Sea Level Rise Vulnerability Analysis Draft V4

PHASE 1

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SUBMITTED TO

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Executive Summary

Continuing to protect coastal infrastructure and valued resources through strategic adaptation will become increasingly pertinent as sea level rise accelerates and tidal flooding and severe storm surge events increase in frequency. The Captiva Erosion Prevention District (CEPD) has actively invested in coastal resilience for decades through beach and dune nourishment and shoreline enhancement projects. The CEPD authorized the development of the "Sea Level Rise Vulnerability Analysis" for Captiva Island to complete the following objectives:

1. Form a deliverable, consistent with state guidance for vulnerability assessments, which is inclusive of sea level rise scenarios for planning horizons in 2040 and 2070 based on the NOAA Intermediate-Low and Intermediate-High projections and inclusive of findings from the 2020 Captiva Island Resiliency Assessment and other recent publicly available assessments.
2. Develop a series of aerial maps to show the potential inundation under sea level rise scenarios in 2040 and 2070 and additional potential water level elevation scenarios.

This vulnerability assessment was conducted in alignment with state guidance and legislation. The analysis accounts for sea level rise projected for 2040 and 2070, tidal flooding, storm surge, and rainfall and surge flooding expected from a 100-year storm and 500-year storm under current sea level conditions. The flood and sea level scenarios were visualized and mapped to determine the extent of the island and the on and off island critical infrastructure that would be exposed. The potential impacts associated with each scenario were summarized by asset type including critical infrastructure, critical facilities, and valued resources on Captiva Island. The likelihood of occurrence of specific scenarios and the associated magnitude of impact of the flooding was analyzed island-wide and by asset to assess risk and rank vulnerabilities. The findings of the vulnerability assessment are intended to support subsequent funding pursuits and project conceptualization to increase community and coastal resilience. This effort may support the incorporation of future conditions planning into the CEPD's Beach and Shore Preservation Program and will serve as the first phase of development of a comprehensive resilience strategy.

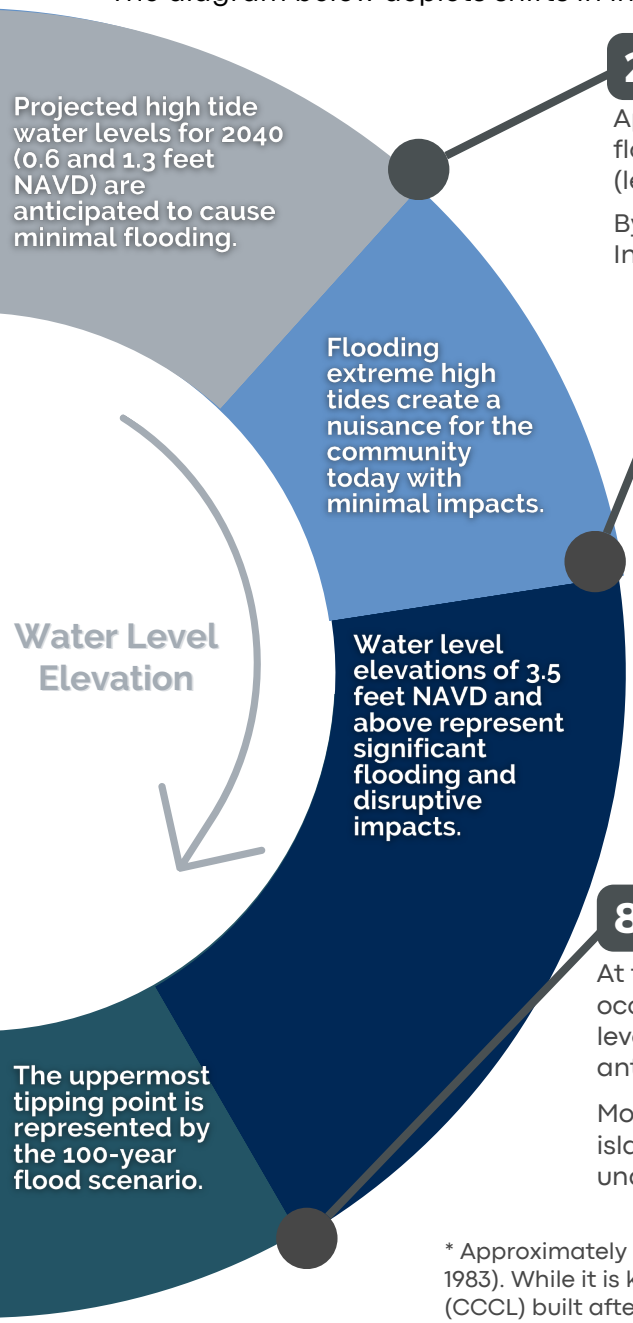
Key findings and takeaways are presented on the next page, followed by a summary of Inundation Tipping Points. To simplify the presentation of analysis findings, these three Inundation Tipping Points are described in detail in the main document sections while the results from the ten scenarios analyzed are included in the appendices. An outline of the organization of this document is then provided, followed by a glossary that defines key technical terms. Appendices I and III-IX include detailed analysis results, followed by Appendix X which contains an introductory presentation to the topics discussed in this analysis.

Key Findings and Takeaways:

- Across current and predicted water level elevations associated with tidal flooding, sea level rise, and storm surge, **bayfront shorelines and associated infrastructure prove to be more vulnerable** to flooding more often than the gulf-front shorelines.
- Flooding across the bayfront shorelines may cause critical infrastructure to be vulnerable in the near term (prior to 2040). **Approximately 97% of bayfront seawalls are currently vulnerable, the majority of which are in the central part of the island**.
- Storm surge protection of bayfront properties and infrastructure will likely be reduced once mangroves are permanently inundated. The majority of on-island and island-adjacent mangroves may be inundated during high and low tides by 2040, leaving properties and assets at the north end of the island and along the Roosevelt Channel less protected. This report focuses on vulnerabilities not adaptation strategies. A mangrove expert may be consulted to evaluate potential seeding or sediment resupply options for the mangroves.
- Approximately 11% of roads including portions of Captiva Drive and local roads at the northern end of Captiva Island may flood during extreme high tides under current conditions. By 2040, up to 62% of roads may temporarily flood during extreme high tides. The majority of local roads north of Chadwick's Square may be inundated during high tides in 2040.
- **Key critical infrastructure vulnerable under current conditions** includes the Wastewater Treatment Plant (WWTP) along South Seas Plantation Road, Lift Station #3 (South of the Fire Station), and the majority of stormwater assets identified in the 2011 Captiva Water Quality Assessment Project Final Report. The Captiva Shores Condominium and Sunset Captiva WWTP may be vulnerable to flooding by 2040.
- Approximately 8% of surveyed **electrical transformers** and utility boxes may be vulnerable to extreme high tides today, and **35% may be vulnerable by 2040** (sixteen located in close proximity to the Fire Station may experience flooding at a depth of >1 foot).
- By 2040, the Communication Tower located along South Seas Plantation Road may experience inundation with an average depth of 0.8 feet.
- The following **assets are not projected to experience significant flooding** under current extreme and 2040 conditions: the Captiva Fire Station, Post Office, and Community Center (on island) and Health Park Hospital and the closest Emergency Operations Center (off island).

Inundation Tipping Points

- Ten water level elevations ranging from 0.6-11.1 feet above the North American Vertical Datum (NAVD) were utilized for this analysis to evaluate the impact and risk that flooding of various kinds poses to Captiva.
- Three of the ten water level elevations represent "tipping points" or points of notable change in overall island flooding and in degree of impact to critical assets.
- The following elevations represent tipping points for various flood scenarios:
  - **2.3 feet NAVD**- represents 2 feet of sea level rise and also was the highest tidal flooding event in 2017.
  - **3.5 feet NAVD**- represents the peak water elevation during a storm surge that reoccurs every 10 years statistically. This elevation is coincidentally the same as the projected extreme high tide in 2040 and as the average high tide projected in 2070 based on the NOAA Intermediate-High projection.
  - **8.8 feet NAVD**- represents the water level elevation that will statistically occur every 100 years.
- The selected tipping point elevations are relevant to Captiva in that they have either occurred in the past 10 years or they represent future scenarios that will occur with increased frequency as sea level rises.
  - The elevation of 2.3 feet NAVD occurred or was exceeded 6 times in the past 10 years.
  - The elevation of 3.5 feet NAVD occurred once in the past 10 years.
  - The elevation of 8.8 feet NAVD may have occurred at least once (based on high water data from Hurricane Ian (SCCF, 2022).
- The diagram below depicts shifts in inundation and associated impacts associated with the tipping points.



2.3 feet NAVD Tipping Point 1

Approximately 37% of building footprints on Captiva Island may have minor flooding at or near building footprints or below their elevated first floors (less than 1 foot of flood depth) at this tipping point.*

By 2040, this elevation may occur up to 130 times annually (based on NOAA Intermediate-High sea level rise projection).

3.5 feet NAVD Tipping Point 2

At this tipping point, flooding may occur along most of the bayfront parcels, within the mangrove areas and along most of the roads directly south of the library. Flooding along the evacuation route and the north end of Captiva Island where utility infrastructure is located may cause delays for the community and service response.

Whether a result of storm surge, sea level rise, or high tides in the future, water levels at this elevation cause disruptive flooding.

At this tipping point, 71% of building footprints on Captiva Island are vulnerable to minor flooding at or near building footprints or below their elevated first floors with their current conditions. Of these homes, nearly one third may have less than 1 foot of flooding adjacent to them and the majority would have between 1 to 2 feet of flooding. *

By 2040, this elevation may occur up to 26 times annually (based on NOAA Intermediate-High sea level rise projection).

8.8 feet NAVD Tipping Point 3

At this tipping point, flooding across most oceanfront and bayfront parcels may occur. While this type of extreme event occurs rarely today, with predicted sea level rise by 2070, the anticipated frequency of storm surge of this magnitude is anticipated to occur once every 25 years rather than once every 100 years.

More than 95% of building footprints on Captiva Island would be affected on the island by this point and experience greater than 2 feet of flooding adjacent to or under buildings.*

* Approximately half of vulnerable footprints were built before the flood insurance standard (before 1983). While it is known that all residential homes seaward of the Coastal Construction Control Line (CCCL) built after 1978 were required to have the base floor level elevated, current day elevation certificates were unavailable, and thus, this analysis solely serves as a first order assessment.

Introduction

Provides background context, technical definitions, introduces sea level rise scenarios and planning horizons, and discusses recent storms in context

Exposure Analysis

Determines what parts of Captiva Island are likely to be affected by each flooding scenario and when flooding may occur. Compares differences in flood extents for each of the selected tipping points.

Sensitivity Analysis

Determines the depth of flooding for each scenario. Summarizes impacts and flood depths by asset sectors. Asset impacts are described in five sections: critical infrastructure, transportation and evacuation route, critical facilities and Captiva resources.

Risk Assessment

Ranks risks to assets based on likelihood of flood scenario occurrence and impact of flooding.

Next Steps

Highlights opportunities for CEPD to enhance resilience strategy

Introduction

Glossary

The following definitions provide explanation of technical terms and provide context for how the terms are used in the report. The introductory community presentation attached in Appendix X provides additional visuals for improved understanding of some of the listed terms.

100 Year Flood

The level of flooding that has a 1% chance of occurring in any given year, and has an equal chance of occurring every year, regardless of whether or not it occurred in previous years.

500 Year Flood

The flood level that has a 0.2% chance of occurring in any given year.

Asset

A physical resource containing economic value and/or future benefit. A critical asset is one whose loss, damage, disruption, or degradation would result in significant adverse impacts to human life, health, or security,

Compound Flooding

Compound flooding results from two or more flooding sources occurring simultaneously or subsequently within a short period of time. The combination of flood sources (storm surge, sea level rise, and heavy rainfall) can lead to higher inundation levels. Compound flooding is often the result of major storms or hurricanes.

Depth

The distance between the top of water surface and the ground/seafloor.

Disturbance

Higher levels of inundation than nuisance flooding (1 to 2 feet) that poses more significant threats to public safety or causes greater property damage.

Elevation

Elevation of a geographic location is its height above or below a fixed reference point, i.e., a datum.

Exposure

A measure of how much change in inundation an asset or community is likely to experience.

Heavy Rainfall

Inland flooding caused by rainfall occurs as the result of steady rainfall occurring over several days and/or a short and intense period of rainfall, often associated with a storm or hurricane.

Impact

Extreme levels of inundation than nuisance flooding (>2 feet) associated with rainfall flooding, which poses extreme threats to public safety or causes major property damage.

Inundation

The rising of a body of water and its overflowing onto normally dry land. Generally, refers to the condition of being flooded.

Nuisance

Low levels of inundation (<1 foot) associated with rainfall flooding, river flooding, and/or coastal flooding. Nuisance flooding does not pose significant threats to public safety or cause major property damage, but can disrupt routine day-to-day activities, put added strain on infrastructure systems such as roadways and sewers, and cause minor property damage.

NAVD

The North American Vertical Datum of 1988 (NAVD 88) is the official vertical datum of the United States. See NOAA Tidal Datums web page to observe how NAVD relates to the tidal datums such as Mean Sea Level and Mean Higher High Water for the location of interest.

Risk

A function of the likelihood of inundation occurrence and the impact of inundation.

Sea Level Rise

Global warming is causing global mean sea level to rise in two ways- thermal expansion caused by warming of the ocean (water expands as it warms) and increased melting of land-based ice glaciers and ice sheets). The ocean is absorbing more than 90 percent of the increased atmospheric heat associated with emissions from human activity, which causes sea level to rise. Sea level plays a role in flooding, shoreline erosion, and hazards from storms. Higher sea level also means more frequent high-tide flooding or "nuisance flooding".

Sensitivity

A measure of whether and how an asset or community is likely to be affected by a given change in inundation.

Storm Surge

Storm surge is the rise in seawater level caused solely by a storm. The surge is caused primarily by a storm's winds pushing water onshore. Higher sea levels mean that storm surges push farther inland.

Tidal Flooding

The temporary inundation of low-lying areas, especially streets, during exceptionally high tide events, such as at full and new moons. The highest tides of the year may be known as the king tide, with the month varying by location.

Vulnerability

A measure of how susceptible a given asset or community is to the impacts of flooding.

Background

As the frequency and intensity of climate-related hazards increases, it is becoming important for local municipalities and entities to identify and quantify vulnerability and determine appropriate measures to address risk. Flooding caused by sea level rise, storm surge, and precipitation, is a climate-related hazard impacting communities worldwide, nationwide, and especially within the state of Florida. The Captiva Erosion Prevention District (CEPD) recognizes this threat and has contracted APTIM to produce a state guidance compliant, vulnerability analysis. This assessment is necessary for state funding eligibility and additional immediate preparatory actions to support applications for resilience and coastal infrastructure funding.

In 2020, Integral Consulting produced a Captiva Island Resiliency Assessment, which served to summarize if roads, parcels, structures and specific on-island critical facilities would be affected under 1, 2, 4 and 7 foot sea level rise scenarios. The results of this assessment helped lay the foundation for understanding flood vulnerability for this area. The value added by this current analysis includes adding sea level rise scenarios for 2040 and 2070 and a sensitivity and risk analysis of the on-island and off-island infrastructure upon which the community depends.

In 2021, state legislation 380.093 F.S. provided criteria for establishing a statewide risk assessment and resilience plan inclusive of projects ranked by priority for potential funding allocations. The Florida Department of Environmental Protection (FDEP) has initiated implementing this legislation by collecting grant applications for resilience projects to be included in the state plan and providing guidance on vulnerability assessments with the requirement that guidance-consistent reports and geodata from assessments to be submitted with applications.

This "Sea Level Rise Vulnerability Analysis" (2023) accounts for the sea level rise scenarios required by the state (NOAA Intermediate-High and Intermediate-Low in 2040 and 2070) and several additional scenarios. These scenarios represent inundation levels caused by storm surge, tidal flooding, and additional extreme flood events, which paints a comprehensive picture of flood vulnerability. Moreover, it completes the analysis of the regional asset inventory of Captiva Island (including on and off island critical infrastructure) for both exposure and sensitivity to flooding and ranks Captiva's vulnerabilities by risk level. Preliminary actions and next steps are outlined to support development of the next phase of the comprehensive resilience strategy and funding applications.

Datums

In order to determine, discuss, and compare water elevation levels for various flood scenarios, it is first necessary to understand the relevant vertical datum and tidal datums that will be referenced. The following definitions were derived directly from the NOAA Tides and Currents glossary. In general, a **datum** is reference point on the earth's surface from which to measure positions. A **vertical datum** is fixed elevation to which heights of other surfaces (like sea level) are referenced. The commonly used vertical datum for the contiguous United States is the North American Vertical Datum of 1988 (NAVD88).

A **tidal datum** is a standard elevation defined by a certain phase of the tide. Tidal datums are used as references or benchmarks to measure local water levels. The National Tidal Datum Epoch is a 19-year period adopted by the National Ocean Service as the official time period over which tide observations are taken to determine mean values for tidal datums. The current tidal epoch from which tidal datums are based is from 1983 to 2001. As such, the tidal datums are based on historic observations not current tide elevations. In areas where sea level is rising, the published tidal datums are underrepresenting current tides. Specific tidal datums that will be referenced within this report include the following:

Mean Higher High Water (MHHW)

The average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch.

Mean High Water(MHW)

The average of all the high water heights observed over the National Tidal Datum Epoch.

Mean Sea Level (MSL)

The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch.

Mean Low Water (MLW)

The average of all the low water heights observed over the National Tidal Datum Epoch.

Flood Scenarios

The Captiva Erosion Prevention District (CEPD) is located in close proximity to two tide gauges- station 8725520 in Fort Myers, FL and station 8725110 in Naples, FL (see **Figure 1**). Both gauges are operated and maintained by NOAA/NOS/CO-OPS, and published on NOAA's Tides & Currents website (http:\\tidesandcurrents.noaa.gov).

Figure 1. Tide Gauge Locations Near Captiva, FL

Sea level rise projections utilized for mapping purposes in this assessment were retrieved from the Fort Myers station as it is the closest gauge with the highest mean sea level (-0.41 NAVD, compared to -0.62 MSL at the Naples, FL gauge). State guidance for vulnerability assessments suggests the closest gauge with the highest mean sea level be used. It is noted that the gauge is located inland and may be an underestimate of actual individual high tide events on Captiva Island. Relative to the current Mean Higher High Water (MHHW) level at the Fort Myers gauge, the sea level change scenarios for Fort Myers indicate a water level of 0.63 feet NAVD according to the 2040 Intermediate-Low scenario, a water level of 1.31 feet NAVD according to the 2040 Intermediate-High scenario and a water level of 3.2 feet NAVD according to the 2070 Intermediate-High scenario. These projections were selected based on state guidance. **Figure 2** depicts the NOAA 2017 relative sea level rise change scenarios for Fort Myers.

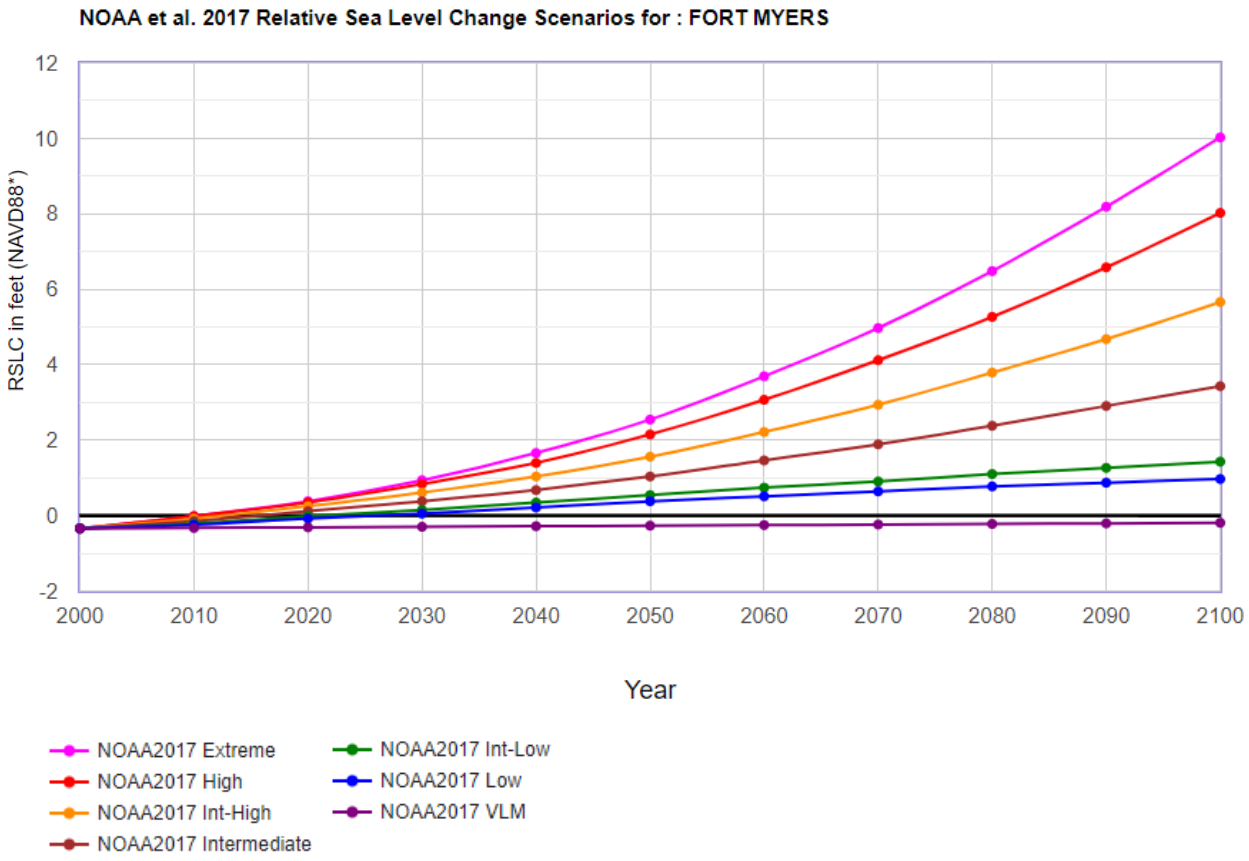


Figure 2. NOAA 2017 Relative Sea Level Change Scenarios for Fort Myers, FL

Additional sea level rise projections representing 1 foot Sea Level Rise, 2 of feet sea level rise, 4 feet of sea level rise, and 7 feet of sea level rise relative to the current Mean Higher High Water (MHHW) level based on the tidal epoch from 1983 to 2001 at the Fort Myers gauge were also included. The inclusion of these water level elevations represents the intent to compare levels and associated impacts to those measurements of identical methodology from the 2020 Captiva Island Resiliency Assessment.

Tidal flooding conditions were also considered within this assessment. High tide flooding occurs in low-lying coastal areas during extreme high tides, or "king tides." To select a tidal flood elevation for this assessment, a review of high tide events from 2017 to 2022 at both the Fort Myers and Naples tide gauges was performed. Extreme current high tide events with elevations ranging from 1.3 to 2.3 feet were measured by the tide gauges.

Rather than representing the current tidal flooding scenario as simply the average of the highest daily tides (also known as mean higher high water), which was found to be lower than typical extreme tides in the area, the highest recent individual tide was selected for the tidal flooding scenario. The highest extreme tide in recent past was measured as 2.3 feet NAVD in Fort Myers on October 7, 2017. This selected elevation is consistent with the elevation embedded in the NOAA Assess Flood Risks Tool. **NOAA indicated the high tide flooding threshold is 1.99 feet NAVD for Fort Myers, and 2.34 feet NAVD for Naples.** Based on these thresholds, from 2017 to 2022, there have been 0 to 7 flood event days per year. This measurement was used to represent the upper bound of current tidal flooding for the purpose of this assessment to avoid an underestimation of tide levels.

To represent **future extreme tidal flooding conditions** (in 2040 and 2070), the NOAA Intermediate-High sea level rise projections were added to the selected 2.3 feet NAVD tidal flood elevation for current extreme conditions. The tidal flood elevations for current extreme conditions, 2040 and 2070 conditions selected were 2.3, 3.5 and 5.2 feet NAVD, respectively.

The water level elevation for the **10 Year storm surge scenario** was sourced from the Lee County FEMA Flood Insurance Study (FIS). The FIS indicated that the stillwater elevation for a 10-year storm for Matlacha Pass would be 3.5 feet NAVD. Also derived from the FIS, were the stillwater elevations for a 1 percent annual chance flood or an **Existing 100 Year Flood Event** (8.8 feet NAVD) and a 0.2 percent annual chance flood or an **Existing 500 Year Flood Event** (11.1 feet NAVD).

The Existing 100 and 500 year flood extents proved to be slightly different from their associated current (effective) FIRM flood zone(s). Instead, they are more consistent with the future (preliminary) FIRM zones resulting from 2019 FEMA's Coastal Flood Risk Study. The future flood zones align with the Category 1 and Category 2 storm surge risk zones, and thus, the storm surge zones were utilized to conduct the sensitivity analysis for the Existing 100 Year and 500 Year Flood Events.

Future storm surge scenarios (in 2040 and 2070) were developed by adding the NOAA Intermediate-High sea level rise projections to the 10-year storm surge elevation for existing conditions. The storm surge elevations for existing, 2040 and 2070 conditions selected were 3.5, 4.5 and 6.4 feet NAVD, respectively.

A summary of the **water level elevations** sourced and derived from the methods outlined in this section are listed in **Table 1.** Technical water level names are listed and those in red represent "duplicate" elevations, as there is a difference of less than six inches between them and other water levels.

In a sensitivity test, the results of the impacts of water level elevations that were considered "duplicates" were found to be insignificant in terms of the critical infrastructure exposed. As such, consolidating and selecting representative scenarios was determined to be helpful in streamlining the assessment while still identifying relevant findings and benchmarks of inundation.

Table 1. Original Water Level Elevation Scenarios for Captiva, FL

Scenarios	Feet NAVD
2040 NOAA Intermediate-Low MHHW	0.6
2070 NOAA Intermediate-Low MHHW	1.2
MHHW 0.28 'NAVD @ Fort Myers +1' Sea Level Rise	1.3
2040 NOAA Intermediate-High MHHW	1.3
MHHW 0.28' NAVD @ Fort Myers 2' Sea Level Rise	2.3
Tidal Flooding, Current Extreme Conditions	2.3
2070 NOAA Intermediate-High MHHW	3.2
Tidal Flooding, 2040	3.3
10 Year Surge, Existing	3.5
MHHW 0.28' NAVD @ Fort Myers +4' Sea Level Rise	4.3
10 Year Surge, 2040	4.5
Tidal Flooding, 2070	5.2
10 Year Surge, 2070	6.4
MHHW 0.28' NAVD @ Fort Myers +7' Sea Level Rise	7.3
1 percent annual chance flood	8.8
.2 percent annual chance flood	11.1

Note: The red text indicates the water level is less than 0.5 feet in difference from an adjacent water level elevation and is duplicative.

