RESILIENT CAPE CANAVERAL

2019

STORM SURGE | FLOODING | SEA LEVEL RISE |

SEA LEVEL RISE + SURGE

This report was prepared for the City of Cape Canaveral, the Florida Department of Environmental Protection and the National Oceanic and Atmospheric Administration by the East Central Florida Regional Planning Council.

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I. Executive Summary

In 2018, the Florida Department of Environmental Protection's Florida Coastal Management Program (FCMP) and the National Oceanic and Atmospheric Administration (NOAA) awarded the City of Cape Canaveral a grant to assess natural current and future vulnerabilities in the City. The grant funding also provided the opportunity to develop strategies to enhance the City's short and long-term resiliency to climate-related hazards. This will also allow the city to comply with "Peril of Flood" legislation put forth by Senate Bill 1094 and consider the designation of Adaptation Action Areas (AAAs) within the City. Vulnerabilities addressed through this project include: flooding, sea level rise, storm surge, and storm surge combined with sea level rise.

The over-arching goal of this report is to identify coastal vulnerabilities specific to the City of Cape Canaveral and provide recommendations to mitigate the effects of flooding, sea level rise and storm surge.

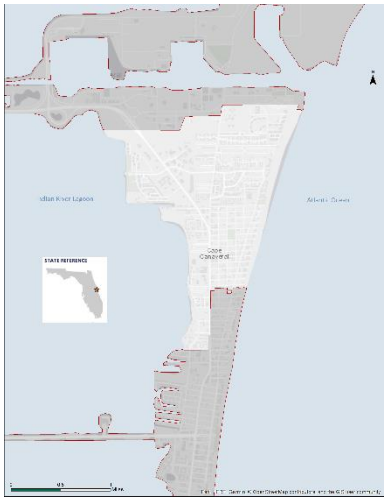
Between October 2018 through May 2019, City Staff, along with staff from the East Central Florida Regional Planning Council, worked with the community to fulfill the following project goals:

- Vulnerability Analysis: Identify the social, economic and functional vulnerabilities facing the City from four natural hazards: storm surge, flooding, sea level rise and nuisance flooding. The combined impacts of sea level rise and storm surge were also analyzed.
- Public Engagement: Engage the community in an educational manner identify vulnerabilities, potential strategies for mitigating vulnerabilities, and facilitate discussion concerning future development strategies and opportunities within the City.
- Strategy and Policy Development: Develop strategies for the City based on public input and best practices for integration into the formulation of comprehensive plan policies for compliance with SB 1094 (Peril of Flood) to enhance resilience in the City.
- Economic Impact Analysis: Conduct an economic impact analysis of a "do-nothing" scenario as well as the implementation of a project or strategy derived through the project to determine economic impacts of future conditions and the specific strategy on the City.

This document provides the following: methodology, data and analysis concerning the vulnerabilities to the City; the process and findings from the public engagement activities; strategies to be considered by the City for implementation and inclusion into the comprehensive plan and other City plans and documents; and the economic impact analysis which assessed the impacts of sea level rise on the City if no action was taken to alter the design of State Road (S.R.) A1A to reduce flood impacts to surrounding businesses.

II. Background

Coastal communities across Florida are encountering increasing flooding and surge impacts which pose risks to critical facilities, community assets, local/regional economics and the health/welfare of residents. Increased frequency and duration of flooding can occur as a result of sea level rise and can have impacts on vital infrastructure. This can result in malfunctioning drainage systems, insufficient stormwater storage, loss of access to facilities and economic losses to properties in the community and region (Council E. C., Space Coast Transportation Planning Organziation Vulnerability Assessment, 2018). Taking a hard look at current and future vulnerabilities, developing strategies across disciplines to mitigate, adapt or retreat from the impacts and implementing policies/programs aimed towards resilience and sustainability is not only what the City should do to become a resilient city but it is also required by state statue through Senate Bill 1094. Additionally, federal agencies such as the Federal Highway Administration (FHWA), Housing and Urban Development (HUD) and Federal Emergency Management Agency (FEMA) are now tying resiliency, flooding, future conditions from sea level rise and flooding to funding programs, making it more important for local jurisdictions and regional/state agencies to assess, plan and implement for the future of coastal communities.



The City of Cape Canaveral, a barrier island community along the coast of Brevard County, Florida is located immediately south of Port Canaveral (one of the world's busiest cruise ports), Kennedy Space Center and Cape Canaveral Air Force Station. It is located north of Patrick Air Force Base, making the City's resiliency and economic sustainability vital to Brevard County's workforce and tourism. The City faces impacts from sea level rise, storm surge and coastal flooding on two fronts as it is situated with the Atlantic Ocean to the east and the Banana River Lagoon to the west. S.R. A1A is a major thoroughfare and evacuation route which runs north-south through the City of Cape Canaveral and then turns west toward the mainland at the northern end of the City. S.R. 520, another major east-west connector and evacuation route from the barrier island is just south of the City of Cape Canaveral in the City of Cocoa Beach. The City is approximately 1.9 square miles with the highest elevation point at 10 feet above sea level. Cape Canaveral's core commercial areas are located along S.R. A1A and N. Atlantic Avenue. The portion of the City east of N. Atlantic Avenue and west of S.R. A1A is comprised predominately of residential properties albeit some public buildings and parks near the center of the City. The northern portion of the City includes industrial and some commercial near the Port. Although the City is nearly built out, there are many opportunities for redevelopment throughout the City, especially in the commercial corridor.

In 2018, the Florida Department of Environmental Protection's FCMP and NOAA awarded the City of Cape Canaveral a grant to assess natural current and future vulnerabilities facing the City. The grant funding also provided the opportunity to develop strategies to enhance the City's short-and-long-term resiliency to climate-related hazards and comply with "Peril of Flood" legislation put forth by Senate Bill 1094 while considering the designation of AAAs within the City. Vulnerabilities addressed through this project and

subsequently assessed include: flooding, sea level rise, storm surge and storm surge combined with sea level rise. The following report encompasses the various aspects of the project process, vulnerability analysis findings, engagement activities/feedback and recommendations for the City.

A. Project Goals

The over-arching goal of this resiliency plan is to identify coastal vulnerabilities specific to the City of Cape Canaveral and provide recommendations to mitigate the effects of flooding, sea level rise, storm surge and storm surge with sea level rise.

Between October 2018 through May 2019, City Staff, along with staff from the East Central Florida Regional Planning Council worked together with the community to fulfill the following project goals:

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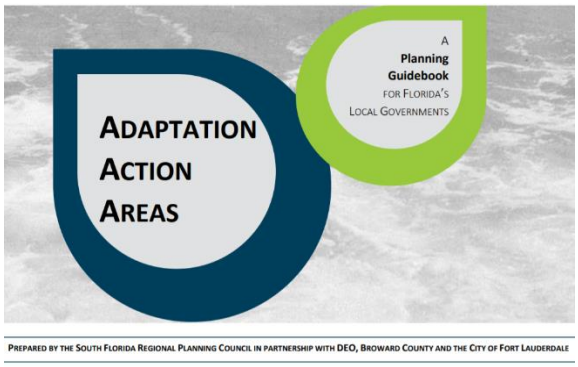
B. Legislative Connection

Florida's 'Peril of Flood' Legislation

Source:: Water Symposium of Florida Inc.

Senate Bill 1094, enacted state legislation passed in 2015, is aimed at standardizing how coastal communities address climate-related vulnerabilities. The law requires local coastal governments in the state of Florida to include a 'Peril of Flood' component within the Coastal Element of their Comprehensive Plans. The Coastal Element guides communities in the management of coastal resources and eliminates inappropriate and unsafe development in coastal areas in order to protect the health and safety of its residents/visitors. Data and maps developed as part of this study will be incorporated into the City of Cape Canaveral's Coastal Element in order to fulfill this state requirement.

Adaptation Action Areas



In addition to Senate Bill 1094, House Bill 7207 was passed in 2011 as part of the Community Planning Act and included the "Adaptation Action Area" (AAA) designation for coastal communities. This optional designation is for *"areas that experience coastal flooding and are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure needs and adaptation planning for the purpose of prioritizing funding for infrastructure needs and adaptation planning."* (Council S. F., 2014)

C. Regional Initiatives and Collaboration

On September 19, 2018, the East Central Florida Regional Planning Council unanimously adopted a resolution to develop a process and framework for a regional resilience collaborative in east Central Florida. To date, two committees have been formed; a Council Sub-Committee and a Steering Committee. The Steering Committee is made of up various disciplines across the region with the knowledge that the interaction of local residents will further enhance the creativity of resiliency strategies. This regional collaborative will help build capacity and establish a shared mission of goals uniting knowledge, lessons learned, and future endeavors.

The formation of the Regional Resiliency Collaborative was an outcome of East Central Florida Regional Resiliency Action Plan (ECF RRAP), which gathered stakeholders in Brevard and Volusia County to identify opportunities and gaps in planning for resilience and to facilitate discussion, collaboration and local actions over a five-year timeframe in order to address climate-related vulnerabilities and strategies.

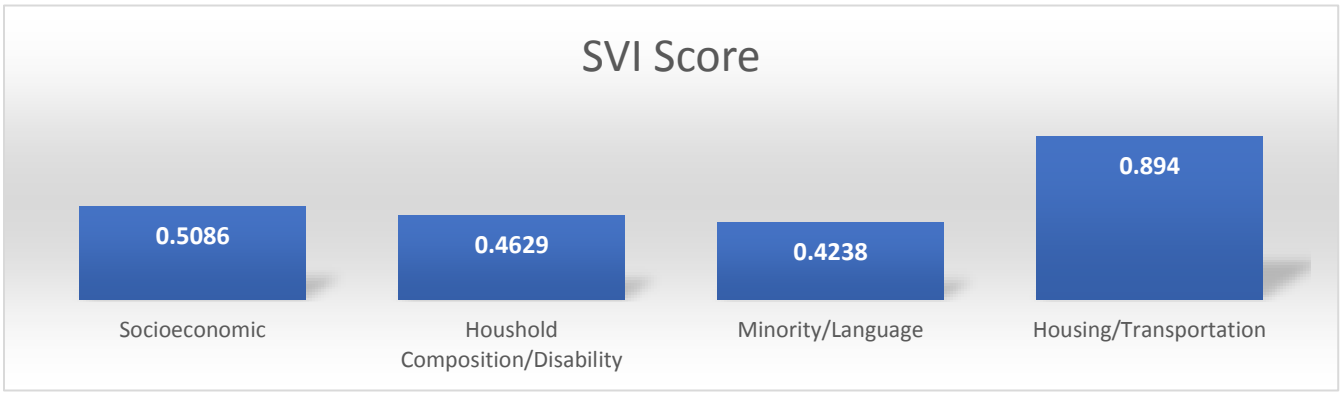
This report builds on the work developed as part of the Resiliency Action Plan and the Regional Resiliency Collaborative in a number of ways, including the use of the RRAP's Regional Approach to Sea Level Rise recommendation. Additionally, some of the recommendations included as part of this report are local government action items deemed relative to the City of Cape Canaveral originally identified in the Regional Resiliency Action Plan.

"Coming together is a beginning; keeping together is progress; working together is success."
– Henry Ford

III. Socio-Economic Profile

Social vulnerability is "how resilient a community is when confronted by external stresses on human health". Stresses can include natural disasters, disease outbreak and human disturbance; all of which can cause economic loss and human health impacts. The Center for Disease Control utilizes census data to identify census tracts that may need support in the preparation of hazards (Center for Disease Control, 2019).

Figure 1: Social Vulnerability Index Score 2016 for Census Tract 686.01



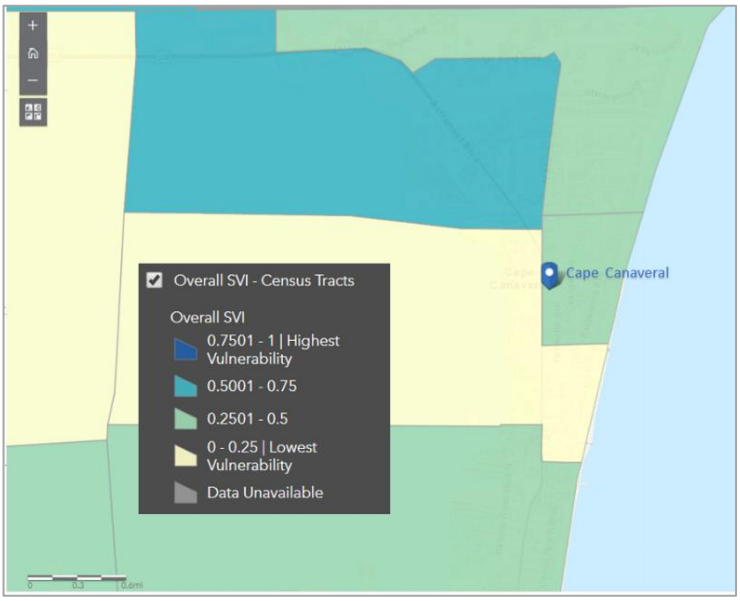
Source: CDC SVI, 2016

The Social Vulnerability Index is based on 14 social factors including vehicle access, poverty, demographics, housing and others grouped into four themes:

- Socioeconomic
- Household Composition/Disability
- Minority/Language
- Housing/Transportation

Figure 2 illustrates Cape Canaveral's Social Vulnerability Index by Census Tract. The highest SVI score is found in Census Tract 686.01 (shown as the darkest color in Figure 2) with a 2016 Overall SVI score of 0.6419 which indicates a moderate to high level of vulnerability. The figure above illustrates the scoring in each of the four themes in this census tract with Housing/Transportation being the highest at 0.894. (ATSDR , 2019)

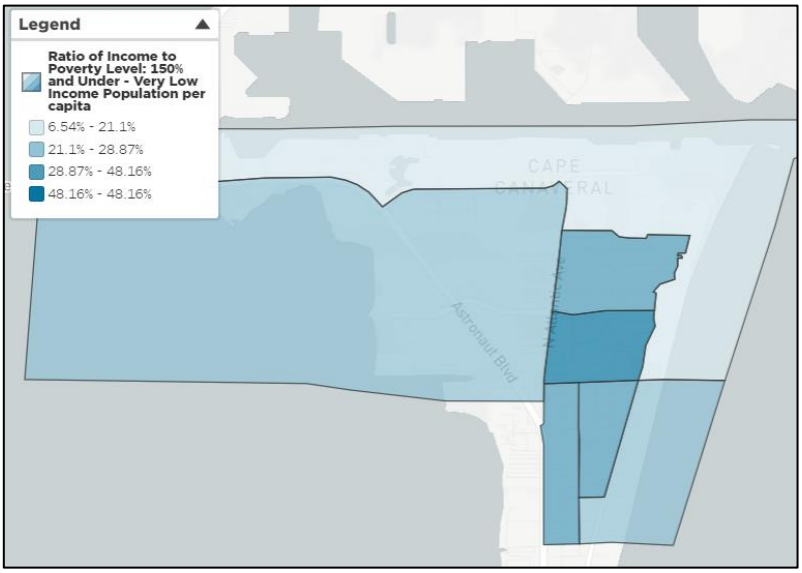
Figure 2: Social Vulnerability Index by Census Tract



Data below reflects socio-economic estimates from the 2013-2017 Census American Community Survey (ACS). It should be noted, that as with many communities across the United States, income and property values are increasing and should be reassessed with the 2020 Census. Also, as the City continues to redevelop, various business ventures continue to come to Cape Canaveral. According to the latest Census data, the population in the City of Cape Canaveral (10,169) is expected to grow to over 10,500 by 2020. Nearly 36% of the population is over the age of 65, while 32% are between the ages of 44 and 64, indicating a continued trend toward an older population over the next 30 years. The average age in the City is 57 years of age. The City's minority population makes up 9% of its residents with nearly 28% of the City's residents classified as very low-income (ratio of income to poverty level – 150% and under). Fortunately, as shown in the map below (Figure 3), the higher concentration of the very low-income population is located in one of the least vulnerable areas of the City. This Census Block Group (120090686022) also has the highest percentage of single female with children households, no vehicle per occupied housing unit, and is inclusive of the Census Tract with highest population living with a disability.

Additionally, in terms of vulnerable populations, approximately 17% of residents are living with a disability, thus increasing the likelihood that these individuals will need assistance in evacuation, special needs shelters, storm preparedness and potential improvements to their property to improve resilience. In 2018-2019, 371 students attended Cape View Elementary, 275 (74%) of which are from Cape Canaveral. With 10% of the population under the age of 18, the potential growth of the City would benefit by retaining this demographic. Engaging and educating them in the concerns associated with resilience and natural hazards would be a benefit in the years to come. Additionally, when considering social vulnerability, the City should engage in conversations with the family households as finding childcare when schools or daycares are closed due to storm damage could financially impact them as they struggle to return to work without childcare.

Figure 3: Very Low-Income Population Per Capita



(Source: ACS 2013-2017)

Table 1: Socio-Economic Summary of Cape Canaveral

Current Total Population (ACS 2013-2017):	10,196
Change in Population (Census 2000-2010)	1,043
Expected Population (Shimberg Center 2040)	11,441
[1]Median Home Value (ACS 2013-2017)	$200,000
Median Household Income (ACS 2013-2017)	$41,250
Families Below Poverty Level (ACS 2013-2017)	263
Households Below Poverty Level (ACS 2013-2017)	825 (15.5%)
People Below Poverty Level (ACS 2013-2017)	1,522 (14.9%)
Population Under Age 18	1036 (10.2%)
Population Age 65 and Over (ACS 2013-2017)	3,652 (35.8%)
Single Female with Children	297 (3%)
Population Living with a Disability	1,746 (17%)
[2]Individuals who speak English less than Very Well (ACS 2013-2017)	141 (1.3%)
[3]Total Persons Unemployed (ACS 2013-2017)	196
Unemployment Rate (ACS 2013-2017)	4.73
Occupied Household with No Vehicle (ACS 2013-2017)	663

The average household income in Cape Canaveral is $41,250 with 15.5% of households living below poverty. According to US HUD and DOT, "Low Income Individuals" spend nearly 92% of their income on housing in Cape Canaveral. This includes related costs, as well such as utilities. "Median Income Families" are spending nearly 28% of their income on housing costs, just below the "cost burdened" threshold. However, when transportation is factored into housing costs, median income households are pushed into the severely cost-burdened category, with 50% of income being spent on housing and transportation, with Low Income Residents spending nearly 140%.

COST BURDENED – THOSE WHO PAY MORE THAN 30% OF THEIR INCOME FOR HOUSING.

SEVERLY COST BURDENED – THOSE WHO PAY MORE THAN 50% OF THEIR INCOME FOR HOUSING.

(HUD)

[1] The Census Bureau defines value as the "estimate of how much the property (house and lot, mobile home and lot, or condominium unit) would sell for if it were for sale. For vacant units, value was the price asked for the property".

[2] Individuals age 5 and older who speak a language other than English at home and who speak English less than very well.

[3] The Census Bureau defines the civilian unemployed population as "civilians 16 years old and over are classified as unemployed if they: (1) were neither "at work" nor "with a job but not at work" during the reference week, and (2) were actively looking for work during the last 4 weeks, and (3) were available to accept a job.

Table 2: Housing Affordability in Cape Canaveral

Location Affordability for a Median Income Households and Families

Cape Canaveral, FL	
Percent of Income Spent on Housing and Transportation - Median Income Families	**50.28%**
Percent of Income Spent on Housing - Median Income Families	**27.6%**
Percent of Income Spent on Transportation - Median Income Families	**22.68%**

Sources: US HUD, DOT, LAI; US HUD & DOT, LAI

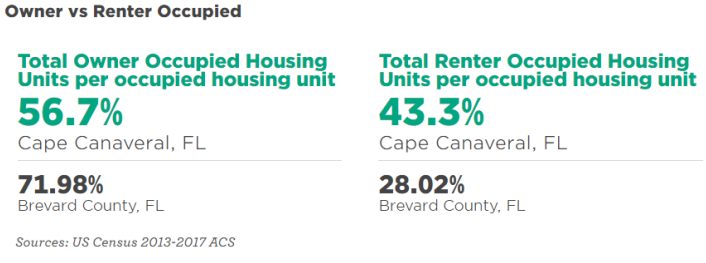
Location Affordability for a Very Low Income Resident

Cape Canaveral, FL	
Percent of Income Spent on Housing and Transportation - Low Income Individuals	**139.26%**
Percent of Income Spent on Housing - Low Income Individuals	**91.64%**
Percent of Income Spent on Transportation - Low Income Individuals	**47.62%**

Sources: US HUD and DOT

The City has a total of 8,954 housing units, a 40% vacancy rate and slightly more Owner-occupied housing units (56.7%) compared to renter-occupied housing units (43.3%). The City's renter population trends higher than the whole of Brevard County (28%). Renters, according to the 2013-2017 US Census ACS data, experience more cost-burden than owners as renters spend approximately 52% of their income on housing costs. This is representative of a high renter's rate and lack of affordable rental homes for lower income families. There are 65% of renters who pay over 30% of their income on gross rent (cost burdened), and 27% of households spending over 50% on gross rent (severely cost-burden). This indicates that renters, as a whole, represent a vulnerable population in terms of disaster preparedness and recovery in the City and are dependent on landlords to make improvements and repairs. While the majority of homeowners in Cape Canaveral actually spend less than 20% on housing costs, 25% of homeowners are cost-burden, 11% of which are severely cost-burdened.

Figure 4: Owner vs. Occupied Housing in Cape Canaveral



Approximately 263 households in the City are living below the poverty level. This is important in terms of social vulnerability because these families, as well as the cost-burdened families (including 65+ residents who are on a fixed income) may not have the available funds to properly prepare for or recover from hazards such as hurricanes, nor have the ability to make improvements to homes or properties to mitigate damage or flooding. These households may also be dependent on income from jobs that, after a disaster, may be closed for a period of time, thus, stressing the financial well-being of the household and ultimately the community.

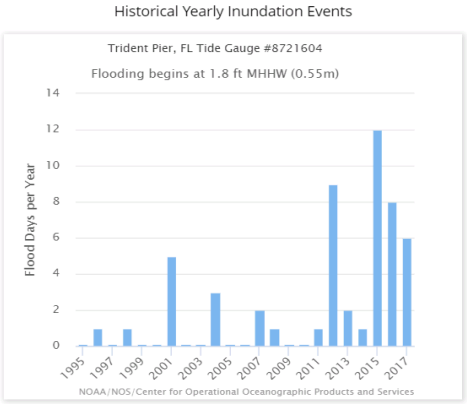
IV. Vulnerability Assessment

As the goal of the vulnerability analysis and subsequent policy actions are based upon specific hazards, the methodology section of this report highlights the base data utilized and the general methods of analysis. The areas of vulnerabilities assessed for this report include: sea level rise, frequent flooding, storm surge and designated flood areas. Modeling by the Tampa Bay Regional Planning Council also assessed storm surge with the effects of sea level rise. It is important to note that as new LIDAR data becomes available, in addition to new modeling technology and parameters and advances in climate science, the data utilized in the vulnerability assessment will update in future years. Continuing to monitor the latest science and data and work with experts will be important for the City.

A. Shallow Coastal Flooding

NOAA's Coastal Flood Exposure Mapper provides data to visualize the potential scale and extent, not exact location, of inundation of low-lying coastal areas susceptible to flooding during extreme high tides, otherwise referred to as shallow coastal flooding or nuisance flooding. According to NOAA, extreme high tides occur a few times per year when the sun, moon, and earth align, or during storm events. Flood levels can increase due to rainfall or wind. Since the 1960's, the occurrences of high tide flooding (exceeding local thresholds for minor impacts to infrastructure) have increased 5- to 10-fold in several U.S. coastal cities.

Figure 5: Historical Yearly Inundation Events (Trident Pier 1995-2017)



The coastal flood data utilized in this vulnerability was obtained from NOAA's Coastal Flood Exposure Mapper. The flood thresholds are derived national flood thresholds from NOAA Technical Report NOS CO-OPS 086: Patterns and Projections of High Tide Flooding along the U.S. Coastline Using a Common Impact Threshold (Sweet, 2018). NOAA is utilizing this data to replace the flood thresholds previously used in the tool from the National Weather Service (NWS) which take into account local flood risk and are used to issue NWS coastal flood watches, warnings and advisories. Trident Pier (Brevard County) is the Station relative to Brevard County. The NOAA NOS CO-OPS 086 report indicates the derived threshold in this area for minor flooding (high tide flooding is 0.55 meters [1.8 ft. above MHHW]). Due to the topography of Brevard County, these impacts can be realized on both sides of the Indian and Banana River Lagoons as well as along the beach side. Wind speed and direction, as well as storms, can make these conditions even worse. NOAA estimates that as sea level rises by 2050, flooding frequency may increase upwards of 85 days/year in the Southeast Atlantic and 364 days by 2100 under the intermediate scenario. The figures from NOAA show the historical yearly flood events at Trident Pier and the trend of rising water levels during the highest tide of the year since 1994.

Figure 6: Maximum Daily Water Levels During the Highest Tide of the Year

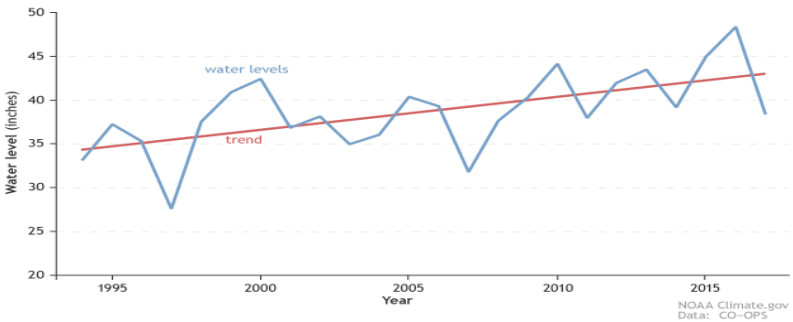
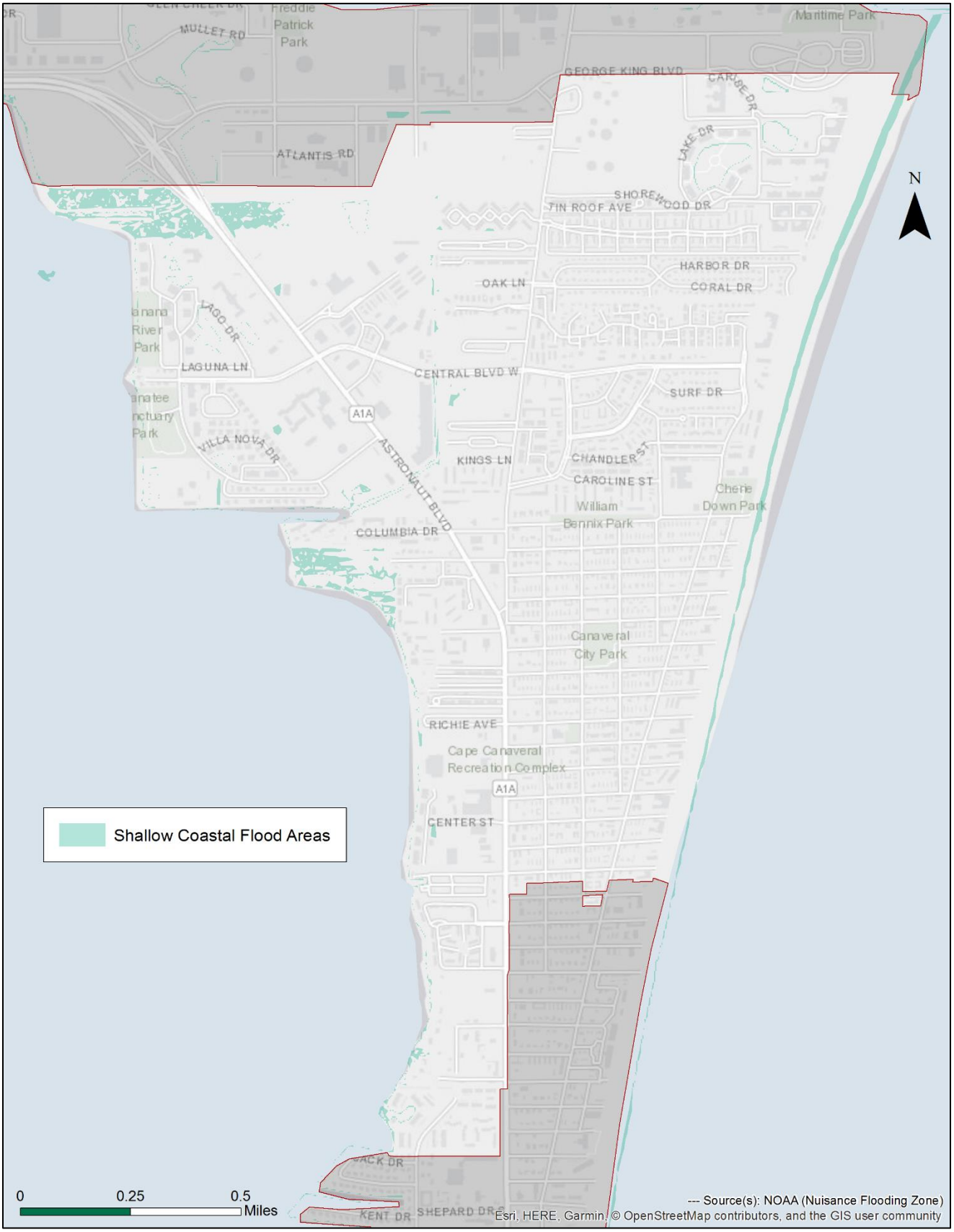
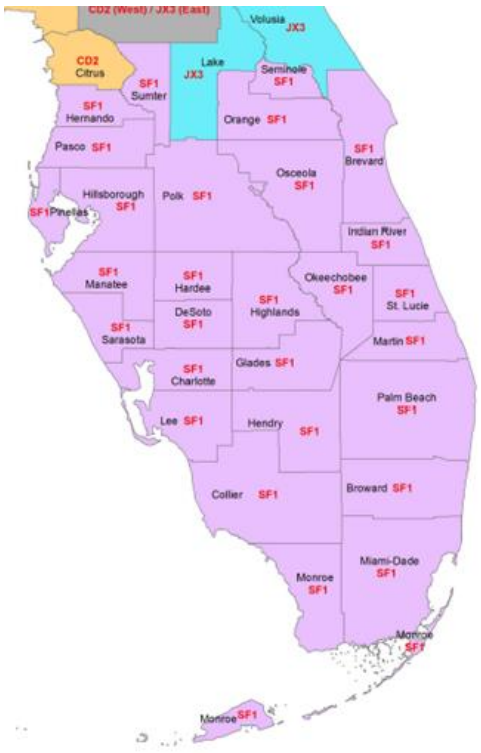


Figure 7: Shallow Coastal Flooding Areas



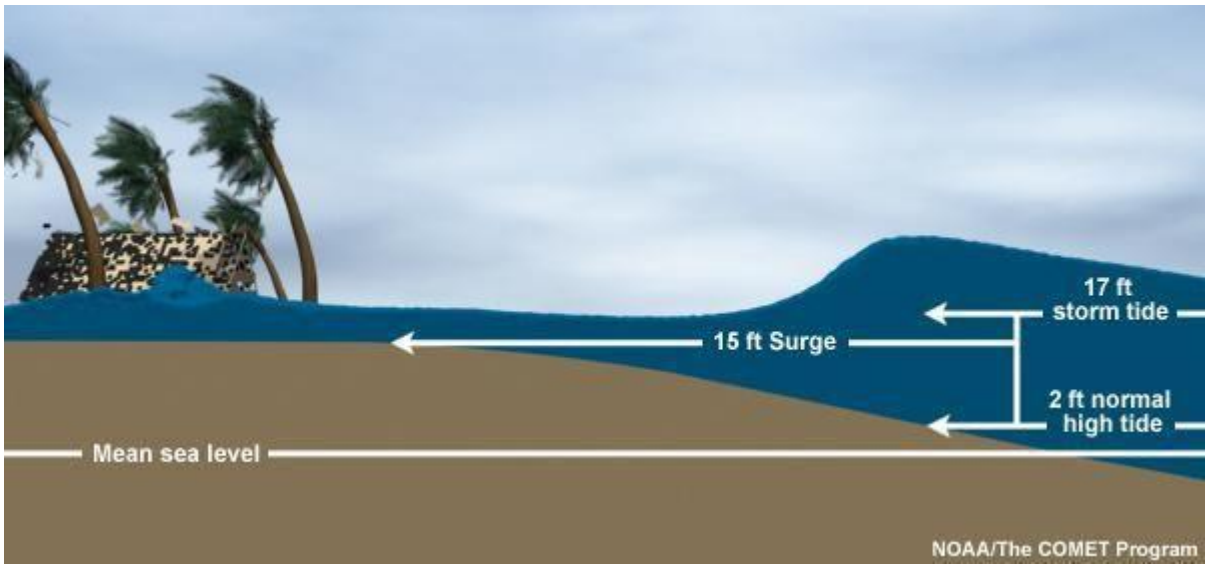
B. Storm Surge

Figure 8: South Florida Super Basin Model Counties (purple)



A SLOSH Basin is a geographical region with known values of land topography and ocean bathymetry. These set basins are used to simulate various hurricane tracks to estimate storm surge inundation in an actual event and/or a worst-case scenario. In 2017, the South Florida Super Basin became operational, spanning from the Tampa Bay Region, south through the Florida Keys, and north up through Cape Canaveral. This basin replaced 6 smaller basins across the region, including the Cape Canaveral Basin which had previously been used for Brevard and Volusia County SLOSH analysis. Having a larger basin more accurately depicts a surge created by a storm traversing a region, such as a storm that follows a coastline for an extended period of time (i.e. Hurricane Dennis in 2005 and Hurricane Matthew in 2016). Having higher resolution and updated elevation data is one of the major reasons for publishing an update to a basin as it improves the accuracy of the model's storm surge prediction. Higher resolution LiDAR data will result in higher grid size resolution thus improving surge representation. In addition, it highlights any physical changes made to the coast from recent storms. In 2017, the state of Florida conducted a new SLOSH Super Basin Model to update storm surge data for Brevard County, along with counties to the south. This new data provides a more accurate analysis and includes smaller grid sizes to process the SLOSH model. This updated data was used in this assessment.

