# TOWN OF LAKE PARK
# FLOODING & SEA LEVEL RISE
# VULNERABILITY ASSESSMENT

## DECEMBER 22, 2023

TOWN OF LAKE PARK
PUBLIC WORKS DEPARTMENT
640 OLD DIXIE HWY
LAKE PARK, FL 33403

WRMA
WATER RESOURCES | ENGINEERING

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# Section 1 Introduction and Background

On May 21, 2015, Governor Rick Scott signed into law Florida Senate Bill 1094 (2015), titled "Peril of Flood". SB 1094 requires consideration of future flood risk from storm surge and sea level rise in certain portions of local government Comprehensive Plans. In accordance with SB 1094, Florida Statute 163.3178(2)(f) now includes sea level rise as one of the causes of flood risk that must be addressed in the "redevelopment principles, strategies, and engineering solutions" to reduce flood risk.

To that end, Water Resources Management Associates, Inc. (WRMA) was contracted to perform a flooding and sea level rise vulnerability assessment for The Town of Lake Park (the Town), an incorporated community located in Palm Beach County, Florida.

**Section 2** of this report details the technical methodology WRMA utilized to determine future flood hazards due to anticipated sea level rise within a 50-year time horizon. Further sections of this report provide an overall risk assessment as well as recommendations for risk adaptation planning.

WRMA's sea level rise (SLR) analysis was conducted using the latest, 2022, SLR projections from the National Oceanic and Atmospheric Administration (NOAA), which account for regional and local effects. Projected values of SLR at the Town were extracted from NOAA's Interagency Sea Level Rise Scenario Tool. The data was taken at the location of the Lake Worth Pier tide gauge, Station ID: 8722670. The Town of Lake Park is adjacent to the Lake Worth Lagoon, and this station is the closest active station nearest the Town and the Lagoon. Note: Due to relative distances, DEP has approved the use of single gauge for this analysis.

The NOAA dataset included several different SLR projections for each decadal year within and beyond the 50-year time horizon. The scenario years for the WRMA analysis are: 2020, 2030, 2040, 2050, 2060, and 2070. Corresponding SLR values extracted from the NOAA Intermediate-Low and Intermediate-High projections, which formed the basis for determining the potential range of future tidal and coastal surge flood elevations for each scenario year. Please note that all elevations in this report refer to the North American Vertical Datum of 1988 (NAVD88), in U.S. feet. Further information on the NOAA projections can be referenced in **Section 2.1** of this report.

For the coastal storm surge analysis WRMA referred to the Federal Emergency Management Agency (FEMA) Preliminary Flood Insurance Study (FIS) for Palm Beach County, Florida, dated December 20, 2019, and the FEMA National Flood Hazard Layer for Palm Beach County, Florida, effective December 11, 2023, in determining the base floodplain for the Town. WRMA applied NOAA's SLR projections upon the established base floodplain to determine the future extent and depths of coastal storm surge flooding.

Flood extents and depths for each analysis were evaluated upon a topographic Digital Elevation Model (DEM) published in December 2018. This DEM raster has an original product resolution of 2.5x2.5-feet and was derived from light detection and ranging (LiDAR) data produced by the Florida Division of Emergency Management for the United States Geological Survey 3D Elevation Program. This LiDAR has a vertical accuracy equal to ±4.38 inches (11.13 cm) at the 95% confidence interval.

The results of WRMA's technical analysis produced 30 flood maps, attached in **Appendices A and B**.

## 1.1 The Peril of Flood Act

The Peril of Flood Act went into effect July 1, 2015. The Act covers three areas:

1. Requires local governments to adopt comprehensive plan goals, objectives and policies related to flood risks within the Coastal Management Element.
2. Requires surveyors to submit elevation certificates to the Florida Division of Emergency Management (FDEM).
3. Addresses issues related to flood insurance.

The Act is only applicable to local governments in Florida that are required to have a Coastal Management Element (CME), per section 380.24, F.S.

Section 163.3178(2)(f) F.S. requires the CME to contain "a redevelopment component that outlines the principles that must be used to eliminate inappropriate and unsafe development in coastal areas when opportunities arise." The component must:

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

## 1.2 Flood Resiliency Grant Funding

Corollary to the Peril of Flood Act is Florida Senate Bill SB 1954, titled "Statewide Flooding and Sea Level Rise Resilience", which went into effect May 12, 2021. This bill changes the way the State of Florida plans for flood-related resilience.

SB 1954 was adopted establishing the Resilient Florida Grant Program within the Florida Department of Environmental Protection (FDEP). It requires the department to complete a Comprehensive Statewide Flood Vulnerability and Sea Level Rise Data Set and Assessment by specified dates; requires the department to develop an Annual Statewide Flooding and Sea Level Rise Resilience Plan (the Plan) and submit said plan to the Governor and Legislature by a specified date; and finally requires the department to implement a scoring system for assessing projects eligible for inclusion in the Plan, etc.

Communities with Coastal Management Elements in their Comprehensive Plans are encouraged to have their projects included in the Statewide Flooding and Sea Level Rise Resilience Plan for funding.

The Plan projects will be compiled from local vulnerability assessments and must comply with the requirements of the new law. The Plan is currently allowed to be $100 million per year. Based on the law FDEP may provide grants to a county or municipality to fund the cost of community resilience planning and necessary data collection for such planning, including:

1. Comprehensive plan amendments and necessary corresponding analyses that address the requirements of the Perils of Flood Act.
2. Vulnerability assessments that identify or address risks of flooding and sea level rise.
3. Development of projects, plans, and policies that allow communities to prepare for threats from flooding and sea level rise.
4. Projects to adapt critical assets to the effects of flooding and sea level rise.

SB 1954 has also made significant changes to statewide standards for vulnerability assessments (the Assessment). The new law's specific requirements, pursuant to Section 380.093 F.S., state:

- The Assessment must encompass the entire county or municipality and must include all critical assets (defined below) owned or maintained by the grant applicant.
- The Assessment must use the most recent publicly available Digital Elevation Model and generally accepted analysis and modeling techniques.
- Locally collected elevation data may also be included as part of the assessment as long as it is submitted to DEP as part of the submission from the Assessment.
- The Assessment must include an analysis of the vulnerability of, and risks to, critical assets, including regionally significant assets, owned or managed by the county or municipality.
- The Assessment must include peril of flood comprehensive plan amendments that address the requirements of Section 163.3178(2)(f) F.S. if the county or municipality is subject to such requirements and has not complied with such requirements as determined by the Department of Economic Opportunity.
- The Depth of:
    - ***Tidal flooding***, including future high-tide flooding, which must use thresholds published and provided by the FDEP. To the extent practicable, the analysis should also geographically display the number of tidal flood days expected for each scenario and planning horizon.
    - ***Current and future storm surge flooding***, using publicly available National Oceanic and Atmospheric Administration (NOAA) or Federal Emergency Management Agency (FEMA) storm surge data. The initial storm surge event used must equal or exceed the current 100-year flood event. Higher-frequency storm events may be analyzed to understand the exposure of a critical asset.
    - (To the extent practicable) ***Rainfall-inducing flooding***, using spatiotemporal analysis or existing hydrologic and hydraulic modeling results. Future boundary conditions should be modified to consider sea level rise and high-tide conditions.
    - (To the extent practicable) ***Compound flooding*** or the combination of tidal, storm surge, and rainfall induced flooding.
- Using the following scenarios and standards:

- All analyses should be in the North American Vertical Datum of 1988 (NAVD88).
- ***At least two local sea level rise scenarios***, which must include the 2017 National Oceanic and Atmospheric Administration Intermediate-Low and Intermediate-High sea level rise projections. ← Note: 2017 projections no longer published; latest effective 2022.
- ***At least two planning horizons*** for the years 2040 and 2070.
- Local sea-level data that has been interpolated between the two closest National Oceanic and Atmospheric Administration tide gauges.

The schematic flowchart below shows the process representation of the Florida Statewide Flooding and Sea Level Rise Resiliency Plan, and the local municipal Vulnerability Assessments.

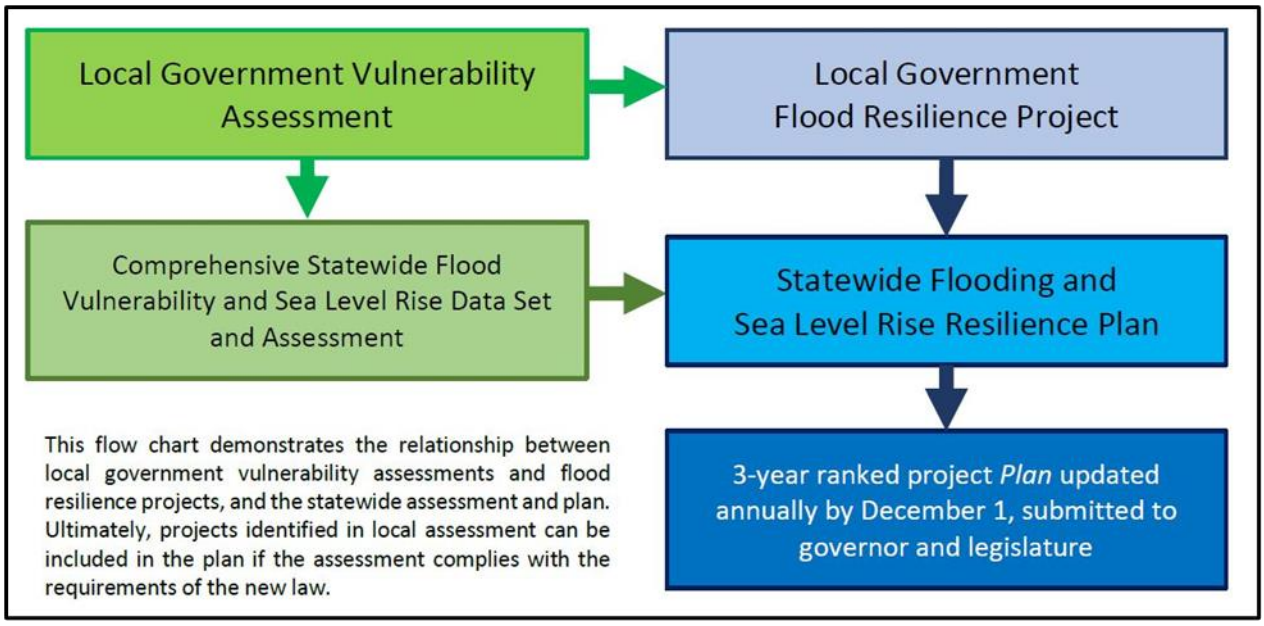


**Figure 1-1 - FL Statewide Resiliency Planning Flowchart**

## 1.3 About the Town of Lake Park

The Town of Lake Park, originally founded as Kelsey City in 1923, was the first zoned municipality in Florida. Located within Palm Beach County, the Town is bounded by North Palm Beach to the north, Riviera Beach to the south, the Lake Worth Lagoon to east, and the C-17 Canal to the west.

The Town has an estimated population of 8,556 as of 2019. It municple boundary encompasses 2.5 square miles of property, consisting of 2.2 square miles of dry land. Approximately 0.18 square miles (7.2%) of the Town's area includes the waters of the Lake Worth Lagoon (LWL). Located in the southwestern quadrant of the Town is the Lake Park Scrub Natural Area, which includes approximately 0.13 square miles of preserved area.

In terms of property distribution, the Town is comprised of 0.70 square miles of high-, medium-, and low-density residential areas on the Town’s eastern boundary. To the west along 10th Street and Dixie Highway are commercial and industrial areas. The downtown area lies along Park Avenue between 10th Street and 6th Street.

**Figure 1-2** below provides an exhibit of the Town of Lake Park limits underlain with a 2021 aerial imagery.

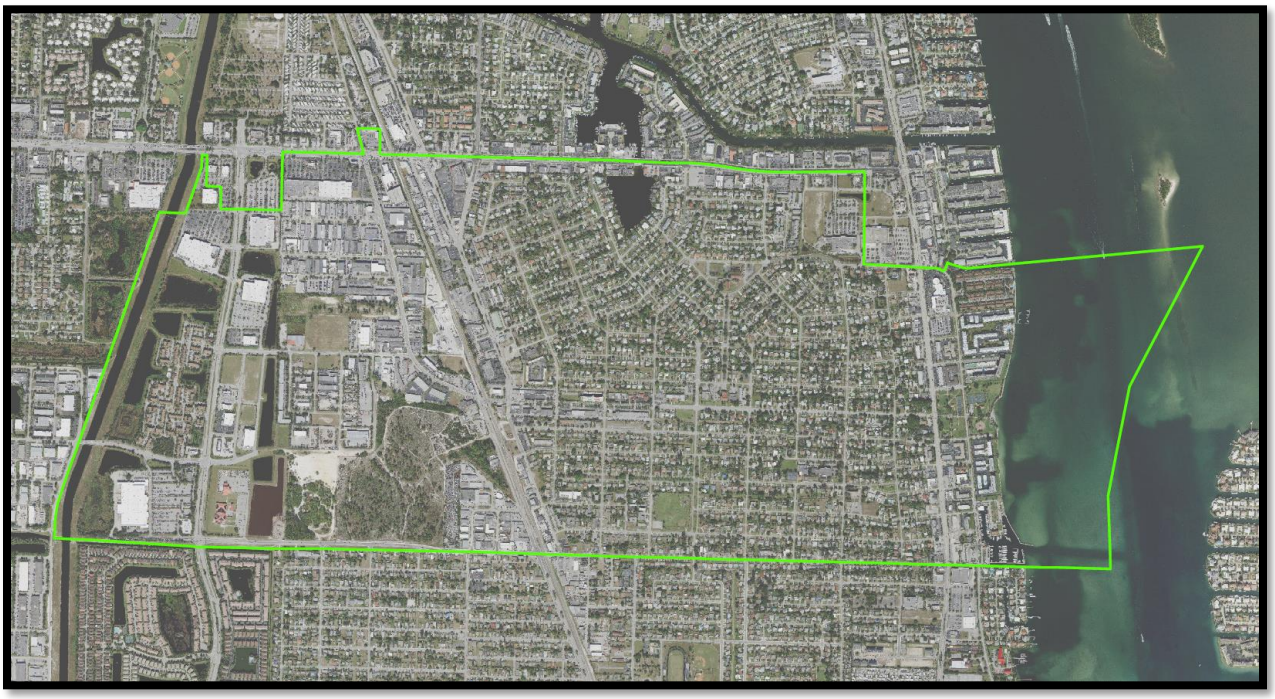

**Figure 1-2 - Town of Lake Park Municipal Boundary**

## 1.4 Lake Park Comprehensive Plan

In 1980, the Town determined there was a need for a comprehensive stormwater drainage improvement program, and hence adopted a Comprehensive Plan. The Comprehensive Plan has undergone significant updates since its commencement. A list of the updates that have been incorporated since 2008 appears below:

- EAR Amendments – Ordinance 04-2008, adopted October 15, 2008
- Ordinance 07-2015, adopted August 23, 2015; incorporated policies related to sea level rise
- Ordinance 12-2016, 2016 EAR Amendments, adopted on May 3, 2017
- Ordinance 09-16, adopted June 2017 (est. FHMUD)
- Ordinance 03-2018, adopted April 18, 2018 (FHMUD)
- Ordinance 02-2020, February 2020 CIP
- Ordinance 03-2020, 2020 Water Supply Facilities Plan, May 2020

Specifically, Ordinance 12-2016 was adopted immediately after the adoption of SB 1954. This Ordinance regulates the following coastal management-related items for consistency with SB1954:

**COASTAL MANAGEMENT (Comprehensive Plan Section 7.2)**

**Objective 4.0:** Provide infrastructure and services at adopted levels of service in the coastal area.

***Policy 4.1:*** Continue to provide for water-dependent and water-related uses in the coastal area including the provision and expansion of the Town Marina, in conjunction with the goals, objectives and policies of this Comprehensive Plan.

***Policy 4.2:*** The Town shall establish a Marina Siting Plan consistent with 163.3178(6), F.S.

**Objective 5.0:** The Town shall annually review its comprehensive plan and land development regulations to verify the accuracy of its designated coastal high hazard areas.

***Policy 5.1:*** The Town shall define its Coastal High Hazard Areas as the area below the elevation of the Category 1 storm surge line as established by Sea, Lake and Overland Surges from 2018 Hurricanes (SLOSH) computerized storm surge model. The Coastal High Hazard Area is identified on the Future Land Use Map.

