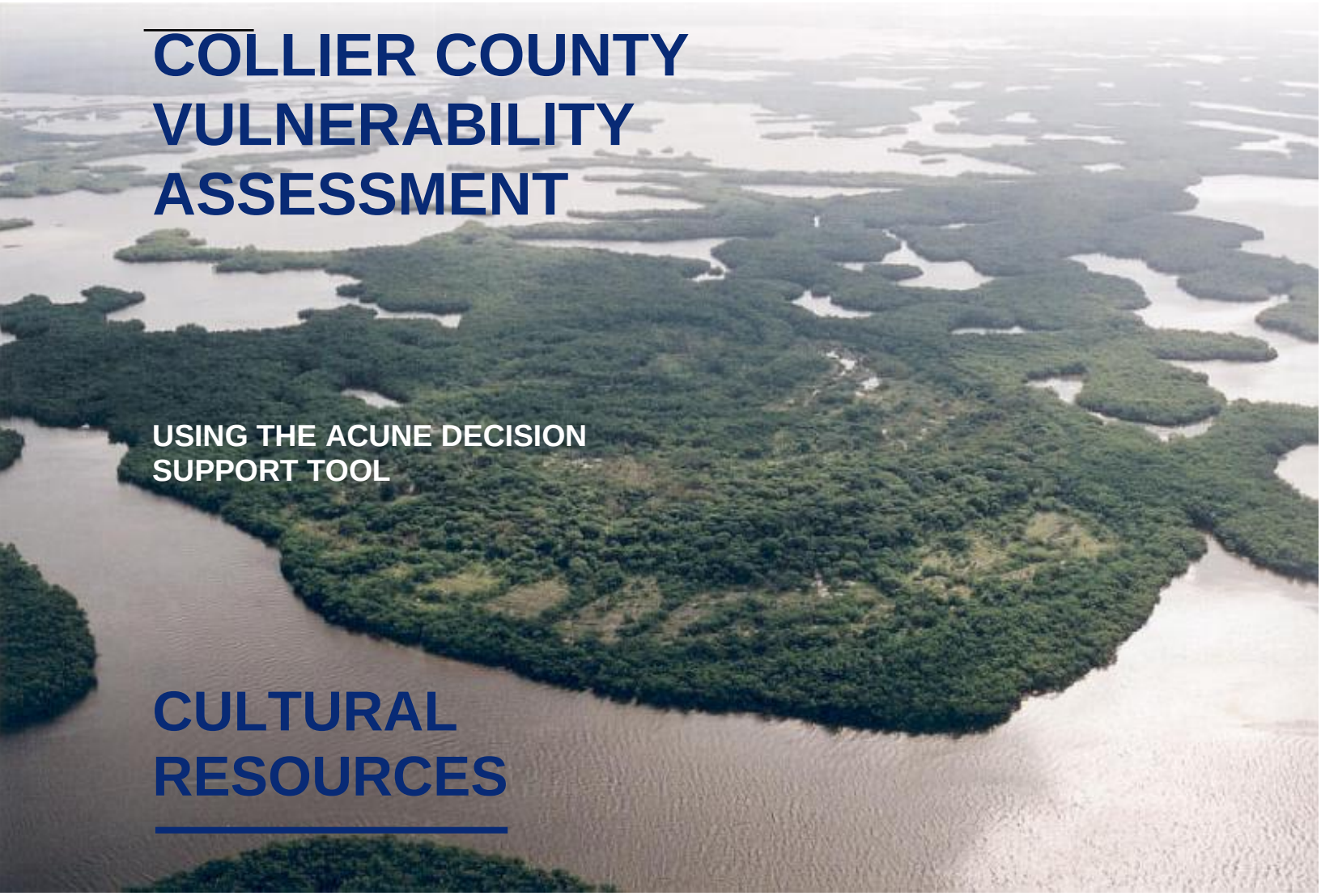

COLLIER COUNTY VULNERABILITY ASSESSMENT

USING THE ACUNE DECISION SUPPORT TOOL

CULTURAL RESOURCES

MARCH 2022

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ACUNE VULNERABILITY ASSESSMENT CULTURAL RESOURCES

Abstract

This Vulnerability Assessment was developed to quantify and characterize the nature of the threats from climate change to archaeological and cultural sites within Collier County using a web-based interactive decision support tool called Adaptation of Coastal Urban and Natural Ecosystems (ACUNE). The assessment identified 267 sites in the county impacted by a 1.0% AEP flood scenario under current sea level, with that number rising to 318 sites in a 2030 1.0% AEP flood under a medium projected sea-level rise (0.72 ft). Following this county-wide survey, the authors examined various scenarios at ten case study sites, documenting their threat of exposure, vulnerability, sensitivity, adaptability, and the consequences if the site were lost; the 10 sites included: Dismal Key archaeological site, Everglades City Museum Building/Everglades Laundry Building, the Fakahatchee Key archaeological site, the Macedonia Missionary Baptist Church, the Marco Island Historical Museum, the Ochopee Post Office, the Otter Mound archaeological site, Rosemary Cemetery, and the Shell Island site. The authors present these data to readers to evaluate and consider different factors together—shell midden sites have high exposure and low adaptability, whereas some buildings may have high exposure but greater adaptability. The ten sites are presented as case studies to serve as a model for land and resource managers attempting to assess their own vulnerable critical assets.

Acknowledgements

Vladimir Paramygin, Peter Sheng, Chip Birdsong, FPAN, all members of the ACUNE interest and working groups, Collier County NAACP, Coalition of Immokalee Workers, Seminole Tribe of Florida

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INTRODUCTION

Collier County is a growing area of Florida with diverse ecosystems and increasing pressure from development as people seek the lifestyle the area offers. Climate-change adaptation planning in the county has increased knowledge and awareness of the threats climate change and sea level rise (SLR) pose to its residents, visitors, and resources.

Cultural resources are often overlooked in climate change planning processes, which focus on emergency services and basic infrastructure needs. However, cultural resources define the county's identity and foster a sense of well-being and belonging to county residents and visitors. Communities located in areas impacted by modern climate change have often been adapting to the impacts of climate change for generations. The archaeological and historic records help to document human adaptation and resilience over centuries. Therefore, including cultural resources in adaptation planning will help ensure the sense of place and history that is integral to many communities and will help planners better understand important and protected land when planning for emergency response.

According to the Department of Environmental Protection (DEP) Florida Adaptation Planning Guidebook (2018), adaptation planning consists of four steps, (1) context, (2) vulnerability assessment, (3) adaptation strategies, and (4) strategy implementation. This report accomplishes elements of the first three steps, focusing heavily on vulnerability assessment. Each element will be discussed in further detail in the next section.

This assessment does not evaluate the vulnerability of every cultural resource in Collier County; it merely provides a guide for resource managers to perform these assessments within their management areas and inform adaptation strategies and implement them to reduce long-term impacts of climate change to cultural resources. Notably, people performing vulnerability assessments must make a conscious choice about what they will value about a particular cultural resource—it is impossible to evenly compare the research potential of one archaeological site to the community value of a historical site to community members.

This assessment used a web-based interactive decision support tool, Adaptation of Coastal Urban and Natural Ecosystems (ACUNE), in southwest Florida (Sheng, et al. 2017, 2021, 2022). This tool was developed by a multi-disciplinary multi-institutional science team led by Dr. Peter Sheng from the University of Florida and an end-user team led by Dr. Michael Savarese from Florida Gulf Coast University who also served as the liaison to Collier County for the tool's application. The ACUNE tool is currently accessible to local governments and NGO's for vulnerability analysis and planning activities, access was granted to the authors specifically for this vulnerability assessment.

ACUNE is a web-based package of tools for assessing the vulnerability of Collier County to sea water inundation caused by sea-level rise, tides, storm surge, and waves. The package employs a number of integrated computer models that collectively: (1) accounts for sea-level rise, storm surge, waves, currents, and baroclinicity on driving inundation and the effects of topography, bathymetry, and vegetation to attenuate flooding (CH3D-SWAN); (2) simulates the shift of mangrove and salt marsh vegetation over time (WARMER) which is then used to re-evaluate inundation in the future; (3) anticipates the economic impact of SLR and storm-related damage using damage functions developed by FEMA and USACE ; and (4) accounts for climate change's effects on the characteristics of future tropical storms. Rather than treating storm effects on inundation by modeling a discrete storm (for example, how might a replay of Hurricane Irma impact inundation under the SLR and climatic conditions in 2030 or 2060), ACUNE employs a "joint probability method" (JPM-OS) to calculate a probabilistic (e.g., 1% annual exceedance probability flood (or flood with 100-year return level) under future climatic conditions.

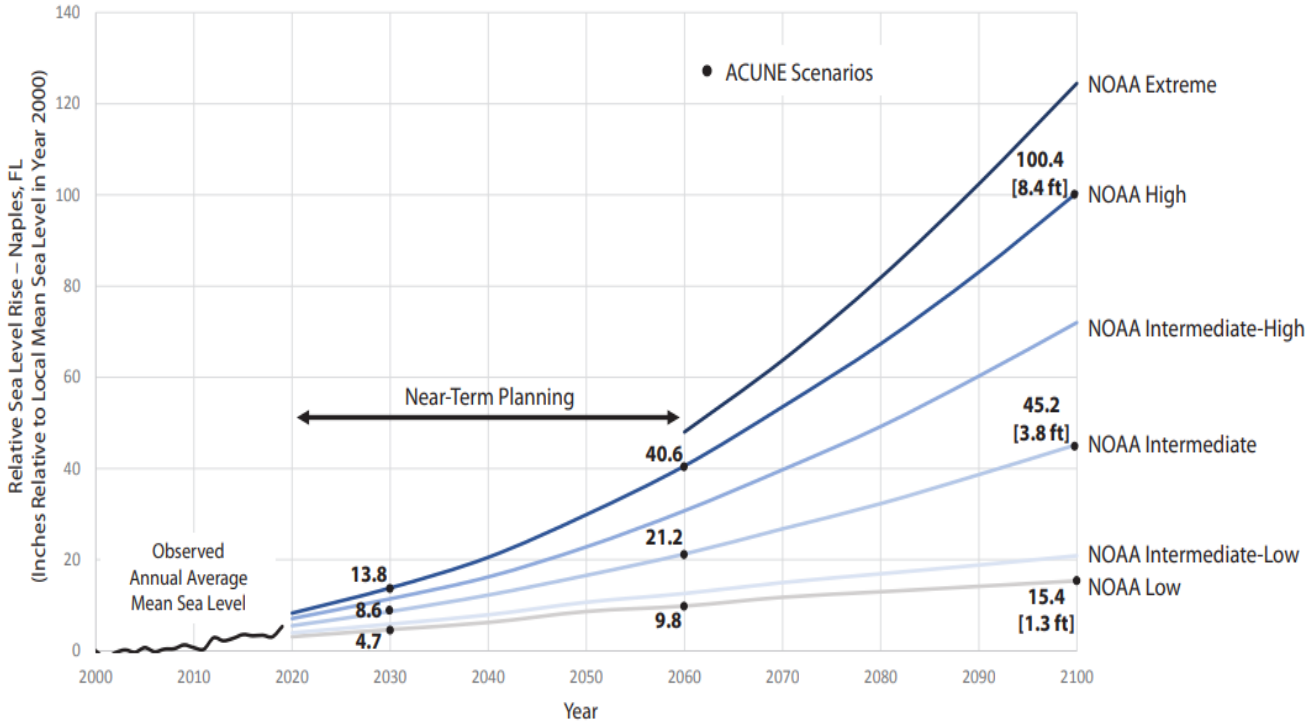
ACUNE can be used to access the depth and geographic extent of inundation caused by nuisance flooding (i.e., by just tides and SLR) or by SLR in combination with storm surge for the 100- and 500-year flood events (i.e., 1% and 0.2% annual exceedance probability flood due to SLR and storms). Currently, ACUNE contains future flood maps for 3 target years: 2030, 2060, and 2100. For each of these years, simulations for 3 SLR magnitudes, based upon the sea-level projected curves prepared by NOAA (Sweet et al., 2017) representing low (17th percentile), medium (50th percentile), and high (83rd percentile) predictions, can be generated (see Table; SLR magnitudes are increases in feet relative to sea level's position in 2000) at the Naples tide station. These Regional Sea Levels at Naples are slightly higher than the Global Mean Sea Level (GMSL) contained in the NOAA (2017) report, due to local subsidence which was not accounted

for in the GMSL scenarios. These SLR scenarios were used as ocean boundary conditions of coastal surge-wave model simulations for the future scenarios. Therefore, ACUNE provides compound flood maps due to tides and SLR, as well as compound flood maps due to future storms and SLR. Existing SLR mapping tools, however, typically only consider the flood maps due to SLR alone. These maps, often referred to as Bathtub maps, contain large errors, although they are readily available from many commercial and non-profit companies (e.g., Climate Central). Whole bathtub maps are available from ACUNE, however we discourage the use of these maps for future adaptation and resilience planning. For this cultural resource vulnerability assessment, ACUNE compound flood maps for both nuisance tides+SLR and storms+SLR were used.

Table 1: Regional Sea Level Rise in Feet in ACUNE 3.0 (Sheng et al. 2022)

Period	RSL (Regional Sea Level) - SLR (ft) ACUNE 3.0		
	Low	Medium	High
2030	0.39	0.72	1.15
2060	0.82	1.77	3.38
2100	1.28	3.77	8.36

Figure 1: ACUNE SLR Scenarios for Naples tide stations compared with NOAA Global Mean Sea Level (GMSL) Curve



Background

Archaeological and cultural sites are vulnerable to threats from climate change (Miller & Murray, 2018). In Southwest Florida, vulnerability is primarily due to impacts from sea-level rise and storm surge. The Archaeological Resource Protection Act (Archaeological Resource Protection Act) of 1979 defines archaeological sites as an irreplaceable part of America's heritage. As sites disappear due to impacts from climate change, we are losing that irreplaceable heritage.

According to the Florida Master Site File, the state's official roster of recorded cultural sites, there are over 1500 cultural sites in Collier County alone. Due to the low topography, proximity to the Gulf of Mexico, and subtropical climate, the county and surrounding area are at high risk for inundation caused by SLR (i.e., nuisance tide flooding) and tropical storms.

A cultural resource working group was created in 2020 to perform this assessment. The group's composition was customized to engage a cross section of professionals familiar with the diversity of cultural assets on the landscape. Representatives were recruited from selected local, state, and federal partners including the NAACP, Coalition of Immokalee Workers, the Seminole Tribe of Florida, local residents, Collier County Museums, Florida Gulf Coast University faculty, Florida State Parks, the Florida Public Archaeology Network, Rookery Bay National Estuarine Research Reserve, and the National Park Service. The team was composed of 15 members including: Sara Ayers-Rigsby of the Florida Public Archaeology Network, Austin Bell of the Marco Island Historical Society, Steve Bertone of Rookery Bay National Estuarine Research Reserve, Jeff Carter of Rookery Bay National Estuarine Research Reserve, Dr. Alison Elgart of Florida Gulf Coast University, Rachael Kangas of the Florida Public Archaeology Network, Dr. Bill Locascio of Florida Gulf Coast University, Victoria Menchaca of Big Cypress National Preserve, Dr. Mike Savarese of Florida Gulf Coast University, William Stanton of the Florida Department of Environmental Protection, and Craig Woodward resident of Naples and Everglades City among others. Many of these working group members have served on the greater project's stakeholder teams and have been engaged with the development of applications of ACUNE since 2017.

Vulnerability Assessment Goals

This vulnerability assessment has three main objectives each addressing various parts of the DEP's Florida Adaptation Planning Guidebook planning process:

1) To use the ACUNE mapping tool to count the total number of archaeological sites on the Florida Master Site File that will be impacted by different flood scenarios at different planning horizons. This goal accomplishes the following elements of the DEP's adaptation planning process:
    a) Context- step 1.4 of the DEP's adaptation planning process "identify community participation opportunities" (Guidebook: 4, 11). A working group was created in an effort to include both land managers who are traditionally included in the planning processes, and community organization that represent communities that have been traditionally overlooked in these discussions.
    b) Vulnerability Assessment- step 2.1 "conduct exposure analysis" (Guidebook: 11, 20). The total county site count provides crucial information on which cultural sites will be exposed to inundation at different planning horizons.
    c) Vulnerability Assessment- step 2.3 "Assign focus areas" (Guidebook: 11, 24) - while this report is not a comprehensive vulnerability assessment of all of Collier County's cultural resources, the total county site count helps to understand on a large scale which areas of the county will need to be focus areas while planning for different impacts of climate change. For example, which areas will likely be inundated, and which will likely be sites of new development as the population moves inland, both are important for future ethical and equitable planning.

2) To conduct a detailed evaluation of case studies of 10 cultural sites in Collier County, scoring them on their exposure, sensitivity, adaptive capacity, and consequence to demonstrate how the ACUNE tool can be combined with local knowledge and expertise to create vulnerability assessments and prioritize sites in order to help local land and resource managers plan for the future of sites. This is not intended as a full assessment of all sites in the county, nor is it a list of the 10 most important cultural sites. Rather, it serves as an example to examine ten local

sites in Collier County which are likely to be impacted by climate change and considered important by various stake-holders. This goal accomplishes the following elements of the DEP's adaptation planning process:

a) Vulnerability Assessment- step 2.1 of the DEP's adaptation planning process "conduct exposure analysis" (Guidebook: 11, 20). This answers for each of these 10 sites the question "'*where*' qualified by two factors – *when* (what time horizon- e.g., 10 years, 25 years) and *how much* (which sea level rise scenario- e.g., 1-foot inundation)" (Guidebook 20, emphasis added).
b) Vulnerability Assessment- step 2.2 "conduct a sensitivity analysis" (Guidebook: 11, 22). For each of the 10 sites the working group assessed the sensitivity to inundation based on the amount of damage that is likely to result from a resource being inundated.
c) Adaptation Strategies- step 3.1 "assess adaptive capacities" (Guidebook: 11, 35). Each site was assessed on its ability to adapt to pressures of climate change, including the ability to move a site.

3) To serve as an example for other resource managers in Collier county to use the ACUNE tool to create similar assessments of resources specific to their management areas and assets. Whether they be cultural sites, hospitals, roads, etc., this report and the methods used are applicable and valuable to adaptation planning and can be an invaluable tool not only in targeting vulnerable assets now but also in establishing a protocol to increase resiliency for the future.

A comprehensive vulnerability analysis of all of Collier's cultural assets was not achievable at this time due to staff time limitations and the 1500+ cultural sites listed on the Florida Master Site File (FMSF); this more modest effort focuses upon 10 sites which are considered important by the local community. We hope this project will serve as a template for resource managers to conduct full vulnerability analyses of all sites under their management purview.

METHODS

To assess vulnerability of specific cultural sites in Collier County, we modeled this assessment after the Florida Adaptation Planning Guidebook's methodology created by Florida DEP. We executed 4 steps from this methodology: (1) Exposure analysis, which depicts the potential inundation of land areas; (2) Sensitivity analysis, which illustrates the variety of assets that may be affected by inundation associated with SLR; (3) Assess adaptive capacity, which defines each asset's ability to adapt to climate change stressors; and (4) Focus area, which defines the locations where adaptation strategy efforts should be focused. Specific goals are detailed above in the "Vulnerability Assessment Goals" section.

Full County Site Count

To complete an exposure analysis, sensitivity analysis, and help define the focus for all cultural sites in Collier County, as outlined in the Florida Adaptation Planning Guidebook produced by DEP, working group members with access to the FMSF performed a count of all cultural sites in Collier County within the FMSF which were vulnerable to inundation under various scenarios in the future. Because the location of archaeological sites is confidential, these asset data were included in a secure GIS layer of ACUNE and only made available to certified professionals who had access to the FMSF. At the time of analysis, there were 1,557 cultural sites listed in Collier County on the FMSF.

The group used the ACUNE tool to examine inundation under two conditions: (1)the 1% AEP flood due to storms under current climate condition ; and (2) the 1% AEP flood due to storms and SLR (0.72 ft higher than the 2000 sea-level) under climate conditions in 2030. All sites among the 1,557 catalogued experiencing flooding (i.e., any water on the landscape surface) were counted for each flooding scenario. The magnitude of increase in the number of affected sites across this short, 10-year period (2020-2030) and under such modest SLR conditions provides resource managers with a relative sense of urgency for decision making and resilience improvement.

This first assessment does not consider a site's archaeological importance, its potential to yield new historic information, its appeal to the community, or its adaptability to climate change. The second assessment does consider these factors for 10 selected sites (see Case Studies).

Case Studies

Candidate sites for the ten case studies were submitted by members of the working group and then voted on by the group. Members endeavored to choose sites that are well-recognized by most Collier County residents. This is not a list of the 10 most important sites in the county, nor is it an assessment of all sites in the county. Rather, the assessment of the 10 sites serves as a proof-of-concept and demonstrates the value of this methodological approach for managing the resilience of all assets of value in the region. The goal of this project was to help identify where to invest resources. Members chose the sites they were most familiar with, or sites with thorough documentation like that provided for sites on the National Register of Historic Places and scored the sites by the criteria detailed below.

To assess vulnerability of specific cultural sites in Collier County we modeled this assessment after the Florida Adaptation Planning Guidebook's methodology created by Florida DEP. We executed 4 steps from this methodology, (1) Exposure analysis, which depicts the potential inundation of land areas; (2) Sensitivity analysis, which illustrates the variety of assets that may be affected by inundation associated with SLR; (3) Assess adaptive capacity, which defines each asset's ability to adapt to climate change stressors; and (4) Focus area, which defines the locations where adaptation strategy efforts should be focused.

Unlike DEP's methodology, however, we only assessed these elements for flooding, as this is the main function of the ACUNE tool. The following elements were scored for each site:

- **Hazard Exposure**- how extensive will the flooding be on the cultural resource?
- **Sensitivity**- will the cultural resource's function, including its physical structure, be impacted by flooding?
- **Adaptive Capacity**- can the cultural resource be modified to reduce the impact of flooding?
- **Consequence**- what are the negative societal consequences of inaction for the history and archaeology of Collier County? Consequences of this inaction are evaluated from the following perspectives:
    - *Environmental* – what are the consequences for the surrounding natural environment with loss of or damage to the cultural resource?

- *Social* – what kind of impacts might occur to the culture or sense of place for the local community?
- *Economic* – will there be workforce disruption, loss of real estate, impacts on tourism or significant industries, or asset damage/loss (AECOM, 2020)?

Many existing studies focus primarily on exposure, but it is important to consider sensitivity, adaptive capacity, and consequence as well. Less urgency may be required for a site with high exposure that also has a high adaptive capacity if it is exposed. Rather than preventing exposure at this site, it may be a more prudent management decision to assist with adaptive capacity. In contrast, a site with high exposure and low adaptive capacity may need to be prioritized as it is more likely to be negatively impacted when it is exposed. For example, a small historic building that will be exposed to flooding in 2030 can easily be elevated or moved to a safer location, whereas a cemetery also exposed to flooding in 2030 is impossible to elevate and more difficult to move and might therefore be of higher priority for resiliency planning. Many archaeological sites have low adaptive capacities, as it is not possible to simply lift a shell midden three feet off the ground in the same manner as an air-conditioning unit, or even a roadway. Accordingly, these represent some of the most vulnerable cultural resources. A study by the State of Florida (Florida Division of Historic Resources, 2004) recommended a strategy of "abandonment in place", or inaction, for archaeological sites; however, it should be noted that it may be possible to increase resilience of these types of resources through means like installing wave barriers or excavating the site to preserve archaeological information. The purpose of these case studies is to demonstrate how resource managers and adaptation planners can assess sites and make informed decisions when prioritizing them in the planning process.

Members of the working group were asked to submit sites important to their community or management area that would be well-recognized by members of the community. We specifically asked for any important cultural site, not simply those listed on the FMSF. It is important to note that the FMSF does not contain every cultural site in existence in Collier County, only those which have been documented through the official process with the State of Florida. Due to processes of systemic oppression and underrepresentation, this has resulted in a disproportionate number of sites that pertain to the post-Columbian history of the region. There have been numerous efforts to increase the representation

of sites and histories of under-represented groups, however this bias is still present within the FMSF database. Accordingly, surveying members of the community for this report resulted in the identification of previously unrecorded critical assets.

Scoring Exposure

Exposure scoring reflects the number of tested scenarios in which flooding from SLR and storms is projected to impact sites. The ACUNE tool was used to map different SLR and storm flooding on various planning horizons and projections of SLR. A site's score was determined as a percentage based on the number of scenarios where any portion of the site is exposed to any amount of water. The exposure scores range from 0 (not exposed in any scenario used) to 100% (exposed to water in the 2020 1.0% AEP flood and all other scenarios [i.e., exposed in 13 of 13 scenarios]).

Table 2: Exposure Scenarios

Scenario	Exposed?	Definition
1		Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2		Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3		Exposed to **Nuisance** flooding based on the **2100 High** SLR
4		Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5		Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6		Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7		Exposed to **Nuisance** flooding based on the **2060 High** SLR
8		Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9		Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10		Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11		Exposed to **Nuisance** flooding based on the **2030 High** SLR
12		Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13		Exposed to flooding or inundation based on the 2020 1%AEP

Scoring Sensitivity

Sites on the 10-site list were assessed for sensitivity to exposure to flood waters and how this exposure would impact a site based on qualitative considerations.

Site sensitivity is partly dependent on the site's relative reliance on susceptible technologies for their function. For example, historic structures with electrical wiring and built frameworks are more likely to have their function compromised, and therefore more sensitive, than a shell mound.

The sensitivity of each site was assessed by the working group based on a set of qualitative considerations employed by AECOM in their City of Naples Climate Change Vulnerability Assessment **(AECOM, 2020)** but amended to more accurately define sensitivities specifically associated with archaeological and historic sites. The following characteristics were used to qualitatively assess the sensitivity to flooding:

- Electrical equipment (flooding or inundation of electrical equipment may lead to operation malfunction or damage to the asset).

- Corrosive material (subsurface structures required for the conveyance of water, sewer, natural gas, and electrical utilities may be made of materials that could corrode prematurely if exposed to saltwater).

- Susceptible to increased frequency, duration, or depth of saltwater inundation (some assets and/or habitats have a narrow tolerance of water depth changes and may experience damage or complete loss of function-example archaeological site protected by vegetation that may be changed/impacted by inundation).

- Susceptible to erosion/scour events (flood event may cause erosion or scour under or directly adjacent to the asset or archaeological site).

- Buildings (some buildings house equipment on lower floors that could be damaged if exposed to flooding).

- Elevation (some assets are elevated above the adjacent ground elevation, making them less sensitive to floodwaters, but access could potentially be impacted).

The cultural resource working group evaluated each site's sensitivity based upon their expertise and experience. Each cultural resource was evaluated on a scale of zero (not sensitive) to three (highly sensitive) (see Table **3**).

Table 3: Criteria for Scoring Sensitivity

Score	Rating	Definition
0	Not Sensitive	No Impact
1	Low Sensitivity	Short-term, minor, or reversible damage
2	Moderate Sensitivity	Significant, but reversible damage
3	High Sensitivity	Irreversible damage

Scoring Adaptive Capacity

Adaptive capacity of a site reflects its potential to adapt to the impacts of flooding to retain its historic or archaeological integrity. For example, historic buildings can be raised or moved, while large shellwork sites cannot. The shellwork site, therefore, has less adaptive capacity. As with sensitivity, the scoring of adaptive capacity employed an approach modified after the Naples Study (AECOM 2020). The following characteristics were considered when grading adaptive capacity to flooding:

- **Flooding (coastal and precipitation) – Built Infrastructure**

  - Ability to elevate infrastructure (the existing archaeological or historic site can easily be raised to reduce its vulnerability to flooding, or have electrical components raised out of the reach of temporary flooding).

  - Ability to relocate infrastructure (archaeological or historic site can be easily moved to higher elevation or outside of floodplain to protect it from flood damage).

  - Ability to retrofit/upgrade (archaeological or historic site can be easily retrofitted with units or with water proofing material without compromising historic status).

• Flooding (coastal and precipitation) – Archaeological Site

- Robustness (some sites are better able to withstand climatic changes and individual extreme events).

Table 4: Criteria for Scoring Adaptive Capacity

Score	Rating	Definition
1	High adaptive capacity	Ability to adapt site to fully offset potential impacts; adaptation is possible at a reasonable cost and low level of effort
2	Low adaptive capacity	Ability to adapt site to partially offset potential impacts; or adaptation is possible, but extremely costly or difficult; creating armoring like a living shoreline to protect a site
3	No adaptive capacity	No ability to adapt asset or possible adaptation does not offset potential impacts; archaeological site would either require full excavation or be lost

Each site was scored for adaptive capacity, with some working group members scoring with a +/-0.5 accuracy (e.g., Fakahatchee Key was scored 1.5). All sites scored with a decimal were shell middens. These sites are difficult to score as there are ways to research the sites (salvage excavation) to offset loss of information, but they are impossible to move and preserve in their entirety.

Scoring Consequence

The authors evaluated the potential consequences of inaction at archaeological and cultural sites, including the potential environmental damage, potential social impacts, and potential economic damage of site loss. These consequences are also modeled after the Naples Study **(AECOM, 2020)** and amended to define consequence of loss at archaeological and historic sites more accurately.

• Potential environmental damage

- Conversion or loss of habitat (existing habitats may face deterioration or complete loss due to inundation).
- Harm to local wildlife (impacts on native or endangered species or species of interest).

- **Potential social impacts**
  - Cultural and historic (loss of historic communities or cultural sites that define the county's identity and provide a sense of well-being or belonging to county residents).
  - Loss of archaeological knowledge/information due to impacts on sites.

- **Potential economic damage**
  - Asset damage (partial or entire loss of site or its ability to function).
  - Operation disruptions (some sites may cause lost revenue due to facility limitations or closure, loss of access via primary roadway, or loss of critical infrastructure).
  - Loss of jobs (sites that require staffing and maintenance currently would no longer support those employees if the site is destroyed or no longer functional).
  - Loss of tourism opportunities (tourism and visitation by seasonal and permanent residence may decline due to climate stressors affecting a site's accessibility or function).
  - Increase in maintenance (financial burden may increase due to increased maintenance required for exacerbated stress placed on site or system).

Each of these three categories of consequence were scored separately, and the scores then averaged to create the overall consequence score. For example, a site that has a moderate environmental consequence (2), a low social consequence (1), and a moderate economic consequence (2) would be scored by averaging the 3 scores, resulting in a total consequence score of 1.67. Complete scoring details for each site are recorded in Appendix A.

Table 5: Criteria for Scoring Consequence

Score	Rating	Definition
1	Low Consequence	Negligible impacts (e.g., inconvenient or temporary effects); easy and not costly to restore
2	Moderate Consequence	Widespread impacts resulting in loss or setback of archaeological site or system; costly, but possible to restore
3	High Consequence	Significant impacts resulting in extensive loss; likely irreversible or very costly to restore

RESULTS

Full County Site Count

Following an evaluation of the vulnerability of Collier County's 1557 sites to flooding in two different scenarios, the working group used the ACUNE tool to determine that in Scenario A, 2020 with 1.0% AEP Flood, 267 of the 1557 sites were shown to be impacted by flood. For Scenario B, 2030 Medium SLR with 1.0% AEP Flood, of the 1557 sites reported in Collier County, 318 sites are predicted to show impacts from flooding. The 10-year difference increases the number of impacted sites by 51. It was not possible at this stage to complete a formal evaluation of all 1557 sites in the county; accordingly, 10 sites particularly important to the local community were selected as case studies and are detailed below.

Table 6: Results of Full County Site Count

Scenario	Flood Projection	Number of Sites impacted
A	**2020 with 1.0% AEP Flood**	**267**
B	**2030 Medium SLR with 1.0% AEP Flood**	**318**

Case Study 1- Dismal Key

Description of Site

The Dismal Key archaeological site is a monumental shellwork which covers over 73 acres (30 ha) (Schwadron, 2010). The property is owned by US Fish and Wildlife Services, 10 Thousand Islands National Wildlife Refuge, along with Rookery Bay National Estuarine Research Reserve. The site consists of two six-meter-tall (approximately 19 feet) mounds, a canal, and finger ridges. A small crescent-shaped shell ring is located in the interior of the site. The form and orientation of the shell ring is consistent with Late Archaic shell rings throughout the southeast (Schwadron 2010), indicating that the site could have been in use during this time (4000-2700 BP). According to a search of archaeological sites conducted on the Digital Index of North American Archaeology (Open Context Editors, 2021), only 88 sites in Collier County contain Archaic components, rendering each site invaluable for the information it may contain.

As a large shellwork site, it is likely impossible to move the entire site or retrofit it to adapt to climate change. The site may acclimatize to rising sea level but conducting an underwater investigation on a submerged site is both more time-consuming and costly (Cook-Hale, et al., 2021).

Table 7: Final scoring for Dismal Key

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Dismal Key	100%	2	1.5	1.75	2	2	2	2

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is calculated to be 100%, a site exposed to six scenarios was calculated to be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 8.

Dismal Key was shown to be exposed to flooding in the 2020 1%AEP flood scenario and all other future scenarios and therefore scores a 100%.

Table 8: Exposure Scenarios for Dismal Key

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3	X	Exposed to **Nuisance** flooding based on the **2100 High** SLR
4	X	Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5	X	Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6	X	Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7	X	Exposed to **Nuisance** flooding based on the **2060 High** SLR
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13	X	Exposed to flooding or inundation based on the **2020 1%AEP**

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 2 (moderate sensitivity; significant, but reversible damage; as described in Table 3) for the site. Dismal Key is a large shellwork site and therefore will likely be impacted, but still able to be researched even if submerged, although research would be much more difficult and costly.

Adaptive Capacity

In order to assess the adaptive capacity for archaeological sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? The site was evaluated to be a 1.5, between high adaptive capacity and moderate adaptive capacity, based on Table 4. Although portions of the site may be destroyed, the site may remain partially intact underwater. Additionally, it would be possible to obtain information from the site through an archaeological survey either prior to total submersion of the site or as an underwater survey.

Consequence

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged. Dismal Key's averaged score is 2 (see **Error! Reference source not found.** and Appendix A for details), moderate consequence with widespread impacts that are possible to restore, as documented in Table 5. Environmental, social, and economic impacts were all scored at 2 out of 3, and the site would have moderate consequences in all three areas if destroyed. Being part of the Rookery Bay National Estuarine Research Reserve, the site is part of a delicate and protected environmental system and is widely known to local residents and even garners some visitation by local tour guides in the area. The site also has the potential to provide significant information about this archaeology and history of Collier County. Therefore, if the site were to be destroyed, it would have negative environmental, social, and economic impacts.

Case Study 2- Everglades City Museum building / Everglades City Laundry building

Description of Site

The Everglades City Laundry building, built in 1927, is a historic building in Everglades City associated with the company town and planned community of Town of Everglades, developed by Baron Gift Collier. The wooden frame vernacular building was used as a laundry facility until World War II, then as an office for the Civilian Air Patrol, and as a woman's club before being conveyed to the county, rehabilitated, and opened as the Everglades City Museum, part of the Collier County Museum System.

The building has withstood almost 100 years of Everglades storms, hurricanes, and climate, however as sea levels continue to rise the wooden structure will be at greater risk of deterioration than other concrete constructed buildings in the area. The building has the potential to be moved, however this mitigation strategy would be very costly and would significantly alter the building's current connection with Everglades City.

Table 9: Final Scoring for Everglades City Museum Building/Everglades City Laundry Building

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Everglades City Museum building/ Everglades City Laundry building	92%	2	2	2	1	2	2	1.67

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is calculated to be 100%, a site exposed to six scenarios was calculated to be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 10.

The Everglades City Museum building/ Everglades City Laundry building was shown to be exposed to flooding in 12 of 13 flood scenarios, therefore scores a 92%.

Table 10: Exposure Scenarios for Everglades City Museum building/Everglades City Laundry building

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3	X	Exposed to **Nuisance** flooding based on the **2100 High** SLR
4	X	Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5	X	Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6	X	Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7	X	Exposed to **Nuisance** flooding based on the **2060 High** SLR
8	X	Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9	X	Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10	X	Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11	X	Exposed to **Nuisance** flooding based on the **2030 High** SLR
12	-	Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13	X	Exposed to flooding or inundation based on the **2020 1%AEP**

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 2 (moderate sensitivity. Significant, but reversible damage) for the site.

Adaptive Capacity

In order to assess the adaptive capacity for architectural sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? Although a costly proposition, raising or moving the building is technically possible and therefore provides some adaptive capacity to the site. Accordingly, the site was evaluated to be a 2 based on Table 4.

Consequence

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged. The Everglades City Museum building/ Everglades City Laundry building's averaged score is 1.67 (See Table 9 for details), moderate consequence with widespread impacts that are possible to restore, as documented in Table 5.

The building's destruction would not have a significant impact on the surrounding environment, however the social and economic impacts of the site's destruction would have moderate effects. The building is part of the historic fabric of Everglades City and as part of the Collier County Museum System it attracts visitors and impacts the local economy via money spent in the town during visits and through the social events the museum hosts and attends as partners.

Case Study 3- Fakahatchee Key

Description of Site

The Fakahatchee Key archaeological site is a major shellwork site which covers 23 ha (56 ac). The site consists of a large midden ridge with shell midden mounds, platforms, and finger ridges and canals. This site shows evidence for a separation of domestic and social spaces (Schwadron, 2010).

The excellent preservation of the site renders it capable of retaining archaeological information that may be difficult or impossible to obtain from other sites in Florida that have been impacted by development. As a large shellwork site, it is likely impossible to move the entire site or retrofit it to adapt to climate change. The site may acclimatize to rising sea level but conducting an underwater investigation on a submerged site is both more time-consuming and costly (Cook-Hale, et al., 2021).

Table 11: Final Scoring for Fakahatchee Key

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Fakahatchee Key	100%	2	1.5	1.75	2	2	2	2

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is calculated to be 100%, a site exposed to six scenarios was calculated to be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 12.

Fakahatchee Key was shown to be exposed to flooding in the 2020 1%AEP flood scenario and all twelve other scenarios listed, therefore scores a 100%.

Table 12: Exposure Scenarios Fakahatchee Key

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3	X	Exposed to **Nuisance** flooding based on the **2100 High** SLR
4	X	Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5	X	Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6	X	Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7	X	Exposed to **Nuisance** flooding based on the **2060 High** SLR
8	X	Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9	X	Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10	X	Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11	X	Exposed to **Nuisance** flooding based on the **2030 High** SLR
12	X	Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13	X	Exposed to flooding or inundation based on the **2020 1%AEP**

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 2 (moderate sensitivity; significant, but reversible damage) for the site.

Adaptive Capacity

In order to assess the adaptive capacity for archaeological sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? The site was evaluated to be a 1.5 based on Table 4 as it may be possible to protect the site through means like a living shoreline and other measures to increase resiliency of the site, however it is impossible to move the entire site.

Consequences

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged.

Fakahatchee Key scored 2 (see Table 11), moderate consequence with widespread impacts that are possible to restore, as documented in Table 5. The site is part of the Rookery Bay National Estuarine Research Reserve and serves as an important part of the delicate environment the Reserve helps to protect. Losing the site would therefore have a moderate impact on the surrounding environment. Likewise, the site is part of the local knowledge of the area and has significant social ties to the area and serves as an anchor for the deep historic and archaeological history. The site has the potential to provide significant information about this archaeology and history of Collier County. It also fosters visitors to the reserve and local guides, adding to the economic sustainability of the area. Due to these ties, the consequences of losing the site are moderate on all three scoring categories.

Case Study 4- Macedonia Missionary Baptist Church, River Park Community

Description of Site

Macedonia Missionary Baptist Church was constructed in 1929 and traditionally has served the historically Black community of River Park. The Church is Naples' oldest and was revitalized by the community in 2015 (Swift, 2015). The site is not listed on the Florida Master Site File or the National Register of Historic Places; however, it is the opinion of the authors that the site is potentially eligible for the NRHP. Future studies should complete a formal evaluation of the site for NRHP.

Growing urban expansion of Collier County and a history of 'urban renewal' in southwest Florida renders resources like the Macedonia Missionary Baptist Church extremely vulnerable to climate change. The social consequences of losing this site would be dire—the site is a resource for a historically underrepresented and underserved community.

The site is less exposed than other sites among these case studies, however it must be noted that the social and economic consequences of losing the site are extremely high. The church is a perfect example of why consequence scores are important to consider in addition to simple exposure and vulnerability.

Table 13: Final Scoring for the Macedonia Baptist Church

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Macedonia Baptist Church	62%	2	2	2	1	3	3	2.33

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is

calculated to be 100%, a site exposed to six scenarios was calculated to be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 14.

Macedonia Missionary Baptist Church was shown to be first exposed to flooding in the 2030 Low SLR 1%AEP flood scenario and a total of 8 flooding scenarios and therefore scores a 62%.

Table 14: Exposure Scenarios for Macedonia Missionary Baptist Church, River Park Community

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3	X	Exposed to **Nuisance** flooding based on the **2100 High** SLR
4	-	Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5	X	Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6	X	Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7	X	Exposed to **Nuisance** flooding based on the **2060 High** SLR
8	-	Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9	X	Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10	X	Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11	-	Exposed to **Nuisance** flooding based on the **2030 High** SLR
12	-	Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13	-	Exposed to flooding or inundation based on the **2020 1%AEP**

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 2 (moderate sensitivity; significant, but reversible damage) for the site. If the site were to be impacted by flooding, the damage would likely be significant and impact the ability of the community to use the space while flooded and would damage the wiring and potentially impact the infrastructure of the building, however this damage would likely be reversible with repairs.

Adaptive Capacity

In order to assess the adaptive capacity for archaeological sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? Due to the cost of adaptation (for example, moving utilities to a higher level or somehow elevating the site) and the fact that adaptations necessary for resiliency might impact the historic nature of the church, the site was evaluated to be a 2: “Ability to adapt site to partially offset potential impacts; or adaptation is possible, but extremely costly or difficult”, based on criteria in Table 4.

Consequences

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged. Macedonia Missionary Baptist Church’s average score is 2.33 (see Table 13), “Significant impacts resulting in extensive loss; likely irreversible or very costly to restore” as documented in Table 5. While the site does not have a significant impact on the local environment, it is a cornerstone of the community in both social and economic ways. The church is a gathering place for locals and is integral to the social fabric of the River Park community. It also impacts the local economy by providing resources to the community that would otherwise be inaccessible, and by organizing events that also impact visitorship and economic stability in the community.

Case Study 5- Marco Island Historical Museum

Description of Site

The Marco Island Historical Museum is located near the center of Marco Island and contains upwards of 50,000 items within its collections including archaeological materials, historic objects, documents, photographs, as well as significant loans from other institutions. The museum is a major tourist attraction in the county and attracts international visitors; the average visitation numbers over the last 6 years (including 2020 and 2021, which were impacted by the COVID-19 pandemic), are over 23,300 people annually. The museum itself is built atop an artificial shell mound that was part of the museum's construction and design. This mound puts the museum at 10 feet above sea level, which is reflected in the ACUNE mapping of the site and lessens the site's exposure rating compared to the surrounding landscape.

Table 15: Final Scoring for the Marco Island Historical Museum

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Marco Island Historical Museum	54%	3	2	2.5	1	3	3	2.33

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is calculated to be 100%, a site exposed to six scenarios was calculated to be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 16.

Marco Island Historical Museum was shown to first be exposed to flooding in the 2030 Low SLR 1%AEP flood scenario and a total of 7 scenarios and therefore scores a 54%.

Table 16: Exposure Scenarios for Marco Island Historical Museum

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3	X	Exposed to **Nuisance** flooding based on the **2100 High** SLR
4	-	Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5	X	Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6	X	Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7	-	Exposed to **Nuisance** flooding based on the **2060 High** SLR
8	-	Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9	X	Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10	X	Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11	-	Exposed to **Nuisance** flooding based on the **2030 High** SLR
12	-	Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13	-	Exposed to flooding or inundation based on the **2020 1%AEP**

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 3 (High sensitivity. Irreversible damage) for the site. This is due to utilities present in the museum as well as the sensitive nature of artifacts and other materials stored in archives for the museum. While the structure could be rehabilitated or repaired, the artifacts contained in the museum would be highly sensitive to exposure to moisture, including moisture that might come through increased humidity if the air conditioning system were compromised, for example.

Adaptive Capacity

In order to assess the adaptive capacity for archaeological sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? The site was evaluated to be a 2, “ability to adapt site to partially offset potential impacts; or adaptation is possible, but extremely costly or difficult”

based on Table 4. It may be possible to make the site more resilient by constructing flood protection measures or moving utilities or important assets higher within the building. The building could also be moved in its entirety, or the contents moved to a new location, however these would all be costly and difficult scenarios. However, this site is unique on the case study list as the building itself is not the resource, the objects within the building are the cultural resources. Therefore, while the object must be housed in an appropriate space, this building is not the only option. If this building were to be impacted by climate change, it is likely most structures on Marco Island would also be similarly if not more severely impacted. Therefore, moving the objects or the building would necessarily require them to be moved off the island which they represent.

Consequences

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged. While loss of the site will likely have negligible impacts to wildlife and associated habitat, there will be significant, irreversible impacts on a social and economic scale, with loss of the story of the history of Marco Island as well as local jobs and a major tourist destination. Considering all these factors, the consequence for loss of the site was averaged to be a 2.33 (see Table 15), “moderate consequence with widespread impacts that are possible to restore” as documented in Table 5.

Case Study 6- Ochopee Post Office (Smallest Post Office Building in the Country)

Description of Site

The Ochopee Post Office is a unique cultural resource in Collier County. Its status as the Nation's smallest operating post office makes it a local attraction featured on travel websites. Yet, Ochopee Post Office also serves about 300 people in three counties, including members of the Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida and provides an essential service to small populations living in remote parts of South Florida.

The connections to Collier County's past, particularly in terms of the early development of infrastructure (for example US 41 / Tamiami Trail) and economy (for example irrigation for cattle and agriculture), make the Ochopee Post Office and the structure it occupies an important part of Florida's heritage. Further, its unique status as the smallest post office building in the U.S. attracts visitors from around the world who show up on a regular basis seeking the "famed Ochopee postmark" (United States Postal Service, 2021). As an operating facility, the Ochopee Post Office provides an essential service to communities in the county. The Ochopee Post Office constitutes an irreplaceable cultural resource.

Its proximity to US 41 makes the Ochopee Post Office more adaptable than some sites. Further, the site's elevation could likely be increased without causing major damage to its integrity.

Table 17: Final Scoring for the Ochopee Post Office

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Ochopee Post Office	69%	2	1	1.5	1	2	2	1.67

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is calculated to be 100%, a site exposed to six scenarios was calculated to be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 18.

The Ochopee Post Office was shown to first be exposed to flooding in the 2030 Low SLR 1%AEP flood scenario and a total of 9 scenarios, and therefore scores a 69%.

Table 18: Exposure Scenarios for Ochopee Post Office

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3	X	Exposed to **Nuisance** flooding based on the **2100 High** SLR
4	X	Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5	X	Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6	X	Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7	X	Exposed to **Nuisance** flooding based on the **2060 High** SLR
8	-	Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9	X	Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10	X	Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11	-	Exposed to **Nuisance** flooding based on the **2030 High** SLR
12	-	Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13	-	Exposed to flooding or inundation based on the **2020 1%AEP**

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 2 (moderate sensitivity; significant, but

reversible damage) for the site. The building would be damaged by flooding, however the size of the building itself would make repair costs lower than larger structures on the case study list.