Figure 9: Storm Surge



Source: Onslow County, NC

Table 3: Potential Storm Tide Heights in Brevard County (In Feet above NAVD88)

*Storm Strength	Surge Heights** Brevard
Category 1	Up to 6'
Category 2	Up to 10'
Category 3	Up to 16'
Category 4	Up to 21'
Category 5	Up to 26'

**Based on the category of storm on the Saffir-Simpson Hurricane Wind Scale*

*** Surge heights represent the maximum values from SLOSH MOMs*

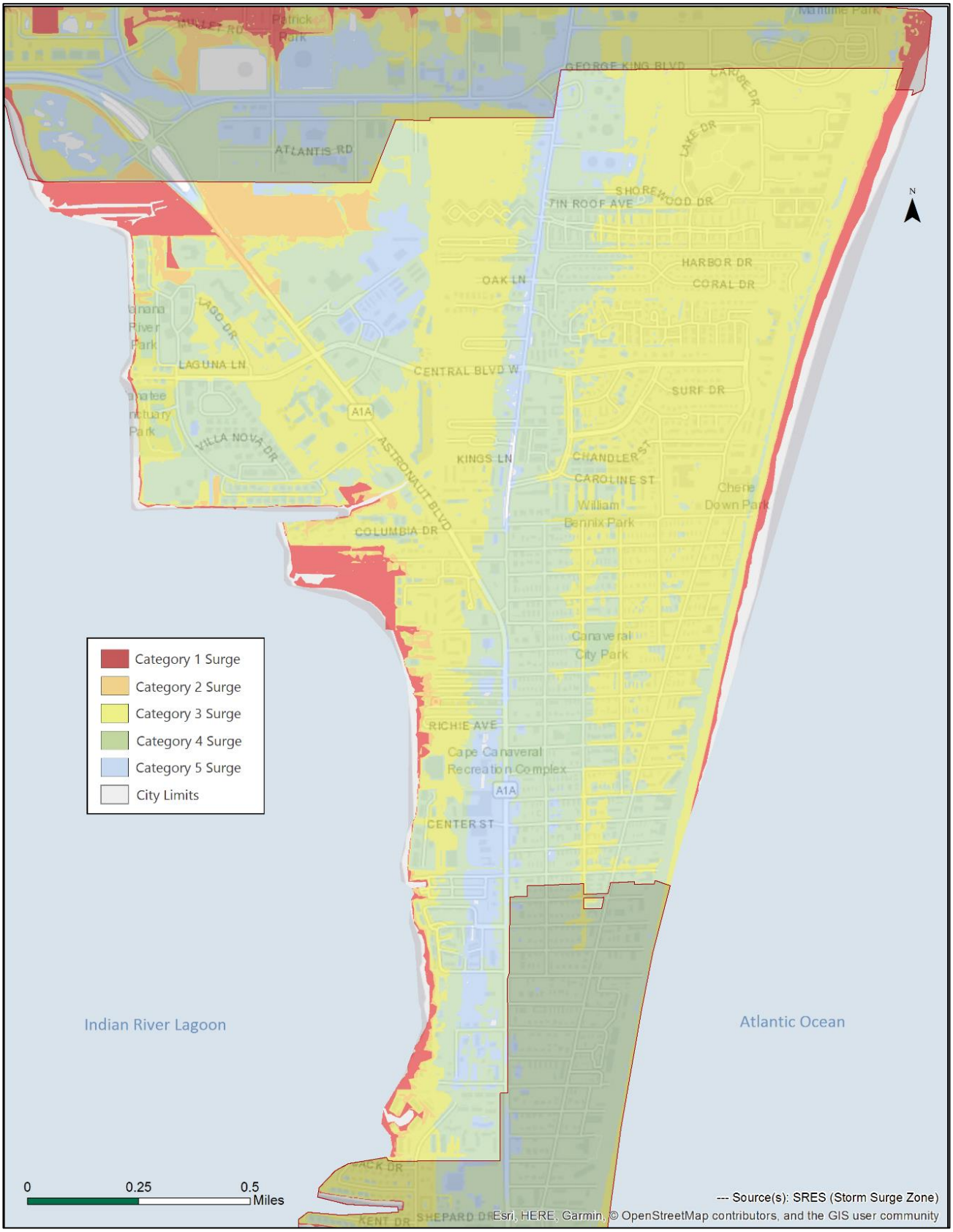
Source: S.R.ES 2012 – Depth Atlas

Storm surge can expose and degrade underground utilities and water mains (see picture below), destroy electrical equipment, wash away seawalls and revetment systems and can destroy entire portions of roadways and sidewalks. Coastal erosion, a side-effect of storm surge, can deteriorate the foundations of critical facilities located adjacent to water bodies resulting in requiring costly improvements.

Storm Surge in Brevard County from Hurricane Irma

Source: Florida Today

Figure 10: Storm Surge Areas in Cape Canaveral



C. Sea Level Rise

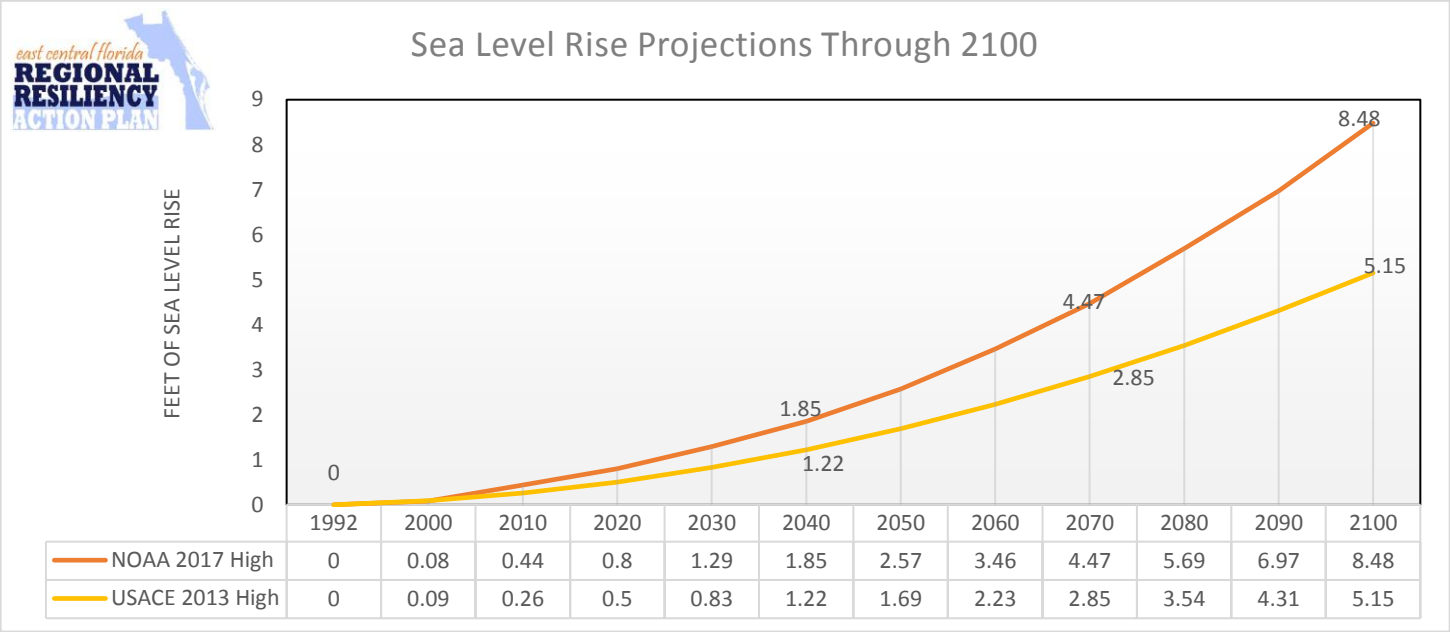
A regional, coordinated approach to planning for sea level rise is important as agencies and communities identify potential risks to infrastructure, plan for future land uses and determine appropriate mitigation and adaptation measures to minimize the risks of flooding and inundation. As part of the East Central Florida Regional Resiliency Action Plan, the Planning for Sea Level Rise Sub-Committee, comprised of federal, regional and local experts, academia and planners across sectors, developed a regional planning approach to sea level rise. The purpose of this approach is to provide local governments and regional agencies with a coordinated and vetted method to planning for sea level rise. The recommendation is as follows - *No one projection rate curve should be used for planning purposes across all projects and programs. Instead, a range of rise should be considered based upon the vulnerability, allowable risk, project service life and the forecast project "in-service" date of a facility or development. The range should include a minimum rise of 5.15 feet by 2100 (2013 USACE High) with an upper range of 8.48 feet by 2100 (2017 NOAA High). Short-term planning should consider impacts out to 2040 (20-year planning horizon), medium-term planning should consider impacts out to 2070 (50-year planning horizon), and long-term planning should extend out to 2100 (80-year planning horizon).* (Council E. C., East Central Florida Regional Resiliency Action Plan, 2018)

The two projection rate curves are derived from National Oceanographic and Atmospheric Administration (NOAA) 2017 and the US Army Corps of Engineers (USACE) 2013 data. The Sea Level Scenario Sketch Planning Tool was developed by the University of Florida (UF) GeoPlan Center for the Florida Department of Transportation (FDOT) to determine future sea level rise inundation areas utilizing U.S. Army Corps of Engineers (USACE). The USACE data were obtained via download from the UF GeoPlan Center. This analysis used the "modified bathtub model that applies a hydrologic connectivity filter to remove isolated inundated areas not connect to a major waterway". The resulting inundation files represent the specific projection rate curve mapped on top of Mean Higher High Water (MHHW). More details concerning the methodology utilized by the University of Florida can be found at the following link: *https://sls.geoplan.ufl.edu/documents-links/*.

As the GeoPlan Center currently only has NOAA 2012 data, updated 2017 NOAA data were downloaded from NOAA's Digital Coast Sea Level Rise Viewer which depicts the potential inundation of coastal areas resulting from a 1-10 foot rise in sea level above current MHHW conditions. These data were produced using a modified bathtub approach that accounts for local and regional tidal variability and hydrological connectivity. Two source datasets are used to create the final inundation data: Digital Elevation Model (DEM) of the area and a tidal surface model that represents spatial tidal variability. Again, these data does not account for erosion, subsidence or any other future changes in an area's hydrodynamics. A detailed methodology for producing these data as well as references to data accuracy can be found at the following link:
http://www.csc.noaa.gov/slr/viewer/assets/pdfs/Inundation_Methods.pdf

Data utilized in the analysis illustrates inundation as it would appear during the MHHW (excluding wind driven tides) in accordance with the amount of sea level rise portrayed.

Figure 11: ECF Regional Resilience Action Plan Regional Approach to Sea Level Rise Planning

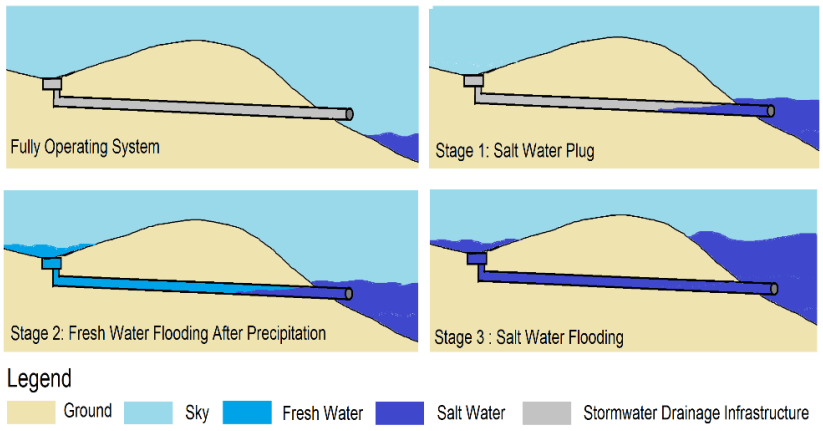


	1992	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
NOAA 2017 High	0	0.08	0.44	0.8	1.29	1.85	2.57	3.46	4.47	5.69	6.97	8.48
USACE 2013 High	0	0.09	0.26	0.5	0.83	1.22	1.69	2.23	2.85	3.54	4.31	5.15

For the purpose of assessing sea level rise vulnerabilities on the City, the ECFRRAP regional approach was used as the parameters for the assessment. The planning horizons for the City of Cape Canaveral include 2040, 2070 and 2100. The maps on the following pages illustrate the potential areas of impact based upon the NOAA and the USACE projection rate curves for the specific planning horizons. It is important to note that these maps show areas that will be inundated during MHHW, but effects may be seen prior to inundation through increased erosion and wave action, as well as failure of the stormwater systems.

Using depth data provided through the GeoPlan Center in regard to the USACE curves, the City can expect to encounter 28 inches of inundation by 1.22 feet of sea level rise (2030-2040), 47 inches with 2.85 feet of rise (2050-2070), and 75 inches of inundation with just over 5 feet of rise (2080-2100).

Figure 12: Stages of Stormwater Infrastructure Failure Due to Sea Level Rise



Source: Stetson University

Figure 13: USACE Sea Level Rise High Curve Projections

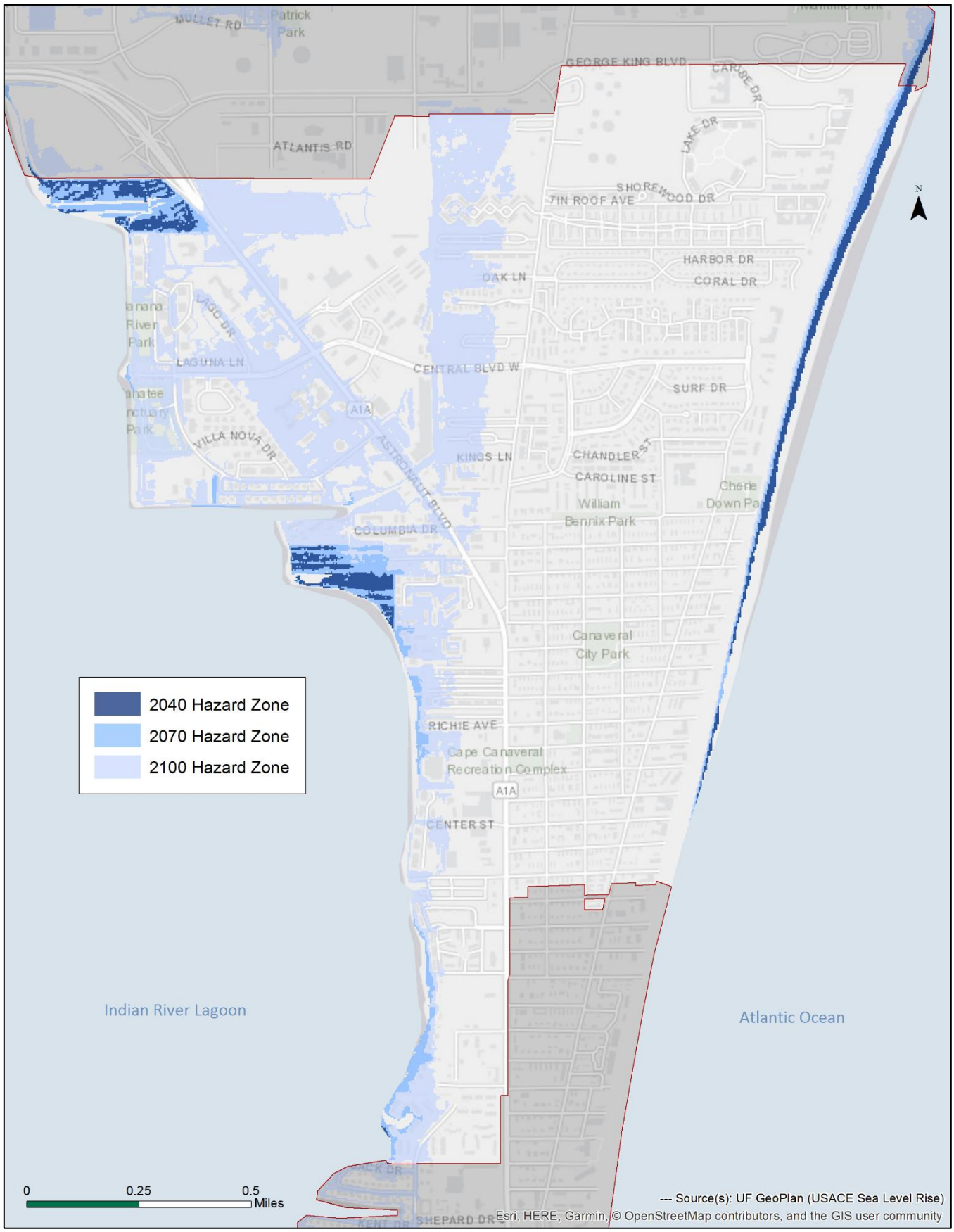
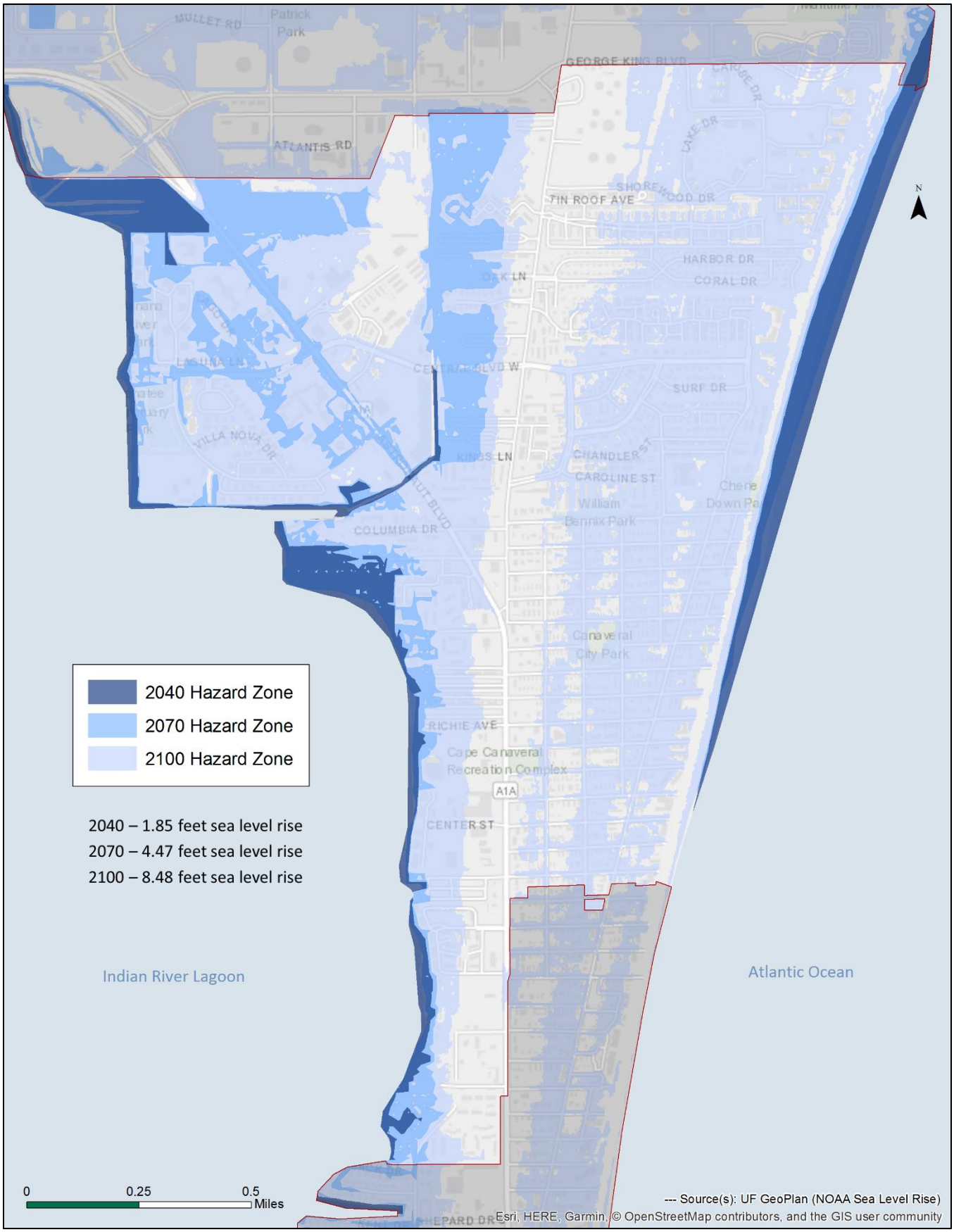


Figure 14: NOAA Sea Level Rise High Curve Projections



D. Storm Surge with Sea Level Rise

The Tampa Bay Regional Planning Council developed an ArcGIS Add-In Tool to model how future sea level rise conditions effect surge based on new National Hurricane Center (NHC) SLOSH "super basins" that provide greater resolution of data for storm surge modeling. The model uses the latest South Florida Super Basin SLOSH data for Brevard County. The model allows users to analyze certain levels of sea level rise (ex: 4 feet) dependent on what horizon SLR curve they choose. The model is agnostic and all that is required is to choose the future surface rise. The model is referenced to NOAA tidal gauges for tidal variability. The model uses the future sea surface determined by project designers; however instead of being referenced to MHHW, the SLR was referenced against Mean Sea Level (MSL). SLOSH basin data is referenced to high tide, so using MHHW and surge together would be like "double-dipping". The data the model uses is comprised of a Digital Elevation Model (DEM), SLOSH Basin, Sea Layer with hydrologic connectivity, and NOAA tidal gauges. It is important to see the effect sea level rise has on coastal and tropical storms. Sea level rise in the near term is not dramatic when viewed on its own. However, coastal storm run-up and storm surge can be pushed past a tipping point when sea levels are higher than today. A Category 1 storm could become a Category 2 or perhaps a Category 3 storm by today's standards. The analysis conducted for this vulnerability assessment focused on a base Category 3 storm with USACE High and NOAA 2017 High projection curves for 2040, 2050, 2070 and 2100. The maps on the following pages represent the model outputs for both projection curves.

Figure 15: Flood Assessment Tool Beta Version

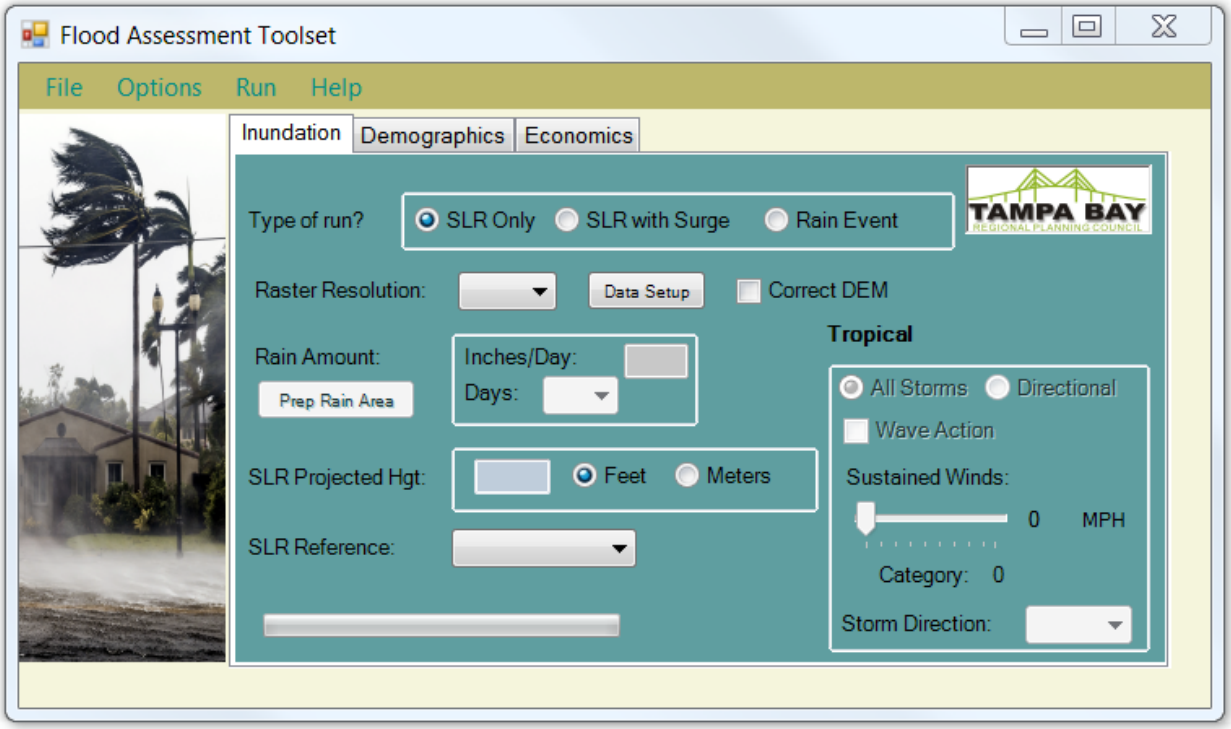


Figure 16: Category 3 Storm Surge with USACE High Sea Level Rise Scenarios

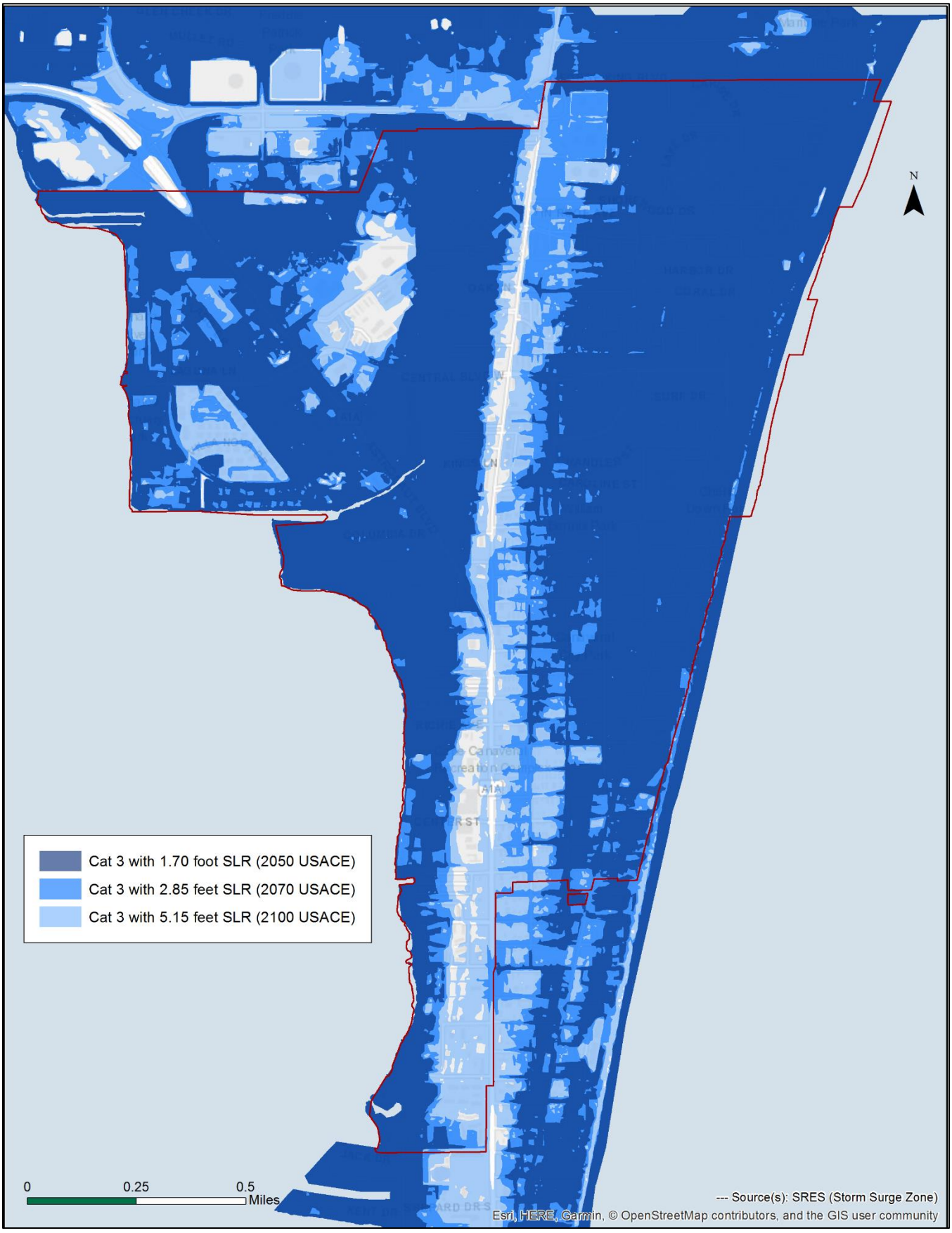
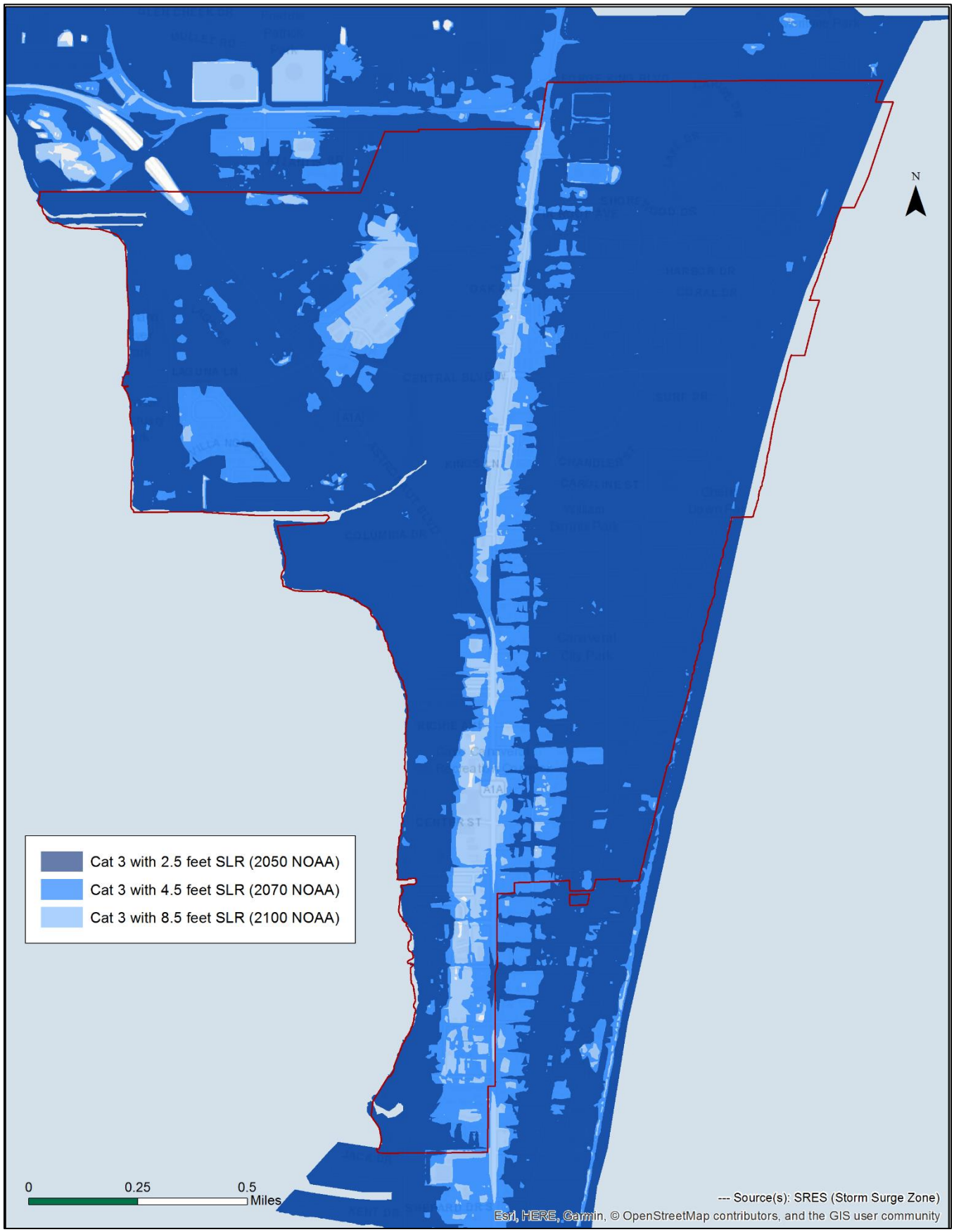


