canker, which is a bacterial disease of citrus trees that is spread by wind-blown rain. Intense wind and rain associated with the storm is believed to not only spread the bacteria across wide geographic areas, but also drove the bacteria past the natural innate defenses of the tree. Guidance was release by UF/IFAS on methods to prevent further spread of the disease and treat trees before damage from the infection became apparent. Quarantine zones for citrus canker are located in the following counties: Hendry, Collier, Lee, Charlotte, and the southern area of Polk county.[82]

Technological and Civil Hazards

There are technological and civil hazards that pose a risk to agricultural systems, and the agricultural industry have an impact on the local community and environment. This is an effect of the globalization of production, an increase of industrialization and a certain level of risk of accidents connected with production, processes, transportation and waste management. These risks are associated with the release of substances in accident condition or with the production of such substances under certain conditions as fire or impacts on the environment that have led to the increased occurrence of sinkholes in near agricultural land. Substances which could affect human health or the environment by contamination and their effects on animals and plants.[83]

Table 4.126: Description of Technological and Civil Hazards that have Historically Affected Hillsborough County, 2016-2018

Date	Information
Phosphorus Byproduct in the Florida Aquifer, August 2016	A sinkhole occurred at the Mosaic Mulberry phosphate plant, leading to 215 million gallons of the phosphoric acid process water in the holding area fell about 220 feet into the Florida aquifer. The phosphoric acid process water, a byproduct of turning phosphate into fertilizer, is considered a pollutant.
Transportation Disruption, October 2018	Transportation incidents are daily occurrences in the Hillsborough area on the small scale (i.e. traffic accidents), however, on October 2, 2018, Fowler Ave. was shut down for 75 hours following a traffic accident in which a semi-truck hauling tomatoes was sent over the of the I-75 overpass after colliding with another driver. The incident caused multiple injuries, one death, and disrupted

[82] Johnson, E. (2018, February). How will Irma affect citrus canker management? *Citrus Industry* (UF/IFAS). https://crec.ifas.ufl.edu/extension/trade_journals/2018/2018_feb_canker.pdf
[83] https://www.preparecenter.org/topics/technological-hazard

Date	Information
	traffic patterns on the interstate and a major secondary road for a prolonged period.[84]

Market Vulnerability

Market vulnerability is the other major disruptor of agriculture in Hillsborough county. Any condition that causes delay in planting, injury death of livestock, or damage and contamination of crops can alter market strength of agricultural industry in Hillsborough County. There are many reasons for variation in market access and sales pricing. Lowered income decreases ability of farm owners to cope with compounding threats and may result in lowered production in future or abandonment of the farm.

Following Hurricane Irma, strawberry growers experienced delays in planting and damage to already prepared and planted fields. This led to Mexico, which produce as a lower cost, to be a highly competitive international market that lowered sales income for U.S. farmworkers.

Terrorism and Cyber Attacks

Although the U.S. has experienced a variety of transboundary disease (TBD) and invasive pest and pathogen events, there have been no reports of agroterrorism or attack on the agricultural system in the U.S. to date. However, intentional contamination of the food supply with germs or chemicals has been documented in food processing facilities, distribution and storage areas, grocery stores, and restaurants.

In 2002, this threat became more credible when documents were found in al-Qaeda strongholds detailing methods of creating plant and animal poisons. U.S. agriculture and food systems are listed as critical infrastructure. Failure of those systems could result in food shortages, civil unrest and violence, and a variety of diseases and conditions related to lower food safety and availability. The U.S. government tracks certain disease-causing germs of particular concern, called select agents. Below is a select agent listing for plant and animal diseases that should be considered dangerous to agricultural production Hillsborough County.

Foot and mouth disease (FMD) is one of the most credible and severe threats against the agricultural industry. This viral disease is responsible for billions of dollars in loss worldwide from lowered production and market restrictions. In 2001, the United Kingdom experienced a FMD outbreak that lasted for nearly 8 months resulting in the death or culling of over 6 million sheep, pigs, and cattle. This outbreak cost the United Kingdom (U.K.) an estimated $9.2 billion in direct and indirect losses. In 2011, a South African man was arrested after ransoming the U.S. and U.K agricultural systems with threat of a FMD attack for $4 million, an act that was motivated by political discontent and economic opportunism.

Farm owners are becoming more dependent on satellite imagery, drones, smart tractors and other technological advancements as they become more useful in helping increase yields and trace agricultural and food commodities throughout the production and distribution process. Cyber has become an increased threat as many of these devices and technological platforms do not have the best cybersecurity infrastructure in place which can then lead to operational interruptions. Cyber threat can range from data theft, to market manipulations, destruction of equipment, or even a national security concern as outside

[84] https://www.tampabay.com/news/publicsafety/accidents/One-dead-after-semitrailer-falls-off-I-75-crushes-vehicle-below_172318483/

threats harness remote sensing and global positioning systems to be able to identify potential targets for large scale disruptions in our food production, processing, and distribution across the United States.

Table 4.127: Important Pests and Diseases of Agriculture in Hillsborough County

Centers for Disease Control and Prevention (CDC) Select Agents	USDA Animal Health Select Agents	USDA Plant Health Select Agents
• Anthrax (*Bacillus anthracis*) • Tularemia (*Fansciella tularensis*) • Brucellosis (all species) • Glanders (*Burkholderia mallei*) • Melliodosis (*Burkholderia pseudomallei*)	• African Swine Fever virus • Avian Influenza virus • Classical Swine Fever virus • Foot and Mouth Disease virus • Rinderpest • Peste des pestis virus • Lumpy skin disease • *Mycoplasma capricolum* • *Mycoplasma mycoides*	• *Peronosclerospora philippinensis* • *Ralstonia solannacearum* • *Rathayibacter toxicus* • *Sclerophthora rayssiae* • *Synchytrium endobioticum* • *Xanthomonas oryzae*

Source: *Federal Select Agent Program. (2017). Select Agents and Toxins List. CDC Federal Select Agent Program.* https://www.selectagents.gov/selectagentsandtoxinslist.html.

4. Probability of Agricultural Disruptions

The probability of any specific disease, pest, weather, or technological hazards is impossible to precisely predict. Many of the hazards are seasonal threats that occur annually like thunderstorms and hurricanes. However, some hazards are continuous or growing concerns such as urban development, market vulnerability, climate change and some pests or diseases. Some are infrequent occurrences (e.g. freezes, terrorism), while others are more problematic such as flooding. The geographic position of Hillsborough County, active international tourism, international trade, and the growing population gives a high probability of disruptive threats. Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability).

5. Agricultural Disruptions Impact Analysis

- Public
    - Human health/disease from contaminated crops or livestock
    - Invasive species that are poisonous/dangerous
- Responders
    - Injury/illness/death of agricultural workers or veterinary staff
    - Injuries from high manual labor
    - Accidental injuries from equipment and slip/fall
    - Wildlife contact
    - Zoonotic disease
    - Psychological trauma
- Continuity of Operations (including delivery of services)
    - Reduced supply of crop or livestock product
    - Increased utility and infrastructure draw

- Property, Facilities, and Infrastructure
  - Facility closures during investigation and response
- Environment
  - Homogenization or decline of natural species
  - Loss of habitat for grazing and agricultural ecology
  - Increased chemical use in responses
  - Management of deceased animals and plants
- Economic Condition
  - Cost of quarantines for disease or pest infestation
  - Cost to eradicate invasive species
  - Product/commodity loss or destruction
  - Cost of outbreak investigations and damage surveys
  - Temporary facility closures may become permanent (lowered business economy)
  - Job loss and worker migration
- Public Confidence in Jurisdiction's Governance
  - Farmers may feel victimized or targeted by outbreak investigations and public response
  - Public fear may produce loss of faith in local business owners, the medical community, or government agencies
  - Tourists may reconsider visiting Central Florida

Impact Summary

How widespread (scope) the disruption of the agricultural system becomes is dependent upon size/scope of the causative hazard. How large (scale) these events become depends on the number of individuals exposed, impact on existing infrastructure and the agricultural systems, and the interdependencies that are connecting local production with state and national demands. The scale of an agricultural disruption may range from a small number of local farms to a nationwide or international disruption causing millions of dollars' worth of damages and the need for emergency declarations or the mobilization of public health and emergency management resources from all levels.

Impact to the Built Environment

The agricultural industry and systems have a critical dependency on several other critical infrastructures in Hillsborough County including water and wastewater systems, transportation systems, energy, and chemical. The sprawl of urban and residential development presents a variety of significant risks and potential impacts on the existing built environment as well as future developments.

Urban Sprawl

Increased human traffic in and around agricultural areas poses increased challenges for biosecurity and quarantine areas. Furthermore, there is an increased risk of human disease and exposures from agricultural production and exposure to chemicals from zoonic diseases, agricultural byproducts, and chemicals or traffic that is correlated with the supply chain and production process.

Neighborhoods and urbanized development in close proximity of agricultural areas may lead to exposure to zoonic diseases. In 2011, the Centers for Disease Control and Prevention (CDC) investigated outbreaks of Q fever, which is a zoonotic disease that occurs in livestock. The outbreak included people that had not contacted sick animals in addition to those who had known animal contact. The investigation found that the disease had become dust-borne, traveling a few miles from the infected farm.[85]

In September 2014, the Florida DOH linked 43 cases of illness to an area exposure of Paladin. Paladin is a commonly used soil fumigant in several agricultural production schemes that produces varying levels of irritation to the eyes and upper respiratory system. In incidents of severe weather, hazard and debris from agricultural areas may be carried miles from the farm into adjacent residential and urban areas. Growing populations and denser peri-agricultural development may increase such events.

Water and Wastewater Systems

Enhanced urban and residential development can alter local water management, which may increase flood risk and contamination of farms with chemicals and germs from surrounding areas. Increasing density and heavier traffic patterns increases costs to farmers in the form of gas consumption in transportation and increases risk of more transportation incidents. Increasing development also amplifies the competition for water consumption between agriculture and residential areas that may overdraw the aquifers. This increases the risk for sinkholes in these areas which has an increased negative impact on the built environment.

Transportation Systems

Hillsborough County has a high volume of international traffic and dynamic transportation system due to the proximity of an active international seaport and number of airports in the area. The expansion of international business and international tourism to the area with an expansion of international ships docking in Port Tampa, this leads to an increased risk of introducing significant diseases and pests to the area that may not be endemic to the area or pose a threat to our population and environment.

Hillsborough's growing population and dense traffic patterns increase the risk of minor and major transportation incidents. Food and agricultural commodities that are involved in transportation incidents are subject to spoilage or contamination, which means those items cannot proceed into the food chain and must be destroyed.

Ecological Impacts of Agricultural Disruption

The location of Hillsborough county on the Florida peninsula presents significant vulnerability for extreme weather events. Tropical cyclones and thunderstorms are seasonal risks that threaten agriculture with high winds, hail, flooding, storm surge, and tornadic weather.

Many important agricultural diseases are carried in wildlife. The 2016 screwworm outbreak involved wild deer species in the Florida Keys, but presented heavy risk to the Florida cattle industry.[86] Multiple outbreaks of avian influenza in U.S. and European poultry showed that the spread of the H5N1 and H5N8

[85] https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6040a5.htm

[86] https://www.avma.org/News/JAVMANews/Pages/170515i.aspx

viruses strongly correlated with the wild avian flyways.[87] Wildlife and insect can also serve as pests causing product loss risk of product and economic losses from foraging and predation behaviors.

Social and Population Impacts from Agricultural Disruptions

Populations that routinely work in and around the agricultural industry are most at risk for harm related to disruption of agriculture. Although a number of good programs have emerged to ensure the safety and well-being of farm workers. Low-income farm workers, including documented and undocumented migrant workers, are most vulnerable to displacement and wage loss due to agricultural disruption.[88]

Some housing for undocumented workers may be unregulated and subject to overcrowding and poor maintenance. However, regulated housing for documented migrants and other farm workers are most commonly mobile homes, which are vulnerable housing that must be evacuated in severe wind events such as tropical storms and hurricanes. Wage loss and damages to housing will likely result in the displacement of these workers to other industries or geographic areas to find work.

Veterinary staff and farm workers are most vulnerable to illness from zoonotic diseases in livestock. Workers who are low-income, foreign-born, and/or have low-English proficiency are especially vulnerable, if illness should occur from a zoonotic disease due to lower access to care, potentially unknown vaccination and exposure history, and increased difficulty in communicating with English-speaking healthcare providers.

6. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 3.1.

[87] Peiris, J.S.; de Jong, Menno; Guan, Yi. (2007). Avian influenza virus (H5N1): a Threat to human health. *Clinical Microbiology Reviews*, 243-267. 10.1128/CMR.00037-06
[88] https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-agriculture-and-food-supply_.html

<table>
<tr><th colspan="5">AGRICULTURAL DISRUPTION</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">Hazards in the agricultural industry come in the form of pests, disease, and severe weather conditions. The Hillsborough county agricultural industry brings in $447 million in cash receipts and an additional $1.86 return to local economy for every dollar of product sold in the form of jobs and taxes. Weather poses a threat to Florida due to the subtropical nature of the state and the time of year that many of the high-value harvests take place. Weather, specifically wind and rain, also facilitates transmission of important agricultural pests and diseases. As a popular destination for tourism and international business, the Hillsborough faces an increased threat of entry by transboundary disease and pest infestations. Finally, as critical infrastructure, agriculture must also be considered a target for intentional tampering or disruption, which is referred to as agroterrorism.</td><td>HIGH</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Likely</td><td>Limited</td><td>Large</td><td>< 6 hrs</td><td>> 1 week</td><td>3.1</td></tr>
</table>

Disease Outbreak and Biologic Incident Hazard Profile

1. Disease Outbreak & Biologic Incident Description

Infectious disease results from the spread "germs" that affect the health and well-being of a population. These "germs" are ***organisms or organic agents*** – virus, bacteria, fungus, parasitic organisms, organic toxins, and prions – that can be found in the environment, in animals or insects, or moving directly from human to human.

There are a variety of situations where involving these "germs", ranging from natural occurrence of disease to man-made biologic attacks that are collectively called ***"biologic incidents"***. According to the Centers for Disease Control and Prevention (CDC), ***disease outbreaks or epidemics*** are identified by the occurrence of more cases of disease than normally expected within a specific place or among a group of people over a specified period of time. Many diseases are ***endemic***, or routinely circulate, in Hillsborough County (e.g. influenza, the common cold, and gonorrhea). Outbreaks of these diseases occur when case numbers increase during a specific time period in comparison to others. Other diseases (e.g. measles, dengue, rabies, and polio) are rare occurrences and even one case warrants an outbreak investigation.

The impact of a newly emerging infectious disease can be severe as the victims generally lack immunity against the disease and health professionals' unfamiliarity with the disease means a potentially longer time before the response to be initiated as the identification of the agent is latent. The emergence or increase in case numbers of disease across multiple countries is called a ***pandemic***. There have been a number of pandemics in the last 20 years including Sudden Acute Respiratory Syndrome (SARS, 2003), H1N1 Influenza (aka "Swine Flu", 2009), Ebola (West Africa, 2014), Zika virus (2016), Chikungunya virus (2014), and Middle Eastern Respiratory Syndrome corona virus (MERS Co-V, 2014).[89]

Hillsborough County is characterized by a dense multinational population, active international airports and seaports, and robust international commerce. Hillsborough County serves as both a departure point for U.S. citizens to engage in international travel and a receiving point for international tourists to access the wide variety of attractions that Central Florida has to offer. The county has also served as a receiving point for refugees and evacuees of various global disasters including Hurricane Matthew in Haiti (2016), Hurricane Maria in Puerto Rico (2017), and The Bahamas following Hurricane Dorian (2019). Global interactions and integration among people, business, and governments provides the means for a variety of diseases to enter the county spread at an accelerated rate if monitoring systems are not in place. As the diverse population of Hillsborough County grows and international commerce and tourism increases, the risk for disease transmission increases. Increasing development in previously undeveloped or agricultural land also increases the chance that people will face risk of ***zoonotic disease*** transmission from local wildlife and livestock, which is diseases that transmit between human and animal hosts.

[89] Centers for Disease Control and Prevention. (2012, May 18). Epidemic disease occurrence. *Principles of Epidemiology in Public Health Practice: An Introduction to Applied Epidemiology and Biostatistics, 3rd ed.* Centers for Disease Control and Prevention, Office for Public Health Scientific Services: Atlanta.

Bioterrorism

Bioterrorism and biologic attacks are another concern today. ***Bioterrorism*** is the deliberate release of organisms or organic agents that used to cause illness or death in people, animals, or plants. The reasons or motivations for such an attack may vary among political, economic, or social agendas. The 2001 anthrax attacks are an enduring example of this threat. Letters containing anthrax spores were mailed government buildings in the D.C. area, producing cases of anthrax spanning weeks and the closure of the affected buildings. Biological agents are readily available in nature and can be manipulated to increase their infectiveness or virulence to increase the agent's ability to cause illness or death. The CDC has organized potential biologic agents into three categories listed below. The occurrence of the diseases featured on this list initiates a special investigation that must include steps to detect potential bioterror threats.[90]

Table 4.128: Center for Disease Control and Prevention (CDC) Bioterrorism Agents and Diseases

Category	Description	Examples
Category A Agents	High priority agents that have the greatest potential for panic and social disruption. These agents can be easily disseminated, result in high rates of illness and death, and require special action for public health preparedness.	• Anthrax • Smallpox • Botulism • Plague • Tularemia • Viral Hemorrhagic Fevers (e.g. Ebola, Lassa, Dengue)
Category B Agents	Second priority agents that have lower potential for panic and social disruption. These agents are moderately easy to disseminate, produce moderate rates of disease with lower occurrence of death, but still require specific enhancements for response.	• Brucellosis • Food & Water Safety Threats • Glanders • Melioidosis • Q fever • Staph. Enterotoxin B • Viral Encephalitis (e.g. West Nile, Eastern Equine Encephalitis)
Category C Agents	These agents are emerging pathogens that could be engineered for mass dissemination in the future due to availability, ease of production, and potential for disease and death	• Nipah Virus • Hantavirus

Symptoms and Disease Detection

Symptoms of disease vary widely depending on the type of germ, organ systems that are affected by infections, and a person's ability to fight off infection. Fever and general feeling of unwellness is a common sign of infection but may not be present in all sick persons. Common signs of foodborne disease include diarrhea and vomiting but these signs may also accompany other types of infections. Healthcare

[90] Centers for Disease Control and Prevention. (2018 April 04). Bioterrorism. *Emergency Preparedness and Response*. https://emergency.cdc.gov/bioterrorism/index.asp

professionals that are trained and experienced in infectious disease diagnosis and control should be consulted when encountering suspected disease outbreak and biologic incidents.

The risk of disease in Hillsborough County is monitored by local health department and hospital epidemiologists, doctors and other health professionals, as well as laboratory professionals. The CDC defines epidemiology as "the study of the distribution and determinants of health-related states in specified populations and the application of this study to control health problems. Epidemiology is the scientific method used by 'disease detectives'—epidemiologists—to get to the root of a public health problem or emerging public health event affecting a specific population". In Hillsborough, local medical facilities report specific incidents, known as reportable events, to the Florida Department of Health – Hillsborough County, which uses epidemiology to track, report, prevent and prepare for outbreaks in the county. These events are then reported to the CDC for tracking or response purposes.

Table 4.129: Centers for Disease Control and Prevention (CDC) Reportable Events[91]

Injuries	• Increased homicides in a community • National surge in domestic violence
Non-infectious Diseases	• Localized or widespread rise in a particular type of cancer • Increase in a major birth defect
Natural Disasters	• Hurricanes Katrina and Rita (2005) • Haiti Earthquake (2010) • Hurricane Irma (2017)
Terrorism	• World Trade Center (2001) • Anthrax release (2001)
Environmental Exposures	• Lead and heavy metals • Air pollutants and other asthma triggers • Red-tide outbreak (2017-2018)
Infectious Diseases	• Foodborne illness • Reportable Diseases • Influenza and pneumonia

Potential Effects of Climate Change on Disease Outbreaks and Biologic Incidents

Environmental changes have a huge impact on the emergence and reemergence of certain infectious diseases. The relationship between infectious diseases outbreaks and climate change events (i.e., El Niño, La Niña, heatwaves, droughts, floods, increased temperature, higher rainfall) or environmental changes (i.e., habitat fragmentation, deforestation, urbanization).

Climate change is expected to continue to alter the behavior and range of certain disease vectors – mosquitoes, ticks, and fleas. Increasing temperature and carbon dioxide levels may optimize growth conditions for some disease-causing fungi. Climate change and globalization is also associated with a progressive northward movement of certain fungal and protozoal germs that may produce outbreaks in

[91] Centers for Disease Control and Prevention. (2014). EXCITE: Excellence in Curriculum Innovation through Teaching Epidemiology. *What is Epidemiology?* Retrieved at http://www.cdc.gov/ EXCITE/epidemiology.html

non-endemic areas. Additionally, rising surface temperatures and acidification of the oceans can increase the development of infectious germs, including *Vibrio* bacteria and the microbes that produce ciguatoxin.

Extreme weather events, especially flooding, sea level rise, and tropical cyclones, can be expected to continue into the future or potentially have a negative impact on the built environment and critical infrastructure, economy, water systems, food production, and vector (insect) control. Extreme events can potentially disrupt services leading to food and water sources being contaminate with bacteria that can cause illness or increase the potential for an outbreak of zoonotic disease by displacing wildlife. Extreme and flooding events may increase the number of insect vectors or growth of mold that has a negative impact on population health. Furthermore, the damaged infrastructure that would have otherwise been designed to protect and support the local population may be compromised.

To avoid or control outbreaks, integrated surveillance systems and effective outreach programs are essential. Due to strong global and local influence on emergence of infectious diseases, a more holistic approach is necessary to mitigate or control the occurrence of disease outbreaks.

2. Geographic Areas Affected Disease Outbreaks and Biologic Incidents

Biologic incidents may affect all areas of the county. Transportation hubs and areas of greater population density, like Downtown Tampa, could be more likely to experience disease outbreaks or biologic incidents. High density population centers are also more likely to experience severe impact during biologic incidents. High density are located central and western areas of the county including Downtown Tampa, South Tampa, Seminole Heights, Tampa Heights, Temple Terrace and Westchase. The eastern and southern areas of the county have lower population densities currently but is the focus for future growth within the county.

3. Historical Occurrences of Disease Outbreaks and Biologic Incidents

This section discusses significant (involving specific disease outbreak investigation or intervention) disease outbreak events. The most significant events, which are categorized as incidents affecting more than 50 individuals, are discussed in detail below.

Table 4.130: Description of Significant Disease Outbreaks that Affected Hillsborough County, 2014 - 2019

Date	Information
Ebola virus (EVD) Pandemic, 2014-2016	An EVD outbreak in West Africa became the largest EVD pandemic in history. A total of 28,652 cases of EVD were reported in Guinea, Liberia, and Sierra Leone with over 11,325 deaths. In August 2014, the World Health Organization declared a public health emergency of international concern. Responders returning to Europe and the U.S. carried the disease before becoming ill in their home countries. In the U.S. the CDC confirmed the first travel-associated case of EVD ever diagnosed in the U.S. While no cases were detected in Hillsborough county, a detection and response plan were developed to protect our residents.[92]

[92] Centers for Disease Control and Prevention (2019, March 08). 2014-2016 Ebola Outbreak in West Africa. *Ebola (Ebola Virus Disease)*. https://www.cdc.gov/vhf/ebola/history/2014-2016-outbreak/index.html

Date	Information
Chikungunya virus (CHKv), Summer 2014	The first domestic cases of Chikungunya virus were recorded in Hillsborough, Broward, and Palm Beach Counties. A total of 40 cases were reported in Hillsborough County between January 2014 and December 2015, which corresponded to the emergence of the disease in the Caribbean and South America. Positive cases in Hillsborough were found to have had a travel history to Chikungunya endemic or epidemic areas in the two weeks prior to onset. There was no documented local transmission of this disease. Those case numbers declined to on case per year following the initial emergence.[93]
Cryptosporidium Outbreak, Summer 2014	An outbreak of cryptosporidium occurred the Tampa Bay area including Hillsborough, Pinellas, and Pasco counties. The outbreak involved 266 cases and was associated with a local water park located in the City of Tampa. The investigation found no critical deficiencies but noted a lack of secondary water disinfection system. In all, Hillsborough County experienced 348 cases of cryptosporidiosis in 2014, most of which were associated with this outbreak. In summer 2015, the same Tampa water park was associated with another cryptosporidium outbreak involving 22 suspected or confirmed cases.[4]
Hurricane Hermine, September 2016	Hurricane Hermine unloaded 22 inches of rain in the Tampa Bay area. Due to heightened levels of flooding and stormwater runoff, Tampa spilled approximately 938,000 gallons after a power outage that occurred at the height of the storm which briefly knocking out the wastewater treatment facility. Following the incident, Tampa issued detailed reports to the state showing there were elevated fecal coliform levels in the Hillsborough River. In addition to this event, jurisdictions across Pinellas County ended up releasing an estimated 199.4 million gallons of partially-treated sewage into the waters of Tampa Bay during this event.
Zika virus Outbreak, Summer 2016	The first recorded outbreak of Zika virus in the Americas with 1,456 cases recorded statewide in Florida, which corresponded to the emergence of this disease in the Caribbean and South America. Hillsborough County reported 33 cases, all of which were individuals that had travelled to the county from areas where the virus was circulating readily. Case numbers decreased to 7 in 2017 with no cases reported in 2018-2019. While there was no reported local transmission of the Zika virus in Hillsborough one locally acquired case was reported in Pinellas County. Zika produces mild febrile illness, which is usually self-limiting. However, the disease is known to cause severe congenital malformations, which is the main source of concern for the disease circulating in the county.[94,95]
Measles Outbreak,	In 2018, fifteen (15) measles cases were reported in four Florida counties, more than two times the number of cases seen in any individual year in the eight years

[93] Florida Department of Health. (2014-2015). Florida Annual Morbidity Statistics Reports. Data and Publications. http://www.floridahealth.gov/diseases-and-conditions/disease-reporting-and-management/disease-reporting-and-surveillance/data-and-publications/fl-amsr1.html

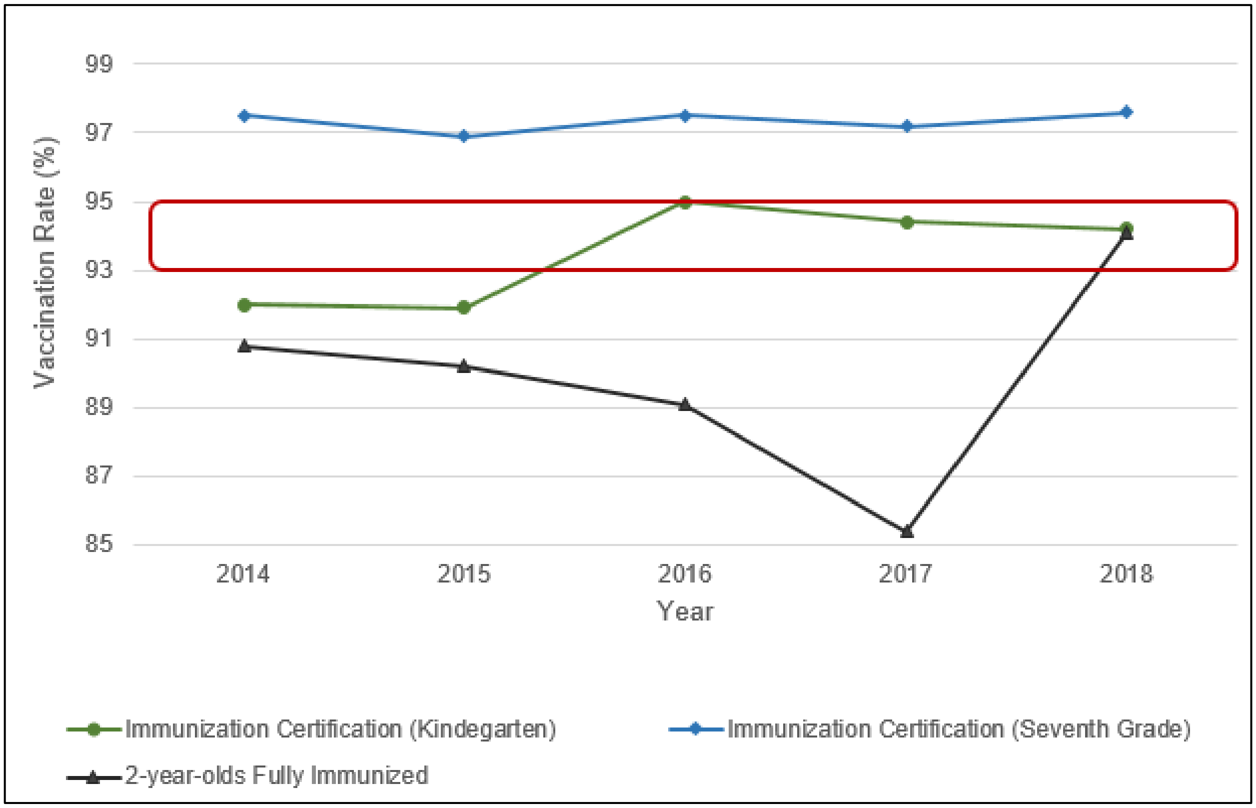
[94] World Health Organization. (2016, February 09). Zika: the origin and spread of a mosquito-borne virus. *Bulletin of the World Health Organization.* http://dx.doi.org/10.2471/BLT.16.171082