Adaptive Capacity

In order to assess the adaptive capacity for archaeological sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? The Ochopee Post Office's proximity to US 41 makes the site more adaptable than some – e.g., it lies in the right-of-way and likely would necessarily be part of large-scale modifications to US 41. Further, it seems that the site's elevation could be increased without causing major damage to its integrity. The site was evaluated to be a 1: "high adaptive capacity; ability to adapt site to fully offset potential impacts; adaptation is possible at a reasonable cost and low level of effort" based on Table 4. This site has the highest adaptive capacity of any site on the case study list, largely due to its small size and location along a major roadway.

Consequences

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged. The Ochopee Post Office score averaged to 1.67 (see Table 17), moderate consequence with minimal environmental impacts but more significant social and economic consequences for loss of the site which would result in widespread impacts that are possible to restore, as documented in Table 5. The structure has little impact on surrounding environmental systems and therefore would have low consequence if lost. Howeve,r the building is a major part of the social and economic fabric of the area. With visitors from around the world making the journey to this structure, its loss would likely result in less visitorship. Further, being an active post office that serves many small communities, the loss of the site would significantly impact those communities and their ability to send a receive mail, a service that is older than the United States itself and that is integral to official dealings with government entities and to social life for community members.

Case Study 7- Otter Mound

Description of Site

Otter Mound today is part of the Conservation Collier preserve management system, which maintains the site as a public park with interpretation about the history, environment, and ecology of the local area (Collier County, Florida, 2021). The mound was originally built c. 750 A.D. during the period of Calusa influence in the area. The mound was later part of Caxambas Village and was associated with the clamming industry on Marco Island. A historic home built on the pre-colonial mound was occupied until it burned in 1978, but the historic outhouse building remains. One of the historic period owners of the home, Ernest and Gladys Otter, used hundreds of whelk shells found in the mound to create walls within the property that the site is well-known for today.

Because the pre-colonial mound cannot be moved, it is at increased risk of deterioration from flooding. However, because of its elevation, engineered by its original builders, and the surrounding topography in this area of Marco Island, the site is somewhat protected from the initial flooding the rest of the area is projected to see. Transportation to the site would be impacted, however, as the surrounding area is impacted by flooding, thus changing the accessibility of the site and its function as a public park.

Table 19: Final Scoring for Otter Mound

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Otter Mound	46%	2	1.5	1.75	2	2	2	2

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is calculated to be 100%, a site exposed to six scenarios was calculated to

be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 20.

Otter Mound was shown to first be exposed to flooding in the 2030 High SLR 1%AEP flood scenario and a total of 6 scenarios, and therefore scores a 46%.

Table 20: Exposure Scenarios for Otter Mound

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3	X	Exposed to **Nuisance** flooding based on the **2100 High** SLR
4	-	Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5	X	Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6	X	Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7	-	Exposed to **Nuisance** flooding based on the **2060 High** SLR
8	-	Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9	X	Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10	-	Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11	-	Exposed to **Nuisance** flooding based on the **2030 High** SLR
12	-	Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13	-	Exposed to flooding or inundation based on the **2020 1%AEP**

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 2 “moderate sensitivity; significant, but reversible damage” for the site based on Table 3.

Adaptive Capacity

In order to assess the adaptive capacity for archaeological sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? The site was evaluated to be a 2 based on Table 19. Given the site’s

inland location (compared to sites that are on the water), and the topography of the surrounding area, the site could potentially be protected from some flooding scenarios by relatively minor changes to the site such as creation of a berm or other physical barrier surrounding the site.

Consequences

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged. Otter Mound's averaged score is 2 (see Table 19), moderate consequence with widespread impacts that are possible to restore, as documented in Table 5. The site plays and important role as a protected environment for a tropical hardwood hammock, one of the most rare, unique, and endangered habitats in the county (Collier County, Florida, 2021); loss of the site would negatively impact the environment. The site is also part of the social and economic fabric of the area. The site fosters wide visitorship by locals and tourists alike and provides maintenance and management jobs for county employees.

Case Study 8- Rosemary Cemetery

Description of Site

Rosemary Cemetery is a historic cemetery located southeast of the intersection of Pine Ridge Road and Tamiami Trail North, in Naples.

Rosemary Cemetery was first opened in 1931, when burials from an earlier cemetery were moved into the area, and in use until 1947. The site is one of Collier County's oldest cemeteries and is currently listed as a historic property within Collier County. In addition to the marked burials within a small fenced in area, the site also includes potential burials in surrounding areas, as indicated on a historic map of the cemetery.

Table 21: Final Scoring for Rosemary Cemetery

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Rosemary Cemetery	15%	3	2	2.5	1	3	2	2

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is calculated to be 100%, a site exposed to six scenarios was calculated to be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 22.

Rosemary Cemetery was only impacted by the most extreme scenarios mapped and was shown to first be exposed to flooding in the 2100 Low SLR 1%AEP flood scenario and a total of 2 scenarios, therefore it scores 15%.

Table 22: Exposure Scenarios for Rosemary Cemetery

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3	-	Exposed to **Nuisance** flooding based on the **2100 High** SLR
4	-	Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5	-	Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6	-	Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7	-	Exposed to **Nuisance** flooding based on the **2060 High** SLR
8	-	Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9	-	Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10	-	Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11	-	Exposed to **Nuisance** flooding based on the **2030 High** SLR
12	-	Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13	-	Exposed to flooding or inundation based on the **2020 1%AEP**

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 3 (High sensitivity. Irreversible damage) for the site. Any flooding would impact the entirety of the site because it lies mostly underground. Further, damage done to graves or headstones can be irreversible depending on the impacts.

Adaptive Capacity

In order to assess the adaptive capacity for archaeological sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? Rosemary Cemetery is an intact cemetery and therefore the only effective way to adapt the site to flooding would be exhume and move the graves to

higher ground. This is possible, but very costly, therefore, the site was evaluated to be a 2 based on Table 4.

Consequences

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged. Rosemary Cemetery's score averaged to be 2 (see Table 21), moderate consequence with widespread impacts that are possible to restore, as documented in Table 5. The site would have low environmental impacts if lost due to its small size. It would have moderate economic impacts is lost, mostly in terms of county staff who are charged with its upkeep and safety. However, the site would have high social consequence if lost. As a cemetery the site is sacred and important to the local community and the ties of the community to its historic past. Further, some of the unmarked burials indicated on the historic map of the site may be those of Black residents of the Naples area. The state of Florida, and the United States as a whole, has structural racial biases that have caused African American cemeteries in particular to be underrepresented on the FMSF, and to be removed from public knowledge and discourse. The state of Florida has recognized this issue and is beginning the process of reconciling this issue, because some of the burials at Rosemary may be of Black residents of the area, it is part of this story. Losing the cemetery due to climate change and flooding would have serious negative impacts on the local community.

Case Study 9- Shell Island Site

Description of Site

The Shell Island site consists of a large shell midden and shellworks including shell mounds constructed of oyster which possibly represent a village site. A portion of the site was disturbed by development. Historic homesteads are also present. The dates for the site extend from Glades I-III (approximately 500 BC to 1763 AD) and the 1890s to the mid-20th century (Florida Division of Historical Resources, 2012).

As a large shellwork site, it is likely impossible to move the entire site or retrofit it to adapt to climate change. The site may acclimatize to rising sea level but conducting an underwater investigation on a submerged site is both more time-consuming and costly (Cook-Hale, et al., 2021).

Table 23: Final Scoring for Shell Island Site

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Shell Island Site	100%	2	1.5	1.75	2	3	2	2.3

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is calculated to be 100%, a site exposed to six scenarios was calculated to be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 24.

Shell Island Site was shown to first be exposed to flooding in the 2020 1%AEP flood scenario and every other tested scenario for a total of 13 scenarios, therefore the site scores a 100%.

Table 24: Exposure Scenarios for Shell Island Site

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the 2100 High SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the 2100 Low SLR 1.0%AEP flood
3	X	Exposed to Nuisance flooding based on the 2100 High SLR
4	X	Exposed to Nuisance flooding based on the 2100 Low SLR
5	X	Exposed to flooding or inundation based on the 2060 High SLR 1.0%AEP flood
6	X	Exposed to flooding or inundation based on the 2060 Low SLR 1.0%AEP flood
7	X	Exposed to Nuisance flooding based on the 2060 High SLR
8	X	Exposed to Nuisance flooding based on the 2060 Low SLR
9	X	Exposed to flooding or inundation based on the 2030 High SLR 1.0%AEP flood
10	X	Exposed to flooding or inundation based on the 2030 Low SLR 1.0%AEP flood
11	X	Exposed to Nuisance flooding based on the 2030 High SLR
12	X	Exposed to Nuisance flooding based on the 2030 Low SLR
13	X	Exposed to flooding or inundation based on the 2020 1%AEP

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 2 “moderate sensitivity; significant, but reversible damage” for the site.

Adaptive Capacity

In order to assess the adaptive capacity for archaeological sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? The site was evaluated to be a 1.5 based on Table 4, between high adaptive capacity and moderate adaptive capacity. It may be possible to create a living shoreline or other measure to help increase the adaptive capacity of the site.

Consequences

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged. There would be a moderate impact to the environment if this site was lost. The social consequence of site loss would be high due to the potential of the site to provide significant information about this archaeology and history of Collier County. The

economic impact of site loss would be moderate. Considering all these factors, the consequence for loss of Shell Island Site was averaged to be 2.3 (see

Table 23), widespread impacts that are possible to restore, as documented in Table 5. The site is part of the Rookery Bay National Estuarine Research Reserve and is an important part of the local environment in the reserve. The site is part of the reserve that attracts tourists from around the world and employs numerous people as part of the upkeep of the reserve, including this site and the economic impacts would be moderate if the site were lost. Further it is easily accessible in the reserve and is part of the social fabric of the current workings of the reserve. The site also has the potential to provide significant information about this archaeology and history of Collier County. Therefore, the social impacts would be the greatest if the site were to be lost.

Case Study 10- Smallwood Store

Description of Site

The Smallwood Store, built in 1917 on the southern tip of Chokoloskee Island, was originally named Smallwood's Trading Post. It was the headquarters for trading in the region, acting as the only post between Fort Myers and Key West when it opened. Smallwood, one of the historic-period pioneers in the area, acted as the postmaster beginning in 1906, first in his house and then in the store. It closed as a store around 1981. Ted Smallwood's granddaughter now runs the store as a historic museum. Visitors to the site view merchandise from all time periods in which it was open. The building serves as the cultural and historic heart of Chokoloskee Island and offers a glimpse into turn-of-the-century Florida.

In 1925, the simple board and batten structure was elevated 6 feet on wooden pilings after a storm inundated the building. Because of its elevation, the building would only be vulnerable to more extreme storm events, even though it is located directly on the bay, placing it directly in danger of sea level rise. A portion of the veranda of the building sits out in the bay, furthering its vulnerability to storms. The only way that the structure would be able to adapt would be either to move it (which may not be possible), or to strengthen and/or lengthen the pilings. Either scenario would be incredibly costly.

Table 25: Final Scoring for the Smallwood Store

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Smallwood Store	54%	2	2	2	1	2	2	1.67

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

Summary of Flood Vulnerability

Exposure

Sites were mapped using the ACUNE tool and a site's exposure score was determined based on the number of scenarios where any portion of the site is exposed to any amount of water and calculated as a percentage. A site which was exposed in all scenarios is

calculated to be 100%, a site exposed to six scenarios was calculated to be 46%, etc. Maps of each site and each flood scenario are contained in Appendix B and the summary is presented in Table 26.

The Smallwood Store was shown to first be exposed to flooding in the 2030 Low SLR 1%AEP flood scenario and a total of 7 scenarios, the site therefore scores 54%.

Table 26: Exposure Scenarios for Smallwood Store

Score	Exposed	Definition
0	-	Not exposed to flooding or inundation
1	X	Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2	X	Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3	-	Exposed to **Nuisance** flooding based on the **2100 High** SLR
4	-	Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5	X	Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6	X	Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7	X	Exposed to **Nuisance** flooding based on the **2060 High** SLR
8	-	Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9	X	Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10	X	Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11	-	Exposed to **Nuisance** flooding based on the **2030 High** SLR
12	-	Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13	-	Exposed to flooding or inundation based on the **2020 1%AEP**

Sensitivity

In order to assess sensitivity, the authors envisioned a scenario where the site was impacted by flooding and calculated a score of 2 (moderate sensitivity, significant, but reversible damage) for the site. If the site were flooded, as it has been in the past, it could be repaired. The repairs however would be very costly and the damage to items inside the building would also likely be significant.

Adaptive Capacity

In order to assess the adaptive capacity for archaeological sites the robustness of the resource was considered—are sites able to withstand climatic change and individual extreme events? The site was evaluated to be a 2, “low adaptive capacity; ability to adapt site to partially offset potential impacts; or adaptation is possible, but extremely costly or difficult” based on Table 4. While the Smallwood Store would only be vulnerable to more extreme storm events, it is located directly on the bay, placing it directly in danger of sea level rise and storms. A portion of the veranda of the building sits in the bay, furthering its vulnerability to storms. The only way for the structure to adapt would be either to move it, or to strengthen and/or lengthen the pilings, both of which would be extremely costly.

Consequences

In order to assess the impact of the loss of the site due to inaction, potential negative environmental, social, and economic impacts were scored individually and averaged. For the Smallwood Store, authors evaluated the environmental impact of a loss of site as being minimal. The potential social and economic consequences, however, were determined to be moderate: the site is a key feature of the area and a major tourist attraction. Considering all these factors, the consequence for loss of the site was averaged to be 1.67 (see Table 25), widespread impacts that are possible to restore, as documented in Table 5.

DISCUSSION

The ACUNE tool is an invaluable resource for any asset manager, whether the assets are cultural, natural, or urban resources. The tool currently incorporates a variety of asset types around the county. Therefore, the ACUNE tool can be used to map, assess, and prioritize a plethora of different resource types. This project focused specifically on cultural resources; however, it demonstrates the tool's usefulness in assessing any assets included in the tool. Its ease of use makes it a perfect choice for the project's working group members, requiring minimal training. It should be noted, however, that ACUNE only assesses vulnerability to sea-level rise and storm surge; there are many other factors (precipitation, heat, etc.) that impose vulnerability on a community and would therefore require enhancement of the ACUNE tool. This study serves as an example for using the ACUNE tool to perform parts of the DEP's Florida Adaptation Guidebook throughout the county.

The project is detailed above, but summarily consisted of two parts 1) evaluating the number of cultural sites in Collier County effected by two future SLR flooding scenarios; and 2) assessing the vulnerability of ten specific cultural sites within the county in order to demonstrate the utility of the ACUNE tool for prioritizing sites based on exposure, sensitivity, adaptive capacity, and consequence if the site was lost.

The scoring listed in the Results section for each case study can be used to prioritize sites for further planning as the scores consider when the site will be exposed to flooding, how vulnerable it is to inundation, and the consequences of site loss. This scoring method is applicable to any study regardless of spatial scale: for all sites in a management area, in a specific focus area (as defined by exposure analysis mapping), or throughout the entire county. Evaluating sites based on the factors listed will help land managers discern an appropriate course of action—for example, it may be easier or more cost efficient for land managers to move a small structure like the Ochopee Post Office than to raise or otherwise harden the structure against flooding.

This tool, as part of an adaptation planning study, is invaluable for planners and land managers to improve resilience for SLR and storminess. For example, land managers focused on the impacts of flooding exposure of a site may find the case study of Everglades City Museum/Everglades City Laundry useful. The site is impacted in 12 out of 13 (92%) scenarios beginning in the 2020 1%AEP flood scenario. Accordingly,

managers of this site may find it helpful to begin a planning process to harden the site or otherwise protect it. Knowing that a site will be exposed, and having data like the mapping available in ACUNE, can also help city managers or building owners seek funding sources for resiliency measures.

Planners focused on vulnerability of sites may find Rosemary Cemetery a useful example to consider. This site will likely not be impacted until later scenarios, and it has a low exposure score. Once the site is exposed, however, it is extremely vulnerable. Therefore, now is the time to design a system for resiliency improvement, and funding may be sought over the next two decades before environmental impacts begin to seriously threaten the site. Knowing that resources may be triaged in this way can help direct limited resources to where they are most needed now.

In terms of consequence if a site is lost, it may be helpful to consider the Macedonia Baptist Church. The site has been a focal point for Collier County's underserved Black community. Growing urban expansion of Collier County and a history of 'urban renewal' in southwest Florida renders resources like the Macedonia Missionary Baptist Church extremely vulnerable to climate change. The social consequences of losing this site would be dire—the site is a community resource for a historically underrepresented and underserved community. Moving the site would decontextualize it and risk divorcing it from this community. Accordingly, the consequences of losing the site are high and efforts to harden the structure or surrounding area to make it more resilient should be employed.

Overall, the working group was able to identify and assess the 10 case study cultural sites, using a straightforward framework for prioritizing sites. This methodology can be used in an entire management unit to help prioritize assets for resiliency work, from hospitals to schools. However, this study also emphasizes the importance of assembling a diverse and equitable group in creating and prioritizing lists of sites and having diverse community members involved in every step of the process. A site like Rosemary Cemetery, which has a lower exposure score, may not initially seem to be a higher priority compared with other sites. However, because the working group consisted of community members, we know this site is incredibly important to the local community and will be a high priority for the community in any planning situation. It may require less thought in terms of flood vulnerability but is crucial for planning as populations move and construction in the area continues. FMSF data are incomplete and are biased towards

certain historic events and figures. In an attempt to combat this, the authors sought input from representatives from traditionally underserved communities and considered properties that may not have been formally listed on the FMSF. We suggest any similar future study include input from communities and groups that may be underrepresented, to ensure that important sites are not missed in planning efforts.

RECOMMENDATIONS

Following the full county site count results and discovering that a large disparity in affected sites between 2020 and 2030 exists, the 10 case study sites were selected for a more thorough vulnerability analysis. Unfortunately, it was not possible at this stage to complete a formal evaluation of all 1557 sites in the county, therefore we recommend future studies complete a more detailed assessment of all 1557 sites within the county.

Additionally, as part of this study, the Macedonia Baptist Church was identified as a new critical asset. This was accomplished by working with local community groups. Future reports should encourage participation from diverse communities. Future cultural resource vulnerability assessments should also attempt to document potentially eligible sites within the county, in addition to those listed on the site file. It is also recommended that the Macedonia Baptist Church be listed on the Florida Master Site File.

Vulnerability assessments are an essential tool to prioritize critical assets at risk due to flooding and other events. Cultural resource assessments should be prepared at a county-wide level for each county in the state of Florida. It may be useful to start with Charlotte and Lee Counties. Working at the county level ensures identification of vulnerable assets important to the local community that may be lost if attempting to prepare an assessment at the state level.

Finally, the targeting potential of using a tool like ACUNE facilitates land and resource managers allocating appropriate resources to critical assets. Additionally, the tool is user friendly and facilitated greater participation from the working group involved in the study. Expanding ACUNE to more counties could facilitate not only assessing cultural sites, but other critical infrastructure as well.

Since the future climate scenarios considered in the ACUNE tool were based on the RCP4.5 and RCP8.5 Representative Concentration Pathway scenarios and the NOAA (2017) SLR scenarios, 1% AEP flood maps in the ACUNE may need to be updated when new climate study results become available. For example, the recently released interagency SLR report lowered the predictions of SLR for 2030, 2060, and 2100 scenarios. RCP4.5 and RCP 8.5 climate scenarios are replaced by the new Shared Social-Economic Pathway scenarios. More details can be found in the IPCC Assessment

Report No. 6 (AR6). In order to keep up with the latest scientific advances in future SLR and storm predictions, we recommend the ACUNE tool be periodically updated with supplemental funding provided by the local stakeholders.

CONCLUSION

Florida is on the front lines of exposure to inundation due to climate change and sea level rise as the state with the second longest coastline. Collier County has a unique and useful resource available to planners that has been developed over the past four years and is now available for use by the county. The county's valuable resources including cultural, natural, and urban assets are all at risk of direct or indirect impacts in the next 80 years. The ACUNE tool is a valuable tool for conducting vulnerability assessments of any type of asset in the county. This vulnerability assessment used the ACUNE tool along with a working group composed of diverse community members and resource managers to identify the overall impacts of inundation on cultural sites in next 10 years and the specific threats of exposure, vulnerability, or consequence for each of 10 cultural sites in the county. The methods outlined in this study can be used by managers of any resources in Collier County to help plan for climate change based on the Florida DEP's Adaptation Planning Guidebook and to seek funding for adaptation and resiliency projects to help safeguard and plan for the best possible future of the county's resources.

APPENDIX A

Exposure is the total number of scenarios in which the site sees flooding.

Table 27: Final Scoring for 10 case studies

Site	Exposure	Vulnerability Scores		Vulnerability Score [Average] (max=3)	Consequence Scores			Consequence Score [Average] (max=3)
		Sensitivity (max=3)	Adaptive Capacity (max=3)		Environmental (max=3)	Social (max=3)	Economic (max=3)	
Dismal Key	100%	2	1.5	1.75	2	2	2	2
Everglades City Museum building/ Everglades City Laundry building	92%	2	2	2	1	2	2	1.67
Fakahatchee Key	100%	2	1.5	1.75	2	2	2	2
Macedonia Baptist Church	62%	2	2	2	1	3	3	2.33
Marco Island Historical Museum	54%	3	2	2.5	1	3	3	2.33
Ochopee Post Office	69%	2	1	1.5	1	2	2	1.67
Otter Mound	46%	2	1.5	1.75	2	2	2	2
Rosemary Cemetery	15%	3	2	2.5	1	3	2	2
Shell Island Site	100%	2	1.5	1.75	2	3	2	2.3
Smallwood Store	54%	2	2	2	1	2	2	1.67

Scores for exposure (as a percentage of 13 scenarios), vulnerability (as an average of the site's sensitivity and adaptive capacity score), and consequence (an average of the environmental, social, and economic consequences of losing the site).

APPENDIX B

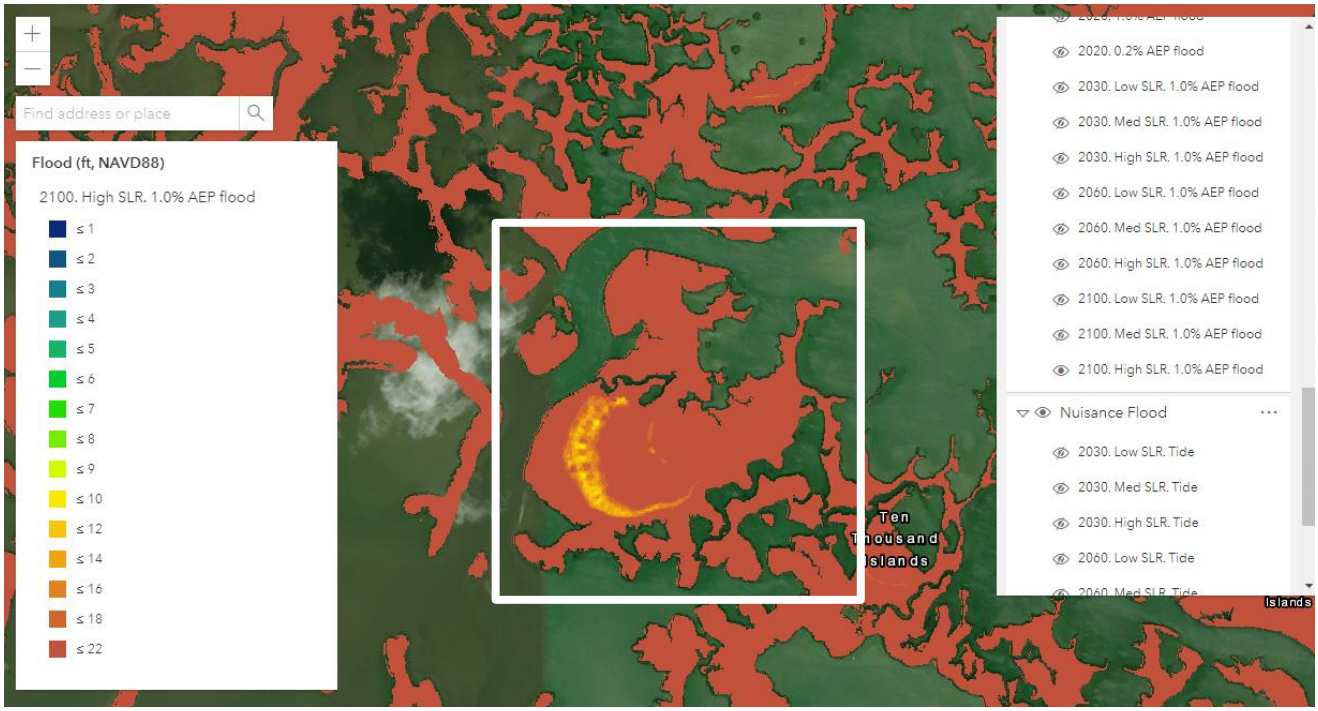
Exposure Scoring Table

Scenario	Exposed?	Definition
1		Exposed to flooding or inundation based on the **2100 High** SLR 1.0%AEP flood
2		Exposed to flooding or inundation based on the **2100 Low** SLR 1.0%AEP flood
3		Exposed to **Nuisance** flooding based on the **2100 High** SLR
4		Exposed to **Nuisance** flooding based on the **2100 Low** SLR
5		Exposed to flooding or inundation based on the **2060 High** SLR 1.0%AEP flood
6		Exposed to flooding or inundation based on the **2060 Low** SLR 1.0%AEP flood
7		Exposed to **Nuisance** flooding based on the **2060 High** SLR
8		Exposed to **Nuisance** flooding based on the **2060 Low** SLR
9		Exposed to flooding or inundation based on the **2030 High** SLR 1.0%AEP flood
10		Exposed to flooding or inundation based on the **2030 Low** SLR 1.0%AEP flood
11		Exposed to **Nuisance** flooding based on the **2030 High** SLR
12		Exposed to **Nuisance** flooding based on the **2030 Low** SLR
13		Exposed to flooding or inundation based on the 2020 1%AEP

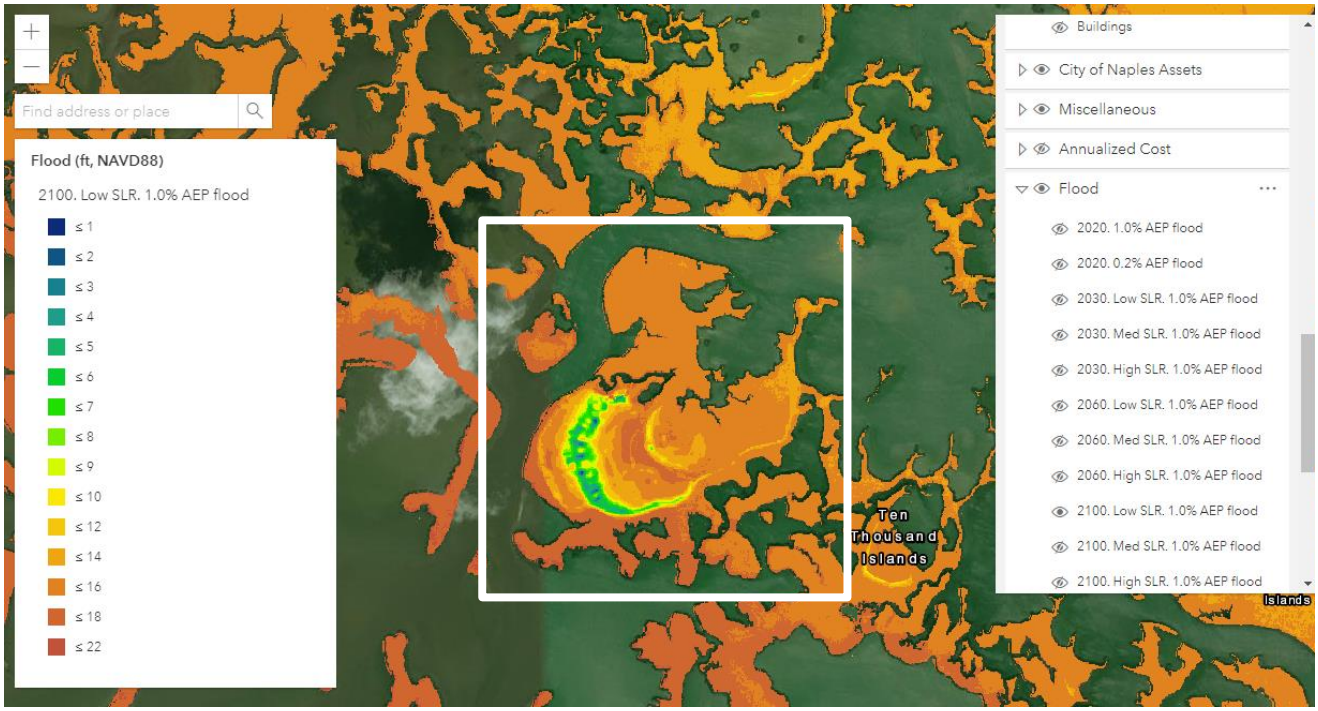
ACUNE Flood Maps for Each Case Study Site

Maps were created by taking screen shots of the ACUNE tool on August 17, 2021, while these screen shots do not contain scales, the ACUNE tool contains a scale and many other options not shown here. Each site is easily identified via internet search and is publicly known and accessible.

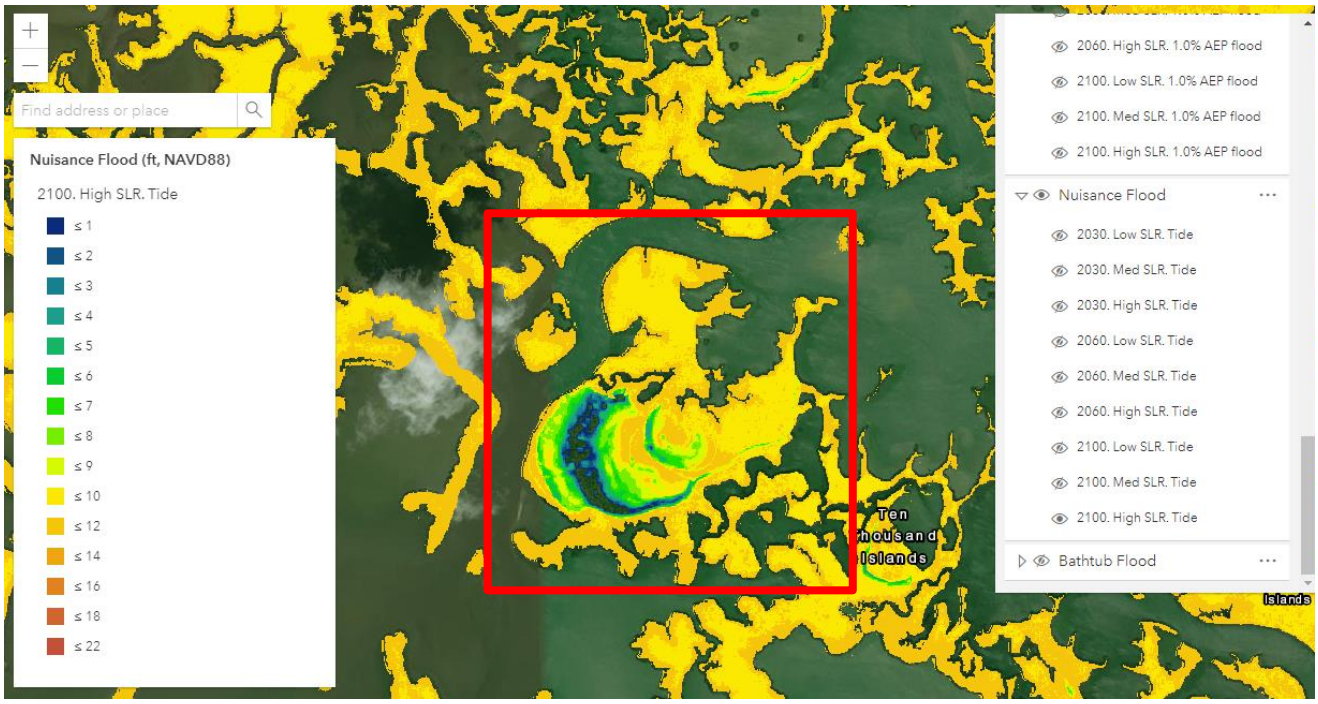
Dismal Key



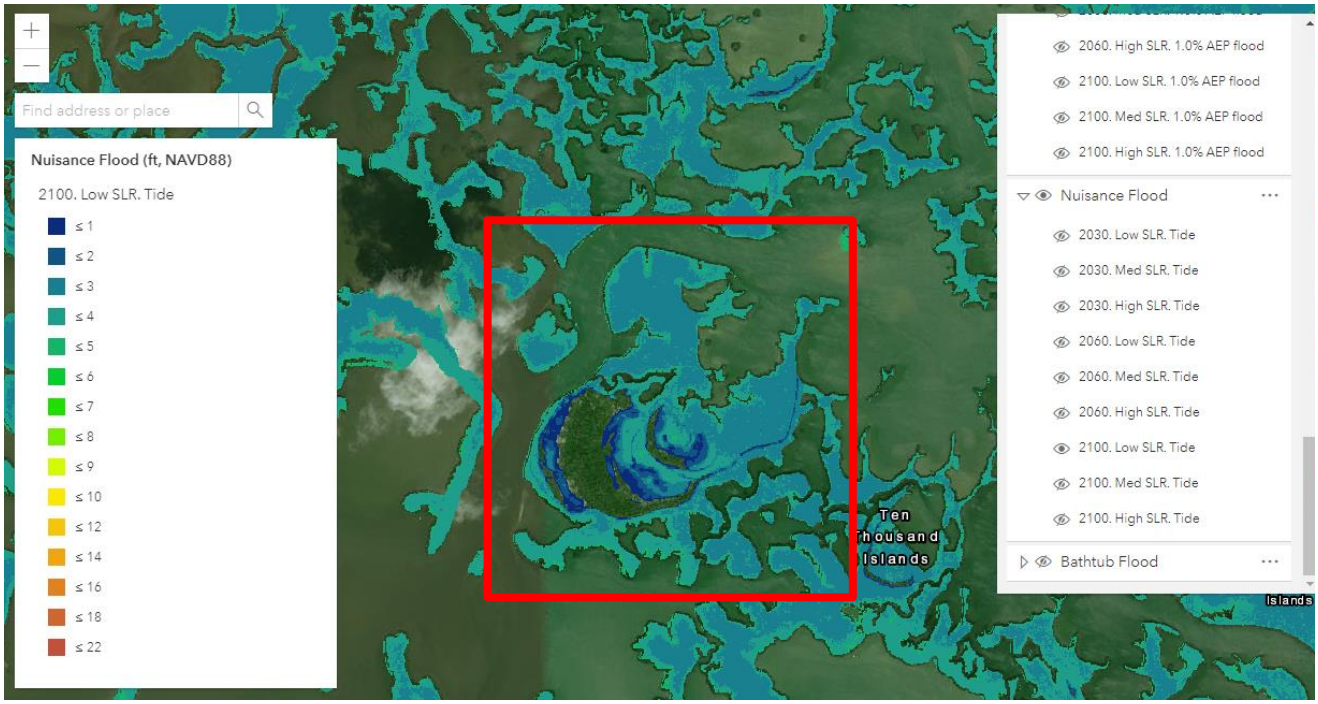
Appendix B. 1- Dismal Key 2100 High SLR 1.0% AEP Flood



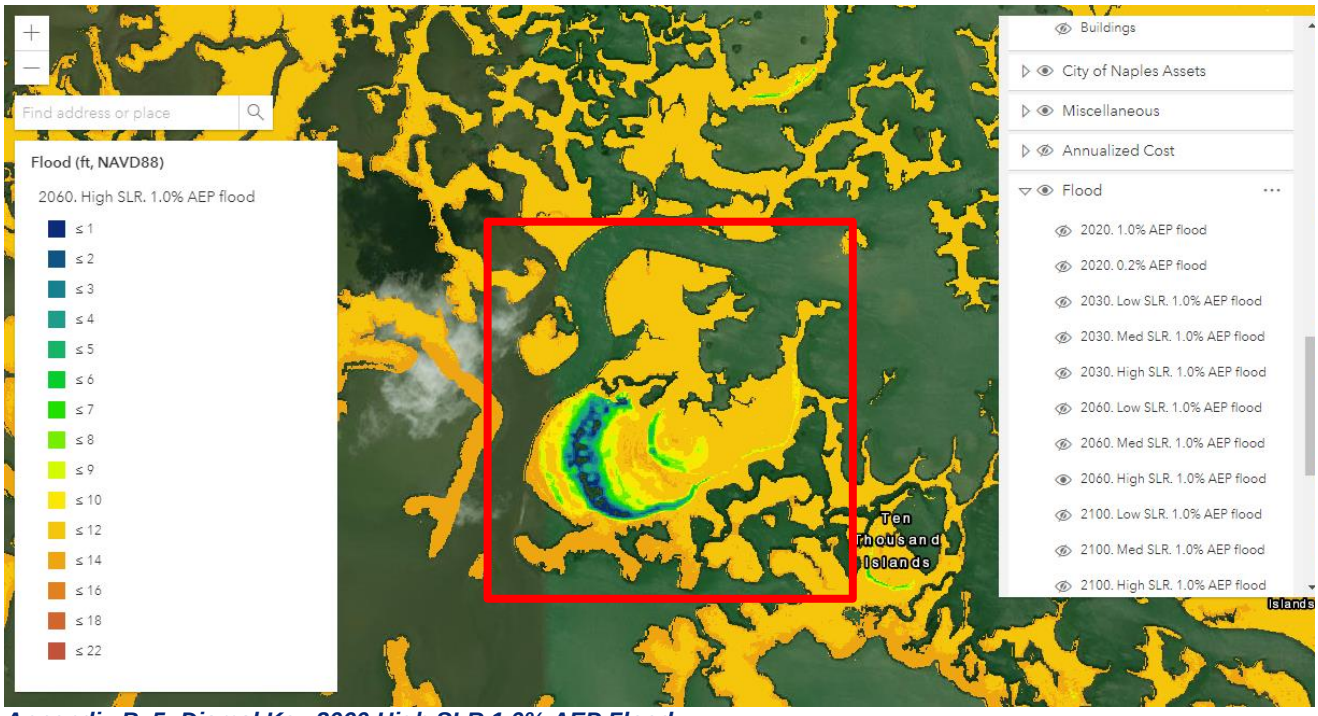
Appendix B. 2- Dismal Key 2100 Low SLR 1.0% AEP Flood



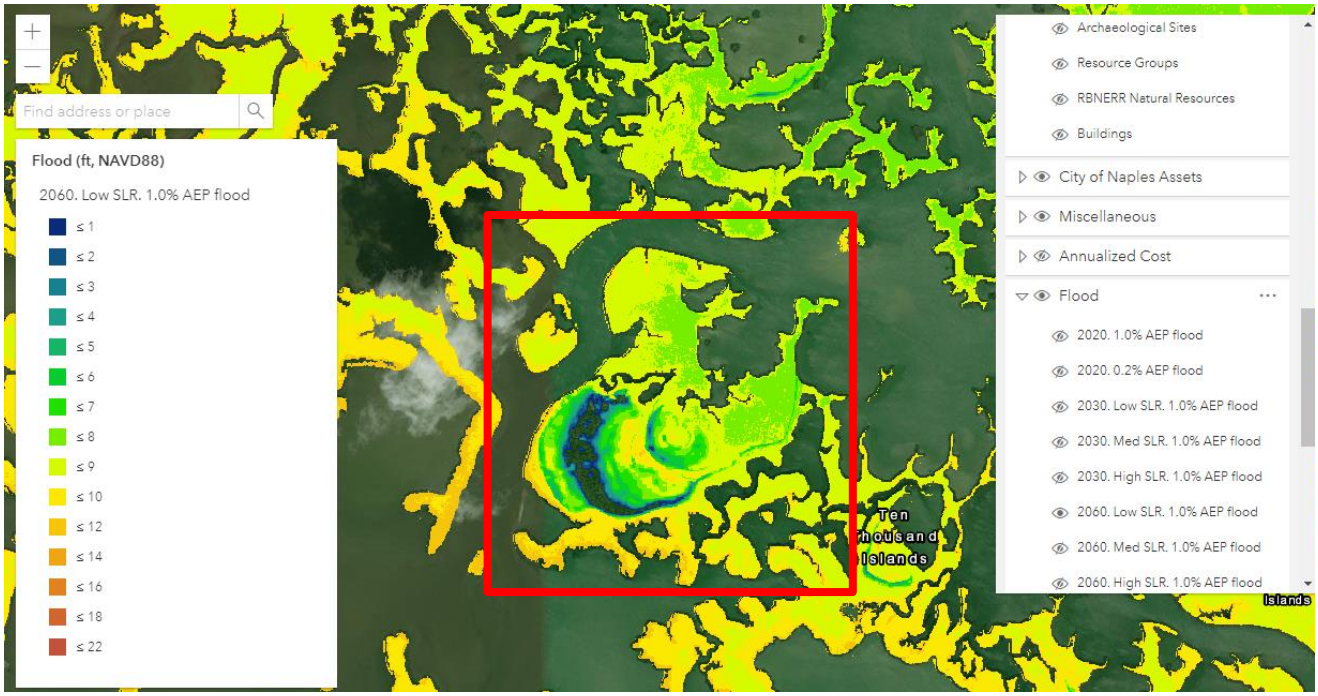
Appendix B. 3- Dismal Key 2100 High SLR Tide Nuisance Flood



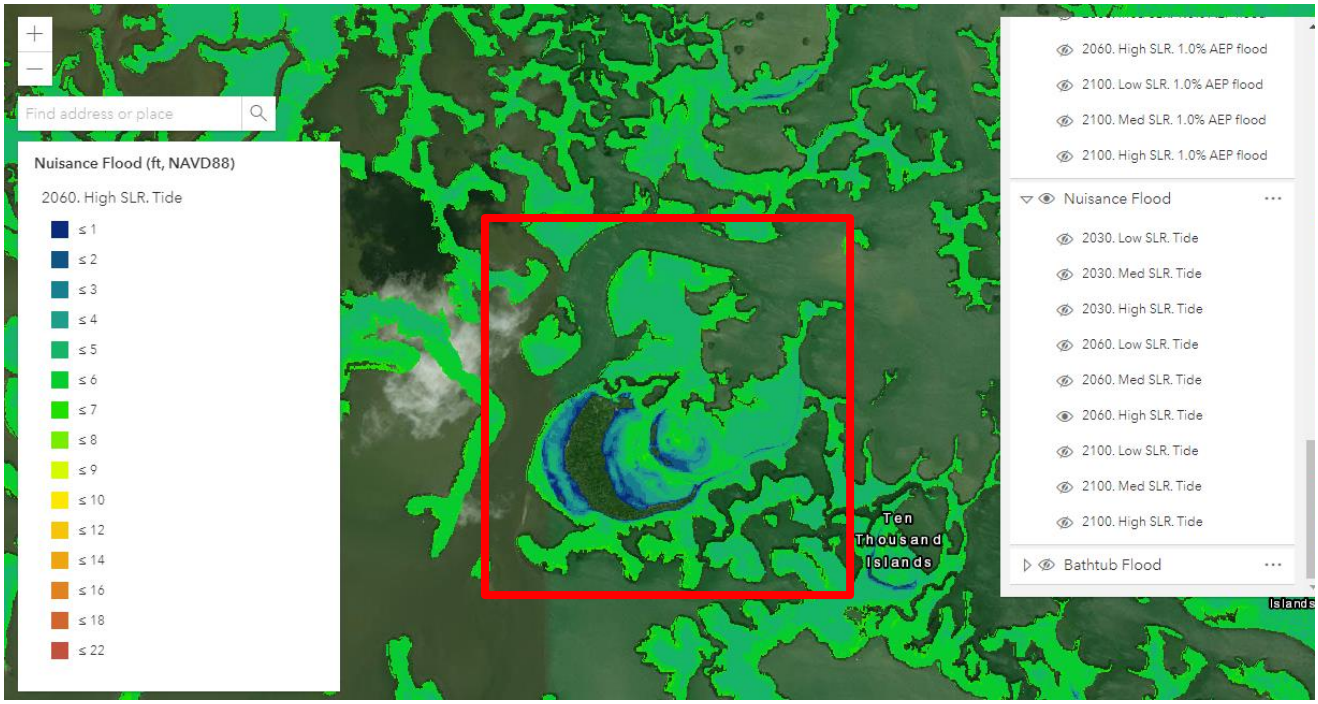
Appendix B. 4- Dismal Key 2100 Low SLR Tide Nuisance Flood



