

VULNERABILITY ASSESSMENT



**TOWN OF MELBOURNE BEACH,
FLORIDA**

FEBRUARY 2019





DISCLAIMER

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Vulnerability Analysis Map Disclaimer (from Satellite Beach Natural Hazard Risk and Vulnerability Analysis)

These data and maps are for planning, educational, and awareness purposes only and should not be used for site-specific analysis, navigation, and flood rates or permitting. As with all data, all features should be verified with a site visit. The data and maps in this report are provided “as is”.

ECFRPC makes no warranty explicit or implied, regarding the accuracy or use of this information. Use at your own risk. The purpose of this data is to provide a preliminary look at sea level rise, erosion, and coastal flooding impacts. The data and maps in this report illustrate the scale of potential flooding, not the exact location. The inundation areas depicted in the Sea Level Rise analysis are not as precise as they may appear. The data, maps, and information provided should be used only as a screening-level tool for management decisions.

Executive Summary

The Town of Melbourne Beach was awarded a grant from FDEP to assist in the preparation for comprehensive plan amendments to the Coastal Management Element for the Melbourne Beach Comprehensive Plan and the Evaluation and Appraisal Report (EAR). In order to accomplish this, maps, data and analysis were provided identifying at-risk coastal areas that currently experience, or have historically experienced flooding and coastal inundation. Within these areas, public and private resources that are at risk of being inundated were identified.

After existing vulnerabilities were noted, an assessment of future impacts due to sea level rise was conducted and maps were developed showing storm surge areas and areas subject to seal level rise and flooding. Impacts to roadways, Town facilities are shown in these analyses including the demographic composition and parcel analysis.

Town Overview

Location

Home to approximately 3,100 individuals, Melbourne Beach is located on the east coast of Brevard County between the Atlantic Ocean and the Indian River lagoon. Indialantic borders the Town on the north, and unincorporated Brevard County borders on the south. The nearest causeway to the mainland is US 192 approximately a half mile to the north. Melbourne Beach is entirely within the 32591 zip code.

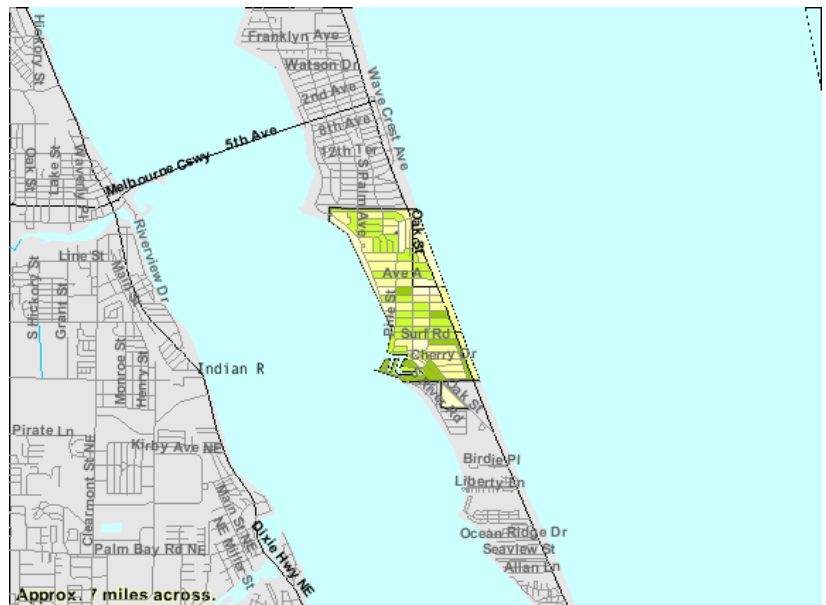


Figure 1 City of Melbourne Beach Location

Population Growth Rate & Projections

The population of Melbourne Beach is projected to decrease by approximately 300 people by the year 2040 based upon projections from the Bureau of Economic and Business Research at the University of Florida. This is due not only to smaller number of people in each house but also to the age brackets of existing residents that are experiencing decreases in population. Two age brackets are increasing; 20 to 34 year olds and 65 and higher and middle age populations, which make up a large part of the Town, are declining. The median resident age is 48, the estimated median household income is about \$81,000 and the median home value is approximately \$355,000 (ACS). It is critical that the Town manages the future population by maintaining the housing stock that is outside of the natural hazard zones.

Table 1 Population Projections

Year	2000	2010	2016	2020	2025	2030	2035	2040
Population	3335	3101	3075	3028	2959	2888	2820	2746

Source: Estimates and projections by Shimberg Center for Housing Studies, based on 2000 and 2010 U.S. Census data and population projections by the Bureau of Economic and Business Research, University of Florida

Build Out Information

The Town has little land that is vacant and is essentially built-out. Approximately one acre remains vacant; however there is opportunity for redevelopment as buildings become obsolete. Rebuilding should be accomplished with higher floor elevations when possible, in order to better survive a storm event.

Table 2 Existing and Future Land Uses, 2018

Land Use	Acres	% of Total
Residential	456.17	72.75
Commercial	10.47	1.66
Recreational	8.25	1.32
Educational	17.90	2.8
Public Facilities	2.88	0.47
Places of Worship	6.32	1.01
Rights-of-Way	117.60	18.75
Vacant	7.41	1.18
TOTAL	627	100.00

Land Use & Density

Melbourne Beach is primarily residential with single-family, detached and multi-family homes. Most of the multi-family land use designation is located along US A1A proximate to the ocean. The American Community Survey estimates that there are 993 owner occupied households and 185 renter occupied households in the Town for a total of 1,177 households on 456 acres, resulting in an average density of 2.58 units per acre. Higher densities are concentrated ocean side.

The commercial area is primarily along Ocean Avenue between Atlantic Street and Oak Street. The public facilities are along Ocean Avenue toward the lagoon (Town hall, community center and Ryckman Park).

Background

Located on the Indian River Lagoon on the east coast of Florida, the Town of Melbourne Beach is vulnerable to a wide array of natural hazards that threaten the long-term economic and functional viability of the community. Because of this, in 2018 the Florida Department of Environmental

Protection's Florida Coastal Management Program (FCMP) and the National Oceanic and Atmospheric Administration (NOAA) awarded the Town of Melbourne Beach with a grant to determine vulnerabilities facing the community and develop a plan to enhance the Town's short-and-long-term resiliency to climate-related hazards. As part of this process, the following analyses and outreach steps were completed:

- **Vulnerability Analysis:** The economic and functional vulnerabilities posed to the Town from five natural hazards were identified; storm surge, flooding, sea level rise, nuisance flooding, and the combined effects of sea level rise and storm surge.
- **Public Workshops and Strategy Development:** The project team worked with members of the community to identify additional vulnerabilities, collect information on past storm events, identify potential strategies for mitigating vulnerabilities, and develop a final set of resiliency themes to guide the Town's actions and priorities moving forward. Two public meetings were held and a survey was developed to complete this portion of the report.

Goals and Impetus of this Resiliency Plan

The over-arching goal of this resiliency plan is to identify coastal vulnerabilities specific to the Town of Melbourne Beach and provide recommendations to mitigate the effects of sea level rise.

Currently, the Town is experiencing nuisance flooding through the confluence of prolonged rain and annual high tide events. This inundation is encroaching on critical infrastructure along the lagoon and, if not addressed, can be detrimental to the Town.



Figure 2 Town Pier on Indian River Lagoon and Ryckman Park

Sea level rise projections from NOAA suggest that by 2070, sea levels will have risen more than 4 feet in coastal Florida, which is enough to permanently inundate part of Melbourne Beach.

Legal Connection: Florida's 'Peril of Flood' Legislation

The Town of Melbourne Beach is completing this resiliency study in response to Senate Bill 1094, newly enacted state legislation passed in 2015 direct coastal cities to address climate-related vulnerabilities. The law requires coastal local governments in the state of Florida to include a 'peril of flood' component within the "Coastal" element of their Comprehensive Plans. The "Coastal" portion of the Comprehensive Plan is meant to address how to eliminate inappropriate and unsafe development in coastal areas. Data and maps developed as part of this study will be incorporated into the Town of Melbourne Beach's "Coastal" element in order to fulfill this state requirement.



Overview of Potential Impacts

Currently, the lagoon side of Melbourne Beach is experiencing periodic nuisance flooding through the confluence of prolonged rain and annual high tide events. This inundation is impacting streets along the lagoon but does not yet encroach upon any critical infrastructure. As sea levels rise, however, flooding can be detrimental to the future of the Town.

Sea level rise projections from NOAA and the U.S Army Corps of Engineers suggests that by 2070, sea levels will have risen more than 4 feet in coastal Florida, which is enough to permanently inundate part of Melbourne Beach along the lagoon and the Harbor East area.

In 2070, the remainder of the Town is relatively unscathed, but by 2100, a larger area will be impacted between elevation 4.5 and 8.5

feet above sea level. The sewage lift station at 7 feet above sea level which is located in Ryckman Park will be under water. Also impacted will be Grace Lutheran Church Preschool, the As We Grow Preschool and the St. Sebastian Episcopal Church, the Melbourne Beach Community Center and other critical infrastructure.

Also impacted by 2100 will be the police and fire stations along with the Town complex.



Figure 3 Harbor East Area at Crab Point in the Southeast Part of Town.

Coastal habitats protecting the lagoon will also be affected, which can cause erosion, salt water intrusion, and the degradation of marine ecosystems vital to the region’s economy. If the sea level rise trend follows its course, the homes along the Indian River Lagoon and the coastal shoreline will be significantly affected, causing permanent damage. *These vulnerabilities must be addressed in a comprehensive way.*

Vulnerability Analysis

The Vulnerability Analysis provides detailed summaries of vulnerabilities to critical facilities, parcels and roadways. As part of the analysis, five natural hazards are addressed. These include: 1) Storm Surge; 2) Sea Level Rise; 3) FEMA 100-and-500-Year Flood Zones; and 4) Nuisance Flooding Area; and, Sea Level Rise plus Storm Surge.

Overview of Hazards

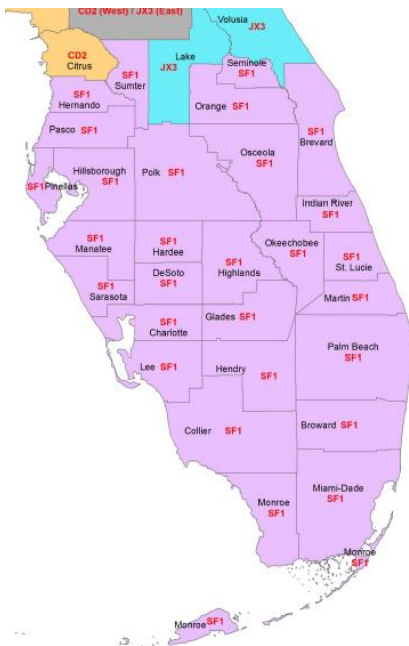
Storm Surge Storm surge occurs when hurricanes and tropical storms raise water levels in coastal areas which is pushed on shore.	
Sea Level Rise Sea level rise is occurring at an alarming pace along Florida’s east coast. This is a long-term hazard.	
100-Year Flood The 100-year flood zone depicts areas that have a 1% annual chance of flooding. FEMA provides this data.	
Nuisance Flooding Nuisance flooding areas are areas that flood frequently during high tide events. This occurs along the lagoon and currently impacts over 92 acres of land.	
Surge + Sea Level Rise Referred to as the “Combined Hazard Zone”, this includes the long-term effects of surge plus sea level rise.	

