Hillsborough TPO
Transportation
Planning Organization

Freight Supply Chain Resilience Study

Hillsborough Transportation Planning Organization

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- Tampa General Hospital
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1.0 Introduction

Supply chains are essential in creating livable, prosperous, and resilient communities. Just about every item in your home or workplace has been touched by a supply chain. A supply chain is defined as the entire system to produce and deliver a consumer good, from the raw materials and machinery used to manufacture the product through to the final delivery of the good to a retail store or to a customer. A supply chain map depicts the components of the supply chain in a process flow-like layout and includes information flows, supplier tiers, natural resource inputs, labor, transportation modes, and other elements that contribute to completing and delivering the product or service. These elements are commonly referred to as supply chain enablers.

We know from past and more current events, such as hurricanes and pandemics, that supply chain disruptions may occur not only when production is stopped by a manufacturer but also when transportation network facilities are blocked, congested, slowed-down, or damaged. Recognizing the importance of supply chains in our daily lives as Hillsborough County citizens, the Hillsborough Transportation Planning Organization (TPO) initiated the Freight Supply Chain Resilience Study to:

- Better understand the supply chains of five critical commodities/services applicable to Hillsborough County;
- Determine potential impacts/vulnerabilities/disruptions to these supply chains as a result of three individual disaster or hazard scenarios and two combinations of concurrent disaster scenarios, as well as impacts of climate change factors (such as sea level rise); and
- Identify actions that can mitigate potential supply chain disruptions, address ways to help the supply chains recover quickly under various disaster scenarios, and strengthen the resilience of the supply chains (and their enabling functions) along with the communities that they support.

Understanding the criticality of supply chain resilience as a vehicle for community habitability and interoperable lifeline resilience, the study recommendations establish a process for continued engagement with key Hillsborough County supply chain partners, stakeholders, and communities that will help define current resiliency and optimal, holistic future outcomes for sustainable and equitable systems planning. The recommendations are intended to be implemented with neighborhood/community context at the forefront, ensuring that safety and critical lifelines are sustained.

This study is a compilation of the following four technical memorandums that were prepared to showcase different aspects and process steps of the study, including Commodity/Service Selection, Disaster Scenario Selection, Commodity/Service Flow, and Supply Chain Resiliency Analysis. Outreach to public and private supply chain actors (stakeholders) and community members that was conducted as part of this study is additionally summarized. Details regarding this engagement may be found in the Outreach & Engagement Summary prepared under separate cover.

2.0 Commodity/Service Selection

This section presents the approach that was used to identify and select the commodities/services that were analyzed as part of this study.

2.1 Methodology

The study focused on examining five commodities/services and their associated supply chains to allow for broader insights and a more diverse breadth of stakeholders to address probable hazard events and impacts of these events to commodities/services and their associated supply chains. The larger range of commodities/services allowed for several specific elements of supply chains, also known as supply chain enablers, to be assessed for potential disaster scenario impacts. Supply chain enablers are defined as those elements that are either needed for a supply chain to function or are more susceptible to supply chain impacts (such as labor, communications, transportation, distribution nodes, and other key nodes or flows within the supply chains).

An initial list of commodities/services was generated from the community lifelines described in the Federal Emergency Management Agency's (FEMA) *Supply Chain Resilience Guide*. Community lifelines are defined as those essentials which allow for the continuous operation of government and business functions to enable human health and safety or economic security. The seven community lifelines include:

- Safety and security;
- Food, water, and shelter;
- Health and medical;
- Energy (power and fuel);
- Communications;
- Transportation; and
- Hazardous material.

The seven lifelines were distilled to more refined and specific sub-categories using FEMA's *Community Lifelines Implementation Toolkit Version 2.0*, resulting in a list of 28 total sub-categories. For each of the 28 sub-categories, multiple commodity/service examples were extrapolated based on research and expertise, resulting in a list of 83 total commodities/services. These 83 commodities/services were then further refined into granular items, some items overlapping multiple commodities/services. The resulting commodities/services list that was developed, documenting this iterative process, may be found in **Appendix A**.

The next step involved pairing down the list of commodities/services to be studied further to a manageable number. The commodities/services were evaluated based on their 1) criticality pertaining to mitigation preparedness and response and recovery operations and 2) relevancy to the Tampa Bay region and specifically Hillsborough County. For example, while home heating fuel might be a relevant commodity to communities in colder climates, it would not be considered as essential as other items pertinent to Hillsborough

County. A total of nine commodities/services were identified and presented to the Hillsborough TPO for consideration. The nine commodities/services included:

- Flood control,
- Commercial food distribution,
- Water utilities (intake, treatment, storage, and distribution),
- Housing (homes and shelters),
- Hospitals,
- Electric transmission systems,
- Fuel distribution system (gas stations and fuel points),
- Wireless communications infrastructure, and
- Banking services.

Based on input from the Hillsborough TPO, the nine commodities/services were revised to include additional parameters for clarity, such as expanding the water utilities category to include wastewater utilities. Each commodity/service was then further analyzed/discussed to determine its ubiquity of need during and after a disaster or disruption and its criticality/value/overlap pertaining to multiple supply chains or commodities/services. For example, banking services or wireless communication infrastructure are part of supply chain flows for the other commodities/services identified on the shorter list. The nine commodities/services were also analyzed regarding data availability to ensure that enough information would be available to develop recommendations at the end of the study. The Hillsborough TPO ultimately selected the five commodities/services shown in **Figure 2.1** for presentation to public agency and private industry stakeholders and community based organizations to seek concurrence. The five commodities/services include food/groceries, water and wastewater utilities, housing material, urgent healthcare services and medicine, and fuel distribution systems. As shown in **Figure 2.2**, seven supply chain enablers (as they relate/apply to each of five proposed commodity supply chains) were additionally identified. The seven supply chain enablers include workforce, vulnerable populations/neighborhoods, financial flows, utilities, communications, transportation, and supply chain partners.

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Figure 2.1 Commodities/Services Selected for Further Study

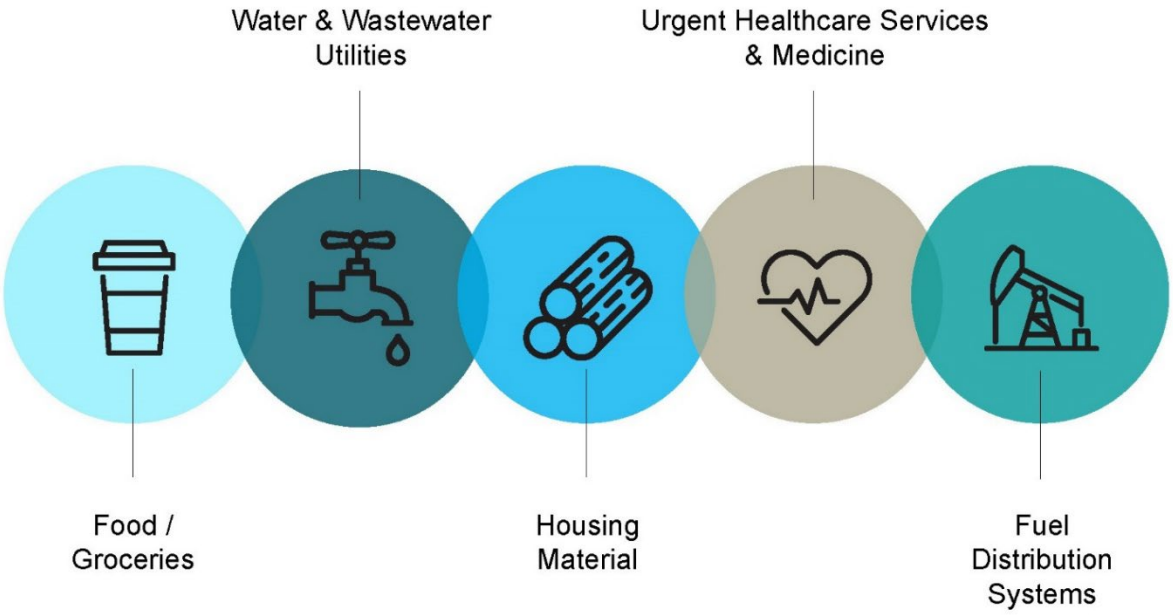
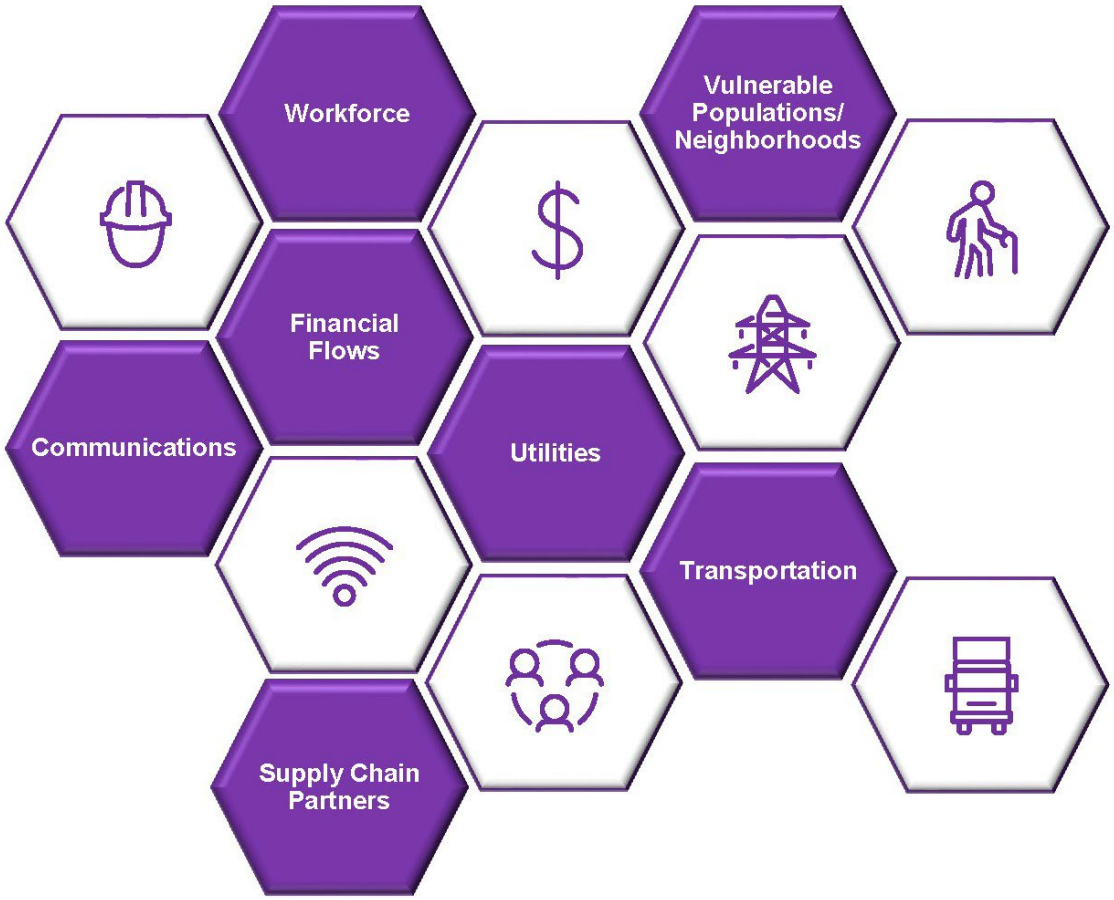


Figure 2.2 Supply Chain Enablers Relevant to Proposed Commodities/Services



2.2 Results

In the months of April and May 2022, six small group stakeholder interviews and meetings with two community organizations took place. For more detailed information regarding these meetings, please refer to the Freight Supply Chain Resilience Study: Stakeholder and Community Engagement Summary prepared under separate cover. During these various meetings, participants were asked to provide input on the proposed commodities/services as well as to share thoughts on any additional commodities/ services to be studied. The proposed supply chain enablers were also briefly discussed. No additional commodities/services were identified by the groups; all unanimously concurred with the five commodities/services that were identified for further study.

To prepare for the next step in creating supply chain maps for each commodity, the five commodity supply chains were focused a bit more based on available data and specifics regarding the Florida supply chain environment. For example, the supply chain for the housing material commodity focused on products that were needed for housing repair (such as lumber, roofing materials, etc.). Given that the State of Florida has an extremely well-resourced and regulated emergency fuel distribution system, the supply chain for the fuel distribution systems commodity focused on the flow of gasoline and diesel.

3.0 Disaster Scenario Selection

This section presents the approach that was used to identify and select the types of disasters that were analyzed as part of this study and the scenarios that were created and applied (based on the selected disaster types) to determine potential impacts/vulnerabilities/disruptions to the five commodity supply chains as noted within Section 2.0.

3.1 Methodology

The study assessed three individual disaster scenarios and two concurrent disaster scenarios to better identify potential disaster consequences on the commodity supply chains and ultimately help develop generalizable recommendations. The number of considered individual disaster scenarios was limited to three to allow for more specific insights to be provided on potential supply chain impacts and coordination with a more diverse breadth of stakeholders across a wide-enough emergency response scope to enable planning that could address extreme disaster events and promote resiliency within Hillsborough County communities. The assessment of concurrent disaster scenarios allowed for examination of extreme stress on supply chains and potential subsequent impacts with the simultaneous occurrence of two disasters.

3.1.1 Selection of Disaster Types

Before the disaster scenarios were created, the types of disasters or hazards to be analyzed were first determined. A number of Hillsborough County, regional, and State of Florida plans and studies were initially reviewed in order to understand the context of emergency mitigation planning within and potential applicable disasters to the Hillsborough County area. A full list of reviewed documents may be found in **Appendix B**.

The Hillsborough County Multi-Jurisdictional Local Mitigation Strategy: 2020 Plan Update (LMS)[1] and the 2018 Enhanced State Hazard Mitigation Plan: State of Florida (SHMP)[2] served as the foundation for the identification of potential disasters to study. Both sources are comprehensive emergency planning documents that consider the most probable disasters that could occur in Hillsborough County and the State of Florida. The LMS and SHMP considered 29 and 30 disasters, respectively. The disasters ranged from natural hazards (such as tropical events and wildfires) to human-caused hazards (such as cyber attacks or transportation incidents). Each disaster was assigned a Priority Risk Index (PRI) score (high, medium, or low) accounting for its potential occurrence probability, impact, spatial extent, warning time, and duration. The disasters identified within the two documents were combined into one list based on similarity. This list was then augmented to include additional disasters not listed within the plans based on a review of case studies of disaster incidents at local, regional, national, and global scales (a full list is provided in **Appendix C**) as well as project team expertise in emergency management and disaster recovery. A total of 47 potential disasters were identified as shown in **Appendix D**.

To narrow down the list of disasters to be examined for further study, those that received a high PRI score in both the LMS and the SHMP were selected. Since these disasters were determined by local and statewide emergency management experts as not only being probable, but also of serious consequence, these events formed the basis of the short list. Other hazards that did not receive a high PRI score in both documents but were considered relevant due to recent events (such as the 2021 ransomware/cyber attack on Colonial Pipeline) were also included. A shorter list containing 12 disasters was created and presented to the Hillsborough TPO for consideration. The 12 disasters included:

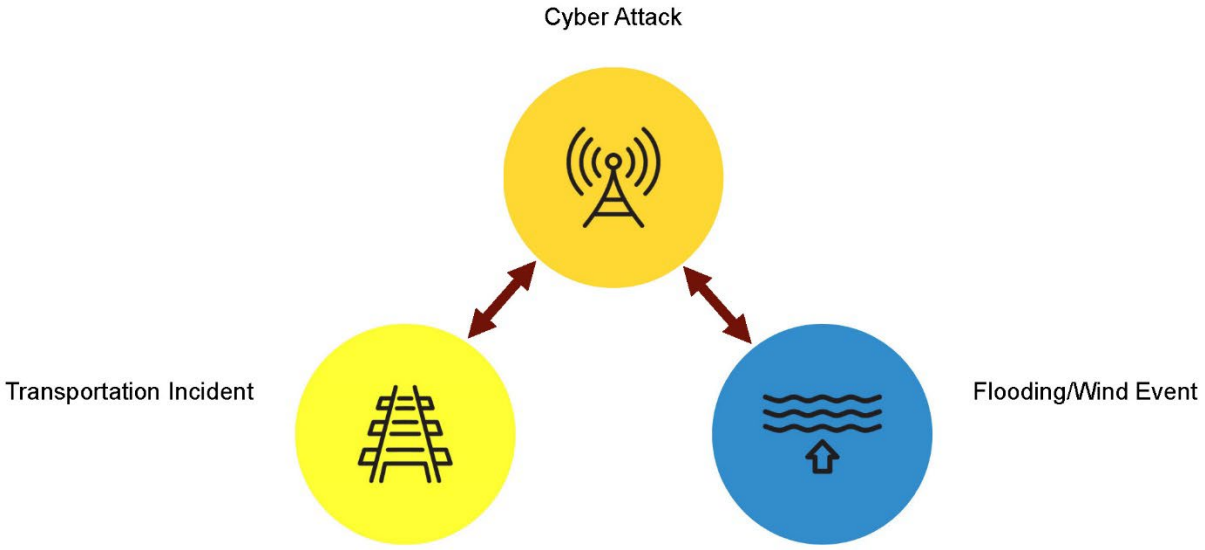
- Flooding/wind event,
- Category 5 hurricane,
- Heavy rainfall (52 inches in 24 hours),
- Flash flood,
- Pandemic (livestock),
- Crop failure,
- Transportation event (sabotage/major accident),
- Explosive attack,
- Nuclear attack,
- Dirty bomb,
- Agricultural disruption, and
- Cyber terrorism.

To further refine the list of disasters, the disasters were reviewed by the Hillsborough TPO to determine which would be the most probable to occur within Hillsborough County, be the most acute, and majorly impact the transportation network and supply chains.

[1] Hillsborough County Multi-jurisdictional Local Mitigation Strategy 2020 Plan Update, Version 1.1 (Hillsborough County) February 2022.
[2] Enhanced State Hazard Mitigation Plan, State of Florida (Florida Division of Emergency Management) 2018.

Recognizing that disasters often occur simultaneously or in a cascading fashion (and rarely take place in a vacuum), the Hillsborough TPO also considered the factors listed above based on two disasters happening concurrently. The Hillsborough TPO ultimately selected the three individual disasters and two different combinations of the individual disasters as shown in **Figure 3.1**. The disasters included cyber attack, transportation incident (such as a major roadway accident), flooding/wind event, cyber attack and transportation incident, and cyber attack and flooding/wind event. Based on consultation with the Hillsborough TPO and availability of data, the following climate change factors were also identified for analysis within the study: 10-year inundation event and 25-year inundation event pertaining to sea level rise and nine inches of rainfall in 24 hours.

Figure 3.1 Disasters Selected for Further Study



3.1.2 Creation of Disaster Scenarios

Once the types of disasters to be studied were determined, specific scenarios were created for each disaster and the concurrent disasters. Available data (specifically modeling data), case studies (narrowed down from the full list in Appendix B based on relevancy to Hillsborough County), and emergency management/disaster recovery project team expertise helped shape each scenario. The disaster scenarios were designed to examine supply chains under severe conditions. While these scenarios are unlikely to take place, they could result in major disruptions to supply chains and impacts to Hillsborough County communities. The inputs consulted for each disaster type to create a scenario applicable to Hillsborough County are as follows:

Cyber Attack: Case Studies

Colonial Pipeline Ransomware/ Cyber Attack	In early May of 2021, a cyber attack on a pipeline system carrying gasoline and jet fuel to the southeastern United States shut down operations and impacted supply chains across the region. Colonial Pipeline supplies up to 45% of all fuel consumed on the East Coast. The attack targeted the billing infrastructure of the company, and

	although the pumping capacity of the pipeline was not impacted, there was fear that further attacks on vulnerable infrastructure would be carried out. The attack resulted in fuel shortages and regional emergency declarations in 17 states and Washington, D.C. The pipeline was restarted after $4.4 million worth of bitcoin was paid to release the ransomware.
Oldsmar Water System Attack	On February 5, 2021, hackers accessed the computer network of a drinking water system in Oldsmar, Pinellas County. Within three to five minutes, the level of sodium hydroxide going into the water for treatment was changed from 100 parts per million to 11,100 parts per million. According to the Centers for Disease Control, sodium hydroxide can cause vomiting, chest and abdominal pain, skin burns, and hair loss consumed in large quantities. A technician noticed the change five hours later, reversed the command, and disabled the software without any of the tainted water reaching consumers.
NotPetya Attack	In 2017, the NotPetya attack began as a Russian attack on Ukraine but quickly took down hundreds of other companies in collateral. One of these companies was Merck, one of the world's largest pharmaceutical companies. This attack made 30,000 computers across sales, manufacturing, and research units inaccessible. There was nothing to be done by the company for two weeks which resulted in $870 million worth in damages and $410 million in lost sales. It disrupted the production of the HPV vaccine, Gardasil, to the point that the company had to use the entire U.S. government's emergency supply.
Expeditors Attack	In February of 2022, Expeditors was forced to shut down global operating systems leaving them with limited functionality due to a ransomware attack. Expeditors has over 300 locations globally and ranks as one of the world's largest logistics companies. Significant expenses were generated to maintain services and investigate the attack. While the systems were down, the company could not book any new shipments, track where existing cargo was, or make it through customs at ports around the world.

Transportation Incident: Case Studies

Atlanta I-85 Fire and Viaduct Collapse	On March 30, 2017, construction materials stored under an Interstate 85 (I-85) overpass in Atlanta, Georgia were set on fire. This caused a 92-foot-long elevated span of I-85 to collapse. No one was injured. The $15 million replacement project required 43 days to complete. No trucks could travel in or out of companies closest to that section of interstate.
Howard Street Tunnel Fire (CSX)	A 60-car CSX freight train derailed in a tunnel in Baltimore, Maryland on July 18, 2001. A resulting chemical fire burned for five or six days, damaged a water main that caused street-level flooding, disrupted passenger rail traffic on the Amtrak Northeast Corridor and Maryland Area Regional Commuter (MARC) lines, and slowed internet service

	throughout the U.S. due to the destruction of a cable passing through the tunnel. The accident caused displacement from offices, severe traffic disruptions in Baltimore, and major impacts on freight rail traffic. At the time, the tunnel was the only direct freight rail link between Washington, D.C. and New York City, handling between 28 to 32 trains a day. The alternative route required trains traveling from Washington, D.C. to Baltimore to detour through Cleveland, Albany, and New York City. Rail traffic was restarted in the tunnel after six days.
Lac-Mégantic Disaster	The Lac-Mégantic rail disaster occurred in the town of Lac-Mégantic, Quebec, Canada on July 6, 2013 at approximately 1:15 AM. An unattended 73-car Montreal, Maine, and Atlantic Railway (MMA) freight train carrying Bakken Formation crude oil rolled down a 1.2% grade in Nantes and derailed in downtown, resulting in the explosion of multiple tank cars. Forty-seven people were killed, and more than thirty buildings were destroyed. All but three of the thirty-nine remaining buildings in the downtown area had to be later demolished due to petroleum contamination of the townsite. Initial newspaper reports described a 1 kilometer (0.6-mile) blast radius.

Flooding/Wind Event: Models and Case Studies

Models

Results from two hurricane models informed the flooding/wind event scenario.

A HAZUS model (a standardized risk modeling tool, developed and managed by the Federal Emergency Management Agency, which identifies areas with high risk for natural hazards and estimates physical, economic, and social impacts of hurricanes, floods, earthquakes, and tsunamis) was first used to understand the probability of direct impacts from a hurricane making direct landfall in downtown Tampa. The inputs and intensity for the model run were derived from the 1921 Tarpon Springs Category 3 hurricane, the last major hurricane to make direct landfall in Hillsborough County. However, the hurricane track for the model run was shifted to the south to increase the likelihood and magnitude of direct impacts to critical supply chain facilities (i.e., Port Tampa Bay, CSX railroad tracks, Tampa International Airport, etc.). The results revealed the various wind speeds/ intensities that would be experienced by the area as well as percentages of buildings (including residences, businesses, fire stations, police stations, emergency operation facilities, hospitals, schools, shelters, etc.) that would be damaged with estimated severity in damages, estimated tonnage of debris generated, estimated displaced households, and estimated economic losses within Hillsborough County.

Data from Project Phoenix (a simulation and table top exercise, developed by the Tampa Bay Regional Planning Council (TBRPC), which uses both the HAZUS model and the Sea Lake and Overland Surges from Hurricanes (SLOSH) model) was also consulted. The SLOSH model was created by the National Weather Service to estimate storm surge heights, accounting for the atmospheric pressure, size, forward speed, and track data of historical, hypothetical, or predicted hurricanes. The scenario that was created through the combined use of these two models was a Category 5 hurricane making landfall in the

Tampa Bay area, bringing significant wind and inundation damage to the City of Tampa and Hillsborough County as a whole.

Case Studies

Hurricane Michael	Hurricane Michael made landfall on October 10, 2018, as a Category 5 hurricane near Mexico Beach and Tyndall Air Force Base, Florida. The storm produced wind speeds of 155 miles per hour at landfall and storm surge of nearly 15 feet at places along the Florida panhandle. Hurricane Michael was directly responsible for 16 fatalities and $25 billion in damages.
Hurricane Maria	Hurricane Maria struck Puerto Rico as a powerful Category 4 hurricane on September 20, 2017, just two weeks after Hurricane Irma. Puerto Rico was devastated by winds and floods. Hurricane Maria knocked down 80 percent of Puerto Rico's utility poles and all transmission lines, resulting in the loss of power to essentially all of the island's 3.4 million residents. In addition, practically all cell phone service was lost and municipal water supplies were severely disrupted. The total damage came to approximately $90 billion, making it the third costliest hurricane in United States history.
Hurricane Irma	Hurricane Irma made a total of seven landfalls, two of which impacted the United States on September 10, 2017, first as a Category 4 hurricane in the Florida Keys and then as a Category 3 hurricane in southwestern Florida. Due to Hurricane Irma's shifting projected path from the east coast to the west coast of Florida, 6.5 million people evacuated, making it the largest hurricane evacuation in the State of Florida's history. Significant traffic congestion and fuel shortages resulted from this historic evacuation effort.
Hurricane Harvey	Hurricane Harvey made landfall in the middle of the coast of Texas as a Category 4 hurricane on August 26, 2017. The storm remained stationary over the Houston area for four days (August 26 – 29, 2017), causing historic flooding. The storm inundated the Houston metro region, dumping more than 60 inches of rain in some areas and displacing more than 30,000 people.
Superstorm Sandy	Making landfall as a post-tropical cyclone on October 29, 2012, Sandy caused catastrophic storm surge along the New York and New Jersey coastlines. "Superstorm Sandy" resulted in 147 direct deaths in the Atlantic Basin, 72 fatalities occurring within the northeastern states, and nearly $50 billion dollars in damages. Over 650,000 homes in the New York/New Jersey area were damaged or destroyed, and saltwater inundation caused major damage to transportation infrastructure (including tunnels, railcars, and communications equipment).
Hurricane Katrina	Hurricane Katrina, after making landfall as a Category 1 hurricane north of Miami in Florida, rapidly intensified to a Category 5 hurricane and made landfall again along the Gulf Coast as a strong Category 3 hurricane at the Louisiana/Mississippi border on August 29, 2005. With estimated storm surge of 24 to 28 feet along 20 miles of the Gulf

	Coast, the natural factors combined with a lack of adequate maintenance and preparation resulted in widespread flooding (about 80% of the City of New Orleans was under flood waters). The storm caused more than 1,800 deaths and $125 billion in damages.

Considering the model results/data, case studies, and project team expertise, a write-up was prepared for each disaster scenario to help flush out details. Each write-up contained the following parameters to help shape the event: narrative of the event; duration of the event; scope of the event (localized, regional, or widespread); severity level of impacts as a result of the event (minimal, moderate, or severe); initial/preliminary impacts on supply chains, the environment, and society as a result of the event; duration to fix operations/logistics of supply chains to perform at a basic/bare minimum level during/after the event; duration to fix operations/logistics of supply chains to perform at a normal (pre-disaster) level; and casualty potential as a result of the event. The write-ups of each disaster scenario may be found in **Appendix E**.

The disasters/disaster scenarios were presented to and vetted with public agency and private industry stakeholders and community based organizations before the study analysis was performed.

3.2 Results

In the months of April and May 2022, six small group stakeholder interviews and meetings with two community organizations took place. For more detailed information regarding these meetings, please refer to the Freight Supply Chain Resilience Study: Stakeholder and Community Engagement Summary prepared under separate cover. During these various meetings, participants were asked to provide input on the proposed disaster types as well as to share thoughts on any additional disasters to be studied. No additional disasters were identified by the groups; all unanimously concurred with the three individual disasters and two combinations of concurrent disasters that were identified for further study.

Brief narratives of the specific scenarios created for the three individual disasters and two concurrent disasters are presented below:

Cyber Attack	A Supervisory Control and Data Acquisition (SCADA) system of the Tampa Electric network has been infiltrated and compromised by malware, disabling operators from making necessary commands and creating subsequent blackouts. A SCADA system is responsible for gathering data from various substations and processing it. The system is used to monitor energy usage, telecommunications, and several other elements of the electric grid. The hackers installed malware into devices used to communicate with Tampa Electric substations and remotely opened substation circuit breakers, gaining access to all 79 network substations and taking them offline.
Transportation Incident	A tanker truck heading eastbound on I-4 at 3:00 PM mid-week collides with the median supports of the southbound I-75 overpass. The tanker truck immediately catches on fire. The impacted overpass

	supports weaken due to both the collision and vehicle fire, causing the southbound I-75 bridge (or overpass) to collapse. This incident results in traffic coming to a standstill at the I-4/I-75 interchange as the mainlines are blocked on southbound I-75 and on I-4 in both directions.
Flooding/Wind Event	Category 5 Hurricane Chaos makes landfall in Downtown Tampa lasting 24 hours.
Cyber Attack & Transportation Incident	A SCADA system of the Tampa Electric network has been infiltrated and compromised by malware, disabling operators from making necessary commands and creating subsequent blackouts. The hackers installed malware into devices used to communicate with Tampa Electric substations and remotely opened substation circuit breakers, gaining access to all 79 network substations and taking them offline. During this disruption, a tanker truck heading eastbound on I-4 collides with the median supports of the southbound I-75 overpass. The tanker truck immediately catches on fire. The impacted overpass supports weaken due to both the collision and vehicle fire, causing the southbound I-75 bridge (or overpass) to collapse. This incident results in traffic coming to a standstill at the I-4/I-75 interchange as the mainlines are blocked on southbound I-75 and on I-4 in both directions.
Cyber Attack & Flooding/Wind Event	Category 5 Hurricane Chaos, originally forecasted to hit the Florida Panhandle, wobbles and unexpectedly heads towards Tampa Bay. The hurricane is now expected to directly hit Downtown Tampa in approximately 24 hours. Concurrently with the change in forecasted hurricane track, a SCADA system of the Tampa Electric network has been infiltrated and compromised by malware, disabling operators from making necessary commands and creating subsequent blackouts. The cyber attack severely complicates communications, hinders information dissemination about the hurricane, and obstructs evacuation efforts. 24 hours after the attack (when Hurricane Chaos makes landfall) residents, businesses, and government agencies are not prepared for the catastrophic devastation.

Details of each disaster scenario may be found in Appendix E. The disaster scenarios and disaster scenario combinations informed the next phase of the study in determining vulnerabilities of the five Hillsborough County commodity supply chains identified within Section 2.0.

4.0 Commodity/Service Flow

This section presents the approach that was used to develop supply chain maps for the five commodities identified within Section 2.0.

4.1 Methodology

A supply chain map is a tool used to convey how a consumer good flows starting from raw materials/manufacturing through to the final delivery of the good to the end customer. It includes the nodes (points where the good may be stored, refined, or processed), the links (how the good is moved by transportation modes), and the various supplier tiers (envision a pyramid-like structure in which the end producer is on the top at level one (Tier 1) and producers closer to the raw materials are at bottom levels (Tier 2, Tier 3, Tier X…)). Supply chain maps are not geospatial maps; they function more like process flow diagrams depicting the nodes, links, and tiers needed to make a commodity available to consumers.

For this study, each supply chain map was used to illustrate and establish a baseline of typical (non-disaster) flow patterns and supply chain conditions for making each of the five commodities (identified in Section 2.0) available within Hillsborough County and the Tampa Metropolitan Statistical Area (MSA). The five commodity supply chain maps were created based on a synthesis of multiple data sources as well as industry knowledge and project team expertise.

4.1.1 Data Sources

Data used to identify the nodes, links, and tiers for each supply chain map was obtained from the following three sources:

Economic Modeling Specialists International Data	Traditional economic development data (such as employment, industry purchase rates, and establishments per industry counts by county and/or MSA) was acquired from Economic Modeling Specialists International (EMSI) data. This data presented the scope and scale of establishments within Hillsborough County and the Tampa MSA.
Environmental Systems Research Institute, Inc. Data	Environmental Systems Research Institute, Inc. (ESRI) data provided businesses listings (such as company names) and related information (such as specific company locations).
Freight Analysis Framework Information	The Bureau of Transportation Statistics (BTS) Freight Analysis Framework (FAF) information identified the inflow and outflow of goods for the region, indicating which commodities had more of the manufacturing or sourcing portions completed within the region and which had more involvement with goods imported from other regions. The FAF information also identified what other metro areas were integral to the production and transportation of the five commodities.

4.1.2 Application of Data Sources

Each of the noted data sources provides different attributes of existing supply chains within the region. This section describes how the sources were used for the development of the supply chain maps.

Economic Modeling Specialists International Data

Employment, Gross Regional Product (GRP) [value add/Gross Domestic Product (GDP)], and establishment information was used to identify the relative size of industries within Hillsborough County and the region (the Tampa MSA). This information was paired with the industry purchase matrix provided through EMSI to determine industry purchases from within Hillsborough County and outside of Hillsborough County (within the Tampa MSA), as well as the United States Bureau of Economic Analysis production relationships between industries and commodities. As such, specific commodity production/use was identified for area industries. In addition, the mix of purchases for transportation industries was compared to identify the relative importance of the purchases and, ultimately, modal split for resource/commodity transport. For example, data revealed that freight rail accounts for approximately 24 percent of transportation purchases pertaining to animal production and crop production while truck transportation accounts for approximately 60 percent.

Environmental Systems Research Institute, Inc. Data

The ESRI data augmented the EMSI data regarding scope and scale of establishments within Hillsborough County and the Tampa MSA by adding more specific information, including company names, specific locations, and other important pieces of data to the picture for both reference and analysis.

Freight Analysis Framework Information

FAF information helped to identify inbound and outbound tonnage/monetary value by FAF Zone (a geography level similar to the Tampa MSA) as well as the modal split of tonnage (inbound and outbound) for each FAF Zone. This allowed for the tracing of commodity flows from other MSAs to Tampa at a very specific geographical level.

Since the FAF flow analysis figures were based on non-consumer purchases, the data not only contributed to understanding how the commodities moved to consumers but how the goods flowed from producers on lower supply chain tiers. This information also provided insight on how the commodities flowed from node to node as well as how the commodities were transported by different modes and, to some extent, the routes taken from location to location.

A limitation to using the FAF data was that there was often less visibility in tracking the commodities (as they involve a combination of many components) through multiple modes (since tonnage is based on origin and destination points only) and between multiple geographies (due to the presence of wholesale and distribution firms). While the FAF information was more focused on the flow of goods to nodes prior to retail and distribution, the consumption point was noted and included where the information was available.

4.1.3 Creation of Supply Chain Maps

For each of the five selected commodities, the FAF flow analysis information identified a number of subcomponents which compose the larger commodity, either as elements of the larger whole or as processes to reach a final finished product. Subcomponents that

were more relevant to community recovery efforts (based on effects of the disaster scenarios/scenario combinations outlined in Section 3.0) were analyzed further to understand the materials, processes, geographies, and transportation modes involved with brining these subcomponents into the Hillsborough County area. For example, to create the supply chain map for the fuel commodity, several different aspects of fuel production were analyzed, including the drilling of crude petroleum, refining of petrol products, and delivery of fuel products via pipeline and other modes of transportation. Post-production distribution activities, such as wholesale and retailing of fuel, were also assessed. The holistic approach attempted to provide insight into specific bottlenecks in the supply chain that could surface as a result of a disaster. The data and information gathered that identified the nodes, links, and tiers for the specified subcomponents of the commodity supply chain were then assembled and arranged into a supply chain map diagram. The five commodity supply chain maps that were created are showcased in **Appendix F**.

4.2 Results

The outcomes and learnings from developing the five commodity supply chain maps were presented to the relevant public agency and private industry stakeholders during one-on-one interviews that were conducted to gather additional insight into specific commodity flows; weaknesses in supply chain flows that could lead to supply chain disruptions during a disaster event; and any current preparations, trainings, or actions established by their respective company/agency to mitigate potential disaster disruptions/impacts to supply chain flows.

The supply chain maps resulted in observations pertaining to supply chain patterns, including proportions of imported versus locally produced resources as well as modal differences between the varying types of commodities. Each supply chain map established a baseline for normal (non-disaster) supply chain flows relevant to each commodity. This was important to understand for later examination/comparison of potential disaster scenario disruptions to each commodity supply chain as described within Section 5.0. The observations that were noted during this step of the study will inform the next step of the analysis. A selection of supply chain flow pattern observations are presented below, by commodity, to illustrate the type of information that can be ascertained through analysis and review of the developed maps:

<u>Food/Groceries</u>

- 58 percent of food/grocery input purchases are procured inside of the Tampa MSA; most of this comes from raw material and food processing where 59 percent and 76 percent of the purchases, respectively, are procured outside of the Tampa MSA.

- The largest retail establishments are Publix, Walmart, and 7 Eleven; large processors/manufacturers are also noted.

- 77 percent of transportation purchases come from truck and another 18 percent come from rail, with the rest being water or air (but proportions are much smaller). The mode share of rail is generally higher towards the base commodity and decreases closer to final distribution and consumption.

Water & Wastewater Utilities

- Water utility purchases are mostly from within the Tampa MSA; however, the wastewater industry is more split (about 45 percent of wastewater service purchases are from outside of the Tampa MSA) and the monetary values of wastewater utilities are much smaller than non-wastewater utilities.

- Transportation purchases are heavily skewed towards truck.

Housing Material

- Construction materials feature a slightly higher share of inputs that are procured locally; although, the share of purchases made within the Tampa MSA reduces toward base commodity (indicating that many of the raw materials are imported to the region). A total of 45 percent of all purchases from this commodity cluster are procured outside of the Tampa MSA; however, the import share spikes to approximately 65 percent for basic materials and manufacturing purchases (for example, more of the purchases from shingle makers and sawmills come from outside of the Tampa MSA). For wholesale activities, only 27 percent is procured outside of the Tampa MSA so there appears to be significant local distribution.

- Home Depot and Lowe's are by far the largest players on the construction retail side along with Sherwin Williams and BMP USA. In terms of raw material producers, Vulcan Materials has at least one fairly big site in the Tampa MSA.

- Most of the purchases originate from truck transportation (68 percent), but 26 percent of the purchases come from rail and 3 percent come from water.

Urgent Healthcare Services & Medicine

- 74 percent of pharmaceutical manufacturing purchases in the Tampa MSA originate from outside of the Tampa MSA, higher than most other categories. Although there are distributors and services that are in Hillsborough County, medical equipment and drugs do not have a lot of local production inside the Tampa MSA (relative to need).

- The largest establishments (outside of hospitals/offices/pharmacies – of which Walgreens and CVS are the main players) are West Pharmaceutical Services (a drug packaging firm which has a large sales volume) and CoreRX (a firm that manufactures a number of pharmaceuticals within the Tampa MSA).

- Transportation modes pertaining to this commodity consist primarily of truck with some rail and water. However, as is the case in many other geographies, a large proportion of purchases for healthcare materials come from air transportation services when compared to other commodities/services.

Fuel Distribution Systems

- The Tampa MSA is highly dependent on purchases from refineries outside of the region. As of 2021, 99 percent of petroleum refinery purchases originated from

outside of the Tampa MSA. As of 2021, there were 3 petroleum refinery establishments within the Tampa MSA.

- The largest refinery by sales is Delek US (a national or multi-state refiner).

The largest volume of transportation purchases, pertaining to pre-storage and blending, come from pipeline (58 percent); the remainder come from truck (36 percent) and then rail.

5.0 Supply Chain Resiliency Analysis

This section presents the approach that was used to assess and determine potential impacts/vulnerabilities/disruptions to the five commodity supply chains (identified within Section 2.0) under the different disaster scenarios outlined within Section 3.0. Based on this analysis, this section additionally presents study findings and the recommended actions that were derived to mitigate the disaster impacts and strengthen the resilience of the commodity supply chains, including the communities that they serve.

5.1 Methodology

The study analysis was based heavily on a range of inputs/factors (such as data and stakeholder input) and the application of the created disaster scenarios.

5.1.1 Inputs/Factors

A number of inputs/factors were used to analyze, understand, and identify the potential impacts of each disaster scenario and disaster scenario combination on the five commodity supply chains. These inputs/factors included:

- Commodity supply chain maps
- Geographic Information System data,
- HAZUS and Project Phoenix model results,
- Climate change factors,
- Case studies,
- Stakeholder and community input, and
- Project team expertise.

The inputs/factors listed above were utilized and applied at varying levels based on the commodity supply chain and disaster scenario being assessed. For example, inputs/factors such as case studies, project team expertise, and stakeholder input were favored for the identification of potential impacts pertaining to a cyber attack as impacts of this type of disaster are more difficult to forecast and quantify than potential impacts of a hurricane, which can be forecasted more easily (such as predicting wind damage and storm surge/inundation through a model).

The different inputs/factors are described in more detail in the following subsections.

5.1.1.1 Commodity Supply Chain Maps

The supply chain maps created for the five selected commodities (as discussed in Section 2.0) were first consulted as they establish a baseline of typical (non-disaster) flow patterns and supply chain conditions for each commodity. Understanding the normal flow patterns formed the basis for deducing how the different disaster events would impact the imported and domestically produced elements, including the possible vulnerabilities, of each supply chain.

As described within Section 2.0, a supply chain map depicts how a consumer good flows starting from raw materials/manufacturing through to the final delivery of the good to a retail store or to a customer. It includes the nodes (points where the good may be stored, refined, or processed) and the links (how the good is moved by transportation modes). Ultimately, each commodity supply chain map shows the nodes and transportation modes used to make the commodity available within Hillsborough County and the Tampa Metropolitan Statistical Area (MSA), including proportions of imported versus locally produced resources pertaining to the commodity.

5.1.1.2 Geographic Information System Data

The supply chains for all five commodities that were examined as part of this study are extremely dependent on transportation and utility infrastructure within Hillsborough County and the surrounding area. Therefore, it was important to understand the geographic distribution and concentration of this infrastructure as it would help to inform potential disaster event impacts on the five commodity supply chains from a transportation network perspective and geographic standpoint.

Multiple Geographic Information System (GIS) layers were obtained to depict locations of transportation facilities (such as roadways, railways, airports, etc.) and critical facilities/infrastructure pertaining to the five commodity supply chains and seven supply chain enablers as discussed within Section 2.0 (such as hospitals, public water supply plants, electric substations, wireless antenna structures, concentrations of vulnerable populations, etc.). For each of the GIS layers, a score was assigned (1 = high priority, 2 = medium priority, and 3 = low priority) based on the contribution of the facility to one of the five commodity supply chains, the facility's role in response/recovery efforts, and the facility's geographic extent. For some of the GIS layers that encompassed a range of facility types or sizes, scores were assigned within the layers themselves based on a specific attribute. For example, public water supply plants were broken out by population served. Those facilities serving a population over 20,000 were assigned a score of 1, those serving populations ranging in size from 1,000 – 20,000 were assigned a score of 2, and those serving a population less than 1,000 were assigned a score of 3.