***Policy 5.2:*** The Town shall utilize its land development regulations to discourage population concentrations and development or redevelopment in, limit public expenditures that subsidize development or redevelopment in, and relocate or replace infrastructure away from Coastal High Hazard Areas if not contrary to the health, safety, or welfare of the residents of Lake Park. Public expenditures shall be limited to maintenance and purchase of public open space, drainage improvements, elimination of existing septic systems, upgrading existing roads, and repair or replacement of the seawall.

***Policy 5.3:*** Redevelopment in Coastal High Hazard Areas is not permitted if the proposed redevelopment results in increased land use intensities.

***Policy 5.4:*** The Town shall, through its land development regulations, set standards for post-disaster redevelopment in Coastal High Hazard Areas within the Town.

***Policy 5.5:*** The Town shall maintain an inventory of any historic buildings and sites in the Coastal High Hazard Areas.

***Policy 5.6:*** Land development regulations shall protect any existing or future historic buildings in the Coastal High Hazard Areas.

***Policy 5.7:*** In regulating development and redevelopment in all areas, including the Coastal High Hazard Area, the Town shall maintain hurricane evacuation times in accordance with Section 163.3178(9), F.S.

***Policy 5.8:*** Land development regulations shall be consistent with the provisions of the Florida Building Code, Standard Mechanical Code, Standard Plumbing Code, Standard Gas 219 Code, and National Electric Code as they pertain to general hazard mitigation and other issues.

***Policy 5.9:*** Infrastructure in Coastal High Hazard Areas that is subject to repeated storm damage shall be removed, relocated, or structurally modified.

**Objective 6.0:** Coastal area population densities shall be coordinated with the Palm Beach County Peace Time and Emergency Management Plan prepared by the Department of Public Safety, Division of Emergency Management.

***Policy 6.1:*** The annual review of the comprehensive plan by the Town shall insure that coastal area population densities are coordinated with the Palm Beach County Peace Time Emergency Management Plan.

**Objective 7.0:** Eliminate unsafe and inappropriate development and mitigate the flood risk to existing and planned development in coastal areas that are at high risk of flooding due to storm surge, high-tide events, flashflood, stormwater runoff, and sea level rise.

***Policy 7.1:*** New development and redevelopment in areas at high risk of flooding due to storm surge, high-tide events, flash flood, stormwater runoff and sea level rise shall be required to utilize building design specifications, engineering solutions, site development techniques, and management practices (i.e. requiring higher minimum floor elevations, retrofitting buildings for increased flood risk, designing infrastructure that can withstand higher water levels such as raising seawalls and installing tidal valves, implementing natural drainage features such as bioswales) that reduce the risk and losses due to flooding. Corresponding requirements for implementation shall be adopted within the Town's land development regulations by June 2018.

***Policy 7.2:*** New development and redevelopment in areas with a high risk of flooding due to storm surge, high-tide events, flash flood, stormwater runoff, and sea level rise shall meet or exceed the flood-resistant construction requirements of the 220 Florida Building Code (i.e., requiring higher minimum flood elevations, retrofitting buildings for increased flood risk, requiring the use of flood damage-resistant materials).

***Policy 7.3:*** Construction activities seaward of the Coastal Construction Line established pursuant to 161.053, F.S. shall be consistent with Chapter 1616 F.S.

***Policy 7.4:*** The Town shall continue to participate in and comply with the National Flood Insurance Program (NFIP) regulations.

***Policy 7.5:*** The Town shall continue to participate in the Community Rating System (CRS) program, which involves managing and documenting activities that the Town performs to gain points under FEMA's CRS Program. This voluntary program rewards communities that improve their flood protection activities with flood insurance discounts for its residents.

***Policy 7.6:*** New development and redevelopment shall be consistent with or more stringent than the floodplain management regulations set forth in 44 C.F.R., part 60, as required by 163.3178(2)(f)(4).

**Objective 8:** The Town shall continue to reduce flood risks to persons and property.

***Policy 8.1:*** Development within floodplains, specifically 100-year flood V and VE zones shall be prohibited.

***Policy 8.2:*** The Town shall prioritize stormwater system upgrades within areas identified as having experienced or being prone to flood hazard to ensure that all new development(s) will meet the Town's adopted level of service standards for the drainage.

***Policy 8.3:*** The Town shall provide adequate funding to continue to implement Town projects and programs funded by the Stormwater Utility Fees to reduce hazards associated with flooding.

***Policy 8.4:*** The Town shall continue its drainage system maintenance program, which involves drain cleaning, mowing of Town rights-of-way, swale areas, street sweeping services, and jet vacuuming clogged drainage systems.

***Policy 8.5:*** The Town shall continue flood inspections, which are used to prioritize various drainage projects being designed for construction improvements.

***Policy 8.6:*** The Town shall require that proven methods be utilized in the design and construction of all drainage systems that provide flood protection, add water quality improvements to the system, and reduce pollution found in stormwater runoff.

***Policy 8.7:*** The Town will continue to participate in the Local Mitigation Strategy (LMS) program, which aids in disaster recovery. The LMS is a community-wide group that assesses a community's potential vulnerabilities in the event of a disaster and develops activities or projects that would reduce those vulnerabilities. If a disaster does occur. The LMS has ready lists of related projects a community can implement to prevent or reduce damages from a similar disaster. The Town shall strive to complete or participate in activities and projects that proactively reduce vulnerabilities.

**Objective 9:** The Town shall continue to promote flood awareness and analyze areas that are vulnerable to flooding.

***Policy 9.1:*** The Town shall utilize the Town's floodplain regulations, which include the 50% rule. This rule requires compliance with current elevation and construction requirements if any structure is damaged or improved to an amount greater than 50% of the structure's market value.

***Policy 9.2:*** The Town shall continue to work with local, state, and federal partners to target repetitive loss properties for acquisition or mitigation of flood hazard through hard and soft structural, and non-structural adaptation strategies including elevating existing structures.

***Policy 9.3:*** The Town shall continue to prohibit development within floodplains in recognition of the important following functions they perform: allowing rainfall to drain, filtering stormwater runoff, reducing flooding, and recharging the regions drinking water supply.

## 1.5 Lake Park Stormwater Master Plan

The development of Lake Park began in earnest in the 1950s. As development progressed, public drainage infrastructure was installed sparsely throughout the Town. Drainage infrastructure on private property was installed as needed or, after 1949, per the requirements of the South Florida Water Management District (SFWMD) and the Town's Land Development Code as it existed at the time of construction. By the late 1980s, the Town was considered fully developed.

In 1986, a Stormwater Master Plan (SWMP) was prepared, which included a stormwater atlas of the existing drainage facilities, and recommendations for prioritization of operations and maintenance activities. The Stormwater Master Plan was updated in 1993, again in 1996, and most recently in 2021.

The Town's current stormwater drainage system consists mostly of grassed swales for conveyance of runoff to catch basins and underground pipes discharging through 14 major outfalls to the Intracoastal Waterway (IWW) and the C-17 Canal.

In the years preceding the latest SWMP update, Lake Park Public Works had noted that the aging drainage infrastructure was failing at a faster-than-normal rate. Development, climate change, and environmental stressors have posed a challenge to the drainage system's capacity to handle storm events of both small and large magnitude.

In 2019 the Town identified the need develop a revised Stormwater Master Plan using updated infrastructure maps that are composed of field-collected survey data, coupled with the application of new geographic information system (GIS)-based LiDAR topography data, state-of-the-art hydrologic and hydraulic modeling technology, and sustainable planning approaches including green infrastructure (GI) best management practices (BMPs) and low-impact development (LID) techniques for management of stormwater runoff.

The latest SWMP update, effective February 2021, is intended to provide the Town with a road map that will allow for the rehabilitation of the existing drainage system infrastructure over the following 20 years, with a forward-looking framework through which sustainable redevelopment practices can be employed, rather than the standard end-of-pipe treatment approach; which typically requires vacant land for construction of detention/retention facilities. The SWMP adheres to innovative approaches to address climate change including:

- Performing Vulnerability and Adaptability assessment for use in stormwater CIP planning and implementation.
- Decentralizing stormwater infrastructure to create opportunities to build resilience and redundancy into urban planning and design, helping communities better prepare for extreme weather events.
- Integrating BMPs in stormwater management Town-wide through new stormwater design standards, education and incentive programs for homeowners and developers who incorporate GI BMP elements into their properties and redevelopment plans, thereby allowing communities to simultaneously manage stormwater for both every day and extreme rainfall events. Examples of BMPs include green roofing, rainwater harvesting, infiltration systems in combination with traditional conveyance and end-of-pipe infrastructure. Rainwater harvesting can be done on almost any scale, even up to providing low-cost rain barrels to capture downspout runoff for residential and commercial property owners; and,
- Emphasizing structural improvements such as stormwater treatment practices, non-structural practices such as enhanced tree canopies, impervious cover disconnection, a zoning overlay district/ordinance impacting new development or a combination of both structural and nonstructural practices (hybrid techniques).

The goal of GI/LID is to reduce the frequency with which the Town's stormwater system releases runoff into the downstream end-of-pipe conveyance system. Traditional end-of-pipe systems use a centralized infrastructure such as the system of swales and pipes in the Town of Lake Park to provide drainage, flood control and pollution management at the end of a sewer line (pond, canal, Intracoastal Waterway).

The traditional swale, culvert, pipe conveyance and end-of-pipe infrastructure systems are being reimagined creating a complete treatment train. Stormwater is managed and treated at all points along its path through the urban environment, rather than only at the end of the line. These treatment train systems can include microbioretention and rain gardens, bioswales, biodetentions, pervious pavement and underground storage filtration chambers. Infiltration chambers use pipes and/or cells to hold back

stormwater and remove nutrients. The treatment train concept is to mimic the way nature handles rainwater in the natural water cycle; it does not mean replacing paved roads with a park, but rather incorporating green infrastructure BMPs into the design of the roadway so that runoff from the paved areas can be intercepted and treated, as opposed to typical capture and conveyance through a storm drain system of inlets and pipes.

Incorporation of climate change impacts into municipal stormwater master plans and capital improvement program (CIP) development decisions is based on existing management planning tools and approaches. These are often used to assist elected officials and infrastructure managers consider and prepare for future climate impacts: vulnerability assessment, risk assessment, and adaptation assessment.

***Vulnerability Assessment*** begins with the identification of existing stressors facing municipal and transportation systems and projects how climate change will impact and/or introduce new stressors in the future. The findings of the assessment can then be ranked to assess, prioritize, and address vulnerabilities.

***Risk Assessment*** evaluates the likelihood and consequence of climate-related impacts on municipal transportation and civil infrastructure. Risk assessment tools are rooted in engineering applications that will quantify the product of the probabilities of exposure.

***Adaptation Assessment*** identifies, plans, prioritizes, implements, and measures civil/transportation drainage infrastructure management options available for effectively adapting to climate change impacts. This assessment addresses ways to reduce civil/transportation infrastructure vulnerability, increase resilience and/or highlight regions of retreat.

The Town of Lake Park Stormwater Master Plan 2021 update adheres to these management planning concepts that are in line with the requirements of SB 1954. The 2021 SWMP update consists of the following sections:

- Section 1 - Introduction
- Section 2 - Data Collection & Management
- Section 3 - NFIP Community Rating System Overview
- Section 4 - Outreach & Communication
- Section 5 - Climate Change and Sea Level Rise Assessment
- Section 6 - Operations & Maintenance (O&M) Program Review
- Section 7 - Water Resources Engineering Modeling Science
- Section 8 - Alternatives Analysis
- Section 9 - Stormwater Utility Administration and Funding Sources

Of particular relevance to this report are Sections 5 and 8 of the SWMP. The full 2021 SWMP has been attached to this report as **Appendix C.**

Section 5 of the SWMP is an extensive analysis of the impact of climate change warming and sea level rise on the Town physical ecosystem. The Section identifies the exposure and the risks associated with each type of flooding hazard and provides adaptation alternatives. **Table 1-1** shows the types of natural flooding hazards expected to be exacerbated by climate change that will affect the Town's stormwater management infrastructure.

**Table 1-1 - Flood Hazards Expected to Affect Lake Park**

| Flooding Hazard | Source | Exposure Type and Level | | | | |
|---|---|---|---|---|---|---|
| | | Private Assets | Natural Area Assets | Govt. Assets | Critical Facilities | Road Assets |
| Nuisance Flooding, Runoff & Erosion | Throughout Town | Yes/Low | Yes/Low | Yes/Low | Yes/Low | Yes/High |
| Regional Canal Flooding | C-17 Canal / Earman River | Yes/High | Yes/Low | Yes/Low | Yes/Low | Yes/High |
| Coastal Storm Surge | Atlantic Ocean Lake Worth Lagoon | Yes/High | Yes/Low | Yes/Low | Yes/High | Yes/High |
| Coastal Sea Level Rise | Atlantic Ocean Lake Worth Lagoon | Yes/High | Yes/Low | Yes/Low | Yes/Low | Yes/High |

Section 8 of the SWMP described how a hydrologic & hydraulic model, constructed in ICPR4, was used to perform hydrodynamic modeling of the Town's storm sewer system at a detailed sub-basin level. The model was completed in a two-dimensional mode to review and map flood plain extents and depths of flooding along the terrain. The terrain was defined using the latest available (at the time) Palm Beach County LiDAR DEM.

Section 8 of the SWMP also addresses future climate change and how the ICPR4 model conditions were adjusted for rainfall intensity increases and for NOAA/IPCC/USACE sea level rise projections. **Figure 1-3** and **Figure 1-4** below exhibit the flood extents modeled for the 3-year and 5-year 24-hour storm events.

Per the aforementioned sections of the 2021 SWMP, the Town of Lake Park Comprehensive Plan is in compliance with Section 163.3178(2)(f) F.S., as modified by SB 1954.

- ✓ ***SB 1094 Requirement: Rainfall-inducing flooding (to the extent practicable), using spatiotemporal analysis or existing hydrologic and hydraulic modeling results. Future boundary conditions should be modified to consider sea level rise and high-tide conditions.***