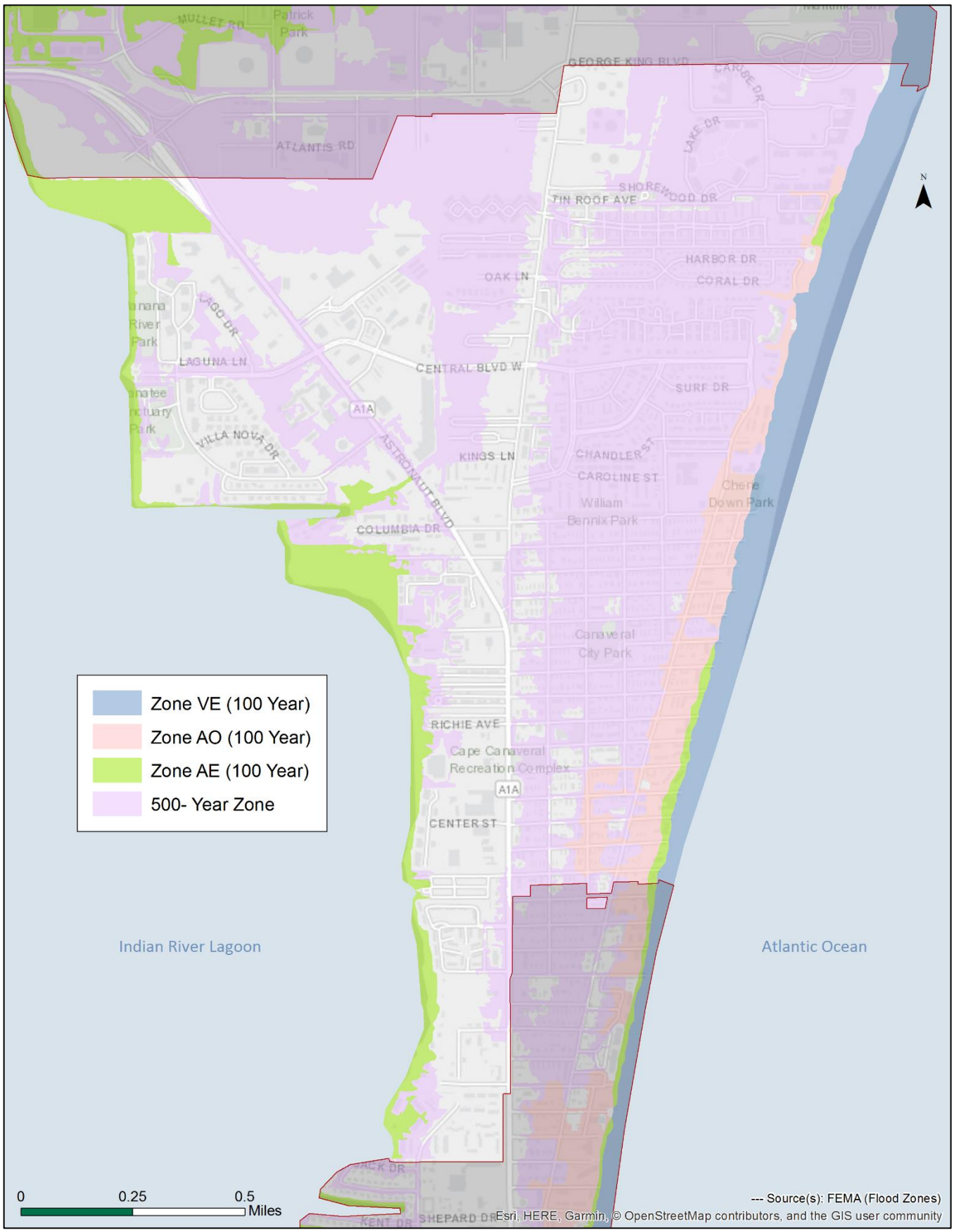
Figure 17: Category 3 Storm Surge with NOAA 2017 High Sea Level Rise Projections



E. Designated Flood Areas

The FEMA Digital Flood Insurance Rate Maps (DFRIM) from 2014 were used to conduct the assessment of assets located in the 100- and 500-year flood zones as well as the VE (Coastal areas with a 1% chance or greater of flooding and additional hazard associated with storm waves) zone. DFIRMS data indicates flood risk information derived from Flood Insurance Studies (FISs), previously published Flood Insurance Rate Maps (FIRMs), flood hazard analyses performed in support of the FISs and FIRMs and new mapping data, where available. According to FEMA, over time as various conditions change from construction and development and as environmental and watershed conditions change, flood risks also change. For this reason, FEMA has been in an effort to conduct a RiskMAP Coastal Restudy for Brevard County which includes revised DFRIMS. As of the time of this analysis, the study and revised DFIRMS have yet to be reviewed and adopted (October 2018). It is recommended that after the DFIRMS are adopted, an analysis should include areas added to the flood zones. The City of Cape Canaveral's 100-Year flood zones are generally located along the two (2) coastlines (river side and ocean side) with some areas cutting into the center of the City. The 500-year zone encompasses a larger swath on the east side of the City and some areas to the northwest. This flood zone is similar in extent and area as the current Category 3 Storm Surge area.

Figure 18: 100- and 500-Year Flood Zones Based on 2014 DFIRM



F. Findings

The findings section of this report provides an overview, maps and tables of potential impacts to critical facilities, transportation infrastructure and takes a look at vulnerable land uses and their values. The hazards addressed include: 1) Shallow Coastal Flooding Areas 2) Storm Surge 3) Sea Level Rise 4) Future Storm Surge with Sea Level Rise and 5) FEMA 100--Year Flood Zone.

Shallow Coastal Flooding

Shallow coastal flooding areas are low lying areas that flood during higher than average tide events.

Storm Surge

Storm surge occurs when hurricanes and tropical storms raise water levels in coastal areas which is pushed on shore.

Sea Level Rise

Sea level rise is occurring at an alarming pace along Florida's east coast. This is a long-term hazard.

Surge + Sea Level Rise

Referred to as the "Combined Hazard Zone", this includes the long-term effects of surge plus sea level rise.

100-Year Flood

The 100-year flood zone depicts areas that have a 1% annual chance of flooding. FEMA provides this data.

1. Transportation Impacts

Roadways are susceptible to degradation across multiple fronts as a result of natural hazards. This includes cracking over long periods of time from the deterioration of surrounding lands or substrate due to flooding, storm surge and wave action. As a result, roadways are likely susceptible to the effects of sea level rise prior to the "horizon year" of roadway surface inundation noted the table below. This may heighten the risk profile of roadways to a greater degree than what is shown under the sea level rise and combined hazard zone analyses in this report. Additionally, as roadways were not designed to be inundated, especially with salt water, even only a few inches of flood water for multiple days can put the integrity of roadways at risk and increase accessibility issues throughout the community, thus impacting everyday activities, economic vitality of the area and emergency operations. Impacts should not only just be considered to the roadway itself but also the utilities that are associated with the roadway in its rights-of-way (ROW) or underground.

The table below summarizes the impacts to roadways within the City of Cape Canaveral by hazard and subdivided by FDOT classification, thus indicating the potential responsible agency. Local roadways, many of which fall under the purview of the City, are expected to experience the greatest amount of inundation from sea level rise, though complete inundation in some areas is not expected until closer to 2070 under the NOAA high curve (nearly three (3) miles of roadway near the center of the City). While these roadways do not have the capacity of larger roadways, disruption to these routes from flooding can affect day to day activities and emergency response times and cut off entire sections of the City. It will be important for the City to share the vulnerability assessment with those responsible for private roads in the City as maintenance and improvements to these roads do not fall under City purview.

Impacts along S.R. A1A are not considered extensive in terms of mileage, however loss or damage of the corridor can have drastic effects on all aspects of the community as this corridor serves as the transportation spine of the City and provides access to the mainland and into the City. The Coastal High Hazard Area (CHHA) is defined as the area below the elevation of the Category 1 storm surge line. While minimal roadways are located in the CHHA, the City begins to see impacts to roadways with a Category 2 surge. As sea level rises, the extent and depth of storm surge is expected to increase, thus potentially changing the areas classified as the CHHA and other surge zones and impacting more roadways.

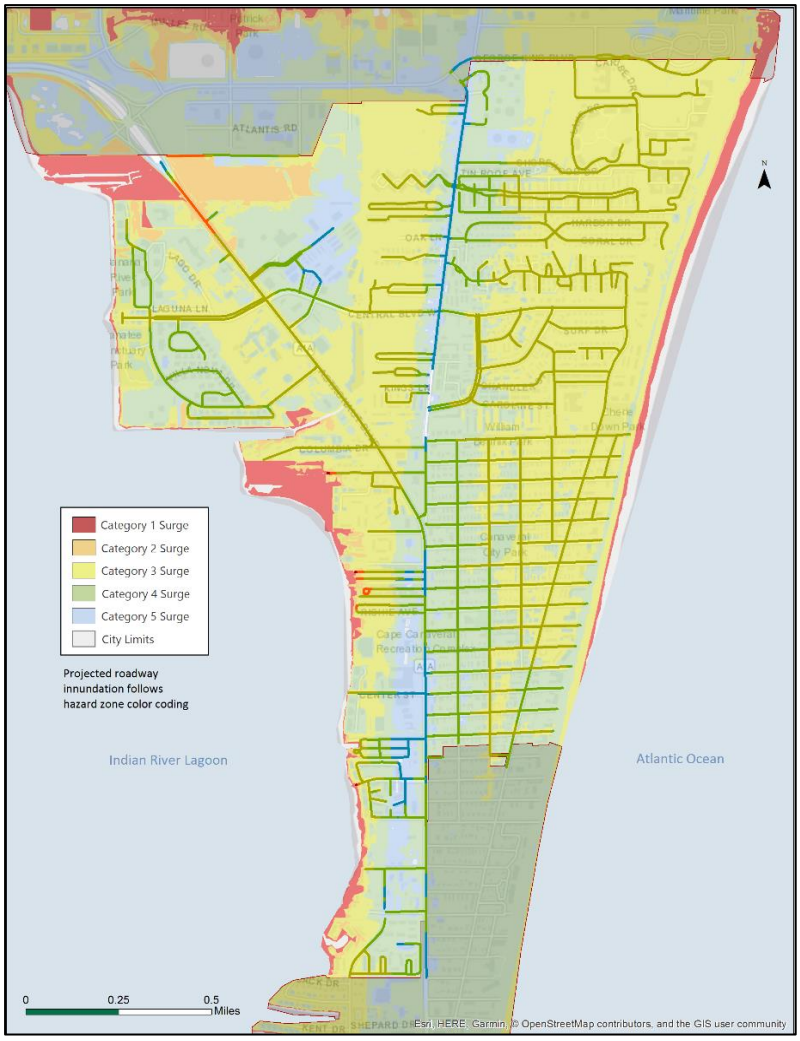
Table 4: Overview of Impacts to the Transportation Network

Roadway Classification *(FDOT)*	Storm Surge CHHA *(Miles)*	NOAA SLR Year 2040 *(Miles)*	NOAA SLR Year 2070 *(Miles)*	NOAA SLR Year 2100 *(Miles)*	USACE SLR Year 2040 *(Miles)*	USACE SLR Year 2070 *(Miles)*	USACE SLR Year 2100 *(Miles)*	100 Year Flood Zone *(Miles)*	Coastal Flood Area *(Miles)*
Principal Arterial Other - Rural & Urban	0	<0.1	0.6	1.1	0	0	0.8	0	<0.1
Major Collector Rural & Urban	0	0	0	0	0	0	0	0.9	0
Minor Collector Rural & Urban	0	0	<0.1	2.4	0	0	<0.1	0	0
Local - Minor Roads	<0.1	0	2.6	27	0	0	4.7	2.9	0
Evacuation Routes	0	<0.1	0.6	1.1	0	0	0.8	0	<0.1

Source: 2018 FDOT RCI

Storm Surge

Figure 19: Roadways in Cat 1-5 Storm Surge Areas



The map illustrates how every roadway in the City is vulnerable to a Category 2-5 storm surge.

The total miles of roadway vulnerable to surge by category is as follows:

Category 2 – 4 miles of roadway

Category 3 – 32 miles of roadway

Category 4 – 87 miles of roadway

Category 5 – 136 miles of roadway

Major roadway impacts are shown in the table below. It should be noted that the total miles of roadway do not indicate a continuous stretch of impact but could represent smaller segments across the corridor. Major roadways were determined per FDOT classifications other than local roads. Impacts to all roads, including local roads, can be found in the database provided to the City.

a)

Table 5: Miles of Major Roadways Per Surge Zone

Road Name	Cat. 1 Surge Projected Inundation	Cat. 2 Surge Projected Inundation	Cat. 3 Surge Projected Inundation	Cat. 4 Surge Projected Inundation	Cat. 5 Surge Projected Inundation
S.R. A1A*	0	0.16	1.03	1.91	3.41
Washington Avenue	0	0	0.38	0.46	0.46
Central Boulevard	0	0	0.66	0.97	0.99
Ridgewood Avenue	0	0	1.02 (2 segments)	1.28 (2 segments)	1.28 (2 segments)

**Indicates Evacuation Route*

Source: 2018 FDOT RCI

Sea Level Rise

Figure 20: Roadways Vulnerable to Sea Level Rise - USACE High

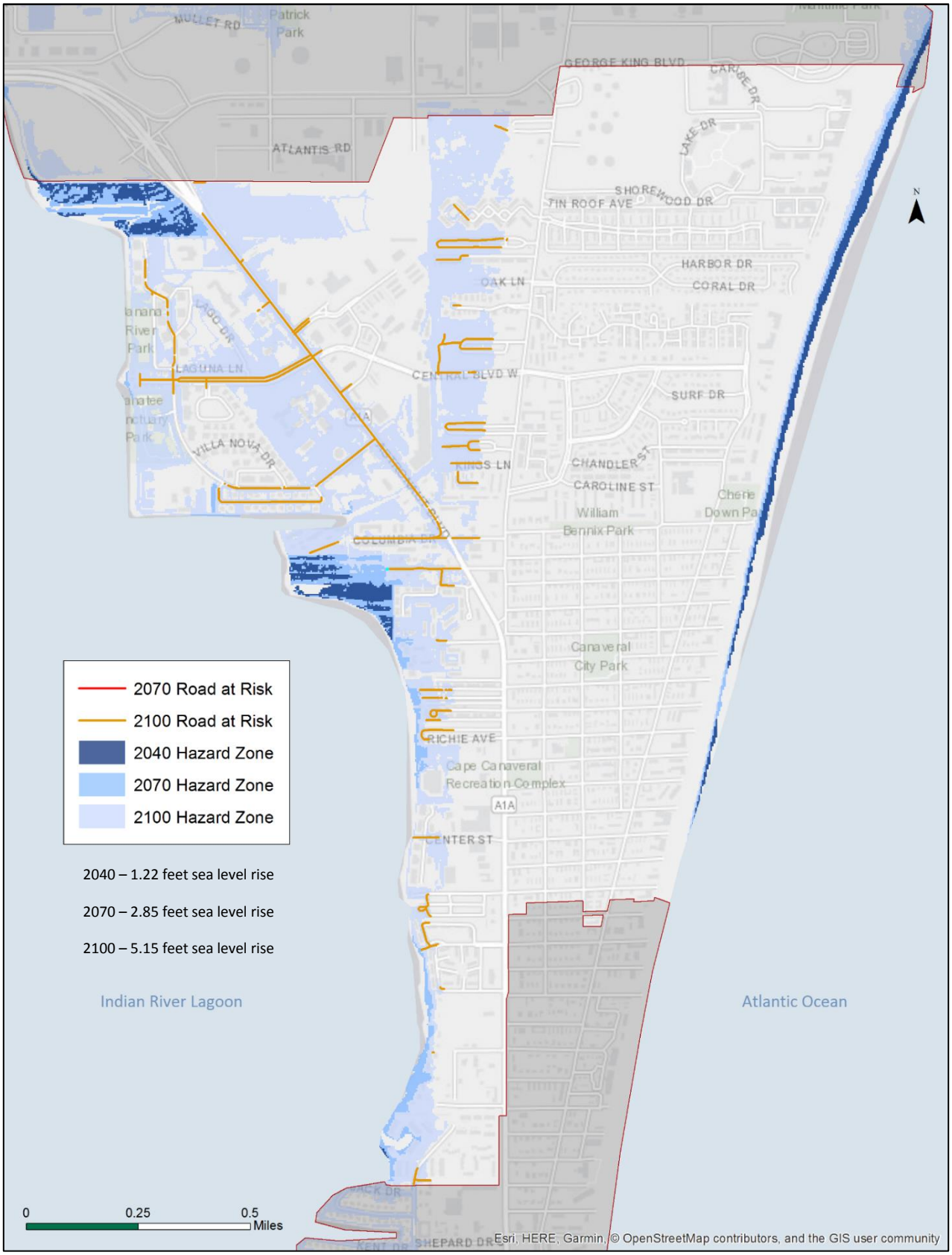


Figure 21: Roadways Vulnerable to Sea Level Rise - NOAA High

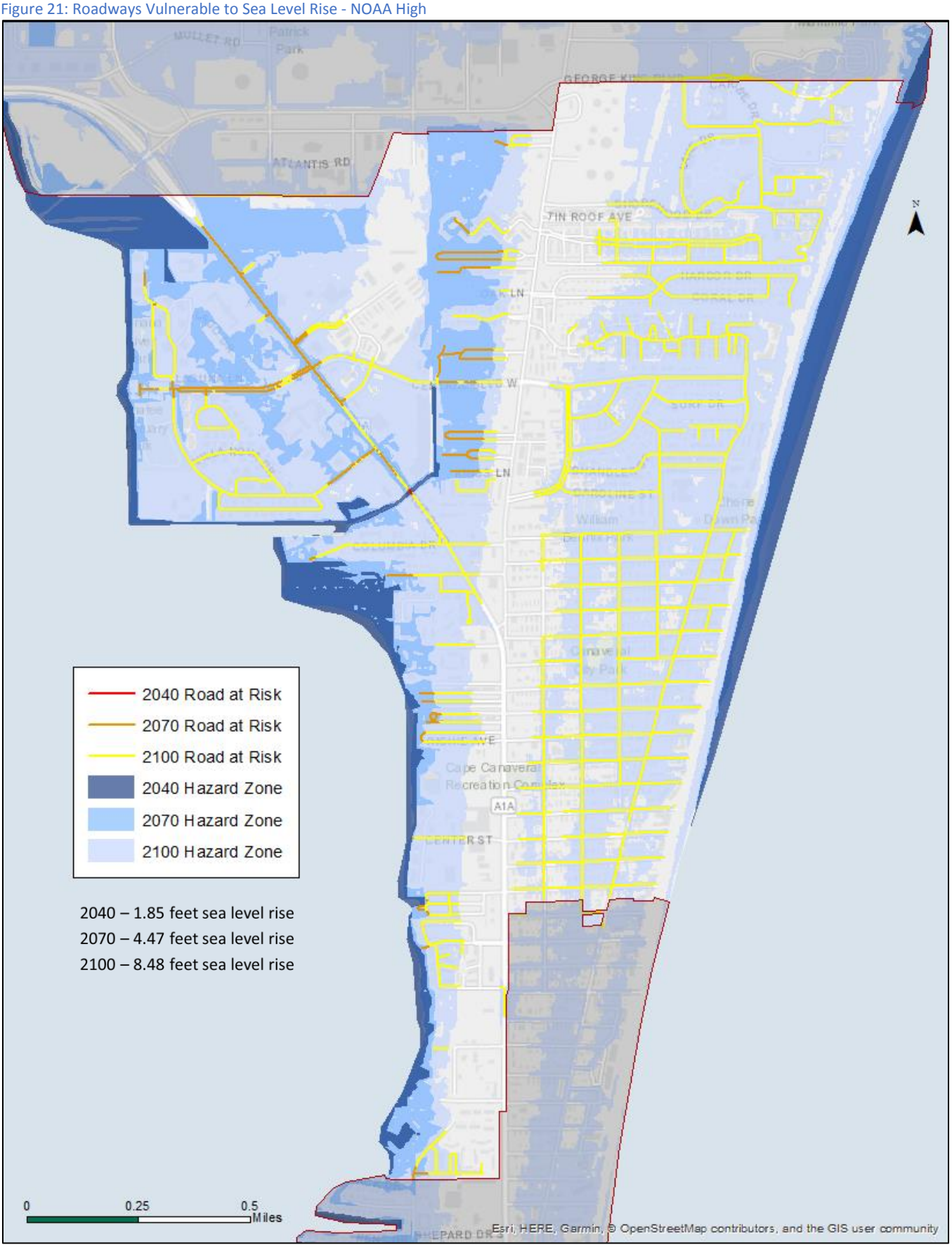


Table 6: Major Roadways Vulnerable to Sea Level Rise by Mile

Road Name Classification	USACE 2040 Projected Inundation	USACE 2070 Projected Inundation	USACE 2100 Projected Inundation	NOAA 2040 Projected Inundation	NOAA 2070 Projected Inundation	NOAA 2100 Projected Inundation
Central Boulevard	0 miles	0 miles	<0.1	0 miles	<0.1	0.87
Astronaut Boulevard (S.R. A1A)*	0 miles	0 miles	0.82	<0.1	0.59	1.7 (2 segments)
Ridgewood Avenue	0 miles	0 miles	0 miles	0 miles	0 miles	1.2 (2 segments)
Washington Avenue	0 miles	0 miles	0 miles	0 miles	0 miles	0.38

Source: 2018 FDOT RCI

**Indicates Evacuation Route*

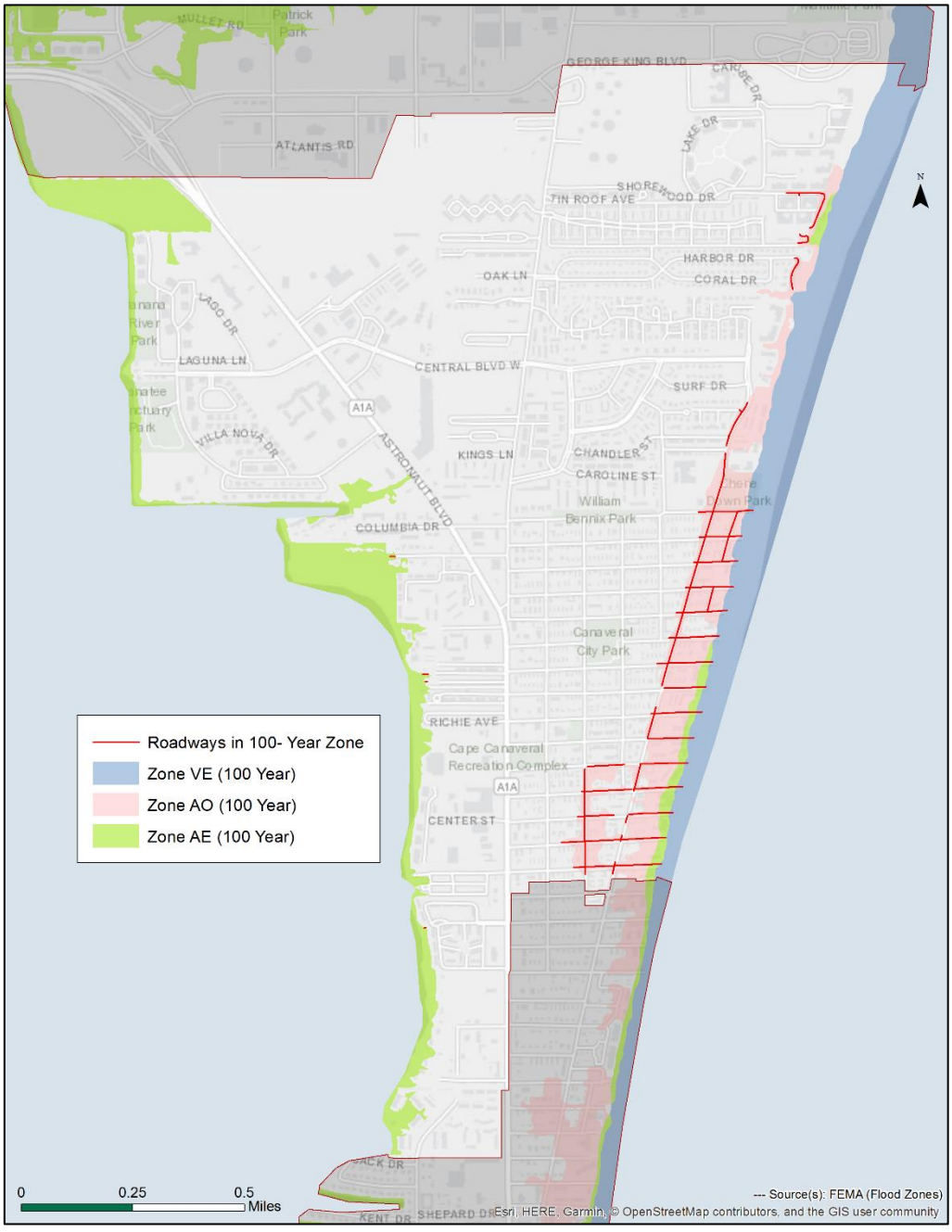
When analyzing impacts to roadways from sea level rise, using both the USACE and the NOAA High curves, significant inundation may be realized by 2100. There is a tipping point between 2070 and 2100 when more impacts will be felt as inundation begins to affect a larger portion of the City through the eastern areas. Most of the impacted roadways are local roads (with the exception of S.R. A1A in the northern portion of the City). As no roads are anticipated to be inundated by 2040 in either scenario except a minor portion of S.R. A1A, the City has time to assess strategies that take into account risk, return on investment and overall long-term resiliency when addressing vulnerabilities to roads. It should be noted however, that just because the roadway will not be impacted during high tides as sea levels rise, as stated earlier, the integrity of the roadway may be compromised as flooding, erosion and inundation may impact surrounding land. By 2100, when considering all roadways impacted in the City under both USACE and NOAA, approximately 6-31 miles of roadway will be inundated by sea level rise.

This image shows how erosion and flooding can begin to impair the integrity of roadways long before inundation occurs and also cause damage the underground utilities.

100 - Year Flood Zone

Less than one (1) mile of major roadways are located in the 100-Year Flood plain, however, as depicted on the map, the most vulnerable roadways to the 100-Year flood are local roads along the eastern coast of the City. Nearly four (4) miles of total roadway are vulnerable to a 100-year flood, approximately three (3) miles of which are local, residential roadways. The flooding of these roads during a storm would ultimately cut off access to and from this section of the City. As these roadways are also vulnerable to surge and sea level rise, creative stormwater mitigation techniques may be a valuable strategy in this area from increasing permeability and retention on-site to acquiring property for water detention that could become part of a hybrid green/gray stormwater system.

Figure 22: Roadways Located in the 100-Year Flood Zones



2. Land Use Impacts

Cape Canaveral's private and publicly-owned properties are at risk to a diverse range of natural hazards, with figures exceeding $1.4 billion dollars (does not include the combination hazard zone) and 1,200 acres of exposure in current property value for all five of the hazards covered in this report. The table below illustrates the number of acres of land each Hazard Zone, the number of units (condos are included), property value and the number of undeveloped acres. Data for land use and property information is derived from the Brevard County Property Appraiser's Office (2018) and the City's 2019 future land use (FLU) data. As the City, at the time of this report, was processing changes to future land use designations of some properties, data also reflects proposed designations. Some items of this analysis to note included:

- Coastal flood impacts more undeveloped acres than all 100-Year Flood Zones.
- In both sea level rise curves, a tipping point occurs between 2070 and 2100.
- Nearly 97% of the City is vulnerable to surge from a Category 3 with 100% vulnerable to a Category 5 storm surge for a total of $1.4 million of potential financial exposure.

Table 7: Hazard Overview by Acres, Building, and Value

Hazard Zone	Acres in Zone	Buildings in Zone	Total Property Value	Undeveloped Acres in Zone
All 100-Year Flood Zones	379	284	$559,463,730	130
Zone AE	195	69	$164,858,920	80
Zone AO	55	178	$85,500,220	8
Zone VE	128	37	$309,104,590	42
500-Year Flood Zone	1115	1935	$1,265,493,970	331
Sea Level Rise - 2040 (USACE)	150	17	$204,447,790	69
Sea Level Rise - 2070 (USACE)	242	54	$287,705,080	93
Sea Level Rise - 2100 (USACE)	664	288	$582,784,350	258
Sea Level Rise - 2040 (NOAA)	309	77	$326,874,310	120
Sea Level Rise - 2070 (NOAA)	600	194	$514,202,250	239
Sea Level Rise - 2100 (NOAA)	1148	1827	$1,319,876,980	338
Shallow Coastal Flooding Zone	275	38	$196,353,360	151
Storm Surge - Category 1	291	73	$339,260,380	117
Storm Surge - Category 2	373	96	$396,310,670	169
Storm Surge - Category 3	1051	1604	$1,237,561,640	332
Storm Surge - Category 4	1212	2105	$1,421,197,790	346
Storm Surge - Category 5	1214	2109	$1,422,862,530	346

Source: 2018 Brevard County Property Appraiser Office

Shallow Coastal Flooding

Coastal flooding impacts each land use within the City with nearly 230 acres of developable lands projected to experience this increasing flooding hazard. This flooding is generally expected to occur along river-front properties and some other areas that are low-lying or have a canal/drainage. Residential comprises over half (55%) of the affected properties. There are approximately 46 acres of Conservation and 7.1 acres of Public/Recreation within the vulnerable area including Banana River Park and Manatee Sanctuary Park. The City should continue, as opportunities present themselves, to acquire properties along the water front to serve as buffers and mitigation areas, while also allowing for eco-tourism and recreational uses. Additionally, as the coastal flooding may increase erosion impacts on riverside properties, the City should work with the property owners to educate and provide opportunities for erosion reduction techniques.

The image shows "Fourth Ward Park" in Atlanta, Georgia, a great example of this park concept. In this park, walkways traverse through stormwater ponds and native plants are used to absorb rainwater without diverting it into drains.

Note: In the following land-use tables (due to the City currently in process of updating parcel land-use) the data in black font indicates the information currently adopted for land-use classifications; whereas the data in red font refers to the information relative to the currently proposed land-use designations.

Table 8: Land-Use by Acres in Shallow Coastal Flood Areas

	C1 Commercial	C2 Commercial	Conservation	M1 Industrial	Public/ Recreation	R1 Residential	R2 Residential	R3 Residential
Acres in Coastal Flooding Area	63.8 40	18.4 3.11	46 44.28	16.5 30.89	7.1 15.17	5.1	0.8 12.76	117 108.79

Source: City Future Land Use

Outside of the general river shoreline, areas in the northwest segment of the City are most vulnerable to coastal shallow flooding. At this point in time, S.R. A1A is above the flood elevation. However, as sea levels rise, this shallow coastal flooding may impact the corridor. The City should work with FDOT to conduct surveying of this area to determine an appropriate strategy to address potential flooding of S.R. A1A as it relates to coastal flooding as well as complete inundation with sea level rise. Strategies may include elevating the road segment or the integration of green infrastructure to mitigate flooding.

Coastal flooding is expected to impact the beach side in the northeast portion of the City, but not reach beach side properties themselves. This area may experience more erosion as a result of this flooding, in addition to storm surge and rising seas. The exception to this is the Solana Shores Condos in which stormwater pond areas may be susceptible to increased flooding.

The northwest area of the City is vulnerable to the USACE sea level rise scenario through 2100 and also includes exposure to multiple hazards, including Category 1-2 storm surge and the AE flood zone, thus, making this general area the most vulnerable to flooding both in short- and long-term. From a City perspective, even if private property is mitigated to prevent flooding and condos redesign the first floor for parking or a floodway to allow for flooding during events, access to many of these properties will remain an issue that may require some short to mid-term flood mitigation strategies and potentially long-term acquisition or relocation from the areas. From a financial perspective, flooding can have a severe impact on affected properties due to accessibility and the need to mitigate structures or property.