[95] FDOH. (2019, June 30). Reportable Diseases Frequency Report. *FL Health Charts*. www.flhealthcharts.com/ChartsReports/rdPage.aspx?rdReport=FrequencyMerlin.Frequency&FirstTime=True

Date	Information
2018	preceding. These cases were a part of national outbreaks that totaled in 372 cases of measles in 2018. Only one incident of measles in Florida so far in 2019. Measles is a highly contagious, vaccine preventable disease that has been a source of controversy with low vaccination rates being determined as the primary cause of recent outbreaks. Measles requires a high rate of vaccination to achieve "herd immunity" (i.e. protection of the entire population, including those that cannot be vaccinated due to health restrictions). While there have been no measles cases reported in Hillsborough county since 2014, 8 out of 12 Florida cases reported in the last two years have been in Pinellas County. Additionally, Hillsborough has been identified as having higher than normal risk for a measles epidemic due to heavy international travel from tourism and international commerce, as well as low vaccination rates.[96,97,98]
Hepatitis A Outbreak, August 2019	The Florida Surgeon General declared a public health emergency related to an ongoing Hepatitis A outbreak. Since the start of 2018, Florida has seen 2,961 cases of hepatis A, which is nearly 5 times more than has been seen from 2014 to 2017 combined. Hillsborough County is included in this outbreak with 200 cases seen between January 2018 and August 2019. The exact source for the outbreak has not been identified. Hepatis A is spread through fecal contaminated food, water, and environmental surfaces. The disease causes inflammation and dysfunction of the liver. A public health emergency declaration signals healthcare professional to give special emphasis to diagnosis, vaccination, and public education.[99]

[96] FDOH. (2019). Measles. floridahealth.gov/diseases-and-conditions/measles/#targetText=So%20far%20in%202019 %2C%202,cases%20were%20reported%20in%202018.
[97] Sarkar, S. Zlojutro, A. Khan, K. Gardner, L. (2019, May). Measles resurgence in the U.S.: How international travel compounds vaccine resistance. *The Lancet, 19*(7), 684-686. https://doi.org/10.1016/S1473-3099(19)30231-2
[98] Public Health Dynamics Laboratory. (2019). FRED Measles Simulator. *University of Pittsburgh Public Health Dynamics Laboratory*. https://fred.publichealth.pitt.edu/measles
[99] Florida Department of Health (FDOH). (2019, September 03). Protect Yourself: Hepatis A is on the rise in Florida counties. www.floridahealth.gov/diseases-and-conditions/vaccine-preventable-disease/hepatitis-a/index.html

Figure 4.65: Measles/Mumps/Rubella (MMR) Vaccination Rates in Hillsborough County, 2014-2018[100]



The red box in the graph above indicates the minimum desired vaccination rates for herd immunity against measles. The current standard for protection is 93%, but new research suggests that may not be enough. The new recommended protective number is 95% of people vaccinated.[101]

Table 4.131: Report of Disease in Hillsborough County (2014-2019)[102]

Hazard or Disease	Frequency						
	2014	2015	2016	2017	2018	2019	Assessment
Sexually Transmitted Infections							
Human Immunodeficiency Virus (HIV)	343	327	303	312	323	*	**Endemic**
Acquired Immunodeficiency Syndrome (AIDS)	174	154	150	153	145	*	**Endemic**
Bacterial Sexually Transmitted Infections	9746	10262	11065	11372	11836	*	**Endemic**

[100] FDOH. (2019, August 29). State Immunization Surveys. http://www.floridahealth.gov/statistics-and-data/immunization-coverage-surveys-reports/state-surveys.html
[101] Funk, S. (2017). Critical Immunity thresholds for measles elimination. London School of Hygiene & Tropical Medicine. www.who.int/immunization/sage/meetings/2017/october/2._target_immunity_levels_FUNK.pdf
[102] FDOH. (2019, June 30). Reportable Diseases Frequency Report. *FL Health Charts*. www.flhealthcharts.com/ChartsReports/rdPage.aspx?rdReport=FrequencyMerlin.Frequency&FirstTime=True

Hazard or Disease	Frequency						
	2014	2015	2016	2017	2018	2019	Assessment
Vector Borne Disease							
Anaplasmosis	-	-	-	-	1	-	**Non-Endemic**
Babesiosis	-	-	-	1	1	-	**Non-Endemic**
Chikungunya Fever*	31	9	1	1	1	-	**Non-Endemic**
Dengue Fever*	3	7	2	-	6	6	**Non-Endemic**
Ehrlichiosis	-	-	-	-	2	-	**Non-Endemic**
Malaria*	2	2	6	7	6	4	**Non-Endemic**
Q Fever (Coxiella burnetii)	-	-	-	1	-	-	**Non-Endemic**
Rocky Mountain Spotted Fever and Rickettsiosis	-	-	-	1	1	1	**Non-Endemic**
West Nile Virus Disease	-	2	-	-	-	-	**Non-Endemic**
Zika Virus	-	-	33	7	-	-	**Non-Endemic**
Other Reportable & Zoonotic Infectious Diseases							
Creutzfeldt-Jakob Disease (CJD)	-	3	3	2	1	1	**Non-Endemic**
Hansen's Disease (Leprosy)	-	-	1	-	-	1	**Non-Endemic**
Leptospirosis	-	1	-	1	2	-	**Non-Endemic**
Meningitis, Bacterial or Mycotic	3	16	9	6	4	8	**Endemic**
Rabies, Animal	-	3	3	3	10	-	**Endemic**
Rabies, Possible Exposure	170	350	280	125	143	40	**n/a**
Staphylococcus aureus Infection, Intermediate Resistance to Vancomycin	-	-	-	1	-	-	**n/a**
Streptococcus pneumoniae Invasive Disease	23	40	45	39	39	35	**n/a**
Tuberculosis	48	41	43	27	29	*	**Endemic**
Vaccine Preventable Diseases							
Haemophilus influenzae Invasive Disease	2	9	21	18	15	14	**Endemic**
Hepatitis B, Acute	29	62	55	55	49	34	**Endemic**
Hepatitis B, Chronic	163	302	333	330	325	203	**Endemic**
Hepatitis B, Pregnant Women	16	27	23	14	9	-	**Endemic**
Hepatitis C, Acute	12	48	32	35	25	58	**Endemic**
Hepatitis C, Chronic (Including Perinatal)	564	1,398	1,699	1,626	1,303	710	**Endemic**
Deaths from Pneumonia	141	148	178	175	156	*	**Endemic**
Deaths from Influenza & Pneumonia	152	153	186	192	180	*	**Endemic**
Preventable Hospitalization from Bacterial Pneumonia	1656	1525	1584	1119	1255	*	**Endemic**
Meningococcal Disease		2	2		2	-	**Non-Endemic**
Mumps	1	1	2	8	1	6	**Endemic**
Pertussis	10	41	72	45	66	44	**Endemic**
Rubella	-	-	1	-	-	-	**Non-Endemic**
Varicella (Chickenpox)	18	74	70	35	68	34	**Endemic**
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**Assessment**

Hazard or Disease	Frequency						
	2014	2015	2016	2017	2018	2019	Assessment
Food and Water Borne Disease							
Botulism, Foodborne	-	-	-	-	-	1	**Non-Endemic**
Brucellosis	-	-	1	-	1	1	**Non-Endemic**
Campylobacteriosis	79	245	261	315	337	221	**Endemic**
Ciguatera Fish Poisoning	-	-	-	3	2	2	
Cryptosporidiosis	318	99	62	55	76	35	**Endemic**
Cyclosporiasis**	-	1	1	12	3	15	**Endemic**
Hemolytic Uremic Syndrome (HUS)	1	2	1	3	1	-	**Endemic**
Hepatitis A	1	5	5	10	84	116	**Endemic**
Hepatitis E	-	1	-	1	2	1	**Non-Endemic**
Giardiasis, Acute	37	55	105	73	62	46	**Endemic**
Listeriosis		2	-	4	3	2	**Non-Endemic**
Legionellosis	1	20	25	19	31	13	**Endemic**
Q Fever (Coxiella burnetii)[3]	-	-	-	1	-	-	**Non-Endemic**
Salmonella Paratyphi Infection	-	-	1	-	-	1	**Non-Endemic**
Salmonellosis (Typhoidal)	-	-	1	3	5	2	**Non-Endemic**
Salmonellosis (Non-Typhoidal)	180	287	307	315	343	152	**Endemic**
Shiga Toxin-Producing Escherichia coli (STEC) Infection		16	12	16	54	31	**Endemic**
Shigellosis	37	216	76	165	32	22	**Endemic**
Vibriosis (Excluding Cholera)	4	11	11	21	11	9	**Endemic**

Notes: The above table depicts the burden of food and waterborne pathogens in Hillsborough County from 2014-2019. Disease burden is determined from the annual case numbers (frequency) and disease duration and death rates (severity). The diseases highlighted in purple have had outbreaks within the previous 5 years.
Endemic = Diseases that are transmitted locally and circulate annually; Non-Endemic (NE) = Diseases that are not transmitted locally and occur on less than annual basis (sporadic)

4. Probability of Disease Outbreaks and Biologic Incidents

Many diseases routinely circulate in Hillsborough County ranging from low (less than 10 cases annually) to high (10,000+ cases annually) endemicity. Disease outbreaks are frequent occurrences in Hillsborough County with at least 4 significant outbreaks affecting the area with cases. The county was additionally named as one of the top high-risk counties for future measles outbreaks. Biologic attacks are relatively infrequent occurrences and no instances of biologic attack or bioterrorism have been recorded in Hillsborough County. However, the risk is still present.

Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability).

5. Disease Outbreaks and Biologic Incidents Impact Analysis

- Public
    - Illness or Death from exposure
        - Mass Casualties
    - Quarantine or Social Isolation
    - Public Fear and Unrest
    - Delays
- Responders
    - Injury/illness/death from treating victims
    - Expose/infect family or friends that may be more vulnerable
    - Psychological Trauma
        - Stress and fear
        - Potential enduring effects
- Continuity of Operations (including delivery of services)
    - Increased disease burden may cause localized to widespread challenges
    - Services may be interrupted from employee absence
    - Increased patient load in hospitals limits operational capacity
- Property, Facilities, and Infrastructure
    - Reduced workforce to maintain workforce, infrastructure and amenities.
    - Damage to property in cases of vandalism or civil disruption
- Environment
    - Product Disposal and other waste management
    - Increased chemical use in response
        - Run-off from decontamination
        - Increased use of sanitizers.
    - Management of Deceased
- Economic Condition
    - Hospitalization and insurance costs
    - Work hours lost in convalescence
    - Cost of epidemiologic investigations
    - Cost of downtime for businesses due to employee absence
    - Temporary facility closures may become permanent (lowered business economy)
- Public Confidence in Jurisdiction's Governance
    - Public fear may produce loss of faith in the medical community or government agencies
    - Tourists may reconsider visiting Florida

Impact Summary

How widespread (scope) outbreak becomes is dependent the type of germ and density of the population that are susceptible to the disease. Germs that can become airborne (e.g. measles or Q fever) have the potential to become very widespread in a short time. Hillsborough County has areas of very dense population that may or may not be susceptible to infection with different germs.

How large (scale) an outbreak becomes depends on the number of individuals exposed to the germ source, whether that be a sick person or animal, contaminated food or water, disease carrying mosquitoes or ticks. The scale of an outbreak may range from a small number of linked cases to a large regional, national or international outbreak involving thousands to tens of thousands involving the mobilization of public health and emergency management resources.

Impact to the Built Environment

Overcrowding, poor regional design, hygiene due to poverty, dirty drinking water, rapid climate changes, and natural disasters, can lead to conditions that allow easier transmission of disease.

Impact of an outbreak on the built environment is variable depending on the total number of victims or those believed to have symptoms of the disease. The effects on the built environment are likely to be minimal unless an outbreak becomes widespread or enduring. For example, if the disease outbreak or biologic incident impacts a large number of people, this could cause hospitals and clinics to be overwhelmed. In this case, there may be a need to establish a Point of Distribution (POD) off site to be able to implement a mass vaccination campaign to administer vaccines or antidotes to the affected population.

An increase in public fear or mistrust may have a variety of effects ranging from minor incidents of violence or vandalism to widespread civil unrest and disruption. Employee absence due to illness may result in the closure of local businesses and lower workforce to maintain infrastructure or lead to a disruption in services. Some facilities or locations may need to be restricted to the public due to contamination or need for proper decontamination. Controlling vectors such as mosquitos, lice, flies, and rodents in the built environment is essential to reducing specific diseases as well.

The effectiveness of a resilient jurisdiction, business, or infrastructure depends on its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event. In the event of an intentional bioterrorism incident, individuals usually choose their targets to maximize the impact of their attack, or rather its consequences. They tend to prefer “soft” targets, such as commercial shopping malls or football stadiums, where a successful attack might produce the greatest effect. Biologic incidents are of concern when looking at vulnerabilities across Hillsborough County.

How Does the Built Environment Impacts Disease Outbreaks and Biologic Incidence?

Looking at how disease outbreaks and biologic incidents affect our built environment is one perspective, however, various conditions within the built environment, proximity of expanding populations into rural agricultural areas, increased population density in the urban core, and even the design of our buildings and critical infrastructure can exacerbate the occurrence of a disease outbreaks or biological threats.

The design of our communities and poor conditions in which residents live, failing infrastructure, or locations in which a large number of people gather (i.e., malls, public schools, sports complexes, theme parks, concert venues) can lead to heightened exposure or conditions that support disease transmission.

For example, the spread of disease in a contaminated water supply could lead to an uptake of disease incidents and a spike in the number of cases of a specific disease. For example, improper waste disposal and inadequate capacity of sewage systems can lead heightened exposes to fecal matter that may expose populations, plants, fish and wildlife to a number of diseases. In September 2016, Hurricane Hermine lead to 22 inches of rain in the Tampa Bay area. Due to heightened levels of flooding and stormwater runoff, jurisdictions across Pinellas County ended up releasing and estimated 199.4 million gallons of partially-treated sewage into the waters of Tampa Bay. Whereas, the City of Tampa spilled approximately 938,000 gallons after a power outage that occurred at the height of the storm which briefly knocking out the wastewater treatment facility. Following the incident, Tampa issued detailed reports to the state showing there were elevated fecal coliform levels in the Hillsborough River that ranged from 6 to 20 times over the limit.

Hospitals and Clinics

The emergency department is the front-line response system for disease threats, and preventing transmission is paramount in maintaining a safe environment. The design of hospitals and clinics to be able to handle a disease outbreak or biological threat can limit the spread of the disease. In 2017, Tampa General Hospital had more than 84,000 adult and 11,000 pediatric patients visit the emergency department (average of 260 patients per day). This leads to the heightened risk of exposure and potentially spreading a deadly or debilitating disease to others if infection control measures are not properly in place.

Ecological Impacts of Disease Outbreaks and Biologic Incidents

Our perception of risk related to biological threats has primarily focused on human health and economic concerns, however, risks to the natural ecosystems should be taken into consideration. Extreme weather events increase the risk of contamination of crops, fisheries, and produce during the production phase. Increases in over-ground water flow (run-off) due to flooding-related events can cause unintentional contamination of food crops with bacteria or other diseases.

Drought may also increase production of certain germs in the environment. *Aspergillus flavus* is a fungus responsible for aflatoxin, which increases in times of drought. Aflatoxin may enter the food chain either directly through contamination of crops but also indirectly though accumulation in milk, eggs, and meat when food animals eat toxin contaminated feeds.

Lastly, the threat of bioterrorism and the use of biological weapons is a concern that can be used to cause death or injury to humans, animals, or plants. Biological weapons are the use of biological organisms, and substances derived directly from living organisms that could be introduced into the environment that leads to exposure to the population or ecosystem that could cause loss of life people, plants, and animals.

Invasive Species

The effects of invasive non-indigenous species comprise one of the most apparent risks of globalization of international trade to both agricultural and natural ecosystems. Once a species or disease is introduced into a region, the risk it poses depends on if it can establish and thrive in its new environment. In some situations, a species may purposely be introduced to the environment for mitigation purposes to reduce the spread of vectors to control disease threats. However, in some situations this could cause other imbalances in the natural system.

Non-endemic Diseases Introduced in the Environment

Some regions may not be susceptible to a particular disease, however, with increases in international travel some cases have not been detected until the individual has returned from a location where the disease may be more prevalent. For example, Hillsborough County reported 33 cases of Zika, all of which were individuals that had travelled to the county from areas where the virus was circulating readily. Case numbers decreased to 7 in 2017 with no cases reported in 2018-2019. While there was no reported Zika virus cases being transmitted locally in Hillsborough County, there was one locally acquired case confirmed in Pinellas County.[103] Due to the disease being sexually transmitted or spread through mosquito vectors, the state and local response focused on mitigating further risk by closely monitoring the disease, taking measures to reduce mosquito populations in the county, and educating the local population about symptoms, precautions, and the health risks associated with the disease to prevent this disease becoming endemic to the region.

Social and Population Impacts from Disease Outbreaks and Biologic Incidents

Certain populations may be more susceptible to the negative effects of disease outbreaks. These include, but are not limited to:

- Very young (less than 5 years old)
- Very old (older than 65 years)
- People with certain diseases and conditions that lower the capability of their immune system (e.g. HIV/AIDS, leukemia, multiple myeloma, some congenital and autoimmune disease)
- People with hepatitis from a virus, toxin, or other cause
- People undergoing treatment for cancer and autoimmune disease
- Pregnant women

There are four groups of people that are considered to be at higher risk to many disease outbreaks: young children, pregnant women, senior adults, and immune suppressed individuals (i.e., patients undergoing chemotherapy and organ transplants). For example, immune suppressed persons, already have a weakened immune system which leads to an increased risk of serious flu complications as they are less likely to be able to fight off an infection. Very old or young persons may be less tolerant of nutrition and hydration losses from vomiting or diarrhea.

In the table below, this is a summary of select vulnerable populations that may increase severity of disease outbreaks. Understanding demographics and social factors with greater vulnerability allows planners to identify strategies to mitigate risk.

[103] FDOH. (2019, June 30). Reportable Diseases Frequency Report. *FL Health Charts*. www.flhealthcharts.com/ChartsReports/rdPage.aspx?rdReport=FrequencyMerlin.Frequency&FirstTime=True

Table 4.132: Vulnerable Populations to Disease Outbreaks and Biological Threats[104]

	Population Statistics[105]		
Vulnerability	**No. (x1000)**	**Percent (%)**	**Reason for Concern**
Elderly (Age 65+)	173	14.3	Lowered immunity, Concurrent disease conditions that may complicate treatment/recovery
Young (< 5 years)	205.5	6.2	Lowered immunity, More susceptible to metabolic stress
HIV/AIDS Incidence (2018)	0.5	<1	Lowered immunity, Concurrent disease conditions that may complicate treatment/recovery
Viral Hepatitis Incidence (2018)	1.8	<1	Lowered immunity; Increased risk of septicemia or other complications
Persons Living below Poverty	222.7	15.5	Lower financial flexibility to handle medical costs; Lower access to healthcare
Unemployment			Lower financial flexibility to handle medical costs; Lower access to healthcare
Persons without Health Insurance[106]	205.5	14.3	Lower financial flexibility to handle medical costs; Lower access to healthcare
Foreign-Born Persons	237.1	16.5	Different disease and environmental exposures; Vaccination status may be incomplete or unknown; Lower familiarity with systems and infrastructure
Non-English-Speaking Persons	409.5	28.5	Limits ability to communicate with English only persons
Notes: This table presents examples of demographics and social factors with greater vulnerability and the reasons for concern for disease outbreaks.[107]			

Tourism and International Trade

Hillsborough County has a large transient population coming from the national and international communities to visit not only the City of Tampa but will pass through the county on their way to beach destinations in Pinellas County or on their way to various other destinations in Central and South Florida. Millions of people come to Florida each year via automobile. In 2018, Port of Tampa welcomed over 1

[104] FDOH. (2019, June 30). FL Health Charts. Florida Department of Health Division of Public Health Statistics & Performance Management. http://www.flhealthcharts.com /charts/default.aspx
[105] Hillsborough Planning Commission. (2018). Facts and Figures 2018. *Plan Hillsborough*. http://www.planhillsborough.org/demographic-economic-data/
[106] Clavery, D. (2017, May 09). Population without Health Insurance by State and County, 2011-2015 (Map). Https://www.arcgis.com/home/item.html?Id=aa71c1ac3ccd46f08304ac57517d0e95
[107] FDOH. (2019, June 30). FL Health Charts. Florida Department of Health Division of Public Health Statistics & Performance Management. http://www.flhealthcharts.com /charts/default.aspx

million passengers arriving by cruise ships.[108] Data on passenger traffic collected by the Tampa International Airport concluded that 21,013,788 visitors used air travel in the 2017-2018 period (fiscal year 2018).[109]

Hospitals and Clinics

Access to medical care is an important factor in the response and recovery of the community from disease outbreaks. Hillsborough county social healthcare network includes 19 hospitals (Bed Capacity 4,593) and 28 family care and general health clinics.[110, 111] There are more private medical clinics, urgent care centers, and non-profit/non-governmental health care organizations. Given that most disease cases are asymptomatic or only require outpatient care, the physical volume of care slots is likely adequate for smaller outbreaks (less than 5,000). Outbreaks that become widespread affecting thousand to tens of thousands or more would overwhelm medical capacity and constitute a mass casualty event. In 2018, the annual county-wide full-scale exercise was postponed due to lowered operational capacity of some hospitals related to a high number of flu-related hospitalizations affecting preparedness measures already underway for our hospital systems response.

Psychological Distress during a Disease Outbreak

Individual behavioral changes, such as fear-induced aversion to workplaces and other public gathering places, are a primary cause of negative shocks to economic growth during a large-scale disease outbreak. Furthermore, some disease outbreak mitigation measures can cause significant social and economic disruption while an increase in political stresses and tensions at the local, state, and national-level can occur. In these contexts, outbreak response measures such as quarantines have sparked violence and tension between government entities and citizens.

6. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be moderate, with a PRI score of 2.3.

[108] Berzina-Smith, V. (2018, September 24). Port Tampa Bay hits major milestone of 1M cruise ship passengers. *Tampa Bay Business Journal*. www.bizjournals.com/tampabay/news/2018/09/24/port-tampa-bay-hits-major-milestone-of-1m-cruise.html

[109] Tampa International Airport. (2018, October 15). Tampa International Airport surpasses 20 million passenger mark record in fiscal year. Tampa International Airport. https://www.tampaairport.com/tampa-international-airport-surpasses-20-million-passenger-mark-record-fiscal-year#targetText=Tampa%20International%20Airport%20surpasses%2020,surpassing%20the%2020%20million%20mark.

[110] Hillsborough County Social Services. (2019). Find Hospitals, Clinics, & Dental Providers. www.hillsborough county.org/en/residents/social-services/health-care-plan/find-hospitals-clinics-and-dental-providers

[111] Florida Hospital Association (FHS), 2019. www.fha.org/reports-and-resources/hospital-directory.aspx

<table>
<tr><th colspan="5">DISEASE OUTBREAK AND BIOLOGIC INCIDENT</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">Biologic Incidents are incidents involving bacteria, viruses, or toxins that can all be harmful or deadly to humans and animals. These various actors are called biological agents. It is important to note that these agents can be naturally occurring disease outbreaks or intentionally dispersed. The act of intentional dispersing these biological agents into a society in order to harm people or animals is referred to as bioterrorism. As a major population center made up of diverse national and international people, a center for tourism, and the location of a major seaport, Hillsborough is at increased risk for disease outbreak compared to some other areas of the state.</td><td>MODERATE</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Likely</td><td>Limited</td><td>Small</td><td>> 24 hrs</td><td>< 1 week</td><td>2.3</td></tr>
</table>

Food and Waterborne Disease Outbreak Hazard Profile

1. Food and Waterborne Disease Outbreak Description

Waterborne disease outbreaks and foodborne disease outbreaks occur when people are exposed to unsafe levels of man-made or naturally occurring contaminants in recreational water, drinking water, and foods. Each year, waterborne and foodborne disease outbreaks affect millions of people across the United States. Caused by bacteria, viruses, parasites, or chemical contaminants in food and water, the health effects from these outbreaks can range from gastrointestinal illness, to respiratory issues, to even death. Estimates of acute gastrointestinal illness associated with public drinking water systems underestimate the true incidence of waterborne disease, because they do not include illnesses associated with recreational water.

The Presidential Policy Directive 21 (PPD-21) names food and agricultural systems as one of the 16 critical infrastructure sectors.[112] The food service and accommodation industries are in the top three industries as a source of employment for Hillsborough county residents (57,492 people). In 2017, agribusiness, which encompasses food production and processing phases, was valued at over $865 million with further commercial food processing, distribution, and preparation contributing $80-100 million annually to the local economy in sales, jobs, and tax revenue.[113] [114] Outbreaks of foodborne illness can produce a loss of faith by consumers in the commercial food industry, which can cause a significant loss of jobs and revenue for agribusiness and food/accommodation industries.

The Centers for Disease Control and Prevention (CDC) define food and waterborne disease outbreaks as incidents in which two or more persons experience a similar illness resulting from the ingestion of a common food item. Foodborne illness, also known as food poisoning and foodborne infections, may result from contamination of food and water items with bacteria, viruses, parasites, fungi, and toxins. This contamination may occur during any point in the process of bringing food from the farm to the table, collectively known as the *food production chain* or *food chain*.[115]

The food chain can be divided into four main phases: (1) Production, (2) Processing, (3) Distribution, and (4) Preparation[116]. This hazard assessment will focus on public food chain activities.