The scored facilities were then mapped to depict concentrations of critical infrastructure (particularly clusters of high priority facilities).

Appendix G contains the full list of GIS layers that were scored and mapped. The supporting maps that were developed for the analysis (as referenced within this subsection and subsections 5.1.1.3 and 5.1.1.4) may be found in **Appendix H**.

5.1.1.3 HAZUS and Project Phoenix Model Results

As explained within Section 3.0, results from two hurricane models informed the flooding/wind event disaster scenario and combined cyber attack and flooding/wind event disaster scenario. The two models included a Federal Emergency Management Agency HAZUS model and the Tampa Bay Regional Planning Council Project Phoenix model. The HAZUS model simulated a Category 3 hurricane making direct landfall in downtown Tampa (based on the 1921 Tarpon Springs Category 3 hurricane). The Project Phoenix model simulated a Category 5 hurricane making landfall in the Tampa Bay area.

The wind speeds/intensities GIS layer derived from the HAZUS model and the inundation/storm surge GIS layer derived from the Project Phoenix model were superimposed on the critical supply chain facilities and infrastructure discussed under Section 5.1.1.2. Other GIS data layers (such as debris, building damage, etc.) and the report generated from HAZUS (indicating percentages of buildings that would be damaged with estimated severity in damages, estimated tonnage of debris generated, estimated displaced households, etc.) as well as material developed as part of the Project Phoenix simulation/tabletop exercise were additionally consulted and reviewed in comparison to the supply chain maps and critical supply chain facilities and infrastructure.

5.1.1.4 Climate Change Factors

In order to understand compounding impacts to critical supply chain facilities as a result of climate change (with and without a disaster event), GIS layers for the following climate change factors (obtained from and created by the Hillsborough TPO) were also overlaid on the mapped supply chain facilities and infrastructure: 10-Year and 25-Year inundation events within the next 20 years (2040) pertaining to sea level rise and nine inches of rainfall in 24 hours.

5.1.1.5 Case Studies

The case studies (as presented in Appendix C) were reviewed more thoroughly as part the study analysis and through the lens of impacts not only to the critical supply chain facilities but to supply chain enablers (as defined in Section 2.0). Out of the 31 case studies reviewed, 11 were weather events, 8 were transportation incidents, and 12 were cyber attacks. Articles related to the three disaster types were additionally reviewed to provide further context/understanding of potential disaster impacts on supply chains.

The findings from the case studies were extrapolated to determine specific impacts of each hypothetical disaster to the supply chain enablers under each commodity. A matrix was created (discussed in Section 5.1.2) to document the potential supply chain effects/vulnerabilities. The outputs of the matrix were additionally used to examine where the impacts of the disaster scenarios would overlap with elements of the supply chain maps and critical facilities and infrastructure.

5.1.1.6 Stakeholder and Community Input

The project team also relied on stakeholder input to better determine possible impacts of each disaster scenario/scenario combination on the five different commodity supply chains and their supporting elements and facilities. During the various group and one-on-

one interviews, stakeholders expanded on preparations or trainings their respective company/agency had established or ways their organization would react to disaster events and potential subsequent impacts. The stakeholders, along with citizens who participated in sessions held as part of this study, relayed personal experiences, challenges, and lessons learned in reacting to/preparing for disaster events, specifically regarding access to essential goods before, during, and after disasters. This input helped to define realistic effects as well as identify weaknesses in supply chain flows (such as lack of substitute resources or redundant infrastructure) that could lead to supply chain disruptions during a disaster event. In many instances, stakeholders and community members directly identified vulnerabilities and gaps that need to be addressed within supply chains (such as reliance on electric power to distribute alternative fuels) and best practices to incorporate within the study recommendations (such as having a point of contact located outside of a potential disaster area to maintain operational continuity).

5.1.1.7 Project Team Expertise

By drawing on years of experience in the realms of supply chains, resilience, and emergency management and response, the project team was able to fill in gaps where possible disaster impacts to areas of the commodity supply chains were less defined. The project team offered direct, practical input and lessons learned that contributed to a holistic understanding of potential commodity supply chain impacts/vulnerabilities/ disruptions and how to mitigate potential disaster effects.

5.1.2 Application of Disaster Scenarios

The five commodity supply chains were analyzed under the different disaster scenarios in two stages.

The first stage of the analysis involved (1) identifying potential impacts of the three individual disaster scenarios and two combinations of concurrent disaster scenarios (as described within Section 3.0) through assessment of the inputs/factors presented above and (2) documenting the findings in a matrix pertaining to each of the five commodities. The five disaster scenarios populated the rows and the seven supply chain enablers (as described in Section 2.0) populated the columns of each matrix. As such, the five individual matrices displayed how each supply chain enabler would be impacted by each disaster scenario as related to a single commodity.

Based on the recorded impacts, levels of severity and scope/geographic scale (in terms of impact) were assigned to each supply chain enabler for each particular disaster scenario as specific to the assessed commodity supply chain. The levels of severity included low, moderate, and severe, with intermediate designations between each option. The levels of scope or geographic scale included widespread, regional, and local (listed in order from largest to smallest extent). These designations helped to focus the study recommendations to address more severe and/or widespread level impacts to supply chain enablers.

As presented through the matrices, a comprehensive analysis was performed resulting in the identification of potential disaster impacts on supply chain enablers as related to the five selected commodities. The completed matrices may be found in **Appendix I**. A few representative points from each commodity based matrix are presented below.

Food/Groceries

Example 1:

Disaster Scenario: Flooding/Wind Event

Supply Chain Enabler: Utilities

Severity: Severe

Scope: Widespread

Impact: Stores are prohibited from selling frozen goods that have been without refrigeration after 4 hours based on the FDA USDA. This food has to be cleared. Lack of electricity means perishable grocery items in stores and in storage will spoil when the generator capacity is exceeded.

Example 2:

Disaster Scenario: Cyber Attack + Flooding/Wind Event

Supply Chain Enabler: Transportation

Severity: Severe

Scope: Widespread

Impact: All port areas fully out of service for 5 days – longer for some elements; reduced depth in the shipping channels to port areas. The weather event would have created roadway blockages preventing alternative goods from reaching their destination.

Water and Wastewater Utilities

Example 1:

Disaster Scenario: Flooding/Wind Event

Supply Chain Enabler: Vulnerable Populations/Neighborhoods

Severity: Severe

Scope: Regional

Impact: Would create water accessibility issues as the infrastructure is destroyed. Portions of vulnerable communities would not have transportation options available to access clean drinking water outside of the impacted areas.

Example 2:

Disaster Scenario: Cyber Attack

Supply Chain Enabler: Utilities

Severity: Severe

Scope: Regional

Impact: The electric grid failing would cause wastewater treatment plants to fail and water to no longer reach consumers. Fire-fighting infrastructure, that relies on the water system, will not be able to fight fires if pumping is needed.

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Housing Material

Example 1:	Example 2:
Disaster Scenario: Transportation Incident **Supply Chain Enabler:** Workforce **Severity:** Moderate **Scope:** Regional **Impact:** Housing material manufacturing, warehouse, and retail employees might have difficulty accessing their workplace and may face full closures around the I-4/I-75 interchange if dangerous materials are involved in the collision.	**Disaster Scenario:** Cyber Attack + Flooding/Wind Event **Supply Chain Enabler:** Communications **Severity:** Moderate **Scope:** Regional **Impact:** Difficulty in tracking shipments; inability to receive shipments. Would have to go through a full stock/restock effort. Sales platform requires internet access. Inability to access the load board or communicate about the shipment of a product. Rerouting deliveries around the transportation incident would become difficult or impossible without access to Google Maps or other WiFi and communications services.

Urgent Healthcare Services and Medicine

Example 1:	Example 2:
Disaster Scenario: Flooding/Wind Event **Supply Chain Enabler:** Vulnerable Populations/Neighborhoods **Severity:** Severe **Scope:** Regional **Impact:** Vulnerable populations/ neighborhoods are often found in lower areas, making flooding more likely during extreme weather events. This would create additional injuries and, with a lack of reliable transportation, make critical healthcare and medicinal services inaccessible.	**Disaster Scenario:** Cyber Attack **Supply Chain Enabler:** Workforce **Severity:** Severe **Scope:** Regional **Impact:** Healthcare services would need to rely on generators that can only sustain partial function (40%) for 96 hours, which would make the workplace difficult. Transportation difficulties accessing workplaces.

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Fuel Distribution Systems

Example 1:	Example 2:
Disaster Scenario: Wind/Flooding Event **Supply Chain Enabler:** Transportation **Severity:** Severe **Scope:** Widespread **Impact:** Fuel shortages would make transportation inaccessible. Central Florida Pipeline, which delivers fuel to Port Tampa Bay, had been damaged/is inoperable so fuel has to get trucked in; blocked roadways could make transporting fuel difficult. Event will worsen an existing shortage of truckers; some drivers will not risk getting a shipment into a disaster area. Ability to book trucking is impacted. Fuel deliveries would need to be rerouted in a few cases to avoid delivering to inoperable facilities due to damage-could create transportation delays.	**Disaster Scenario:** Cyber Attack + Transportation Incident **Supply Chain Enabler:** Financial Flows **Severity:** Moderate **Scope:** Regional Impact: Without cash, credit infrastructure could be down and prevent payments. Fuel stations without generators would not be able to pump without electricity, which could create a shortage. Could create a major financial loss.

In the second stage of the analysis, the most salient points from the matrices (i.e., the most important impacts of each disaster scenario that pertain to the supply chain of an individual commodity) were incorporated into the disaster scenario write-ups (found in Appendix E). This helped to narrow down and focus the impacts to be considered/addressed in the development of the study recommendations.

5.2 Results

This section presents the overall outcomes of the supply chain resiliency analysis that was performed as part of this study. A graphical depiction of the supply chain resiliency analysis approach may be found in **Appendix J**.

5.2.1 Observations/What Was Learned

A number of key observations/findings were revealed through the supply chain resiliency analysis, as presented below, that guided the development of the study recommendations:

- There is a link between climate change; Environmental, Social, and Corporate Governance (ESG) principles; and supply chain resilience – these factors create habitability and interoperable lifelines. By having a strong communication network in place along with equitable, resilient, and sustainable Hillsborough County communities that thrive under normal circumstances, the more resilient and better prepared Hillsborough County as a whole will be to withstand and recover from emergency situations.

- Many of the critical supply chain facilities are susceptible to inundation during storm events; climate change makes maintaining access to these facilities even more critical.
- There are clusters of critical freight facilities located throughout the county; these areas should be prioritized for resiliency solutions (e.g., redundant infrastructure, raised profiles, etc.). Improved access and redundant access to those facilities that currently have circuitous and/or limited access are essential, especially during an emergency.
- Hillsborough County has redundant transportation infrastructure overall; however, there are network gaps at critical facilities and backup facilities are not equipped to handle the demand of primary facilities.
- Pedestrian and bicycle safety is a major issue in many Environmental Justice communities that are bordering strategic freight facilities or freight heavy areas, such as the Port. While bicycle/pedestrian infrastructure and safety are extremely important in meeting community needs within all areas of Hillsborough County, these factors are especially important in EJ communities where these populations have a higher propensity to bike and/or walk to access essential services. It will be necessary to better define space and enhance safety for these roadway users. Solutions must balance freight needs, community needs, and resilience.
- Beyond hurricanes and weather-related events, other hazards (such as cyber attacks, transportation incidents, etc.) need to be considered universally in emergency planning by public agencies and private industries.
- Redundant infrastructure/facilities and resources, including having available and redundant resource substitutions, are critical in mitigating effects of a disaster.
- Having emergency staffing plans in place and cross training staff on use of equipment/operations are critical in sustaining supply chain operations and flows.

5.2.2 Recommendations

The final step of the supply chain resiliency analysis entailed developing actionable recommendations. The recommendations were based on the key observations/findings as discussed above (in Section 5.2.1) that stemmed from the consulted inputs/factors (as discussed in Section 5.1.1), which contributed to the disaster scenario descriptions and identification of impacts as recorded within the five commodity-based matrices (discussed in Section 5.1.2).

The recommendations propose measures to:

- Address vulnerabilities of critical facilities and infrastructure relevant to the five commodity supply chains to help mitigate potential impacts/disruptions to these supply chains,
- Address ways to help the supply chains recover under various disaster scenarios, and
- Build the resilience of the supply chains in the long term along with the communities that they support to sustain safety and essential lifelines.

The recommendations are intended to be implemented in partnership with Hillsborough County supply chain actors, stakeholders, and communities to ensure neighborhood context, roadway safety/Vision Zero initiatives, and quality of life goals are integrated and upheld.

The study resulted in 81 actionable recommendations categorized by (1) action type and (2) role the Hillsborough TPO is to serve in executing the recommended actions. The recommendations were categorized into the following five action types to better prioritize and increase the understanding and organization of the proposed actions: **Transportation, Study/Guide/Research, Coordination, Training/Tool/Education, and Grant Opportunity**. The three different roles defined for the Hillsborough TPO as part of this study, include:

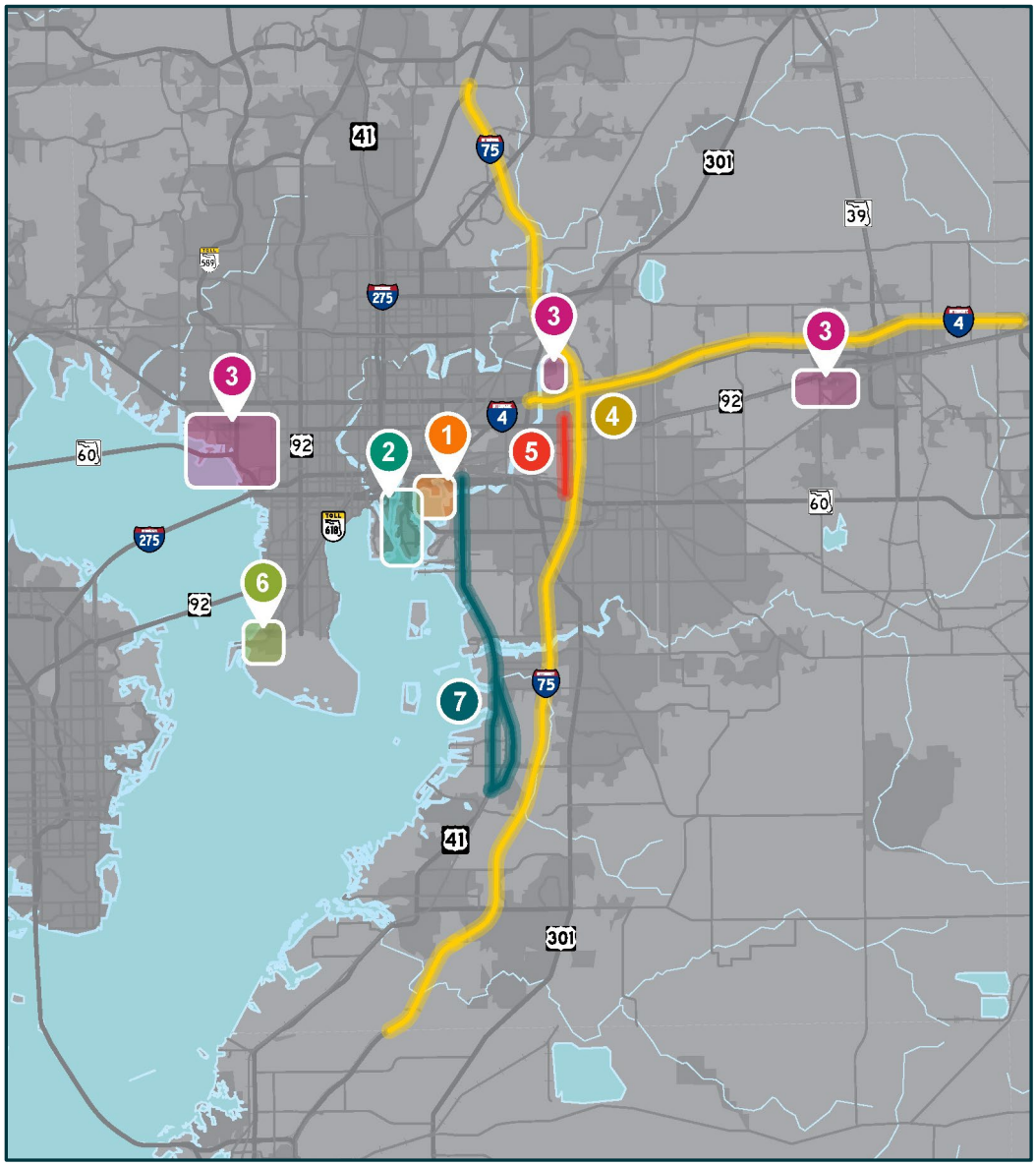
> Leader: TPO to serve as the leader in the implementation or advancement of the recommended action. The identified recommended action is aligned with a core function(s) of the TPO as an organization.
>
> Collaborator: TPO to collaborate with other agencies, stakeholders, non-profit organizations, etc. to actively implement or advance the recommended action by contributing knowledge, insights, and expertise of the transportation planning process and understanding of federal, state, local, and community-based programs.
>
> Facilitator: TPO to help coordinate and connect specific contacts and entities with each other in order to facilitate the advancement of the recommended action.

The full list of recommended actions may be found in **Appendix K**.

Some of the specific recommendations that are classified as Transportation and oriented to the Hillsborough TPO serving in the Leader role to advance the proposed actions are presented below. The recommendations consist of a series of studies to be performed that will identify opportunities to enhance access to Port Tampa Bay facilities as well as throughput of freight on the interstate system (for instance). However, community need will be at the forefront of all studies. The recommendations of this study and suggested example improvements are intended to balance bicycle/pedestrian safety, freight access, and resiliency. For example, mountable curbs and bicycle/pedestrian infrastructure within freight areas mean that safety is not sacrificed to allow freight vehicles critical access. In addition, improvements such as smart loading zones can help prevent freight vehicles from blocking sidewalks, bicycle lanes, and/or traffic. Activated stormwater infrastructure (such as the Lucy Dell Community Pond in Hillsborough County) can improve resiliency while giving the community increased recreational resources and open space. Finally, improved stormwater facilities, raised roadway profiles, and strengthened/enlarged bridges and culverts will not only help maintain access to critical supply chain facilities but will also address flooding in neighboring residential areas.

Figure 5.1 displays the locations of these noted recommendations.

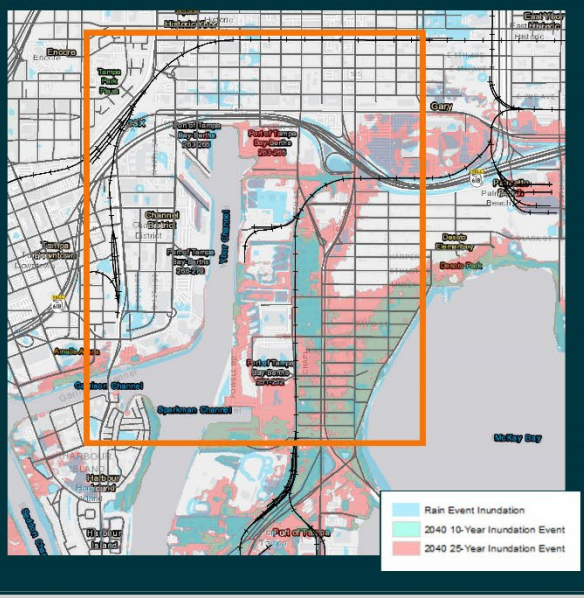
Figure 5.1 Locations of Transportation Categorized Recommendations



1. Ybor Channel Complete Street/Freight Access/Resilience Study
2. Hooker's Point Road/Rail Access Resilience Study
3. Hillsborough County Airports Access Study
4. Study Managed Lanes Infrastructure/ Policies to Enhance Access to Port
5. Falkenburg Road County Facility Access Resiliency Study
6. Port Tampa Bay Road/Rail Access Resilience Study
7. US 41 Corridor Road/Rail Access Resilience Study

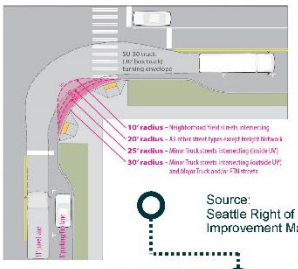
1 Ybor Channel Complete Street/Freight Access/Resilience Study

- **Conduct a combined complete street/freight access/resilience study for the Ybor Channel Area** (Channelside Drive, Southern Ybor City, Palmetto Beach, etc.) **to identify infrastructure improvements that address freight traffic in a pedestrian-centered neighborhood that includes areas susceptible to rainfall and sea-level rise inundation** [T-4]
  - Example improvements: truck aprons, mountable infrastructure, improved stormwater facilities, activated stormwater infrastructure, etc.



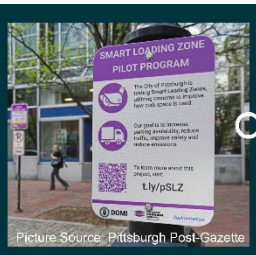
Joint Ped & Truck Infrastructure

Separate Bike/Ped Infrastructure



Source:
Seattle Right of Way Improvement Manual

Appropriate Radii

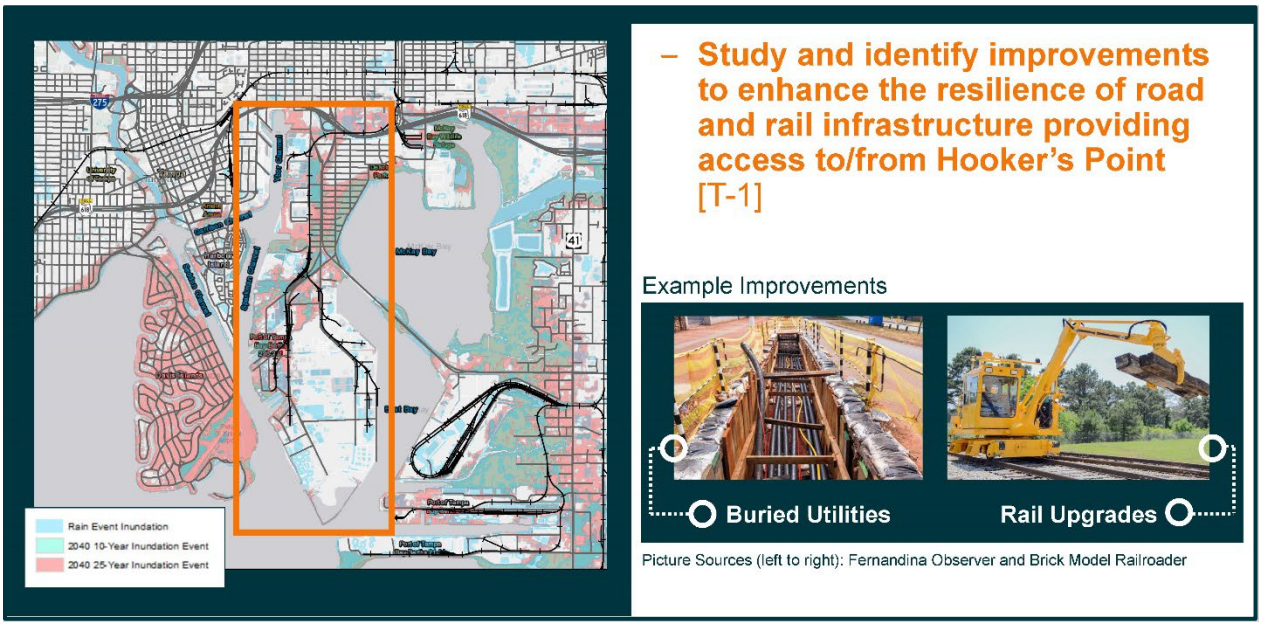


Smart Loading Zones

Stormwater Parks

With development along Water Street in Tampa and the ongoing revitalization of Ybor City, it will be important to balance increased pedestrian activity with the critical freight activity of the Ybor Channel Area. A study should be conducted to identify infrastructure improvements that address the presence of freight traffic in pedestrian-centered neighborhoods that are susceptible to rainfall and sea-level rise inundation. Potential improvements to be explored include joint pedestrian and truck infrastructure, separated bicycle/pedestrian infrastructure, appropriate radii for trucks, smart loading zones, and stormwater parks.

2 Hooker's Point Road/Rail Access Resilience Study



Given that this area houses critical facilities of Hillsborough County (port facilities and a wastewater treatment plant) and critical elements of supply chains, is vulnerable to inundation, and has limited road and rail infrastructure, improvements could include enhancing the existing road and rail infrastructure and identifying opportunities to create infrastructure redundancies (such as redundant railroad tracks). A study would be conducted to determine specific improvements.

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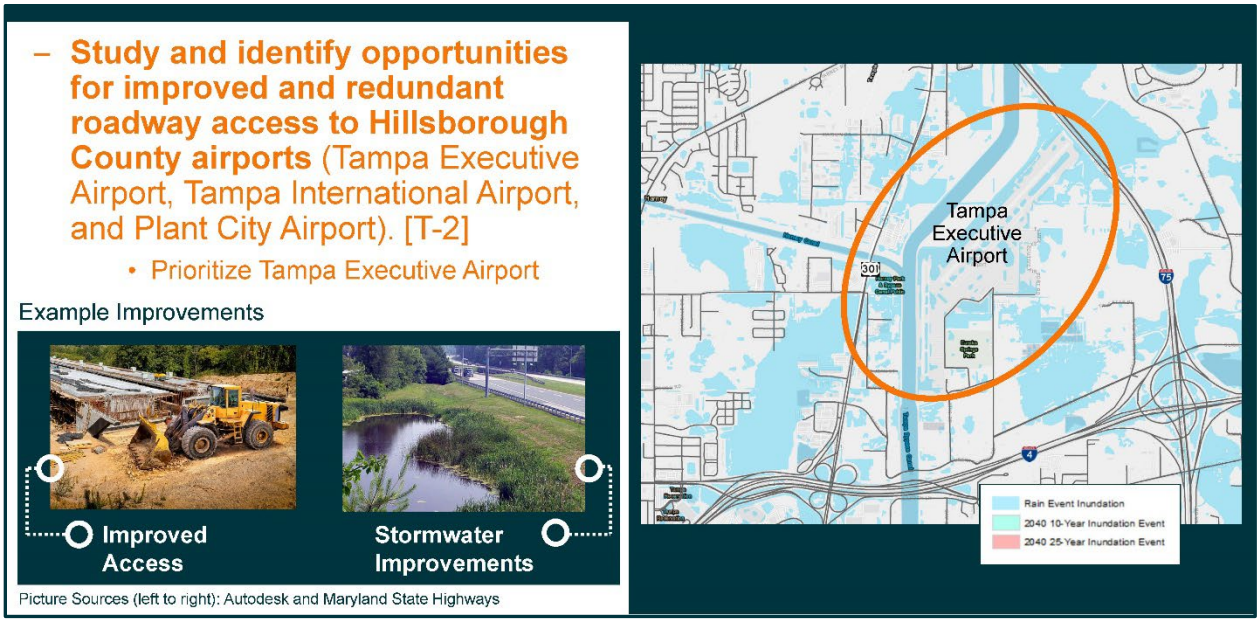
3 Hillsborough County Airports Access Study



Having redundant roadway access to Hillsborough County airports is important from a supply chain perspective. Access to Tampa Executive Airport should be prioritized given its current limited roadway access. This will enhance its capability to serve as a back-up facility to Tampa International Airport in the event of a supply chain disruption.

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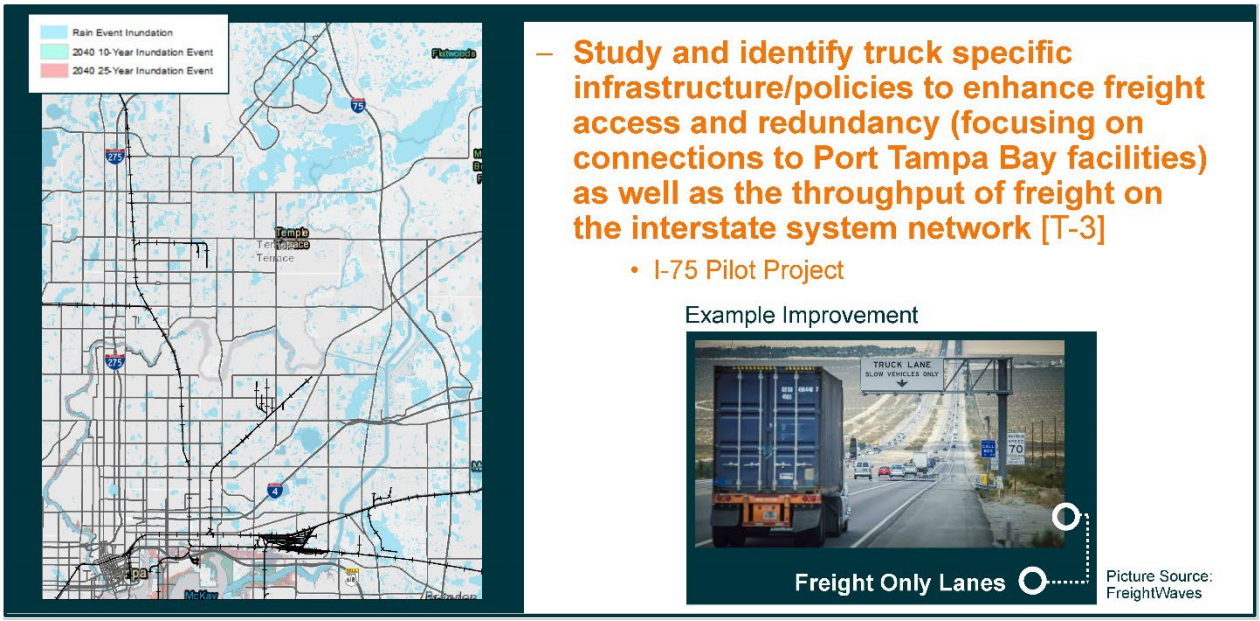
4 Study Managed Lanes Infrastructure/Policies to Enhance Access to Port



Identifying opportunities to enhance access to Port Tampa Bay facilities as well as throughput of freight on the interstate system should be studied. These opportunities could be in the form of designated or dedicated truck lanes, temporal separation of freight traffic through use of managed lanes, direct ramp connections to freight activity centers, automated or connected vehicle technology, and/or intelligent transportation systems technology. A pilot project should be considered along I-75.

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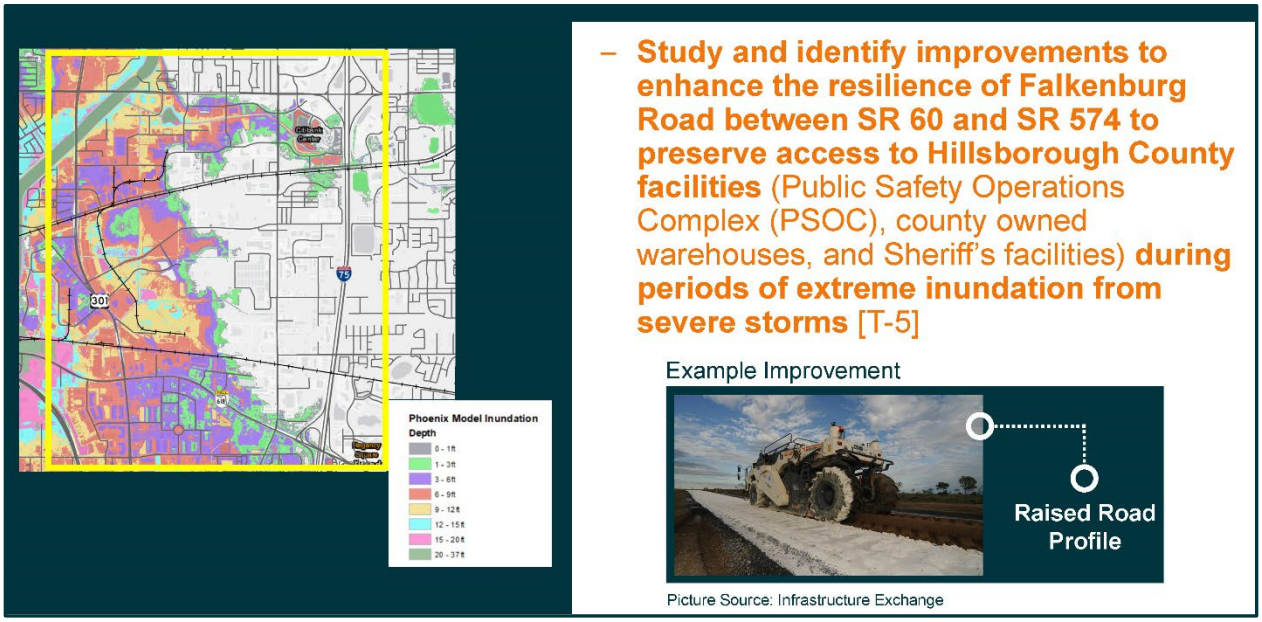
5 Falkenburg Road County Facility Access Resiliency Study



Inundation information from the Project Phoenix Hurricane Simulation Model (a model of a Category 5 hurricane hitting Tampa Bay) reveals that important Hillsborough County facilities (such the Hillsborough County Public Safety Operations Complex, Hillsborough County Sheriff's facilities, and county owned warehouses) would be cut off in terms of access to major roadways (such as I-75 and SR 60). As Falkenburg Road provides direct access to the noted county facilities, improving the roadway's resilience is important. Improvements could include raising the roadway profile, enhancing stormwater facilities along the corridor, strengthening/enlarging bridge/culvert structures, increasing permeable surfaces, etc.

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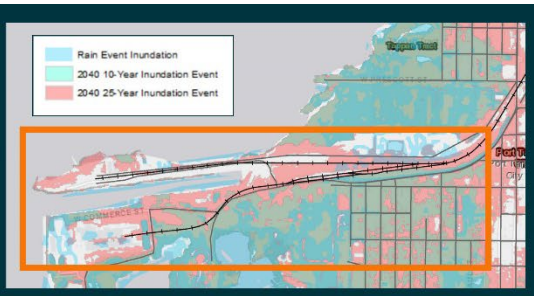
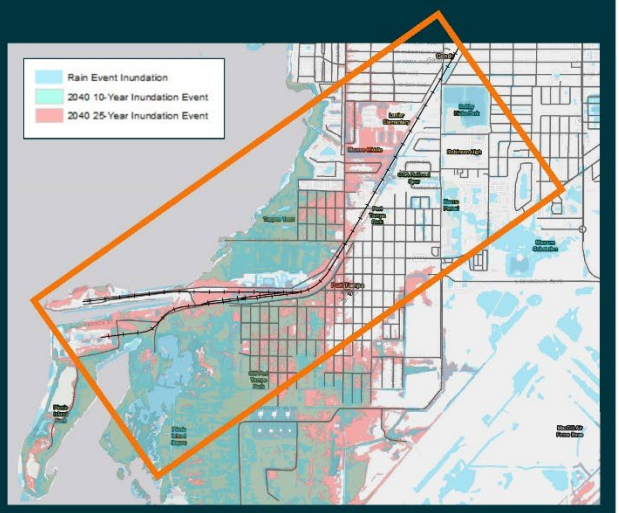
6 Port Tampa Bay Road/Rail Access Resilience Study

- **Study and identify improvements to enhance the resilience and safety of Commerce Street/Port Tampa Drive in Port Tampa City west of Interbay Boulevard to preserve access to port area facilities during 10-Year and 25-Year inundation events within the next 20 years [T-6]**
  - Example improvements: complete street features, raised roadway profile, enhanced stormwater facilities, strengthened/enlarged bridge/culvert structures, increased permeable surfaces, etc.



Example Improvements Picture Source: City of Minneapolis

Complete Street Features & Enhanced Stormwater Facilities



- **Study and identify improvements to enhance the resilience of CSX Port Tampa Spur Rail Line in the Port Tampa City area west of Manhattan Avenue to preserve access to port area facilities during 10-Year and 25-Year inundation events within the next 20 years [T-7]**

Example Improvement Picture Source: BNSF

Strengthened/ Enlarged Culvert Structure

Roadway and rail infrastructure within the Port Tampa City area is susceptible to inundation based on 10-Year and 25-Year inundation events within the next 20 years (2040). To preserve access to port area facilities, improvements to Commerce Street/Port Tampa Drive west of Interbay Boulevard should be considered to enhance the resilience of the road. Improvements to the CSX Port Tampa Spur Rail Line should also be considered to enhance the resilience of the railway. Example improvements could include complete street features, raised roadway profile, raised railbed profile, enhanced stormwater facilities, strengthened/enlarged bridge/culvert structures, increased permeable surfaces, and hardened communications infrastructure.

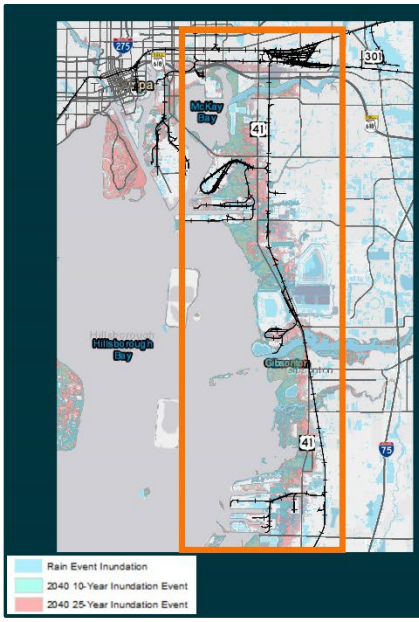
7 US 41 Corridor Road/Rail Access Resilience Study

– **Study and identify improvements to enhance the resilience of US 41 between Big Bend Road and SR 60 to preserve access to port area facilities** (Bayside Power Station, Big Bend Power Station, and industrial activities along the corridor) **during 10-Year and 25-Year inundation events within the next 20 years** [T-8]

- Example improvements: raised roadway profile, enhanced stormwater facilities, strengthened/enlarged bridge/culvert structures, increased permeable surfaces, etc.

Example Improvement

Picture Source: perviouspavement.org



– **Study and identify improvements to enhance the resilience of CSX Tampa Terminal Subdivision Rail Line parallel to US 41 between Big Bend Road and CSX Uceta Yard to preserve access to port area facilities** (Bayside Power Station, Big Bend Power Station, and industrial activities along the corridor) **during 10-Year and 25-Year inundation events within the next 20 years** [T-9]

Example Improvement

Picture Source: Presto Geosystems

Roadway and rail infrastructure within this area of Hillsborough County is susceptible to inundation based on 10-Year and 25-Year inundation events within the next 20 years (2040). To preserve access to port area facilities (including Bayside Power Station, Big Bend Power Station, and industrial activities of the area), improvements to US 41 from Big Bend Road to SR 60 should be considered to enhance the resilience of the road. Improvements to the CSX Tampa Terminal Subdivision Rail Line, extending from Big Bend Road to the CSX Uceta Yard that runs parallel to the US 41, should also be considered to enhance the resilience of the railway. Example improvements could include raised roadway profile, raised railbed profile, enhanced stormwater facilities, strengthened/ enlarged bridge/culvert structures, increased permeable surfaces, and hardened communications infrastructure.

6.0 Stakeholder and Community Outreach

Public and private supply chain actors (stakeholders) and community members relevant to Hillsborough County, the Tampa Metropolitan Statistical Area, and surrounding region were engaged at various stages during the study through stakeholder group meetings (small and large), individual stakeholder interviews, and community sessions.

The small group interviews were conducted in April 2022 with one or more representatives from several agencies that were associated with the five selected commodities or seven supply chain enablers or that conducted resiliency-related or emergency management and recovery planning for Hillsborough County or the Tampa Bay region as a whole. The stakeholders were invited to a specific interview based on topic, including:

- Resilience
- Transportation
- Communications & Utilities
- Economic Development & Land Use
- Emergency Management & Medical
- Freight
- Medical

To supplement the information collected from the stakeholder interviews, the Hillsborough TPO staff facilitated small group discussions with Hillsborough County residents in May 2022, piggybacking on vocational trainings held by the Corporation to Develop Communities of Tampa, Inc. and University Area Community Development Corporation.

To expand on issues and/or mitigation opportunities identified during the stakeholder small group interviews or address points noted by community members, seven individual stakeholder interviews were held between June 2022 and August 2022 with one or more representatives from a single entity. The one-on-one interviews were conducted with the following entities:

- Hillsborough County Water Resources Department, Innovation & Resiliency Environmental Services Division
- Florida Department of Transportation District 7 Aviation and Seaports Office
- Florida Division of Emergency Management, Emergency Fuels Program
- Hillsborough County Aviation Authority, Government and Community Relations
- Florida Department of Highway Safety & Motor Vehicles, Commercial Vehicle Enforcement
- Port Tampa Bay
- Florida Department of Health (Hillsborough County), Public Health Preparedness

Further, presentations were made at the Hillsborough County Local Mitigation Strategy Working Group Meeting in August 2022 and the Tampa Bay Regional Planning Council ONE BAY Livable Communities Working Group Meeting in September 2022 in which feedback was received from members of each group on various aspects of the study. Additional input was gathered during presentations in August 2022 at the Hillsborough

TPO Technical Advisory Committee Meeting and Hillsborough TPO Citizen Advisory Committee Meeting.

These noted stakeholders and citizens vetted the commodities and disaster scenarios that were studied; relayed personal experiences, challenges, and lessons learned in reacting to/preparing for disaster events, specifically regarding access to essential goods before, during, and after disasters; identified vulnerabilities and gaps that need to be addressed within supply chains; and relayed best practices to incorporate within the study recommendations. Stakeholders also provided insight on preparations/trainings their respective company/agency had established or ways their organization would react to disaster events and subsequent impacts. This input helped to define realistic disaster effects and better understand access to essential goods during disasters, identify weaknesses in supply chain flows that could lead to supply chain disruptions during a disaster event, and develop practical actionable recommendations to mitigate impacts and strengthen the individual commodity supply chains.

Details regarding this engagement and input received may be found in the Outreach & Engagement Summary prepared under separate cover.