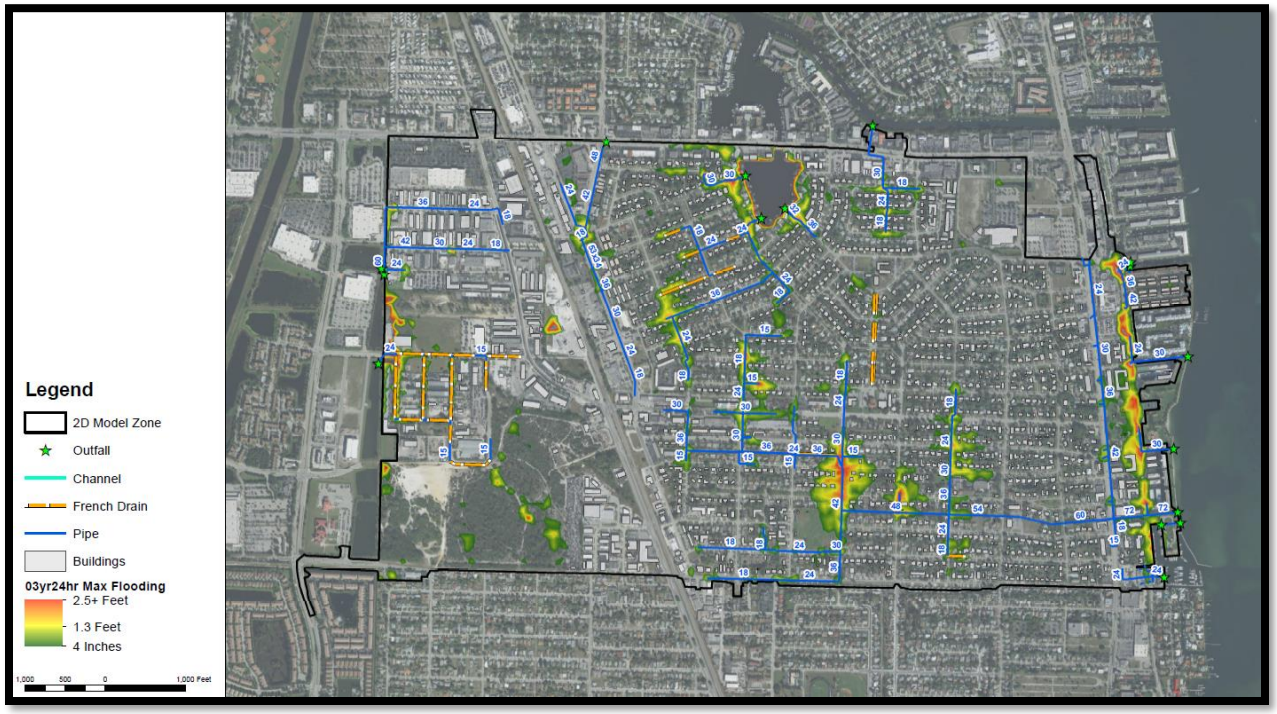


**Figure 1-3 - Maximum Flooding Depths for the 3-Year 24-Hour Storm**

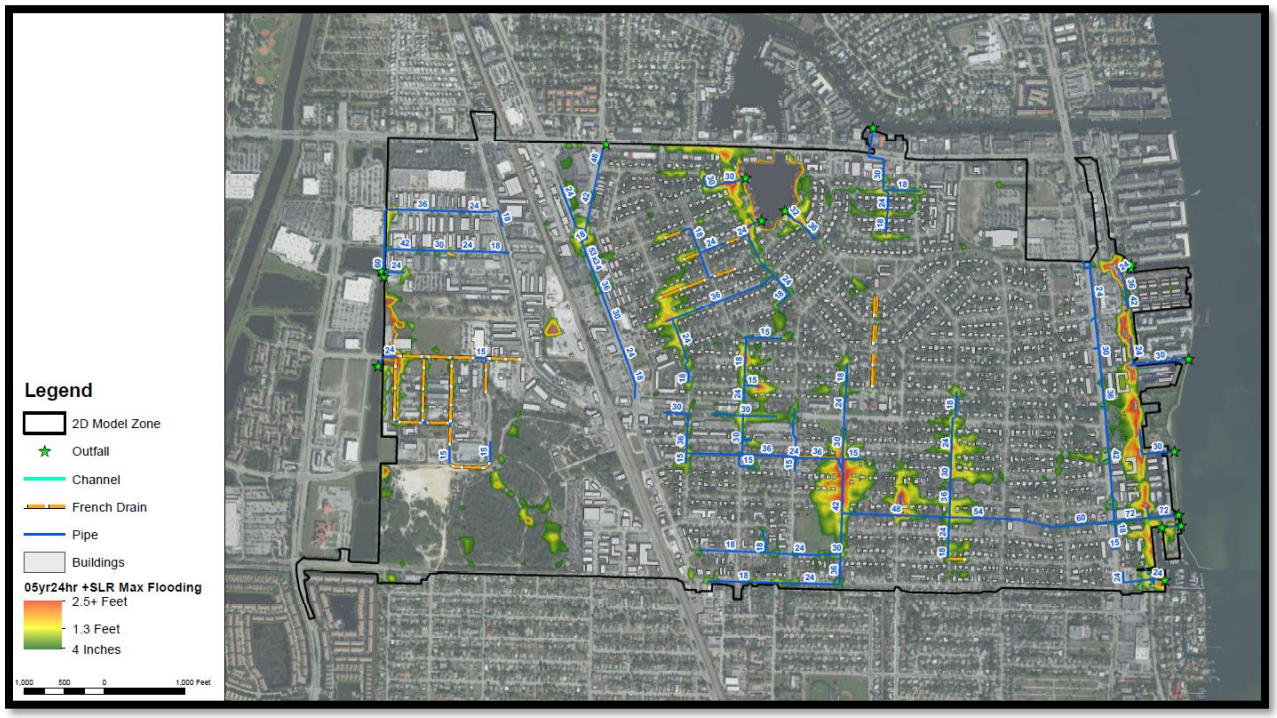


**Figure 1-4 - Maximum Flooding Depths for the 5-Year 24-Hour Storm Event**

# Section 2 Vulnerability Analysis Methodology

## 2.1 Projecting Sea Level Rise

Sea level rise (SLR) is the byproduct of a number of compounding factors, many of which are attributed to the high concentrations of heat-trapping greenhouse gases emitted into Earth's atmosphere since the early 20th century (EPA, NASA, IPCC).

Due to the fact that future SLR is highly dependent upon the amount of these emissions generated in the next decade and onward (Compact, 2019), the uncertainty of estimates for future rates of SLR increases as we look out in time. For example, SLR estimates for the year 2030 are far more likely to be realized than estimates for the year 2100.

Factors considered to substantially affect sea levels include, but are not limited to: global temperature rise, the gravitational effects of melting ice masses, changes to dynamic systems within the ocean such as the Gulf Stream, thermal expansion of the warming ocean, and even vertical land movement. The combined effects of these interellated factors and others manifest in uneven rates of sea level change across the globe. Thus, in addition to global projections scientists have also produced regional projections for future sea level changes. In some regions, such as in parts of Alaska, the mean sea level is actually projected to lower; i.e. negative sea level rise.

To address the complexities of future human activities and the evolution of human technology as they relate to future green-house gas emissions, Representative Concentration Pathways (RCPs) have been established by scientists for the purposes of climate modeling activities worldwide. RCPs are essentially future scenarios for global greenhouse gas emissions, and they are technically classified by the amount of radiative forcing expected in the year 2100 as a result of cumulative greenhouse gas emissions. These emissions are known to trap energy within Earth's atmosphere. Radiative forcing is therefore seen in this context as the net change of energy in the lower atmosphere, measured in watts per meter squared ($W/m^2$).

Given the established RCPs that the climate may take, globally and regionally, SLR has been projected by many different agencies usually across many different curves. NOAA for instance, has modeled six distinct curves of SLR for the United States:

- Low
- Intermediate-Low
- Intermediate
- Intermediate-High
- High
- Extreme

These curves reflect the spectrum of RCP outcomes for the U.S. as well as the various levels of conservatism appropriate for State/County/Municipal planning and development needs.

In an effort to coordinate sea level rise resilience planning at the Statewide level, Florida's legistlative Statutes were updated to standardize the approach that FL agencies and entities use to assess flood-related vulnerabilities. To that end, Section 380.093 F.S. currently requires that vulnerability assessments evaluate the NOAA Intermediate-Low and Intermediate-High SLR projections.

Since the enactment of the aforementioned Florida Statute, NOAA has provided a 2022 update to their 2017 report on *Global and Regional Sea Level Rise Scenarios for the United States*. The 2022 Report and updated SLR database reflects the current state of the art in sea level rise modeling for the U.S., with output directly from United Nations Intergovernmental Panel on Climate Change (IPCC) and the NASA Sea Level Change Team.

The online database published by NOAA via their Interagency Sea Level Rise Scenario Tool provides available SLR projections regionally with1-degree grids along the U.S. coastline, which are in turn downscaled at specific NOAA tide-gauge locations. **Figure 2-1** below displays the median [50th percentile] SLR projections taken at the Lake Worth Pier tide guage (*note: Extreme curve not provided*). The SLR amounts given are in feet rise above the baseline year 2000 mean sea level (MSL).

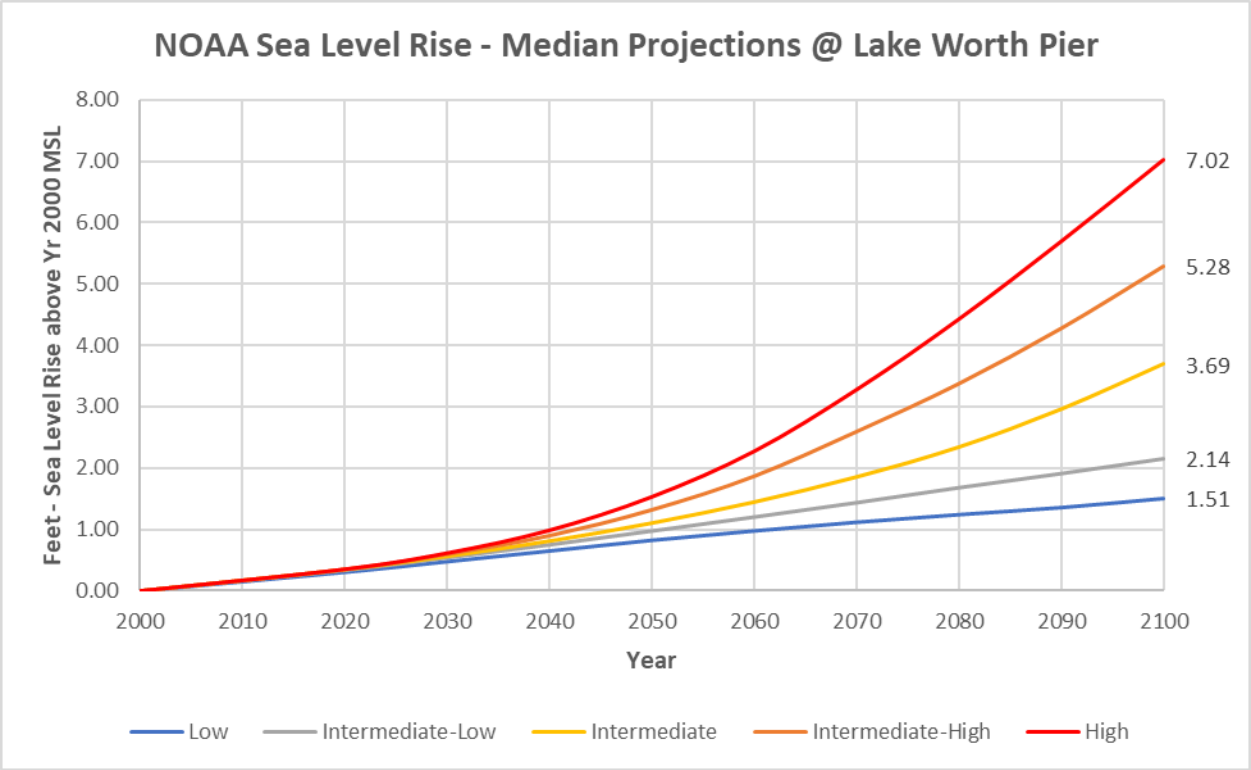


**Figure 2-1 – NOAA Sea Level Rise Projections for Lake Worth Pier**

To contextualize the likelihood of these scenario curves, NOAA has produced observation-based extrapolations of already measured global mean sea level rise (GMSL), as well as that for the contiguous United States (CONUS). NOAA has determined the median estimate of the extrapolations places the GMSL and the CONUS MSL between the Intermediate-Low (grey) and Intermediate (yellow) scenario curves in the year 2050. In other words, at the current trajectory of sea level rise already witnessed, and barring no signification change in the level of green-house gas emissions worldwide, SLR projections at or below the NOAA Intermediate-Low curve may be taken as statistically likely to occur.

As previously noted, the curves used for the Lake Park SLR vulnerability assessment are the NOAA Intermediate-Low (grey) and Intermediate-High (orange). Of these, the Intermediate-Low is the most

likely to occur with an amount of SLR equal to 1.43-feet by the year 2070. On the high estimate curve, the amount of SLR equals 2.59-feet by the year 2070.

The SLR, in feet, along these curves is shown **Table 2-1** for each decadal year of this analysis.

**Table 2-1 - Sea Level Rise in Feet by Decade**

| Year | Intermediate-Low | Intermediate-High |
|---|---|---|
| **2000** | 0.00 | 0.00 |
| **2020** | 0.34 | 0.35 |
| **2030** | 0.54 | 0.60 |
| **2040** | 0.75 | 0.90 |
| **2050** | 0.97 | 1.32 |
| **2060** | 1.20 | 1.87 |
| **2070** | 1.43 | 2.59 |

## 2.2 Tidal Inundation Mapping

Tidal inundation, also known as “sunny day flooding”, is the result of high tide water overtopping low lying coastal areas. Considering future sea level rise, tidal inundation has the prospect of becoming more than the occasional nuisance experienced with seasonal king tides, but rather a daily issue.

Southeast Florida has a semidiurnal tide pattern, meaning that it experiences two high and two low tides every lunar day. So not only could tidal inundation in the Town occur on a daily basis, but it could also occur twice per day depending on the amount of SLR and the relative terrain.

The NOAA Office for Coastal Management, and generally accepted engineering practice, dictate using the highest average daily tide for mapping tidal inundation. Given SE Florida’s semidiurnal tide pattern, there are two average high tides: The Mean High Water (MHW), and the Mean Higher High Water (MHHW); the latter being marginally higher in magnitude. For the purposes of this study WRMA used the MHHW at the Lake Worth Pier tide gauge (Station ID: 8722670) as the reference for projecting the future highest tide. As seen in **Figure 2-2**, this station is approximately 13 miless south from the Town. The next nearest gauge is South Port, further south near Ft. Lauderdale, which is approximately 50 miles from the Town. Due to the relative distances of these stations, WRMA has received approval from the Florida Department of Environmental Protection (DEP) for the use of a single guage in this vulnerability assessment.

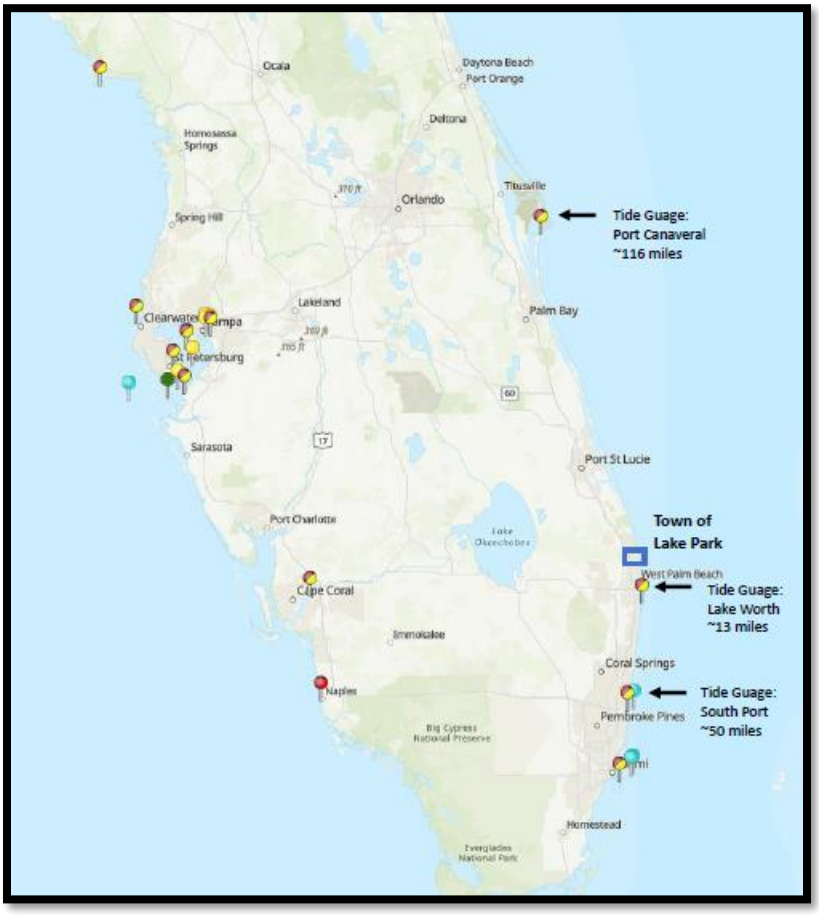


**Figure 2-2 - NOAA Tide Guage Locations near Lake Park**

Normally NOAA's published MHHW values are based on a National Tidal Datum Epoch (NTDE). This is a statistical averaging period of 19 years, with the present NTDE extending from 1983 to 2001. Given this period does not match the baseline condition of the NOAA's current SLR projections, WRMA forward adjusted the MHHW from the mid-point of the current epoch, 1992, to the year 2000 at a rate of annual sea level rise consistent with NOAA's observed sea level rise trend for the Lake Worth Pier station. For that station, the relative sea level rise trend is 4.03 mm/year with a 95% confidence interval of +/- 0.53 mm per year, based on monthly mean sea level data from 1970 to 2022. **Table 2-2** displays the forward adjusted datum values used for the SLR analysis.

**Table 2-2 - Lake Worth Pier Tide Levels**

| Lake Worth Pier Tide Levels (feet-NAVD88) | | |
|---|---|---|
| **Mean Level** | **NTDE** | **Year 2000** |
| MHHW | 0.55 | 0.66 |
| MHW | 0.37 | 0.48 |
| MSL | -0.97 | -0.86 |
| MLW | -2.35 | -2.24 |
| MLLW | -2.51 | -2.40 |

With the baseline tide condition set at the MHHW in the year 2000, WRMA calculated the anticipated highest tide for each decade up to the year 2070, for both the NOAA Intermediate-Low and Intermediate-High SLR projections. **Table 2-3** shows the values used in determining inundated topography within the Town for each scenario year.