In the City, 63 parcels with 38 structures and a taxable value of nearly $155 million may be vulnerable to coastal shallow flooding. Other properties are located along the river; however, the modeling indicated such insignificant areas of impact that they were not included in this analysis as such findings could be attributed to model error. The map on page 34 illustrates the vulnerable properties by taxable value. As evident from the financial exposure map, there is a mix of values throughout the hazard area. It is important to note the potential impact from the financial exposure aspect of buildings such as condos, that have multiple units in one vulnerable building.

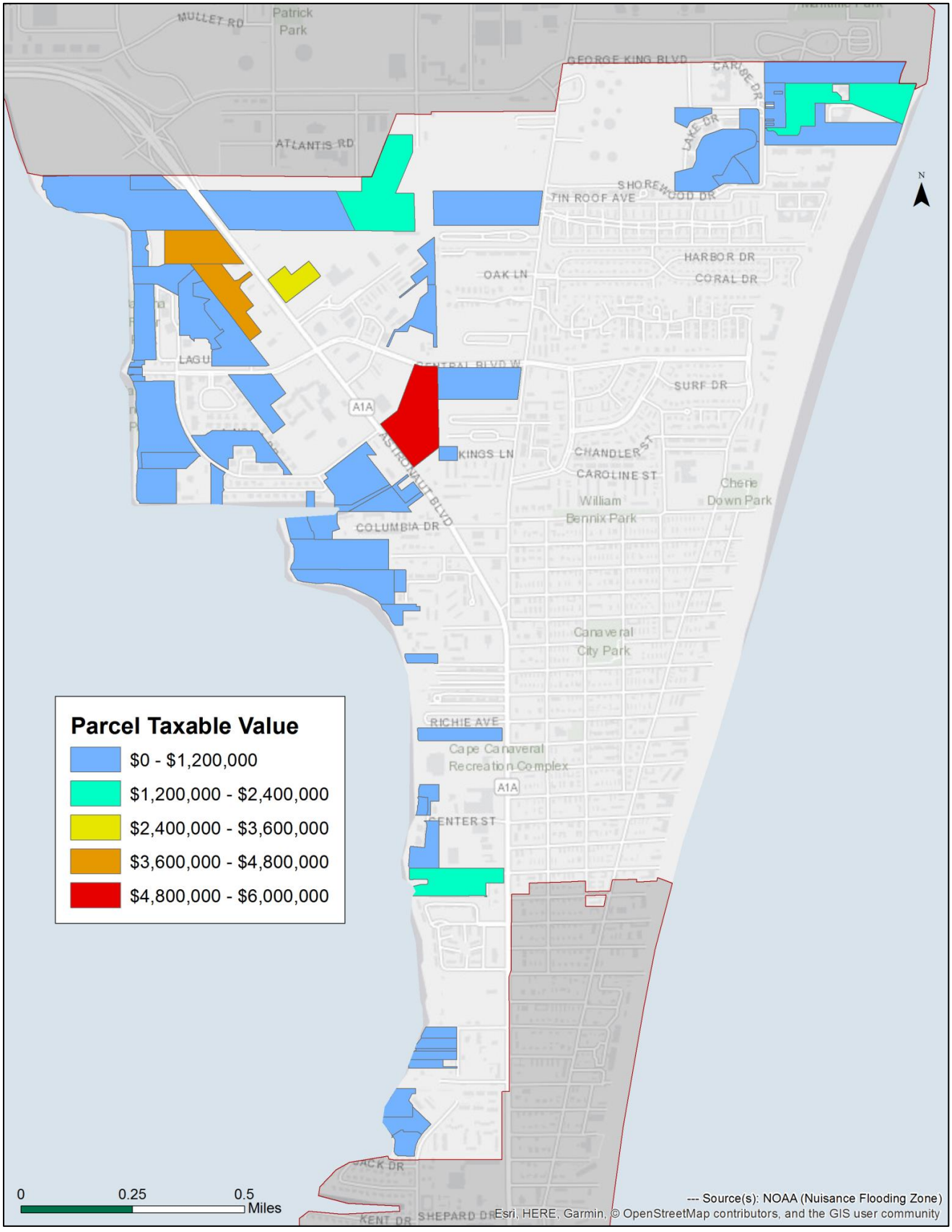
From a build year perspective, the vast majority of exposed buildings were built after 1968 when flood insurance was first required from property owners in flood-prone areas. A total of only 4 of the 38 structures in the hazard zone were built before this critical date. Furthermore, 16 vulnerable buildings were built after the modern Florida Building Code went into effect. The table below depicts these building figures and the associated financial exposure by build year.

Table 9: Shallow Coastal Flood Impacts by Financial Exposure

				Built Pre-1968	Built 1968-2001	Built 2002 - 2018
Zone	# Parcels in Zone	Parcels w/ Buildings	Taxable Value	# Buildings Total Value	# Buildings Total Value	# Buildings Total Value
Shallow Coastal Flooding Area	63	38	$154,505,434	4 $3,272,000	18 $14,067,290	16 $9,480,000

Source: 2018 Brevard County Property Appraiser Office

Figure 20: Shallow Coastal Flood Taxable Property Value



Source: 2018 Brevard County Property Appraiser Office

Storm Surge

Nearly 97% of the City is vulnerable to surge from a Category 3 storm with 100% vulnerability to Category 5 storm surge, for a total of nearly $1.4 billion of potential financial exposure. Residential land uses are the most impacted to all surge categories ranging from 55% of vulnerable parcels (Category 4-5) to 68% (Category 1). Fortunately, only 1% of buildings (2% of all vulnerable parcels) are in the Coastal High Hazard Area (Category 1) and are the most vulnerable to surge. Nearly 70% of parcels and buildings are located on higher elevations and are vulnerable to Categories 4 and 5 storm surge. The number of acres for conservation lands that could be used to help mitigate surge and resulting erosion is consistent throughout the categories, indicating the conservation areas are located in a Category 1 surge zone. The City should work to increase this number along with the public/recreation areas that could serve as areas to capture or buffer surge to reduce impacts further inland. The majority of the housing stock was built between 1968 and 2001 which has the potential for greater damage from flood and wind due to older building standards. As homes are rebuilt either because of reinvestment or damage, they will need to be built to current standards. The City, in the areas most vulnerable to flooding from surge, nuisance flooding and sea level rise, may wish to require standards that will facilitate the raising of the first living floor well above flood levels or above a determined elevation above the crown of the road to minimize flood impacts.

Table 10: Storm Surge Exposure by Future Land Use Classification by Acres

	C1 Commercial	C2 Commercial	Conservation	M1 Industrial	Public/ Recreation	R1 Residential	R2 Residential	R3 Residential
Category 1	20.4 29.42	12 10.86	45.94 53.16	0	13.7 22.76	14.87 5.92	0	184.2 175.13
Category 2	50.4 43.93	21.3 19.84	45.94 53.16	29.4 43.41	16.4 25.24	16 6.67	0	193.2 181.53
Category 3	182.4 153.28	70.3 65.8	45.94 53.16	114.6 125.27	30.9 41.86	92.7 83.88	192.2 227.22	322.2 303.87
Category 4	250.6 177.05	82.5 78.05	45.94 53.16	127.9 137.99	37.9 50.26	101.6 91.28	219.9 278	345.6 323.83
Category 5	251 177.05	82.5 78.05	45.94 53.16	129.3 139.02	37.9 50.26	101.8 91.28	219.9 278	345.6 323.83

Table 11: Surge Impacts by Financial Exposure

							Built Pre-1968	Built 1968-2001	Built 2002-2018
Storm Surge Zone	# Parcels in Zone	Number of Buildings	Number of Units	Land Value	Assessed Value	Taxable Value	# Buildings Total Value	# Buildings Total Value	# Buildings Total Value
Category 1	102	73	1,154	$28,631,070	$339,260,380	$310,629,310	9 $6,319,700	44 $202,506,150	20 $112,035,900
Category 2	137	96	1,246	$37,966,150	$396,310,670	$360,058,560	10 $7,309,110	61 $213,244,590	25 $151,191,840
Category 3	1774	1,604	4,608	$152,646,900	$1,237,561,640	$1,073,652,476	372 $142,731,250	1,047 $646,388,660	185 $402,271,960
Category 4	2315	2,105	5,169	$185,024,770	$1,421,197,790	$1,218,428,822	549 $184,412,630	1,309 $730,302,090	247 $457,173,050
Category 5	2319	2,109	5,220	$185,092,270	$1,422,862,530	$1,219,838,806	549 $184,412,630	1,313 $731,966,830	247 $457,173,050

Sea Level Rise

Property in the City is also susceptible to sea level rise. By 2040, projections show that rising seas will impact between 150 – 309 acres of land and 17-77 buildings (2,319 condo units), thus exposing upward of $204 million – $327 million of property value to sea level rise by 2100. By 2100, exposure may increase 400-800% as the tipping point for the City is between 2090 and 2100 or about 7-8 feet of sea level rise. Exposure under the NOAA High Cure, increases from 194 buildings in 2070 to over 1,800 in 2100 as the eastern portion of the City becomes inundated at this point. Using the lower boundary, USACE, land use exposure is primarily limited to the western portion of the City with just under 290 buildings and 664 acres impacted, by 2070. As stated earlier in the report, it is important to recognize that while some buildings or parcels may be at an elevation that keeps them from inundation, access to these areas may be impacted by flooding in its vicinity.

Similar to other hazards, residential properties are the most impacted future land-use category with 71% of vulnerable parcels in 2040 being residential. As sea level rise reaches the S.R. A1A corridor and the commercial area between S.R. A1A and Atlantic Avenue by 2070-2100, more commercial and industrial areas are anticipated to be impacted by sea level rise. Increasing the amount of conservation or recreation lands that can help serve as buffers or other types of mitigation and adaptation strategies that can divert water and protect developed properties would be beneficial.

Table 12: Sea Level Rise Exposure by Future Land-Use Classification by Acres

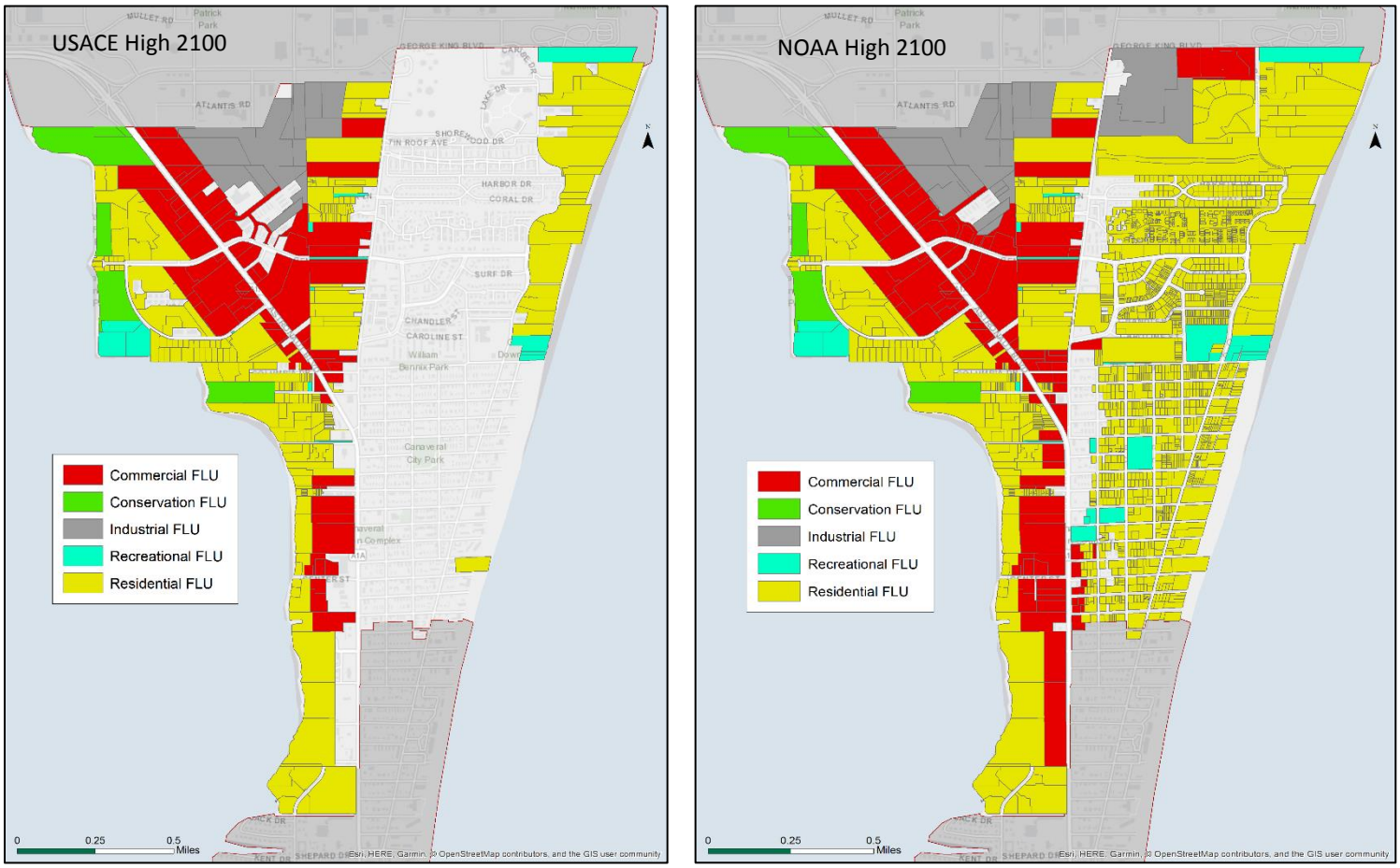
	C1 Commercial	C2 Commercial	Conservation	M1 Industrial	Public/ Recreation	R1 Residential	R2 Residential	R3 Residential
2040	8.13	0	30.6	0	4.95	0	0	106.4
USACE Curve	8.17	0	37.91	0	5.7	0	0	177.17
2070	13.2	12	40.9	0	9.4	14.9	0	152
USACE Curve	22.67	10.86	48.15	0	10.07	5.92	0	219.9
2100	163.9	67.4	46	66.6	16.8	3.4	30.5	254.3
USACE Curve	121.3	62.88	53.16	82.99	27.19	11.44	78.52	383.3
2040	32.6	23.7	46	0	13.7	14.9	2.4	175.6
NOAA Curve	41.77	23.3	53.16	0	14.62	5.92	19.44	267.09
2070	148.5	57	46	64.2	16.4	16.9	28.6	222
NOAA Curve	111.09	52.6	53.16	80.63	17.78	10.02	93.17	341.96
2100	213.2	82.5	46	120.7	36.6	92.6	211.6	344.8
NOAA Curve	165.69	78.05	53.16	135.16	48.04	83.68	375.38	515.94

Source: City Future Land Use

Table 13: Sea Level Rise Impacts by Financial Exposure

					Built Pre -1968	Built 1968 - 2001	Built 2002 - 2018
Horizon Year	# Parcels in Zone	Total Number of Buildings	Total Number of Units	Value of Parcels in Zone	Buildings Total Value	Buildings Total Value	Buildings Total Value
2040 *USACE Curve*	32	17	685	$204,447,790	0 $0	12 $137,716,710	5 $66,731,080
2070 *USACE Curve*	77	54	943	$287,705,080	8 $4,864,700	34 $180,791,880	12 $97,699,120
2100 *USACE Curve*	379	288	2,319	$582,784,350	30 $35,760,270	169 $270,113,660	89 $251,518,800
2040 *NOAA Curve*	111	77	1,136	$326,874,310	10 $6,322,340	47 $208,516,070	20 $112,035,900
2070 *NOAA Curve*	265	194	2,000	$514,202,250	24 $24,098,040	108 $250,921,090	62 $239,183,120
2100 *NOAA Curve*	2039	1,827	4,922	$1,319,876,980	467 $166,537,710	1157 $693,694,830	203 $443,908,730

Figure 23: 2100 Sea Level Rise Impacts by Proposed Future Land-Use Category



100-Year Flood Zone

Fortunately, less than 200 acres of property over 337 parcels and 284 buildings yielding approximately $560 million worth of property in the City are located in the 100-year flood zone. Residential properties comprise 71% of vulnerable parcels in the 100-year flood zone. While the AE zone has the largest number of acreages, the AO zone comprises the greatest number of parcels and buildings, vulnerable to the 100-year flood. The vast majority of building units are located in the "VE" zone. Approximately 85% of buildings in the 100-year flood zone were built prior to 2002, when new building codes were implemented. As flooding and storms become more frequent in the City, these buildings will most likely need to be retrofitted, mitigated or rebuilt to the new standards.

Table 14: Flood Zone Exposure by Future Land-Use Classification by Acres

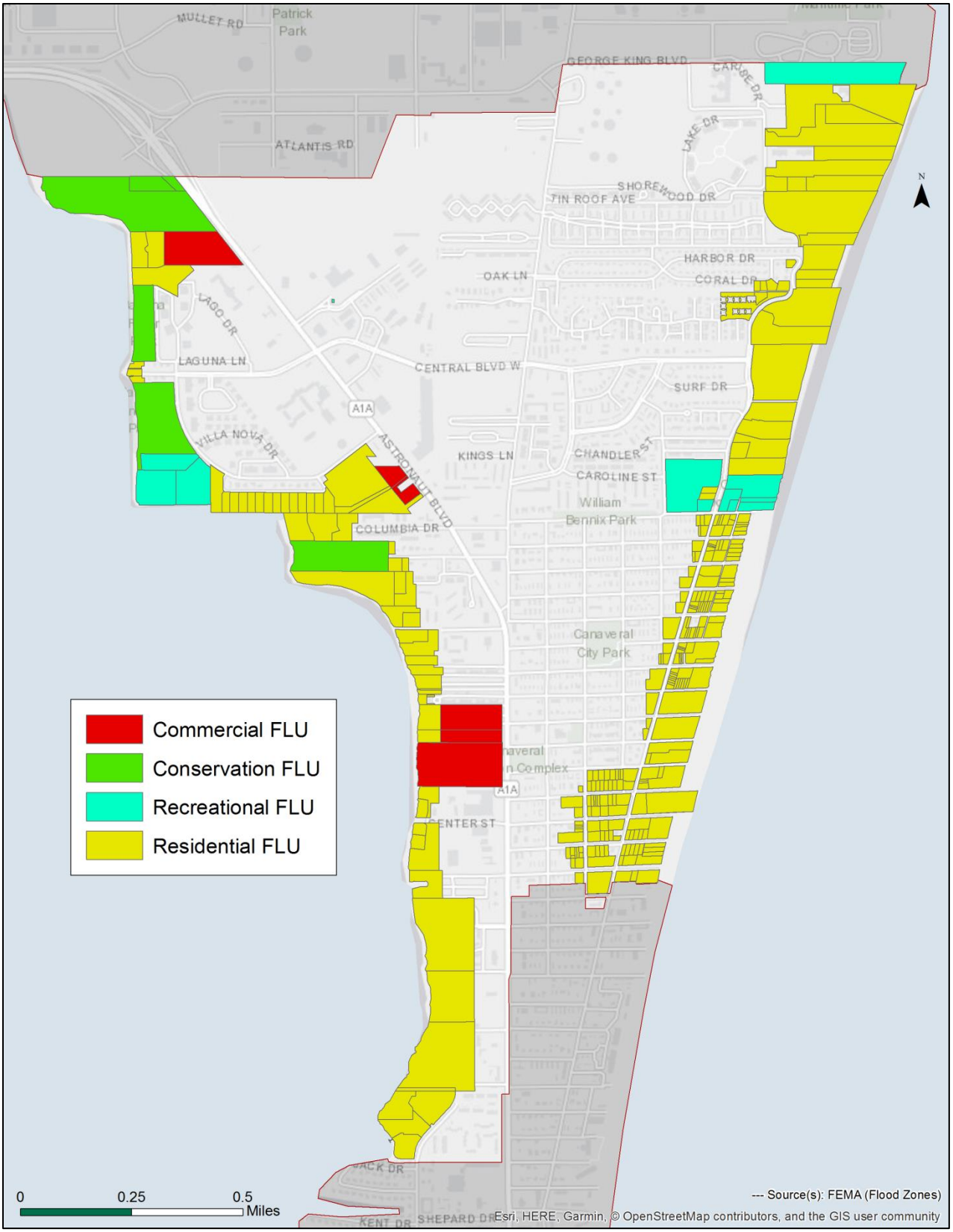
	C1 Commercial	C2 Commercial	Conservation	M1 Industrial	Public/ Recreation	R1 Residential	R2 Residential	R3 Residential
Zone AE *(100-Year)*	22.8 20.46	12 10.86	46 45.28	0	11.5 10.9	15.1 6.2	0	87.8 85.86
Zone AO *(100-Year)*	0	0	0	0	9.2 9.46	4.1 3.82	22.1 20.74	19.8 20.1
Zone VE *(100-Year)*	0	0	0	0	5 14.34	0	0	123.4 115.28
500-Year *(Includes 100-Year)*	238.4 180.39	60.1 66.59	46 95.99	120.1 130.77	38 73.7	98.1 100.37	205.2 302.24	309.4 435.47

Table 15: 100-Year Flood Zone Impacts by Financial Exposure

							Built Pre-1968	Built 1968-2001	Built 2002-2018
Flood Zone	# Parcels in Zone	Number of Buildings	Number of Units	Land Value	Assessed Value	Taxable Value	# Buildings Total Value	# Buildings Total Value	# Buildings Total Value
Zone AE *(100-Year)*	91	69	614	$19,690,380	$164,858,920	$122,633,312	9 $6,319,700	41 $83,202,860	19 $64,097,360
Zone AO *(100-Year)*	196	178	432	$12,840,310	$85,500,220	$69,256,790	50 $22,896,420	108 $52,914,540	20 $9,689,260
Zone VE *(100-Year)*	50	37	999	$7,012,200	$309,104,590	$268,918,136	2 $1,131,000	31 $5,881,200	4 $73,940,900
500-Year *(Includes 100-Year)*	2138	1,935	4,570	$145,170,520	$1,265,493,970	$1,052,451,465	521 $169,936,210	1,205 $464,603,510	209 $390,545,860

Source: 2018 Brevard County Property Appraiser Office and City Future Land Use

Figure 24: Proposed Future Land-Use in the 100-Year Flood Zone



3. Critical Facility Impacts

The critical facilities analysis in this report details the risk posed to government operations and facilities that are vital to life, safety, health and the continuity of operations City-wide following storm events. Facility types in this analysis include HazMat facilities, utilities, lift stations, schools and governmental facilities. As shown in Table 16, no facilities are located in the 100-year flood zone or are vulnerable to shallow coastal flooding. All critical facilities are located in a Category 3–5 storm surge zone, with the exception of Lift Station 5, located on Columbia Drive, which is in a Category 2 zone. It would be beneficial for the City to prioritize mitigation efforts to raise the lift stations, or utilize other viable strategies, to ensure continued functionality of the stations following storms. Acquiring generators for all stations would also be advantageous for pre- and post-disaster planning. The majority of critical facilities also are not vulnerable to inundation by sea level rise until the year 2100 in both scenarios. The only exception to this are: Lift Stations 3, 5, 7 and 9, which are anticipated to be inundated by 2070 under the NOAA High Curve. While this analysis was based on exposure of the building footprint to each vulnerability, as noted previously in the report, access to these facilities should also be considered, especially in the northwestern portion of the City. Of special concern would be the Banana River Park Debris Staging area as, if the area is flooded due to high tides, it would not be useable for debris post-storm. Additionally, the Wastewater Collection System, the Water Reclamation Facility and the Community Services Building are located on parcels located in the low-lying area of the northwest quadrant.

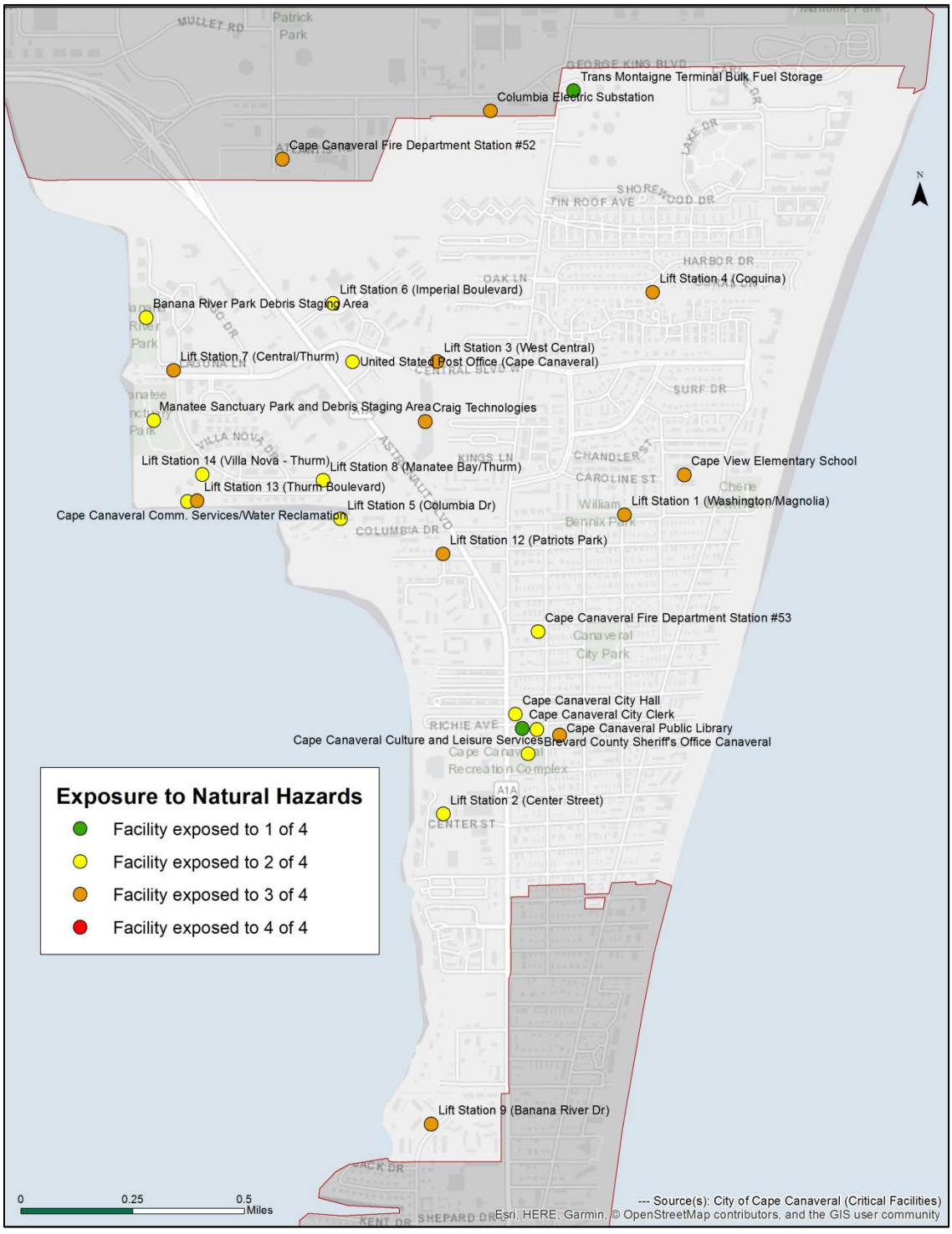
Source: Global Spec

Source: Google Earth

Table 16: Critical Facilities by Hazard

Facility	Facility Type	Storm Surge Zone	USACE SLR Horizon	NOAA SLR Horizon	Flood Zone	Shallow Flood Area
		Lowest	Earliest	Earliest		
Banana River Park Debris Staging Area	Waste Facility	Category 4	None	2100	None	No
Brevard County Sheriff's Office Canaveral	Law Enforcement	Category 4	None	None	500 year	No
Cape Canaveral City Clerk	Government	Category 5	None	None	None	No
Cape Canaveral City Hall	Government	Category 5	None	None	None	No
Cape Canaveral Culture and Leisure Services	Government	Category 5	None	None	None	No
Cape Canaveral Fire Department Station #52	Fire Service	Category 4	None	2100	500 year	No
Cape Canaveral Fire Department Station #53	Fire Service	Category 4	None	None	500 year	No
Cape Canaveral Public Library	Government	Category 4	None	2100	500 year	No
Cape Canaveral Community Services and Fleet Storage	Transportation Operations	Category 3	2100	2100	None	No
Cape View Elementary School	School	Category 3	None	2100	500 year	No
Columbia Electric Substation	Utility	Category 3	None	2100	500 year	No
Craig Technologies	HazMat Facility	Category 3	2100	2100	500 year	No
Lift Station 1 (Washington/Magnolia)	Utility	Category 3	None	2100	500 year	No
Lift Station 2 (Center Street)	Utility	Category 3	None	2100	None	No
Lift Station 3 (West Central)	Utility	Category 3	2100	2070	500 year	No
Lift Station 4 (Coquina)	Utility	Category 3	None	2100	500 year	No
Lift Station 5 (Columbia Drive)	Utility	Category 2	2100	2070	Zone AE	No
Lift Station 6 (Imperial Boulevard)	Utility	Category 4	None	2100	None	No
Lift Station 7 (Central/Thurm)	Utility	Category 3	2100	2070	500 year	No
Lift Station 8 (Manatee Bay/Thurm)	Utility	Category 3	2100	2100	None	No
Lift Station 9 (Banana River Drive)	Utility	Category 3	2100	2070	500 year	No
Lift Station 12 (Patriots Park)	Utility	Category 3	2100	2100	500 year	No
Lift Station 13 (Thurm Boulevard)	Utility	Category 3	2100	2100	500 year	No
Lift Station 14 (Villa Nova - Thurm)	Utility	Category 4	None	2100	None	No
Manatee Sanctuary Park Solid Waste Facility	Waste Facility	Category 4	None	2100	None	No
Pen Pals Childcare Center	Day Care	Category 3	None	2100	500 year	No
Transmontaigne Terminal Bulk Fuel Storage	HazMat Facility	Category 4	None	None	None	No
United Stated Post Office (Cape Canaveral)	Government	Category 4	None	2100	None	No

Figure 25: Critical Facilities Exposure to Natural Hazards



This map depicts the number of vulnerabilities to which each of the City's critical facilities is exposed. Since all critical facilities in the City are located in a surge zone, each is vulnerable to at least one hazard. For this reason, future storm surge with increasing sea level rise was not included in the development of this map.

4. Storm Surge with Sea Level Rise

As sea levels rise, storm surge from hurricanes are expected to become higher and impact a greater extent of the City. This analysis explored the impact that rising seas would have on a Category 3 storm surge using the USACE High and NOAA 2017 High projection rate curves for 2040, 2050, 2070, and 2100. The GIS add-in tool will be available for further analysis upon completion of this report and it would be advantageous for the City or County to conduct further assessment of varying sea level increases with each storm surge category, especially the Category 1 surge zone which constitutes the Coastal High Hazard Area.

Current Category 3 storm surge impacts approximately 795 acres (1.25 sq. miles) of the City or 58% of the City. As sea level rises to 8.5 feet, the extent of impact grows upward of 72% impacting nearly the entire City (99.9%) by 2100 under NOAA High. In thinking about the short-term, by 2040, sea level is expected to rise approximately 1.22-1.85 feet. This would increase the areas impacted by a Category 3 storm surge by 38-42%. Analysis shows that a rise of 4.5 feet, estimated to occur between 2070 (NOAA High) and 2090 (USACE High), will ultimately be the point in which a current Category 4 zone will become the new Category 3 zone. It is expected that by 2050 with 1.7 – 2.57 feet of sea level rise, Category 3 surge heights could reach between 16.3 and 17.3 feet and 17.5 feet and 18.7 feet by 2070, compared to the current potential of 16 feet of surge. Looking at depth data for this combined Storm Surge and Sea Level Rise zone, heights of inundation at each year and projection can be determined. These are estimations of how much flooding, in feet, would affect parts of the City. The depth data was applied to the list of Critical Facilities in order to produce inundation estimations. This information is useful for the City moving forward as another indicator to determine which facilities are appropriate for elevating or hardening and analyzing the remaining functional lifespan of the facility.

Tables 17 and 18 illustrate the changes of impacts from a Category 3 surge as sea levels rise. The map on page 44 illustrates potential increase in Category 3 storm surge extent over the next 30 years with a 1.70 foot and 2.57 feet in sea level rise. Finally, Table 19 provides the projected depth of inundation of critical facilities based on the parameters in this section.