Appendix A – Commodities/Services List

Commodities/Services List

Community Lifeline	Category	Commodity/Service/Function	Specific Commodities
Safety and Security	Law Enforcement/Security	Police Stations	Police, Facilities, Detention, Enforcement Tools, Guns and Ammunition, PPE, Vehicles, Fuel, Electricity, Communications
		Law Enforcement	Police, Facilities, Detention, Enforcement Tools, Guns and Ammunition, PPE, Vehicles, Fuel, Electricity, Communications
		Site Security	Security Personnel, Vehicles, Enforcement Tools, Fuel, Electricity, Camera Surveillance, Communications
		Correctional Facilities	Correctional Staff, Medical Staff, Medical Equipment, Facilities, Enforcement Tools, Food, Laundry, PPE, Vehicles, Fuel, Electricity, Communications, Recordkeeping, Facilities, Facilities Maintenance, Cleaning
	Fire Service	Fire Stations	Fire Stations, Electricity, Water, Gas, Food, Communications
		Firefighting Resources	Firefighters, Firefighting Equipment, PPE, Vehicles, Water, Hydrants, Firefighting Chemicals
	Search and Rescue	Local Search and Rescue	Emergency Response Equipment, Search and Response Equipment, Communications
	Government Services	Emergency Operations Centers	Workforce, Electricity, Water, Communications
		Essential Government Functions	Workforce, Electricity, Water, Communications
		Government Offices	Workforce, Electricity, Water, Communications
		Schools	Teachers, Learning Materials, Books, Paper, Computers, Electricity, Water, Meal Programs
		Public Records	Workforce, Electricity, Water, Communications, Archival Products
		Historic/Cultural Resources	Workforce, Electricity, Water, Communications
	Community Safety	**Flood Control**	Workforce, Vehicles, Contruction Equipment, Flood Barriers, Barricades, Sandbags, Sand, Pumps, Electricity, Communication
		Other Hazards	Workforce, Vehicles, Contruction Equipment, Electricity, Communication
		Protective Action	Workforce, Testing Supplies, Research Facilities, Radiological Protection Equipment, PPE, Communication
Food, Water, and Shelter	Food	**Commercial Food Distribution**	Workforce, Food, Cold Storage, Warehouses, Trucking, Packaging, Stores, Electricity, Water, Communication
		Commercial Food Supply Chain	Workforce, Food, Cold Storage, Warehouses, Trucking, Packaging, Stores, Electricity, Water, Communication
		Food Distribution Programs (Food Banks)	Workforce, Food, Cold Storage, Warehouses, Trucking, Packaging, Stores, Electricity, Water, Communication
	Water	**Drinking Water Utilities (intake, treatment, storage, and distribution)**	Water, Water Treatment, Chemicals, Coagulants, Storage Tanks, Piping, Pumps, Valves, Water Meters, Testing Equipment, Electricity
		Wastewater Systems	Water, Storage Tanks, Piping, Pumps, Valves, Water Meters, Electricity
		Commercial Water Supply	Water, Storage Tanks, Piping, Pumps, Valves, Water Meters, Electricity
	Shelter	**Housing (Homes, Shelters)**	Workforce, Lumber, Pressboard, Vapor Barrier, Shingles, Drywall, Electrical and Plumbing Fixtures, Interior Finishing Materials
		Commercial Facilities (Hotels)	Workforce, Lumber, Pressboard, Vapor Barrier, Shingles, Drywall, Electrical and Plumbing Fixtures, Interior Finishing Materials
	Agriculture	Animals and Agriculture	Workforce, Animals, Feed, Seed, Fertilizer, Veterinary Care, Supplements, Water, Farm Equipment, Husbandry, Electricity, Chemicals, Animal Transport

Commodities/Services List

Community Lifeline	Category	Commodity/Service/Function	Specific Commodities
Health and Medical	Medical Care	**Hospitals**	Workforce, Medical Supplies, PPE, Gases, Testing Equipment, Sterilization Equipment, Electricity, Vehicles, Fuel, Communications, Recordkeeping, Facilities, Facilities Maintenance, Cleaning, Generators, Diesel
		Dialysis	Workforce, Dialysis Supplies, PPE, Electricity
		Pharmacies	Workforce, Pharmaceuticals, Personal Care, Recordkeeping, Security, Electricity, Communication
		Long-Term Care Facilities	Workforce, Medical Supplies, PPE, Gases, Electricity, Vehicles, Fuel, Communications, Recordkeeping, Facilities, Facilities Maintenance, Cleaning, Generators, Diesel, Food, Personal Care
		VA Health Services	Workforce, Medical Supplies, PPE, Gases, Testing Equipment, Sterilization Equipment, Electricity, Vehicles, Fuel, Communications, Recordkeeping, Facilities, Facilities Maintenance, Cleaning, Generators, Diesel
		Veterinary Services	Workforce, Veterinarians, Vet Techs, Medical Supplies, PPE, Gases, Vehicles, Fuel, Electricity, Clinics, Generators, Diesel
		Home Care	Workforce, Nurses, Medical Supplies, PPE, Vehicles, Fuel, Communication, Recordkeeping, Facilities, Facilities Maintenance, Cleaning
	Patient Movement	Emergency Medical Services	Workforce, Emergency Vehicles, Medical Supplies, PPE, Gases, Fuel, Communication
	Facility Management	Mortuary and Post-Mortuary Services	Cremation, Natural Gas, Chemicals, Caskets, Cold Storage
	Public Health	Epidemiological Surveillance	Workforce, Laboratory Equipment, Sterilization Equipment, Laboratory Chemicals, Electricity, Water, Shipping Materials (Boxes, Containers)
		Laboratory	Workforce, Laboratory Equipment, Sterilization Equipment, Laboratory Chemicals, Electricity, Water, Shipping Materials (Boxes, Containers)
		Clinical Guidance	Workforce, PPE
		Assessment/Interventions/Treatments	Workforce, PPE
		Human Services	Workforce, PPE
		Behavioral Health	Workforce, PPE
	Medical Supply Chain	Blood/Blood Products	Blood/Blood Products, Plastics, Testing Supplies
		Manufacturing: Pharmaceutical	Workforce, Manufacturing Equipment, Sterilization Equipment, Plastics, Metals, Chemicals, Electricity, Water, Shipping Materials (Boxes, Containers)
		Manufacturing: Device	Workforce, Manufacturing Equipment, Sterilization Equipment, Plastics, Metals, Chemicals, Electricity, Water, Shipping Materials (Boxes, Containers)
		Manufacturing: Medical Gases	Workforce, Manufacturing Equipment, Testing Equipment, Cylinders, Chemicals, Electricity, Water, Shipping Materials (Boxes, Containers)
		Distribution	Workforce, Warehousing, Trucks, Cold Storage Equipment, Electricity, Security
		Critical Clinical Research	Workforce, Testing Supplies, Research Facilities, Gases, Electricity, Security
		Sterilization	Electricty, Gases, Packaging
		Raw Materials	Mining, Metals, Plastic Resins, Chemicals
Energy	Power Grid	Generation Systems	Workforce, Coal, Water, Oil, Gas, Turbines, Power Generation Operations & Maintenance Supplies
		Transmission Systems	Workforce, Wirelines, Steel Transmission Towers, Wood and Steel Posts, Pipes, Transmission Mains, Distribution Mains, Voltage Regulators, Capacitors, Insulators, Transformers, Lightning Supression
		Distribution Systems	Workforce, Wirelines, Posts, Pipes, Transmission Mains, Distribution Mains, Voltage Regulators, Capacitors, Insulators, Transformers, Lightning Supression
	Fuel	Refineries/Fuel Processing	Workforce, Electricity, Oil and Gas Operations and Maintenance Supplies, Steel, Waste and Byproducts (Removal)
		Fuel Storage	Workforce, Oil and Gas Operations and Maintenance Supplies, Tanks, Steel, Electricity
		Pipelines	Workforce, Oil and Gas Operations and Maintenance Supplies, Steel, Electricity
		Fuel Distribution (gas stations, fuel points)	Workforce, Fuel, Tanker Trucks, Gas Stations, Electricity
		Off-shore Oil Platforms	Workforce, Helicopter Aviation, Operations & Maintenance Ships, Oil and Gas Operations and Maintenance Supplies, Steel, Electricity

Commodities/Services List

Community Lifeline	Category	Commodity/Service/Function	Specific Commodities
Communications	Infrastructure	**Wireless**	Workforce, Cellular Communications, Electricity, Cellular Operations & Maintenance Supplies
		Cable Systems	Workforce, Broadcast Facilities, Broadcast Equipment, Electricity, Cable, Cable Operations & Maintenance Supplies
		Broadcast (tv and radio)	Workforce, Broadcast Facilities, Broadcast Equipment, Electricity, Generators, Diesel, Satellite Operations & Maintenance Supplies, Satellite Communications
		Satellite	Workforce, Broadcast Facilities, Broadcast Equipment, Electricity, Generators, Diesel, Satellite Operations & Maintenance Supplies, Satellite Communications
		Data Centers/Internet	Generators, Diesel, Electricity, Data Center Operations & Maintenance Supplies
	Alerts, Warnings, and Messages	Local Alert/Warning Ability	Television, Radio, IPAWS
		Access to Integrated Public Alert & Warning System (IPAWS: WEA, EAS, NWR)	Cellular Communications, Electricity, Broadcast Equipment
		National Warning System (NAWAS) Terminals	Communications, 4-wire Terminals, Lightning Supression Systems
	Responder Communications	Land Mobile Radio (LMR) Networks	Communications, Radios, Transmitters, Electricity, Batteries
	Finance	**Banking Services**	Workforce, Electricity, Communications, ATM Facilities, Currency
		Electronic Payment Processing	Electricity, Communications
Transportation	Highway/Roadway/Motor Vehicle	Roads	Roadways, Steel, Diesel, Asphalt, Concrete, Roadway Operations & Maintenance Supplies
		Bridges	Bridges, Steel, Diesel, Asphalt, Concrete, Roadway Operations & Maintenance Supplies
	Mass Transit	Bus	Buses, Workforce, Diesel, Bus Operations & Maintenance Supplies, Communications
		Rail	Locomotives, Railcars, Workforce, Diesel, Rail Operations & Maintenance Supplies, Communications
		Ferry	Ferries, Workforce, Diesel, Ferry Operations & Maintenance Supplies
	Railway	Freight	Locomotives, Railcars, Workforce, Fuel, Rail Operations & Maintenance Supplies, Shipping Materials (Boxes, Containers)
		Passenger	Locomotives, Railcars, Workforce, Fuel and Electricity, Rail Operations & Maintenance Supplies
	Aviation	Commercial (cargo/passenger)	Aircraft, Ground Service Equipment, Workforce, Aviation Fuels and Lubricants, Air Operations & Maintenance Supplies, Air Traffic Control, Communications
		General	Aircraft, Ground Service Equipment, Workforce, Aviation Fuels and Lubricants, Air Operations & Maintenance Supplies, Air Traffic Control, Communications
		Military	Aircraft, Ground Service Equipment, Military Forces, Aviation Fuels and Lubricants, Air Operations & Maintenance Supplies, Air Traffic Control, Communications
	Maritime	Waterways	Barges, Tugs, Diesel, Workforce, Operations & Maintenance Supplies
		Ports and Port Facilities	Longshoremen, Diesel, Electricity, Port Service Equipment, Cranes, Port Operations & Maintenance Supplies
Hazardous Materials	Facilities	Oil/HazMat Facilities (chemical, nuclear)	HazMat Management, Emergency Response Materials, Emergency Response Equipment, Containment Materials, Communications
		Oil/HazMat/Toxic Incidents from Facilities	HazMat Management, Emergency Response Materials, Emergency Response Equipment, Containment Materials, Communications
	HazMat, Pollutants, Contaminants	Oil/HazMat/Toxic Incidents from Non-Fixed Facilities	HazMat Management, Emergency Response Materials, Emergency Response Equipment, Containment Materials, Communications
		Radiological or Nuclear Incidents	HazMat Management, Emergency Response Materials, Emergency Response Equipment, Containment Materials, Communications

Appendix B – Literature Review

Literature Review

Resource	Agency	Date	Notes	Link
Statewide Commodity Flow Analysis	FDOT	February 2021	- Examines Transearch data. - Captures internal, external to internal, internal to external, and external to external movements. - 30-year forecast for freight derived from the HIS Global Insight's long-term U.S. Macroeconomic and Business Markets Insights forecast. - Executive summary details the top 5 commodities by inter-state imports, inter-state exports, intra-state, and intra-county. - Top import and export commodities for Hillsborough County included on page D-7.	https://www.fdot.gov/statistics/multimodaldata/multimodal/freight-study
Hillsborough County Freight and Logistics Overview Brochure	FDOT	February 2021	- Standalone document that is part of the Statewide Commodity Flow Analysis. - Shows top commodity imports and exports by tonnage and value. - Shows domestic and intrastate trading partners for both imports and exports. - Shows locations of the largest freight employers in Hillsborough County as well as other freight parcels. - Identifies the modal split of tonnage and value and major Hillsborough County commodities compared to Florida as a whole.	https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/statistics/multimodaldata/freight/freight-hillsborough.pdf?sfvrsn=b496df53_2
Statewide Truck GPS Data Analysis	FDOT	April 2019	- Study undertaken to develop a methodology for using truck GPS data and other data sources to evaluate truck parking supply and utilization. - A subsequent study will be conducted to identify critical truck parking needs in the state and identify solutions (truck parking study, also summarized in this table). - 1/3 of truck parking locations and 1/3 of spaces are publicly owned. Florida has a high ratio of publicly owned vs privately owned truck parking spaces compared to other states. - Districts 6 and 7 have low numbers of spaces per 100,000 daily truck miles traveled. - Statistics provided about private facilities vs public facilities and peak usage of facilities by FDOT District.	fdotcoswtruckgpsparkingfinalreportb03efb1d092a4d23b31c29a5dd13d4d6.pdf (windows.net)

Literature Review

Resource	Agency	Date	Notes	Link
Truck Empty Backhaul Report	FDOT	January 2018	- Document quantifies truck empty backhaul in Florida using Weigh in Motion (WIM) data. - 2015-2017 data provided. - Florida is heavier on consumption than manufacturing so most empty backhaul are outbound (north or west). - Highest percentage of truck empty backhaul in Florida is northbound on I-75 in the Tampa area. - Recommendations include: 1. Increase the development of manufacturing; 2. Investigate the need for trailer transfer stations to allow drivers to stay within smaller regions; 3. Support projects that improve the efficiency of goods movement at the statewide level; and 4. Additional future studies for FDOT to consider (expand study to all freight modes, explore more the WIM data, partner with FDACS, etc.).	https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/statistics/docs/truck-empty-back-haul-final-report-2018.pdf?sfvrsn=8efaa9c_0
Tampa Bay Regional Strategic Freight Plan	FDOT D7	November 2018	- Analyzes the region for large-scale freight logistics patterns. - Contains freight movement by mode per Kton for the State of Florida. - Details transportation networks by mode. - Identified freight activity centers within FDOT District 7. - Identified corridor based project needs and “freight hot spots.” - Identifies primary freight investments by the project and provides intersection improvements to facilitate the movement of trucks.	tampa-bay-regional-strategic-freight-plan-update_nov2018.pdf (windows.net)
Multimodal Data Systems Program	FDOT D7	N/A	- FDOT’s freight data reporting and analysis center. - Features the Truck Empty Backhaul Study, Statewide Truck GPS Data Analysis, and Statewide Commodity Flow Analysis (further outlined below). - Also has links to Freight Data Source Profiles (by mode), FHWA Freight Office, Florida Aviation Database, Florida Disaster Geospatial Assessment Tool, Freight Moves Florida, and Freight Moves Tampa Bay.	https://www.fdot.gov/statistics/multimodaldata/default.shtm

Literature Review

Resource	Agency	Date	Notes	Link
District 7 Freight Resources	FDOT D7	N/A	- Managed by Brian Hunter (AECOM is identifying freight intersection improvements for him). - Relevant documents include: 1. Tampa Bay Regional Strategic Freight Plan (2018 and 2012), 2. Freight Roadway Design Considerations, and 3. Truck Parking Tech Memo.	FDOT District 7 Freight Resources
Post-Disaster Redevelopment Plan Documents	Hillsborough County	July 2010	- Can be helpful in determining commodities for the rebuilding phase. - Older documents (July 2010). - Implementation of Priority Redevelopment Area Concept. - Pre-Disaster Action Reports. - Post-Disaster Action Reports. - From TPO: 1. Business resumption and economic redevelopment, 2. Environmental restoration, 3. Financial considerations, 4. Housing repair and reconstruction, 5. Infrastructure restoration and mitigation, 6. Short-term recovery actions that affect long-term redevelopment, and 7. Sustainable land use. - The plan also addresses other long-term recovery issues identified by the community.	https://www.hillsboroughcounty.org/en/residents/public-safety/emergency-management/post-disaster-redevelopment-plan
Storm Evacuation and Shelter-in-place Scenarios Study	Hillsborough TPO	August 2022	The Storm Evacuation Forecast & Shelter-in-Place Scenarios Study will supplement this ongoing work by providing a high-level analysis of Hillsborough's evacuation practices today. The study will evaluate best practices in evacuation regionally and nationally, assess potential evacuation enhancement options in Hillsborough County, and develop a set of recommendations and next steps for the Hillsborough Transportation Planning Organization and other agencies to consider to support emergency evacuations in Hillsborough County.	https://planhillsborough.org/wp-content/uploads/2022/07/Evac-Shelter-Study-Final-Report-06302022v2.pdf

Literature Review

Resource	Agency	Date	Notes	Link
Resilient Tampa Bay: Transportation	Hillsborough TPO	June 2020	- From TPO: The project found that 20% of major roads in Hillsborough County could be washed out in a Category 3 storm, factoring in the sea level rise predicted for the next two decades. Pinellas County is even more vulnerable at 57%. In a severe rainfall event, 11% of Hillsborough County roads could be affected by inland flooding. The study recommended that Hillsborough County should increase countywide investment in stormwater projects by about half (approximately $22 million per year) and should nearly double investment in road resurfacing, hardening pavement and sub-base, and preserving shorelines (~$72 million per year). If crucial roads are impassible after a severe storm, the impact to economic recovery reaches a break-even point, compared to the cost of these improvements, at about 2 ½ weeks. These cost estimates include expenses of all local and state governments and transportation agencies operating in Hillsborough County. - Has recommendations for protecting infrastructure and infrastructure vulnerability. - Has adaptation strategy toolbox.	https://planhillsborough.org/wp-content/uploads/2020/07/Resilient-Tampa-Bay-Final-Report-June2020-508_JB.pdf
Freight Logistics Zone (FLZ) Strategic Plan	Hillsborough TPO	June 2016	- Strategic plan for a corridor from Port Tampa Bay and south along I-75 over along the I-4 corridor and south along US 27 in Polk County. - Profiled facilities, truck volumes, network, projects, etc. within the area.	https://planhillsborough.org/wp-content/uploads/2016/01/FLZ_StrategicPlan_063016_rev10-17-FINAL-post-resolutions.pdf

Appendix C – Case Studies Review

Case Studies Review

Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
August 1, 2015 Heavy Rainfall: Not associated with any tropical system, weeks of rain saturated the soil and filled retention facilities throughout the summer of 2015 in Hillsborough County. The worst flooding in 65 years occurred on August 1, 2015, but flooding had been happening for most of July. 15-20 inches of rain fell within 10 days, 3.89 inches on 8/1 alone, with some areas getting as much as 7 inches on 8/1. Persistent onshore winds led to coastal flooding in Crystal River (Hernando County), and 40 residents were evacuated from flood waters in northern Pinellas County. https://www.baynews9.com/fl/tampa/weather/2020/08/06/five-years-since-the-infamous-tampa-bay-flood	Natural Disaster	Flooding	Inundated and inaccessible roads	Regional - Several road closures over the ten days of rain and the following weeks due to downed trees and debris. Increased emergency responses, closed public services (libraries), downed utilities, and increased shelter use.	Increased flood resilience.	Low	Hillsborough County and Neighboring Counties, Florida	- - -	- - -	- - -	- - -	X	- - -	X
Hurricane Michael: Hurricane Michael made landfall on October 10, 2018, as a Category 5 hurricane near Mexico Beach and Tyndall Air Force Base, Florida. The storm produced wind speeds of 155 miles per hour at landfall and storm surge of nearly 15 feet at places along the Florida panhandle. Hurricane Michael was directly responsible for 16 fatalities and $25 billion in damages. https://www.nhc.noaa.gov/data/tcr/AL142018_Michael.pdf	Natural Disaster	Flooding and wind damage	Inundated and inaccessible roads, damaged structures and bridges	Regional - 3-6 inches of rain fell with the hurricane, with areas experiencing 11-13 inches of rain.	Impacts to air force base and coastal communities; sparsely populated area/low infrastructure density and intensity; structures built to hurricane standards withstood impacts at higher rates.	Medium	Florida Panhandle	- - -	- - -	- - -	- - -	X	- - -	X
Hurricane Harvey: Hurricane Harvey made landfall in the middle of the coast of Texas as a Category 4 hurricane on August 26, 2017. The storm remained stationary over the Houston area for four days (August 26 – 29, 2017), causing historic flooding. The storm inundated the Houston metro region, dumping more than 60 inches of rain in some areas and displacing more than 30,000 people. https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf	Natural Disaster	Flooding	Inundated and inaccessible roads, unusable facilities	National - A third of Houston was underwater, increased federal aid, major structural damage to businesses and residences. Some roads and major highways were unusable for weeks following the storm. Flooding caused hazardous spills and toxic releases that negatively impacted water and air quality. Impacts caused gas price increases that were felt across the United States. 46 percent of the river forecast points in the area reached new record levels. https://aiahouston.org/v/site-page/Houston-2020-Visions/Harvey-and-the-Aftermath/9e/	Houston's local streets were designed to serve as a secondary drainage system in the event of a major storm, but they were impassable for weeks. The city's system for dealing with floodwater can only handle an influx of a foot of water every 24 hours. Major call for resilient planning in Houston yet policy continues to avoid the issue. In order to upgrade sewer systems to prevent overflows during major storms, some estimates say that the needed improvements would be around $5 billion. https://www.bidnet.com/resources/business-insights/hurricane-harvey-irma-infrastructure-damage-texas-florida-en.jsp Port Houston closed from 8/25 at noon until 7AM on 9/1 - second busiest port in the United States. 63 of the 102 ships scheduled to enter the port between 8/23 and 8/31 were diverted elsewhere. Even a month after the storm, a heavy buildup of silt blocked many of the barges using the Gulf Intracoastal Waterway between Houston and Corpus Christi, estimates saying delays cost upwards of $2.5 billion. The Houston Ship Channel lost 3 feet of depth, 1 foot of depth costs the U.S. economy as much as $280 million a year. The U.S. Army Corps of Engineers embarked on a $20 million dredging project. City Docks lost as much as 5 feet in depth after a completed dredging project just two years before. 1750 miles of rail track between Brownsville and Beaumont were out of service; repair and inspection crews were able to restore that within a week but it caused significant delay. https://www.ttnews.com/articles/transportation-rebounding-hurricane-harveys-havoc	Severe	Houston, Texas	X	- - -	X	- - -	X	- - -	X

Case Studies Review

Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
Superstorm Sandy: Making landfall as a post-tropical cyclone on October 29, 2012, Sandy caused catastrophic storm surge along the New York and New Jersey coastlines. “Superstorm Sandy” resulted in 147 direct deaths in the Atlantic Basin, 72 fatalities occurring within the northeastern states, and nearly $50 billion dollars in damages. Over 650,000 homes in the New York/New Jersey area were damaged or destroyed, and saltwater inundation caused major damage to transportation infrastructure (including tunnels, railcars, and communications equipment). https://www.adaptationclearinghouse.org/resources/transportation-during-and-after-hurricane-sandy-new-york-new-jersey.html https://www.nhc.noaa.gov/data/tcr/AL182012_Sandy.pdf	Natural Disaster	Flooding	Inundated and inaccessible roads, damaged goods, inaccessible petroleum supply. FEMA coordinated military and civilian assets to transport equipment from utilities providing mutual aid to impacted communities.	Regional - New York City and New Jersey were hit the hardest by this storm, especially regarding New York City's public transportation system.	Hurricane Sandy, along with Hurricane Irene that preceded Hurricane Sandy in 2007, taught New York City to focus on redundancy in transportation. Hurricane Sandy created a traffic gridlock from 10/31 to 11/1 when the rest of the city's transit system was down. There were people stranded as a gas shortage prevented people from using buses or their own cars. These gaps were filled through bikes and the region's extensive network of privately run commuter vans. On a typical day, the subway system has 700 pumps that drain 13 million gallons of water - the Hugh L. Carey Brooklyn-Battery Tunnel and Queens-Midtown Tunnel were flooded and inaccessible. Queens Midtown was able to open partially on 11/8 and fully on 11/16; Hugh L. Carey Brooklyn Battery Tunnel opened partially on 11/12 and fully on 11/13. Through these periods, the Metropolitan Transportation Authority (MTA) was working diligently to pump out the tunnels and open as they were available. 10 million people rely on the MTA network of subways, buses, commuter rail, as well as bridges and tunnels. Some services were closed from 10/28 through 11/2, though the modes that were available ran fare-free through 11/2. One innovative solution that emerged was impromptu Bus Rapid Transit - 330 buses replaced missing subway services. Another was a temporary ferry service between Rockaways and Manhattan on 11/9, and a new ferry to serve the southeastern neighborhoods of Staten Islands on 11/20. New York City continues to base improvements on the delays suffered during this period, increased pumping and new flood gates in the subways, more ferries, more bike access, porous sidewalks in flooding areas, and bus priority lanes among other innovations. The MTA shut down all transit service and moved cars and equipment to higher ground prior to landfall. https://wagner.nyu.edu/files/faculty/publications/sandytransportation.pdf	Medium	New York and New Jersey	X	X	- - -	- - -	X	- - -	X
Hurricane Irma: Hurricane Irma made a total of seven landfalls, two of which impacted the United States on September 10, 2017, first as a Category 4 hurricane in the Florida Keys and then as a Category 3 hurricane in southwestern Florida. Due to Hurricane Irma’s shifting projected path from the east coast to the west coast of Florida, 6.5 million people evacuated, making it the largest hurricane evacuation in the State of Florida’s history. Significant traffic congestion and fuel shortages resulted from this historic evacuation effort. https://www.myfloridahouse.gov/Sections/Documents/loaddoc.aspx?PublicationType=Committees&CommitteeId=2978&Session=2018&DocumentType=General%20Publications&FileName=SCHRP%20-%20Final%20Report%20online.pdf	Natural Disaster	Flooding	In Florida, evacuation efforts caused major slowdowns on major interstates. Coordination prior to the storm making landfall reduced the potential damages. Several ports in the southeast were shut down in preparation. There were significant losses accrued by workers from lost wages due to evacuations and shutdowns.	Regional - Irma's path ended up avoiding several areas it was originally forecasted to hit, but the strength of the storm caused $50 billion in damages to the places where it made landfall. Irma first made landfall on 9/6 in Barbuda. From there, it went on to hit the British Virgin Islands, Turks and Caicos, Cuba, the Bahamas, the Florida Keys, and Miami. The storm accrued significant damages and is ranked as the fifth costliest hurricane in United States history.	In central Florida, a portion of the interstate highway washed away while Irma passed. U.S. Highway 1, the only way in or out of the Florida Keys, was shut down for a full day on 9/11 as a clean-up team pushed for first stage clean-up and repair in one day. Other major roads like I-75, I-95, I-4, and Florida's Turnpike were cleared of debris and repaired within the first couple of days following the storm though officials warned of dangerous conditions and asked for essential traffic only. Most gas stations ran out of fuel 1-2 days before the storm made landfall. Port Tampa Bay was closed until 9/12, two days after landfall. It took two full days before fuel to fulfill shortages could be delivered to Port Tampa Bay. https://www.washingtonpost.com/news/dr-gridlock/wp/2017/09/11/irma-washed-away-part-of-a-florida-highway-roads-remain-dangerous-and-impassable/	Medium	Florida	- - -	- - -	- - -	- - -	X	- - -	X

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Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
Hurricane Maria: Hurricane Maria struck Puerto Rico as a powerful Category 4 hurricane on September 20, 2017, just two weeks after Hurricane Irma. Puerto Rico was devastated by winds and floods. Hurricane Maria knocked down 80 percent of Puerto Rico's utility poles and all transmission lines, resulting in the loss of power to essentially all of the island's 3.4 million residents. In addition, practically all cell phone service was lost and municipal water supplies were severely disrupted. The total damage came to approximately $90 billion, making it the third costliest hurricane in United States history. https://www.nhc.noaa.gov/data/tcr/AL152017_Maria.pdf	Natural Disaster	Flooding and wind damage	Communications on Puerto Rico were taken down completely, including cell towers, which made coordination extremely difficult. Ports were shut down and roads were destroyed, preventing the delivery of supplies. As an island community, Puerto Rico is especially dependent on these ports for supplies. Power was down in parts of Puerto Rico all the way through August 2018, causing other additional disruptions to businesses. https://www.sciencedirect.com/science/article/abs/pii/S2212420919302031	Regional - Puerto Rico continues to suffer the impacts of this storm and the severely damaged utilities. The electrical grid is still weak even in the places where it is considered restored.	In Puerto Rico, 34 pedestrian bridges were damaged and 24 vehicular bridges collapsed due to the storm. There were 6,000 separate heavily damaged transportation incidents, including 388 related to bridges and 400 related to landslides. Nearly 20 percent of Puerto Rico's bridges were damaged. The Association of General Contractors estimated that hurricane reconstruction from the combined storms would require an additional 50,000 employees over 3 years. Estimated recovery would require $1.8 billion in repair costs and another $1.1 billion in recommended resilience upgrades in an immediate sense. Two years after the storm, the damages persisted with experts estimating a required $1.23 billion to $2.3 billion annually over ten years to restore the island. https://cait.rutgers.edu/studying-the-damage-from-hurricane-maria-can-make-future-infrastructure-more-resilient/ https://highways.dot.gov/public-roads/winter-2020/coming-back-disaster	Medium	Puerto Rico	X	- - -	- - -	- - -	X	X	X
Hurricane Katrina: Hurricane Katrina, after making landfall as a Category 1 hurricane north of Miami in Florida, rapidly intensified to a Category 5 hurricane and made landfall again along the Gulf Coast as a strong Category 3 hurricane at the Louisiana/ Mississippi border on August 29, 2005. With estimated storm surge of 24 to 28 feet along 20 miles of the Gulf Coast, the natural factors combined with a lack of adequate maintenance and preparation resulted in widespread flooding (about 80% of the City of New Orleans was under flood waters). The storm caused more than 1,800 deaths and $125 billion in damages. https://www.nhc.noaa.gov/data/tcr/AL122005_Katrina.pdf	Natural Disaster	Flooding and wind damage	The damaged ports were down for weeks, preventing major shipments reaching New Orleans and their final destinations. There were major grain and sugar shortages.	National - The ports that were severely damaged by Hurricane Katrina in New Orleans and Mississippi provide 60 percent of the United States grain exports. The Port of New Orleans (Port NOLA) is the nation's largest coffee supplier. Other goods ship through this port and were completely destroyed by the storm. Port NOLA was closed completely for two weeks, and the port was getting 36-40 ship calls a week prior to the storm. Port NOLA ranked 5th among U.S. ports in tons of cargo in 2003 and 12th in total foreign trade. Police headquarters and several district offices were destroyed by the storm destroying vehicles, uniforms, ammunition, etc. Limited fire and police and communications severely hampered. Had major issues getting ground-truthed information out to federal officials. In Mississippi there were issues getting goods the last mile to consumers.	30 percent of Port NOLA was completely destroyed. The power to the port warehouses was down, and there were millions of pounds of ruined perishable goods. The Mississippi River was blocked and prevented the delivery of essential goods in the time of crisis. The Port of Gulfport in Mississippi was in the direct path of the storm and was destroyed with 40-foot containers scattered through downtown Gulfport. I-10 between New Orleans and Slidell suffered heavy damage, US-90 in Mississippi was "basically destroyed", and upwards of 20 railway terminals were affected by the storm. The railway lines cooperated with one another to find alternatives to reroute traffic to the Gulf Coat region. Passenger rail service was completely wiped out and has still not been rebuilt due to a conflict between ports and freight. The U.S. Army Corps of Engineers invested $14.5 billion in one of the largest public works project in history to enhance infrastructure, reducing flooding and providing protection from future storms in New Orleans and surrounding areas. https://www.trucknews.com/features/transportation-infrastructure-is-decimated-by-katrina/ https://www.ncsl.org/research/environment-and-natural-resources/the-storm-that-changed-disaster-policy-forever-magazine2022.aspxhttps://www.nytimes.com/2006/01/03/business/worldbusiness/new-orleans-port-is-getting-over-katrina.html https://t4america.org/2022/02/17/rail-barons-return-how-two-freight-railroads-are-trying-to-derail-the-infrastructure-laws-historic-investment-in-passenger-rail/	Severe	Louisiana and Mississippi	X	X	X	- - -	X	X	X
December 16, 2020 Pinellas Park Tornado: On December 16, 2020, a tornado touched down in Pinellas Park, Pinellas County before moving over Hillsborough and Polk Counties. Downed trees and roof damage were reported in the Pinellas Park area with some more minor damage in Hillsborough County near Westshore Plaza and north of Columbus Drive. No injuries reported in any location.	Natural Disaster	Wind	- - -	Local	- - -	Very Low	Hillsborough County and Neighboring Counties, Florida	- - -	- - -	- - -	- - -	- - -	- - -	X

Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
October 3, 1992 Pinellas Park Tornado: A 2.5-mile long F3 tornado touched down in Pinellas Park, Pinellas County on October 3, 1992. The tornado killed 3 people and injured 75. The tornado completely destroyed several mobile homes and houses in the Pinellas Park area. No impacts in Hillsborough County.	Natural Disaster	Wind	- - -	Local	- - -	Very Low	Pinellas County, Florida	- - -	- - -	- - -	- - -	- - -	- - -	X
April 4th, 1966 Across Florida Tornadoes: Two 100-mile long tornadoes killed 11 people across the State of Florida (7 in Pinellas County, 3 in Hillsborough County, and one elsewhere). One of the two tornadoes was classified as F4 (one of only two documented F4 tornadoes ever in the State of Florida).	Natural Disaster	Wind	- - -	Local	- - -	Low	Hillsborough County and Neighboring Counties, Florida	- - -	- - -	- - -	- - -	- - -	- - -	X
2011 Joplin Tornado: A powerful EF5 multiple vortex tornado hit the area of Joplin, Missouri on May 22, 2011. The tornado killed 158 people, injured 1,150, and resulted in $2.8 billion in damages. This was the deadliest tornado to strike the U.S. since 1947 and was the costliest single tornado in U.S. history.	Natural Disaster	Wind	- - -	Local - Communications were lost in the community and power was knocked out too many areas. The tornado destroyed a hospital and other critical facilities.	Draws attention to the need for a better warning system - both for residents of the City (and surrounding areas) and drivers on area roads. Drivers may not be able to receive the same notification as everyone else; there needs to be a better organized strategy for alerts. 35% of city streets were replaced in the long-term along with 800,000 feet of sidewalks. Interstate 44 (the main highway between the Midwest and the Southwest) passes through the city and had to be rerouted. https://www.nist.gov/feature-stories/joplin-tornado-calamity-and-boon-resilience-10-years https://www.kmov.com/2022/05/21/eleven-years-later-remembering-may-22-2011-tornado-joplin/	Medium	Joplin, Missouri	- - -	- - -	- - -	X	X	- - -	X
Sunshine Skyway Bridge Collapse: At 7:38 AM on May 9, 1980, the freighter MV Summit Venture collided with a pier during a sudden squall, sending over 1,200 feet of the Sunshine Skyway Bridge (the bridge connecting Pinellas and Manatee Counties in Florida across the mouth of Tampa Bay) into the bay. The collision caused six cars, a truck, and a Greyhound bus to fall 150 feet into the water, killing 35 people. After the Summit Venture disaster, the southbound span of the bridge was turned into a public fishing pier, and the northbound span was converted to a two-lane, bidirectional bridge until a new bridge was built.	Transportation Incident	Freighter collided into bridge	Rerouted ground traffic and reengineered mechanisms surrounding the new bridge.	Local - The bridge operated as a two-lane facility until the new bridge was constructed and opened seven years later. The new bridge was built at a better location with a raised profile and the piers were surrounded by "dolphin" structures to protect them from future impacts. https://www.wtsp.com/article/news/local/sunshine-skyway-bridge-collapse/67-f1dca2d4-4188-4461-9579-1ee9f32127d5	The bridge is not part of a critical freight route, but catastrophic failure can happen on a freight route and severely disrupt freight movement.	Medium	Pinellas and Manatee Counties, Florida	- - -	- - -	- - -	- - -	- - -	- - -	X
Atlanta I-85 Fire and Viaduct Collapse: On March 30, 2017, construction materials stored under an Interstate 85 (I-85) overpass in Atlanta, Georgia were set on fire. This caused a 92-foot-long elevated span of I-85 to collapse. No one was injured; one person was arrested and later charged with criminal damage to property. The $15 million replacement project required 43 days to complete. No trucks could travel in or out of companies closest to that section of interstate. https://www.ntsb.gov/investigations/AccidentReports/Reports/HAB1802.pdf	Transportation Incident	Intentional fire causing bridge collapse	Ground freight traffic rerouted to avoid collapsed section of I-85.	Regional - The damaged section of I-85 disrupted freight travel for the two months needed for repair work. No trucks could come in or out of Sweetwater Brewing after the collapse. (Martin Transport is the freight provider, see cyber incidents). MARTA saw increases of 20%-30% after the collapse. Atlanta Regional Commission has data about impacts: https://www.nrel.gov/transportation/secure-transportation-data/tsdc-georgia-traffic-study.html	Georgia Department of Transportation reviewed the placement of all construction materials in the state and determined that there were no other instances of similar storing beneath overpasses.	Severe	Atlanta, Georgia	X	- - -	- - -	- - -	- - -	X	X

Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
January 9, 2008 I-4 Crash: Drivers on Interstate 4 in Polk County, Florida, near mile marker 55, encountered a blinding mixture of smoke and fog during the early morning hours of January 9, 2008. Seventy cars and trucks collided resulting in 5 deaths and 38 injuries. The dangerous conditions were the result of a prescribed burn. The interstate was shut down for hours. This was similar to another crash as a result of a fog/smoke mix that occurred in 2012 on Interstate 75 near Gainesville, Florida that killed 10 people.	Transportation Incident	Combination of fog and smoke resulting from a prescribed burn that created unsafe driving conditions	Interstate closed for hours - ground freight rerouted.	Local - The shutdown was limited to a few hours in the early morning.	Concerns for the effects of prescribed burns and how they can impact roadway visibility.	Low	Polk County, Florida	X	- - -	- - -	- - -	- - -	- - -	X
I-95 Reopened: Several Crashes Cause Fiery Scene on I-95; Multiple Dead in Volusia County: In March of 2022, a deadly chain reaction caused a vehicle pile up on Interstate 95 in Volusia County, Florida. There were multiple fatalities and more than a dozen vehicles were involved. Investigators attribute the crash to a combination of dense super fog combined with smoke from a prescribed burn that made it nearly impossible to see. Florida Highway Patrol says that the notification issued by the Forest Service was not thorough enough to ensure all necessary parties were notified. https://www.wesh.com/article/fiery15-vehicle-crash-prompts-i-95-closure/39305489	Transportation Incident	Natural fog combined with prescribed burn	Interstate partially closed for hours.	Local - The shutdown was limited to a few hours in the early morning.	Concerns for the effects of prescribed burns and how they can impact roadway visibility.	Low	Volusia County, Florida	X	- - -	- - -	- - -	- - -	- - -	X
Howard Street Tunnel Fire (CSX Tunnel Fire): A 60-car CSX freight train derailed in a tunnel in Baltimore, Maryland on July 18, 2001. A resulting chemical fire burned for five or six days, damaged a water main that caused street-level flooding, disrupted passenger rail traffic on the Amtrak Northeast Corridor and Maryland Area Regional Commuter (MARC) lines, and slowed internet service throughout the U.S. due to the destruction of a cable passing through the tunnel. The accident caused displacement from offices, severe traffic disruptions in Baltimore, and major impacts on freight rail traffic. At the time, the tunnel was the only direct freight rail link between Washington, D.C. and New York City, handling between 28 to 32 trains a day. The alternative route required trains traveling from Washington, D.C. to Baltimore to detour through Cleveland, Albany, and New York City.	Transportation Incident	Derailed train causing a chemical fire, street-level flooding, disruption of rail traffic, and slow internet throughout the U.S.	The five-day fire and street level flooding disrupted passenger rail traffic and resulted in office displacements and extensive freight rail detours.	National - The chemical fire disrupted internet access all across the United States. Regional - Freight traffic in Baltimore and up and down the east coast shut down; several cars were carrying hazardous materials that started a massive chemical fire. Dozens of trains were rerouted and some remained idle while the fire continued to burn inside the tunnel. Rail traffic headed south from the Port of Baltimore was detoured for hundreds of miles, and officials announced that rail shipments might be delayed as long as two weeks. Rail traffic was restarted in the tunnel after six days.	Freight train cars have a new standard - thicker tank shells that have more thermal protection.	Severe	Baltimore, Maryland	X	- - -	X	- - -	X	- - -	X
Lac-Mégantic Disaster: The Lac-Mégantic rail disaster occurred in the town of Lac-Mégantic, Quebec, Canada on July 6, 2013 at approximately 1:15 AM. An unattended 73-car Montreal, Maine, and Atlantic Railway (MMA) freight train carrying Bakken Formation crude oil rolled down a 1.2% grade in Nantes and derailed in downtown, resulting in the explosion of multiple tank cars. Forty-seven people were killed, and more than thirty buildings were destroyed. All but three of the thirty-nine remaining buildings in the downtown area had to be later demolished due to petroleum contamination of the townsite. Initial newspaper reports described a 1 kilometer (0.6-mile) blast radius. https://www.tsb.gc.ca/eng/rapports-reports/rail/2013/r13d0054/r13d0054-r-es.html	Transportation Incident	Improperly parked train led to a derailment and explosion	Specific supply chain disruptions unknown.	Regional - Town center destroyed. Freight rail was stopped on the line for 6 months. Rail line originally rebuilt through the village. New rail line to bypass the village started construction in 2022. Originally no liquids were allowed on the rebuilt rail line, but this was lifted by 2015.	Deregulation trend in the railway industry reversed noted accident. Directive is to avoid population centers with dangerous cargo, if possible. The DOT-111 cars that crashed had limited crash resistance; these cars have been banned from carrying dangerous materials and have been phased out completely.	Severe	Lac-Mégantic, Quebec, Canada	X	- - -	- - -	- - -	X	X	X

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Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
I-40 Bridge Failure Causes Multimodal Challenges: Arkansas Department of Transportation bridge inspectors found a crack in the Hernando DeSoto Bridge structure that prompted the shutdown of both the bridge and the waterways beneath the bridge. This bridge carries Interstate 40 (I-40) over the Mississippi River.	Transportation Incident	Structural concerns due to aging infrastructure	Rerouting of vessel and ground traffic (under the bridge and on the interstate). Rerouting of vessel traffic caused a three-day backup on the Mississippi River.	Regional - During the three days that the Mississippi River access was closed, there was a backup of 62 tugs carrying 1058 barges. I-40 ground traffic was rerouted to the I-55 bridge, adding up to an hour of extra travel time during peak periods.	The I-40 Hernando DeSoto Bridge had a sufficiency factor of 58.0% (with 0.0% being poor and 100.0% being very good) prior to being shutdown. The bridge that ground traffic was rerouted to, I-55, had a score of 48.5%.	Moderate	West Memphis, Arkansas and Memphis, Tennessee	X	- - -	- - -	- - -	X	- - -	X
Colonial Pipeline Ransomware Attack: In early May of 2021, a cyber attack on a pipeline system carrying gasoline and jet fuel to the southeastern United States shut down operations and impacted supply chains across the region. Colonial Pipeline supplies up to 45% of all fuel consumed on the East Coast. The attack targeted the billing infrastructure of the company, and although the pumping capacity of the pipeline was not impacted, there was fear that further attacks on vulnerable infrastructure would be carried out. The attack resulted in fuel shortages and regional emergency declarations in 17 states and Washington, D.C. The pipeline was restarted after $4.4 million worth of bitcoin was paid to release the ransomware.	Cyber Attack	A single compromised password allowed hackers remote access to the company's network	Colonial Pipeline is the largest fuel pipeline in the U.S. The pipeline was shut down for five days - this was first time the pipeline had been shut down in its 57 years of operation. The company transports roughly 2.5 million barrels of fuel daily from the Gulf Coast to the Eastern Seaboard. The shut down led to gas shortages and long lines at gas stations.	National - The fuel shortage was felt across the United States. On May 12, 2021 at 11 AM CST, five days after operations had initially stopped, the following percentages were reported for all stations in states without gasoline: Georgia-10.4%, Alabama-1.1%, Tennessee-1.0%, South Carolina-8.3%, North Carolina-16.0%, Florida-3.4%-10.2%, and Maryland-1.6%. https://www.bizjournals.com/dallas/news/2021/06/21/long-term-effects-of-colonial-pipeline-ransomware.html	Though no critical operational technology was hacked or accessed, it highlighted the risk the energy sector faces. Colonial Pipeline paid the ransom and still required a lengthy recovery period. All infrastructure with a cyber element is at risk of being derailed by a similar attack.	Severe	Southeastern/ Eastern United States	X	- - -	- - -	- - -	X	- - -	- - -
Oldsmar Water System Attack: On February 5, 2021, hackers accessed the computer network of a drinking water system in Oldsmar, Pinellas County. Within three to five minutes, the level of sodium hydroxide going into the water for treatment was changed from 100 parts per million to 11,100 parts per million. According to the Centers for Disease Control, sodium hydroxide can cause vomiting, chest and abdominal pain, skin burns, and hair loss consumed in large quantities. A technician noticed the change five hours later, reversed the command, and disabled the software without any of the tainted water reaching consumers.	Cyber Attack	Attack on software of remote employee access that granted external users remote access to maintenance operations	The water supply chain was not disrupted in any way.	Local - This water plant supplies potable water for 15,000 people in the City of Oldsmar. Danger of remote accessibility for critical infrastructure (like water).	Security risk of remote access for maintenance operations in water facilities. It received national media attention and emphasized the idea that critical infrastructure failures at any level could potentially place residents' lives at risk.	Very Low	City of Oldsmar, Pinellas County, Florida	- - -	- - -	X	- - -	X	- - -	- - -
Hacker Tries to Poison San Francisco Water Treatment Plant: The hacker had the username and password for a former employee's TeamViewer account, which allowed them to remotely control the computers. Once obtaining access, the hacker deleted programs that the water plant used to treat drinking water. The hack was not discovered until the next day when the facility changed the passwords and reinstalled the programs. There were no failures or illnesses reported as a result of this attack. https://www.nbcnews.com/tech/security/hacker-tried-poison-calif-water-supply-was-easy-entering-password-rcna1206	Cyber Attack	Attack on software of remote employee access that granted external users remote access to maintenance operations	The water supply chain was not disrupted in any way. The amount of chemicals that it would take to cause a disruption would need to be "astronomical".	Local - The water treatment plant serves a portion of the citizens in the San Francisco Bay Area. Danger of remote accessibility for critical infrastructure (like water).	Security risk of remote access for maintenance operations in water facilities. Emphasized the need for multi-factor authentication.	Very Low	San Francisco, California	- - -	- - -	X	- - -	X	- - -	- - -
Kansas Water Utility Attack Underscores Security Limitations in Municipalities: In March of 2019, a former employee of the Ellsworth County Rural Water District was able to remotely access the system using a password that had yet to be revoked. He shut down processes behind the facility's cleaning and disinfecting processes that were caught prior to any damage being reported.	Cyber Attack	Attack on software of remote employee access that granted external users remote access to maintenance operations	The water supply chain was not disrupted in any way.	Local - The water treatment plant serves the immediate community in Ellsworth County.	Security risk of remote access for maintenance operations in water facilities.	Very Low	Ellsworth County, Kansas	- - -	- - -	X	- - -	X	- - -	- - -