**Table 2-3 - Tidal Inundation Elevations**

| MHHW (feet-NAVD88) | | | | |
|---|---|---|---|---|
| **Ref Curve:** | **NOAA Intermediate-Low** | | **NOAA Intermediate-High** | |
| **Year** | **SLR (inches)** | **Elevation (feet)** | **SLR (inches)** | **Elevation (feet)** |
| 2000 | - | 0.66 | - | 0.66 |
| 2020 | 4.0 | 1.00 | 4.2 | 1.01 |
| 2030 | 6.5 | 1.20 | 7.2 | 1.26 |
| 2040 | 9.0 | 1.41 | 10.8 | 1.56 |
| 2050 | 11.7 | 1.63 | 15.8 | 1.98 |
| 2060 | 14.4 | 1.86 | 22.4 | 2.53 |
| 2070 | 17.2 | 2.09 | 31.1 | 3.25 |

## 2.3 Coastal & Riverine Flood Mapping

For flood risk mapping, FEMA designates the Special Flood Hazard Area (SFHA) as the area with a special flood or mudflow, and/or flood related erosion hazard. The purchase of flood insurance for properties within the SFHA is a conditional provision of the current National Flood Insurance Program's floodplain management regulations, for those properties to be fully eligible for Federal financial assistance in the event of a flood-related disaster.

Section 380.093 F.S. requires use of the SFHA as the minimum baseline condition for flood vulerability assessments. Therefore, WRMA used the SFHA as the reference floodplain for estimating coastal storm surge flooding in each decadal SLR scenario.

Typically, the SHFA is defined by the land area inundated by the 1% annual chance flood (a.k.a. the 100-year flood, or base flood). The corresponding base floodplain consists of areas flooded by coastal waterbodies, rivers/canals, and depressional areas known to pond. In addition to these, Lake Park is also subject to surcharge flooding from inadequate drainage. However, drainage flooding is not normally considered in FEMA studies.

In riverine areas, the floodplain is the result of insufficient conveyance of flow from an upstream watershed through a channel section. Factors affecting channel conveyance include the channel's profile grade (rate of fall), the cross-sectional area, the friction of the channel linings, the horizontal alignment, the tailwater elevation, the contributing flow rates, and of course the overall condition of the channel which evolves over time. The hydraulic performance of a channel can vary widely across different storm events. In urban areas, it can be a challenge for channels to accommodate flows from a 1% annual chance storm, especially at the downstream end of a tributary. For such intense storm events channels can become a source of extensive flooding. Hence, FEMA has a mandate to map potential riverine floodplains.

In coastal areas, the floodplain is the sum effects of the astronomical tide, coastal surge, and wave action. Coastal surge is the result of water being pushed towards the land, causing a rise in water levels above and beyond that produced by astronomical tides. Wave action is a representative term describing the combined effects from (1) the mass transport and onshore accumulation of water by deepwater waves (a.k.a. wave setup) and (2) the inland propagation of high velocity cresting waves (a.k.a. wave runup). Coastal surge and wave action can be produced by high surface winds or seismic events. In the case of Florida, those effects are typically produced by hurricanes or similarly strong storm events.

FEMA creates Flood Insurance Rate Maps (FIRMs) with regulatory Base Flood Elevations (BFEs) by modeling the above components for riverine and coastal area.

For coastal areas BFEs are the sum of the stillwater elevation (SWEL) plus wave runup, or the wave crest elevation, whichever is greater. A summary graphic of FEMA's designations for various coastal flood hazard zones and BFEs is shown below in **Figure 2-3**.

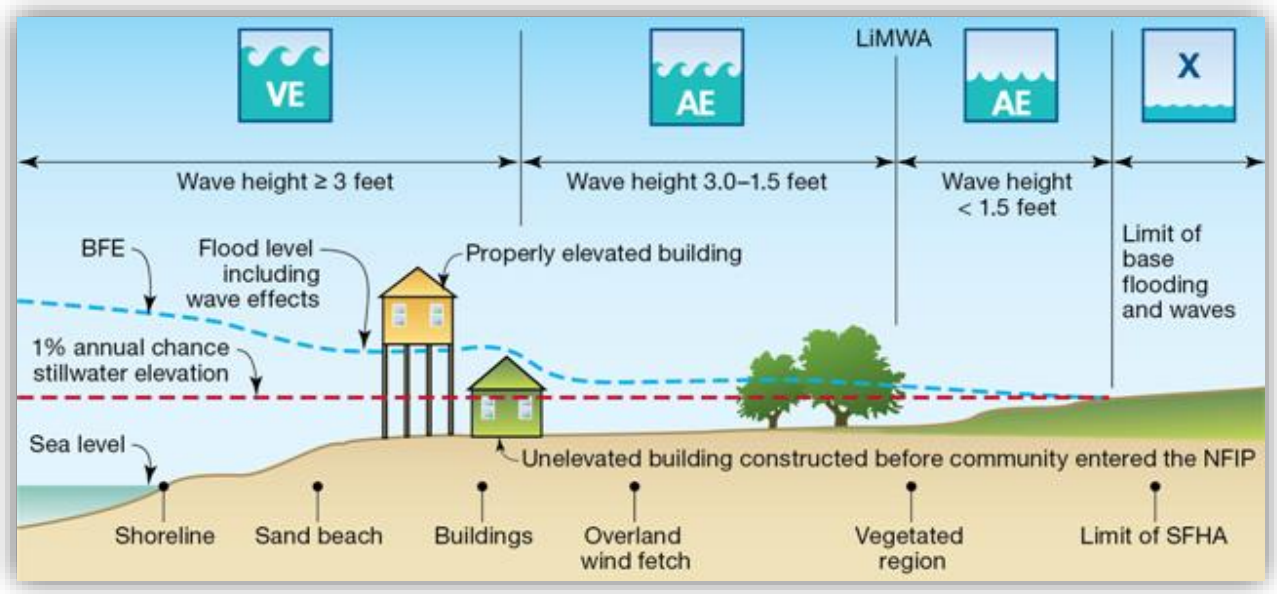


**Figure 2-3 - FEMA Coastal Transect depicting Flood Hazard Areas**

In review of FEMA's latest FIS for the Town of Lake Park, it was determined that the inland extent of coastal flooding defining the SFHA of Lake Park is governed by the 1% annual chance stillwater elevation (SWEL) of the Lake Worth Lagoon, located in the Intracoastal Waterway. As can be seen in **Figure 2-4**, the Preliminary 2019 FEMA FIS analyzed several transects adjacent to the Town. Of particular interest are Transects 183 through 185, which were used to analyze storm surge within the Intracoastal Waterway.

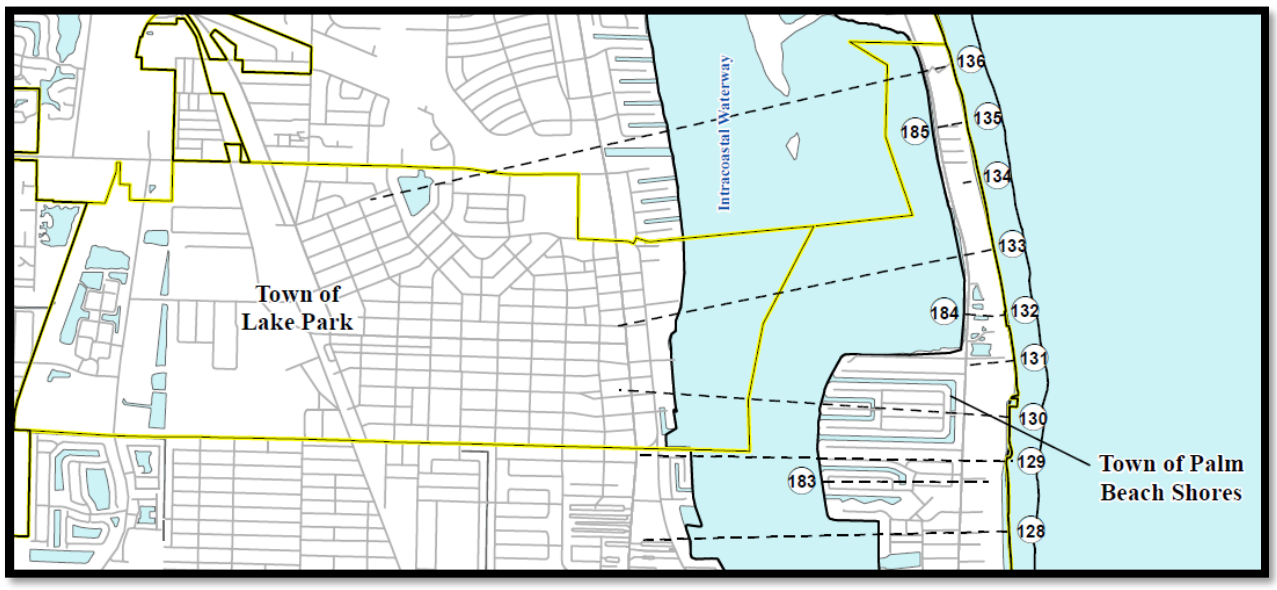


**Figure 2-4 - FEMA Transects for 2019 Preliminary Palm Beach Co. FIS**

Table 16 of the FIS, **Figure 2-5** below, shows that 1% Annual Chance Stillwater Elevations for this area ranged from 5.90' to 6.40' NAVD88. FEMA predominantly used value of 6.30' for the starting 1% SWEL in their modeling activities. WRMA chose in-kind to use a base 1% SWEL of 6.30' for the purposes of this vulnerability assessment.

**Table 16: Coastal Transect Parameters (continued)**

| Flood Source | Coastal Transect | Starting Wave Conditions for the 1% Annual Chance | | Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Significant Wave Height $H_s$ (ft) | Peak Wave Period $T_p$ (sec) | 10% Annual Chance | 4% Annual Chance | 2% Annual Chance | 1% Annual Chance | 0.2% Annual Chance |
| Intracoastal Waterway | 181 | 3.3 | 3.0 | 2.3<br>2.3-2.3 | 2.6<br>2.6-2.7 | 5.4<br>5.1-5.4 | 6.2<br>5.9-6.2 | 7.7<br>7.6-7.7 |
| Intracoastal Waterway | 182 | 2.6 | 2.8 | 2.3<br>2.3-2.3 | 2.6<br>2.6-2.6 | 5.4<br>5.0-5.4 | 6.2<br>5.9-6.2 | 7.7<br>7.5-7.7 |
| Intracoastal Waterway | 183 | 3.8 | 3.2 | 2.3<br>2.2-2.3 | 2.6<br>2.5-2.7 | 5.5<br>5.1-5.5 | 6.3<br>5.9-6.3 | 7.9<br>7.6-7.9 |
| Intracoastal Waterway | 184 | 2.6 | 2.7 | 2.3<br>2.3-2.3 | 2.6<br>2.6-2.6 | 5.5<br>5.4-5.5 | 6.3<br>6.0-6.3 | 7.9<br>7.6-7.9 |
| Intracoastal Waterway | 185 | 3.4 | 3.0 | 2.4<br>2.4-2.4 | 2.7<br>2.6-2.7 | 5.6<br>5.5-5.6 | 6.4<br>6.3-6.4 | 8.1<br>7.6-8.1 |
| Intracoastal Waterway | 186 | 2.8 | 2.8 | 2.5<br>2.3-2.5 | 2.8<br>2.6-2.8 | 5.8<br>5.4-5.9 | 6.7<br>6.2-6.8 | 8.5<br>7.6-8.6 |
| Intracoastal Waterway | 187 | 4.0 | 3.5 | 2.5<br>2.2-2.6 | 2.9<br>2.5-2.9 | 6.0<br>5.3-6.1 | 6.9<br>6.0-7.1 | 8.8<br>7.5-8.9 |

**Figure 2-5 - FEMA Transect Data from 2019 Preliminary Palm Beach Co. FIS**

It must be noted that the 1% annual chance SWEL is not the same between the Effective 2017 FIS and the Preliminary 2019 FIS.

- Table 10 of the Effective 2017 FIS puts the 1% SWEL for the Intracoastal Waterway at this location equal to 5.40' NAVD88
- Table 16 of the Preliminary 2019 FIS puts the 1% SWEL for the Intracoastal Waterway at this location equal to 6.30' NAVD88 (+0.9 feet)

In each SLR scenario, the future coastal floodplain was defined by the current 1% SWEL + SLR (i.e. the projected 1% SWEL).

In consideration of coastal BFEs, WRMA approximated base flood elevations by adding SLR on top of the current BFEs. Note from **Figure 2-3**, BFEs can be higher than the SWEL due to wave action, and typically decrease as water moves further inland. Where inland areas were *newly* inundated in a future scenario and thereby lacked a BFE, WRMA assigned a BFE equal to the projected 1% SWEL. A minimum BFE equal to the projected 1% SWEL was maintained throughout.

Regarding riverine flooding, full riverine analysis requires topographic & bathymetric data, and modeling at a level of detail outside the scope of this study. Given that riverine flooding is relevant for the Town, WRMA included those riverine areas which are included in FEMA's SFHA, but the riverine floodplains and associated BFEs were kept constant throughout each SLR scenario.

To summarize, the inland extent of future base flooding was approximated by the projected 1% SWEL and current riverine flooding, and the depth of flooding was approximated by the current BFE + SLR (riverine BFEs are constant).

**Table 2-4** displays the projected 1% SWEL, used to determine the extent of inundated topography within the Town for each scenario. The sea level rise values shown are relative to the year 2020, which is the approximate year of the 2019 FEMA FIS. These values were derived from the values shown in **Table 2-1**.

**Table 2-4 - Coastal Storm Surge Stillwater Elevations**

| 1% SWEL (feet-NAVD88) | | | | |
|---|---|---|---|---|
| **Ref Curve:** | **NOAA Intermediate-Low** | | **NOAA Intermediate-High** | |
| **Year** | **SLR (inches)*** | **Elevation (feet)** | **SLR (inches)*** | **Elevation (feet)** |
| 2020 | - | 6.30 | - | 6.30 |
| 2030 | 2.4 | 6.50 | 3.0 | 6.55 |
| 2040 | 5.0 | 6.71 | 6.6 | 6.85 |
| 2050 | 7.6 | 6.94 | 11.6 | 7.27 |
| 2060 | 10.4 | 7.16 | 18.2 | 7.82 |
| 2070 | 13.1 | 7.40 | 26.9 | 8.54 |

** SLR relative to year 2020 (approximate FIS effective date), as calculated from NOAA baseline year 2000*

# Section 3 Technical Analysis

## 3.1 Tidal Inundation Analysis

Fundamentally, tidal inundation in the Town will be felt when the future MHHW overtops the seawall *or* flows into low-lying terrain (below the MHHW) via hydraulic connections to the Lake Worth Lagoon. Terrain higher than the MHHW will effectively block the floodwater, however erosive conditions may emerge as SLR increases.

WRMA reviewed potential impacts from stormsewer infrastructure hydraulically connected to the Lake Worth Lagoon for each scenario year. Early-onset inundation may occur as low-lying drainage inlets and manholes surcharge from the tailwater. Hydraulic data for this analysis was derived from a previous survey of the Town's stormwater infrastructure completed by Calvin, Giordano & Associates, Inc. in 2019, and from acquired as-built plans for the Lake Shore Drive Improvements project completed by Baxter & Woodman, Inc. in 2022. Surcharge elevations were evaluated against the rim/grate elevations of the storm sewer structures.

Regarding seawall overtopping, Javier E. Bidot Associates, PSC., Corp. was contracted by WRMA to survey cross sections of the seawall along Lake Shore Drive (Lake Park) for the Seawall Assessment Project. This survey along with the 2018 LiDAR DEM provided an accurate picture of the coastal terrain in the Town.

Included in **Figure 3-1** and **Figure 3-2** are:

- The profile of the seawall cap (gray fill)
- Elevations of the projected MHHW, corresponding to the evaluated NOAA SLR projection
- Elevations of the projected 1% SWEL, corresponding to the evaluated NOAA SLR projection
    - Note: BFEs are higher than the SWEL along the seawall due to wave action
- The ground elevation profile set back 30 feet westward from the seawall face (black dashed line).