Table 17: Change in Category 3 Storm Surge Impact Area with Sea Level Rise

Zone	Acres	Percent Change	Percent of City
2017 Category 3	1051		65.10%
Category 3 *1.7 foot SLR (USACE 2040)*	1093.14	4%	89.51%
Category 3 *1.7 foot SLR (USACE 2040)*	1125.4	7%	92.15%
Category 3 *1.7 foot SLR (USACE 2050)*	1111.43	6%	91.01%
Category 3 *2.5 foot SLR(NOAA 2050)*	1178.72	12%	96.52%
Category 3 *2.85 foot SLR(USACE 2070)*	1192.64	13%	97.66%
Category 3 *4.5 foot SLR(NOAA 2070)*	1219.31	16%	99.84%
Category 3 *5.15 foot SLR(USACE 2100)*	1221.24	16%	100.00%
Category 3 *8.5 foot SLR(NOAA 2100)*	1221.24	16%	100.00%

Table 18: Change in Category 3 Storm Surge Property Impacts with Sea Level Rise

						Built Pre-1968	Built 1968-2001	Built 2002 - 2018
Zone	# Parcels in Zone	Number of Buildings	Land Value	Assessed Value	Taxable Value	# Buildings Total Value	# Buildings Total Value	# Buildings Total Value
2017 Category 3	1774	1,604	$152,646,900	$1,237,561,640	$1,073,652,476	372 $142,731,250	1,047 $646,388,660	185 $402,271,960
Category 3 *1.7 foot SLR (USACE 2050)*	1,998	1,789	$167,072,770	$1,320,207,690	$1,095,224,826	440 $157,404,110	1,148 $684,456,980	201 $430,922,120
Category 3 *2.5 foot SLR (NOAA 2050)*	2,206	1,983	$179,821,090	$1,380,988,400	$1,144,939,098	514 $177,553,110	1,239 $707,794,920	230 $447,039,250
Category 3 *2.85 foot SLR (USACE 2070)*	2,271	2,044	$182,143,900	$1,397,827,730	$1,157,230,922	601 $180,245,070	1,372 $715,216,350	236 $453,620,880
Category 3 *4.5 foot SLR (NOAA2070)*	2,342	2,104	$185,022,270	$1,421,783,790	$1,177,585,986	549 $184,412,630	1,310 $731,247,380	245 $456,813,760
Category 3 *5.15 foot SLR (USACE 2100)*	2,347	2,109	$185,092,270	$1,422,862,530	$1,178,570,466	623 $184,412,630	1,404 $731,966,830	247 $457,173,050
Category 3 *8.5 foot SLR (NOAA 2100)*	2,347	2,109	$185,092,270	$1,422,862,530	$1,178,570,466	549 $184,412,630	1,313 $731,966,830	247 $457,173,050

Figure 26: Category 3 Storm Surge with 1.70 and 2.5 Feet of Sea Level Rise

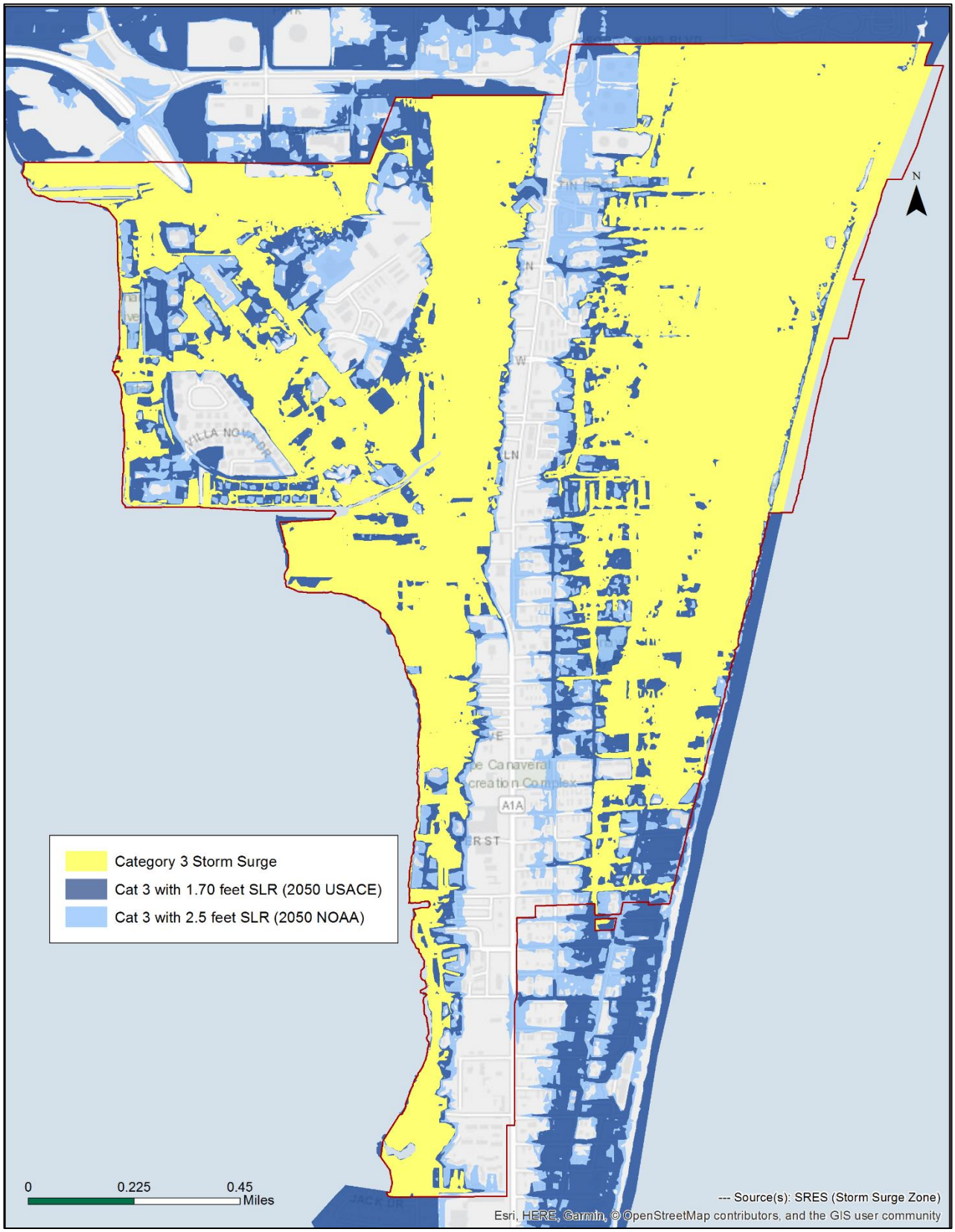


Table 19: Feet of inundation from a Category 3 storm surge with future sea level rise projections at critical facilities.

Facility	Facility Type	Category 3 *1.7 feet SLR(USACE 2050)*	Category 3 *2.85 feet SLR(USACE 2070)*	Category 3 *5.15 feet SLR(USACE 2100)*	Category 3 *2.5 feet SLR(NOAA 2050)*	Category 3 *4.5 feet SLR(NOAA 2070)*	Category 3 *8.5 feet SLR(NOAA 2100)*
Banana River Park Debris Staging Area	Waste Facility	0	0	1.08	0	0.39	4.45
Brevard County Sheriff's Office Canaveral	Law Enforcement	0	0	0.89	0	0.23	4.26
Cape Canaveral City Clerk	Government	0	0	0	0	0	2.77
Cape Canaveral City Hall	Government	0	0	0.82	0	0.16	4.19
Cape Canaveral Culture and Leisure Services	Government	0	0	1.49	0	0.87	4.84
Cape Canaveral Fire Department Station #52	Fire Service	0	0.38	2.67	0.13	1.99	6.06
Cape Canaveral Fire Department Station #53	Fire Service	0	0	1.77	0	1.11	5.17
Cape Canaveral Public Library	Government	0	0	1.85	0	1.19	5.23
Cape Canaveral Comm. Services/Water Reclamation	Transportation Operations	0	0.71	3.13	0.49	2.51	6.47
Cape View Elementary School	School	1.45	2.76	4.97	2.41	4.30	8.31
Columbia Electric Substation	Utility	1.72	2.96	5.23	2.70	4.49	8.68
Craig Technologies	HazMat Facility	1.23	2.38	4.70	2.12	3.98	8.01
Lift Station 1 (Washington/Magnolia)	Utility	0.34	1.35	3.76	0.66	3.04	6.47
Lift Station 2 (Center Street)	Utility	0.99	2.22	4.51	2.02	3.71	7.80
Lift Station 3 (West Central)	Utility	2.75	4.23	6.37	4.80	5.42	9.73
Lift Station 4 (Coquina)	Utility	2.76	4.06	6.35	3.84	5.55	9.69
Lift Station 5 (Columbia Dr)	Utility	1.77	2.99	5.18	3.02	4.64	8.80
Lift Station 6 (Imperial Boulevard)	Utility	0	0	1.28	0	0.54	4.66
Lift Station 7 (Central/Thurm)	Utility	1.78	2.91	5.29	2.70	4.64	8.79
Lift Station 8 (Manatee Bay/Thurm)	Utility	1.07	2.11	4.41	1.23	3.92	7.81
Lift Station 9 (Banana River Dr)	Utility	1.36	2.40	4.78	2.49	4.22	8.16
Lift Station 12 (Patriots Park)	Utility	2.05	3.15	5.50	2.63	4.82	8.61
Lift Station 13 (Thurm Boulevard)	Utility	1.32	2.37	4.85	1.92	4.17	8.02
Lift Station 14 (Villa Nova - Thurm)	Utility	0.16	1.37	3.73	1.32	3.04	7.21
Manatee Sanctuary Park Solid Waste Facility	Waste Facility	0	0.05	2.45	0	1.80	5.89
Transmontaigne Terminal Bulk Fuel Storage	HazMat Facility	0	0.10	2.43	0	1.81	5.70
United Stated Post Office (Cape Canaveral)	Government	0	0	0.95	0	0.34	4.35

V. Public Engagement

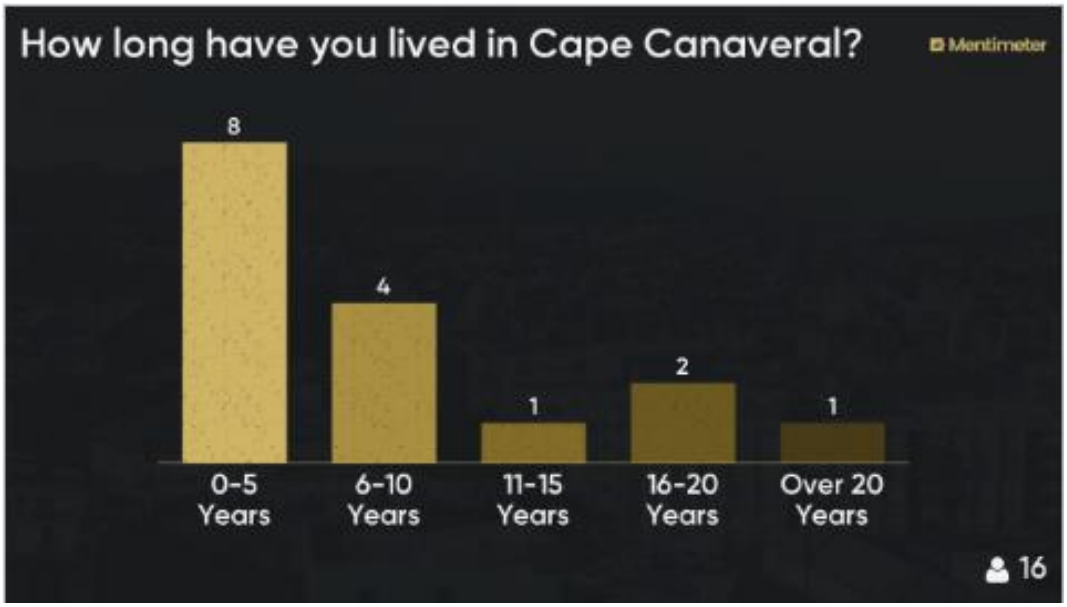
The City of Cape Canaveral worked extensively to engage the public throughout the "Resilient Cape Canaveral" project process. Outreach included social media, the City's website, weekly updates and even a message on water bills. This section provides a summary of two workshops, the on-line MetroQuest survey and activities with students at Cape View Elementary.

A. City of Cape Canaveral Stakeholder Workshop #1 | November 29, 2018

The first public workshop was held at the Cape Canaveral Library on Thursday November 29, 2018 from 6pm – 8pm. Approximately 35 parties were in attendance. The workshop included an educational presentation about federal and state resilience statutes, program integration and the FDEP Resilience grant awarded to the City and the tasks associated with the grant. An overview of vulnerability analyses was included as well as information concerning the National Oceanographic and Atmospheric Administration (NOAA) and the United States Army Corps of Engineers (USACOE) sea level rise projections. The projected impacts of sea level rise on the City of Cape Canaveral were visually displayed as well as the current impacts from nuisance flooding using NOAA frequent flood data.

To engage the audience in the presentation, they participated in an interactive Mentimeter poll which asked three questions:

1) How long have you lived in the City of Cape Canaveral?



2) What does resilience mean to you?

3) Considering short and long-term horizons, what do you consider a vulnerability for Cape Canaveral's resilience.

The majority of the residents in attendance have lived in the City less than 10 years. When describing resilience, the most common words used were: recovery, survival, safety and mitigation. The discussion of vulnerabilities took place in two smaller breakout groups.

The top vulnerabilities discussed in both breakout groups were as follows, in no particular order:

Flooding; Hurricanes (including storm surge and services during/following a disaster); Politics (including funding and economics); Sea level rise; and Indian River and Banana River Lagoon health.

The following summarizes the strategies and opportunities discussed for the City, City partners, the public and others that may address the vulnerabilities identified.

Flooding

- Reassess zoning and make appropriate changes to move people out of harms way or allow for innovative approaches to building resilient structures
- Develop and adopt smart growth ordinances
- Participate in information sharing and research best practices
- Retrofit existing structures to stronger standards and rebuild to higher standards and elevations
- Raise streets
- Evaluate infrastructure to determine upgrade priorities and develop a hybrid infrastructure plan that integrates green and gray infrastructure with best practices
- Assess creative stormwater management systems
- Reassess and potentially reduce parking standards and incorporate green infrastructure in parking designs
- Downzone in vulnerable areas
- Increase green spaces, especially in areas where they can be utilized for stormwater detention
- Reassess vulnerable areas and buildings; including mobile home parks
- Assess evacuation routes for vulnerabilities and mitigation or enhancement opportunities to improve resilience (Assessment completed as part of the Space Coast TPO SLR assessment)

Hurricanes

This includes hurricanes, services, and storm surge strategies.

- Reassess zoning and codes in the City
- Conduct a Causeway Vulnerability Analysis (S.R. A1A)
- Conduct a vulnerability evaluation of evacuation routes and include nuisance flooding
- Proactive Public Information
- More education on preparedness and recovery
- Evaluate gaps in shelters, evacuation and transportation plans and processes
- Improve tree ordinances
- Identify main/critical services needed before, during or after an event (stormwater, medical, first responders, utilities, food, gas stations, emergency management)
- Communicate with emergency management for needs of businesses and services to be open for recovery efforts
- Education to vulnerable populations
- Promotion of information
- Assess mandatory evacuation approach to facilitate greater participation
- Destigmatize/prioritize storm shelter use

- Adapt building codes to be more resilient
- Incentivize low-impact landscape
- Improve beach elevation
- Promote living shorelines
- Only allow sea walls or rip rap if living shorelines are incorporated and maintained
- Encourage more dune vegetation (sea oats) for private property owners
- Utilize bioswales
- Maintenance of infrastructure and the built environment in private areas (condo communities)
- Maintain greenspace and improve fertilizer ordinance

Politics

This includes politics, funding and economics.

- Make public aware of candidates voting practices
- Educate public and elected officials about resilience
- Encourage public participation in meetings and workshops
- Advertise ways for the public to be involved in the community government
- Social media integrity
- Ongoing simple messaging to the public
- Sustainable information
- Top down and bottom up recognition
- Reassess building codes for elevation
- If increasing taxes, provide specifics concerning what the funding will be used for
- Reduce government waste; term and benefit limits
- Promote home rule
- Code enforcement/penalties

Sea Level Rise

- Dams
- Stormwater management
- Increase permeable surfaces
- Swales
- Education
- Incentivize relocation
- Investigate economic opportunities

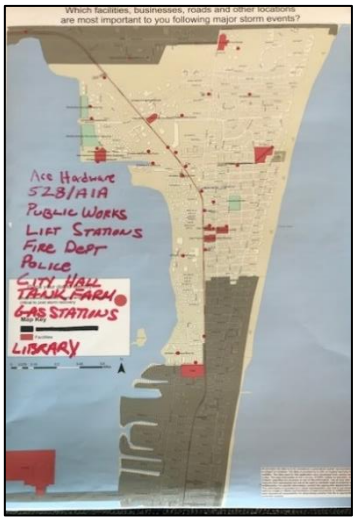
- Creative water usage for unusable property
- Floodplain restoration
- Stilting, elevating structures (reassess Land Development Codes)

Climate Change

- Incentives for electric vehicles (City response: 8 free public electric vehicle chargers are currently available)
- Create citizen ownership of solutions to climate change
- Education and awareness
- Promote solar and microgrids
- Assess city policies to address climate change
- Lobby for power plant standard changes
- Improve/increase walkability and bikeability
- Conduct a traffic assessment to change traffic patterns
- Collaboration between communities

Lagoon Health

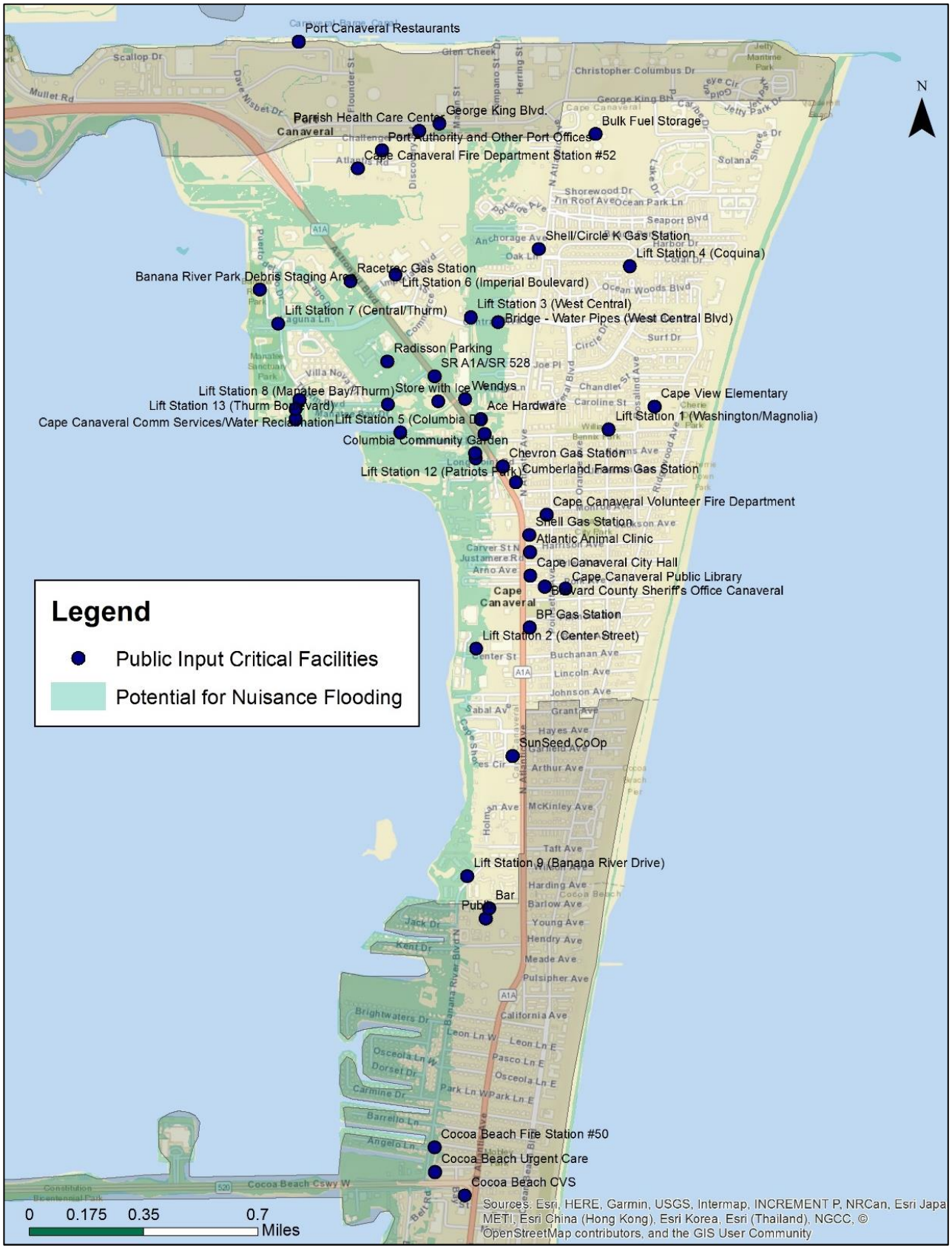
- Remove septic tanks; connect to sewer (City Response: To our knowledge, only one property is still on septic)
- Stop tax cuts; use special assessments (with education and specific uses of the assessment)
- Span the causeways
- Natural vegetative buffer between lagoon and turf
- Avoid turf and fertilizer
- Improve fertilizer ordinance
- Green infrastructure



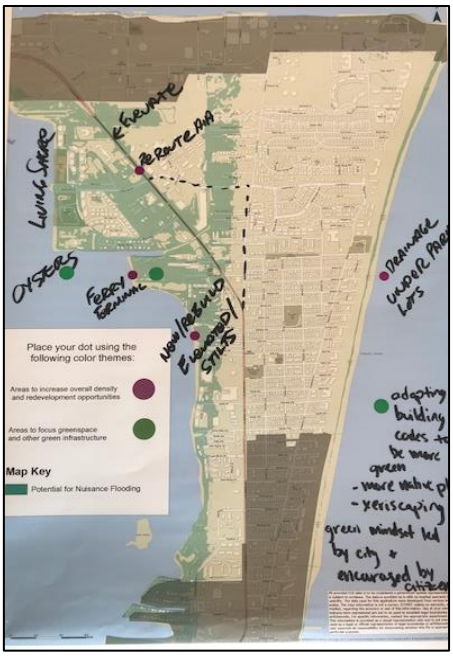
Two additional breakout groups focused on mapping exercises. The first exercise asked the question "Which facilities, businesses, roads and other locations are most important to you following major storm events?" Attendees responded by placing dots in critical locations or writing information on the map. S.R. 520/528 and S.R. A1A were identified as major roadway infrastructure while Port Canaveral businesses were listed as other important facilities. Many of the facilities identified are considered critical by the City, such as lift stations, City assets, and emergency response facilities. Other facilities included businesses with ice, food, and other preparedness supplies such as Publix, ACE and gas stations. It was noted that the City is in need of an urgent care facility and a heliport. *(Canaveral City Park is the City's designated air medical emergency landing site.*) The map below displays the identified facilities noted during the workshop.

Note: Shallow coastal flood (nuisance flood) data depicted on these maps had been updated by NOAA after the workshop. To maintain consistency with the public thought process, the original data is shown in the following maps.

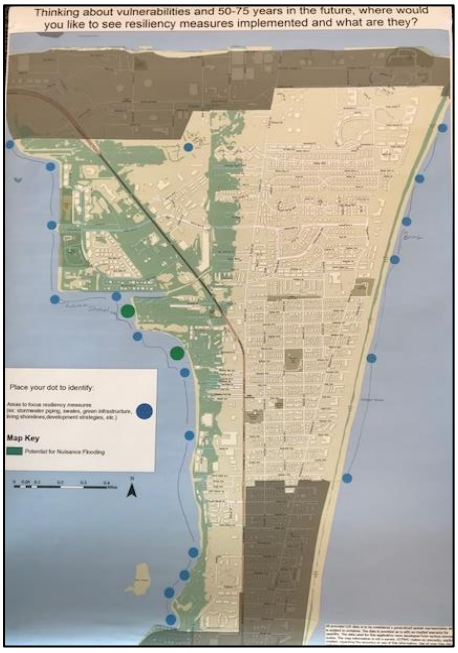
Figure 27: Critical Facilities as Noted by the Public

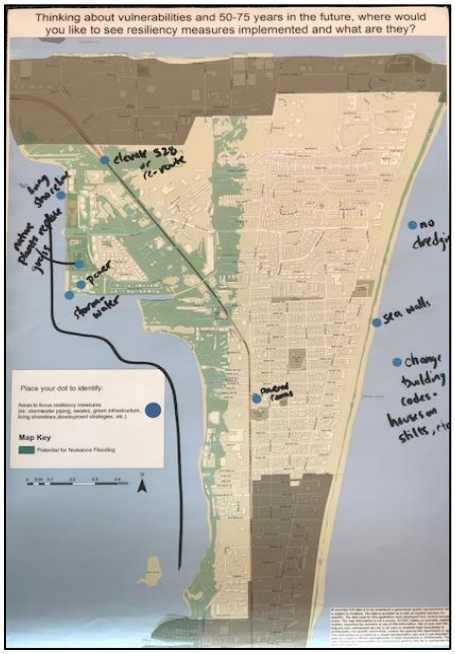


The second exercise asked two questions: "Thinking about vulnerabilities and 50-75 years in the future, where would you like to see redevelopment and greenspace?" Attendees identified areas to increase overall density and redevelopment opportunities as well as areas to integrate greenspace and other green infrastructure.



The second question asked "Thinking about vulnerabilities and 50-75 years in the future, where would you like to see resiliency measures implemented and what are they?" In this exercise, attendees identified specific locations to implement various measures to mitigate or adapt to hazards and where possible, provided specific strategies for those locations. Below are examples of the map exercise.

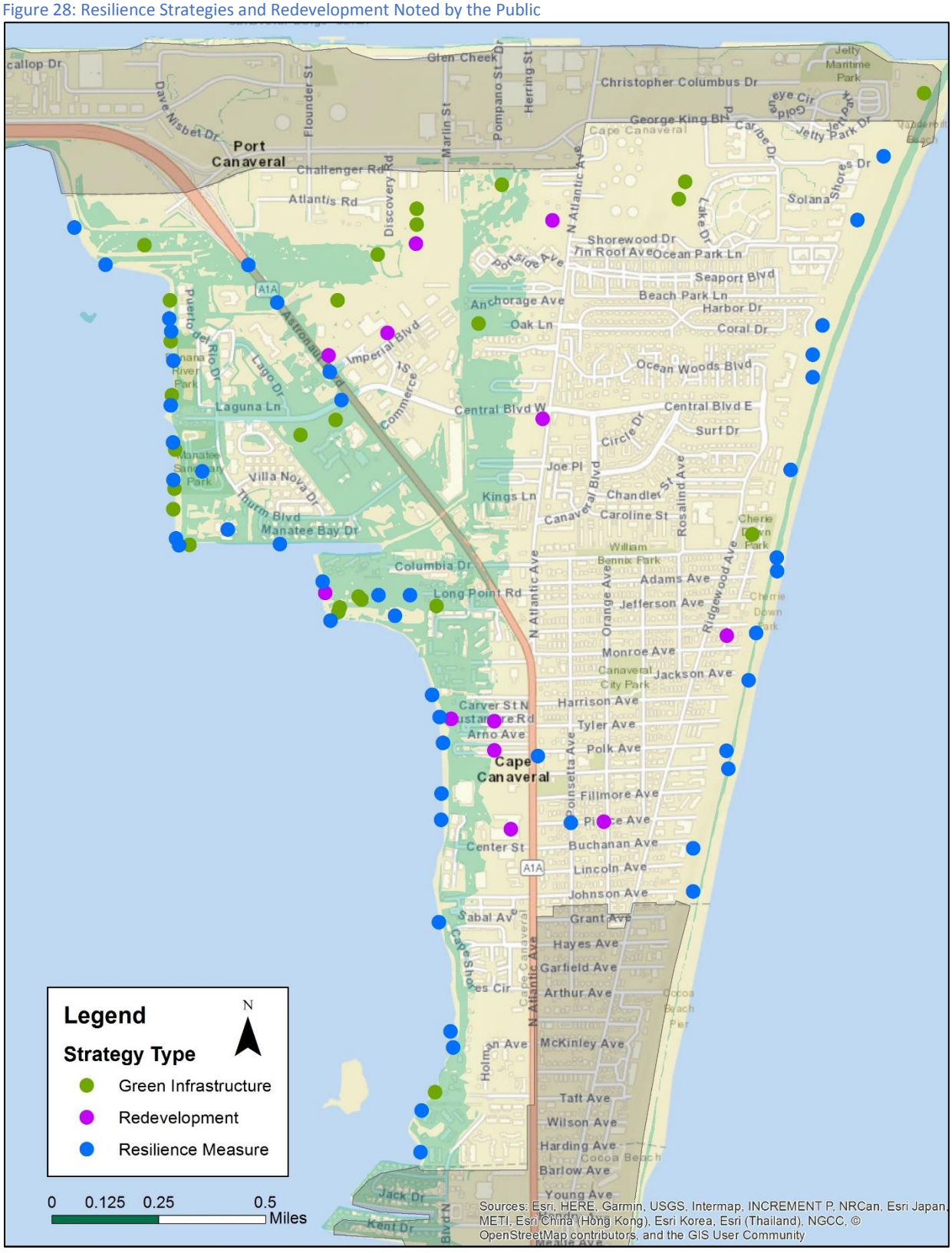




Feedback on the maps concerning various issues included the need for grid improvement, the breakage of pipes under S.R. 520/528, the need for additional sewage capacity, rats in sewer lines, and freshwater accessibility. Strategies identified include changing building codes to allow houses on stilts, avoid dredging, transfer ownership of Brevard County's Cherie Down Park to the City, work with Publix to restock effectively and efficiently and to get employees back to work, ocean front building code modifications to raise living space, drainage under parking lots, develop "green building codes", more native and xeriscaping landscaping, re-evaluate parking standards, and green infrastructure.

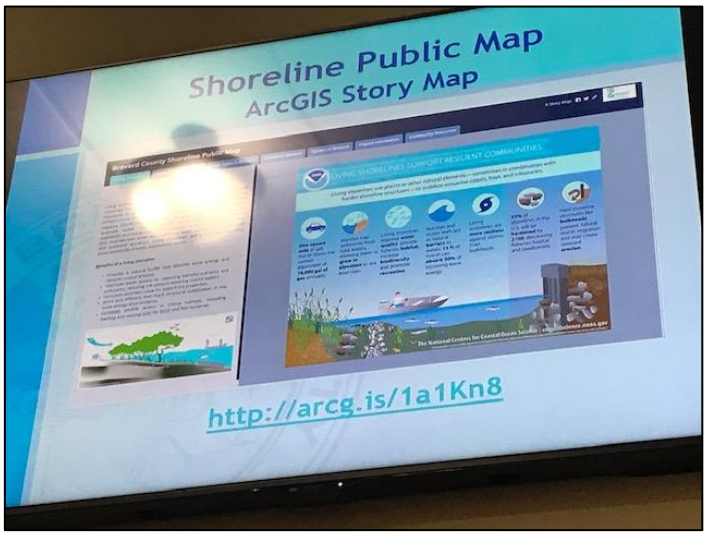
The following map has combined the information provided during the workshop concerning where green infrastructure / open space, redevelopment and other resilience strategies should be implemented.

Figure 28: Resilience Strategies and Redevelopment Noted by the Public



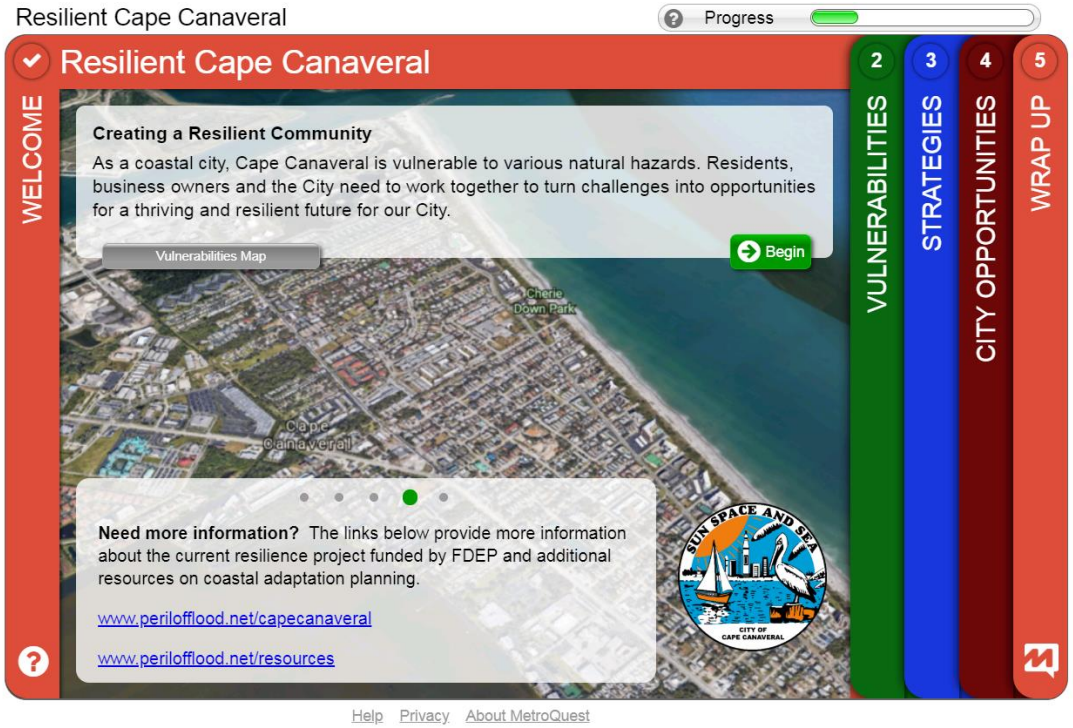
B. City of Cape Canaveral Stakeholder Workshop #2 | April 4, 2019

The second public workshop was held at the Cape Canaveral City Hall on April 4, 2019 from 6pm – 7:30 pm. 13 attendees signed in at the workshop. The format of this event was an open house. Posters from the previous workshop as well as new posters that showcased the impacts of sea level rise on storm surge and the results from the survey. A presentation was made by the ECFRPC that discussed project process including the stakeholder engagement activities, hazards being analyzed and major findings from the vulnerability analysis. Draft recommendations that are being presented to the City for further discussion were also reviewed in the presentation. The Brevard County Natural Resources Stormwater Program Outreach Coordinator was also in attendance and spoke to the work being completed through the Save Our Indian River Lagoon Tax such as living shorelines, baffle boxes and others as the projects integrated both green and gray infrastructure and showcased strategies being presented to the City.