Methodology

As the goals 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.

Frequent Flooding

NOAA's Flood Exposure Mapper provides data to visualize the potential scale and extent, not exact location, of inundation of coastal areas susceptible to tidal flooding, otherwise referred to as shallow coastal flooding or nuisance flooding, derived from data National Weather Service issued Coastal Flood Advisories. As per the metadata associated with the dataset from NOAA, the Coastal Flood Advisory areas are based on individual Weather Forecast Office (WFO) guidance thresholds at monitored tide stations and are referenced to the MLLW tidal datum. A modified bathtub approach that attempts to account for both local and regional tidal variability was used to develop the data using source datasets, depending on geographic location, to derive the final inundation data. These source datasets include the Digital Elevation Model (DEM) and a tidal surface model that represents spatial tidal variability. Methods used to produce these data does not account for erosion, subsidence, or any future changes in an area's hydrodynamics and is a method to derive data in order to. These data can be viewed in the NOAA-CSC Sea Level Rise and Coastal Flooding Impacts Viewer.



Storm Surge

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 as the Brevard and Volusia County SLOSH Basin. 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 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 data was used in this assessment.

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 future 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).*

For the purpose of assessing sea level rise vulnerabilities on the Town, the regional approach was used as the parameters of the assessment. The planning horizons for the Town of Melbourne Beach include 2030, 2050, 2070 and 2100.

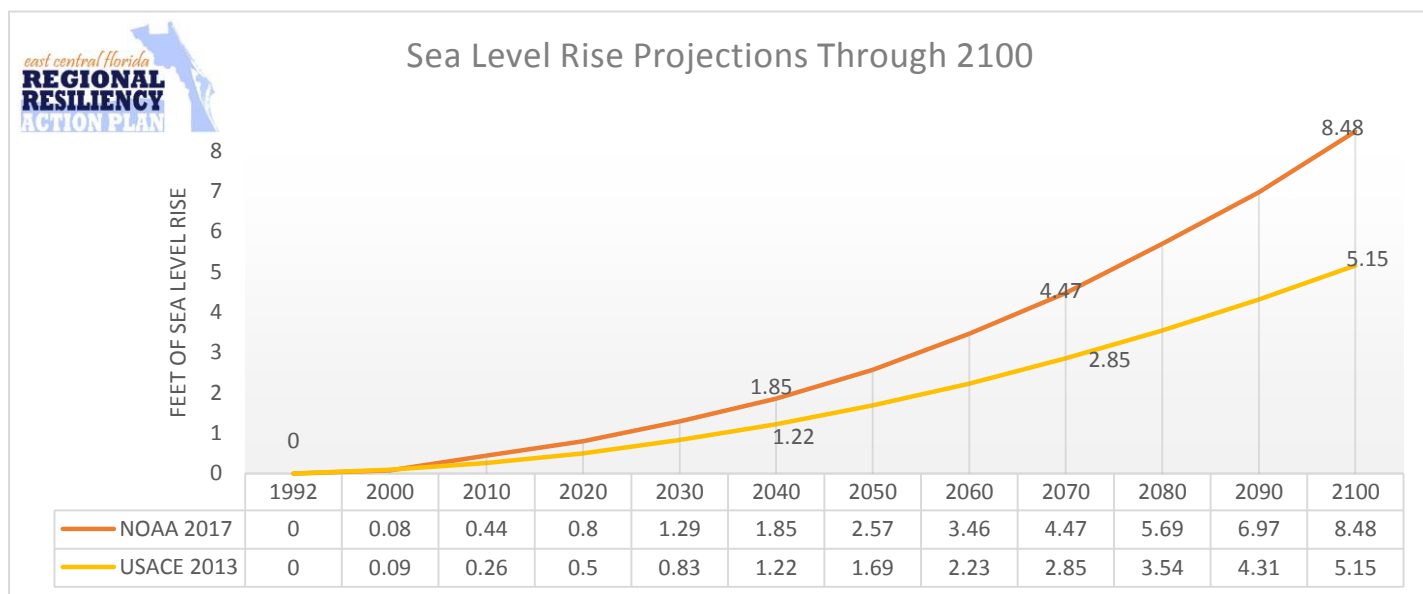
The two projection rate curves are derived from National Oceanographic and Atmospheric Administration (NOAA) 2017 and the US Army Corps of Engineers (USACE) 2013. The Sea Level Scenario Sketch Planning Tool was developed by the University of Florida GeoPlan Center for the Florida Department of Transportation (FDOT) to determine future sea level rise inundation areas utilizing U.S. Army Corps of Engineers (USACE). The USACE data was obtained by download from the 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 MHHW. Unfortunately, the USACE data from the GeoPlan Center does not include the year 2030; therefore, assessment of the USACE data begins for the year 2050. 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, the 2017 update 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 Mean Higher High Water (MHHW) conditions. The data was 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, this data does not account for erosion, subsidence or any other future changes in an area's hydrodynamics. A detailed methodology for producing these data can be found via the following url: 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 highest high tides (excluding wind driven tides) in accordance with the amount of sea level rise portrayed.

Figure 4 Sea Level Rise Projections Through 2100



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 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 comprises 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 runup 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.

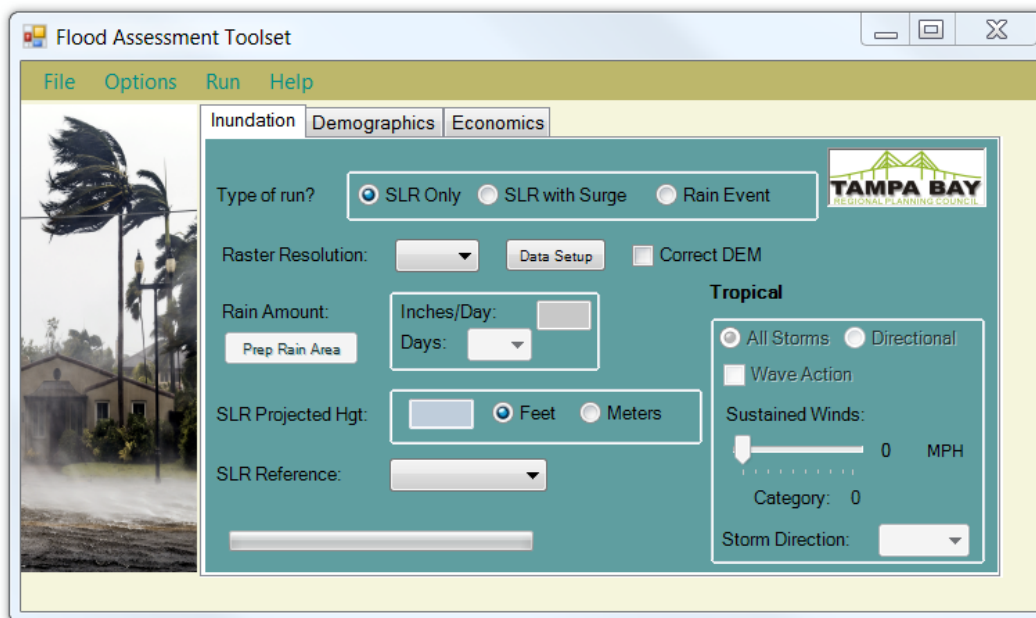


Figure 5 Flood Assessment Tool Beta Version

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, 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 DFIRMS. 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.

Use of Geographic Information Systems (GIS) to Complete the Vulnerability Assessment

The East Central Florida Regional Planning Council utilized Geographic Information Systems (GIS) to complete the vulnerability assessment in this report.

The following steps were completed:

- 1) Collected GIS data for 1) critical facilities, 2) roadways and 3) parcels
 - a. Quality assured this data with satellite imagery
- 2) Imbedded hazard fields into the attribute tables of the GIS files
- 3) Populated hazard fields
 - a. The following priorities were assigned (highest priority hazard zones were queried last in the event that an asset was in multiple hazard zones)
 - i. Sea Level Rise: Earlier horizons receive higher priority
 - ii. Flood Zone Priority: VE, AO, AH, AE, A (due to zone descriptiveness)
 - iii. Storm Surge: Category 1, 2, 3, 4 and then 5
 - b. Executed a select-by-location function to identify assets in each hazard zone for:
 - i. Parcels (Polygon)
 - ii. Critical Facilities (Polygon)
 - c. Executed the clip function to identify the roadway segments in each hazard zone
 - i. Re-calculated geometry for roadways (length, in miles) after the clip function was executed
- 4) Populated report by querying the completed data tables

The following special circumstances were encountered:

- 1) Some parcels had an earlier horizon per the USACE dataset than the NOAA dataset, which is not possible because the projections for NOAA are higher. This occurred because of how the layers are drawn over the lagoon. In these circumstances, the horizon for the USACE curve (per asset) was utilized as the horizon for the NOAA curve.
- 2) NOAA sea level rise values (per time horizon) were rounded to the nearest whole number.
- 3) It is recommended that the Town document the actual height (above mean sea level) for all of the outfalls within the Town.

Financial Exposure

The Town of Melbourne Beach is at risk to a diverse range of natural hazards for both publicly and privately owned property. The Town is subject to a diverse range of natural hazards with figures showing over two hundred million dollars of potential impacts within the 100 year flood zone, primarily along Riverside Drive and the lagoon.

Nuisance flooding is also an issue with property values of approximately \$137 million within this area, also primarily along the lagoon. Most of these properties are located in the FEMA flood Zone.

Sea level rise impact estimates vary between the Army Corps of Engineers (USACOE) and the National Oceanographic and Atmospheric Administration (NOAA) estimates, which assume a higher sea level rise impact. By 2030, impacts could exceed \$49,358,700 and by 2050, \$79,861,420 with the NOAA

projections. For 2070 and 2100, the range is from \$18,073,020 to \$135,584,690, and \$108,098,570 to \$466,092,230, respectively (using current values).

Category 5 storm surge from hurricanes can impact the Town severely, with \$682 million worth of property that may be impacted. Damage will likely affecting most of the structures in the Town to some extent. Even the impacts of a category 1 storm would impact over \$84 million in property. Again, the properties that would be impacted with a category 1 storm are also the properties experiencing nuisance flooding and those in the 100 year flood zone, primarily along Riverside Drive and the homes along the lagoon.