Station 0+00 begins at the northern edge of the Lake Park Harbor Marina, in close proximity to the Southern Outfall. The final Station, 29+16, terminates at the northern end of Lake Park near E Jasmine Drive.

For the following subsections, please refer to the seawall cap profiles below, and the flood maps located in **Appendix A**.

> *Note: Due to relative flood extents and depths, flood depth maps were only produced for the 2060 and 2070 NOAA Intermediate-High SLR scenarios.*

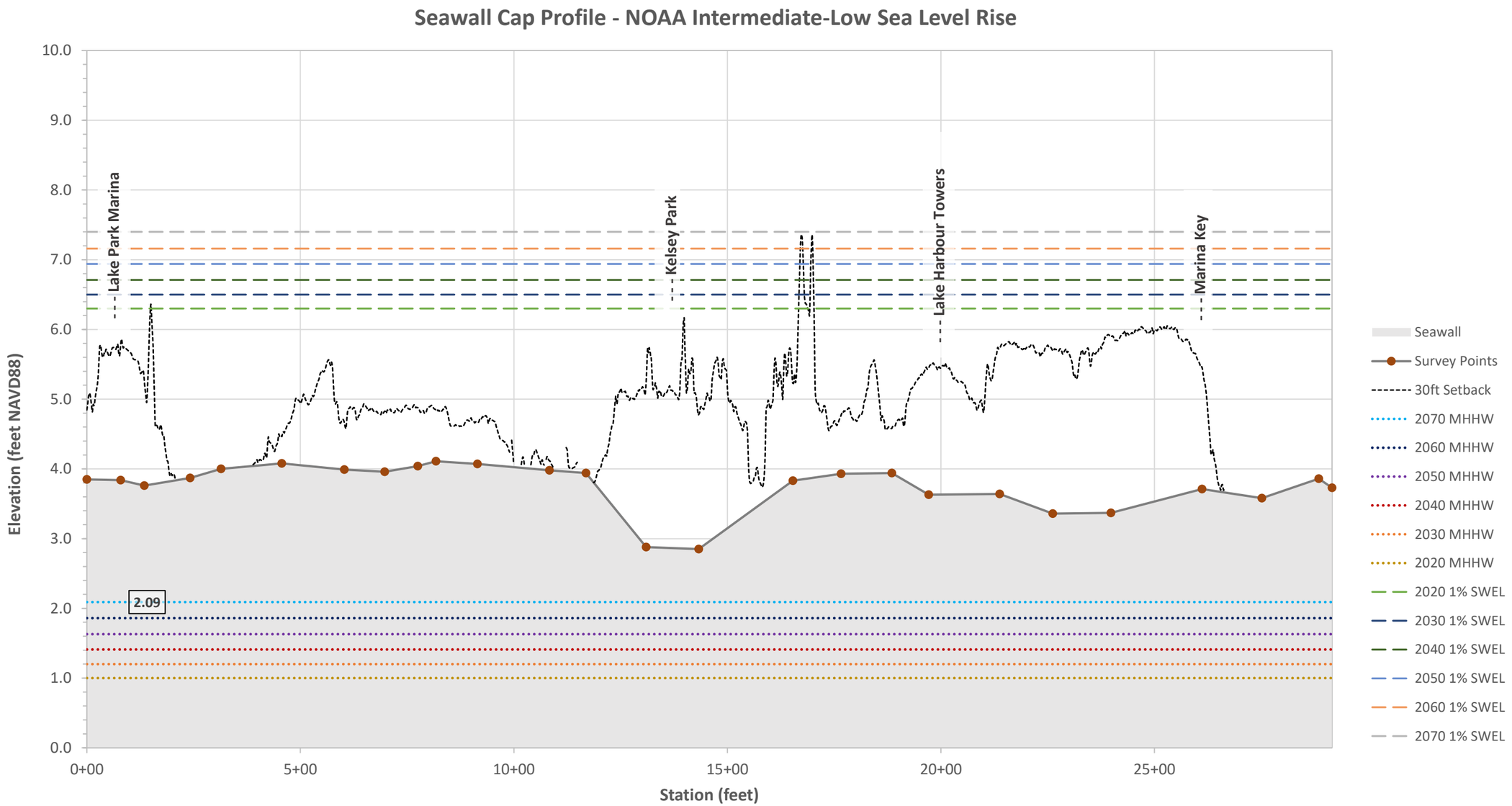


**Figure 3-1 - Lake Park Seawall Profile NOAA Intermediate-Low**

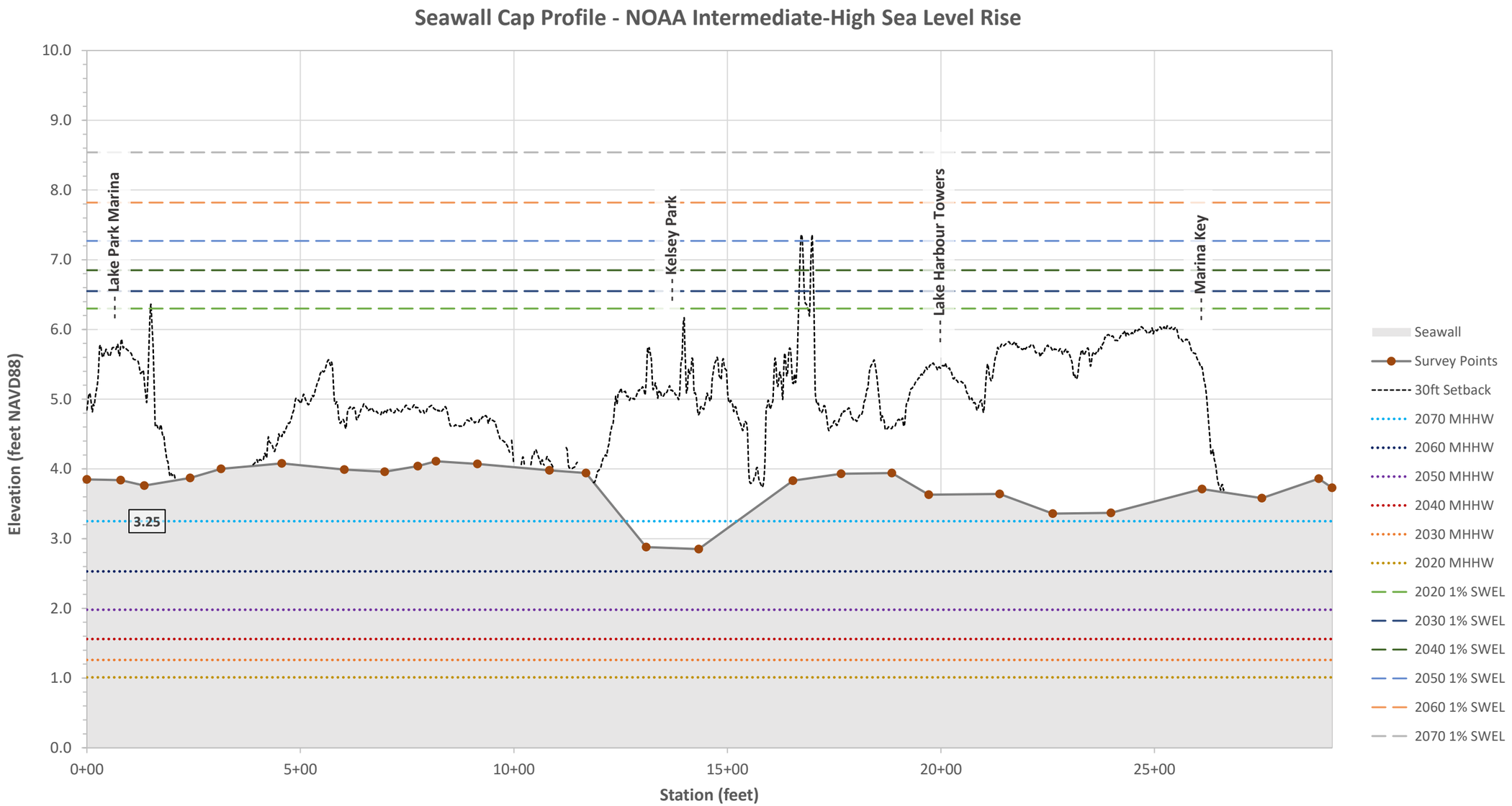


**Figure 3-2 - Lake Park Seawall Profile NOAA Intermediate-High**

### 3.1.1 2020 Tidal Inundation

None

### 3.1.2 2030 Tidal Inundation

None

### 3.1.3 2040 Tidal Inundation

None

### 3.1.4 2050 Tidal Inundation

*NOAA Intermediate-Low Projection:*

None

*NOAA Intermediate-High Projection:*

Tidal water will begin surface at inlet & manhole locations adjacent to Kelsey Park and the Lake Park Marina parking lot, below elevation 1.98'. The magnitude of inundation will be very minor, and the extent limited to grassed areas only.

### 3.1.5 2060 Tidal Inundation

*NOAA Intermediate-Low Projection:*

Tidal water will begin surface at inlet & manhole locations adjacent to Kelsey Park and the Lake Park Marina parking lot, below elevation 1.86'. The magnitude of inundation will be very minor, and the extent limited to grassed areas only.

*NOAA Intermediate-High Projection:*

Tidal water will surface at inlet & manhole locations along Lake Shore Drive and at the Lake Park Marina, below elevation 2.53'. The magnitude of inundation along Lake Shore Drive will be great enough to cross the roadway crown. As shown in **Figure 3-3**, surfaced water will collect at the sags in Lake Shore Drive's roadway profile and will be particularly concentrated near Kelsey Park. However, the extent of inundation will not significantly encroach into nearby properties.

Due to the recurrent flooding on Lake Shore Dr, the east portion of Kelsey Park (east of Lake Shore Dr) will be at risk of a permanent loss of function (PLOF) despite incurring no physical damage. The west portion of Kelsey Park adjacent to US-1 will remain accessible, though the dedicated parking lot located east of Lake Shore Dr will be blocked. Parking will be restricted to available spaces parallel to Foresteria Dr and Greenbriar Dr.

Similarly, the high-density condominiums of 301 Lake Shore Dr and 401 Lake Shore Dr, two of the three the Lake Harbour Towers, will not risk physical damage but will be at risk of PLOF when the driveways become inaccessible.

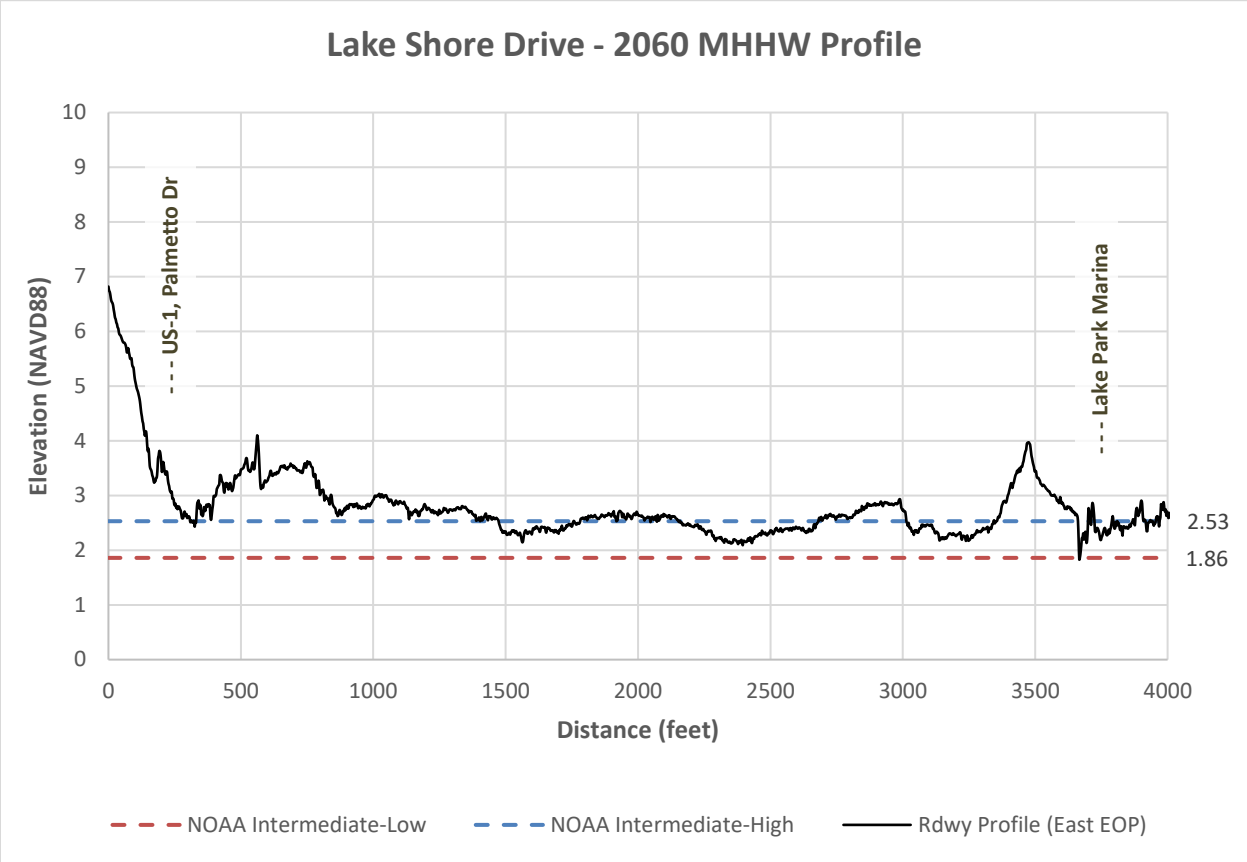


**Figure 3-3 - Lake Shore Drive 2060 MHHW Profile**

Furthermore, a cluster of properties located on the northern edge of the Town and surrounding a branch end of the Earman River, otherwise known as "South Lake", may begin to experience minor but daily tidal encroachment from the waterfront as the water level exceeds the elevation of the existing docks and seawall at high tide. The properties are bounded by Flagler Blvd, W Kalmia Dr and Northlake Blvd.

### 3.1.6 2070 Tidal Inundation

*NOAA Intermediate-Low Projection:*

Tidal water will surface at inlet & manhole locations adjacent to Kelsey Park and the Lake Park Marina parking lot, below elevation 2.09'. The magnitude of inundation will be minor, though the extent of inundation will begin to encroach into the roadway of Lake Shore Dr and hence become a daily nuisance.

*NOAA Intermediate-High Projection:*

**Figure 3-2** shows that the seawall will be overtopped in 2070 at Kelsey Park. However, the ground profile 30 feet behind (inland) the seawall indicates that adjacent terrain is high enough to preclude tidal inundation via overtopping alone.

Despite the seawall overtopping being negated at Kelsey Park, tidal water will surface along Lake Shore Drive and extend into the lawn portions of [West] Kelsey Park, including two tennis courts.

Previously isolated surcharge in 2060 (*NOAA Intermediate-High*) will become interconnected and span the entire length of the roadway. The magnitude of inundation will render Lake Shore Drive largely inaccessible, due to a daily flood depth of 8-inches on average and up to 15-inches at the maximum. This depth can be seen visually in **Figure 3-4**.