C. Public On-Line Survey

The information derived from the workshop was combined with best practice strategies to develop a city-wide survey to engage a broader constituency, support for specific actions, policy changes or other strategies to address resilience. The survey was made available from January 14, 2019 - March 5, 2019. A total of 239 respondents participated in the survey. The findings from the survey are described below.



The respondents were primarily full-time Cape Canaveral Residents who have lived in the City for a variety of years, most being less than 5 years. There was also a spread of age ranges taking the survey but the largest age group consisted of those 61 and over, followed by 41 to 60.

Cape Canaveral Affiliation

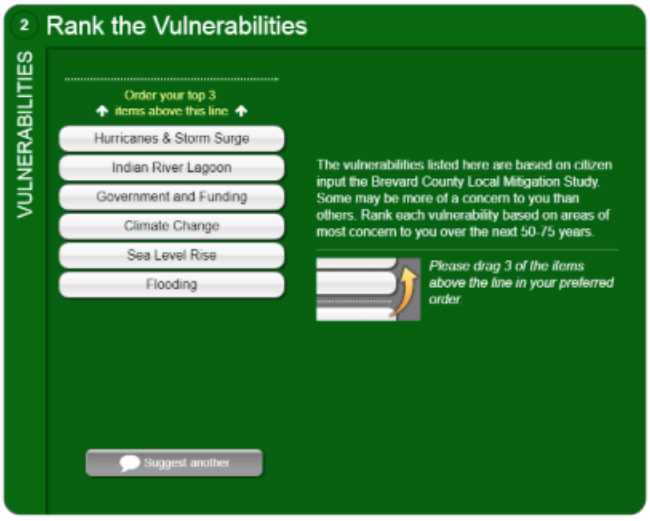
125	FullTime Resident
28	Property Owner
6	Seasonal Resident
2	No Affiliation
1	Business Owner
162	Total

How long have you lived in Cape Canaveral

60	Less than 5 years
41	Between 11 and 20 years
37	Between 5 and 10 years
24	More than 21 years
162	Total

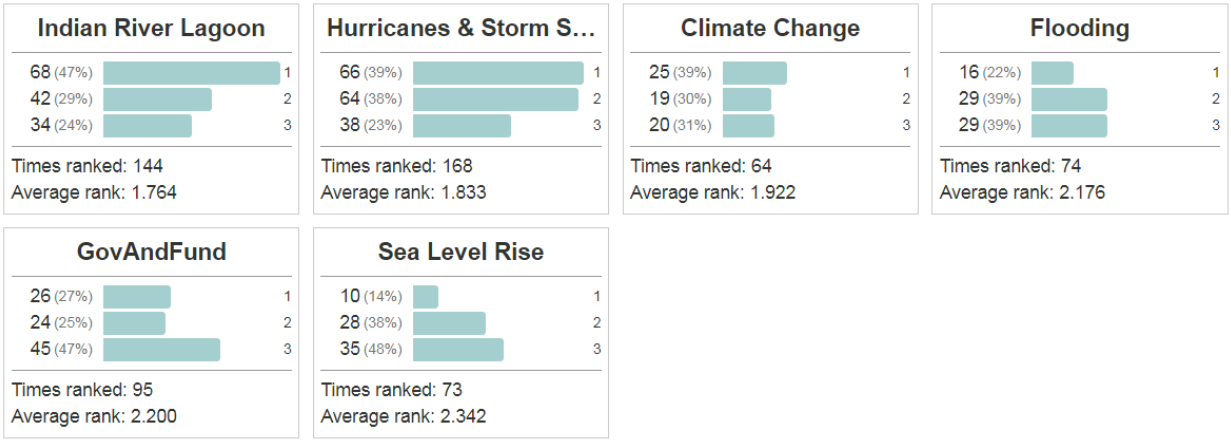
Your Age

81	61 to 80
55	41 to 60
20	26 to 40
3	81 and over
2	25 and under
161	Total



The first exercise asked for participants to rank their top 3 vulnerabilities in order of importance or priority. These vulnerabilities were generated based on the first public workshop as well as the Brevard County Local Mitigation Strategy.

The image below shows the average ranking of each vulnerability as well as the number of times it was ranked. The Indian River Lagoon (1.764) was ranked as the highest priority, followed by hurricanes and storm surge (1.833), and then climate change (1.922). The bottom three vulnerabilities included flooding (2.176), government and funding (2.200) and sea level rise (2.342). Hurricanes and storm surge was ranked the greatest number of times, however, it was only ranked as the top vulnerability by 39% of respondents who ranked it, while Indian River Lagoon was ranked #1 by 47% of the respondents who ranked it.



Participant comments provided on this screen are below:

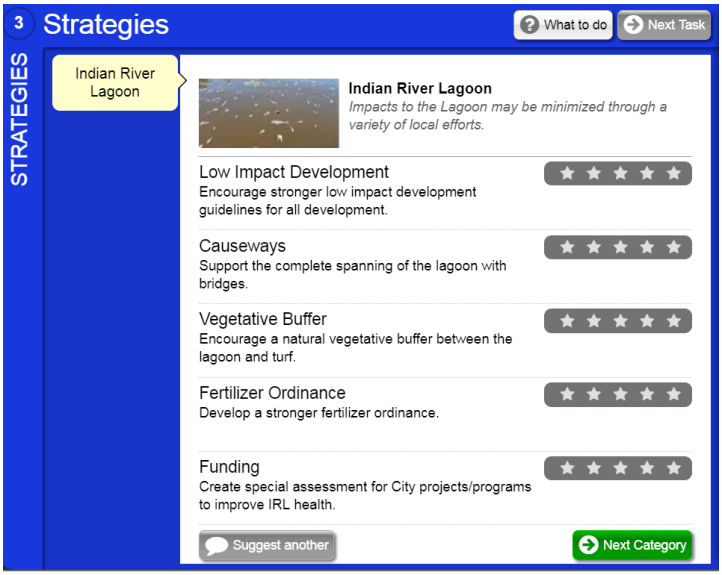
Tsunami
city over spending on projects not really needed.
overpopulation leading to loss of wildlife
Getting all of our power off poles and under ground....
clean up ocean beaches
School playground funding with safe space afterschool
infrastructure
Traffic speed on A1A
stop filling every pothole w/cement -no greenery will be visible - cement city!!!

The second exercise was linked to the previous screen and asked participants to rate strategies related to the vulnerabilities they previously ranked as their top 3. These strategies were generated based on the first public workshop as well as the best practice research.

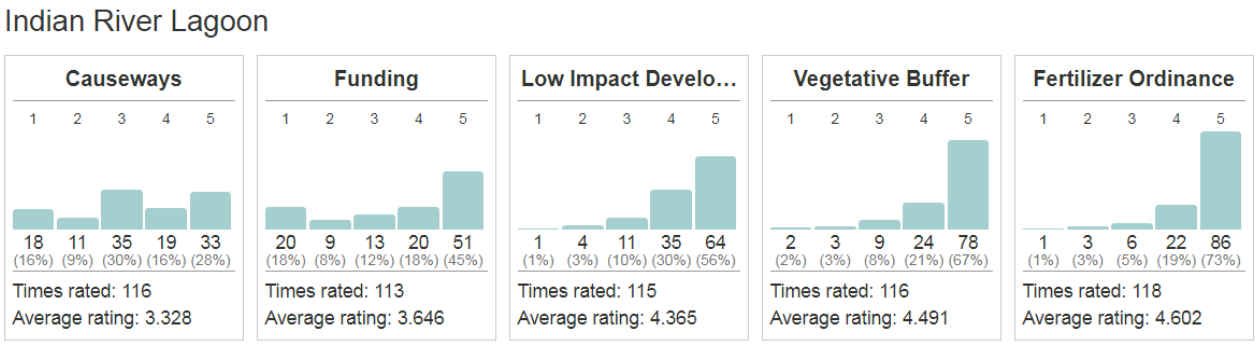
Participant comments provided on this screen are below:

Although not an issue with Cape Canaveral, but getting all homes on or near the rivers off of Septic systems should be the main goal.
Tangibly support Brevard Zoo based oyster growth program.
Remove failing septic tanks along waterways
Excessive spending on unfunded projects
Develop a "Penny for Brevard County" to increase money for funding projects. This is what happened in Pinellas County. Now they have excellent trails and other projects funded.

Indian River Lagoon

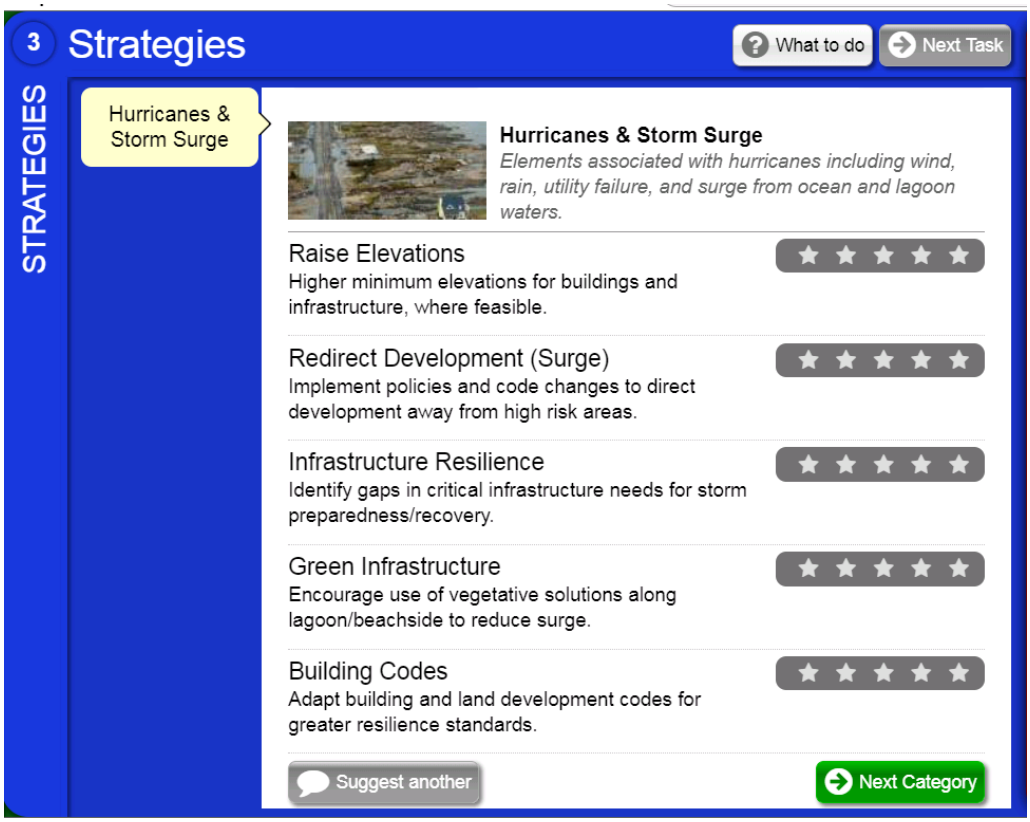


For this vulnerability (the top ranked), strategies focused on minimizing impacts to the Lagoon. Developing a stronger fertilizer ordinance had the strongest support with a 4.602 rating, followed closely by encouraging natural vegetative buffers between the lagoon and turf (4.491) and encouraging stronger low impact development guidelines (4.365). Creating special assessments for City projects and programs for IRL health and supporting the spanning of the lagoon with bridges were somewhat supported.



Hurricanes and Storm Surge

For this vulnerability (the second ranked), strategies focused on dealing with the elements associated with hurricanes, including wind, rain, utility failure and surge from both the ocean and lagoon. Encouraging use of vegetative (green infrastructure) solutions along the lagoon and beachside to reduce surge was the top supported strategy (4.444), followed closely by identifying gaps in critical infrastructure needs for preparedness and recovery (4.407). Adapting building and land development codes for greater resilience (4.243) and redirecting development away from high risk areas (4.157). Although rated lowest at 3.538, raising minimum elevations of buildings and infrastructures was supported, though not strongly.

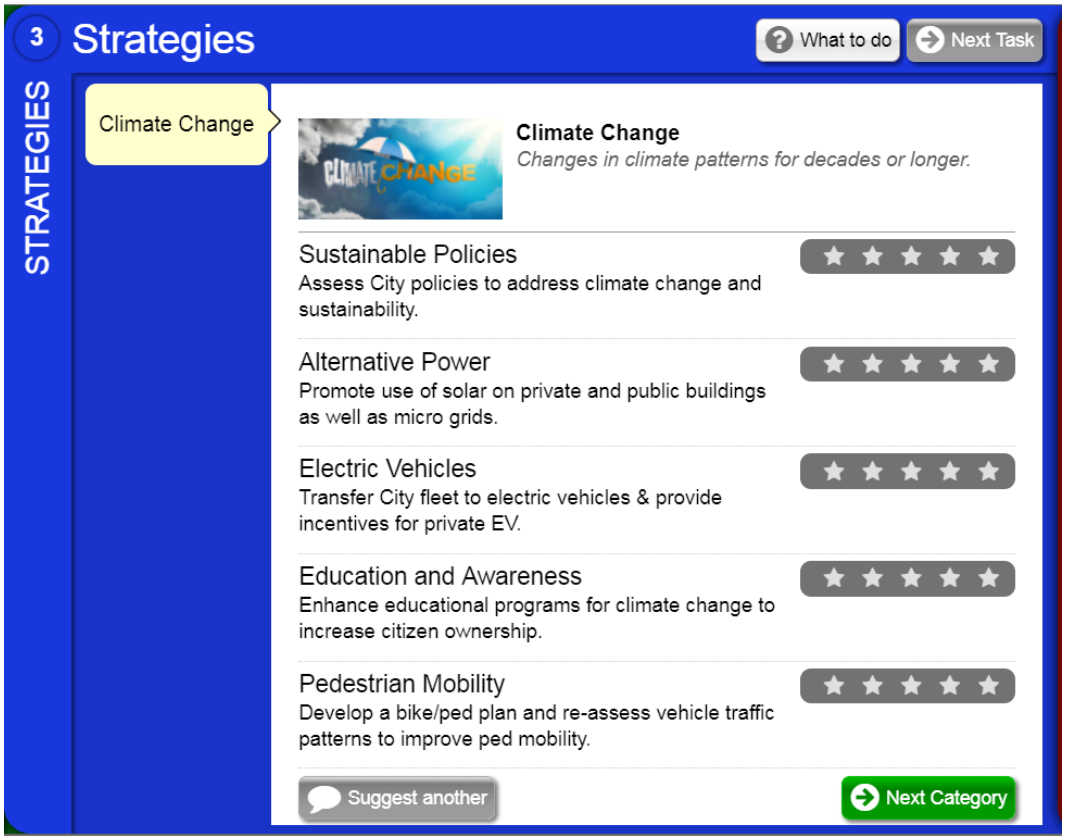


Hurricanes Storm Surge

Raise Elevations	Redirect Developm...	Building Codes	Infrastructure Resil...	Green Infrastructure
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
13 (10%)	3 (2%)	4 (3%)	- (0%)	3 (2%)
10 (8%)	4 (3%)	3 (2%)	1 (1%)	4 (3%)
37 (28%)	25 (19%)	24 (18%)	18 (13%)	11 (8%)
37 (28%)	39 (29%)	30 (22%)	41 (30%)	29 (21%)
35 (27%)	63 (47%)	75 (55%)	75 (56%)	88 (65%)
Times rated: 132	Times rated: 134	Times rated: 136	Times rated: 135	Times rated: 135
Average rating: 3.538	Average rating: 4.157	Average rating: 4.243	Average rating: 4.407	Average rating: 4.444

Climate Change

For this vulnerability (the third ranked), strategies focused on dealing with climate change. All five strategies had strong support and were close in average ratings, all being a 4.0 and above. Promoting the use of solar on private and public buildings as well as micro grids was the top supported strategy (4.547), followed very closely by assessing City policies to address climate change and sustainability (4.500). Developing a bike/ped plan and reassessing vehicle traffic patterns to improve pedestrian mobility (4.463) ranked third, followed by enhancing educational programs for climate change to increase citizen ownership (4.345). Adapting building and land development codes for greater resilience (4.243) and redirecting development away from high risk areas (4.157). Transferring City fleet to electric vehicles and providing incentives for private EV was supported with a 4.507.

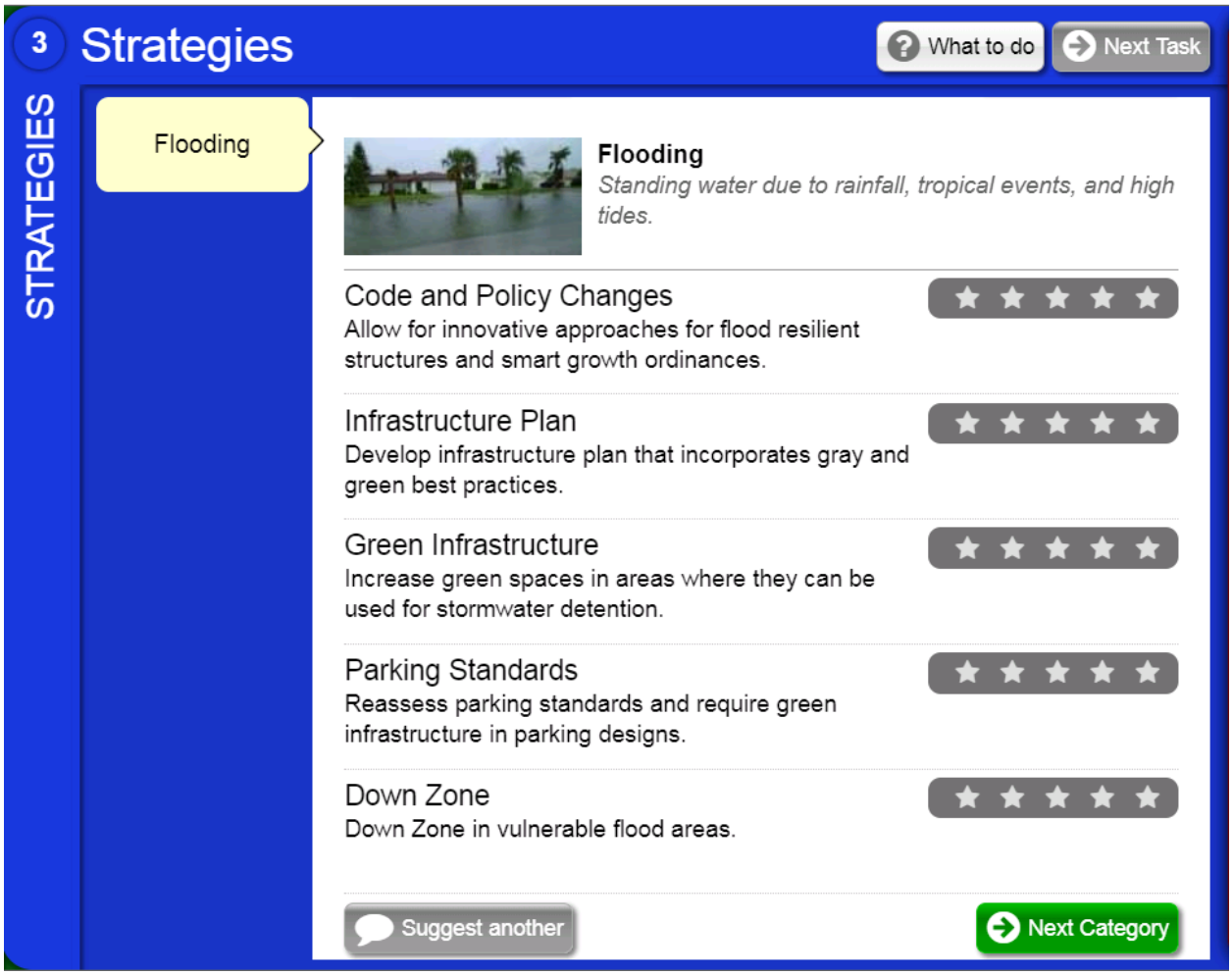


Climate Change

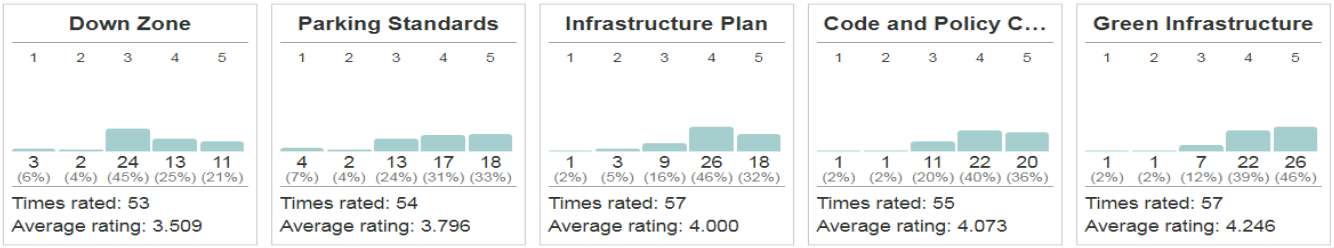
Electric Vehicles					Education and Awa...					Pedestrian Mobility					Sustainable Policies					Alternative Power				
1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1 (2%)	4 (8%)	10 (19%)	14 (26%)	24 (45%)	- (0%)	1 (2%)	11 (20%)	11 (20%)	32 (58%)	1 (2%)	2 (4%)	5 (9%)	9 (17%)	37 (69%)	1 (2%)	- (0%)	6 (11%)	11 (20%)	36 (67%)	- (0%)	3 (6%)	3 (6%)	9 (17%)	38 (72%)
Times rated: 53					Times rated: 55					Times rated: 54					Times rated: 54					Times rated: 53				
Average rating: 4.057					Average rating: 4.345					Average rating: 4.463					Average rating: 4.500					Average rating: 4.547				

Flooding

For this vulnerability (the fourth ranked), strategies focused on standing water due to rainfall, tropical events and high tides. Increasing green space in areas for stormwater detention (4.246) was the highest ranked strategy, followed by updating codes and policies to allow for innovative approaches for flood resilient structures and smart growth ordinances (4.073) and developing an infrastructure plan that incorporates gray and green best practices (4.000). Reassessing parking standards (3.796) and downzoning in vulnerable areas had some support but not overwhelmingly (3.509).

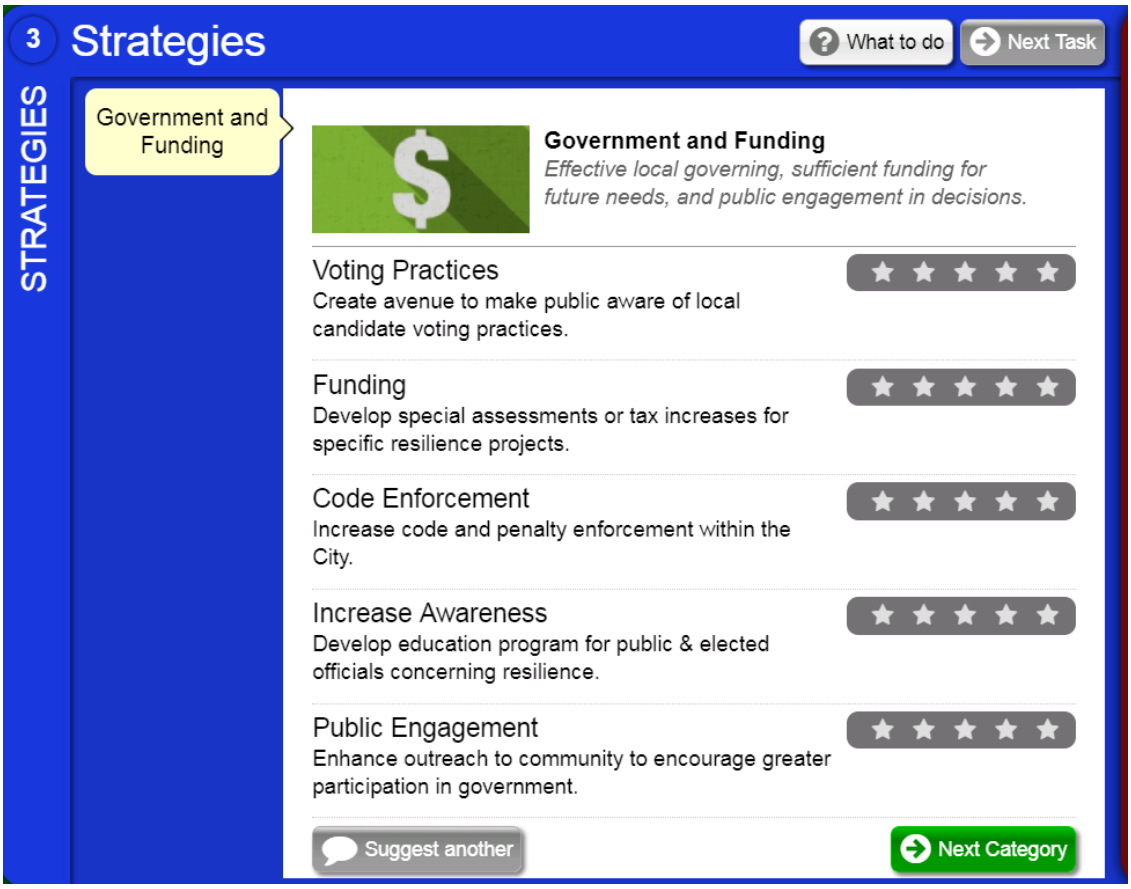


Flooding

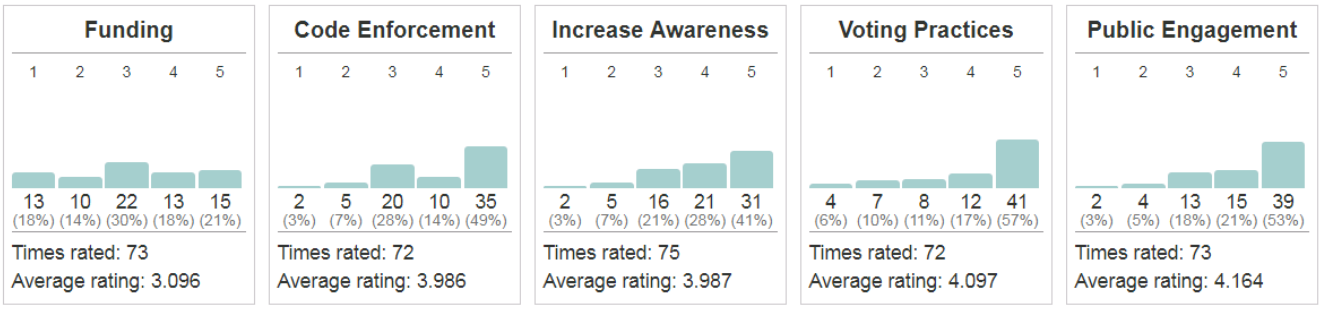


Government and Funding

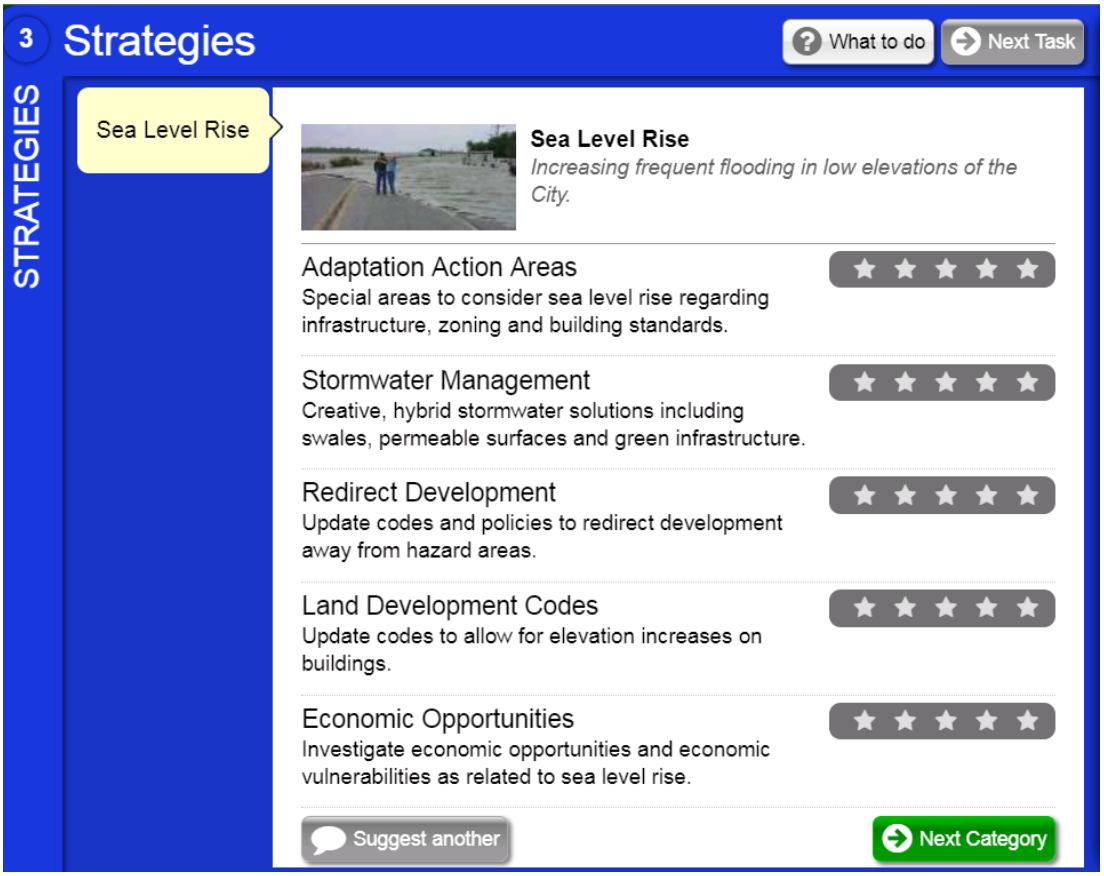
For this vulnerability (the fifth ranked), strategies focused on effective local governing, sufficient funding for future needs and public engagement in decisions. Public engagement (4.164) was the highest ranked strategy, followed by creating an avenue to make the public aware of local candidate voting practices (4.097). Developing an educational program for public and elected officials concerning resilience (3.987) and increasing code and penalty enforcement (3.986) were extremely close in support. Developing special assessments or tax increases for specific resilience projects was ranked with an average neutral rating (3.096).



GovAndFund

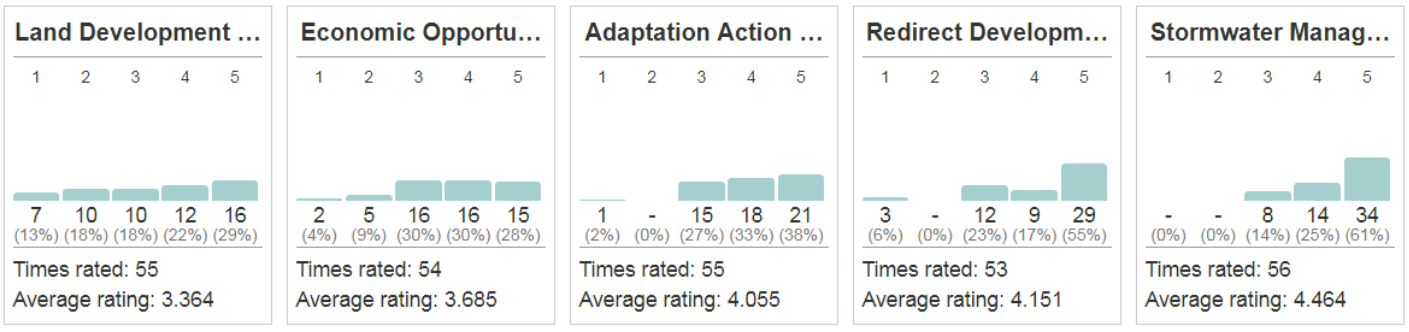


Sea Level Rise



For this vulnerability (the last ranked), strategies focused on the increasing of flooding in low elevations from sea level rise. Creative, hybrid stormwater solutions (4.464) was the highest ranked strategy, followed by updating codes and policies to redirect development away from hazard zones (4.151). Developing Adaptation Action Areas (4.055) was also supported. Investigating economic opportunities and vulnerabilities (3.658) and updating codes for elevation increases for buildings (3.364) were also supported but not overwhelmingly.