Table 3 Overview of Impacts to Critical Facilities: All Hazards

Hazard Zone	Acres in Zone	Buildings in Zone	Total Property Value	Undeveloped Acres in Zone
All 100 Year Flood Zones	337.632	305	\$200,717,060	12.59
Zone A	0	0	0	0
Zone AE	63.634	148	\$102,366,010	1.9
Zone AH	0	0	\$0.00	0
Zone VE	273.998	157	\$98,351,050	10.69
500 Year Flood Zone	697.884	686	\$431,035,710	25.19
Sea Level Rise - 2030 (USACOE)	0	0	\$0.00	0
Sea Level Rise - 2050 (USACOE)	0	0	\$0.00	0
Sea Level Rise - 2070 (USACOE)	13.4766	21	\$18,073,020	0.919866
Sea Level Rise - 2100 (USACOE)	68.61	167	\$108,098,570	1.65
Sea Level Rise - 2030 (NOAA)	31.4	73	\$49,358,700	1.88
Sea Level Rise - 2050 (NOAA)	51	111	\$79,861,420	2.08
Sea Level Rise - 2070 (NOAA)	85.9	184	\$135,584,690	2.08
Sea Level Rise - 2100 (NOAA)	381.67	928	\$466,092,230	6.33
Nuisance Flooding Zone	89.6	244	\$137,654,950	92.26
Storm Surge - Category 1	53.03	118	\$83,834,240	1.42
Storm Surge - Category 2	69.76	171	\$110,049,680	1.68
Storm Surge - Category 3	113.57	311	\$245,473,130	3.04
Storm Surge - Category 4	601.78	1036	\$500,029,430	20.42
Storm Surge - Category 5	984.31	1557	\$682,078,280	40.17
Combined Zone - Cat. 3 (2050)	539.07	838	\$351,991,140	16.93
Combined Zone - Cat. 3 (2070)	637.11	1133	\$468,056,970	21.92
Combined Zone - Cat. 3 (2100)	984.31	1557	\$605,041,900	40.19

*Exposure in acres is equal to the total acreage of exposed parcels

Flood Zone AE: Shallow flooding Special Flood Hazard Area (SFHA). where base flood elevations are provided. AE-Zone delineations are used on newer FIRMs instead of A# Zones.

Flood Zone AH: SFHA Base flood elevations in relation to a national datum are provided.

Vulnerability Summary | All Hazards

Most of the critical facilities identified within the Town will be impacted by a category 4 hurricane storm surge. Also, after 2070, many, but not all facilities will be impacted by sea level rise.

Table 4 Overview of Impacts to Property

Facility	Facility Type	Storm Surge Zone	ACOE SLR Horizon	NOAA SLR Horizon	Flood Zone	Nuisance Flood Area	Combined Zone
As We Grow Preschool	Day Care	Category 4	None	2100	None	No	2050
Exxon Mobile Gas Station	Utility	Category 4	None	None	None	No	2070
Gemini Elementary School	School	Category 4	None	2100	None	No	2050
Grace Lutheran Church Preschool	Day Care (Shelter)	Category 4	None	2100	None	No	2050
Melbourne Beach Fire Department Station #58	Fire Service	Category 4	None	None	None	No	2050
Melbourne Beach Police Department	Law Enforcement	Category 4	None	None	None	No	2050
Melbourne Beach Town Hall	Government	Category 4	None	None	None	No	2050
St. Sebastian Episcopal Church Shelter	Shelter	Category 4	None	2100	None	No	2050
United States Post Office (Melbourne Beach)	Government	Category 4	None	2100	None	No	2050

Overview of Impacts to Critical Facilities

Overall, the Town of Melbourne Beach has a relatively low exposure of critical facilities to natural hazards, as compared to more urbanized areas. The dunes along the ocean protect the Town from impacts from the ocean and, while rising waters from the lagoon will impact residents in the long term, critical facilities will not experience impacts until after the 2070 timeframe.

Impacts to critical facilities in Melbourne Beach are not immediate from sea level rise or nuisance flooding. The tipping point for storm surge would occur from a Category 4 hurricane, which theoretically occur at any time. The last Category 4 hurricane in the area was Hurricane Frances in September of 1994 with 145 mph winds just off the coast, but made landfall in St. Lucie County with slightly lesser winds. In 2004, Hurricane Jeanne made landfall with Category 3 winds in Brevard County, but only Tropical Storm Fay in 2008 (with 20 inches of rain), Hurricane David in 1979 (Category 2) and Tropical Storm Gordon in 1994 (harboring several tornados) impacted the area in the last 50 years.

Critical Facilities | Cumulative Exposure to Natural Hazards



Figure 6 Critical Facilities Cumulative Exposure to Natural Hazards

Overview of Impacts to the Transportation Network

Riverside Drive is approximately a mile in length and is a major collector along much of the Indian River Lagoon. This roadway will experience flooding with hurricane surge from a category 1 or higher. Flooding will increase as sea level rise occurs or if the surge is coincident with a king tide. Other roadways will be impacted by storm surge with major events, including minor arterials such as Ocean Avenue and A1A

Table 5 Roadway Impacts (in Miles) from Storm Surge

Road Name Classification	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
Riverside Drive Major Collector	0.016	0.151	0.52	0.811	0.811
Oak Street Minor Collector	0	0	0	1.22	1.253
State Highway A1A Minor Arterial	0	0	0	0.04	0.689
Ocean Avenue Minor Arterial	0	0	0	0.025	0.222
Ocean Avenue Major Collector	0	0	0	0.297	0.297
Atlantic Street A1A Minor Arterial	0	0	0	0	0.872

Table 6 Roadway Impacts (in Miles) from Sea Level Riase

Road Name Classification	USACOE 2030 Projected Inundation	USACOE 2050 Projected Inundation	USACOE 2070 Projected Inundation	USACOE 2100 Projected Inundation		NOAA 2030 Projected Inundation	NOAA 2050 Projected Inundation	NOAA 2070 Projected Inundation	NOAA 2100 Projected Inundation
Riverside Drive Major Collector	0 miles	0 miles	0	0.15		0	0	0.017	0.81
Oak Street Minor Collector	0 miles	0 miles	0	0		0	0	0	0.676
Ocean Avenue Major Collector	0 miles	0 miles	0	0		0	0	0	0.165

Hazard-Specific Vulnerability | Storm Surge

This portion of the report focuses on the effects to critical facilities, parcels and roadways from storm surge. In-depth vulnerability statistics are provided to determine risk from a land use, financial and transportation perspective.

Figure 7 Coastal Erosion in Melbourne Beach after Hurricane Matthew in 2016. (Florida Today)

Hazard Overview

Storm surge occurs as a result of tropical systems such as hurricanes and tropical storms and primarily affects coastal areas and barrier islands. According to NOAA, storm surge is “the abnormal rise in seawater level during a storm” and “is caused primarily by a storm’s winds pushing water onshore”. This rise in water often occurs rapidly and presents immediate danger to life and property. Storm surge can occur on inland waterbodies such as the Indian River Lagoon, which increases the Town’s risk profile in addition to being on a barrier island.



Past Impacts and Hazard Frequency in Melbourne Beach

While the Central Florida coastline rarely experiences direct hurricane hits, passing incoming and outgoing storms have historically impacted the lagoon coastline. Storm surge has occurred in Melbourne Beach intermittently over the past half-century, with five low to Category 1 storm surge events occurring since the year 2000. This includes Hurricane Frances, 2004; Hurricane Jeanne, 2004; Hurricane Charley, 2004; Hurricane Fay, 2008; Hurricane Matthew, 2016; and Hurricane Irma in 2017. Storm surge effects from storms greater than a Category 1 hurricane were not experienced in Melbourne Beach as part of any of the aforementioned storm systems, and a direct hit on Central Florida is rare.

Types of Infrastructure at Risk

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



Mitigating the effects of storm surge before an occurrence can be costly, but can save dollars over the long term. It is important for local jurisdictions to locate electric substations and main sewer systems away from coastlines whenever possible, and to ensure that major roadways are elevated. It is critical to note that while roadways themselves may not be affected, the subsurface and embankments can be undermined.

The path of Hurricane Matthew came perilously close to delivering a forceful blow to Melbourne Beach and if the path were slightly more to the west, shoreline erosion would have been a more severe problem.

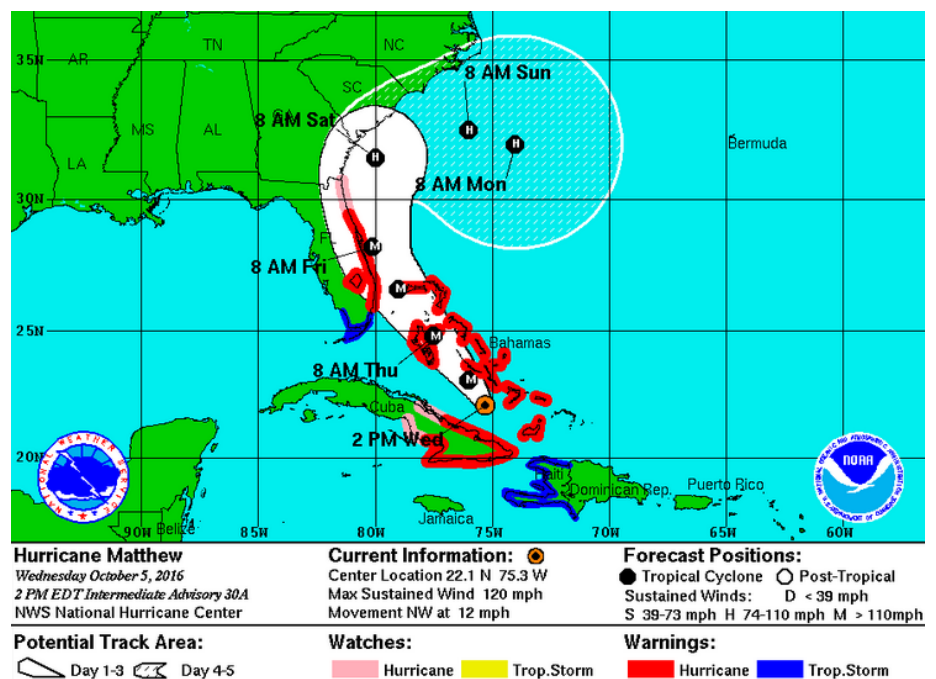


Figure 8 Hurricane Storm Surge Impact Zone Coverage

Hurricane Storm Surge Zones



Storm Surge Land Use Exposure

The impacts of storm surge are primarily focused along the Indian River Lagoon coastline and, depending on the Category of the storm, can breach up to approximately one half mile inland. The Town has some canals in the southern part, which heightens its risk profile.

Even a category 1 hurricane storm surge with winds up to 95 mph (Table 7, Saffir-Simpson Hurricane Intensity Scale), would impact as many as 118 mostly residential properties located adjacent to the lagoon.

Saffir-Simpson Hurricane Intensity Scale			
Strength	Wind Speed	Central Pressure	Storm Surge
Category 1	74-95 mph	> 980 mb	4-5 ft.
Category 2	96-110 mph	965-979 mb	6-8 ft.
Category 3	111-130 mph	945-964 mb	9-12 ft.
Category 4	131-155 mph	920-944 mb	13-18 ft.
Category 5	156+ mph	< 920 mb	< 18 ft.