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[112] https://www.dhs.gov/cisa/critical-infrastructure-sectors

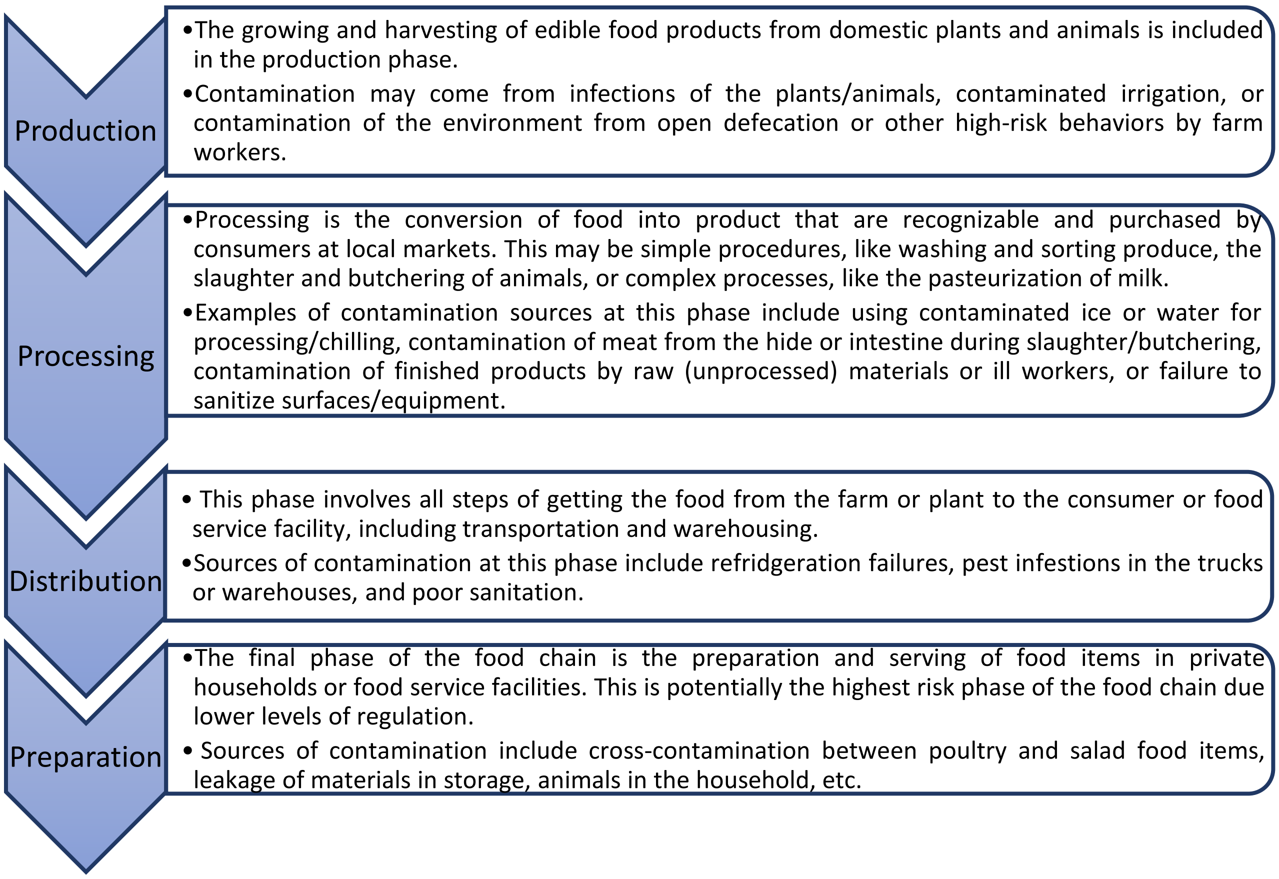
[113] Hodges, A., & Stevens, T. (2016). Economic contributions of agribusiness and food industries in Hillsborough County, Florida. Retrieved from https://fred.ifas.ufl.edu/pdf/Extension/Economic contributionsagribusinessfoodindustrieshillsboroughcounty.pdf

[114] UF/IFAS Hillsborough County Extension. (2019). Military Agricultural Tour (Presentation).

[115] Food and Drug Administration. (2018, September 05). What you need to know about foodborne illness. *FDA Consumers*.https://www.fda.gov/food/consumers/what-you-need-know-about-foodborne-illnesses

[116] Centers for Disease Control and Prevention. (2017, September 05). How Food Gets Contaminated. *Food Safety*. https://www.cdc.gov/foodsafety/production-chain.html

Figure 4.66: Food Production Chain Scheme



Furthermore, understanding food production and food/waterborne disease outbreak requires an understanding of the following definitions:

- **Food Security**: the reliable availability of a sufficient quantity of food that is safe and nutritious and appropriate for that population (i.e. does not conflict with intrinsic religious or cultural preferences)
- **Food Safety**: the protection of food products from **unintentional** contamination by germs or chemicals reasonably **likely to occur** in that food chain scheme (e.g. E. coli, Listeria, or chemicals/sanitizers used in production)
- **Food Defense**: the protection of food products from **intentional** contamination by biological, chemical, physical, or radiological agents that are **not likely to occur** in that food chain scheme.
- **Consumer Product Tampering**: this refers to the intentional contamination of food or water items at the consumer level (i.e. in grocery stores and food service facilities); includes contamination of products with bodily fluids (e.g. spitting), opening of packages/containers to taste or alter contents, etc.; consumer product tampering is a punishable offense.

- **<u>Agroterrorism</u>**: the deliberate introduction of an animal or plant disease with the goal of generating fear over the safety of food, causing economic loss, and/or undermining social stability; usually considered a subset of bioterrorism; sometimes referred to as food terrorism

Additional definitions are included in the *Disease Outbreak and Biologic Incidents Hazard Profile*.

<u>Symptoms and Disease Detection</u>

Food and waterborne illness often result in generalized gastrointestinal symptoms including diarrhea, intestinal cramping, vomiting, fevers, and general feeling of unwellness (malaise). These symptoms are usually self-limiting and mild in the average healthy individual but can become severe in some situations. *Clostridium botulinum* produces the most toxic substance on the planet resulting in profound weakness and respiratory arrest, a syndrome known as botulism. Listeria species can cause infections of the brain coverings (meninges) and failure of pregnancy in women. Biologic and non-biologic chemical contaminants can cause any number of symptoms ranging from mild to severe acute to severe chronic effects.[117]

The majority of food and waterborne disease outbreaks occur due to food safety challenges or failures. These failures may stem from pathogens routinely carried by food animal sources, contamination from sick or ill food handlers, refrigeration failures, or consumption of raw or undercooked food products. For example, the well-known Listeria outbreak related to Blue Bell Ice Cream products (2015) was traced to contaminated fruit and nuts that are added to the ice cream in the final stages of processing.[118] The more recent *Escherichia coli* O157:H7 outbreak (2018) linked to romaine lettuce grown in northern and central California likely occurred due to contamination of the lettuce at the production (farm) phase.[119] More locally, a Hillsborough County restaurant was sued recently due to a foodborne disease incident that resulted in Guillain Barre syndrome and permanent debilitation of a Florida resident. News reports surrounding this incident indicate that the disease was the result of consuming raw oysters.

Each of the following agencies are responsible for regulating specific types of food-handling facilities:

Florida Department of Health (FDOH), Division of Environmental Health

- Institutional settings
- Civic and fraternal organizations
- Theaters
- Drinking water safety/testing
- Food safety and sanitation ratings

[117] Centers for Disease Control and Prevention. (2015, October 15). Confirming Diagnosis. *Foodborne Outbreaks*. <u>Https://www.cdc.gov/foodsafety/outbreaks/investigating-outbreaks/confirming_diagnosis.html</u>
[118] Centers for Disease Control and Prevention. (2015, June 10). Blue Bell Creameries Ice Cream Products. *Listeria (Listeriosis)*. https://www.cdc.gov/listeria/outbreaks/ice-cream-03-15/index.html
[119] Centers for Disease Control and Prevention. (2019, January 09). Outbreak of E. coli Infections Linked to Romaine Lettuce. *E. coli (Eschericha coli)*. https://www.cdc.gov/ecoli/2018/o157h7-11-18/index.html

Florida Department of Business and Professional Regulation (DBPR), Division of Hotels and Restaurants

- Public Lodging

Florida Department of Agriculture and Consumer Services (DACS), Division of Food Safety

- Grocery stores
- Gas stations
- Food Recalls

Institutional customers, like food service vendors or non-regulatory government agencies, can require customer audits of food production and processing facilities to guarantee that products purchased meet their standards. Local governments, private customers, and non-governmental organizations can set requirements and standards for food production/processing/service facilities. However, these organizations cannot set standards that deviate from the minimum level of safety set by the federal equivalent agencies (i.e. U.S. Department of Agriculture, Environmental Protection Agency, Food and Drug Administration, and CDC) and code of federal regulation.

In addition to food safety issues, there are documented cases of threatened or actual intentional tampering of the food chain. Intentional food chain contamination or tampering may stem from a variety of political, economic or social motivations.[120] Consumer product tampering is most often non-malicious acts of mischief, which are rarely investigated or reported. Cases of disgruntled food industry workers sabotaging the food chain in retaliation to an employer is another relatively frequent occurrence according to the Food and Drug Administration (FDA). Larger offenses stemming from specific political or economic agendas, agroterrorism or food-terrorism attacks are rare occurrences. Efforts to prevent these types of malicious activities fall under the food defense definition.

Potential Effects of Climate Change on Food and Waterborne Disease Outbreaks

Extreme weather events, especially droughts, heat waves, severe storms, and hurricanes, can be expected to continue into the future or potentially negatively impact the protection of the food chain. As previously discussed, risk of contamination due to extreme weather events impacts all phases of food production.[121]

Additionally, climate change and globalization are also associated with a progressive northward movement of certain fungal and protozoal germs that may produce outbreaks in non-endemic areas. Rising surface temperatures and acidification of the oceans can increase also infectious germs, including *Vibrio* bacteria and the microbes that produce ciguatoxin. Increasing solubility due to rising ocean temperatures may also increase concentrations of non-organic toxins, like mercury. Chemicals that are absorbed by plants, which are then eaten by animals, can become widespread and increase in

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[120] Mackzka, C. (2008, January). Food Safety vs. Food Defense: Differences and Similarities (Presentation). Office for Food Defense and Emergency Response, Food Safety and Inspection Services. https://www.slideshare.net/AhmedGamalAbdElhamid/food-safety-vs-food-defense

[121] Her, Y.G., Boote, K.j., Migliaccio, K.W., Fraisse, C., Letson, D., Mbuya, O., …, Asseng, S. (2017, November 29). Climate Change Impacts and Adaptation in Florida's Agriculture. *Florida's Climate Book*. Florida Climate Institute. Http://floridaclimateinstitute.org/docs/climatebook/Ch08-Her.pdf

concentration, affecting all areas of the food chain. This process is known as biomagnification. Rising risk of food poisoning from a variety of food and water sources should be considered into the future.[122]

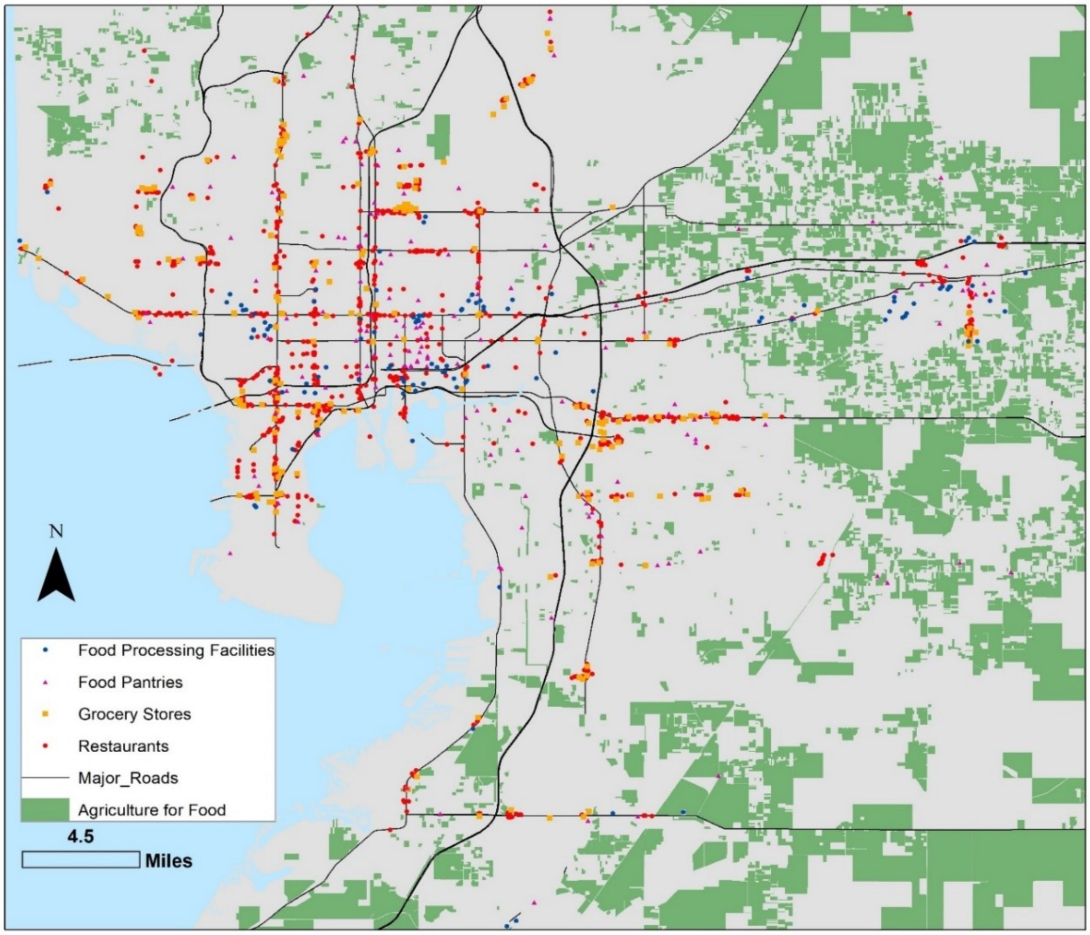
2. Geographic Areas Affected by Food and Waterborne Disease Outbreaks

Any person or facility that produces or handles food and drink products has the potential to cause a foodborne illness among consumers of the contaminated products. Public facilities such as restaurants, grocery stores, farmer's markets, cafeterias, and gas stations are examples of facilities that pose higher risk of foodborne disease outbreaks. Public recreational water facilities, including pools, fishing areas, and waterparks are an additional source of food and waterborne disease outbreaks. About half of Hillsborough's land mass is dedicated to some phase of commercial food chain.

The food chain is pervasive throughout the county as seen in the map below. Food production (agriculture) is localized most intensely to the eastern and southern areas of the county. Post-production activities (i.e. food processing, distribution, and preparation) are localized to population dense areas in the central area of the county (downtown, South Tampa, and along major traffic corridors), along State Road 60 in Brandon, US 301 in Riverview, and in the Plant City area.

[122] U.S. Global Change Research Program. (2016). *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, DC. Http://dx.doi.org/10.7930/JOR49NQX

Figure 4.67: Map of the Food Chain in Hillsborough County, 2019



Source: Hillsborough County Property Appraiser[123] and Tampa Bay Network to End Hunger[124]

The map above shows a representative distribution of businesses and facilities that are dedicated to some aspect of the food chain in Hillsborough County and may not show all possible locations of where food is prepared and served. Assisted living facilities, hospitals, hotels, day care facilities, schools, and private residents are additional locations where food is likely being prepared and served that are not depicted in this map.

3. Historical Occurrences of Food and Waterborne Disease Outbreaks

This section discusses significant (involving specific disease outbreak investigation or intervention) food and waterborne disease outbreak events. The most significant events, which are categorized as incidents affecting more than 50 individuals, are discussed in detail below.

[123] Hillsborough County Property Appraiser. (2018). Hillsborough County Parcels. Hillsborough County Property Appraiser Downloadable Maps and Data. https://www.hcpafl.org/Downloads/Maps-Data.
[124] Tampa Bay Network to End Hunger. (2018, May 31). Hillsborough County Food Pantries. http://networktoendhunger.org/web/wp-content/uploads/2018/06/Hillsborough-Pantries-May-2018.pdf.

Table 4.133: Description of Significant Food and Waterborne Disease Outbreaks in Hillsborough County

Date	Information
Lysergic Acid Diethylamide (LSD), Spring 2014	The Florida Department of Health received notification of two separate instances of suspected intoxication with Lysergic Acid Diethylamide (LSD) associated with meat products. The first cluster involved a family treated for symptoms consistent with LSD intoxication and presence of the drug confirmed in a skirt steak consumed by the family. The second instance involved potentially contaminated ground beef that was consumed by person(s) that died shortly following. Autopsy results indicate that the LSD exposure was not the direct cause of death. These occurrences represent a possible intentional or unintentional contamination of the food chain by a chemical agent not normally found in the food production chain scheme. Although not proven, this incident represents a case of food defense related issues. LSD is not a chemical routinely found in the meat industry and may be the result of consumer product tampering or intentional/accidental release of the LSD chemical by a worker somewhere along the food chain.[125] [126]
Cryptosporidium Outbreak, Summer 2014	An outbreak of cryptosporidium occurred the Tampa Bay area including Hillsborough, County. The outbreak involved 266 cases and was associated with a local water park located in the City of Tampa. The investigation found no critical deficiencies but noted a lack of secondary water disinfection system. In all, Hillsborough County experienced 348 cases of cryptosporidiosis in 2014, most of which were associated with this outbreak. In summer 2015, the same Tampa water park was associated with another cryptosporidium outbreak involving 22 suspected or confirmed cases.
Hepatitis A Outbreak, August 2019	The Florida Surgeon General declared a public health emergency related to an ongoing Hepatitis A outbreak. Since the start of 2018, Florida has seen 2,961 cases of hepatis A, which is nearly 5 times more than has been seen from 2014 to 2017 combined. Hillsborough County is included in this outbreak with 200 cases seen between January 2018 and August 2019. The exact source for the outbreak has not been identified. Hepatis A is spread through the contamination of food, water, and environmental surfaces with infected fecal material. The disease causes significant inflammation and dysfunction of the liver. The Surgeon General's public health emergency declaration signals healthcare professionals to give special emphasis to diagnosis, vaccination, and public education.[127]

[125] https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5218a3.htm
[126] http://www.floridahealth.gov/diseases-and-conditions/disease-reporting-and-management/disease-reporting-and-surveillance/data-and-publications/fl-amsr1.html
[127] Florida Department of Health. (2019, September 03). Protect Yourself: Hepatis A is on the rise in Florida counties. *Hepatitis A*. http://www.floridahealth.gov/diseases-and-conditions/vaccine-preventable-disease/hepatitis-a/index.html

Table 4.134: Report of Foodborne Diseases in Hillsborough County, 2014-2019

Hazard or Disease	Severity		Frequency						
	Duration	Death Rate	2014	2015	2016	2017	2018	2019	Assessment
Botulism, Foodborne	Weeks to Months	5-10%	-	-	-	-	-	1	**NE**
Brucellosis	Weeks to Months	<1%	-	-	1	-	1	1	**NE**
Campylo-bacteriosis	2-10 Days	<1%	79	245	261	315	337	221	**Endemic**
Ciguatera Fish Poisoning	2-6 Days	Rare	-	-	-	3	2	2	**Endemic**
Cryptospori-diosis	2-14 Days	Rare	318	99	62	55	76	35	**Endemic**
Cyclosporiasis[1]	Days to months	Rare	-	1	1	12	3	15	**Endemic**
Hemolytic Uremic Syndrome (HUS)	2-9+ days	3-5%	1	2	1	3	1	-	**Endemic**
Hepatitis A	1-2 weeks	2-3%	1	5	5	10	84	116	**Endemic**
Hepatitis E	2 weeks	1-4%	-	1	-	1	2	1	**NE**
Giardiasis, Acute	2-6 weeks	<1%	37	55	105	73	62	46	**Endemic**
Listeriosis	Days to Weeks	0-30% (70-80%)[2]	-	2	2	4	3	2	**NE**
Legionellosis			1	20	25	19	31	13	**Endemic**
Q Fever (Coxiella burnetii)[3]	1-2 weeks (18+mos.)	<1% (to 60%)	-	-	-	1	-	-	**NE**
Salmonellosis (Typhoidal)	2-4 weeks	0-10%	-	-	1	3	5	2	**NE**
Salmonellosis (Non-Typhoidal)	4-7 days	1-4%	180	287	308	315	343	153	**Endemic**
Shiga Toxin-Producing Escherichia coli (STEC) Infection	2-9 days	<1%	-	16	12	16	54	31	**Endemic**
Shiga Toxin-Producing Escherichia coli (STEC) Infection	2-9 days	<1%	-	16	12	16	54	31	**Endemic**
Shigellosis	5-7 days	0-15%	37	216	76	165	32	22	**Endemic**
Vibriosis (Excluding Cholera)	2-6 days	~2% (20-30%)[2]	4	11	11	21	11	9	**Endemic**

Hazard or Disease	Severity		Frequency						
	Duration	Death Rate	2014	2015	2016	2017	2018	2019	Assessment

Notes: The above table depicts the burden of food and waterborne pathogens in Hillsborough County from 2014-2019. Disease burden is determined from the annual case numbers (frequency) and disease duration and death rates (severity). The diseases highlighted in purple have had outbreaks within the previous 5 years.[128]

Endemic = Diseases that are transmitted locally and circulate annually; Non-Endemic (NE) = Diseases that are not transmitted locally and occur on less than annual basis (sporadic)

1 Cyclosporosis is an increasingly common foodborne illness in. since 2014. Despite annual occurrence of this disease in the spring and summer months, it is not considered endemic to the U.S. as cases are often traced to imported food items from or travel to endemic areas in the tropics and subtropics

2 Mortality rates noted in parentheses indicate severe presentations of the illness/disease

3 Coxiellosis can be foodborne, airborne, or vector borne. Source of transmission is not indicated in reporting.

Table 4.135: Facility Inspections, Outbreak Investigations, and Food Safety Recalls (2014 – 2019)

Over 389 food product recalls initiated by the U.S. Department of Agriculture and Florida Department of Health.[129]	**<u>Top 5 Reasons for Recalls</u>** 1. Listeria Contamination 2. Salmonella Contamination 3. *E.coli* Contamination 4. Quality Assurance or General Spoilage 5. *Clostridium* spp. Contamination
Florida Department of Health investigated 32 food and water-borne disease outbreaks.[130]	**<u>Top 5 Reasons for Outbreaks</u>** 1. Norovirus 2. Unidentified/Not Specified 3. Scombroid Toxin 4. Legionella 5. Ciguatera Toxin
Florida Department of Health issued 629 unsatisfactory Ratings to Hillsborough County Facilities[131]	Average of 63 unsatisfactory ratings to Food Service Operations annually. Average of 63 unsatisfactory ratings to Pools/Spas/Recreation Water Facilities annually

* Two recalls initiated as a result of intentional employee tampering.

News media reports for the last year were reviewed to assess the potential occurrence of other consumer product tampering or food defense cases. Over two dozen cases were reviewed nationwide ranging from

[128] Florida Department of Health. (2019, June 30). Reportable Diseases Frequency Report. *FL Health Charts*. http://www.flhealthcharts.com/ChartsReports/rdPage.aspx?rdReport=FrequencyMerlin.Frequency&FirstTime=True
[129] Food and Drug Administration. (2019, August 28). Recalls, Market Withdrawals, & Safety Alerts dataset. *Safety* website. https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts
[130] Florida Department of Health. (2018, December 27). Food and Waterborne Disease. *Florida Health: Diseases and Conditions*.http://www.floridahealth.gov/diseases-and-conditions/food-and-waterborne-disease/
[131] Florida Department of Health. (2019, June 30). FL Health Charts. Florida Department of Health Division of Public Health Statistics & Performance Management. http://www.flhealthcharts.com /charts/default.aspx

opening sealed food containers in local grocery stores to cases of licking and urination on food items. There were at least two reported instances of consumer product tampering impacting Hillsborough County residents.

One Pinellas County woman is facing felony charges after spitting and urinating in the products of a local ice cream parlor. Her motivations were not disclosed. In the other incident, a local mother reports that baby formula that she had purchased had been replaced with flour. This is not the first instance of this kind of tampering. Nationwide, the USDA FSIS and FDA have initiated two separate food recalls for incidents of employee tampering in the previous five years.

Because notable malicious attacks on the food chain are a relatively rare, review has been extended to notable historic incidents of malicious attacks on the U.S. food chain. In 1984, a total of 751 persons fell ill with Salmonella Typhimurium due to the intentional contamination of salad bars in four Dallas (OR) restaurants by the Rajneesh cult. In 2003, the FDA and CDC investigated an incident involving the suspected intentional contamination of 200 pounds of ground beef with Black Leaf 40 pesticide, which contains high levels of nicotine. The person responsible for the contamination was an employee of the supermarket chain. The product is reported to have caused illness in over 148 persons, which is due to the product contamination occurring at a single grocery store. If the product had occurred at the processing plant, the outbreak would have been larger and more widespread.[132]

4. Probability of Food and Waterborne Disease Outbreaks

Food and waterborne disease outbreaks and related activities, including food product recalls, are frequent occurrences in Hillsborough County. There are hundreds to thousands of cases of food and water-related illness reported on an annual basis.

The Florida Department of Health has investigated over 32 separate outbreaks of food and waterborne disease between 2014 and 2019, with two significant outbreaks (affecting greater than 50 persons). That is an average of 6-7 food and waterborne disease outbreaks per year. Additionally, the U.S. Department of Agriculture and FDA have initiated over 379 food recalls for issues ranging from quality control to potential contamination of food and water products by disease causing germs and chemicals. Any one of these recalls may be impacting Hillsborough food processing facilities, grocery stores, or food service facilities.[133] [134]

In general, intentional contamination of the food chain is less common than unintentional incidents, but still occur at least annually. There has been one investigation by the Florida Department of Health in the last five years for contamination of food products by chemicals/germs that are not a part of the normal food chain. Two separate food product recalls were initiated due to known instances of employee tampering. Additionally, the FDA cites that contamination from consumer product tampering is likely a

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[132] Centers for Disease Control and Prevention. (2017, September 05). How Food Gets Contaminated. *Food Safety*. https://www.cdc.gov/foodsafety/production-chain.html

[133] Florida Department of Health (2019, August 29). Florida Food Recalls Search: *Food and Waterborne Disease*. http://www.floridahealth.gov/diseases-and-conditions/food-and-waterborne-disease/florida-food-recalls.html

[134] Food and Drug Administration. (2019, August 28). Recalls, Market Withdrawals, & Safety Alerts dataset. *Safety* website. https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts

daily occurrence that is rarely reported. Specific food terrorism attacks are relatively rare occurrences, only occurring every 10-20+ years.

Based on historical information, this hazard was determined to have a probability level of likely (10 to 100% annual probability).

5. Food and Waterborne Disease Outbreak Impact Analysis

- Public
  - Injury/Illness or Death
  - Mass Casualties
  - Public Fear and Unrest
  - Delays
- Responders
  - Injury/illness/death from the similar food and water sources
  - Injury/illness/death from treating victims
- Continuity of Operations (including delivery of services)
  - Increased disease burden may cause localized challenges
  - Increased patient load in hospitals limits operational capacity
- Property, Facilities, and Infrastructure
  - Facility closures during investigation and response
- Environment
  - Product Disposal and other waste management
  - Increased chemical use in response
  - Management of Deceased
- Economic Condition
  - Hospitalization and insurance costs
  - Work hours lost in convalescence
  - Cost of investigations
  - Cost of downtime and response/cleaning for businesses
  - Product loss/destruction
  - Temporary facility closures may become permanent (lowered business economy)
- Public Confidence in Jurisdiction's Governance
  - Business owners may feel victimized or targeted by outbreak investigations and public response
  - Public fear may produce loss of faith in local business owners, the medical community, or government agencies
  - Tourists may reconsider visiting Florida

Impact Summary

How widespread (scope) outbreak becomes is dependent upon the phase when that the food product become contaminated. Contamination of food products in the production or processing phases may result in multi-state outbreak, while contamination of food products at the grocery store or food service locations are more geographically confined to a single city or region. Food- and waterborne disease outbreaks affecting Hillsborough county from 2014-2019 have been localized to the greater Tampa area except for the Hepatitis A outbreak, which is part of a statewide outbreak. However, as a major seaport and tourist destination, there is a strong risk of connection with national or international disease outbreaks.

How large (scale) an outbreak becomes depends on the number of individuals exposed to the contaminated food or water source before the contamination is recognized and/or eliminated. The scale of an outbreak may range from a small number of linked cases to a nationwide or international outbreak of thousands or more involving the mobilization of public health and emergency management resources from all levels. The scale of local outbreaks in Hillsborough (2014-2019) ranged from a few index cases to several hundred cases. No single foodborne disease outbreak was associated with case numbers above 500 within the county.

Impact to the Built Environment

The food chain is a complex system that is vulnerable to many hazards in the built environment including facility fires, utility failures, transportation incidents, hazardous material releases, radiologic incidents, human error, and malicious tampering. Food production and food processing facilities range from light construction to large concrete structures. Additionally, construction of food chain facilities have variable food safety and defense capabilities depending on time, money, attention, and awareness of the facility owners/managers. Any of these hazards may produce a breach in the protections that prevent germs and chemical contamination in our food and water. The complexity of the system can also be a vulnerability. The more complex and tightly organized a system becomes, the more opportunity there is for error and severity of consequences increases should error or breach occur.

