



JUNE 2025 | TOWN OF SURFSIDE

# **FINAL VULNERABILITY ASSESSMENT**

## *REPORT, MAPS, AND TABLES*

DEP Agreement Number 23PLN90

*Prepared for*



Town of Surfside  
9293 Harding Avenue  
Surfside, Florida 33154

*Prepared by*

**Kimley»Horn**

Kimley-Horn and Associates, Inc.  
8201 Peters Road  
Suite 2200  
Plantation, FL 33324



# The Town of Surfside Vulnerability Assessment

## Task 4 – Final Vulnerability Assessment

Prepared for



Town of Surfside  
9293 Harding Avenue  
Surfside, Florida 33154



Florida Department of Environmental Protection  
3900 Commonwealth Boulevard  
Tallahassee, Florida 32399

Prepared by:

**Kimley»Horn**

Kimley-Horn and Associates, Inc.  
8201 Peters Road, Suite 2200  
Plantation, FL 33324

© Kimley-Horn and Associates, Inc.

Registry No. 696

Plantation, Florida 143332009

This document, together with the concepts and designs presented herein, as an instrument of service, is intended only for the specific purposes and client for which it was prepared. Reuse of and improper reliance on this document without written authorization and adaptation by Kimley-Horn and Associates, Inc. shall be without liability to Kimley-Horn and Associates, Inc.

## TABLE OF CONTENTS

|                                                                        |    |
|------------------------------------------------------------------------|----|
| LIST OF FIGURES .....                                                  | 3  |
| LIST OF TABLES.....                                                    | 3  |
| LIST OF APPENDICES .....                                               | 5  |
| ABBREVIATIONS .....                                                    | 6  |
| 1. PROJECT BACKGROUND.....                                             | 7  |
| 2. GOALS AND OBJECTIVES.....                                           | 7  |
| 3. TOWN OF SURFSIDE BACKGROUND INFORMATION .....                       | 7  |
| 4. METHODOLOGY.....                                                    | 9  |
| TASK 1 – KICK-OFF MEETING AND ACQUIRE BACKGROUND DATA .....            | 9  |
| DIGITAL ELEVATION MODEL (DEM) .....                                    | 9  |
| NOAA ATLAS RAINFALL DATA .....                                         | 10 |
| SFWMD RAINFALL CHANGE FACTORS .....                                    | 11 |
| SEA LEVEL RISE DATA.....                                               | 11 |
| NOAA TIDES AND CURRENTS GAUGE DATA.....                                | 12 |
| STORM SURGE DATA.....                                                  | 12 |
| CRITICAL ASSETS INVENTORY .....                                        | 12 |
| TASK 2 – EXPOSURE ANALYSIS .....                                       | 13 |
| SEA LEVEL RISE SCENARIOS .....                                         | 14 |
| RAINFALL-INDUCED FLOODING SCENARIOS .....                              | 16 |
| TIDAL FLOODING SCENARIOS .....                                         | 18 |
| STORM SURGE FLOODING SCENARIOS .....                                   | 19 |
| COMPOUND FLOODING SCENARIOS .....                                      | 21 |
| RESULTS .....                                                          | 24 |
| TASK 3 – SENSITIVITY ANALYSIS .....                                    | 27 |
| METHODOLOGY.....                                                       | 27 |
| TRANSPORTATION AND EVACUATION ROUTES .....                             | 30 |
| CRITICAL INFRASTRUCTURE .....                                          | 32 |
| CRITICAL COMMUNITY AND EMERGENCY FACILITIES.....                       | 34 |
| NATURAL, CULTURAL, AND RESOURCES.....                                  | 35 |
| DUNE VULNERABILITY .....                                               | 37 |
| RESULTS AND DISCUSSION.....                                            | 37 |
| TASK 4 – FINAL VULNERABILITY ASSESSMENT REPORT, MAPS, AND TABLES ..... | 38 |
| HIGHLY SENSITIVE ASSETS .....                                          | 38 |

|                            |    |
|----------------------------|----|
| ADAPTATION STRATEGIES..... | 39 |
|----------------------------|----|