Final scenario selection included selecting an approximate, representative water level elevation for each of the scenarios in **Table 1** and reducing the overall number of scenarios to simplify presentation of results. The following scenarios were not mapped for exposure or sensitivity purposes as their inundation extent and resulting impact are accounted for by proxy by the water elevations close in measurement. More specifically:

- 2070 NOAA Intermediate-Low scenario (1.2 feet NAVD) and MHHW 0.3 'NAVD @ Fort Myers +1' sea level rise are "duplicates" of 2040 NOAA Intermediate-High scenario (1.3 feet NAVD)
- MHHW 0.3' NAVD @ Fort Myers +2' sea level rise (2.3 feet NAVD) is a "duplicate" of Existing Tidal Flooding scenario (2.3 feet NAVD)
- 2040 Tidal Flooding scenario (3.3 feet NAVD) and Existing 10 Year Surge scenario (3.5 feet NAVD) are "duplicates" of 2070 NOAA Intermediate-High MHHW (3.2 feet NAVD)
- 2040 10 Year Surge scenario (4.5 feet NAVD) is a duplicate of MHHW 0.3' NAVD @ Fort Myers 4' sea level rise scenario (4.3 feet NAVD)

Table 2 depicts the finalized ten scenarios that were utilized for the exposure and sensitivity analysis of Captiva, FL.

Table 2. Consolidated Water Level Elevations for Captiva, FL.

Water Level Elevation (feet NAVD)	Scenarios Represented by Water Level
0.6	2040 NOAA Intermediate-Low sea level rise
1.3	2040 NOAA Intermediate-High Sea Level Rise 2070 NOAA Intermediate-Low Sea Level Rise 1 foot Sea Level Rise*
2.3	Current Extreme Tidal Flooding 2 Foot Sea Level Rise*
3.5	2070 NOAA Intermediate-High Sea Level Rise Existing 10 Year Surge 2040 Tidal Flooding
4.5	2040 10 Year Surge 4 Foot Sea Level Rise*
5.2	2070 Tidal Flooding
6.4	2070 10 Year Surge
7.3	7 Foot Sea Level Rise*
8.8	Existing 100 Year Flood
11.1	Existing 500 Year Flood

*1 foot, 2 feet, 4 feet, and 7 feet sea level rise projections are referenced above the current Mean Higher High Water (MHHW) elevation datum at Fort Myers tide gauge, respectively.

Context for Elevations

Figure 3 depicts the Fort Myers water elevations for relevant tidal datums in comparison to the flood scenarios outlined in **Table 2**. The purpose of this comparison is to help visualize the water level discrepancy and incrementation between the mean local elevations and the predicted flood elevations. All levels are in feet NAVD88. These water level elevations were utilized to determine the depth of flooding experienced by Captiva assets and areas throughout this report. As an example, under current extreme tidal flooding conditions (2.3 feet NAVD), an asset with an elevation of 2 feet NAVD would experience inundation with a depth of 0.3 feet or approximately 4 inches.

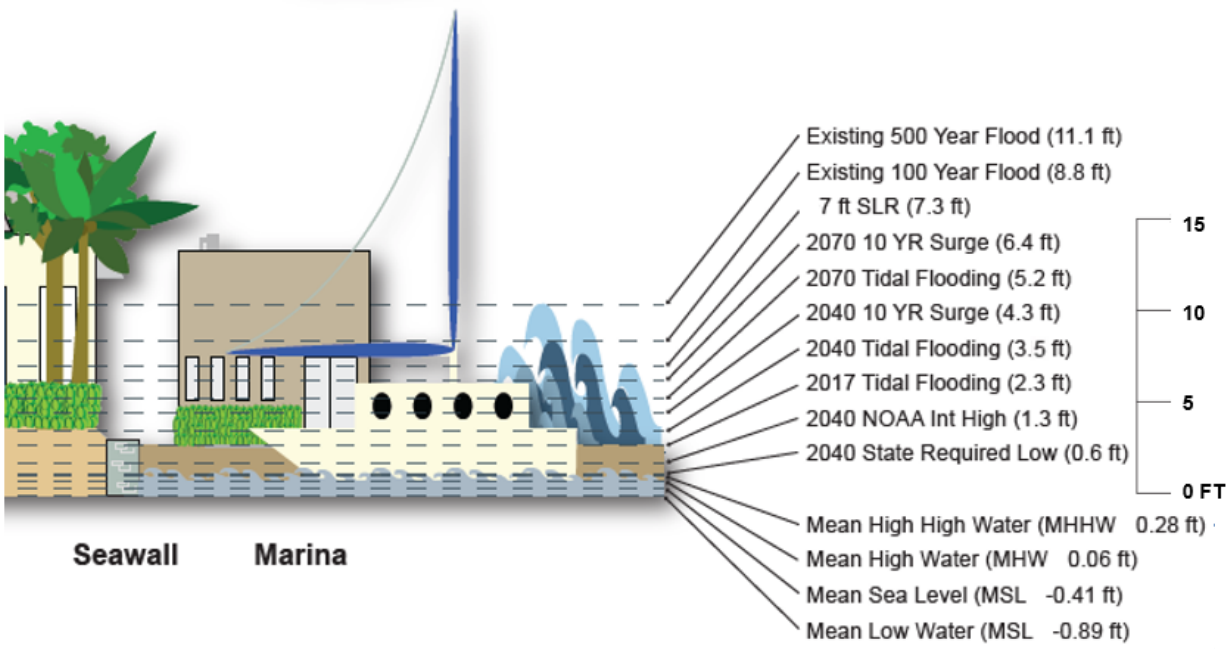


Figure 3. Comparison of Local Tidal Datum Elevations and Flood Elevations

Context from Historic Occurrence

Table 3 shows how often select water level elevations have already occurred and are projected to occur in 2040 and 2070, according to the NOAA Intermediate-High Sea Level Rise Projections as published in 2017.

- **The "Current" column of Table 3** shows the average number of days per year where the water levels have exceeded the selected water level elevations of 1.3 ft, 2.3 ft, and 3.5 feet NAVD thresholds in the past 10 years in Naples and Fort Myers. Water levels have exceeded 1.3 feet NAVD between 19 (Fort Myers) and 46 times (Naples) between 2012 and 2022, or on average approximately 2 to 5 times per year. Tidal flooding is not currently observed at this low elevation (1.3 feet NAVD) based on anecdotal information on Captiva Island. At a slightly higher elevation, 2.3 feet NAVD, tidal flooding has been observed. Measured data indicates on average this water level elevation has been exceeded on an average of 6 times per year over the past 10 years (Fort Myers, Table 3). This comparison adds further justification for the selection of 2.3 feet NAVD as the tidal flooding scenario.
- **The "2040" column of Table 3** lists the number of days that the selected water levels may be exceeded in 2040 based on the 2017 NOAA Intermediate-High Sea Level Rise projection. Land elevations at or below 1.3 feet NAVD would be expected to be submerged daily or continuously submerged (inundated). Land below 2.3 feet NAVD would be expected to be flooded or submerged 80 days (Naples) to 130 days (Fort Myers) per year. This amount of tidal flooding is a tipping point for the island.
- **The "2070" column of Table 3** suggests that by 2070, some temporary flooding or continuous inundation may occur at the three selected elevations. Land areas lower than 1.3 feet NAVD may likely be continuously submerged. Land between mean low water and 3.5 feet NAVD may likely be inundated by tides daily.

Table 3. Number of Current and Projected Flooding Days Per Year

	Current Average number of days per year where water levels exceeded the threshold in the past 10 years			2040 Number of days that water levels will exceed threshold in 2040			2070 Number of days that water levels will exceed threshold in 2070		
Location/ Threshold (NAVD)	1.3 ft	2.3 ft	3.5 ft	1.3 ft	2.3 ft	3.5 ft	1.3 ft	2.3 ft	3.5 ft
Naples	46	13	3	365	80	13	365	365	365
Fort Myers	19	6	1	365	130	26	365	365	365

Frequencies of water elevations were derived from the NOAA Inundation Analysis Tool.

Context from Recent Storms

Captiva Island is located off the southwest coast of Florida and is part of the barrier islands along the state's southern peninsula. The island connects to Sanibel Island through a road bridge at Blind Pass. The coastline of Captiva Island includes gulf-front beaches, bayside shorelines and inlet shorelines. According to the Captiva Island Resiliency Assessment from 2020, Captiva's coastline is comprised of mangroves (39%), beaches (27%) and a mix of intermittent mangroves and landscaping (22%). Since 1900, there have been eight hurricanes within 20 nautical miles from the island of Captiva.

The geomorphic composition of the island is actually the result of a 1921 hurricane which separated Captiva into two islands (now Captiva and North Captiva) at Redfish Pass. Two intense hurricanes that impacted the Island since 1990, include Hurricane Charley (2004) and Hurricane Ian (2022). Both storms resulted in power outages, disruption to communications and water treatment plants, and destruction and inundation to major roadways.

Figure 4. Hurricane Damage on Captiva Island

On August 13, 2004, **Hurricane Charley** made landfall near North Captiva Island as a Category 4 storm, which resulted in impacts along Captiva Island.

According to a 2005 report from the Lee County Division of Natural Resources entitled "Impacts of Hurricane Charley on the Southwest Florida Coastline Focusing on Lee County", Captiva Island lost an average of 13 feet of shoreline, most prominently at its southern end, as a result of Hurricane Charley. The report also details a significant increase in the heights of escarpment across the island, from 2 to 3 feet before Hurricane Charley, to 5 or 6 feet after the storm. Maximum storm surge was recorded at 8 feet high- a water level elevation higher than the majority of the Island itself.

On September 28, 2022, during the completion of this assessment, Captiva was impacted by **Hurricane Ian.** Hurricane Ian made landfall on Captiva Island as a Category 4 storm with storm surge nearing 12 feet in some areas of the Island and 155 mph sustained winds. More specifically, according to the Sanibel- Captiva Conservation Foundation (SCCF) team, who located an intact water logger on west Sanibel, the maximum water level elevation recorded was over 11.2 feet NAVD (11.6 feet, Mean Sea Level) at 2:05 p.m. on September 28, 2022 (**Figure 5**). This level of storm surge was comparable to water level elevations anticipated for a 500-year flood event in the area.

The SCCF team also noted a significant decrease in beach elevation relative to mean sea level across Sanibel and Captiva after Hurricane Ian. The average elevation of Captiva's sea turtle nest sites was of 7.2 feet before the storm and decreased to 3.6 feet after the storm.

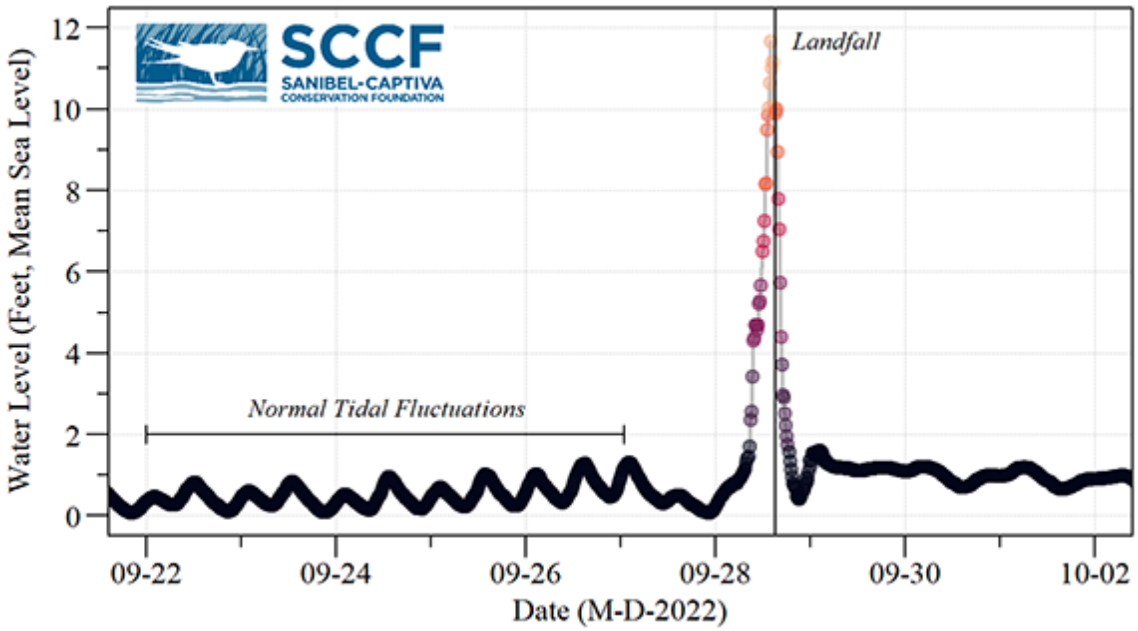


Figure 5. Hurricane Ian Water Elevation Data near Sanibel, FL

The SCCF team reported water elevations over 7.6 feet NAVD (8 feet mean sea level) from 12-3:30 pm, which is a water level that is close to the "7-foot sea level rise scenario" but less than the 100 year water elevation published by FEMA in the Flood Insurance Study. **Figure 6** depicts the approximate inundation extent for the area, under these conditions, according to the NOAA Sea Level Rise Viewer.

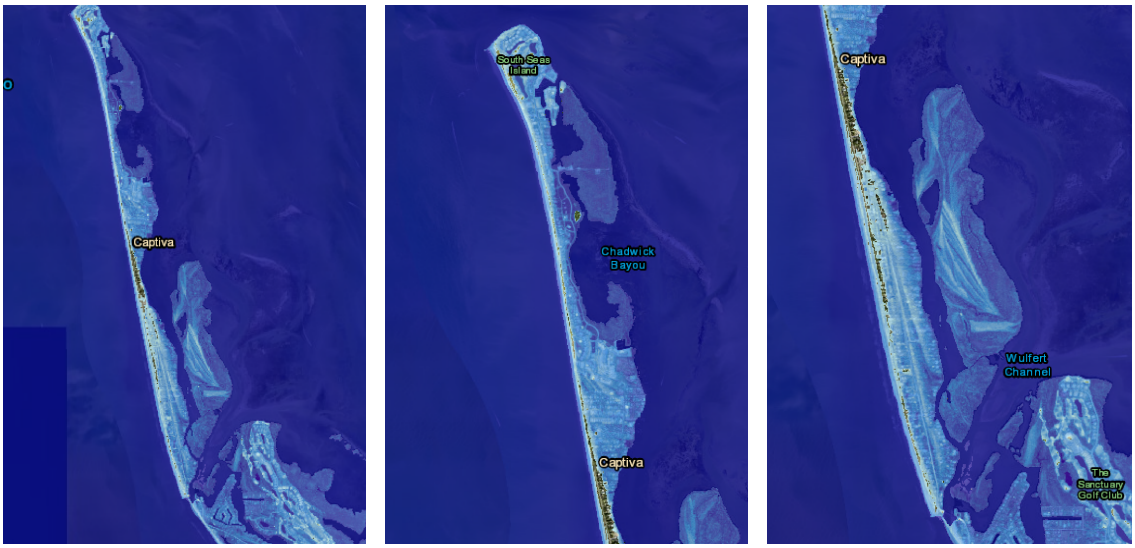


Figure 6. Captiva Inundation Approximating Peak 3 Hour Period in Hurricane Ian - NOAA Sea Level Rise Viewer (Water Level Elevation at 8.3 Feet NAVD)

The bayside of Captiva Island experienced a high degree of flooding, which resulted in impacts to communication facilities and roadways. According to FPL's Power Tracker (electric utility), 85% of Lee County FPL customers were without power the morning after the storm. Much of Captiva's key infrastructure such as water treatment plants, and evacuation route were all impacted by inundation. **Figure 7** highlights an example of infrastructure damage in the aftermath of Ian. Of significance was the collapse of approximately 50 to 65 feet of the Sanibel Causeway bridge, which resulted from the storm's aggressive storm surge and powerful winds. This bridge serves as the only vehicle connection from Captiva and Sanibel to the mainland of Florida, and thus its destruction served as a significant hinderance to Captiva Island residents as they were unable to access resources and aid.

Figure 7. Hurricane Ian Damage to Sanibel Causeway (FDOT, 2022)

CEPD Exposure Analysis

Overview

To provide a comprehensive view of inundation, it is important to review the exposure predictions of Captiva Island under all relevant scenarios and planning horizons mentioned. By doing so, various inundation depths and spatial extents can be compared to each other and in relation to the depths utilized in the 2020 Captiva Island Resiliency Assessment and more incremental flooding can be visualized (**Figures 9-12**). **Figure 8** compares the overall percentage of island inundation for each of the scenario water level elevations. **Table 3** can be referenced to identify the associated scenarios represented by each of the water level elevations depicted in **Figure 8.**

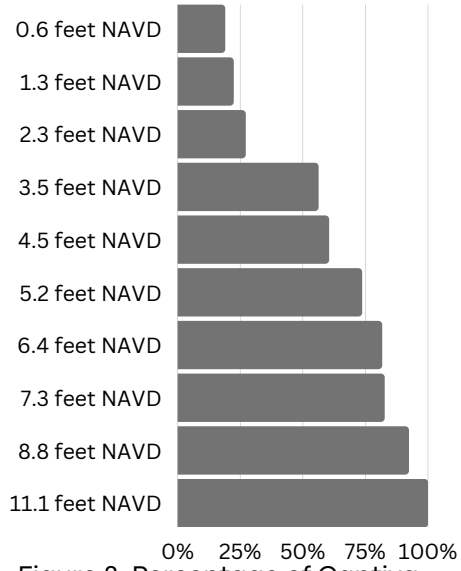


Figure 8. Percentage of Captiva Inundated Under All Flood Scenarios

Rainfall

In this analysis, rainfall was accounted for in conjunction with surge and tidal flooding in the 100 year flood scenario (8.8 feet NAVD). Rainfall flooding was not independently analyzed as it was not required per state guidance, hydrologic modeling results were not publicly available, and rainfall alone was anticipated to pose less flooding threat than surge and other compound flooding scenarios. Tidal, sea level rise, and storm surge flooding will be the prevalent drivers for flooding on Captiva Island.

Table 4 outlines the precipitation frequency estimates with 90% confidence intervals (in inches) for the Fort Myers station, according to the NOAA Precipitation Frequency Data Server (PFDS). A 100 year rainfall event, with precipitation of 8 to 12 inches for a 6-hour and 24-hour duration storm, respectively, would likely result in nuisance or disruptive flooding depending upon soil storage capacity. As an example, on June 4, 2022, over 11 inches of rain fell overnight and resulted in a few inches of standing floodwaters in low lying areas, much of the rain drained into the soil or was diverted off island as runoff. In the future such an event may be more disruptive if soil storage capacity is limited by sea level rise and high tides.

Table 4: PDS-based Precipitation Frequency Estimates with 90% Confidence Intervals (in inches)

Duration	Approximate Rainfall Amounts with a 100%, 20%, and 1% Probability of Being Exceeded Within a Given Year		
	1 Year Event (100% chance)	5 Year Event (20% chance)	100 Year Event (1% chance)
6 hour	3 inches	5 inches	8 inches
24 hour	4 inches	6 inches	12 inches

NOAA Scenario Consolidation

The state guidance for vulnerability assessments requests the use of the NOAA intermediate-low and intermediate-high sea level rise projections (published in 2017) for the planning horizons of 2040 and 2070. As stated previously, due to the close proximity of water elevation levels, the 2040 NOAA Intermediate-High (1.2 feet NAVD) and 2070 NOAA Intermediate-Low (1.3 feet NAVD) do not represent significant differences in inundation extent or depth. To confirm there is no critical difference between the inundation extents of these two elevations, the results of both were compared (**Figure 9).** The lack of difference further validates the consolidation of similar water levels into one scenario. **It is important to note that while Buck Key is included within figures, it was not included in inundation percentages or key metrics presented within this report.**

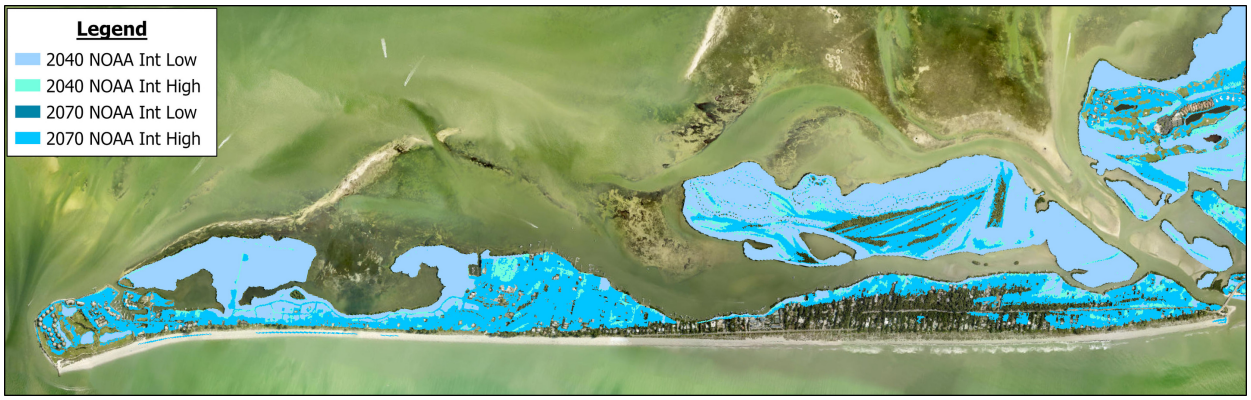


Figure 9. Island Inundation Comparison Map for NOAA Scenarios- 2040 NOAA Intermediate-High and 2070 NOAA Intermediate-Low

Island Exposure Maps

The results of the exposure analysis for the ten scenarios outlined in **Table 3** are represented in **Figures 10-12.** Scenarios were layered and mapped in order of increasing water level elevation to show incremental inundation change across the island. The ten scenarios were mapped across three figures in order to show relative change within specific water elevation level increments and to prevent visual confusion.

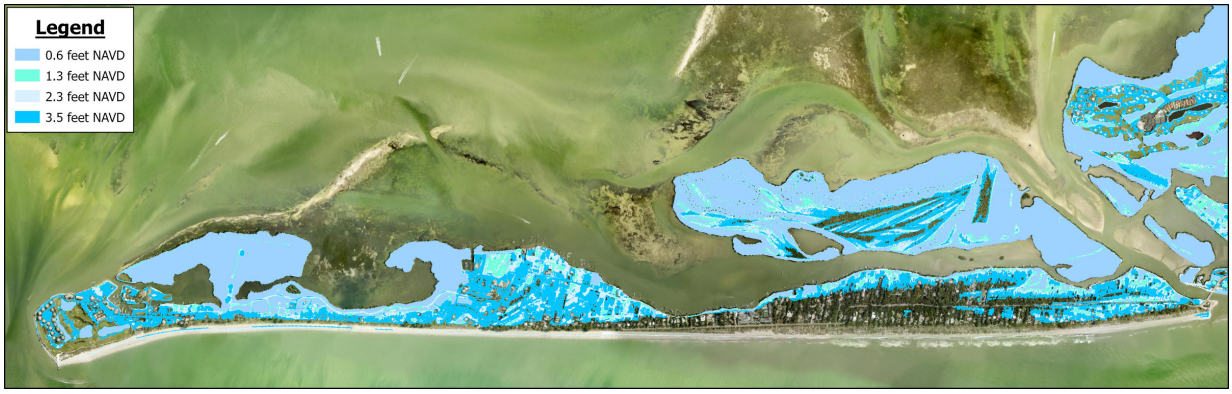


Figure 10. Captiva Exposure Map 1

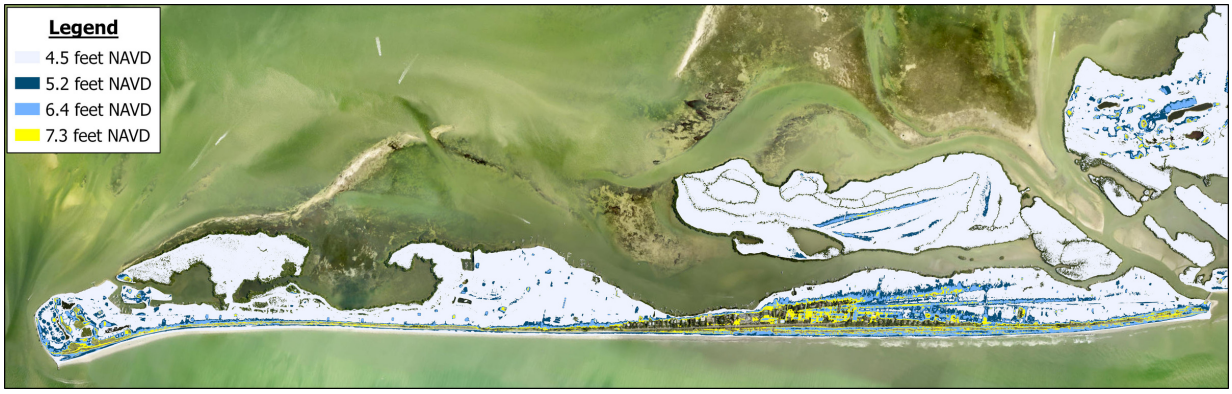


Figure 11. Captiva Exposure Map 2

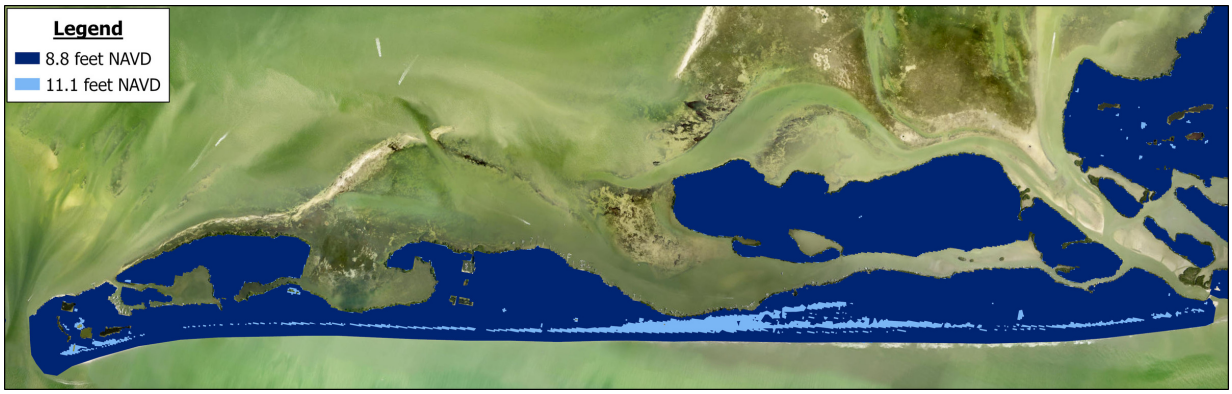


Figure 12. Captiva Exposure Maps by Scenario

Inundation Tipping Point Scenarios

The assessment of asset and infrastructure sensitivity was conducted for all of the ten flood scenarios outlined in **Table 3**, in order to satisfy the new state requirements for resiliency grant funding eligibility. Throughout this report, the overall sensitivity per scenario will be briefly outlined at a high level, however the entirety of the analysis results per critical asset will be detailed in Appendices III-VII. For the purpose of this report and to identify key areas of concern, three of the twelve scenarios were identified as "tipping points" of impact for Captiva Island and these three scenarios will be fully explored and addressed within the report. These three scenarios, outlined below, represent significant changes in overall island inundation and in degree of impact to critical assets and thus will be the focus of this analysis:

1

2.3 feet NAVD

What does this water level represent? This level represents the water level elevation for Current Extreme Tidal Flooding which is also representative of the water level for feet of sea level rise.