Source: StormGeo

Table 7 Saffir-Simpson Hurricane Intensity Scale

Category 2 and 3 storm surge models project some additional impacts to areas, mostly to the southwest and northwest parts of the Town along the lagoon. Most of the critical facilities are still not impacted. However, with category 4, at least half of the Town may experience surge waters and with a category 5 storm, most of the Town will be impacted except for some areas behind the dunes and parts of a small ridge that runs parallel to the Atlantic coast about 1,000 feet inland.

The map on the following page depicts (by color) the land uses projected to be inundated under the storm surge zone by category. Most of the Town is impacted by the category 5 storm and critical facilities are impacted the category 4 storm.

Figure 9 Hurricane Storm Surge and Critical Facilities

Hurricane Storm Surge Zones & Critical Facilities



Hazard-Specific Vulnerability | Sea Level Rise

This portion of the report focuses on the effects to critical facilities, parcels and roadways from sea level rise. In-depth vulnerability statistics are provided to determine risk from a land use, financial and transportation perspective.

Hazard Overview

Sea level rise is a long-term natural hazard that is occurring as a result of rising global temperatures and local subsidence. As global temperatures rise water temperatures also rise, resulting in thermal expansion of water molecules and a greater volume of water on Earth. Sea level rise is already affecting communities in southeast Florida on a high-frequency basis and is often magnified by high tide and king tide events. Sea level rise can have impacts on inland water systems such as the Indian River Lagoon and the St. Johns River, so risk is not exclusive to ocean-front and barrier island communities. Areas low in elevation and in close proximity to water bodies that are hydrologically-connected to the Atlantic Ocean are particularly vulnerable to sea level rise. In this report, the project team utilized sea level rise projections from the U.S. Army Corps of Engineers and NOAA.

Impacts and Frequency in Melbourne Beach

Sea level rise is a long-term event that is currently impacting Melbourne Beach and its impact is projected to increase indefinitely into the future. As a result of rising seas, normal rain events can cause coastal nuisance flooding (especially when paired with a king tide event) and the frequency of flooding events can increase. It is projected that sea level rise may lead to daily flooding during normal rain events in some areas. Moreover, the effects of storm surge can be exacerbated when paired with sea level rise over the long term.

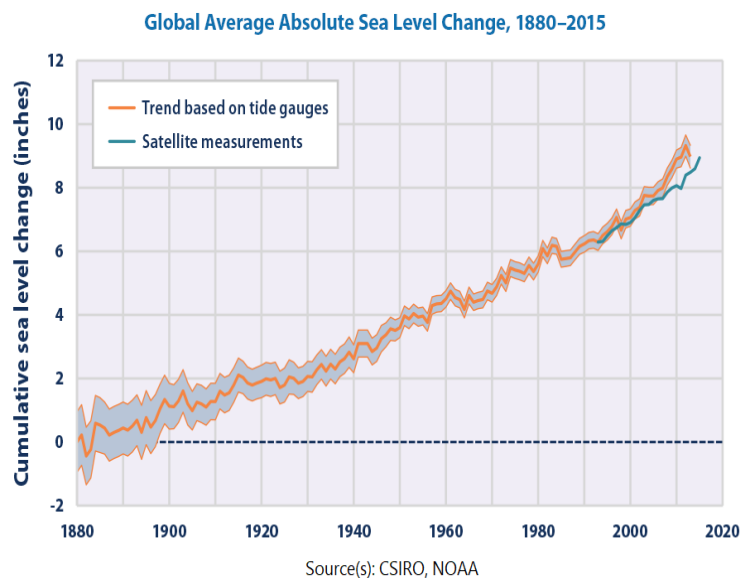


Figure 10 Global Average Absolute Sea Level Change, 1880 - 2015

Types of Infrastructure at Risk

While the total impacts of sea level rise remain unclear, stormwater outfalls, drinking water wells and roadways are among the most at-risk infrastructure systems over the long term. Stormwater outfalls and drinking water wells are at risk of saltwater intrusion, which over the long term can degrade the interior lining of these facilities. Additionally, sea level rise can have drastic impacts on roadways and the ground supporting them, which may contribute to roadway degradation before sea levels meet the surface of the roadway. It is recommended that the Town raise endangered stormwater outfalls, keep drinking water wells away from the Indian River Lagoon, and monitor roadway systems in the decades prior to the “horizon years” for roadways as determined as part of this section of the report.

Land Use Exposure

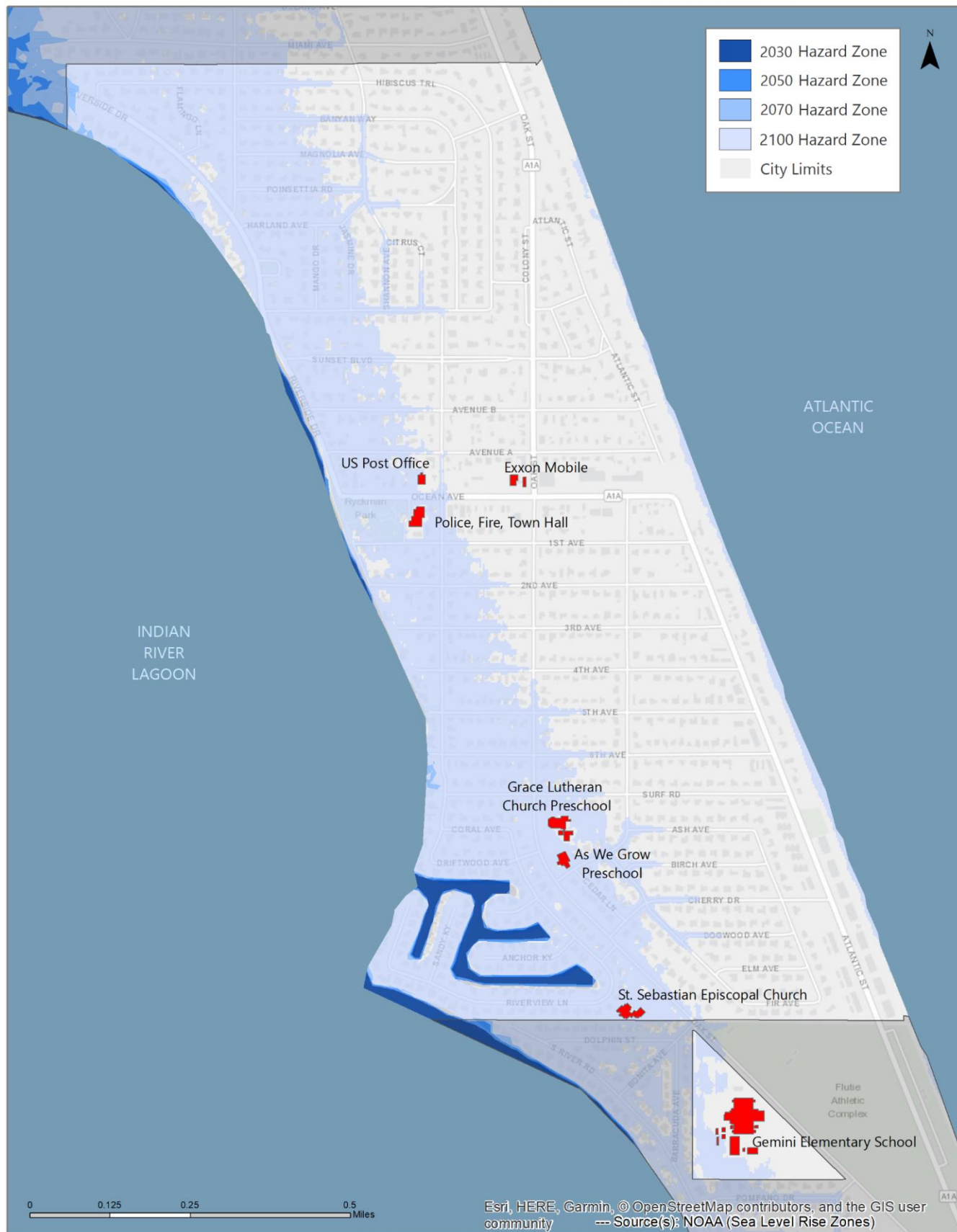
Based upon the more severe NOAA curves, impacts to residential, residential business and public and recreation areas will be felt by 2030 and increase with time. It is notable that the 2050 and 2070 impacts under the NOAA curve are very similar, so sea level impacts are not much greater for this 20 year period. After 2070, however, a tipping point is reached where much greater land areas will be impacted with over 240 acres of residential areas being impacted along with 22.7 acres of residential business and 4.49 acres of public and recreation areas. The USACOE curve show impacts beginning in 2070, and represents the lower end of the range. In both cases, impacts are primarily to residential properties. Table 8 and Figure 10, below, depict sea level rise impacts in acres and graphically to critical facilities.

Table 8 Land Use Exposure to Sea Level Rise, in Acres

	Single Family Residential	Multi-Family Residential	Residential Business	General Commercial	Downtown Business	Public & Recreation
Flood Zone	Acres	Acres	Acres	Acres	Acres	Acres
2030 <i>USACOE Curve</i>	0	0	0	0	0	0
2050 <i>USACOE Curve</i>	0	0	0	0	0	0
2070 <i>USACOE Curve</i>	13.42	0	0	0	0	0.05
2100 <i>USACOE Curve</i>	63.41	0	0.71	0	0	4.49
2030 <i>NOAA Curve</i>	30.5	0	0.71	0	0	0.23
2050 <i>NOAA Curve</i>	45.86	0	0.71	0	0	4.49
2070 <i>NOAA Curve</i>	49.35	0	0.71	0	0	4.49
2100 <i>NOAA Curve</i>	239.05	1.68	22.7	0	0	4.49

Figure 11 NOAA Sea Level Rise Zones & Critical Facilities

NOAA Sea Level Rise Zones & Critical Facilities



Financial Exposure to Sea Level Rise

The financial exposure for Melbourne Beach from sea level rise varies based on the lower AOCE range and the higher NOAA range curves. Impacts with the USACE curve are only evident by 2070 while the NOAA curve shows almost \$50 million worth of property in the impact zones in 2030. Similar to the land use exposure, the value of parcels in 2050 and 2070 that are impacted are not that different, but by 2100, the value impacted almost triples from roughly \$86 million to \$287 million in the following 40 years. A greater level of magnitude increase is seen for the USACE curve from roughly \$18 million to \$90 million for the same 40 year period from 2070 to 2100.