Appendix B. 5- Dismal Key 2060 High SLR 1.0% AEP Flood

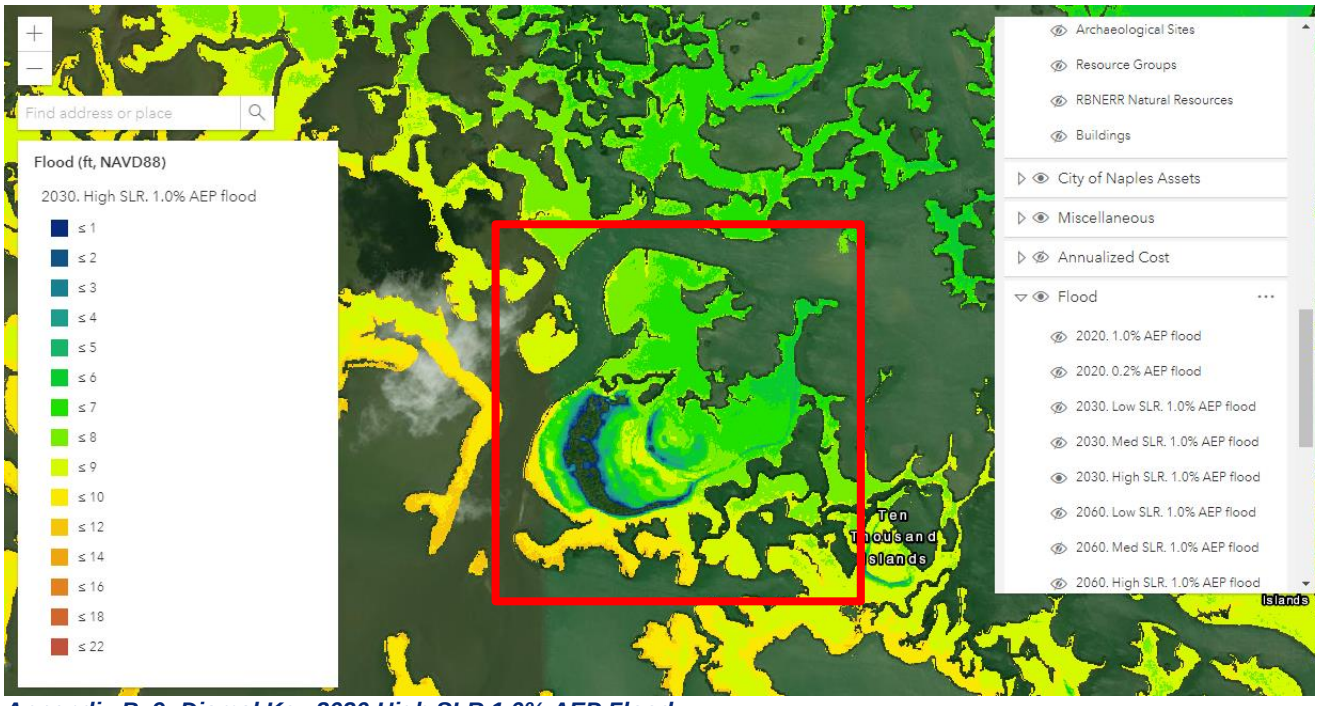


Appendix B. 6- Dismal Key 2060 Low SLR 1.0% AEP Flood

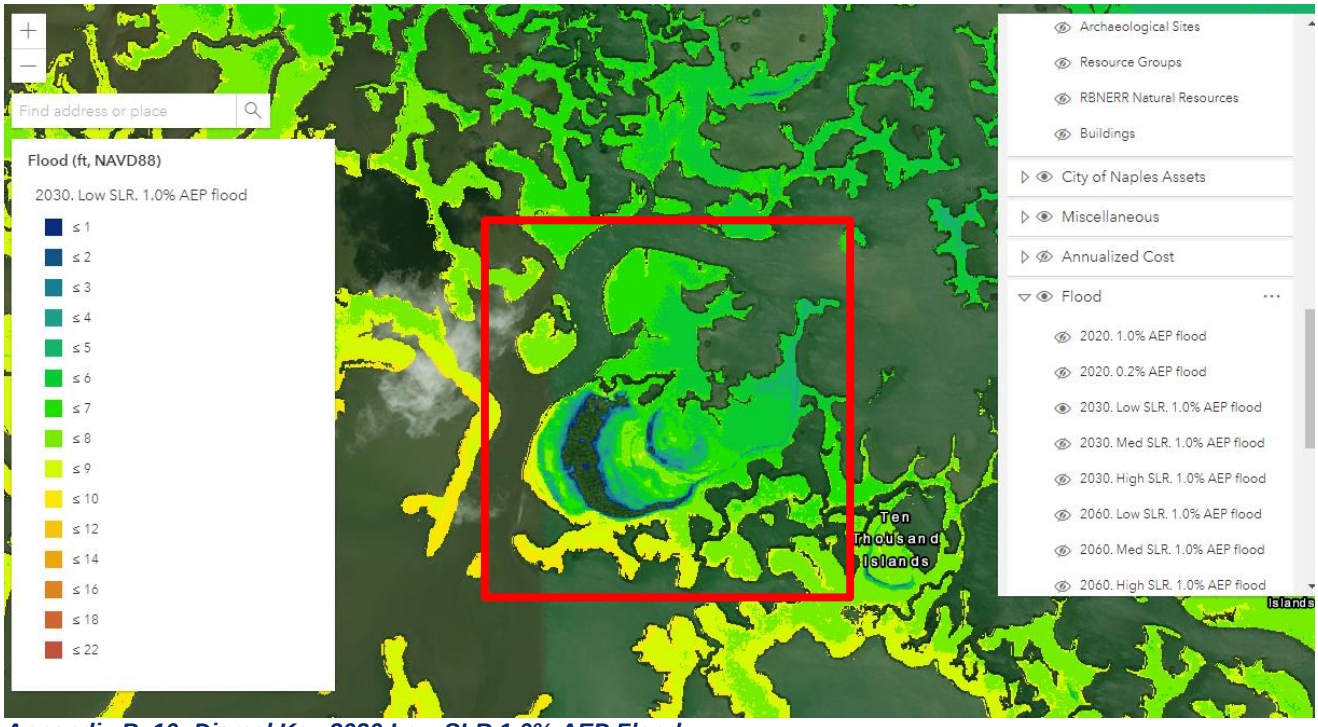


Appendix B. 7- Dismal Key 2060 High SLR Tide Nuisance Flood

Appendix B. 8- Dismal Key 2060 Low SLR Tide Nuisance Flood

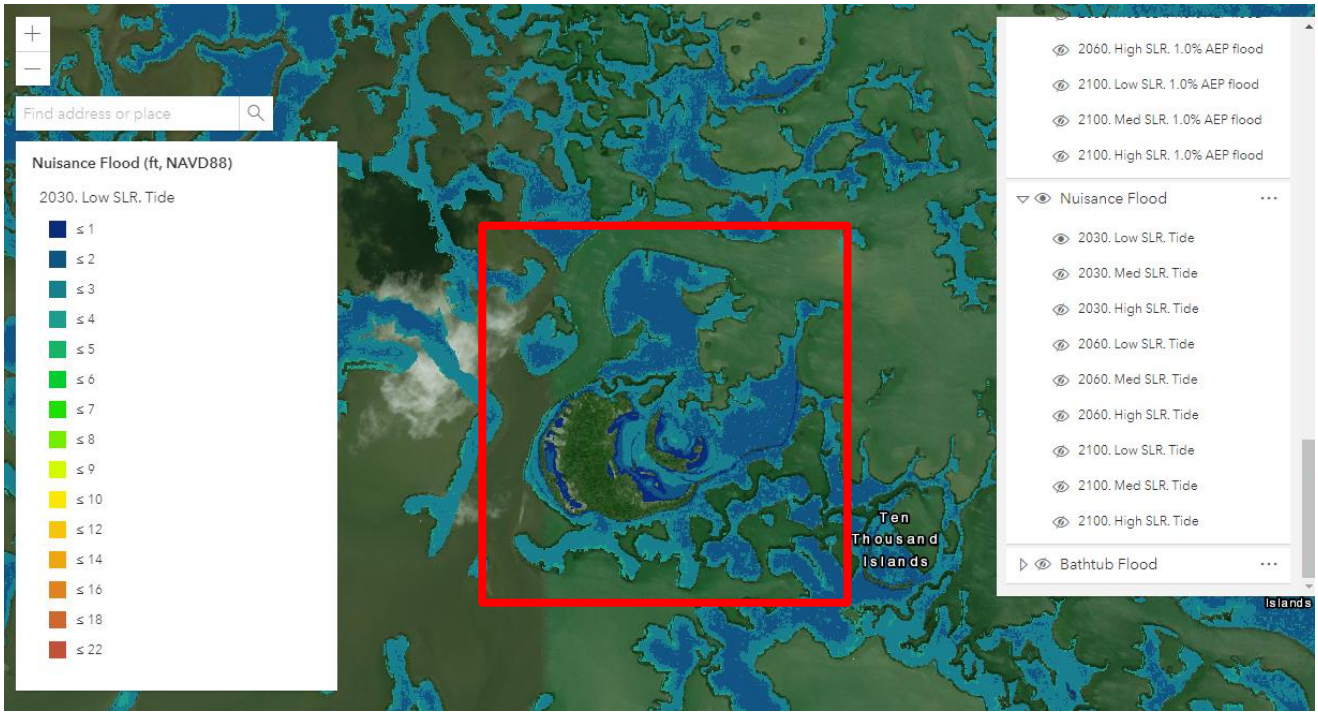


Appendix B. 9- Dismal Key 2030 High SLR 1.0% AEP Flood

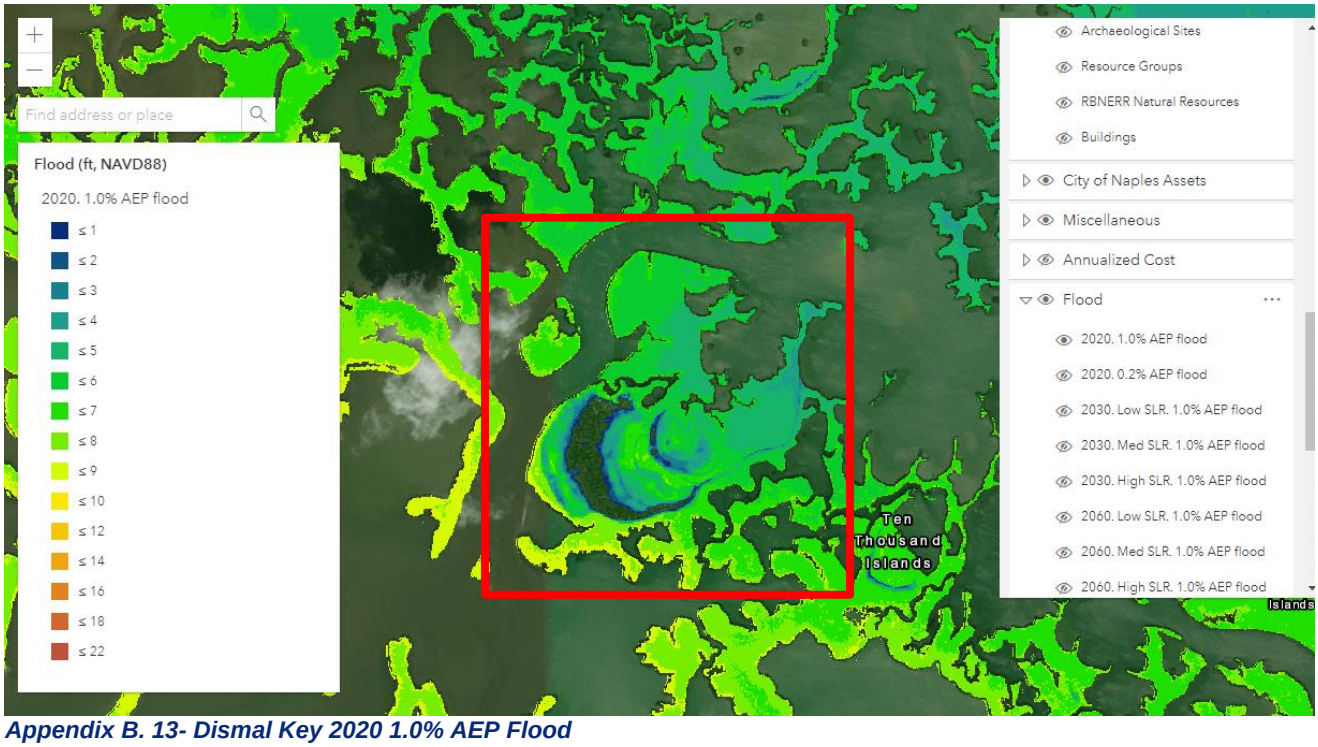


Appendix B. 10- Dismal Key 2030 Low SLR 1.0% AEP Flood

Appendix B. 11- Dismal Key 2030 High SLR Tide Nuisance Flood



Appendix B. 12- Dismal Key 2030 Low SLR Tide Nuisance Flood

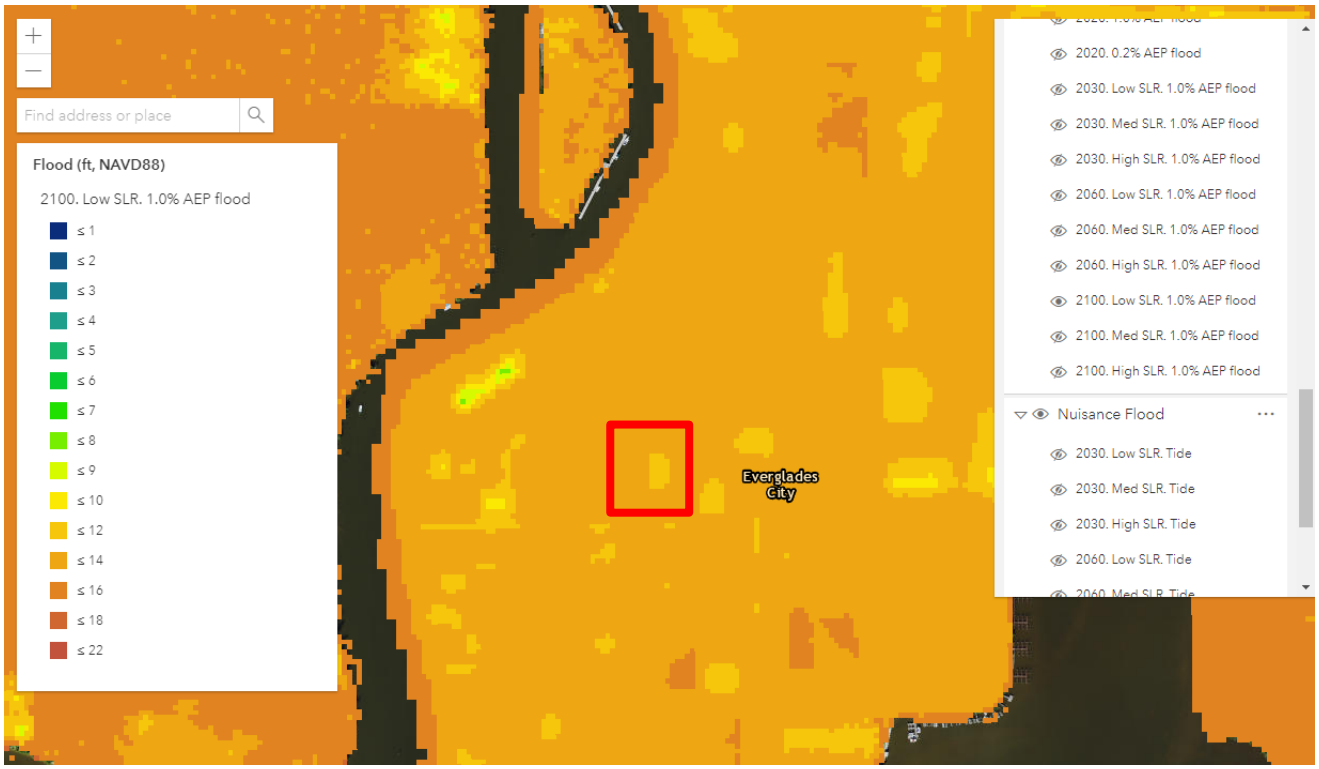


Appendix B. 13- Dismal Key 2020 1.0% AEP Flood

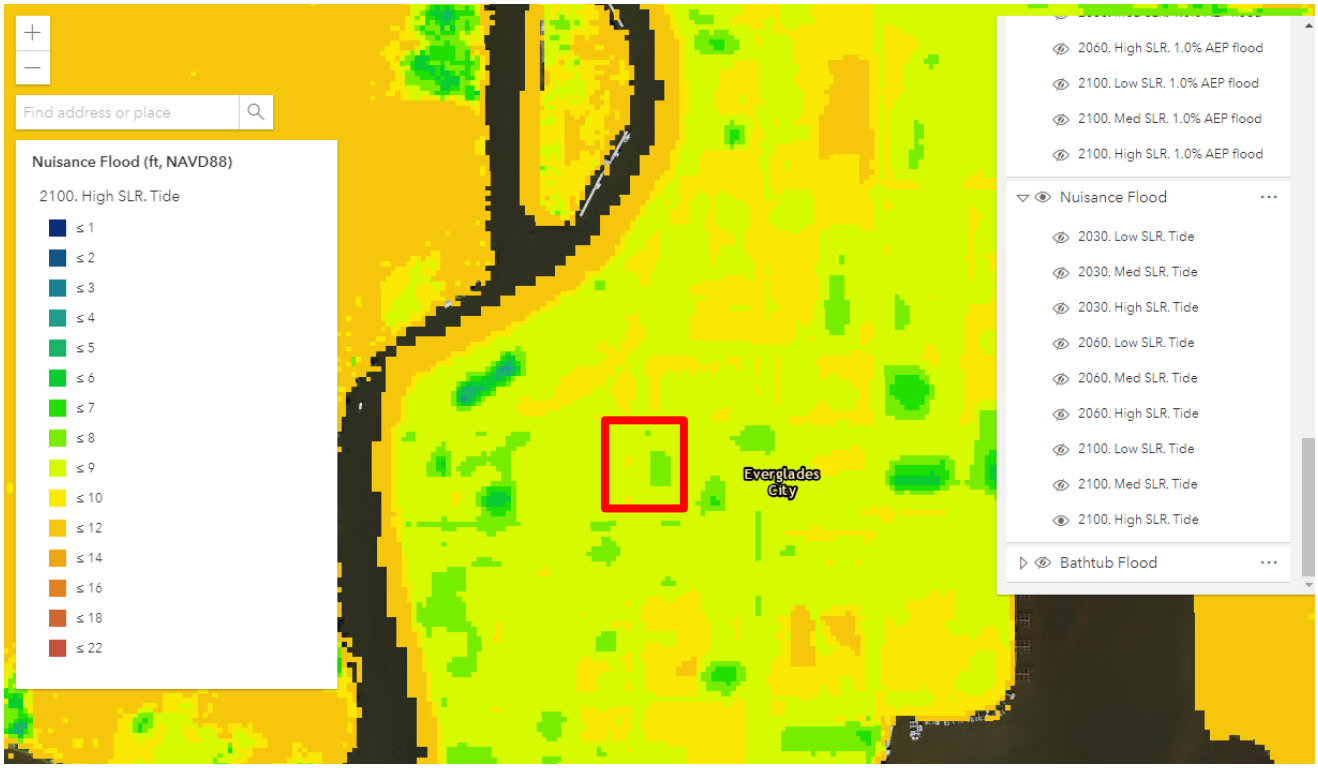
Everglades City Museum Building/ Everglades City Laundry Building

Appendix B. 14- Everglades City Laundry with No Flood Map

Appendix B. 15- Everglades City Laundry 2100 High SLR 1.0% AEP Flood



Appendix B. 16- Everglades City Laundry 2100 Low SLR 1.0% AEP Flood

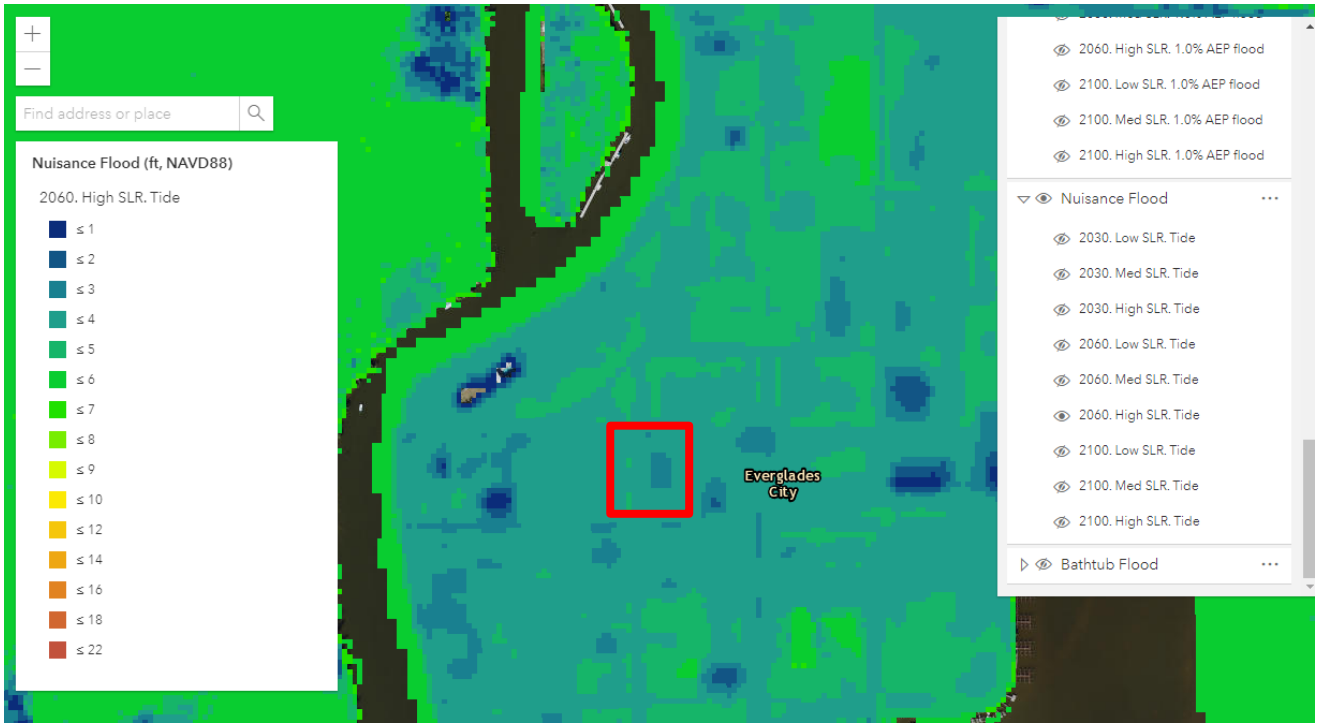


Appendix B. 17- Everglades City Laundry 2100 High SLR Tide Nuisance Flood

Appendix B. 18- Everglades City Laundry 2100 Low SLR Tide Nuisance Flood

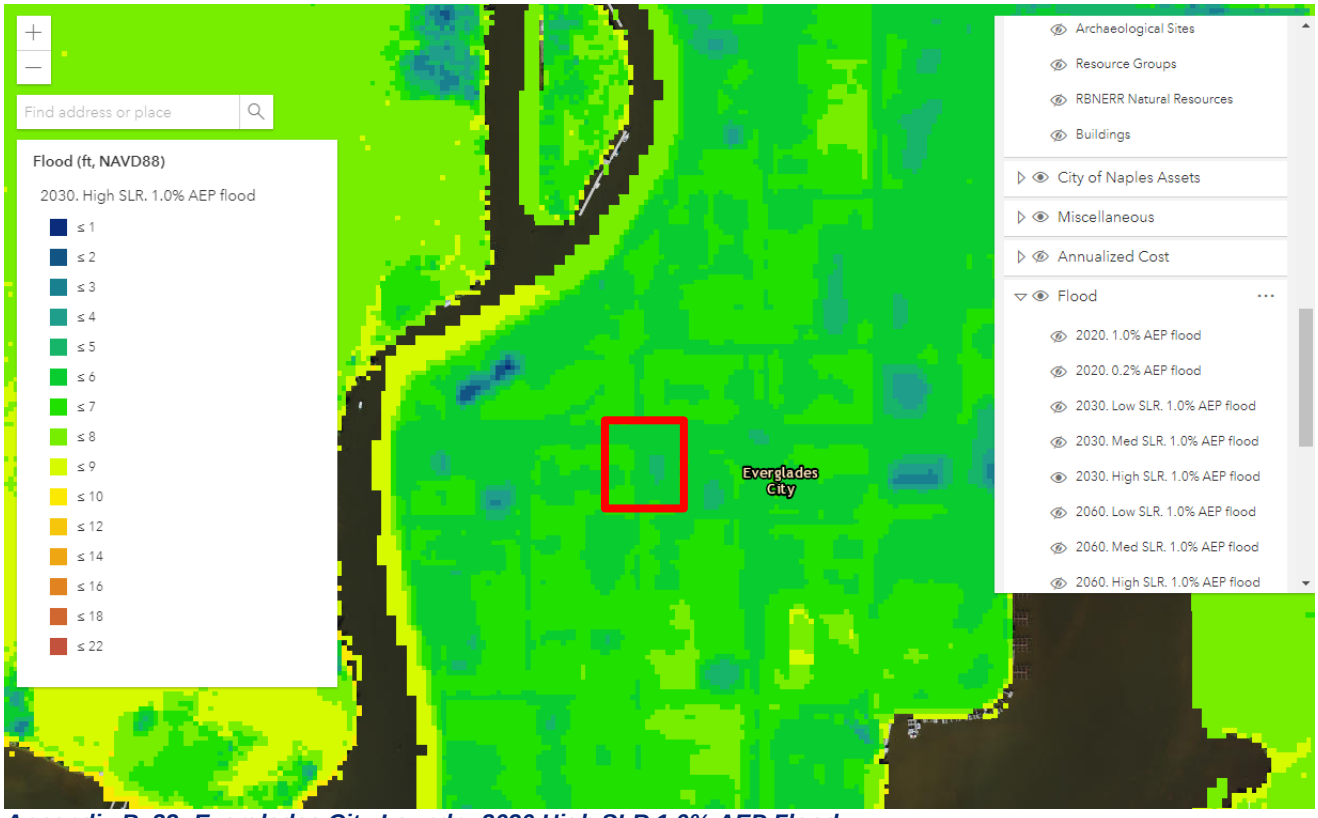
Appendix B. 19- Everglades City Laundry 2060 High SLR 1.0% AEP Flood

Appendix B. 20- Everglades City Laundry 2060 Low SLR 1.0% AEP Flood

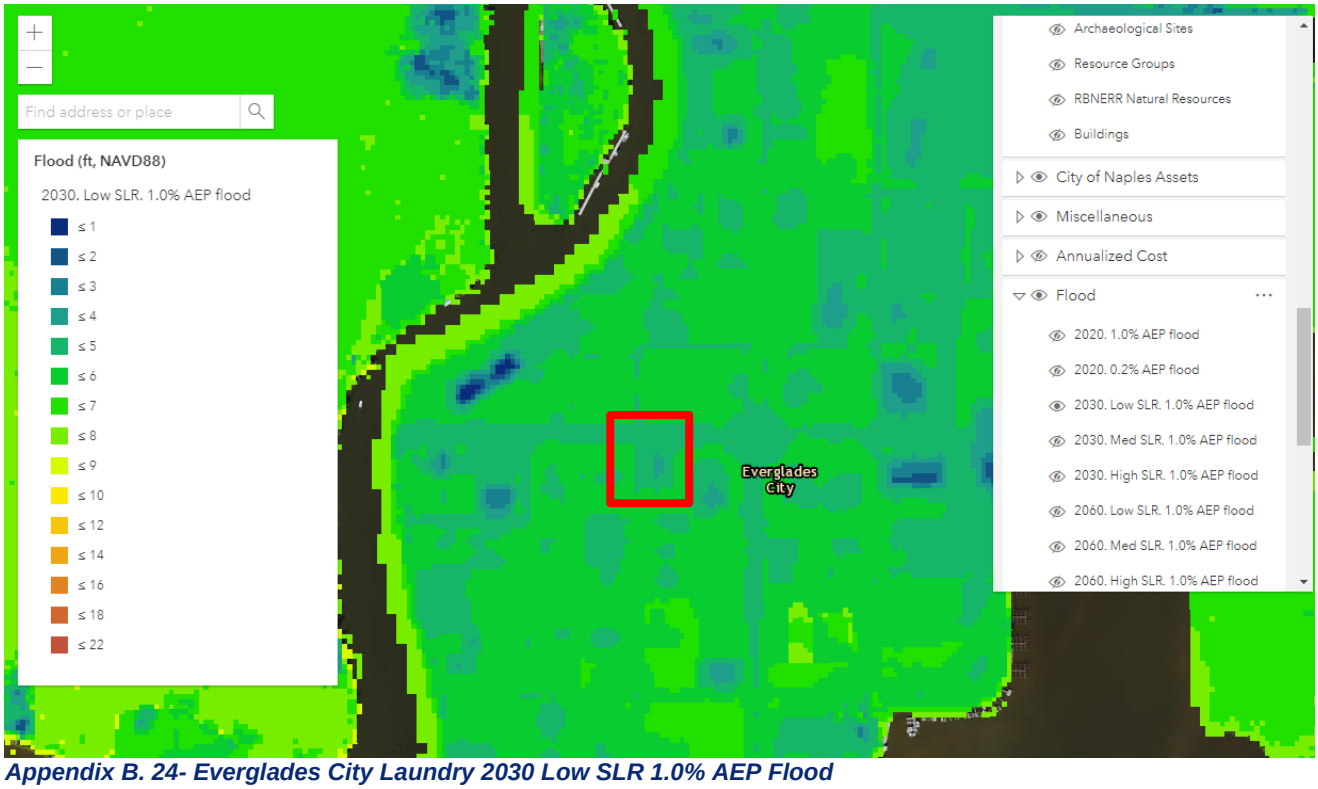


Appendix B. 21- Everglades City Laundry 2060 High SLR Tide Nuisance Flood

Appendix B. 22- Everglades City Laundry 2060 Low SLR Tide Nuisance Flood



Appendix B. 23- Everglades City Laundry 2030 High SLR 1.0% AEP Flood



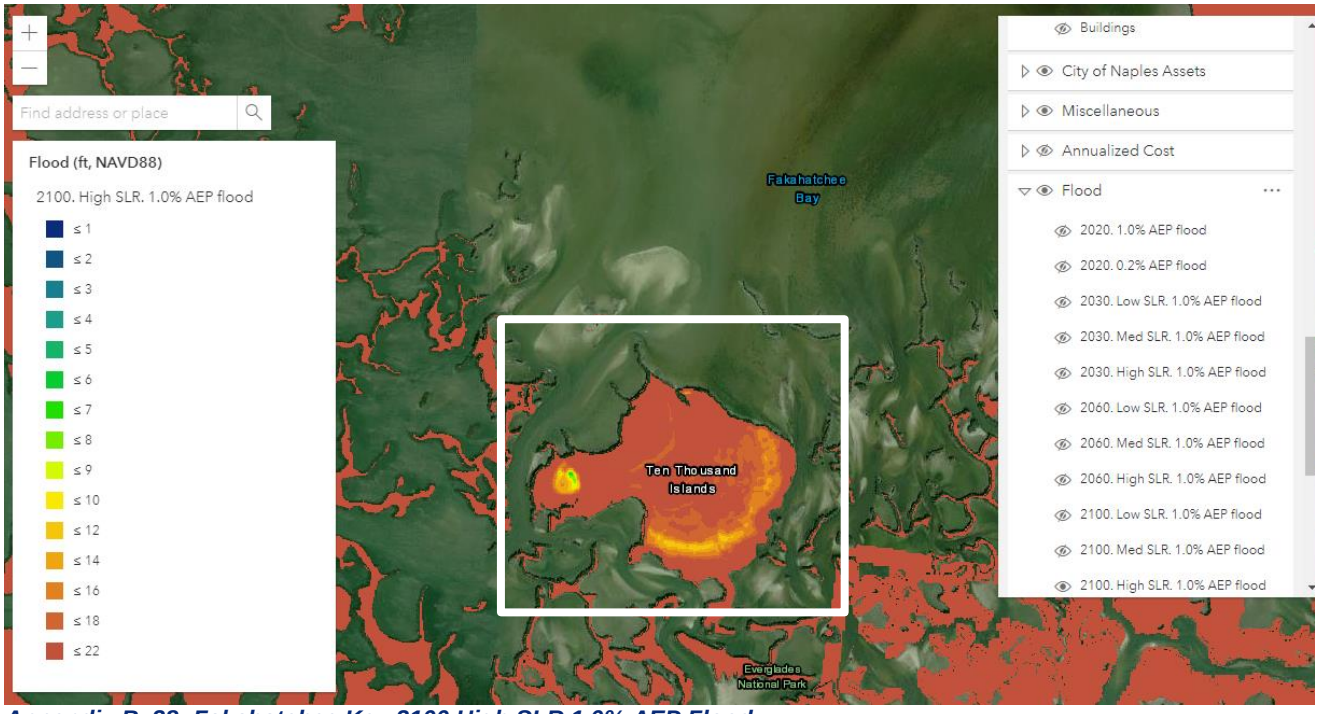
Appendix B. 24- Everglades City Laundry 2030 Low SLR 1.0% AEP Flood

Appendix B. 25- Everglades City Laundry 2030 High SLR Tide Nuisance Flood

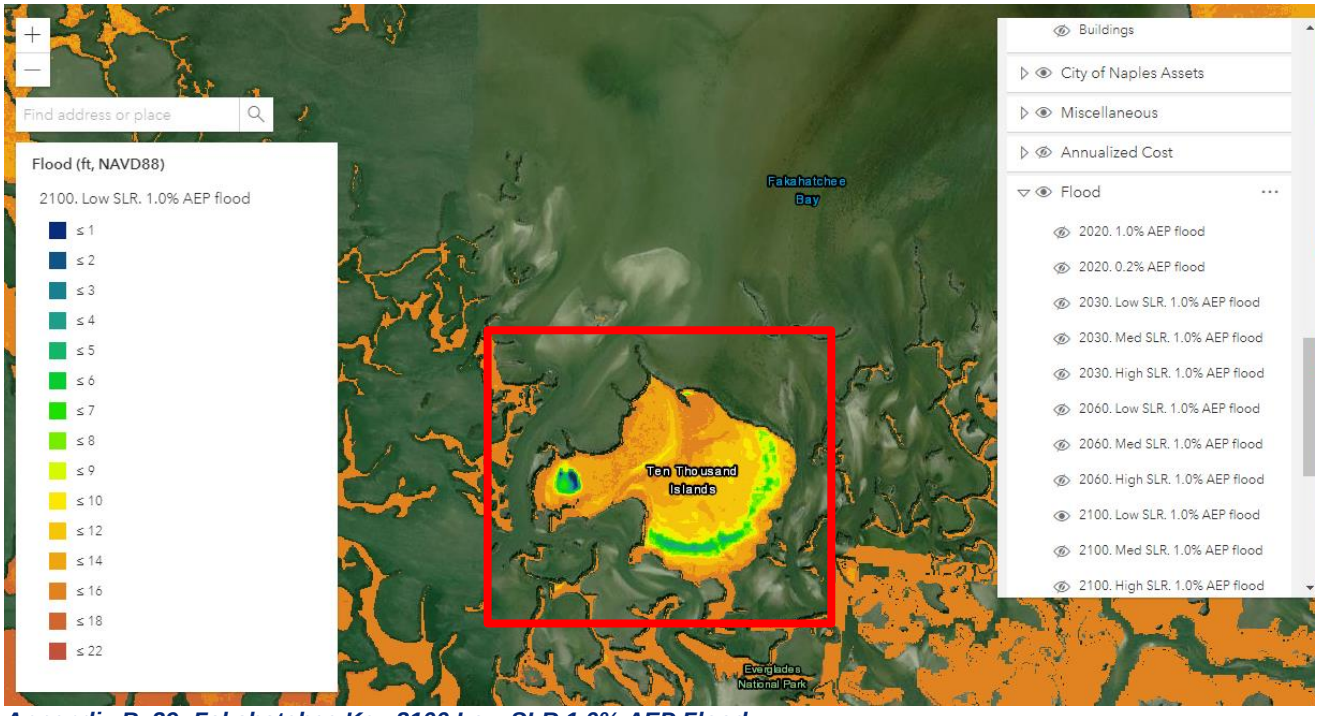
Appendix B. 26- Everglades City Laundry 2030 Low SLR Tide Nuisance Flood

Appendix B. 27- Everglades City Laundry 2020 1.0% AEP Flood

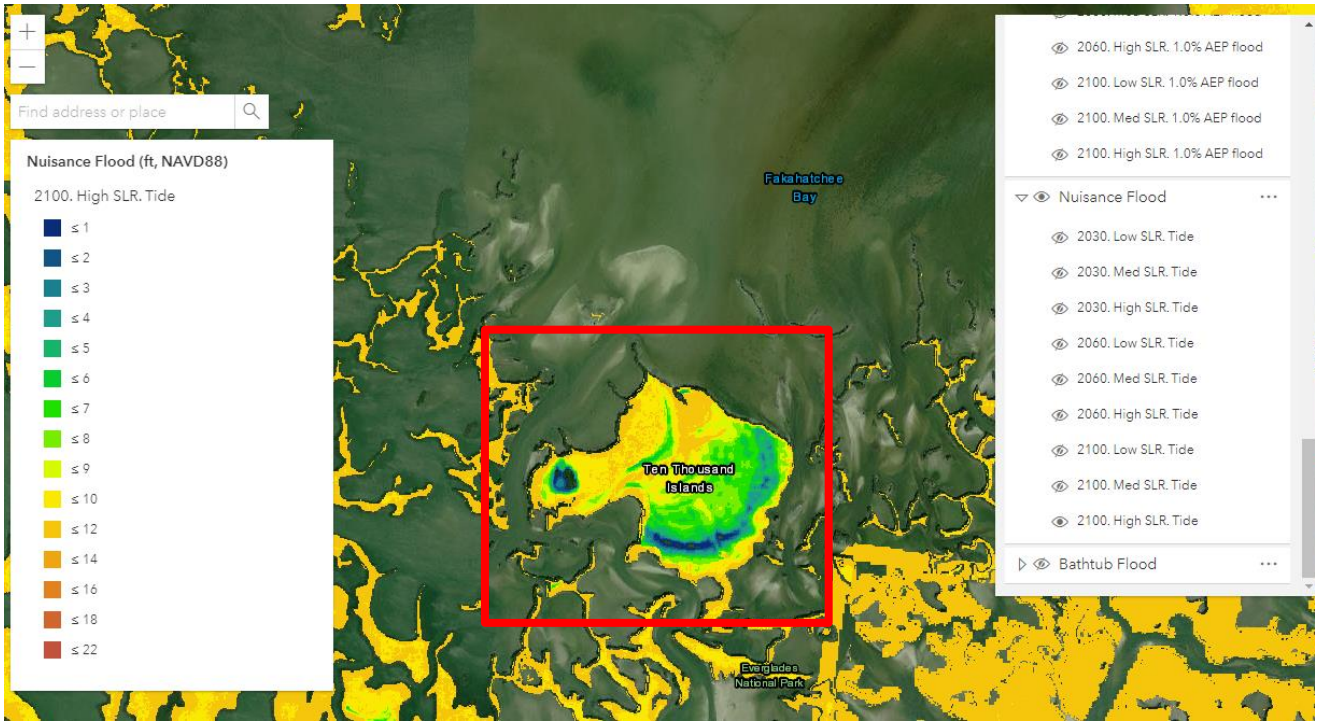
Fakahatchee Key



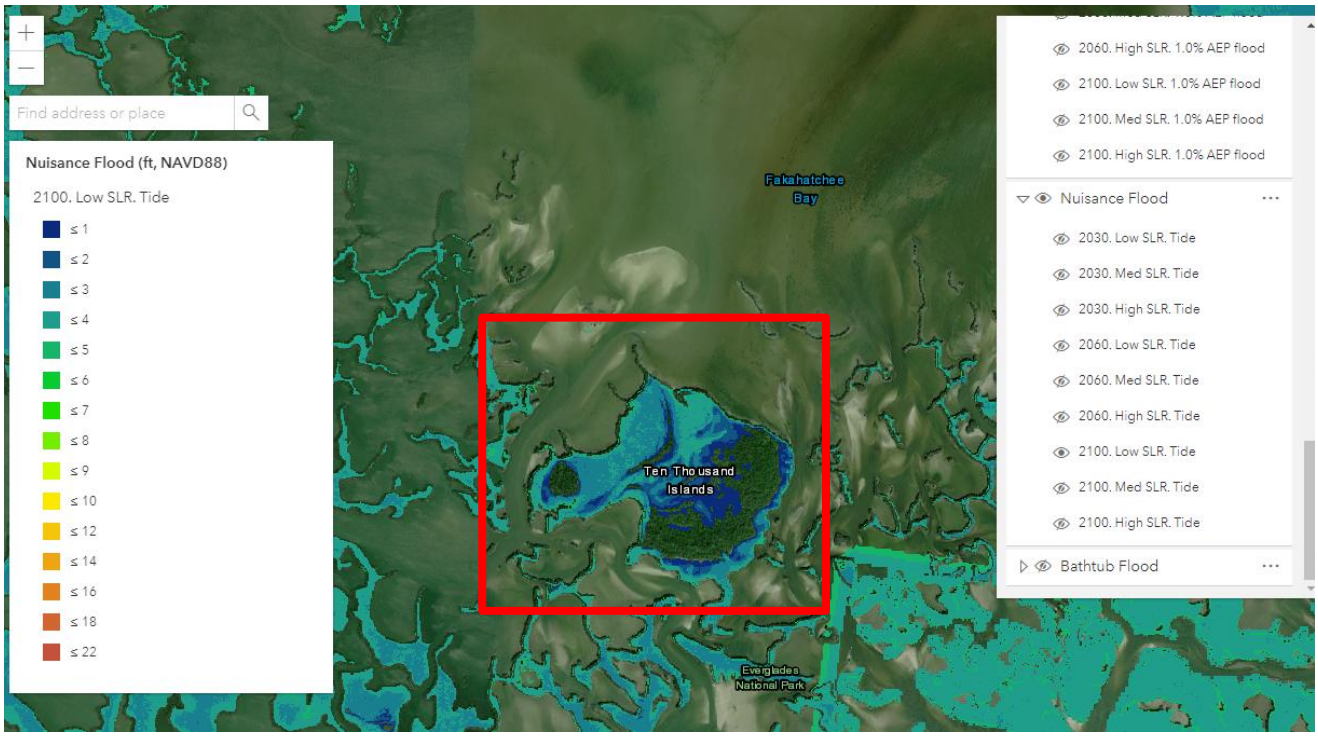
Appendix B. 28- Fakahatchee Key 2100 High SLR 1.0% AEP Flood



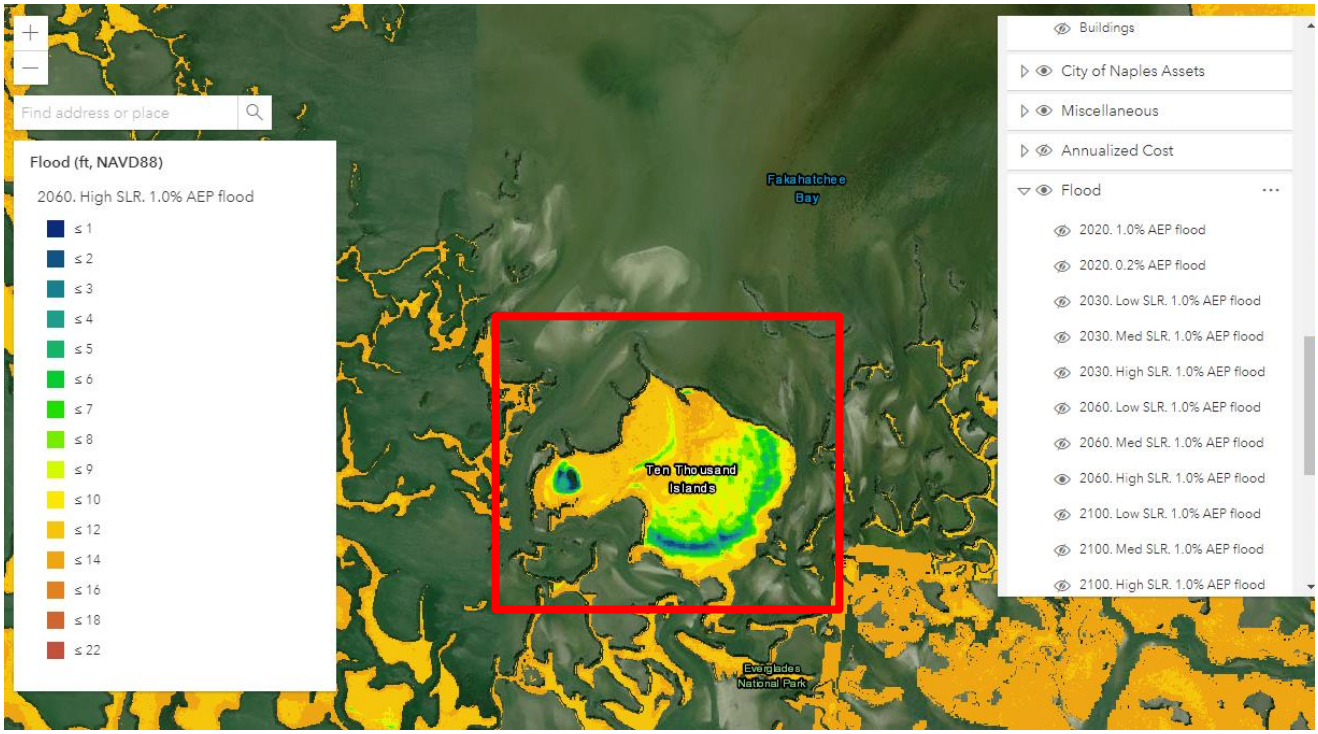
Appendix B. 29- Fakahatchee Key 2100 Low SLR 1.0% AEP Flood



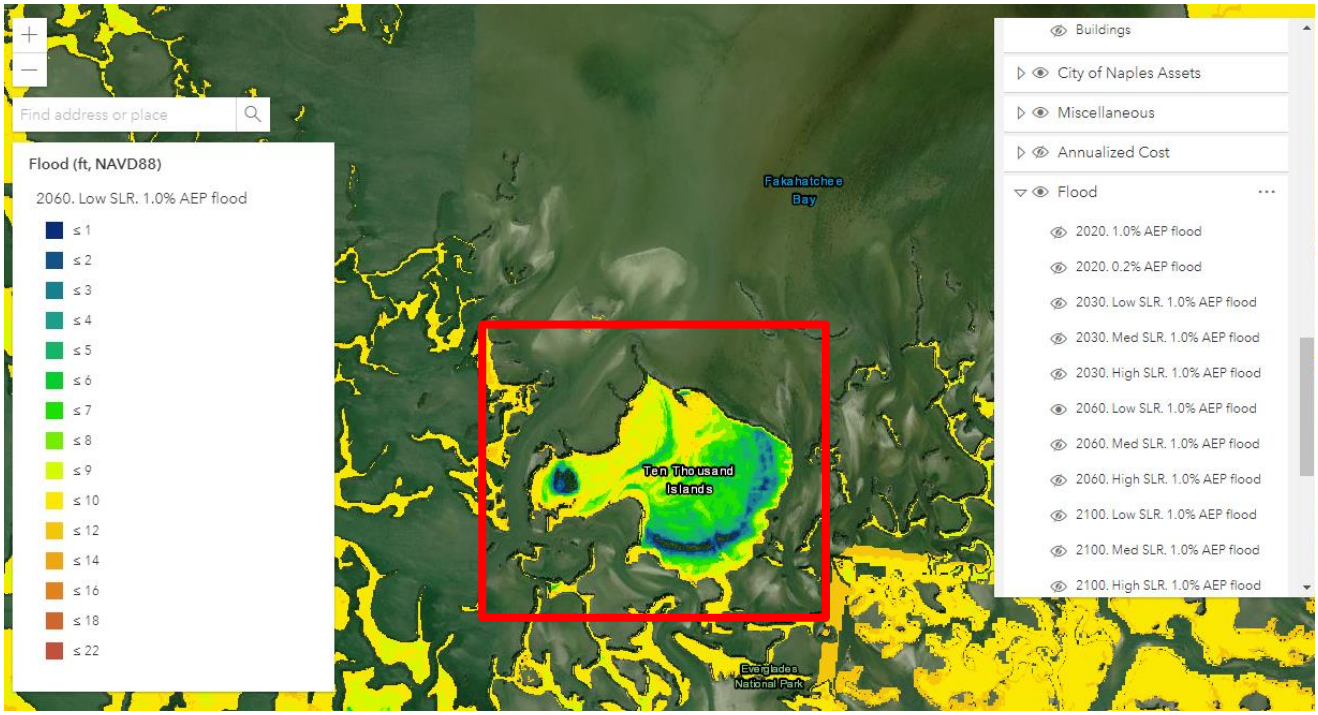
Appendix B. 30- Fakahatchee Key 2100 High SLR Tide Nuisance Flood