Why was this water level chosen as a tipping point? At this level, inundation begins to occur from the bay side, flooding around stormwater infrastructure, minimal flooding of evacuation route, and flooding impacts to some roads.

2

3.5 feet NAVD

What does this water level represent? This level represents the water level elevation for the 2070 NOAA Intermediate-High Sea Level Rise Scenario, which is also representative of the Existing 10 Year Surge and is also representative of the 2040 Tidal Flooding conditions.

Why was this water level chosen as a tipping point? At this level, flooding of roads directly south of the Captiva Library, flooding of all parcels along the shoreline, and mangrove inundation becomes more significant.

3

8.8 feet NAVD

What does this water level represent? This level represents the water level elevation for an Existing 100-year Flood Event.

Why was this water level chosen as a tipping point? At this level, flooding of all almost all parcels is predicted to occur (Figure 12).

Critical Infrastructure Sensitivity Analysis

Parcels

Parcel data was obtained from the Florida Department of Revenue (FDOR) and analyzed for inundation impact from the various flood scenarios. A total of 1,105 parcels exists within Captiva Island. **Figure 13** depicts the number of parcels likely to experience flooding per scenario.

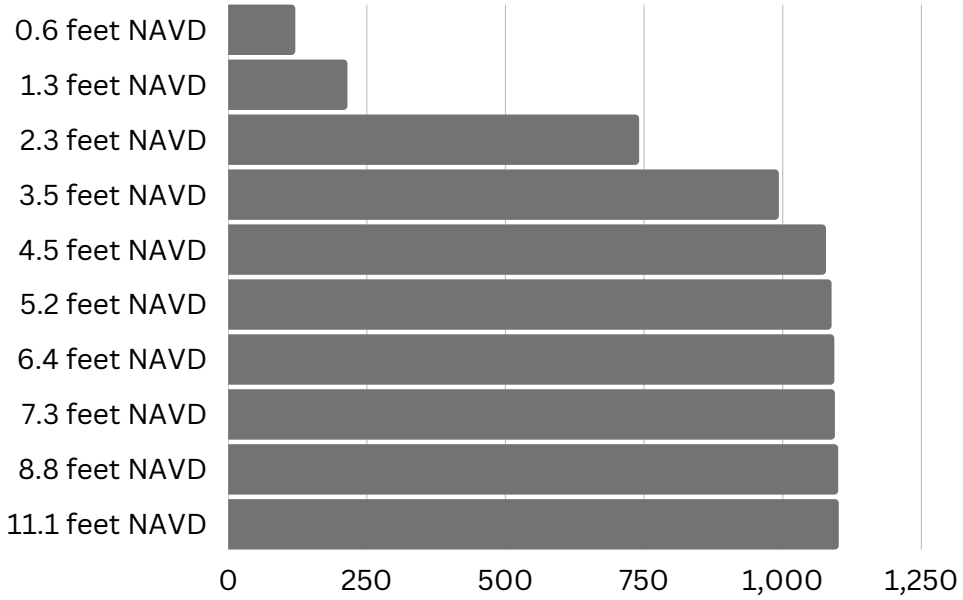


Figure 13. Predicted Number of Impacted Parcels Across All Flood Scenarios

Figure 14 displays the number and percentage of inundated parcels for each of the three inundation tipping point scenarios. **Figure 15** depicts a spatial view of the results of this analysis.

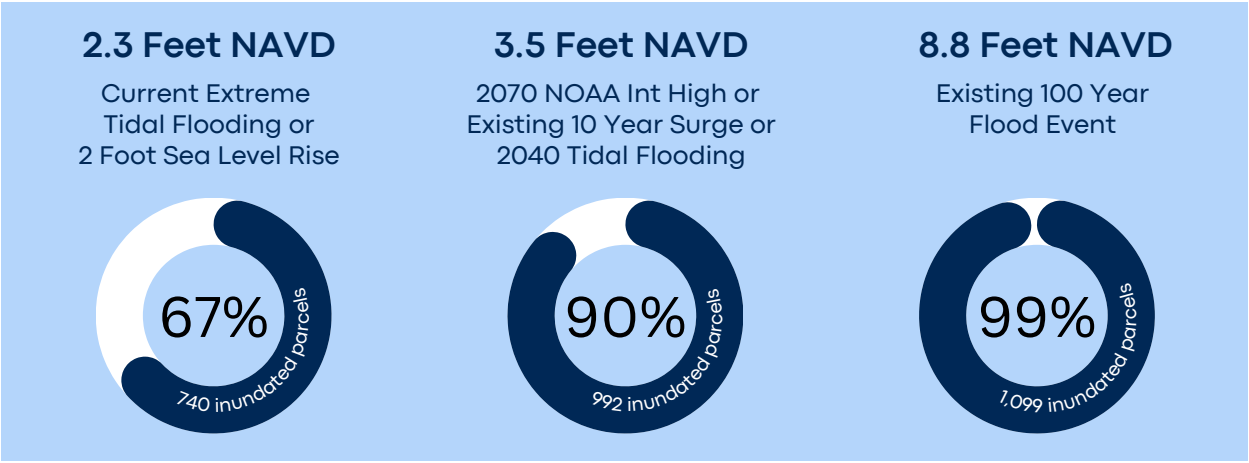


Figure 14. Percentage of Parcel Inundation Under Inundation Tipping Point Scenarios

Figure 15. Parcel Inundation Map for Inundation Tipping Point Scenarios.

Further analysis included estimating the average inundation depth of parcels per flood scenario. The overall results of the inundation depth analysis for the three inundation tipping point scenarios can be seen in **Figure 16.** The further analysis also involved estimating the value of impacted parcels by totaling the value of relevant building footprints within each parcel.

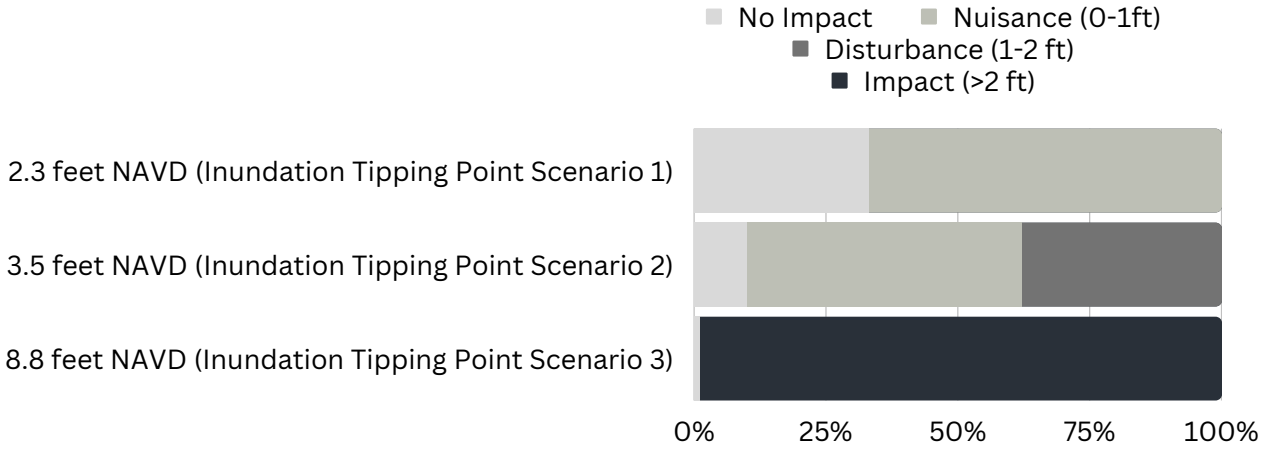


Figure 16. Parcel Inundation Depth Under Inundation Tipping Point Scenarios

Under the Inundation Tipping Point Scenario 1 (2.3 feet NAVD), 67% of all parcels on Captiva Island will experience nuisance flooding of a depth of below one foot. The market value of affected parcels is $1.1 billion; however, damage costs of nuisance flooding would be anticipated to be minimal or null.

Under Inundation Tipping Point Scenario 2 (3.5 feet NAVD), 52% of island parcels are subject to nuisance flooding and 38% of all parcels are subject to flooding >1 foot of depth. The inundation from this scenario is projected to impact parcels totaled at a value of $1.3 billion. Under the Inundation Tipping Point Scenario 3 (8.8 feet NAVD), 99% of island parcels will experience flooding at a depth greater than 2 ft. The value of the parcels impacted equates to $1.6 billion.

The age of the structures built were reviewed in relation to the 1983 FEMA base flood elevation standard (**Figure 17**). For presentation purposes, structure ages were grouped by decade and compared to 1980 rather than 1983. Specifically, under the Inundation Tipping Point Scenario 1 (2.3 feet NAVD), 60% of vulnerable parcels were built before 1980, with an estimated present market value of $500 million. Under the Inundation Tipping Point Scenario 2 (3.5 feet NAVD), 64% of the total vulnerable parcels were built before 1980, with an estimated present market value of $610 million. According to the Inundation Tipping Point Scenario 3 (8.8 feet NAVD), 60% of impacted parcels were built before 1980, and 40% were built after. The impacted parcels have an estimated present market value of $650 million. For the purpose of this evaluation, those parcels without a designated built year (labeled "N/A"), were not included in the total parcel count as it is unclear if these parcels were built before or after the implementation of the 1983 FEMA base flood elevation standard.

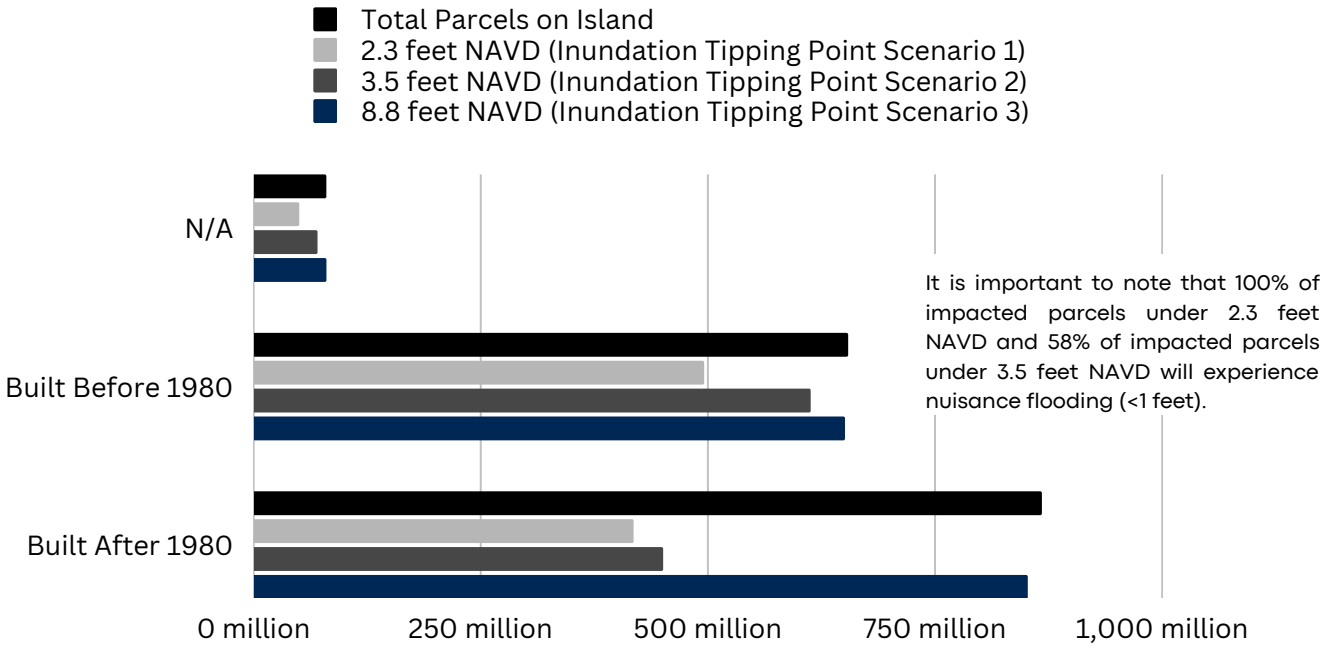


Figure 17. Impacted Parcels by Decade Built and Parcel Value

Buildings

Seven hundred and forty-seven buildings are located on Captiva. The building footprints for Captiva Island were obtained from Lee County and analyzed for initial inundation impact under the various flood scenarios. **Figure 18** displays the number of building footprints that may experience flooding if their elevations is at ground level. **This analysis does not account for elevation certificates or actual structure first floor elevations. An elevated building will not be inundated.**

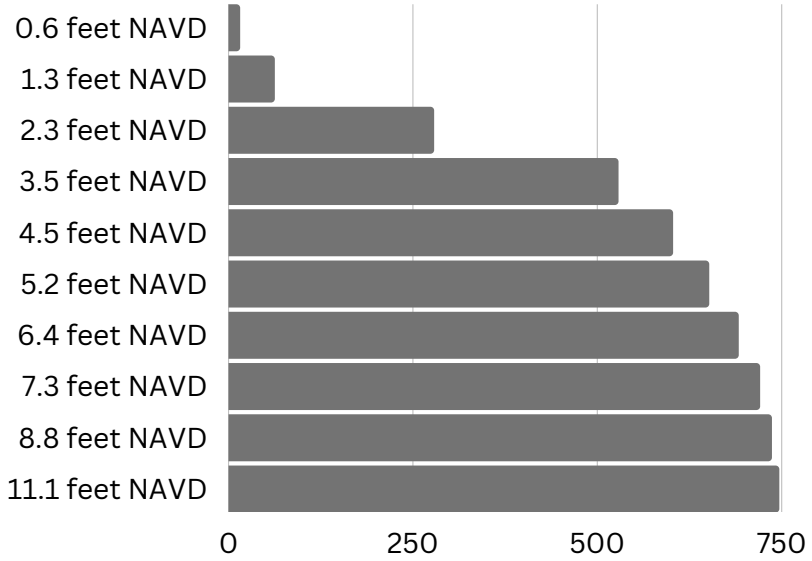


Figure 18. Building Footprint Inundation Across All Flood Scenarios

Figure 19 displays the number and percentage of inundated building footprints for each of the three inundation tipping point scenarios. The location and extent of building impact per scenario can be seen in **Figure 20**.

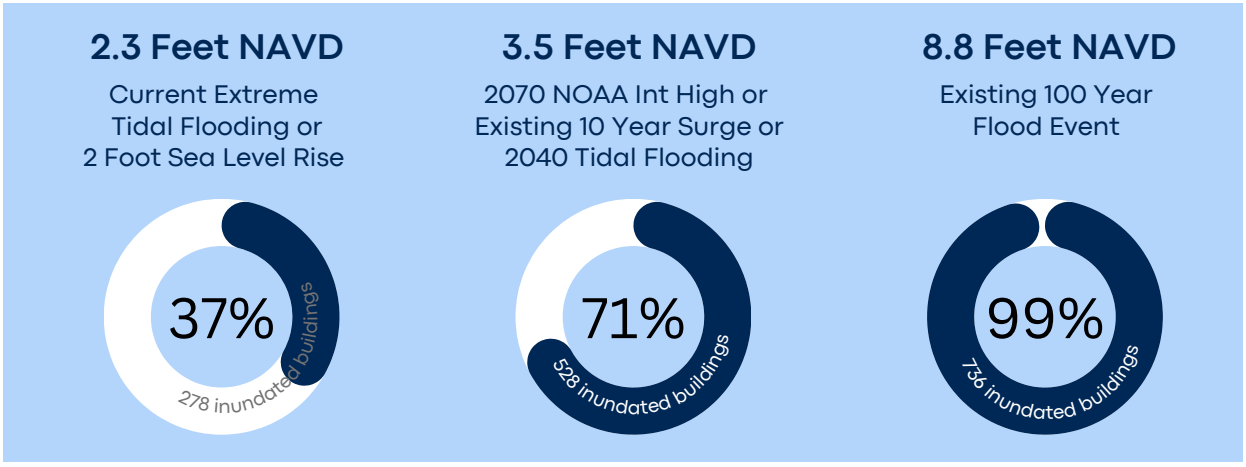


Figure 19. Percentage of Building Footprint Inundation Under Inundation Tipping Point Scenarios

Figure 20. Building Footprint Inundation Map for Inundation Tipping Point Scenarios

A more thorough analysis of building footprint inundation included estimating average building footprint inundation depth, classifying the building footprint data by decade built, and estimating building value per scenario. The methodology used here is the same as that used to complete the parcel inundation analysis. Average depth is represented by the center of the grid of inundation. Thus, the total number of impacted building footprints is reduced as not every footprint that intersects the inundation polygons has its center point fall within the inundation grid. **Figure 21** details building sensitivity per scenario and the associated flooding type- nuisance (< 1 foot of flooding), disturbance (1 to 2 feet of flooding), and impact (> 2 feet of flooding).

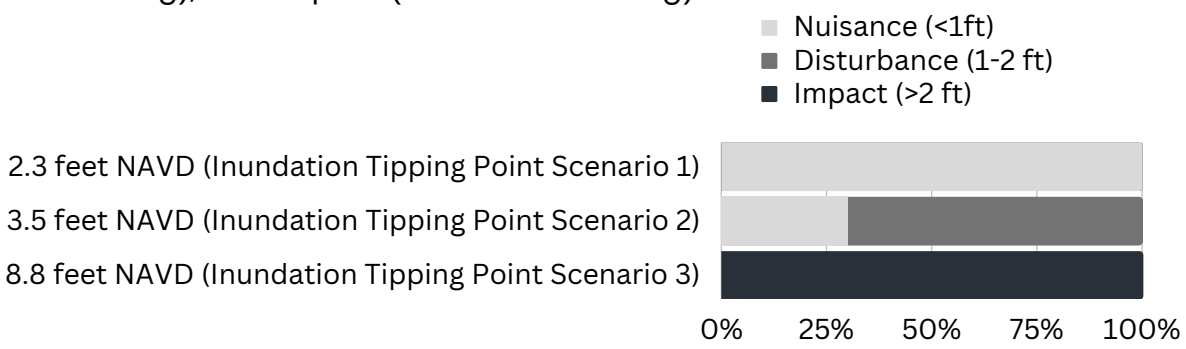


Figure 21. Building Footprint Inundation Depth Under Inundation Tipping Point Scenarios

When classifying projected inundated buildings by flooding type, 100% of all impacted buildings under the 2.3 feet NAVD water level elevation will experience flooding at a depth below 1 foot. This percentage decreases to 30% under the 3.5 feet NAVD water level elevation, with 60% of buildings projected to experience flooding of 1-2 feet deep. Both the degree and depth of flooding across impacted building footprints increases over time. Under the 8.8 feet NAVD water level elevation, 100% of all impacted buildings will experience flooding at a depth greater than 2 feet.

When reviewing the distribution of the predicted inundated building footprints and their associated estimated value over the decades (**Figure 22**), it is clear that the approximately half of the vulnerable footprints were built before the flood insurance standard (before 1983). Again, it is important to note that this analysis does not take into account the current base floor elevations of the buildings. While it is known that all residential homes seaward of the Coastal Construction Control Line (CCCL) built after 1978 were required to have the base floor level elevated, current day elevation certificates were unavailable, and thus, this analysis solely serves as a first order assessment. In general, the findings of this analysis depict the building footprints that are predicted to have flooding at the ground level adjacent to the building.

Under the 2.3 feet NAVD water level elevation, 36% of the buildings experiencing inundation will have been built before 1980. These buildings have a combine estimated value of $150 millionllars. According the 3.5 feet NAVD water level elevation, 49% of the buildings predicted to be inundated are buildings built before 1980, with a total estimated value of 240 million. Under the 8.8 feet NAVD water level elevation, 46% of effected buildings were built before 1980, with an estimated value of 250 million. As stated previously, parcels without a designated built year were not included in the total parcel count.

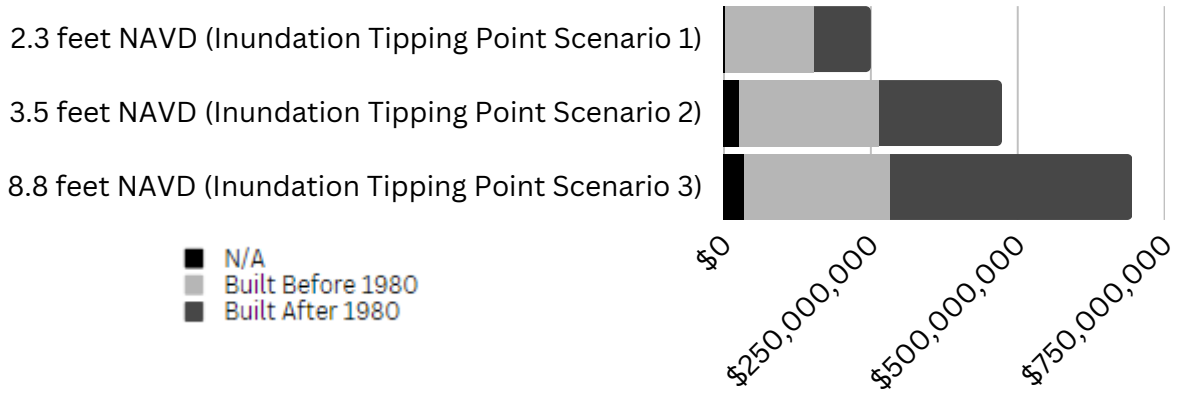


Figure 22 Impacted Building Footprints by Decade Built and Property Value

Seawalls

Seawalls line portions (not all) of Captiva's bayfront shorelines, serving to control erosion and preventing inundation by high tides and surges. Local seawalls along Captiva Island were digitized from 2021 aerial imagery. It is important to note that vegetation exists along the shoreline of the island which obscures the view of some areas, and thus it is possible that not all seawalls were seen and digitized. The result of this digitization depicts a total of approximately 8,600 linear feet of seawall along the bayfront Captiva Island. Seawalls along the gulf front were not included in this analysis.

As-built survey data was not available for the analysis of seawall height, so an alternative method to represent seawalls in the analysis was performed using available ground elevation data for parcels. The predicted exposure (in linear feet) of seawalls per scenario is depicted in **Figure 23.** All seawalls are expected to be exposed under all water level elevations 4.5 feet NAVD and above.

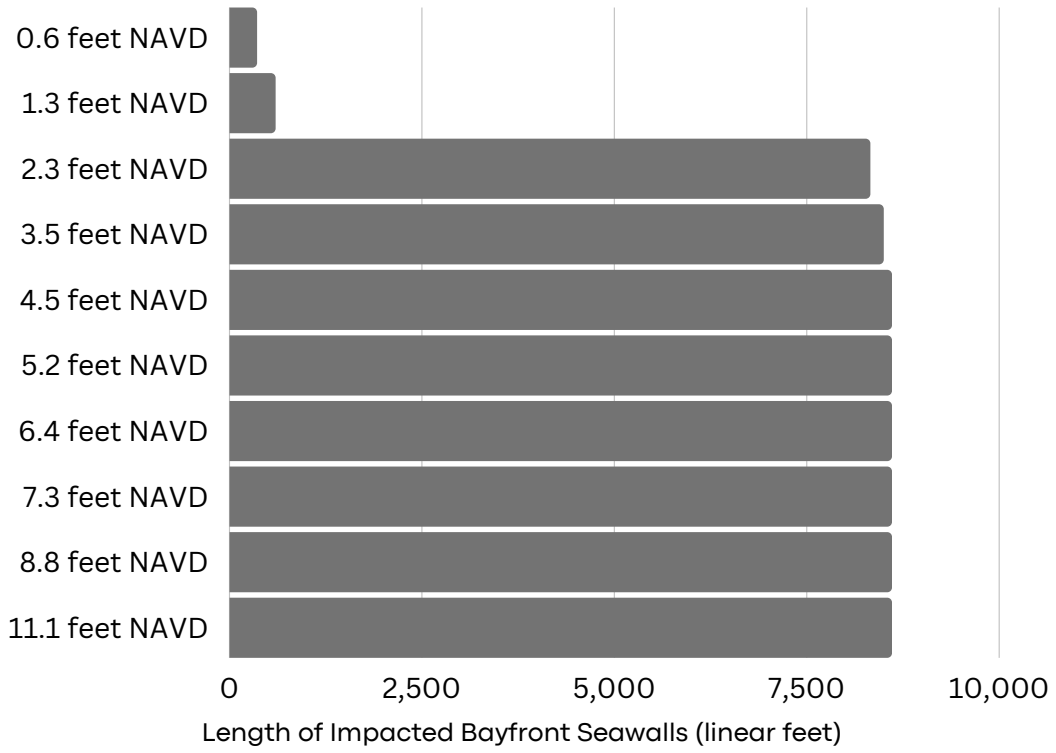


Figure 23. Length of Seawalls Inundated for Each Flood Scenario (Linear Feet of Seawall)

The majority (>97%) of bayfront seawalls are expected to experience flooding under all flood scenarios. Approximately 8,319 linear feet of seawalls are expected to be exposed under the first inundation tipping point scenario (2.3 feet NAVD). Seawall inundation increases to 8,493 linear feet under the 3.5 feet NAVD water level elevation. Under tipping point scenario 3 at 8.8 feet NAVD, all of Captiva's seawalls will experience flooding. The locations and extents of inundated seawalls per tipping point scenario can be viewed in **Figure 25**.