Table 9 Financial Exposure

					Built Pre-1968	Built 1968-2001	Built 2002 - 2018
Horizon Year	# Parcels in Zone (% of All Parcels)	Value of Parcels in Zone	Percent with Building on Site	Total Number of Buildings	Buildings Total Value	Buildings Total Value	Buildings Total Value
2030 <i>USACE Curve</i>	0 (0%)	\$0	0%	0	0 \$0	0 \$0	0 \$0
2050 <i>USACE Curve</i>	0 (0%)	\$0	0%	0	0 \$0	0 \$0	0 \$0
2070 <i>USACE Curve</i>	23 (1.41%)	18,073,020	91.30%	21	10 7,225,210	8 7,048,180	3 3,231,890
2100 <i>AOCE Curve</i>	173 (10.58%)	90,025,550	96.53%	167	42 23,041,630	113 70,360,080	12 13,394,670
2030 <i>NOAA Curve</i>	79 (4.83%)	49,358,700	92.40%	73	14 8,729,820	54 34,670,940	5 4,398,070
2050 <i>NOAA Curve</i>	118 (7.22%)	79,861,420	94.07%	111	25 15,854,950	76 50,612,470	10 11,816,810
2070 <i>NOAA Curve</i>	130 (7.95%)	86,225,990	94.62%	123	26 16,280,070	87 56,551,920	10 11,816,810
2100 <i>NOAA Curve</i>	702 (42.94%)	287,514,040	97.29%	683	319 109,294,000	333 147,151,620	31 28,152,020

Hazard-Specific Vulnerability | FEMA 100 and 500-Year Flood Zones

This portion of the report focuses on the effects to critical facilities, parcels and roadways from the 100-year and 500-year FEMA flood zones. In-depth vulnerability statistics are provided to determine risk from a land use, financial and transportation perspective.

Hazard Overview

The Federal Emergency Management Agency (FEMA) provides digital flood insurance rate maps (DFIRM) maps depicting 100-and-500-year flood hazard zones in order to determine which properties require the purchase of flood insurance. The 100-year flood zone (also referred to as the Special Flood Hazard Area) is generally defined as areas with a 1% annual chance of flooding. Flood zones can include areas susceptible to sitting water (ponding), areas susceptible to sheet flow on sloping terrain, and areas susceptible to flooding as a result of velocity wave action. All three of these scenarios are analyzed as part of this vulnerability analysis.

The zones in Table 10 can be characterized as follows, based on FEMA definitions;

Zone A; Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30 – year mortgage. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones.

Zone AE; the base floodplain where base flood elevations are provided. AE Zones are now used on new format Flood Insurance Rate Maps (FIRM).

Zone AH; Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.

Zone VE; Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.

Past Impacts and Hazard Frequency in Melbourne Beach

The Town of Melbourne Beach has areas that are exposed to 100-year flood zone A, AE, AH, and VE in addition to the 500-year floodplain. As described by FEMA, these areas are susceptible to flooding events once every 100 years (excluding the 500-year floodplain, which is susceptible to flooding once every 500 years). In recent years, flooding along Riverside Drive has occurred, and the stormwater system has been upgraded to address more frequent flooding.

Land Use Exposure

Table 10 lists the number of acres impacted by flooding and Figure 10 shows the flood zone areas in relation to the critical facilities in Melbourne Beach. The highest likelihood for shallow flooding is along the Indian River Lagoon for single family homes (Zone AH). Multi-family homes along the oceanfront has a high exposure as well

(Zone VE). The 500 year flood exposes additional single family residential and public and recreation areas to flooding.

Table 10 FEMA Flood Zone Exposure

	Single Family Residential	Multi-Family Residential	Residential Business	General Commercial	Downtown Business	Public & Recreation
Flood Zone	Acres	Acres	Acres	Acres	Acres	Acres
Zone A <i>(100 Year)</i>	0	0	0	0	0	0
Zone AE <i>(100 Year)</i>	0	0	0.71	0	0	4.49
Zone AH <i>(100 Year)</i>	58.43	0	0	0	0	0
Zone VE <i>(100 Year)</i>	14.36	256.51	0	0	1.04	2.09
500 Year <i>(Includes 100 Year)</i>	95.41	256.51	0.71	0	1.04	6.58



Brevard County Emergency Management has public service announcements and web pages to educate the public about living in a flood zone.

FEMA Flood Zones & Critical Facilities



Figure 12 FEMA Flood Zones and Critical Facilities

Financial Exposure

Table 11 depicts the number of parcels and the value of the buildings within each zone. Most of the 100 year flooding along the lagoon is in the far northwest or southwest part of Town and directly along the lagoon. Several areas, mostly multi-family units, along the oceanfront are also within the 100 year flood zone. About 150 buildings are within each of these zones, with the oceanfront property values being much higher while the lagoon side building value is much higher. The taxable value of the oceanfront parcels is about 11 times higher than the lagoon side parcels, but the combined values of the buildings on the lagoon side are about 25% higher than the combined oceanfront values.

The 500 year flood impacts dwarf the 100 year impacts. The overall taxable value of the land in the 500 year flood zone is over \$37 million compared to just under \$17 million for the 100 year flood zones, a 117% difference. The value of the buildings, however, is closer between the scenarios; \$223 million for the 500 year flood v. \$177 million for the total 100 year flood event, or a 26% difference. (both lagoon and Oceanside). This indicates that, while the land values are greater near the ocean, the value of the buildings is greater along the lagoon.

Flood Zone	# Parcels in Zone (% of All Parcels)	Number of Buildings	Land Value	Assessed Value	Taxable Value	Built Pre-1968	Built 1968-2001	Built 2002 - 2018
						# Buildings Total Value	# Buildings Total Value	# Buildings Total Value
Zone A (100 Year)	0 (0%)	0	0	0	0	0 0	0 0	0 0
Zone AE (100 Year)	155 (9.48%)	148	1,530,060	1,577,190	1,410,060	32 20,298,380	104 67,095,770	12 13,394,670
Zone AH (100 Year)	0	0	0	0	0	0	0	0
Zone VE (100 Year)	170 (10.4%)	157	13,979,750	21,110,760	15,410,130	23 21,110,760	126 58,599,090	8 13,410,750
500 Year (Includes 100 Year)	401 (24.53%)	381	28,996,760	52,289,540	37,070,000	86 51,221,050	269 141,942,130	26 30,347,830

Table 11 Financial Exposure to Flooding, by Zone

Transportation Network Exposure

The transportation network on Riverside Drive is vulnerable to the 100 and 500 year floods. Riverside Drive is not an evacuation route. The roadway is adjacent to the Indian River Lagoon.

Road Name Classification	100-Year Flood Zones A, AE, AH, AO, VE --- Projected Inundation	VE Flood Zone (Wave Velocity) Projected Inundation	500-Year Flood Projected Inundation
Riverside Drive Major Collector	0.118	0	0.207

Table 12 Roadways Impacted by Flooding

Hazard-Specific Vulnerability | Nuisance Flooding

This portion of the report focuses on the effects to critical facilities, parcels and roadways from nuisance flooding. Statistics showing the level of vulnerability for Melbourne Beach are provided to determine risk from a land use, financial and transportation perspective.

Hazard Overview

Nuisance flooding is “minor, recurrent flooding that takes place at high tide” and “occurs when the ocean has reached the brim locally” according to NOAA. Like other hazards analyzed in this report, nuisance flooding is tied to the presence of other natural hazards such as sea level rise. While not immediately life threatening, nuisance flooding is just that – a nuisance – and the costs over the long term may rise. Nuisance flooding is expected to increase in frequency and duration over time as sea levels rise, according to NOAA. The frequency of nuisance flooding depends on the season; Florida’s “wet months” primarily fall within the summer and fall.

Land Use Exposure

None of the Town’s critical facilities are impacted by nuisance flooding. Approximately 87 acres of residential, .71 acres of residential businesses and 4.49 acres of public and recreation acres are impacted by nuisance flooding. None of the critical facilities identified by the Town are impacted. The extent of nuisance flooding is very similar to the 500 year flood zones, indicating that the tides can be as impactful as a major storm event that does not include storm surge. The low areas that are consistently subject to nuisance flooding are in the lowest elevations in the Town and outside of these areas, elevations increase substantially enough to be out of both the nuisance and 500 year flood zones. The area that is impacted by nuisance flooding will increase with sea level rise.

	Single Family Residential	Multi-Family Residential	Residential Business	General Commercial	Downtown Business	Public & Recreation
Zone	Acres	Acres	Acres	Acres	Acres	Acres
Nuisance Flooding Area	87.1	0	0.71	0	0	4.49

Table 13 Nuisance Flooding Impacts by Land Use

Financial Exposure

Nuisance flooding impacts 235 buildings with a total land value of over \$67 million, most of which were built between 1968 and 2001. This represents almost 15% of all parcels. Nuisance flooding is more impactful than what is listed in the 500 year flood zones for the Town and less impactful than the 100 year storm damage.

						Built Pre-1968	Built 1968-2001	Built 2002 - 2018
Zone	# Parcels in Zone (% of All Parcels)	Number of Buildings	Land Value	Assessed Value	Taxable Value	# Buildings Total Value	# Buildings Total Value	# Buildings Total Value
Nuisance Flooding Area	244 (14.92%)	235	67,693,850	13,5644,790	92,454,700	65 31,265,100	151 86,603,670	19 17,776,020

Table 14 Impacts of Nuisance Flooding by Value

Transportation Network Exposure

Nuisance flooding impacts .24 miles of Riverside Drive, located along the Indian River Lagoon. The Town has recently upgraded some of the storm drains along Riverside Drive to help water dissipate more quickly.

Road Name Classification	Nuisance Flooding Area Projected Inundation	Evacuation Route	Maximum AADT
Riverside Drive	0.24 miles	No	1,200

Table 15 Impacts of Nuisance Flooding on Roadway Facilities

Nuisance Flooding Areas & Critical Facilities



Figure 13 Nuisance Flooding Areas and Critical Facilities

Hazard-Specific Vulnerability | Combined Hazard Zone

The effects of the combined hazard zone are expected to be drastic for critical facilities, parcels and roadways within the Town. In-depth vulnerability statistics will be provided at a future time to determine risk from a land use, financial and transportation perspective to this hazard. The impacts of sea level rise will also have an impact on nuisance flooding with high tides. This specific scenario assumes a high tide along with sea level rise and storm surge.