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Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
JBS Cyber Attack on Operations: JBS is one of the world's largest meat suppliers. The ransomware attack shut down operations in Australia, Canada, and the United States. Shut downs affected a fifth of meat production in the United States. The company paid a ransom of $11 million to gain access back. https://www.bbc.com/news/world-us-canada-57318965	Cyber Attack	Ransomware attack	13 U.S. plants were shut down for a day.	National - JBS is the biggest beef supplier in the United States in a highly consolidated industry. The shut down delayed shipments and processing of meats. No clear numbers regarding shortages, but if it had taken the company more than a couple of weeks to restore normal function, consumers would have felt the impacts of the cyber attack. This specific event magnified concern after shortages experienced during COVID-19 pandemic. https://www.cnn.com/2021/06/01/business/jbs-cyberattack-meat-shortage/index.html	Drew more attention to the consolidation of the meat industry that makes a cyber attack like this so damaging to national and global demands.	Low	Australia, Canada, and United States	X	X	---	---	---	---	---
Marten Transport Threatened by Ransomware Attack: In October of 2021, Marten Transport was a victim of a cyber attack that took more than 100 gigabytes of data, placing employee personal information at risk. The company did not report any service changes or loss in revenue resulting from the attack. https://www.freightwaves.com/news/marten-transport-discloses-cyberattack-warns-employee-data-could-be-at-risk	Cyber Attack	Ransomware attack	No known supply chain disruptions.	Local - Limited to the company; threatened exposure of personal data.	Highlighted the security risks in freight transport companies and the potential for data breaches.	Low	---	X	---	---	---	---	---	---
Expeditors Hacked and Locked out of Normal Operations: Expeditors is a Seattle-based company with over 300 global locations; it ranks as one of the world's largest logistics companies (sixth largest company globally). In February of 2022, Expeditors was forced to shut down global operating systems leaving them with limited functionality due to a ransomware attack. Significant expenses were generated to maintain services and investigate the attack. While the systems were down, the company could not book any new shipments, track where existing cargo was, or make it through customs at ports around the world. https://www.wsj.com/articles/expeditors-international-shuts-down-computer-systems-after-cyberattack-11645566461	Cyber Attack	Ransomware attack	Global operations had to shut down - Expeditors is considered a major player in the global supply chain.	International - This interrupted the entire global supply chain, resulting in more than two weeks of delays. Expeditors is a unique middleman on the supply chain scheme. They do not own any of the aircrafts, ships, or trucks that they use for operations. Rather, they are in charge of a complex logistics scheme that coordinates thousands of shipments of goods for huge companies (like HP and Walmart).	Emphasized how ill-equipped logistics companies are to handle such a cyber attack. Highlights other concerns of supply chain disruptions caused by cyber attacks.	Medium	Global	X	---	---	---	---	---	---	X
Ransomware Attack on a Small Trucking Company: Many small freight companies consider themselves safe from the cyber attacks that tend to target larger companies. One small 15-truck fleet became a victim of a ransomware attack as hackers threatened to release screenshots taken from the fleet's transportation management system. The hackers demanded a $300,000 ransom in exchange to not leak the data. https://www.freightwaves.com/news/inside-a-ransomware-attack-on-a-small-trucking-company	Cyber Attack	Poor cybersecurity at the small business level	The screenshots were not as threatening as the idea that these smaller companies (which keep so much of the American freight system running) are quite vulnerable to cyber attacks.	Regional - These small freight companies will not have the radius that larger companies have but are still essential in the supply chain.	More consideration needs to go into assuring the security of all freight.	Low	Regional	X	---	---	---	---	---	X

Case Studies Review

Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
Ransomware Attack on OmniTRAX: OmniTRAX is based in Colorado and operates 21 short line railroads in the United States and one in Canada. At some point before December 24, 2020, the company was hacked using a double-exhortation ransomware technique which involves stealing and encrypting data then demanding payment in exchange for unlocking the systems and promising not to release the data publicly. This was the first known case of this happening against a U.S. freight rail operator. https://www.freightwaves.com/news/ransomware-attack-hits-short-line-rail-operator-omnitrax	Cyber Attack	Poor cybersecurity at the small business level	No known impacts to rail operations.	Regional - Compromised operations of short line railroads could cause disruptions with the delivery of goods and services.	First instance of a freight rail attack; calls the security of the entire industry into question.	Low	Colorado	X	- - -	- - -	- - -	- - -	- - -	X
NotPetya Attack on Merck: In 2017, the NotPetya attack began as a Russian attack on Ukraine but quickly took down hundreds of other companies in collateral. One of these companies was Merck, one of the world's largest pharmaceutical companies. This attack made 30,000 computers across sales, manufacturing, and research units inaccessible. There was nothing to be done by the company for two weeks which resulted in $870 million worth in damages and $410 million in lost sales. It disrupted the production of the HPV vaccine, Gardasil, to the point that the company had to use the entire U.S. government's emergency supply. https://foreignpolicy.com/2022/02/21/merck-insurance-cyberattack-russia-ukraine-notpetya/	Cyber Attack	A cyber attack on Ukraine by Russia as an act of hostility with supply chain ripple effects outside of the target area	The cyber attack originally targeted a Ukrainian firm but caused global impacts due to the interconnectedness of the supply chain.	International - Though the cyber attack originally targeted a Ukrainian firm, it caused a ripple of impacts felt through the global supply chain. Estimated to have caused $10 billion in damages globally. The attack impacted pharmaceutical company, Merck, causing $870 million worth in damages and $410 million lost in sales. It disrupted the production of the HPV vaccine, Gardasil, to the point that the company had to use the entire U.S. government's emergency supply. It also impacted FedEx, Mondelez (food producer), Maersk, and one of the largest container ports in India.	The magnitude of the supply chain disruption is larger for customers with fewer suppliers in the same industry. https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr937.pdf	Medium	International	X	- - -	- - -	X	- - -	- - -	- - -
Attacks on AstraZeneca, Pfizer/BioNTech, and AstraZeneca: In 2020, during the race to create a COVID-19 vaccine, many drug companies were victims of cyber-attacks. North Korean actors targeted AstraZeneca employees through fake job offers on LinkedIn and WhatsApp. A 2020 report by IBN and the Ponemon Institute found that an average breach cost exceeds $5 million and takes an average of 257 days to be detected. https://www.pharmaceutical-technology.com/analysis/pharma-cyber-attacks/	Cyber Attack	Complicated chain of activity that led to difficulty in detecting hacking activity	No known supply chain disruptions.	- - -	Indicative of the threat to pharmaceuticals that can emerge from mundane locations. And on the intricacies of the breach, the companies are too large to monitor every aspect which leaves the door open to infiltrations that can go undetected and continue to cause damage for months.	Low	- - -	- - -	- - -	- - -	X	- - -	- - -	- - -
Hospital Ransomware Attack Linked to Potential First Ransomware Death: Springhill Medical Center in Mobile, Alabama was victim of a ransomware attack in 2019. Instead of paying the ransom, the center shut down systems for three weeks. This made it difficult for staff to access medical records and monitor patients' vital signs. In labor and delivery, staff were not able to use the central monitoring system with real-time vitals. Nurses were instructed to stay near the patients' rooms and consult a paper readout of the fetal heart monitor. This backfired when a baby was delivered and deprived of oxygen due to the umbilical cord as the readout and communication between the nurse and delivering doctor failed. The baby passed, and the mother is suing for medical malpractice as she was not aware of the ransomware attack when deciding to deliver at the hospital. https://www.advisory.com/daily-briefing/2021/10/12/ransomware	Cyber Attack	A ransomware attack that was not accurately conveyed to the patients or to all medical staff	No known supply chain disruptions.	Local - Limited to the Springhill Medical Center	Critical infrastructure - like medical care - is at risk of cyber threats. These cyber threats can go beyond simple inconveniences; they can cause loss of life through the denial of complete services.	Low	Mobile, Alabama	- - -	- - -	- - -	X	- - -	- - -	- - -

Case Studies Review

Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
Semitruck Crash on I-95 near Duval, Nassau County Line Backs Up Traffic in Both Directions for Hours: The driver of a semitruck failed to stay in proper lane and drove off the road to the left, flipping on the truck on its side and landing on top of the guardrail in the median. This caused the left and center northbound lanes and one southbound lane on Interstate 95 (I-95) to be closed for around eight hours. https://www.firstcoastnews.com/article/traffic/semitruck-crash-i-95-duval-nassau-county-line-backs-traffic-both-directions-for-hours/77-d713e2dd-4db3-4d12-97d8-becdfd82b2d1	Transportation Incident	Driver error	Interstate closed for hours - ground freight rerouted	Local - Limited to interstate lane shut downs. The crash occurred in between two Florida counties.	Underscores the importance of having emergency plans in place to recover quickly from every day incidents that can lead to supply chain delays.	Very Low	Duval County and Nassau County, Florida	X	---	---	---	---	---	X
Electricity Grid Cybersecurity - Department of Energy - Needs to Ensure Its Plans Fully Address Risks to Distribution Systems: In August of 2019, the United States Government Accountability Office (GAO) found that the Department of Energy's (DOE) plans and assessment for national cybersecurity strategies in critical infrastructure did not fully address the idea of a national strategy. The GAO recommended that the DOE develop a plan that addresses this. In October of 2020, the DOE issued a plan that support its Multi-Year Plan for Energy Sector Cybersecurity but it does not fully address the elements of risks. Though the severity of an attack on a distribution system might not be as significant as the bulk power system, GAO believes DOE is not prepared for the potential national significance.	Cyber Attack	---	---	---	Need for increased cybersecurity.	---	---	---	---	---	---	---	---	---
Alert (AA22-040A) 2021 Trends Show Increased Globalized Threat of Ransomware: The Cybersecurity & Infrastructure Security Agency (CISA) identified surging efforts by several ransomware groups to develop code designed to stop critical infrastructure or industrial processes. CISA offers no-cost cyber hygiene services to help critical infrastructure organizations assess, identify, and reduce their exposure to threats. The U.S. Department of State's Rewards for Justice (RFJ) program offers a reward of up to $10 million for reporting foreign government malicious activity against the United States. https://cisa.gov/uscert/ncas/alerts/aa22-040a	Cyber Attack	---	---	---	Warning on the increases in ransomware.	---	---	---	---	---	---	---	---	---
U.S. Water Supply System Being Targeted By Cybercriminals: There are 70,000 individual water and wastewater utilities across the country, many of them serving populations of less than 10,000 people. As such, many have outdated Information Technology (IT) and do not have the budget to update their cyber defenses. It could cost a small local municipality from $500,000 to a million dollars to update security to the point it should be at to defend against cyber attacks. The small utility facilities that supply most of America's water consistently do not have the skills or funds for these endeavors. https://www.forbes.com/sites/jimmagill/2021/07/25/us-water-supply-system-being-targeted-by-cybercriminals/?sh=7e20d49628e7		---	---	---	Need for increased cybersecurity on water infrastructure.	---	---	---	---	X	---	---	---	---

Case Studies Review

Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
Biden Administration Moves to Boost Cybersecurity of Water Systems: The Biden Administration has acknowledged the threat of cyber attacks and the need to bolster cybersecurity efforts, especially for smaller companies like those that run the water system. After the Colonial Pipeline incident, the Biden Administration mandated that United States pipeline operators report cyber attacks to the federal government via the Transportation Security Administration (TSA). When asked why that was not the same for water sector, a senior administration official said that the EPA “has far more limited authorities for the water sector" compared to TSA.	Cyber Attack	---	---	---	Imminent policy changes on water and cybersecurity.	---	---	---	---	X	---	---	---	---
Water Systems Face Unique Challenges from Russian Cyber Threats: Water infrastructure is unique for the number of organizations that control it, placing it at a more significant risk for cyber attacks. In recent years, operational technology systems have been installed to enable gathering remote data to support activities like metering and billing or predictive equipment maintenance. This places these systems at an even greater risk of hacking as they fail to properly protect these connections. https://www.governing.com/security/water-systems-face-unique-challenges-from-russian-cyber-threats	Cyber Attack	---	---	---	Growing threat of foreign attacks on water systems.	---	---	---	---	X	---	---	---	---
Automation in Pharmaceutical Industry Makes it a Prime Target for Cyber Attacks: The pharmaceutical industry is highly automated with little forethought to potential nation-state attacks. A report from Black Kite, a cyber-risk monitoring company, found that nearly 10% of pharmaceutical manufacturers are highly susceptible to a ransomware attack, more than 12% of pharmaceutical industry vendors are likely to incur a ransomware attack, and that almost half of all pharmaceutical companies have more than 1,000 leaked employee credentials exposed on the deep web. https://www.biospace.com/article/security-strategist-automation-makes-pharma-a-prime-target-for-cyber-attacks-/	Cyber Attack	---	---	---	The threat of automation in the pharmaceutical industry	---	---	---	---	---	X	---	---	---
Report on Improving Cybersecurity in the Health Care Industry: A report was prepared in June 2017 by a 21-member task force that worked to identify and discuss the biggest threats to the health care industry on the cybersecurity front. The Task Force identified six high level imperatives by which to organize its recommendations: define streamline leadership for health care industry cybersecurity, increase security and resilience of medical devices, develop health care workforce capacity necessary to prioritize and ensure cybersecurity awareness and technical capabilities, increase health care industry readiness through improved cybersecurity awareness and education, identify mechanisms to protect research and development efforts and intellectual property from attacks or exposure. The report describes the diversity of the health care industry that can create openings for cyber attacks.	Cyber Attack	---	---	---	Task force identified the most critical threats to healthcare via cybersecurity	---	---	---	---	---	X	---	---	---

Case Study Description	Disruption	Underlying Cause	Supply Chain Disruption	Impact	Potential Implications	Severity	Location	Industries						
								Freight	Food	Water	Medical	Critical Infrastructure	Construction	General Transportation
Vehicle Cybersecurity Department of Transportation (DOT) and Industry Have Efforts Under Way, but DOT Needs to Define Its Role in Responding to a Real-World Attack: In-Vehicle communications networks have evolved in recent decades to simplify the connections between different systems in a vehicle. Vehicles now have central communication systems connecting directly to brakes, the telematic system, engine control unit, tire pressure monitoring system, and steering control unit rather than the complicated web it once was. This can create potential vulnerabilities to cyber attacks.	Cyber Attack	---	---	---	The danger of central in-vehicle communication networks.	---	---	---	---	---	---	---	---	---	X
Threats Posed by State-Owned and State-Supported Enterprises to Public Transportation: Hearing before the Committee on Banking, Housing, and Urban Affairs of the United States Senate to discuss the growing cybersecurity threat on public transportation. The hearing emphasized the dependency of the industry on China for parts and whole vehicles in the quest for increasing the sophistication of American transit. This reliance is accompanied by the threat of cyber attacks and the risk of creating backdoors or means to infiltrate public transportation systems through these features by China once in use.	Cyber Attack	---	---	---	Risks in foreign technology that threaten public transit.	---	---	---	---	---	---	---	---	X

Appendix D – Potential Disaster Types

Potential Disaster Types

Type	Family	Event	Example	Summary PRI Results in HC LMS	SHMP Overall Vulnerability	Notes
Natural	Weather Related	Major Wind Event (Category 5 Hurricane)	Hurricane Maria in PR	***High (Minor - TD to Cat 2);*** PRI Score: 3.0; Probability: Likely, Impact: Critical, Spatial Extent: Large, Warning Time: >24 hours, Duration: < 1 Week. ***High (Major - Cat 3 to Cat 5);*** PRI Score: 3.0; Probability: Possible, Impact: Catastrophic, Spatial Extent: Large, Warning Time: >24 hours, Duration: < 1 Week. ***High (Severe Storm);*** *PRI Score: 3.1; P*robability: Highly Likely, Impact: Critical, Spatial Extent: Moderate, Warning Time: 6-12 hours, Duration: < 6 Hours.	***High (Tropical Cyclone)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: High, Environment: High) ***High (Severe Storm)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: High, Infrastructure: Medium, Environment: Low)	LMS in SHMP: Medium/High Risk for tropical cycles (SHMP 90-92, 161); LMS in SHMP: High Risk for severe storms (SHMP 90-92, 198); Hillsborough has 186,000 (Cat 2) 471,028 (Cat 5) people in the coastal flood hazard area (SHMP 163)
		Major Flood Event (52 inches in 24 hours)	Hurricane Michael in FL	***High (Flood);*** *PRI Score: 3.3;* Probability: Likely, Impact: Critical, Spatial Extent: Moderate, Warning Time: 6 to 12 hours, Duration: < 1 Week.	***High (Flood)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: High, Infrastructure: High, Environment: High)	High in LMS Table (SHMP 90-92); Not Identified in the LMS (Page 118) 86,000 people in the inland 100-year flood zone (2nd highest county population in Florida) (SHMP 120)
		Flash Flood	Hurricane Ida in NYC	***High (Flood);*** PRI Score: 3.3; Probability: Likely, Impact: Critical, Spatial Extent: Moderate, Warning Time: 6 to 12 hours, Duration: < 1 Week.	***High (Flood)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: High, Infrastructure: High, Environment: High)	High in LMS Table (SHMP 90-92); Not Identified in the LMS (LMS 118); 86,000 people in the inland 100-year flood zone (2nd highest county population in Florida) (SHMP 120)
		Tornado	2011 Joplin Tornado	***Moderate (Tornado);*** PRI Score: 2.7; Probability: Likely, Impact: Critical, Spatial Extent: Small, Warning Time: <6 hours, Duration: < 6 Hours.	(Not specifically analyzed, part of the severe storms hazard profile)	High in LMS Table (SHMP 90-92); LMS: low risk for tornados (SHMP 199)
		Wildfire	2018 Camp Fire in CA	***Moderate (Wildfire)*** PRI Score: 2.8; Probability: Likely, Impact: Limited, Spatial Extent: Moderate, Warning Time: <6 hours, Duration: < 1 Week.	***High (Wildfire)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: Medium, Infrastructure: Medium, Environment: High)	LMS in SHMP: High Risk for wildfires (SHMP 90-92, 213)
		Extreme Heat	---	***Moderate (Extreme Heat);*** PRI Score: 2.5; Probability: Likely, Impact: Minor, Spatial Extent: Large, Warning Time: >24 hours, Duration: > 1 Week.	***High (Extreme Heat)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: High, Infrastructure: Low, Environment: Low)	Low in LMS Table (SHMP 90-92); LMS: Not Identified for Extreme Heat (SHMP 235)
		Extreme Cold	2021 Texas Power Crisis	***Low (Winter Storm and Freeze);*** PRI Score: 2.1; Probability: Possible, Impact: Minor, Spatial Extent: Large, Warning Time: > 24 hours, Duration: < 1 Week.	***Medium (Winter Storm and Freeze)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: Medium, Infrastructure: Low, Environment: Medium)	Low in LMS Table (SHMP 90-92); LMS: Not identified for freeze hazard (SHMP 275)
		Winter Storm	2021 Texas Power Crisis	***Low (Winter Storm and Freeze);*** PRI Score: 2.1; Probability: Possible, Impact: Minor, Spatial Extent: Large, Warning Time: > 24 hours, Duration: < 1 Week.	***Medium (Winter Storm and Freeze)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: Medium, Infrastructure: Low, Environment: Medium)	LMS in SHMP: Low Risk for Winter Storms (SHMP 90-92, 274)
		Severe Drought	Ongoing California Drought	***Moderate (Drought);*** PRI Score: 2.5; Probability: Likely, Impact: Minor, Spatial Extent: Large, Warning Time: > 24 hours, Duration: > 1 Week.	***Medium (Drought)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: Low, Infrastructure: Low, Environment: Medium)	LMS in SHMP: Low Risk for Drought (SHMP 90-92, 248)
		Space Weather Incident	---	***High (Space Weather);*** PRI Score: 2.8; Probability: Unlikely, Impact: Catastrophic, Spatial Extent: Large, Warning Time: < 6 hours, Duration: < 6 Hours.	***Medium (Space Weather Incident)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: Medium, Infrastructure: Medium, Environment: Low)	---

Potential Disaster Types

Type	Family	Event	Example	Summary PRI Results in HC LMS	SHMP Overall Vulnerability	Notes
Natural	Geological/ Seismic	Earthquake	---	***Low (Seismic Event);*** PRI Score: 2.5; Probability: Possible, Impact: Minor, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: < 6 Hours.	***Low (Seismic Events)*** (Frequency; Not Likely, Probability: Not Likely, Injuries/Deaths: Low, Infrastructure: Low, Environment: Low)	LMS: Not Identified for seismic hazards (SHMP 90-92, 286)
		Sinkhole/Subsidence	---	***Moderate (Suspect Soil);*** PRI Score: 2.5; Probability: Likely, Impact: Limited, Spatial Extent: Small, Warning Time: < 6 hours, Duration: < 24 Hours.	***Medium (Geological)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: Medium, Environment: Low)	LMS: Medium risk for sinkholes (SHMP 90-92); Links to SLR? (not mentioned in SHMP for SLR, but increased extreme weather from Climate Change could make this worse); Hillsborough listed as a "most favorable" county for sinkholes by FDEP
		Subsidence Related Waste Leak (Phosphate)	---	---	---	---
		Coastal Erosion	---	***Moderate (Erosion);*** PRI Score: 2.6; Probability: Likely, Impact: Limited, Spatial Extent: Moderate, Warning Time: >24 hours, Duration: > 1 Week.	***High (Erosion)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: Low, Infrastructure: Medium, Environment: Medium)	Low Risk in LMS Table (SHMP 90-92); LMS: Medium risk for erosion (SHMP 225)
		Tsunami	---	***Low (Tsunami);*** PRI Score: 1.8; Probability: Unlikely, Impact: Limited, Spatial Extent: Small, Warning Time: < 6 hours, Duration: < 6 Hours.	***Low (Tsunami)*** (Frequency; Not Likely, Probability: Not Likely, Injuries/Deaths: Low, Infrastructure: Low, Environment: Low)	Not impacted by Climate Change (SHMP 290)
		Landslide	---	---	---	Not Identified in LMS Table (SHMP 90-92); Not likely in Florida (SHMP 257)
	Biological	Red Tide/Algae Bloom	---	***Moderate (Disease Outbreak and Biologic Incident);*** PRI Score: 2.3; Probability: Likely, Impact: Limited, Spatial Extent: Small, Warning Time: > 24 hours, Duration: < 1 Week.	Medium (Biological Incident) (Frequency: Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: Low, Environment: Low)	Biological Incident (or similar) identified in the HC LMS (SHMP 408)
		Water Supply Contamination	---	***Moderate (Disease Outbreak and Biologic Incident);*** PRI Score: 2.3; Probability: Likely, Impact: Limited, Spatial Extent: Small, Warning Time: > 24 hours, Duration: < 1 Week.	***Medium (Biological Incident)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: Low, Environment: Low)	Biological Incident (or similar) identified in the HC LMS (SHMP 408)
		Stormwater Intrusion Contamination	---	***Moderate (Disease Outbreak and Biologic Incident);*** PRI Score: 2.3; Probability: Likely, Impact: Limited, Spatial Extent: Small, Warning Time: > 24 hours, Duration: < 1 Week.	***Medium (Biological Incident)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: Low, Environment: Low)	Biological Incident (or similar) identified in the HC LMS (SHMP 408)
		Pandemic (Human)	---	***Moderate (Disease Outbreak and Biologic Incident & Food and Waterborne Disease Outbreak);*** PRI Score: 2.3; Probability: Likely, Impact: Limited, Spatial Extent: Small, Warning Time: > 24 hours, Duration: < 1 Week.	***Medium (Biological Incident)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: Low, Environment: Low)	Biological Incident (or similar) identified in the HC LMS (SHMP 408)
		Pandemic (Livestock)	---	***High (Agricultural Disruption);*** PRI Score: 3.1; Probability: Likely, Impact: Limited, Spatial Extent: Large, Warning Time: < 6 hours, Duration: > 1 Week.	***High (Agricultural Disruption)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: Low, Infrastructure: High, Environment: High)	Agricultural Disruption or Pests and Diseases listed in HC's LMS (SHMP 396)
		Crop Failure	---	***High (Agricultural Disruption);*** PRI Score: 3.1; Probability: Likely, Impact: Limited, Spatial Extent: Large, Warning Time: < 6 hours, Duration: > 1 Week.	***High (Agricultural Disruption)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: Low, Infrastructure: High, Environment: High)	Agricultural Disruption or Pests and Diseases listed in HC's LMS (SHMP 396)

Potential Disaster Types

Type	Family	Event	Example	Summary PRI Results in HC LMS	SHMP Overall Vulnerability	Notes
Human	Accidents	Oil Spill/Chemical Spill	---	***High (HazMat Incident);*** PRI Score: 2.9; Probability: Possible, Impact: Critical, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: > 1 Week.	***Medium (Hazardous Materials Incident)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: Medium, Infrastructure: Medium, Environment: Medium)	HC has natural gas pipelines (SHMP 305)
		Industrial Accident	West, Texas	***High (HazMat Incident);*** PRI Score: 2.9; Probability: Possible, Impact: Critical, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: > 1 Week.	***Medium (Hazardous Materials Incident)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: Medium, Infrastructure: Medium, Environment: Medium)	Medium Risk in LMS Table (Technological Incident)(SHMP 90-92); Hazardous materials addressed in the LMS for Hillsborough (SHMP 337)
		Nuclear Materials Accident	---	---	***Medium (Radiological Incidents)*** (Frequency; Not Likely, Probability: Not Likely, Injuries/Deaths: High, Infrastructure: Medium, Environment: Medium)	Medium Risk in LMS Table (Technological Incident)(SHMP 90-92);Radiological Event addressed in the Hillsborough County LMS; Hillsborough County not in the EPZ or the IPZ of the nearest nuclear plant. Plant was decommissioned in 2013 (SHMP 357)
		Major Roadway Accident	Atlanta	***High (Transportation Incident);*** PRI Score: 2.8; Probability: Possible, Impact: Critical, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: < 1 Week.	***High (Transportation Incidents)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: High, Infrastructure: Medium, Environment: Medium)	Parts of Hillsborough County within the highest area for fog risk. (SHMP 298)
		Brownouts/ Power Interruption	---	---	---	Medium Risk in LMS Table (Technological Incident)(SHMP 90-92)
		Dam Failure	---	***Medium (Dam/Levee Failure);*** PRI Score: 2.3; Probability: Unlikely, Impact: Critical, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: < 6 Hours.	---	Medium Risk in LMS Table (SHMP 90-92); High or significant hazard dam identified (SHMP 110)
	Terrorism	Transportation Sabotage	---	***Moderate (Infrastructure Disruption);*** PRI Score: 2.5; Probability: Possible, Impact: Limited, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: < 1 Week. ***High (Terrorism);*** PRI Score: 2.9; Probability: Possible, Impact: Critical, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: > 1 Week.	***High (Terrorism)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: High, Environment: Medium)	Low Risk in LMS Table (Terrorism)(SHMP 90-92); HC has natural gas pipelines (SHMP 305); Terrorism included in the Hillsborough LMS (SHMP 379).
		Explosive Attack	---	***High (Terrorism);*** PRI Score: 2.9; Probability: Possible, Impact: Critical, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: > 1 Week.	***High (Terrorism)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: High, Environment: Medium)	Low Risk in LMS Table (Terrorism)(SHMP 90-92); Terrorism included in the Hillsborough LMS (SHMP 379).
		Cyber Attack	PG&E Northern California	***Moderate (Cyberterrorism);*** PRI Score: 2.5; Probability: Possible, Impact: Limited, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: < 1 Week.	***High (Cyber Incident)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: High, Infrastructure: Medium, Environment: Low)	Low Risk in LMS Table (Terrorism)(SHMP 90-92); Cyber Incident Included in LMS for Hillsborough County (SHMP 336)
		EMP	---	***Moderate (Infrastructure Disruption);*** PRI Score: 2.5; Probability: Possible, Impact: Limited, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: < 1 Week.	***High (Terrorism)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: High, Environment: Medium)	Low Risk in LMS Table (Terrorism)(SHMP 90-92)
		Nuclear Attack	---	***High (Terrorism);*** PRI Score: 2.9; Probability: Possible, Impact: Critical, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: > 1 Week.	***High (Terrorism)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: High, Environment: Medium)	Low Risk in LMS Table (Terrorism)(SHMP 90-92)
		Dirty Bomb	---	***High (Terrorism);*** PRI Score: 2.9; Probability: Possible, Impact: Critical, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: > 1 Week.	***High (Terrorism)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: High, Environment: Medium)	Low Risk in LMS Table (Terrorism)(SHMP 90-92)

Potential Disaster Types

Type	Family	Event	Example	Summary PRI Results in HC LMS	SHMP Overall Vulnerability	Notes
Human	Social Upheaval	Human Trafficking	---	---	---	---
		Social Unrest	---	***High (Civil Disturbance);*** PRI Score: 2.8; Probability: Possible, Impact: Critical, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: < 1 Week.	***Medium (Civil Disturbance)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: Medium, Infrastructure: Medium, Environment: Low)	---
		Labor Shortage (Truck Drivers)	---	---	---	---
		General Strike	---	***Moderate (Infrastructure Disruption);*** PRI Score: 2.5; Probability: Possible, Impact: Limited, Spatial Extent: Moderate, Warning Time: < 6 hours, Duration: < 1 Week.	***Medium (Civil Disturbance)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: Medium, Infrastructure: Medium, Environment: Low)	---
		Mass Migration (Conflict Related)	---	***Low (Mass Migration);*** PRI Score: 1.7; Probability: Unlikely, Impact: Minor, Spatial Extent: Moderate, Warning Time: > 24 hours, Duration: > 1 Week.	***Medium (Mass Migration)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: Low, Environment: Low)	Low Risk in LMS Table (Mass Migration)(SHMP 90-92)
		Mass Migration (Weather Event Related)	---	***Low (Mass Migration);*** PRI Score: 1.7; Probability: Unlikely, Impact: Minor, Spatial Extent: Moderate, Warning Time: > 24 hours, Duration: > 1 Week.	***Medium (Mass Migration)*** (Frequency; Likely, Probability: Likely, Injuries/Deaths: High, Infrastructure: Low, Environment: Low)	Low Risk in LMS Table (Mass Migration)(SHMP 90-92)
		Banking Crisis	---	---	---	---
		Economic Collapse	---	---	---	---
		Agricultural Disruption	---	***High (Agricultural Disruption);*** PRI Score: 3.1; Probability: Likely, Impact: Limited, Spatial Extent: Large, Warning Time: < 6 hours, Duration: > 1 Week.	***High (Agricultural Disruption)*** (Frequency; Very Likely, Probability: Very Likely, Injuries/Deaths: Low, Infrastructure: High, Environment: High)	Agricultural Disruption or Pests and Diseases listed in HC's LMS (SHMP 396)
		Supply-Chain Disruption (Water)	---	---	---	---
		Supply-Chain Disruption (Gas)	---	***Moderate (Food and Waterborne Disease Outbreak);*** PRI Score: 2.3; Probability: Likely, Impact: Limited, Spatial Extent: Small, Warning Time: > 24 hours, Duration: < 1 Week.	---	---
		Supply-Chain Disruption (Food)	---	***Moderate (Food and Waterborne Disease Outbreak);*** PRI Score: 2.3; Probability: Likely, Impact: Limited, Spatial Extent: Small, Warning Time: > 24 hours, Duration: < 1 Week.	---	---
		Supply-Chain Disruption (Medicine)	---	---	---	---

Appendix E – Disaster Scenario Write-Ups

Disaster Scenario Write-Up Parameters

Disaster Type	**Cyber Attack, Transportation Incident, Flooding/Wind Event, etc.**
Scenario	Narrative of the disaster scenario
Duration	Duration of event
Scope	Scope of event (e.g.: Localized, Regional, Widespread)
Severity	Severity of event (e.g.: Minimal, Moderate, Severe)
Impact on Supply Chains	Impact of the event on supply chains
Impact on Environment	Impact of the event on the environment
Impact on Society	Impact of the event on society, especially socially vulnerable communities
Immediate Recovery (Response)	Duration of time to fix operations/logistics of supply chains to perform at a basic/bare minimum level
Long Term Recovery (Response)	Duration of time to fix operations/logistics of supply chains to perform at a normal level (pre-disaster event)
Casualty Potential	Potential for the event to have human casualties

Cyber Attack

Scenario	A Supervisory Control and Data Acquisition (SCADA) system of the Tampa Electric network has been infiltrated and compromised by malware, disabling operators from making necessary commands and creating subsequent blackouts. A SCADA system is responsible for gathering data from various substations and processing it. The system is used to monitor energy usage, telecommunications, and several other elements of the electric grid. The hackers installed malware into devices used to communicate with Tampa Electric substations and remotely opened substation circuit breakers, gaining access to all 79 network substations and taking them offline. This event is similar to the Russian attack on the Ukrainian Prykarpattyaoblenergo Control Center (PCC) in December 2015[1].
Duration	72-hour widespread power outage (minimum definition of a long-term outage according to the Power Outage Incident Annex to the Response and Recovery Federal Interagency Operational Plans).
Scope	Regional (Hillsborough County and small sections of neighboring counties). As of 2018, Tampa Electric serves approximately 2,000 square miles with over 725,000 residential, commercial, and industrial customers.
Severity	Severe
Impact on Supply Chains	- Entire Tampa Electric network is hit and rendered inoperable. - Hospitals rely on their generators. Hospitals are required to ensure generators run for 96 hours; however, generators only allow 40 percent of each hospital to be powered. There are extra services required resulting from accidents, and non-essential services fail to operate at necessary capacity due to the outage. - Generators are required to preserve perishable goods; over 1,000 tons of perishable goods are lost in stores and in warehouses without adequate generators as frozen goods are not able to be sold after four hours in an environment without electricity, accordingly to U.S. Food and Drug Administration regulation. (In 2019, when energy companies in California cut power to 800,000 customers to prevent forest fires, the majority of perishable food was donated or thrown away.) - 40% of the water processing capability in potable water plants is lost as losing electricity prevents other SCADA processes (water and other utilities) even in cases where the facility is maintained by in-house generators. - Water in towers will serve customers for another 12 hours (approximate standard time); water will run out after this duration if

[1] https://www.globalsign.com/en/blog/cyber-autopsy-series-ukranian-power-grid-attack-makes-history#:~:text=It%20is%20the%20world's%20first,30%20substations%20for%20three%20hours.

	electricity is not restored. This will become a larger issue if fires break out during the outage due to loss of ability to pump water. - Sewage plants malfunction causing raw sewage to contaminate waterways. (Consider 2017 windstorm in Wyoming that knocked out large power lines. Water and sewage treatment continued initially but the pumps that moved sewage from low-lying areas to the treatment plants on higher grounds were not designed to have generators. Residents of affected city had to evacuate; power was restored within a week (https://hbr.org/2020/01/how-to-safeguard-against-cyberattacks-on-utilities).) - Air traffic control is unable to communicate with flights. Runway lights and other safety features are inoperable creating dangerous landing situations. Hydrogen and other fuel vehicles of airports are inoperable as electric power is needed to support the fuel distribution system for these vehicles. - Traffic signals and all streetlights in Hillsborough County are inoperable, causing unsafe driving conditions. Consumer and fleet electric vehicles are inoperable as they cannot be charged. - While emergency dispatch is still operable, smaller field offices and members of the public have difficulty communicating as cell phones run out of battery and non-central office locations run out of generator capabilities. (The minimum Federal Communications Commission requirement for central offices is to maintain at least 24 hours of backup power and sites that are not part of a central office to maintain at least 8 hours of backup. Central offices directly connected to Public Safety Answering Points (PSAPs) or house databases that serve 9-1-1 are required to annually certify that they meet 24-hour backups under full loads. For central offices that house 9-1-1 routing equipment, the annual certification is for 72 hours of backup under full load (oshi.gov).) - Communications infrastructure is limited as portions of the network are down. Cellular towers are required to have a minimum of 8 hours of backup under nominal loading, but many can operate for 12-24 hours before needing to be refueled. - Interruption to fuel supplies as panic buying compounds immediate issues of unloading fuel at Port Tampa Bay, and 30% of gas stations are closed due to the power outage. - Without communications infrastructure, port authorities are unable to coordinate deliveries and dockings as record keeping has become increasingly electronic. Shipments are delayed as power outage has made it impossible to access or record new information. Port areas are heavily dependent on electricity; the fuel offloading process is automated. There is no ability at present to manually offload fuel. Perishable goods are rerouted or stored in areas with generators. There are no requirements for ports to have generators; many port area functions are powered by diesel.

Impact on Environment	- There are disruptions to environmental regulatory infrastructure, causing sewage backups and contaminations of other varieties. (While standard best practices from the United States Environmental Protection Agency encourage backup power services for sewage, there are no statutory requirements.) - Organizations, companies, and residents of Hillsborough County switching to generators temporarily creates greater consumption of unclean fuels (like diesel), which impacts air quality negatively.
Impact on Society	- Panic generated from the power outage promotes fuel shortages and shortages of other goods as people overbuy. - Lower-income persons that live in food deserts are at a disadvantage in preserving food supply and obtaining groceries during the blackout. - Crime increases during the event; multiple businesses are looted during the outage.
Immediate Recovery (Response)	Power to 20% of Hillsborough County is restored within the first 24 hours.
Long Term Recovery (Response)	Partial restoration of power creates an unstable power grid which provokes cascading shutdowns, taking previously restored areas offline, resulting in some areas without power for weeks.
Casualty Potential	Moderate: 7 killed as some essential services are shut down and hospitals are unable to provide certain medical services (similar to what happened with assisted living facilities during Hurricane Irma). Deaths and injuries are compounded by overheating conditions created due to lack of power.

Transportation Incident

Scenario	A tanker truck heading eastbound on I-4 at 3:00 PM mid-week collides with the median supports of the southbound I-75 overpass. The tanker truck immediately catches on fire. The impacted overpass supports weaken due to both the collision and vehicle fire, causing the southbound I-75 bridge (or overpass) to collapse. This incident results in traffic coming to a standstill at the I-4/I-75 interchange as the mainlines are blocked on southbound I-75 and on I-4 in both directions. I-4 is a six-lane, east-west roadway with an Annual Average Daily Traffic (AADT) volume of 152,500 vehicles per day and a truck AADT volume of 17,538 trucks per day. I-75 is a six-lane, north-south roadway with an AADT volume of 148,000 vehicles per day and a truck AADT volume of 17,822 trucks per day. The northbound and southbound lanes of I-75 are carried over I-4 on separate bridge structures. The southbound I-75 bridge structure consists of seven spans with six sets of supports. The northern second and third spans of the southbound I-75 bridge cover the westbound and eastbound lanes of I-4; the supports for these spans are located in the I-4 median. The impacted southbound I-75 bridge spans are approximately 91 feet and 97 feet in length, respectively. This event is similar to the Atlanta I-85 Fire and Viaduct Collapse Case Study that occurred in March 2017[2].
Duration	Collision and collapse duration is one hour.
Scope	Regional (West Coast of Florida)
Severity	Severe
Impact on Supply Chains	- Three-day blockage of interstate for initial response (two days for demolition work and one day for site repaving and setting up safety measures/maintenance of traffic). - Southbound traffic blocked on I-75 and eastbound and westbound traffic blocked on I-4. Northbound I-75 traffic blocked intermittently (as needed) while clean-up, site repaving, maintenance of traffic, etc. activities are being conducted. - Approximately 5.6 miles of southbound I-75 is closed between exit 265 (SR 582/Fowler Ave/Temple Terrace) and exit 260 (SR 574/Dr Martin Luther King Jr Blvd). This same stretch of northbound I-75 is closed intermittently as noted above. - Approximately 3.3 miles of eastbound and westbound I-4 is closed from exit 7 (US 301/US 92 East/Riverview/Zephyrhills) to exit 10 (CR 579/Mango/Thonotosassa). - Main detour route for I-75 is along US 301 with US 41, SR 583/50th St, Williams Rd, and Harney Rd serving as alternate routes.

[2] https://www.ntsb.gov/investigations/AccidentReports/Reports/HAB1802.pdf

	- Main detour route for I-4 is along US 92 with Selmon Expy, SR 60, US 92, SR 574/Dr Martin Luther King Jr Blvd, SR 580/Busch Blvd/Bullard Pkwy) serving as alternate routes. - I-75 traffic and I-4 traffic on the main detour routes will need to merge across a single point (where US 301 and US 92 converge), creating additional traffic congestion. - North/South traffic experiences more severe cascading impacts as there are not as many upgraded arterial alternatives as East/West travel. - After 24 hours of disruption, the governor issues an emergency declaration and waives rest hours and weight limits for trucks. - I-4 is a significant corridor for non-pipeline fuel; transport of this fuel is disrupted by the event. In addition, as diesel and gasoline from the Central Florida Pipeline arrive at Port Tampa Bay, the incident causes fuel delivery delays and shortages, especially at gas stations west of I-4. - Many logistics facilities and companies along I-4 and US 301 are cut off by the I-4 closure or have significant access delays (such as Rooms to Go and Amazon on Mango Rd; Old Dominion Freight Line, Southport Truck Group, Americold Logistics, Goodman Distribution, Axis Redistribution, Amazon Fresh and DHL on US 301; New South Window Solutions, Ferguson HVAC Supply, American Metals Supply, Colonial Distributing, and Commercial Duct Systems on Williams Rd; and Hillsborough County School Buses on Harney Rd). - Cascading delays are occurring on the major detour routes around the Hillsborough County Public Safety Operations Complex (PSOC), including SR 60 to the south, SR 574/Dr Martin Luther King Jr Blvd to the north, US 301 to the west, and Williams Rd to the east. These roadways, along with I-75, create a box around PSOC, making emergency response and coordination difficult. - Detouring traffic causes gridlock on US 301 to the west and Williams Rd to the east as well as roadway reliability interruption for access to the Tampa Executive Airport. (In an interview with the airport, roadway access to the airport was identified as currently inadequate; the airport is also the 2nd most resilient air facility in the area and a future depot for alternative air mobility vehicles.)
Impact on Environment	- More dwell for trucks classes 9 and up cause more carbon dioxide emissions (twice as high) - Hazmat materials involved in the crash include diesel fuel, tanker fuels, and other volatile liquids. Hazmat release from the site drains to the Palm River with downstream Environmental Justice (EJ) communities.
Impact on Society	- More dwell for trucks classes 9 and up means more carbon dioxide emissions and other harmful fumes and noise as well as trucks hauling hazmat through unfamiliar neighborhoods with EJ communities.