Access to medical care is an important factor in the response and recovery of the community from disease outbreaks. Hillsborough county social healthcare network includes 19 hospitals (Bed Capacity 4,593) and 28 family care and general health clinics.[135] There are more private medical clinics, urgent care centers, and non-profit/non-governmental health care organizations. Given that most of the food and waterborne disease cases are asymptomatic or only require outpatient care, the physical volume of care slots is likely adequate. However, if the source of illness is geographically localized certain facilities can become overwhelmed.

Ecological Impacts of Food and Waterborne Diseases

Extreme weather events increase the risk of contamination of crops, fisheries, and produce during the production phase. Increases in over-ground water flow (run-off) in thunderstorms, as well as severe decreases seen in drought, can cause unintentional contamination of food crops with germs or chemicals. Flooding and flash flooding can bring chemicals and germs from local housing developments, compromise water and wastewater management, and accumulate in low lying areas typically occupied by agricultural land. Drought can also cause increases in certain pathogens due to lower access to water for hygiene, which is a concern for imported food products. Drought may also increase production of certain germs in

[135] Florida Hospital Association (FHS), 2019. http://www.fha.org/reports-and-resources/hospital-directory.aspx

the environment. *Aspergillus flavus* is a fungus responsible for aflatoxin, which increases in times of drought. Aflatoxin may enter the food chain either directly through contamination of crops but also indirectly though accumulation in milk, eggs, and meat when food animals eat toxin contaminated feeds.

Food processing, storage, and distribution is also affected by variability in the climate and extreme weather events. In 2017, Hurricane Irma prevented raw milk sales for processing for several days, costing the Florida dairy industry approximately $1 million in lost revenue from milk spoilage and milk dumping. Widespread power outages also impacted the food chain from food material stored in processing plants to distribution facilities to local grocery stores and restaurants to the individual consumers. Heat waves also present unique challenges to food distribution and preparation due to some foods being sensitive to increased temperatures.

Social and Population Impacts from Food and Waterborne Diseases

Certain populations may be more susceptible to the negative effects of illness from food and waterborne germs and toxins. These include, but are not limited to:

- Very young (less than 5 years old)
- Very old (older than 65 years)
- People with certain diseases and conditions that lower the capability of their immune system (e.g. HIV/AIDS, leukemia, multiple myeloma, some congenital and autoimmune disease)
- People with hepatitis from a virus, toxin, or other cause
- People undergoing treatment for cancer and autoimmune disease
- Pregnant women

There are four groups of people that are considered to be at higher risk of foodborne illness: young children, pregnant women, senior adults, and immune suppressed individuals (i.e., patients undergoing chemotherapy and organ transplants). For example, immune suppressed persons and those with hepatitis infections, may not be able to fight off germs associated with food and water contamination. Very old or young persons may be less tolerant of nutrition and hydration losses from vomiting or diarrhea. Contamination of food items with some toxins or germs can cause specific and severe illness.

The association of viral hepatitis with worsening food and waterborne illness is an important concern given the current Hepatitis A outbreak in Florida. The Florida Surgeon General has declared a public health emergency in response to this outbreak that has been ongoing since 2018. There is a strong association the outbreak cases to homelessness, but the exact risk factors still unknown. Persons with ongoing hepatitis infections experience lower gastrointestinal health and innate immunity, which increases the risk of severe illness with food and waterborne germs. People with concurrent hepatitis are more likely to experience sepsis, multi-organ dysfunction, and other complications as a result of food and waterborne infections.[136]

[136] Florida Department of Health. (2019 September). Protect Yourself: Hepatis A is on the rise in Florida counties. Http://www.floridahealth.gov/diseases-and-conditions/vaccine-preventable-disease/hepatitis-a/index.html

In the table below, this is a summary of select vulnerable populations that may increase severity of disease outbreaks. Understanding demographics and social factors with greater vulnerability allows planners to identify strategies to mitigate risk.

Table 4.136: Vulnerable Populations in Hillsborough County to Food and Waterborne Disease Outbreaks

	Population Statistics[137]		
Vulnerability	**No. (x1000)**	**Percent (%)**	**Reason for Concern**
Elderly (Age 65+)	173	14.3	Lowered immunity, Concurrent disease conditions that may complicate treatment/recovery
Young (< 5 years)	205.5	6.2	Lowered immunity, More susceptible to metabolic stress
HIV/AIDS Incidence (2018)	0.5	<1	Lowered immunity, Concurrent disease conditions that may complicate treatment/recovery
Viral Hepatitis Incidence (2018)	1.8	<1	Lowered immunity; Increased risk of septicemia or other complications
Persons Living below Poverty	222.7	15.5	Lower financial flexibility to handle medical costs; Lower access to healthcare
Unemployment			Lower financial flexibility to handle medical costs; Lower access to healthcare
Persons without Health Insurance[138]	205.5	14.3	Lower financial flexibility to handle medical costs; Lower access to healthcare
Foreign-Born Persons	237.1	16.5	Different disease and environmental exposures; Vaccination status may be incomplete or unknown; Lower familiarity with systems and infrastructure
Non-English-Speaking Persons	409.5	28.5	Limits ability to communicate with English only persons
Notes: This table presents examples of demographics and social factors with greater vulnerability and the reasons for concern in food and waterborne disease outbreaks. [139]			

[137] Hillsborough Planning Commission. (2018). Facts and Figures 2018. *Plan Hillsborough*. http://www.planhillsborough.org/demographic-economic-data/

[138] Clavery, D. (2017, May 09). Population without Health Insurance by State and County, 2011-2015 (Map). Https://www.arcgis.com/home/item.html?Id=aa71c1ac3ccd46f08304ac57517d0e95

[139] Florida Department of Health. (2019, June 30). FL Health Charts. Florida Department of Health Division of Public Health Statistics & Performance Management. http://www.flhealthcharts.com /charts/default.aspx

6. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be moderate, with a PRI score of 2.3.

FOOD AND WATERBORNE DISEASE OUTBREAK					Overall Vulnerability
Overview					
Food and waterborne disease outbreaks are a subcategory of biologic incidents where food or water have become contaminated with bacteria, parasites, fungi, viruses, prions or toxic chemicals. These incidents are commonly referred to as "food poisoning". Intentional contamination of food and water sources may be referred to as bioterrorism or food terrorism. The symptoms of food and waterborne illness varies with the exact causative agent. Hillsborough county business and tourism industries rely heavily on the safety and reliability of food and water sources and outbreaks in the county can lead to multistate or even international disease transmission to the high traffic of people in and out of the county.					MODERATE
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Likely	Limited	Small	> 24 hrs	< 1 week	2.3

Coastal Oil Spill Incident Hazard Profile

1. Coastal Oil Spill Incident Description

An oil spill is the release of crude oil, or liquid petroleum, into the environment. This is usually associated with marine spills but can also happen on land. Oil spills are caused by the release of oil from offshore platforms, drilling rigs, tankers, ships that have sunk, and any vehicle used to transport crude oil over the water or land. These spills have far reaching effects including continued damage to the environment and a financial loss to communities affected.

As of June 2019, there are 26 operating rigs in the Gulf of Mexico, 24 drilling for crude oil and 2 drilling for natural gas.[140] While there are currently no drilling rigs on the east coast of Florida, the U.S. Chamber of Commerce predicts that rigs could be seen in the future as exploration estimates roughly 4.72 billion barrels of recoverable oil and 37.51 trillion cubic feet of recoverable natural gas from Maine to Florida.[141] As of 2017, Florida produced 1.9 million barrels of crude oil.[142]

Given Hillsborough County's coastal location on the Gulf of Mexico and dependence on tourism and the related sales tax revenue, an oil spill, which is classified as a type of HazMat event, could affect any of Hillsborough County's many natural resources, which could be catastrophic.

In addition to economic impacts, an oil spill in Florida or off its shores could have severe consequences for wildlife, ecosystems, and the ecology. The Deepwater Horizon spill affected the wildlife populations of numerous species of turtles, birds, bottlenose dolphins, whales, and fish. Gulf states saw a decrease in bottlenose reproduction and a rise in deaths; the Kemp's Ridley sea turtle, already endangered, saw a massive drop in numbers; and scientists estimate the habitats on the bottom of the Gulf could take anywhere from multiple decades to hundreds of years to fully recover.[143]

2. Geographic Areas Affected by Coastal Oil Spill Incident

Oil spills can happen anywhere oil is drilled, transported, or used, but as the name suggests, Coastal Oil Spills would most directly impact coastal portions of Hillsborough County, as well as the coastal areas of the City of Tampa. As these materials are processed and stored, those in the immediate vicinity are at risk of toxic fumes, soil contamination, and water contamination. Coastal Oil Spills are most likely to occur in the shipping lanes serving the Tampa Port Authority.

3. Historical Occurrences of Coastal Oil Spill Incidents

Hillsborough County is surrounded by water with hundreds of commercial and private marine vessels traveling its waterways daily. The Port of Tampa resides to the east of the county and is one of the busiest in the Gulf of Mexico, making the probability of a major spill more likely to occur. The last major incident

[140] https://www.wtrg.com/rotaryrigs.html
[141] Hackbarth, S. (2014, August 13). Will We See Oil Rigs In The Atlantic? Retrieved from U.S. Chamber of Commerce website: https://www.uschamber.com/above-the-fold/will-we-see-oil-rigs-the-atlantic
[142] https://s3images.americangeosciences.org/agi/statefactsheets/FL_GeoscienceInYourState_AGI.pdf
[143] http://www.nwf.org

occurred in August 1993 when three ships collided at the entrance to Tampa Bay causing a major fire and oil spill, which affected the southern third of the county significantly.

On August 10, 1993, two tank barges collided with a freighter just south of Mullet Key near the entrance to Tampa Bay, Florida. Both barges were damaged in the collisions. As a result of the damage to one tank barge, approximately 330,000 gallons of #6 fuel oil was discharged into lower Tampa Bay. The freighter caught fire upon impact, burned for close to 18 hours and, during that period, released approximately 32,000 gallons of Jet A fuel, diesel, and gasoline in the same vicinity. The surface waters of lower Tampa Bay and shoreline areas nearby were heavily impacted. Over the next few days, winds and outgoing tides carried much of the oil out of the lower bay and to the Gulf of Mexico. The oil remained offshore until an approaching storm quickly pushed oil back toward shore. Most of the oil came ashore on August 14 and 15, stranding on the sand beaches along Pinellas County barrier islands. In addition to injuring birds, sea turtles, mangroves and other natural resources in Boca Ciega and lower Tampa Bay, the spill oiled about 13 miles of beaches in Pinellas County. The spill and associated response activities disrupted public access to and recreational use of these beaches and resulted in temporary restrictions on use of certain waterway areas and isolated shellfish beds. The Trustees estimate that approximately 280,000 beach user days were lost as a result of the incident[144].

4. Probability of Future Coastal Oil Spill Incident

Coastal oil spills can happen anywhere along the coastal portions of Hillsborough County and the City of Tampa wherever oil is transported or used. These include chemical manifesting plants, laboratories, shipyards, railroad yards, warehouses, or chemical disposal areas. Illegal dumpsites can appear anywhere. Accidents involving the transportation of hazardous materials can occur at any time and severely impact the affected community. Recent evidence shows that hazardous materials incidents may be the most significant threat facing local jurisdictions.

This hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Coastal Oil Spill Incident Impact Analysis

- Public
  - Loss of life or injury from contamination
  - Diseases may be exacerbated
- Responders
  - Loss of life or injury from contamination, explosions, cleanup, and destruction
  - Diseases
  - Cleanup and destruction at waste sites and incident sites
- Continuity of Operations (including continued delivery of services)
  - Lost oil is unusable and could lead to shortages and price increases
- Property, Facilities, Infrastructure
  - Damage due to excavation and removal of soil and water
  - Inability to rebuild in affected areas

[144] https://darrp.noaa.gov/what-we-do-resources/explore-cases

    - Services could be closed or blocked due to the contaminant
        - Roads
        - Trains
        - Airplanes
        - Bridges
        - Waterways
    - Long-term contamination at spill sites
- Environment
    - Death or illness to pets or wildlife near the spill
    - Damage to plants and wildlife
    - Airborne issues such as toxic fumes, gases, or vapors caused by chemicals
    - Water contamination
    - Soil contamination
    - Loss of critical or endangered species
    - Pollution
- Economic Condition
    - Business closures may lead to lost revenue and wages
    - Loss of tourism and income
    - Loss of product
    - Cost of cleanup and restoration
- Public Confidence in Jurisdiction's Governance
    - If the government does not communicate with the public, fear could ensue, leading to a fear of the government
    - If cleanup is slow, the public could believe the government does not know how to properly clean it up or that the accident was malicious

6. Vulnerability Analysis and Estimated Losses by Jurisdiction

Oil spills can happen anywhere oil is drilled, transported, or used, but as the name suggests, Coastal Oil Spills would most directly impact coastal portions of Hillsborough County, as well as the coastal areas of the City of Tampa.

Oil spills pose short- and long-term toxicological threats to humans and to terrestrial and aquatic plants and wildlife. As noted previously, should an oil spill or accident occur in the Port of Tampa under favorable weather conditions, a significant number of people working, visiting, or living near the port could be adversely affected. As an active port, two factors are present which contribute to the need for vigilance. First, as a port, hazardous materials will always be present, either in transit or storage. Second, as a port, the potential for accidents is always present, either in the transfer of hazardous materials from ship-to-shore to storage or transfer from storage to overland transport. Given the amount of ship traffic at the port and its location should a spill or fire/explosion occur the impact on the surrounding community could be catastrophic.

7. Vulnerability Analysis and Estimated Losses of Critical Facilities

Coastal Oil Spills are unlikely to directly impact critical facilities at the geographical location of an event. However, these spills would potentially indirectly impact the critical facilities by limiting the fuel available to the community. Furthermore, an oil spill could occur in a channel that limits the availability for shipping traffic and correspondingly, prolongs the supply chain to the community which could negatively impact critical facilities.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.9.

COASTAL OIL SPILL INCIDENT					Overall Vulnerability
Overview					
An oil spill is the release of crude oil, or liquid petroleum, into the environment. Oil spills are caused by the release of oil from offshore tankers, ships that have sunk, and any vehicle used to transport crude oil over the water. These spills have far reaching effects including continued damage to the environment and a financial loss to communities affected.					HIGH
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Possible	Critical	Moderate	< 6 hrs	> 1 week	2.9

Port Vessel Collision Incident Hazard Profile

1. Port Vessel Collision Incident Description

The Port of Tampa Bay is Florida's largest port by tonnage and physical size, and handles a diverse portfolio of cargo, including:

- **Liquid bulk** (incl. petroleum, sulfur, ammonia, orange juice, etc.)
- **Dry bulk** (incl. fertilizer, limestone, granite, cement, coal, etc.)
- **Break-bulk** (we are Florida's largest steel handling port with a cluster of related activities involving manufacturing, fabrication, processing and distribution with a focus on exports)
- **Containers** (imports and exports of food and beverage products, consumer goods such as furniture, lubricants, agricultural products, etc.)
- **Automobiles** (a target growth area for short sea given plant expansion in Mexico and Southeast US)
- **Cruise** (Nearly 1 million passengers/year)
- **Shipbuilding & Repair** (while not core to cargo, one of the largest shipbuilding and repair ports in the southeast is seen as adding to diversity and comprehensive full-service status as a seaport)

Additionally, Tampa is home to several globally successful exporters, such as Amalie Oil (manufacturer of specialty engine oils exporting to over 100 countries) and Tampa Tank/Florida Structural Steel (manufacturer of bridges, petroleum storage tanks and specialized steel structures with a focus on Latin American exports, as well as domestic markets).[145] There are approximately 3,000 vessel berths at the port every year, including cruises[146].

2. Geographic Areas Affected by Port Vessel Collision Incident

Hazardous material incidents can occur during the production, transportation, use, and storage of those hazardous materials and can happen anywhere within the county. As these materials are processed and stored, those in the immediate vicinity are at risk of toxic fumes, soil contamination, and water contamination. Even those communities removed from production or storage facilities are at risk given that hazardous materials are routinely and frequently transported via roadways, railways, pipelines, and waterways, concluding that all areas of the county are potentially at risk.

The Port of Tampa contains the largest concentration of hazardous materials in Hillsborough County. Included are such products as petroleum and ammonia. Although these products are stored within an industrial area, the port is located immediately adjacent to downtown Tampa and large residential concentrations on Harbour Island and Davis Island.

145 Port Tampa About Page (porttb.com)
146 https://www.porttb.com/statistics

Port vessel collisions and on-water hazardous materials spills are most likely to occur in the shipping lanes serving the Tampa Port Authority.

3. Historical Occurrences of Port Vessel Collision Incidents

Hillsborough County is surrounded by water with hundreds of commercial and private marine vessels traveling its waterways daily. The Port of Tampa resides to the east of the county and is one of the busiest in the Gulf of Mexico, making the probability of a major spill more likely to occur. As indicated within the *Coastal Oil Spill Incident Hazard Profile*, the last major incident occurred in August 1993 when three ships collided at the entrance to Tampa Bay causing a major fire and oil spill, which affected the southern third of the county significantly. More than 330,000 gallons of No. 6 oil were spilled following a three-vessel collision. This spill caused significant ecological and economic damage to local shorelines and beaches.

An earlier event occurred in January of 1980, when the US Coast Guard cutter *Blackthorn*, a 180-foot seagoing buoy tender, and the tanker SS *Capricorn* collided near the Sunshine Skyway Bridge. According to the USCG Marine Report[147], the losses were as follows:

"As a result of the impact, the port anchor of *Capricorn* became imbedded in *Blackthorn*'s port side. The momentum of the two vessels caused the *Capricorn*'s port anchor chain to become taut and resulted in the capsizing of the *Blackthorn*. The *Capricorn* grounded on the north side of Cut "A" channel and the *Blackthorn* sand in Cut "A" channel. Twenty-seven *Blackthorn* crew members were rescued, however, twenty-three crew members perished. There were no personnel casualties abord the *Capricorn*."

4. Probability of Future Port Vessel Collision Incident

According to an article[148] in the Tampa Bay Times from 2006:

"A two-month investigation of Coast Guard records by the Times found that since 1986, Tampa Bay has had an average of four spills a year of 1,000 gallons or more. A collision occurs between commercial ships about three times a year on average. Groundings or collisions with docks are even more frequent: about 10 times a year. Also alarming is what the records say about close calls. There has been an average of 18 mishaps per year where a potential spill was avoided."

This hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Port Vessel Collision Incident Impact Analysis

- Public
  - Mass casualties
  - Injury or death
  - Delays
- Responders
  - Danger in reaching victims/survivors
  - Injury or death during rescue efforts

[147] https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/CG-5PC/INV/docs/boards/blackthorn.pdf
[148] https://www.tampabay.com/archive/1993/10/17/danger-on-the-bay-special-report-day-one/

- Continuity of Operations (including continued delivery of services)
  - Normal transportation operations may not return to return to normal for a significant time due to repairs
  - Goods cannot be delivered or accepted
- Property, Facilities, Infrastructure
  - Potential damage to infrastructure and public transportation programs
  - Shutting down affected highways, railways, airports, etc.
- Environment
  - Hazardous material spills
  - Pipeline burst/leak
- Economic Condition
  - Cost for repairs and down time
  - Could cause loss in revenue or wages
    - Loss in shipping revenues
    - Loss of tourism
- Public Confidence in Jurisdiction's Governance
  - Citizens may lose trust in particular public transportation services
  - Tourists may reconsider visiting Florida

6. Vulnerability Analysis and Estimated Losses by Jurisdiction

Due to the significant tourism in the county, all the municipalities are at risk. Hillsborough and the City of Tampa at a higher risk with large transportation hubs such as the port and the three cruise terminals.

Port Vessel Collisions can occur along the waterways of Hillsborough and the City of Tampa. Accidents involving the transportation of hazardous materials can occur at any time and severely impact the affected community. The shipping channel and port area would be most impacted by a vessel collision causing a chemical release.

7. Vulnerability Analysis and Estimated Losses of Critical Facilities

Port Vessel Collisions can result in loss of life at the point of impact or as a consequence of a hazardous materials release from the collision. By the nature of this hazard's specificity, the geographic area of impact is confined to the area in and around the port. In most cases, they do not result in serious impacts to critical facilities. However, critical facilities that store or handle hazardous chemicals listed in the Environmental Protection Agency (EPA) Superfund Amendments and Reauthorization Act (SARA) Title III are most vulnerable.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.9.

PORT VESSEL COLLISION INCIDENT					Overall Vulnerability
Overview					
A port vessel collision is geographically confined to those areas in and immediately surrounding Port Tampa Bay. Port Vessel Collisions can result in damages to people at the point of impact or to people, places, and submerged lands or aquatic environments as a result of a hazardous materials release. The Port’s size and amount of cargo traffic attribute to the profile’s high score.					HIGH
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Possible	Critical	Moderate	< 6 hrs	< 1 week	2.8

Utility Failure Hazard Profile

1. Utility Failure Description

Utility failure is defined in this plan by an interference with the availability of a power supply and/or water supply resulting in a loss of these services. A significant power failure is defined as any incident of a long duration, which would require the involvement of the local and/or State emergency management organizations to coordinate provision of food, water, heating, cooling, and shelter.

Power/water utility failures often occur hand in hand with other hazards. For example, they can be caused by rising flood waters or high winds. These events most commonly occur when wind events knock down power lines or water treatment plants are flooded by rising waters, thereby shutting down these utilities. The impacts from these failures are often widespread and can affect thousands of people even when small parts of this infrastructure are affected. Other failures in the power distribution network can happen due faults at a power station, shorts or overloading in a circuit(s), or physical damages at a substation.

There are three different types of power outages – transient faults, brownouts, and blackouts. A transient fault is a brief outage caused by a fault in a power line. The issue is corrected when the power flow clears the faulty part of the circuit, and power is returned. A brownout occurs when voltage falls to an inadequate level. A blackout occurs when there is a complete loss in the power supply. Blackouts are generally longer lasting outages than the previous two examples and may involve significant repairs. These outages can range from minutes to weeks or more depending on the significance of the failure in the network.

2. Geographic Areas Affected by Infrastructure Disruption

Due to the unpredictable nature of where exactly a utility failure will occur, the entire county is considered to be equally susceptible to this hazard. However, it should be noted that in more urbanized areas, the effects of a disruption at a single location or facility would likely impact large numbers of people.

3. Historical Occurrences of Infrastructure Disruption

Most lengthy infrastructure disruptions have been due to tropical cyclone and severe storm events. Over Christmas weekend of 1989, extremely cold weather caused extended power outages throughout the county.

4. Probability of Future Infrastructure Disruption

There is no sure way to predict future utility failure as most incidents typically occur without warning. Utility failure is most likely to occur during an extreme weather event.

This hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Infrastructure Disruption Impact Analysis

- Public
  - Transportation tie-ups and accidents

    - Medical emergencies
    - Communications disruptions
- Responders
    - Issues related to transportation, medical equipment, extreme weather temperatures, and communications issues
    - Increased call volume
    - Impact to notification processes and increased response times
- Continuity of Operations (including continued delivery of services)
    - Power outages and communications disruptions
- Property, Facilities, Infrastructure
    - Loss of food/refrigeration
    - Medical equipment failure
    - Grounded flights and suspended operations
    - Transportation infrastructure failure
    - Loss of communications
- Environment
    - Minimal
    - Some disruptions may cause spillover effects from cascading events such as fires or sewer backups
- Economic Condition
    - Shut down businesses
    - Significant financial impacts
    - Event/commercial activity disruption
- Public Confidence in Jurisdiction's Governance
    - Disruptions for extended periods give the appearance that the jurisdiction does not know how to restore power

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Exposure

Due to the nature and unpredictability of technological hazards, all property and infrastructure in the county are at risk to these events. While a utility failure event could happen anywhere in the county, it should be noted that in more urbanized areas, the effects of a disruption at a single location or facility would likely impact larger numbers of people.

Some issues that need to be considered during a power outage include transportation tie-ups and accidents, medical emergencies, and communications disruptions. The transportation problems would likely be related to traffic lights and signals not working or from decreased visibility during the night. Medical emergencies could stem from homes not having power to operate heating and air conditioning systems, particularly during conditions of extreme temperatures. Also, medical equipment that relies on power could shut off, no longer providing a patient with treatment he or she requires. Communications issues could prevent the public from being able to call emergency services. Business disruptions could also impact services that the public wants or needs. Lastly, well pumps would not function without power unless on backup generator power.

Many residential structures do not have backup generators in place. If power fails, the residents of these homes may not be able to refrigerate their food, regulate medical equipment properly (such as oxygen), etc. until power is restored. Power outages can also sometimes lead to sparks that may rarely ignite fires or damage other components of the electric grid, causing extensive damage. Other utility failures may also cause damage when they go down, such as sewer systems. Shutdowns or damage to these systems can result in hazardous environments that expose the built environment to waste products.

In terms of transportation infrastructure, airports may have to ground flights and suspend operations as a result of a power outage until power can be restored. Extended outages may cause more significant impacts on flight patterns. Signals at railroad crossings may not work appropriately and in more severe cases, networks may be stopped until power is restored to prevent incidents.

Communications infrastructure may also be damaged or disrupted. Cellular telephone towers generally have backup power to function during power outages. However, depending on the presence of other hazards or lengthy outages, cell phone reception may be impacted. Internet connections that originate from or are linked to energy sources in affected areas will likely see effects from a power outage.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Utility failure can occur anywhere in Hillsborough County; therefore, all of the county critical facilities are equally vulnerable and at risk. The impact of infrastructure disruptions to structures, including critical facilities, are listed above under Exposure.

8. Overall Vulnerability

Each of the five PRI categories was assigned value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.5.

<table>
<tr><th colspan="5">UTILITY FAILURE</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">Utility failure is interference with the availability of a power supply and/or water supply resulting in a loss of these services. These events have cascading impacts to all aspects of the community. However, historic occurrences are rare, and many critical facilities have redundancy or back-up methods installed to mitigate significant losses.</td><td>MODERATE</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Possible</td><td>Limited</td><td>Moderate</td><td>< 6 hrs</td><td>< 1 week</td><td>2.5</td></tr>
</table>

Civil Disturbance Hazard Profile

1. Civil Disturbance Description

According to FEMA, civil disturbance, sometimes referred to as civil unrest, is an activity such as a demonstration, riot, or strike that disrupts a community and requires intervention to maintain public safety.[149]

Most protestors are law abiding citizens who intend their protest to be nonviolent; however, sometimes these situations become highly emotional and tense which can turn a peaceful crowd into a violent riot.

According to the U.S. Army Civil Disturbance Operations Manual, civil disturbances and riots can arise from crowds. Crowds are gatherings of a multitude of individuals and small groups that have temporarily assembled in the same place, usually representing a group belief or cause.

There are two types of gatherings, impromptu and organized. Impromptu gatherings develop informally and by word of mouth, while organized gatherings involve well-established groups that plan and organize the gathering.

There are three phases of gatherings: the assembly process, the building of the crowd, and the dispersal process. The assembly process refers to the movement of people to a common location within a given period, usually coinciding with activities of individual or groups with a specific agenda, like yelling a slogan.

During the building of the crowd phase, it is important to note that not all participants are the same and that the majority of crowds are comprised of several small groups and only some individuals. Additionally, not all participants have the same motivations.

The dispersal phase is the movement of people from the assembly location to one or more alternate locations. Dispersal can be routine, emergency, or coerced. Routine dispersal is often specified in advance by organizers, while emergency dispersal occurs when people evacuate an area in response to an unexpected crisis. A coerced dispersal involves the use of force from law enforcement at some level; however, this is not necessarily the best or safest way to force crowd dispersal.

Most gathered crowds are orderly, nonviolent, and do not cause problems for authorities, but there are three types of crowds that can create a civil disturbance. A public disorder is the basic breach of civic order, meaning the crowd has a tendency to disrupt the normal flow of things around them, such as traffic. A disorder is escalated to a public disturbance, or a demonstration that is designed to cause turmoil and disruption. These crowds chant, yell, and sing to voice collective opinions. Finally, a disturbance escalates to a riot when it turns violent. The crowd suddenly becomes a mob that violently expresses itself by destroying property, assaulting others, and creating an extremely volatile environment.