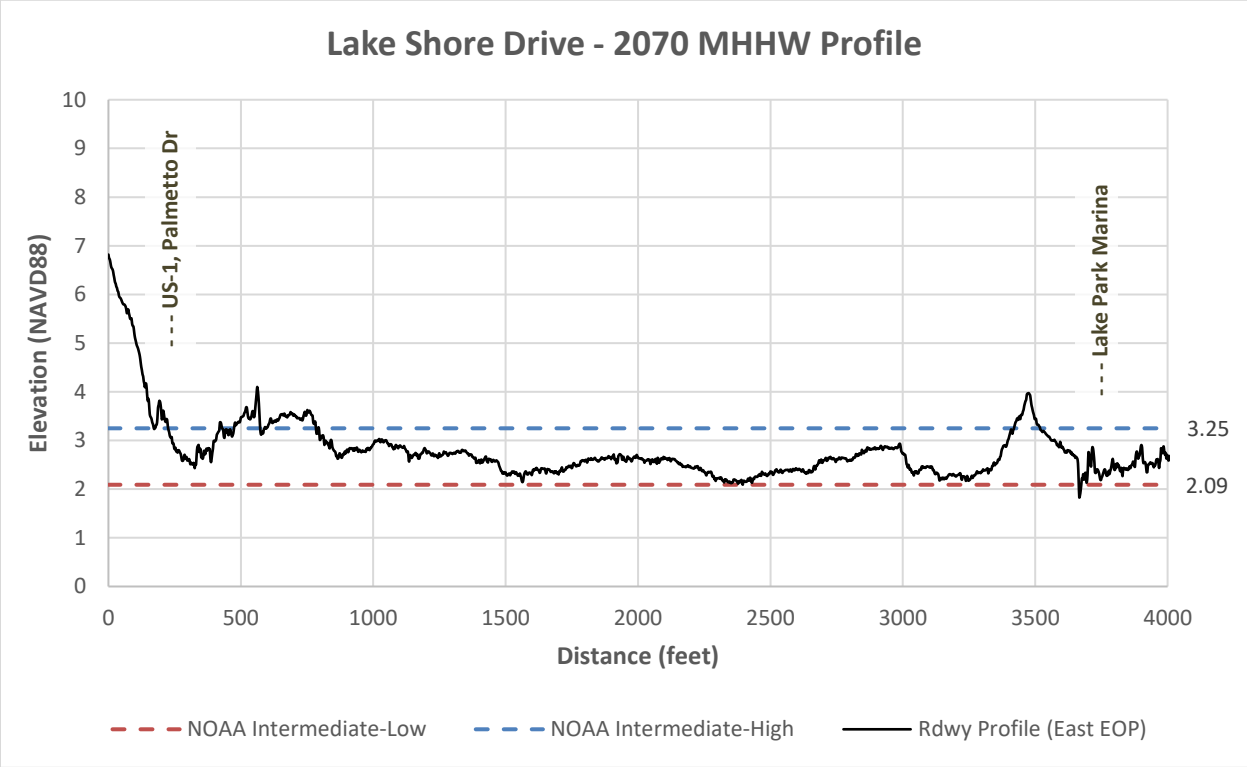


**Figure 3-4 - Lake Shore Drive 2070 MHHW Profile**

Access will be restricted for properties along Lake Shore Dr without secondary access points from N Federal Hwy (US-1), potentially resulting in PLOF for those properties. Furthermore, the Lake Park Marina also receives significant inundation. This inundation stems from both overtopping of the seawall and pier within the confines of the Marina, as well as from a detention pond control structure located within the marina pier. Flood waters will extend south along Lake Shore Dr towards the boat ramp and the Marina's parking lot. It should be noted that the tidal condition in the years preceding 2070 could pose a hazard to boats or floating structures mooring at the docks & pier.

The following properties were noted to be at risk of potential structural inundation if their associated first floors are below the projected MHHW elevation (3.25'):

- 414 Lake Shore Dr (Multifamily home)
- 810 Lake Shore Dr (Condominium complex), *Lake View Condominium*
- 510 Lake Shore Dr (Condominium complex), *Lake Shore Condominium Apartments*
- 210 Lake Shore Dr (Condominium complex), *Nautilus 220*

Lastly, the properties located at South Lake will experience further tidal encroachment from the waterfront, though they will not be at risk of structural inundation.

## 3.2 Coastal Flood Analysis

WRMA selected FEMA's Special Flood Hazard Area (SFHA) as the representative floodplain for each decadal SLR scenario. As described in **Section 2.3**, the Town of Lake Park's SFHA is fundamentally equivalent to the area inundated under the 1% annual chance stillwater elevation (SWEL). WRMA approximated the extent of the future base flood by adding projected sea level rise to the current 1% SWEL. High ground areas inundated by current day wave action, as modeled in the effective FEMA FIS, were also incorporated.

In addition, for each coastal storm surge scenario WRMA reviewed potential impacts from stormsewer infrastructure hydraulically connected to the Lake Worth Lagoon. Areas found to be inundated by tailwater surcharge were included in each flood map.

As for the riverine areas of Lake Park along the C-17 Canal, this stretch is subject to the controlled influence of a dam structure located near the northwest corner of the Town. Spillway #44, or S-44, is maintained and operated by the South Florida Water Management District to control water levels downstream of the dam as well as to protect the C-17 from saltwater intrusion. To properly evaluate the hydraulic performance of this canal, and in-turn potential floodplain, requires a vast amount of detailed survey data as well complex modeling outside the scope of this analysis. For these reasons, the current SFHA extent and associated BFEs of this area were kept constant in each scenario.

For the following subsections, please refer to the maps in **Appendix B**. Keep in mind the impacts and risks described in each scenario are cumulative.

### 3.2.1 2020 Base Flood

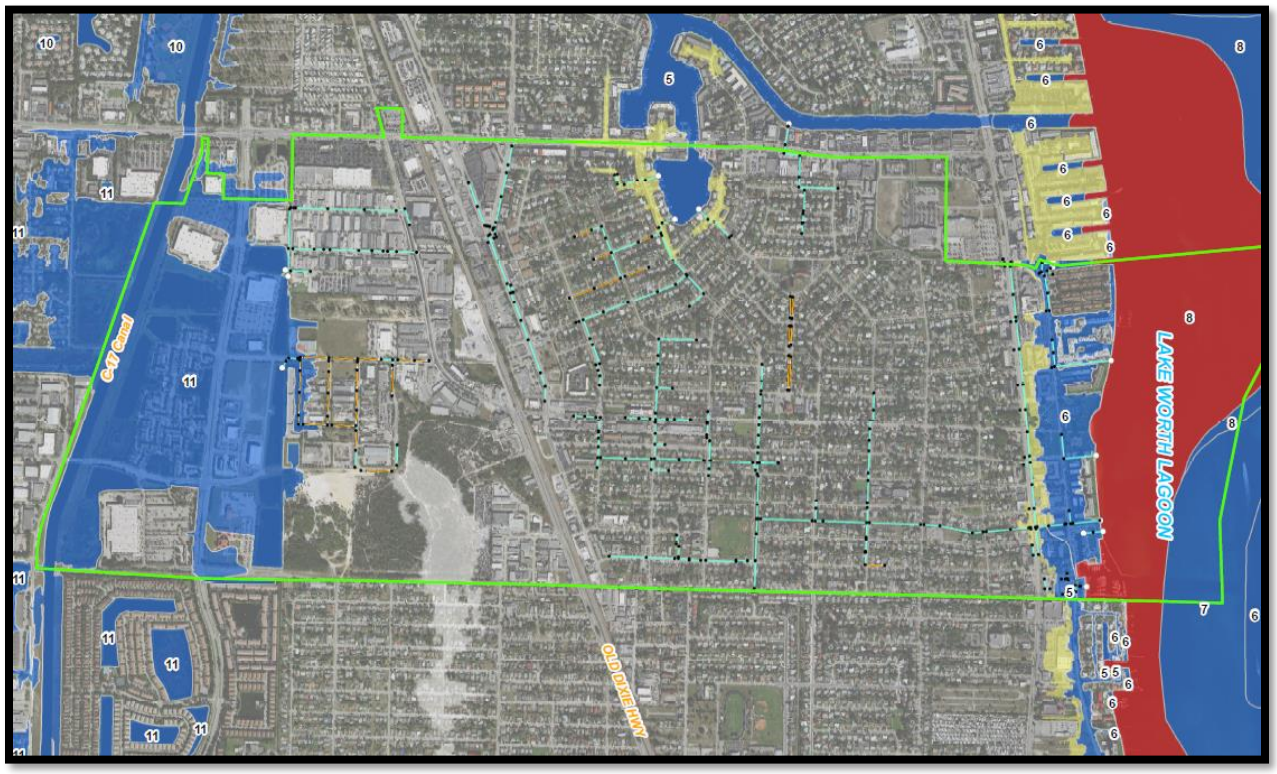


**Figure 3-5 - FEMA Flood Hazard Areas - Effective 2017**

The current FEMA SFHA for this area, effective 2017, is shown above in **Figure 3-5**.

The blue-shaded zones represent the base floodplain of the 1% annual chance (100-year) storm event. The red-shaded zone represents the same base floodplain where waves greater than 3 feet may occur. The yellow-shaded zone represents the floodplain of the 0.2% annual chance (500-year) storm event, which is not studied in this analysis.

WRMA observed no changes in the SHFA of Lake Park in the 2023 NFHL compared to the effective FIRMs of the area, indicating that the current GIS database has not been updated with modeled results of the 2019 Preliminary FIS. It must be noted that the 1% annual chance SWEL is not the same between the Effective 2017 FIS and the Preliminary 2019 FIS.

- Table 10 of the Effective 2017 FIS puts the 1% SWEL for the Intracoastal Waterway at this location equal to 5.40’ NAVD88
- Table 16 of the Preliminary 2019 FIS puts the 1% SWEL for the Intracoastal Waterway at this location equal to 6.30’ NAVD88 (+0.9 feet)

For the above reason, WRMA has provided an updated year 2020 flood map as a baseline reference to compare with the following SLR scenarios.

As it stands, the effective FEMA flood map shows that the 100-year coastal surge from the Lake Worth Lagoon overtops the primary seawall in the present-day scenario. Waves potentially greater than 3 feet will propagate inland from the Lagoon. Coastal flooding in the effective 100-year event will broadly cover the waterfront area and extend far to the west but stop short of N Federal Hwy (US-1). Numerous structures of various use types will be inundated, including the facility at Earl Stewart Toyota.

Other structures above the 1% SWEL, but which are still subject to wave action, may be subject to inundation. Notably, the Bay Reach Condominiums are located on relatively higher ground. The Condominiums' roadway, however, will become inundated and may inundate adjacent residential structures. The Condominiums there closest to the seawall may experience wave-induced flooding.

From the west, properties along the C-17 Canal will be subjected to riverine surge, with base flood elevations reaching up to 11 feet. Properties at risk in that area include but are not limited to: Kohl's, PetSmart, Aldi Food Market, RaceTrac, and the U.S. Army Reserve facility. However, the large retail stores of Lowe's Home Improvement and the Walmart Supercenter are elevated above the floodplain.

At the north side of the Town, drainage located in Flagler Blvd, Northern Dr, and W Kalmia Dr will be subject to tailwater surcharge from the Earman River. FEMA currently (effective 2017) shows the SFHA in this area as being limited by the seawall and puts the inland area within the 0.2% annual chance (500-year) floodplain. However, WRMA's analysis shows that the 1% SWEL of the preliminary 2019 FIS, equal to 6.30', overtops the seawall and extends into this area. The corresponding tidal water will structurally inundate a few of the adjacent homes. This surcharge will also extend into a portion of Northlake Blvd from the corner of Poplar Ct to the west approach of the South Lake bridge. Flood waters here will reach up to 2 feet in depth, completely blocking traffic. Note: a water depth of 6-inches is enough to reach the bottom of most passenger cars and induce a loss of control or motor-stall.

This is a significant risk to note. North Lake Blvd serves as a primary escape route for residents of the Town, as it provides direct access to I-95. WRMA recommends having a plan to divert traffic coming from the east of the bridge. Coordination with FDOT and local officials to the north (North Palm Beach) and south (Riviera Beach) will be essential, as US-1 may also be blocked in certain locations.

### 3.2.2 2030 Base Flood

*[The following is inclusive of all inundation described in the present-day scenario.]*

*NOAA Intermediate-Low Projection:*

Flooding along the Lagoon waterfront will progress westward but remain short of US-1. Connected drainage inlets & manholes along US-1 will surcharge if their rim/grate elevation is below the 6.50' SWEL elevation.

The roadway of the Bay Reach Condominiums will see expanded inundation.

Properties near South Lake (northern edge of the Town) will see a pronounced increase in flooding, extending into Magnolia Dr. Two additional single-family homes in the area will be inundated. The extent of inundation along Northlake Blvd will be mostly unchanged.

*NOAA Intermediate-High Projection:*

Inundation will be approximately the same as above, with a marginally expanded extent. Associated base flood elevations will be higher.

### 3.2.3 2040 Base Flood

*[The following is inclusive of all inundation described in the previous scenarios.]*

*NOAA Intermediate-Low Projection:*

The roadway of the Bay Reach Condominiums will see expanded inundation.

Drainage inlets & manholes at the corner of Foresteria Dr and US-1 will produce shallow ponding, though likely not enough to preclude assess to US-1.

Several more properties near South Lake will be affected as inundation expands into Poplar Dr and Jasmine Dr. One additional building in the area will be inundated. The extent of inundation along Northlake Blvd will be mostly unchanged.

*NOAA Intermediate-High Projection:*

Every structure east of US-1 is at risk of inundation from the coastal flood, including all of Beach Reach Condominiums.

Again, South Lake will see more impacts as flood waters propagate further upstream. Two additional residential structures will be inundated.

### 3.2.4 2050 Base Flood

*[The following is inclusive of all inundation described in the previous scenarios.]*

*NOAA Intermediate-Low Projection:*

By 2050, every property east of US-1 will be inundated from the coastal flood, even in the Intermediate-Low projection. Flooding along US-1 itself will be concentrated at the sag between Cypress Dr and Date Palm Dr (approx. location of Dunkin' Donuts) and be deep enough to cover the roadway crown. However, the roadway should remain traversable given the shallow depth of flooding.

Drainage connections will permit floodwater to flow into 2nd St. as well as Foresteria Dr., though this surcharge will be very minor.

The extent of flooding at South Lake will be marginally larger than the 2040 projection. No additional structures in this area are expected to be inundated.

*NOAA Intermediate-High Projection:*

The expansion of inundation into residential streets is much more pronounced in the Intermediate-High projection.

Flooding at 2nd St and Foresteria Dr will be interconnected, affecting several more residential properties, and inundating two additional structures.

All the waterfront properties at South Lake will be structurally inundated. Additional structures will be inundated in the adjacent side streets.

The inundation along North Lake Blvd will approximately extend from the corner of Prosperity Farms Rd to the South Lake Bridge.

### 3.2.5 2060 Base Flood

*NOAA Intermediate-Low Projection:*

*[The 1% SWEL of the 2060 NOAA Intermediate-Low Projection was noted to be lower than that of the 2050 NOAA Intermediate-High, but still higher than the 2050 NOAA Intermediate-Low. Thus, this projection is inclusive of all inundation described at or under the 2050 NOAA Intermediate-Low projected 1% SWEL.]*

Flooding at 2nd St and Foresteria Dr will be interconnected, affecting several more residential properties, and inundating two additional structures.

All the waterfront properties at South Lake will be structurally inundated. Flooding will continue to branch out from South Lake, though no additional side street structures from the previous scenario will be inundated.

*NOAA Intermediate-High Projection:*

*[This projection is inclusive of all inundation described in the previous scenarios.]*

Coastal inundation will spread further into the residential side streets west of US-1 and will encompass the previous areas as well as Cypress Dr, Evergreen Dr, Park Ave, Greenbriar Dr. Nearly 20 residential homes in this area will be structurally inundated.

Flooding at the sag of US-1 may preclude the roadway as a viable escape route, with flood depths exceeding 1-foot.

Flooding at South Lake will again expand, and due to drainage connections and isolated portion of W Ilex Dr will also be inundated. All properties northward of Flagler Blvd and Jasmine Dr will be completely cut off by floodwaters.

### 3.2.6 2070 Base Flood

*NOAA Intermediate-Low Projection:*

*[The 1% SWEL of the 2070 NOAA Intermediate-Low Projection was noted to be lower than that of the 2060 NOAA Intermediate-High, but still higher than the 2060 NOAA Intermediate-Low. Thus, this projection is inclusive of all inundation described at or under the 2060 NOAA Intermediate-Low projected 1% SWEL.]*

Flooding at 2nd St and Foresteria Dr will be interconnected, affecting several more residential properties. Five structures within the affected properties will experience inundation.

All the waterfront properties at South Lake will be structurally inundated. Flooding will continue to branch out from South Lake, and three additional side street structures from the previous scenario will be inundated.

*NOAA Intermediate-High Projection:*

*[This projection is inclusive of all inundation described in the previous scenarios.]*

Apart from E Kalmia Dr, coastal inundation will spread across all side streets west of US-1, inundating up to 60 structures. Additionally, drainage connections along 4th St, 5th St, and 6th St will surcharge if their rim/grate elevation resides below the projected 1% SWEL.

Flooding along US-1 will extend from south of the Town's boundary (Riviera Beach) to the E Ilex Dr, with flood depths exceeding 2-feet.

Previously isolated drainage surcharge along W Ilex Dr will be interconnected with the expanded floodwaters stemming from South Lake. All properties northward of Flagler Blvd and Jasmine Dr will be completely cut off by floodwaters.