	- Temporal/geographical inflexibility of bus routes limit access to jobs and essential services for EJ communities.
Immediate Recovery (Response)	Three-day blockage of interstate (two days for demolition work and one day for site repaving and setting up safety measures/maintenance of traffic). Temporary solutions to reopen I-4 and I-75 include: 1. Establish safety, address casualties, and clear debris; 2. Establish detours/maintenance of traffic plan; 3. Begin repairs/construction.
Long Term Recovery (Response)	1.5 to 2 months to rebuild based on the 2017 Atlanta I-85 Fire and Viaduct Collapse Case Study and 2001 Veterans Expressway Bridge Collapse in Hillsborough County.
Casualty Potential	Two deaths and seven injuries due to the crash.

Flooding/Wind Event

Scenario	Category 5 Hurricane Chaos makes landfall in Downtown Tampa lasting 24 hours. This event is similar to Hurricane Michael (which occurred in October 2018), Superstorm Sandy (which occurred in October 2012), and Hurricane Katrina (which occurred in August 2005).
Duration	The storm lasts 24 hours.
Scope	Widespread from Monroe/Collier Counties and the City of Naples in the south to Okaloosa County and the City of Destin in the north.
Severity	Catastrophic
Impact on Supply Chains	- Westshore, western part of South Tampa, MacDill Air Force Base, Bayshore Boulevard, Davis and Harbour Islands, Downtown Tampa waterfront, Port Tampa Bay and Port Tampa, as well as Palm River areas experience 20-37 feet of storm surge. - CSX Uceta Yard is under 3 to 20 feet of water; all areas are above axle level of train car (13-inch threshold). - Tampa International Airport is under 3 to 37 feet of water depending on elevation; the entire footprint is in the inundation zone. Tampa Executive Airport is completely inundated by 9 to 15 feet of water. - All of Tampa General Hospital and portions of St Joseph's Hospital are inundated. Most major roads leading to St Joseph's Hospital experience inundation (SR 574/Dr Martin Luther King Jr Blvd to the east by the Hillsborough River, western approaches to the hospital, and Armenia Ave to the south near Columbus Dr and to the north by SR 574/Dr Martin Luther King Jr Blvd). - Inundated roadways include I-275 north of the Hillsborough River, I-275 west of Dale Mabry Hwy, I-75 and I-4 near the interchange, I-75 near Riverview, and most of Selmon Expy. - Hillsborough County Public Safety Operations Complex (PSOC) is not inundated, but access is difficult due to inundation at Falkenburg Rd north of Broadway Ave, Broadway Ave both east and west of Falkenburg Rd, Columbus Dr west of Falkenburg Rd, and Falkenburg Rd at SR 60. The only roadway providing access to the rest of the network would be Woodbury Rd via the I-75 underpass. - Approximately 9 inches of rain fall across the impact area; this causes inland flooding within the 100-year flood zone. Culverts and catch basins fill with debris, causing localized flooding. It takes two weeks to fully clear debris from the inland flooding areas. - All port areas (Port Tampa Bay and Port Tampa) fully out of service for 5 days or longer; reduced depth in the shipping channels to both port areas (based on Hurricane Harvey). - Fuel shortages during the evacuation period and after as infrastructure is repaired.

	- Damage to the electrical system; some areas without power for weeks. - Transmission and distribution systems require replacement in coastal impact areas. Composite transmission pole areas need service but not replacement, and all wooden poles require full replacement. - Big Bend and Bayside Power Stations are inundated with 20 to 37 feet of water. Both plants are severely damaged, taking 3,500 megawatts of Tampa Electric's approximately 5,000 megawatts of power generation capability down for one to two months. - Residences flooded and damaged/compromised structures of businesses, warehouses, etc. impact distribution and retail capabilities.
Impact on Environment	- Ecological damage primarily from storm surge with secondary damages from winds. - Flood inundation distributes petrochemical and biological contaminants at street grade caused by storm surge, riverine impacts from storm surge, and localized flooding from the stormwater management system. - Widespread sewage backflows into homes and businesses. - Local saltwater intrusion into the groundwater threatening the Floridan Aquifer. - Two phosphate gypsum stacks are located in or next to the inundation zone north of the Alafia River near Gibsonton. Contaminated water from these stacks escapes and enters Tampa Bay as well as groundwater. - Potential for hazmat release that drains to the Palm River with downstream Environmental Justice (EJ) communities. - More dwell for trucks classes 9 and up cause more carbon dioxide emissions (twice as high)
Impact on Society	- Access to shelter at Jennings Middle School is inundated with 3 to 6 feet of water, and inundation comes to within 250 feet of the shelter at Boyette Springs Elementary - Evacuation efforts did not result in the mandatory evacuation of an estimated 63,000 transit-dependent residents. - Many households were severely impacted by coastal flooding that resulted in major loss of life and injury. - Adverse health impacts, especially for socially vulnerable populations, are experienced due to a lack of essential readiness supplies while sheltering in place. - Roadway impacts inhibit temporary location to Hillsborough County and City of Tampa emergency shelters. - Severe impacts to grocery stores, pharmacies, and restaurants limit availability of food and medicine. - The event resulted in 4100 air evacuations.

Immediate Recovery (Response)	Two weeks to clear all debris from inundated areas and roadways. Two to three months for power recovery in the inundated areas.
Long Term Recovery (Response)	Two years to rebuild all damaged infrastructure.
Casualty Potential	High: An estimated 2,000 resident deaths from direct hurricane impacts (such as drowning in floodwaters, car accidents and washouts, etc.). Secondary impacts (such as lack of emergency medical and trauma care) resulted in a significant number of deaths not yet quantified.

Cyber Attack + Transportation Incident

Scenario	A Supervisory Control and Data Acquisition (SCADA) system of the Tampa Electric network has been infiltrated and compromised by malware, disabling operators from making necessary commands and creating subsequent blackouts. The hackers installed malware into devices used to communicate with Tampa Electric substations and remotely opened substation circuit breakers, gaining access to all 79 network substations and taking them offline. During this disruption, a tanker truck heading eastbound on I-4 collides with the median supports of the southbound I-75 overpass. The tanker truck immediately catches on fire. The impacted overpass supports weaken due to both the collision and vehicle fire, causing the southbound I-75 bridge (or overpass) to collapse. This incident results in traffic coming to a standstill at the I-4/I-75 interchange as the mainlines are blocked on southbound I-75 and on I-4 in both directions.
Duration	The widespread power outage lasts 72 hours; the vehicle collision and I-75 bridge collapse duration is one hour.
Scope	The power outage impact is regional, affecting Hillsborough County and small sections of neighboring counties. Traffic impacts from the collision and I-75 bridge collapse are also felt at a regional scale; impacts are concentrated within the West Coast of Florida.
Severity	Severe
Impact on Supply Chains	- The SCADA attack impacts communications throughout the West Coast of Florida and complicates the rescue response at the transportation incident. The entire Tampa Electric network is rendered inoperable as a result of the attack. - Emergency management efforts are somewhat split and reduced as the response to the cyber attack and response to the transportation incident are handled by different agencies that generally have different equipment needs. - Due to the power outage, hospitals rely on their generators. Hospitals are required to ensure generators run for 96 hours; however, generators only allow 40 percent of each hospital to be powered. There are extra services required resulting from accidents, and non-essential services fail to operate at necessary capacity. - Due to the power outage, over 1,000 tons of perishable goods are lost in stores and in warehouses without adequate generators as frozen goods are not able to be sold after four hours in an environment without electricity. - Due to the power outage, 40% of the water processing capability in potable water plants is lost as losing electricity prevents other SCADA processes (water and other utilities) even in cases where the facility is maintained by in-house generators. - Water in towers will serve customers for another 12 hours (approximate standard time); water will run out after this duration if electricity is not restored. This is an issue with the large vehicle fire

	occurring as a result of the collision as the fire department is having difficulty pumping water due to the power outage. - Due to the power outage, sewage plants malfunction causing raw sewage to contaminate waterways. - Due to the power outage, air traffic control is unable to communicate with flights. Runway lights and other safety features are inoperable creating dangerous landing situations. Hydrogen and other fuel vehicles of airports are inoperable as electric power is needed to support the fuel distribution system for these vehicles. - Due to the power outage, traffic signals and all streetlights in Hillsborough County are inoperable, causing unsafe driving conditions. Consumer and fleet electric vehicles are inoperable as they cannot be charged. These unsafe conditions are compounded as drivers use alternative routes to avoid I-75 and I-4 in the collision area. North/ South traffic experiences more severe cascading impacts as there are not as many upgraded arterial alternatives as East/West travel. - Due to the transportation incident, there is a three-day blockage of the interstate for initial response (two days for demolition work and one day for site repaving and setting up safety measures/maintenance of traffic). - Due to the transportation incident, southbound traffic blocked on I-75 and eastbound and westbound traffic blocked on I-4. Northbound I-75 traffic blocked intermittently (as needed) while clean-up, site repaving, maintenance of traffic, etc. activities are being conducted. - Due to the transportation incident, approximately 5.6 miles of southbound I-75 is closed between exit 265 (SR 582/Fowler Ave/ Temple Terrace) and exit 260 (SR 574/Dr Martin Luther King Jr Blvd). This same stretch of northbound I-75 is closed intermittently as noted above. - Due to the transportation incident, approximately 3.3 miles of eastbound and westbound I-4 is closed from exit 7 (US 301/US 92 East/Riverview/Zephyrhills) to exit 10 (CR 579/Mango/Thonotosassa). - While emergency dispatch is still operable due to the power outage, smaller field offices and members of the public have difficulty communicating as cell phones run out of battery and non-central office locations run out of generator capabilities. Stress on the emergency dispatch system is compounded with the current transportation incident and subsequent traffic incidents as a result of extreme congestion and inoperable traffic signals. - Due to the transportation incident, cascading delays are occurring on the major detour routes around the Hillsborough County Public Safety Operations Complex (PSOC), including SR 60 to the south, SR 574/Dr Martin Luther King Jr Blvd to the north, US 301 to the west, and Williams Rd to the east. These roadways, along with I-75, create a box around PSOC, making emergency response and coordination difficult.

	- Due to the power outage, communications infrastructure is limited as portions of the network are down. - Interruption to fuel supplies as panic buying compounds immediate issues of unloading fuel at Port Tampa Bay, and 30% of gas stations are closed due to the power outage. - Without communications infrastructure due to the power outage, port authorities are unable to coordinate deliveries and dockings as record keeping has become increasingly electronic. Shipments are delayed as power outage has made it impossible to access or record new information. Port areas are heavily dependent on electricity; the fuel offloading process is automated. There is no ability at present to manually offload fuel. Perishable goods are rerouted or stored in areas with generators. There are no requirements for ports to have generators; many port area functions are powered by diesel. - I-4 is a significant corridor for non-pipeline fuel; transport of this fuel is disrupted by the transportation incident. In addition, as diesel and gasoline from the Central Florida Pipeline arrive at Port Tampa Bay, the two events cause major fuel delivery delays and shortages, especially at gas stations west of I-4. - Many logistics facilities and companies along I-4 and US 301 are cut off by the I-4 closure or have significant access delays (such as Rooms to Go and Amazon on Mango Rd; Old Dominion Freight Line, Southport Truck Group, Americold Logistics, Goodman Distribution, Axis Redistribution, Amazon Fresh and DHL on US 301; New South Window Solutions, Ferguson HVAC Supply, American Metals Supply, Colonial Distributing, and Commercial Duct Systems on Williams Rd; and Hillsborough County School Buses on Harney Rd). -As a result of the transportation incident, the main detour route for I-75 is along US 301 with US 41, SR 583/50th St, Williams Rd, and Harney Rd serving as alternate routes. The main detour route for I-4 is along US 92 with Selmon Expy, SR 60, US 92, SR 574/Dr Martin Luther King Jr Blvd, SR 580/Busch Blvd/Bullard Pkwy) serving as alternate routes. I-75 traffic and I-4 traffic on the main detour routes will need to merge across a single point (where US 301 and US 92 converge), creating additional traffic congestion. - Due to the transportation incident, detouring traffic causes gridlock on US 301 to the west and Williams Rd to the east as well as roadway reliability interruption for access to the Tampa Executive Airport. - After 24 hours of disruption, the governor issues an emergency declaration and waives rest hours and weight limits for trucks.
Impact on Environment	- Due to the power outage, there are disruptions to environmental regulatory infrastructure, causing sewage backups and contaminations of other varieties. - Organizations, companies, and residents of Hillsborough County switching to generators temporarily due to the power outage creates

	greater consumption of unclean fuels (like diesel), which impacts air quality negatively. - More dwell for trucks classes 9 and up cause more carbon dioxide emissions (twice as high) as a result of both the power outage (due to inoperable traffic signals and communications) and the transportation incident. - Hazmat materials involved in the transportation incident include diesel fuel, tanker fuels, and other volatile liquids. Hazmat release from the site drains to the Palm River with downstream Environmental Justice (EJ) communities.
Impact on Society	- Panic generated from the power outage promotes fuel shortages and shortages of other goods as people overbuy. - Lower-income persons that live in food deserts are at a disadvantage in preserving food supply and obtaining groceries during the blackout. - Crime increases during the power outage; multiple businesses are looted during the event. - More dwell for trucks classes 9 and up means more carbon dioxide emissions and other harmful fumes and noise as well as trucks hauling hazmat through unfamiliar neighborhoods with EJ communities as a result of the power outage and transportation incident. - Temporal/geographical inflexibility of bus routes limit access to jobs and essential services for EJ communities as a result of the power outage and transportation incident.
Immediate Recovery (Response)	Power to 20% of Hillsborough County is restored within the first 24 hours. Immediate response/recovery efforts for the transportation incident last 3 days (2 days for demolition work and one day for site repaving and setting up safety measures/maintenance of traffic). Temporary solutions to reopen I-4 and I-75 include: 1. Establish safety, address casualties, and clear debris; 2. Establish detours/maintenance of traffic plan; 3. Begin repairs/construction.
Long Term Recovery (Response)	Partial restoration of power creates an unstable power grid which provokes cascading shutdowns, taking previously restored areas offline, resulting in some areas without power for weeks. It takes 1.5 to 2 months to rebuild the southbound I-75 bridge.
Casualty Potential	Moderate: 7 killed due to power outage as some essential services are shut down and hospitals are unable to provide certain medical services. Deaths and injuries are compounded by overheating conditions created due to lack of power. The transportation incident resulted in two deaths and seven injuries. Potential for additional deaths and injuries due to state of disorder created by the concurrent power outage and transportation incident (i.e., more crashes with inoperable traffic signals, more pedestrian or bicycle deaths/injuries with inoperable street lights, hospitals limited to provide certain medical services, etc.).

Cyber Attack + Flooding/Wind Event

Scenario	Category 5 Hurricane Chaos, originally forecasted to hit the Florida Panhandle, wobbles and unexpectedly heads towards Tampa Bay. The hurricane is now expected to directly hit Downtown Tampa in approximately 24 hours. Concurrently with the change in forecasted hurricane track, a Supervisory Control and Data Acquisition (SCADA) system of the Tampa Electric network has been infiltrated and compromised by malware, disabling operators from making necessary commands and creating subsequent blackouts. The hackers installed malware into devices used to communicate with Tampa Electric substations and remotely opened substation circuit breakers, gaining access to all 79 network substations and taking them offline. The cyber attack severely complicates communications, hinders information dissemination about the hurricane, and obstructs evacuation efforts. 24 hours after the attack (when Hurricane Chaos makes landfall) residents, businesses, and government agencies are not prepared for the catastrophic devastation.
Duration	The widespread power outage lasts 72 hours; the storm duration is 24 hours.
Scope	The power outage impact is regional, affecting Hillsborough County and small sections of neighboring counties. The storm impacts are widespread extending from Monroe/Collier Counties and the City of Naples in the south to Okaloosa County and the City of Destin in the north.
Severity	Catastrophic
Impact on Supply Chains	***Hurricane Changes Track + Cyber Attack Causes Power Outage*** - Carrying out last minute evacuation and stationing efforts has become severely hampered as communications infrastructure is now limited with portions of the network down due to the power outage. - Hillsborough County workers have limited access to the cellular network as cell towers experience unstable service from the power outage and storm. - Refueling generators for communications infrastructure is now competing with normal hurricane preparation; some generators will not get refueled in time and some hurricane preparation/stationing activities will not take place or will be insufficient, such as the delivery of food, water, portable toilets, and other goods to shelters; evacuations by transit bus; etc. - Disruption to communication causes evacuation efforts to not reach all people in the evacuation zones. Some people in vulnerable communities do not receive information about evacuation by transit bus and available shelters. Last minute evacuations of assisted living facilities and hospitals do not take place.

	- Fuel shortages due to hurricane evacuations are exacerbated by older gas stations that may have fuel but no generator so there is no ability for gas to be pumped. - Unreliable cellular data service complicates evacuations by personal vehicles, especially among people reliant on GPS for navigation, causing major traffic congestion and an overreliance on the interstates as evacuation routes as well as general confusion about other or alternative routes. - Directing traffic at intersections due to traffic lights being down pulls police officers away from evacuation/emergency response duties. - Final shipments of diesel and gasoline by pipeline are halted due to the lack of electricity to run the pipelines; this also exacerbates the fuel shortages. - Incoming shipments of food, fuel and other goods are disrupted by the lack of communications and navigation, leading to trucks blocking roadways, missing deliveries, and choosing not to pick up shipments bound for the Hillsborough County area. - Generators are required to preserve perishable goods after the cyber attack, which results in major losses of perishable food in stores and in warehouses without adequate generators. - Stores without generators are unable to process sales for EBT, debit, and credit transactions. Some are unable to take cash as they are unable to open the register. This is exacerbated in vulnerable neighborhoods that are often food deserts. ***Hurricane Makes Landfall + Ongoing Power Outage Due to Cyber Attack*** - Westshore, western part of South Tampa, MacDill Air Force Base, Bayshore Boulevard, Davis and Harbour Islands, Downtown Tampa waterfront, Port Tampa Bay and Port Tampa, as well as Palm River areas experience 20-37 feet of storm surge. - CSX Uceta Yard is under 3 to 20 feet of water; all areas are above axle level of train car (13-inch threshold). - Tampa International Airport is under 3 to 37 feet of water depending on elevation; the entire footprint is in the inundation zone. Tampa Executive Airport is completely inundated by 9 to 15 feet of water. - All of Tampa General Hospital and portions of St Joseph's Hospital are inundated. Most major roads leading to St Joseph's Hospital experience inundation (SR 574/Dr Martin Luther King Jr Blvd to the east by the Hillsborough River, western approaches to the hospital, and Armenia Ave to the south near Columbus Dr and to the north by SR 574/Dr Martin Luther King Jr Blvd). - Inundated roadways include I-275 north of the Hillsborough River, I-275 west of Dale Mabry Hwy, I-75 and I-4 near the interchange, I-75 near Riverview, and most of Selmon Expy.

	- Hillsborough County Public Safety Operations Complex (PSOC) is not inundated, but access is difficult due to inundation at Falkenburg Rd north of Broadway Ave, Broadway Ave both east and west of Falkenburg Rd, Columbus Dr west of Falkenburg Rd, and Falkenburg Rd at SR 60. The only roadway providing access to the rest of the network would be Woodbury Rd via the I-75 underpass. - Approximately 9 inches of rain fall across the impact area; this causes inland flooding within the 100-year flood zone. Culverts and catch basins fill with debris, causing localized flooding. It takes two weeks to fully clear debris from the inland flooding areas. - All port areas (Port Tampa Bay and Port Tampa) fully out of service for 5 days or longer; reduced depth in the shipping channels to both port areas. - Damage to the electrical system complicates recovery from the cyber attack. - Transmission and distribution systems require replacement in coastal impact areas. Composite transmission pole areas need service but not replacement, and all wooden poles require full replacement. - Big Bend and Bayside Power Stations are inundated with 20 to 37 feet of water. Both plants are severely damaged, taking 3,500 megawatts of Tampa Electric's approximately 5,000 megawatts of power generation capability down for one to two months. - Residences flooded and damaged/compromised structures of businesses, warehouses, etc. impact distribution and retail capabilities. This is compounded with the power outage.
Impact on Environment	- Due to the power outage, there are disruptions to environmental regulatory infrastructure, causing sewage backups and contaminations of other varieties. Widespread sewage backflows into homes and businesses from both the power outage and storm. - Flood inundation as a result of the storm distributes petrochemical and biological contaminants at street grade caused by storm surge, riverine impacts from storm surge, and localized flooding from the stormwater management system. - Two phosphate gypsum stacks are located in or next to the storm inundation zone north of the Alafia River near Gibsonton. Contaminated water from these stacks escapes and enters Tampa Bay as well as groundwater. - Potential for hazmat release as a result of the storm that drains to the Palm River with downstream Environmental Justice (EJ) communities. - Organizations, companies, and residents of Hillsborough County switching to generators temporarily due to the power outage creates greater consumption of unclean fuels (like diesel), which impacts air quality negatively. - Ecological damage primarily from storm surge with secondary damages from winds.

	- Local saltwater intrusion into the groundwater threatening the Floridan Aquifer. -Evacuation traffic and increased traffic congestion from the blackout increase dwell for trucks classes 9 and up, causing more carbon dioxide emissions (twice as high); these impacts are dwarfed by the environmental impacts from the actual storm.
Impact on Society	- Panic generated from the power outage promotes fuel shortages and shortages of other goods as people overbuy. - Lower-income persons that live in food deserts are at a disadvantage in preserving food supply and obtaining groceries during the blackout. - Crime increases during the power outage; multiple businesses are looted during the event and after the storm. - As the cyber attack disrupted evacuation efforts and information dissemination, 10,000 air evacuations occurred. - Access to shelter at Jennings Middle School is inundated with 3 to 6 feet of water, and inundation comes to within 250 feet of the shelter at Boyette Springs Elementary. - Evacuation efforts did not result in the mandatory evacuation of an estimated 63,000 transit-dependent residents. - Many households were severely impacted by coastal flooding that resulted in major loss of life and injury. - Adverse health impacts, especially for socially vulnerable populations, are experienced due to a lack of essential readiness supplies while sheltering in place. - Roadway impacts inhibit temporary location to Hillsborough County and City of Tampa emergency shelters. - Severe impacts to grocery stores, pharmacies, and restaurants limit availability of food and medicine.
Immediate Recovery (Response)	Two to three months for power recovery in the inundated areas. Two weeks to clear all debris from inundated areas and roadways. Some power in areas not as impacted by the hurricane (northwest and southeast) will be able to see power restored in 48 hours once the cyber attack is resolved.
Long Term Recovery (Response)	Two years to rebuild all damaged infrastructure.
Casualty Potential	Very high: An estimated 4,000 resident deaths from direct hurricane impacts (such as drowning in floodwaters, car accidents and washouts, etc.). Secondary impacts (such as lack of emergency medical and trauma care) resulted in a significant number of deaths not yet quantified. Casualties are compounded by the disruption in evacuation efforts and public engagement as a result of the power outage.

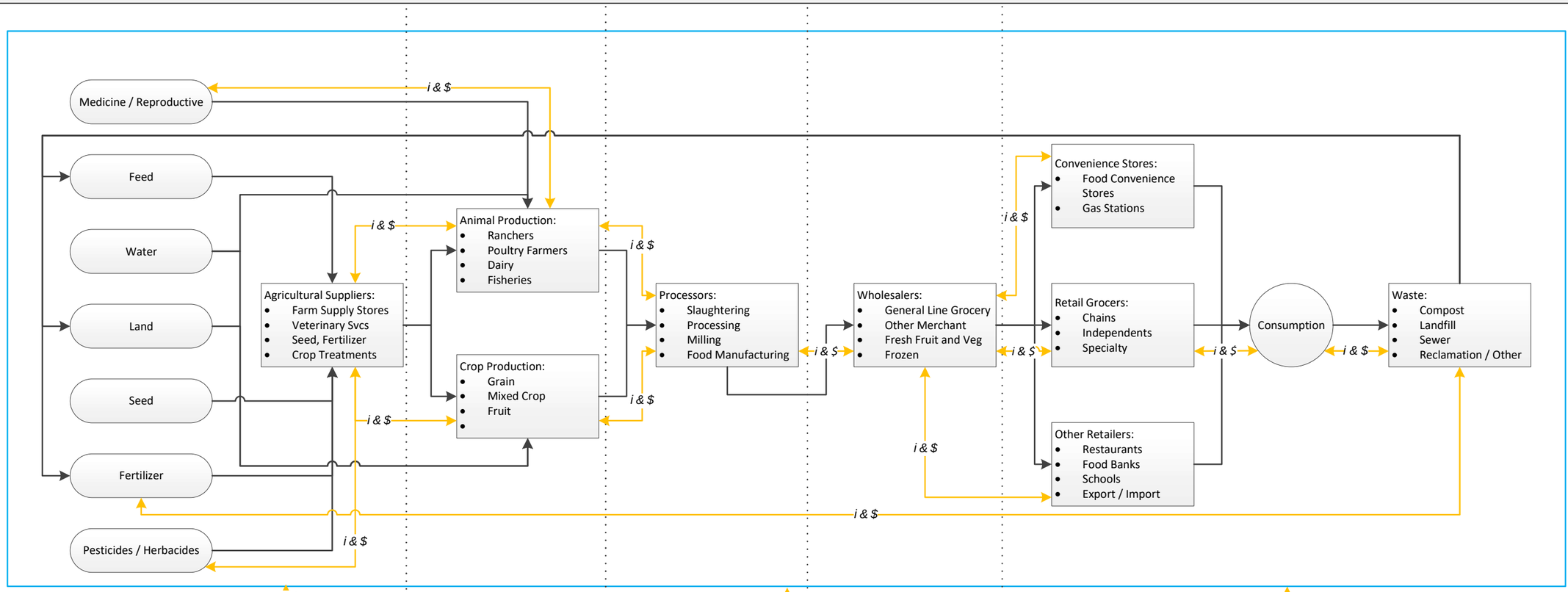
Appendix F – Supply Chain Maps

Hillsborough Transportation Planning Organization
Freight Supply Chain Resilience Study
Food/Groceries Supply Chain Map

Hillsborough TPO
Transportation
Planning Organization

05/24/2022

Supply Chain Flow Diagram



Modal Split

	Agricultural Suppliers	Animal Production	Crop Production	Processors	Wholesalers	Retail Grocers	Other Retailers	Consumption	Waste
Air:	5.8%	3.1%	2.7%	15.2%				12.8%	
Rail:	23.6%	24.2%	18.3%	5.3%				10.4%	
Water:	10.9%	7.2%	2.4%	3.2%				1.1%	
Truck:	**59.7%**	**65.4%**	**76.6%**	**76.4%**				**75.7%**	

Import Percent

	Agricultural Suppliers	Animal Production	Crop Production	Processors	Wholesalers	Retail Grocers	Other Retailers	Consumption	Waste
	Import % Tampa Purchases: 42.2%	**Import % Tampa Purchases: 58.6%**	**Import % Tampa Purchases: 76.0%**	Import % Tampa Purchases: 12.0%				Import % Tampa Purchases: 7.1%	
	In-Tampa MSA % Purchases: 57.8%	In-Tampa MSA % Purchases: 41.4%	In-Tampa MSA % Purchases: 24.0%	**In-Tampa MSA % Purchases: 88.0%**				**In-Tampa MSA % Purchases: 92.9%**	

Key Suppliers / Vendors

Agricultural Suppliers	Animal Production	Crop Production	Processors	Wholesalers	Retail Grocers	Other Retailers	Consumption	Waste
1. Mosaic	1. Fancy Farms Inc	1. Coca Cola	1. Performance Food Group				1. Publix	
2. Trademark Nitrogen Corp	2. Grimes Produce	2. Darling Intl	2. Great Bay Distributors Inc				2. Winn-Dixie	
3. Cargill	3. Davis Farms	3. Catalina Finer Foods Corp	3. Pepin Distributing Company				3. McDonald's	
4. Tractor Supply Co	4. Sweetwater Organic Farm	4. Tampa Florida Brewing	4. Johnson Brothers of Florida				4. Burger King	
5. Agronomic Resources	5. Voyager Farms	5. Pepsi	5. Wishnatzki Packing House				5. Chili's	
6. Helm Fertilizer Company	6. Oak Ridge Fish Hatchery	6. JM Smucker	6. American Food Distribution				6. Whole Foods Market	
7. Fox's Feed Depot	7. Bob's Blueberry Farm	7. Karma Kitchen	7. Bulk Nation				7. Subway	
8. Causeway Hydroponics Supply	8. Sunripe Farms	8. Joe & Son's Olive Oil	8. Pinellas Wholesale Meats				8. ALDI	
9. Suncoast Irrigation	9. Sharp Tree Farm & Nursery	9. Minute Maid	9. Pet Food Warehouse				9. Trader Joe's	
10. Hay Exchange	10. Polygro	10. Lettuce Help	10. Food Parade Wholesale Meats				10. Cracker Barrel	

Industry and transportation purchase data is obtained from EMSI, a proprietary source of industry employment and output data. Industry purchase data are based on proprietary modeling from EMSI, including the BEA's make and use tables. The transportation purchase propensities should be considered directional as opposed to precise. Business listing data was extracted from ESRI Business Analyst, using business listing data provided by Infogroup.

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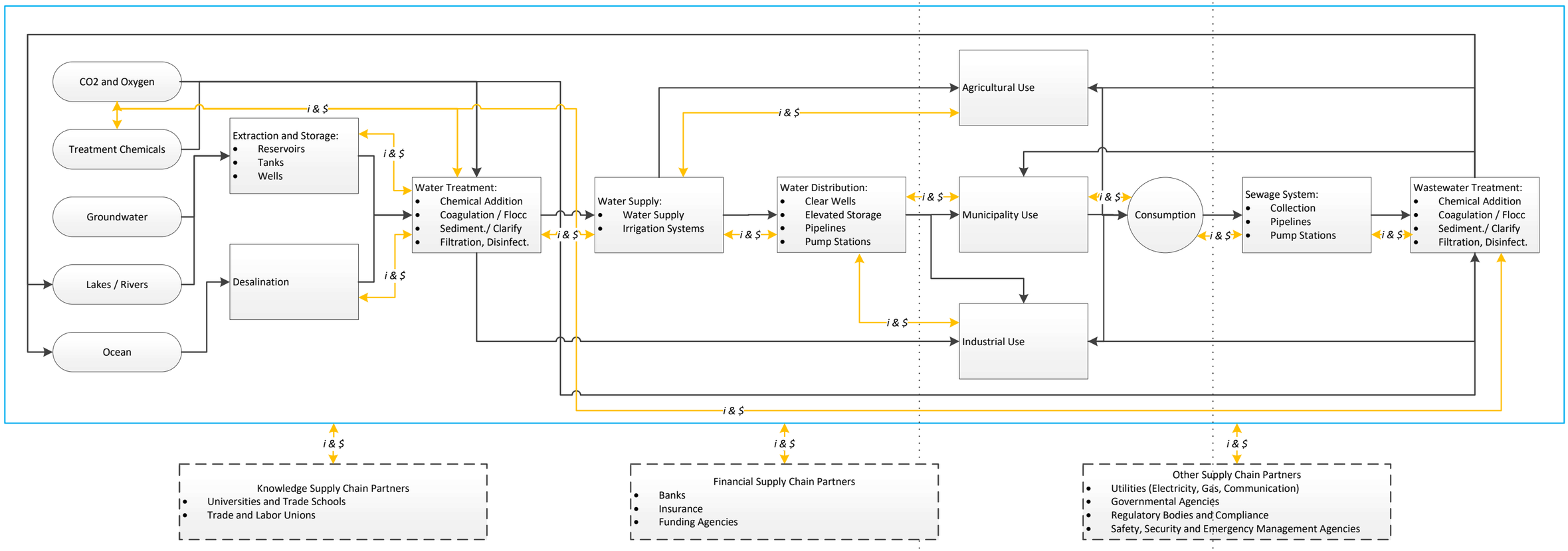
Hillsborough Transportation Planning Organization
Freight Supply Chain Resilience Study
Water and Wastewater Utilities Supply Chain Map

Hillsborough TPO
Transportation
Planning Organization

06/06/2022

Supply Chain Flow Diagram



Modal Split

	Water Treatment	Water Distribution	Consumption
Air:	0.9%	2.0%	1.9%
Rail:	8.3%	6.5%	6.5%
Water:	3.1%	2.8%	2.7%
Truck:	**86.1%**	**87.5%**	**87.5%**
Pipeline:	1.5%	1.3%	1.3%

Import Percentage

	Water Treatment	Water Distribution	Consumption
Import % Tampa Purchases:	4.9%	22.3%	44.9%
In-Tampa MSA % Purchases:	**95.1%**	**77.7%**	**55.1%**

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Key Suppliers / Vendors

Water Treatment	Water Distribution	Consumption
1.Gulfport City-Water Sewer	1. Hillsborough County Pubc Utlts	1. Marolf Environmental Inc
2. Hendry Corp	2. Tampa Bay Water	2. Jtv Inc
3. Florida Gas & Electric Corp	3. Hillsborough County Water Dept	3. Slaughter Plumbing
4. Preferred Drilling Solutions	4. Clearwater Water Dept	4. Environmental Equipment Sales
5. S & S Directional Boring	5. All Seasons Landscaping & Nrsy	5. Electrical & Mechanical Svc
6. R & H Svc	6. Jacobs Air Water Systems	6. Adams Darrel Environ Svc Inc
7. Johnston Trust	7. Hudson Water Works	7. All South Underground Llc
8. Ambient Technologies Inc	8. St Pete Complete Environ	8. Airvac Vacuum Sewer Systems
9. Southeast Drilling Svc	9. Oldsmar Wastewater Dept	9. Sewage Service Inc
10. Gibson Marine Construction	10. Ni Florida	

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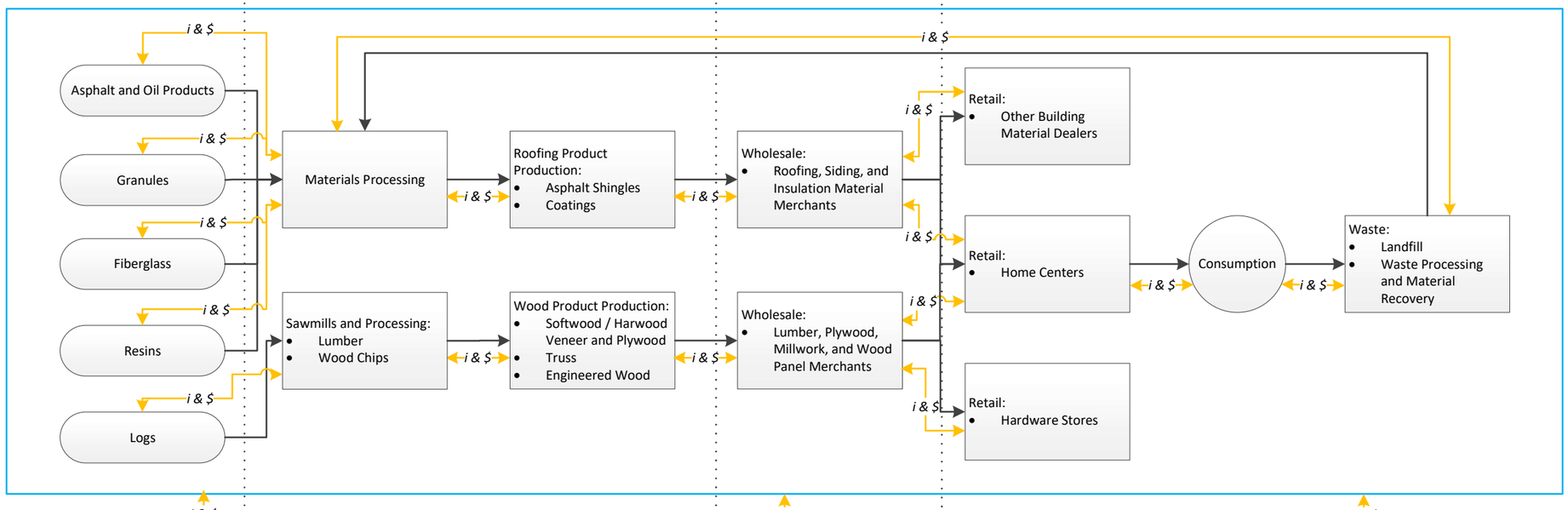
Hillsborough Transportation Planning Organization
Freight Supply Chain Resilience Study
Housing Material Supply Chain Map

Hillsborough TPO
Transportation
Planning Organization

06/06/2022

Supply Chain Flow Diagram



Modal Split

	Air:	Rail:	Water:	Truck:
Asphalt and Oil Products, Granules, Fiberglass, Resins, Logs	5.1%	8.6%	4.1%	**82.1%**
Materials Processing, Roofing Product Production, Sawmills and Processing, Wood Product Production	3.9%	25.5%	2.9%	**67.7%**
Wholesale	31.1%	3.1%	3.4%	**62.5%**
Retail, Consumption, Waste	2.1%	1.8%	1.7%	**94.4%**

Import Percentage

Asphalt and Oil Products, Granules, Fiberglass, Resins, Logs	**Import % Tampa Purchases: 80.4%** In-Tampa MSA % Purchases: 19.6%
Materials Processing, Roofing Product Production, Sawmills and Processing, Wood Product Production	**Import % Tampa Purchases: 50.2%** In-Tampa MSA % Purchases: 49.8%
Wholesale	Import % Tampa Purchases: 26.8% **In-Tampa MSA % Purchases: 73.2%**
Retail, Consumption, Waste	Import % Tampa Purchases: 45.3% **In-Tampa MSA % Purchases: 54.7%**

Industry and transportation purchase data is obtained from EMSI, a proprietary source of industry employment and output data. Industry purchase data are based on proprietary modeling from EMSI, including the BEA's make and use tables. The transportation purchase propensities should be considered directional as opposed to precise. Business listing data was extracted from ESRI Business Analyst, using business listing data provided by Infogroup.