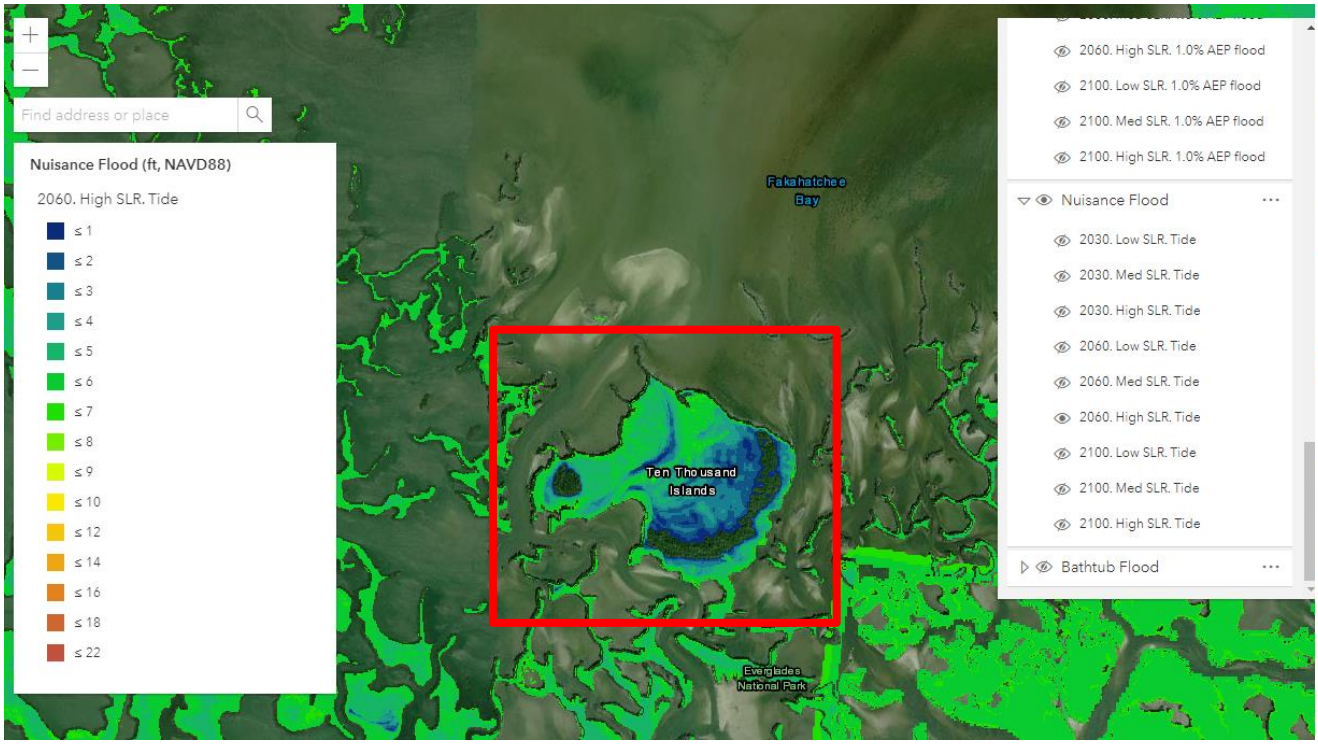
Appendix B. 31- Fakahatchee Key 2100 Low SLR Tide Nuisance Flood



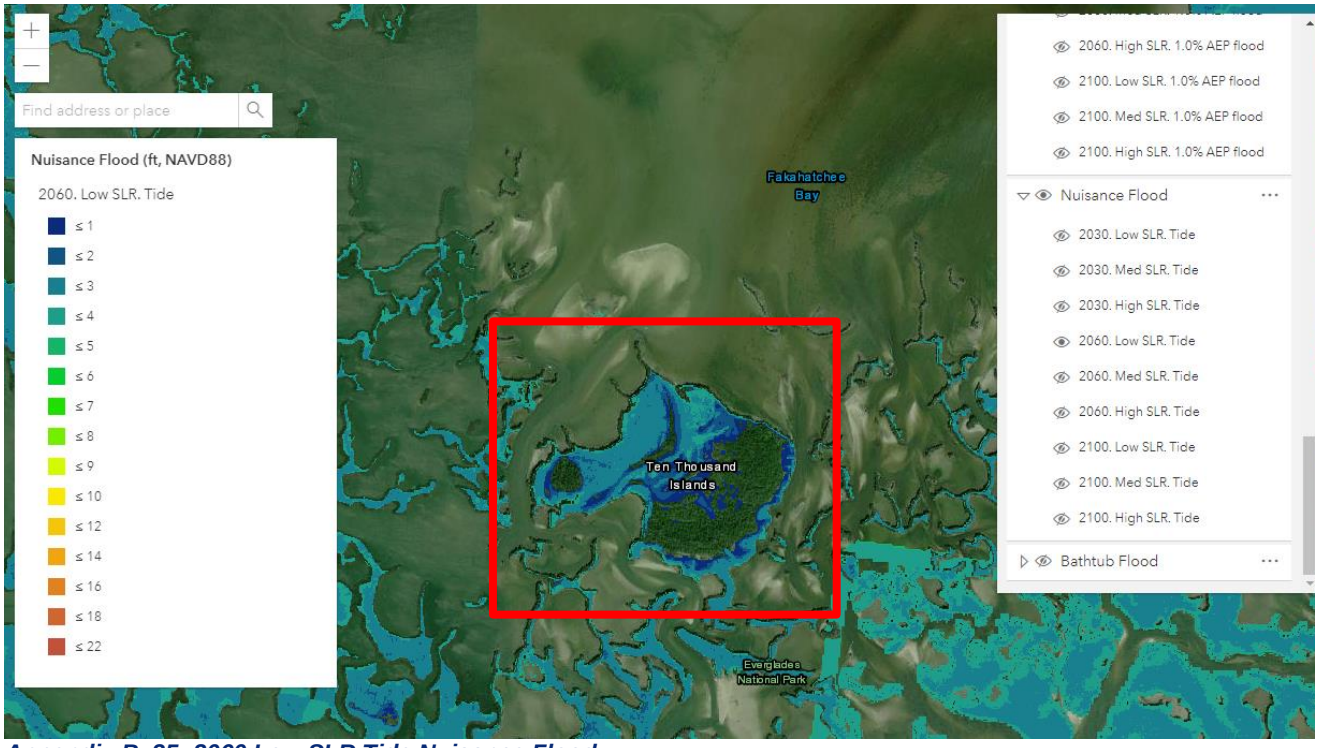
Appendix B. 32- Fakahatchee Key 2060 High SLR 1.0% AEP Flood



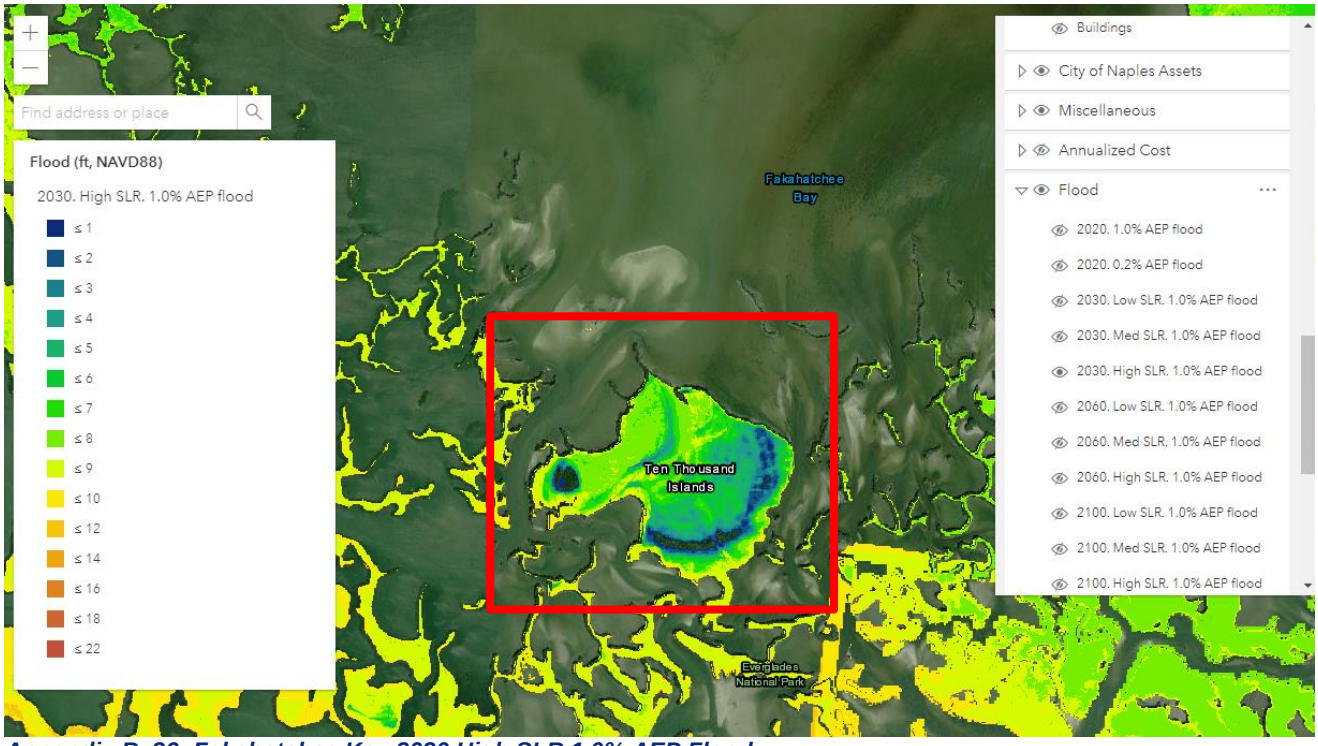
Appendix B. 33- Fakahatchee Key 2060 Low SLR 1.0% AEP Flood



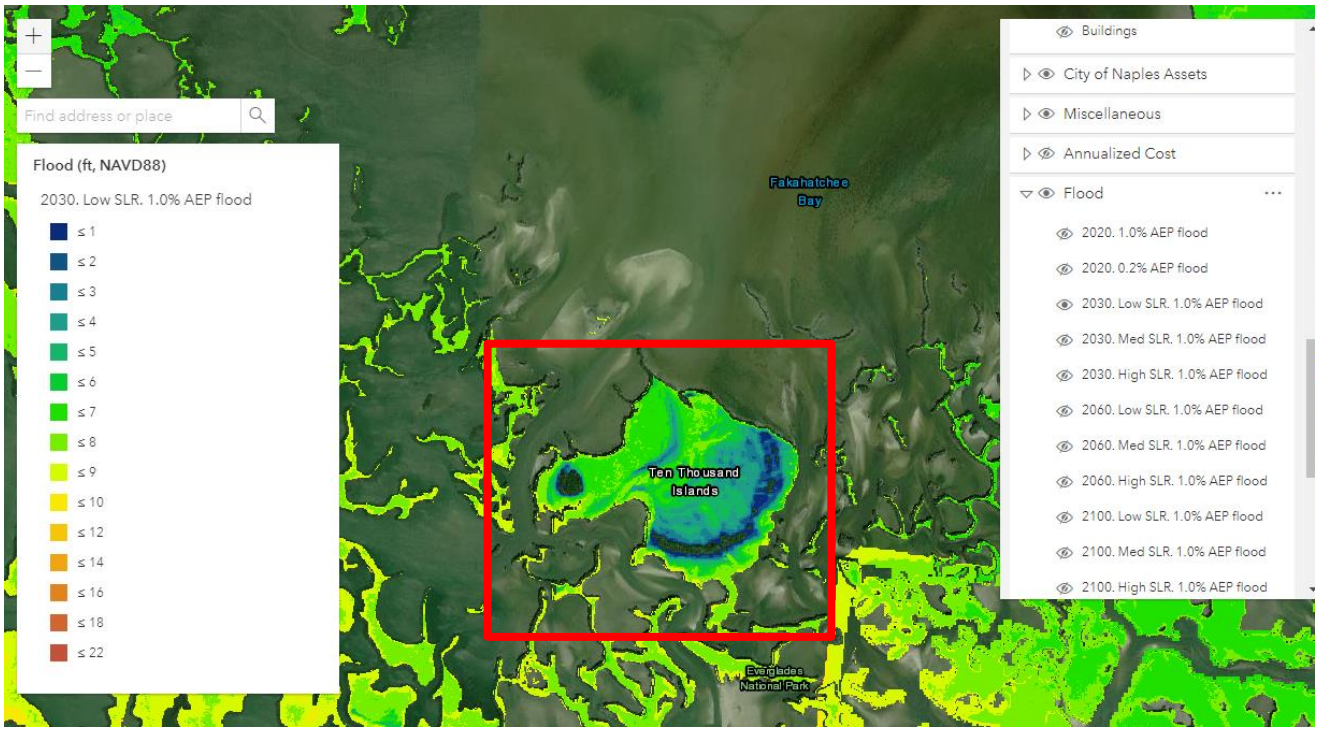
Appendix B. 34- 2060 High SLR Tide Nuisance Flood



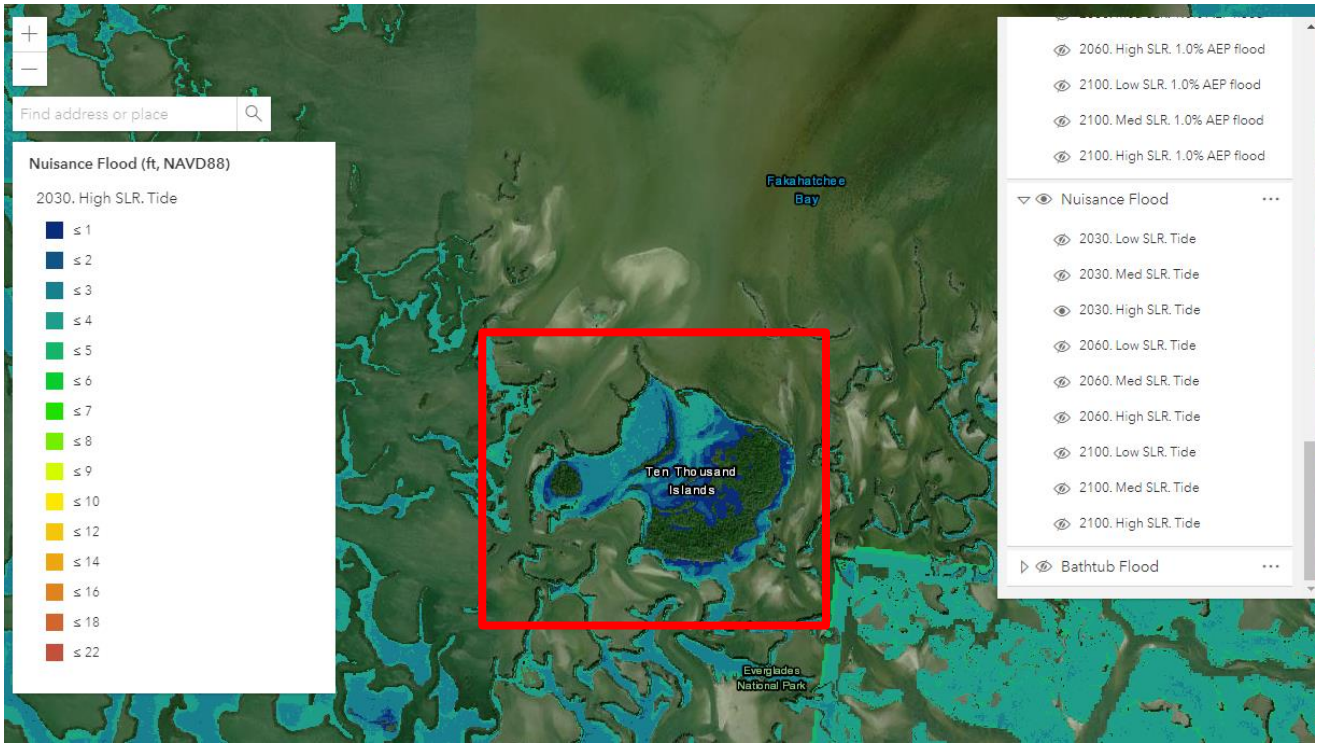
Appendix B. 35- 2060 Low SLR Tide Nuisance Flood



Appendix B. 36- Fakahatchee Key 2030 High SLR 1.0% AEP Flood

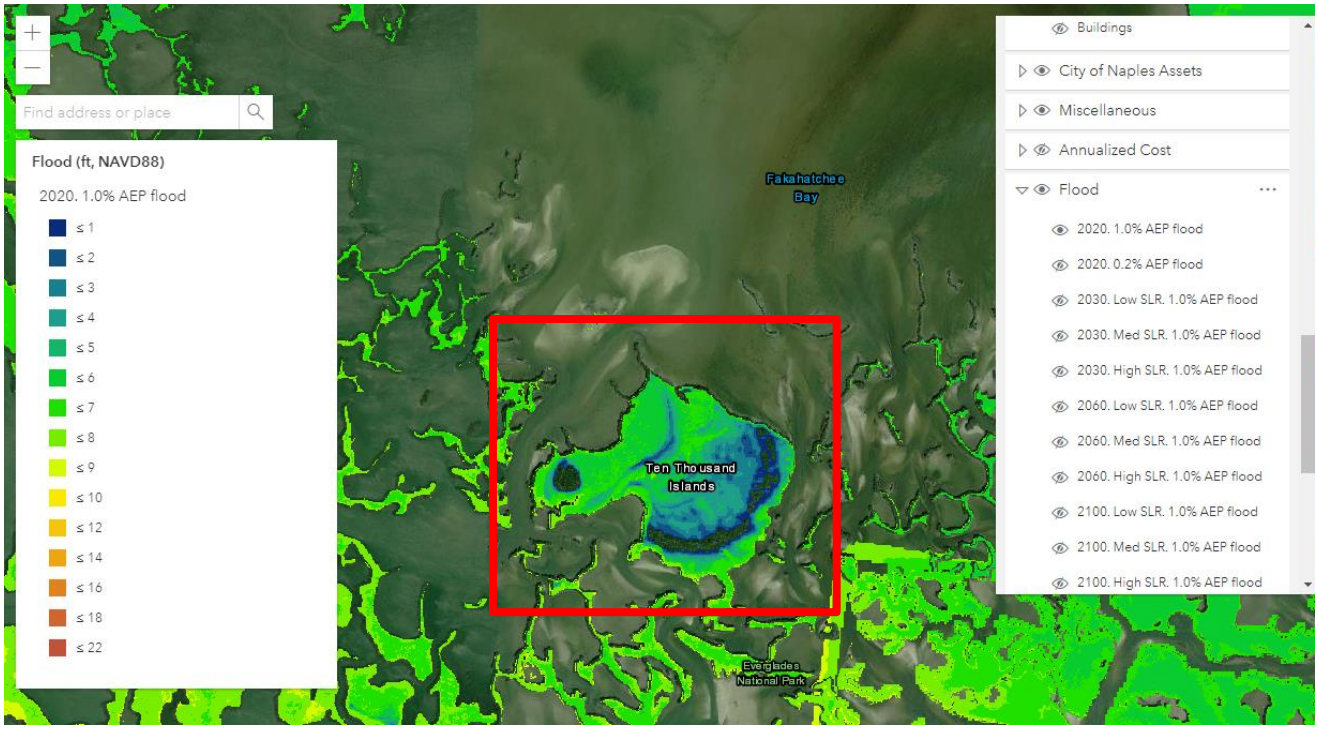


Appendix B. 37- Fakahatchee Key 2030 Low SLR 1.0% AEP Flood



Appendix B. 38- Fakahatchee Key 2030 High SLR Tide Nuisance Flood

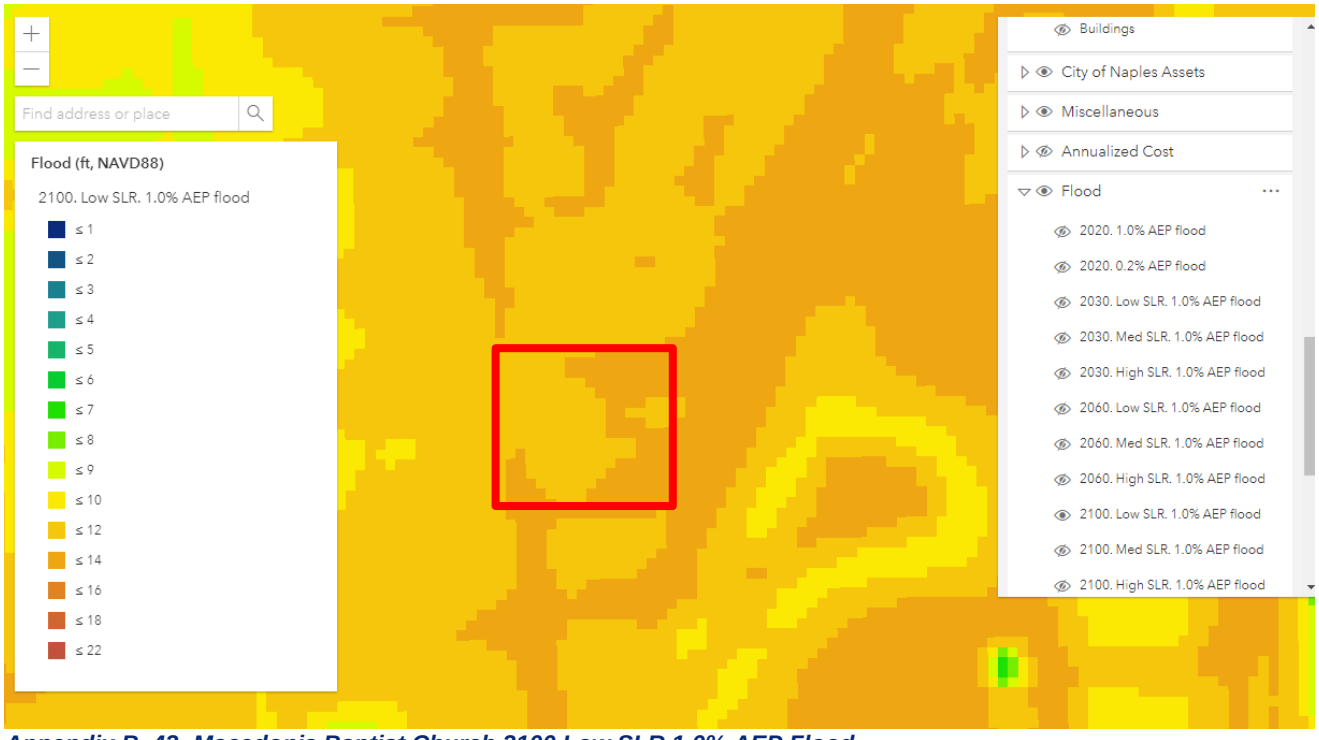
Appendix B. 39- Fakahatchee Key 2030 Low SLR Tide Nuisance Flood



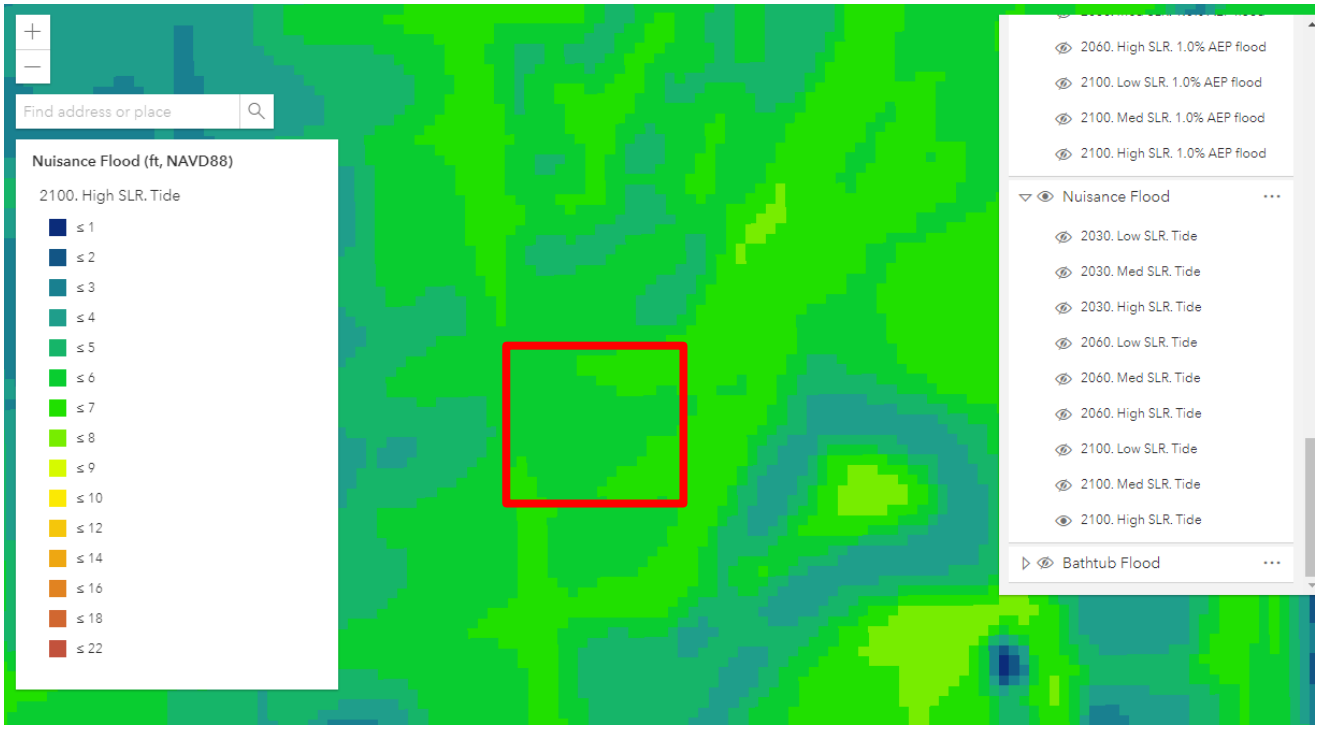
Appendix B. 40- Fakahatchee Key 2020 1.0% AEP Flood

Macedonia Baptist Church, Riverpark Community

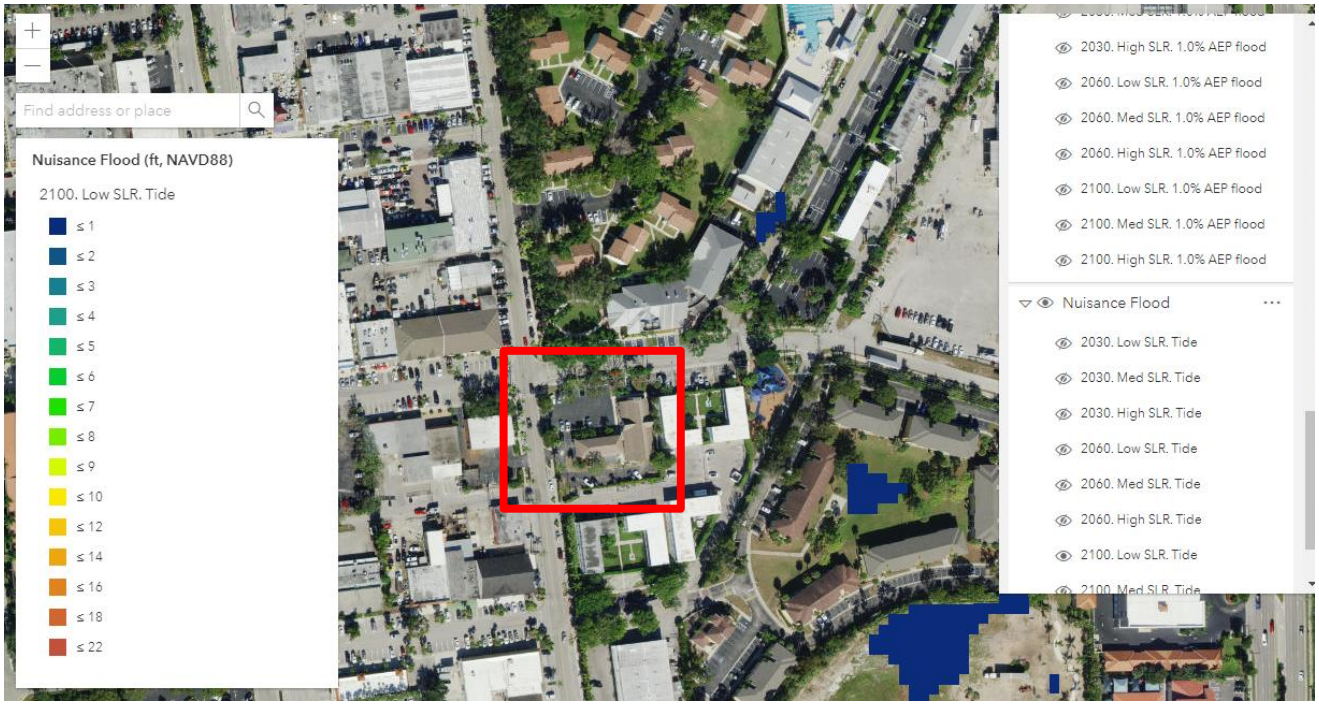
Appendix B. 41- Macedonia Baptist Church 2100 High SLR 1.0% AEP Flood



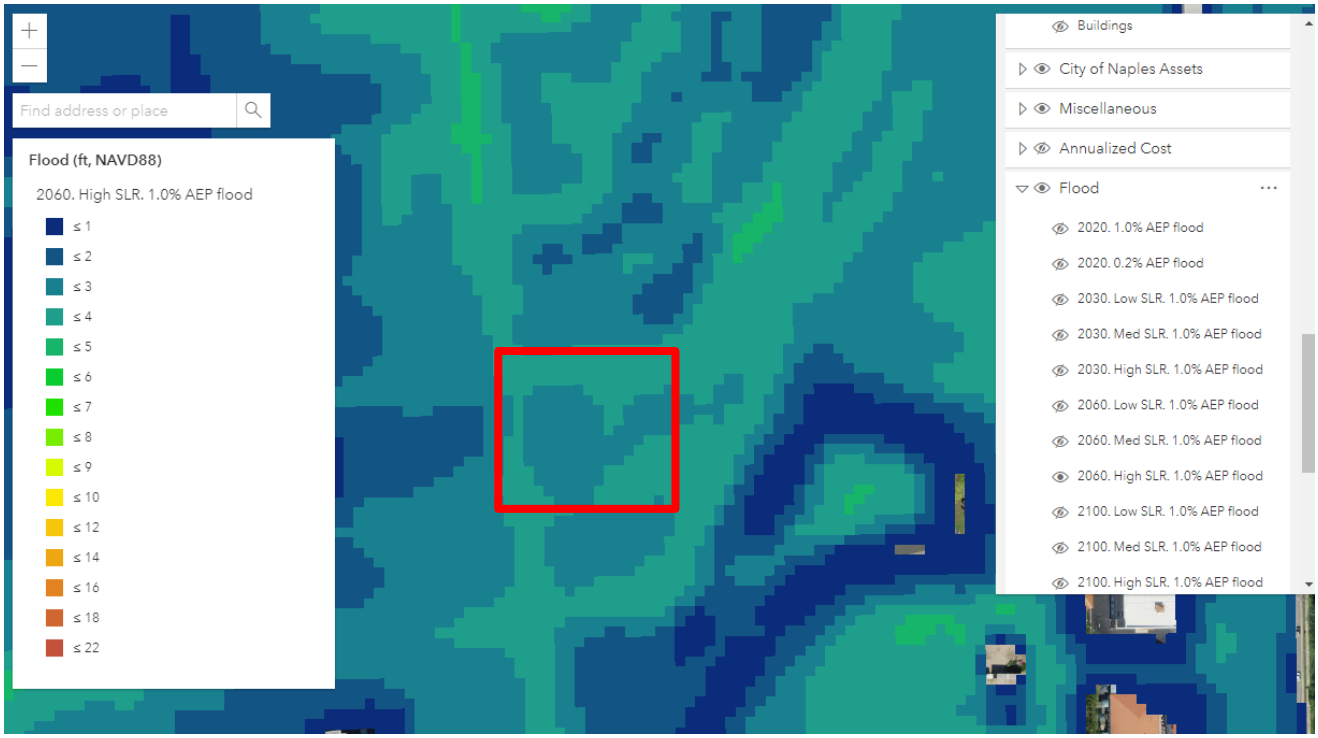
Appendix B. 42- Macedonia Baptist Church 2100 Low SLR 1.0% AEP Flood



Appendix B. 43- Macedonia Baptist Church 2100 High SLR Tide Nuisance Flood



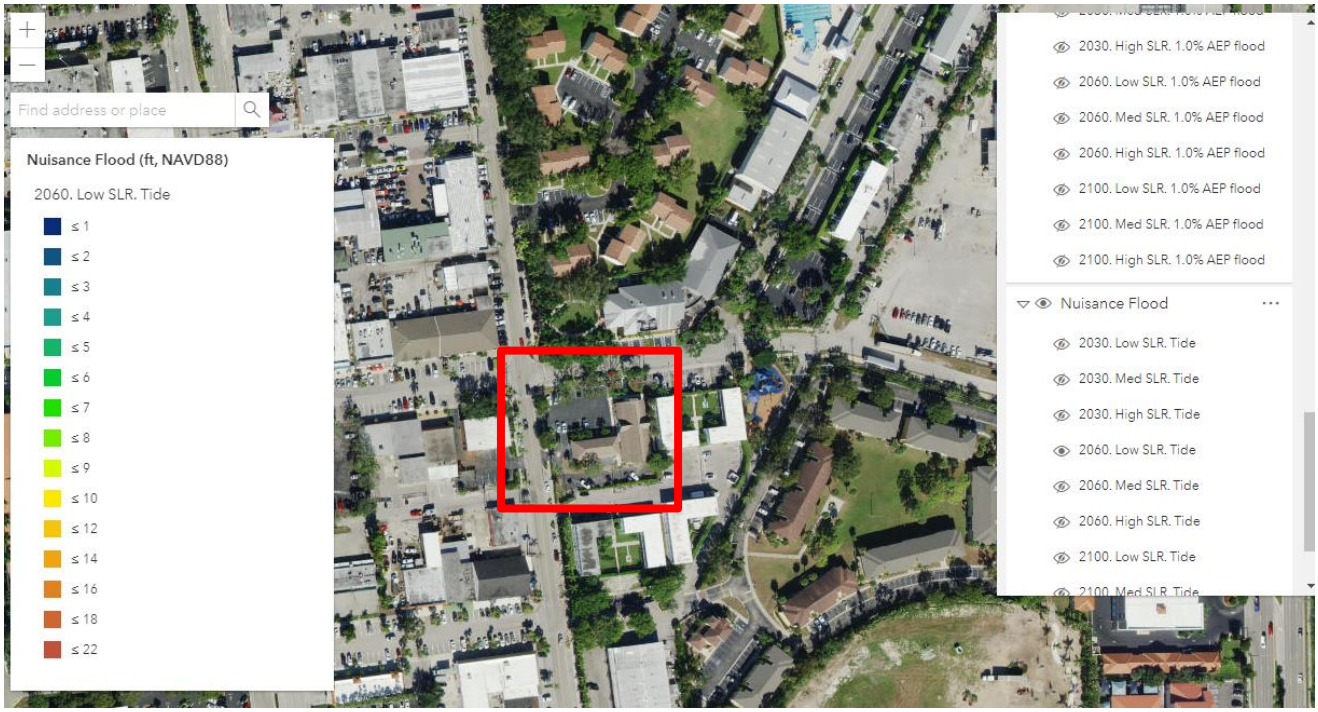
Appendix B. 44- Macedonia Baptist Church 2100 Low SLR Tide Nuisance Flood



Appendix B. 45- Macedonia Baptist Church 2060 High SLR 1.0% AEP Flood

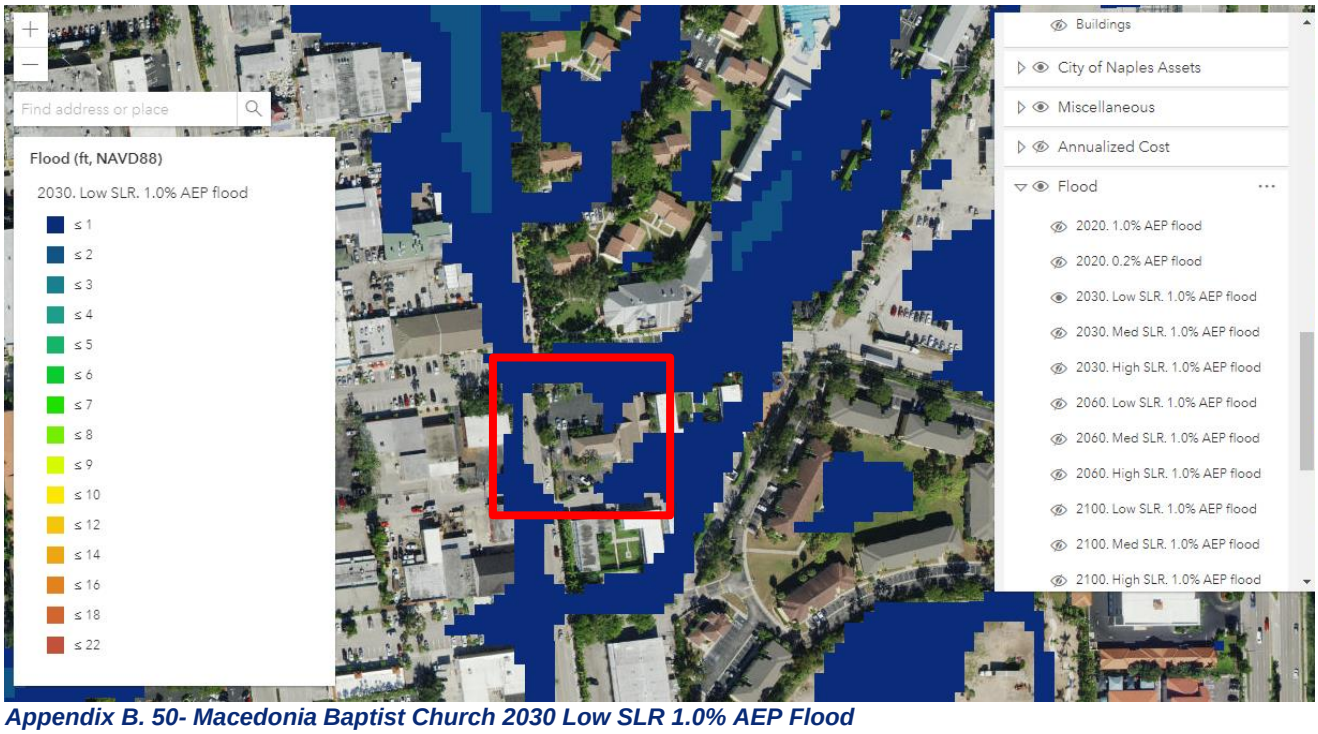
Appendix B. 46- Macedonia Baptist Church 2060 Low SLR 1.0% AEP Flood

Appendix B. 47- Macedonia Baptist Church 2060 High SLR Tide Nuisance Flood

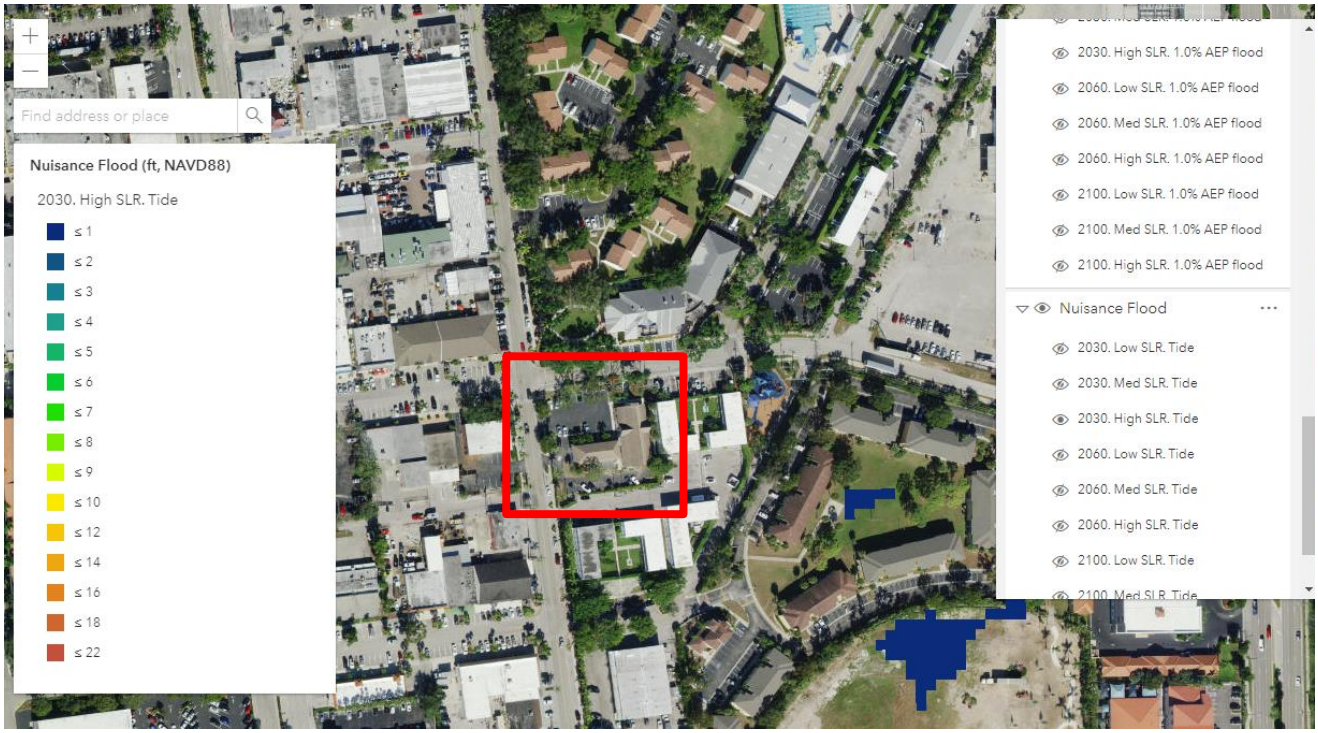


Appendix B. 48- Macedonia Baptist Church 2060 Low SLR Tide Nuisance Flood

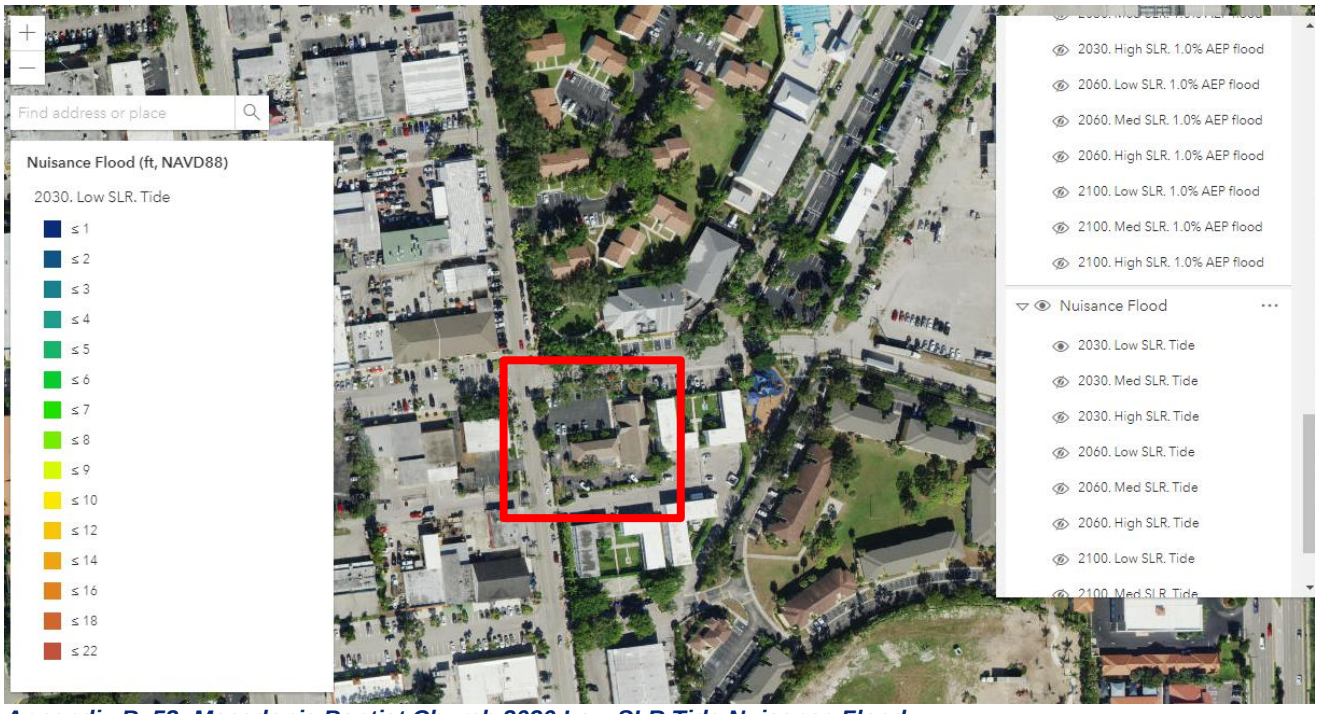
Appendix B. 49- Macedonia Baptist Church 2030 High SLR 1.0% AEP Flood