Sea Level Rise

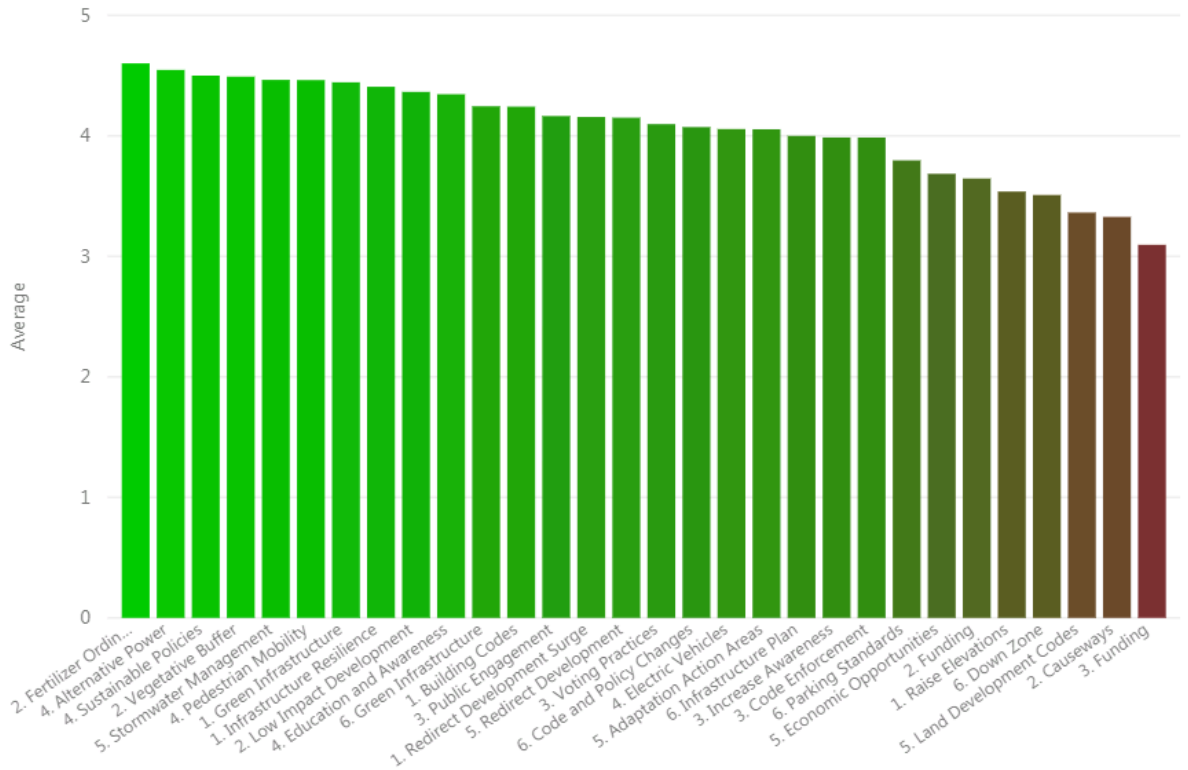


All Strategies

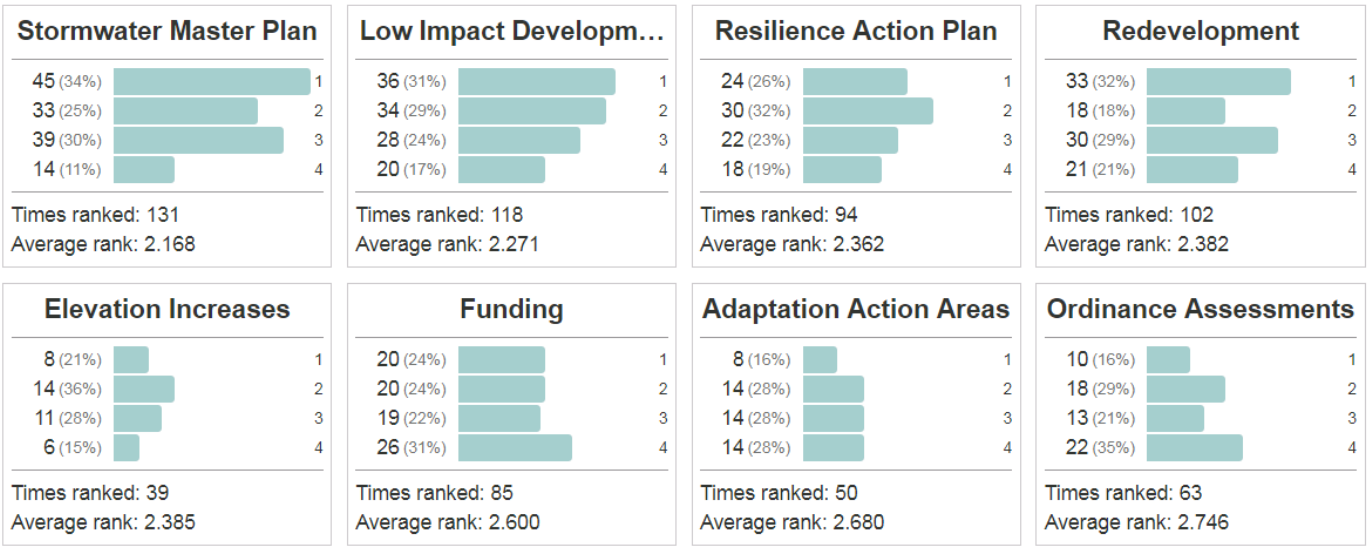
When examining the strategies holistically, most were supported and almost evenly ranked above a 4.0. No strategy was strongly unfavorable across the survey. As many of the strategies are considered cross-cutting and can address multiple hazards, it is recommended that the City not only to consider the top strategies for each hazard but also the whole to determine areas of overlap and to obtain the biggest return on investment.

The 10 top rated strategies across the board focused on stronger fertilizer ordinance, alternative power, creating sustainable policies in regards to climate change, requiring vegetative buffer between the lagoon and turf, create a hybrid stormwater management plan, increasing pedestrian mobility, utilizing green infrastructure for flooding, improving resilience in infrastructure, requiring low impact development and education citizens about climate change.

While no strategy was overwhelmingly unsupported there was a trend in the lower ranking strategies that focused on special funding and raising elevations. Ratings between 3 and 4 included increasing the awareness of officials voting practices, code enforcement, assessing parking standards, analyzing economic opportunities and impacts of sea level rise, creating special assessments for the Indian River Lagoon as well as resilience, raising minimum elevations of buildings and infrastructure and updating required policies to allow this, downzoning in vulnerable flood areas and spanning the river with causeways.



The third exercise in the survey asked respondents to rank opportunities for the City to consider for addressing vulnerabilities and opportunities they provide. "Create a more hybrid approach to the stormwater master plan and identify use of green infrastructure to improve stormwater train and water quality and identify areas to create greenspace water re/detention" was ranked the most number of times and also received the highest average rank. This is followed by "Update codes and policies to require low impact development techniques that emphasizes conservation and use of on-site nature features to protect water quality and manage stormwater run-off" and "Work with City departments, the community and others to develop an action plan to determine appropriate measures to mitigate, adapt or relocate critical assets and population vulnerable to extensive flooding and sea level rise, and identify other necessary activities." The lowest ranked items included "Identify or create funding mechanisms that focus on specific sustainable projects within the City", creating Adaptation Action Areas, and "Reassess ordinances, ex: tree and fertilizer ordinances, to determine areas of improvement for resilience". The results of this screen are somewhat similar to the previous screen with the importance of the stormwater master plan and low impact development. It was surprising that the ordinance assessment had the lowest ranking score, but improving the fertilizer ordinance received the highest rating. One could ascertain that respondents want a stronger fertilizer ordinance but may not be supportive of changing the tree ordinance. "Elevation Increases" had a ranking of 2.385, but was the least ranked indicating that those who felt it was a priority, felt strongly about it. It should also be noted that every option was ranked, at least 39 – 131 times.



Participant comments provided on this screen are below:

Stop over development by big business, especially big hotels.
Developed a Pedestrian/ Bikeway along A1A and portions of the Banana River area.
More tourist income from child friendly businesses

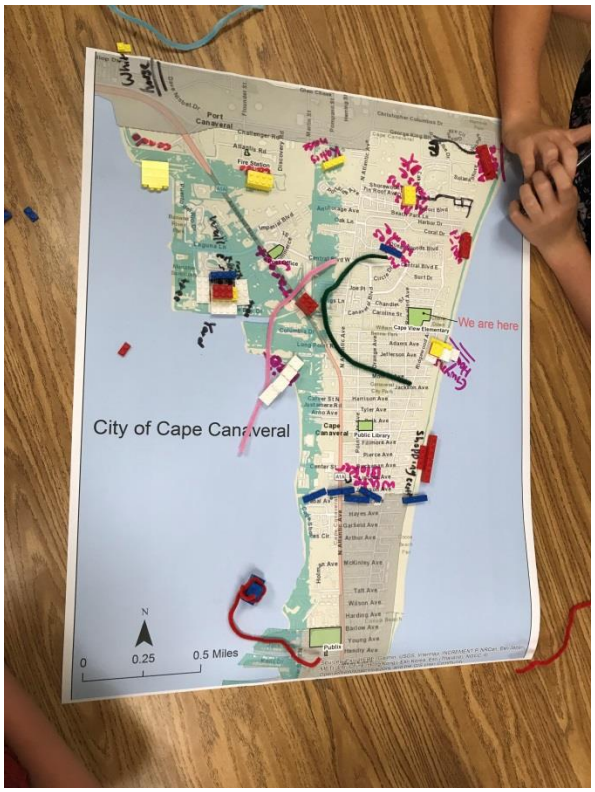
Respondents were able to provide comments on the last screen of the survey. Participant comments provided on this screen are below:

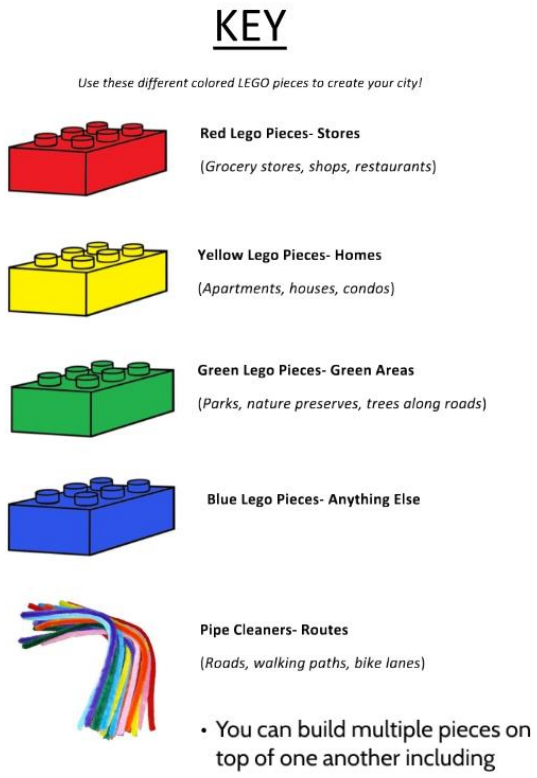
One of the council members has close ties to solar that he could profit from personally. I think he should recuse himself from any votes on the issue and should also refrain from proposing legislative changes regarding this topic.
I believe coastal communities throughout the US are under acute threat from the effects of climate change and rising sea levels.
No more hotels and Port parking lots ! Enough is enough !!!
We suggest that the City create a plan with practical and meaningful action items that are attainable in the near future as well as long term. Keep it as simple as possible. Don't merely adopt someone else's "packaged" coastal plan. Make it VERY unique to Cape Canaveral. Let's get on the low hanging fruit right away, take action and create momentum. For example, strategically buy more "orphan" property that stand little chance of private development and enhance stormwater treatment (along with beautiful native green space) to protect the lagoon. Also, be more aggressive with dune preservation: more sea oat plantings over larger areas; what else can the City legally do and permit, in partnership with condo associations and other beachfront private property owners, to protect and enhance the dunes? The dunes are currently an underappreciated resiliency asset of the City.
My wife and I are very happy to be living in this well run community.
Thank you.
Resident property owners need to feel code and other city officials are working with us, not against us! My experience has been to feel code inspectors are adversarial even though I get proper permits and try to do things correctly.
Glad to see we're at this stage and it the progression into this issue.
I would like to add more such as the use of MU (mixed use) zoning but that is covered under redevelopment if I am not mistaken. But still perhaps if can be a category under that,
Dog-friendly parks
I think saving what's left of the lagoon is easily a top priority. No more fertilizer. No more dumping.
We are gone for 3 months during peak hurricane season.
Thanks for all you do!
CC is a beautiful beach area and whatever it takes to keep it healthy and clean is very very important!!! Expecting compliance to the beach rules is especially important. I am not seeing that right now!!
Add more crosswalks with traffic light controls.
We need trees and vegetations cleared from intersection for better visibility of pedestrians and traffic. Some of the large oak trees need to be trimmed to prevent downed lines during hurricane season.
"opportunities" section seemed a bit vague to me.
No waterfront high rise buildings development
We do not want to see high rises... Ever... And burying our power supply lines underground versus on these 70 year-old poles would be a very smart thing...
I'm very interested in learning more about, and implementing solutions.
Stop building new hotels. Great tax base, but we can't afford to have all these additional developments add to our infrastructure - we're too fragile!
Like to see better management of the 11 acres of mangroves??(East side Banana river) a lot of scub oaks vs actual mangroves!
Love this city!!
Yes! Let's make Cape Canaveral more resilient!
The city staff is working hard and doing a great job educating our city about this important topic.
Sewer system development and storm water runoff are two major concerns.

It seems the appointed/elected officials are more interested in providing for tourists then the welfare of the full-time residents. They seem to make it harder to be a home owner and business owner then to be a developer.
I'll help
We love Cape Canaveral! Keep up the good work.
no more taxes
No additional comments
Ticket parked cars and trailers blocking what few sidewalks from A1A to beach. Change ALL side streets east of A1A to 4 way stops.
Fiscal responsibility. We cannot go from a surplus of $12million to borrowing $13million
I am very distressed that the welcome signs at each end of the city look very neglected. When I first moved here twelve years ago they were well tended and very attractive. Please address this!!
Plans for the future are always important to be considered. However, beginning with"visioning" it appears that the City has been championing a "predetermined" destiny on some planner's or officials' part. The forcing of hotel building and the A1A project are examples. The excess spending on buildings and facilities not requested by a large number of citizens/residents in Cape Canaveral are examples. Resilient = returning to the original form or position after being bent, compressed or stretched. It would be nice to see Cape Canaveral return to its form before being overspent and stretched beyond its means through the actions of the City Council presently.
We have a long history here, greatly preceding being property owners. We love the Cape and appreciate the solid city management and opportunity to offer input. Thank you.
Gotta love computer writers. Highlight Indian River and get bounced out. I am probably the only person that does not know what "drag three choices to the top". Fishing and access to the ocean have always been important to us.
Speed on A1A needs to be addressed. This route is a business as well residential area. 45MPH is too fast and noisy to us residents.
Re Design the city as a city not like now. The city actually looks like a corridor of cars to cocoa beach.

D. Youth Outreach| February 21, 2019

On February 21, 2019, ECFRPC staff traveled to Cape View Elementary to engage 5th grade students for a planning and outreach activity. The purpose of the activity was to receive input from the youth of Cape Canaveral for the Resilient Cape Canaveral project. The students were given a short presentation explaining the project, the process and why the ECFRPC and City wanted their input. They participated in a mapping activity where the students got the opportunity to build their future Cape Canaveral while considering flood hazards. They took large printed maps that showed shallow flooding areas and some critical buildings and used toy bricks to build new infrastructure for the City of Cape Canaveral. Students used categories as shown below in the key: Stores, Homes, Green Spaces, Routes, and anything else they may decide in order to build. The resulting maps were interesting because the students used concepts such as multi-story buildings, open space, and had a lot of focus on skating and connecting important destinations.





VI. Strategies for Incorporating Resiliency into City Plans, Policies and Programs

The strategies presented in this Report are based on input from public engagement activities, findings from the vulnerability analysis, review of the Coastal Element of the City's Comprehensive Plan and best management practices research. Recommended strategies presented here may take the form of policies, ordinances, land development codes, or the creation of other plans or processes and are based on education, land use and building practices, mitigation, adaptation and relocation.

Resiliency strategies take the form of policies, ordinances, codes, plans, processes, education, land use and building practices.

A. Infrastructure

Through the public engagement process, numerous facilities were identified as being critical to pre- and post-storm preparedness and recovery — these facilities include lift stations, gas stations and stores that provide food, water, ice and other necessary goods. The East Central Florida Regional Planning Council (ECFRPC) recommends obtaining generators for all lift stations and traffic lights at major intersections. Ultimately, it will be essential for the City to have alternative power sources such as solar or gas generators and an ample supply of gasoline or propane for at least two weeks to maintain these generators. Other options would include making traffic lights solar powered or installing temporary solar traffic signals in the event of an outage. According to an article in the Miami New Times, cities around the globe are already installing this technology. After Hurricane Irma, the City of Coral Springs was "one of the only Florida Cities to embrace the technology, using 13 temporary solar powered signals to keep traffic moving." (Times) As technologies develop that support alternative power sources for infrastructure, the City should stay apprised of these new technologies and seek opportunities to serve as a pilot City.

Temporary solar traffic signals in Coral Springs after Hurricane Irma. (Image courtesy of Coral Springs Police.)

As Lift Stations 3, 5, 7 and 9 are to be rebuilt in the near future, the City should complete a survey of the area and determine next steps based on the functionality life span, potential inundation depth from surge and sea level rise to develop appropriate measures to help maintain their integrity and functionality. These measures may include raising the lift stations, enlarging the well capacity, fortification, or relocation to a less vulnerable area in the service area.

B. Indian River Lagoon (IRL) and Banana River Lagoon (BRL)

According to respondents of the online survey, the IRL is of great importance to the Community. The Indian River Lagoon and the Banana River Lagoon are not only important economic resources to the region — but are also the source of potential flooding and storm surge. The City should prioritize projects that serve multiple functions: 1) protect the health of the lagoons by limiting direct run-off and 2) provide a mechanism to reduce surge impacts. In order to accomplish these goals, the City should not only continue its innovative approach of stormwater management as evidenced by the placement of a large exfiltration system under Canaveral City Park and at City Hall, wet detention at Manatee Sanctuary Park and swales in Banana River Park, but explore additional and new hybrid stormwater approaches through the use of both gray and green infrastructure to capture larger quantities of stormwater prior to discharge while allowing for naturally occurring filtration. Additionally, the City should work with property owners and the St. Johns River Water Management District (SJRWMD) to identify opportunities to restore coastal vegetation through plantings.

Stormwater system in City Park. (Image courtesy of City of Cape Canaveral.)

Assessing and creating a stronger fertilizer ordinance was one of the highly ranked strategies in the public engagement survey. As this is an effort already being undertaken by the County, the City should make sure its ordinance, at a minimum, reflects the same standards of the County and develop a stronger one, if needed. It will be important to work with stores and landscapers who service the City for conformance, enforcement and education. Having a county-wide messaging process will be important for both residents and businesses. Using a uniform educational flier at stores and other strategic locations will help users of fertilizers make educated decisions rather than relying solely on the fertilizer industry or stores restricting sales.

According the City's Basin Management Action Plan Compliance Strategy (BMAPCS) final report in 2014, Low Impact Development (LID) methods such as bioswales, green roofs, rain gardens, and tree boxes were described as techniques allowable for BMAP credit. Some strategies to help the City lessen the load on the overall stormwater system should include requiring or incentivizing private property owners and other agencies with facilities in the City to capture as much stormwater on site as possible for infiltration. Working with businesses, homeowners and other partners to implement these and other LID techniques where feasible and appropriate could have substantial positive impacts on the amount and quality of water discharging into the IRL, onto streets and on private and public property. As properties are redeveloped in the City, requiring or incentivizing developments, businesses and homes to design to a 100% on-site retention for a minimum of a 25-year flood, though using a 100-year flood for design regulations (see City of Rockledge stormwater design guidelines) would be more resilient and progressive. This can be achieved through a variety of techniques to advance the City's resilience and sustainability. The City should investigate its codes, ordinances and plans to determine if a net-zero discharge is feasible, even with additional modifications to development requirements, or if an incentive approach is more practicable.

C. Green Infrastructure and LID

LID also includes the innovative design of parking lots which are a major source of impervious pavement. "Green Parking Lots", with high levels of natural absorbent landscaping are a great mitigation strategy to help reduce stormwater run-off, increase natural filtration, reduce the heat island effect and improve water quality. According to Naturally Resilient Communities, the use of pervious concrete is much more durable in hot climates than porous asphalt pavement. Green parking lots can vary depending on use and location. The images below showcase a green parking lot in Copenhagen that is, generally speaking, "entirely landscaped" compared to the more urban green parking lot we typically see in the U.S. To achieve greener parking lots, the City should assess local codes to minimize the land area devoted to parking by reducing parking stall dimensions, promote shared parking and reduce the minimum number of parking spaces required. A parking audit may be necessary to determine if there is an overabundance or deficit in parking availability.

Green Parking Lot in Copenhagen (Image courtesy of Thomas Oles.)

Urban Green Parking Lot(Image courtesy of Chesapeake Bay Program.)

Additionally, as State Road (S.R.) A1A projects advance, as well as other local road projects, the City should require that future conditions, based on the operational life of the said project, be assessed to determine appropriate measures to reduce flood risk. In the short-term in roadway projects where landscaping is feasible, the City should prohibit the use of turf and require trees to be placed in tree boxes or use other techniques to enhance stormwater capture and filtration.

Stormwater Park as Community Amenity (Image courtesy of Architecture Magazine.)

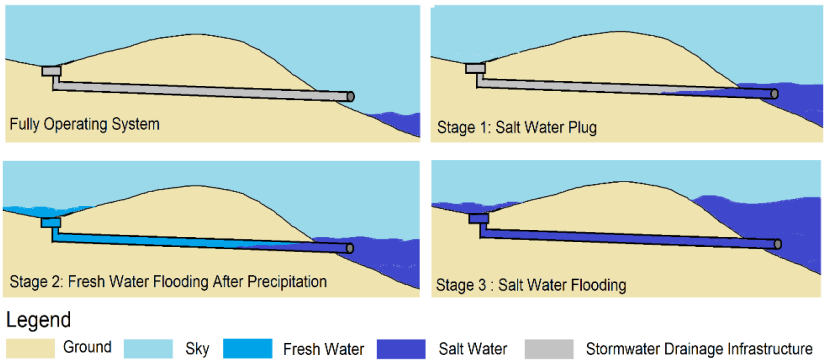
The City should also examine strategic locations for using open space for green infrastructure projects that create amenities for the community, especially in the dry season. Locations may include repetitive loss properties, undeveloped properties, underdeveloped/utilized properties, public properties or existing open space. This may require the acquisition of private property, if over the long-term, the benefits to the City outweigh the cost of acquisition. Various mechanisms exist for acquiring essential property including donation of easements,

bond measures, transfer of development rights, federal funding and grants, and others. The City will need to investigate the potential options if it wishes to develop an acquisition program.

Finally, as sea levels rise, outfalls are generally the first point of failure in the stormwater system. Ultimately, outfalls with lower elevations will be the first to fail as salt water will intrude into the pipes and cause flooding within the City from rainwater or storm surge. The City should assess the elevation of each outfall to determine those most vulnerable to rising water levels from the BRL due to their elevation.

The Stormwater Master Plan should be integrated or, at the very least, compatible with the City's Conservation Element and Parks and Recreation Plan. The integration of the two plans and ensuring compatibility with the Conservation Element in the Comprehensive Plan will decrease potential barriers to creating innovative approaches to stormwater management, while continuing to create health and recreational spaces and opportunities for residents and visitors along with natural areas and lagoon access. Creating an integrated plan will help the City work outside of silos and better plan through cross-collaboration to make use of available space and resources while increasing resilience and the quality of life in the City. Utilizing open space for stormwater during the wet season or storms, while serving the community as an eco-tourism destination or area of activity for the remainder of the year, is a win-win for the community. Hosting experts in green infrastructure and stormwater management to help identify feasibility and locations for projects is also advised. This would include City Staff, Florida Department of Environmental Protection (FDEP), SJRWMD, and potentially higher education facilities such as Florida Institute of Technology (FIT) or University of Central Florida (UCF). Additionally, although Cherie Down Park is owned by Brevard County, the park is centrally located in the community, and the City may wish to investigate the potential for acquiring the park to implement resilience strategies in addition to or in lieu of the proposed dry retention pond along the western side of the park.

When assessing projects in the storm water Master Plan, the City's goal should be prioritizing projects, both gray and green, that will be sustainable in future conditions through the operational life span of the project and ultimately reduce the cost of the overall stormwater system by off-setting demand on the system through the use of increased green space and more on-site capturing capacity by private property. Assessing the budget to ensure adequate funding for appropriate maintenance for green infrastructure functionality will also be important as is developing a process or checklist to ensure that future flooding, storm surge and sea level rise have been assessed for each project and appropriate techniques are implemented based on the findings.



Source: Stetson University

D. Business and Home Protection

Working with businesses to identify and provide opportunities to minimize risk and speed recovery efforts would be beneficial. Generators for certain businesses such as those identified in the public workshops, especially gas stations and the health clinic, are critical. The City could develop and implement a program to help businesses become "disaster resilient" through structure fortification, development of business continuity plans, ensuring employees have a disaster response plan and educating businesses about the variety of funding and financing tools available for fortifying their properties. There are many tools and resources available to help fund resilient and sustainable buildings. The City should educate the public on programs such as the Florida PACE Funding Agency (PACE) https://www.floridapace.gov and promote the Solar and Energy Loan Fund (SELF) to aid businesses, and homeowners, as well as the City itself, in financing improvements to property to make them more energy efficient and storm resilient. Also, the Florida Green Building Coalition (FBGC) is another resource that helps not only businesses and homeowners build to new standards but also offers a certificate for local governments that "set goals and implements environmental practices that can lead to tangible reductions in operation cost and capital outlays". FGBC not only leads and promotes sustainability but also provides recommendations to fortify homes for resilience through "disaster mitigation" points. These points are based on the "Fortified for Safer Living Standards" administered by the Institute for Business and Home Safety (IBHS) and provide new ways to build homes in hazard-prone areas. The Fortified Builders Guide and Designation criteria can be found at www.disastersafety.org/fortified along with many tools and strategies and includes items such as a checklist for reroofing with recommendations for nail types, flashing deck and standards for roofs within 3,000 feet of salt water. Other fortification techniques range from supporting buildings on deep foundations such as piles and drilled shafts, and the inclusion of steam and breakaway walls, along with elevating the first-floor living area well above base flood elevation (BFE). This could mean increasing building heights and also ensuring that all electrical boxes are elevated above flood levels. According to the IBHS, a "fortified designation increases property appraised value by 7% and even more, closer to the Coast". (Safety, 2019)

A common Midwest home and a gold-level Fortified home are subjected to 100mph winds at an Insurance Institute for Business and Home Safety testing facility.

E. Community Engagement and Education

As education was a major recommendation from the public engagement activities, finding opportunities to engage property owners in ways to make their property more resilient and sustainable should be a priority. These outreach opportunities, educational materials and other avenues should focus on storm pre- and post-preparedness, appropriate tree maintenance, ways to fortify structures, green infrastructure/LID techniques and living shoreline strategies and prioritization.

The City should host a forum with experts to educate both businesses and residents on the funding and building resources mentioned above, strategies/techniques and available funding and benefits associated

This is an example of a sustainable building was presented at New York IT's 3C Comprehensive Coastal Communities Competition, and subsequently recognized as one of the six most promising designs to help inspire new approaches to resilient housing typologies that illustrate possible ideas for elevation (without "stilting") while including LID.

with sustainable and resilient building. Pilot or "showcase" homes/businesses can be completed in the City by working with a willing business or homeowner to secure funding to implement a variety of these "fortified building" and sustainable building practices, including low impact/Florida-Friendly landscaping, living shorelines and solar to serve as an example of sustainable buildings.

Leading by example and instituting changes in municipal buildings that ultimately save tax payers money for years to come is a strategy that the City should embrace. Requiring all City buildings to install and operate from solar and working towards utilizing Florida-Friendly landscaping and other strategies such as cisterns, rain barrels and rain gardens in order to capture the greatest amount of stormwater on-site is a good first step.

Salt Lake City Fire Department with Solar Panels.

As facilities are built or refurbished, higher standards such as building materials should be included. The City may wish to investigate the requirements and feasibility of the Florida Green Local Government Designation Standard via the FGBC. There are a number of cities across the U.S., like Salt Lake City, that are moving toward powering all governmental facilities on renewable energy. In Salt Lake City, a total of 756 solar panels were installed at seven facilities, including five fire stations, at a cost of $500,000 that is expected to be paid back through utility savings.

In order to ensure that no barriers exist to allow businesses and homeowners to implement the FGBC standards for sustainability and disaster mitigation, the City should review all land development codes and the Comprehensive Plan for consistency. Landscape requirements, height limitations, required buffers/setbacks, and parking standards are areas that may create barriers to implementing these standards in the City. It is important for codes and policies to be in place that promote, require and/or incentivize resilience standards because without them, many will resort to business as usual and not develop structures and developments in a way that protect life and property.

F. Comprehensive Plan and Development

To be compliant with the 2015 Florida Peril of Flood Act (SB 1094), the City must update its Comprehensive Plan to include goals, objectives and policies to address sea level rise, flooding and storm surge. This update should include data and analysis derived from the vulnerability analysis completed by the ECFRPC, which illustrates areas of impact as well as infrastructure and facilities vulnerable to coastal hazards. A reference should be made in the Comprehensive Plan to the vulnerability assessment for further information. Goals, objectives and policies in the Coastal Element of the Comprehensive Plan should cite items for legislative compliance as per Section 163.3178 (2)(f) and listed below, but should also include language that considers future conditions in planning decisions and processes that consider financial feasibility and appropriateness. Additionally, ensuring language addresses the objectives presented are based on the premise of the protection of life and property is of great importance. The six comprehensive planning provisions listed in Section 163.3178(2)(f), Florida Statutes are as follows. A redevelopment component should outline the principles that must be used to eliminate inappropriate and unsafe development in the coastal areas when opportunities arise.

The components must:

1. Include development and redevelopment principles, strategies, and engineering solutions that reduce the flood risk in coastal areas which results from high-tide events, storm surge, flash floods, stormwater runoff, and the related impacts of sea-level rise.
2. Encourage the use of best practices development and redevelopment principles, strategies, and engineering solutions that will result in the removal of coastal real property from flood zone designations established by FEMA.
3. Identify site development techniques and best practices that may reduce losses due to flooding and claims made under flood insurance policies issued in this state.
4. Be consistent with, or more stringent than, the flood-resistant construction requirements in the Florida Building Code and applicable flood plain management regulations set forth in 44 C.F.R. part 60.
5. Require that any construction activities seaward of the Coastal Construction Control Lines established pursuant to Section 161.053 be consistent with Chapter 161.
6. Encourage local governments to participate in the National Flood Insurance Program Community Rating System (NFIPCRS) administered by the Federal Emergency Management Agency to achieve flood insurance premium discounts for their residents.

The City's main challenge will be, in the Coastal Element to include or enhance development, redevelopment strategies/solutions and site development techniques to reduce flood risk and encourage best practice use to remove coastal real property from flood zone designations.

When considering engineering solutions and site development techniques, the City should consider both gray and green engineering solutions for infrastructure, as well as development of the site and building design. Such solutions could include larger stormwater pipes, stormwater parks, first floor elevation increases, floatable structures, green streets and various LID techniques. Due to the barrier island community exposure to water from both the Atlantic Ocean and the Lagoon, it is recommended that many of these recommendations be implemented City-wide. Others may be more relevant and necessary in the lower elevations and more highly vulnerable areas west of S.R. A1A and along the beach front.