Key Suppliers / Vendors

Asphalt and Oil Products, Granules, Fiberglass, Resins, Logs	1. Florida Crushed Stone 2. Florida Synthetic Turf 3. Cj Granite Design 4. Wesley Chapel Nursery 5. Artificial Turf Installations 6. Kurt Weiss Greenhouses Inc 7. Pasco Excavation Llc 8. Next Level Turf Management 9. FCS Brooksville Quarry 10. General Mining Devmnt
Materials Processing, Roofing Product Production, Sawmills and Processing, Wood Product Production	1. Masonite International 2. Jacobsen Manufacturing Inc 3. Cast-Crete Corp 4. Palm Harbor Homes Inc 5. His Cabinetry & Countertops 6. Cemex 7. Gatsby Spas Inc 8. Model Screw Products Inc 9. Heritage Plastics Inc 10. Coreslab Structures Inc
Wholesale	1. Marcone Supply 2. All Crane Rental 3. Commercial Concrete Products 4. Maxx Air Vent 5. Athena Granite & Marble 6. Allied Building Products 7. Dixie Plywood & Lumber Co 8. Stone Warehouse Of Tampa 9. Southern Stucco & Stone Inc 10. Pinellas/Pasco Glass & Mirror
Retail, Consumption, Waste	1. Home Depot 2. Lowe'S Home Improvement 3. Builders First Source 4. Ikea 5. Speedling Inc 6. Bed Bath & Beyond 7. Home Goods 8. Abc Supply Co 9. Harbor Freight Tools 10. Sherwin-Williams

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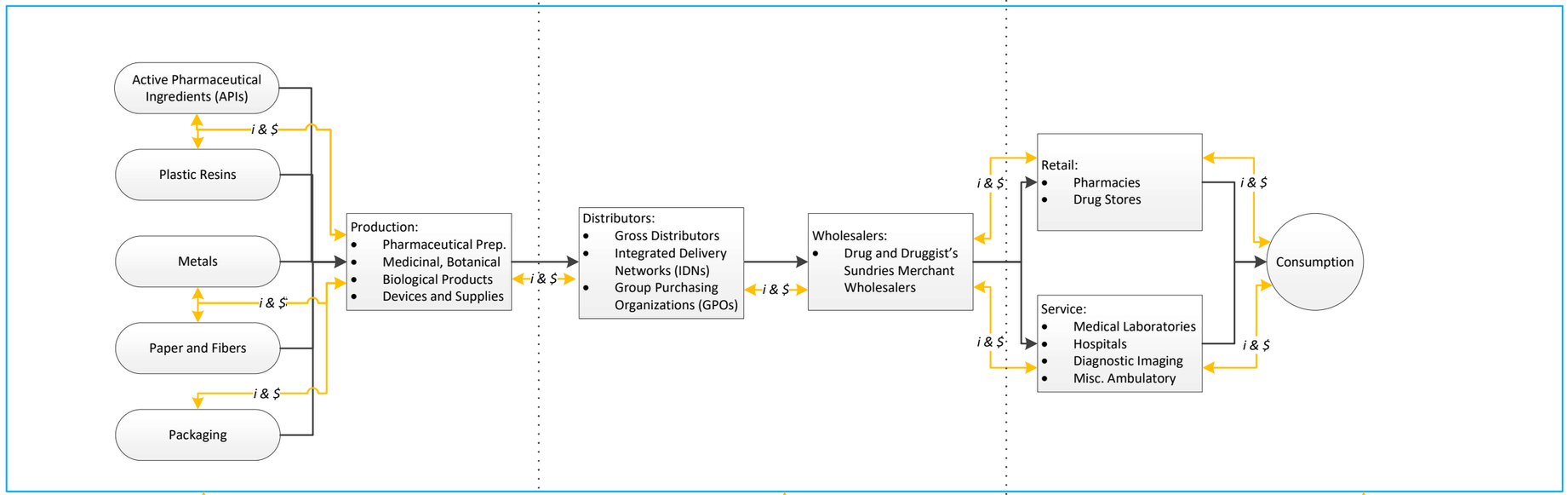
Hillsborough Transportation Planning Organization
Freight Supply Chain Resilience Study
Urgent Healthcare Services and Medicine Supply Chain Map

Hillsborough TPO
Transportation
Planning Organization

06/06/2022

Supply Chain Flow Diagram



Modal Split

	Production	Distributors	Retail / Service / Consumption
Air:	8.5%	21.0%	40.0%
Rail:	12.7%	1.2%	9.0%
Water:	1.1%	2.6%	4.0%
Truck:	**77.7%**	**75.2%**	**46.9%**

Import Percentage

	Production	Distributors	Retail / Service / Consumption
	Import % Tampa Purchases: 73.9%	**Import % Tampa Purchases: 51.3%**	Import % Tampa Purchases: 6.1%
	In-Tampa MSA % Purchases: 26.1%	In-Tampa MSA % Purchases: 48.7%	**In-Tampa MSA % Purchases: 93.9%**

Key Suppliers / Vendors

Production	Distributors	Retail / Service / Consumption
1. West Pharmaceutical Svc	1. Catalent Pharma Solutions Inc	1. Florida Hospital Child Care
2. Core Rx Pharmaceuticals Inc	2. West Pharmaceutical Svc	2. Walgreens
3. Bausch + Lomb Inc	3. Cardinal Health	3. C W Bill Young Va Hosp Med Ctr
4. Oscor Inc	4. A Signature Club Ltd	4. Cvs/Pharmacy
5. Romark Laboratories	5. Mercury Enterprises Inc	5. Usf Medical Svc Support Corp
6. Meridian Pharmaceuticals Llc	6. Pharmalink Pharmaceuticals Pvt	6. Morton Plant Hospital
7. Bristol-Myers Squibb	7. Belcher Pharmaceuticals Inc	7. Brandon Regional Hospital
8. Beach Products Inc	8. S G Pharmaceuticals Llc	8. Lab Corp
9. Apollo Pharmaceuticals Corp	9. Biomarin Pharmaceutical Inc	9. Publix Pharmacy
10. Mercury Medical	10. Sagene Pharmaceuticals Inc	10. Usf Physicians Group

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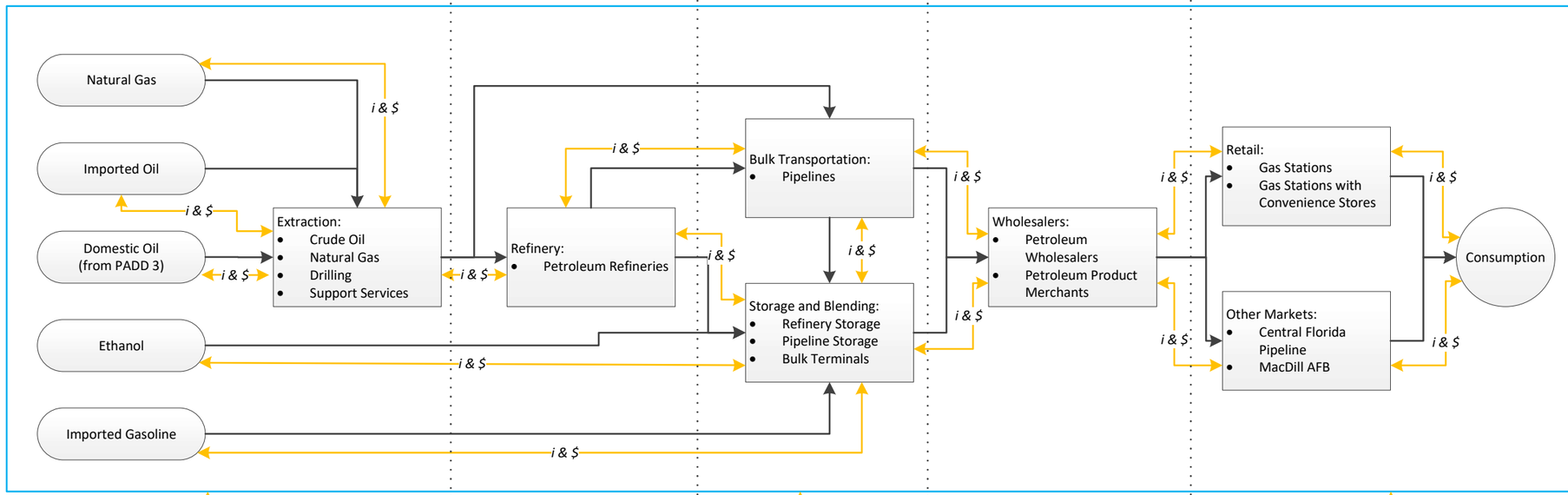
Hillsborough Transportation Planning Organization
Freight Supply Chain Resilience Study
Fuel Distribution Systems Supply Chain Map

Hillsborough TPO
Transportation
Planning Organization

06/06/2022

Supply Chain Flow Diagram



Modal Split

	Extraction	Refinery	Bulk Transportation	Wholesalers	Retail / Other Markets
Air:	1.6%	0.5%	8.5%	4.5%	1.0%
Rail:	6.5%	6.0%	14.2%	5.7%	2.0%
Water:	3.8%	0.3%	11.6%	2.3%	1.1%
Truck:	19.8%	35.6%	**64.7%**	**86.3%**	**95.2%**
Pipeline:	**68.3%**	**57.6%**	1.0%	1.2%	0.6%

Import Percentage

	Extraction	Refinery	Bulk Transportation	Wholesalers	Retail / Other Markets
	Import % Tampa Purchases: 95.0%	**Import % Tampa Purchases: 98.6%**	**Import % Tampa Purchases: 77.0%**	Import % Tampa Purchases: 45.3%	Import % Tampa Purchases: 34.2%
	In-Tampa MSA % Purchases: 5.0%	In-Tampa MSA % Purchases: 1.4%	In-Tampa MSA % Purchases: 23.0%	**In-Tampa MSA % Purchases: 54.7%**	**In-Tampa MSA % Purchases: 65.8%**

Key Suppliers / Vendors

Extraction	Refinery	Bulk Transportation	Wholesalers	Retail / Other Markets
1. Energy Professionals Llc	1. Howco Environmental Svc	1. Kinder Morgan Inc	1. Amalie Oil Co	1. Flying J Travel Plaza
2. Norris & Samon Pump Svc Inc	2. American Aviation	2. Florida Gas Transmission Co	2. Airgas	2. Sunoco
3. Inspectorate America Inc	3. Delek Us	3. Nustar Energy Lp	3. Port Sutton Terminal	3. Mobil
4. Family Oil & Lube	4. Mascot Petroleum Co Inc	4. Tampa Bay Pipeline	4. J H Williams Oil Co Inc	4. Travel Centers Of America
5. Whetstone Oil Co	5. E 3 Petroleum Corp	5. Mplx Terminals Llc	5. Brandon Running Assoc	5. Shell
6. Americas Oil Express	6. Indy Petroleum Inc	6. Central Florida Pipeline Co	6. Radiant Oil Co Of Tampa Inc	6. Radiant Food Store
7. R & R Petroleum Oil	7. Dunkle'S Fuel Svc	7. Legacy Pipeline Svc Llc	7. Bahr'S Propane Gas	7. Marathon
8. Best Line Oil Co Inc	8. J S R Food & Petroleum Llc	8. Subterrain Technologies	8.Best Oil Co Inc	8. Citgo
9. Teco Guatemala Holdings Llc	9. K K Petroleum Inc	9. Petrotech Services Inc	9. Port Consolidated Inc	9 Wawa Gas Station
10. Everyoung Argan Oil Products	10. Hernando Oil Co Inc	10. Stelka Pipeline Inc	10. Matheson	10. Buckeye Partners

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Appendix G – GIS Layers

GIS Layers

Type	Rank	Content Title/Layer Name	File Name	Publication Date	Notes
		TRANSPORTATION & UTILITIES			
Rail Infrastructure	1	AMTRAK Stations in Florida - 2020	AMTRAK_2020	20200417	
Rail Infrastructure	2	Florida Department of Transportation RCI Railroad Facility Crossings - April 2022	RAIL_CROSSS_APR22	20220423	This dataset contains the midpoint of roadway facilities that cross under or over a railroad
Rail Infrastructure	1	Florida Department of Transportation Railroad Crossing - April 2022	RCI_RAIL_XING_APR22	20220423	At-grade crossings
Rail Infrastructure	Rank based on Field "Trkclass"	Rail Network in Florida - 2021	RAILS_2021	20210721	
	1	4			
	1	3			
	2	2			
	3	1 (except tracks leading to the port, which should be classed at primary (1))			
	3	0 (except tracks leading to the port, which should be classed at primary (1))			
Rail Infrastructure	2	RAILROAD BRIDGES OVER NAVIGABLE AND NON-NAVIGABLE WATERWAYS IN FLORIDA - 2010	RRBRIDGES_2010	2010	
Water Infrastructure	1	National Inventory of Dams (NID) in Florida - 2019	USACE_DAMS_2019	20201201	
Water Infrastructure	1	U.S. Army Corp of Engineers Ports in Florida - 2020	ACPORT_2020	20200116	
Water Infrastructure	Rank based on FAC_TYPE_1	MARINAS IN FLORIDA - JANUARY 2017	MARINAS_JAN17	20160314	
	1	Commercial Marina			
	1	Public Owned & Operated/Government/Military			
	3	all others			
Water Infrastructure	3	Boat Ramps in Florida - March 2020	BOAT_RAMPS_MAR20	20090830	
Water Infrastructure	1	Navigable Waterway Network in Florida - 2019	BTSWW_2019	20190704	
Air Facilities	Rank based on NOTAM_WX_F	Airports in Florida - 2020	AIRPORTS_2020	20200822	Only field that seems to include TIA, MacDill, Tampa Executive, Peter O Knight, and Plant City.
	1	Has input			
	2	Null value			
Roadway & Bridges Infrastructure	Rank based on ADT_029	National Bridge Inventory in Florida - December 2020	BTS_BRIDGE_DEC20	20201231	
	1	>30,000			
	2	30,000-10,000			
	3	<10,000			
Roadway & Bridges Infrastructure	See Ranking Below	Florida Department of Transportation Functional Classification - April 2022	FUNCLASS_APR22	20220423	
	1	Urban Principal Arterial (Interstate, Freeway & Expressway, & Other)			
	1	Urban Major Collector			
	2	Urban Minor Arterial			
	2	Urban Minor Collector			
	3	Urban Local			
	1	Rural Principal Arterial (Interstate, Freeway & Expressway, & Other)			
	1	Rural Major Collector			
	2	Rural Minor Arterial			
	2	Rural Minor Collector			
	3	Rural Local			
Roadway & Bridges Infrastructure	2	FDOT OFFICE OF MAINTENANCE LOCATIONS	FDOTOOM_JUL08	20080721	Old layer, mixture of administration & maintenance offices. Might be a good idea to include, but not priority. No fields to differentiate.

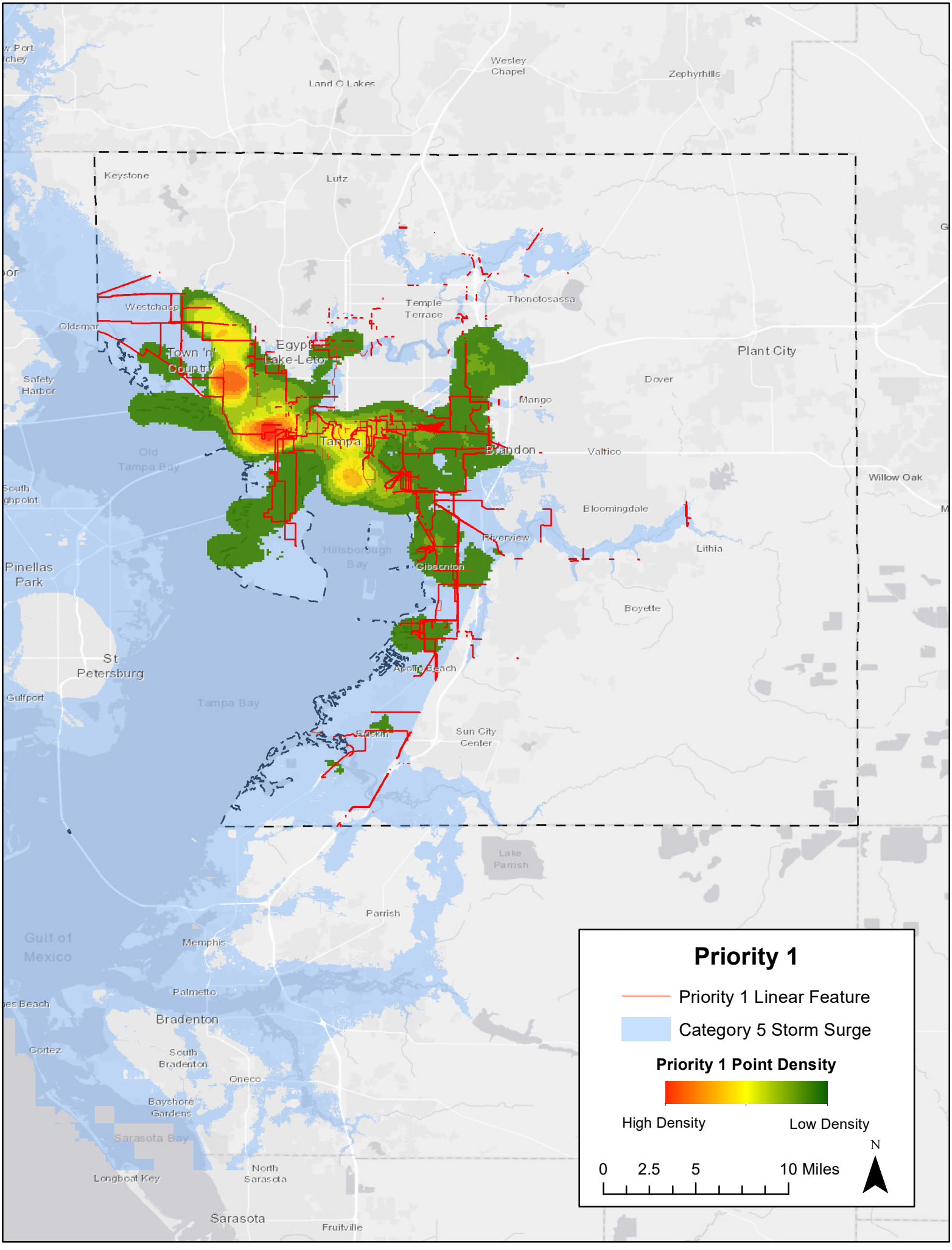
GIS Layers

Type	Rank	Content Title/Layer Name	File Name	Publication Date	Notes
Intermodal Facilities	1	INTERMODAL FACILITIES	INTERMODAL	20030000	Freight Intermodal Facilities, no major differentiation, old layer but important.
Intermodal Facilities	Rank by FAC_Type	Intermodal Passenger Connectivity Database (IPCD) of Transportation Terminals in Florida - 2020	BTS_IPCD_2020	20201023	
	1	1 (Facility is primarily an airport)			
	1	2 (Facility is primarily served by intercity bus)			
	2	8 (Facility primarily serving light rail transit)			
	1	10 (Station on the national railroad network served by intercity trains)			
	3	12 (Facility primarily serving bike-share)			
Intermodal Facilities	1	INTERMODAL TERMINAL FACILITIES - 2004	FCTF_MAR04	20040315	Intermodal Facilities (not overlapping with others), all are open, not any other good differentiators.
Fuel Infrastructure	Rank by GROUPS_WIT	Alternative Fuel Facilities in Florida - 2021	ALTFUELS_2021	20210420	
	1	PRIVATE - GOVERNMENT ONLY			
	2	PUBLIC (ALL PUBLIC FIELDS)			
	3	PRIVATE (ALL OTHER PRIVATE FIELDS)			
Communication Infrastructure	2	Registered Wireless Antenna Structure Locations in Florida - August 2021	ANTREG_AUG21	20210823	No good differentiation field. Densely distributed over the county, so chose to make them secondary.
Communication Infrastructure	1	REGISTERED CELLULAR ANTENNA STRUCTURE LOCATIONS IN FLORIDA - AUGUST 2019	CELLUR_AUG19	20190805	Seems to be some, but not total overlap with the previous layer. No good differentiation in fields.
Communication Infrastructure	1	Registered Television Broadcast Structure Locations in Florida - August 2021	TVBCST_AUG21	20210823	Seems to be total overlap with the 1st antenna layer; however, entries don't match. No good differentiation in fields.
Communication Infrastructure	1	AM Tower Structures in Florida - August 2021	AMTOW_AUG21	20210823	There are classifications of strength, but as we are looking at local impacts, may not matter as much.
Communication Infrastructure	1	FM Tower Structures in Florida - August 2021	FMTOW_AUG21	20210823	There are classifications of strength, but as we are looking at local impacts, may not matter as much.
Water Utilities	Rank by PWS_POP_SERVED	Public Water Supply (PWS) Plants (Non-Federal) in Florida - June 2021	PWS_PLANTS_NONFED_JUN21	20150106	
	1	>20,000			
	2	1,000-20,000			
	3	<1,000			
Water Utilities	3	LIMITED USE DRINKING WATER WELLS IN FLORIDA - MARCH 2018	DRINKWATER_MAR18	20180323	Smaller wells provide water to individuals and small groups.
Water Utilities	1	Wastewater Facilities - April 2022	WAFR_APR22	19990630	Could use Design Capacity of Facility; however, some are industrial and some are for phosphate mining,; not certain a lower capacity would actually mean less important.
Water Utilities	3	SUPER ACT WELLS IN FLORIDA - JULY 2011	SUPERACT_WELL_JUL11	201107	Will be caught in the public water supply layer if important. Well types field values are not defined in the metadata.
Waste Utilities	Rank by FACILITY_S	Solid Waste Facilities - April 2022	SLDWST_APR22	19990630	
	2	Active			
	2	Registered			
	3	Activity Not Permitted/Registered			
	Do not include	All Others			
Waste Utilities	3	ONSITE SEWAGE LOCATIONS IN FLORIDA - JUNE 2012	SEPTIC_JUN12	201206	No differentiation by field, smaller than the wastewater plants.
Electric Utilities	1	Electric Substations in Florida - 2020	ELECTRIC_SUBSTAT_JUL20	20200708	
Electric Utilities	1	Electric Power Transmission Lines in Florida - 2020	POWERLINES_JUN20	20200623	
Electric Utilities	Rank by NAMEPCAP	US EPA Emissions and Generation Resource Integrated Database (EGRID 2019) for Electricity Generating Plants in Florida - Published 2021	EPAEGRID_2019	20210223	
	1	>200			
	2	60-200			
	3	<60			

GIS Layers

Type	Rank	Content Title/Layer Name	File Name	Publication Date	Notes
		BUILDINGS			
	2	CORRECTIONAL FACILITIES IN FLORIDA - 2017	GC_CORRECTIONAL_SEP17	20170906	
	2	School Facilities (Private) Boundaries in Florida - 2017	GC_SCHOOLSBND_PRIV_SEP17	20200221	
	3	GROUP CARE FACILITIES IN FLORIDA - MARCH 2018	GROUPCARE_MAR18	20180323	
	3	LODGING FACILITIES IN FLORIDA - 2016	GC_HOTELS_AUG16	20160807	
	3	Mobile Home Parks in Florida - 2019	GC_MOBILEHOMES_APR19	20190416	
	3	MIGRANT CAMPS IN FLORIDA - DECEMBER 2016	MIGRANT_DEC16	20161213	
	1	HOSPITAL FACILITIES IN FLORIDA - 2017	GC_HOSPITALS_SEP17	20170906	
	1	LAW ENFORCEMENT FACILITIES IN FLORIDA - 2018	GC_LAWENFORCE_NOV18	20181101	
	1	FIRE DEPARTMENT AND RESCUE STATION FACILITIES IN FLORIDA - 2018	GC_FIRESTAT_MAY18	20180522	
	1	U.S. MILITARY INSTALLATIONS IN FLORIDA - MARCH 2010	MILITR_MAR10	201003	
	2	SOCIAL SERVICES FACILITIES IN FLORIDA - 2016	GC_SOCIALSERVICE_JAN16	20160129	
	2	LOCAL, STATE, AND FEDERAL GOVERNMENT BUILDINGS IN FLORIDA - 2013	GC_GOVBUILD_FEB13	20120213	
	1	HEALTH CARE FACILITIES IN FLORIDA - 2014	GC_HEALTH_AUG14	20140812	
	3	ASSISTED RENTAL HOUSING UNITS IN FLORIDA - JULY 2013	GC_ASSISTED_HOUSING_JUL13	20130715	
	2	School Facilities (Public and Post-Secondary) in Florida - 2021	GC_SCHOOLS_MAR21	20210324	
	1	Shelters	https://hillsborough.maps.arcgis.com/home/item.html?id=2465ac82ea874d68b39b3347ad814dd1#overview		
		ADDITIONAL - TO BE APPLIED LATER			
Backup to EJ Areas Layer		EJ Areas from Hillsborough TPO			
		US EPA Environmental Justice Screening and Mapping Tool (EJSCREEN) Block Group Level Indicators in Florida - 2021	EJSCREEN_BLKGRP_2021	20220222	
		Residential Uses			
		NOAA Sea Level Layers			
		Flood Hazard Zones of the Digital Flood Insurance Rate Map (DFIRM) in the State of Florida - December 2021	DFIRM_FLDHAZ_DEC21	20211215	To determine 100-year floodplain.
		Florida Department of Transportation Roadways Maintained by FDOT - April 2022	RCI_ON_APR22	20220423	
		Evacuation Routes in Florida - September 2020	EVACUATION_ROUTES_SEP20	202009	
		Superfund/National Priority List (NPL) Waste Cleanup Sites in Florida - April 2022	HAZWASTE_SP_NPL_APR22	20010223	
Air Facilities	INTERSECT ONLY	AVIATION TRANSPORTATION FACILITIES RUNWAY BOUNDARIES IN FLORIDA - 2016	GC_RUNWAYBND_JAN16	20160114	Values are included for the airport; intersect only.
Air Facilities	INTERSECT ONLY	AVIATION TRANSPORTATION FACILITIES BOUNDARIES IN FLORIDA - 2016	GC_AVIATIONBND_JAN16	20160114	Values are included for the airport; intersect only.

Appendix H – Supporting GIS Maps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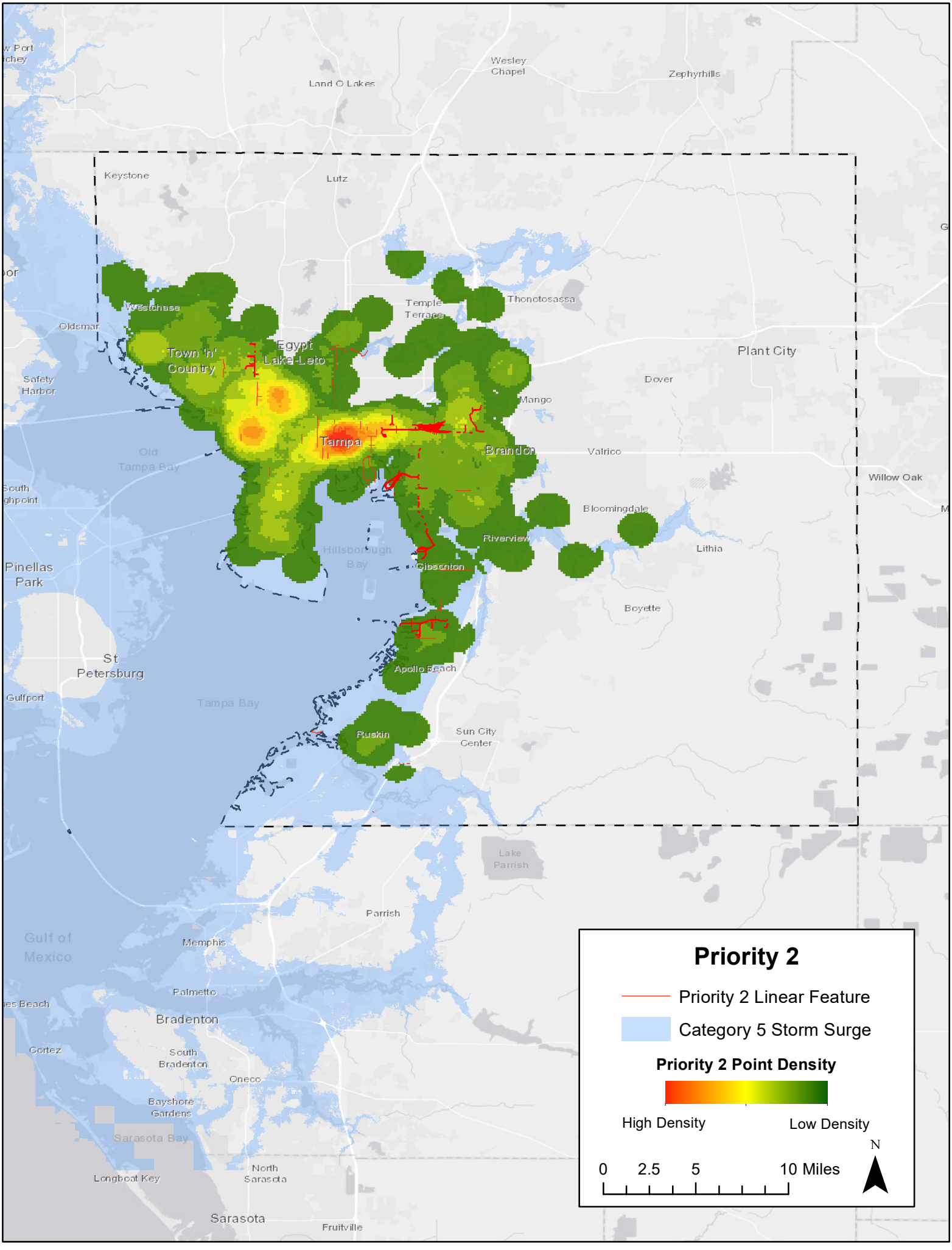
Land O Lakes
Wesley Chapel
Zephyrhills
Westchase
Oldsmar
Temple Terrace
Thonotosassa
Egypt Lake-Leto
Town 'n' Country
Safety Harbor
Plant City
Dover
Mango
Tampa
Brandon
Valrico
Old Tampa Bay
Willow Oak
Bloomingdale
Riverview
Lithia
Hillsborough Bay
Gibsonton
Pinellas Park
Boyette
St Petersburg
Gulfport
Apollo Beach
Tampa Bay
Ruskin
Sun City Center
Lake Parrish
Parrish
Gulf of Mexico
Memphis
Palmetto
Bradenton
Cortez
South Bradenton
Oneco
Bayshore Gardens
Sarasota Bay
North Sarasota
Longboat Key
Sarasota
Fruitville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Low Density
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Land O Lakes
Wesley Chapel
Zephyrhills
Westchase
Oldsmar
Temple Terrace
Thonotosassa
Town 'n' Country
Egypt Lake-Leto
Safety Harbor
Plant City
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Brandon
Valrico
Old Tampa Bay
Willow Oak
Bloomingdale
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Hillsborough Bay
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Pinellas Park
Boyette
St Petersburg
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Gulfport
Tampa Bay
Ruskin
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Parrish
Gulf of Mexico
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Oneco
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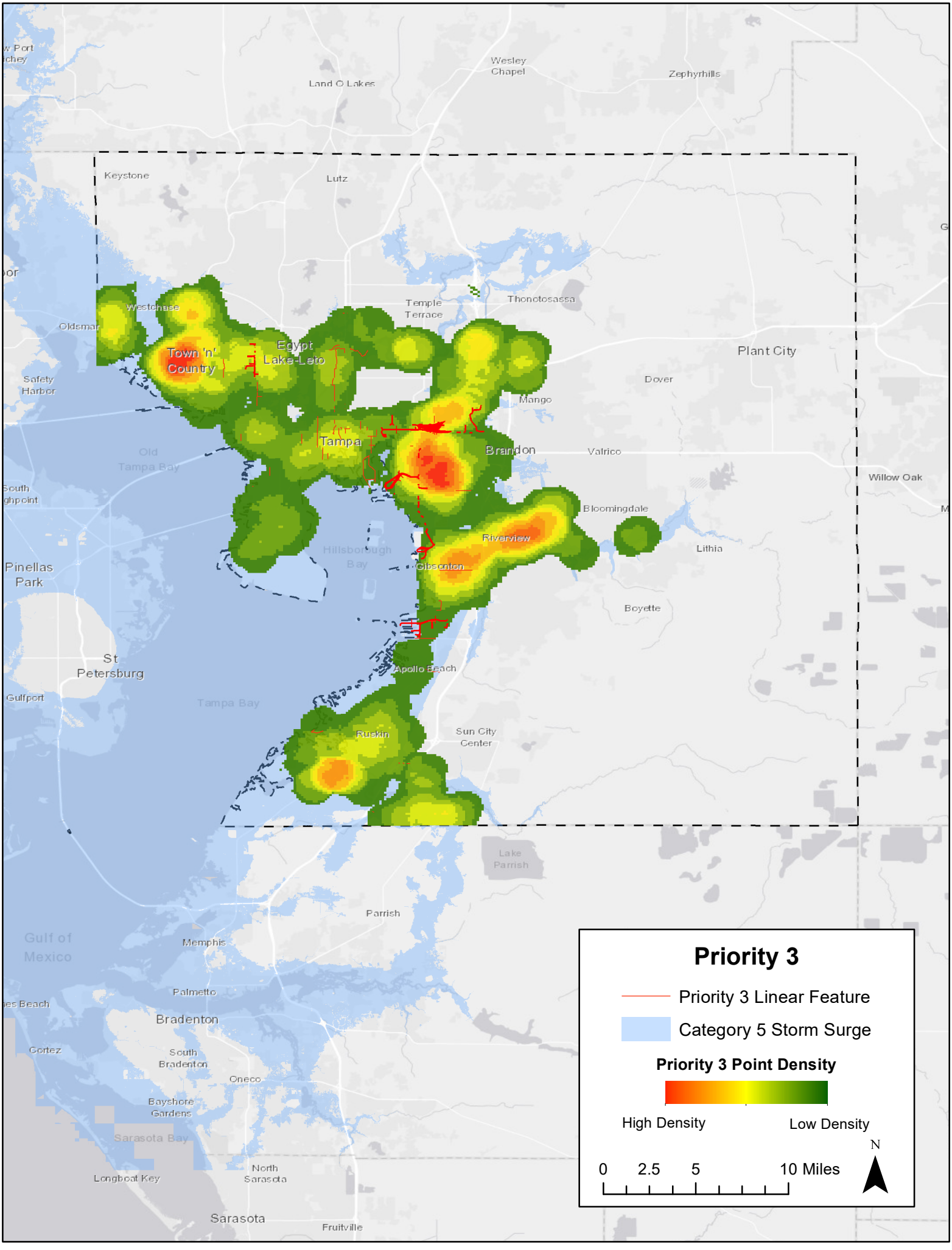
Sarasota
Fruitville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Low Density
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Lutz
Land O Lakes
Wesley Chapel
Zephyrhills
Westchase
Oldsmar
Town 'n' Country
Egypt Lake-Leto
Temple Terrace
Thonotosassa
Plant City
Dover
Mango
Safety Harbor
Tampa
Brandon
Valrico
Old Tampa Bay
Willow Oak
Bloomingdale
Riverview
Lithia
Hillsborough Bay
Gibsonton
Pinellas Park
Boyette
St Petersburg
Apollo Beach
Gulfport
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Sun City Center
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Gulf of Mexico
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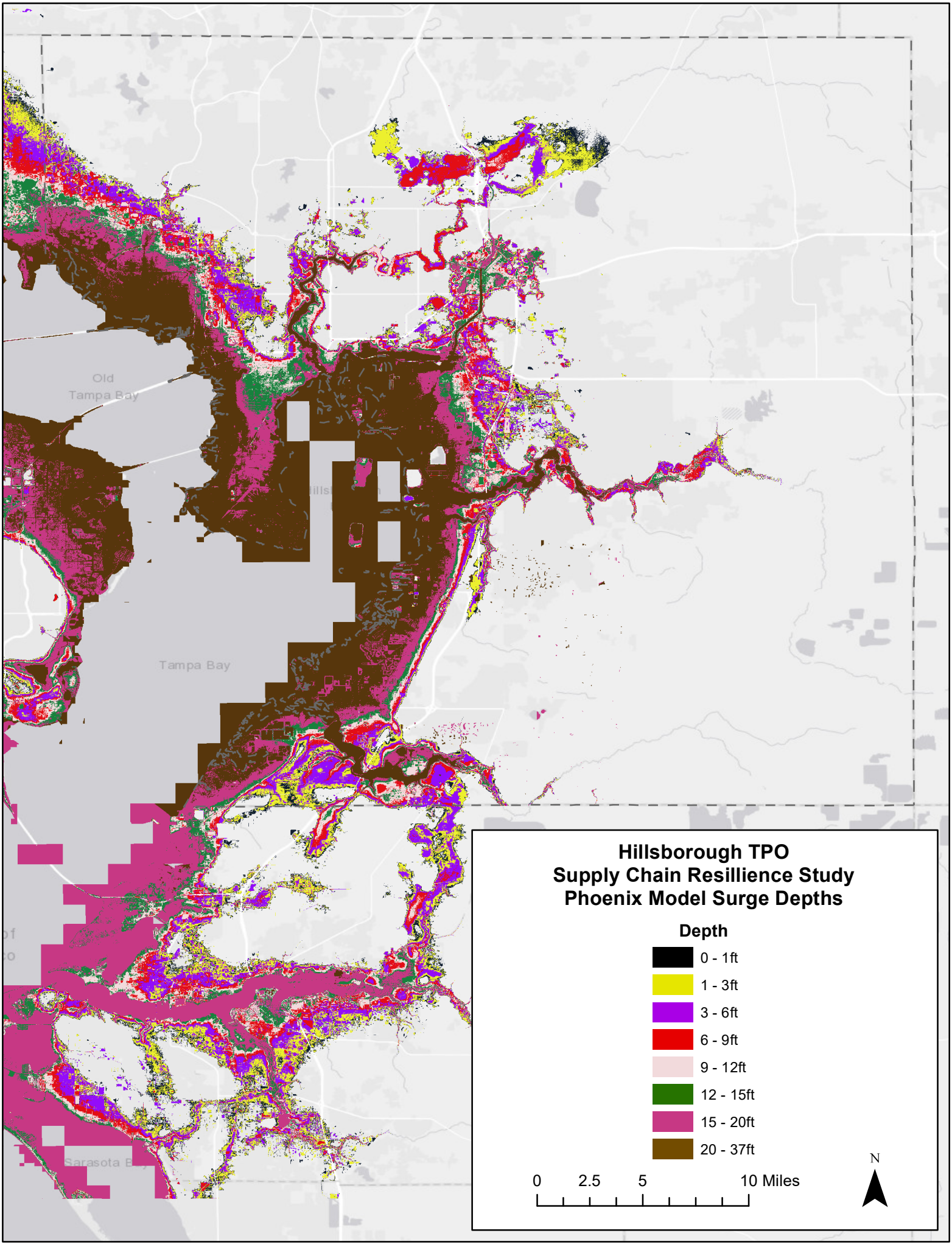
Longboat Key
North Sarasota
Sarasota
Fruitville


Old
Tampa Bay
Tampa Bay
Hillsborough TPO
Supply Chain Resillience Study
Phoenix Model Surge Depths
Depth
0 - 1ft
1 - 3ft
3 - 6ft
6 - 9ft
9 - 12ft
12 - 15ft
15 - 20ft
20 - 37ft
0
2.5
5
10 Miles
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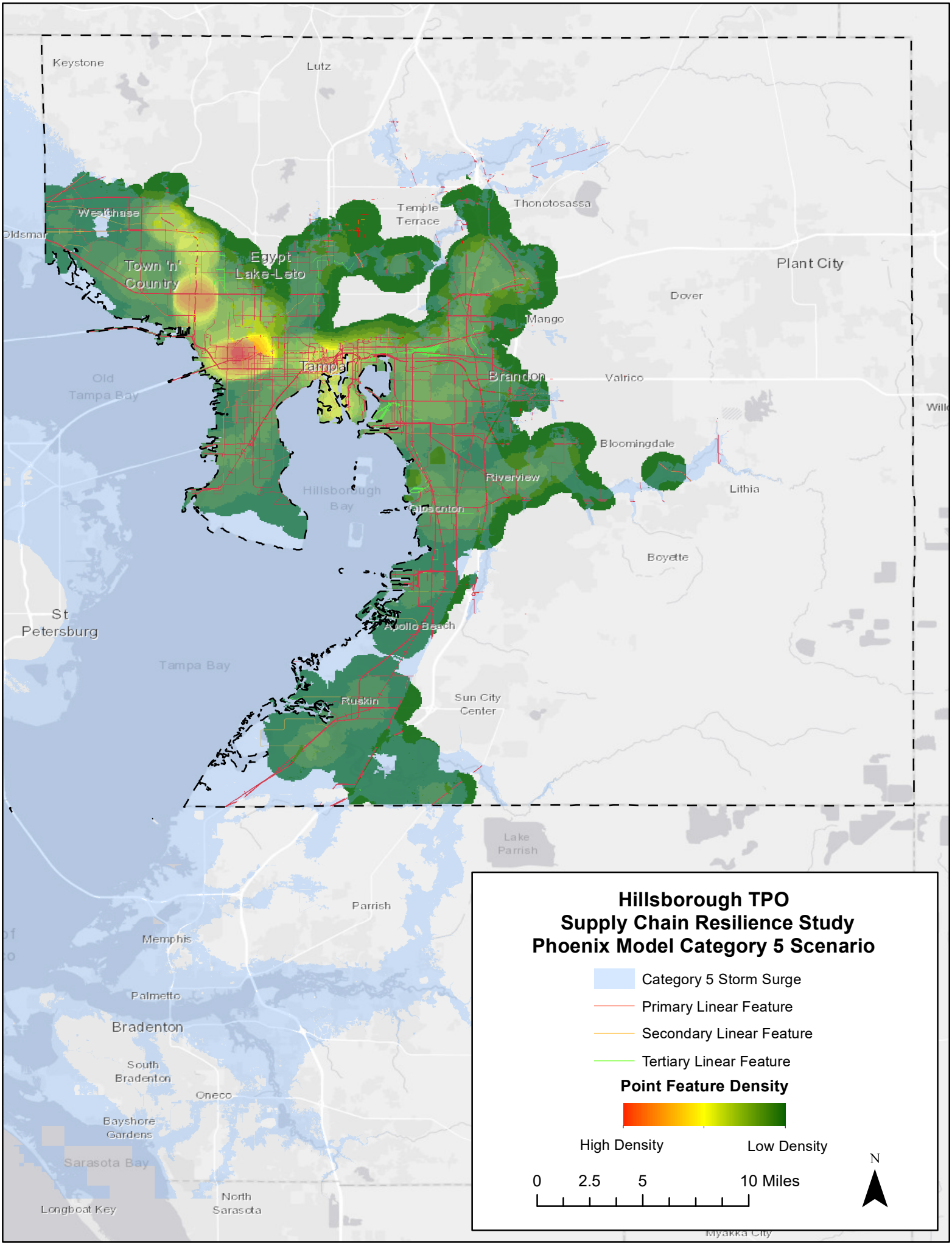
Keystone
Lutz
Temple Terrace
Thonotosassa
Westchase
Town 'n' Country
Egypt Lake-Leto
Plant City
Dover
Mango
Tampa
Brandon
Valrico
Old Tampa Bay
Bloomingdale
Riverview
Hillsborough Bay
Gibsonton
Lithia
Boyette
St Petersburg
Apollo Beach
Tampa Bay
Ruskin
Sun City Center
Lake Parrish
Parrish
Memphis
Palmetto
Bradenton
South Bradenton
Oneco
Bayshore Gardens
Sarasota Bay
Longboat Key
North Sarasota
Myakka City
Hillsborough TPO
Supply Chain Resilience Study
Phoenix Model Category 5 Scenario
Category 5 Storm Surge
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Secondary Linear Feature
Tertiary Linear Feature
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Low Density
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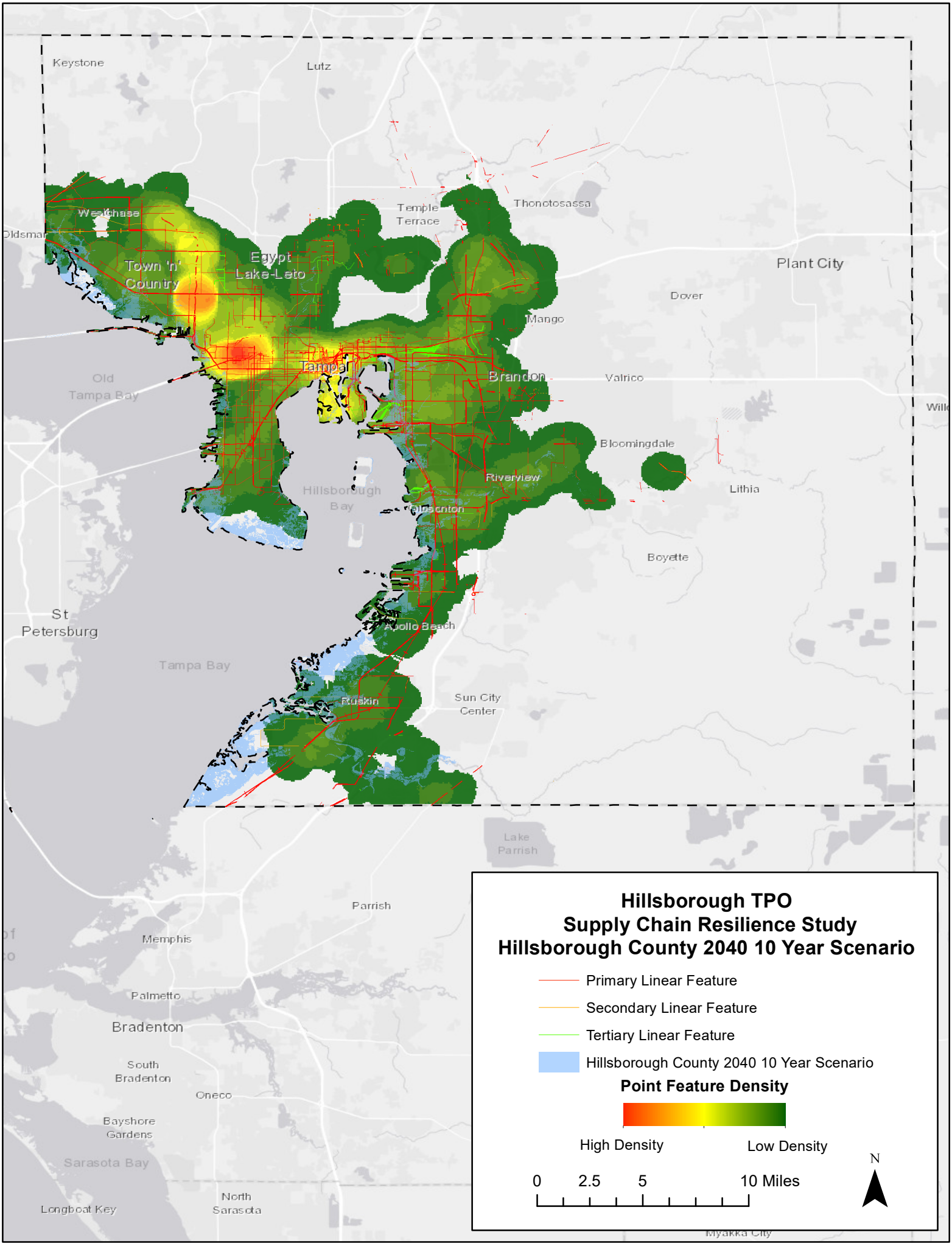
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Lutz
Temple Terrace
Thonotosassa
Westchase
Town 'n' Country
Egypt Lake-Leto
Plant City
Dover
Mango
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Brandon
Valrico
Old Tampa Bay
Bloomingdale
Riverview
Hillsborough Bay
Gibsonton
Lithia
Boyette
St Petersburg
Apollo Beach
Tampa Bay
Ruskin
Sun City Center
Lake Parrish
Parrish
Memphis
Palmetto
Bradenton
South Bradenton
Oneco
Bayshore Gardens
Sarasota Bay
Longboat Key
North Sarasota
Myakka City
Hillsborough TPO
Supply Chain Resilience Study
Hillsborough County 2040 10 Year Scenario
Primary Linear Feature
Secondary Linear Feature
Tertiary Linear Feature
Hillsborough County 2040 10 Year Scenario
Point Feature Density
High Density
Low Density
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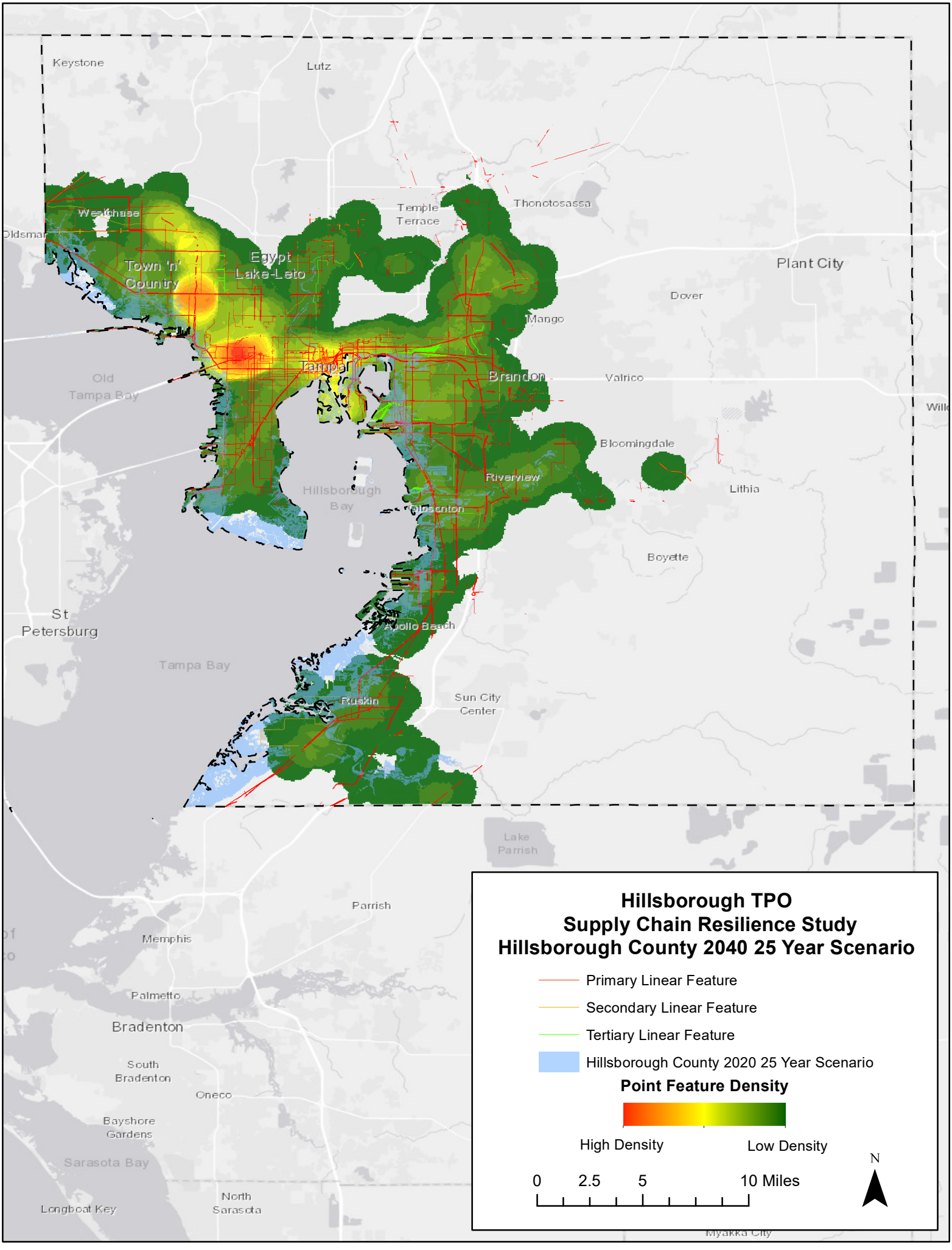
2.5
5
10 Miles
N