Riots can be further categorized into communal, protest, commodity, and celebration riots. Communal riots are those involving a group of people with deep-seated ethnic, religious, or language differences. Protest riots are those involving people aggressively and sometimes violently opposing something.

[149] https://training.fema.gov/programs/emischool/el361toolkit/glossary.htm#C

Commodity riots involve an attack on property with vandalism, looting, or arson. Celebration riots are those involving a group of people celebrating some event, usually a sports team victory.

There are several types of crowds, including casual, sighting, agitated, and mob-like. Casual crowds are those that consist of people gathered in the same place but have nothing in common, such as a crowd at a mall. Sighting crowds are those where people have gathered in the same location for a specific event, such as a concert. Agitated crowds are similar to sighting crowds, but strong emotions are also present, which can spread, developing a sense of unity and changing the demeanor of the crowd from pleasant to yelling, screaming, crying, and name-calling. Finally, mob-like crowds are agitated crowds that are also aggressive, physical, and sometimes violent. While all types of crowds can turn violent, agitated and mob-like crowds have the greatest tendency to do so.

Crowd dynamics and how people act when they are part of a crowd are complex topics. Crowds provide a sense of anonymity and therefore a sense of invulnerability, and anyone in a crowd is susceptible to behaving contrary to their normal behavior. Emotional contagion is a serious psychological factor of crowd dynamics, which provides a temporary bond of unity and can push a simple organized crowd into a mob.

Crowds, especially angry and organized crowds, use certain tactics to provoke law enforcement and defeat authorities. One common tactic is verbal abuse, such as obscene language, racial remarks, taunts, and ridicules, to anger, demoralize, and provoke a physical response from law enforcement. Another common tactic is throwing rocks, bottles, smoke grenades, or Molotov cocktails to disrupt and confuse the control force. Other tactics include creating barricades to protect themselves and even feinting and flanking actions to attempt to engage, surround, or overpower the control force.

Crowds can become a riot or a violent mob very quickly. These are the types of civil disturbances that are of primary concern to the State of Florida. Violent crowds strike out physically at bystanders and others in the crowd, destroy private and government property, and often set fires and smash glass. Riots or mobs also often create barricades or physical barriers, using any available materials such as vehicles, trees, furniture, and fencing, to impede movement of authorities and to provide a source of protection against law enforcement.

Although violent riots or mobs are a serious concern, nonviolent crowds can be considered a civil disturbance too. Nonviolent actions can be disruptive if they are in direct conflict with instructions from authorities. Examples of disruptive nonviolent actions are refusing to leave when instructed, locking arms, and sitting in areas that authorities are attempting to clear.

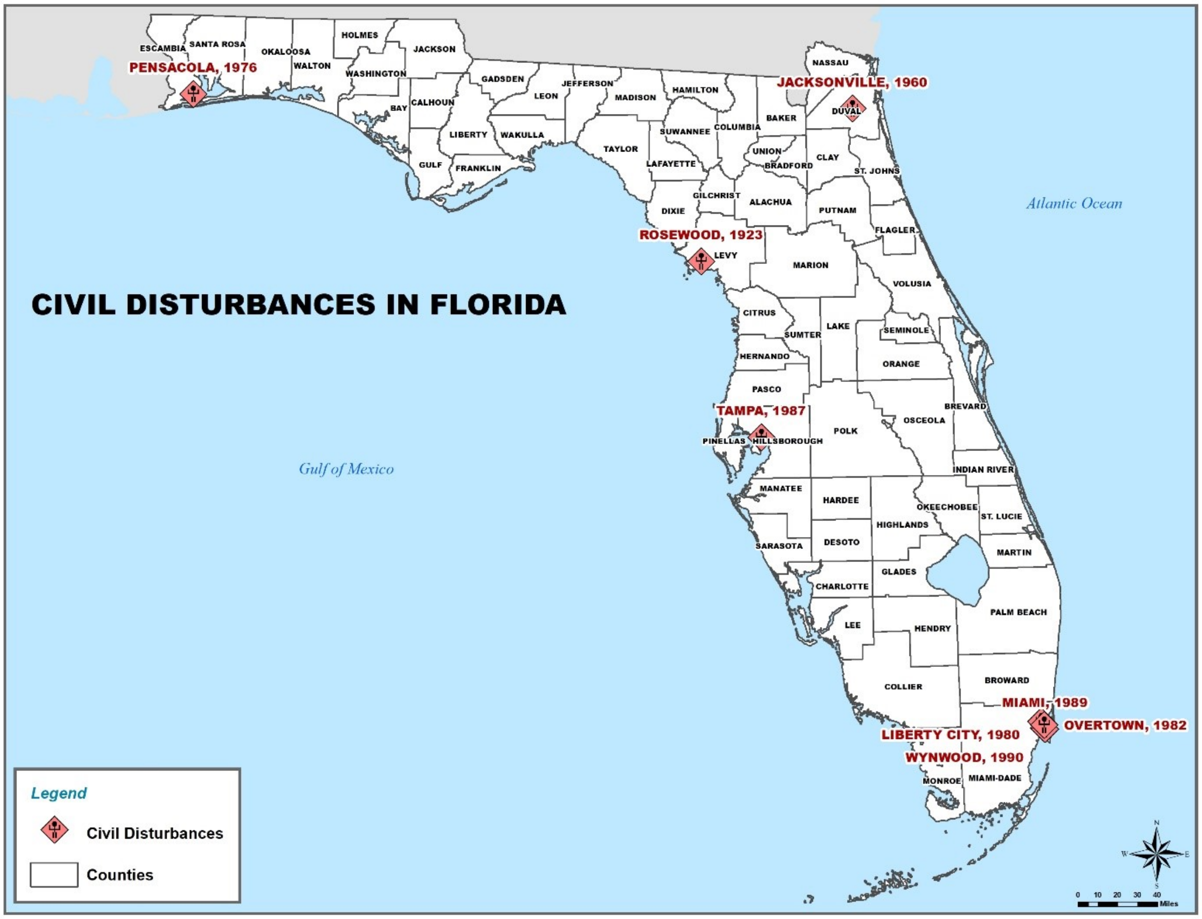
Each local jurisdiction should have a civil disturbance response plan; however, it is important to remember that each incident is unique and intelligence about a specific group, such as their demonstrators, capabilities, and possible courses of action, is key to developing a successful response plan. Additionally, the response plans should emphasize prevention and de-escalation, not confrontation.[150]

[150] http://documents.theblackvault.com/documents/gardenplot/fm3-19CivilDisturbanceOPs.pdf

2. Geographic Areas Affected by Civil Disturbance

Civil disturbances tend to occur in urban areas but can occur anywhere. Below is a map depicting major incidents of civil disturbance in Florida, which are discussed below in Historical Occurrences.

Figure 4.65: Florida Historical Occurrences, Civil Disturbance



3. Historical Occurrences of Civil Disturbance

Civil disturbances occur infrequently but have been quite large in the past. The City of Tampa had a series of civil disturbances in 1987. A police officer used a controversial chokehold to subdue a Black man in custody, who later died of suffocation. Later that evening, the media reported the arrest of a famous Black athlete from Tampa. That night a riot broke out with angry citizens throwing rocks and bottles. The violence lasted for several nights.

4. Probability of Future Occurrences of Civil Disturbance

It is likely that occurrences of civil disturbance will continue in the future. The potential for civil disturbance is always present especially in the urbanized areas of the county, and protesting is a fundamental right protected by the US Constitution. Since 1996, however, Hillsborough law enforcement and community agencies have instituted several successful programs that have opened communication lines preventing conflicts to escalate between conflicting parties. Social, political, and economic factors are very dynamic and must be monitored to gauge the threat of civil unrest.

This hazard was determined to have a probability level of likely (1 to 10% annual probability).

5. Civil Disturbance Impact Analysis

- Public
  - Injury
  - Death
  - Arrested
- Responders
  - Injury
  - Death
- Continuity of Operations (including continued delivery of services)
  - Disrupt transportation systems
  - Disrupt operations of the facility that is being blocked
- Property, Facilities, Infrastructure
  - May damage roads, fencing, benches, etc.
  - Businesses and adjacent buildings may be vandalized or damaged
- Environment
  - The use of Molotov cocktails or other forms of fire could create environmental issues and cascade into other hazards such as fires
- Economic Condition
  - Blocked roads could lead to an inability for businesses to open or employees to get to work, causing economic impacts
- Public Confidence in the Jurisdiction's Governance
  - If the law enforcement cannot control civil disturbances, then it is likely that the public will view the jurisdiction as weak and that they are able to be taken advantage of

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

It is impossible to conduct a vulnerability analysis and loss estimation by jurisdiction for civil disturbances. While peaceful protests or demonstrations occur frequently, it is difficult to determine when a protest will become a civil disturbance or riot, by disrupting daily operations or by becoming violent. Based on the historical occurrences, the large, urban areas of the state are more likely to be affected by civil disturbances than the small rural areas.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Critical facilities are not particularly vulnerable to civil disturbances. There is a chance the group would protest in a critical facility and that the protest might turn violent or destructive. There is also the chance that since sometimes critical facilities are in downtown areas, that a facility may be damaged during civil disturbances or riots in the general downtown area. A loss estimation of critical facilities for civil disturbances is not possible to conduct.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.8.

CIVIL DISTURBANCE					Overall Vulnerability
Overview					
Civil disturbance is an activity such as a demonstration, riot, or strike that disrupts a community and requires intervention to maintain safety in the community. The different types of gatherings include impromptu and organized. Civil disturbance incidents tend to occur in urban locations but can realistically happen anywhere.					HIGH
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Possible	Critical	Moderate	< 6 hrs	< 1 week	2.8

Cyber Incident Hazard Profile

1. Cyber Incident Description

Cyber incidents are becoming more common and more costly in our society. Because of this, cyber incidents will be profiled as a hazard to the state of Florida. The word cyber refers to anything that contains, is connected to, or is controlled by computers and computer networks. A computer is a machine that can take instructions and perform computations based on those instructions. Cyber-technology refers to the computers and computer networks and the information and services we rely upon. For example, critical infrastructure relies on such computers and the Internet. Critical infrastructure includes sectors such as communications, energy, financial services, health care, transportation, and water and wastewater systems among others. A cyber incident, then, refers to an incident involving computers, networks, and information or services that affect daily operations of critical infrastructure.

A cyber incident differs from traditional hazards such as a flood, which makes it difficult to plan for, respond to, recover from, and mitigate against. For example, there is often a lack of physical presence or evidence of a cyber incident, making it difficult to understand the scope of the incident. Furthermore, the scope will likely cross municipal jurisdictions because of the nature of cyber-technology. There are also fewer resources for cyber incidents due to a lack of awareness and knowledge of the cyber threat.[151]

Cyber threat refers to the possibility of a malicious attempt to damage or disrupt a computer network or system.[152] This is a global threat because of the nature of cyber-technology and the wide scope of cyber incidents. In fact, in 2013, the United States intelligence community assessed cyber threats as the top global threat followed by terrorism.[153]

This makes it clear that cybersecurity is directly linked to our national defense.[154] According to DHS's National Infrastructure Protection Plan (NIPP), cybersecurity is defined as the

> *"prevention of damage to, unauthorized use of, or exploitation of, and if needed, the restoration of electronic information and communication systems and the information contained therein to ensure confidentiality, integrity, and availability; includ(ing) protection, restoration, when needed, of information networks and wireline, wireless, satellite, public safety answering points, and 911 communications systems and control systems."* [155]

Put more simply, cybersecurity is protecting the machines connected to networks and the Internet and the information stored, accessed, or transmitted. A cybersecurity incident then, refers to a data breach. A data breach is when a name plus another record (i.e., financial, medical, credit card) is put at risk, either electronically or in a hard copy.

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[151] FEMA. (2016). *Community Preparedness for Cyber Incidents MGT 384* (Version 1.1). Page 2.7–2.8
[152] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.4
[153] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.4
[154] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 1.12
[155] https://www.dhs.gov/sites/default/files/publications/national-infrastructure-protection-plan-2013-508.pdf

There are many causes of a data breach or a cyber incident. A cyber incident could be a malicious attack, or it could stem from a system glitch or human error. In 2014, the average cost of a data breach to an organization in the United States was $6.53 million.[156] With so much at stake, it is important to be prepared for a cyber incident. Cyber preparedness is defined as the process of ensuring that an agency has developed, tested, and validated its capability to protect against, prevent, mitigate, respond to, and recover from a significant cyber incident.[157]

Though a cyber-incident is different than traditional hazards, all phases of emergency management are still applicable. For instance, Mitigation, Prevention, and Preparedness occur before a cyber incident happens by implementing policies and increasing awareness. Response is attempting to stop the cyber incident or a data breach. Recovery, and sometimes Mitigation, are after the cyber incident and involve restoring networks, replacing damaged equipment, and eliminating vulnerabilities that allowed the breach.[158]

Cyberattacks

Some cyber incidents are cyberattacks, meaning they have a malicious intent. The most significant risk for exposure to attack stems from human error. Any computer system that is accessible from the Internet is a potential target. The goal of a cyberattack is the theft of proprietary, personal, or financial information. Additionally, cyber warfare and cyber espionage, carried out by other nation states, are possible goals in today's society.[159]

There are three levels of cyberattacks: unstructured, structured, and highly structured.

Unstructured attacks have little to no organization and no significant funding. These are usually carried out by amateurs who use pre-made tools to take advantage of well-known flaws. These pre-made tools are easily downloadable from the Internet. These attacks are the most common type of threat but they are also easily spotted by network security.[160]

Structured attacks involve more organization and planning and have decent financial backing. These attacks also have specific targets and are intended to disrupt operations to a specific organization or sector. Additionally, these attacks are conducted over long periods of time to avoid detection. The impacts from a structured attack can range from minimal to significant. Potential perpetrators include insider threats, like a disgruntled employee; industrial competitors, like rivals stealing company secrets; organized crime groups, like Columbian drug traffickers; hacktivists motivated by a specific cause, like Anonymous; or blackmail and ransom hackers, using extortion to receive money.[161]

Highly structured attacks involve extensive organization, planning and funding. Attackers conduct reconnaissance and then use multiple attacks to achieve their goal. Sometimes these attacks even include

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[156] FEMA. (2016). *Community Preparedness for Cyber Incidents MGT 384* (Version 1.1). Page 1.25
[157] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.4
[158] FEMA. (2016). *Community Preparedness for Cyber Incidents MGT 384* (Version 1.1). Page 2.29 – 2.31
[159] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 1.12
[160] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.7 – 2.13
[161] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.14 – 2.23

physical attacks along with a cyberattack. Possible attackers conducting highly structured attacks include ideological groups, cyber terrorists, and nation states.[162]

Malware

Cyberattacks are conducted using different types of malware. Malware is *mal*icious soft*ware* that can infect a computer or network and cause harm. Malware can destroy all data, damage networks, or steal information. Malware must be introduced to a computer or network using methods such as removable media, phishing, and drive by downloads. This can be completed using tools such as a virus, worm, trojan, or adware.[163]

A virus spreads malicious code by copying itself and infecting host computers through downloads, email attachments, or removable media. The virus then corrupts or deletes data on your computer or erases the hard drive.

A worm is a malicious computer program that replicates itself to spread to other computers. It relies on security failures and utilizes the computer network to spread itself. Worms can cause harm to the network, consume bandwidth, install backdoors (for access later), and allow the creation of botnets.

A trojan is a malicious program that is disguised as legitimate software. It looks useful to an unsuspecting user but is actually harmful when executed. After installed, the trojan waits silently on the infected machine and invisibly carries out its misdeeds with remote administration capabilities. Trojans can control the mouse and keyboard, format drives, log keystrokes, play sounds, record sound and video, and use the Internet connection to perform Denial of Service attacks. [164]

Methods

Attackers use several methods to complete their goals. The following will be discussed here: social engineering, botnets, denial-of-service (DoS) attacks, zero-day exploits, web-based attacks, malicious insider attacks, and unintentional actions or errors.

Social engineering is a very common method to conduct attacks that involves manipulating legitimate users and convincing them to perform actions or give confidential information using email, phone, in-person encounters, dumpster diving, or insider threats. People are often the weakest link in the cybersecurity chain, and social engineering takes advantage of that. There are several types of social engineering, but phishing is one of the most common. Phishing is when an attacker sends an email that appears to originate from a legitimate source, such as a bank, advising that verification of account information is needed immediately to prevent serious consequences. The email usually contains a link to a fraudulent website with a form for customers to enter their information. Similarly, spear phishing is when an attacker sends a phishing email to a specific organization or person. Whaling is when attackers attempt to spear phish a high priority target, such as a CEO.[165]

[162] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.23
[163] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.10–2.12
[164] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.32 – 2.33
[165] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.38–2.40

Botnets are another method to conduct an attack. A "bot" is malware that allows attackers to take control of the computer. A "botnet," then, is a ro*bot net*work of infected computers used to conduct malicious activities. A botnet is created when one bot infects several computers and then networks them together. Botnets can be used for denial-of-service attacks, malware distribution, and covert intelligence gathering. Owners of computers that are part of a botnet often have no idea their computer has been compromised. A botnet can include thousands or millions of bots and may remain quietly operational for years. This method is successful because it distributes the activities to several computers, making it more difficult to track and block.[166]

Denial-of-service attacks are simply what they sound like, the attackers attempt to prevent legitimate users from accessing information or services of a computer system or network by overwhelming the system with more traffic than it can handle. When you type an address into your web browser, you are sending a request to that site's computer server to view the page. The server can only process a certain number of requests at one time, so when it is overloaded, the website does not work. A denial-of-service (DoS) attack occurs when an attacker overwhelms the server with false requests so that the server cannot process the legitimate requests. A distributed DoS, or DDoS, attack occurs when attackers use multiple computers and multiple Internet connections to conduct the attack. This greatly increases the magnitude of false requests that can be sent, meaning a larger DDoS attack. Attackers sometimes use botnets, as discussed above, to carry out DDoS attacks. These types of attacks can be used against a wide variety of targets from retail websites to nation states.[167]

A zero-day exploit is an attack that takes advantage of a security risk on the same day that the risk becomes known to the public. Because there is no known solution to the risk yet, attackers are able to conduct attacks without being stopped. These exploits can be purchased from those who find these security risks and choose not to report to them to the company but rather sell the information to would-be attackers. Attacks such as these have been used to target programs like Microsoft Word, PowerPoint, Excel, Adobe, and Flash Player.[168]

Web-based attacks involve websites redirecting the browser to a malicious website where malicious software downloads to the computer. These attacks are known as drive by downloads and involve malicious code downloading in the background of a computer just from visiting a certain site without clicking on anything. These attacks require no action from the target and they often have no idea their computer has been infected.

Another method is to use a malicious insider to conduct an attack. A malicious insider is a person with special advantage, influence, or proprietary knowledge who uses it for malicious intent. These could be current or former employees or even contractors or vendors. Malicious insiders risk the theft of confidential information and the sabotage of systems.

As stated earlier, humans are the weakest link in cybersecurity. Unintentional actions or errors can provide an opportunity for attackers to steal information and gain unauthorized access. For example,

[166] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 1.34–1.35
[167] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.20; FEMA. (2016). *Community Preparedness for Cyber Incidents MGT 384* (Version 1.1). Page 2.36–2.37
[168] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 2.22

unintentional acts or failures directly compromise the security of a computer network or a resource dependent on the network. This includes not properly updating software or a network and the failure to remove or change system permissions after personnel changes.[169]

Vulnerabilities

Because our society is increasingly reliant upon cyber technology and the Internet, new vulnerabilities are presenting themselves. There are vulnerabilities at the personal, local, and national scale. For example, an individual person may have their identity stolen. Additionally, hackers may take a local 911 system offline for an extended period of time. Finally, there could be a multi-state power outage or a hack of a large company that affects many across the nation, such as the Yahoo or Target breaches.

More specifically, critical infrastructure often relies upon cybertechnology and the Internet, making critical infrastructure vulnerable to cyber incidents. Additionally, many critical infrastructure systems are interconnected, so even if a particular critical sector is not reliant upon cybertechnology, it may be reliant upon a critical sector that is reliant upon cybertechnology. These possible cascading impacts are very important to consider when planning for hazard mitigation. This can be complicated though as not all critical infrastructure sectors are controlled by the government, some include privately owned companies, like a private energy company, financial institution, or hospital. Sometimes the priorities of privately owned organizations differ from those of the government. For example, while the government is concerned with protecting all critical infrastructure from cyberattacks, these privately owned organizations may be more concerned with profits or public reputation. Furthermore, the interconnectivity of sectors expands the scope from one geographical area to large regional areas that likely cross political jurisdictions, making planning more complicated.[170]

Another vulnerability is that the Internet was designed with efficiency and access concerns, not specifically with security considerations. Now that cybertechnology and Internet capabilities have expanded, vulnerabilities are appearing. For example, many critical infrastructure systems are controlled remotely using systems called Supervisory Control and Data Acquisition (SCADA) or Distributed Control Systems (DCS). These systems are used to manipulate functions and services of systems remotely, so people do not have to deploy to sites in the field where equipment is located but can instead alter systems, like adjusting pressure or flow, from their offices.[171] This is a concern because these systems can be hacked and controlled by enemies.

SHODAN is a search engine to find Internet connected devices. From 2012 to 2014, a research project to increase awareness of the vulnerabilities, Project SHINE, attempted to find SCADA and DCS systems. The project found hundreds of thousands of SCADA and DCS devices and systems. When the project ended in 2014, it wasn't because they had found all the devices, it was because they saw no end in sight with hundreds and sometimes thousands of devices being added every day.

Some of these devices and connections are not secure, meaning they can be hacked. Policies and procedures need to be adopted by all critical infrastructure sectors using Internet connected devices. Many times owners keep the default username and password, which are very easy to hack. The Project

[169] FEMA. (2016). *Community Preparedness for Cyber Incidents MGT 384* (Version 1.1). Page 2.40–2.43
[170] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 1.15–1.16
[171] FEMA. (2016). *Essentials of Community Cybersecurity AWR 136.* Page 1.12

SHINE report concluded that critical infrastructure and cyber security professionals must not continue to use "compliance-based security," but focus on an "attitude of safety, vigilance, and performance awareness."[172]

Cybersecurity and Cyber Preparedness

Presidential Policy Directive (PPD) 8 aimed at strengthening the security and resilience of the US through systematic preparation for the threats that pose the greatest risk to the security of the Nation, including acts of terrorism, cyberattacks, pandemics, and catastrophic natural disasters.[173]

PPD 41 gives principles for the Federal Government response to any cyber incident. It also recognizes that cyber incidents are occurring more frequently and that responding to cyber incidents that pose a significant threat requires deliberative planning, coordination and exercising of the response plan.[174]

The US also has a National Cyber Incident Response Plan that was published in December 2016 after PPD 41 was issued, detailing the response activities and responsibilities of federal agencies during a significant cyber incident.[175]

The State of Florida has several cyber security mechanisms. One is the Florida Computer Crime Center (FC3), which conducts cyber investigations, trainings, research, and prevention. The FC3 also developed the Florida Infrastructure Protection Center (FIPC) to anticipate, prevent, react to, and recover from acts of terrorism, sabotage, and cyber crime. There are three components to the FIPC: the "Secure Florida" Education and Awareness campaign, the Central Analysis and Warning Point to monitor and analyze information, and the Computer Incident Response Team (CIRT). The CIRT is always on-call to respond to critical cyber incidents in Florida.[176]

The Florida Infrastructure Protection Center (FIPC) has evolved into a group of services, which range from investigations, awareness training, intelligence, and domestic security. All FDLE regions have sworn agents that conduct high-tech investigations into computer crimes. Additionally, FDLE has strong cyber intelligence efforts within the Cyber Intelligence Unit and the Domestic Security Critical Infrastructure Unit is expanding as well. The Secure Florida group within the FIPC conducts business and consumer education awareness and efforts.

The Computer Incident Response Teams (CIRT) are used in two ways. For example, an individual criminal incident, such as the unauthorized access into a computer system and theft of data, are investigated as criminal cases by the Regional Network Intrusion Unit or the Cyber Crime Unit. Larger scale cyber incidents, such as those that affect several organizations and systems within Florida's critical infrastructure system, are investigated by the Domestic Security Working Group, which is composed of several agencies including AST, the FBI, the Florida National Guard, FDEM, and other stakeholders.

172 https://scadahacker.com/library/Documents/ICS_Vulnerabilities/Infracritical%20-%20Project%20SHINE%20Findings%20Report%20-%20Oct%202014.pdf
173 https://www.dhs.gov/presidential-policy-directive-8-national-preparedness
174 https://fas.org/irp/offdocs/ppd/ppd-41.html
175 https://www.us-cert.gov/sites/default/files/ncirp/National_Cyber_Incident_Response_Plan.pdf
176 http://www.fdle.state.fl.us/cms/FCCC/About-Us.aspx)

Additionally, the Agency for State Technology (AST)[177] developed a Statewide Strategic Information Technology Security Plan. This plan is designed to ensure state data is secure and outlines their roadmap to continually enhance cybersecurity and operational effectiveness. The key to the AST information security strategy is the protection of the confidentiality, integrity, and availability of the state's IT resources. The plan lists three strategies:

1) Establish a strong cybersecurity framework, improve situational awareness to empower information security personnel, and cultivate partnerships for response efforts;

2) Establish objectives for assessing and enhancing the state's data center infrastructure; and

3) Establish objectives for project assurance and oversight and promote strategic business alignment by collaborating with state agencies to understand and support their mission-specific strategies.

AST has accomplished several goals since they were created in 2014, including creating the Florida Cybersecurity Standards Security Rule in the Florida Administrative Code (74-2, FAC).[178]

Finally, the Florida Division of Emergency Management has a Cyber Incident Plan that details policies and procedures in the event of a cyber incident within the Division.

The National Institute of Standards and Technology (NIST) has developed the Cybersecurity Framework, which promotes the protection of critical infrastructure through standards, guidelines, and practices for organizations to adopt. The framework is designed to work with existing business processes and to improve existing cybersecurity efforts.

The core functions of the framework follow along with the phases of emergency management. For example, the first two core functions are Identify and Protect, which are similar to Mitigation and Preparedness. In the framework, identify means naming the risk and then removing the behavior creating the risk. This is completed by implementing policies and procedures to reduce, remove, or transfer risk. Protect refers to protecting data from unauthorized disclosure by authenticating access, promoting information security, implementing business continuity plans, and ensuring confidentiality of data.[179] More information about the NIST Cybersecurity Framework can be found at: link.com.

There are many resources for agencies and organizations to develop a cybersecurity program. Some are outlined below.

The Department of Homeland Security Cyber Infrastructure Security Agency (CISA) is useful for information sharing and cyber smart resources.

US Computer Emergency Response Team (US-CERT) was created in the early 2000's in response to cyber breaches in federal government. The team responds to incidents and analyzes data about emerging cyber threats. Additionally, the team provides cybersecurity protection to Federal civilian executive branch agencies through intrusion detection and prevention capabilities. They also collaborate with foreign

[177] http://www.ast.myflorida.com/publications.asp
[178] https://www.flrules.org/gateway/ChapterHome.asp?Chapter=74-2
[179] FEMA. (2016). *Community Preparedness for Cyber Incidents MGT 384* (Version 1.1). Page 1.38 – 1.43

governments and international entities to enhance the nation's cybersecurity posture. US-CERT also has a scoring system to determine risk and priority in a national context, which can be viewed online.[180]

The FBI has a Cyber Crime division and is the lead federal agency for investigating cyberattacks by criminals, overseas adversaries, and terrorists. According to the FBI, cyber intrusions are becoming more common and dangerous, especially considering that our nation's critical infrastructure is targeted. The FBI also has the Internet Crime Complaint Center to report cyber crimes and the Cyber Action Team which provides rapid incident response for major computer intrusions and other cyber related emergencies.

Infraguard is a partnership between the FBI and the private sector to share information and intelligence to prevent hostile acts against the US. Florida has several chapters including Jacksonville, Orlando, South Florida, Tallahassee, and Tampa Bay.[181]

Individuals can report identify theft to the Federal Trade Commission here: https://www.ftc.gov/.