It is important to begin to guide development out of the most vulnerable areas and manage infrastructure and development to protect life and property from natural hazards. Many communities prohibit an increase in density in the CHHA (Category 1 Storm Surge). However, as sea level rises, the degree of storm surge and depth will increase. To plan for this, it is recommended that the City prohibit density increases in the 100-year flood plain and areas vulnerable to at least a Category 2 storm surge, and sea level rise by 2070 using the USACE High Projection Rate Curve (the lower/minimum projection of the regional approach to sea level rise planning as recommended by the East Central Florida Regional Resilience Action Plan. These areas of impact could also be designated as an AAA. This optional designation is for "areas that experience coastal flooding and are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure needs and adaptation planning for the purpose of prioritizing funding for infrastructure needs and adaptation planning." (Council S. F., 2014)

The City should also consider policies and codes that either prohibit or severely restrict variances seaward of the CCCL. Additionally, it can be expected that as sea levels rise, modeling will show movement of the CCCL therefore it would be advantageous to assess the potential of adjusting minimum setbacks from the CCCL.

The Coastal Element of the Comprehensive Plan focuses on the protection of the natural shoreline. It will be important for the City's resiliency to continue to prioritize the protection and functionality of the shoreline along both public and private property. Continuing sea oat plantings should be a priority for the City along with other living shoreline strategies, such as mangrove plantings along the BRL. The City should utilize partnerships with the Brevard Zoo, University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) and Brevard County to review the living shoreline data collected and determine the appropriate areas for the various strategies. To facilitate the implementation and sustainability of living shorelines, the City should develop codes and ordinances to prohibit the destruction or removal of living shoreline habitats and buffers, and establish or require a minimum buffer of Lagoon-friendly vegetation to help stabilize the shoreline.

Florida Friendly Landscaping: Image courtesy of Go Native Landscaping

Ultimately, site design and land use techniques in the Coastal Element will need to be mirrored or referenced in the Future Land Use Element (FLUE). It will also be important that the FLUE process does not allow for increased density in the highly vulnerable areas of the City.

As the City moves to assess projects and make land use decisions, future conditions will force the City to adopt a comprehensive approach to sea level rise. It is recommended that the City adopt the ECFRRAP's approach to sea level rise. The recommendation is that no one projection rate curve should be used for

planning purposes across all projects and programs. Instead, a range of rise should be considered based upon the vulnerability, allowable risk, project service life and the forecast project "in-service" date of a facility or development. The range should include a minimum rise of 5.15 feet by 2100 (2013 USACE High) with an upper range of 8.48 feet by 2100 (2017 NOAA High). Short-term planning should consider impacts out to 2040 (20-year planning horizon), medium-term planning should consider impacts out to 2070 (50-year planning horizon), and long-term planning should extend out to 2100 (80-year planning horizon).

The Transportation Element of the Comprehensive Plan should be updated to include findings from the vulnerability assessment and include associated policies that ensure sea level rise, current and future flood risks and enhanced surge are considered in planning decisions. Review and enhancement of the Transportation Element of the Comprehensive Plan should include prioritization of street trees, infiltration planters, increased vegetation, swales, tree boxes, and other green street techniques, along with a policy to ensure all transportation projects include an assessment of impacts from flood hazards. The image following from Sandpoint Streets illustrates various techniques for creating green streets. As a small barrier island community, raising streets throughout the City would be extremely difficult. However, as mentioned previously, S.R. A1A serves as the critical corridor for the City and other jurisdictions along the barrier island. Ensuring S.R. A1A is engineered to be free of complete inundation or even extensive flooding will be a critical step towards the resilience of the City. Public engagement showed a high priority for assessing the roadway and bike/pedestrian system throughout the City. Creating greater bike/pedestrian connectivity as various redevelopment, green space and roadway improvement projects emerge, would help create an active and healthy community with alternative modes of transportation.

(Image courtesy of City of Sandpoint.)

The Capital Improvement element should be updated to include policies that evaluates projects funded by the City based on an assessment of sea level rise, future flood risks and elevated storm surge to determine acceptable risk and associated costs for adapting or mitigating those risks. At some point in the future, as certain areas or infrastructure such as roadways face continuous or exacerbated flood hazards,

the City will need to determine the appropriate strategy for these areas: adapt, protect or strategically relocate. It is recommended that as other communities across the nation and world begin to answer these questions, the City keep abreast of strategies and processes to ensure decisions are made in an appropriate timeframe and manner to protect, to the greatest extent possible, life, property and investment.

Finally, it is recommended that the City develop a "Community Fiscal and Resilience Balancing Test" that will examine and promote the planning and construction of infrastructure in a cost-effective, technologically and environmentally sound manner that balances the benefits, costs and challenges of infrastructure with design considerations for future impacts during the service-life of the project.

As the City participates in the NFIPCRS program there are opportunities for the City to obtain additional points through some of the strategies above and through its land development code to require buildings and structures to be designed and constructed to comply with the more restrictive applicable requirements of the Florida Building Code, Building Section 3109 and Section 1612, Residential Section R322.

The following information are additional strategies to not only comply with Peril of Flood overall, but also obtain points for the CRS program. The 2017 CRS manual incorporates the consideration of sea level rise into a number of elements, including Higher Study Standards (HSS) under Activity 410 (Flood Hazard Mapping); Coastal A Zone (CAZ) credit under Activity 430 (Higher Regulatory Standards); and Watershed Master Plan (WMP), under Activity 450 (Stormwater Management). Including sea level rise in WMP is required for coastal communities to meet the Class 4 prerequisite, and HSS credit for future-conditions hydrology is a Class 1 prerequisite. (CRS prerequisites are described in Section 211.)

According to FEMA's document for the NFIP CRS for Small Communities, these small communities may benefit from some activities that could increase their rating, some of which are described below. Communities should focus on land in the floodplain and how it is managed, as the more designated open space in the Special Flood Hazard Area (SFHA), the more CRS credit is received. As recommended earlier, the City should assess potential for open space opportunities, especially if it removes built environment from within the SFHA. Enforcing regulations for development in the SFHA that exceed minimum requirements of the NFIP through freeboard, building codes and protection of critical facilities, may also increase CRS points. Based upon the findings of the vulnerability assessment, City Staff (planning, stormwater, building official, etc.) should reassess required elevations and fortification of properties, especially in the Coastal High Hazard Area (CHHA), the SFHA, and designated Adaptation Action Areas (AAA) — if so designated — and other areas vulnerable to sea level rise, flooding and storm surge (at least a Category 2). Many local governments are updating ordinances to increase the BFE of the lowest floor. Examples include: elevating the lowest habitable floor to 10 feet above BFE in CHHA areas; elevating the first floor to a minimum of either seven feet National Geodetic Vertical Datum (NGVD) or 30 inches above the highest point of any abutting street. FEMA also suggests developing an "impact adjustment map" to illustrate areas in the SFHA protected as open space and those affected by higher than NFIP building standards. If elevation certificates do not exist for the entirety of the City, it would be beneficial to work on completing this information, not only for Activity 310 of the CRS, but also to assist in a more strategic effort for resilience and better understanding potential flood risks of assets and private development. Some communities have developed an online platform for hosting the certificates. This platform could be

integrated into an overall section of the City's website that could serve as a portal for all things flood hazard related. This would include access to information about the FIRM, flood insurance, flood depth, sea level rise information, and flood protection information as well as outreach information concerning flood mitigation projects being implemented in the City. The site may also include a way for citizens to document historic and current flooding issues that may be occurring in the City. The City can also receive credit for working with local real estate agents to help foster disclosure of flood hazards.

The recommendations presented in this section are for consideration by the City and may require partnerships with other entities and cross department collaboration. Many of these recommendations can also filter into the comprehensive plan, land development codes and other plans.

Project reports and the ArcGIS story map can be found here: https://www.perilofflood.net/capecanaveral

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The Economic Impact Of a Resiliency Adaptation Project in Brevard County

PREPARED BY THE EAST CENTRAL FLORIDA REGIONAL PLANNING COUNCIL
For the City of Cape Canaveral

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East Central Florida Regional Planning Council

June 7, 2019

About the East Central Florida Regional Planning Council

The ECFRPC was established in 1962 as an area-wide association of local governments. It is one of Florida's ten regional planning councils and serves governments and organizations located within Brevard, Lake, Marion, Orange, Osceola, Seminole, Sumter and Volusia counties. Council staff provides technical assistance in the areas of land use and environmental planning, emergency preparedness, geographic information systems (GIS), health, housing, urban design, transportation and economic and fiscal analysis among others. Because of the ECFRPC, member governments have received more than $10.6 million in federal grants since 2011. This represents a return on investment of $2.53 for every dollar paid in assessments.

Since 2003, The ECFRPC has been using the Regional Economic Models, Inc. (REMI) Policy Insight economic model to calculate the economic effects of a variety of policies and investments. The REMI model builds on the strengths of four major modeling approaches: Input-Output, General Equilibrium, Econometric, and Economic Geography. More detailed information about the model can be found at www.remi.com.

Any questions about this economic impact analysis should be referred to Luis Nieves-Ruiz, AICP. He can be reached at (407)245-0300, ext. 308 or via e-mail at luis@ecfrpc.org.

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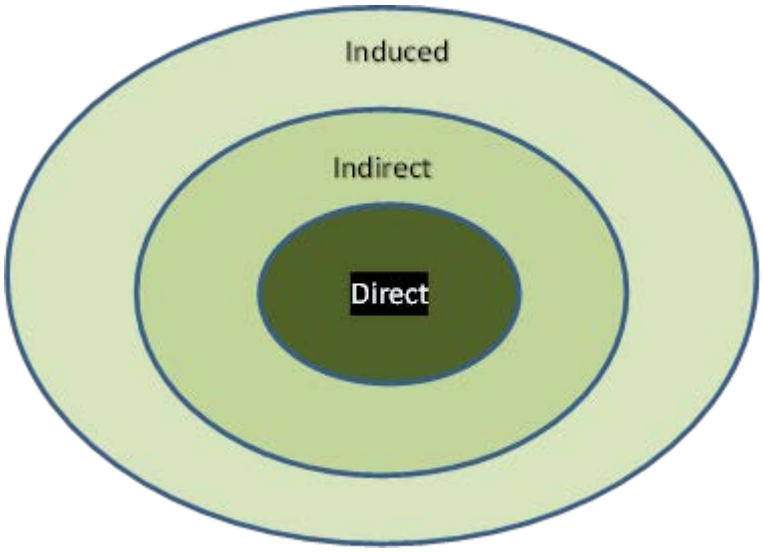
Introduction

The City of Cape Canaveral is located on a barrier island off of Brevard County's coast, immediately south of Port Canaveral, one of the world's busiest cruise ports. The City is also close to critical federal assets such as Kennedy Space Center, Cape Canaveral Air Force Station, and Patrick Air Force Base. Because of its proximity to the Atlantic Ocean and the Banana River Lagoon, the City is one of the most susceptible areas to sea level rise and coastal flooding from heavy rainfall and tidal surge events in Brevard County. Understanding the economic impact of these vulnerabilities is critical for the City's efforts to become a resilient community. In 2018, the Florida Department of Environmental Protection's Florida Coastal Management Program (FCMP) and the National Oceanic and Atmospheric Administration (NOAA) awarded a grant to the City of Cape Canaveral to develop a community resilience plan. As part of this process, the ECFRPC conducted an economic impact analysis of sea level rise using the REMI PI+ model.

Economic impact analysis helps to estimate the direct, indirect and induced effects of a new activity or investment. The direct effect is defined as the benefits created by the original investment or policy change. Besides these direct effects, this new activity will also generate additional demand for goods and services that are usually met by local suppliers. This is considered an indirect economic impact. Finally, the new employees will spend their incomes on household needs such as rent, food, and entertainment among others. This is considered the local consumption or induced economic effect. These indirect and induced impacts are often referred to as the economic ripple effect.

Figure 1: Economic Impact Ripple Effect



This economic impact analysis project includes two different scenarios. First, the ECFRPC made changes to the REMI's forecast to account for the economic impact of sea level rise between 2030 and 2060. This "what if" scenario estimates the economic consequences of doing nothing to address sea level rise. The ECFRPC then used this new baseline forecast to develop an economic scenario that takes into account the actions taken by the City and State officials to adapt to sea level rise. In this case, the City is interested in developing State Road (SR) A1A, also known locally as

Astronaut Boulevard into a Complete/Green Street that includes features to address the estimated inundation levels.

Methodology, Inputs and Assumptions

The first part of this project was to determine the inundation levels that the City of Cape Canaveral will need to adapt from. The ECFRPC downloaded the inundation level data from NOAA's Digital Coast Sea Level Rise Viewer, which depicts the potential inundation of coastal areas resulting from a 1 to 10-foot rise in sea level above current Mean Higher High Water (MHHW) conditions. This data depicts inundation levels created by rising sea levels during a forty-year period (2030-2070). The City of Cape Canaveral is not expected to have to deal with the brunt of inundation until the last two decades. However, the REMI forecast only goes to 2060. The ECFRPC decided to start entering inputs in the decade prior to the NOAA inundation curve starting at 2030. This decision also recognizes that rising waters will be creeping slowly through the study period rather than all at once.

The City of Cape Canaveral is interested in exploring how developing SR A1A (Astronaut Boulevard) as a Complete/Green Street could help to address some of the City's future resiliency issues. The degree to which a Complete/Green Street can address sea level rise has never been properly quantified. However, Smart Growth America states that Complete Streets that are combined with green infrastructure features (bioswales, permeable surface materials, and paving) can serve as important storm water management tools. Thus, this simulation assumes that limiting the amount of impervious surface would alleviate the problems arising from sea level rise.

To develop the actual simulation, the ECFRPC relied on three main data sources. First, the ECFRPC identified all establishments located within the sea level rise inundation areas using Infogroup's Reference USA database. Home businesses and those businesses without a website or other form of verification were eliminated. This decision reduced the total number of businesses from 121 to just 44. Another challenge is that high technology companies like those that locate in the Space Coast usually are classified as 999 (unclassified establishments). Economic modeling software only includes the North American Industry Classification System (NAICS) standard classification, which ends at 92 (Public Administration). Thus, the ECFRPC provided a new NAICS classification to these businesses based on the information provided by their websites. Most of the affected businesses are located along SR A1A (Astronaut Boulevard).

Figure 2: New Jobs near SR A1A (Astronaut Boulevard) area

Type of Use	Multiplier	Number of Rooms	Estimated Employees
Hotel	0.5 Jobs/Room	678	339
Light Manufacturing/Storage	1 Job/850 sq. ft	161,619	190
Total Employees			529

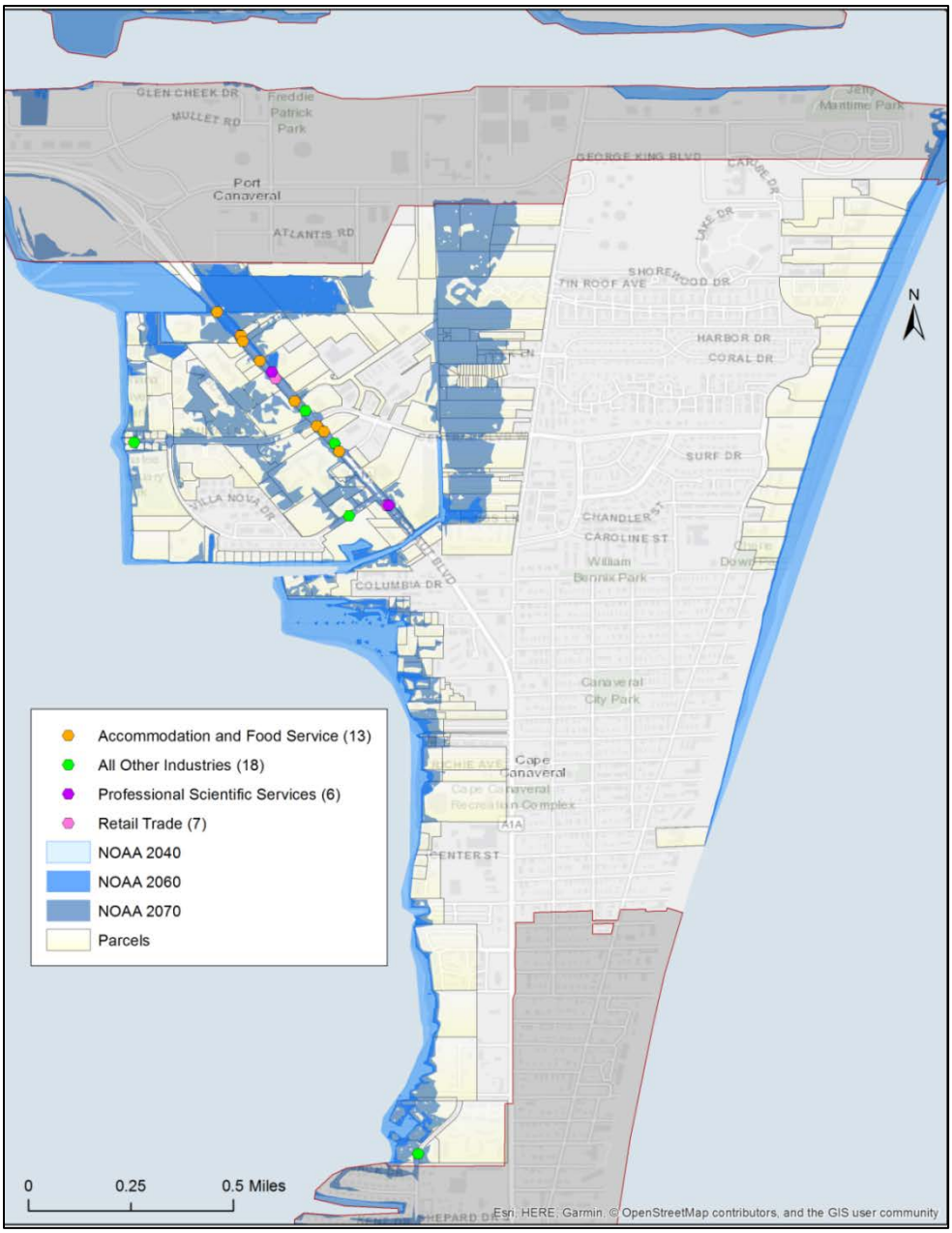
Source: City of Cape Canaveral, ECFRPC calculations

In addition to Infogroup, the City of Cape Canaveral provided the ECFRPC with the location of several projects that are currently on the development review pipeline within the inundation area. This includes four new hotels and a mixed-use Planned Development project that will include

light manufacturing and self-storage uses. ECFRPC staff geocoded these new businesses and estimated their total number jobs based on the number of hotel rooms and square footage using the job multipliers provided in the next table. Based on this methodology, the new projects should yield about 529 new jobs.

To calculate the economic impact of these business losses, the ECFRPC used total annual business sales (output) as provided by Infogroup. In the case where the business record did not have that information, the ECFRPC multiplied the total number of employees by REMI's labor productivity industry numbers for Brevard County to calculate the total output.

Figure 3: Businesses in Cape Canaveral within Sea Level Rise Zones 2040, 2060, and 2070



Source: Infogroup, NOAA

The last source of information used for this analysis was the Brevard County Property Appraiser's tax rolls. According to NOAA's sea level rise layers and ECFRPC analysis, there are more than 250 parcels that would be affected by rising sea levels. These properties will be either completely or partially inundated or would lose access because of flooded roads. To simplify this analysis, ECFRPC staff assumed that all these parcels would lose their value because of being permanently flooded or inaccessible. Currently, these properties have a total taxable value of over $114.5 million. The ECFRPC calculated the tax revenue loss based on the 2018 property values. It would be very difficult to assess property value and tax rate changes for a thirty year period. Therefore, the ECFRPC decided to use the 2018 Adopted Tax Rate (15.191200) and the 2018 tax rates when calculating tax revenue loss. These property tax losses are cumulative as more parcels become gradually affected by sea level rise. Moreover, because the REMI forecast stops at 2060, the ECFRPC added the revenue losses a decade earlier.

Development of New Baseline Scenario

The purpose of economic impact analysis modeling is to measure the effects that one-time events or policy changes can have on a region's economy. This type of model traces spending through the regional economy based on several preset variables such as regional employment and industry structure patterns. When the modeler introduces a shock (new jobs or investment), the model will react based on this predetermined scenario. This regional control forecast also estimates future regional demand and economic conditions based on historical patterns. Because it is a fairly new phenomenon, the REMI forecast does not contemplate the devastating effects that sea level rise will have on the coastal economies. Because sea level rise is gradual in nature, its economic impacts need to be incorporated annually. After consulting with REMI staff, the ECFRPC decided to develop a new baseline forecast that takes into account the output and tax revenue losses resulting from sea level rise.

The ECFRPC is referring to this adjusted forecast as the sea level rise baseline. It shows additional positive economic activity during the first two decades (2020-2040) because of the addition of the new hotel and light manufacturing projects currently under review. After 2040, economic activity starts to decline because of the detrimental effects of sea level rise and start becoming negative after 2050. This is when Cape Canaveral can be expected to suffer the brunt effects of sea level rise. Output losses were entered as Detailed Industry Sales variables.

Figure 4: Industry Output Losses as Entered into the Baseline Forecast

Infogroup	REMI variable	Output/Sales Loss Per Year	
		2040-2049 (2060)	2050-2060 (2070)
44-45	Other Retail	-$791,700	-$144,909
523	Other Financial Investment Activities	-$57,143	-$57,143
532	Automotive Equipment Rental and Leasing	-$87,190	-$87,190
721	Accommodation	-$2,148,300	-$6,658,364
	All Other Industries	N/A	-$6,947,606

Source: Infogroup, ECFRPC calculations

The ECFRPC used the company NAICS codes to determine the most appropriate REMI sectors. The output numbers were divided for the two different curves (2060, 2070) and aggregated (Figure 4). The output losses will be entered gradually by year into the model. All numbers were entered as negatives. The City also provided additional future businesses that were added to the analysis.

These property tax revenue numbers were entered into the model as State and Local Government Spending, because any losses in tax revenue will affect how much money the government can spend on goods and services. These losses started a decade later than the output losses.

Figure 5: Property Tax Losses As Entered into the Forecast

Inundation Curve	Total Parcels	Taxable Value Loss	Total Tax Revenue Loss
2040	111	$40,284,570	**$611,971**
2060	132	$58,527,290	**$889,100**
2070	265	$114,502,660	**$1,739,433**
Total		$213,314,520	**$3,240,504**

Source: Brevard Property Appraiser and ECFRPC calculations

These three variables were used to develop the new Sea-level Baseline Forecast for Brevard County. On average, the new baseline shows 656 jobs less annually than the REMI forecast. The baseline forecast also shows $179.5 million less in sales and close to $95 million less on personal income than the original forecast. Finally, Brevard County's Gross Domestic Product (GDP) is about 20 percent in the baseline scenario. The ECFRPC used this adjusted baseline to develop a new mitigation scenario.

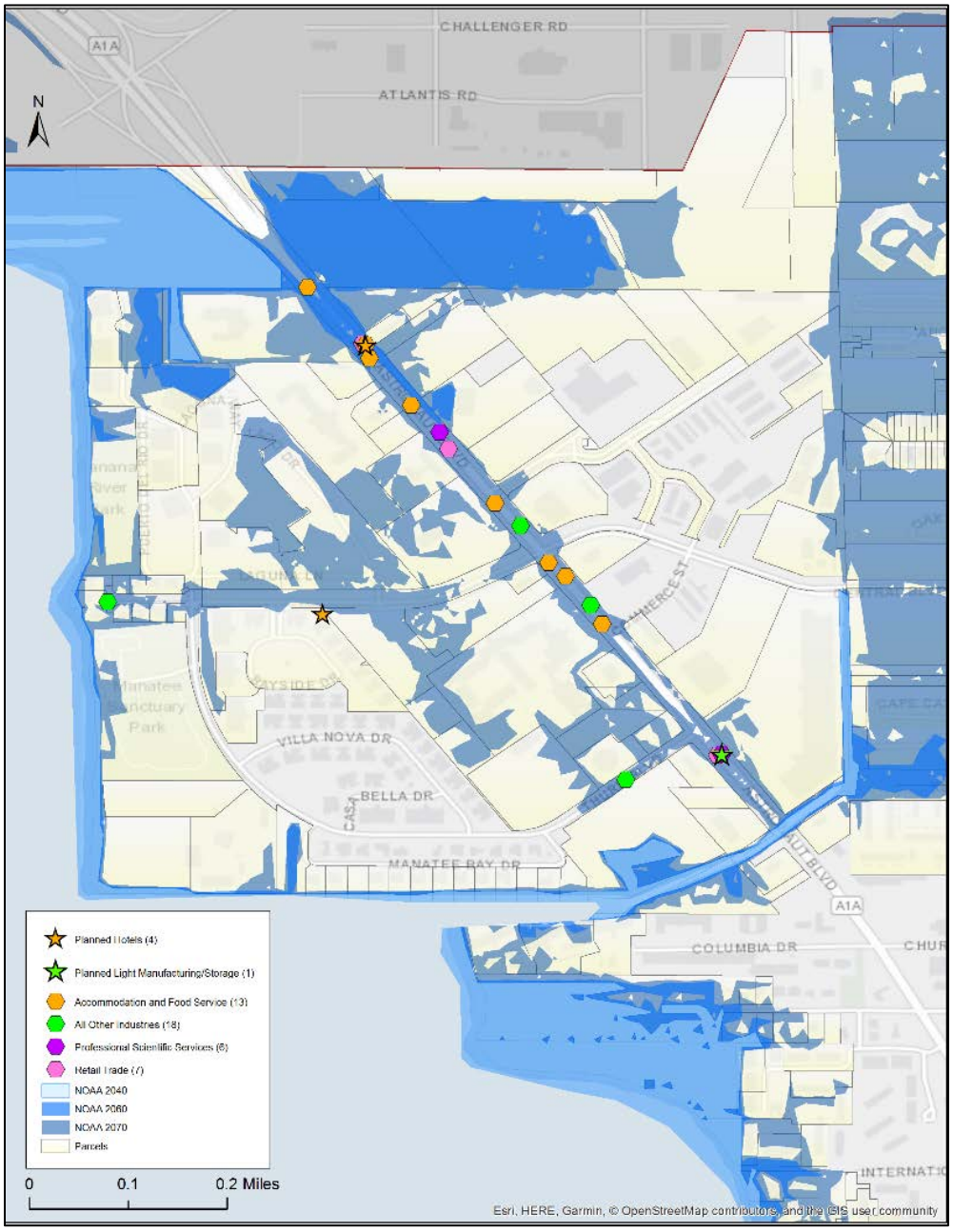
Mitigation Scenario: SR A1A (Astronaut Boulevard) Complete/Green Street Project

Once the new Sea-Level Baseline forecast was completed, the ECFRPC proceeded to develop a sea level rise mitigation scenario. The City of Cape Canaveral is interested in exploring how developing SR A1A (Astronaut Boulevard) as a Complete/Green Street could help to address some of the City's future resiliency issues. This road is the spine of an important business corridor that includes hotels, professional offices, and high tech industries. There are also at least four projects planned along the road that will increase its economic importance to the City. Based on NOAA's sea level rise curve, Astronaut Boulevard will be almost completely flooded by 2070. The loss of this corridor would be catastrophic to Cape Canaveral's economy.

The ECFRPC did not find any examples of jurisdictions that have quantified the economic benefit of using a Complete Streets strategy to mitigate sea level rise. However, according to Smart Growth America, Complete Streets that are combined with green infrastructure features such as bioswales, permeable surface materials, and paving do serve as important stormwater management tools. The Federal Emergency Management Agency estimates that for every dollar invested in mitigation projects, the jurisdiction receives $5 dollars in economic benefit. Based on this information, the ECFRPC assumed that turning SR A1A (Astronaut Boulevard) into a Complete/Green Street will help to address resiliency issues along this corridor.

The first variables entered into the model were the construction and maintenance costs of the Complete/Green Street. According to Smart Growth America, these costs can vary based on the type of features included in the project, the road context, and environmental constraints. Since the objective of this project is not to recommend any specific costs design, the ECFRPC estimated the cost per mile of the green street based on the best available information. The City of Cape Canaveral is proposing a Complete Streets project near SR A1A (Astronaut Boulevard) that is estimated to cost $1.435 million for two road segments that are 4,940 linear feet in length. This would be a construction cost of $1,533,765 per mile. These construction estimates exclude soft costs such as engineering plans, permitting, surveys, and other contingencies. For the purpose of this simulation, it would be safe to assume that a Complete/Green street could easily cost $2 million per mile.

Figure 6: Astronaut Boulevard



Sources: City of Cape Canaveral, Infogroup, NOAA

Based on the GIS measuring tool, the portion of SR A1A (Astronaut Boulevard) evaluated for this project is approximately .74 miles. Therefore, the ECFRPC entered a $2 million cost for the project into the model as State Government spending in 2030. The ECFRPC also assumed that road maintenance costs would be 10 percent of the total cost of the road. This $200,000 cost was entered annually from 2031 to 2060. All these numbers were entered as negatives.

Turning SR A1A (Astronaut Boulevard) into a Complete/Green street should produce economic benefits to the businesses located within this corridor. The literature examined for this project states that there are multiple economic development benefits of turning regular roads into complete streets. However, the ECFRPC decided to stay with more conservative estimates to avoiding having to make assumptions. To do this, the ECFRPC assumed that the new Complete/Green Streets project will reduce business production costs for the businesses located along SR A1A (Astronaut Boulevard). The ECFRPC is assuming that making this corridor a Complete/Green Street (with less impervious surfaces, natural walkways, and water retention areas, among other features) will help to manage additional water from sea level rise. This will help these businesses save some expenses needed to adapt to sea level rise.

Figure 7: Property Tax Losses by As Entered into the Forecast

Construction	Annual Maintenance
-$2,000,030	-$200,003

Source: ECFRPC Estimates

The ECFRPC selected only the industries with the highest output losses to lower their production costs. These were Accommodation, Automotive Rental and Leasing, Construction, Other Financial Investment, Search Detection and Navigation Instruments, and Retail Trade. Based on conversations with REMI staff, the ECFRPC decided to take a conservative approach and only reduce production costs three percent between 2031 and 2060. The ECFRPC used REMI's interpolate linear function which added the production costs progressively through this 30-year period.

These variables were entered into the REMI model to calculate the impact that this mitigation project would have on the Sea-Level Rise Baseline forecast. One limitation of the REMI model is that it can only provide results at the county level. However, since the inputs entered to create this model are specific to Cape Canaveral, it can be assumed that the brunt of the economic impacts will be felt at the city level. The results of this simulation are summarized in the next section of the document.

Summary of Economic Simulation Results

Figure 8 depicts the economic differences between the Sea-level Rise Baseline forecast and the mitigation scenario. Based on the losses in business output and government revenue, not addressing sea level rise could, on average, cost a total of 656 jobs, $175.5 million in sales, close to $95 million in personal income, and $97.1 million in gross domestic product. These numbers are countywide, but it can be assumed that the City of Cape Canaveral would bear the effect of these

losses. To avoid this scenario, the State could work with the City to develop a Complete/Green Street project along the SR A1A (Astronaut Boulevard) commercial corridor that could help to mitigate the effects of sea level rise. According to the REMI model, the construction and annual maintenance costs of this project will be more than offset by the benefits it would provide to businesses in the form of reduced adaptation costs.

According to REMI, developing this mitigation will help to create more than 1,574 jobs. This employment estimate includes full-time, part-time, and temporary positions, which the model gives equal weight. Most of these new jobs will be created in the Retail Trade, Manufacturing, Construction, and Accommodation and Food Services.

Figure 8: Comparison of Baseline Forecast and Mitigation Scenario

Baseline		Mitigation Scenario
Economic Indicator	**Average Loss/Gain**	**Average Loss/Gain**
Total Employment	-656	1,574
Output	-$179,545,455	$512,829,268
Personal Income	- $94,909,091	$569,707,317
Gross Regional Product	-$97,181,818	$315,024,390

Source: REMI PI+ East Central Florida Region v 2.2

Often referred to as total sales volume, output measures the gross level of business revenue which includes both the costs of labor and materials (intermediate inputs) and value added activities (compensation and profits). Since business output is the broadest measure of economic activity, it tends to generate the largest numbers. This new scenario shows that on average there will be an increase of close to $513 million in sales during this 41-year study period.

Personal income refers to total earnings from employee compensation, wage supplements, rents, transfer payments, and other business ventures. The construction and operation of this new development will add $569.7 million of personal income to City and county residents. Finally, another important economic indicator is gross regional product (GRP), sometimes referred to as gross domestic product (GDP), this figure represents the market value of all goods and services produced by labor and property. Based on the results of this simulation, the construction and operation of the new facility will add more than $345 million to Brevard County's GRP.

In conclusion, the REMI model estimates that this Complete/Green Street project would have a positive impact on Brevard County and the City's economy. These results are based on the inputs and assumptions used to develop this scenario. These include the project's construction and maintenance costs, and the reduction of business production costs. One limitation of this simulation was the dearth of quantitative data explaining the cost/benefit ratio of resiliency projects. Because of this situation, the ECFRPC had to make several assumptions to cover these data gaps. This should be addressed as the inundation models become more sophisticated. A future iteration of this model would also benefit from having more comprehensible data regarding the costs of constructing and maintaining a Complete/Green street project in Florida.