Hazard Overview

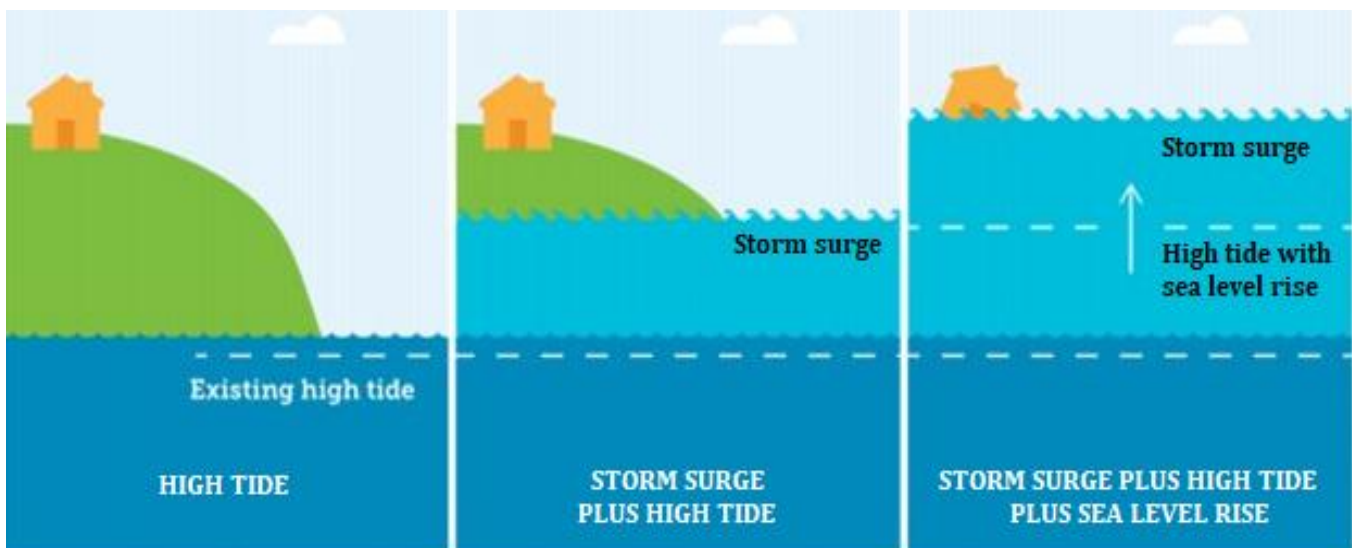
For the purposes of this report, the “Combined Hazard Zone” is defined by the American Meteorological Society as the cumulative long-term effects of sea level rise in addition to (or on top of) storm surge. According to researchers, sea level rise will “amplify” the effects of storm surge over the long term.

Hazard Frequency in Melbourne Beach

The combined hazard zone is a forward-looking risk scenario and data does not currently exist showing the relative increase that historic sea level rise has had on observed storm surge levels. In general, the frequency of storm surge will not increase over time as a result of sea level rise, but the severity of storm surge (and hurricanes, in general) will.

Types of Infrastructure at Risk

Similar to storm surge and sea level rise, a vast array of infrastructure is at risk as a result of the combined hazard of sea level rise on top of storm surge. This includes buildings, underground infrastructure, stormwater infrastructure, sea walls, electrical substations and water treatment plants.



Source: Climate Commission 2013

Figure 14 Illustration of Combined Impacts of High Tide, Storm Surge and Sea Level Rise

NOAA Combined Hazard Zone & Critical Facilities

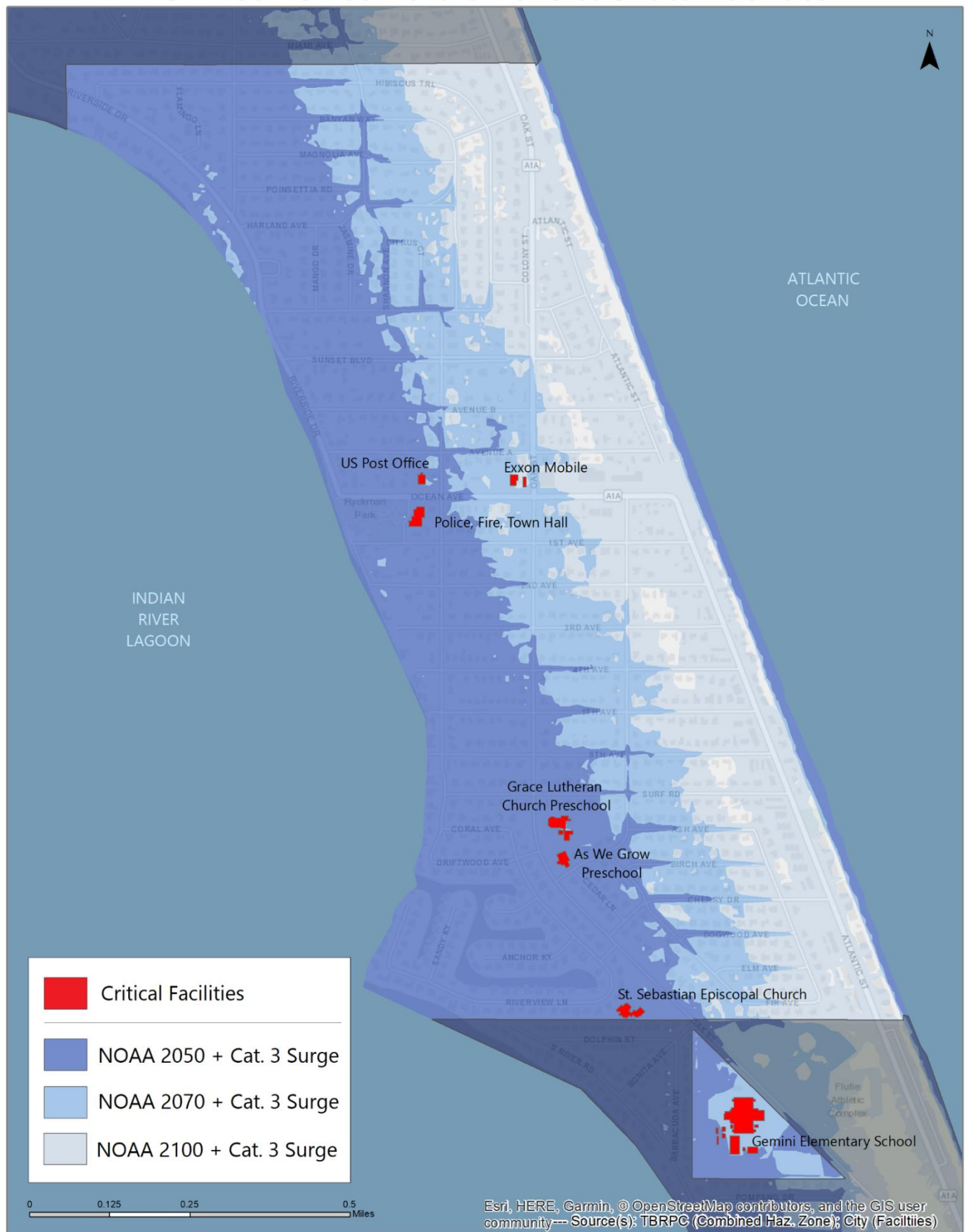


Figure 15 Combined Hazard Zone & Critical Facilities

Based upon NOAA projections, the Combined Hazard Zone and Critical Facilities map above, indicates that, with sea level rise, the a category 3 storm surge will cover most of the Town, similarly to the category 5 storm surge would without sea level rise (see Figure 8). Some of the areas just behind the dunes will not be inundated nor will portions of a ridge that runs parallel with the shoreline about an eighth of a mile inland. All of the critical facilities will be impacted. It is important to note that the USACOE predicts lower amounts of sea level rise, as shown in Figure 15 below. The tables and discussion below is based on the NOAA projections and not the USACOE projections, which utilizes less of a sea level rise as shown in Figure 4, previously.

Table 17 below shows the number of acres and the value of land impacted. The impacts are substantially higher when compared to category 3 storm surge without sea level rise, as would be expected. The numbers are very similar to the impacts of a category 5 storm. Please see Table 9.

	Single Family Residential	Multi- Family Residential	Residential Business	General Commercial	Downtown Business	Public & Recreation
Zone	Acres	Acres	Acres	Acres	Acres	Acres
Category 3 <i>Year 2050</i>	254.45	253.78	23.55	0	1.04	6.25
Category 3 <i>Year 2070</i>	342.87	256.51	26.41	1.14	3.60	6.58
Category 3 <i>Year 2100</i>	485.97	454.53	26.41	1.14	9.69	6.58

Table 16 Category 3 Impacts to Buildings, in Acres from Storm Surge with NOAA Sea Level Rise Projections

						Built Pre-1968	Built 1968-2001	Built 2002 - 2018
Zone	# Parcels in Zone (% of All Parcels)	Number of Buildings	Land Value	Assessed Value	Taxable Value	# Buildings Total Value	# Buildings Total Value	# Buildings Total Value
Category 3 Year 2050	866 (53.0%)	838	\$166,023,590	\$351,991,140	\$234,111,922	337 \$117,976,800	467 \$197,104,730	34 \$30,274,010
Category 3 Year 2070	1176 (71.9%)	1133	\$229,680,520	\$468,056,970	\$309,971,266	468 \$162,175,560	621 \$256,271,680	44 \$39,321,480
Category 3 Year 2100	1635 (100%)	1,557	\$289,146,150	\$605,041,900	\$406,615,816	612 \$205,480,520	887 \$332,383,390	58 \$53,223,670

Table 17 Combined Land Use Impacts from Category 3 Storm Surge with NOAA Sea Level Rise

The table above, Combined Land Use Impacts from Category 3 Storm Surge with Sea Level Rise, shows the number of parcels, buildings and values for the category 3 storm with 2050, 2070 and 2100 projected sea level rise from NOAA. In 2050, 53% of the parcels are shown as impacted. This increases to about 72% by 2070 and 100% by 2100. A parcel can be impacted, but not entirely flooded, as shown in Figure 14 above. The values across the table show a sizable increase in all categories as sea level rises, even as the storm category remains constant at a category 3 storm surge.

Non-Local Roadway Classification	Category 3 Surge + NOAA 2050 Sea Level Rise	Category 3 Surge + NOAA 2070 Sea Level Rise	Category 3 Surge + NOAA 2100 Sea Level Rise
A1A Minor Arterial	0 miles	0.69 miles	1.95 miles
Oak Street Minor Collector	1.25 miles	1.25 miles	1.25 miles
Ocean Avenue Major Collector & Minor Arterial	0.30 miles	0.52 miles	0.52 miles
Riverside Drive Major Collector	0.96 miles	0.96 miles	0.96 miles
Local Roadways Top 5 by Inundation Amount / Year	Category 3 Surge + NOAA 2050 Sea Level Rise	Category 3 Surge + NOAA 2070 Sea Level Rise	Category 3 Surge + NOAA 2100 Sea Level Rise
See Ranking to Right Top 5 Per Time Horizon >>>	1. Hibiscus Trail 0.95 miles	1. Hibiscus Trail 0.95 miles	1. Hibiscus Trail 0.95 miles
	2. Pine Street 0.87 miles	2. Pine Street 0.87 miles	2. Pine Street 0.87 miles
	3. Shannon Avenue 0.70 miles	3. Sunset Boulevard 0.86 miles	3. Sunset Boulevard 0.86 miles
	4. Sunset Boulevard 0.70 miles	4. Shannon Avenue 0.70 miles	4. Shannon Avenue 0.70 miles
	5. Orange Street 0.66 miles	5. Orange Street 0.66 miles	5. Orange Street 0.66 miles

Table 18 Roadway Impacts from Category 3 Storm Surge and NOAA Sea Level Rise

Regarding roadways, Oak Street, Riverside Drive, and most local streets listed all will experience the same impacts for all years. A1A, the most critical facility for evacuation, will not be impacted by 2050, but will have flooding in later years. This highlights the importance of ensuring evacuation occurs well before a hurricane begins to impact the coast. Also, while the distances do not seem that impressive for many of the roadway lengths, it is essential to recognize that the width and length Melbourne Beach is relatively small at just over half a mile across and a mile and a half in length.