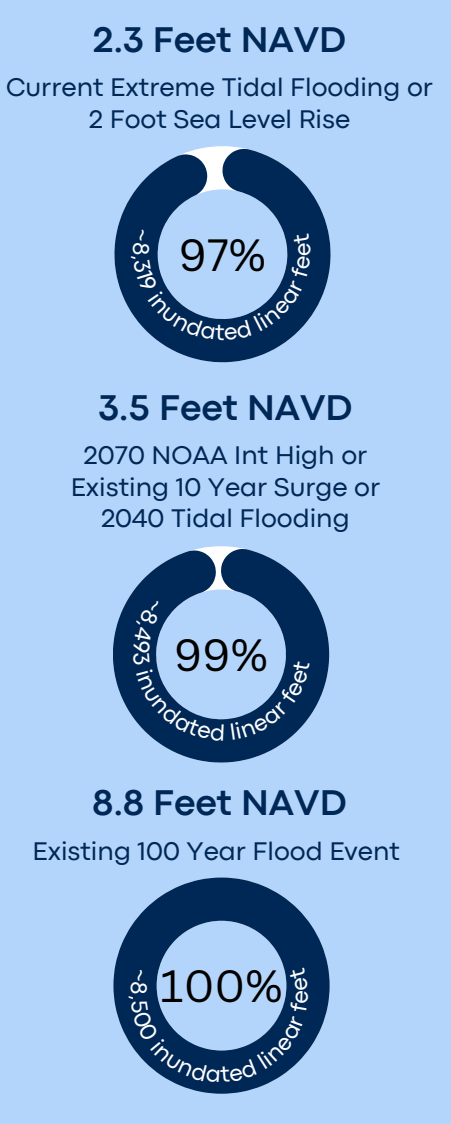


Figure 24. Percentage of Seawall Exposure Under Inundation Tipping Point Scenarios

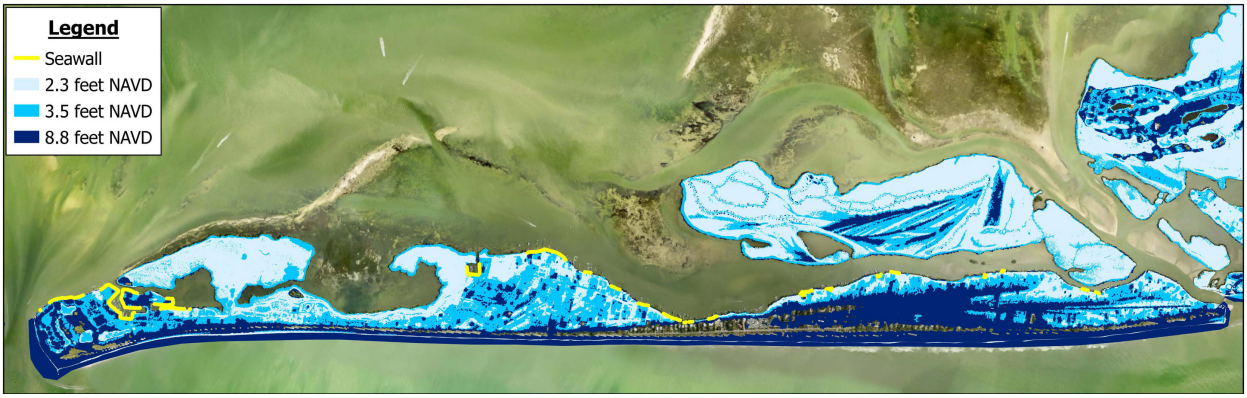


Figure 25. Seawall Exposure Map for Inundation Tipping Point Scenarios

Wastewater Treatment Facilities and Lift Stations

In July 2021, Kimley-Horn completed an engineering study to determine the best ways a central sewer system can fit within Captiva's landscape. The firm prepared a conceptual layout for a wastewater collection and conveyance system for the unsewered portion of Captiva Island that consists of the areas outside the South Seas Resort, which has its own system. More specifically, this includes three areas currently serviced by package Wastewater Treatment plants- the Village Service Area, the Tween Waters Service Area, and the Estates Service Area (**Figure 26**).

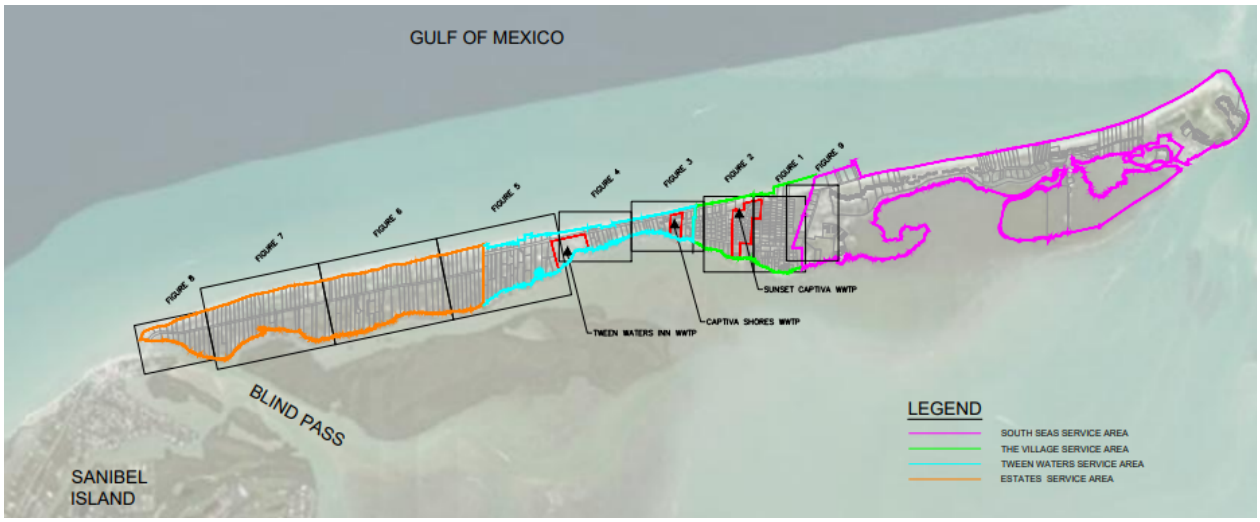


Figure 26. July 2021 Kimley-Horn Study - Unsewered Service Areas of Captiva

Data acquired from Lee County was utilized to map the four Wastewater Treatment Plants (WWTP) located on Captiva Island to determine potential inundation impacts. The analysis results depict the average depth of inundation occurring at the South Seas Plantation WWTP, which is the only WWTP at risk of inundation across the three inundation tipping point scenarios. The South Seas Plantation WWTP is likely to experience inundation at an average depth of 0.3 feet under the 2.3 feet water level elevation, 3.4 feet under the 3.5 feet NAVD water level elevation, and 6 feet under the 8.8 feet NAVD water level elevation (**Table 5**). The Tween Waters Inn WWTP is not expected to experience flooding under any of the three inundation tipping point scenarios.

The results of the analysis depict an average flood depth of 1.5 feet for the Captiva Shores Condominium WWTP under the 3.5 feet NAVD water level elevation and an average depth of 4 feet under the 8.8 feet NAVD water level elevation. Lastly, for the Sunset Captiva WWTP, nuisance flooding is anticipated under the 3.5 feet NAVD water level elevation (with an average depth of 0.7 feet), and flooding with an average depth of 3 feet is anticipated under the 8.8 feet NAVD water level elevation (**Table 5**).

Table 5. Wastewater Treatment Plant Average Inundation Depth (in feet) Under Inundation Tipping Point Scenarios

WWTP Location	2.3 Feet NAVD (inundation tipping point scenario 1)	3.5 Feet NAVD (inundation tipping point scenario 2)	8.8 Feet NAVD (inundation tipping point scenario 3)
South Seas Plantation	0.3	1.5	6.8
Tween Waters Inn	None	None	None
Captiva Shores Condominium	None	1.1	6.1
Sunset Captiva	None	None	4.8

Three lift stations are located on the island of Captiva- one at each of the package plant stations and one City of Sanibel lift station at Turner Beach that serves the Lee County Park. The locations of the lift stations were identified by Kimley Horn (2021) and were approximated for the purposes of this assessment. **Figure 27** highlights the locations of the lift stations, and the wastewater treatment plants on Captiva Island.

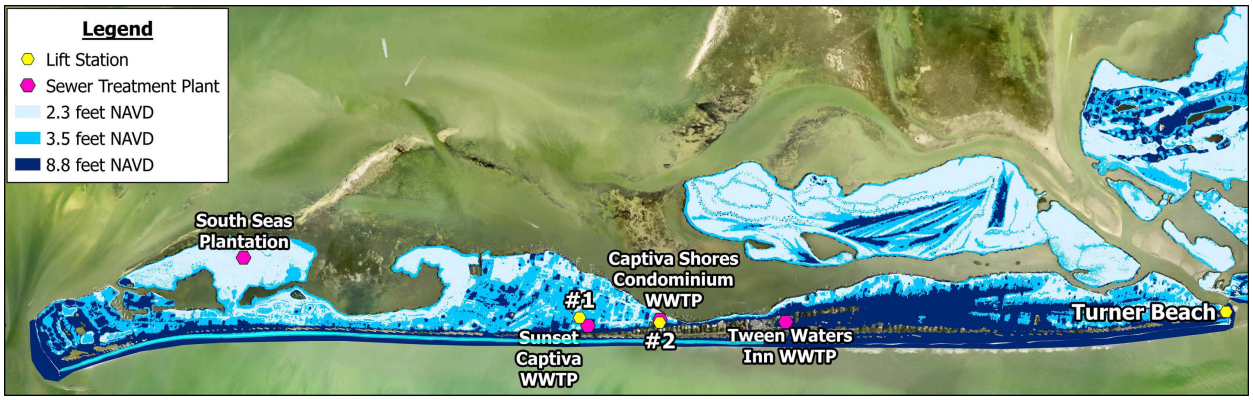


Figure 27. Wastewater Treatment Plant and Lift Station Inundation Map for Inundation Tipping Point Scenarios

While not flooded at tipping point Scenario 1, lift station #1 will likely flood at the remaining two scenarios. Under tipping point Scenario 2, the average inundation depth is 1 foot. Under tipping point Scenario 3, the lift station is predicted to experience an average flood depth of 4 feet. Lift station #2 and the Turner Beach lift station are not likely to experience flooding under inundation tipping point Scenarios 1 and 2 but will experience flooding under inundation tipping point Scenario 3 with an average depth of 4 and 3 feet, respectively. Average inundation depths are outlined in **Table 6**.

Concern for sea level rise is one of the motivators for a wastewater collection system, as the existing septic systems will become largely inoperable due to high ground water if sea level rises as predicted. Consideration of the impacts of sea level rise, following NOAA guidance, helped guide the collection system design. In order for the collection systems to be functional in high ground water situations, lift stations will need to be hardened to storm surge and existing lift stations will need to be rebuilt to a higher "utility grade" standard.

The Kimley-Horn conceptual design also proposes new lift stations for future use, the locations of which were not analyzed for the purpose of this assessment. It is important to note that future wastewater treatment infrastructure may be vulnerable to storm surge, sea level rise, and tidal flooding if not factored into future design.

Table 6. Lift Station Average Inundation Depth (in feet) Under Inundation Tipping Point Scenarios

Lift Station	**2.3 Feet NAVD** (inundation tipping point scenario 1)	**3.5 Feet NAVD** (inundation tipping point scenario 2)	**8.8 Feet NAVD** (inundation tipping point scenario 3)
Lift station #1	None	1	4
Lift station #2	None	None	4
Turner Beach Lift Station	None	None	3

Stormwater Treatment Facilities and Pump Stations

Comprehensive stormwater data for Captiva Island was not available for the purpose of this assessment. Instead, limited longitudinal data was extracted from the 2011 Captiva Water Quality Assessment Project Final Report prepared by the SCCF Marine Laboratory in Sanibel, FL. This report was generated for the Lee County Tourist Development Council (TDC) and the Captiva Community Panel (CCP), and its overall purpose was to investigate the conditions of Captiva's nearshore waters and the potential problems contributing to local water quality. Included within the data collection was a list of all water quality sites established for the project, which included site types related to stormwater infrastructure and storm water occurrences. Specifically, longitudinal data for Captiva catch basins and pipes, swales and retention ponds, standing water, sewer, and outfalls from the report were plotted and assessed for inundation impacts (**Figure 28**).

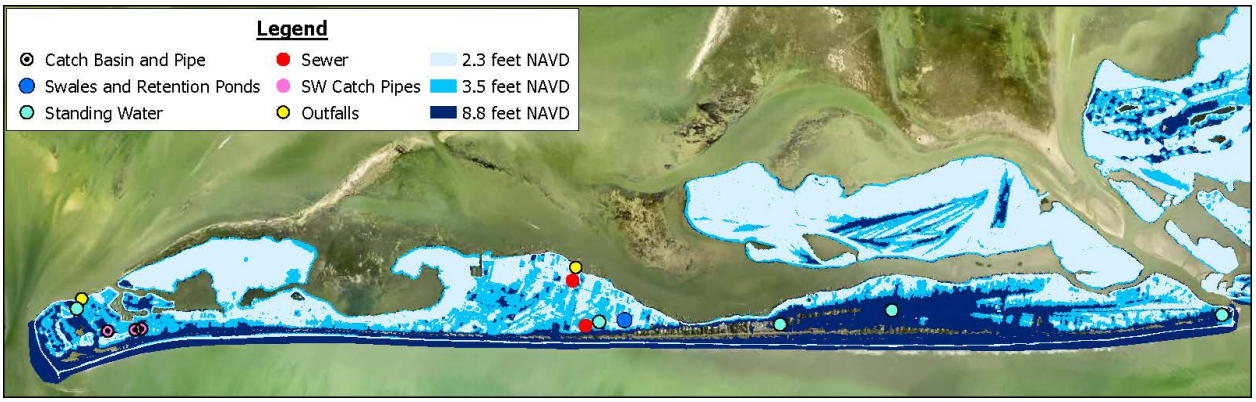


Figure 28. Stormwater Infrastructure Inundation Map for Inundation Tipping Point Scenarios

The water quality report includes sites for three catch basin pipes, one retention pond, six standing water areas, two sewers, and two outfalls located on Captiva Island. These assets do not represent the entirety of the stormwater infrastructure on the island, and with more complete surveying, a future, more comprehensive analysis should be completed. The retention pond is vulnerable to flooding across all three inundation tipping point flood scenarios. Regarding the other stormwater infrastructure types, the number of assets impacted by flooding increase across the tipping point scenarios (**Table 7**). Similarly, the average depth of the predicted inundated increases across tipping point scenarios (**Table 8**).

Table 7. Stormwater Infrastructure Inundation for Inundation Tipping Point Scenarios

Type	Total Number	Inundation (feet)		
		2.3 Feet NAVD (inundation tipping point scenario 1)	**3.5 Feet NAVD** (inundation tipping point scenario 2)	**8.8 Feet NAVD** (inundation tipping point scenario 3)
Catch Basin Pipe	3	0	2	3
Swales and Retention Pond	1	1	1	1
Standing Water	6	2	2	5
Sewer	2	0	1	1
Outfalls	2	2	2	2

Table 8. Stormwater Infrastructure Average Inundation Depth (in feet) Under Inundation Tipping Point Scenarios

Type	Average Inundation (feet)		
	2.3 Feet NAVD (inundation tipping point scenario 1)	**3.5 Feet NAVD** (inundation tipping point scenario 2)	**8.8 Feet NAVD** (inundation tipping point scenario 3)
Catch Basin Pipe	N/A	0.9	3.7
Swales and Retention Pond	0.5	1.9	5
Standing Water	0.4	2.4	3.5
Sewer	N/A	1.5	5
Outfalls	1.8	1.2	6

Electrical Transformers and Utility Boxes

Official electrical data was not available for Captiva Island, so to account for the electrical transformers and utility boxes on Captiva, the street view of Google maps was used to map their locations along Captiva Drive. This exercise was conducted for assets on Captiva Island, outside the South Seas Island Resort area. A total of eighty transformers and utility boxes were surveyed and accounted for the purpose of this analysis, the locations of which are depicted in **Figure 29**. A portion of the utility boxes mapped may represent communication boxes, but additional site visits would need to be conducted in order to verify. Under Inundation Tipping Point Scenario 1, 8% of the assets will be affected by flooding, under Inundation Tipping Point Scenario 2, 35% will be affected, and under Inundation Tipping Point Scenario 3, 100% will be affected. The depth of flooding anticipated for the eighty assets, under each scenario are summarized in **Figure 30**. The sixteen electrical transformers and utility boxes projected to experience tidal flooding at a depth of >1 foot by 2040 are located in the area denoted by a circle within **Figure 29.**

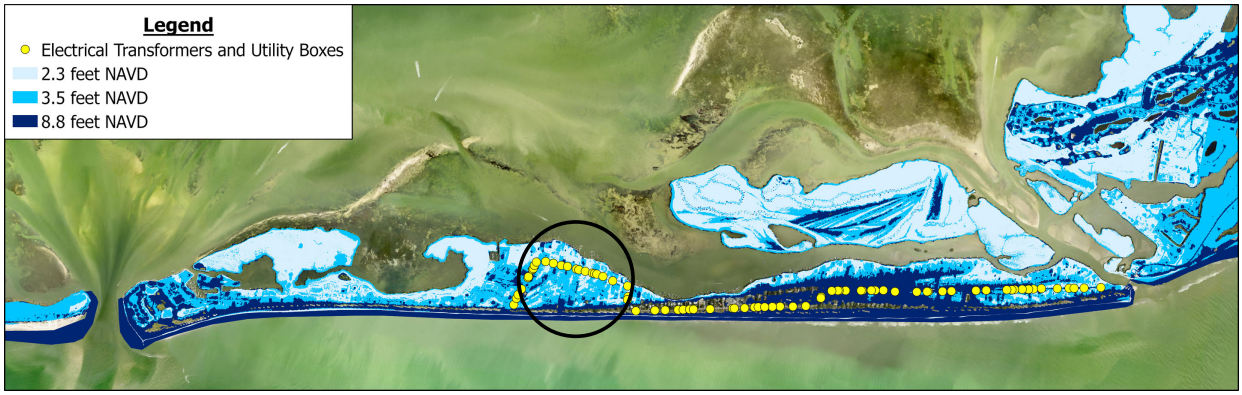


Figure 29. Electrical Transformers and Utility Boxes Location & Inundation Map for Inundation Tipping Point Scenarios.

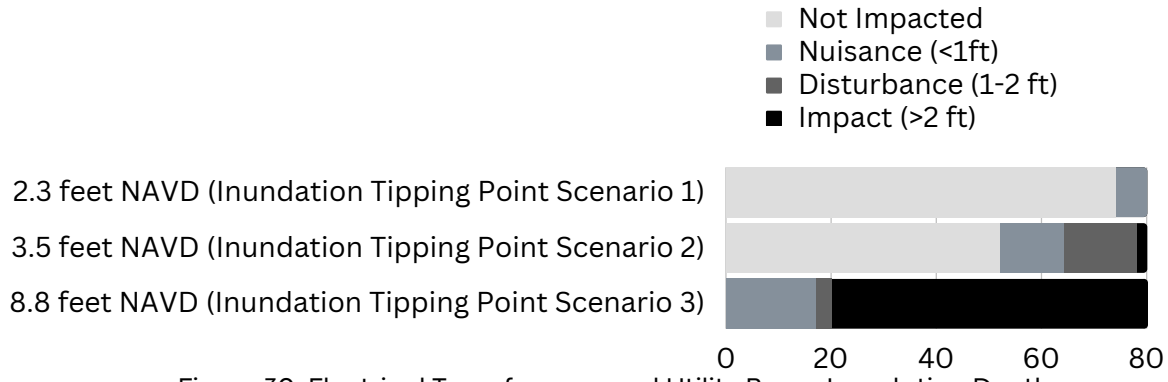


Figure 30. Electrical Transformers and Utility Boxes Inundation Depth Under Inundation Tipping Point Scenarios

Communication Facilities

Individuals rely on communication facilities to relay information, connect with others, call for help, etc. If a communication tower is flooded and inoperable, it could result in nearby residents and facilities being unable to reach or receive calls which can be dangerous, especially because the local Emergency Medical Services (EMS) facility is located on Captiva Island. **Figure 31** depicts the communication facility on Captiva Island located directly west of the South Seas Wastewater Treatment Plant. The South Seas tower was identified in the 2020 Captiva Island Resiliency Assessment produced by Integral consulting. Additional communication facilities across Lee County can be viewed in Appendix I.

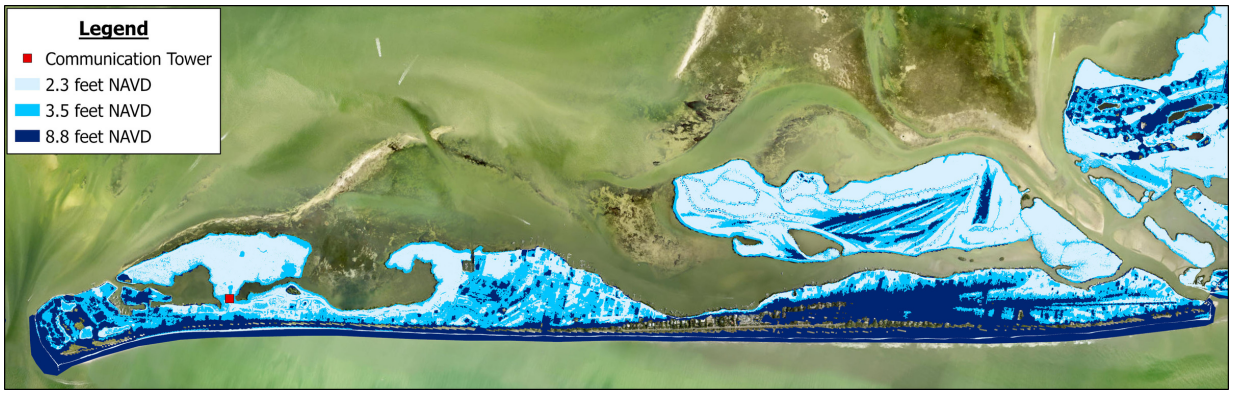


Figure 31. Communications Facilities Inundation Map for Inundation Tipping Point Scenarios

The closest inundation point was utilized to predict potential flood impacts to the communication tower. The results of this analysis predict that under the 2.3 feet NAVD water level elevation, the communication tower will not experience flooding. According to the Inundation Tipping Point Scenario 2 (3.5 feet NAVD), the South Seas Tower will experience inundation with an average depth of 0.8 feet. The flooding threat to the tower increases under the 8.8 feet NAVD water level elevation, with an average projected flood depth of six feet.

Solid and Hazardous Waste Facilities

A Solid and Hazardous Waste Facility does not exist on Captiva Island. The nearest facility, the Sanctuary Golf Club was examined for the purpose of this assessment and is located one mile from Captiva's southern tip (**Figure 32**). The average depth of anticipated inundation under the three inundation tipping point scenarios are as follows:

1. **2.3 feet NAVD:** 0.4 feet
2. **3.5 feet NAVD:** 0.8 feet
3. **8.8 feet NAVD:** 3.1 feet

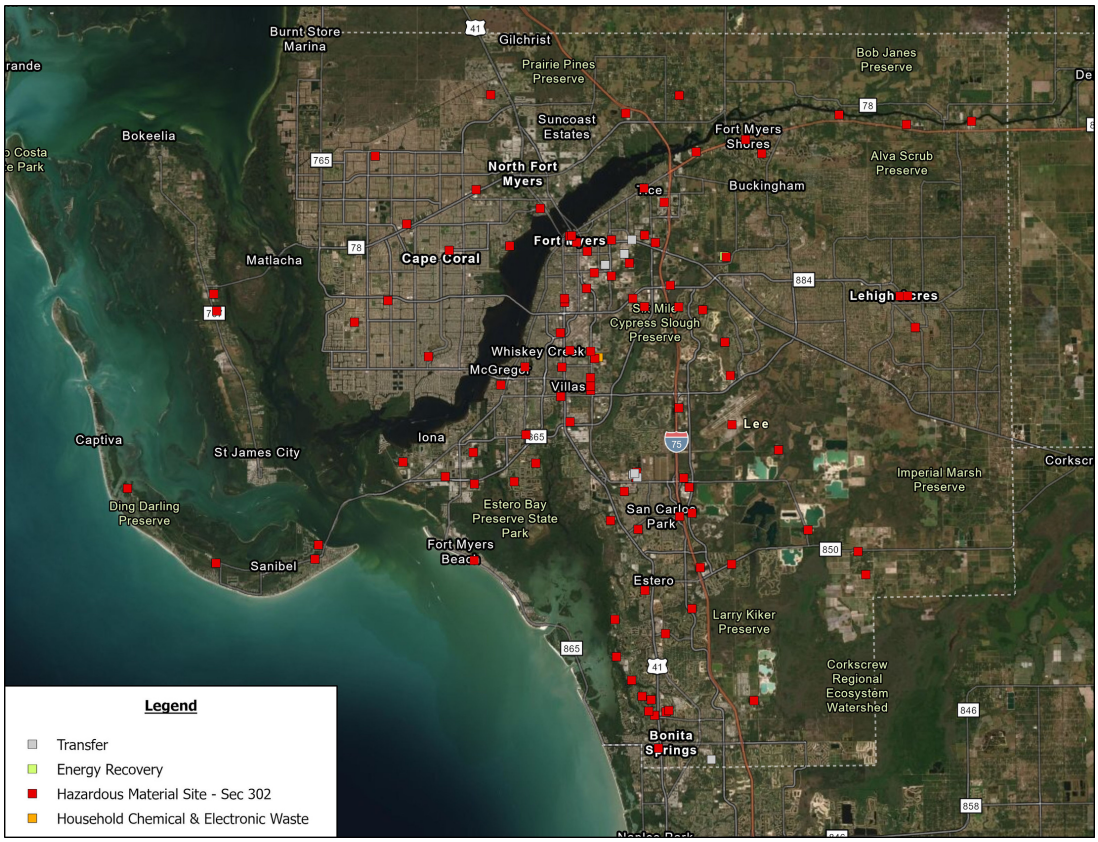


Figure 32. Lee County Solid and Hazardous Waste Facilities

Disaster Debris Management Sites

One Disaster Debris Management Site (DDMS) is located on Captiva Island (**Figure 33**). A DDMS is a temporary staging area for disaster debris including demolition waste and yard waste. The DDS is located within South Seas, so is generally not accessible to all of Captiva residents. However, Disaster Debris Management Sites are a state defined critical asset, and thus it was included within this assessment.

Figure 33. Disaster Debris Management Sites Inundation Map
for Inundation Tipping Point Scenarios

The site itself does not intersect with the Inundation Tipping Point Scenarios 1 and 2 (2.3 feet NAVD and 3.5 feet NAVD, respectively). However, the surrounding parcels, roads, and infrastructure are projected to be inundated by 2070, which would decrease or eliminate the accessibility of the site. Under Inundation Tipping Point Scenario 3 (8.8 feet NAVD), the site will be impacted by inundation with an average depth of 3 feet.