Appendix B. 50- Macedonia Baptist Church 2030 Low SLR 1.0% AEP Flood



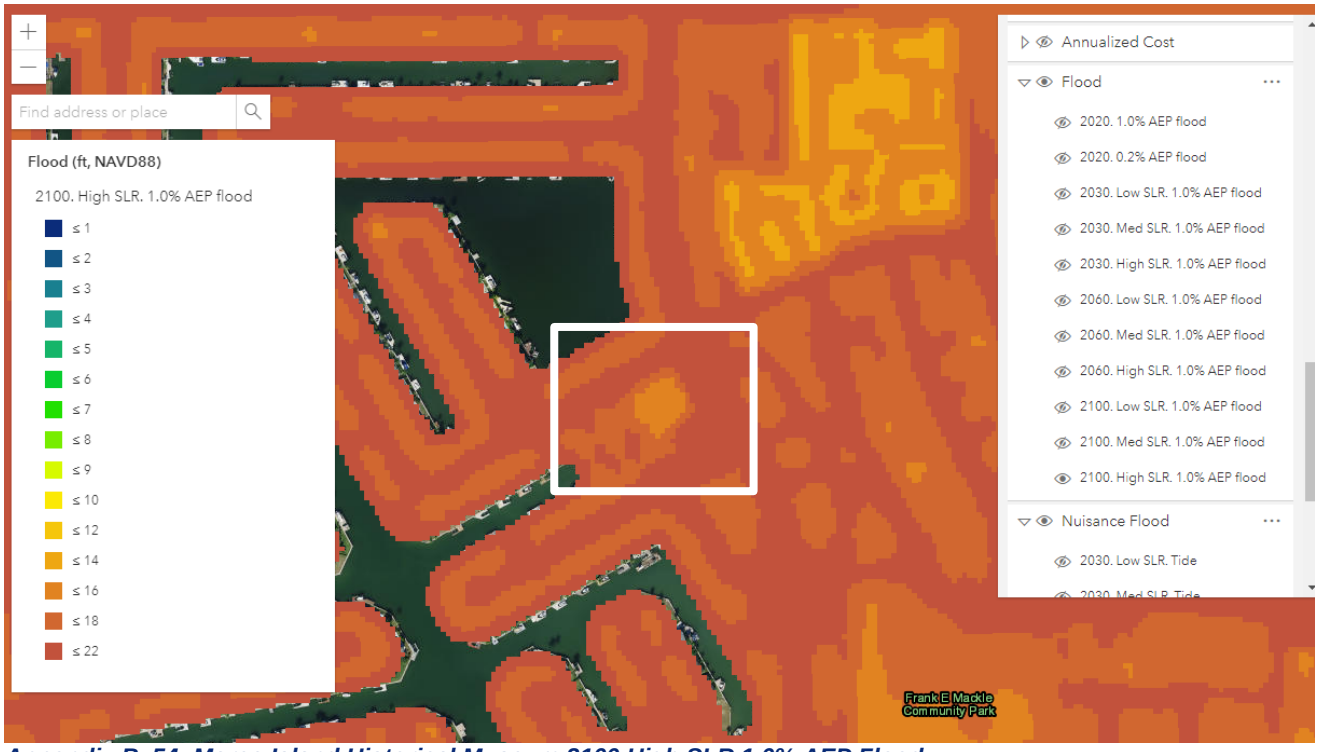
Appendix B. 51- Macedonia Baptist Church 2030 High SLR Tide Nuisance Flood



Appendix B. 52- Macedonia Baptist Church 2030 Low SLR Tide Nuisance Flood

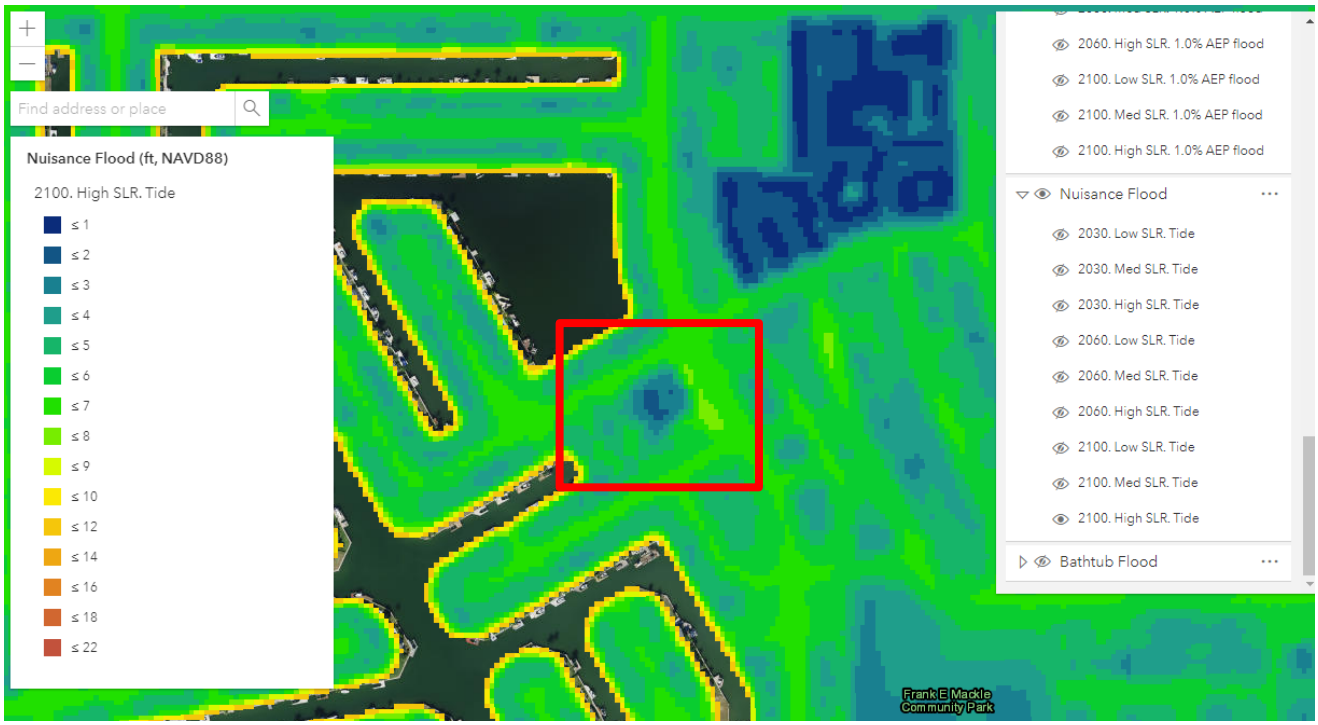
Appendix B. 53- Macedonia Baptist Church 2020 1.0% AEP Flood

Marco Island Historical Museum

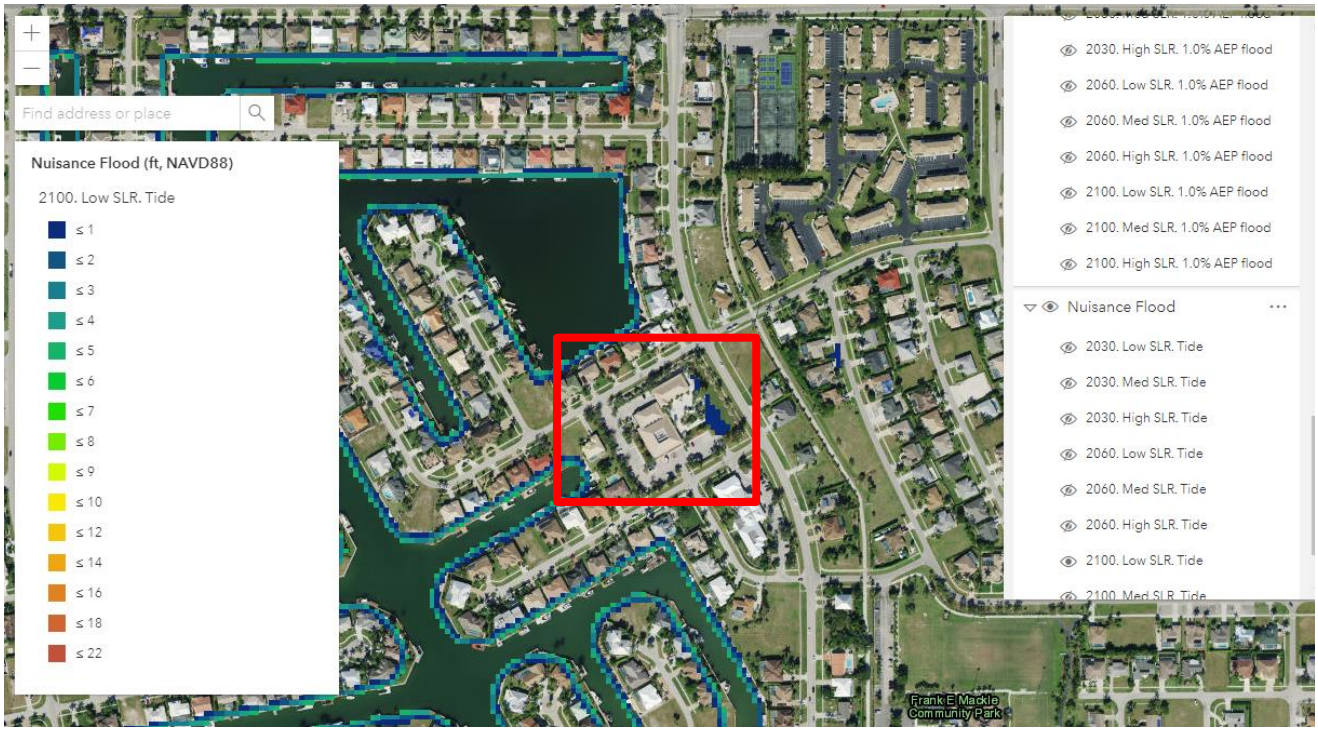


Appendix B. 54- Marco Island Historical Museum 2100 High SLR 1.0% AEP Flood

Appendix B. 55- Marco Island Historical Museum 2100 Low SLR 1.0% AEP Flood

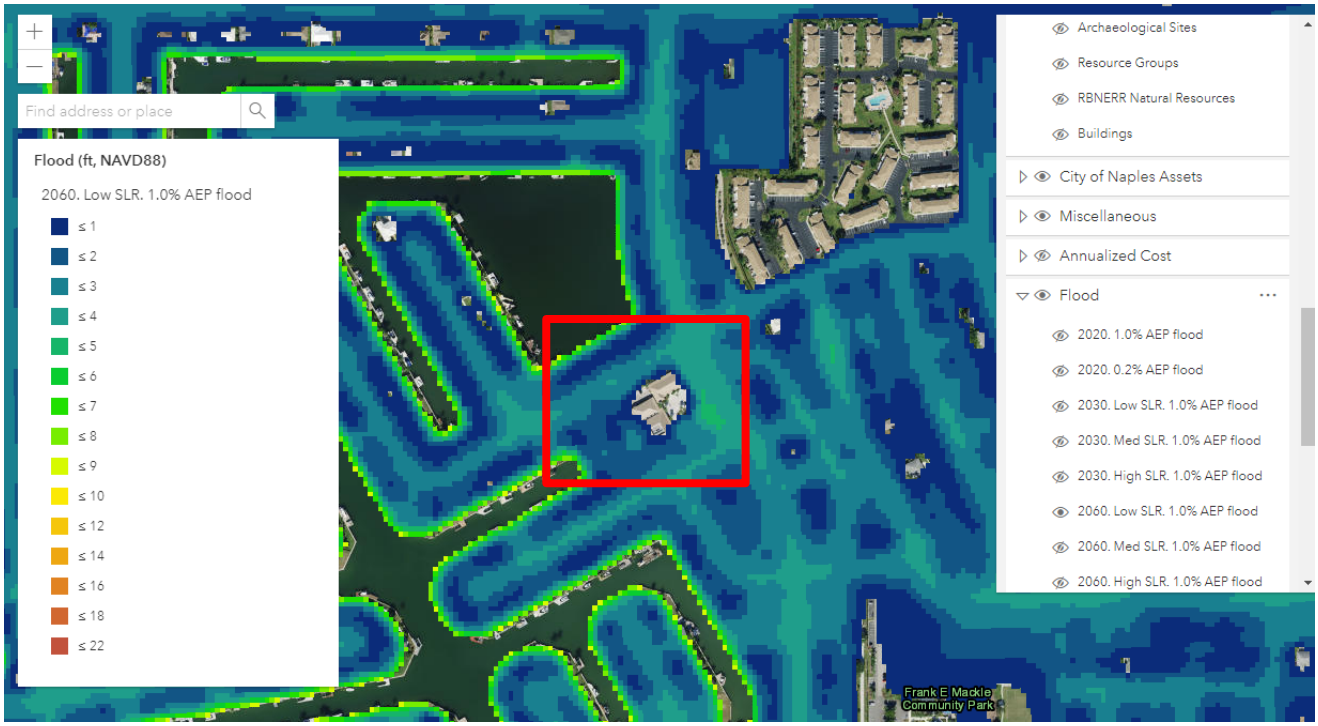


Appendix B. 56- Marco Island Historical Museum 2100 High SLR Tide Nuisance Flood



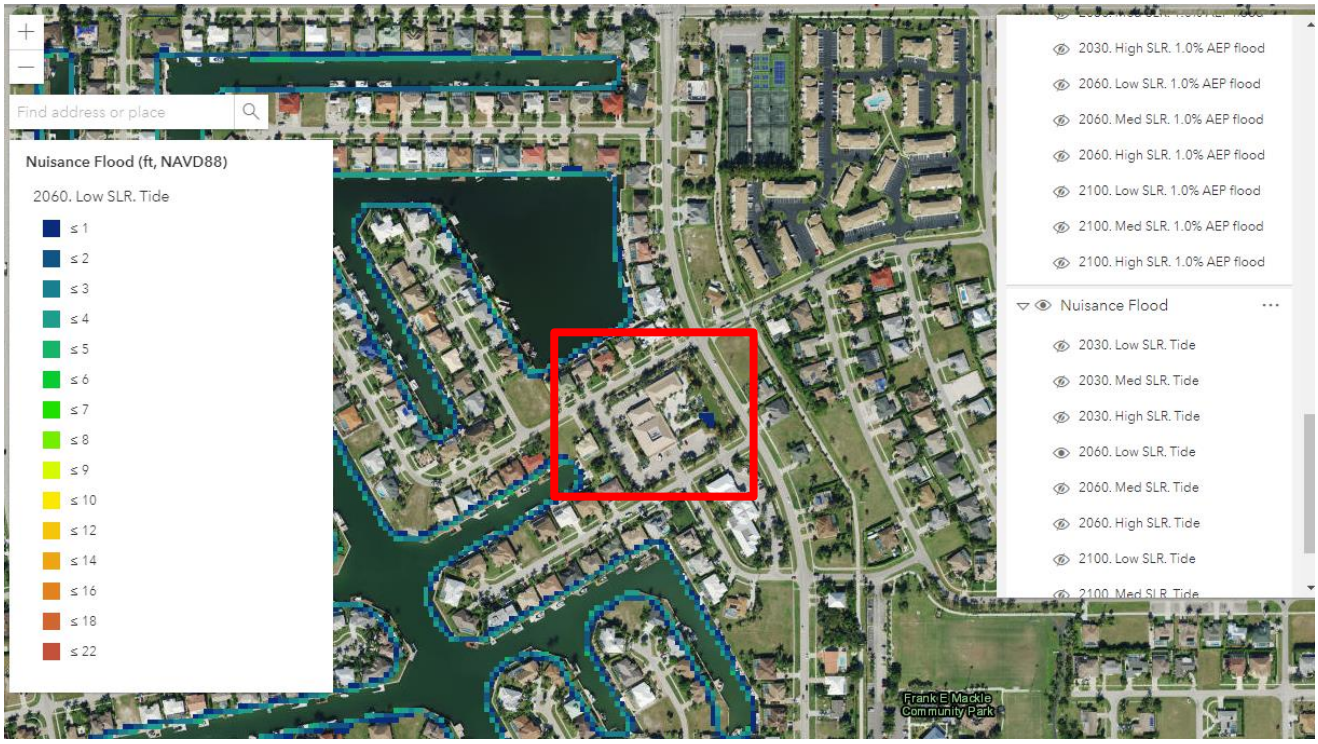
Appendix B. 57- Marco Island Historical Museum 2100 Low SLR Tide Nuisance Flood

Appendix B. 58- Marco Island Historical Museum 2060 High SLR 1.0% AEP Flood

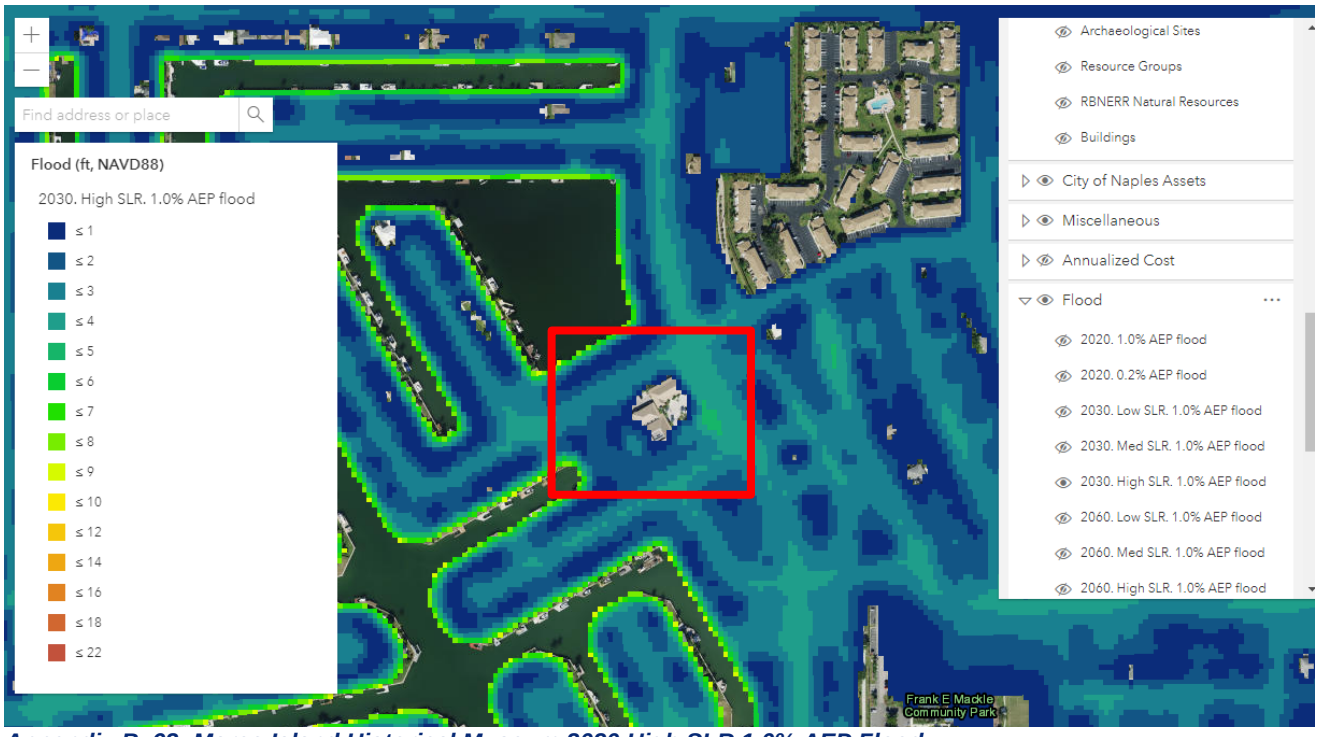


Appendix B. 59- Marco Island Historical Museum 2060 Low SLR 1.0% AEP Flood

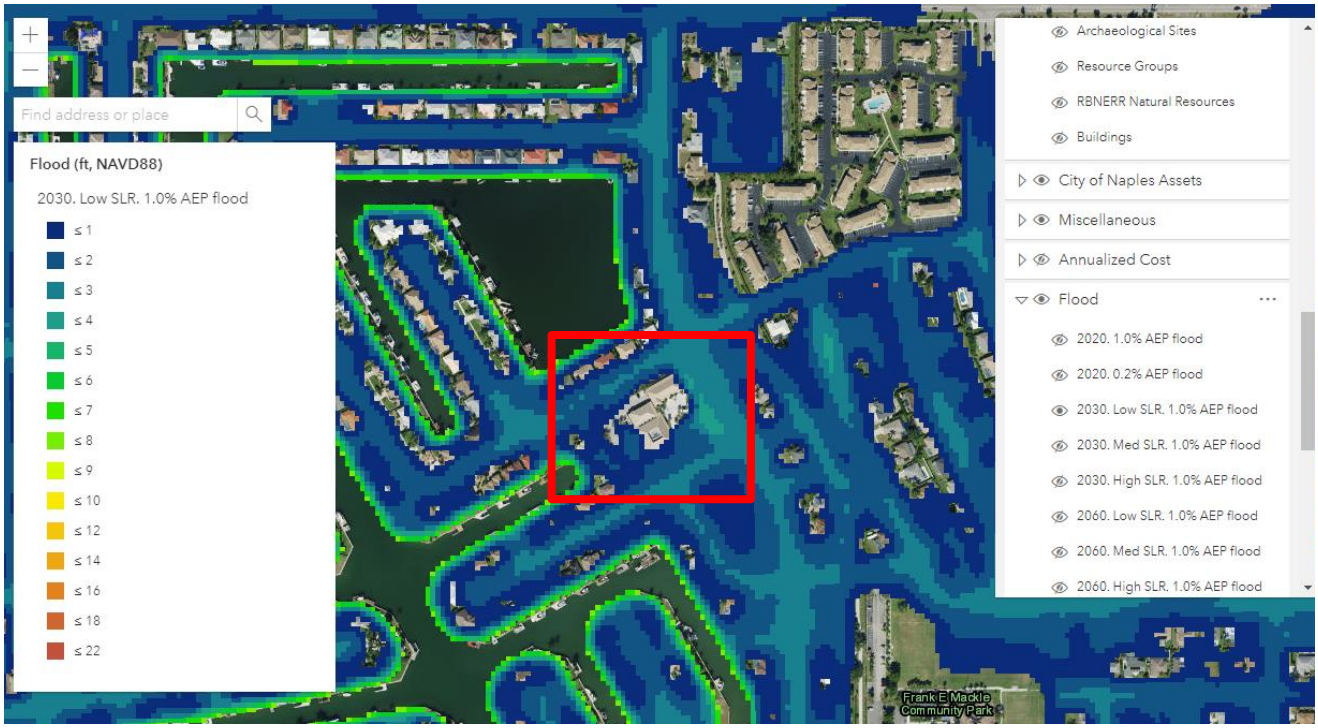
Appendix B. 60- Marco Island Historical Museum 2060 High SLR Tide Nuisance Flood



Appendix B. 61- Marco Island Historical Museum 2060 Low SLR Tide Nuisance Flood

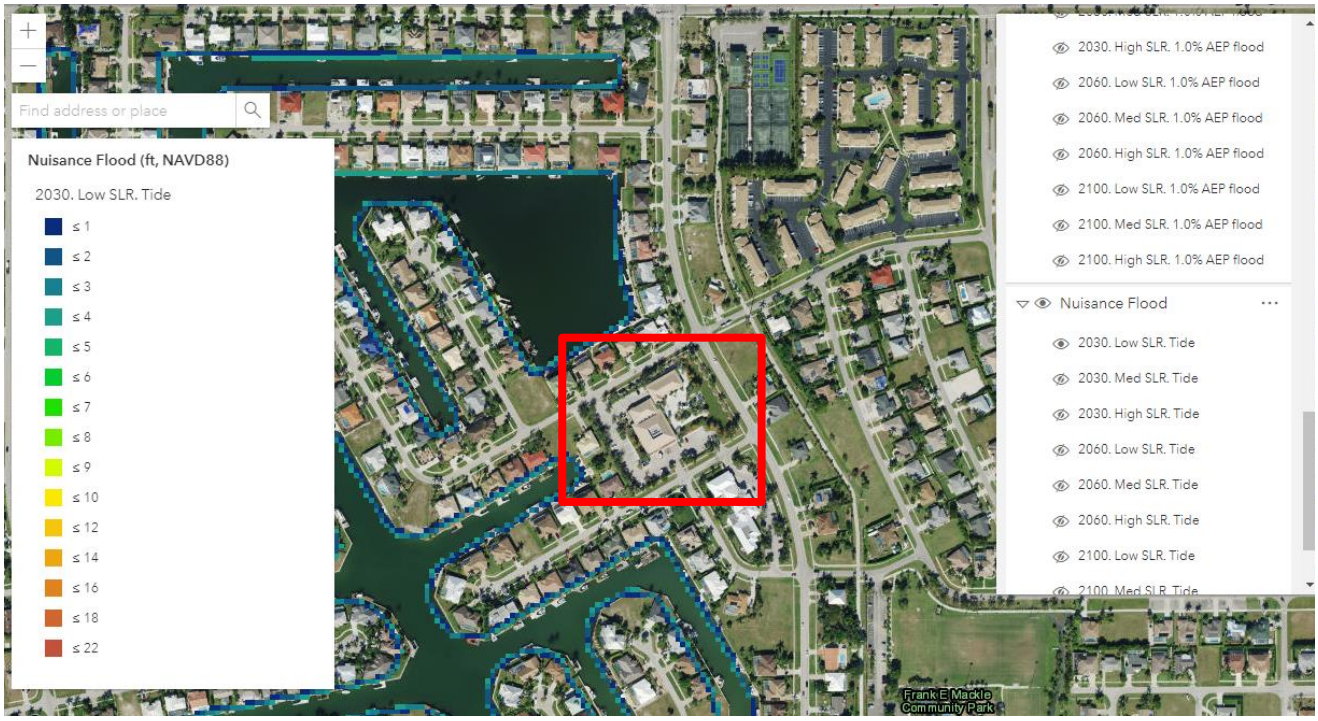


Appendix B. 62- Marco Island Historical Museum 2030 High SLR 1.0% AEP Flood

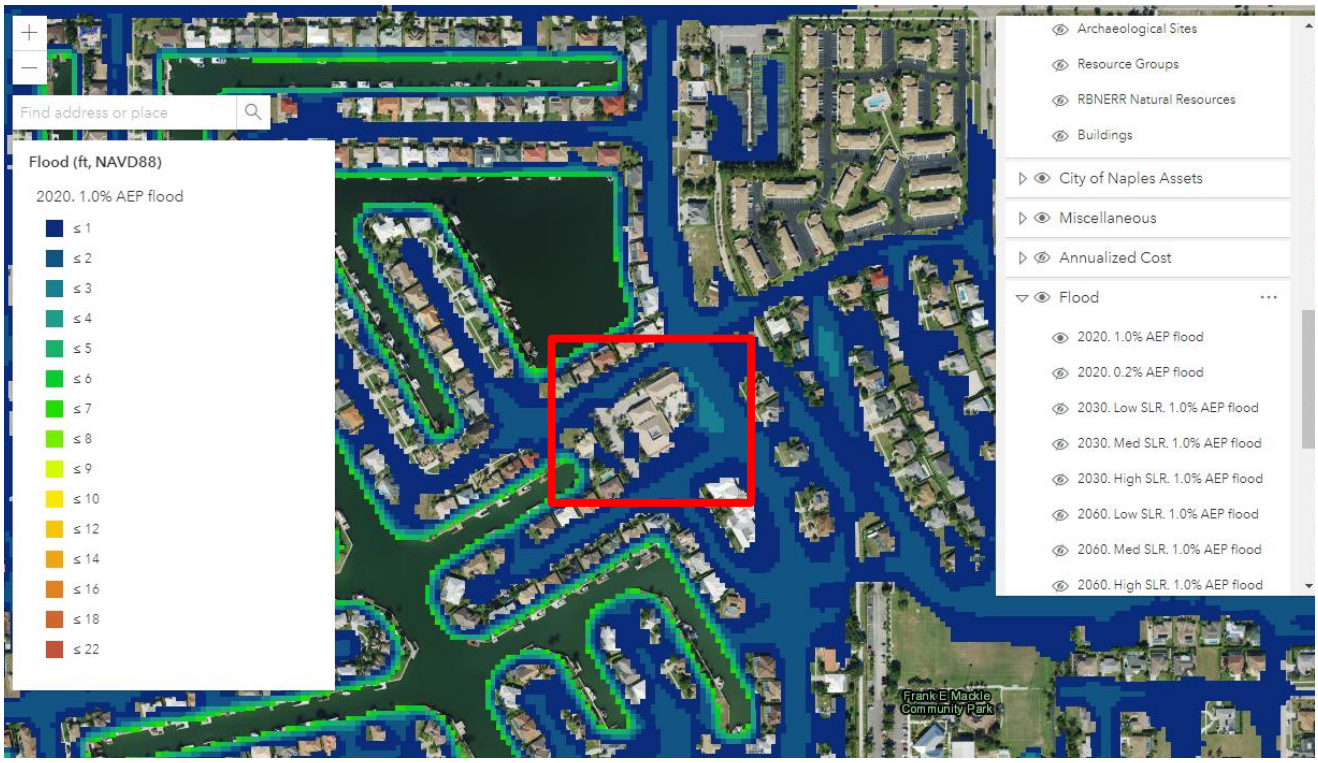


Appendix B. 63- Marco Island Historical Museum 2030 Low SLR 1.0% AEP Flood

Appendix B. 64- Marco Island Historical Museum 2030 High SLR Tide Nuisance Flood

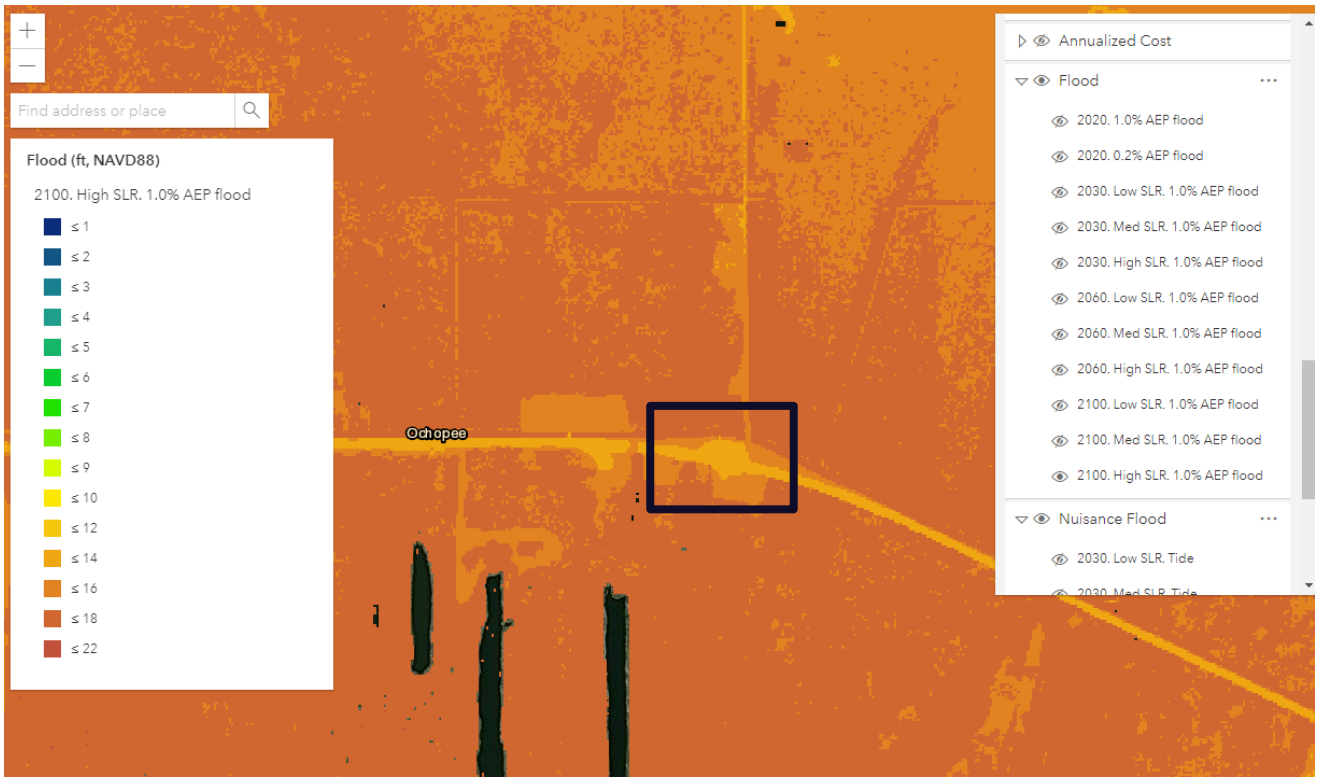


Appendix B. 65- Marco Island Historical Museum 2030 Low SLR Tide Nuisance Flood

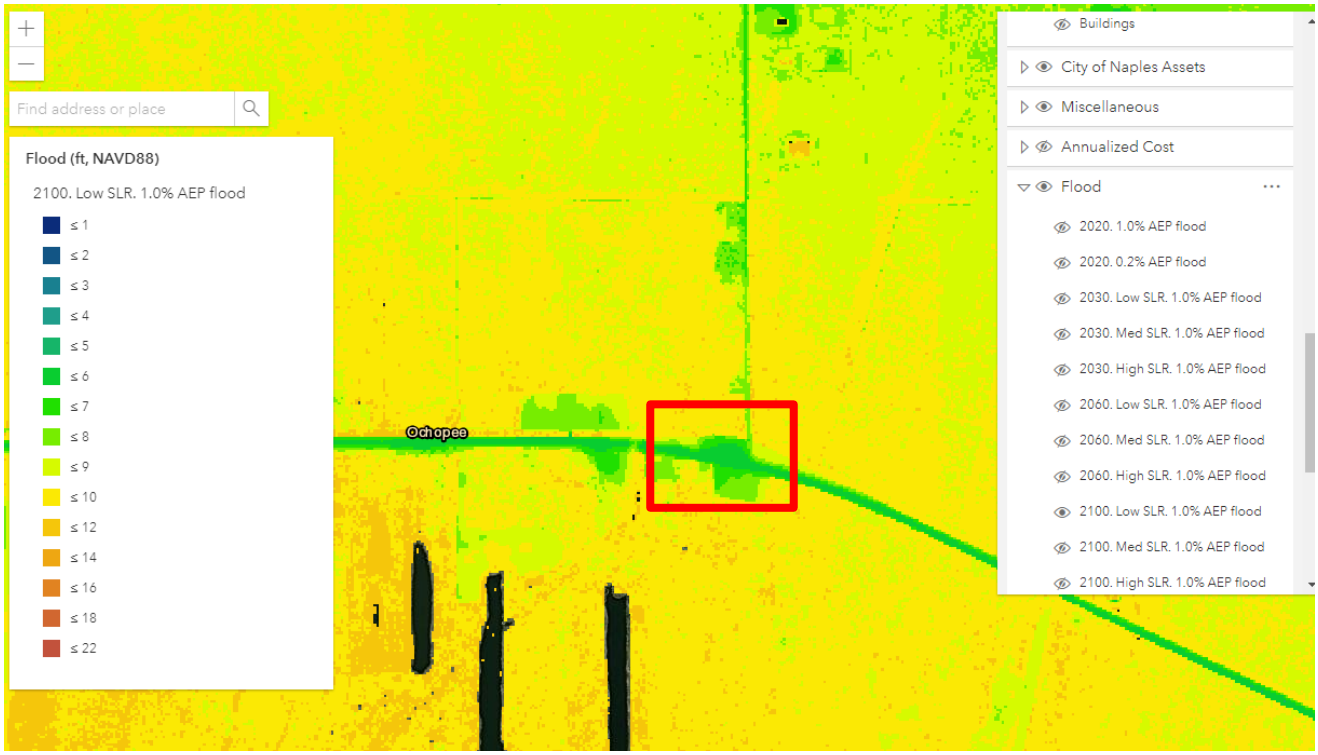


Appendix B. 66- Marco Island Historical Museum 2020 1.0% AEP Flood

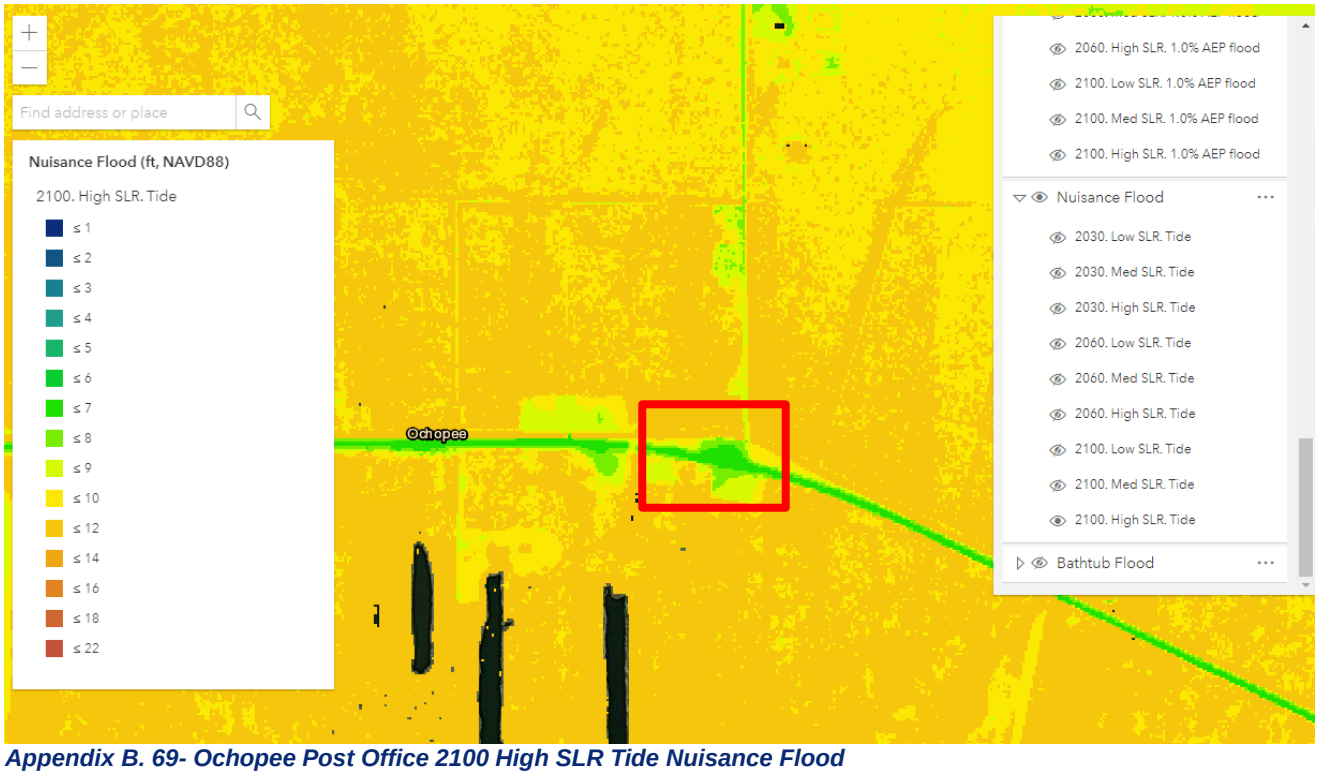
Ochopee Post Office (Smallest Post Office in the Country)



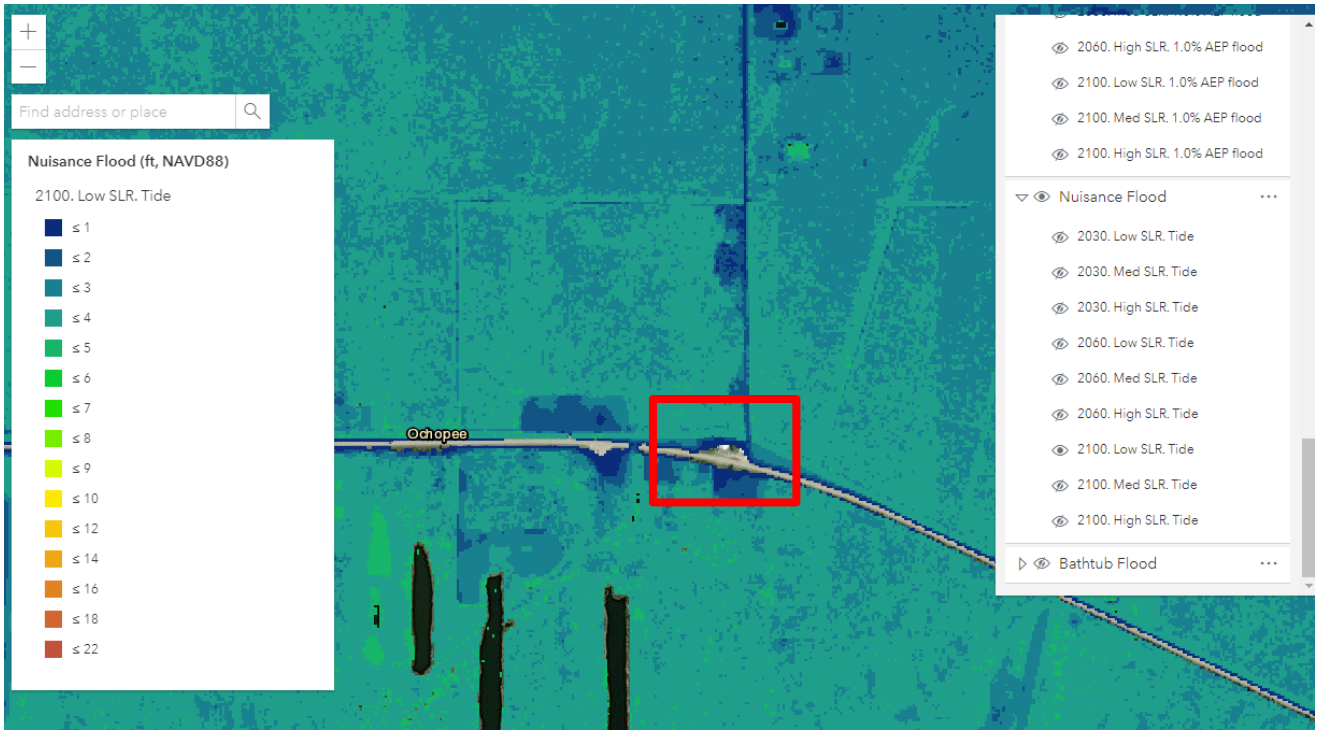
Appendix B. 67- Ochopee Post Office 2100 High SLR 1.0% AEP Flood



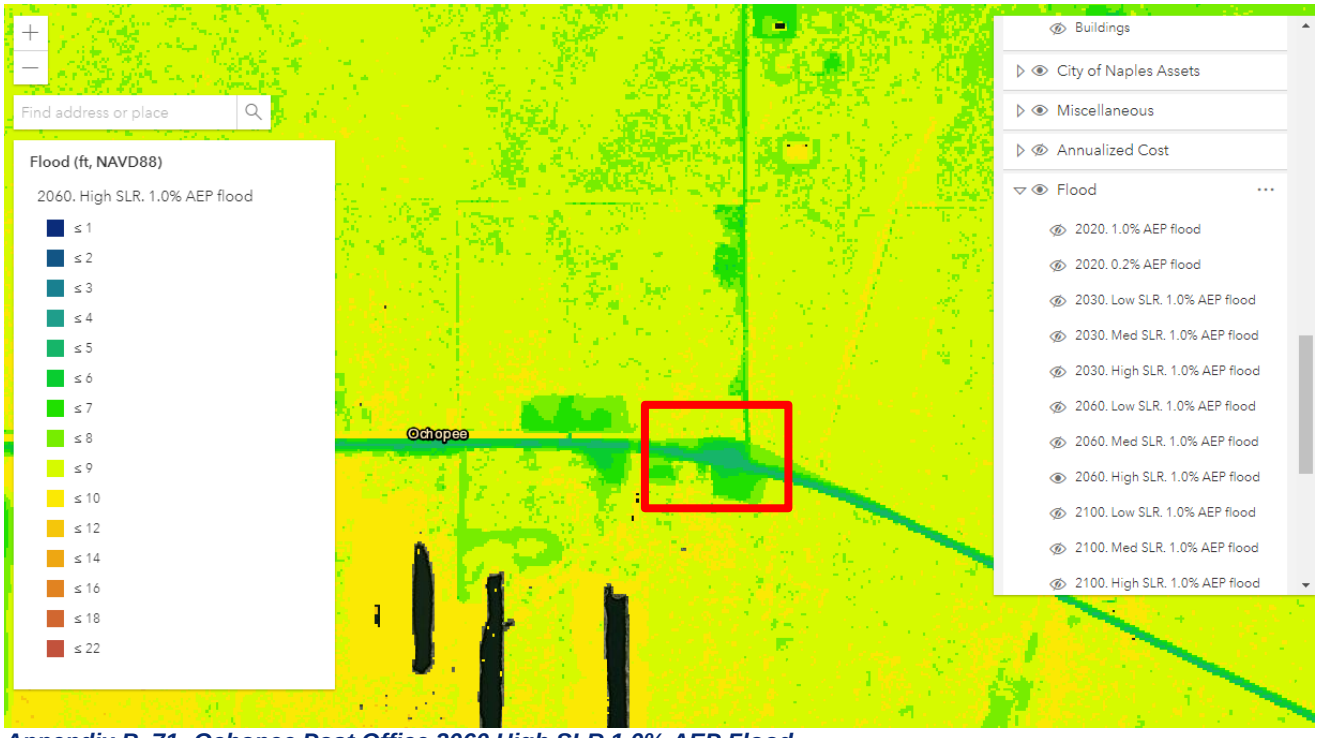
Appendix B. 68- Ochopee Post Office 2100 Low SLR 1.0% AEP Flood



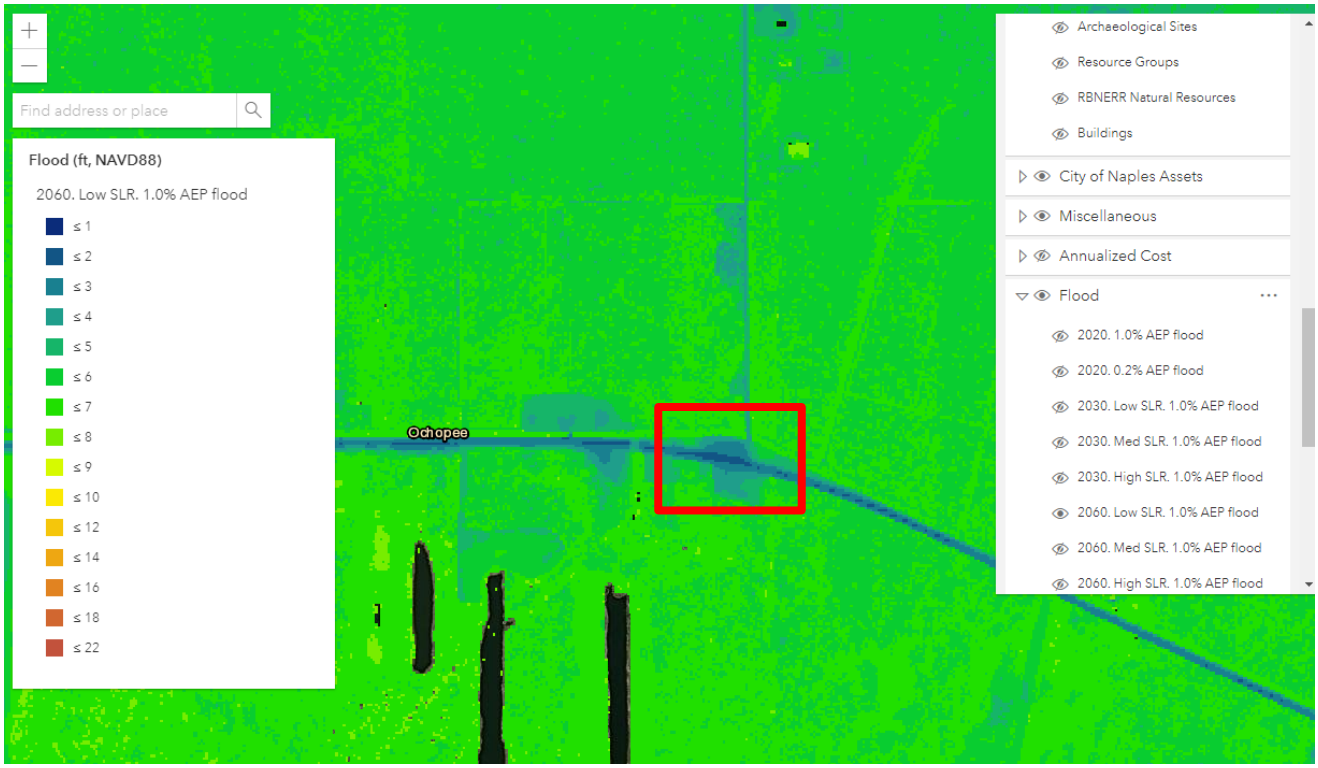
Appendix B. 69- Ochopee Post Office 2100 High SLR Tide Nuisance Flood