## LIST OF FIGURES

|                                                                                       |    |
|---------------------------------------------------------------------------------------|----|
| Figure 1: Project Location Map .....                                                  | 8  |
| Figure 2: Elevation in Surfside .....                                                 | 10 |
| Figure 3: NOAA 2022 Intermediate-Low and Intermediate SLR Projections .....           | 11 |
| Figure 4: Flooding in the 100-Year, 72-Hour Rainfall Plus SLR Int 2080 Scenario ..... | 15 |
| Figure 5: Flooding in the 100-Year, 72-Hour Event .....                               | 17 |
| Figure 6: Flooding in the Current Tidal Scenario .....                                | 19 |
| Figure 7: Flooding in the Category 3 Storm Surge Scenario.....                        | 20 |
| Figure 8: Flooding in the 100-Year, 72-Hour Plus Category 3 Storm Surge Scenario..... | 22 |
| Figure 9: Compound Flooding with 100-Year, 72-Hour Rainfall and King Tide .....       | 23 |
| Figure 10: Wastewater Lift Station Electrical Panel .....                             | 30 |
| Figure 11: Potential Local Drainage Improvement Locations.....                        | 41 |
| Figure 12: Road Elevation Locations.....                                              | 44 |

## LIST OF TABLES

|                                                                                          |    |
|------------------------------------------------------------------------------------------|----|
| Table 1: Methodology Steps.....                                                          | 9  |
| Table 2: NOAA Atlas 14 Rainfall Depths .....                                             | 10 |
| Table 3: SFWMD Change Factors and Future Rainfall Depths .....                           | 11 |
| Table 4: SLR Data .....                                                                  | 12 |
| Table 5: Tidal Flooding Data .....                                                       | 12 |
| Table 6: SLOSH Maximum Water Surface Elevation.....                                      | 12 |
| Table 7: Town Critical Assets.....                                                       | 13 |
| Table 8: Scenario Description .....                                                      | 14 |
| Table 9: Compound Flooding Parameters.....                                               | 21 |
| Table 10: Exposure analysis legend.....                                                  | 24 |
| Table 11: Transportation Assets and Evacuation Routes Impacted by Scenarios .....        | 24 |
| Table 12: Critical Infrastructure Assets Impacted by Scenarios .....                     | 25 |
| Table 13: Critical Community and Emergency Facilities Assets Impacted by Scenarios ..... | 26 |
| Table 14: Natural, Cultural, and Historical Assets Impacted by Scenarios.....            | 27 |
| Table 15: Site Visit Assets.....                                                         | 29 |
| Table 16: Transportation Assets and Evacuation Routes .....                              | 31 |
| Table 17: Critical Elevation, Bridges.....                                               | 31 |
| Table 18: Critical Infrastructure .....                                                  | 32 |
| Table 19: Critical Elevations for Critical Infrastructure .....                          | 33 |
| Table 20: Critical Community and Emergency Facilities .....                              | 34 |
| Table 21: Critical Elevation; Critical Community and Emergency Facilities.....           | 35 |
| Table 22: Natural, Cultural, and Historical Resources .....                              | 36 |
| Table 23: Parks, Total Area.....                                                         | 36 |
| Table 24: Surface Water, Historical, and cultural asset Critical Elevations .....        | 36 |
| Table 25: Dune Vulnerability Scenarios.....                                              | 37 |
| Table 26: Highly Sensitive Assets .....                                                  | 39 |
| Table 27: Protection Adaptation Strategies .....                                         | 40 |
| Table 28: Potential Stormwater System Expansion Locations .....                          | 42 |

|                                                     |    |
|-----------------------------------------------------|----|
| Table 29: Accommodation Adaptation Strategies ..... | 43 |
| Table 30: Strategy Ranking Criteria .....           | 48 |
| Table 31: Adaptation Strategy Scoring .....         | 49 |