Transportation Assets and Evacuation Routes Sensitivity Analysis

Roadways and Bridges

Major roadways along Captiva Island are essential not only in emergencies, but in everyday life as residents depend on them to sustain their lifestyles. The functionality of roadways determines the mobility of people and the accessibility of places and resources. Flooding can impact road networks making them unusable and unreliable. Even in non-evacuation scenarios, roadways need to be navigable for emergency purposes so emergency response services such as fire trucks and ambulances can access residents and infrastructure. To determine the level of impact flooding is predicted to have on roads within Captiva Island, roadway data was downloaded from UF Geoplan Center. Linear footage of roadway inundation and roadway type were identified for each flood scenario.

A total of 48,797 linear feet of roads exist on Captiva Island and **Figure 34** outlines linear feet of roadway exposed per scenario.

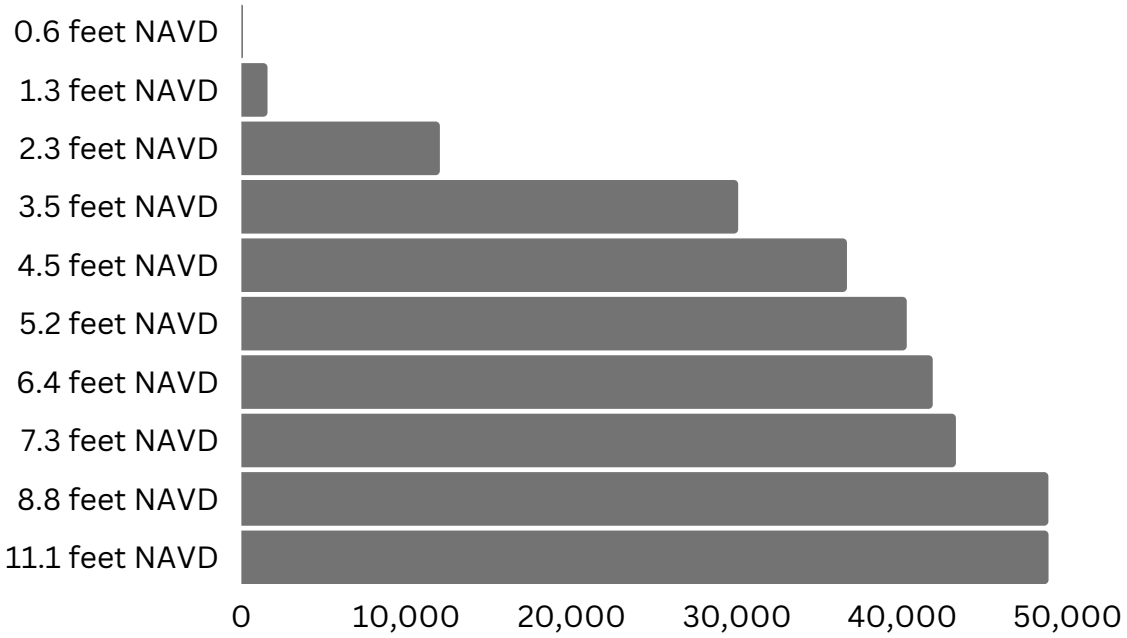


Figure 34. Roadway Exposure Across All Flood Scenarios (in linear feet)

Figure 35 depicts road elevation for all roads on Captiva, which helps to visualize low lying areas and road segments that would be the first to flood. It is evident that the majority of roads on the northern half of the island are at lower elevations than roads on the southern half of the island.

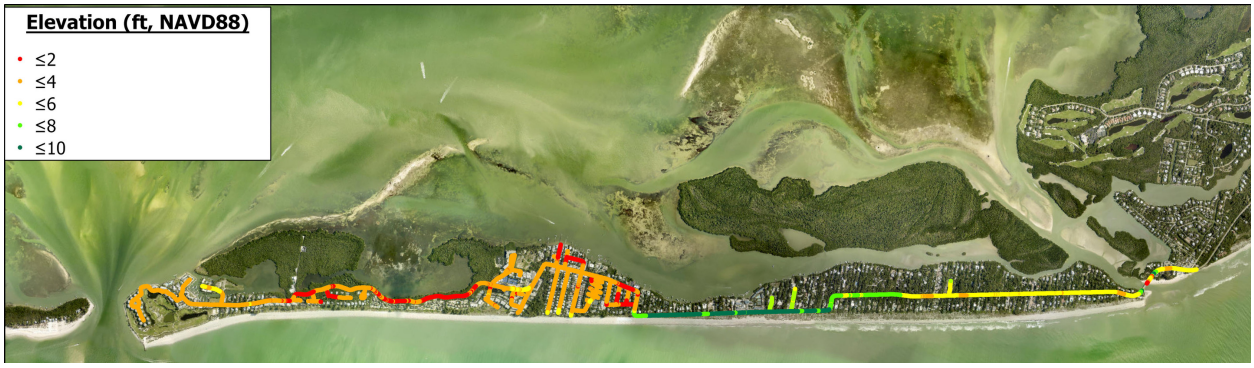


Figure 35. Captiva Roads Elevation Map

Inundated roads were also classified by owner **(Table 9)**. For the purpose of this analysis, public and private roads were identified. This evaluation and level of detail helps to characterize the impact of inundation on public roads vs private roads. **Figure 36** displays this breakdown via percentages to show approximately half of inundation impacts occur to public roads and half occur to private roads, under the three tipping point scenarios.

Table 9. Inundated Roadways Classified by Owner Under Inundation Tipping Point Scenarios

	Road Owner - Linear feet (% of total)		
	Public Roads	Private Roads	Total Roadways
2.3 feet NAVD	5,640 (47%)	6,359 (53%)	11,999
3.5 feet NAVD	16,1496 (46%)	19,097 (54%)	35,246
8.8 feet NAVD	17,417 (41%)	25,488 (59%)	42,905

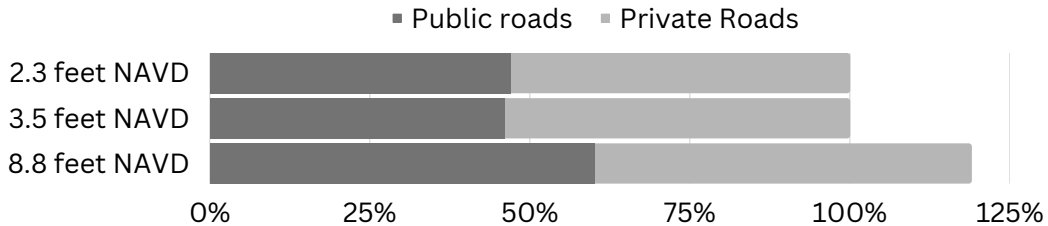


Figure 36. Percentage of Roadway Inundation by Roadway Type for Inundation Tipping Point Scenarios

When evaluating the vulnerability of roadways, it is important to identify any bridges along major routes that may also be vulnerable to flooding. The only bridge that exists on Captiva Island connects the Island to Sanibel Island. The road before the bridge on the Captiva side is predicted to experience inundation as is the parcel adjacent to the bridge **(Figure 37)**. The vulnerability of the surrounding infrastructure and connected roadways will consequently impact the bridge's accessibility and reliability. If connected roadways are flooded and residents are unable to access the bridge, the mobility and movement of people and resources will be impacted.

The elevation of the lowest point of the ascending bridge is 6.9 feet NAVD, resulting in anticipated flooding of the bridge itself at 7 feet of sea level rise, and during an Existing 100 Year Flood Event (8.8 feet NAVD) and a 500-year Flood Event (11.1 feet NAVD). **Table 10** depicts the predicted average inundation depths for each of these scenarios.

Table 10. Bridge Average Inundation Depth (in feet) for Relevant Scenarios

Scenario	Average Inundation Depth (feet)
7 Foot Sea Level Rise	0.4
Existing 100 Year Flood Event (8.8 feet NAVD)	1.9
Existing 500 Year Flood Event (11.1 feet NAVD)	4.2

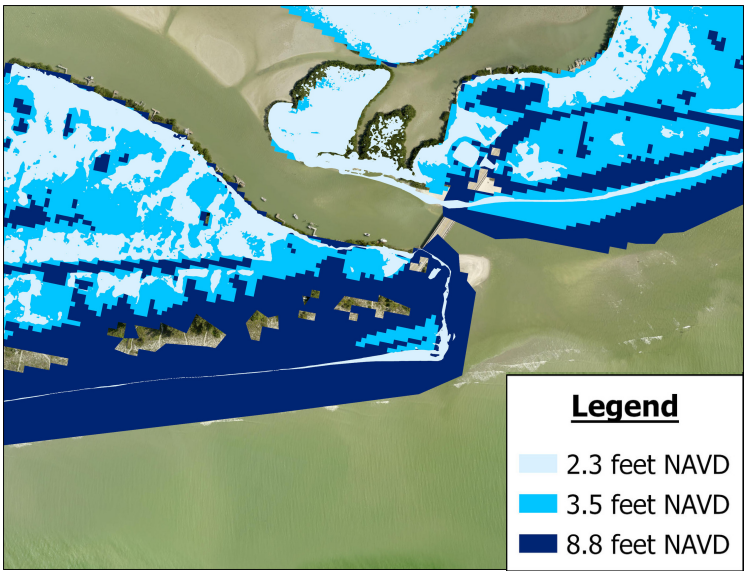


Figure 37. Bridge Inundation for Inundation Tipping Point Scenarios

Evacuation Routes

Captiva Drive serves as the island's evacuation route and its only connection to Sanibel. Inundation along this roadway could result in service interruptions, road closures, traffic delays, emergency service delays and overall loss of evacuation. The elevation of this roadway was assessed to determine the specific segments of the roadway at the lowest elevations, as these areas are most likely to flood first and to pose threat to service and evacuation interruptions. **Figure 38** depicts the results of the initial elevation evaluation. Overall, the northern portion of Captiva Island sits at a lower elevation than the remainder of the roadway and runs in close proximity to the bayside edge of Captiva Island with little to no buffer against the water body. It is important to note that Captiva Island is within evacuation zone A, and thus, it is expected that during storm surge events, the island will be evacuated, and roadway accessibility will not be required. However, flooding from tidal conditions, sea level rise, and compounded sources, pose inundation threats to the evacuation route, which residents would rely on to leave the island if circumstances necessitated.

Figure 38. Captiva Evacuation Route Elevation

Utilizing the approximate centerline of Captiva Drive, road segments were then assessed to determine specific locations and magnitudes of inundation per scenario. The average inundation depth in feet for the evacuation route per scenario is outlined in **Figure 39**.

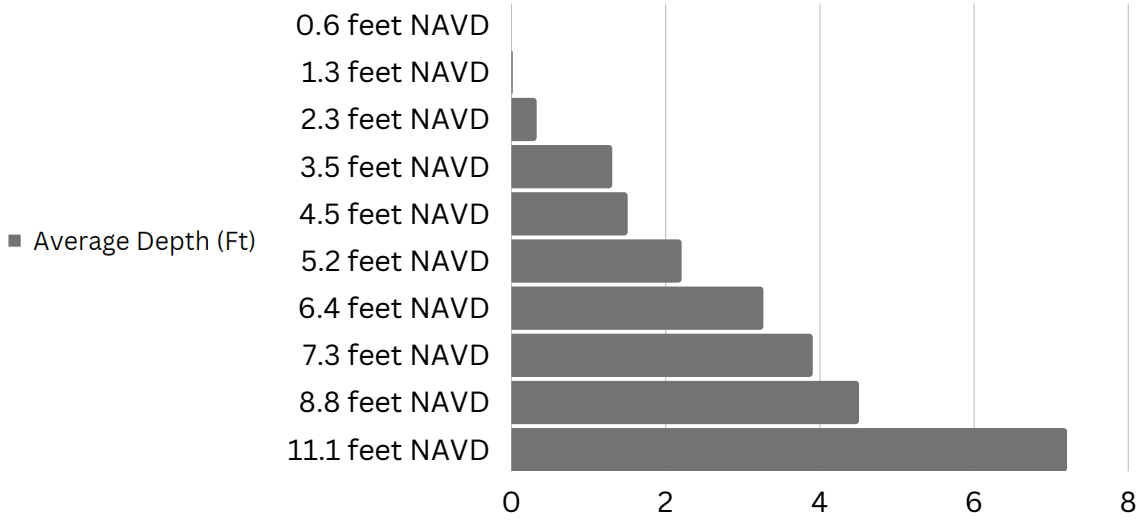


Figure 39. Captiva Evacuation Route Average Inundation Depth Across All Flood Scenarios

The average, minimum, and maximum, inundation depth for each inundation tipping point scenario is outlined in **Table 11**. Flooding depths greater than one foot have the ability to not only inhibit mobility but can eliminate the ability of emergency response and evacuation to and from the northern region of Captiva Island. In instances of hurricanes and storms, this can be extremely dangerous, leaving residents stranded without the ability to reach resources and aid. **Figure 40** depicts the predicted evacuation route inundation for the three inundation tipping point scenarios.

Table 11. Evacuation Route Elevation Summary Under Inundation Tipping Point Scenarios

	Inundation Depth (feet)		
	Average	Minimum	Maximum
2.3 feet NAVD	0.3	0	0.9
3.5 feet NAVD	1.3	0	2.4
8.8 feet NAVD	4.5	1	8

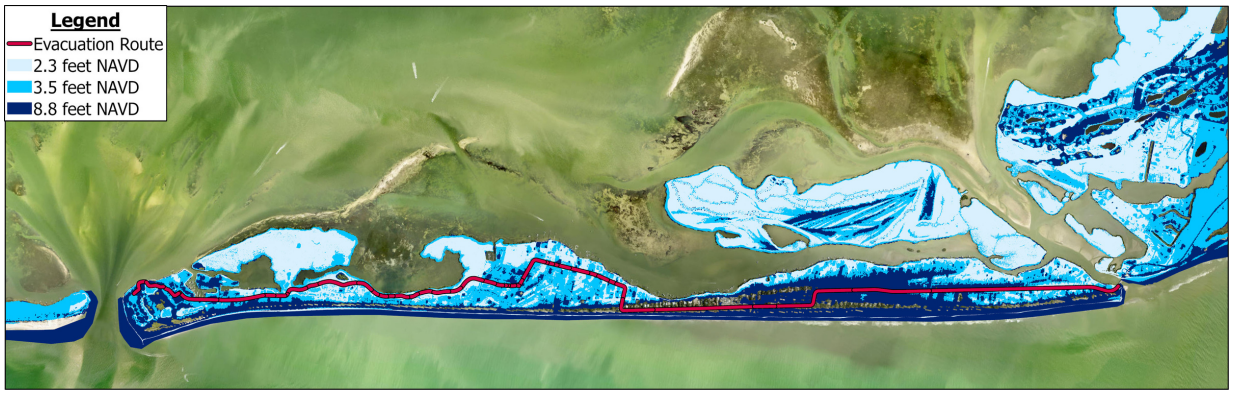


Figure 40. Evacuation Route Inundation Map for Inundation Tipping Point Scenarios

Marinas

Seven marinas exist on Captiva Island (**Figure 41**). The associated parcel for each marina coordinate point was utilized to estimate inundation under the ten flooding scenarios.

Figure 41. Captiva Marinas

All scenarios cause flooding to all seven marinas, except for the scenarios with the two lowest water level elevations (0.6 feet NAVD and 1.3 feet NAVD), which impact four and six marinas respectively. To better understand the magnitude of this inundation, inundation depth was estimated for each marina, under each flood scenario. The results of this analysis for the three inundation tipping point scenarios are summarized in the subsequent pages, in **Figures 42-48** and **Table 12** and **Table 13**.

Depth represents the average across the relevant parcel so while a greater extent of inundation may exist under certain scenarios, the flooding depths across the expanded area vary and reduced depths in some areas can result in a reduced overall average depth. Under Inundation Tipping Point Scenario 1 (2.3 feet NAVD), six of the seven marinas will experience nuisance flooding (<1 foot deep), and one marina (located at 2800-5640 South Seas Plantation Road) will experience more significant flooding at 1.6 feet deep. According to Inundation Tipping Point Scenario 2 (3.5 feet NAVD), the average inundation at all impacted marinas will be greater than 1.5 feet. Again, the marina located at 2800-5640 South Seas Plantation Road is anticipated to experience flooding at a greater depth than the others, at an average of 2.8 feet deep. The marina located at 15903 Captiva Drive is also projected to experience more impactful flooding, with an average inundation depth of 2.4 feet. The extent of flooding exposure for each marina was examined in detail to identify specific impacts on infrastructure and accessibility. The results of this qualitative review for Inundation Tipping Points 1 and 2 are summarized in **Table 14**. Inundation Tipping Point Scenario 3 (8.8 feet NAVD) was not included in **Table 14** because the majority of the island is inundated under this scenario, resulting in the inundation of all marinas.

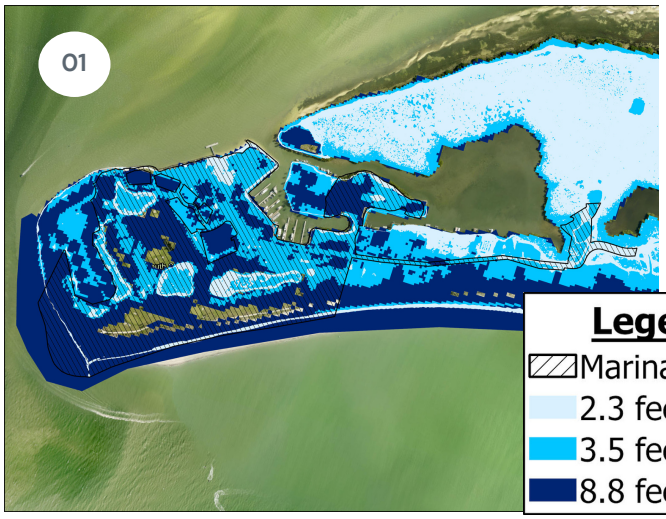


Figure 42. 1057-1900 South Seas Plantation Road Marina Inundation Map

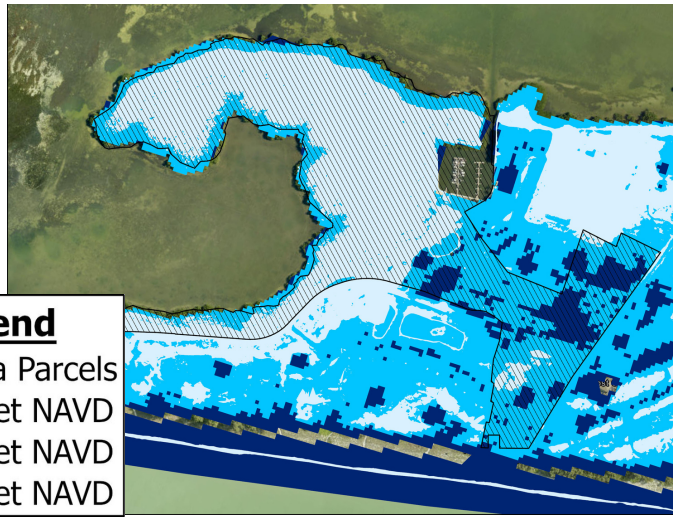


Figure 43. 2800-5640 South Seas Plantation Road Marina Inundation Map

Table 12. Marina Average inundation Depth (in feet) Under Inundation Tipping Point Scenarios-Part 1

		Average Inundation Depth (feet)		
	Marina Address	2.3 Feet NAVD (Inundation Tipping Point 1)	3.5 Feet NAVD (Inundation Tipping Point 2)	8.8 Feet NAVD (Inundation Tipping Point 3)
01	1057-1900 South Seas Plantation Road	0.7	1.6	4
02	2800-5640 South Seas Plantation Road	1.6	2.8	6
03	11401 Andy Rosse Lane	0.2	1.7	6
04	15107 Captiva Drive	0.3	1.7	6

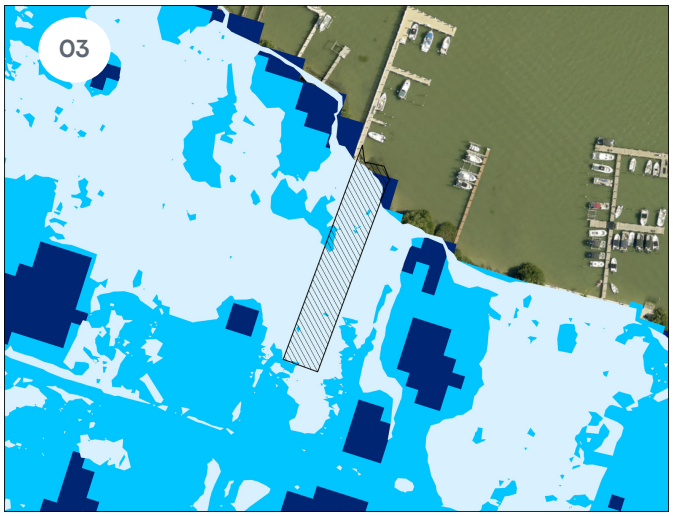


Figure 44. 11401 Andy Rosse Lane Marina Inundation Map

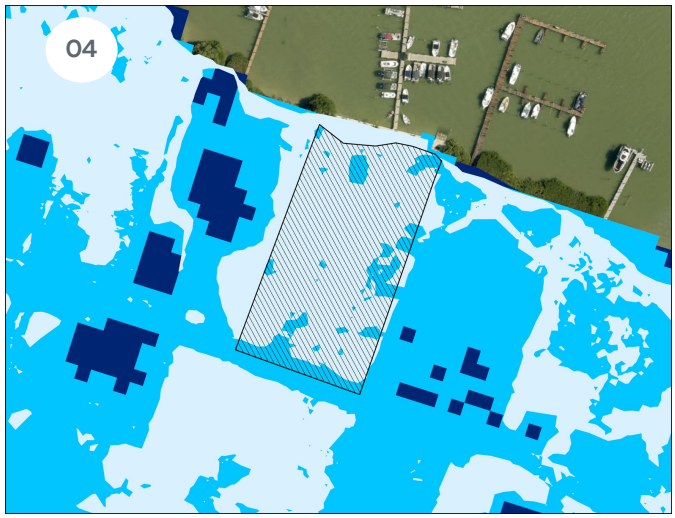


Figure 45. 15107 Captiva Drive Marina Inundation Map

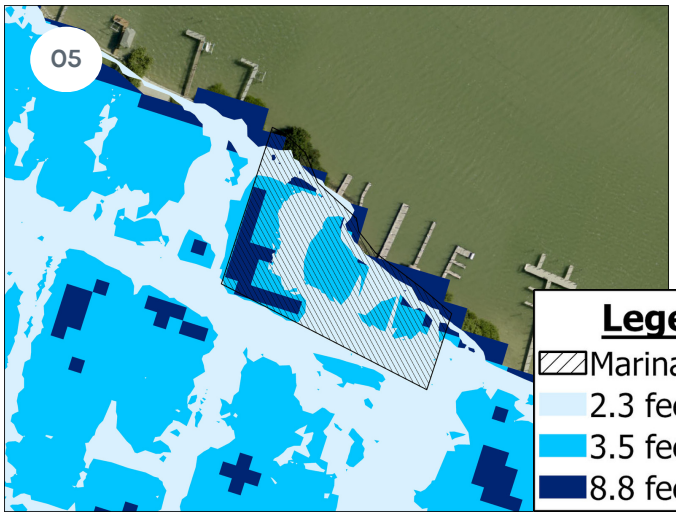


Figure 46. 15183 Captiva Drive Marina Inundation Map

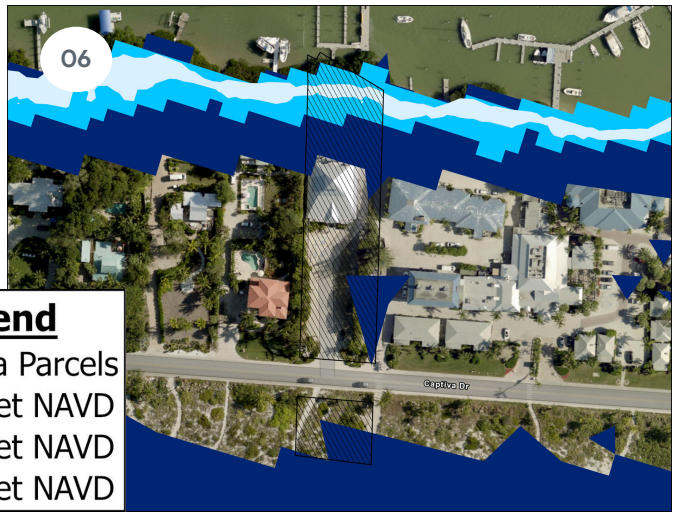


Figure 47. 15903 Captiva Drive Marina Inundation Map

Table 13. Marina Average inundation Depth (in feet) Under Inundation Tipping Point Scenarios-Part 2

		Average Inundation Depth (feet)		
	Marina Address	2.3 Feet NAVD (Inundation Tipping Point 1)	3.5 Feet NAVD (Inundation Tipping Point 2)	8.8 Feet NAVD (Inundation Tipping Point 3)
05	15183 Captiva Drive	0.2	1.5	5
06	15903 Captiva Drive	0.7	2.4	3
07	15951 Captiva Road	0.9	1.8	3

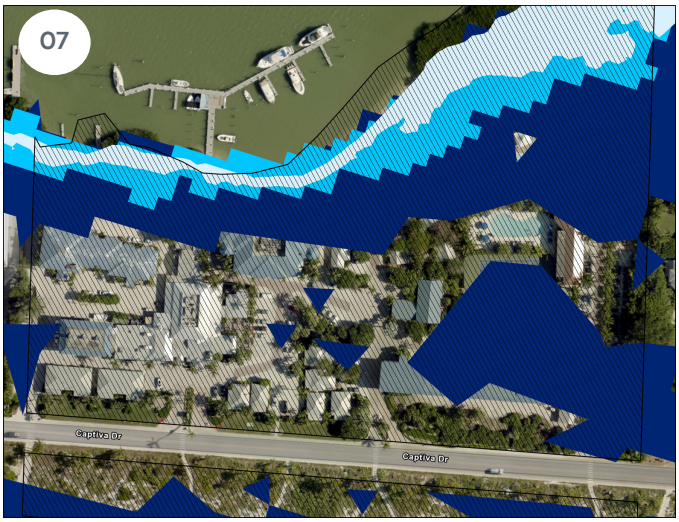


Figure 48. 15951 Captiva Road Marina Inundation Map

Table 14. Marina Impact Under Inundation Tipping Point Scenarios

	Marina Address	2.3 Feet NAVD (Inundation Tipping Point 1)	3.5 feet NAVD (Inundation Tipping Point 2)
01	1057-1900 South Seas Plantation Road	Entire mangrove area impacted by flooding. Southern portion of Plantation Road and bayside parcels begin to flood. Portions of South Seas Resort flooded.	The majority of Plantation Road and local roads experience inundation. Major points of entry, bayside properties, resorts, and marina infrastructure impacted.
02	2800-5640 South Seas Plantation Road	Significant portions of mangroves and inland greenspace flooded, along with Plantation Road, local roads surrounding marina, and bayfront properties.	Anticipated flooding along major segments of Bayside VIs and Bayside Marina and other local roads, and along the parking lot and structures at the entrance of marina.
03	11401 Andy Rosse Lane	Initial inundation to the entire marina parcel- major roads, parking lot, and marina structures.	All land access to marina is estimated to be inundated- major roads, parking lot, and marina structures.
04	15107 Captiva Drive	Initial inundation to majority of marina parcel and to bayfront. Majority of Captiva Drive not impacted.	All land access to marina is estimated to be inundated- major roads, parking lot, and marina structures.
05	15183 Captiva Drive	Majority of marina parking lot and building impacted by flooding. Neighboring parcels and Captiva Drive flooded.	The remainder of the marina parking lot is inundated, along with all nearby roads and parcels.
06	15903 Captiva Drive	Minor anticipated flooding along the pathway from marina to parking lot and vegetation.	Greater extent of anticipated flooding along the pathway from marina to parking lot and inland along eastern edge of parking lot.
07	15951 Captiva Road	Similar conditions as observed for Marina 6, as they are adjacent. Initial flooding along bayside impacting pathway from marina to parking lot.	More flooding along the pathway from marina to parking lot and along eastern edge of parking lot.