# Section 4 Vulnerability Assessment

## 4.1 Tidal Inundation Risk Assessment

WRMA's analysis has determined that the overall risk associated with tidal inundation is low in the 30-year time horizon but will eventually become high by 2070.

In addition to considering the risks apparent from semidiurnal high tides, this assessment also accounts for the added risks of seasonal King Tides due to anticipated sea level rise. The effects of king tides cannot be discounted; especially on a new or full moon and when the Moon is at its perigee. This can occur 6 to 8 times per year and yield exceptionally high tides in the Fall and Spring. Sea level rise will only exacerbate these tides, and therefore king tides are likely to become a concerning issue in the decades preceding 2070.

Though king tides are a known phenomenon, they typically are not used in tidal inundation mapping due to their variability geographically and throughout the seasons. For Florida, the highest king tides are usually experienced in the Fall rather than Spring, due to local seasonal temperatures and currents (NOAA). To illustrate the possible magnitude of king tides that Florida can experience, the following king tides were recorded in 2019 at the Lake Worth Pier tide gauge:

- Fall – November 28, 2019 – 1.64' NAVD88
- Spring – April 19, 2019 – 1.05' NAVD88

The fall king tide above was approximately three times higher than the average highest high tide throughout the current tidal epoch (0.55' NAVD88). Given the potential magnitude of Kind Tides, an appropriate level of conservatism would at least put such tides above the current MHHW.

By that estimation, low-lying drainage infrastructure within the Town could be a point of vulnerability by 2040, when between 9- to 11-inches of sea level rise is projected. This is not likely to result in any significant physical damage, if at all. However, by 2060 the risk will be appreciably higher as sea level rise may enable king tides to overtop the Town's seawall several times per year.

The assessed risks for each decadal scenario are qualitatively categorized below in **Table 4-1**.

**Table 4-1 - Tidal Inundation Risk Assessment**

| Scenario Year | Parcel Units Risking PLOF | Scenario Risks | Overall Risk Assessment |
|---|---|---|---|
| 2020 | 0 | - | Low |
| 2030 | 0 | - | Low |
| 2040 | 0 | King Tides | Low |
| 2050 | 0 | Drainage + King Tides | Low |
| 2060 | 280 | Drainage + King Tides | Moderate |
| 2070 | 656 | Drainage + Overtopping | High |

The assessment table shows an accelerated transition of risk from low-to-high in the period between 2050 and 2070. This primarily reflects the loss of property access along Lake Shore Drive as the result of recurrent inundation by drainage surcharge in 2060 and onward. Referring to **Figure 3-3** and **Figure 3-4**, average daily flood depths along this road could reach 2.5 inches in 2060 and 8-inches in 2070, up to a maximum daily flood depth of 15-inches.

As a result of this flooding Kelsey Park, a major attraction and critical asset for the Town, will be subject to limited use by 2060 and risk permanent closure by 2070.

**Prior to the year 2060, this vulnerability could be addressed by adjusting the rim/grate elevations of existing drainage structures along Lake Shore Dr to lay above the projected MHHW.**

Considering further risks to Lake Shore Dr, a key point of vulnerability is the existing bridge on Lake Shore Dr, near the Lake Park Marina entrance. The lowest elevation along the crest of this bridge approximately equals 3.70'. As indicated by LiDAR, overtopping of the Marina seawall will occur as the MHHW exceeds elevation 3.15'. However, this inundation will be blocked from continuing north into Lake Shore Dr by the higher existing bridge crest.

This condition is only temporary though. The elevational difference between the low point of the bridge crest and the current MHHW (referenced to the year 2000) is 3.04-feet. An equal amount of sea level rise may occur by the mid-2070s according to the NOAA Intermediate-High projection. The consequences of the tidal overtopping of the Marina followed by the Lake Shore Dr bridge crest may be categorized as severe.

**Prior to the year 2070, this vulnerability could be addressed by:**

- **Installing permanent (mechanically deployed) flood barriers at the approximate location of the bridge**
- **Retrofitting (raising) the existing seawall from the southern boundary of the Town to the property line of 301 Lake Shore Dr**
- **Reconstructing portions of the Lake Park Marina to have ground elevations adjacent to the seawall high enough to preclude the spread of tidal flooding**
- **Raising the profile of Lake Shore Dr**

Overall, risks in 2070 become much higher due to the high-occupancy residential structures along Lake Shore Drive potentially rendered functionally uninhabitable, either by inaccessibility or structural inundation. This is reflected by the number of parcel units shown in **Table 4-1**.

Lastly and not yet discussed are the disruptive impacts sea level rise will have on the ability of stormsewer throughout the Town to effectively discharge. As the Mean Sea Level continues to rise throughout the 50-year time horizon, the advancing tailwater will continually degrade hydraulic efficiency. Hydraulic grade line (HGL) elevations along the gravity-fed storm sewer will increase, in turn increasing head losses across the system. During typical storm events, HGL elevations could reach high enough to surcharge drainage structures previously operating adequately. Such flooding may become even more widespread during particularly intense storm events coinciding with high tides or king tides. The Town is advised to note areas already known to experience recurrent flooding during storm events. These locations will likely experience exacerbated flooding because of higher future tides.

### 4.1.1 Tidal Inundation Risk to Critical Facilities

Several critical facilities, as determined by the standards set forth in Section 380.093 F.S, were noted to be in the projected tidal floodplain within the 50-year time horizon. These are bulleted below.

- The following local streets:
  - Lake Shore Dr
  - Cypress Dr
  - Date Palm Dr
  - Evergreen Dr
  - Foresteria Dr
  - Greenbriar Dr
  - Hawthorne Dr
  - E Ilex Dr
  - E Jasmine Dr
- Kelsey Park
- Lake Park Harbour Marina

The projected tidal flood depths at each facility can be viewed in **Appendix A**.

## 4.2 Coastal Storm Surge Risk Assessment

In general, risks associated with the 1% annual chance (100-year) flood are inherently high throughout all scenarios.

As shown in the **Appendix B** flood maps, a large portion of flooding stems from the C-17 Canal, with a base flood elevation of 11-feet NAVD88. Numerous structures are shown to be theoretically inundated, because LiDAR elevations for that area register below the BFE. However, South Florida Water Management District - Environmental Resource Permits (ERPs) issued since 2002 for this area, known as Westlake, mandate that any new construction must have a building first floor elevation of 13-feet NGVD29 (11.5-feet NAVD88). This value comes from previous FIS studies and a 2002 hydraulic study of the C-17 Canal performed by Mock Roos. Given that current properties in the Westlake area were not constructed until 2002 and later, they are subject to the permits' mandate and as such should have been constructed with first floors at or above the established BFE.

Considering this, WRMA assumed that structures in the Westlake area would NOT be inundated. However, it must be noted that a future rise in the base flood elevation of a foot or more could result in structural inundation at significant monetary cost. This is due to the large concentration of multi-family structures which serve as affordable housing in the Westlake area, and other notable properties including the high-square-footage community storefronts such as Kohls, PetSmart, etc. These storefront properties are valued quite high, and their structural contents are also valued higher relative to other residential and office properties.

Aside from the westward risk of the C-17 Canal, much of the remaining flood risk is derivative of the waterfront areas along the Lake Worth Lagoon. In the 50-year projections, flooding from the Lagoon encompasses the entire eastern border of the Town and extends as far west as 2nd St, well past N Federal Hwy (US-1). By 2070, 154 structures are expected to be at risk of inundation from floodwater stemming from the Lake Worth Lagoon. Structural damages will be markedly high for those properties subject to SLR-increased wave action.

Risk to residences is also high for the properties located on Lake Park's northern border, adjacent to the branch end of the Earman River (South Lake). These properties are vulnerable to the tailwater condition of the river. This location is also the outlet for three stormsewer networks serving a drainage area of 169 acres. By 2070, 114 structures in this area are expected to be inundated by floodwater stemming from the Earman River.

Regarding roadways, drainage along US-1 which is directly connected to the Lagoon will induce surcharge flooding and preclude use of the roadway as a viable escape by 2070. With access to Northlake Blvd already precluded in the present day, WRMA recommends a plan to divert all Lake Park traffic to Park Avenue and/or Silver Beach Road, to be directed westward to Old Dixie Hwy followed by I-95.

It should be noted that this analysis did not include hydrologic & hydraulic modeling of the storm sewer. The total flood hazard area could be much more extensive in the future scenarios due to overall drainage inadequacies, regardless of coastal surge.

### 4.2.1 Coastal Storm Surge Risk to Critical Facilities

Broadly speaking, most of the coastal storm surge flood risk is spread across the residential properties throughout the Town. However, several critical facilities, as determined by the standards set forth in Section 380.093 F.S, were noted to be in the projected SFHA within the 50-year time horizon. These are bulleted below.

- Northlake Blvd (major thoroughfare)
- N Federal Hwy (major thoroughfare)
- The following local streets:
    - Lake Shore Dr
    - Palmetto Dr
    - E Jasmine Dr
    - E Ilex Dr
    - Hawthorne Dr
    - Greenbriar Dr
    - Park Ave
    - Foresteria Dr
    - Evergreen Dr
    - Date Palm Dr
    - Cypress Dr
    - 2nd St
    - 5th St
    - Prosperity Farms Rd
    - Poplar Ct
    - Poplar Dr
    - Flagler Blvd
    - W Kalmia Dr
    - Northern Dr
    - Magnolia Dr
    - Laurel Dr
    - Jasmine Dr
    - W Ilex Dr
    - Palmetto Rd
    - Teak Dr

- Affordable housing at 303 N Congress Ave, known as San Marco Villas
    - Resides within the C-17 floodplain, may have first floors at or above BFE
- U.S. Army Reserve Center at 1700 Silver Beach Rd
    - Resides within the C-17 floodplain, may have first floors at or above BFE
- 700 Federal Hwy (Medical Office)
- 624 Federal Hwy (Medical Office)
- 500 Federal Hwy (Medical Office)
- 406 Federal Hwy (Children's Academy)
- Kelsey Park

- Lake Park Harbour Marina
- The following Wastewater Lift Stations (Seacoast Utility Authority):
    - LS 140, located at 778 San Marcos Circle
    - LS 045, located at Water Rd
    - LS 139, located in Lowe's parking lot
    - LS 063, located at 1120 West St
    - LS 013, located in Kelsey Park [West] along Greenbriar Dr

The projected coastal storm surge flood depths at each facility can be viewed in **Appendix B**.

# Section 5 Adapting to Sea Level Rise

## 5.1 Resiliency and Flood Risk Reduction

Even today the impacts of coastal flooding can be severe and long-lasting. WRMA's analysis of flood risks for the Town of Lake Park has shown that sea level rise will escalate those risks substantially by the year 2070.

Broadly speaking, addressing such risks will be a challenge for communities in the coming decades. Extreme flood events are becoming relatively more extreme, and a question for many communities is where to draw the line in terms of future flood protection. Do they protect for the 100-year storm, or the 50-year storm? Costs associated with hard flood protections for extreme events are typically very high and may not be within the budgetary constraints of a community, even if the benefit-cost ratio is greater than 1.0 (essentially worth doing). Public health & safety is of course the governing factor, but it often is the case that protecting against smaller more frequent events is the only economically feasible option.

Each community is unique, and however extreme the risks are, the best starting point for any community pursuing flood risk reduction is promoting what is known as resiliency.

Resiliency is the ability of a facility or infrastructure to withstand and quickly recover from the occurrence of natural disaster. In practice, resiliency can be implemented at all levels of design. This includes architectural and structural design, utility and water resources design, and even roadway design. Generally, the earlier that resiliency is implemented the better, even at the planning and development phase.

There are four main considerations in promoting resiliency:

- **Prioritizing Assets**

  Implementing resiliency begins with the identification of critical assets. These are assets which the public's health, safety, and culture are reliant upon, such as hospitals, pump stations, treatment facilities, government facilities, churches, escape routes, and so on… It is important that should the community as a whole not have sufficient protection against certain natural hazards, these assets will remain in service or quickly bounce back into service in the event of a catastrophe.

- **Determining Useful Life**

  Useful life represents the total expected service life of a facility, beyond the intended lifespan for which it was designed. It is not uncommon for some buildings designed for only 30 years to remain in use an additional 20 years, or even 50 years. The siting of more permanent infrastructure such as government buildings or sewer outfalls should be considerate of this, and final designs should reflect some level of conservatism and flexibility for extended service life.

- **Identifying Hazards**

  Hand in hand with useful life is the consideration of hazards, which must not only account for today's climate but also extend to future climate conditions which may present additional hazards throughout the useful life of a facility. In the case of the Town, future hazards consist of daily

tidal inundation, coastal flooding from extreme storm events, and extreme heat as a result of global temperature rise.

- **Flexibility**

  In accounting for potential useful life and future hazards, designers can manage uncertainty by planning for adaptation. For instance, a flood wall's structure and foundation can be designed to support an integral increase in height should the need arise.

  Designing for adaptation to begin with could reduce the overall barrier to entry for higher-level protections to an affordable point in the future. Not doing so may result in having to reinforce the infrastructure or rebuild it altogether, which could be outside budgetary constraints if not practically impossible.

These factors will inform designers and planners on what measures can be taken to cost-effectively manage flood risk and make communities more resilient.

## 5.2 Comprehensive Plan Projects

Section 8.4.2.4 of the 2021 SWMP presents a complete list of the Capital Improvement Projects (CIPs) for development as part of the Town's 20-year plan.

To address future warming and thereby increased rainfall intensities, the SWMP is prioritizing the creation of more pervious areas to offset future runoff production. The objective is a 10% reduction of impervious areas along right-of-way areas and at paved parking lots.

To achieve this objective the Town is implementing the 5% Roadway Bioswale program and the following projects have been identified for implementation in the 2021-2025 CIP 5-year plan.

> *Note: Due the large number of projected in the long-term plan, all CIPs have been arranged into divisions that will facilitate the organization of information pertaining to the various stages of project development, including planning, grant pursuits, engineering, permitting and construction phases.* ***Figure 5-1*** *displays the divisional CIPs currently in progress or development.*


**Figure 5-1 – Current Divisional Projects in Progress (or Development)**

## Division G – 2nd Street Corridor Roadside Swale and Green Infrastructure Improvements

**Project Objective**: To install bio-retention planters and grade a roadside swale system along both sides of the right-of-way and at each intersection along 2nd Street, in order to alleviate nuisance flooding at multiple intersections.

**Project Background:** The project area includes an area south of Palmetto Drive and north of Date Palm Drive between 2nd and 3rd Streets that lacks a dedicated drainage collection system and is known to flood along the intersections of these roads. The placement of bioswales at strategic locations to address these nuisance flooding locations is contemplated as part of the 20-year SWMP implementation plan. The 2nd Street corridor was selected as a priority project per consultation with the O&M staff that provided documentation of periodic shallow flooding along 2nd Street at the intersection with Evergreen Drive, Foresteria Drive, and Ilex Drive. **Figure 5-2** shows this type of shallow inundation at 2nd Street and Ilex Drive in June 2016.


**Figure 5-2 - Nuisance Flooding at 2nd Street and Ilex Drive**

The 2nd Street Corridor Project was proposed for funding through the Florida Department of Environmental Protection Coastal Partnership Grant Program. This grant application, submitted in October 2020, was successfully funded, and awarded in the first quarter of FY2021.

The FDEP grant will provide funding for 100% design plans and the Town will be applying for construction implementation funding via the Resilient Florida Program.

### Division E – Lake Park Municipal Complex Pavement Restoration and GI Improvements

**Project Objective:** Pavement restoration of the municipal complex parking lot, as well as the addition of additional drainage infrastructure to accommodate a GI-based bio-detention facility on the southwest corner of the municipal complex property.

**Project Background:** This project entails the provision of water quality treatment at the Town Hall municipal complex along Park Avenue (Town Hall, Palm Beach Sheriff's Office Building, and Library). The complex currently discharges untreated runoff to a 24-inch RCP along a 6$^{th}$ Street storm sewer, part of the Southern Outfall northern tributary. **Figure 5-3** shows the proposed GI/LID improvements.


**Figure 5-3 - Lake Park Municipal Complex Drainage and GI Improvements**

Sixty percent of this project's design cost will be funded through an FDEP Coastal Resiliency Grant, applied for in October 2019. Grant funding is expected in the fall of FY2021. The Town of Lake Park will be applying for 100% design and for construction implementation funding via the Resilient Florida Program.