Keystone
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Temple Terrace
Thonotosassa
Westchase
Town 'n' Country
Egypt Lake-Leto
Plant City
Dover
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Brandon
Valrico
Old Tampa Bay
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Memphis
Palmetto
Bradenton
South Bradenton
Oneco
Bayshore Gardens
Sarasota Bay
North Sarasota
Longboat Key
Myakka City
Hillsborough TPO
Supply Chain Resilience Study
Hillsborough County 2040 25 Year Scenario
Primary Linear Feature
Secondary Linear Feature
Tertiary Linear Feature
Hillsborough County 2020 25 Year Scenario
Point Feature Density
High Density
Low Density
0
2.5
5
10 Miles
N

Appendix I – Disaster Impact Matrices by Commodity

Disaster Impact Matrices by Commodity

Food/Groceries								
Disaster Scenario	**Metrics**	**Workforce**	**Vulnerable Populations/Neighborhoods**	**Financial Flows**	**Utilities**	**Communications**	**Transportation**	**Supply Chain Partners**
Flooding/Wind Event	Severity	Moderate	Severe	Moderate	Severe	Moderate	Severe	---
	Scope	Regional	Regional	Regional	Widespread	Regional	Widespread	---
	Impact	Lower rate of workers reporting to work during event. Event worsens existing employee shortages, lack of affordable childcare, lack of effective public transit. Difficulty in accessing workplaces. Additional workforce needed to clear destroyed product.	Vulnerable populations living in food deserts would have a difficult time accessing food or grocery alternatives if the weather event destroyed storage capability or existing supplies in disadvantaged neighborhoods.	Without cash, credit infrastructure would be down and prevent payments. Many stores will be unable to open registers even if their supplies are undamaged given electric grid failures. EBT would not be available when power is down. If using generator to power cold storage, will not have the power to run registers. Electric grid is down, there is no way to scan the prices of food/groceries, cause delays in payment.	Stores are prohibited from selling frozen goods that have been without refrigeration after 4 hours based on the FDA USDA. This food has to be cleared. Lack of electricity means perishable grocery items in stores and in storage will spoil when the generator capacity is exceeded.	Difficulty in tracking shipments; inability to receive shipments. Would have to go through a full stock/restock effort. Sales platform requires internet access. Newer sensor based tracking systems in cold storage, etc. rely on internet access. Inability to access the load board or communicate about the shipment of a product.	Increased demand after the destruction of existing supplies could create a need for alternative methods of delivery. Event will worsen an existing shortage of truckers, some drivers will not risk getting a shipment into a disaster area. Ability to book trucking is impacted. Food/grocery deliveries would need to be rerouted to avoid delivering to inoperable facilities- will create transportation delays.	---
Transportation Incident	Severity	Low to Moderate	Low to Moderate	Low	Low	Low to Moderate	Severe	---
	Scope	Regional	Local	Local	Local	Local	Regional	---
	Impact	Independent or small trucking or owner-operator small fleet size trucking companies will not accept loads if they don't think it will be profitable. Will no call no show. Late showings might miss pickups/ deliveries/dock times which causes a cascading issue for other deliveries. Will cause delivery delays or mild shortages, difficulty accessing workplaces.	Vulnerable populations or neighborhoods would have increased difficulty accessing food/groceries during shortages. Smaller retailers may have a lower priority for deliveries when cascading delays start, especially without their own fleet (such as Publix or Winn Dixie).	---	Underground communications utilities on the north side of I-4 disrupted due to accident, minor disruption to internet service.	Local overload on cell network in the immediate area.	The destruction of a critical roadway would delay deliveries, forcing rerouting that could congest other roadways.	---
Cyber Attack	Severity	Moderate to Severe	Severe	Severe	Severe	Severe	Severe	---
	Scope	Regional	Regional	Regional	Regional	Regional	Regional	---
	Impact	Food and grocery workers would be unable to work if their workplaces are without power. Credit payments cannot be taken, produce will be lost or donated. Lost freezer and refrigeration capacity forces workers to sort through those goods and throw away, donate, or restore.	Vulnerable populations or neighborhoods without access to generators would have a difficult time securing fresh food after what is in their refrigerators has spoiled. Possible food donations of the refrigerated goods from shops without power for more than four hours.	Without cash, credit infrastructure would be down and prevent payments. Many stores will be unable to open registers even if their supplies are undamaged without grid access. EBT would not be available when power is down. If using generator to power cold storage, may not have the power to run registers. If the electric grid is down, there would be no way to scan the prices of food/groceries, causing delays in payment.	Stores are prohibited from selling frozen goods that have been without refrigeration after 4 hours based on the FDA USDA. This food would then have to be cleared. Food/grocery storage would be compromised (without access to generators).	Difficulty in tracking shipments; inability to receive shipments. Would have to go through a full stock/restock effort. Sales platform requires internet access. Newer sensor based tracking systems in cold storage, etc. rely on internet access. Inability to access the load board or communicate about the shipment of a product.	Increased demand after the destruction of existing supplies would create a need for alternative methods of delivery. Event will worsen an existing shortage of truckers. Ability to book trucking is impacted. Food/ grocery deliveries would need to be rerouted to avoid delivering to inoperable facilities- will create transportation delays.	---
Cyber Attack + Flooding/Wind Event	Severity	Severe	Severe	Severe	Severe	Severe	Severe	---
	Scope	Regional	Regional	Regional	Regional	Regional	Widespread	---
	Impact	Food and grocery facilities would likely be closed. If they were not impacted physically by the weather event, the produce would still be ruined via the downed grid. Event worsens existing employee shortages, lack of affordable childcare, lack of effective public transit. Difficulty in accessing workplaces. Additional workforce needed to clear destroyed product.	Vulnerable populations or neighborhoods without access to generators would have a difficult time securing fresh food after what is in their refrigerators has spoiled. The weather event would make it difficult for them to transport themselves to getting fresh food if public transit is down or roads are blocked.	Without cash, credit infrastructure would be down and prevent payments. Many stores will be unable to open registers even if their supplies are undamaged if the electric grid is down. EBT would not be available when power is down. If using generator to power cold storage, may not have the power to run registers. If the electric grid is down, there would be no way to scan the prices of food/groceries, causing delays in payment.	Stores are prohibited from selling frozen goods that have been without refrigeration after 4 hours based on the FDA USDA. This food would then have to be cleared. Food/grocery storage would be compromised (without access to generators).	This would combine an overstressed grid attempting to compensate for downed physical infrastructure and a sudden decrease in available electricity. Difficulty in tracking shipments; inability to receive shipments. Would have to go through a full stock/restock effort. Sales platform requires internet access. Newer sensor based tracking systems in cold storage, etc. rely on internet access. Inability to access the load board or communicate about the shipment of a product.	Increased demand after the destruction of existing supplies either via ruined produce by unavailable electricity or physical destruction incited by the storm could create a need for alternative methods of delivery. Event will worsen an existing shortage of truckers. Ability to book trucking is impacted. Food/grocery deliveries would need to be rerouted to avoid delivering to inoperable facilities- could create transportation delays. All port areas fully out of service for 5 days - longer for some elements; reduced depth in the shipping channels to both port areas. The weather event would have created roadway blockages that would prevent those alternative goods from reaching their destination.	---

Disaster Impact Matrices by Commodity

Food/Groceries								
Disaster Scenario	**Metrics**	**Workforce**	**Vulnerable Populations/Neighborhoods**	**Financial Flows**	**Utilities**	**Communications**	**Transportation**	**Supply Chain Partners**
Cyber Attack + Transportation Incident	Severity	Severe	Severe	Severe	Severe	Severe	Severe	---
	Scope	Regional	Regional	Regional	Regional	Regional	Regional	---
	Impact	The cyber event would initially create increased demand - especially for non-perishable goods that would weather the lack of electricity thus pushing for an increased supply via trucking. Independent or small trucking or owner-operator small fleet size trucking companies will not accept loads if they don't think it will be profitable. Will no call no show. Late showings miss pickups/deliveries/dock times which cause a cascading issue for other deliveries. Would cause delivery delays or mild shortages; difficulties accessing workplaces. These supply chain issues would only amplify the initial shortages created by the cyber event.	Vulnerable populations or neighborhoods without access to generators would have a difficult time securing fresh food after what is in their refrigerators has spoiled. Possible food donations of the refrigerated goods from shops without power for more than four hours. This would be a greater issue for vulnerable populations/neighborhoods if they have difficulty accessing these resources or if that roadway was their primary access point.	Without cash, credit infrastructure would be down and prevent payments. Many stores will be unable to open registers even if their supplies are undamaged if the electric grid is down. EBT would not be available when power is down. If using generator to power cold storage, may not have the power to run registers. If the electric grid is down, there would be no way to scan the prices of food/groceries, causing delays in payment.	Stores are prohibited from selling frozen goods that have been without refrigeration after 4 hours based on the FDA USDA. This food would then have to be cleared. Food/grocery storage would be compromised (without access to generators)	Difficulty in tracking shipments; inability to receive shipments. Would have to go through a full stock/restock effort. Sales platform requires internet access. Newer sensor based tracking systems in cold storage, etc. rely on internet access. Inability to access the load board or communicate about the shipment of a product. The combination of a transportation event would make navigating that area especially difficult and would cause a more significant overload of the cell network.	Increased demand after the destruction of existing supplies would create a need for alternative methods of delivery. Event will worsen an existing shortage of truckers. Ability to book trucking is impacted. Food/ grocery deliveries would need to be rerouted to avoid delivering to inoperable facilities- could create transportation delays. Without cellular or grid power, GPS functions could be unavailable which would make rerouting deliveries more difficult and less accessible.	---

Disaster Impact Matrices by Commodity

Water and Wastewater Utilities								
Disaster Scenario	**Metrics**	**Workforce**	**Vulnerable Populations/Neighborhoods**	**Financial Flows**	**Utilities**	**Communications**	**Transportation**	**Supply Chain Partners**
Flooding/Wind Event	Severity	Moderate	Severe	Low	Severe	Low	Moderate	---
	Scope	Regional	Regional	Regional	Regional	Regional	Regional	---
	Impact	Water and wastewater utilities employees will be unable to access their workplace. Workplaces in general that have been cut off from water and wastewater access will not be able to function normally. City of Tampa wastewater plant is on Hookers Point; this area would experience 15-37 feet of inundation, making it inaccessible to the workforce. The workforce present would need to evacuate.	Would create water accessibility issues as the infrastructure is destroyed. Portions of vulnerable communities would not have the transportation options to access clean drinking water available outside of the impacted areas.	---	Would destroy wastewater treatment plants and sewer treatment plants or the infrastructure they rely on to clear sewage or deliver water. City of Tampa wastewater plant is on Hookers Point; this area would experience 15-37 feet of inundation, making it inaccessible to the workforce. The workforce present would need to evacuate. Fire fighting infrastructure, which relies on the water system, will not be able to fight fires if pumping needed.	Most cell towers have a required generator capacity of 24 hours - if they house 9-1-1 routing equipment, the requirement is 72 hours. Partial cell capacity will be available on units not destroyed or damaged in the event.	If ports or roadways are contaminated by wastewater buildup created by the destruction or inoperability of plants, those ports and roads could be temporarily inaccessible. Destroyed or damaged pipe infrastructure would have to be repaired or replaced before reopening utility service and materials for repair/replacement may be difficult to procure/transport.	---
Transportation Incident	Severity	Low	Moderate	Low	Low	Low	Low	---
	Scope	Regional	Local	Local	Local	Local	Local	---
	Impact	---	The site drains to Palm River, with vulnerable populations and neighborhoods potentially downstream. If there is additional runoff, it would pollute the water.	---	Underground communications utilities on the north side of I-4 disrupted due to accident; minor disruption to internet service.	---	---	---
Cyber Attack	Severity	Severe	Severe	Low	Severe	Low	Moderate	---
	Scope	Regional	Local	Regional	Regional	Regional	Regional	---
	Impact	Employment facilities without access to clean water or sewage would be inoperable or not able to function as normal. Would additionally take down SCADA processes and make remote control impossible.	Portions of vulnerable communities would not have the transportation options to access clean drinking water available outside of the impacted areas.	---	The electric grid failing would cause wastewater treatment plants to fail and water to no longer reach consumers. Fire fighting infrastructure, which relies on the water system, will not be able to fight fires if pumping needed.	Most cell towers have a required generator capacity of 24 hours - if they house 9-1-1 routing equipment, the requirement is 72 hours. Partial cell capacity will likely be available.	If the electric grid is sabotaged, sewage would back up as the wastewater treatment plants are unable to perform. This back up would end up on the streets or polluting the ports, causing temporary inaccessibility.	---
Cyber Attack + Flooding/Wind Event	Severity	Severe	Severe	Low	Severe	Moderate	Severe	---
	Scope	Regional	Regional	Regional	Regional	Regional	Regional	---
	Impact	Potential electrical failures that would result from lost grid power from the cyber attack would be magnified by infrastructure failures created by inundation or other weather-related destruction. Would likely leave residents without access to clean water and sewage (with sewage plants inoperable).	Vulnerable communities would have water accessibility issues if the weather event took down public transportation. A simultaneous cyber attack would widen the scope and severity of the downed water infrastructure.	---	Water infrastructure, like the wastewater plant on Hookers Point would likely encounter inundation resulting from the weather event. This would be combined with potential electrical failures created by grid outages, likely leaving residents without access to clean water and with inoperable sewage plants. Fire fighting infrastructure, which relies on water system, will not be able to fight fires if pumping needed - fires created by the weather event through downed facilities or electrical malfunctions would be more difficult to maintain. Two phosphate gypsum stacks are located in or next to the inundation zone north of the Alafia River near Gibsonton. Contaminated water from these stacks escapes and enters Tampa Bay as well as groundwater.	Combining the potential infrastructural destruction with the total reliance on generators within the first 72 hour period would create more stress on the cell towers. Rather than distributing the traffic to the towers with generators during a grid outage, some of those will be destroyed.	If the electric grid causes wastewater treatment plants to back up, street inundation would further the spread of the contamination.	---
Cyber Attack + Transportation Incident	Severity	Severe	Severe	Low	Severe	Low	Moderate	---
	Scope	Regional	Local	Regional	Regional	Regional	Regional	---
	Impact	Employment facilities without access to clean water or sewage would be inoperable or not able to function as normal. Would additionally take down SCADA processes and make remote control impossible.	The populations closest to the site would have issues with runoff from the initial destruction and the resulting construction. The grid outage could make it more difficult to access clean water through this potential contamination and reduced transportation options.	---	The electric grid failing would cause wastewater treatment plants to fail and water to no longer reach consumers. Fire fighting infrastructure, which relies on the water system, will not be able to fight fires if pumping needed.	Most cell towers have a required generator capacity of 24 hours - if they house 9-1-1 routing equipment, the requirement is 72 hours. Partial cell capacity will likely be available.	If the electric grid is sabotaged, sewage would back up as the wastewater treatment plants are unable to perform. This back up would end up on the streets or polluting the ports, causing temporary inaccessibility.	---

Disaster Impact Matrices by Commodity

Housing Material								
Disaster Scenario	**Metrics**	**Workforce**	**Vulnerable Populations/Neighborhoods**	**Financial Flows**	**Utilities**	**Communications**	**Transportation**	**Supply Chain Partners**
Flooding/Wind Event	Severity	Severe	Severe	Low	Moderate	Moderate	Severe	---
	Scope	Regional	Regional	Regional	Local	Regional	Widespread	---
	Impact	Housing material manufacturing, warehouse, and retail employees will be unable to access their workplace. Workplaces may be inundated for multiple days, destroyed or damaged by wind and water. Lower rate of workers reporting to work during event. Event worsens existing employee shortages, lack of affordable childcare, lack of effective public transit. Additional workforce needed to clear destroyed product.	The jobs by housing materials (i.e., warehouse, retail, or industrial employees) will be unable to work either due to business shutdowns or inaccessible transportation. Without consistent income, those in more economically vulnerable groups will not be able to afford basic goods. Vulnerable populations will not have transportation options to get to suppliers before and after event.	There would be economic ripples and delays from unavailable housing materials.	Lack of electricity will make sales systems inaccessible. If water and wastewater impacted, will need portable toilets at worksites.	Difficulty in tracking shipments, inability to receive shipments. Would have to go through a full stock/restock effort. Sales platform requires internet access. Inability to access the load board or communicate about the shipment of a product.	Increased demand after damage to structures. Event will worsen an existing shortage of truckers, some drivers will not risk to get shipment into a disaster area. Ability to book and track shipping is impacted. housing material deliveries would need to be rerouted to avoid delivering to inoperable facilities- would create transportation delays. Inability to receive shipments. Inability to access the load board or communicate about the shipment of a product. Lack of fuel for product deliveries.	---
Transportation Incident	Severity	Moderate	Low to Moderate	Low	Low	Low	Moderate	---
	Scope	Regional	Local	Local	Local	Local	Regional	---
	Impact	Housing material manufacturing, warehouse, and retail employees might have difficulty accessing their workplace, and may face full closures around the I-4/I-75 interchange if dangerous materials are involved in the collision.	If getting to work becomes more difficult or takes longer, drivers will need to spend more on gas and lose more time to traffic. Vulnerable populations will have less disposable income to spend, forcing other cuts.		Underground communications utilities on the north side of I-4 disrupted due to accident, minor disruption to internet service.		As a core road to get materials in and out of Tampa and to surrounding locations, rerouting would require additional driving or time spent in order to get the required materials to their destinations or congestion if the lanes were limited.	---
Cyber Attack	Severity	Moderate to Severe	Low	Low	Low	Moderate	Severe	---
	Scope	Regional	Regional	Regional	Local	Regional	Regional	---
	Impact	Housing material manufacturing, warehouse, and retail employees might be unable to access their workplace. Lower rate of workers reporting to work during event. Event worsens existing employee shortages, lack of affordable childcare, and lack of effective public transit. Workplaces will be closed if they don't have adequate generator capacity. Delivery and demand tracking will be impacted. Commutes will be extended or logistically difficult.	The jobs by housing materials (i.e., warehouse, retail, or industrial employees) will be unable to work either due to business shutdowns or inaccessible transportation. Without consistent income, those in more economically vulnerable groups will not be able to afford basic goods.	Lack of electricity will make sales systems inaccessible.	Lack of electricity will make many of the regular functions necessary for housing inaccessible (construction equipment, shipping equipment, etc.).	Difficulty in tracking shipments; inability to receive shipments. Would have to go through a full stock/restock effort. Sales platform requires internet access. Inability to access the load board or communicate about the shipment of a product.	Without electricity to guide roadway transportation, traveling at night would become dangerous. Any freight deliveries scheduled for the night would need to be delayed, any construction work scheduled for the night would need to be delayed.	---
Cyber Attack + Flooding/Wind Event	Severity	Severe	Severe	Moderate	Moderate	Moderate	Severe	---
	Scope	Regional	Regional	Regional	Regional	Regional	Widespread	---
	Impact	Housing material manufacturing, warehouse, and retail employees will be unable to access their workplace. Workplaces will be inundated for multiple days, destroyed or damaged by wind and water. Lower rate of workers reporting to work during event. Event worsens existing employee shortages, lack of affordable childcare, and lack of effective public transit. Additional workforce needed to clear destroyed product. Workplaces will be closed if they don't have adequate generator capacity. Delivery and demand tracking will be impacted. Commutes will be extended or logistically difficult. Workplaces would likely be inoperable facing worker shortages as the weather event makes it difficult to travel and general material shortages.	The jobs by housing materials (i.e., warehouse, retail, or industrial employees) will be unable to work either due to business shutdowns or inaccessible transportation. Without consistent income, those in more economically vulnerable groups will not be able to afford basic goods. Vulnerable populations will not have transportation options to get to suppliers before and after event.	There will be economic ripples and delays from housing materials destroyed by the storm that would be magnified by downed grid and that would make sales systems inaccessible.	Lack of electricity will make many of the regular functions necessary for housing inaccessible (construction equipment, shipping equipment, etc.). If water and wastewater impacted, will need portable toilets at worksites.	Difficulty in tracking shipments; inability to receive shipments. Would have to go through a full stock/restock effort. Sales platform requires internet access. Inability to access the load board or communicate about the shipment of a product. Rerouting deliveries around the transportation incident would become difficult or impossible without access to Google Maps or other WiFi and communications services.	Structural demand by the weather event will create an increased demand which will magnify an existing shortage of truckers. Some drivers will not risk going into disaster areas to deliver a shipment. The grid being down would magnify this by making it difficult to coordinate the shipment of the product. The ability to book and track shipping of impacted goods would have to be rerouted to operational facilities which would be especially difficult given a lapse in communication capabilities created by the grid. There would be an inability to access the load board or communicate about the shipments. Any construction work scheduled for the night would likely need to be rescheduled due to the downed grid and the inability to provide thorough roadway and site lighting.	---

Disaster Impact Matrices by Commodity

Housing Material								
Disaster Scenario	**Metrics**	**Workforce**	**Vulnerable Populations/Neighborhoods**	**Financial Flows**	**Utilities**	**Communications**	**Transportation**	**Supply Chain Partners**
Cyber Attack + Transportation Incident	Severity	Moderate to Severe	Moderate	Low	Low	Moderate	Severe	---
	Scope	Regional	Regional	Regional	Regional	Regional	Regional	---
	Impact	Housing material manufacturing, warehouse, and retail employees might be unable to access their workplace. This would be magnified if such a critical roadway was partially unavailable without the benefit of highest capacity Google Maps or other services for rerouting. Lower rate of workers reporting to work during event. Event worsens existing employee shortages, lack of affordable childcare, lack of effective public transit. Workplaces will be closed if they don't have adequate generator capacity. Delivery and demand tracking will be impacted. Commutes will be extended or logistically difficult.	The jobs by housing materials (i.e., warehouse, retail, or industrial employees) will be unable to work either due to business shutdowns or inaccessible transportation. The transportation incident would cause an increase in fuel prices as commutes get longer, making it more difficult for vulnerable populations to transport themselves. Without consistent income, those in more economically vulnerable groups will not be able to afford basic goods.	Lack of electricity will make sales systems inaccessible.	Lack of electricity will make many of the regular functions necessary for housing inaccessible (construction equipment, shipping equipment, etc.).	Difficulty in tracking shipments, inability to receive shipments. Would have to go through a full stock/restock effort. Sales platform requires internet access. Inability to access the load board or communicate about the shipment of a product. Rerouting deliveries around the transportation incident would become difficult or impossible without access to Google Maps or other WiFi and communications services.	Without electricity to guide roadway transportation, traveling at night would become dangerous. A major roadway and entrance point to Tampa being down would add to the confusion and difficulties. Any freight deliveries scheduled for the night would need to be delayed, any construction work scheduled for the night would need to be delayed. It would become difficult to provide proper lighting to the work site for repairs on the downed section of the bridge, potentially delaying the repair process.	---

Urgent Healthcare Services and Medicine								
Disaster Scenario	**Metrics**	**Workforce**	**Vulnerable Populations/Neighborhoods**	**Financial Flows**	**Utilities**	**Communications**	**Transportation**	**Supply Chain Partners**
Flooding/Wind Event	Severity	Severe	Severe	Low	Severe	Severe	Severe	---
	Scope	Regional	Regional	Local	Regional	Regional	Regional	---
	Impact	Inundated roadways would make it difficult for emergency services to reach their destinations. Electrical outages would require these services to rely on the generators in their facilities (approximately 40% for 96 hours) and make it difficult for the workforce to complete their duties.	Vulnerable populations/neighborhoods are often found in lower areas, making flooding more likely during extreme weather events. This would create additional injuries and, with a lack of reliable transportation, also make critical healthcare and medicinal services inaccessible.	Health care company systems will be inaccessible to record patient information for future payment.	The extreme weather event would take down electrical infrastructure, forcing healthcare and medicine to rely on generators for services. It would also damage access to water, critical for many healthcare services.	If communications are taken out by the storm, then healthcare services would be unable to coordinate emergency rescues or requests for additional materials. Newer sensor based tracking systems in cold storage, etc. rely on internet access, tracking for pharma needed to be able to use the products. Issues with overall event response communications due to lack of infrastructure would cause cascading effects with medical response. Health care company system will be inaccessible for patient medical history.	Inundated roads would make it difficult for healthcare services to reach those in need. If additional materials are required by medical services, it will be difficult for them to reach the facilities via inundated or damaged roadways. Emergency evacuation transportation is needed for patients who can move.	---
Transportation Incident	Severity	Moderate	Low	Low	Low	Moderate	Moderate	---
	Scope	Regional	Local	Local	Local	Local	Regional	---
	Impact	The destruction of a core roadway would necessitate rerouting, making it difficult for healthcare services to access their workplace.			Underground communications utilities on the north side of I-4 disrupted due to accident, minor disruption to internet service.	Lack of reliable cell service in area would produce additional collisions and impact efficient emergency response.	If emergency services are rerouted, it will make it more difficult to reach the emergency as quickly.	---
Cyber Attack	Severity	Severe	Moderate	Low	Severe	Severe	Moderate	---
	Scope	Regional	Regional	Local	Regional	Regional	Regional	---
	Impact	Healthcare services would need to rely on generators that can only sustain partial function (40%) for 96 hours, which would make the workplace difficult. Transportation difficulties accessing workplaces.	Vulnerable populations/neighborhoods without power would be more at risk of heatstroke or other related medical issues. Lack of reliable transportation would make it difficult to seek medical attention in these cases.	Health care company systems will be inaccessible to record patient information for future payment.	Healthcare services are reliant on the electric grid for many of their essential functions, without electricity many of their critical procedures would be impossible. This cyber incident would eventually sabotage the water as well as electric, making service even more difficult.	Without electricity, much of the communication grid would be out. This would make the healthcare services unable to receive distress calls or communicate easily with first responders.	Downed electrical infrastructure, like roadway lighting or warning signs, would cause dangerous or delayed conditions for first responders or those seeking medical attention.	---
Cyber Attack + Flooding/Wind Event	Severity	Severe	Severe	Low	Severe	Severe	Severe	---
	Scope	Regional	Regional	Local	Regional	Regional	Regional	---
	Impact	Inundated roadways would make it difficult for emergency services to reach their destinations. All of Tampa General Hospital and portions of St. Joseph's Hospital are inundated, most major roads leading to St Joseph's experience inundation making it difficult for the workforce and emergency vehicles to get to proper facilities. The electrical grid being down would require these services to rely on the generators in their facilities (approximately 40% for 96 hours) and make it difficult for the workforce to complete their duties.	Vulnerable populations/neighborhoods are often found in lower areas, making flooding more likely during extreme weather events. Lack of power/access to power could increase the risk of heatstroke or other related medical issues. Combined, there could be a significant increase in injuries and, with a lack of reliable transportation or inundated resources, could also make critical healthcare and medicinal services inaccessible.	Health care company systems will be inaccessible to record patient information for future payment.	Downed electric grid would require healthcare and medicine to rely on generators for services. The weather event would damage access to water, critical for many healthcare services. The electric grid being down would add considerable stress to the water infrastructure, magnifying the potential for water inaccessibility.	Cell towers would be taken out by the storm and the surviving towers would be forced to rely on generators as the cyber attack takes out grid access. Then healthcare services would be unable to coordinate emergency rescues or requests for additional materials. Newer sensor based tracking systems in cold storage, etc. rely on internet access, tracking for pharma needed to be able to use the products which would become very difficult during the cyber attack. Issues with overall event response communications due to lack of infrastructure could cause cascading effects with medical response. Health care company system may be inaccessible for patient medical history.	Inundated roads would make it difficult for healthcare services to reach those in need. If additional materials are required by medical services, it will be difficult for them to reach the facilities via inundated or damaged roadways. The cyber attack would down electrical infrastructure like roadway lighting or warning signs and cause more danger and delays for those seeking medical attention. Emergency evacuation transportation is needed for patients who can move.	---

Disaster Impact Matrices by Commodity

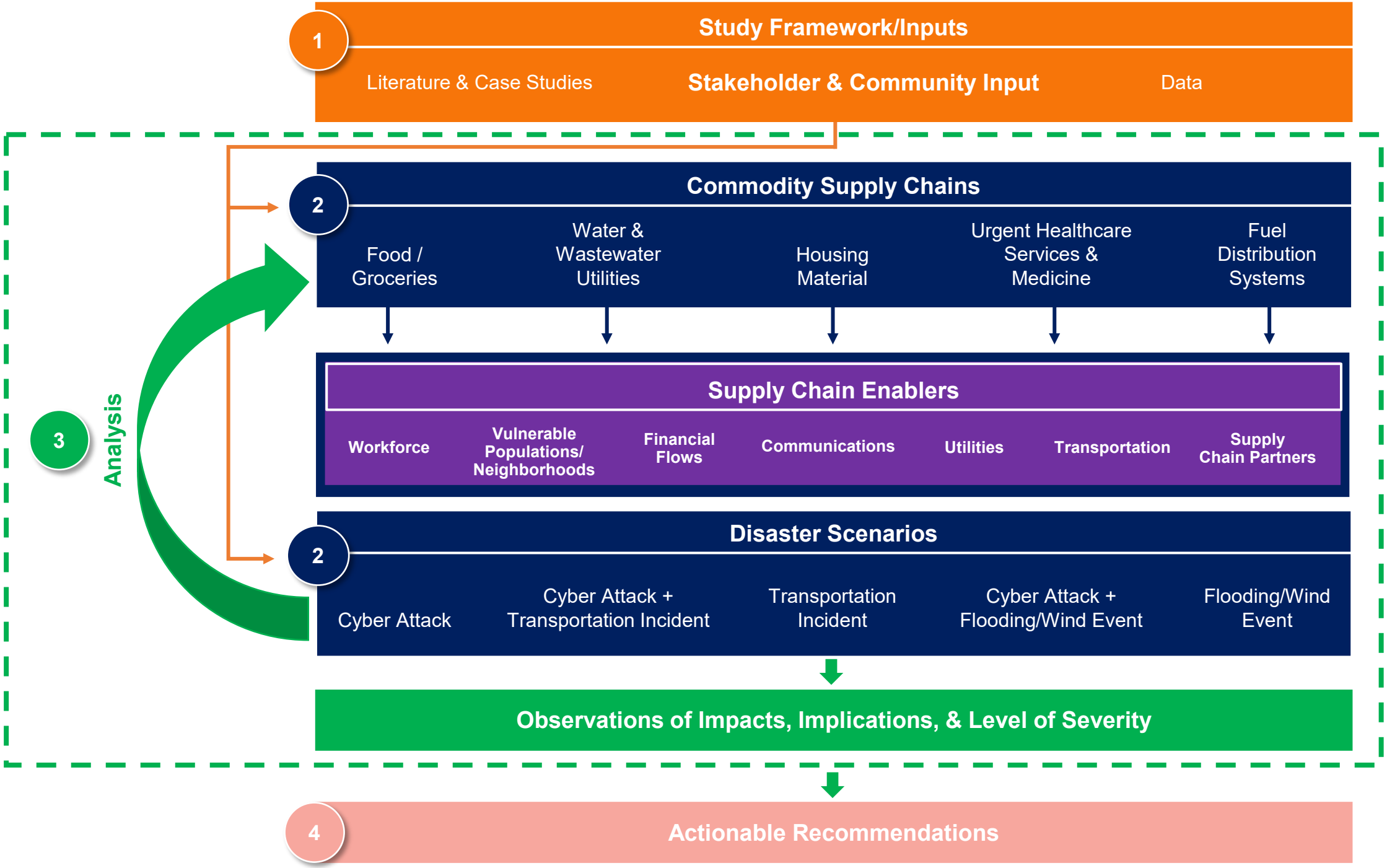
Urgent Healthcare Services and Medicine								
Disaster Scenario	**Metrics**	**Workforce**	**Vulnerable Populations/Neighborhoods**	**Financial Flows**	**Utilities**	**Communications**	**Transportation**	**Supply Chain Partners**
Cyber Attack + Transportation Incident	Severity	Severe	Moderate	Low	Severe	Severe	Moderate	---
	Scope	Regional	Regional	Regional	Regional	Regional	Regional	---
	Impact	Healthcare services would need to rely on generators that can only sustain partial function (40%) for 96 hours, which would make the workplace difficult. A core roadway being partially inaccessible would necessitate rerouting, making it difficult for healthcare workers to access the workplace.	Vulnerable populations/neighborhoods without power would be more at risk of heatstroke or other related medical issues. Lack of reliable transportation would make it difficult to seek medical attention in these cases. A critical roadway being down would further exacerbate the inaccessibility.	Health care company systems will be inaccessible to record patient information for future payment.	Healthcare services are reliant on the electric grid for many of their essential functions; without electricity, many of their critical procedures would be impossible. This cyber incident could eventually sabotage water, making service even more difficult.	Without electricity, much of the communication grid could be out. This would make the healthcare services unable to receive distress calls or communicate easily with first responders. That section of I-4/I-75 being down could cause a concentration of cellular usage as people attempt to avoid delays, stressing a system that would be relying on generators and impacting the efficiency of emergency response.	Downed electrical infrastructure, like roadway lighting or warning signs, would cause dangerous or delayed conditions for first responders or those seeking medical attention. Rerouting I-4/I-75 would further delays in that area and make it more difficult to reach or be reached by emergency services.	---

Fuel Distribution Systems								
Disaster Scenario	**Metrics**	**Workforce**	**Vulnerable Populations/Neighborhoods**	**Financial Flows**	**Utilities**	**Communications**	**Transportation**	**Supply Chain Partners**
Flooding/Wind Event	Severity	Severe	Severe	Low	Severe	Low to Moderate	Severe	---
	Scope	Regional	Regional	Regional	Regional	Regional	Widespread	---
	Impact	The weather event and preceding panic would cause fuel shortages and price spikes. This would make it difficult and costlier to get to work. Lower rate of workers reporting to work during event. Event worsens existing employee shortages, lack of affordable childcare, lack of effective public transit. Difficulties in accessing workplaces.	Fuel prices rising would impact vulnerable populations/neighborhoods disproportionately. Panic buying gas and price increases would make it difficult for these citizens to evacuate when it becomes necessary. Don't have the resources to chase gas.	Without cash, credit infrastructure could be down and prevent payments. Many stores will be unable to open registers even if their supplies are undamaged if the electric grid is down.	Central Florida Pipeline, which delivers fuel to the port, has been damaged/is inoperable so fuel has to get trucked in. Fuel would be in demand for generators in the case of utility outage; hospitals, cell towers, private homes are forced to rely on generators which rely on some sort of fuel.	Difficulty in tracking shipments; inability to receive shipments. Sales platform requires internet access. Inability to access the load board or communicate about the shipment of a product. Many of the generators for communications are diesel-powered, leading to an increased consumption if there is a prolonged outage.	Fuel shortages would make transportation inaccessible. Central Florida Pipeline, which delivers fuel to the port, has been damaged/is inoperable so fuel has to get trucked in; blocked roadways could make transporting fuel difficult. Event will worsen an existing shortage of truckers; some drivers will not risk getting a shipment into a disaster area. Ability to book trucking is impacted. Fuel deliveries would need to be rerouted in a few cases to avoid delivering to inoperable facilities due to damage- could create transportation delays.	Emergency fuel goes through the head of the Petroleum Institute.
Transportation Incident	Severity	Low to Moderate	Low to Moderate	Low	Low	Low to Moderate	Moderate	---
	Scope	Regional	Regional	Local	Local	Local	Regional	---
	Impact	Independent or small trucking or owner-operator small fleet size trucking companies will not accept loads if they don't think it will be profitable. Will no call no show. Late showings might miss pickups/deliveries/dock times which cause a cascading issue for other deliveries. Would cause delivery delays or mild shortages, difficulty accessing workplaces. Additional fuel could be consumed by the freight industry or other employees attempting to access the workplace and having to use alternate routes with more traffic	Vulnerable populations/neighborhoods would be impacted by rerouting if it creates increased congestion and environmental effects. Delays will have a larger impact on transit. Highways have historically been built in low income neighborhoods so detours off these facilities will more likely impact vulnerable communities.	---	Underground communications utilities on the north side of I-4 disrupted due to accident; minor disruption to internet service.	Local overload on cell network in the immediate area.	There will be increased demand for fuel if rerouting creates significant congestion and increased fuel consumption. The destruction of a critical roadway would delay deliveries, forcing rerouting that would congest other roadways	---
Cyber Attack	Severity	Low to Moderate	Low	Moderate	Severe	Severe	Moderate	---
	Scope	Regional	Regional	Regional	Regional	Regional	Regional	---
	Impact	If the normal electric grid was down, generators would require alternative fuel sources that would create shortages that could stall general populations and limit travel to and from work.	Fuel shortages will limit vulnerable populations and their ability to travel to work. Gas stations in low income areas are often older and will not have generators as is required for any station built after 2006 (Florida Statute 526.143).	Without cash, credit infrastructure would be down and prevent payments. Fuel stations without generators would not be able to pump without electricity which could create a shortage. Could create a major financial loss.	Electricity being down would prevent fuel stations from functioning normally; there would be limited access to this utility. Central Florida Pipeline, which delivers fuel to the port, will not operate under generator power; gas will have to get trucked in. As in Hurricane Katrina, fuel pipelines will not operate without power as it is not feasible to operate under generator power.	Many of the generators for communications are diesel-powered, leading to an increased consumption if there is a prolonged outage. The minimum Federal Communications Commission requirement for central offices is to maintain at least 24 hours of backup power; sites that are not in central office must maintain at least 8 hours of backup. Central offices directly connected to Public Safety Answering Points (PSAPs) or house databases that serve 9-1-1 are required to annually certify that they meet 24-hour backups under full loads. For central offices that house 9-1-1 routing equipment, the annual certification is for 72 hours of backup under full load (oshi.gov). Cellular towers are required to have a minimum of eight hours of backup under nominal loading, but many can operate for 12-24 hours before needing to be refueled. Record-keeping has become increasingly electronic; shipments would be delayed; power outages make it impossible to access or record new information. Ports are dependent on diesel powered generators for reduced operations.	Event will worsen an existing shortage of truckers. Ability to book trucking is impacted. Fuel deliveries would need to be rerouted to avoid delivering to inoperable facilities due to lack of a generator- would create transportation delays.	---

Fuel Distribution Systems								
Disaster Scenario	**Metrics**	**Workforce**	**Vulnerable Populations/Neighborhoods**	**Financial Flows**	**Utilities**	**Communications**	**Transportation**	**Supply Chain Partners**
Cyber Attack + Flooding/Wind Event	Severity	Severe	Severe	Moderate	Severe	Severe	Severe	---
	Scope	Regional	Regional	Regional	Regional	Regional	Widespread	---
	Impact	The weather event and preceding panic would cause fuel shortages and price spikes. The electric grid being down would require generators, which would create additional shortages. This would make it difficult and costlier to get to work. Lower rate of workers reporting to work during event. Event worsens existing employee shortages, lack of affordable childcare, and lack of effective public transit. Difficulties in accessing workplaces.	Fuel prices rising could impact vulnerable populations/neighborhoods disproportionately. Fuel shortages could limit vulnerable populations and their ability to travel to work. The cyber attack would require generators to power gas stations. Gas stations in low income areas are often older and may not have generators as is required for any station built after 2006 (Florida Statute 526.143). Panic buying gas and price increases could make it difficult for these citizens to evacuate when it becomes necessary. Don't have the resources to chase gas.	Without cash, credit infrastructure could be down and prevent payments. Many stores will be unable to open registers even if their supplies are undamaged if the electric grid is down as fuel stations without generators would be unable to pump.	Central Florida Pipeline, which delivers fuel to the port, has been damaged/is inoperable due to the weather event; fuel cannot be pumped via generator and the cyber attack has taken down all electricity so fuel has to get trucked in. Fuel would be in demand for generators in the case of utility outage; hospitals, cell towers, private homes are forced to rely on generators which rely on some sort of fuel. There would be limited access to fuel stations as only those with generators would be able to operate.	Difficulty in tracking shipments; inability to receive shipments. Sales platform requires internet access. Inability to access the load board or communicate about the shipment of a product. Many of the generators for communications are diesel-powered, leading to an increased consumption during prolonged outage. Cellular towers can operate on generators for 8-72 hours depending on what they are connected to, but this does not account for the physical infrastructure downed by the weather event that could further stress available services.	Fuel shortages could make transportation inaccessible. Central Florida Pipeline, which delivers fuel to the port, has been damaged/is inoperable so fuel has to get trucked in; blocked roadways could make transporting fuel difficult. Event will worsen an existing shortage of truckers, some drivers will not risk getting a shipment into a disaster area. Ability to book trucking is impacted. Fuel deliveries would need to be rerouted in a few cases to avoid delivering to inoperable facilities due to damage-could create transportation delays. There will be an increase in demand for fuel to power the generators necessary to keep various industries functioning through the cyber outage and the supply chain delays will create further shortages.	---
Cyber Attack + Transportation Incident	Severity	Moderate	Moderate	Moderate	Severe	Severe	Moderate	---
	Scope	Regional	Regional	Regional	Regional	Regional	Regional	---
	Impact	Independent or small trucking or owner-operator small fleet size trucking companies will not accept loads if they don't think it will be profitable. Will no call no show. Late showings might miss pickups/deliveries/dock times which cause a cascading issue for other deliveries. Would cause delivery delays or mild shortages, difficulty accessing workplaces. Additional fuel could be consumed by the freight industry or other employees attempting to access the workplace and having to use alternate routes with more traffic. The grid being down would require more fuel to support other industry functions in many cases.	Vulnerable populations/neighborhoods could be impacted by rerouting if it creates increased congestion and environmental effects. Delays will have a larger impact on transit. Highways have historically been built in low income neighborhoods so detours off these facilities will more likely impact vulnerable communities. Vulnerable populations could have less access to fuel stations if they are older and do not fall within the 2006 generator requirements.	Without cash, credit infrastructure could be down and prevent payments. Fuel stations without generators would not be able to pump without electricity which could create a shortage. Could create a major financial loss.	Electricity being down would prevent fuel stations from functioning normally, there would be limited access to this utility. Central Florida Pipeline, which delivers fuel to the port, will not operate under generator power so gas will have to get trucked in. As in Hurricane Katrina, fuel pipelines will not operate without power as it is not feasible to operate under generator power.	Difficulty in tracking shipments; inability to receive shipments. Sales platform requires internet access. Inability to access the load board or communicate about the shipment of a product. Many of the generators for communications are diesel-powered, leading to an increased consumption during prolonged outage. Cellular towers can operate on generators for 8-72 hours depending on what they are connected to. The area where there is downed transportation would further stress these generators if the demand is increased as drivers attempt to reroute or are trapped in congestion.	There would be increased demand for fuel if rerouting creates significant congestion and increased fuel consumption. The destruction of a critical roadway would delay deliveries, forcing rerouting that would congest other roadways. The cyber attack would cause outages that would require further rerouting to operable facilities that have generators. This, combined with a cyber attack, would worsen the existing shortage of truckers and create additional delays.	---

Appendix J – Supply Chain Resiliency Analysis Approach

Supply Chain Disruption Methodology



Appendix K – Recommendations

FREIGHT SUPPLY CHAIN RESILIENCE STUDY

The Freight Supply Chain Resilience Study resulted in 81 actionable recommendations. These recommendations are categorized by 1) role the Hillsborough Transportation Planning Organization (TPO) is to serve in executing the recommended actions as well as 2) action type. The recommendations are intended to build the resilience of Hillsborough County communities and be implemented in partnership with Hillsborough County supply chain actors, stakeholders, and communities to ensure neighborhood context, roadway safety/Vision Zero initiatives, and quality of life goals are integrated and upheld.