The National Cyber Security Alliance has created the StaySafeOnline.org website with resources for individuals and businesses.[182]

NetSmartz is a resource for children to learn about different types of cyber crime and cybersecurity.[183]

2. Geographic Areas Affected by Cyber Incidents

Because cyber incidents occur in "cyberspace," there are not always geographic areas affected by cyber incidents. However, cyber incidents may cause physical disruptions in critical infrastructure, which could affect a jurisdiction or a power grid. It is important to note that power grids are vast, sometimes crossing state lines, meaning that a cyber incident at one facility at one location could cause disruptions at other locations hundreds of miles away.

3. Historical Occurrences of Cyber Incidents

A record of historical occurrences of cyber incidences in Hillsborough County is not available at this time.

4. Probability of Future Cyber Incidents

The probability of cyber incidents occurring is increasing every day. Hospitals are highly likely, but so are local jurisdictions and federal and state agencies.

It is estimated that every 40 seconds, a business falls victim to a ransomware attack and it is predicted that attacks will rise to every 14 seconds by 2019.[184]

In 2015, government was among the top five most cyber-attacked industries and that is expected to remain accurate in the future.[185]

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[180] https://www.us-cert.gov/sites/default/files/publications/NCCIC_Cyber_Incident_Scoring_System.pdf
[181] infraguard.org
[182] staysafeonline.org
[183] netsmartz.org
[184] https://cybersecurityventures.com/hackerpocalypse-cybercrime-report-2016/
[185] *X-Force Cyber Security Intelligence Index*. (2016). IBM

According to an Accenture Cyber Crime Cost Study in 2017, the average number of security breaches each year is 130, which is a 27.4% increase in average annual number of security breaches.[186]

This hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Cyber Incident Impact Analysis

- Public
  - Release of sensitive information including bank accounts and social security numbers
  - Financial loss
    - Possible loss of wages if organization is forced to close
- Responders
  - Long hours outside of regular work hours to stop and/or remediate attack
  - First responders may not be able to respond properly if a cyberattack targets emergency or public safety systems
- Property, Infrastructure, Facilities
  - Incident could lead to damage of equipment for infrastructure
  - Organization may lose revenue and may have significant costs for remediation, legal fees, and public relations
  - Organization may lose customer confidence or may sustain damage to their reputation or to their market share
- Continuity of Operations (including continued delivery of services)
  - Incident could take operations offline for any amount of time and/or make information inaccessible or distribute false information
  - Interrupt public safety or other critical services
  - Loss of productivity
  - Loss of critical systems or data
  - May disable emergency or public safety systems
- Environment
  - An incident could cause a release of some material, which could damage the environment
- Economic Condition
  - Incidents cost millions of dollars to consumers and organizations in the form of lost wages, lost revenue, and recovery and remediation costs
- Public Confidence in Jurisdiction's Governance
  - Lost confidence in ability to keep services operational and safe
  - Private organization – loss of public or consumer confidence in an organization leading to loss of market share and possibly loss of future sales

[186] https://www.accenture.com/t20170926T072837Z__w__/us-en/_acnmedia/PDF-61/Accenture-2017-CostCyberCrimeStudy.pdf

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Without having access to each jurisdiction's Cyber Incident Plan and the ability to analyze that plan, it is impossible to determine the vulnerability of a jurisdiction. However, it is reasonable to assume that the county and municipalities will continue to be vulnerable to cyber incidents. Any jurisdiction that utilizes computers and the Internet for major utilities, transportation routes, or data storage is vulnerable to a cyber incident.

Cyberattacks are very costly and it is expected that from 2017 until 2021, $6 trillion will be spent on cybercrime damages.[187]

Financial impacts on enterprises such as the electronic leakage of data cost an average of $1.9 million in 2017.[188]

The top five cyber-attacked industries in 2015 were healthcare, manufacturing, financial services, government, and transportation, and it is believed this trend will continue.[189]

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

It is reasonable to assume that most jurisdictions will continue to be vulnerable to cyber incidents. Any department that utilizes computers and the Internet is vulnerable to a cyber incident.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be medium, with a PRI score of 2.5.

[187] Morgan, S. (2017, December 13). Cyber Attack Surface Facts, Figures and Statistics from 2017 to 2022. Retrieved from CSO website: https://www.csoonline.com/article/3241816/security/cyber-attack-surface-facts-figures-and-statistics-for-2017-to-2022.html

[188] Smith, M. (2017, September 20). Cyber Attacks Cost U.S. #1.3 Million On Average in 2017. Retrieved from CSO website: https://www.csoonline.com/article/3227065/security/cyber-attacks-cost-us-enterprises-13-million-on-average-in-2017.html

[189] *X-Force Cyber Security Intelligence Index*. (2016). IBM

<table>
<tr><th colspan="5">CYBER INCIDENT</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">Cyber incidents are described as involving computers, networks, information, or services that affect daily operations of critical infrastructure. These hazards lack a physical presence as well as physical evidence, making them unlike traditional hazards and, therefore, difficult to plan for, respond to, and recover from.</td><td>MODERATE</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Possible</td><td>Limited</td><td>Moderate</td><td>< 6 hrs</td><td>< 1 week</td><td>2.5</td></tr>
</table>

Mass Migration Hazard Profile

1. Mass Migration Description

Florida's proximity to the Caribbean Basin makes it a vulnerable point of entry for a massive influx of immigrants and refugees entering the United States. While the majority come from the Caribbean, they can come from other locations such as Mexico and South America. Even though all of Florida's counties are subject to receiving such arrivals, the most vulnerable counties are Monroe, Miami-Dade, Broward, Palm Beach, Martin, St. Lucie, Indian River, Lee, and Collier. The consequences of a mass arrival of undocumented entrants include the threat of health, safety, and welfare of citizens and that of entrants that may be detained for an extended length of time. Florida has participated with the federal government in the development of a federal Mass Immigration Annex that bridges components of the federal Mass Immigration Plan with the National Response Framework.

Mass Migration

According to United States Code Title 8, Chapter 12, the definition of mass migration is a migration of undocumented aliens that is of such magnitude and duration that it poses a threat to the national security of the United States as determined by the President. This usually refers to an event, or series of events, that may take place over the course of several years or even decades. The event could be economic, social, or political in nature, but it is something that causes a mass exodus from the country of origin. While some counties and state agencies use a specific number that determines when an emergency exists for operational purposes, the State of Florida understands that a continuous and high volume flow of migrants over a period of time could exceed the normal capabilities of the local offices of the United States Coast Guard and Customs and Border Protection.[190] The main problem posed by undocumented individuals is the inability of the system to assimilate them without affecting already strained local economies and infrastructure such as health, medical, and social services. The Pew Research Center estimates that, in fiscal year 2014, Florida had an influx of 850,000 (+/- 40,000) undocumented migrants and that the state experienced growth of the undocumented population at the national average of 250%.[191]

Unaccompanied Minors

Children who arrive in the United States alone or who are required to appear in immigration court on their own often are referred to as unaccompanied children or unaccompanied minors.[192] Unaccompanied alien child (UAC) is a technical term defined by law as a child who has no lawful immigration status in the United States; has not attained 18 years of age; and, with respect to whom, there is no parent or legal guardian in the United States or no parent or legal guardian in the United States is available to provide care and physical custody. Unaccompanied children generally leave their home countries to join family already in the United States; escape abuse, persecution, or exploitation in their home country; or seek employment or educational opportunities in the United States. The age of these individuals, their separation from

[190] http://www.floridadisaster.org/documents/CEMP/2012/MASS%20MIGRATION%20ANNEX.pdf
[191] http://www.pewhispanic.org/interactives/unauthorized-trends/
[192] https://www.americanimmigrationcouncil.org/sites/default/files/research/a_guide_to_children_arriving_at_the_border_and_the_laws_and_policies_governing_our_response.pdf

parents and relatives, and the hazardous journey they take make unaccompanied children especially vulnerable to human trafficking, exploitation, and abuse. When a child who is not accompanied by a parent or legal guardian is apprehended by immigration authorities, the child is transferred to the care and custody of the Office of Refugee Resettlement (ORR).[193] Federal law requires that ORR feed, shelter, and provide medical care for unaccompanied children until it is able to release them to safe settings with sponsors (usually family members) while they await immigration proceedings.

The following table shows the total number of unaccompanied children released to sponsors in fiscal year 2017.

Table 4.137: Unaccompanied Minors Released to Sponsors, FY 2019[194]

County	Total number of children
Broward	414
Collier	236
Duval	206
Hillsborough	212
Lee	479
Manatee	103
Martin	142
Miami-Dade	1,189
Orange	336
Palm Beach	1,099
Polk	62
St. Lucie	71

Mass Immigration

Immigration is the movement of people to another country of which they are not natives and where they do not possess citizenship in order to settle or reside there. The definition of an immigrant or alien from the United States Code Title 8[195] means "an applicant for admission coming or attempting to come into the United States at a port-of-entry, or an alien seeking transit through the United States at a port-of-entry, or an alien interdicted in international or United States waters and brought into the United States by any means, whether or not to a designated port-of-entry, and regardless of the means of transport." The Bureau of Economic and Business Research shows that migration or immigration is the primary source of Florida's population growth, and the U.S. Census Bureau estimates that, in fiscal year 2015, 86% of the total population growth since 2010 was due to net migration and immigration. Palm Beach, Broward, Miami-Dade, Orange, and Hillsborough counties see the highest influx of immigration, and Miami-Dade alone accounted for a quarter of Florida's total foreign immigrants between 2005 and 2009. As with mass

[193] https://www.acf.hhs.gov/orr/programs/ucs
[194] https://www.acf.hhs.gov/orr/resource/unaccompanied-alien-children-released-to-sponsors-by-county
[195] https://www.ecfr.gov/cgi-bin/text-idx?SID=29f9238515a0b92dcfa5f8f11f2d5abb&mc=true&node=se8.1.1_12&rgn=div8

migration, an influx of immigrants to any particular county could overwhelm the local economy and infrastructure.

Repatriation

Repatriation is the procedure where United States citizens and their dependents, who have been identified by the U.S. Department of State, are returned from a foreign country to the United States because of destitution, illness, war, threat of war, or a similar crisis. This could also include third country nationals (TCN) who are individuals approved by the Department of State that are neither a U.S. Department of Defense dependent nor a U.S. citizen. Emergency repatriation is the influx of 500 or more U.S. citizens or dependents from foreign countries. Through ORR agreements, states that are designated as ports of entry will be asked to activate their state emergency repatriation plan during an emergency repatriation.[196] Florida has three designated ports of debarkation, and the bases and installations designated with primary responsibilities will be the lead agent. The American Red Cross is the lead agency on providing shelters, mass feeding, first aid, emergency communications, and access to financial assistance to those in need. Florida currently has a repatriation plan that can be activated should the need arise.

2. Geographic Areas Affected by Mass Migration

Although it is possible that any Florida county could receive a migrant landing, either maritime or aviation, counties in the southern half of the state are most vulnerable due to geography. South Florida is in proximity to islands such as Cuba, Puerto Rico, Dominican Republic and Haiti, and the Gulf Coast is within proximity of Mexico. Mass migration can also occur domestically due to an impending hazard causing large groups of people to head north or inland to other counties in an effort to evacuate.

3. Historical Occurrences of Mass Migration

The 1980 Mariel Boatlift was one of the largest incidents of mass migration to affect Florida. Beginning in April 1980 and ending in October 1980, over 125,000 Cubans and between 40,000 and 80,000 Haitians made their way to South Florida. The Cuban President at the time, Fidel Castro, granted permission to all Cubans who wanted to leave access to the Port of Mariel. The United States Coast Guard was tasked with assisting the boats and rafts making their way to Florida and it would become one of the largest operations they had ever undertaken during peacetime.[197]

In the autumn of 1991, a military coup overthrowing Haitian President Aristide led to a mass exodus of roughly 38,000 people towards South Florida. Many perished at sea on failing vessels or homemade rafts and those that survived were detained and interviewed at Guantanamo Bay before being forcibly sent back to Haiti. Of the thousands that left, roughly 200 were granted asylum in the United States with many of them settling in Florida's metropolitan areas.[198]

The Cuban Exodus in August 1994 saw over 35,000 refugees on often handmade boats and rafts, fleeing to South Florida. Many died at sea but those that survived were apprehended by the United States Coast

[196] http://www.floridadisaster.org/documents/CEMP/2012/Repatriation%20Annex%20to%20the%20CEMP.pdf
[197] https://fas.org/sgp/crs/row/R40566.pdf
[198] http://www.crf-usa.org/bill-of-rights-in-action/bria-10-2-b-haiti-and-the-boat-people

Guard and detained at Guantanamo Bay. In May 1995, almost all those detained, roughly 30,000 people, were released and allowed entry into the United States. Many of them settled in South Florida and this exodus would lead to a change in public policy and the creation of the "Wet foot, Dry foot" policy.[199]

While not an incident of mass migration, the 2010 Haiti Earthquake resulted in a number of unique immigration situations and challenges. Florida supported the repatriation of U.S. citizens, as well as helping Haitian and other foreign nationals with passports or visas into the United States. 50,000 Haitians were brought into the United States under Temporary Protected Status (TPS) with many resettling in Miami and Orlando. Some Haitians visiting or residing in Florida at the time of the earthquake were unable or unwilling to return to their newly devastated homeland and were given TPS in order to remain in the United States.[200]

In 2016, 800 unaccompanied minors were transported to Homestead, Florida, and placed within a temporary tent city. They came from multiple countries including Honduras, Guatemala, and El Salvador to escape violence, poverty, or abuse. The American Red Cross and the Office for Refugee Resettlement worked together to care for these children and ultimately place them with sponsors throughout the state.[201]

Hillsborough County does not have history of mass migration, but due to the already dense population of the county, any mass migration to the area would be difficult to absorb.

4. Probability of Future Mass Migration Events

There is no sure way to predict future mass migration events as most typically occur without warning. The probability of a migration influx in the state of Florida is perceived to be high, and planning must be done as part of the larger national DHS initiatives. As political unrest and large-scale natural disasters continue to increase within the Caribbean and South American regions, there will be people wanting to leave. South Florida is in close proximity and has an extensive network of people from these countries in place. The Mass Migration Annex of the Florida State Comprehensive Emergency Management Plan provides augmentation information that connects with the U.S. Department of Homeland Security Plan entitled "Operation Vigilant Sentry" and subsequent revisions.

This hazard was determined to have a probability level of unlikely (less than 1% annual probability).

5. Mass Migration Impact Analysis

- Public
  - Loss of life
  - Injury
  - Fear of going to law enforcement can lead to undocumented individuals not seeking help or evacuating in the event of a hazard
  - Few resources available:

[199] https://www.hrw.org/legacy/reports/pdfs/c/cuba/cuba94o.pdf
[200] http://www.migrationpolicy.org/article/haitian-immigrants-united-states/
[201] https://www.local10.com/news/tent-village-near-homestead-air-reserve-base-prepared-to-shelter-refugee-children

        - Food
        - School
        - Water
        - Work
        - Translators
        - Housing
- Responders
    - Public safety resources could be strained or depleted causing community-wide problems
    - Local law enforcement is affected with added population and confrontation with undocumented individuals
    - Customs and Border Protection is responsible for ensuring all incoming immigrants have proper documentation and intervening with unauthorized entry into the state; this can lead to a strain on the agency
    - Coast Guard is responsible for protecting the shores and intervening with any unauthorized entry into the state; this can lead to a strain on the agency
- Continuity of Operations (including continued delivery of services)
    - Evacuations in the event of a hazard can get congested with additional population numbers
    - Overwhelmed public service of too many people go to the same places, such as schools or jobs
- Property, Facilities, Infrastructure
    - Strain on detention facilities following mass undocumented intervention could lead to economic strain and lack of space
    - Education is used by undocumented families and can place a strain on local schools and facilities within a community
    - Social services can be strained to accommodate incoming immigrants/migrants and unaccompanied children
- Environment
    - Additional pressure on the environment and natural resources
    - Could bring invasive species
- Economic Condition
    - A financial strain on communities is present when the population grows quickly and local communities, or the state, cannot account for them all in terms of services and emergency needs
    - Growth of population can cause impacts to urban planning and resources such as local economies and social services
- Public Confidence in Jurisdiction's Governance
    - Lack of ability to integrate these people reflects poorly on government
    - Reports of mistreated detained immigrants reflects poorly on government

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

Due to the nature and unpredictability of human-caused hazards, all property and infrastructure in the state of Florida is at risk to these events. Even though all of Florida's counties are subject to receiving such arrivals, Hillsborough County is not one of the most vulnerable.

Florida recognizes that jurisdictions are vulnerable to human caused hazards, but there is a lack of data to quantify the economic vulnerability from these hazards compared to others.

7. Vulnerability Analysis and Loss Estimation of Critical Facilities

Due to the nature and unpredictability of human-caused hazards, all critical facilities could potentially be at risk. The facilities could become overwhelmed, have a lack of space, and programs could become drained.

Though the county recognizes that critical facilities are vulnerable to human caused hazards, there is a lack of data to quantify the vulnerability of facilities to these hazards compared to natural hazards.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be low, with a PRI score of 1.7.

MASS MIGRATION					Overall Vulnerability
Overview					
Florida's proximity to the Caribbean Basin makes it a vulnerable point of entry for a massive influx of immigrants and refugees entering the United States. While the majority come from the Caribbean, they can come from other locations such as Mexico and South America. The consequences of a mass arrival of undocumented entrants include the threat of health, safety, and welfare of citizens and that of entrants that may be detained for an extended length of time.					LOW
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Unlikely	Minor	Moderate	> 24 hrs	< 1 week	1.7

Terrorism Hazard Profile

1. Terrorism Description

The population, property, and environmental resources of the state of Florida are vulnerable to a threatened or actual terrorist attack. While there are multiple definitions and political connotations that accompany the term terrorism, for the purpose of this document, the following definition will be used:

> *"Terrorism is defined in the Code of Federal Regulations as 'the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives. It is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom.'"*

State and local governments have primary responsibility in planning for and managing the consequences of a terrorist incident using available resources in the critical hours before federal assistance can arrive. If a terrorist incident occurs in a city or county, communities may receive assistance from federal agencies under the existing Integrated Emergency Management System. The Department of Homeland Security is the lead federal agency for supporting state and local response to the consequences of terrorist attacks.[202]

Terrorism is often categorized as either domestic, international, or lone wolf.

Domestic

The U.S. Patriot Act defines domestic terrorism as an attempt to "intimidate or coerce a civilian population; to influence the policy of a government by intimidation or coercion; or to affect the conduct of a government by mass destruction, assassination, or kidnapping."

Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of the U.S. government or population without foreign direction. It is the unlawful use, or threatened use, of violence by a group or individual based and operating entirely within the United States, or its territories, without foreign direction, committed against persons or property to intimidate or coerce a government, the civilian population, or any group, in furtherance of political or social objectives. This can also include single issue groups looking to further specific social ideas or practices.[203]

International

International terrorism involves groups or individuals whose terrorist activities are foreign based and/or directed by countries or groups outside the United States or whose activities transcend national boundaries. This distinction refers not to where the terrorist act takes place but rather to the origin of the individuals or groups responsible for it.

For example, the 1995 bombing of the Murrah Federal Building in Oklahoma City was an act of domestic terrorism, but the attacks of September 11, 2001, were international in nature. For the purposes of consequence management, the origin of the perpetrator(s) is of less importance than the impacts of the

[202] https://www.fema.gov/pdf/plan/managingemerconseq.pdf
[203] https://archives.fbi.gov/archives/news/testimony/the-terrorist-threat-confronting-the-united-states

attack on life and property; thus, the distinction between domestic and international terrorism is less relevant for the purposes of mitigation, preparedness, response, and recovery than for understanding the capabilities of terrorist groups and how to respond to the impacts they can generate.

Lone Wolf

Lone wolf terrorism is used to describe violent acts committed by a single perpetrator. The person acts independently and without the help of outside organizations. A lone wolf terrorist may, however, follow the ideology of a particular organization or group and may commit acts of terror to show their support of said group. Many of these individuals exclude themselves, or feel excluded, from normal social interactions and day-to-day relationships. In their social exclusion, lone individuals feel deprived of what they perceive as values to which they are entitled and form grievances against the government or people who they feel are responsible for their problems, such as unemployment, discrimination, and injustices. Their violence is a means to achieve their goals and to punish those responsible.[204]

Effects

The effects of terrorism can vary significantly from loss of life and injuries to property damage and disruptions in services such as electricity, water supply, public transportation, and communications. One way that governments attempt to reduce vulnerability to terrorist incidents is by increasing security at airports and other public facilities that could be considered as targets.

While one can never predict what target a terrorist will choose, the following are some of the factors many use when selecting a target:

- Produce a large number of victims
- Cause mass panic
- Target locations that have symbolic or cultural value and areas where large groups congregate
- Garner the greatest possible media attention

Terrorists are likely to target heavily populated, enclosed areas like stadiums, government buildings, sporting events, airport terminals, subways, shopping malls, and industrial manufacturing facilities.

A terrorist attack can take several forms depending on the technological means available to the terrorist, the nature of the political issue motivating the attack, and the points of weakness of the terrorist's target. Other possibilities include an attack at transportation facilities, an attack against utilities or other public services, an incident involving chemical or biological agents, an active shooter, or a cyberattack.

In 2011, the U.S. Department of Homeland Security (DHS) replaced the color-coded alerts of the Homeland Security Advisory System (HSAS) with the National Terrorism Advisory System (NTAS), designed to more effectively communicate information about terrorist threats by providing timely, detailed information to the public. The system uses the following three alerts:

- Bulletin: describes current developments or general trends regarding threats of terrorism
- Elevated Alert: warns of a credible terrorism threat against the United States

[204] https://www.ncjrs.gov/pdffiles1/nij/grants/248691.pdf

- Imminent Alert: warns of a credible, specific, and impending terrorism threat against the United States

In an effort to include and prepare the entire community, DHS created the “If You See Something, Say Something” campaign. It is a national campaign that raises public awareness of the indicators of terrorism and terrorism-related crime as well as the importance of reporting suspicious activity to state and local law enforcement. Suspicious activity could include, but is not limited to, unusual items or situations, eliciting information, and observation or surveillance.

Terrorism in Florida

Florida is considered to be vulnerable because the chief objective of a terrorist is to spread fear and create economic damage. Florida is a major tourist attraction with large theme parks, beaches, cruise lines, and military bases.

The open availability of basic shelf-type chemicals and mail-order biological research materials, coupled with access to even the crudest laboratory facilities, could enable the individual extremist or an organized terrorist faction to manufacture highly lethal substances or to fashion less-sophisticated weapons of mass destruction (WMD). The use of such weapons could result in mass casualties and long-term contamination, wreaking havoc on both the state and national economies.

Unlike natural disasters, there are relatively few methods to predict the time or place of a terrorist incident. This fact negates the “watch” and “warning” time phases. The action phases for a terrorist incident are prevention, protection, mitigation, response, and recovery. Activities associated with each action are detailed below.

- *Prevention Phase*
    - The actions during this phase are those taken by local, state, and federal agencies to monitor and coordinate intelligence and other potential indicators to prevent, defend against, prepare for, and mitigate the impacts of terrorist attacks against the nation.
    - Florida uses intelligence provided by Fusion Centers, Joint Terrorism Taskforces, and Regional Domestic Security Taskforces.
- *Protection Phase*
    - The actions during this phase are those taken by local, state, and federal agencies to limit the impacts of a potential event on a specific area.
- *Mitigation Phase*
    - The actions during this phase are those that require time to carry out. They include training, planning, public awareness, and any activities that require long-term programs to accomplish their objectives.
- *Response Phase*
    - These actions are those taken immediately after an incident to 72 hours after the incident, with the major goal of saving lives, alleviating suffering, and preventing further disaster.
    - When responding to disaster events, the National Incident Management System (NIMS) is used by qualified staff to manage the response actions.

- *Recovery Phase*
    - The actions during this phase are those taken during the first one to two months after the incident.
    - These actions, which begin immediately after the emergency response operations, have the goal of returning the state and citizens to normal conditions.
    - The emphasis will transition from saving lives to cleanup of the affected areas and returning people to normal activities.

Florida realizes that there is appropriate concern that a terrorist event is possible due to the state's highly visible and popular tourist destinations. The state also has nuclear power plant locations, numerous international shipping ports, cruise ship destinations, and large-capacity arenas.

Mitigation and preparedness planning grants are one way that Florida works to mitigate the risks of terrorist attacks. The Florida Division of Emergency Management (FDEM) is the State Administrative Agency (SAA) for the Department of Homeland Security Grant Program (HSGP). HSGP is comprised of three grant programs. The Domestic Security Unit is responsible for the administration of these programs for the State of Florida. The three programs include:

- State Homeland Security Grant Program (SHGP): The SHGP assists state, tribal, territorial, and local preparedness activities that address high-priority preparedness gaps across all core capabilities that support terrorism preparedness.
- Urban Area Security Initiative (UASI): The UASI program assists high-threat, high-density urban areas in efforts to build, sustain, and deliver the capabilities necessary to prevent, protect against, mitigate, respond to, and recover from acts of terrorism.
- Operation Stonegarden (OPSG): The OPSG Program supports enhanced cooperation and coordination between Customs and Border Protection, United States Border Patrol, and federal, state, local, tribal, and territorial law enforcement agencies. The OPSG Program provides funding to support joint efforts to secure the United States' borders along routes of ingress from international borders to include travel corridors in states bordering Mexico and Canada as well as states and territories with international water borders.

With the vast majority of America's critical infrastructure owned and/or operated by state, local, and private sector partners, critical infrastructure and key resource (CI/KR) locations within the state that are determined to be credible targets of a terrorist event can be documented and monitored. Structures selected for inclusion in the CI/KR list are eligible for additional government grant funding to increase their security against a terrorist event.

One example of funding for which CI/KR sites qualify is the Buffer Zone Protection Program (BZPP). The purpose of the BZPP is to make it more difficult for terrorists to conduct planning activities or successfully launch attacks from the immediate vicinity of likely targets. The program is based on the premise that local law enforcement agencies and first responders are on the front lines preventing, defending against, preparing for, and mitigating the impacts of terrorist attacks against our nation. The funds provided by the BZPP are provided to increase the preparedness capabilities of jurisdictions responsible for the safety and security of communities surrounding high-priority critical infrastructure and key resource (CIKR) assets through allowable planning and equipment acquisition.

Florida utilizes the Domestic Security Strategic Plan for terrorist attacks. Florida's Domestic Security Strategic Plan remains a working document, reviewed and prioritized each year. Seven Regional Domestic Security Task Forces (RDSTF's), co-chaired by a local sheriff or police chief and the local FDLE Special Agent in Charge, are the foundation of Florida's Domestic Security Strategy. These multi-jurisdictional and multidisciplinary task forces work together to strengthen Florida's domestic security preparedness, prevention, protection, mitigation, and response. In addition to law enforcement, task force members include first responders such as fire rescue, emergency management, public health, and hospitals. The task force also works with schools, businesses, and private industries.[205]

Chemical

Chemical terrorism is the deliberate release of certain chemicals that could poison people, animals, plants, or the environment. Chemical agents can be delivered in various forms, such as vapors, aerosols, liquids and solids, and by a wide variety of methods, including sprays and explosives. Chemical warfare agents are substances specifically designed to kill, seriously injure, or disable people. In general, terrorists use chemical agents because they are relatively easy and cheap to make.