Airports, Ports, Bases, and Bus Terminals

While there are no airports, ports, or seaplane bases located on Captiva, the nearest facilities were mapped (**Figure 49**). There are no bus terminals or routes on Captiva either. **Table 15** depicts the names of these facilities and the distance to them from Captiva.

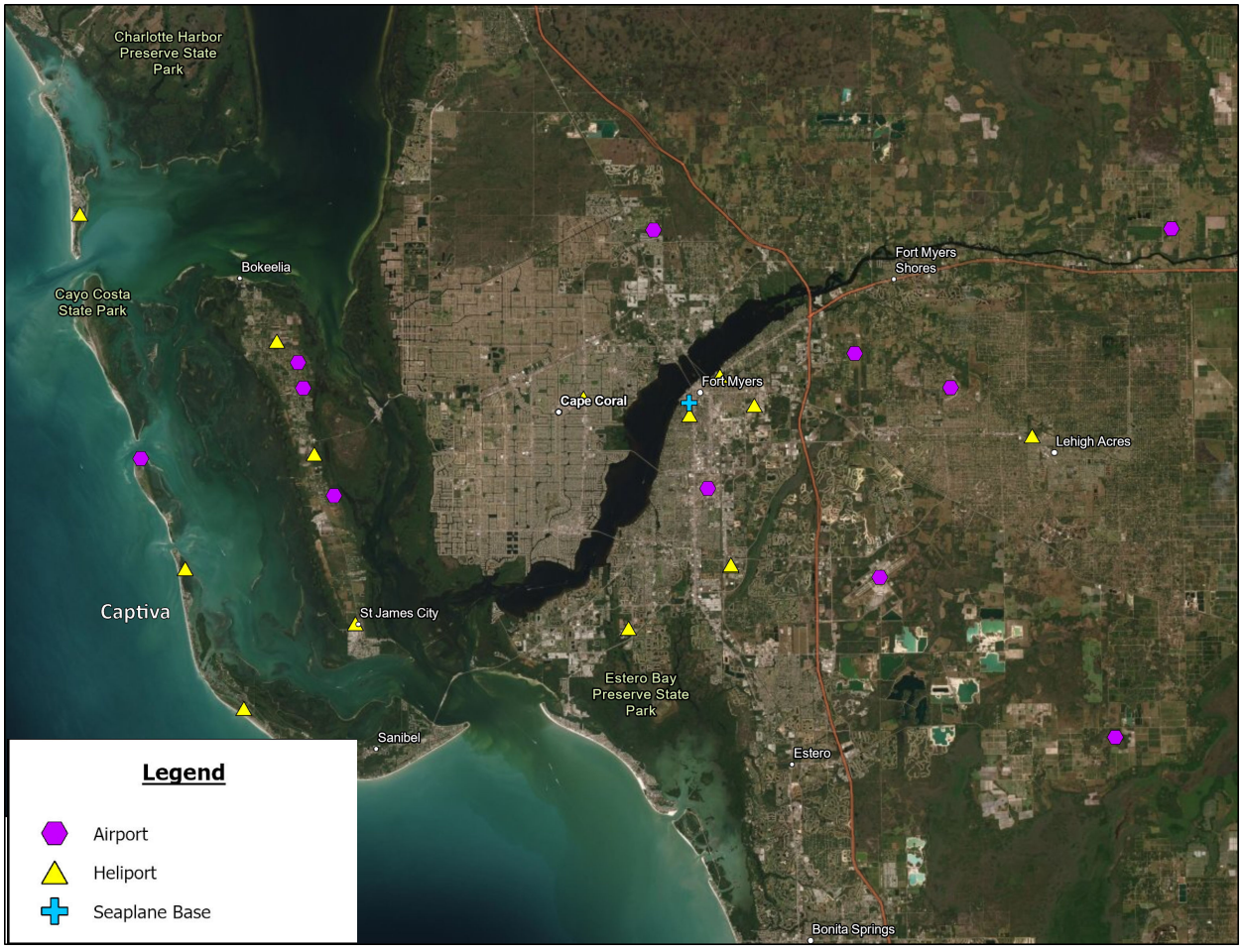


Figure 49. Lee County Airports, Ports, Bases, and Bus Terminals

Table 15. Nearest Bus terminal, Airport, Port, and Seaplane Base

Facility Type	Facility Name	Approximate Distance from Captiva (miles)
Bus Terminal	Lee Tran Intermodal Transfer Center	15
Airport	Page Field Airport	21
Seaplane Base	Caloosa Downtown Seaplane Base	22
Port	Port Manatee	85

The heliport location on Captiva Island was assessed for anticipated inundation, as it is a critical asset to the Island of Captiva. According to the analysis results, the Captiva heliport is likely to experience flooding with an average depth of 1.8 feet under Inundation Tipping Point 1 (2.3 feet NAVD), an average doeth of 3.6 feet under Inundation Tipping Point 2 (3.5 feet NAVD), and an average depth of 7 feet under Inundation Tipping Point 3 (8.8 feet NAVD). A flooding depth greater than one foot is expected to disturb functioning and accessibility, and greater than two feet is expected to have serious impacts on the facility. Depths of 3.6 feet and 7 feet would likely pose severe impacts to the heliport.

Critical Community and Emergency Facilities Sensitivity Analysis

Critical Community Facilities

Critical community facilities are those facilities that are vital to the community's functioning, safety, and health. For the island of Captiva, critical facilities include schools, community centers, fire stations, law enforcements facilities, correctional facilities, local and state government facilities, healthcare facilities and hospitals. Point data for the nearest critical facilities were obtained and utilized for this analysis. As is evident in **Figure 50**, while some critical facilities serving Captiva are located on the island, many are located outside of the CEPD boundary. These facilities within the larger area of Lee County were still included within this analysis as they are critical to the functioning and wellbeing of the CEPD community and any risk of inundation and potential disturbance to these facilities would impact the lives of the CEPD residents dependent on them.

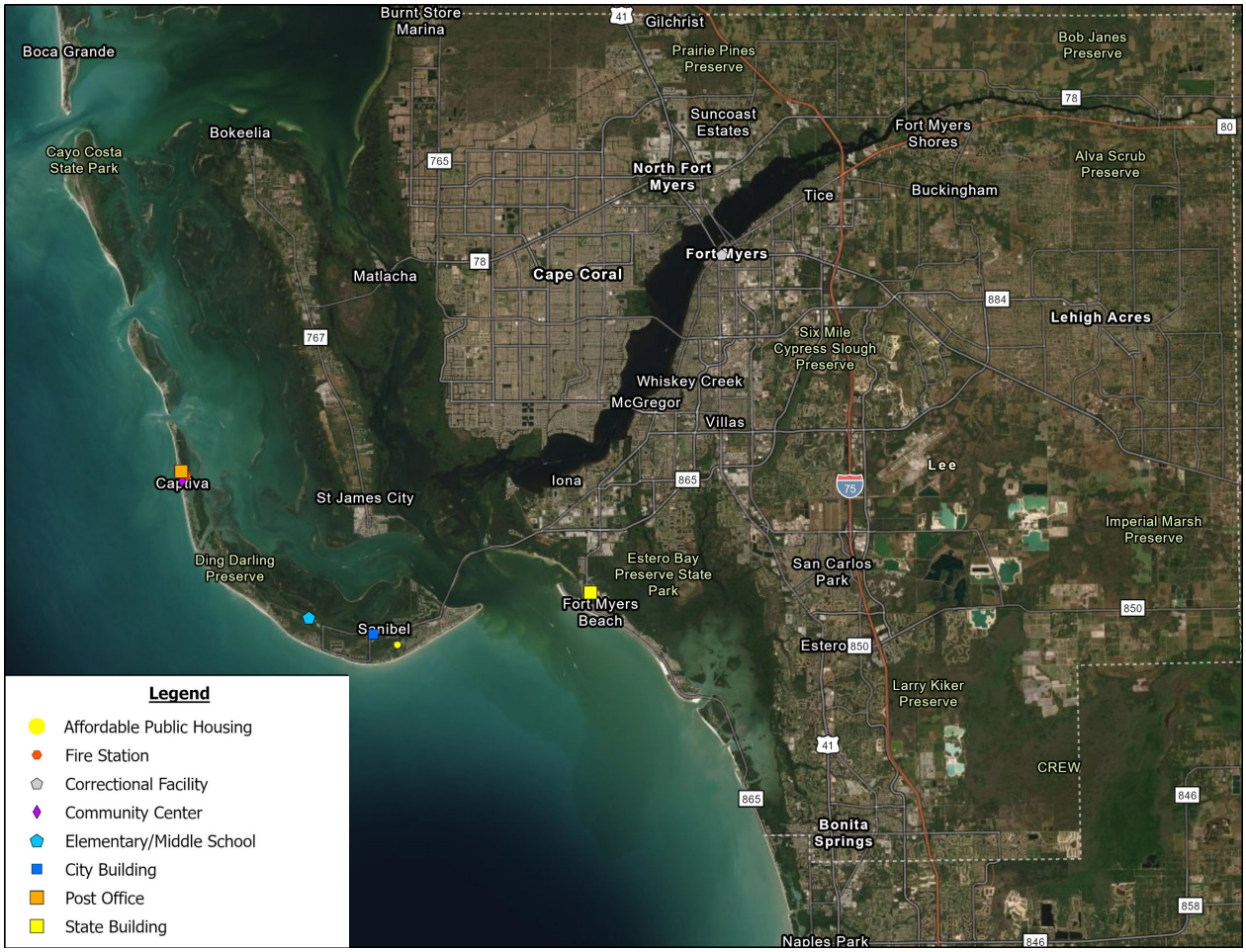


Figure 50. Off Island Critical Community Facilities Map

In summary, point data for the closest critical facilities to CEPD were analyzed for initial inundation impact under the three inundation tipping point scenarios. One community center (Captiva Civic Association, Inc), one fire station (Captiva Fire Station #181), one federal government facility (U S. Postal Service Captiva), and one local law enforcement building are located on the island of Captiva and serve the island's community **(Figure 51)**.

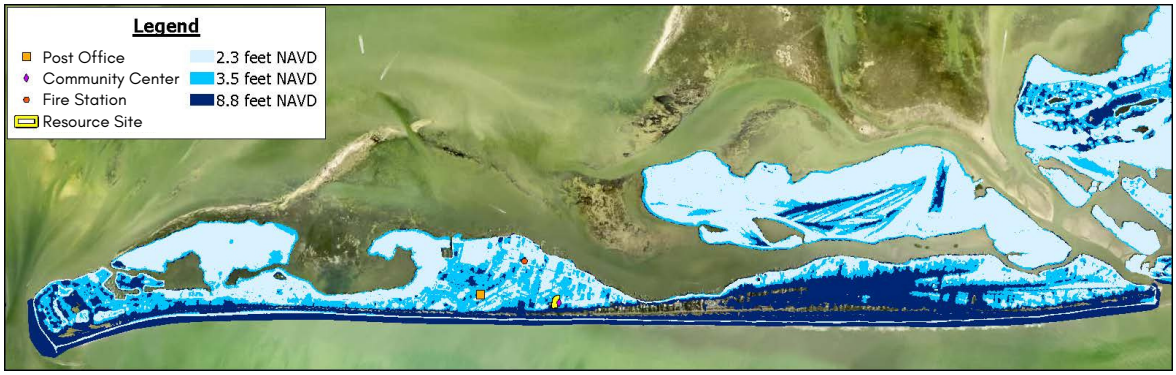


Figure 51. On Island Critical Community Facilities Map

2022 LiDAR data associated with Hurricane Ian was utilized to approximate elevations and inundation depths for these four assets, as the 2017 LIDAR used for all other assets within this report did not account for building construction and elevation increases of these four buildings that occurred after 2017. Flooding is not anticipated for the four critical community assets under current extreme tidal flooding conditions (2.3 feet NAVD) (**Table 16**). Under 2040 tidal flooding conditions (3.5 feet NAVD), the resource site is anticipated to experience nuisance flooding. Captiva's Post Office proves to not be vulnerable to flooding, even under 8.8 feet NAVD. Under this flood scenario, the fire station, community center, and resources site are expected to experience impactful flooding with an average depth of 3.2 feet NAVD, 4.6 feet, and 5.5 feet NAVD, respectively.

Table 16. On Island Critical Community Facilities Inundation Depth (in feet) Under Inundation Tipping Point Scenarios

Facility Type	Island Total	Facility Name	Inundation Depth (feet) 2.3 Feet NAVD Current Extreme Tidal Flooding/ 2 Foot Sea Level Rise	3.5 Feet NAVD 2070 NOAA Int High/ Existing 10 Year Surge/ 2040 Tidal Flooding	8.8 Feet NAVD Existing 100 Year Flood Event
Community Centers	1	Captiva Civic Association, Inc	-	-	4.6
Fire Stations	1	Captiva Fire -Station #181	-	-	3.2
Federal Government Facilities	1	U S. Postal Service Captiva	-	-	-
Local Law Enforcement	1	Resource Site	-	0.8	5.5

The remaining critical facility types included in this assessment do not exist on the island of Captiva, and thus, for the purpose of this analysis, the closest location within Lee County representing each facility type was assessed for future inundation. **Table 17** details the facility type, the approximate distance in miles to the closest facility outside of Captiva Island (straight line from end of island to facility), the facility name, and the estimated inundation under the three inundation tipping point scenarios.

Correctional Facility, Hospital, and Local Government Facility

The nearest correctional facility (Lee County Jail), located 5 miles from Captiva Island, is not estimated to experience any inundation across the scenarios. The nearest hospital (Lee Health- Health Park Hospital) located 17 miles from Captiva Island and the nearest local government facility (Island Civic Center) located 7 miles from Captiva Island will not experience flooding under the inundation tipping points 1 and 2, however will experience impactful inundation under the Inundation Tipping Point 3. The average inundation depth for these two facilities under this scenario is around 3 feet.

School and Health Care Facility

The closest school serving the island of Captiva is the Sanibel School K-8, located 5 miles off the Southern tip of Captiva Island. Flooding is anticipated at this location for all tipping point scenarios at a depth of 1.3 feet, 1.8 feet, and 5 feet, respectively. The San-Cap Medical Center serves as the health care facility for Captiva residents and is approximately 4 miles from the Captiva's southern tip. This center proves to be at risk for inundation, with an estimated inundation depth of 1.8 feet under Inundation Tipping Point 2 and a depth of 5.8 feet under Inundation Tipping Point 3.

Law Enforcement Facility and State Government Facility

The nearest official law enforcement facility (Sanibel Police Department) and the nearest affordable housing unit (unit 2) experience a similar incremental inundation pattern. Minimal flooding (0.08 feet) under Inundation Tipping Point 1 is unlikely to cause disruption or impact the functionality of these facilities. However, under Inundation Tipping Point 2, both facilities will experience disturbance from flood levels which could limit or prohibit normal operations and under the Inundation Tipping Point 3, the facilities will be inoperable. Flooding of the police department could result in reduced response time and reduced ability and accessibility to immediate aid. The state government facility (SW Florida Marine Institute) would not be of highest priority in the case of a flood, but similar to other facilities, it still proves to be highly vulnerable under Inundation Tipping Point 1 (with an average flood depth of 7.5 feet). The inundation depths per scenario are outlined in **Table 17**.

Table 17. Off Island Critical Community Facilities Inundation Depth (in feet) Under Inundation Tipping Point Scenarios

			Inundation Depth (feet)		
Facility Type	Distance to Closest (mi)	Facility Name	2.3 Feet NAVD (inundation tipping point scenario 1)	3.5 Feet NAVD (inundation tipping point scenario 2)	8.8 Feet NAVD (inundation tipping point scenario 3)
Schools and colleges	5	The Sanibel School K-8	1.3	1.8	5
Correctional Facilities	22	Lee County Jail	0	0	0
Health Care Facilities	4	San-Cap Medical Center	0	1.8	5.8
Hospitals	17	Lee Health - Health Park Hospital	0	0	3.1
Law Enforcement	7	Sanibel Police Dept	0.1	1.7	5.7
Local Government Facilities	7	Island Civic Center	0	0	3
State Government Facilities	15	SW Florida Marine Institute	0	.3	7.5
Affordable Public Housing	8	Community Housing and Resources Minor Subdivision at Sanibel Highlands	0.1	1.2	7

Emergency Facilities

Emergency facilities included in this assessment consist of three facilities on Captiva and two outside of Captiva, displayed in **Figure 52**. These facilities can be critical to the safety and survival of residents during and after a hazard or disaster.

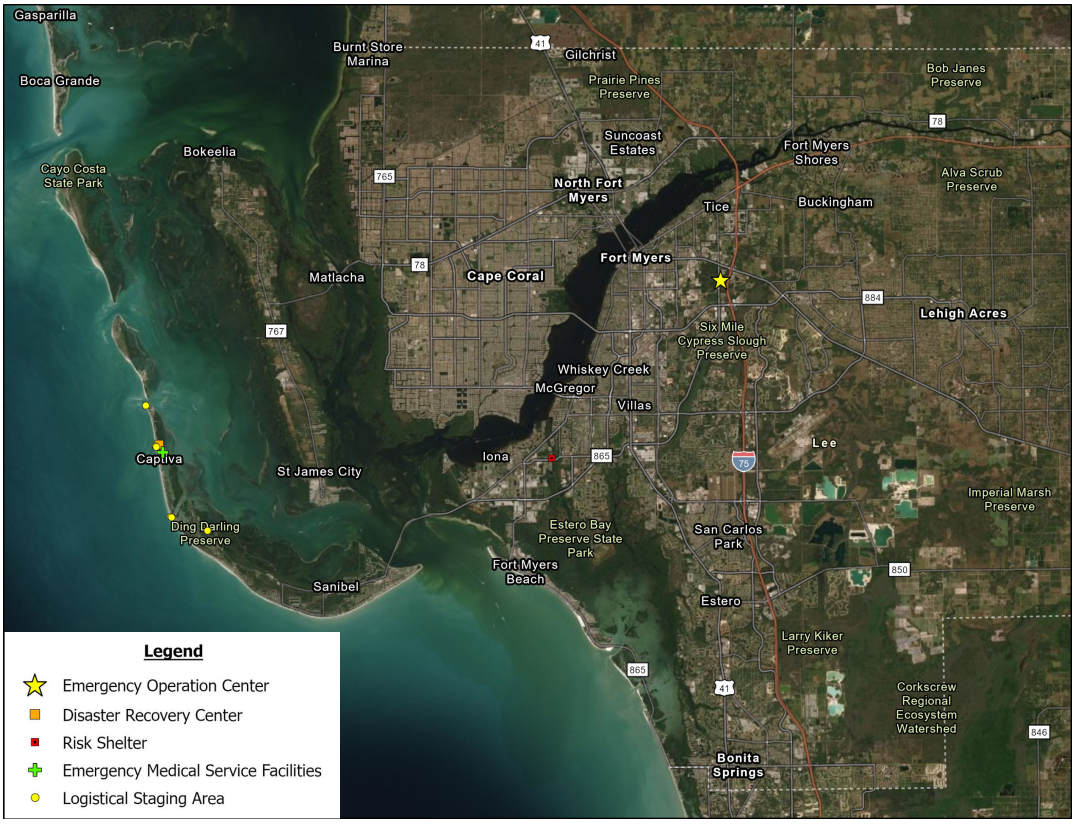


Figure 52. Off Island Emergency Facilities Map

The emergency medical service facility, disaster recovery center, and logistical staging area are located on the island of Captiva (**Figure 52**). The local fire station (Captiva Fire Station #18) mentioned previously serves as the local emergency medical service facility and will respond to emergency calls on the island of Captiva. The results of the fire station inundation analysis were reviewed in the previous section.

Chadwick's at South Seas Plantation is the on-island disaster recovery center (DRC) which serves as the dedicated, accessible and established location where survivors are assisted through the recovery process via information and resources. This DCR is not expected to experience any flooding under the 2.3 feet NAVD water level elevation.

However, according to the 3.5 feet NAVD and 8.8 feet NAVD water level elevations, Chadwick's is likely to experience impactful inundation at an average depth of 2.8 and 5.8 feet, respectively. This degree of flooding has the potential to make the DCR inoperable, which would prohibit residents from receiving the aid and assistance needed. The logistical staging areas along Captiva are predicted to experience nuisance flooding under 2.3 feet NAVD (with an average depth of 0.6 feet) and under 3.5 feet NAVD (with an average depth of 0.1 feet). While the 3.5 feet NAVD scenario represents a higher water level elevation, the type of flooding impacts the direction and introduction of water to the area, and when averaged across multiple parcels, the average can sometimes be reduced. Inundation depths for the individual Staging Areas can be reviewed in Appendix VI. **Table 18** summarizes inundation depths and **Figure 53** represents the spatial impacts to the facilities under the three inundation scenarios.

Table 18. On Island Emergency Facilities Inundation Depth (in feet) Under Inundation Tipping Point Scenarios

			Inundation Depth (feet)		
Facility Type	Island Total	Facility Name	2.3 Feet NAVD (inundation tipping point scenario 1)	3.5 Feet NAVD (inundation tipping point scenario 2)	8.8 Feet NAVD (inundation tipping point scenario 3)
Emergency Medical Service Facilities	1	Captiva Fire -Station #181	-	-	0.6
Disaster Recovery Centers	1	Chadwick's at South Seas Plantation	0	2.8	5.8
Logistical Staging Areas	5	Multiple	0.6	0.1	4

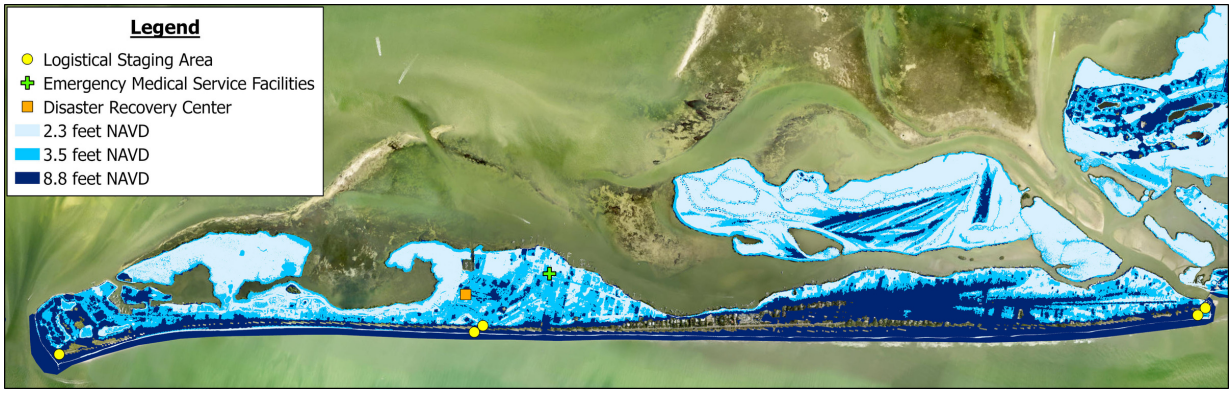


Figure 53. On Island Emergency Facilities Map

Table 19 outlines the off-island emergency facilities and their average inundation depths under the relevant scenarios. The closest emergency operations center to Captiva Island is located in Fort Myers, about 25 miles from the Southern tip of Captiva Island. According to FEMA, an Emergency Operations Center is a protected site from which State and local civil government officials coordinate, monitor, and direct emergency response activities during an emergency. Situated inland and away from the coast, no inundation is anticipated for this center, however, road inundation between Captiva Island and the center could serve as an obstacle for Captiva residents under various flood scenarios.

Approximately 16 miles from Captiva Island, the nearest risk shelter (Heights Elementary School) will likely not experience flood risk under Inundation Tipping Points 1 and 2 and would thus be operable and accessible to Captiva residents. Under the greater water elevation level predicted for Inundation Tipping Point 3, flooding is predicted at a depth of 5 feet. Flooding at this depth would eliminate the accessibility and protection of the shelter. A shelter slightly closer to Captiva Island is located on Fort Myers but was not included in this assessment because the included shelter at approximately the same distance is located more mainland and should experience less flooding.

Table 19. Off Island Emergency Facilities Inundation Depth (in feet) Under Inundation Tipping Point Scenarios

Facility Type	Distance to Closest (mi)	Facility Name	Inundation Depth (feet)		
			2.3 Feet NAVD (inundation tipping point scenario 1)	3.5 Feet NAVD (inundation tipping point scenario 2)	8.8 Feet NAVD (inundation tipping point scenario 3)
Emergency Operations Centers	25	Emergency Operations Center	0	0	0
Risk Shelter Inventory	16	Heights Elementary School	0	0	5

Natural, Cultural, and Historical Resources Sensitivity Analysis

Conservation Lands

While not necessarily critical to the survival or basic functionality of the island, the natural and cultural and historical resources on Captiva prove to be essential to the island's integrity and identity. The natural resources considered in this report include conservation lands, parks, and wetlands. Conservation land data was downloaded from the Florida Natural Areas Inventory and was analyzed for impact and average depth over the entire areas. In general, the acreage of conservation lands inundated for each flood scenario remains rather constant across all flood scenarios, increasing by only four acres from the 0.3 feet NAVD water level elevation to the 11.1 feet NAVD water level elevation. It is important to note that the results of this analysis and the subsequent analysis of mangrove inundation represent some degree of overlap. **Figure 54** depicts the locations of conservation lands across the Island of Captiva. While Buck Key was not factored into the calculation of inundation acreage of conservation land, it is identified within **Figure 54**, as it plays a role in storm surge and wave protection for Captiva Island.