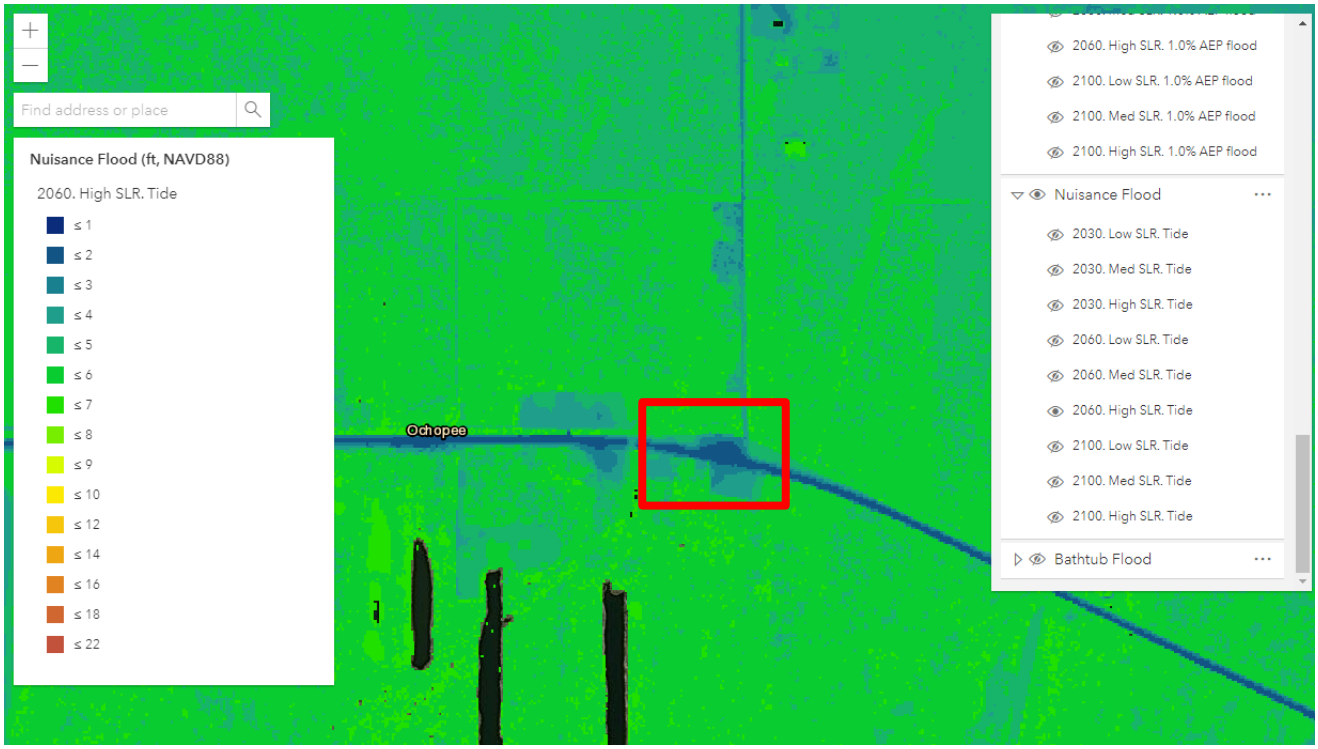
Appendix B. 70- Ochopee Post Office 2100 Low SLR Tide Nuisance Flood



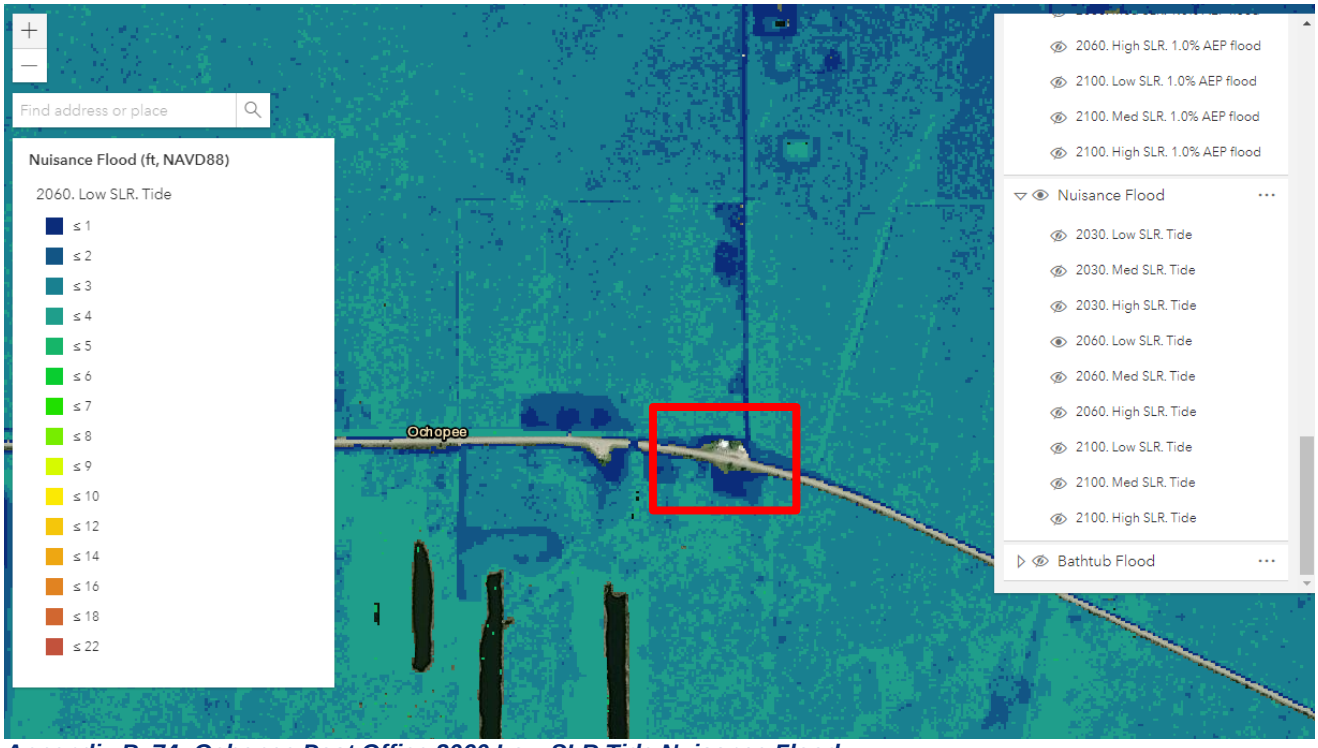
Appendix B. 71- Ochopee Post Office 2060 High SLR 1.0% AEP Flood



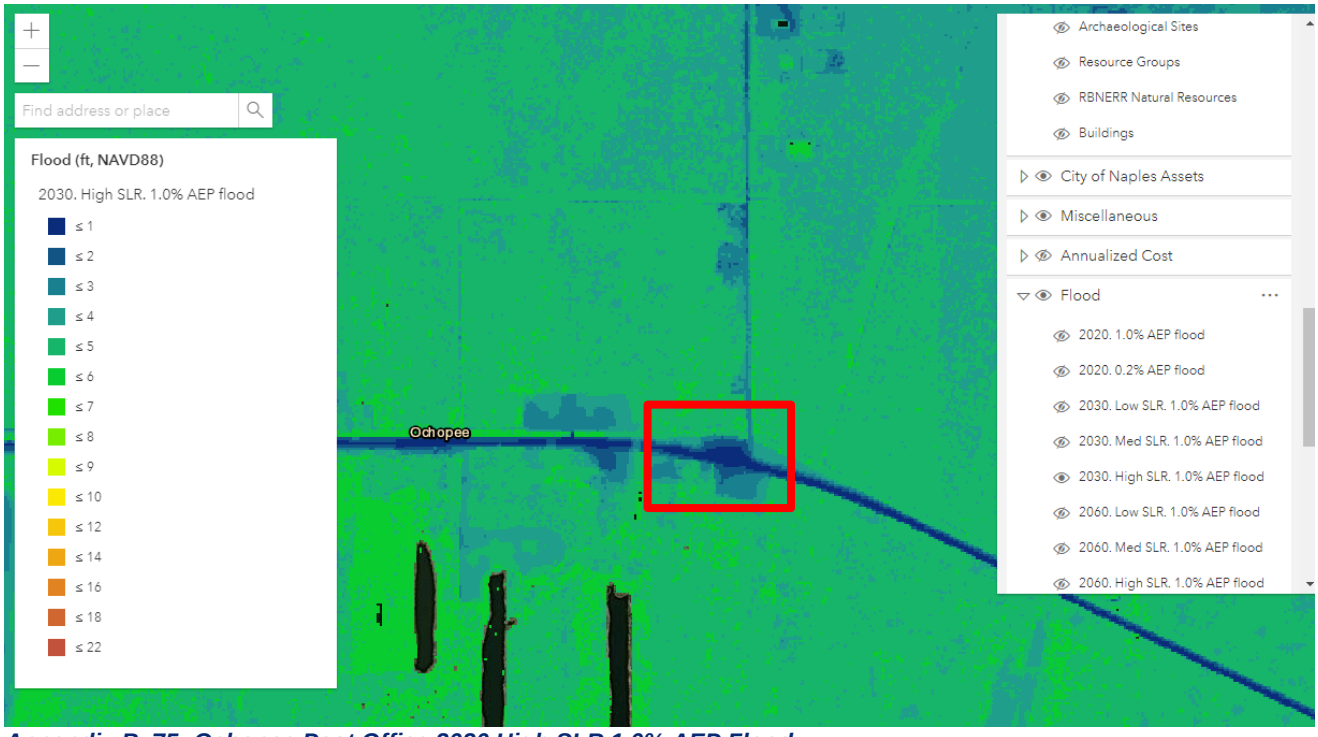
Appendix B. 72- Ochopee Post Office 2060 Low SLR 1.0% AEP Flood



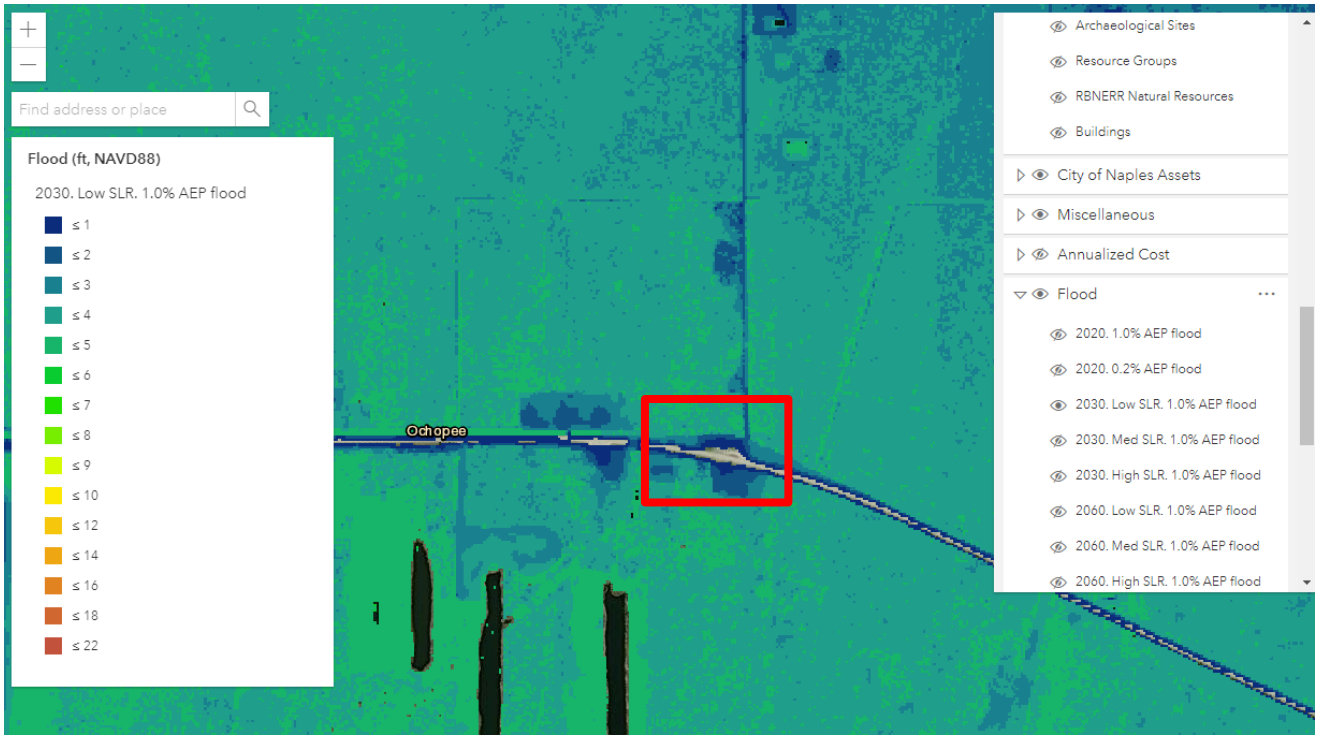
Appendix B. 73- Ochopee Post Office 2060 High SLR Tide Nuisance Flood



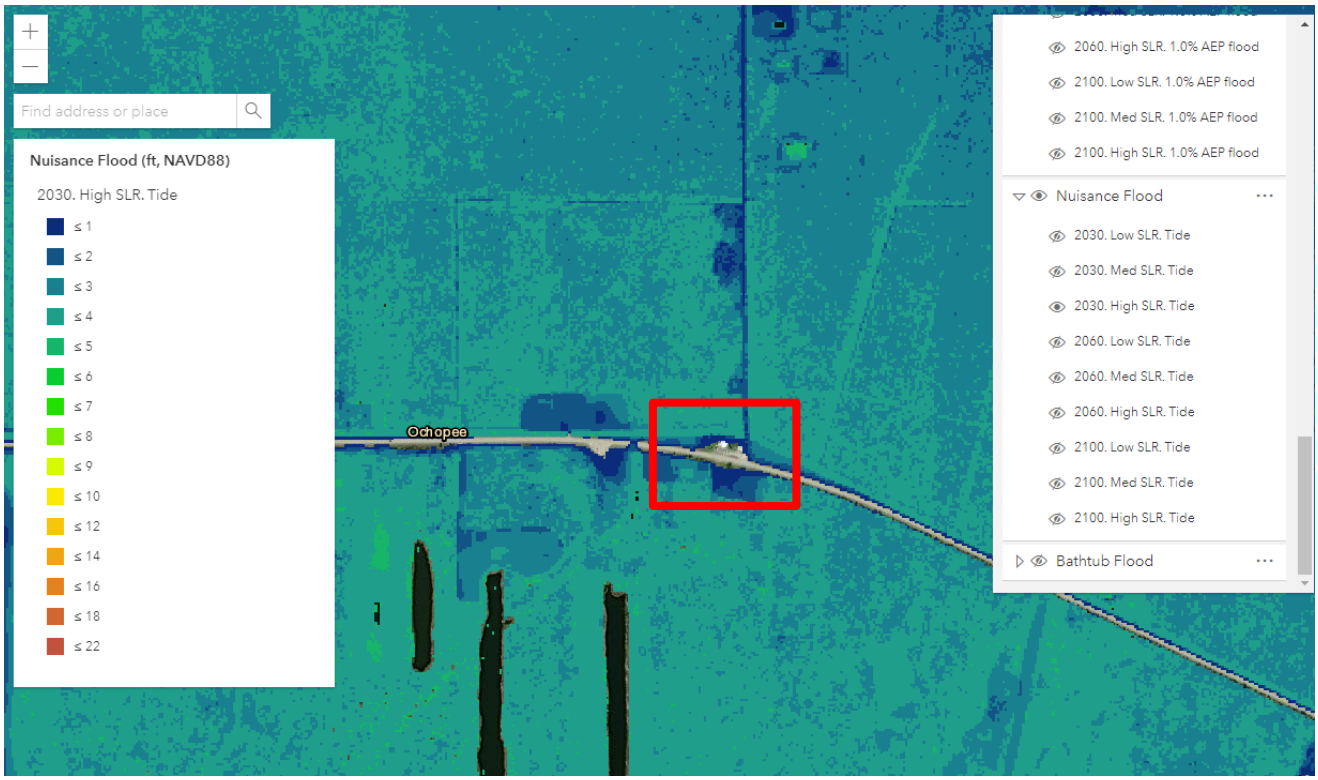
Appendix B. 74- Ochopee Post Office 2060 Low SLR Tide Nuisance Flood



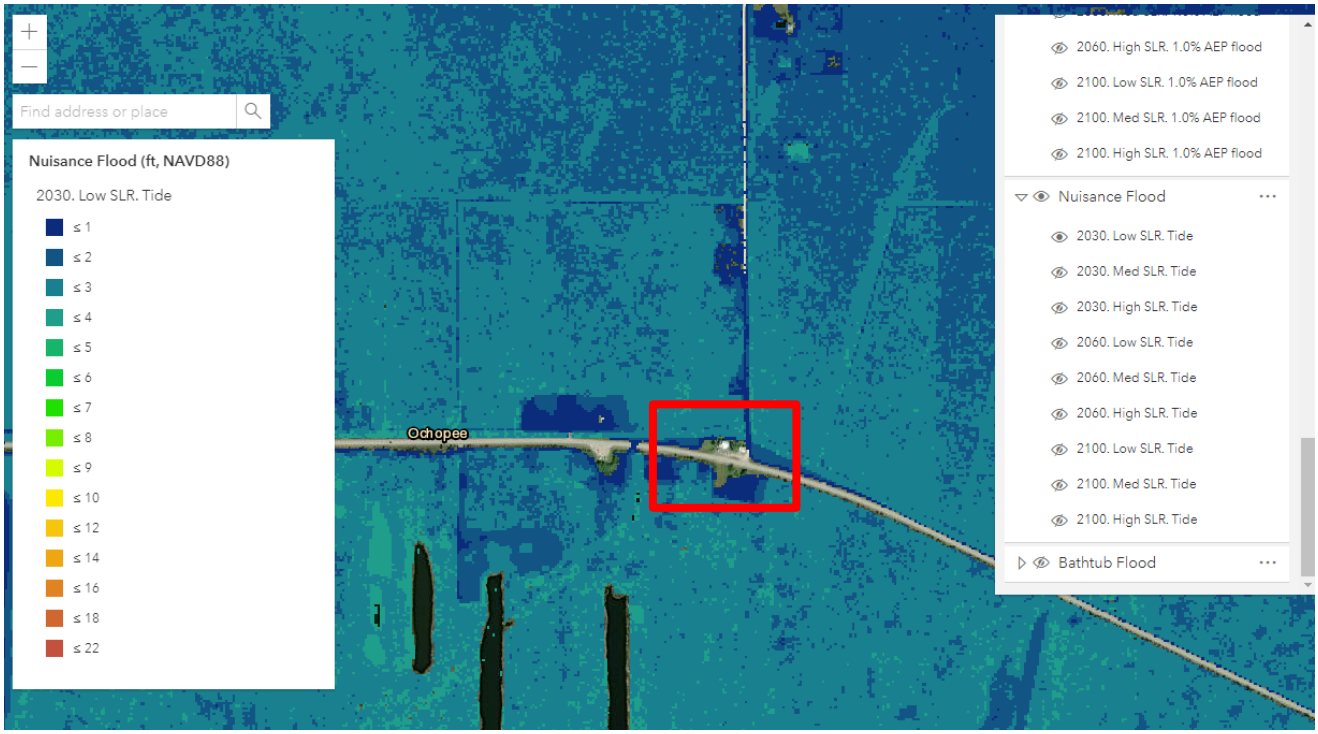
Appendix B. 75- Ochopee Post Office 2030 High SLR 1.0% AEP Flood



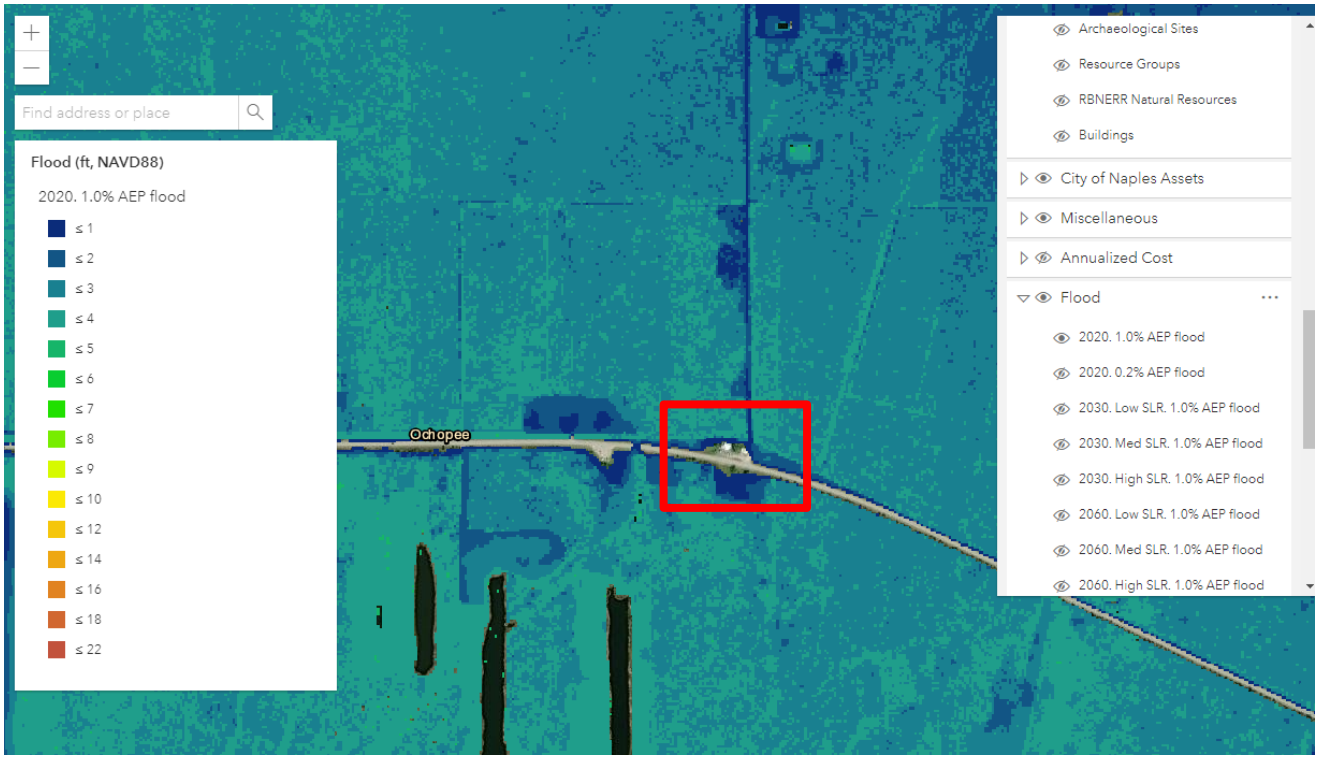
Appendix B. 76- Ochopee Post Office 2030 Low SLR 1.0% AEP Flood



Appendix B. 77- Ochopee Post Office 2030 High SLR Tide Nuisance Flood

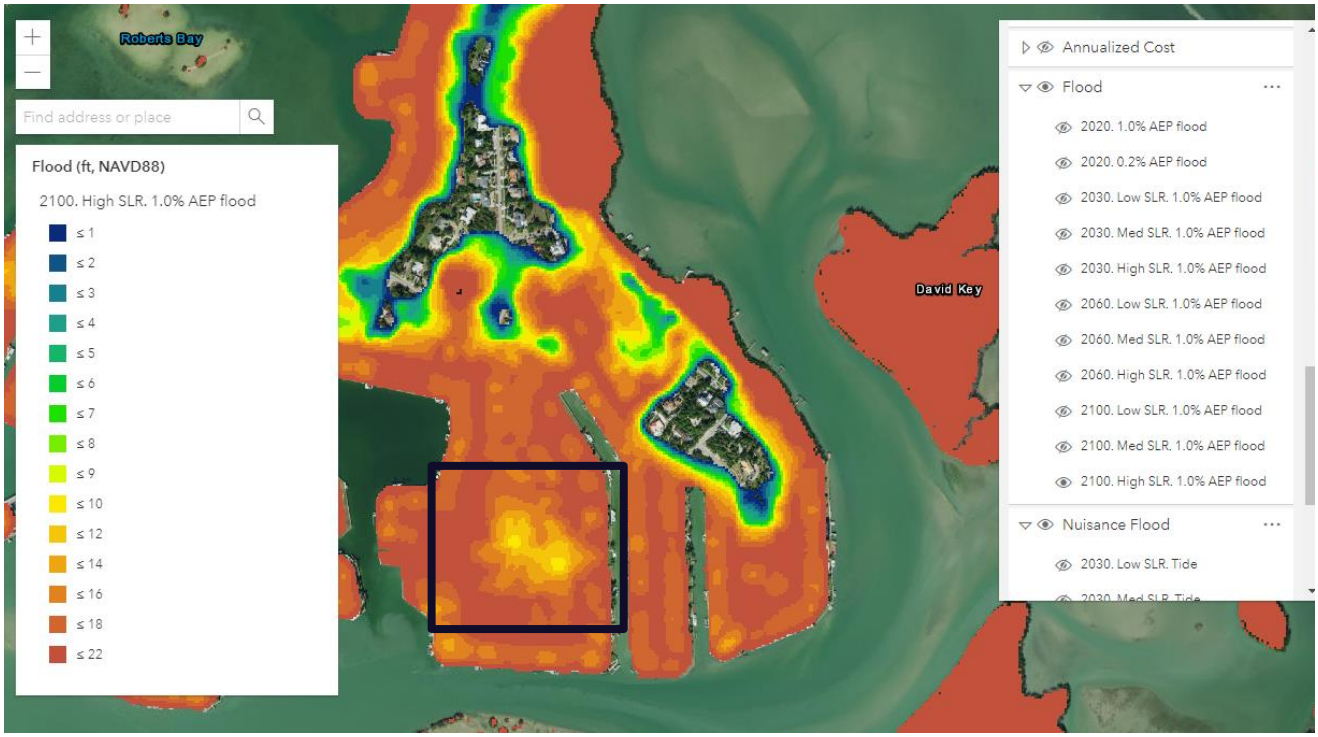


Appendix B. 78- Ochopee Post Office 2030 SLR Tide Nuisance Flood

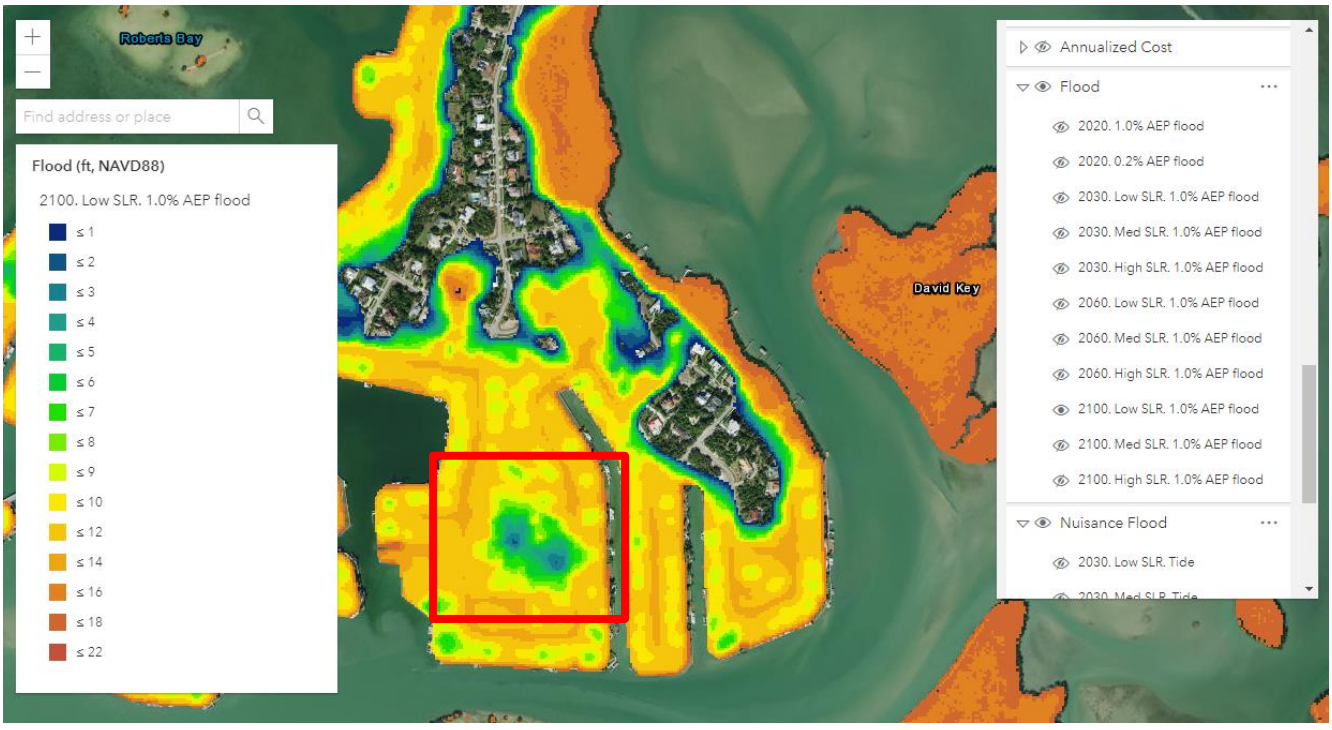


Appendix B. 79- Ochopee Post Office 2020 1.0% AEP Flood

Otter Mound



Appendix B. 80- Otter Mound 2100 High SLR 1.0% AEP Flood



Appendix B. 81- Otter Mound 2100 Low SLR 1.0% AEP Flood

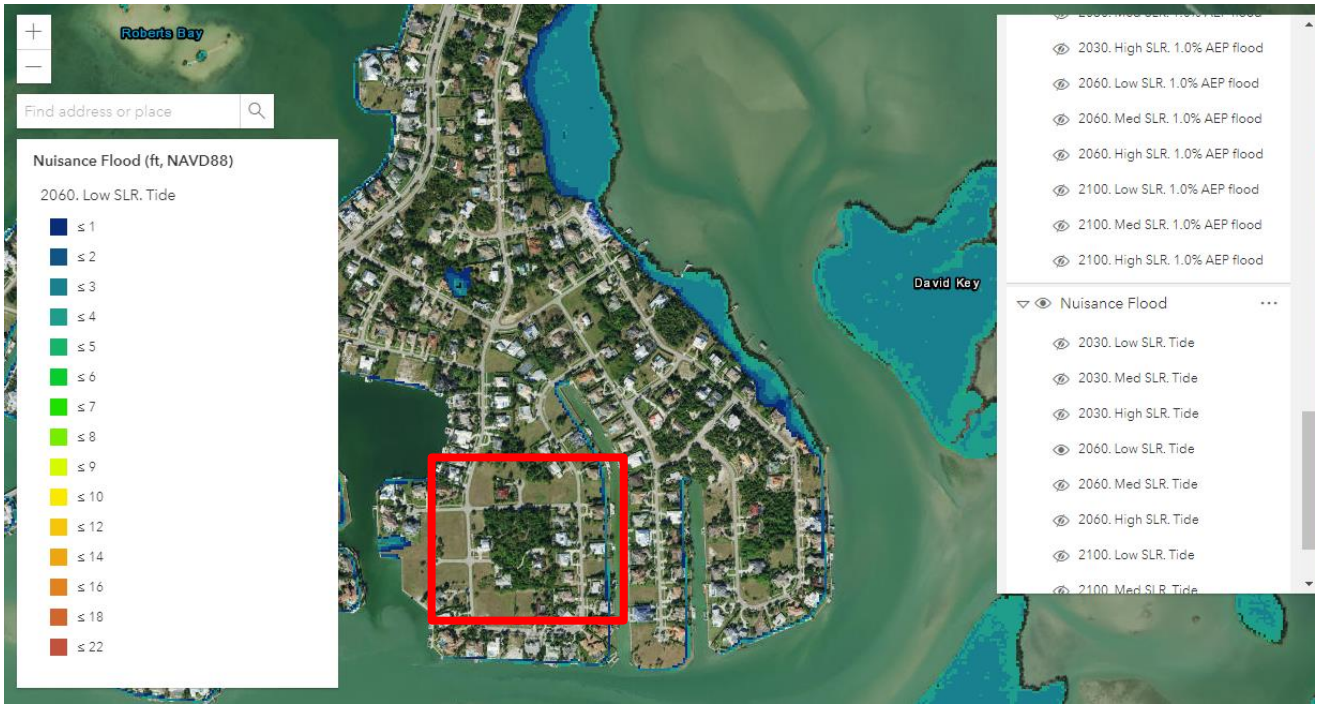
Appendix B. 82- Otter Mound 2100 High SLR Tide Nuisance Flood

Appendix B. 83- Otter Mound 2100 Low SLR Tide Nuisance Flood

Appendix B. 84- Otter Mound 2060 High SLR 1.0% AEP Flood

Appendix B. 85- Otter Mound 2060 Low SLR 1.0% AEP Flood

Appendix B. 86- Otter Mound 2060 High SLR Tide Nuisance Flood

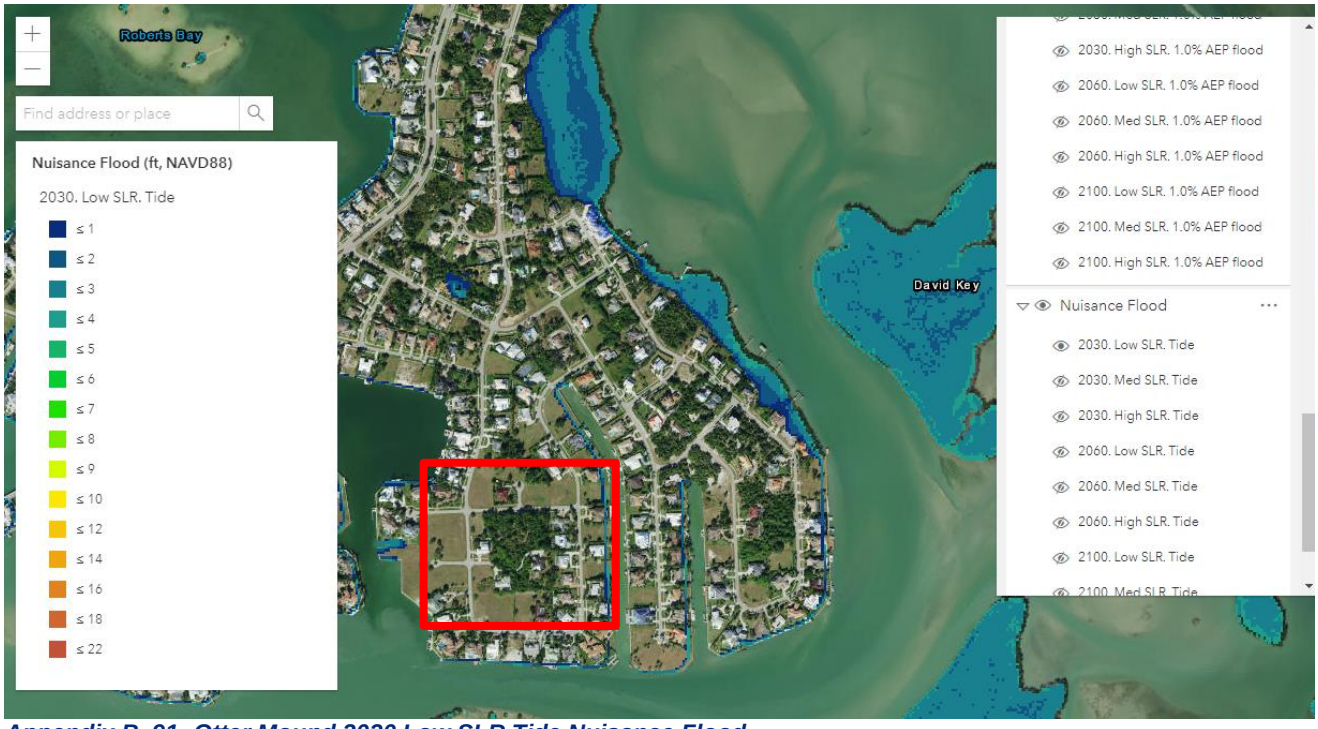


Appendix B. 87- Otter Mound 2060 Low SLR Tide Nuisance Flood

Appendix B. 88- Otter Mound 2030 High SLR 1.0% AEP Flood

Appendix B. 89- Otter Mound 2030 Low SLR 1.0% AEP Flood

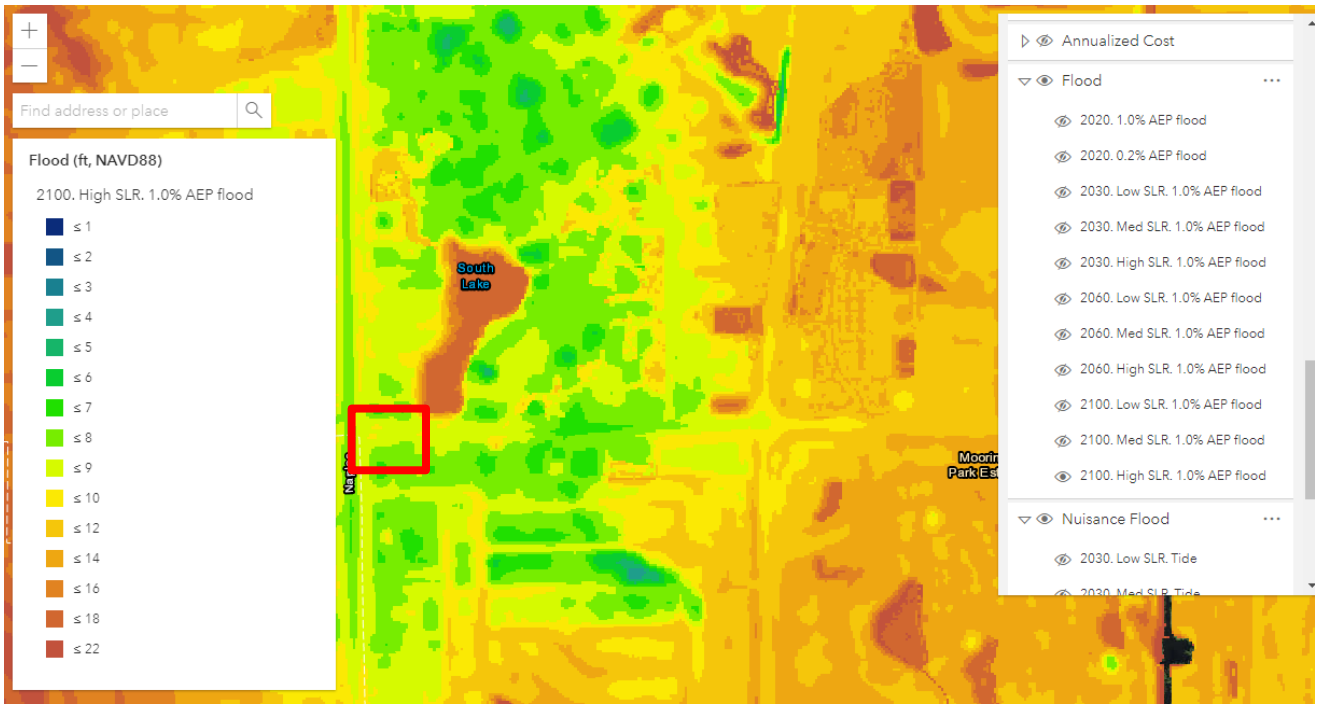
Appendix B. 90- Otter Mound 2030 High SLR Tide Nuisance Flood



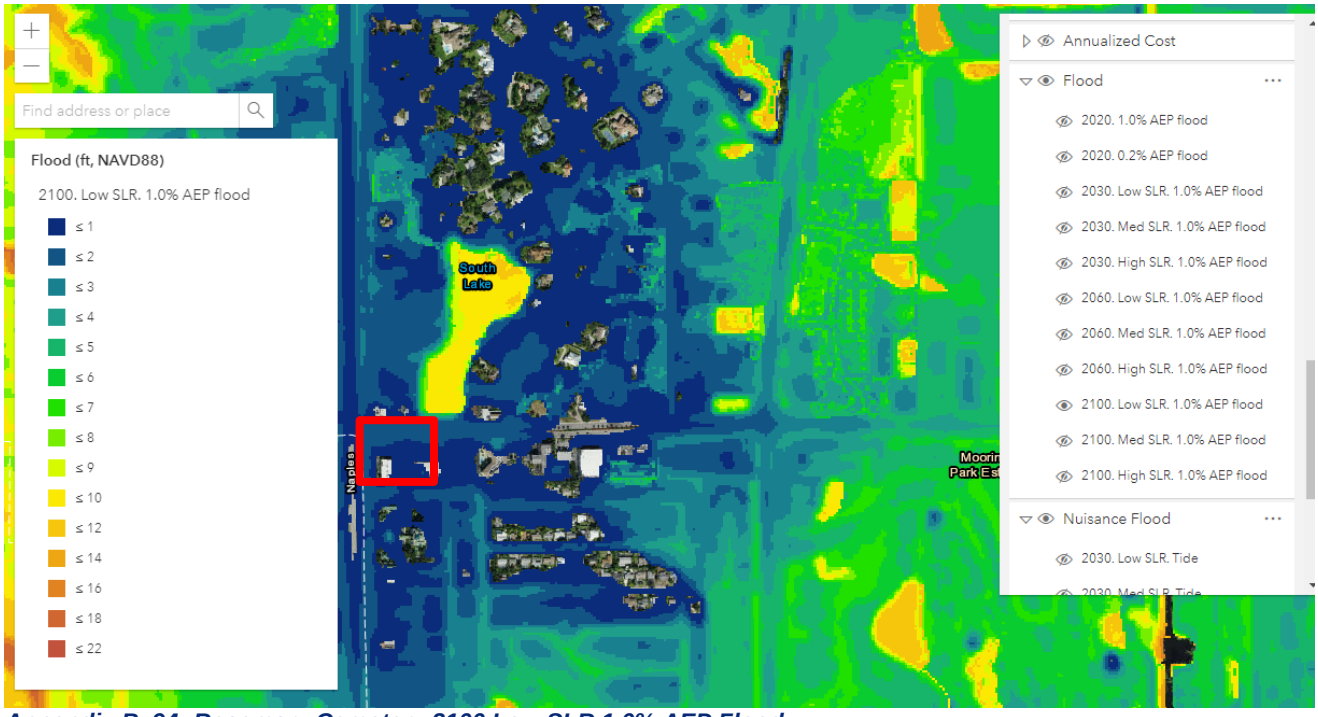
Appendix B. 91- Otter Mound 2030 Low SLR Tide Nuisance Flood

Appendix B. 92- 2020 1.0% AEP Flood

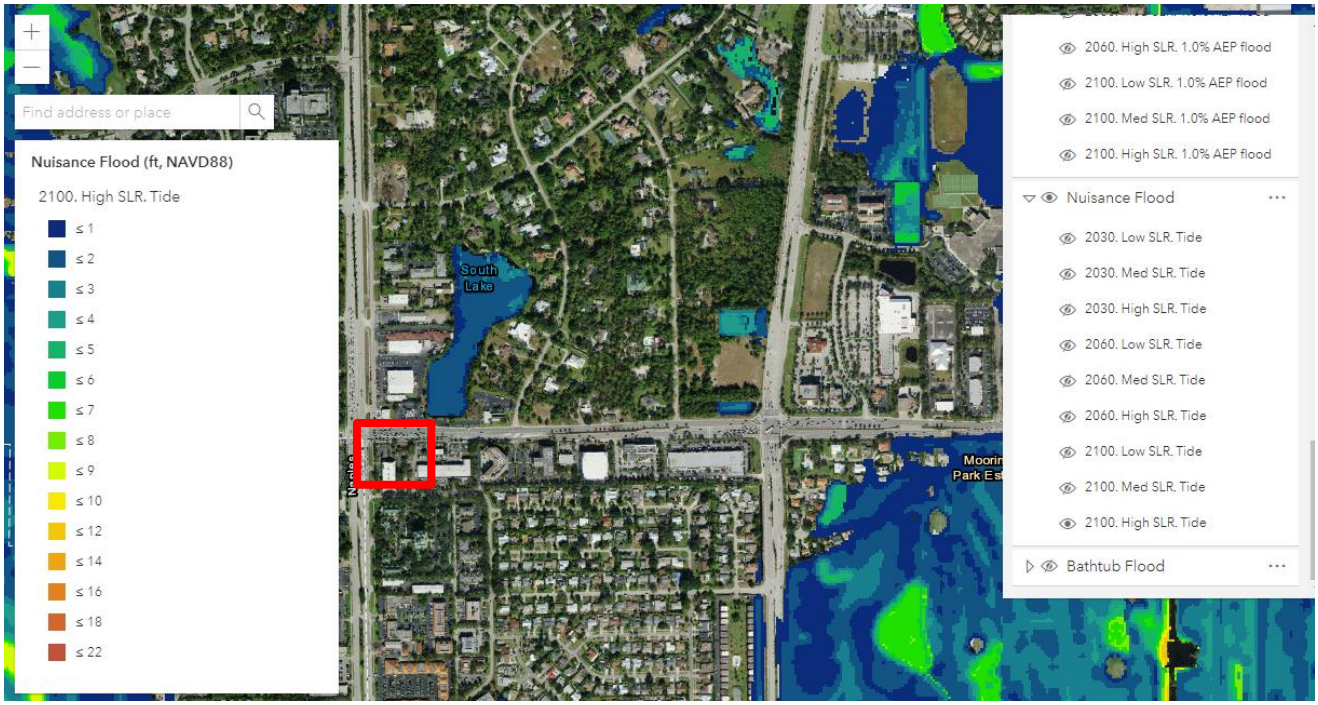
Rosemary Cemetery



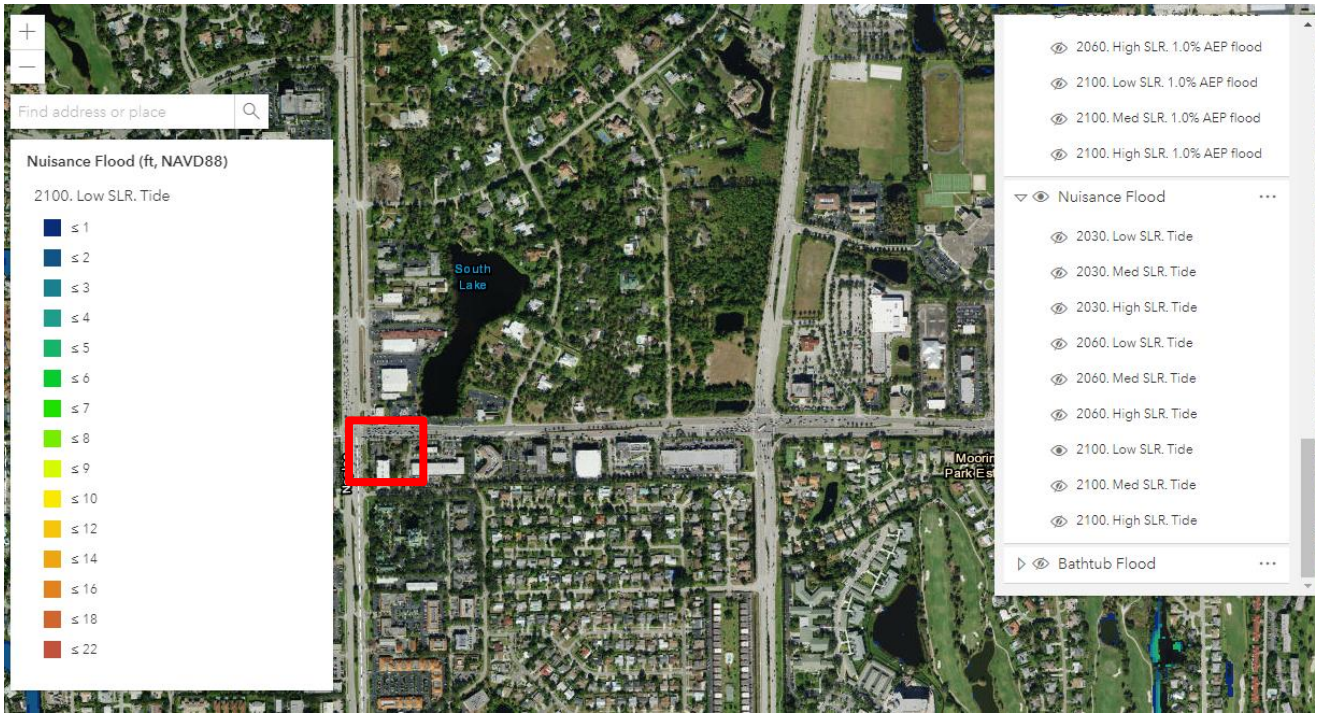
Appendix B. 93- Rosemary Cemetery 2100 High SLR 1.0% AEP Flood