Most chemical agents, depending on their type, concentration, and length of exposure, can be deadly. These chemicals can be categorized by type or by their effect. The Center for Disease Control (CDC) categorizes the following types:

- Anticoagulants – cause uncontrolled bleeding
- Biotoxins – come from plants or animals
- Blister agents – blister the eyes, skin, or throat and lungs
- Blood agents – absorbed into the blood
- Caustics – burn on contact
- Choking, lung, and pulmonary agents
- Incapacitating agents – alter consciousness or thinking
- Metallic poisons
- Nerve agents – prevent the nervous system from functioning properly
- Organic solvents – damage living tissue by dissolving fats and oils
- Tear gas and riot control agents
- Toxic alcohols
- Vomiting agents

Chemical agents can produce effects quickly, sometimes within a few seconds, or slowly, sometimes as many as two days after exposure, with some agents being odorless and tasteless.[206]

205 http://www.fdle.state.fl.us/Publications/Documents/Brochures/DomesticSecurity_Brochure_2017_02.aspx
206 http://www.acsim.army.mil/readyarmy/Chemical_Terrorism_Fact_Sheet.pdf

Biological

Bioterrorism refers to the intentional release of toxic biological agents to harm and terrorize civilians in the name of a cause. Biological agents are living organisms, or the products of living organisms, that can be deadly. Biological agents can go undetected for hours to days. Signs and symptoms might initially look like a bad cold, flu, or other common illness. Some agents can be extremely lethal in very small quantities. Biological weapons fall into three categories: bacteria, viruses, and toxins with bacteria. All three types can potentially be deadly to people and animals. The CDC has classified the viruses, bacteria, and toxins that could be used in an attack. Category A biological diseases are those most likely to do the most damage. They include:

- Anthrax (*Bacillus anthracis*)
- Botulism (*Clostridium botulinum toxin*)
- Plague (*Yersinia pestis*)
- Smallpox (variola major)
- Tularemia (*Francisella tularensis*)
- Hemorrahagic fever
- Ebola virus

Bioweapons can also be spliced to create a super-virus that either has no cure or is resistant to already formulated antidotes. For more information on biological hazards, please see the *Disease Outbreak and Biologic Incident Hazard Profile*.

Nuclear

Nuclear terrorism refers to a number of different ways nuclear materials might be exploited as a terrorist tactic. These include attacking nuclear facilities, purchasing nuclear weapons, building nuclear weapons, or otherwise finding ways to disperse radioactive materials. There are low levels of radiation exposure present in the everyday environment, but the danger in a nuclear terrorist attack comes with the amount and type of radiation given off.

Given the number of capable groups with serious intent, the increasing accessibility of weapons or nuclear materials from which elementary weapons could be constructed, and the countless ways in which terrorists could smuggle a weapon across borders, nuclear terrorism has become a clear and present danger.

Nuclear terrorism can involve the use of weapons of mass destruction (WMD). Weapons of mass destruction are defined as (1) any destructive device as defined in 18 U.S.C., Section 2332a, which includes any explosive, incendiary, poison gas, bomb, grenade, or rocket having a propellant charge of more than four ounces, missile having an explosive or incendiary charge of more than one quarter ounce, mine or device similar to the above; (2) poison gas; (3) any weapon involving a disease organism; or (4) any weapon that is designed to release radiation or radioactivity at a level dangerous to human life.

The effects of a nuclear attack depend on how much radiation is received, how long someone is exposed to the radiation, and how the radiation entered the body.

Environmental

Ecoterrorism, a recently coined term, describes violence in the interests of environmentalism. In general, environmental extremists sabotage property to inflict economic damage on industries or actors they see as harming animals or the natural environment. These have included fur companies, logging companies, and animal research laboratories. This can also be known as special interest terrorism.

Special interest terrorism differs from traditional right-wing and left-wing terrorism in that extremist special interest groups seek to resolve specific issues, rather than effect widespread political change. These groups continue to conduct acts of politically motivated violence to force segments of society, including the general public, to change attitudes about issues considered important to their causes. These groups occupy the extreme fringes of animal rights, pro-life, environmental, anti-nuclear, and other movements. Some special interest extremists, most notably within the animal rights and environmental movements, have turned increasingly toward vandalism and terrorist activity in attempts to further their causes. The Animal Liberation Front (ALF) and the Earth Liberation Front (ELF) have also become well known for their use of arson to destroy facilities and spread their message.

Bombing

The easiest to obtain and use of all weapons is still a conventional explosive device, or improvised bomb, which may be used to cause massive local destruction or to disperse chemical, biological, or radiological agents.

Many of the devices used by terrorists today are IEDs.[207] An improvised explosive device (IED) is a homemade bomb or destructive device used to destroy, incapacitate, harass, or distract. IEDs are categorized as being explosive or incendiary, employing high- or low-filler explosive materials to explode or cause fires. IEDs can come in many forms, ranging from small, easy to make pipe bombs to more sophisticated devices capable of mass damage and loss of life. These devices can be lightweight and easy to carry such as the backpacks of the Boston Marathon bombers; however, they can also be large enough that use of a vehicle to transport is necessary, such as the bombing of the Alfred P. Murrah Federal Building in Oklahoma City. IEDs can also be made of numerous chemicals and hazardous materials and may include the use of shrapnel such as nails or ball bearings.

The components are readily available, as are detailed instructions to construct such a device. Large, powerful devices can be outfitted with timed or remotely triggered detonators and can be designed to be activated by light, pressure, movement, or radio transmission. The potential exists for single or multiple bombing incidents in single or multiple municipalities. Historically, less than five percent of actual or attempted bombings were preceded by a threat. Explosive materials can be employed covertly with little signature and are not readily detectable. Secondary explosive devices may also be used as weapons against responders and the public in coincident acts.[208]

[207] https://www.dhs.gov/xlibrary/assets/prep_ied_fact_sheet.pdf
[208] https://www.fema.gov/pdf/plan/managingemerconseq.pdf

Cyberattack

Cyberterrorism is the premeditated use of disruptive activities, or the threat thereof, against computers and/or networks, with the intention to cause harm or further social, ideological, religious, political, or similar objectives or to intimidate any person in furtherance of such objectives. Cyberterrorists use information technology to attack civilians and draw attention to their cause. This form of terrorism could severely disrupt the U.S. financial sector and banking, communications, transportation systems, business operations, and all major government infrastructure that relies on computers and the Internet.

This may mean that they use information technology, such as computer systems or telecommunications, as a tool to orchestrate a traditional attack. More often, cyberterrorism refers to an attack on information technology itself in a way that would radically disrupt networked services. For example, cyberterrorists could disable networked emergency systems or hack into networks housing critical financial information.[209] For more information on cyberattacks, please see the *Cyberterrorism Hazard Profile*.

Active Shooter

An active shooter is an individual actively engaged in killing or attempting to kill people in a confined and populated area. Multiple active shooters are a group that participates in a random or systematic shooting spree demonstrating their intent to continuously harm or kill others. In most cases, active shooters use numerous types of firearms and there is no pattern or method to their selection of victims. Active shooter situations are unpredictable and evolve quickly, with most active shooter situations over within 10 to 15 minutes. Warning signs that someone may be planning an attack are:[210]

- Increasingly erratic, unsafe, or aggressive behaviors.
- Hostile feelings of injustice or perceived wrongdoing.
- Drug and alcohol abuse.
- Marginalization or distancing from friends and colleagues.
- Changes in performance at work.
- Sudden and dramatic changes in home life or in personality.
- Financial difficulties.
- Pending civil or criminal litigation.
- Observable grievances with threats and plans of retribution.

The Department of Homeland Security defines certain characteristics of an active shooter as the following:[211]

- Active shooters are likely to engage more than one target. They may target particular individuals, or they may be intent on killing as many randomly chosen people as possible.
- Active shooters often go to locations with high concentrations of people, such as schools, theaters, shopping centers, or other places of business.

[209] http://www.crime-research.org/library/Cyberterrorism.html
[210] https://www.dhs.gov/sites/default/files/publications/dhs-pathway-to-violence-09-15-16-508.pdf
[211] https://www.alicetraining.com/active-shooter/

- Active shooters often, but not always, are suicidal and may attempt suicide by police. Escape from the police is usually not a priority of an active shooter. Most active shooters do not attempt to hide their identity.

2. Geographic Areas Affected by Terrorism

It is almost impossible to predict where and when a terrorist attack could occur. Generally, terrorists target densely populated or high-profile areas, making any of the state's major urban areas a potential target. High-profile infrastructure, such as government and state buildings, amphitheaters, amusement parks, ports, and airports, is also at risk of a potential attack. The specific motivations of terrorists dictate target selection; therefore, any location within the county has the potential to become a target of terrorism, especially since it is one of the most populated counties in the state of Florida.

Tampa contains numerous targets of opportunity for potential terrorist groups. Being one of the top 15 media markets in the country, containing a major seaport and international airport, hosting major NFL, MLB, and NHL sports teams are all among the factors which could attract terrorist activity to the area. Tampa houses MacDill Air Force Base, a major military base with a worldwide orientation. MacDill is the headquarters for two major commands; special U.S. Operations Command and U.S. Central Command.

Additionally, it houses Coalition Village which is comprised of representatives from 65 nations who are working together to combat terrorism. An incident involving weapons of mass destruction (WMD) by a terrorist organization using chemical, biological, or nuclear substances is a distinct possibility in light of the contemporary worldwide terrorist threat.

3. Historical Occurrences of Terrorism

In January 2012, Sami Osmakac, an American citizen born in the former Yugoslavia who is a Florida resident, was charged with plotting a terrorist spree around Tampa, including bombing nightclubs, destroying bridges, and shooting police officers in the name of radical Islam.[212]

Additionally, Hillsborough County does host large events and supports security initiatives for major events in the region such as the Super Bowl (2009) and Republican National Convention (2012). The Super Bowl is also slated to be in Hillsborough County again in 2021.

4. Probability of Future Terrorism Incidents

There is no sure way to predict future terrorism events as most typically occur without warning. The probability of a major terrorist event in the state of Florida is perceived to be high, and planning must be done as part of the larger national DHS initiatives. The Florida Division of Law Enforcement (FDLE) plays a large part in providing the state with critical intelligence and serves as a prevention measure to the state.

[212] Brown, R. (2012, January 9). Florida Man Charged With Plotting Terror Campaign in Name of Islam. The New York Times. Retrieved from http://www.nytimes.com/2012/01/10/us/florida-man-charged-with-plotting-strikes-in-name-of-islam.html?_r=1

FDLE is part of an ongoing assessment of the state's vulnerability and coordinates efforts to prepare for, prevent, mitigate, respond to, and recover from acts of terrorism that affect the state.[213]

This hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Terrorism Impact Analysis

- Public
  - Witnesses are at risk of PTSD and survivor's guilt following a large-scale attack
  - Fear throughout the affected community, and the country, is high causing a hazardous environment
  - Civilians are a target for attacks and are at risk
  - Exposure to hazardous materials is a possibility and could affect the nearby population and first responders
  - Lack of clean running water can cause unsanitary conditions and dehydration
- Responders
  - First responders are at risk of PTSD and other health issues following a violent attack
  - First responders are a target for second wave attacks and are at risk during rescue operations
  - Exposure to hazardous materials is a possibility and could affect the nearby population and first responders
  - Lack of communications and disruption of critical services can delay emergency response times
- Continuity of Operations (including continued delivery of services)
  - Tourism can decline following an attack and could cause lost revenue to a community and the economy
  - Airports in surrounding areas may close causing delays, leaving travelers stranded
  - Streets blocked with debris or closed due to proximity can cause street congestion and slow down response times and evacuation routes
  - Bridges could be closed causing issues evacuating and responding
  - Train disruptions can cause delays and stranded passengers
  - Communication grid overload can cause the system to crash following a large attack
  - Damage to phone lines can cause issues getting information and calling for emergency services
  - Loss of Internet can affect numerous industries and emergency response
- Property, Facilities, Infrastructure
  - Bridges could be destroyed or damaged causing issues evacuating a community
  - Train tracks could be damaged or destroyed causing further delay in passengers and cargo being transported
  - Cars in the vicinity could be damaged or destroyed

[213] http://www.fdle.state.fl.us/cms/Domestic-Security/Domestic-Security-Home.aspx

- Roads can be damaged or destroyed causing prolonged delays and reduced access for evacuation
- Damage to buildings can include:
  - Collapse (full/partial)
  - Windows blown out
  - Fire
- Damage or destruction of government buildings could delay necessary services for the community
- Damage or destruction to critical infrastructure such as places of travel, banks, and utilities could cause stress and hardship within the community
- Outages can be widespread
- Damage to power grid can prolong outages

- Environment
  - Exposure to hazardous materials is a possibility and could affect the environment and wildlife
  - Could contaminate the food and water sources
  - Damage to green spaces
- Economic Condition
  - Prolonged loss of revenue could cause businesses to close and the economy to suffer
  - Loss of wages could affect citizens' ability to buy necessities and could affect the economy
  - The economy (business, personal, and government) could be affected if banks are closed or not able to access the Internet
- Public Confidence in Jurisdiction's Governance
  - Lack of communication from leadership to the public
  - Evacuation timeframe
  - Response timeframe
  - Recovery timeframe
  - Not stopping an attack could lead to a loss of respect or confidence

6. Vulnerability Analysis and Loss Estimation by Jurisdiction

The county recently has conducted and been involved in numerous large scale multi-jurisdictional terrorism exercises. Joint planning efforts with a number of response agencies are currently under way. It is expected that resultant changes in a number of procedures will ultimately minimize the potential effects of a terror incident, should one occur. According to the Regional Domestic Security Task Force, the sector most at risk is Commercial Facilities. The threat category contributing the most risk is IED (Incendiary Explosive Device).

Areas with large populations, major transportation hubs, theme parks or cruise ships, and those with a large influx of tourism are the most at risk for a terrorist attack. The impact of a single terrorist attack would vary depending on the attack. A terrorist attack which is successful could kill or injure a large number of people. There are also potential long-term environmental and/or economic impacts of an attack.

7. Vulnerability Analysis and Estimated Losses of Critical Facilities

Though the county recognizes that critical facilities are vulnerable to terrorism, the abstract way in which terrorism occurs creates a vacuum of high-level detailed vulnerability and risk assessment. As such, while it is prudent to recognize the threat, there is not a viable manner in which to quantitatively communicate the vulnerability or loss of facilities compared to other hazards.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.9.

<table>
<tr><th colspan="5">TERRORISM</th><th rowspan="2">Overall Vulnerability</th></tr>
<tr><th colspan="5">Overview</th></tr>
<tr><td colspan="5">In the Florida Code of Regulations, terrorism is defined as “the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of political or social objectives.” This is something that is difficult to mitigate against due to sheer unpredictability. Hillsborough County faces a particular threat from events involving terrorism due to the booming tourist industry, international ports, etc.</td><td>HIGH</td></tr>
<tr><th>Probability</th><th>Impact</th><th>Spatial Extent</th><th>Warning Time</th><th>Duration</th><th>PRI Score</th></tr>
<tr><td>Possible</td><td>Critical</td><td>Moderate</td><td>< 6 hrs</td><td>> 1 week</td><td>2.9</td></tr>
</table>

Special Events Incident Hazard Profile

1. Special Events Incident Description

Hillsborough County hosts several professional sports teams and several annual special events such as the Florida State Fair, Gasparilla Festival, and the Strawberry Festival. On occasion, because of the location of Tampa, the city also hosts large scale national events. In addition, Hillsborough County is home to Busch Gardens, a significant tourist attraction. These events and activities all increase the population for the duration of the events within a geographical area. These activities of themselves do not pose any threat to the county. However, special events and large gatherings of people do lend themselves to be at greater risks of terrorist activity or civil disturbances.

Annual attendance estimates for the County's main events are indicated below:

- Gasparilla Pirate Invasion (Boat and Land parade): Over 300,000 for the parade and over one million attending at least one Gasparilla event
- Florida State Fair: Over 400,000 during the total 12 days
- Florida Strawberry Festival: Over 400,000 during the total 11 days
- Concert/Sport Venues
  - Amalie Arena
    - Home to the Tampa Bay Lightning of the National Hockey League (Approximately 40 events per year; 19,000 capacity)
    - Concert Venue (Approximately 57 events per year; 20,000 capacity)
    - National Events Venue – The arena has also been used for national college championships in women's and men's basketball as well as men's hockey. The arena has hosted the Republican National Convention in 2012, professional wrestling events, and the NHL's All-Star Weekend in 2018[214].
  - Yuengling Center (on the University of South Florida campus)
    - Yuengling Center is a multi-purpose facility, hosting approximately 300 different events each year, including sporting events, concerts, home and garden shows, trade shows, religious services and conventions, ethnic festivals, rodeos, bull riding competitions, youth sports camps, wrestling, boxing, gymnastics and cheerleading competitions, commencement ceremonies, lectures and political rallies among other corporate, community and university events[215].
  - Raymond James Stadium
    - Raymond James Stadium is home to the Tampa Bay Buccaneers, University of South Florida Bulls football, college football's Outback Bowl and Gasparilla Bowl, Monster Jam truck event, and the Sunset Music Festival. The stadium has hosted

[214] https://www.amaliearena.com/arena-info/about
[215] https://www.yuenglingcenter.com/venue-information

the International Indian Film Academy awards (IIFA), Super Bowl XXXV and Super Bowl XLIII as well as many superstar concerts. Raymond James Stadium hosted the 2017 college football playoff national championship, which marked the first time this event had been hosted in the southeast united states. Raymond James Stadium also hosted the historic Super Bowl LV and WrestleMania 37[216].

2. Geographic Areas Affected by a Special Events Incident

A special event could be held anywhere within the County but major events are typically held within designated areas such as downtown Tampa, sporting arenas, and fairgrounds. Many of the events listed above are within the city limits of Tampa. The Florida Strawberry Festival is held within the City of Plant City and the Florida State Fairgrounds are located within the unincorporated portion of the county. The waterways within the area are also utilized for special events such as the Gasparilla Pirate Invasion and events held along the Hillsborough River near the Tampa Riverwalk.

3. Historical Occurrences of Special Event Incidents

There have not been any recorded significant incidents specific to special events. Special events of national significance (or larger-sized local events) will have after-action reports to capture challenges in the implementation, monitoring, and demobilization related to the special event.

4. Probability of Future Special Event Incident

There is no sure way to predict future occurrences of suffering damages at special events as most typically occur without warning. The probability of a special event resulting in damages is perceived to be high, particularly those with national significance, and planning must be done as part of the larger national DHS initiatives. The Florida Division of Law Enforcement (FDLE) plays a large part in providing the state with critical intelligence and serves as a prevention measure to the state.

This hazard was determined to have a probability level of possible (1 to 10% annual probability).

5. Special Event Incident Impact Analysis

- Public
  - Witnesses are at risk of PTSD and survivor's guilt following a large-scale attack
  - Fear throughout the affected community, and the country, is high causing a hazardous environment
  - Civilians are a target for attacks and are at risk
  - Exposure to hazardous materials is a possibility and could affect the nearby population and first responders
  - Lack of clean running water can cause unsanitary conditions and dehydration
- Responders
  - First responders are at risk of PTSD and other health issues following a violent attack

[216] https://raymondjamesstadium.com/about-us

  - First responders are a target for second wave attacks and are at risk during rescue operations
  - Exposure to hazardous materials is a possibility and could affect the nearby population and first responders
  - Lack of communications and disruption of critical services can delay emergency response times
- Continuity of Operations (including continued delivery of services)
  - Tourism can decline following an attack and could cause lost revenue to a community and the economy
  - Airports in surrounding areas may close causing delays, leaving travelers stranded
  - Streets blocked with debris or closed due to proximity can cause street congestion and slow down response times and evacuation routes
  - Communication grid overload can cause the system to crash following a large attack
  - Damage to phone lines can cause issues getting information and calling for emergency services
  - Loss of Internet can affect numerous industries and emergency response
- Property, Facilities, Infrastructure
  - Cars in the vicinity could be damaged or destroyed
  - Roads can be damaged or destroyed causing prolonged delays and reduced access for evacuation
  - Damage to buildings can include:
    - Collapse (full/partial)
    - Windows blown out
    - Fire
  - Damage or destruction of government buildings could delay necessary services for the community
- Environment
  - Could contaminate the food and water sources
  - Damage to green spaces
- Economic Condition
  - Prolonged loss of revenue could cause future events to be canceled
  - An attack or disruption of services at a special event could cause other events to be canceled out of perceived or real threats that effects the local economy
- Public Confidence in Jurisdiction’s Governance
  - Lack of communication from leadership to the public
  - Evacuation timeframe
  - Response timeframe
  - Recovery timeframe
  - Not stopping an attack could lead to a loss of respect or confidence

6. Vulnerability Analysis and Estimated Losses by Jurisdiction

The county recently has conducted and been involved in numerous large scale multi-jurisdictional terrorism exercises which also relate to special events. Joint planning efforts with a number of response agencies are currently under way. It is expected that resultant changes in a number of procedures will ultimately minimize the potential effects of a terror incident, should one occur.

Areas with large populations, major transportation hubs, theme parks or cruise ships, and those with a large influx of tourism are the most at risk for a terrorist attack. The impact of a single attack or disruption that could occur would vary depending on the attack. Any attack which is successful at a special event could kill or injure a large number of people. There are also potential long-term environmental and/or economic impacts of an attack.

7. Vulnerability Analysis and Estimated Losses of Critical Facilities

Though the county recognizes that critical facilities are vulnerable to events that occur at special events, the abstract way in which damage occurs limits the level of detailed vulnerability and risk assessment. As such, while it is prudent to recognize the threat, there is not a viable manner in which to quantitatively communicate the vulnerability or loss of facilities compared to other hazards.

8. Overall Vulnerability

Each of the five PRI categories was assigned a value from 1 to 4 and the pre-determined weighting factor was applied to calculate a PRI score. PRI scores can range from 1.0 to 4.0 and the overall vulnerability ranking or high, moderate, or low was assigned based on the PRI scores.

Based on the probability, impact, spatial extent, warning time, and duration, the overall vulnerability of this hazard was determined to be high, with a PRI score of 2.9.

SPECIAL EVENTS INCIDENT					Overall Vulnerability
Overview					
Countywide, there are many special events that occur throughout the year via sporting events, festivals, and concerts, etc. Additionally, the area hosts national events for sporting or political activities. This is something that is difficult to mitigate against due to sheer unpredictability.					HIGH
Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Possible	Critical	Moderate	< 6 hrs	> 1 week	2.9

POTENTIAL FUNDING SOURCES SECTION

Introduction

One of the requirements for the LMS is the identification of potential funding for mitigation projects. Federal, state, and local governments have programs which provide funding for various types of mitigation. Some funding is available prior to a disaster while other programs are initiated in a post-disaster scenario. Typically, many more resources specifically earmarked for mitigation activities are available following a federal disaster declaration.

Local and state agencies have dedicated financial resources toward the funding of mitigation projects. The majority of the state funds that indirectly support mitigation related activities are provided for land acquisition, water quality and quantity-related issues, as well as meeting non-federal match requirements for various federally-funded mitigation assistance programs. Similarly, local governments fund various projects including implementation of growth management initiatives; planning, permitting and code enforcement; acquisition and maintenance of parks and conservation areas; stormwater projects; housing mitigation assistance programs for low- and moderate-income citizens; and construction and structural hardening of critical facilities, such as public safety and emergency operations centers, fire and police stations, city halls, etc.

Both the State of Florida and local governments leverage funds available from federal and state sources to provide financial assistance to implement the hazard mitigation projects that have been identified, prioritized, and documented by the Local Mitigation Strategy (LMS) Working Group as well as the projects submitted under the Flood Mitigation Assistance Program (FMAP), Repetitive Flood Claims and Severe Repetitive Loss Programs.

Funding Source Identification and Usage

The county uses a variety of programs and funds to achieve its mitigation goals. Various programs and sources of project funding are described throughout this section.

Federal Funding

Mitigation opportunities are pursued on a year-round basis in Florida. While many opportunities exist to fund projects at the local level, both the state and local applicants rely heavily on the use of federal funds to implement mitigation projects. The following federal funding sources are some of the most popular programs used to help achieve the county's mitigation goals. More information regarding federal funding sources can be found on FEMA's website.

Below is a snapshot of both Federal and State funding sources that the county has utilized in the past.

Table 5.1: LMS Funding Source Identification

Funding Source: (Federal Grant, State/Community Funds, Tax); Availability: (Pre-Disaster or Post-Disaster/Annual);

Funding and Projects Section: LMS Projects Funding Matrix																		
	Federal Grants									State/Community Funds						Tax		
	Available Post-Disaster			Available Pre-Disaster/Annually														
	HMPG	406	Public Assistance	PDM/ FMA	HLMP	CDBG	EMPA	EMPG	State Homeland Security Program	Revenue Bonds	Jurisdiction Funds	General County Fund	State/ County Agencies	Florida Communities Trust	In-Kind	Ad Valorem	Stormwater	Sales
Hillsborough	X			X									X					X

All mitigation measures submitted to the state for funding under FEMA's Hazard Mitigation Assistance (HMA) programs which include the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) grant program, the Flood Mitigation Assistance (FMA) program, the Severe Repetitive Loss (SRL), and the Hazard Loss Mitigation Program (HLMP) program must:

- Be consistent with the SHMP.
- Solve or at the very least address a problem.
- Be technically feasible.
- Be cost effective.
- Comply with environmental regulations.
- Identify a non-federal match (if required).

In addition, to the standard federal requirements, the State of Florida has developed additional eligibility criteria for all proposed multi-hazard mitigation measures submitted to FDEM. These criteria are reflected in Florida Administrative Code 27P-22.005, in which, Florida requires the prioritized project list outlines the estimated costs and associated funding source for each project listed. Florida is the only known state to have a legislatively approved process for distributing HMGP funds. The law serves to strengthen local planning processes while providing autonomy in how funds are distributed.

In the instances where a cost effective, eligible, and technically feasible project submitted under a specific grant program fails to receive a grant due to lack of funds, DEM will provide information on the next available qualifying funding source. For example, if an acquisition is submitted under HMGP and meets all program eligibility requirements but is not funded due to limited HMGP funds, this project will be provided to the FMA staff for consideration under the next open cycle.

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) is authorized by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (PL 93-288 as amended). This program, administered by DEM's HMGP Unit, is designed to help states, local governments, private non-profit organizations, and tribes implement long-term hazard mitigation measures following a major disaster declaration. Funds may be used to protect public or private property. They may also be used to purchase property that has been subjected to, or is in danger of, repetitive damage. Projects include acquisition and relocation, multi-hazard retrofits, minor flood control projects, and construction of safe rooms.

The standard federal mitigation funding allocation for this program is 15 percent of allocated disaster relief (the sum of public assistance, individual assistance and Small Business Administration (SBA)). States with an approved Enhanced SHMP are eligible to receive an additional five percent of the disaster relief funds. Up to seven percent of HMGP money can be used for mitigation planning activities.

In Florida, it is up to the state as to how those planning funds will be allocated. Often times the seven percent planning funds are used for state level planning initiatives. Under this program, the state requests the additional seven percent set aside, which requires approval from FEMA. Other set-asides can include a five percent initiative for special state initiatives and potentially another five percent for activities that address promoting disaster-resistant codes for all hazards.

The state's five percent initiative funds are used to implement special mitigation priorities set by the Governor and the Governor's Authorized Representative (GAR). These statewide projects include those mitigation activities that are proposed by state and regional agencies. This includes activities proposed by DEM that are regional or statewide in scope. If there are no priorities set for these initiative funds, the five percent can be applied to local initiatives, at the discretion of the state.

Key objectives of the HMGP are to:

- Prevent future losses of lives and damage to property due to disasters.
- Implement state or local hazard mitigation plans.
- Enable mitigation measures to be implemented during immediate recovery from a disaster.
- Provide funding for mitigation measures that benefit the disaster area.

<u>Eligibility for Hazard Mitigation Grant Program Grants</u>

To be eligible for mitigation funding, a project must be listed in the community's Local Mitigation Strategy (LMS) and satisfy the requirements listed below.

These criteria are also listed in the HMGP Administrative Plan, which is used for all federal hazard mitigation programs:

- Be in conformance with the SHMP.
- Have a beneficial impact upon the declared disaster area. A project located outside the declared disaster area cannot be eligible unless it has a direct and beneficial impact to the disaster area or until all projects within the declared disaster area have been funded.
- Conform to 44 CFR, Part 9, Floodplain Management and Protection of Wetlands, and 44 CFR, Part 10, Environmental Considerations.
- Solve a problem independently or constitute a functional portion of a solution where there is assurance that the project will be completed as a whole. Projects that merely identify or analyze hazards or problems are not eligible.
- Be cost-effective and substantially reduce the risk of future damage, hardship, loss, or suffering resulting from a major disaster. The grantee must demonstrate this by documenting that the project:
- Addresses a problem that has been repetitive, or a problem that poses a significant risk to public health and safety if left unsolved.

- Will not cost more than the anticipated value of the reduction in direct damages and subsequent negative impacts to the area if future disasters were to occur.
- After consideration of a range of options, has been determined the most practical, effective, and environmentally sound alternative.
- Contributes to a long-term solution to what it is intended to address.
- Considers long-term changes to the areas and entities it protects and has manageable future maintenance and modification requirements.