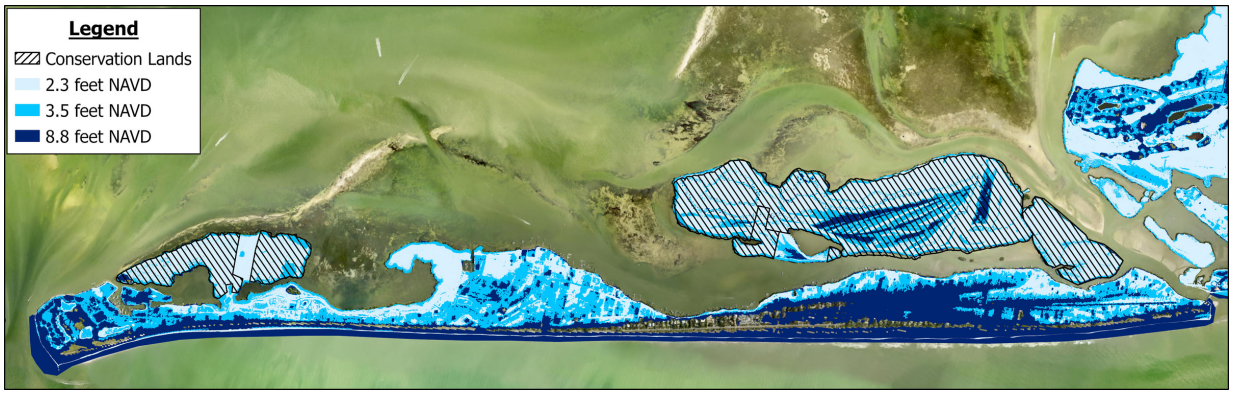


Figure 54. Conservation Land Inundation Map for Inundation Tipping Point Scenarios

Wetlands

Data from the Fish and Wildlife Research Institute depicted the location and extent of the mangroves along Captiva Island. As previously stated, when analyzing mangroves for inundation extent and depth, it is important to note that some of these areas overlap with conservation lands and thus some of the resulting metrics may be duplicative in nature. 96% of all wetlands will be inundated under 3.5 feet NAVD, and 100% will be inundated under 8.8 feet NAVD.

Parks, Preserves, and Beach Access Areas Related to Greenspace

County parks, preserves, zoned parks, and beach access areas related to greenspace, totaling 2.4 acres, were included in the following analysis as they are mostly all managed by CEPD. **Figure 55** depicts projected inundation impacts for all parks along Captiva Island under the inundation tipping point scenarios. Park inundation does not prove to be a major anticipated threat under 2.3 feet NAVD (Inundation Tipping Point 1), which estimates that only 8% of parks will experience flooding with an average depth of 0.7 feet. The predicted average inundation depth is the same under 3.5 feet NAVD (Inundation Tipping Point 2), with only 12% of parks inundated. As was the case with the conservation lands and wetlands, under 8.8 feet NAVD (Inundation Tipping Point 3), 100% of all parks will experience flooding (average depth: 6.5 feet).

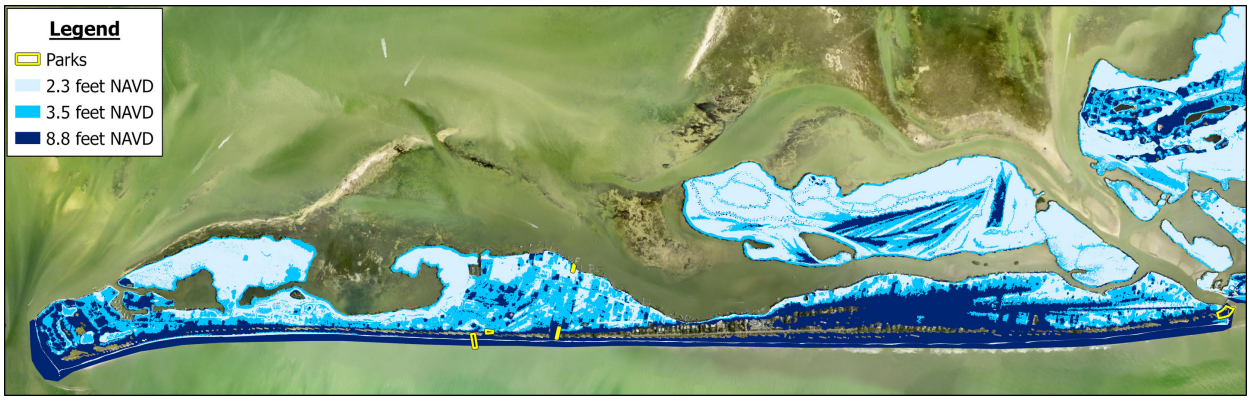


Figure 55. Park Inundation Map for Inundation Tipping Point Scenarios

Shorelines

To determine estimated gulf-front shoreline inundation, the 1982 and 1983 Erosion Control Lines (ECL) were assessed under the relevant inundation scenarios. The ECLs cover the island's beach front running from the groin at South Seas to the groin at Turner Beach. Beach profiles were not utilized to estimate inundation. **Figure 56** highlights the elevation of Captiva's shoreline.

Figure 56. Shoreline Elevation Map.

Captiva Island possesses 25,823 linear feet of gulf-front shoreline and under 2.3 feet NAVD (Inundation Tipping Point 1), 0% of the shoreline will experience inundation. The degree of shoreline inundation increases to only 1% according to the 3.5 feet NAVD water level elevation (Inundation Tipping Point 2). Gulf-front shoreline inundation increases drastically under the 8.8 feet NAVD water level elevation (Inundation Tipping Point 3), which anticipates that 60% of shorelines will be impacted by flooding (**Figure 57**).

Figure 57. Shoreline Inundation Map for Inundation Tipping Point Scenarios.

Historical and Cultural Assets

Historic and cultural facility data are logged and maintained at the state level by the Florida's State Historic Preservation Offices (SHPO) of the Florida Bureau of Historic Preservation (BHP). Nationally, facilities are tracked by the National Park Service (NPS) who compile the National Register of Historic Places (NRHP). The NRHP is the official list of properties and areas recognized as historical and nationally preserved, two of which are located within Captiva Island (the Tween Waters Inn Historic District and the Chapel-by-the-Sea Historic District). **Figure 58** depicts the general locations of these historic districts, indicated by stars on the map. An additional 73 properties have been identified by the SHPO as potential historical and cultural sites, labeled on **Figure 58** as "Not Evaluated by SHPO".

When assessing the NRHP districts and the SHPO potential historical places for predicted inundation, 21% are likely to experience flooding under Inundation Tipping Point 1, 45% are likely to experience flooding under Inundation Tipping Point 2, and 69% are likely to experience flooding under Inundation Tipping Point 3.

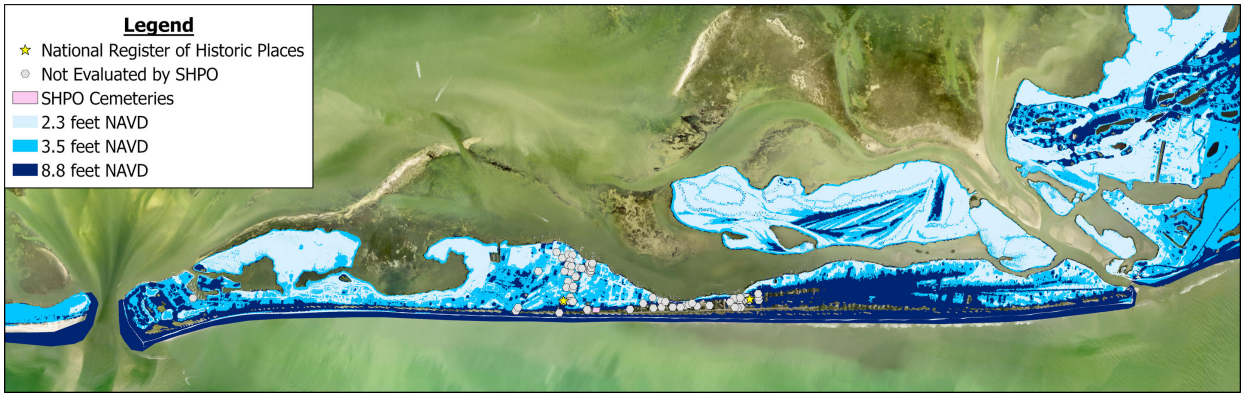


Figure 58. Historical and Cultural Assets Inundation Map for Inundation Tipping Point Scenarios

Risk Assessment

Methodology Overview and Risk Matrix

Determining the risk of the several types, degrees, and occurrences of flooding helps to qualify the susceptibility of critical assets on the island of Captiva. Determined inundation depths and flood scenarios are utilized to generate a standardized risk score on a scale to help compare vulnerabilities and prioritize risks to assets.

More specifically, flood risk is a combination of the probability (likelihood or chance) of an event happening and the consequences (impact) if it occurred. Risk was calculated by multiplying likelihood by impact and then assigning a rank of high low, medium, or high risk based on value. The following equation and descriptions outline the evaluation of risk per asset:

Likelihood (or probability) of a given flood scenario occurring in a year [Table 18] **X** **Impact Score** (based on the anticipated depth) of the asset under the given flood scenario [Table 19] **=** **Risk Score** [Table 20]

The likelihood of occurrence of each flood scenario was assigned a probability based on annual probability of occurrence. Annual probability of occurrence ranges are outlined in **Table 20**.

Table 20. Flood Likelihood per Scenario

Water Level Elevation (feet NAVD)	Scenario	Likelihood/ Probability
0.6	2040 NOAA Int Low	4.345
1.3	2040 NOAA Int High/ 2070 NOAA Int Low/ 1 Foot Sea Level Rise	1.873
2.3	Current Extreme Tidal Flooding Conditions/ 2 Foot Sea Level Rise	0.53
3.5	2070 NOAA Int High/ Existing 10 Year Surge/ 2040 Tidal Flooding	0.143
4.5	2040 10 Year Surge/ 4 Foot Sea Level Rise	0.075
5.2	2070 Tidal Flooding	0.053
6.4	2070 10 Year Surge	0.031
7.3	7 Foot Sea Level Rise	0.021
8.8	Existing 100 Year Flood	0.01
11.1	Existing 500 Year Flood	0.002

The impact of flood scenario was determined by the anticipated inundation depth of an asset under the relevant flood scenario. Each asset was assigned an impact score of 0,1, 33, 66, or 100 based on the inundation depth ranges outlined in **Table 21**. Calculated risk scores were then assigned a qualitative risk rank based on the risk score value according to the ranges outlined in **Table 22**.

Table 21. Impact Score per inundation Depth Range (in feet)

Inundation Depth (feet)	Impact Score
0	0
0-1 foot	1
1-2 feet	33
2-5 feet	66
>5 feet	100

Table 22. Risk Ranks per Score Range

Risk Score	Risk Rank
0	No Foreseeable Risk
0 -4.5	Low Risk
4.5 -20	Medium Risk
> 20	High Risk

An example of the risk calculation is outlined below for an asset under the 2070 Tidal Flooding Scenario experiencing inundation at a depth of 2.5 feet:

.053 (Likelihood) X **66** (Impact Score) = **3.5 Low Risk**

Table 23 displays the finalized risk matrix that was utilized to determine risk per asset for this assessment. **Table 24** summarizes risk across the inundation tipping point scenarios for singular on island assets and **Table 25** summarizes risk rank counts for grouped island assets. Note that the 8.8 feet NAVD scenario has a lower likelihood and despite potential higher impacts, the calculation resulted in a lower risk score than the 2.3 feet NAVD or 3.5 feet NAVD scenarios.

Risk Scores per Asset

Table 23. Risk Matrix

		Impact Score per Flood Water Depth Range				
		0	1	33	66	100
Water Level Elevation (Feet NAVD)	Probability of a given flood scenario occurring in a year (P)	Water Depth =0	Water Depth 0-1 ft	Water Depth 1-2 ft	Water Depth 2-5 ft	Water Depth >5 ft
0.6	4.345	No Foreseeable Risk	Low Risk	High Risk	High Risk	High Risk
1.3	1.873	No Foreseeable Risk	Low Risk	High Risk	High Risk	High Risk
2.3	0.534	No Foreseeable Risk	Low Risk	Medium Risk	High Risk	High Risk
3.5	0.143	No Foreseeable Risk	Low Risk	Medium Risk	Medium Risk	Medium Risk
4.5	0.075	No Foreseeable Risk	Low Risk	Low Risk	Medium Risk	Medium Risk
5.2	0.053	No Foreseeable Risk	Low Risk	Low Risk	Low Risk	Medium Risk
6.4	0.031	No Foreseeable Risk	Low Risk	Low Risk	Low Risk	Low Risk
7.3	0.021	No Foreseeable Risk	Low Risk	Low Risk	Low Risk	Low Risk
8.8	0.01	No Foreseeable Risk	Low Risk	Low Risk	Low Risk	Low Risk
11.1	0.002	No Foreseeable Risk	Low Risk	Low Risk	Low Risk	Low Risk

Table 24. Risk Ranks for On Island Singular Assets

		Asset Risk Under Inundation Tipping Point Scenarios		
Asset Type	**Name of Asset(s)**	**2.3 Feet NAVD (inundation tipping point scenario 1)**	**3.5 Feet NAVD (inundation tipping point scenario 2)**	**8.8 Feet NAVD (inundation tipping point scenario 3)**
Community Centers	Captiva Civic Association, Inc. (11550 Chapin Lane, Captiva, FL 33924)	Low Risk	Low Risk	Low Risk
Fire Station/ EMS	Captiva Fire Station #181 (14981 Captiva Dr, Captiva, FL 33924)	Low Risk	Low Risk	Low Risk
Federal Government Facilities	U S. Postal Service Captiva (14812 Captiva Dr SW, Captiva, FL 33924)	Low Risk	Low Risk	Low Risk
Disaster Recovery Centers	Chadwick's at South Seas Plantation (5400 Plantation Rd, Captiva, FL 33924)	No Foreseeable Risk	Medium Risk	Low Risk
Heliport	Captiva Heliport	Medium Risk	Medium Risk	Low Risk
Wastewater Treatment Facilities	South Seas Plantation	Low Risk	Medium Risk	Low Risk
	Tween Waters Inn WWTP	No Foreseeable Risk	No Foreseeable Risk	No Foreseeable Risk
	Captiva Shores Condominium WWTP	No Foreseeable Risk	Medium Risk	Low Risk
	Sunset Captiva WWTP	No Foreseeable Risk	Low Risk	Low Risk
Lift Stations	Lift station #1	No Foreseeable Risk	Medium Risk	Low Risk
	Lift station #2	No Foreseeable Risk	No Foreseeable Risk	Low Risk
	Turner Beach Lift Station	No Foreseeable Risk	No Foreseeable Risk	Low Risk
Communications Facilities	East Side of Chadwick's Square Shopping Center	No Foreseeable Risk	Medium Risk	Low Risk
	Communication Tower at north end near Wastewater Treatment	No Foreseeable Risk	Low Risk	Low Risk

		Asset Risk Under Inundation Tipping Point Scenarios		
Asset Type	**Name of Asset(s)**	**2.3 Feet NAVD** (inundation tipping point scenario 1)	**3.5 Feet NAVD** (inundation tipping point scenario 2)	**8.8 Feet NAVD** (inundation tipping point scenario 3)
Marinas	1057-1900 South Seas Plantation Road	Low Risk	Medium Risk	Low Risk
	11401 Andy Rosse Lane	Low Risk	Medium Risk	Low Risk
	15107 Captiva Drive	Low Risk	Medium Risk	Low Risk
	15183 Captiva Drive	Low Risk	Medium Risk	Low Risk
	15903 Captiva Drive	Low Risk	Medium Risk	Low Risk
	15951 Captiva Drive	Low Risk	Medium Risk	Low Risk
	2800-5640 South Seas Plantation Road	Medium Risk	Medium Risk	Low Risk
Historical and Cultural Assets	Tween Waters Inn Historic District	No Foreseeable Risk	No Foreseeable Risk	No Foreseeable Risk
	Chapel-by-the-Sea Historic District	No Foreseeable Risk	No Foreseeable Risk	Low Risk
Conservation Lands/ Wetlands	Mangrove Swamp North	Medium Risk	Medium Risk	Low Risk
	Mangrove Swamp South	Medium Risk	Medium Risk	Low Risk
	J. N. Ding Darling National Wildlife Refuge 1	Medium Risk	Medium Risk	Low Risk
	J. N. Ding Darling National Wildlife Refuge 2	Medium Risk	Medium Risk	Low Risk
	J. N. Ding Darling National Wildlife Refuge 3	Medium Risk	Medium Risk	Low Risk
	J. N. Ding Darling National Wildlife Refuge 4	High Risk	Medium Risk	Low Risk
	Sanibel-Captiva Conservation Foundation Conservation Lands 1	Medium Risk	Medium Risk	Low Risk
	Sanibel-Captiva Conservation Foundation Conservation Lands 2	Medium Risk	Medium Risk	Low Risk

		Asset Risk Under Inundation Tipping Point Scenarios		
Asset Type	**Name of Asset(s)**	**2.3 Feet NAVD** (inundation tipping point scenario 1)	**3.5 Feet NAVD** (inundation tipping point scenario 2)	**8.8 Feet NAVD** (inundation tipping point scenario 3)
Parks	Turner Beach	Low Risk	No Foreseeable Risk	Low Risk
	Andy Rosse Lane Kayak Launch	Low Risk	Medium Risk	Low Risk
	Andy Rosse Lane Beach Access	Low Risk	Low Risk	Low Risk
	Alison Hagerup Beach Park 1	Medium Risk	No Foreseeable Risk	Low Risk
	Alison Hagerup Beach Park 2	No Foreseeable Risk	Low Risk	Low Risk
Logistical Staging Areas	South Seas Island Resort	Medium Risk	No Foreseeable Risk	Low Risk
	Allison Hagerup Beach Park A	Medium Risk	No Foreseeable Risk	Low Risk
	Allison Hagerup Beach Park B	No Foreseeable Risk	Low Risk	Low Risk
	Turner Beach A	Low Risk	Low Risk	Low Risk
	Turner Beach B	No Foreseeable Risk	No Foreseeable Risk	Low Risk
Stormwater Treatment Facilities and Pump Stations	Catch Basin 1 (SSPGCCB1)	No Foreseeable Risk	Low Risk	Low Risk
	Catch Basin 2 (SSPGCCB2)	No Foreseeable Risk	Medium Risk	Low Risk
	Catch Basin 3 (SSPGCCB3)	No Foreseeable Risk	No Foreseeable Risk	Low Risk
	Retention Pond	Low Risk	Medium Risk	Low Risk
	Swale10	No Foreseeable Risk	No Foreseeable Risk	Low Risk
	Swale19	No Foreseeable Risk	No Foreseeable Risk	Low Risk
	Swale20	No Foreseeable Risk	No Foreseeable Risk	Low Risk
	Swale21	Low Risk	Medium Risk	Low Risk
	Swale23	No Foreseeable Risk	Low Risk	Low Risk
	Sewer 1- ST62	Low Risk	Medium Risk	Low Risk
	Sewer 2- Influent at Sunset Captiva WWTP	No Foreseeable Risk	No Foreseeable Risk	No Foreseeable Risk
	AROUT	High Risk	Low Risk	Low Risk
	SSPOutFall1	Medium Risk	Low Risk	Low Risk

Table 25. Risk Rank Counts for Grouped Island Assets

	Risk (NFR, L, M, H)	**2.3 Feet NAVD** (inundation tipping point scenario 1)	**3.5 Feet NAVD** (inundation tipping point scenario 2)	**8.8 Feet NAVD** (inundation tipping point scenario 3)
Parcels (#)	No Foreseeable Risk	358	103	12
	Low Risk	747	582	1,093
	Medium	-	420	-
	High	-	-	-
	Total at Risk	**747**	**1,002**	**1,093**
Building Footprints (#)	No Foreseeable Risk	469	219	37
	Low Risk	278	160	710
	Medium	-	368	-
	High	-	-	-
	Total at Risk	**278**	**528**	**710**
Roadways (ft)	No Foreseeable Risk	36,825	18,777	11
	Low Risk	11,799	9,421	48,788
	Medium	132	20,599	-
	High	41	-	-
	Total at Risk	**11,972**	**30,020**	**48,788**
Oceanfront Shorelines (non-armored with seawalls) (ft)	No Foreseeable Risk	25,810	25,618	7,143
	Low Risk	5	156	18,680
	Medium	5	49	-
	High	3	-	-
	Total at Risk	**13**	**205**	**18,680**

The risk ranks for individual and grouped assets across Captiva Island and across flood scenarios help to identify the assets most susceptible when considering not only flood extent and depth but also timeframe. All conservation lands and Captiva marinas prove to be at risk across all inundation tipping point scenarios, all of which are at medium risk under Scenario 2 (3.5 feet NAVD). The Marina located at 2800-5640 South Seas Plantation Road and the J. N. Ding Darling National Wildlife Refuge 4 are most at risk under Scenario 1 (2.3 feet NAVD).

Three critical community assets-the Captiva Civic Association, Fire Station, and U.S Postal Service- prove to be at low risk across all Inundation Tipping Point Scenarios. The Captiva Heliport and South Seas Plantation WWTP are at risk across all Tipping Points, proving to be at medium risk under 2040 tidal flooding conditions. It is important to also note the assets that are under no risk across the tipping point scenarios- Tween Waters Inn WWTP, Tween Waters Inn Historic District, and Sewer #2. Aside from these assets, all individual assets are at low risk under the inundation tipping point Scenario 3 (**Table 24**).

The following subsection outlines additional takeaways from the risk assessment for each of the three inundation tipping point scenarios. As was mentioned previously, there are 1,105 parcels, 747 building footprints, and 48,797 linear feet on Captiva Island. The metrics below represent the percentages of the total number of assets at risk compared to the total number of assets on the island and the percentage of low-risk assets compared to all at risk assets under each inundation tipping point scenario. These metrics are based on the counts outlined in **Table 25.** Risk per asset for the remaining scenarios can be viewed in Appendices VII and VIII.

1

2.3 feet NAVD

67% of parcels at risk (100% at low risk)
37% of buildings at risk (7% at low risk)
25% of linear feet of roads at risk (10% at low risk)

2

3.5 feet NAVD

90% of parcels at risk (58% at low risk)
71% of buildings at risk (30% at low risk)
62% of linear feet of roads at risk (31% at low risk)

3

8.8 feet NAVD

98% of parcels at risk (100% at low risk)
95% of buildings at risk (100% at low risk)
100% of linear feet of roads at risk (100% at low risk)

Conclusions

Conclusions

The Sea Level Rise Vulnerability Analysis for Captiva Island has identified the geographic areas and physical assets vulnerable to current and future flooding. Key takeaways from the analysis include the following:

- Potential flooding across the bayfront shorelines near the central area of the island causes critical infrastructure to be vulnerable in the near term.

- Under the NOAA intermediate Low Sea Level Rise flood scenario, 4% of bayfront seawalls are exposed to flooding by 2040 and 7% are exposed by 2070. Under the NOAA Intermediate-High scenario, 99% of bayfront seawalls will be exposed by 2070.

- Under the NOAA Intermediate-Low Sea Level Rise flood scenario, gulf-front shorelines are not anticipated to be at risk to flooding by 2040 or 2070. Under the Intermediate-High scenario, 1% of gulf-front shorelines will be at risk to flooding by 2070 (76% at low risk and 24% at medium risk).

- Key critical infrastructure vulnerable to extreme high tides in near term that may experience interruptions to operation and accessibility include:
  - 8% of surveyed electrical transformers and utility boxes
  - WWTP located along South Seas Plantation Road
  - Lift Station #3 (South of the Fire Station)
  - Majority of stormwater assets identified in the 2011 Captiva Water Quality Assessment Project Final Report
  - Captiva Heliport

- At water elevations of 3.5 feet NAVD which may occur during storm surge in the near term or future extreme and high tides, up to 62% of roads, three water treatment facilities, and up to 71% of building footprints are at risk of flooding.

- 35% of surveyed electrical transformers and utility boxes may be vulnerable by 2040 (sixteen located in central and south Captiva) will experience flooding at a depth of >1 foot).

Three tipping points were defined through the analysis as leading to particularly problematic flooding for the community.

1. **2.3 feet NAVD** Current Extreme Tidal Flooding OR 2 Foot Sea Level Rise

   Extreme tide found to temporarily affect 67% of all Captiva parcels with an average inundation depth under one foot.

2. **3.5 feet NAVD** 2070 NOAA State Required High OR Existing 10 Year Surge OR 2040 Tidal Flooding

   Determined to potentially affect 90% of Captiva parcels. While more than half of these parcels may flood less than one foot, the remainder may flood up to two feet.

3. **8.8 feet NAVD** Existing 100 Year Flood Event

   Resulted in island-wide flooding. 98% of Captiva parcels and 95% of building footprints on Captiva Island would be affected and experience greater than 2 feet of flooding adjacent to or under buildings.

Mapping assets and projected conditions and analyzing risk was an essential first step for resilience strategy development. Planning now for future water levels benefits property owners in multiple ways including risk mitigation, value preservation, bond rating security and insurance and maintenance cost avoidance. With consideration of CEPD's responsibilities and authority to prevent erosion and protect shorelines, an adaptation strategy consisting of alternative pathways or sequences of progressive actions triggered by changing conditions can be developed as a next step. Additionally, there are funding partnership opportunities that would likely assist in addressing the vulnerabilities of the evacuation route, the oceanfront shorelines and recurrent flood risks in the floodplain. The findings of this analysis will directly support advancement of future work including the future conceptualization, feasibility analysis and evaluation of adaptation and resilience strategies for the community.

Compilation of Findings To Date

The findings from this Sea Level Rise Vulnerability Analysis were intended to be compiled with findings from the 2020 Captiva Island Resiliency Assessment and other recent publicly available assessments.