### Division A – 10th Street Corridor Restoration and Green Infrastructure Improvements

**Project Objective:** Pavement restoration of the 10th Street ROW corridor and installation of a drainage system via GI BMPs.

**Project Background:** The 10th Street ROW does not currently have a drainage system. The 10th Street ROW area natural drainage, via sheet flow of untreated runoff, is towards the Southern Outfall south tributary branch along Bayberry Drive. This project, shown in **Figure 5-4**, was selected to be a Pilot Demonstration project for GI/LID implementation throughout the Town as part of the 20-year SWMP update. A system of bioswales and underground filtration chambers will be placed along the 10th Street segment south of Park Avenue to Silver Beach Road.

The project includes a preliminary site plan for a Tri-Rail Station site that has been identified by the Regional Transportation Planning Agency (TPA) along 10th Street. It includes GI/LID Best Management Practices for stormwater management. **Figure 5-5** shows the proposed Tri-Rail Station concept plan.

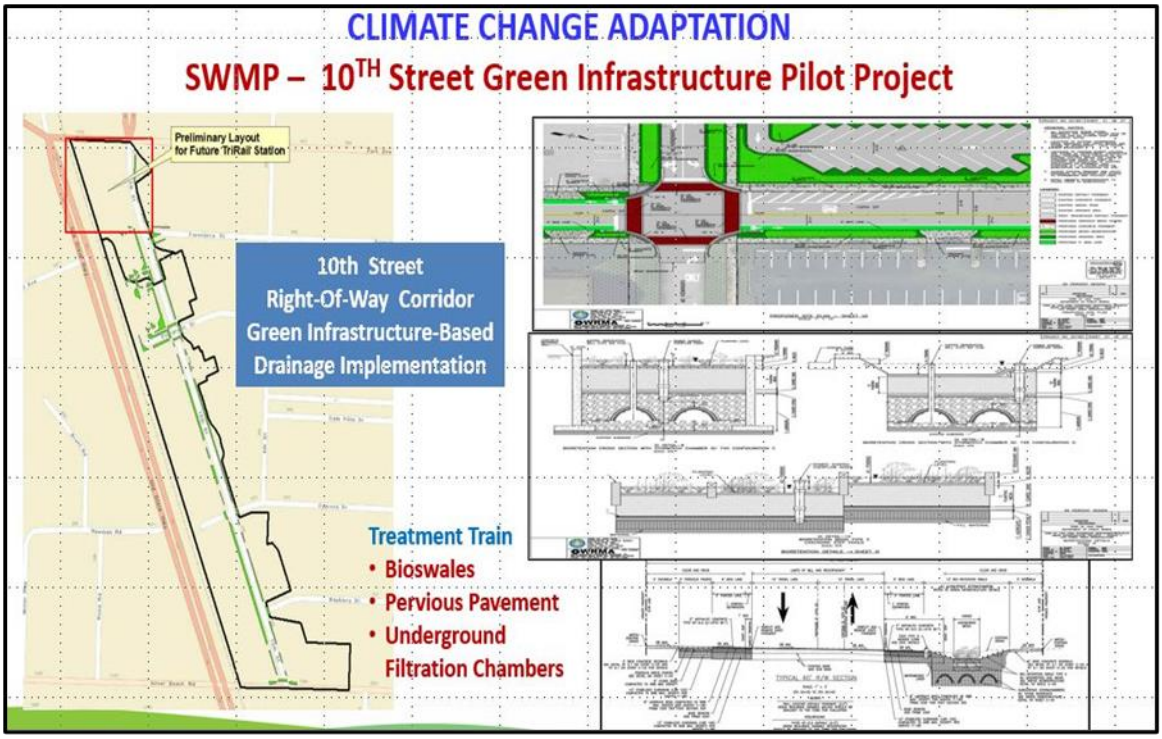


**Figure 5-4 - 10th Street Green Infrastructure Pilot Project**

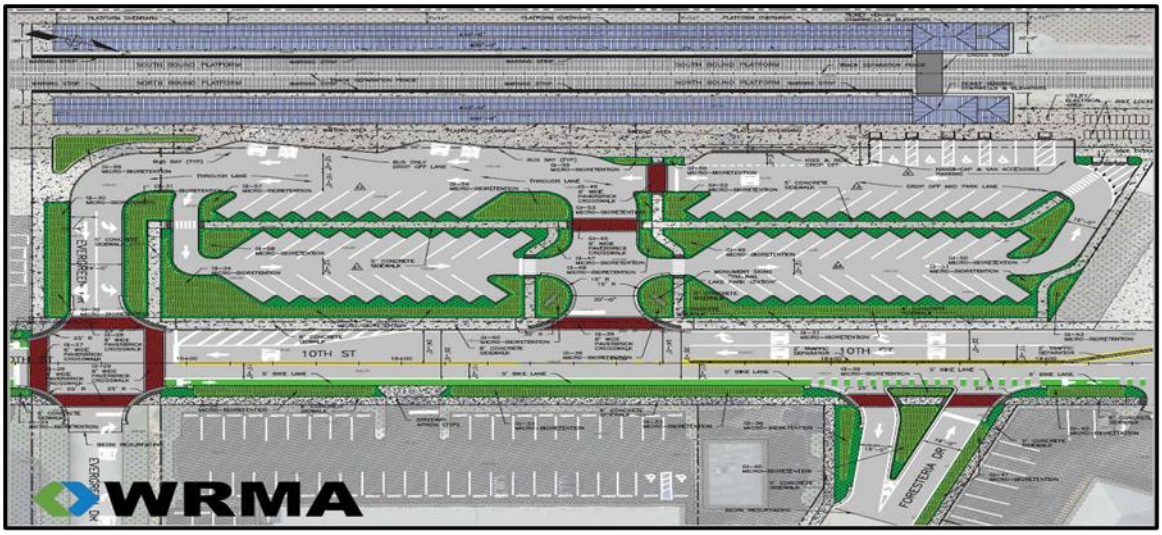


**Figure 5-5 - Proposed Tri-Rail Station Concept at 10th Street**

This project design is already at 40% Basis of Design Review (BODR) and additional funding for utility surveys and 100% design will be applied for via the Resilient Florida Grant Program in the future.

## Division C – Southern Outfall 72-Inch CAP Replacement and Green Infrastructure Improvements

**Projects Objective:** To replace a portion of the existing 72-inch CAP outfall pipe previously installed in the early 1970s and provide water quality treatment prior to discharge into the Lake Worth Lagoon.

**Projects Background:**

The SWMP has identified that current and predicted sea level rise severely impact the ability of the Town's storm sewer system to discharge to the Lake Worth Lagoon. The Southern Outfall storm sewer system serves approximately 50% of the Town's watersheds and it lacks capacity to safely convey and discharge untreated runoff to the Lake Worth Lagoon.

To address this capacity issue, the 2021-2025 CIP has formulated three major projects along the outfall storm sewer trunk system.

- Replacement of the existing 72-inch CAP Outfall to increase capacity and decrease upstream surcharges due to SLR tailwater conditions.
- Bert Bostrom Park Underground Storage Filtration Chambers. Upstream Southern Outfall discharges will be diverted to the underground chambers to provide peak runoff volume detention and water quality treatment (currently untreated runoff is discharged to the Lake Worth Lagoon).
- 10th Street Green Infrastructure LID Pilot Project (previously addressed).

**Figure 5-6** shows the project locations.

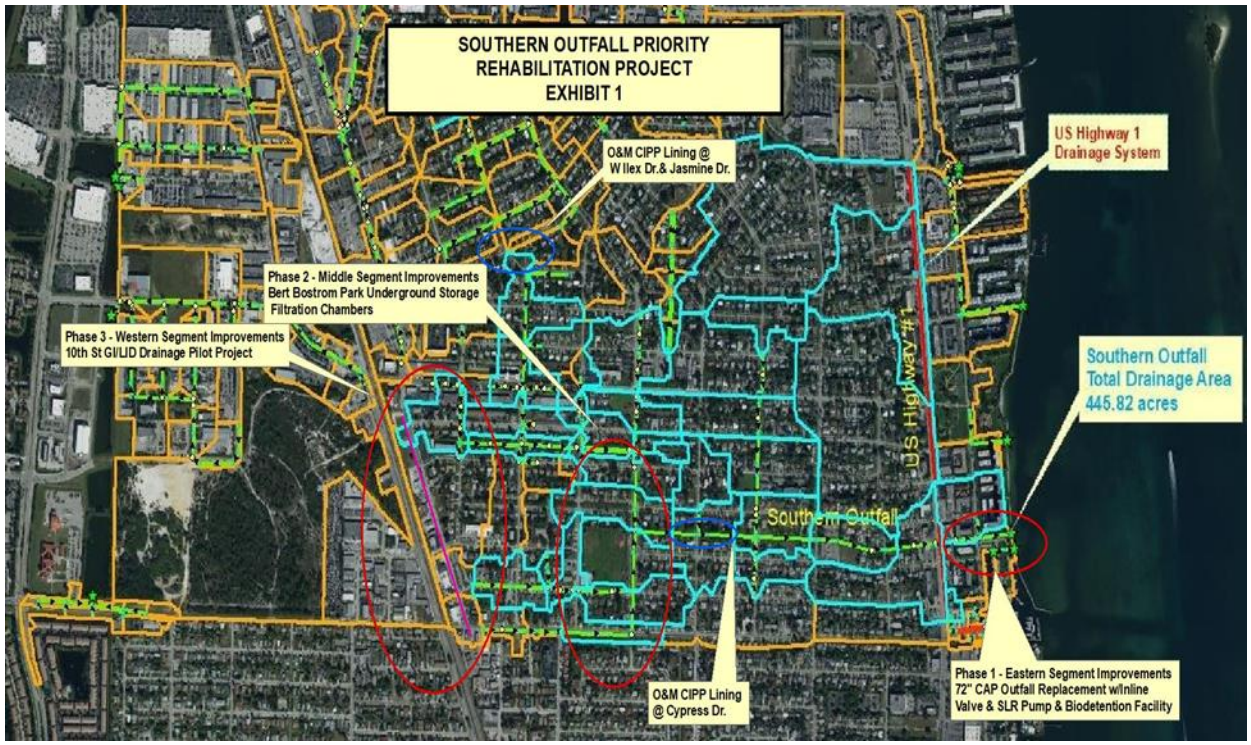


**Figure 5-6 - Drainage & Water Quality Improvement Projects for Southern Outfall**

The Southern Outfall 72-Inch CAP Replacement Project has been formulated in tandem with Division B (Bert Bostrom Park GI) to address the lack of capacity along the Southern Outfall drainage network to facilitate funding. These projects have been planned and submitted for grant funding as two separate project phases. The Bert Bostrom Park GI project does not entail upsizing of pipes or placement of new detention ponds. Rather, the projects entail the implementation of GI/LID BMPs.

### Division B – Southern Outfall Diversion: Bert Bostrom Park Renewal & Green Infrastructure Project

**Project Objective:** Upstream Diversion to Bert Bostrom Park Subsurface Storage Filtration Facility and Park Renewal

**Project Background:** The goal of the Stormwater Master Plan is to decentralize the flow of stormwater runoff into the linear storm sewer network. The project entails a decentralization of the northern tributary network by redirection of the runoff discharges to a large system of underground chambers at Bert Bostrom Park located north of Bayberry Road (at 6th Street and Date Palm Drive). Currently, the lack of capacity in the main trunk of the Southern Outfall is reflected in inlet surcharging (backflow) in the mid-section of the storm sewer network with only minor storm events. The proposed decentralization of the Southern Outfall northern/western tributary network will address this ongoing flooding situation. **Figure 5-7** shows the project location.


**Figure 5-7 - Southern Outfall Diversion and GI Improvements**

The design portion of this project is being funded through a Florida Department of Environmental Protection Coastal Resiliency Grant (60% design plans). Grant funding for 100% design and construction will be sought via the Resilient Florida Grant Program in the future.

## Division F – C-17 Canal Berm Flood Protection Improvements

**Project Objective:** To remove the existing areas east of the C-17 Canal from the existing FEMA Flood Map by increasing the top of berm elevation along the east bank of the C-17 Canal.

**Project Background:** Although not studied in detail, the portion of the Town west of Congress Avenue is prone to flooding from overtopping of the C-17 Canal and a project has been initiated to minimize this risk by elevating the C-17 Canal berms. The Town has already approached the neighboring City of Palm Beach Gardens to elevate the flood retrofit project to the Pam Beach County Local Mitigation Strategy (LMS) Group for FEMA/HMGP construction funding. However, 30%, 60% and 100% design funding of the project will be sought from the Resilient Florida Grant Program. **Figure 5-8** shows the project location.


**Figure 5-8 - C-17 Canal Berm Improvements Project**

## 5.3 Risk Adaptation Pathways

Aside from the ongoing and planned projects, there are several additional measures available to the Town to make it more resilient and substantially reduce future flood risk.

First, all critical facilities within the future floodplains (as depicted in the **Appendix A and B** flood maps) should be reinforced. Options for reinforcement include:

- Dry floodproofing
    - If ceiling heights permit, raising the first-floor elevation may be practical for facilities near the fringe of the floodplain
    - Floodwalls (permanent or deployable) at an appropriate future BFE
        - A quick estimation for the future BFE is to take the current FEMA BFE and add an amount of sea level rise appropriate for the expected useful life of the facility
- Wet floodproofing
    - Not occupying the first floor (still usable for storage and access purposes)
    - Raising vulnerable utilities and infrastructure within the first floor above the future BFE

Should reinforcement not be practical (e.g. older buildings), relocation of the facility may be required if the secondary (backup) location for operations is not outside of the future floodplain.

Next, WRMA's analysis noted that much of the future inundation is induced as a result of tailwater surcharge through the Town stormsewer networks, specifically along Lake Shore Drive and the streets adjacent to South Lake. Redesign or the construction of new sewers in lieu of abandoning the current sewers in place should be a priority for the Town.

Addressing the sewer issues at South Lake will be critical for ensuring North Lake Blvd is a viable escape route during coastal surge events. As for Lake Shore Drive, addressing drainage there should at least protect the surrounding area from tidal inundation until around 2060, at which point the roadway grade will likely be too low regardless of drainage redesigns. This is especially true in consideration of king tides by that time. The road will need to have been reconstructed and a new roadway profile established to a minimum elevation above the 2060 (or later) MHHW. This design will be contingent on other concurrent or completed flood protection projects preceding 2060. Design and construction for this eventuality should be *completed* by 2050, or earlier as evolving conditions dictate. Construction may not be possible if daily tidal inundation is already happening or emergent. Accordingly, planning and coordination should take place sufficiently early to permit construction on time.

In the case that drainage redesigns or new drainage systems are infeasible, the installation of pump stations may be necessary. These pump stations should discharge to outfalls elevated as high as practicable, so as not to be submerged under future high tides.

As noted in **Section 3.1.6**, the Lake Park Marina will be overtopped by 2070. Stopping floodwaters there will be critical in protecting properties along Lake Shore Drive. Eventually, either the marina and/or adjoining roads (driveway, south end of Lake Shore Dr) will have to be raised, or a flood barrier will have to be put in place. The flood barrier could be permanent or deployable in nature, or a combination.

Deployable barriers are reliant upon human operation and are often prone to mechanical failures. On the other hand, permanent barriers are invariably expensive. It will be up to the Town on which path to choose. It should be noted that the 2070 water level at the marina may be too high and thereby unsafe for

boaters mooring to the docks/piers. Given this, raising the marina might be an inevitability should the Town wish to keep it in operation.

Regarding coastal storm surge, in terms of hard flood protections against the Lagoon and C-17, there are three options available (though they are not mutually exclusive). The options are:

1) Constructing floodwalls (permanent and deployable)
2) Raising roadways
3) Raising the seawall bulkhead

If one alone would not be sufficient the goal would be to provide a seamlessly integrated flood protection system consisting of two or all three options.

> *A potential fourth option could be in-water flood barriers crossing the Lagoon. That, however, would require extraordinary funding and planning at the State or Federal level.*

Potential alignments would vary by storm recurrence interval and future scenario sea level rise. As such, benefit-cost analyses would be required for each recurrence interval and corresponding SLR, before a best value engineering judgement could be made.

Lastly, any and all future development in the Town of Lake Park should conducted utilizing the concepts outlined in **Section 5.1**, with future sea level rise in mind. FEMA has published guidelines for planners and designers which explain how to adapt their standards to future SLR.

# Section 6 References

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