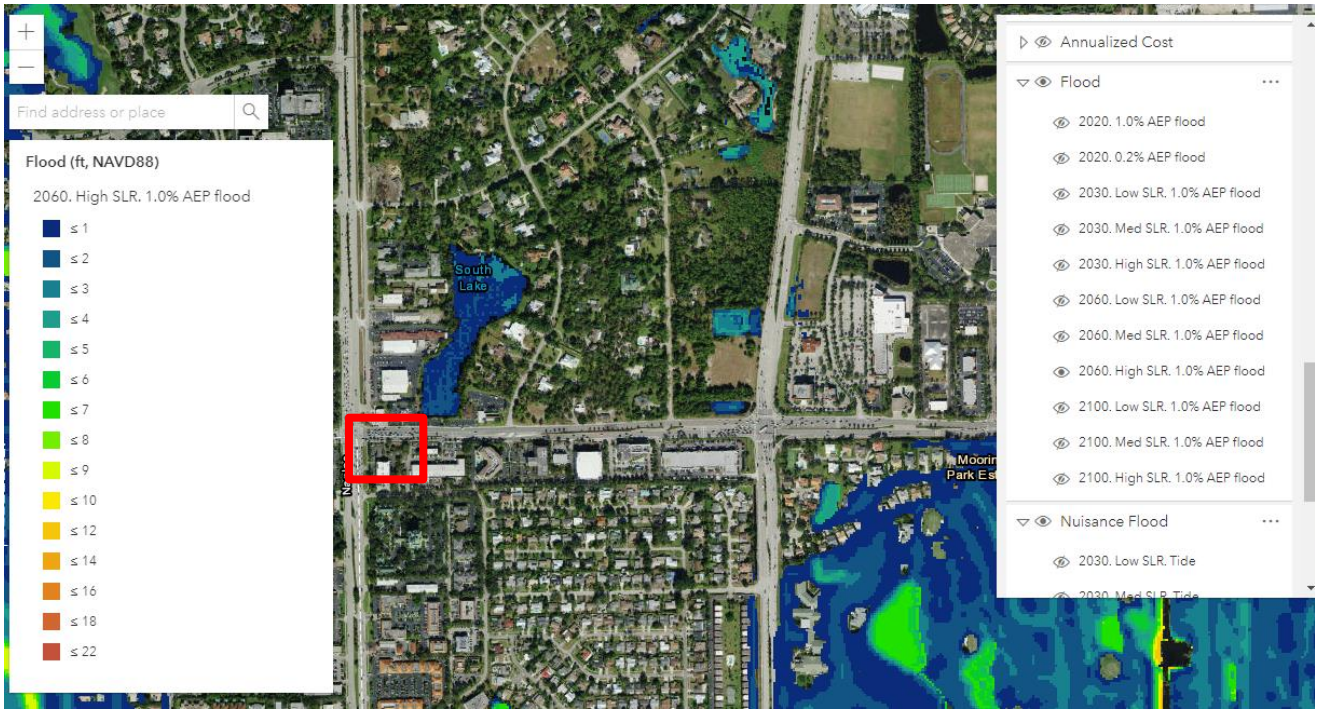
Appendix B. 94- Rosemary Cemetery 2100 Low SLR 1.0% AEP Flood



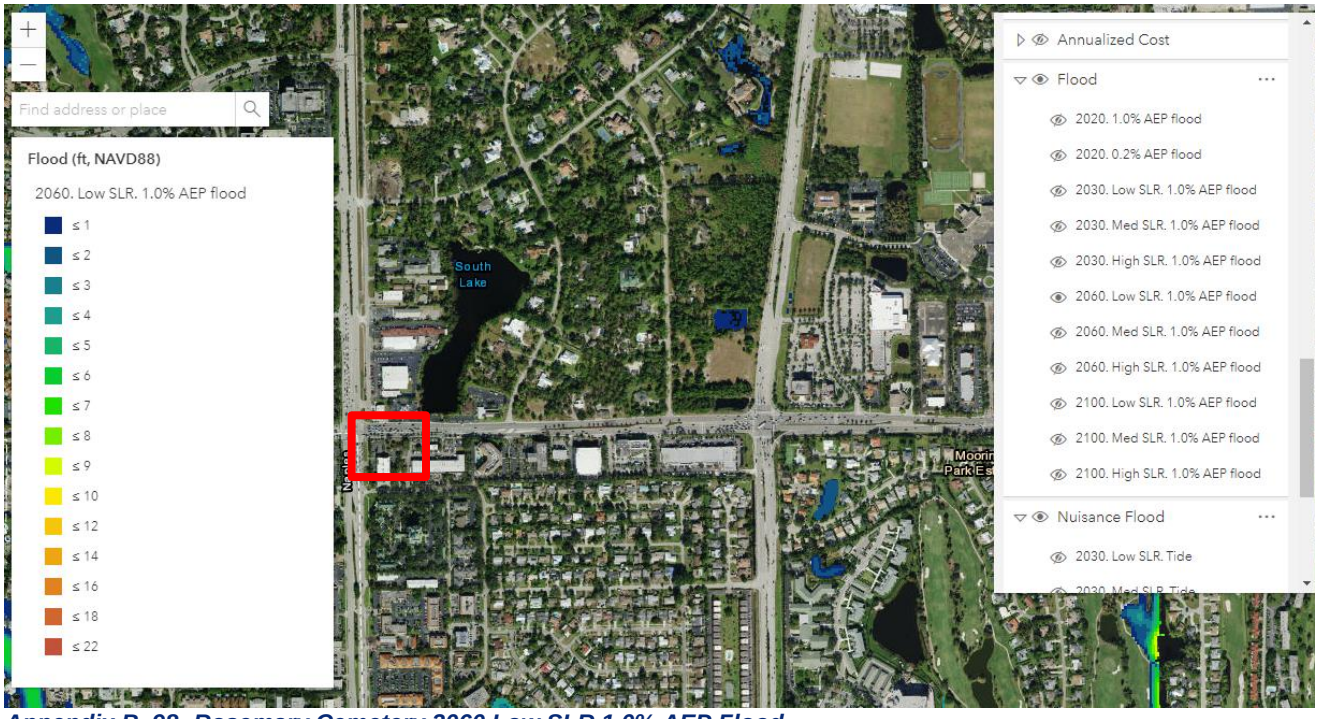
Appendix B. 95- Rosemary Cemetery 2100 High SLR Tide Nuisance Flood



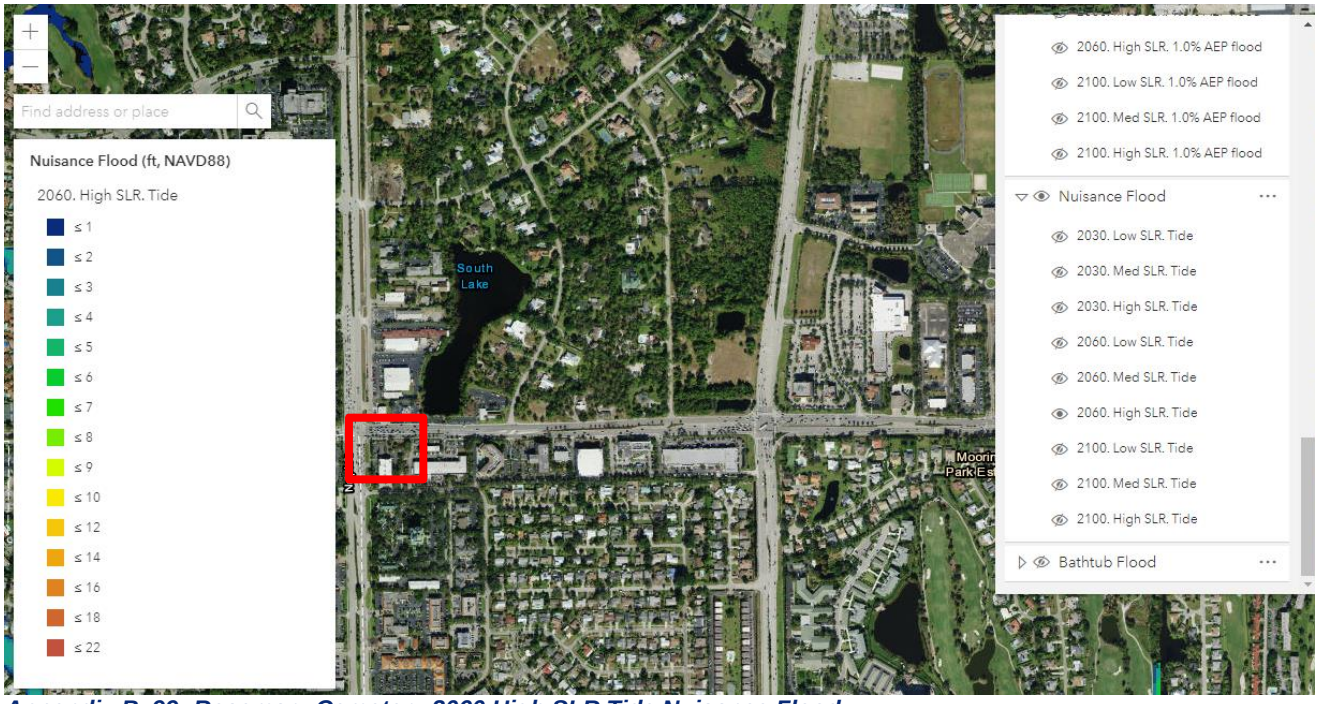
Appendix B. 96- Rosemary Cemetery 2100 Low SLR Tide Nuisance Flood



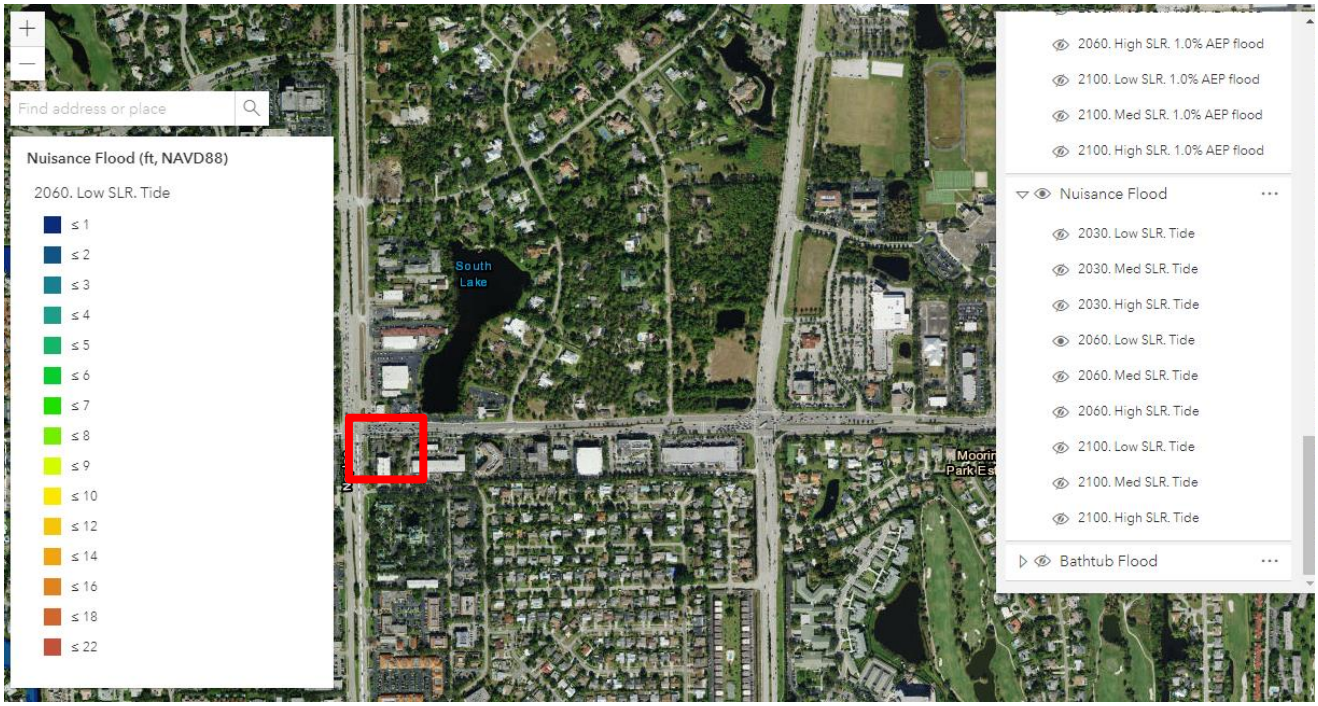
Appendix B. 97- Rosemary Cemetery 2060 High SLR 1.0% AEP Flood



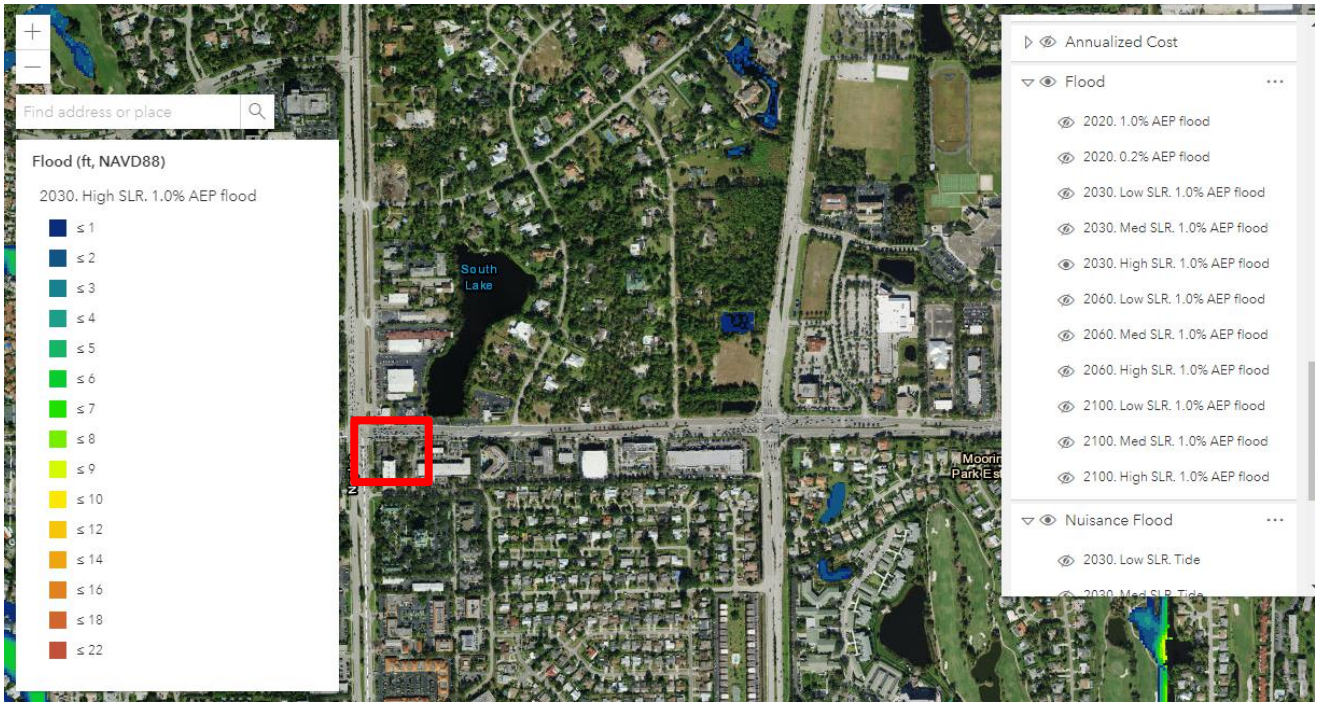
Appendix B. 98- Rosemary Cemetery 2060 Low SLR 1.0% AEP Flood



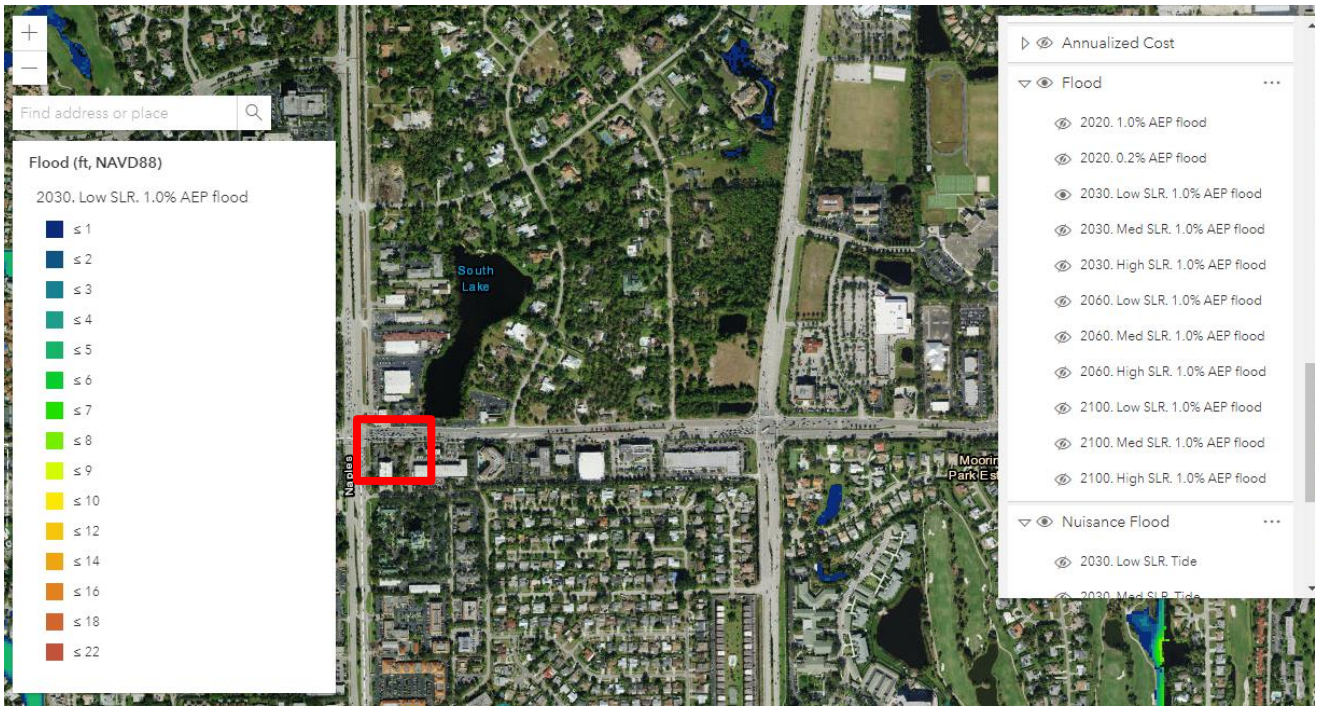
Appendix B. 99- Rosemary Cemetery 2060 High SLR Tide Nuisance Flood



Appendix B. 100- Rosemary Cemetery 2060 Low SLR Tide Nuisance Flood

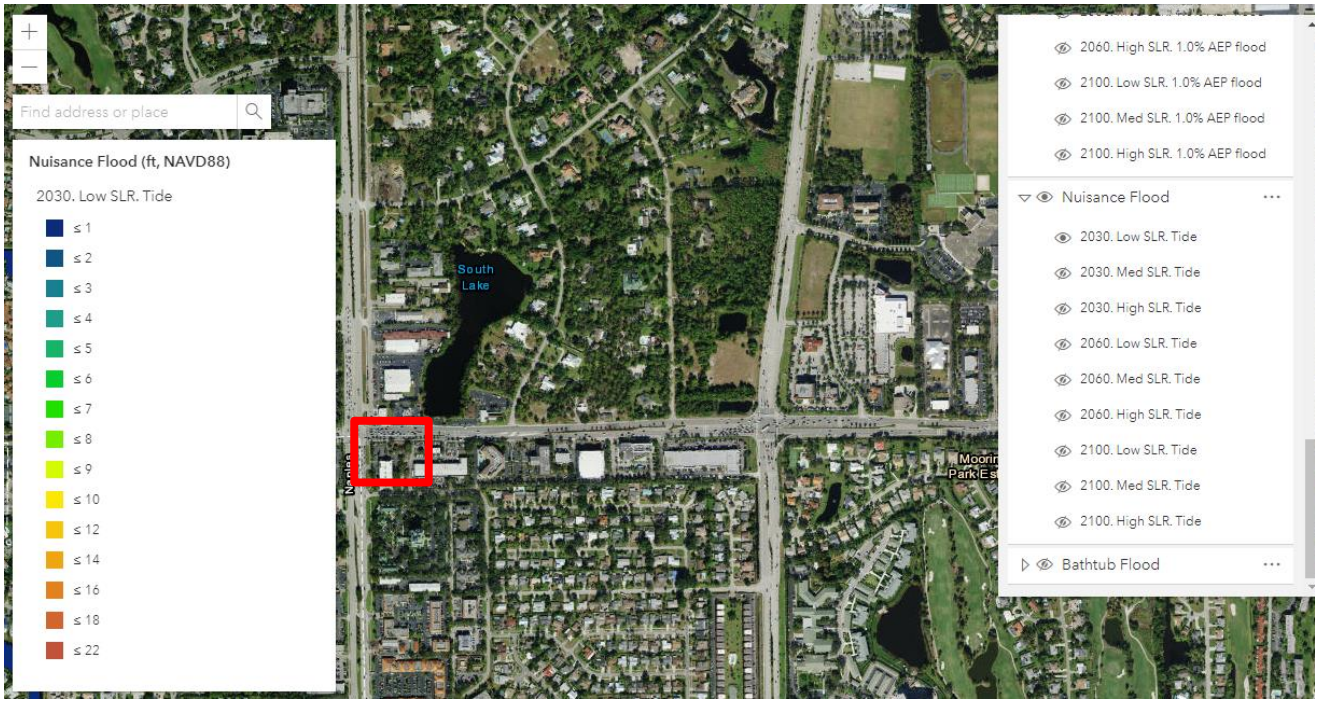


Appendix B. 101- Rosemary Cemetery 2030 High SLR 1.0% AEP Flood

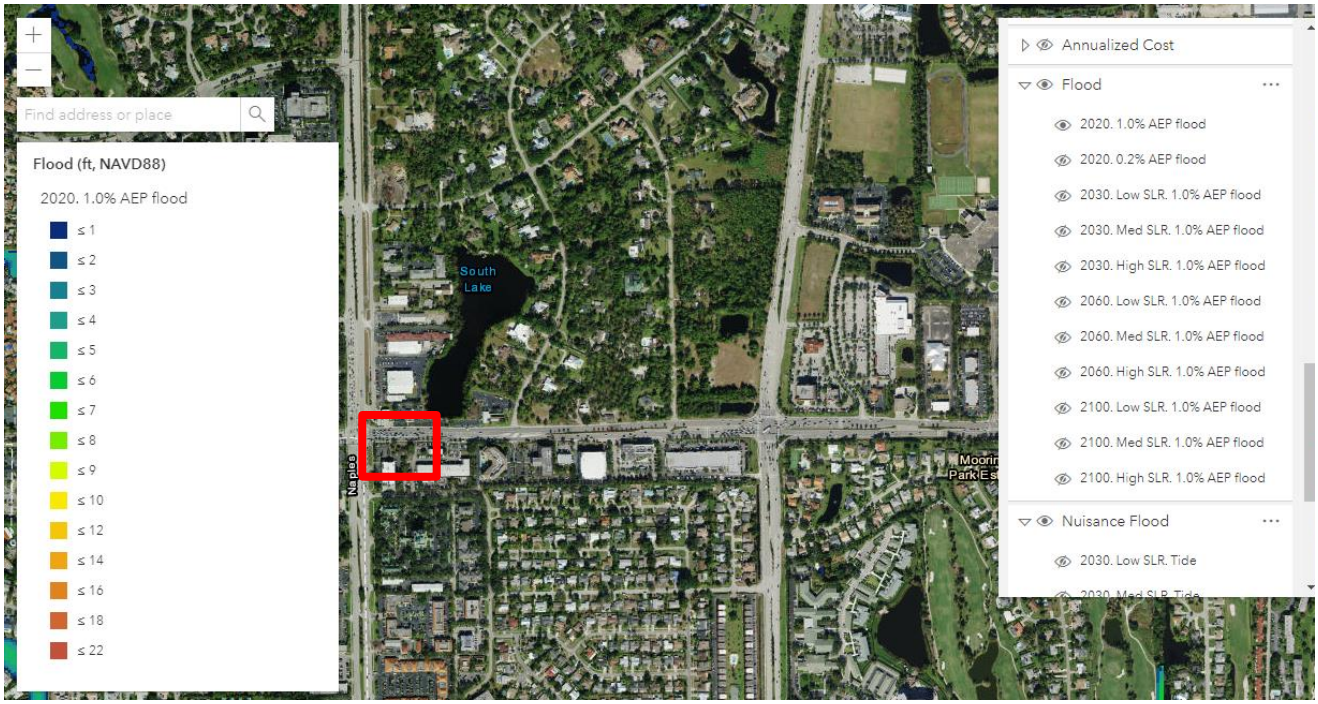


Appendix B. 102- Rosemary Cemetery 2030 Low SLR 1.0% AEP Flood

Appendix B. 103- Rosemary Cemetery 2030 High SLR Tide Nuisance Flood

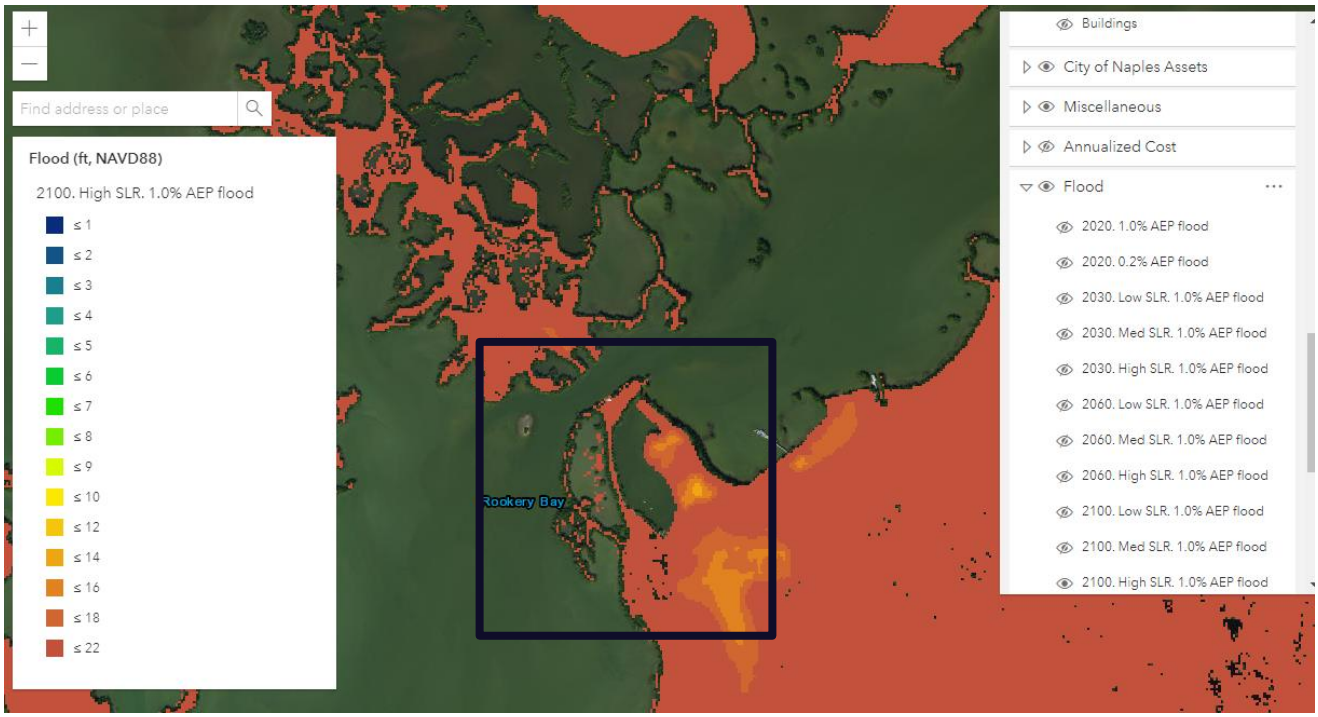


Appendix B. 104- Rosemary Cemetery 2030 Low SLR Tide Nuisance Flood

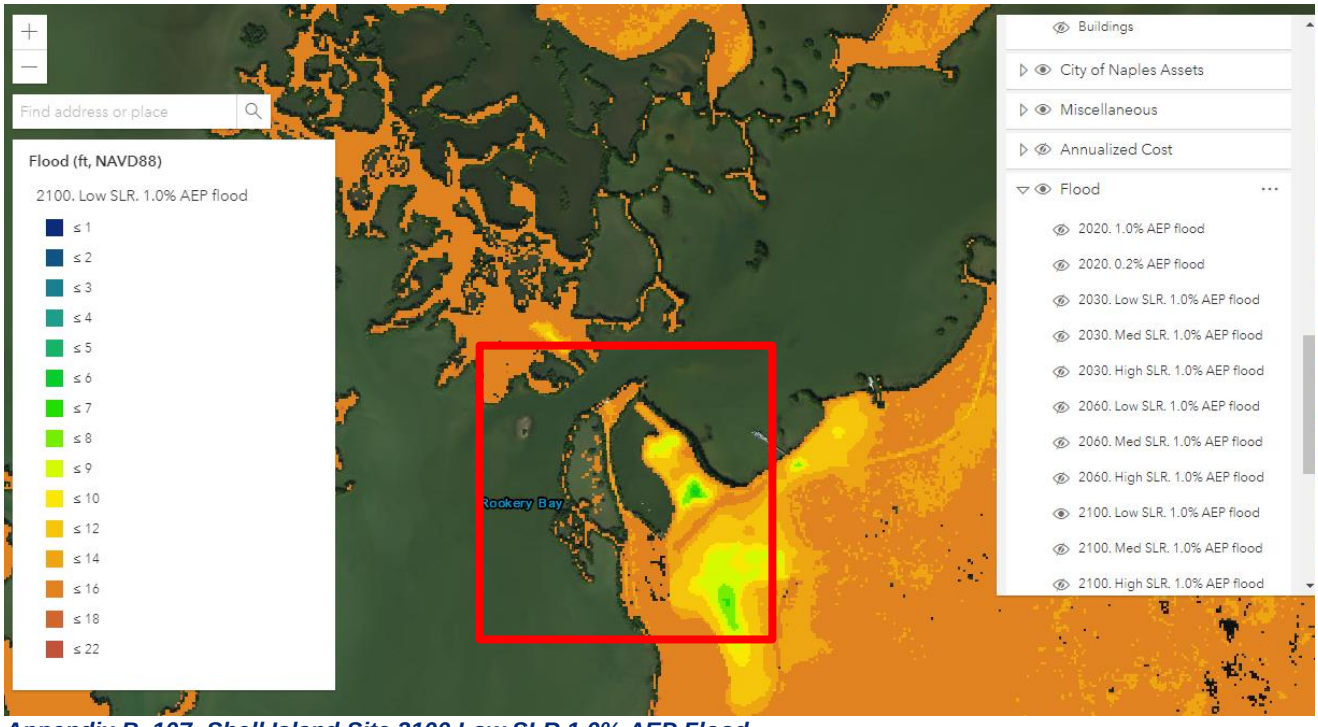


Appendix B. 105- Rosemary Cemetery 2020 1.0% AEP Flood

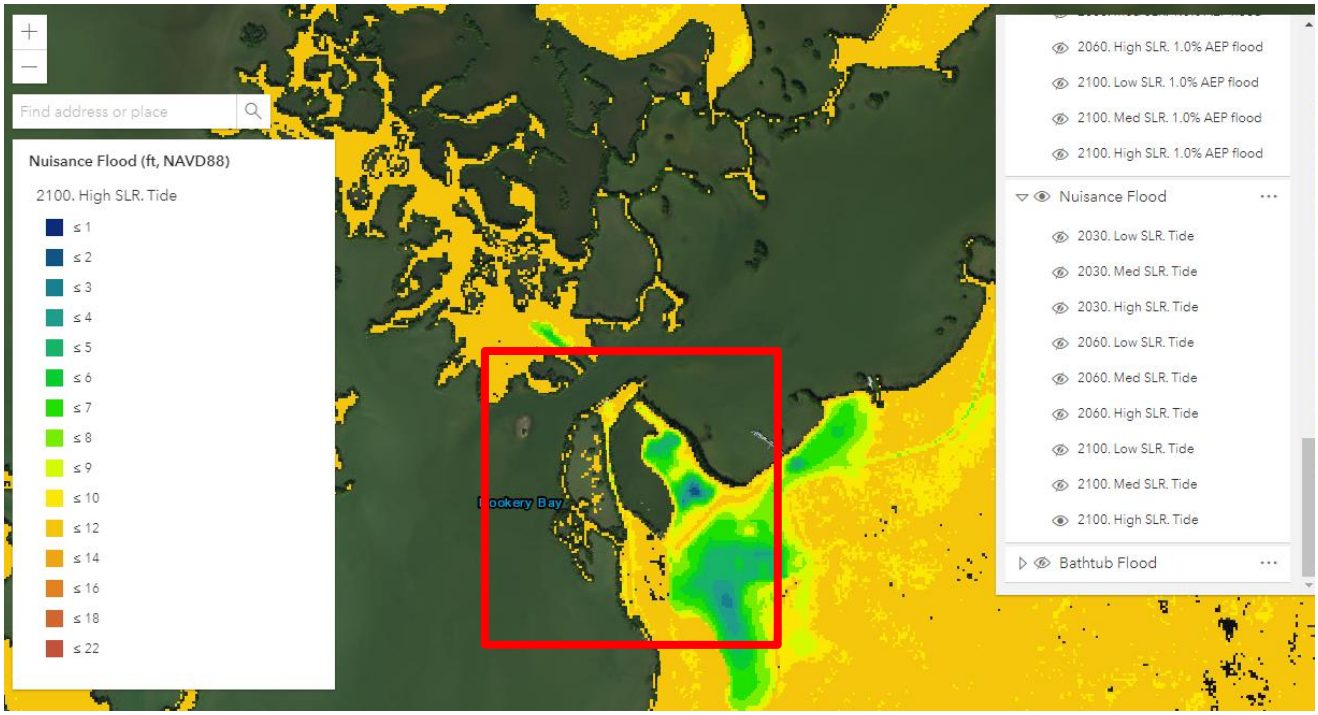
Shell Island Site



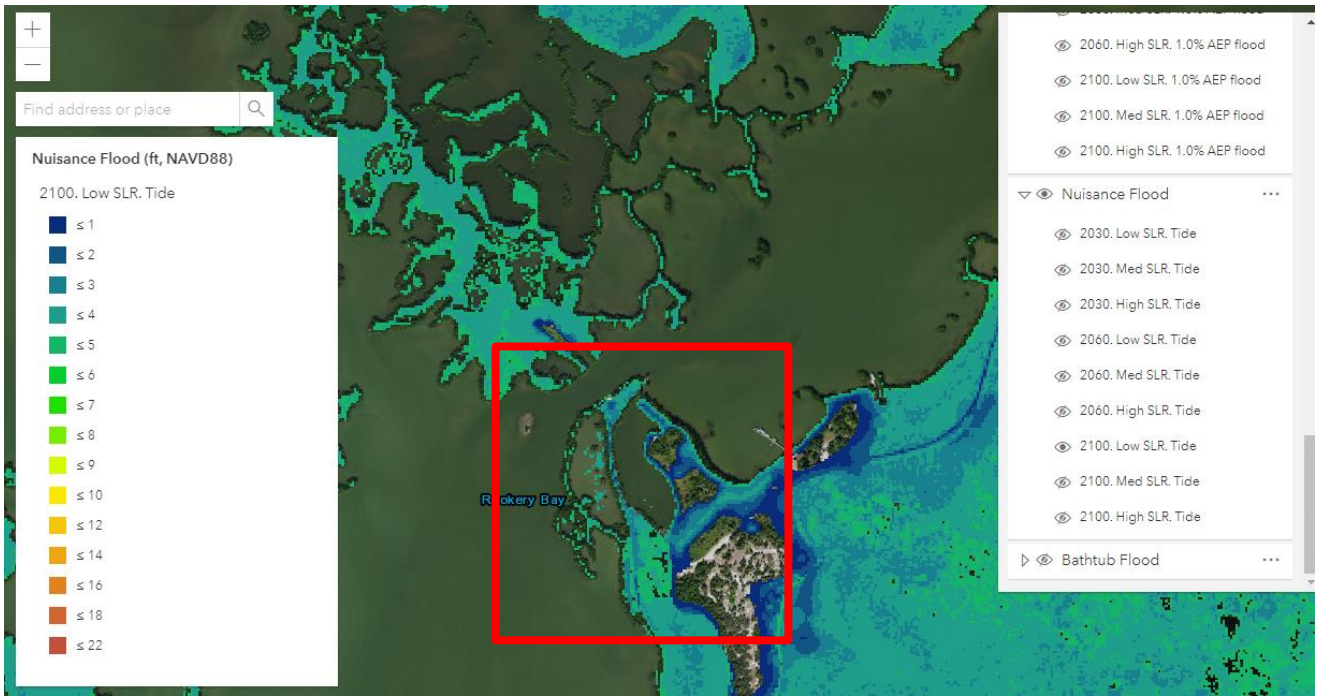
Appendix B. 106- Shell Island Site 2100 High SLR 1.0% AEP Flood



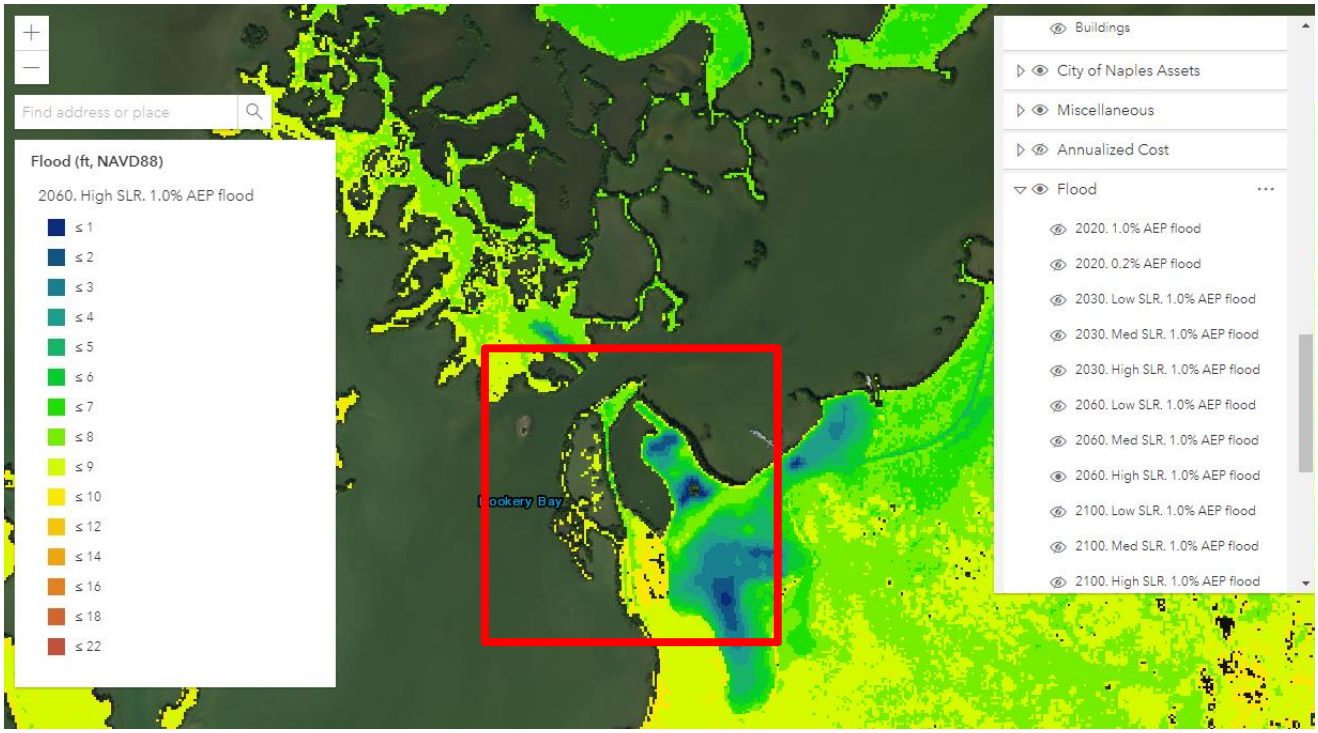
Appendix B. 107- Shell Island Site 2100 Low SLR 1.0% AEP Flood



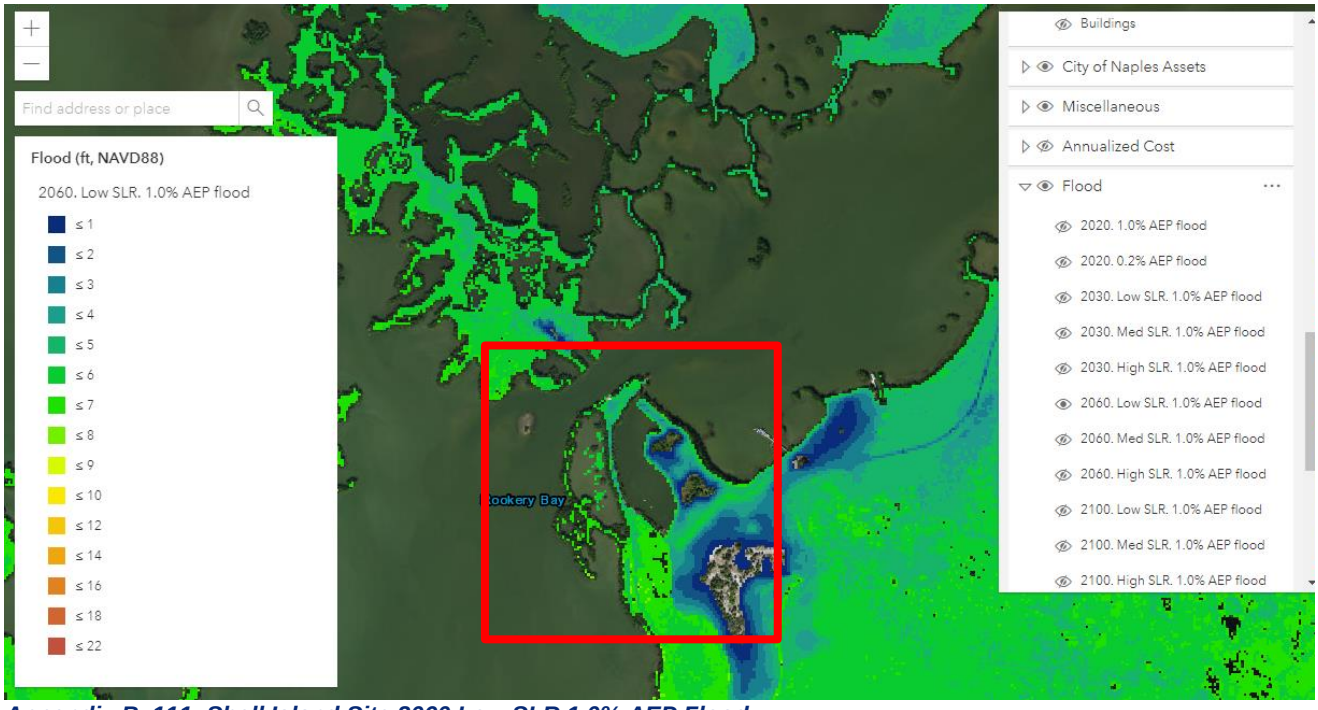
Appendix B. 108- Shell Island Site 2100 High SLR Tide Nuisance Flood