- The 2020 Captiva Island Resiliency Assessment found the "probable threshold for severe impact to infrastructure and roads" was when daily high tides reached elevations between 2.3 feet NAVD (2 feet of sea level rise) and 4.3 feet NAVD (4 feet of sea level rise).
  - This 2023 Sea Level Rise Vulnerability Analysis refined this finding, suggesting that when high tides reach 3.5 feet NAVD as early as 2040 (depending upon the rate of sea level rise), the majority of critical infrastructure analyzed will be impacted by nuisance flooding between 13 to 26 days per year based on NOAA projections for tidal flooding and sea level rise. At this tipping point, these assets are at medium risk. Impacts to roads, communication, electrical, wastewater utility infrastructure and stormwater infrastructure may cause disruption to service depending on the interconnectivity and redundancy of these systems (see Critical Infrastructure Sensitivity Analysis, Transportation and Evacuation Sensitivity Analysis and Risk Assessment sections).

- In 2022, WS SSIR Owner, LLC commissioned the Captiva Island Vulnerability Assessment and Adaptation Plan. The plan noted the most vulnerable asset to be the Florida Government Utility Authority wastewater treatment plant (also known as South Seas Plantation Wastewater Treatment Plant). The remaining vulnerable assets noted included nine public right-of-way areas.
  - This 2023 Sea Level Rise Vulnerability Analysis analyzed exposure, depth of impact and the risk to critical infrastructure on- and off-island based on likelihood and consequence of impacts required by the state guidance for vulnerability assessments. Critical Infrastructure including the wastewater treatment plant south of South Seas, the lift station near the Fire Station, the heliport, 8% of communication and on-ground electrical infrastructure and specific stormwater infrastructure assets were highlighted as vulnerable by 2040.

Compilation of Findings Cont.

    - The 2020 Captiva Island Resiliency Assessment also noted exposure at the South Seas wastewater treatment plant, McCarthy's Marina, Jensen's Twin Palm Cottages and Resort, a restaurant, the road along South Seas Plantation Road north of Chadwick Bayou, and infrastructure supporting Tween Waters Inn. The 2023 Analysis adds complimentary impact and risk findings to the exposure analysis in the 2020 Resiliency Assessment.

- The 2020 Captiva Island Resiliency Assessment found present day flooding may affect 6 structures. Under future water levels inclusive of 1, 2, and 4 of sea level rise, as many as 13, 94, and then 374 structures, respectively, may be affected.
    - This 2023 Sea Level Rise Vulnerability Analysis provides counts of parcels, shorelines, seawalls, and building footprints (categorized by year built, and quantified by real estate market value) to provide further insight into potential impacts to private property (see Critical Infrastructure Sensitivity Analysis, pages 32-38). Additionally, the results from the flood exposure, sensitivity and risk analysis for 10 water level elevations representing 16 scenarios were provided in this report (results for an additional 6 water level elevations not included in the 2020 Assessment).

- There is overlap in findings across the three documents discussed in this section. Each provides useful, complimentary information regarding the vulnerabilities on Captiva Island. As guidance, these sections, maps and datasets may provide uniquely useful from each.
    - 2023 Sea Level Rise Vulnerability Analysis
        - Digitized seawalls and shoreline shapefiles (created for project)
        - Digitized electric and communication utility infrastructure (was not publicly available at this level of detail)
        - Risk matrix for critical infrastructure
        - Map series for inundation representing 16 flood scenarios
    - 2022 Captiva Island Vulnerability Assessment and Adaptation Plan
        - Map series of exposure for Category 1 Hurricane plus sea level rise
        - Tidal flooding depth and number of flood day maps
        - Precipitation extent maps for 25-year 1 day storm with sea level rise
    - 2020 Captiva Island Resiliency Assessment
        - Table of road lengths impacts by owner (county, non-County, private) and bike paths impacted

Appendices

Appendix I: Lee County Facilities Maps

Appendix II: References and Data Sources

Appendix III: Parcel and Building Impacts for all Scenarios

Appendix IV: Parcel Impacts, Inundation Depths, and Estimated Values for all Scenarios

Appendix V: Building Impacts, Inundation Depths, and Estimated Values for all Scenarios

Appendix VI: Evacuation Route Inundation for all Scenarios

Appendix VII: On Island Singular Asset Inundation Depths and Risk Scores for all Scenarios

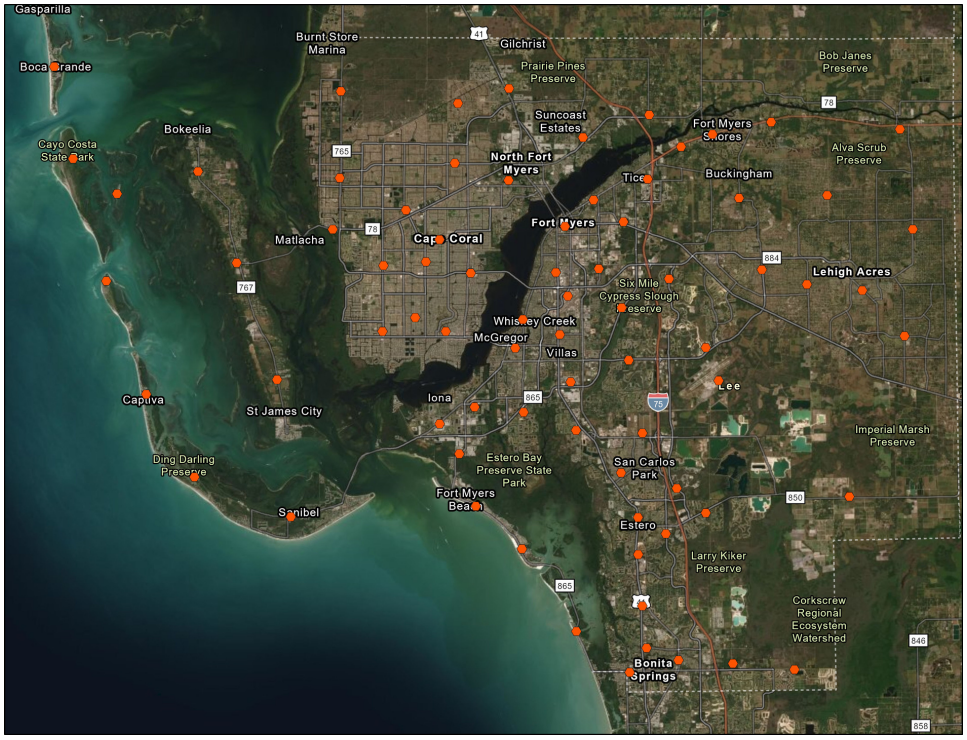
Appendix VIII: Risk Rank Counts for Grouped Island Assets for all Scenarios

Appendix IX: Off Island Singular Asset Inundation Depths and Risk Scores for all Scenarios

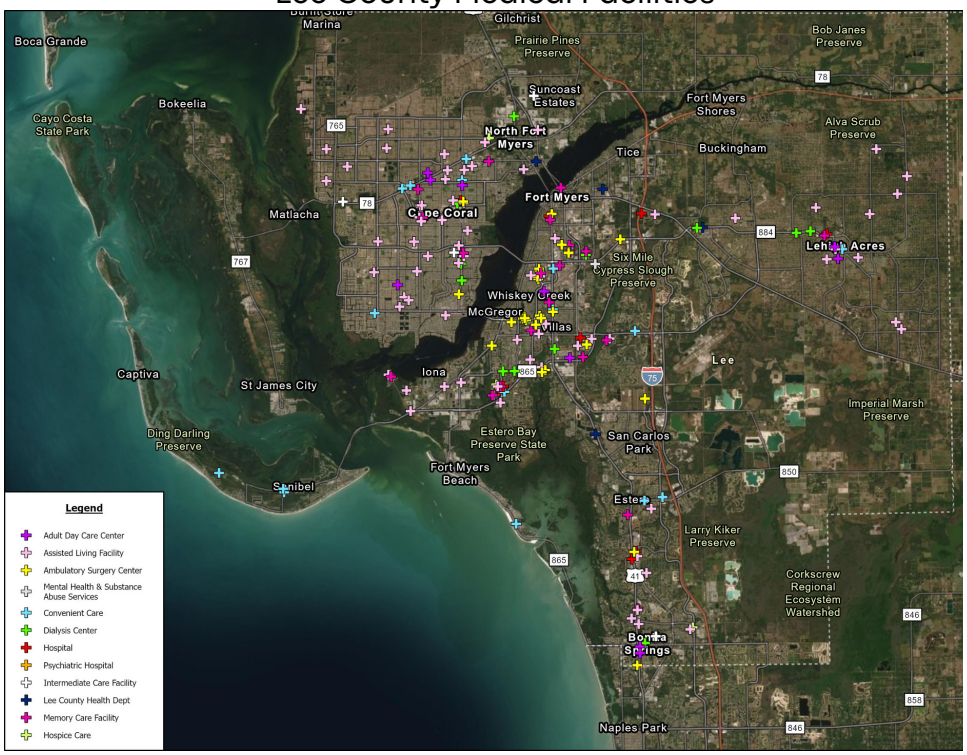
Appendix X: Community Presentation

Appendix I: Lee County Facilities Maps

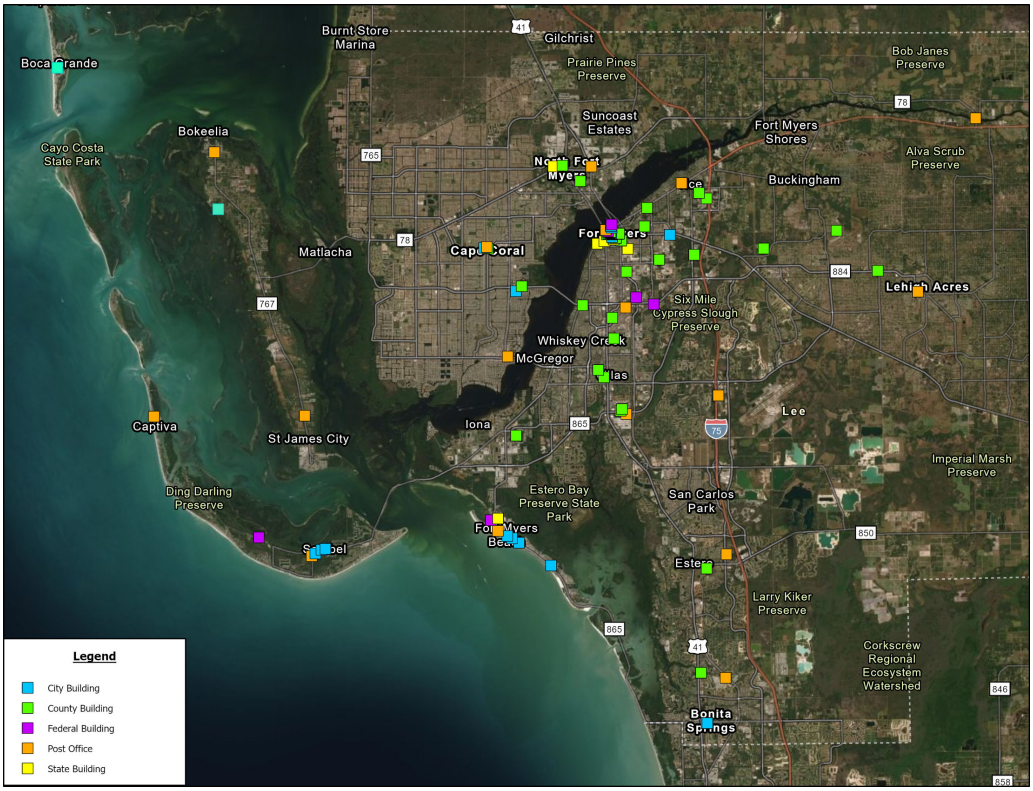
Lee County Fire Stations



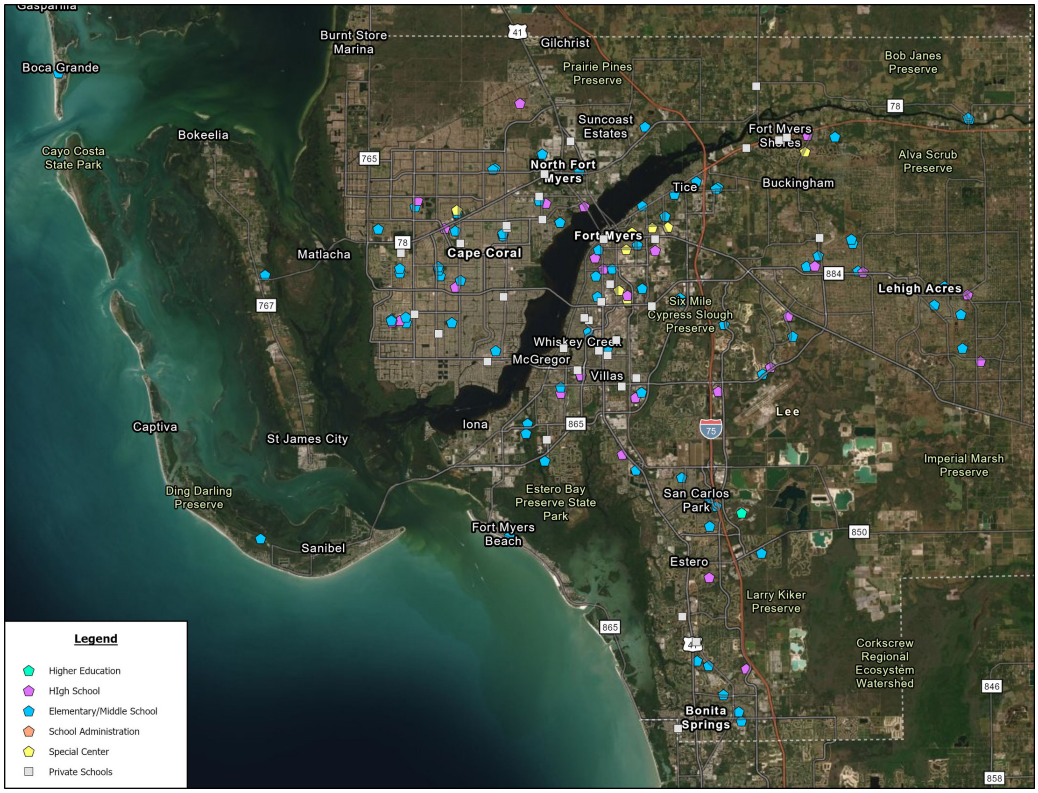
Lee County Medical Facilities



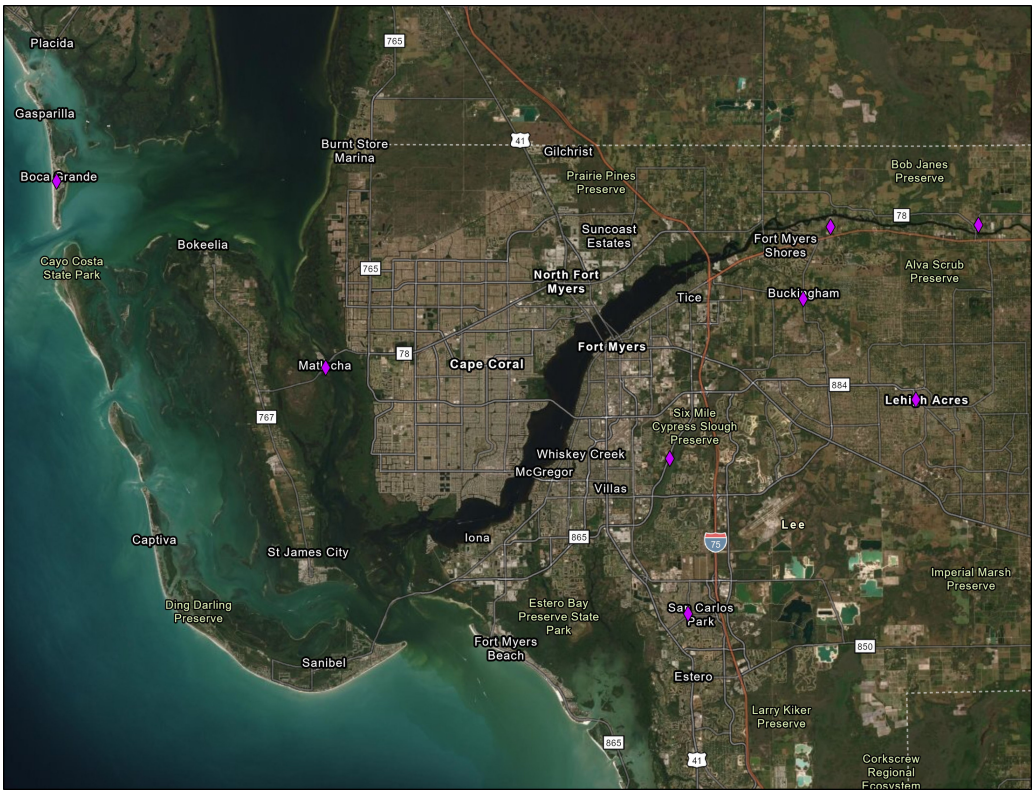
Lee County Local Government.



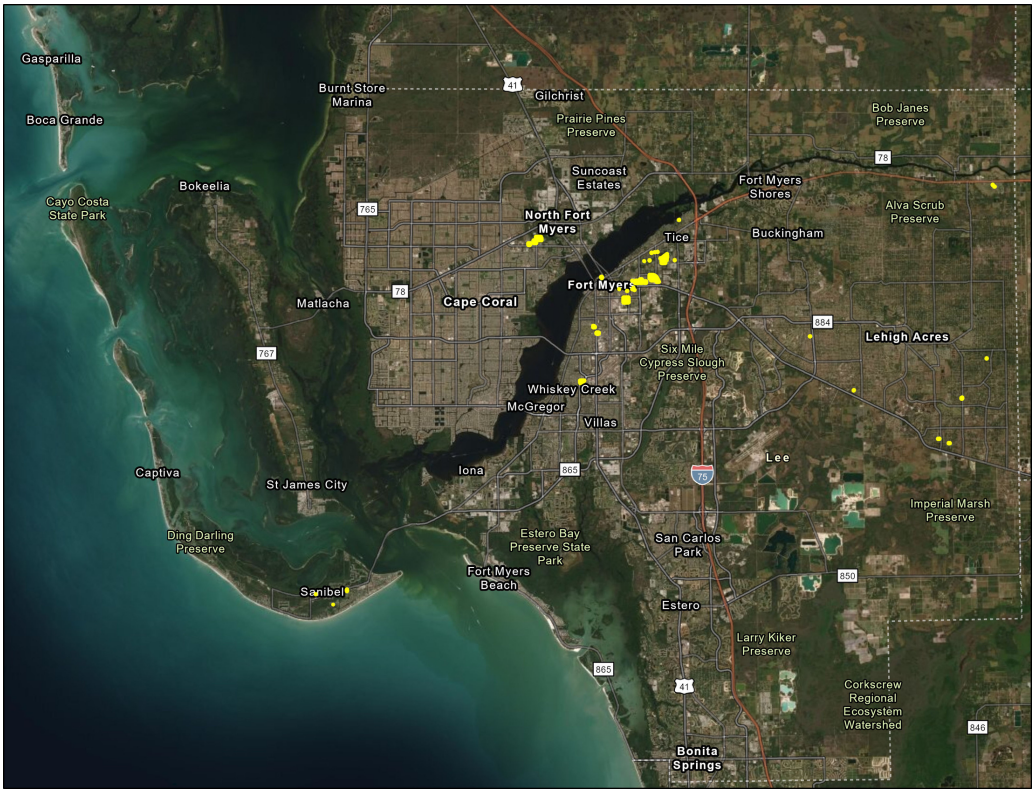
Lee County Schools



Lee County Community Centers

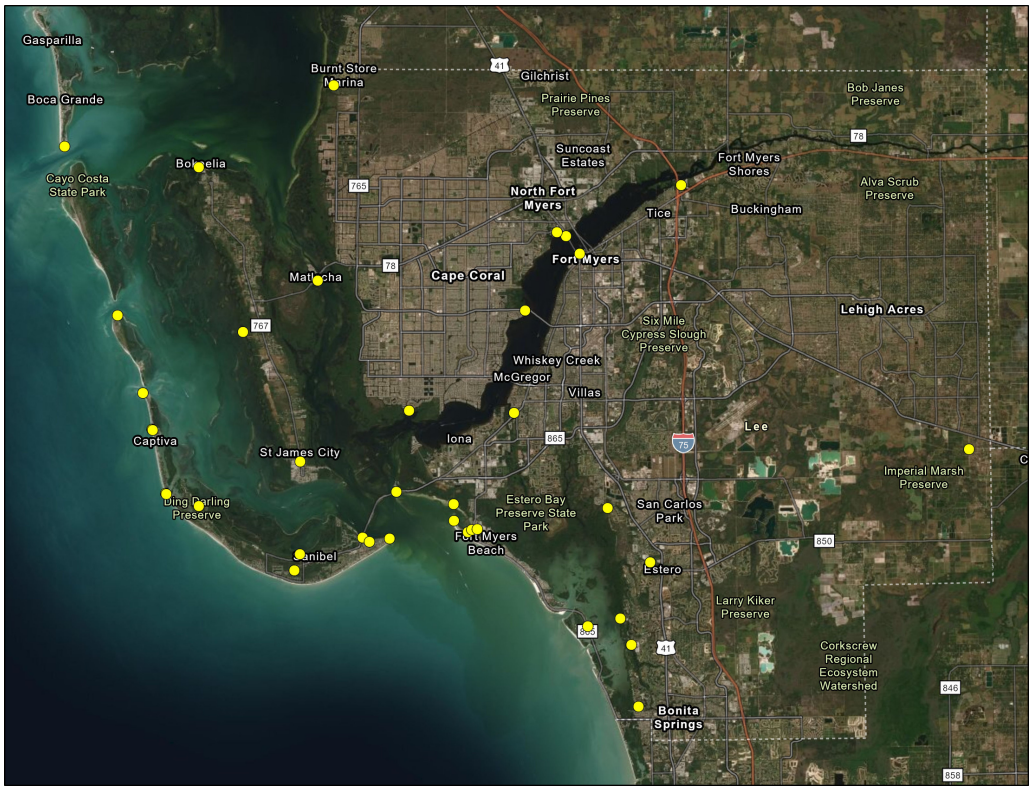


Lee County Affordable Housing



Lee County Communication Facilities

Logistical Staging Areas



Appendix II: References & Data Sources

2022 Aerials - ESRI Aerial Imagery

FEMA. Future Flood Insurance Studies (FIS). [Lee County, FL] (2018) FEMA Flood Map Service Center: https://msc.fema.gov/portal/home

Find My Flood Zone: https://leegis.maps.arcgis.com/apps/instant/sidebar/index.html?appid=f1e5ab7d08514f93b1f04f252d42f389

Flood Zones - Effective and Preliminary Coastal Study: https://leegis.maps.arcgis.com/apps/webappviewer/index.html?id=48494a7a717d4213aff365c7d830d250

Hapke, C.,Revell, D., Jamieson, M. (April 03, 2020). Captiva Island Resiliency Assessment - Technical Memorandum. Integral Consulting Inc.

Joint Airborne Lidar Bathymetry Technical Center of Expertise - 2022 [Preliminary] Pre-Ian LiDAR. https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/JALBTCX/

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Lee County Division of Natural Resources (2015). Impacts of Hurricane Charley on t the Southwest Florida Coastline Focusing on Lee County.

National Storm Surge Risk Maps - Version 3: National Storm Surge Risk Maps - Version 3 (noaa.gov)

NOAA Tides & Currents: https://tidesandcurrents.noaa.gov/datum_options.html

OCM Partners, 2023: 2018 USGS/NRCS Lidar: Southwest Florida, https://www.fisheries.noaa.gov/inport/item/59066

Sea Level Rise Scenario Sketch Planning Tool - University of Florida GeoPlan Center https://sls.geoplan.ufl.edu/download-data/

Sea Turtle Nest Found, Beach Impacts Discussed. Sanibel Captiva Conservation Foundation (SCCF). (2022, October 28). https://www.sccf.org/news/blog/sea-turtle-nest-found-beach-impacts-discussed

Thompson, M., Coen, L., Milbrandt, E., Rybak, A., & Bartleson, R. (2011). Captiva Water Quality Assessment Project Final Report. Sanibel, FL: SCCF Marine Laboratory

Zachry, B. C., W. J. Booth, J. R. Rhome, and T. M. Sharon, 2015: A National View of Storm Surge Risk and Inundation. Weather, Climate, and Society, 7(2), 109–117. DOI: http://dx.doi.org/10.1175/WCAS–D–14–00049.1

SEA LEVEL RISE VULNERABILITY ANALYSIS

Asset Types	Data Source
Schools and Colleges	Lee County GIS & Homeland Infrastructure Foundation- Level Data (private schools)
Health Care Facilities and Hospitals	Lee County GIS
Emergency Operations Centers	Lee County GIS
Risk Shelter Inventory	Homeland Infrastructure Foundation- Level Data
Airports	Lee County GIS
Seaplane Base	Lee County GIS
Ports	Homeland Infrastructure Foundation- Level Data
Community Centers	Lee County & Fort Myers Websites
Fire Stations	Lee County GIS
Government Facilities	Lee County GIS
Emergency Medical Service Facilities	Lee County GIS
Heliport	Lee County GIS
Disaster Recovery Centers	https://www.leegov.com/publicsafety/Documents/EmergencyManagement/LeeCountyAPPROVED_2019CEMPRedacted.pdf
Logistical Staging Areas	FDEP & APTIM Staging areas from last nourishment
Correctional Facilities	Lee County GIS
Law Enforcement	Lee County GIS
Solid and Hazardous Waste Facilities	Lee County GIS, Oak Ridge National Laboratory (ORNL); National Geospatial-Intelligence Agency (NGA) Homeland Security Infrastructure Program
Wastewater Treatment Facilities and Lift Stations	Lee County GIS and Kimley Horn Study
Bus Terminals	Lee County GIS
Communications Facilities	Lee County GIS & FCC
Rail Facilities and Railroad Bridges	Federal Railroad Administration (FRA)
Affordable Public Housing	Lee County Parcels
Parcels	Florida Department of Revenue
Building Footprints	Lee County GIS

Flood Hazards and LiDAR	Data Source
NOAA 2040 and 2070 Intermediate-Low and Intermediate-High Sea Level Rise Scenarios	Sea Level Rise Scenario Sketch Planning Tool - University of Florida GeoPlan Center
Tidal Flooding, Current Extreme Conditions	NOAA's Tides & Currents website (http:\\tidesandcurrents.noaa.gov).
10 Year Storm Surge Scenario	Lee County FEMA Flood Insurance Study (FIS)
100 and 500 Year Flood Event	Lee County FEMA Flood Insurance Study (FIS) and NOAA. (n.d.) National Hurricane Storm Surge Risk Maps. https://experience.arcgis.com/experience/203f772571cb48b1b8b50fdcc3272e2c/page/Category-3/.
2018 LiDAR	2018 USGS/NRCS Lidar DEM, Southwest FL
2022 LiDAR	APTIM Preliminary Pre-Ian data from 05/25/2022