The three different roles defined for the Hillsborough TPO as part of this study, include:

Leader: TPO to serve as the leader in the implementation or advancement of the recommended action. The identified recommended action is aligned with a core function(s) of the TPO as an organization.

Collaborator: TPO to collaborate with other agencies, stakeholders, non-profit organizations, etc. to actively implement or advance the recommended action by contributing knowledge, insights, and expertise of the transportation planning process and understanding of federal, state, local, and community-based programs.

Facilitator: TPO to help coordinate and connect specific contacts and entities with each other in order to facilitate the advancement of the recommended action.

To better prioritize and increase the understanding and organization of the proposed actions, the recommendations were categorized into five action types:

Transportation | **Study/Guide/Research** | **Coordination** | **Training/Tool/Education** | **Grant Opportunity**

The recommendations (as listed below) are presented by Type and TPO Role.

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRANSPORTATION RECOMMENDATIONS							
Study and identify improvements to enhance the resilience of road and rail infrastructure of Hooker's Point	Study and identify improvements to enhance the resilience of road and rail infrastructure providing access to/from Hooker's Point. Specifically work with CSX to identify opportunities to increase track redundancies.	Mitigation	All	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation Utilities	Leader	Transportation [T-1]
Study and identify opportunities for improved and redundant roadway access to Hillsborough County airports	Study and identify opportunities for improved and redundant roadway access to Tampa Executive Airport, Tampa International Airport, and Plant City Airport. Enhanced access to Tampa Executive Airport should be prioritized.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation	Leader	Transportation [T-2]

FREIGHT SUPPLY CHAIN RESILIENCE STUDY

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRANSPORTATION RECOMMENDATIONS							
Study and identify truck specific infrastructure/policies to enhance freight connections to Port Tampa Bay facilities	Study and identify truck specific infrastructure/policies to improve freight access and redundancy (focusing on connections to Port Tampa Bay facilities) as well as freight throughput on the interstate system. Potential improvements may include designated truck lanes on the interstate system, direct ramp connections to freight activity centers, temporal separation of freight traffic through use of managed lanes, automated/ connected vehicle technology, intelligent transportation systems technology, etc.).	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation Utilities	Leader	Transportation [T-3]
Conduct a combined complete street/freight access/resilience study for the Ybor Channel Area	Conduct a combined complete street/ freight access/resilience study for the Ybor Channel Area (Channelside Drive, Southern Ybor City, Palmetto Beach, etc.) to identify infrastructure improvements that address freight traffic in a pedestrian-centered neighborhood that includes areas susceptible to rainfall and sea-level rise inundation. Improvements could include truck aprons, mountable infrastructure, improved stormwater facilities, activated stormwater infrastructure, etc. Improvements should prioritize pedestrian safety and consider periods of peak cruise activity.	Mitigation	All	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation	Leader	Transportation [T-4]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRANSPORTATION RECOMMENDATIONS							
Study and identify improvements to enhance the resilience of Falkenburg Road between SR 60 and SR 574	Study and identify improvements to enhance the resilience of Falkenburg Road between SR 60 and SR 574 to preserve access to Hillsborough County facilities (Public Safety Operations Complex (PSOC), county owned warehouses, and Sheriff's facilities) during periods of extreme inundation from severe storms. Falkenburg Road could serve as a main "back up" connection to the County facilities as they would be cut off in terms of access to major roadways (such as I-75 and SR 60) during an extreme inundation event. Improvements could include raised roadway profile, enhanced stormwater facilities, strengthened/enlarged bridge/culvert structures, increased permeable surfaces, etc.	Mitigation Recovery	All	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation	Leader	Transportation [T-5]
Study and identify improvements to enhance the resilience and safety of Commerce Street/Port Tampa Drive in Port Tampa City west of Interbay Boulevard	Study and identify improvements to enhance the resilience and safety of Commerce Street/Port Tampa Drive in Port Tampa City west of Interbay Boulevard to preserve access to port area facilities during 10-Year and 25-Year inundation events within the next 20 years. Improvements could include complete street features, raised roadway profile, enhanced stormwater facilities, strengthened/enlarged bridge/culvert structures, increased permeable surfaces, etc.	Mitigation Recovery	All	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation	Leader	Transportation [T-6]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRANSPORTATION RECOMMENDATIONS							
Study and identify improvements to enhance the resilience of CSX Port Tampa Spur Rail Line in the Port Tampa City area west of Manhattan Avenue	Study and identify improvements to enhance the resilience of CSX Port Tampa Spur Rail Line in the Port Tampa City area west of Manhattan Avenue to preserve access to port area facilities during 10-Year and 25-Year inundation events within the next 20 years. Improvements could include raised railbed profile, enhanced stormwater facilities, strengthened/enlarged bridge/culvert structures, hardened communications infrastructure, etc.	Mitigation Recovery	All	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation Utilities	Leader	Transportation [T-7]
Study and identify improvements to enhance the resilience of US 41 between Big Bend Road and SR 60	Study and identify improvements to enhance the resilience of US 41 between Big Bend Road and SR 60 to preserve access to port area facilities (Bayside Power Station, Big Bend Power Station, and industrial activities along the corridor) during 10-Year and 25-Year inundation events within the next 20 years. Improvements could include raised roadway profile, enhanced stormwater facilities, strengthened/ enlarged bridge/culvert structures, increased permeable surfaces, etc.	Mitigation Recovery	All	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation	Leader	Transportation [T-8]
Study and identify improvements to enhance the resilience of CSX Tampa Terminal Subdivision Rail Line parallel to US 41 between Big Bend Road and CSX Uceta Yard	Study and identify improvements to enhance the resilience of CSX Tampa Terminal Subdivision Rail Line parallel to US 41 between Big Bend Road and CSX Uceta Yard to preserve access to port area facilities (Bayside Power Station, Big Bend Power Station, and industrial activities along the corridor) during 10-Year and 25-Year inundation events within the next 20 years. Improvements could include raised railbed profile, enhanced stormwater facilities, strengthened/enlarged bridge/culvert structures, hardened communications infrastructure, etc.	Mitigation Recovery	All	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation Utilities	Leader	Transportation [T-9]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRANSPORTATION RECOMMENDATIONS							
Study and identify backup infrastructure for major County facilities	Study and identify backup or redundant infrastructure if main facilities are not accessible/not able to function (other area airports, arterial roadways for interstates, other rail lines, inland ports, etc.). Determine/recommend improvements to backup infrastructure if not equipped to handle demand/ functions of main facilities.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Transportation	Leader	Transportation [T-10]
Study resilient transportation options to provide access to supply chain critical workplaces	Study resilient transportation options to provide access to supply chain critical workplaces. This could include transit, Transportation Network Companies (TNCs)/ridesharing, or other mobility options.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Transportation	Leader	Transportation [T-11]
Study use of Advanced Air Mobility (AAM) and Electric/Hybrid-Electric Powered Vertical Take-Off and Landing (eVTOL) aircraft for recovery efforts	Study use of Advanced Air Mobility (AAM) and Electric/Hybrid-Electric Powered Vertical Take-Off and Landing (eVTOL) aircraft to serve as first mile/last mile of supply chains for recovery efforts.	Recovery	Food/Groceries Urgent Healthcare Services & Medicine	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Transportation	Leader	Transportation [T-12]
Enhance existing programs in partnership with HART and the HCEOC to provide emergency transportation for transportation disadvantaged populations	Enhance existing programs (such as Sunshine Line) in partnership with the Hillsborough Area Regional Transit (HART) Authority and the Hillsborough County Emergency Operations Center (HCEOC) to provide transportation (via buses, shuttles, school buses, etc.) for transportation disadvantaged populations to access supplies, shelters, medical services, etc. before and after disasters.	Recovery	All	Cyber Attack + Flooding/Wind Event Flooding/Wind Event	Transportation Vulnerable Populations/ Neighborhoods	Collaborator	Transportation [T-13]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRANSPORTATION RECOMMENDATIONS							
Create a program for transportation disadvantaged populations pertaining to transport/delivery of housing materials	Contract with local logistics companies to provide transportation options for transportation disadvantaged populations to transport housing materials or to access a service that delivers housing materials to these populations before and after a disaster.	Mitigation Recovery	Housing Material	Flooding/Wind Event Cyber Attack + Flooding/Wind Event	Supply Chain Partners Transportation Vulnerable Populations/ Neighborhoods	Collaborator	Transportation [T-14]
Study and designate truck appropriate alternative freight routes to interstates	Study and designate truck appropriate alternative freight routes (routes that have already been improved or planned to be improved to accommodate trucks) with special attention to vulnerable bridges/abutments and structures or new potential routes to I-75, I-4, and I-275; provide signage and promote routes to trucking industry. Incorporate this into the LRTP planning efforts and include the Supply Chain Resilience Network in the designation process. Work with FDOT, Hillsborough County, and/or appropriate municipalities on procedures/triggers to wave truck weight loads on alternative routes (as necessary).	Mitigation Recovery	All	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Transportation	Collaborator	Transportation [T-15]
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Incorporate supply chain resilience into the TPO Long Range Transportation Plan	Incorporate resiliency measures (specifically focusing on freight supply chain resilience) into the TPO Long Range Transportation Plan.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Leader	Study/ Guide/ Research [S-1]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Develop a local supply chain resilience best practices guide	Develop a Hillsborough County supply chain resilience best practices guide in collaboration with critical supply chain partners. Make available on the Hillsborough County Emergency Management Website and the City of Tampa "Tampa Ready" Website.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Leader	Study/ Guide/ Research [S-2]
Apply stated TPO transportation equity objectives to emergency response and recovery initiatives	Apply stated TPO transportation equity goals to emergency response and recovery initiatives to better facilitate workforce mobility and supply chain resilience pertaining to vulnerable populations and disadvantaged communities.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Transportation Vulnerable Populations/ Neighborhoods	Leader	Study/ Guide/ Research [S-3]
Study the changes related to alternative power within freight logistics	Study the changes from a freight logistics perspective related to alternative power and requirements for powering, fueling, and facilitating the buildout of freight focused resilient charging infrastructure. Communicate available incentives and rebates to support the transition to alternative powered equipment.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Transportation Utilities	Leader	Study/ Guide/ Research [S-4]
Perform 100-mile "foodshed" study and identify potential supply chain gaps	Perform "foodshed" study to better understand what is produced within a 100-mile radius of Hillsborough County and identify potential supply chain gaps.	Mitigation	Food/Groceries	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Vulnerable Populations/ Neighborhoods Supply Chain Partners	Leader	Study/ Guide/ Research [S-5]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Determine inland alternative sites for offloading and storing fuel	Conduct a study to determine inland alternative sites to Port Tampa Bay for storing and/or offloading fuel; identify fuel depots/reserve access points (especially if Port is cut off). Incorporate transportation network and business accessibility within the requirements.	Mitigation	Fuel Distribution Systems	Cyber Attack + Transportation Incident Cyber Attack + Flooding/Wind Event Flooding/Wind Event Transportation Incident	Utilities	Collaborator	Study/ Guide/ Research [S-6]
Study hardened and/or resilient consolidated warehouse and distribution facilities	Study, identify, and build partnerships for consolidated hardened facilities and consolidated storage facilities of critical public and private supply chain actors. Determine opportunities for critical supply chain commodities and services to jointly stockpile. For example: vehicles, equipment, vehicle and/or equipment parts, essential goods (canned food, bottled water, toilet paper, soap, baby formula, diapers, wipes, batteries, etc.) for essential workers and families, etc.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners	Facilitator	Study/ Guide/ Research [S-7]
Assess emerging aerial communications technologies for use during an event	Partner with local utility providers to assess implementation of emerging aerial communications technologies (such as AT&T's "Cell on Wing" (COW)) or other drone-based technologies to provide wireless communications during emergency events.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Communications Supply Chain Partners	Facilitator	Study/ Guide/ Research [S-8]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Evaluate mechanisms to provide shelter, childcare, elder care, etc. for essential workers and their families	Evaluate mechanisms/programs to provide shelter, childcare, elder care, etc. for essential workers and their families during emergency situations to help keep supply chains running.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation Workforce	Facilitator	Study/ Guide/ Research [S-9]
Assess the opportunity for standardizing back-up power generation	Assess the opportunity for standardizing back-up power generation units and associated service parts for assets critical to Hillsborough County (such as Port Tampa Bay, airports, David L. Tippin Water Treatment Facility, Howard F. Curren Advanced Wastewater Treatment Plant, etc.). Consider advanced purchase agreements, designated stockpiles of generators, alternative power sources (including renewable microgrids), and the availability of supporting equipment.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Utilities	Facilitator	Study/ Guide/ Research [S-10]
Study and identify locations for “electricity or power hubs” or electricity/power kiosks	Study and identify locations for “electricity or power hubs” (small scale power plants) or electricity/power kiosks that operate independent of the utility grid and/or can use alternative power sources (such as solar). These can be co- located with shelters and/or located in areas vulnerable to power outages.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Utilities	Facilitator	Study/ Guide/ Research [S-11]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Bury critical utilities infrastructure	Study and prioritize locations to bury critical utilities infrastructure, targeting critical utilities in vulnerable areas and along major transportation corridors.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Utilities	Facilitator	Study/ Guide/ Research [S-12]
Bury critical communications infrastructure	Study and prioritize locations to bury critical communications infrastructure, targeting critical supply chain actors in vulnerable areas and along major transportation corridors.	Mitigation	All	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Communications Utilities	Facilitator	Study/ Guide/ Research [S-13]
Study cold storage facilities/capacity to determine expansion opportunities	Study cold storage facilities/cold storage facility capacity within Hillsborough County in partnership with local distributors and retailers and determine if opportunities exist to identify additional facilities (partnerships with private sector)/expand capacity of existing facilities/modernize existing facilities.	Mitigation Recovery	Food/Groceries Urgent Healthcare Services & Medicine	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Utilities	Facilitator	Study/ Guide/ Research [S-14]
Analyze procurement agreements and strategic placement of mobile/portable refrigerated units	Analyze procurement agreements and strategic placement of mobile/portable refrigerated units throughout Hillsborough County (such as at or near shelter locations or areas with high concentrations of food warehouses, grocery stores, restaurants, or other food-related businesses).	Mitigation Recovery	Food/Groceries	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Financial Flows Supply Chain Partners Vulnerable Populations/ Neighborhoods	Facilitator	Study/ Guide/ Research [S-15]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Establish emergency plan for transfer of perishable goods to back-up cold storage facilities	Establish an emergency plan or program for donation of perishable goods to food desert communities/underserved communities or transfer of perishable goods to back-up facilities that can retain cold storage capacity.	Recovery	Food/Groceries	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Supply Chain Partners Vulnerable Populations/ Neighborhoods	Facilitator	Study/ Guide/ Research [S-16]
Perform an inventory of water and wastewater utility service parts and arrange procurement agreements with suppliers	Perform an inventory of water and wastewater utility service parts and readiness of critical parts replacement; define and arrange procurement agreements with suppliers of parts/ equipment such as pumps, backflow, valves, etc. Have redundancy of vendors available. Determine storage/ stockpiling of parts/equipment.	Mitigation Recovery	Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Financial Flows Supply Chain Partners Utilities	Facilitator	Study/ Guide/ Research [S-17]
Perform an inventory of potable water storage facilities and maintain a deployment strategy	Perform an inventory of potable water storage facilities within Hillsborough County in partnership with local distributors and retailers and determine if opportunities exist to identify additional facilities (partnerships with private sector)/expand capacity of existing facilities/modernize existing facilities. Provide map/list of facilities that have potable water available for distribution. Maintain a deployment strategy targeting critical workforce facilities and vulnerable communities for emergency supplies of water.	Mitigation Recovery	Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Financial Flows Supply Chain Partners Transportation Utilities Vulnerable Populations/ Neighborhoods Workforce	Facilitator	Study/ Guide/ Research [S-18]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Perform an inventory of portable toilet storage facilities and maintain a deployment strategy	Perform an inventory of portable toilet storage facilities within Hillsborough County in partnership with local distributors and retailers and determine if opportunities exist to identify additional facilities (partnerships with private sector)/expand capacity of existing facilities/modernize existing facilities. Provide map/list of facilities that have portable toilets available for distribution. Maintain a deployment strategy targeting critical workforce facilities and vulnerable communities for portable toilets during emergency events.	Mitigation Recovery	Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Financial Flows Supply Chain Partners Transportation Utilities Vulnerable Populations/ Neighborhoods Workforce	Facilitator	Study/ Guide/ Research [S-19]
Further study implications of disruptions to the Wastewater Treatment and Water Treatment facilities	Further study implications of disruptions to Howard F. Curren Advanced Wastewater Treatment Plant and David L. Tippin Water Treatment Facility. Identify specific emergency recommendations and assess the supply chain for intensity of water use and impacts of disruption.	Mitigation Recovery	Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Communications Utilities	Facilitator	Study/ Guide/ Research [S-20]
Further study resilience of the Strategic Use of Aquifer Storage and Recovery System during a cyber attack	Further study the resilience of the Strategic Use of Aquifer Storage and Recovery System under a cyber attack (focusing on Supervisory Control And Data Acquisition (SCADA) and Programmable Logic Controller (PLC) systems).	Mitigation Recovery	Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident	Communications Utilities	Facilitator	Study/ Guide/ Research [S-21]
Further study impacts of saltwater infiltration/ contamination on Hillsborough River Dam and Reservoir	Further study impacts to infrastructure and drinking water of the Hillsborough River Dam and Hillsborough River Reservoir if these facilities are compromised by saltwater infiltration/ contamination. Identify specific emergency recommendations.	Mitigation Recovery	Water & Wastewater Utilities	Cyber Attack + Flooding/Wind Event Flooding/Wind Event	Utilities Communications	Facilitator	Study/ Guide/ Research [S-22]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Perform an inventory of housing material storage facilities and determine opportunities for expansion	Perform an inventory of housing material storage facilities within Hillsborough County in partnership with local distributors and retailers and determine if opportunities exist to identify additional facilities (partnerships with private sector)/expand capacity of existing facilities/modernize existing facilities. Provide map/list of facilities that have housing material and material types. Consider material other than plywood (such as metal sheeting, sheet rock, PVC, cast iron, concrete, and aggregate) that should be stored and stockpiled.	Mitigation Recovery	Housing Material	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Supply Chain Partners	Facilitator	Study/ Guide/ Research [S-23]
Determine strategic staging yards for housing materials pre- and post-disaster	Determine strategic staging yards for access to housing materials pre- and post-disaster; consider locations that are near disadvantaged communities for equitable access.	Mitigation Recovery	Housing Material	Cyber Attack + Flooding/Wind Event Flooding/Wind Event	Vulnerable Populations/ Neighborhoods Workforce	Facilitator	Study/ Guide/ Research [S-24]
Perform an inventory of storage facilities for medical supplies and pharmaceuticals to determine the potential for expansion	Perform an inventory of storage facilities for medical supplies (including equipment, PPE, cleaning products/chemicals, linens, etc.) and pharmaceuticals (including alternative substances) within Hillsborough County in partnership with local distributors and retailers and determine if opportunities exist to identify additional facilities (partnerships with public and private sectors)/expand capacity of existing facilities/modernize existing facilities including cold storage. Provide map/list of facilities that have certain medical supplies and pharmaceuticals to target storage and stockpiling.	Mitigation Recovery	Urgent Healthcare Services & Medicine	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners	Facilitator	Study/ Guide/ Research [S-25]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Perform an inventory of dedicated water sources and storage for hospital use	Perform an inventory of dedicated water sources and storage for hospital use. Provide list of providers/sources and map. Explore opportunities for public-private partnerships. Define and arrange procurement agreements. The Supply Chain Resilience Network would be instrumental in this effort.	Mitigation Recovery	Urgent Healthcare Services & Medicine	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Financial Flows Supply Chain Partners Utilities	Facilitator	Study/ Guide/ Research [S-26]
Prepare a plan to assist critical Hillsborough County facilities with having fueling capabilities during emergencies	Prepare a plan to assist critical Hillsborough County facilities (such as Port Tampa Bay, airports, etc.) with having specific back-up power generation sources for fueling capabilities, manual override capabilities for fueling terminals/equipment, and able/trained employees to fuel trucks and other vehicles/equipment manually.	Mitigation Recovery	Fuel Distribution Systems	Cyber Attack Cyber Attack + Transportation Incident Cyber Attack + Flooding/Wind Event Flooding/Wind Event Transportation Incident	Utilities Workforce	Facilitator	Study/ Guide/ Research [S-27]
Prepare a plan to assist gas stations in securing back-up power generation sources	Prepare a plan to assist Hillsborough County gas stations in securing back-up power generation sources. Have designated stockpiles of generators, alternative power sources, and supporting equipment available for gas station use. (Opportunity to integrate effort with grant program recommendations).	Mitigation Recovery	Fuel Distribution Systems	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Supply Chain Partners Utilities	Facilitator	Study/ Guide/ Research [S-28]
Assess pre-disaster program for critical County employees/ businesses to purchase gasoline for personal vehicles	Assess the opportunity to keep supply chains running through a pre-disaster program to allow critical Hillsborough County employees and then critical businesses and employees to purchase an allocated amount of gasoline to fuel personal vehicles.	Mitigation	Fuel Distribution Systems	Cyber Attack + Flooding/Wind Event Flooding/Wind Event	Vulnerable Populations/ Neighborhoods Workforce	Facilitator	Study/ Guide/ Research [S-29]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
STUDY/GUIDE/RESEARCH RECOMMENDATIONS							
Research methods to implement recommendations cited in the USF CUTR August 2020 Tampa Bay Case Study for Fuel Resilience: Takeaways and Lessons Learned report (https://www.cutr.usf.edu/wp-content/uploads/2021/02/WO-2-Report-Tampa-Bay-Case-Study_Final-compressed.pdf)	Research methods to implement recommendations cited in the University of South Florida (USF) Center for Urban Transportation Research (CUTR) August 2020 Tampa Bay Case Study for Fuel Resilience: Takeaways and Lessons Learned report, including: 1) Ensuring adequate fuel storage: public agency fleets should store enough fuel to sustain a fleet's operation for 7-14 days without any fuel deliveries. 2) Diversifying fuel supply: explore fuel diversification strategies, including transitioning a portion of public agency fleets to alternative fuels. 3) Implementing a robust communication and sharing procedure: Develop a system that would track fuel usage/availability in real time of public agency fleets and allow sharing of fuel (or other resources) to entities in need.	Mitigation Recovery	Fuel Distribution Systems	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Communications Supply Chain Partners Utilities Workforce	Facilitator	Study/ Guide/ Research [S-30]
COORDINATION RECOMMENDATIONS							
Organize and establish a Supply Chain Resilience Network	Coordinate with the FDOT Freight and Rail Office to establish a Supply Chain Resilience Network to include critical supply chain actors identified within the Freight Supply Chain Resilience Study supply chain maps and critical supply chain facilities (Port Tampa Bay, airports, hospitals, etc.). This network would allow the actors and entities to convene to discuss issues/changes to supply chains and goods movement and prepare solutions as well as share continuity and resiliency practices and concerns. This group could interface with the Hillsborough County Local Mitigation Strategy Working Group and members could be invited to co-locate at the Hillsborough County Emergency Operations Center during emergency events.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Leader/ Facilitator	Coordination [C-1]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
COORDINATION RECOMMENDATIONS							
Increase TPO participation in existing tabletop exercises and establish an annual Hillsborough County supply chain focused tabletop or functional practice exercise	Work with agencies that host existing tabletop disaster planning exercises to increase the TPO's participation in these exercises. In addition, establish an annual Hillsborough County supply chain focused tabletop or functional practice exercise for Supply Chain Resilience Network members and local community lifeline providers. The tabletop exercise will rotate focus through the disaster scenarios and commodities/services identified by this study. The goals of the exercise are to practice emergency communication flows and to conduct an incident command structure exercise that advises all agencies, companies, and operations on where they fit and what is expected of them.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Collaborator	Coordination [C-2]
Promote expanding existing tabletop scenarios to include a wider variety of disaster scenarios	Promote the idea of expanding existing tabletop scenarios to include a wider variety of disaster scenarios like cyber attacks and transportation incidents.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Collaborator	Coordination [C-3]
Identify government affairs representatives for critical supply chain actors	Identify government affairs individuals (as opposed to the operations individuals) representing each of the critical supply chain actors noted within each of the supply chain maps. This recommendation is intended to support the establishment of private sector contacts for future resiliency planning and execution efforts.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Collaborator	Coordination [C-4]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
COORDINATION RECOMMENDATIONS							
Work with railroad and trucking companies to increase share of products transported by rail to reduce strain on trucking industry	Work with railroad and trucking companies (including the Association of American Railroads and the Florida Trucking Association) and FDOT to explore opportunities/incentives to increase share of food supplies and products, housing material, and fuel that can transported by rail to reduce strain on trucking industry. This action has sustainability as well as resiliency/ redundancy benefits.	Mitigation	Food/Groceries Housing Material Fuel Distribution Systems	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation	Collaborator	Coordination [C-5]
Continue to work with the Coalition of Community Gardens in food desert communities	Continue to work with the Coalition of Community Gardens to establish community gardens in food desert communities and underserved communities; educate neighborhoods on other available grants, loans, and programs to establish/maintain community gardens.	Mitigation	Food/Groceries	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Vulnerable Populations/ Neighborhoods	Collaborator	Coordination [C-6]
Encourage critical supply chain actors to place designated personnel outside of affected area(s) in their continuity planning	Encourage critical supply chain actors to have designated personnel outside of affected area(s) to help with communication/coordination efforts in their continuity planning and understand what the protocol is within their respective organizations regarding communications. Encourage an annual refresh and designate that person as a conduit for communications with the Hillsborough County Emergency Operations Center during the disaster event.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Communications Supply Chain Partners	Facilitator	Coordination [C-7]
Coordinate with American Red Cross and Direct Relief and understand capabilities of Amazon's Disaster Relief Hub	Coordinate with American Red Cross and Direct Relief to understand the capabilities of Amazon's Disaster Relief Hub in Atlanta.	Mitigation	All	Flooding/Wind Event Cyber Attack + Flooding/Wind Event	Supply Chain Partners	Facilitator	Coordination [C-8]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
COORDINATION RECOMMENDATIONS							
Collaborate with Tampa Electric on the use of renewables and battery backup for supply chain resilience	Collaborate with Tampa Electric on the use of renewables and battery backup capabilities to decouple critical infrastructure from the power grid and increase resilience for the supply chain.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Utilities	Facilitator	Coordination [C-9]
Identify partnerships regarding inputs/outputs for liquid oxygen and alternate substances	Explore opportunities for partnerships between Howard F. Curren Advanced Wastewater Treatment Plant and David L. Tippin Water Treatment Facility and area hospitals to share liquid oxygen/distribution plans. Howard F. Curren Advanced Wastewater Treatment Plant has an 80-ton Pure Oxygen air separator on-site. Partner to secure redundant vendors as alternate sources. Partner to determine storage/stockpiling/ distribution of liquid oxygen and alternate substances.	Mitigation Recovery	Urgent Healthcare Services & Medicine Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Financial Flows Supply Chain Partners	Facilitator	Coordination [C-10]
Define and arrange procurement agreements with suppliers for critical housing material	Define and arrange procurement agreements with suppliers for critical housing material (plywood, tarps, roofing shingles, etc.). Have redundancy of vendors available.	Mitigation Recovery	Housing Material	Cyber Attack + Flooding/Wind Event Flooding/Wind Event	Financial Flows Supply Chain Partners	Facilitator	Coordination [C-11]
Collaborate with local building material suppliers annually to address high demand periods	Collaborate with local hardware stores, roofing material retailers, big box home improvement retailers, etc. annually and develop a process to address high demand periods for building products. Coordinate with the Supply Chain Resilience Network and the Hillsborough County Local Mitigation Strategy Working Group to perform an initial assessment of demand during a modelled disaster disruption (such as a flooding/wind event).	Mitigation	Housing Material	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners	Facilitator	Coordination [C-12]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
COORDINATION RECOMMENDATIONS							
Define and arrange procurement agreements for medical supplies and pharmaceuticals	Create list of specialty equipment, medical supplies, and pharmaceuticals. Define and arrange procurement agreements with brokers, suppliers, vendors, and manufacturers of specialty equipment, medical supplies, and pharmaceuticals (including alternative substances). Have redundancy of companies available and incorporate lessons from the COVID-19 pandemic (what pharmaceutical goods were difficult to obtain, insufficient, etc.). The Supply Chain Resilience Network would be instrumental in this effort.	Mitigation	Urgent Healthcare Services & Medicine	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Financial Flows Supply Chain Partners Workforce	Facilitator	Coordination [C-13]
Arrange procurement agreements for sulfur dioxide and chlorine	Define and arrange procurement agreements with suppliers of sulfur dioxide and chlorine. Have redundancy of vendors available. Determine storage/stockpiling of alternate substances. The Supply Chain Resilience Network would be instrumental in this effort.	Mitigation Recovery	Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Financial Flows Supply Chain Partners Utilities	Facilitator	Coordination [C-14]
Ensure agreements are in place with other water input sources	Ensure agreements are in place with other water input sources (such as Tampa Bay Water) covering adequate supplies to address disruptions/ emergency events.	Mitigation Recovery	Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Financial Flows Utilities	Facilitator	Coordination [C-15]

FREIGHT SUPPLY CHAIN RESILIENCE STUDY

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
COORDINATION RECOMMENDATIONS							
Arrange procurement agreements to establish mobile fueling stations	Define and arrange procurement agreements with private companies (in state and out of state) to establish mobile fueling stations, fuel lines, fuel trucks, etc. to address fuel shortages. Establish redundancy of available companies (The Supply Chain Resilience Network would be instrumental in this effort). Assess how this changes as electrification of vehicles becomes more pervasive.	Mitigation Recovery	Fuel Distribution Systems	Cyber Attack Cyber Attack + Transportation Incident Cyber Attack + Flooding/Wind Event Flooding/Wind Event Transportation Incident	Financial Flows Supply Chain Partners Transportation	Facilitator	Coordination [C-16]
TRAINING/TOOL/EDUCATION RECOMMENDATIONS							
Engage freight planning actors and emergency response actors on supply chain resilience study recommendations	Engage with statewide freight planning actors (such as the Florida Department of Transportation (FDOT) Freight and Rail Planning Office, FDOT Florida Freight Advisory Committee, FDOT staff in charge of Freight Mobility & Trade Plan updates, etc.) as well as state and regional emergency response agencies (such as Tampa Bay Regional Planning Council (TBRPC), Hillsborough County, Florida Division of Emergency Management (FDEM), etc.) to educate them on/provide them with the outcomes, recommendations, and best practices of the Hillsborough TPO Freight Supply Chain Resilience Study. The engagement will increase visibility of the recommendations, increase integration of the Supply Chain Resilience Network, allow increased contact and collaboration between freight planning and emergency planning organizations, and allow these agencies to weave the recommendations into their own individual plans.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Leader	Training/ Tool/ Education [E-1]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRAINING/TOOL/EDUCATION RECOMMENDATIONS							
Promote supply chain resilience best practices through social media platforms	Enhance the dissemination of supply chain resilience best practices/ information through social media platforms. The best practices and information could be focused on addressing impacts of additional disaster scenarios (such as cyber attacks and transportation incidents).	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Leader	Training/ Tool/ Education [E-2]
Create an online information and contact repository for supply chain actors	Establish a shared OneDrive folder for critical supply chain actors (including those identified within each of the supply chain maps). Public and private companies could be given permission/ access to this folder. The folder could contain a list of supply chain actors/contacts (including those specializing in cold supply chain and specialized logistics) that should be engaged prior to and during emergencies. The list could be accessed/updated in real time. The folder could also serve as a repository of resources/information exchange. Automated rules could be applied to request updates after a specific time period in order to keep the information current. The repository could be linked through the Hillsborough County Emergency Management Website and the City of Tampa “Tampa Ready” Website.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Collaborator	Training/ Tool/ Education [E-3]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRAINING/TOOL/EDUCATION RECOMMENDATIONS							
Coordinate with the Hillsborough County Local Mitigation Strategy Working Group to enhance their Hazard Mitigation Viewer to better assess supply chain impacts and resilience	Coordinate with the Hillsborough County Local Mitigation Strategy Working Group to enhance their Hazard Mitigation Viewer to better understand the geospatial distribution of supply chain actors within Hillsborough County and better assess supply chain impacts and resilience. The viewer could include hazard models, real-time traffic, real-time fuel availability, and other crowd-sourced data to examine more granular impacts on supply chains through multi-hazard, multi-magnitude disaster scenario planning for response and resilient/climate adaptive recovery. The viewer findings could inform the supply chain resilience portion of the LRTP. The viewer could also be accessed by the Supply Chain Resilience Network during a disaster/disruption.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Collaborator	Training/ Tool/ Education [E-4]
Develop supply chain resilience best practices training for managers in critical retail and distribution positions	Develop best practices training for managers (train the trainer approach) in critical retail and distribution positions. The best practices could include concepts like manual workarounds for critical processes, communication approaches, identification of supply and demand mismatch, and other methods to ensure continuity in operations and supply.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Collaborator	Training/ Tool/ Education [E-5]
Educate business/small businesses on grants, loans, and programs for supply chain resilience	Educate businesses/small businesses on available grants, loans, and programs that will help/encourage them to harden their infrastructure for supply chain resilience. For example: relocating certain critical infrastructure, communications/IT hardware or infrastructure and securing backup generators/alternative power sources for power outages.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Collaborator	Training/ Tool/ Education [E-6]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRAINING/TOOL/EDUCATION RECOMMENDATIONS							
Promote and educate neighborhoods about non-government organization (NGO) emergency-related programs	Promote and educate neighborhoods about existing emergency related programs via non-government organizations (NGOs)/non-profits/ government-sponsored non-governmental organizations (GONGOs), such as Hillsborough County's Community Emergency Response Team (CERT) Program and Feeding Tampa Bay Disaster Readiness Team. Determine if there is opportunity for them to serve as first mile/last mile of supply chains (delivering foods, potable water, medical supplies, & gasoline to neighborhoods/neighbors or assisting transportation disadvantaged neighbors to access supplies/medical care). Develop opportunities for partnerships and formal cooperative relationship(s) with non-profits to support transportation needs for transportation disadvantaged households.	Mitigation Recovery	Food/Groceries Housing Materials Urgent Healthcare Services & Medicine Water and Wastewater	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Transportation Vulnerable Populations/ Neighborhoods	Collaborator	Training/ Tool/ Education [E-7]
Require a sea level rise checklist for all capital improvement projects	Consider incorporating or requiring completion of a sea level rise checklist as part of all capital improvement projects during the planning, design, and/or approval process(es).	Mitigation	All	Cyber Attack + Flooding/Wind Event Flooding/Wind Event	Transportation Utilities	Collaborator	Training/ Tool/ Education [E-8]
Ensure critical supply chain actors have available copies of critical contacts and operations records when the main file source is offline	Ensure critical supply chain actors identified within each of the supply chain maps have physical copies or local digital copies of critical contacts and operations records to maintain access to critical files when the main file source is offline due to a disaster.	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Communications Supply Chain Partners	Facilitator	Training/ Tool/ Education [E-9]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
TRAINING/TOOL/EDUCATION RECOMMENDATIONS							
Expand Hillsborough County Aviation Authority partnership with Hillsborough Community College to include other entities	Expand Hillsborough County Aviation Authority (HCAA) partnership with Hillsborough Community College (HCC) to include other entities (Port Tampa Bay, Florida Trucking Association, CSX) and other universities (University of Tampa and University of South Florida) to create training/vocational programs to address industry and supply chain needs (including truck driving).	Mitigation Recovery	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Workforce	Facilitator	Training/ Tool/ Education [E-10]
Promote workforce training opportunities for fuel distribution and HAZMAT-licensed drivers	Promote and support Hillsborough County area trucking workforce training opportunities that support fuel distribution to gas stations and convenience stores with gas stations. The intent is to increase the number of HAZMAT licensed truck drivers in the Hillsborough County area.	Mitigation	Fuel Distribution Systems	Cyber Attack Cyber Attack + Transportation Incident Cyber Attack + Flooding/Wind Event Flooding/Wind Event Transportation Incident	Workforce	Facilitator	Training/ Tool/ Education [E-11]
Train employees to monitor the USEPA Water Supply Chain Disruption Tool	Train employees and have them actively monitor the newly released United States Environmental Protection Agency Water Supply Chain Disruption Tool. The tool may be utilized if certain inputs are impacted and alternate sources of supply and procurement arrangements need to be considered to increase the reliability of supplies.	Mitigation Recovery	Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Utilities Workforce	Facilitator	Training/ Tool/ Education [E-12]
Train Wastewater Treatment and Water Treatment facility employees to have redundant equipment operation skills	Train employees of Howard F. Curren Advanced Wastewater Treatment Plant and David L. Tippin Water Treatment Facility to have redundant skill sets of equipment operation. Partner with local higher education/vocational schools to create training/vocational programs.	Mitigation	Water & Wastewater Utilities	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event	Utilities Workforce	Facilitator	Training/ Tool/ Education [E-13]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
GRANT OPPORTUNITY RECOMMENDATIONS							
Assess BIL grants establishing Alternative Fuel Corridors	Assess the opportunity to apply for grants available through the Infrastructure Investment and Jobs Act/Bipartisan Infrastructure Law (BIL) to study/identify Alternative Fuel Corridors. The corridors are intended to strategically deploy publicly accessible electric vehicle charging infrastructure, hydrogen fueling infrastructure, propane fueling infrastructure, and natural gas fueling infrastructure. This infrastructure can be used to increase supply chain resilience by providing alternative fueling sources to freight vehicles, including Type 8 trucks and above. The TPO could work with FDOT on this study.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation Utilities	Leader	Grant Opportunity [G-1]
Assess opportunities presented by the Transportation Access Pilot Program through the BIL	Assess the opportunity to participate in the Transportation Access Pilot Program through the BIL legislation. The pilot program will measure the level of access by surface transportation modes to important destinations (jobs, health care, childcare, educational and workforce training facilities, housing, food sources, supply chain points for freight commodities, etc.) and assess the change in accessibility that would result from new transportation investments.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Supply Chain Partners Transportation	Leader	Grant Opportunity [G-2]
Establish a business/small business grant program for supply chain resilience	Establish a grant program to assist businesses/small businesses in hardening their infrastructure for supply chain resilience. For example: relocating certain critical infrastructure, communications/IT hardware or infrastructure, and backup generators/alternative power sources for power outages.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	All	Collaborator	Grant Opportunity [G-3]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
GRANT OPPORTUNITY RECOMMENDATIONS							
Identify grant opportunities for CSX to serve as an emergency fuel transportation method	Identify opportunities for grant funding to potentially have CSX serve as an emergency source for transporting fuel (address new sidings for staging tank cars for fuel shipment).	Mitigation	Fuel Distribution Systems	Cyber Attack Cyber Attack + Transportation Incident Cyber Attack + Flooding/Wind Event Flooding/Wind Event Transportation Incident	Financial Flows Supply Chain Partners Transportation	Collaborator	Grant Opportunity [G-4]
Assess Regional Center of Excellence for Resilience and Adaptation designation and associated grants through the BIL	Assess the opportunity to become a designated Regional Center of Excellence for Resilience and Adaptation through the BIL legislation. The centers of regional excellence will receive grants to advance research and development that improves the resilience to natural disasters, extreme weather, and the effects of climate change on surface transportation infrastructure and infrastructure dependent on surface transportation.	Mitigation	All	Cyber Attack Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Transportation	Collaborator	Grant Opportunity [G-5]
Secure grants/provide incentives for small fleet size trucking companies to provide services during emergency events	Create a program to provide incentives for small fleet size trucking companies to pick-up/deliver loads during emergency periods. Hazard pay for small/ independent trucking companies would help overcome the increased barriers and potentially decreased profit margins on providing trucking services during a severe disruption.	Mitigation Recovery	All	Cyber Attack Transportation Incident Flooding/Wind Event Cyber Attack + Transportation Incident Cyber Attack + Flooding/Wind Event	Transportation Workforce	Facilitator	Grant Opportunity [G-6]

Recommendation	Description	Mitigation or Recovery Strategy	Applicable Supply Chain	Applicable Disaster Scenario	Supply Chain Enablers	TPO Role	Type
GRANT OPPORTUNITY RECOMMENDATIONS							
Secure grants/provide incentives for food processing companies/activities to locate within Hillsborough County	Secure grants/provide incentives for food processing companies/activities to locate within Hillsborough County to address high percentage of importation linked to food processing. This is aimed at increasing resiliency by reducing high reliance on out of region supply chain elements. (This effort can be further informed or expanded by the 100-mile "foodshed" study.)	Mitigation	Food/Groceries	Cyber Attack + Flooding/Wind Event Cyber Attack + Transportation Incident Flooding/Wind Event Transportation Incident	Financial Flows Supply Chain Partners	Facilitator	Grant Opportunity [G-7]