US Army Corps of Engineers Projected Impacts

The sea level rise curves are less for the USACE though the critical facilities impacted do not change significantly. Gemini Elementary School and the Exxon Mobile station are not impacted by 2030; however the gas station is impacted by 2050.

USACE Combined Hazard Zone & Critical Facilities

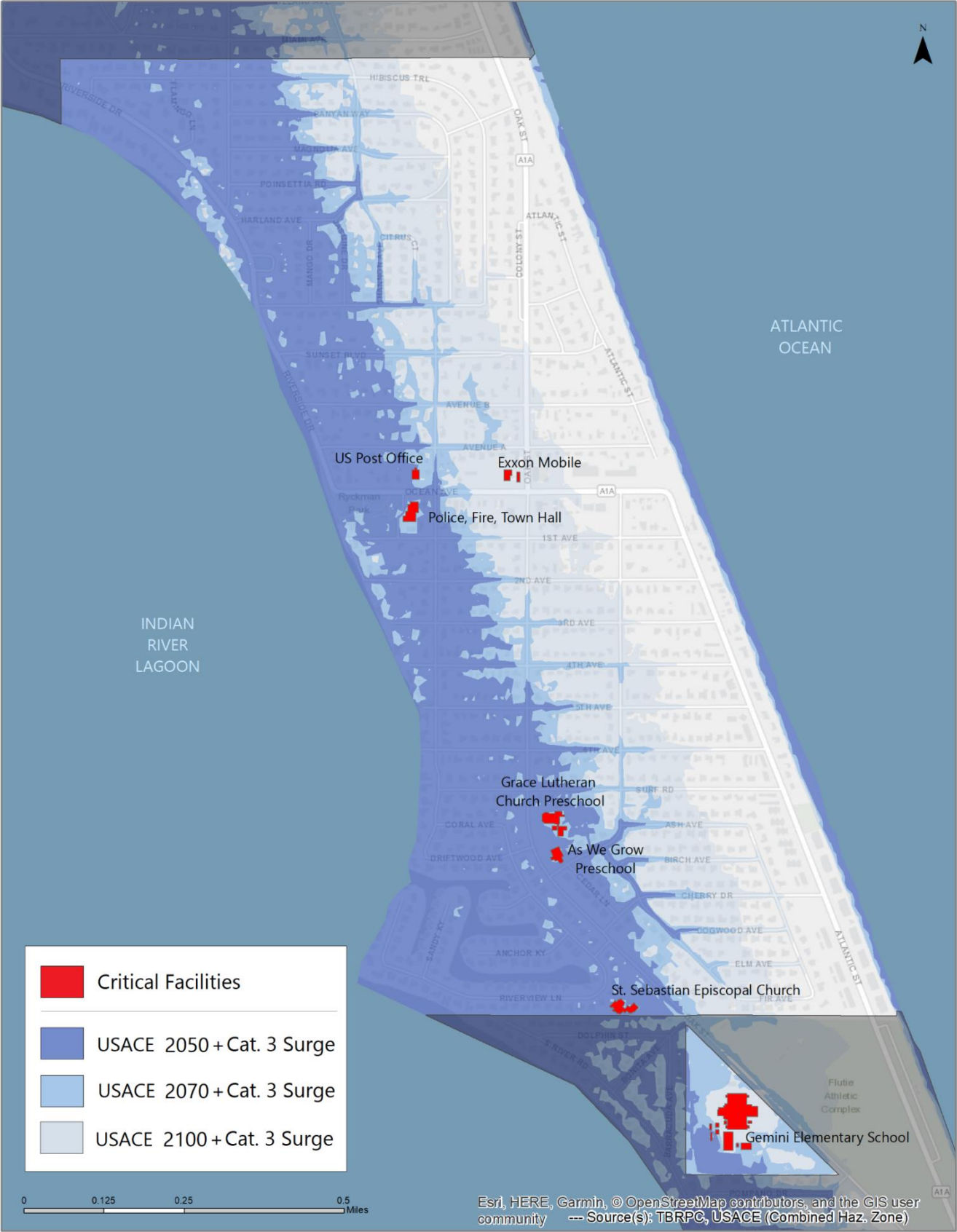


Figure 16 USACE Combined Hazard Zone and Critical Facilities

Hazard-Specific Vulnerability | Social Impacts

This portion of the report focuses on the social impacts to the population in Melbourne Beach. The vulnerability of coastal populations that are exposed to inundation will be greater for some sub-populations due to differences in their socio-demographic characteristics.

Hazard Overview

Melbourne Beach is predominately Caucasian, with Hispanic being the next major category at 3.2%. Other than Asian, other categories are less than 1 percent. City-Data.com reports that the percentage of residents living in poverty is 1.9% for whites and 2.2% for white non-Hispanic residents. Educational attainment shows a significantly higher number of residents with a bachelor’s degree, master’s degree and higher. The average age in the Town is 48.0 compared to 42.1 for the state. Average income is over \$80,000 per household, which is \$30,000 more than the state average. The per capita income in Town is about \$45,000. The estimated home and condo value is \$355,000 compared to under \$200,000 for the state.

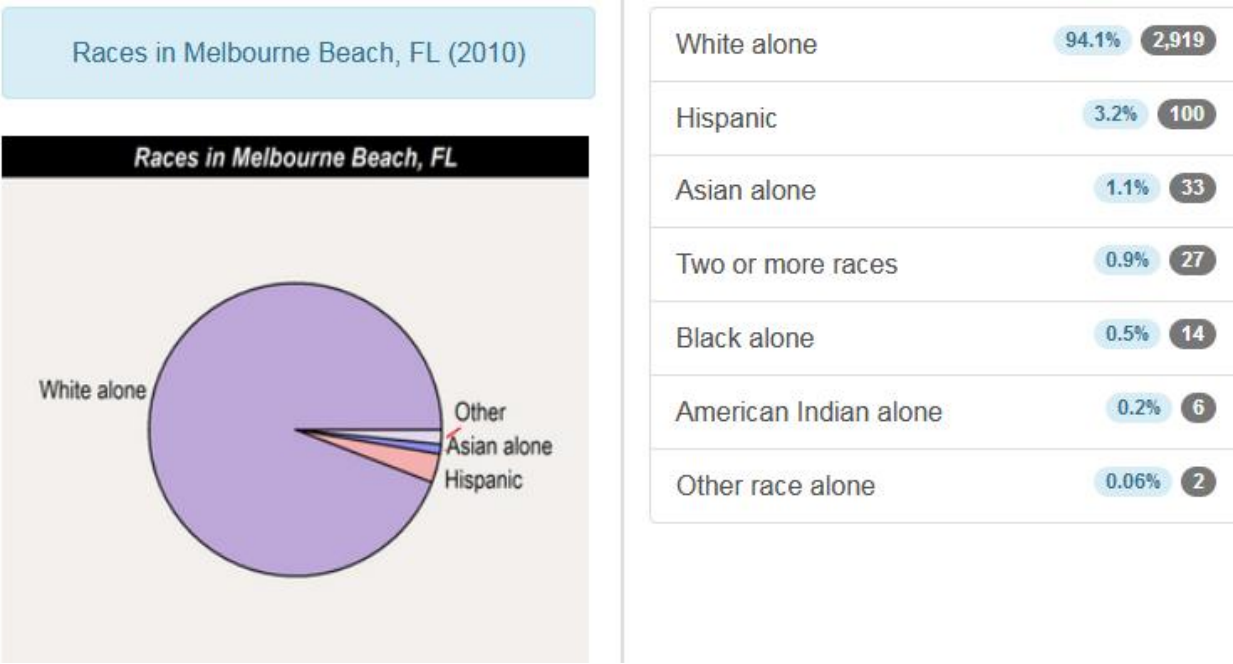


Figure 17 Races in Melbourne Beach, 2010 source: City-Data.com

Senior citizens comprise about one quarter of the Town’s population at 678 individuals, with women comprising the majority of that number. This indicates that there are more elderly, single females than males. Senior citizens comprise one of the more vulnerable populations, particularly as it relates to the ability to evacuate the barrier island before a storm event. This population may require additional assistance and the government agencies tasked with this responsibility should be made aware of this need.

Melbourne Beach FI Population Pyramid 2019

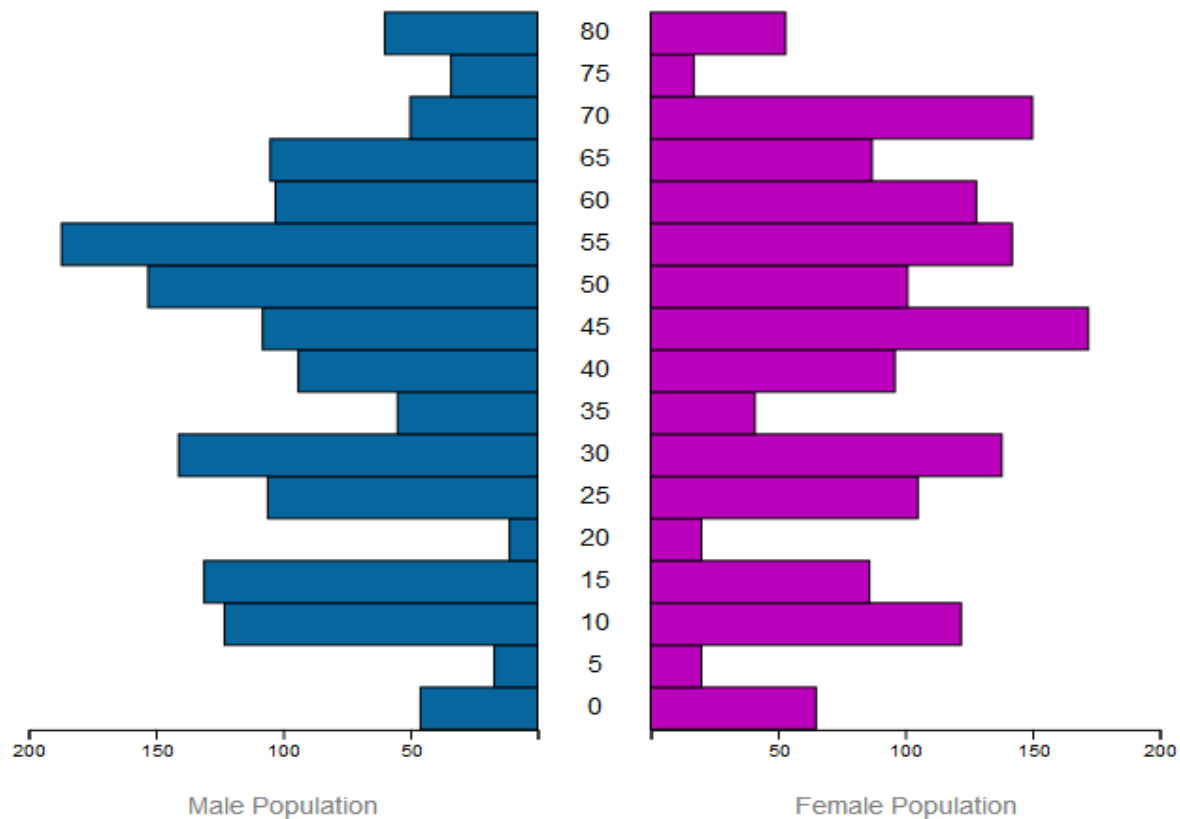


Figure 18 Melbourne Beach Population Pyramid, 2019. source: WorldPopulationView.com

Social Vulnerability Exposure

The primary vulnerability to the population of Melbourne Beach rests with the elderly population that may not be mobile and may need assistance in the event of an evacuation. This population may also have a disadvantage in preparing for an event that may impact their home, such as nuisance flooding from high tides or preparing their home for a hurricane that may or may not require evacuation.