FEMA defines hazard mitigation as an action intended to reduce repetitive losses from future natural disasters. In this context, "repetitive" refers to similar types of losses caused by a recurring natural hazard. The term "losses" refers to expenditures for the repair or replacement of public and private property and for the relief of personal loss or other hardship. Post-disaster projects that simply repair and reconstruct damaged property to pre-disaster conditions are not eligible. Rather than mitigating loss, these types of projects serve to perpetuate the cycle of damage, reconstruction, and repeated damage.

Acquisition or construction of a site in the designated Special Flood Hazard Area (SFHA) of a community not participating in NFIP is not eligible for HMGP funding. This includes communities suspended from participation. Non-participating communities may submit projects to the HMGP only if the projects are located in unmapped areas or outside of the SFHA.

Any HMGP construction project located within a SFHA must be comply with the minimum NFIP standards for such projects.

The Disaster Mitigation Act of 2000 (DMA2K) requires, as a condition for receipt of federal mitigation assistance funds, local governments develop a FEMA approved local mitigation plan. The plan must contain locally prioritized projects that are technically feasible, cost effective, and environmentally sound. In Florida, the prioritized project lists serve a very important purpose.

Prioritization for HMGP Funds

Upon notice from FEMA of the availability of HMGP funds, the mitigation staff determines the amount of funds that have been dispersed in each of the declared counties from the Individual Assistance (IA) Program, the Public Assistance (PA) Program, and the SBA Disaster Loan Program. Each county receives a proportional HMGP allocation based on these figures.

DEM will use the 90-day estimate in order to determine the percentage of funds allocated to each county. This process repeats after each successive estimate and the allocations adjust accordingly. When county allocations have been determined, a Notice of Funding Availability (NOFA) is published in Florida Administrative Weekly and distributed to mitigation partners throughout the state.

Local mitigation projects are prioritized by each LMS Working Group. Prioritized lists are submitted to the state each year as a part of the FAC 27P-22 rule update process and again with five-year plan updates. DEM has delegated its authority to set priorities and select projects to the LMS Working Groups in order to validate the local mitigation planning process embodied in the LMS. Under the rule, only prioritized projects from the LMS are eligible for HMGP project funding. LMS Working Groups are encouraged to gather estimates of costs and conduct a simple benefit-cost review as part of the priority setting process, not only to help meet federal planning requirements but also because it is critical to early implementation of projects in a disaster's aftermath.

A letter from the LMS Chairperson must accompany each application submitted endorsing the project and assigning a funding priority. To meet the requirements of DMA2K, the letter must indicate the LMS goal (and objective where appropriate) addressed by the project. The state mitigation staff verifies that the community is listed as an approved participant in the LMS.

To ensure that all of the HMGP project funds are used, DEM uses a three-tiered distribution system as described below.

Table 5.2: Hazard Mitigation Grant Program Distribution System

Tier 1	HMGP funds are allocated to counties included in the relevant Presidential disaster declaration. Funds are allocated in proportion to each county's share of federal disaster funding from the PA, IA, and SBA Disaster Loan Program as of the date of receipt of the FEMA NOFA. Eligible projects are funded in order of LMS priority until allocations (through the 12-month lock-in) are exhausted or all eligible projects are funded.
Tier 2	Any funds remaining after all eligible projects are funded are re-allocated to declared counties with insufficient allocations to fund all submitted eligible projects. Priority for re-allocating funds begins with the declared county with the lowest initial allocation.
Tier 3	If funds remain, they shall be applied to fund eligible projects submitted first-come-first-served from counties that did not receive a Tier 1 allocation because they were not included for IA, PA, or SBA loans.

<u>Prioritization for Hazard Mitigation Grant Program Set-Asides</u>

Prioritization for special set-asides under the HMGP are handled a different way. If the state chooses to use the five percent initiative funding under HMGP, the Governor and the GAR in consultation with the state legislature set priorities for the funding based upon the hazard, type of damages, and identified need resulting from a hazard event. If the Governor and legislature do not set statewide priorities for funds, projects will be deferred to a Project Review Committee of subject matter experts. In all cases, the projects recommended for funding must be in compliance with all other applicable federal requirements.

<u>Prioritization for Hazard Mitigation Grant Program Planning (Seven Percent) Funds</u>

When these funds are available, the review of projects submitted for funding will consist of a Project Review Team comprised of subject matter experts. A standardized process has been developed to rank planning grants for when the amount of available funding is not enough to cover all projects submitted or when similar projects are received from different jurisdictions or agencies.

The scoring system below, as established by DEM, determines how HMGP planning projects will be prioritized for funding.

Table 5.3: Hazard Mitigation Grant Program Prioritization Scoring System

The clarity of the defined mitigation need and the degree to which the projected outcome of the planning project addresses the need.	75 points

The consistency of the planning project with risk analysis and the goals and objectives of the relevant LMS, other local plans, and the SHMP.	75 points
The degree to which the planning project integrates with other local plans.	100 points
The suitability of the proposed planning process to address the need including proposed actions to involve the public and, where appropriate, participants from surrounding neighborhoods as well as appropriate state and local agency or other personnel.	100 points
Creativity of approach to meeting the required match.	50 points
The capability of the applicant to complete the project based on experience, resources and demonstrated ability.	25 points
TOTAL Scoring	**425 points**

Tiebreaker: The degree to which the planning project builds on earlier planning projects.

“406 Mitigation”

HMGP is similar to the PA Program authorized by Section 406 of the Stafford Act. PA funds allow an eligible applicant to incorporate mitigation measures into the repair of an existing damaged structure and infrastructure if the measures are cost-effective or required by code. HMGP can fund mitigation measures to protect public or private property in compliance with the program's guidelines. It is appropriate to fund mitigation measures for public property damage in a disaster under Section 406 before applying for assistance under HMGP.

Flood Mitigation Assistance Program

The Flood Mitigation Assistance (FMA) program is authorized by Section 1366 of The National Flood Insurance Act of 1968, as amended (Pub. L. No. 90-448) (42 U.S.C. § 4104c) and appropriated annually by the Consolidated Appropriations Act. Since the last plan update, consistent with the legislative changes made in the Biggert-Waters Flood Insurance Reform Act of 2012, the established partnership was designed to help states, local, and tribal governments reduce or eliminate long-term risks of flood damage to repetitively flooded structures insured under NFIP. The goals of the FMA are to:

- Fund cost-effective and technically feasible measures that reduce or eliminate long-term risk of flood damage to structures insured through NFIP.
- Encourage long-term, comprehensive mitigation planning against repetitive flooding.
- Reduce repetitively or substantially damaged structures and associated claims on the National Flood Insurance Fund (NFIF) by giving priority to Severe Repetitive Loss (SRL) structures.
- Complement other federal and state mitigation programs with similar goals.

As of FY 2017, the types of grants available through FMA are: Community Flood Mitigation Advance Assistance, Community Flood Mitigation Projects, Mitigation Planning, and Residential Mitigation Projects. Projects include the following eligible activities:

- Development of Mitigation Strategies and/or Data to Prioritize, Select, and Develop Viable Community Flood Mitigation Projects
- Projects that Integrate Cost Effective Natural Floodplain Restoration Solutions and Improvements to NFIP-Insured Properties
- Development of State or Local Flood Plans and Flood Plan Updates

- Acquisition and demolition
- Acquisition and relocation
- Standard elevation
- Mitigation reconstruction
- Dry flood-proofing
- Minor flood control projects

Eligibility for Flood Mitigation Assistance Grants

State mitigation staff evaluate all applications to ensure that the applicant and proposed projects are eligible according to 44 C.F.R. Part 79 and the HMA Guidance. Projects must conform to regulations found in 44 C.F.R. Part 79 and the HMA Guidance. Projects must be:

- Eligible, cost-effective, and technically feasible.
- In conformance with applicable environmental laws and regulations.
- Included in, and in conformance with, the Floodplain Management Plan.
- Physically located in a participating NFIP community not on probation or the project must benefit such a community directly by reducing future flood damage.
- NFIP insured at the time of the opening of an application period and maintained through at least the completion of the project. For projects where a structure remains in the special flood hazard area (SFHA), properties must maintain a flood insurance policy for the life of the structure.

State agencies, federally recognized tribes, and local governments/communities are eligible to apply.

Prioritization for Flood Mitigation Assistance

The State of Florida supports and encourages multi-hazard planning and each LMS must include a flood component. Specialized flood planning is an eligible activity through FMA to augment multi-hazard plans. As the FMA applicant, FDEM has the authority to rank or prioritize project and planning grants applications. FDEM also has the authority to decide whether to submit sub-applications to FEMA for FMA related activities.

FDEM utilizes FEMA's priorities to assist communities with determining if they may benefit from FMA project and/or planning opportunities. In conjunction with communities, staff considers various circumstances to make this determination. These include the impact of flooding on the community and the desire to initiate new and improved flood hazard initiatives or implement strategies to improve their usage of FMA project funds.

There was never a case in which the number of projects exceeded the FMA allocation, but in the event there was, the following method would have been used to review and rank local government applications:

- Priority #1: Local governments that have experienced a significant flood event and did not receive a presidential disaster declaration.
- Priority #2: Local governments that have severe repetitive loss structures but have never submitted or infrequently submitted applications to FMA for flood mitigation projects.
- Priority #3: Local governments that have a high number of FEMA repetitive loss structures.
- Priority #4: Local governments that have targeted repetitive loss structures.

- Priority #5: Those who participate in CRS with ten or more FEMA repetitive loss properties.

Should multiple applicants rank equally, the highest number of severe repetitive loss structures will have priority. FDEM elects not to provide FEMA with sub-applications that exceed its annual allocation of FMA funds.

Pre-Disaster Mitigation Grant Program

The Pre-Disaster Mitigation Grant Program (PDM) is authorized by Section 203 of the Robert T. Stafford Disaster Relief and Emergency Act, as amended (Public Law 93-288) (42 U.S.C. 5133) and appropriated annually by the Consolidated Appropriations Act. It exists to assist communities in reducing overall risk to the population and structures from natural disasters. Eligible applicants are state agencies, federally recognized Indian tribal governments, and local governments. Private non-profit organizations are not eligible to apply; however, they may request a local government submit an application for proposed activities on their behalf.

Potential project types include:

- Acquisition/Demolition; Acquisition/Relocation
- Elevation
- Mitigation Reconstruction
- Dry Flood proofing
- Generators
- Engineering studies
- Hydrologic/hydraulic studies/analyses
- Localized and Non-localized flood reduction projects
- Protective measures for utilities
- Retrofitting
- Safe rooms
- Storm water management projects
- Soil Stabilization
- Wildfire Mitigation

Through PDM, Florida has provided protection to local government structures and critical facilities, as well as reduced flooding in neighborhoods.

<u>Eligibility for Pre-Disaster Mitigation Program Grants</u>

State mitigation staff evaluates the projects to be sure that the applicant and project are eligible according to FEMA's most recent HMA Guidance. The project must conform to regulations found in this Guidance, including:

- Be in conformance with the LMS, local ordinances, planning requirements, and floodplain management plans as applicable.
- Be complete and cost-effective.
- Be long-term and technically feasible.
- Conform to all applicable environmental, historic, or cultural preservation reviews.

- Benefits must not duplicate those available through another primary source or program.

Prioritization for Pre-Disaster Mitigation Program

Florida will only consider PDM applications from communities that have a FEMA-approved LMS. Typically, PDM funds are available to all eligible applicants statewide for projects that are designed to reduce future risk to individuals and property from natural hazards. While not required to be prioritized by the local LMS working groups, projects submitted for funding under the PDM must be consistent with the LMS and documented as such.

Since funding for PDM is competitive nationwide and the federal guidance material may or may not limit the total number of sub-applications a state may submit, FDEM provides technical assistance to all eligible applicants with a FEMA approved LMS. When these funds are available, the review of projects submitted for funding will consist of a Project Review Team composed of subject matter experts.

In those instances where federal guidance limits the number of sub-applications a state may submit, FDEM will limit its submittals to eligible cost-effective sub-applications as provided in the guidance. In any case, FDEM will prioritize and rank eligible cost-effective project applications by FEMA's priorities, benefit cost ratio and technical feasibility.

In situations where there is a tie, FDEM will prioritize those project applications from communities that have not received any HMGP funds over a 12-month period.

Emergency Management Performance Grant

FEMA is responsible for leading and supporting the nation in a comprehensive, risk-based, all hazards emergency management program. The primary means of ensuring the development and maintenance of such a program is FEMA funding to states through the Emergency Management Performance Grant (EMPG). The purpose of the Emergency Management Performance Grant (EMPG) Program is to provide federal funds to states to assist state, local, territorial, and tribal governments in preparing for all hazards. DHS/FEMA make grants available for the purpose of providing a system of emergency preparedness for the protection of life and property in the United States from hazards and to vest responsibility for emergency preparedness jointly in the Federal Government, states, and their political subdivisions. The Federal Government, through the EMPG Program, provides necessary direction, coordination, and guidance as well as assistance to support a comprehensive all hazards emergency preparedness system.

FDEM uses EMPG funding for programs in all four phases of emergency management: preparedness, response, recovery and mitigation. Examples of EMPG funded mitigation activities include initiating or achieving whole community approach to security and emergency management; updating emergency plans; completing the State Preparedness Reports (SPR), including the Threat and Hazard Identification and Risk Assessment (THIRA) process; designing and conducting exercises that engage a whole community of stakeholders and validate core capabilities; and conducting training.

U.S. Army Corps of Engineers Grant Sources

Beach Erosion Control Projects

The U.S. Army Corps of Engineers provides a funding program to control beach and shore erosion occurring on public shores through programs not specifically authorized by Congress.

Flood Control Projects

The U.S. Army Corps of Engineers provides a funding program to reduce flood damages through projects not specifically authorized by Congress.

Floodplain Management Services

The U.S. Army Corps of Engineers provides a full range of technical services and planning guidance to communities to support effective, local floodplain management. Services may include site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Studies can also be conducted for floodplain delineation/hazard, dam failure analyses, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, flood proofing, and inventories of flood prone structures.

National Fish and Wildlife Foundation (NFWF): Resilient Communities 2020

Enhancing community capacity to plan and implement resiliency projects and improve the protections afforded by natural ecosystems by investing in green infrastructure and other measures. Specifically, they request proposals involving conservation projects, community capacity building, and adaptation focused on small businesses and affordable housing.

Environmental Protection Agency (EPA)

Development of community capacity by providing modest assistance to diverse local partnerships for river, wetland, riparian, forest and coastal restoration, and wildlife conservation. Water monitoring, stormwater management, sourcewater protection, urban tree canopy restoration, and projects designed to prevent trash from entering waterways are just some of the types of projects that are awarded grants.

Brownfield Program

The EPA provides a wide variety of grants towards brownfield assessment, cleanup, loans, technical assistance, and research. Within the category of pre-disaster, the Revolving Loan Fund Grants, Cleanup Grans, and Multipurpose Grants are of relevance.

Environmental Justice Small Grants Program

This program supports grants that aim to engage, educate, and empower communities for environmental and public health issues, specifically emphasizing projects that address emergency preparedness and increase resiliency or projects that include needs for veterans and the homeless population. Some other categories of projects include clean air, healthy waters, land revitalization, and environmental health projects.
https://www.epa.gov/environmentaljustice/environmental-justice-small-grants-program

Urban Waters Small Grants

At the time of writing, there is no open request for proposals for this grant. Successful proposals should aim to protect and restore urban waters, improve water quality, and enhance the local community and businesses overall.
https://www.epa.gov/urbanwaters/urban-waters-small-grants

Section 319 Polluted Runoff: Nonpoint Source Pollution
This grant, which can be applied for by eligible state and tribal governments, is used to implement and monitor approved nonpoint source management programs. This grant money can be used to provide technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring.
https://www.epa.gov/nps/319-grant-program-states-and-territories

Clean Water State Revolving Fund
This program allows states to gain funding for projects that address their highest priority water quality needs. This can include construction of municipal wastewater facilities, nonpoint sources of pollution control, construction of decentralized wastewater treatment systems, green infrastructure projects, protection of estuaries, and more.
https://www.epa.gov/cwsrf

Future EPA grants for specific water needs can be located at the following website:
https://www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities

Additional U.S. Army Corps Funding Sources:

Protection, Clearing and Straightening Channels

Protection of Essential Highways, Highway Bridge Approaches, and Public Works

Snagging and Clearing for Flood Control

Watershed Protection and Flood Prevention

The U.S. Department of Agriculture's Watersheds and Wetlands Division provide resources to support technical and financial assistance in carrying out works of improvement to protect, develop, and utilize the land and water resources in small watersheds.

Community Assistance Program State Support Services Element (CAP-SSSE)

To ensure that communities participating in the National Flood Insurance Program (NFIP) are achieving flood loss reduction measures consistent with program direction. The CAP-SSEE is intended to identify, prevent and resolve floodplain management issues in participating communities before they develop into problems requiring enforcement action. Fundable activities include: strategic planning, entering floodplain management data into the Community Information System (CIS), ordinance assistance, CAP gap analysis, Community Assistance Visits (CAV), outreach, workshops, training, mapping coordination, technical assistance, and coordination with other state programs and agencies. State agencies designated by statute or the Governor's declaration as a NFIP state coordinating agency are eligible for funding support.

Emergency Advance Measures for Flood Prevention

This source of funding is from the U.S. Army Corps of Engineers to perform activities prior to flooding or flood fight that would assist in protecting against loss of life and damages to property due to flooding. The governor of the state must request the assistance.

Community Development Block Grant Disaster Recovery (CDBG-DR)

In the wake of a disaster, Congress may appropriate funding for long-term recovery need to the Department of House and Urban Development (HUD). The funding maybe be utilized for disaster relief, long-term recovery, restoration of infrastructure, housing, and economic revitalization. Funding can be awarded directly to state and local governments. The funding is supplemental and may be combined with other federal recovery assistance programs.

Building Resilient Infrastructure and Communities (BRIC)

This is a program federally funded with the Disaster Relief Fund as a six percent set aside from the estimated disaster expenditures. It is geared towards large infrastructure projects at the state and local level for critical facilities and community lifelines to create more continuity of operations.

State Funding

The following is an overview of available state funding sources that have been used as the non-federal share for federal grant programs as well as to fund non-federally funded local projects.

Hurricane Loss Mitigation Program

The Florida Division of Emergency Management created the Hurricane Loss Mitigation Program (HLMP) with a purpose aimed towards minimizing damages caused by hurricanes. The program began as an active response to the devastation brought by Hurricane Andrew, specifically to the insurance market in the State of Florida. With an annual budget of 10 million, provided by the Florida Hurricane Catastrophe Trust Fund, the program is funding activities that promote property resiliency through retrofits made to residential, commercial, and mobile home properties, the promotion of public education and public information, and through hurricane research activities.

The specific areas funded by the $10 million appropriation include retrofits for existing public facilities, the Mobile Home Tie Down program administered by Tallahassee Community College, a hurricane research program conducted by Florida International University, wind mitigation retrofit projects, and public outreach programs.

Up to $3.4 million is to be used on improving community resiliency through the Hurricane Loss Mitigation Program Grant. Through partnering with local housing authorities and non-profit organizations, the Division has been able to promote wind and flood mitigation and provide hazard mitigation retrofitting to residential and commercial properties. Funded activities include retrofits, inspections, and construction or modification of building components designed to increase a structure's ability to withstand hurricane-force winds and flooding. The Retrofit Program utilizes the Florida Building Code as its standard for all retrofitting.

Florida Communities Trust Fund

Florida Communities Trust Fund (FCT) is a state land acquisition grant program housed within the Department of Environmental Protection. Funding for FCT grants comes from the Florida Forever program. When Florida Forever funding is available, FCT's Parks and Open Space program receives 21 percent of the funds and FCT's Stan Mayfield Working Waterfronts program receives 2.5 percent of the funds.

The FCT was created to help implement the goals, objectives, and policies outlined in the conservation, recreation and open space, and coastal management elements of local comprehensive plans. It also helps local governments bring their comprehensive plans into compliance as well as conserve natural resources and resolve land use conflicts. The FCT has acquired over 85,000 acres of private lands to be placed in public trust free from future development. Many of these lands are in floodplains along the state's vast rivers and coastal lands.

The FCT makes grants available to local governments and non-profit environmental organizations through a competitive application cycle to help purchase parks, greenways, and open spaces identified in local comprehensive plans. Under this program, all local governments are required to provide a minimum 25 percent match, except small local governments (counties with a population fewer than 75,000 and cities with a population fewer than 10,000) who would qualify for a 100 percent grant.

Coastal Partnership Initiative Grant Program

The Coastal Partnership Initiative (CPI) grant program promotes the protection and effective management of Florida's coastal resources at the local level. The Florida Coastal Management Program (FCMP) makes National Oceanic and Atmospheric Administration (NOAA) funds available, on a competitive basis, to eligible local governments. Project must be feasible and completed within one year. The project is governed by Rule 62S-4 of the Florida Administrative Code.

<u>Eligibility for Coastal Partnership Initiative Grant Program</u>

Eligible local governments are defined as Florida's 35 coastal counties and all municipalities within their boundaries that are required to include a coastal element in their local comprehensive plan. Florida's public colleges and universities, regional planning councils, national estuary programs, and non-profit groups may also apply if an eligible local government agrees to participate as a partner. Each year in the fall FCMP publishes a notice of availability of funds in the Florida Administrative Register to solicit CPI applications from eligible entities. CPI grants provide support for innovative local coastal management projects in four program areas: resilient communities, coastal resource stewardship, access to coastal resources, and working waterfronts.

<u>Prioritization for Coastal Partnership Initiative Grant Program</u>

CPI applications are reviewed by a technical evaluation committee with knowledge of coastal resource management. The highest rated projects will be considered for funding, subject to the availability of funds from NOAA. All applications are evaluated using the following criteria:

- Project Location
- Project Description
- Demonstrated need and benefit to coastal resource management
- Objectives, tasks, deliverables, and timelines that clearly relate to project
- Cost-effectiveness
- Technical feasibility

Florida Small Cities Community Development Block Grant Program

The Florida Small Cities Community Development Block Grant Program provides federal funding for low income housing rehabilitation and community development. The program, regulated by the U. S. Department of Housing and Urban Development (HUD), assists smaller local governments to provide water and sewer infrastructure, housing rehabilitation opportunities for low income homeowners, commercial revitalization, and economic development projects.

<u>Eligibility for Florida Small Cities Community Development Block Grant Program</u>

The following communities are eligible to apply for funds:

- Non-entitlement cities with fewer than 50,000 residents
- Counties with fewer than 200,000 residents
- Cities that opt out of the urban entitlement program

Prioritization for Florida Small Cities Community Development Block Grant Program

To be eligible for funding, an activity must meet at least one of the following national objectives:

- Low-Moderate National Objective: at least 51 percent of the beneficiaries must be low- and moderate-income persons (total family income is at or below 80 percent of the area's median income).
- Slum and Blight National Objective: the area must be a slum or blighted area as defined by state or local law.
- Urgent Needs National Objective: the activity must alleviate existing conditions which pose a serious and immediate threat to those living in the area and are 18 months or less in origin. The local government must demonstrate that it is unable to finance the activity on its own and that other funding is not available.

Community Development Block Grant Disaster Recovery Initiative

Congress began allocating Community Development Block Grant (CDBG) Disaster Recovery funds to Florida following the 2004 Hurricane Season in response to unusual hurricane activity. Subsequent allocations for 2005 and 2008 storms assist with disaster relief, long-term recovery, restoration of infrastructure, and mitigation efforts in the most impacted and distressed areas.

<u>Eligibility for Community Development Block Grant Disaster Recovery Initiative</u>

CDBG Disaster Recovery funds are made available to states, units of local governments, and insular areas designated by the President of the United States as disaster areas. Communities must have significant unmet recovery needs and the capacity to carry out a disaster recovery. Disaster Recovery funds are most appropriate for long-term recovery needs. Grantees may use funds for recovery efforts that involve housing, economic development, infrastructure and prevention of further damage to affected areas.

Examples of eligible activities include restoration of affordable housing, rehabilitation, demolition, replacement, acquisition, new construction, transitional housing, emergency shelter facilities, and complementary housing activities.

Prioritization for Community Development Block Grant Disaster Recovery Initiative

Activities must meet at least one of three program national objectives:

- Benefit persons of low and moderate income.
- Aid in the prevention or elimination of slums or blight.
- Meet other urgent community development needs.

The Weatherization Assistance Program

The Weatherization Assistance Program (WAP) provides grants to community action agencies, local governments, Indian tribes, and non-profit agencies to fund energy-saving repairs to low-income homes throughout the state. The grants may be used for insulation, weather stripping, water heater wraps, and the reduction of air infiltration. The program may also fund the repair or replacement of inefficient heaters and air conditioners.

Eligibility for the Weatherization Assistance Program

The total household income may not be more than 200 percent above the national poverty level. Preference is given to elderly (60 years-plus) or physically disabled residents, families with children under 12, and households with a high energy burden (repeated high utility bills).

Prioritization for Weatherization Assistance Program

The revised WAP allocation formula is based on three factors for each state:

- Low-income population: This number represents how many low-income households live in each state and is expressed as a percentage of the total for the country.
- Climatic conditions: These data are obtained from the heating and cooling degree-days for each state and deal proportionally with the energy needed for heating and cooling.
- Residential energy expenditures by low-income households: This number is an approximation of the financial burden that energy use places on low-income households in each state.

Beach Management Funding Assistance (BMFA) Program

This program is intended to provide and manage grants for local governments for the planning and implementation of beach and inlet management projects to protect upland structures and infrastructure, to provide critical habitat for threatened and endangered species, to provide recreational opportunities and to support local economies through tourism. This program is managed by the Florida Department of Environmental Protection’s Division of Water Resource Management.

Eligibility for Beach Management Funding Assistance Program

Financial assistance in an amount up to 50 percent of project costs is available to local governments, including county and municipal governments, community development districts and special taxing districts. Potential activities can include beach restoration and nourishment activities; project design and engineering studies; environmental studies and monitoring; inlet management planning; inlet sand transfer; dune restoration; beach and inlet protection activities; and other beach erosion prevention related activities consistent with the adopted Strategic Beach Management Plan.

Projects must be accessible to the public, located on the Gulf of Mexico, Atlantic Ocean or Straits of Florida as well as within an area listed as critically eroded.

Local Funding

Local Mitigation Strategy (LMS) projects funded by grants usually require a local match for implementation. LMS projects span a wide range of mitigation issues including coordination/ integration of public and private sector mitigation projects, post-disaster planning, long-term redevelopment, and public education.

The following provides a synopsis of data obtained from reviewing each of the existing 67 LMS's to identify local funding sources that have been used in the past to fund local mitigation related projects. This list contains funding sources that have been used as a match for federal grant programs as well as to fund non-federally funded local projects.

Ad Valorem Tax

The ad valorem tax is levied based on the value of real and tangible personal property as of January 1 of each year and is intended to increase total revenue of local governments.

Stormwater Tax Assessment

The fee is based on the total amount of a property's impervious surface and has been used to prepare a stormwater program and fund a wide range of drainage improvements.

In-Kind Services

Services or equipment for projects provided by those in the community.

Impact Fees/ Development Exaction

Impact fees on new development such as 1) Water and Sewer Connection Fee; 2) Fire Impact Fee; 3) Law Enforcement Impact Fee; 4) Transportation Impact Fee; and 5) School Impact Fee are used for the purchase and construction of capital assets. (School impact fees may be remitted periodically to the County School Board).

Tourist Tax Local Option

A local tax is levied on most rents, leases or lets, and living accommodations in hotels, motels, apartments, houses, and mobile homes (contracted for periods of less than six months or less) in promotion of tourism and tourist-type activities.

Revenue Bonds

This is revenue derived from the issuance of long-term debt, such as bonds or commercial paper. Proceeds are deposited into capital projects funds and/or debt service funds.

Permit Fees

This is revenue derived from the issuance of local licenses and permits. Exceptions include occupational licenses and building permits.

State Revenue Sharing

Two tax sources are earmarked for sharing with counties: 2.9 percent of net cigarette tax collections; 41.3 percent of net intangible tax collections. Intangible tax collections provide 95 percent of total revenue shared with counties in this category.