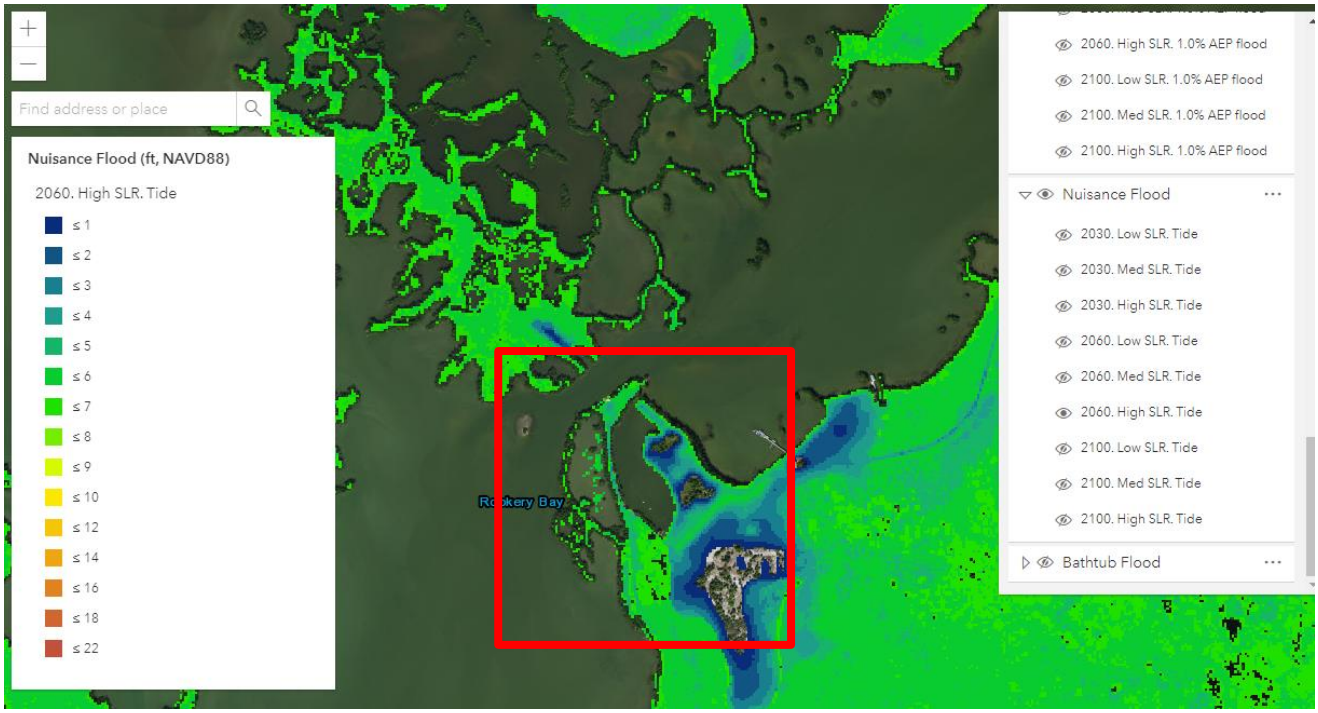
Appendix B. 109- Shell Island Site 2100 Low SLR Tide Nuisance Flood



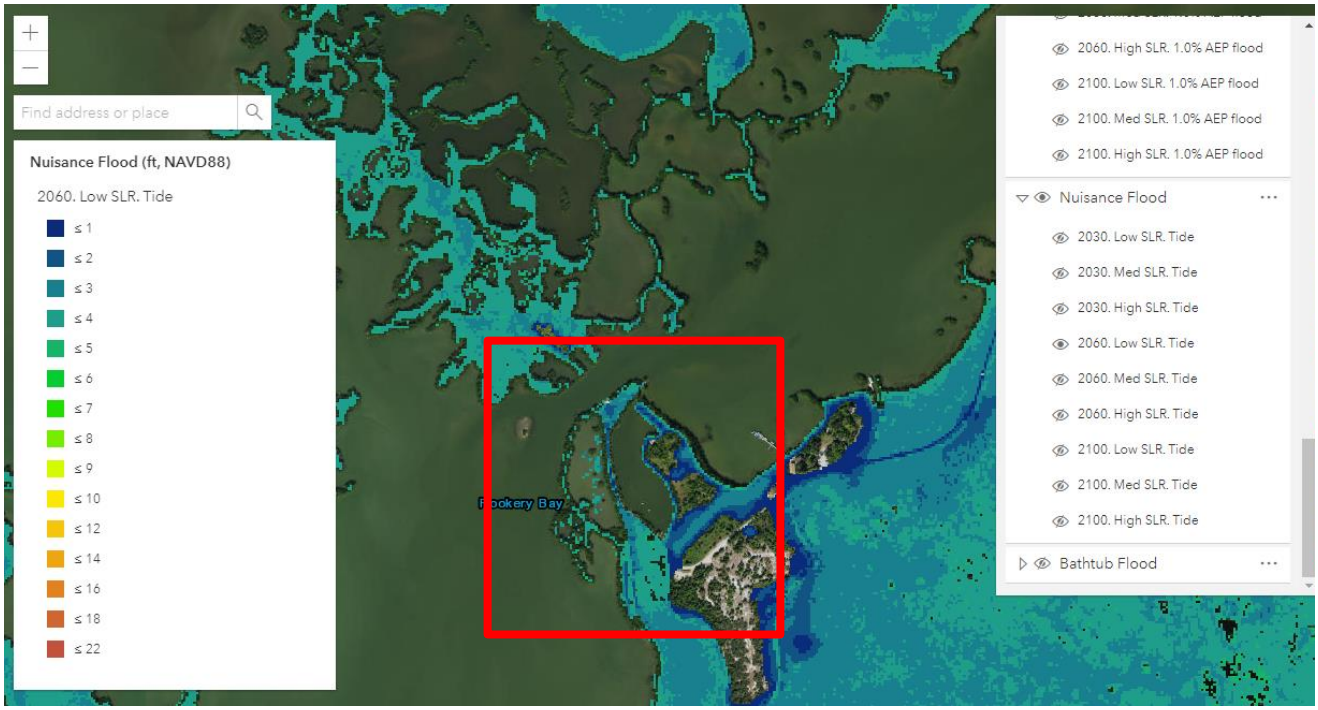
Appendix B. 110- Shell Island Site 2060 High SLR 1.0% AEP Flood



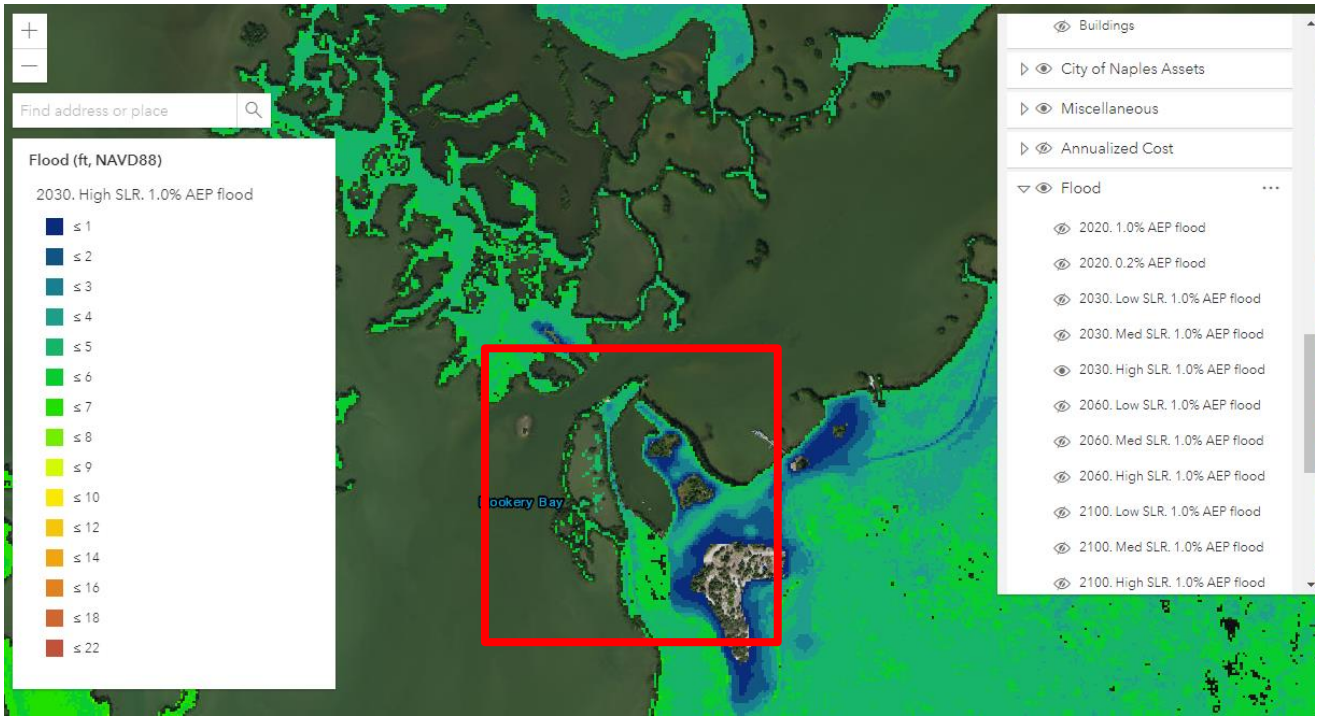
Appendix B. 111- Shell Island Site 2060 Low SLR 1.0% AEP Flood



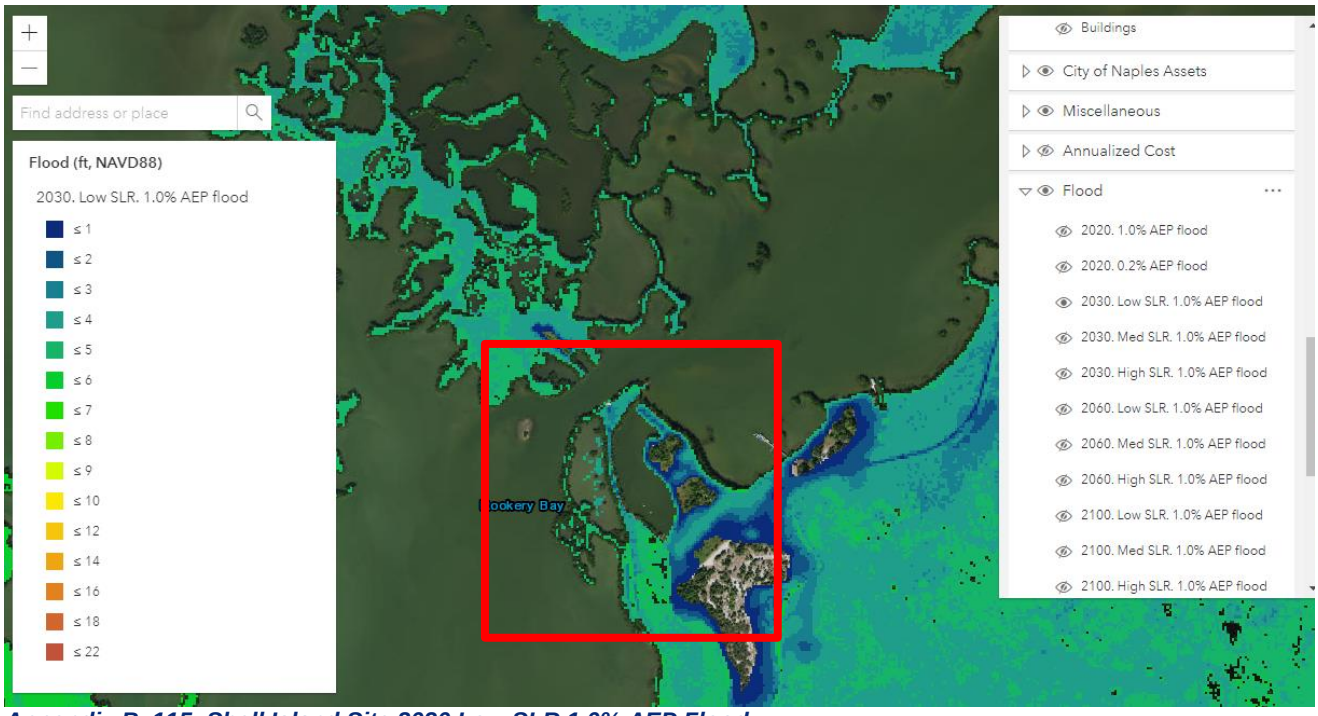
Appendix B. 112- Shell Island Site 2060 High SLR Tide Nuisance Flood



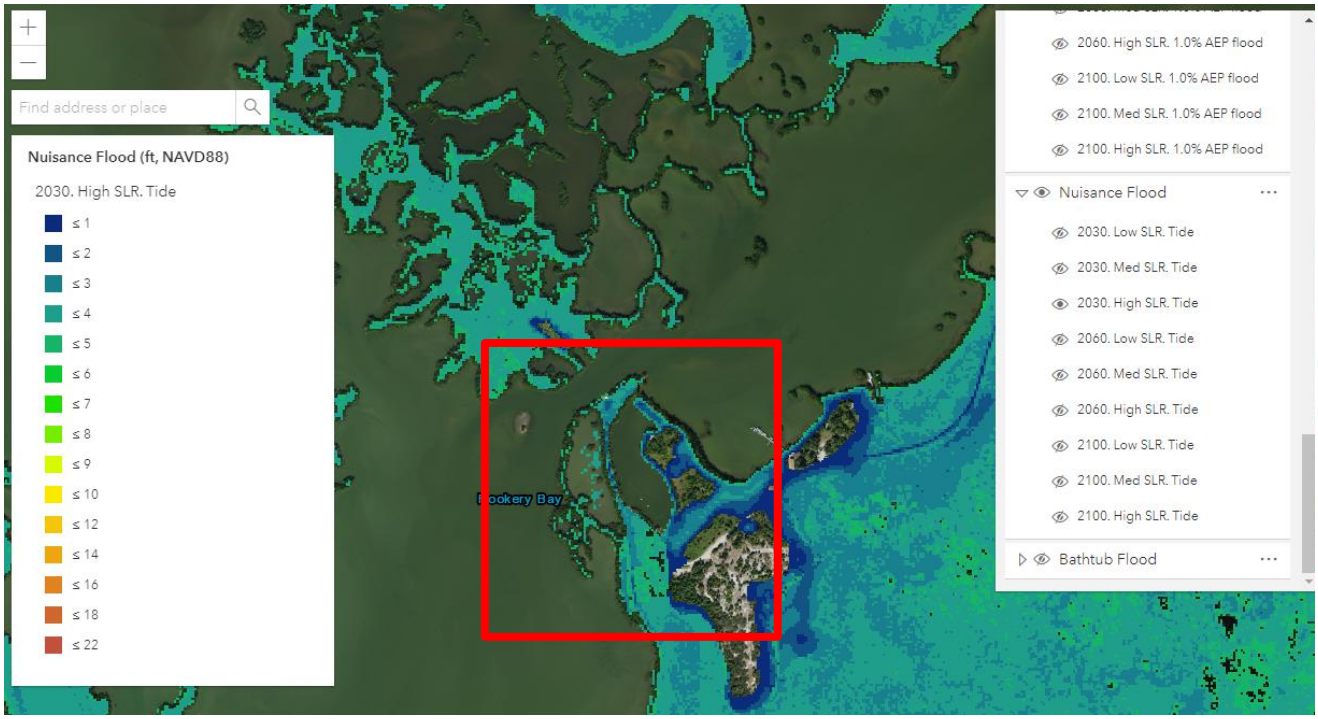
Appendix B. 113- Shell Island Site 2060 Low SLR Tide Nuisance Flood



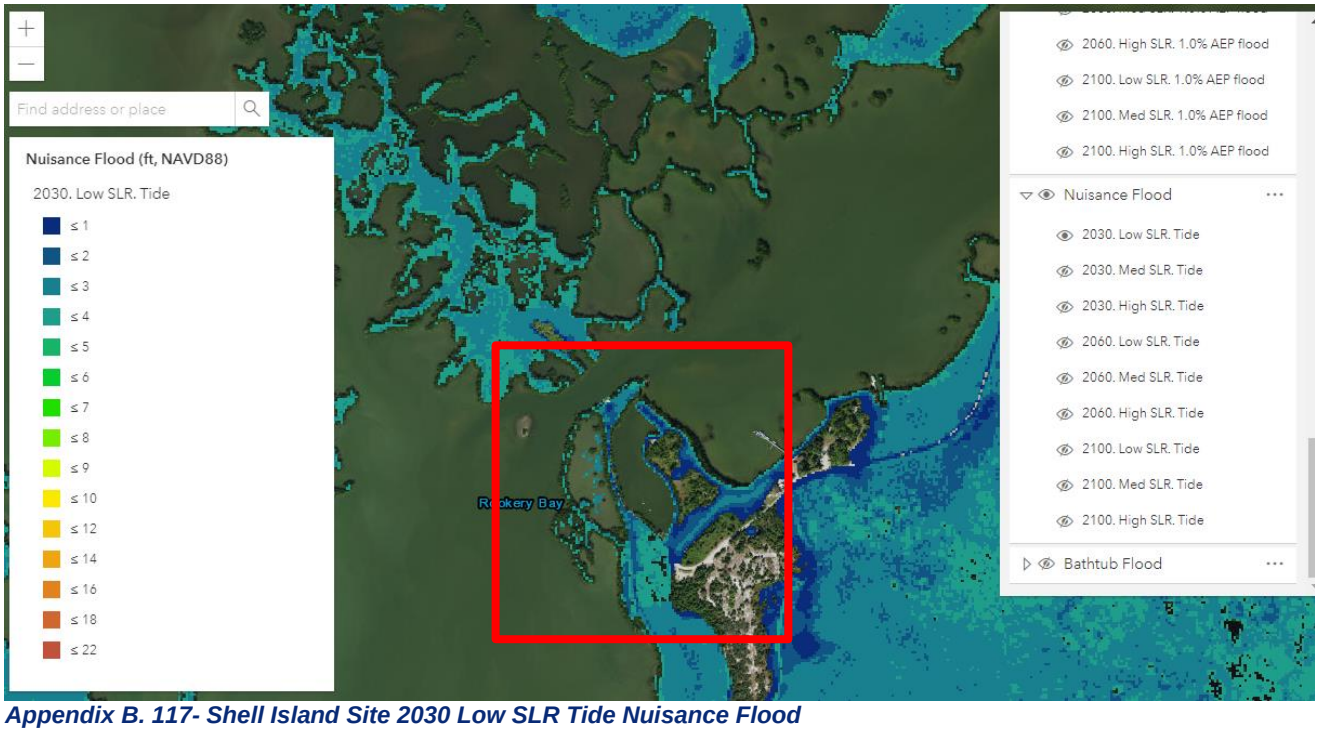
Appendix B. 114- Shell Island Site 2030 High SLR 1.0% AEP Flood



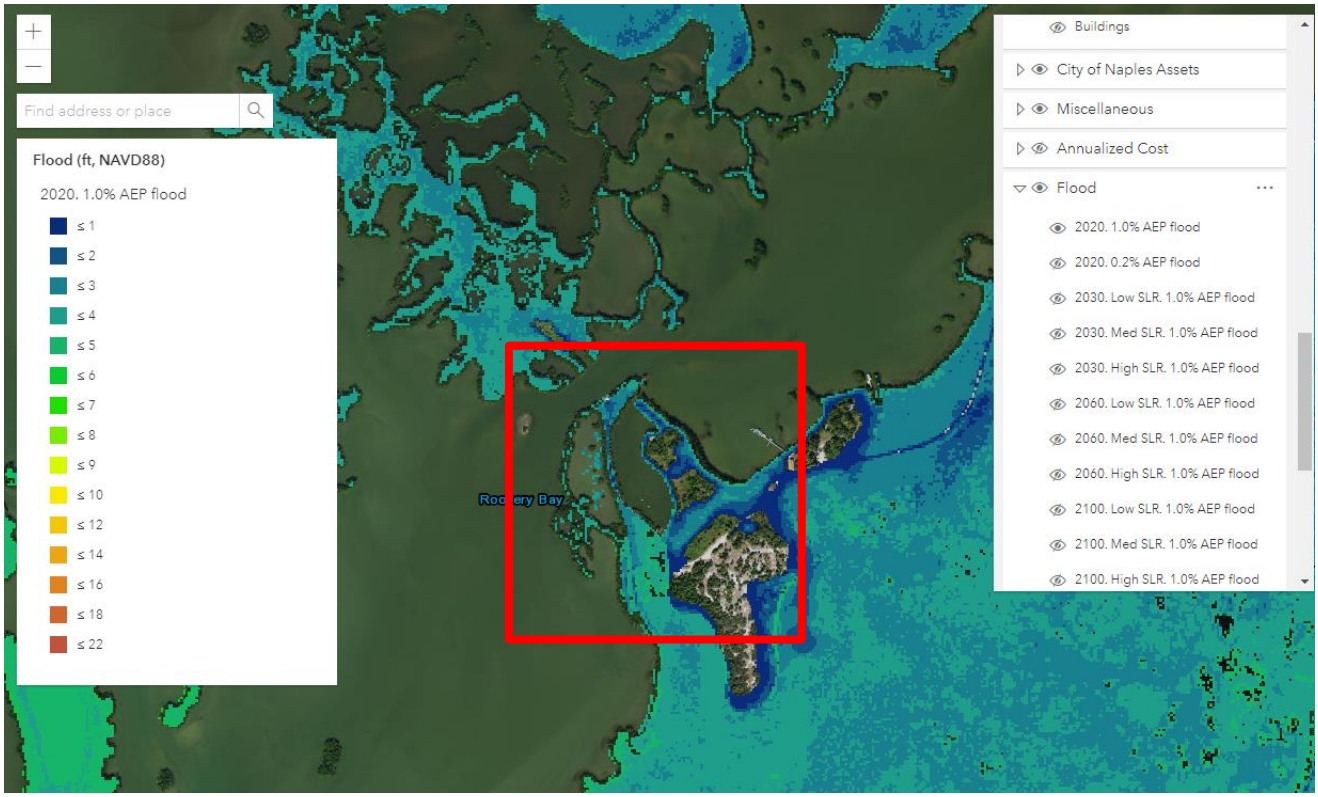
Appendix B. 115- Shell Island Site 2030 Low SLR 1.0% AEP Flood



Appendix B. 116- Shell Island Site 2030 High SLR Tide Nuisance Flood

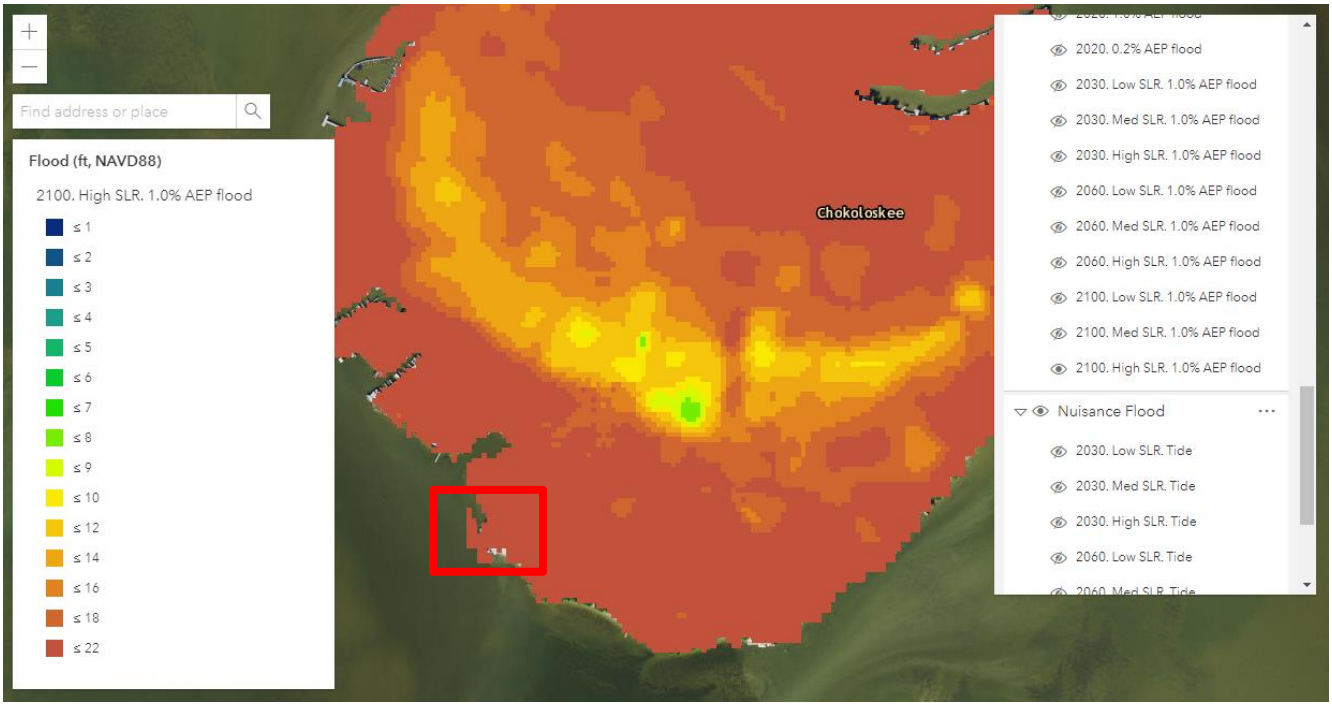


Appendix B. 117- Shell Island Site 2030 Low SLR Tide Nuisance Flood

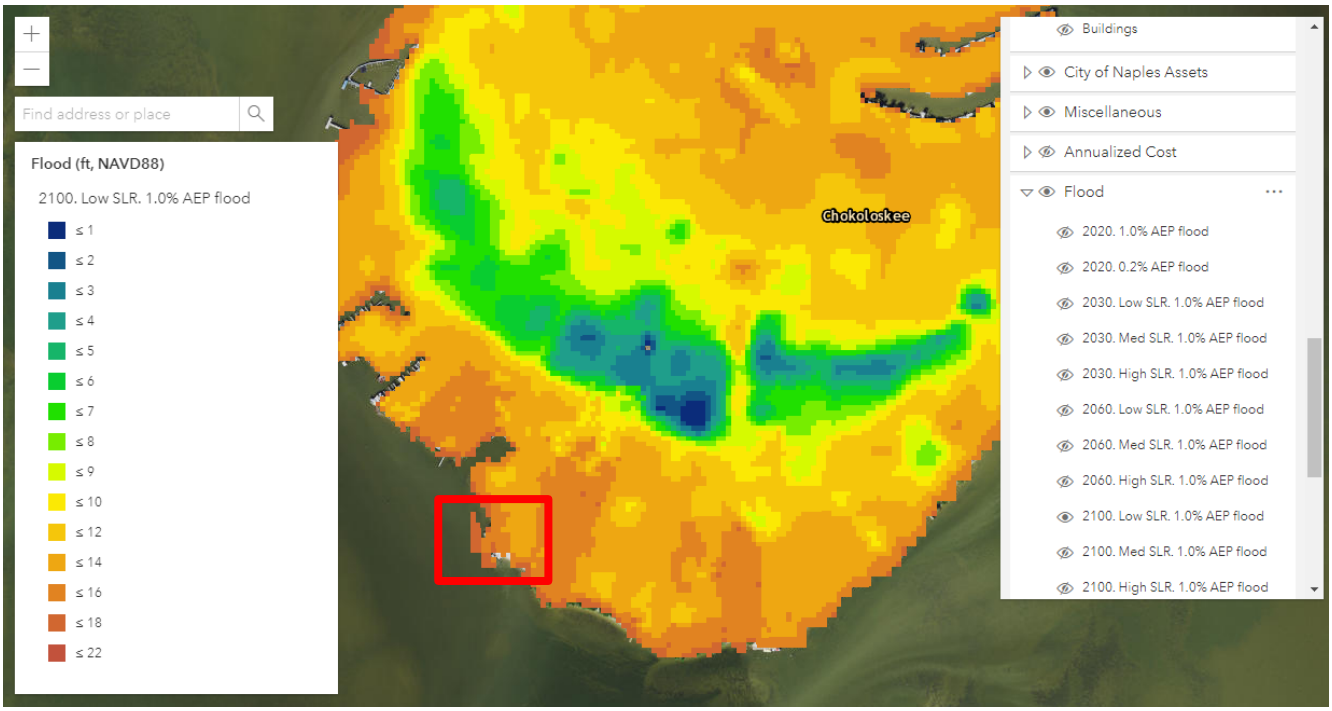


Appendix B. 118- Shell Island Site 2020 1.0% AEP Flood

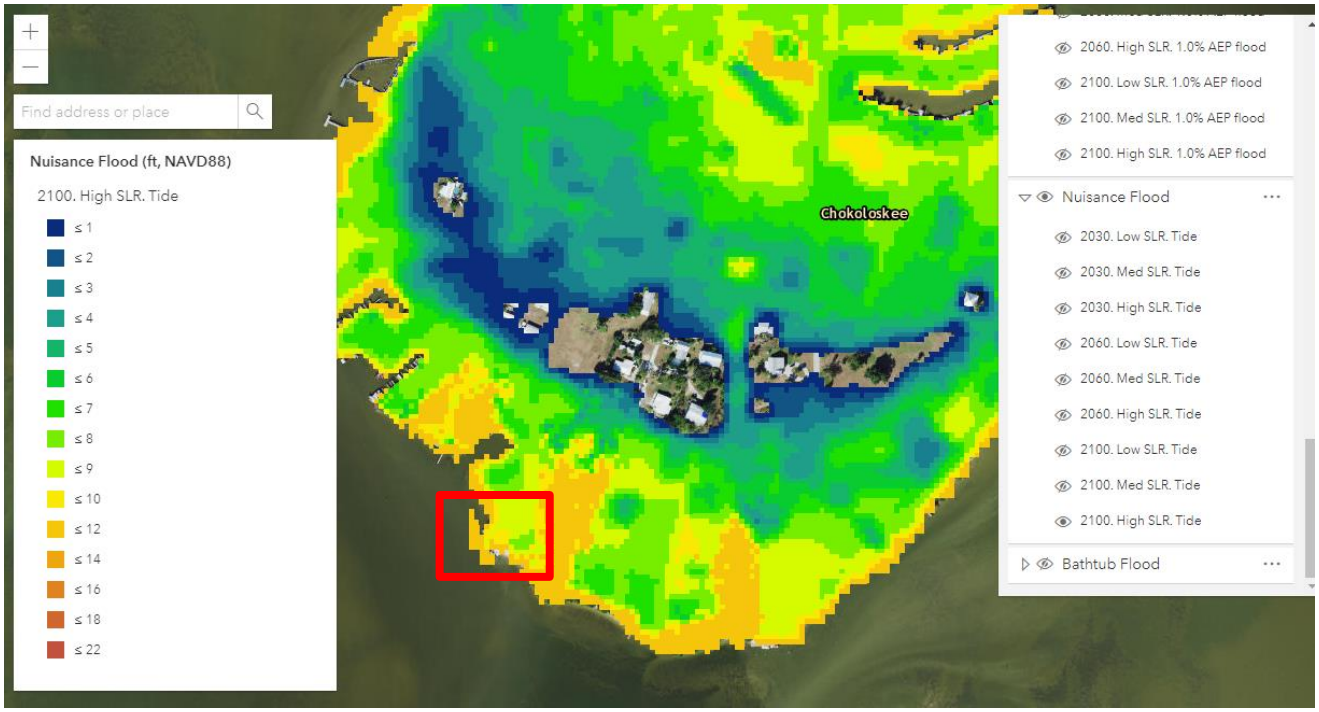
Smallwood Store



Appendix B. 119- Smallwood Store 2100 High SLR 1.0% AEP Flood

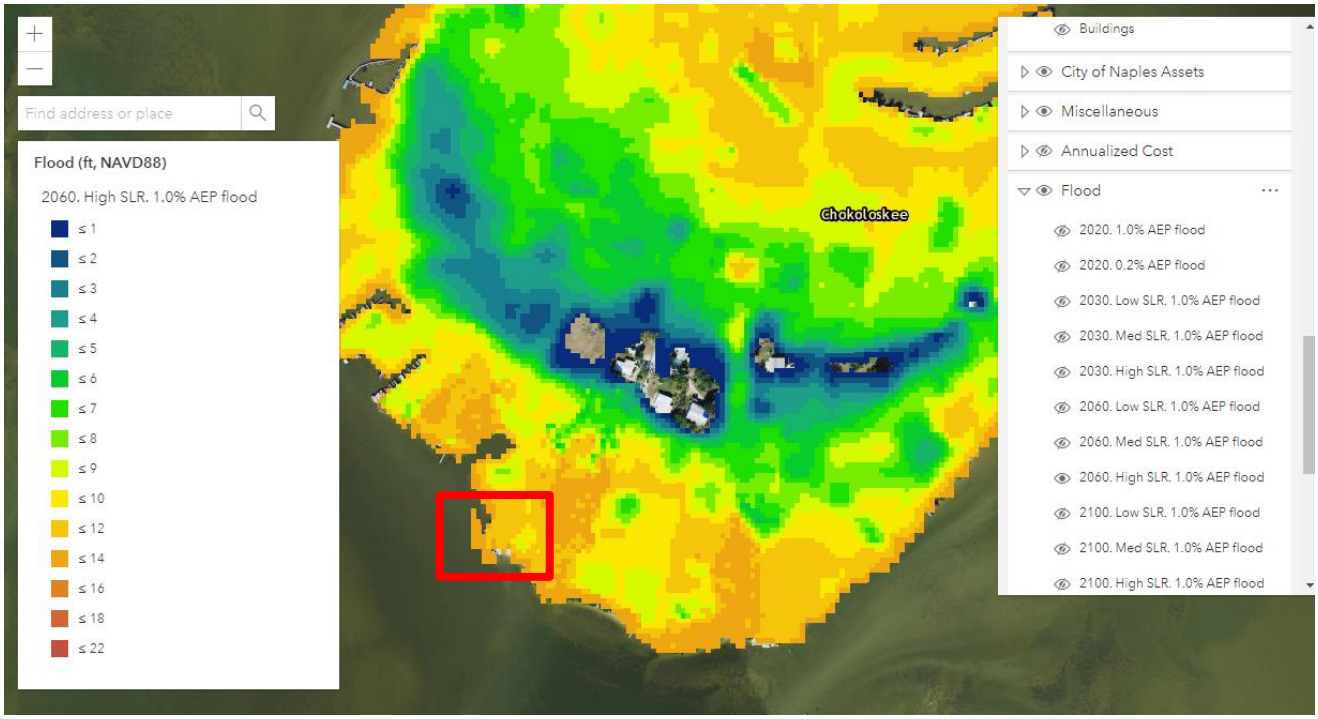


Appendix B. 120- Smallwood Store 2100 Low SLR 1.0% AEP Flood

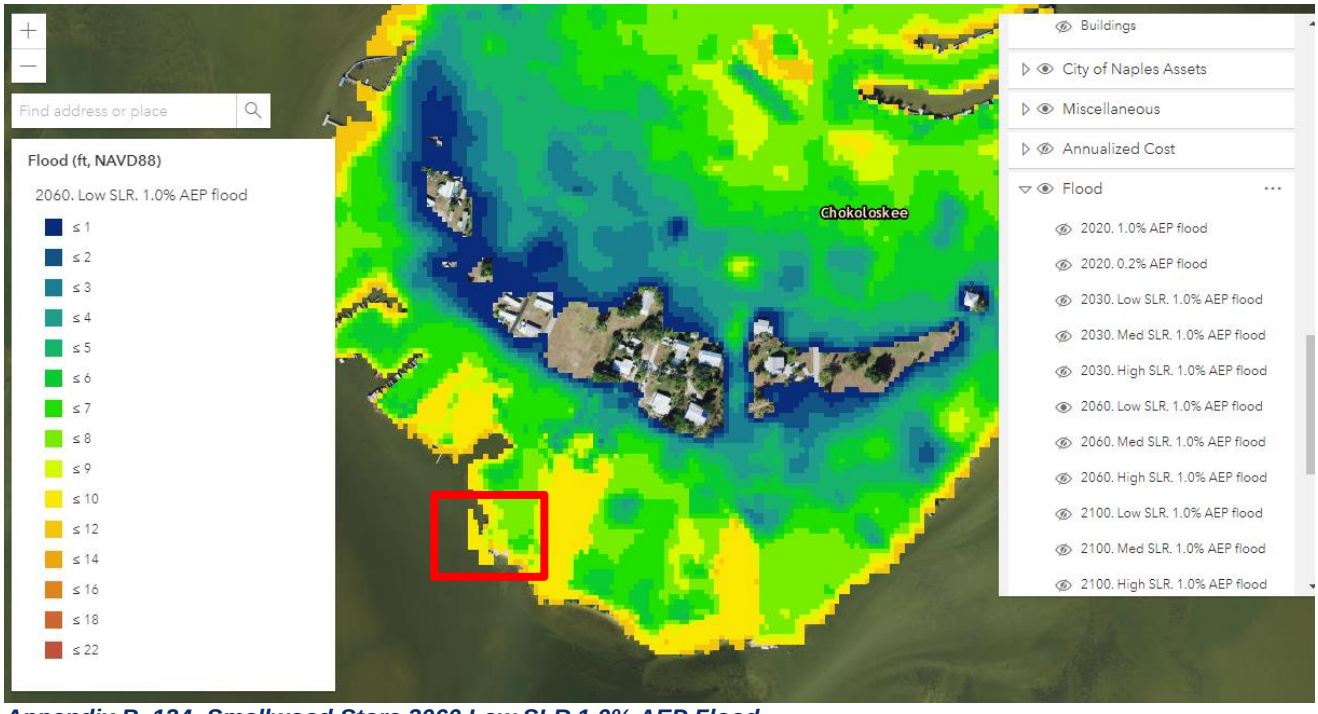


Appendix B. 121- Smallwood Store 2100 High SLR Tide Nuisance Flood

Appendix B. 122- Smallwood Store 2100 Low SLR Tide Nuisance Flood



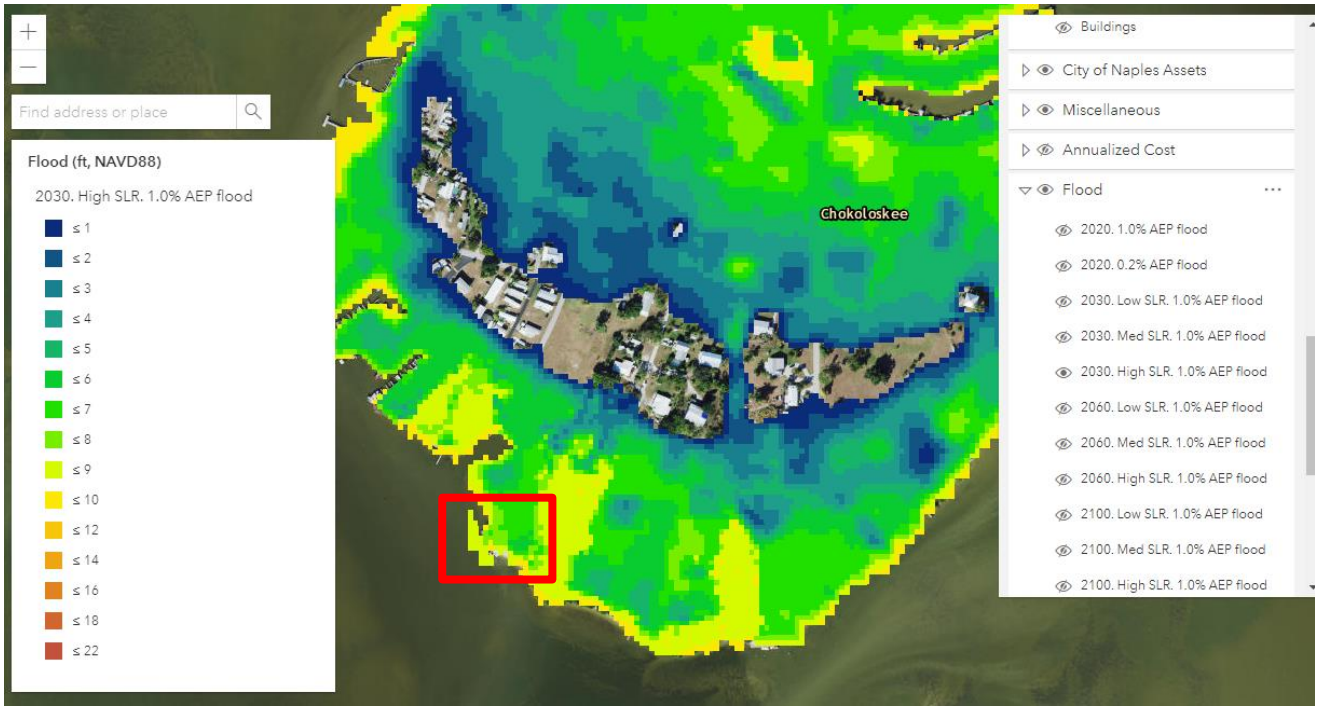
Appendix B. 123- Smallwood Store 2060 High SLR 1.0% AEP Flood



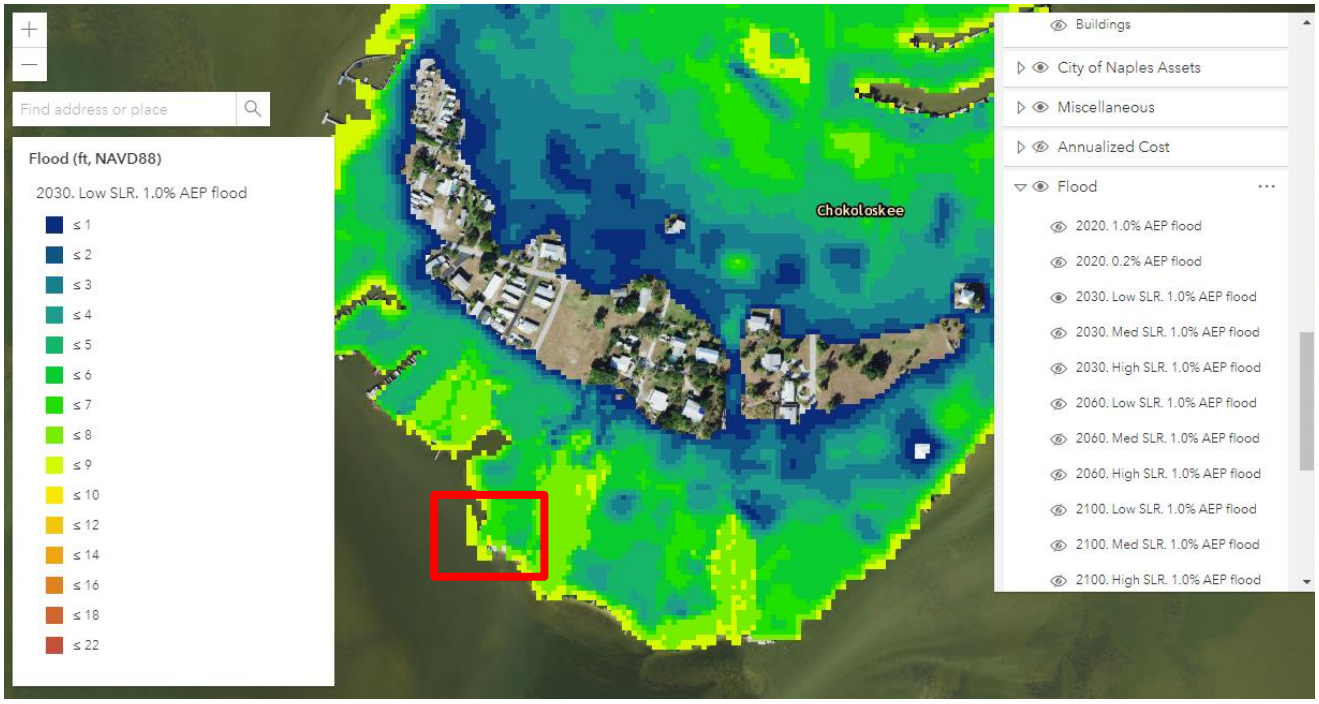
Appendix B. 124- Smallwood Store 2060 Low SLR 1.0% AEP Flood

Appendix B. 125- Smallwood Store 2060 High SLR Tide Nuisance Flood

Appendix B. 126- Smallwood Store 2060 Low SLR Tide Nuisance Flood



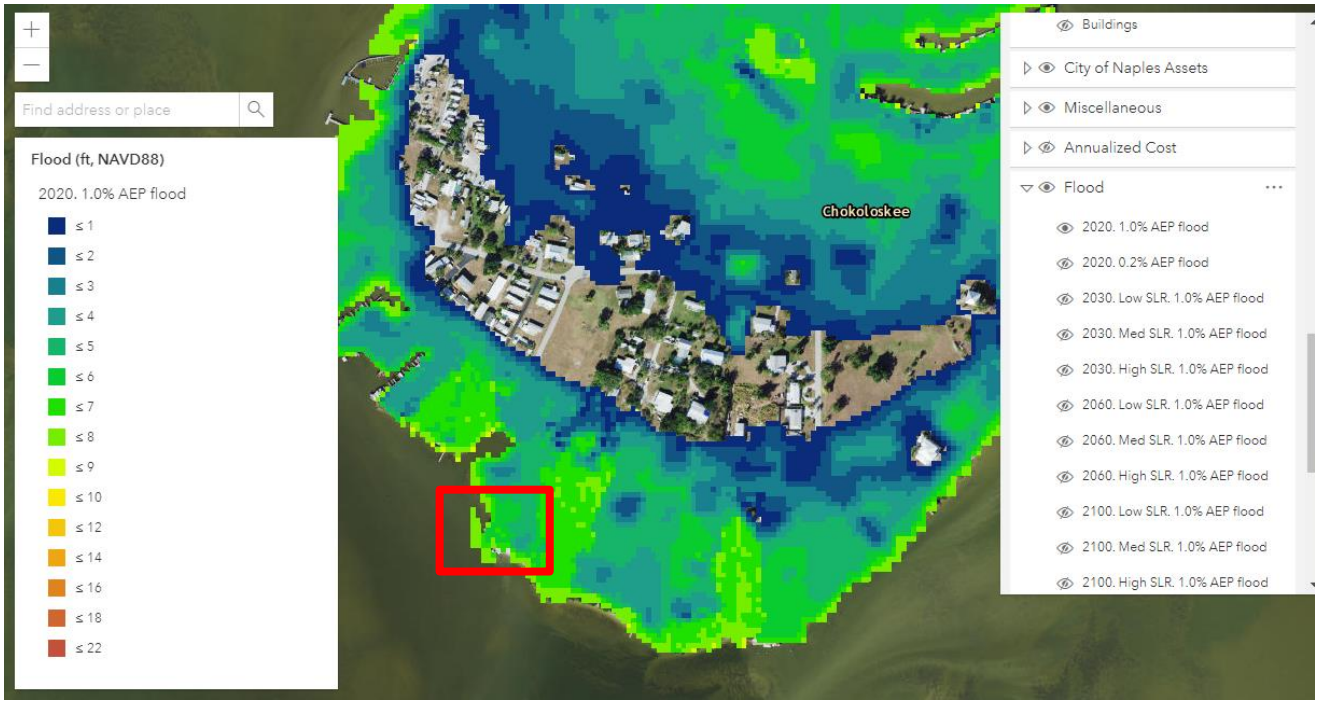
Appendix B. 127- Smallwood Store 2030 High SLR 1.0% AEP Flood



Appendix B. 128- Smallwood Store 2030 Low SLR 1.0% AEP Flood

Appendix B. 129- Smallwood Store 2030 High SLR Tide Nuisance Flood

Appendix B. 130- Smallwood Store 2030 Low SLR Tide Nuisance Flood



Appendix B. 131- Smallwood Store 2020 1.0% AEP Flood

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