The Town does not have a large population of non-English speakers, so communicating a threat of an event should not be an issue. Most of the population can afford the means to evacuation or prepare for a storm event.

Lift Station Impacts

The Town has one lift station in Ryckman Park on Ocean Avenue near the pier on the Indian River Lagoon. The Town is served by Brevard County and is within the South Beaches Wastewater Service Area. In the short term, this lift station should be fortified against inundation. In the longer term, alternate and/or redundant systems should be considered as this area could be impacted by sea level rise.



Figure 19 Ryckman Park with Lift Station near Indian River Lagoon (from Google Earth)

Brevard County services several areas that are relatively low and that will be exposed to sea level rise and more frequent flooding. Figure 15 depicts the service areas covered by the county and Melbourne Beach entirely serviced by the county utility.

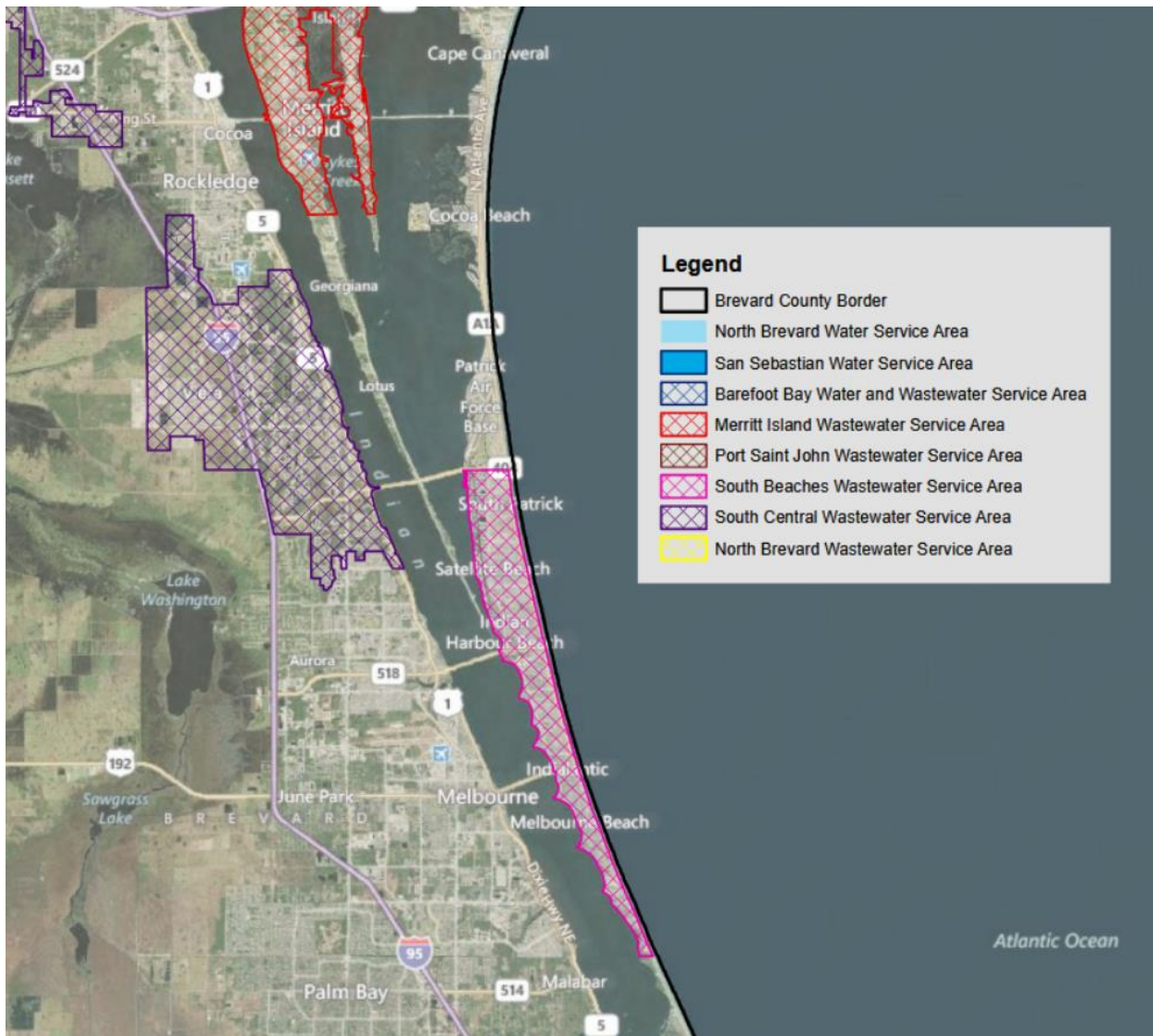


Figure 20 Brevard County Sewer Service Areas

It is likely that other areas are in a similar situation and the county will need to act to minimize impacts to their lift stations. Otherwise, wastewater could be released into the Indian River Lagoon and increase the likelihood for algae blooms and other unsanitary situations. Additionally, service to customers could be disrupted with additional unsanitary consequences. Options for the county to fortify these include relocating the lift station to higher ground, building dikes around the lift stations or otherwise raising the walls of the chambers to prevent water from entering. The Town should coordinate with Brevard County so actions can be identified and funding set aside for when fortification is required.

Stormwater Outfall Impacts

Stormwater infrastructure is critical to flood management, and the natural hazards addressed in this report can cripple its ability to function effectively. Storm surge can damage outfalls in short periods of time, while sea level rise and nuisance flooding can lead to long term corrosion of outfalls due to saltwater intrusion. It is recommended that the Town perform a more in-depth study of the elevation of these structures above mean sea level and consider raising the most at-risk outfalls.

As sea levels rise, the installation of check valves that function to allow water to drain to the lagoon, but prevent the water from entering from the lagoon and flooding streets. Cities such as St. Augustine and several in south Florida currently use check valves to address high tide flooding.

The following stormwater map shows the current system of stormwater disposal.

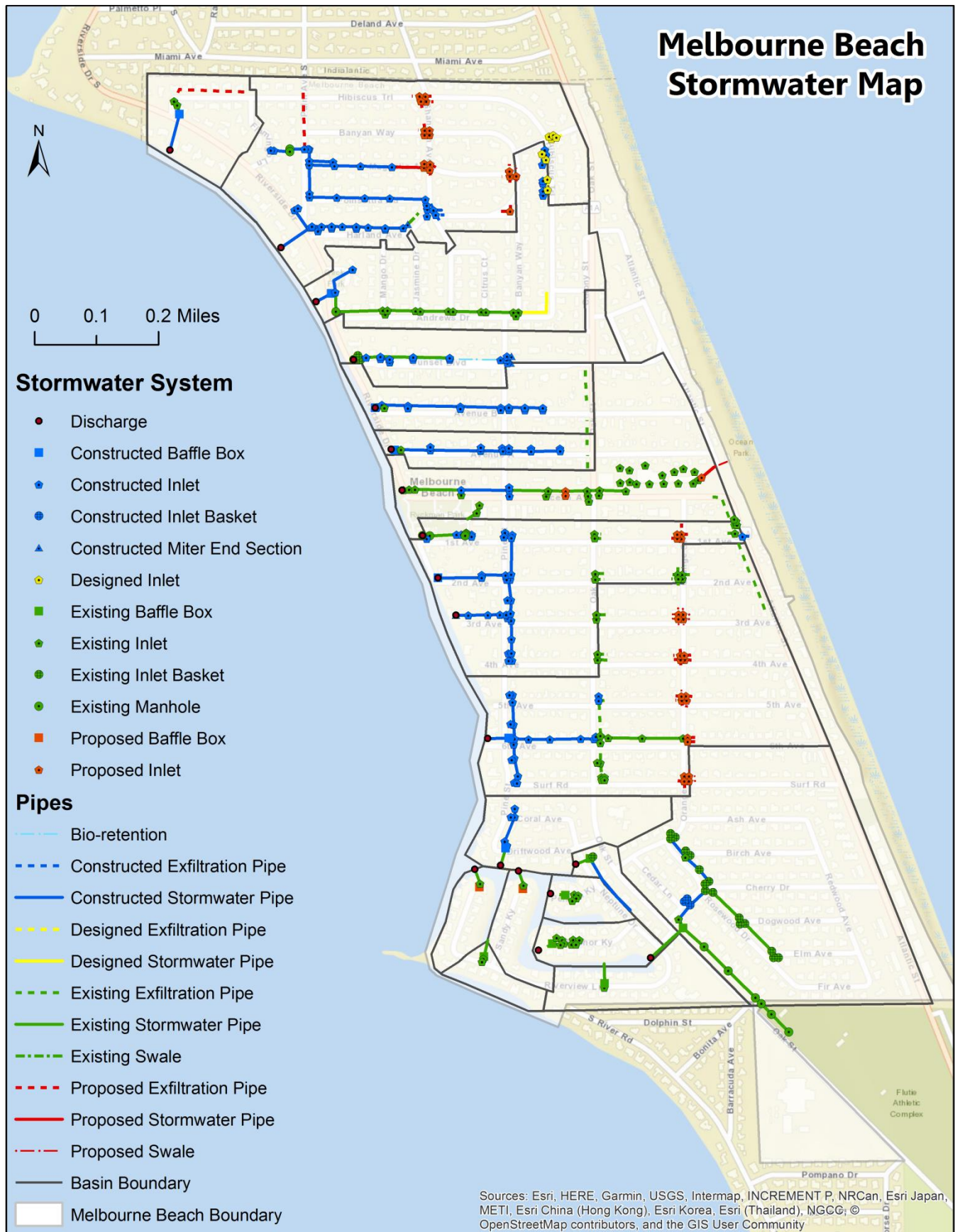


Figure 21 Melbourne Beach Stormwater Map