## **LIST OF APPENDICES**

Appendix A – Kick Off Meeting Minutes

Appendix B – Data Collection Technical Memorandum

Appendix C – FEMA Firms

Appendix D – Exposure Analysis Inundation Maps

Appendix E – Sensitivity Analysis Maps

Appendix F – Sensitivity Analysis Paired Asset-Threat Matrices



## **ABBREVIATIONS**

|                |                                                       |
|----------------|-------------------------------------------------------|
| <b>AEP</b>     | Annual Exceedance Probability                         |
| <b>BFE</b>     | Base Flood Elevations                                 |
| <b>DEM</b>     | Digital Elevation Model                               |
| <b>FDEM</b>    | Florida Department of Emergency Management            |
| <b>FDEP</b>    | Florida Department of Environmental Protection        |
| <b>FEMA</b>    | Federal Emergency Management Agency                   |
| <b>FFE</b>     | Finished Floor Elevation                              |
| <b>FIRM</b>    | Flood Insurance Rate Map                              |
| <b>FIS</b>     | Flood Insurance Study                                 |
| <b>F.S.</b>    | Florida Statute                                       |
| <b>IH</b>      | Intermediate-High                                     |
| <b>IL</b>      | Intermediate-Low                                      |
| <b>LiDAR</b>   | Light Detection and Ranging                           |
| <b>MHHW</b>    | Mean Higher High Water                                |
| <b>NAVD 88</b> | North American Vertical Datum of 1988                 |
| <b>NOAA</b>    | National Oceanographic and Atmospheric Administration |
| <b>NWS</b>     | National Weather Service                              |
| <b>SFWMD</b>   | South Florida Water Management District               |
| <b>SLR</b>     | Sea Level Rise                                        |
| <b>SLS</b>     | Sea Level Scenario                                    |
| <b>USACE</b>   | U.S. Army Corps of Engineers                          |

## 1. PROJECT BACKGROUND

Kimley-Horn was retained under a Task Order for the Town of Surfside on June 6<sup>th</sup>, 2024. Pursuant to F.S. 380.093, a Vulnerability Assessment for critical infrastructure and community assets in the Town of Surfside (hereinafter referred to as “Town”) was completed to ultimately prepare a comprehensive Town-wide flood vulnerability and sea level rise assessment to address risk of impacts from sea level rise (SLR), storm surge, and rainfall-induced flooding.

The Town of Surfside received funding from the Florida Department of Environmental Protection through the Resilient Florida Program to conduct a Townwide Vulnerability Assessment. The objective of the Town of Surfside Vulnerability Assessment Project is to identify critical assets as classified in s. 390.093(2) 1-4, F.S. and assess risk of flooding and sea level rise within the Town and specify the scenarios in which these areas are vulnerable.

This work was funded in part through a grant agreement from the Florida Department of Environmental Protection’s Office of Resilience and Coastal Protection Resilient Florida Program. The views, statements, findings, conclusions, and recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the State of Florida or any of its subagencies.

## 2. GOALS AND OBJECTIVES

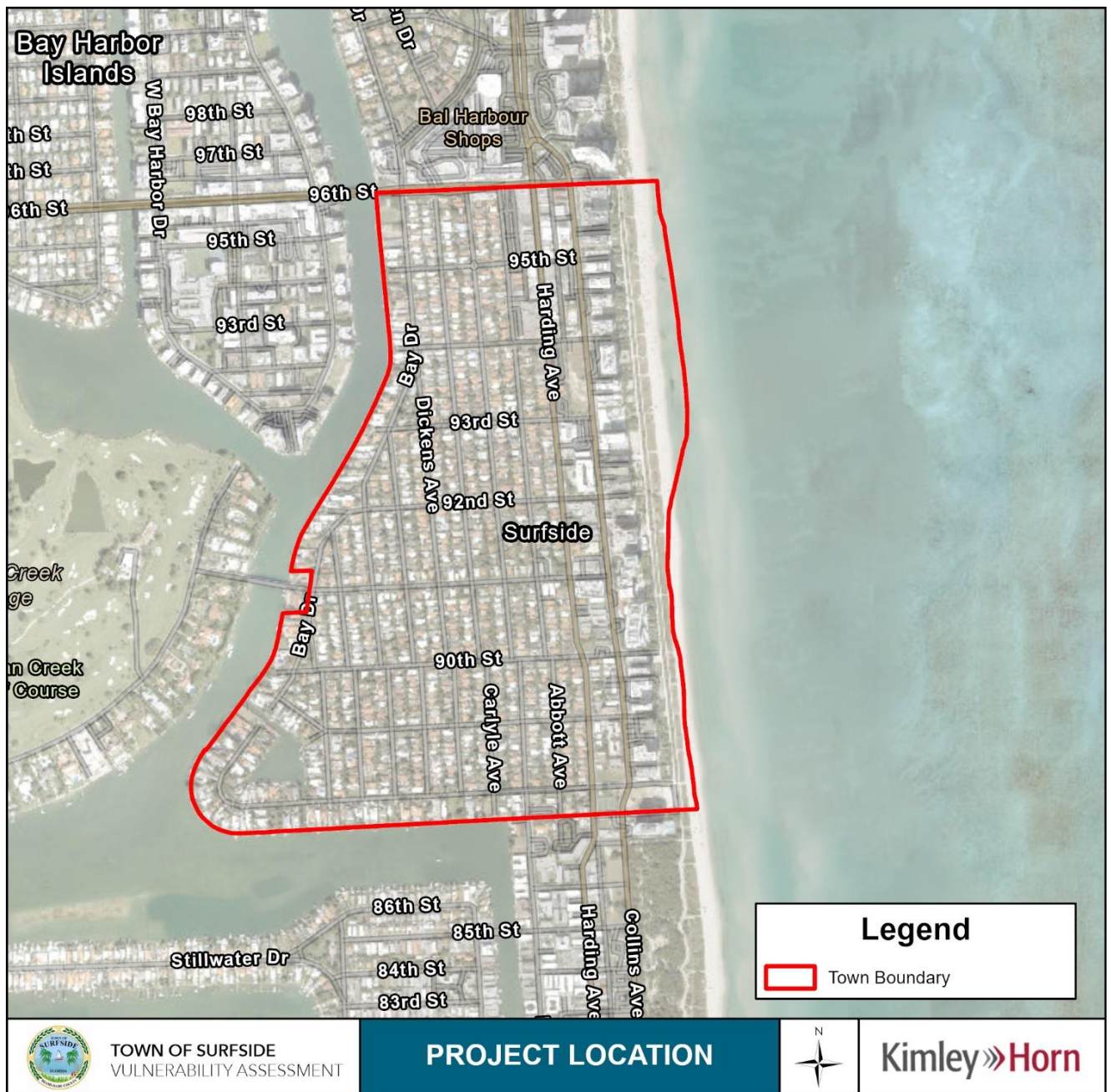
The main objections of this study were:

- To conduct a vulnerability assessment pursuant to s. 380.093, F.S.
- To present a list of critical and regionally significant assets impacted by each flood scenario ranked by risk.
- To provide all electronic mapping data used to illustrate flooding and sea level rise impacts identified in the VA.
- To provide a signed Vulnerability Assessment Compliance Checklist Certification

## 3. TOWN OF SURFSIDE BACKGROUND INFORMATION

The Town of Surfside is a coastal municipality located in east Miami Dade County, Florida, approximately 0.6 square miles in area. The Town is bounded by Biscayne Bay to the west, the Atlantic Ocean to the east, the City of Miami Beach to the south, and Bal Harbour Village to the north. The estimated population is 31,238 residents as of July 1, 2023, per the United States Census Bureau.

Biscayne Bay, the Atlantic Ocean, low-lying topography, and a high groundwater table make the Town vulnerable to the impacts of SLR, storm surge, extreme weather, and other shocks and stressors. These impacts tax the Town’s built and natural environments and require a concerted approach to devise an actionable resilience plan that sustains the quality of life, aligns policies and programs, balances life-cycle costs, and ultimately adapts to change. **Figure 1** shows the project location map for the Town of Surfside Vulnerability Assessment.



**FIGURE 1: PROJECT LOCATION MAP**

## 4. METHODOLOGY

This study methodology follows a five-step process following state guidelines as summarized in **Table 1**. The focus of Task 1 was to acquire background data, and take an inventory of critical and regionally significant assets. The focus of Task 2 was to take the data collected in Task 1 and conduct an exposure analysis of critical and regionally significant assets based on a collection of various flooding scenarios. Task 3 takes the flood scenario data obtained in Task 2 and analyzes the sensitivity of critical and regionally significant assets based on factors such as flood depth and percent inundation.

**TABLE 1: METHODOLOGY STEPS**

| Task   | Description                                             |
|--------|---------------------------------------------------------|
| Task 1 | Kick-Off Meeting and Acquire Background Data            |
| Task 2 | Exposure Analysis                                       |
| Task 3 | Sensitivity Analysis                                    |
| Task 4 | Final Vulnerability Assessment Report, Maps, and Tables |
| Task 5 | Town Hall EOC Adaptation Plan                           |

### TASK 1 – KICK-OFF MEETING AND ACQUIRE BACKGROUND DATA

The first step in this project included a kick-off meeting held on July 31<sup>st</sup>, 2024, during which the team members were introduced, and project goals, objectives, and schedule were discussed.

During the kick-off meeting, project stakeholders were introduced and their role in the project was identified. A formal steering committee was not assembled for this Vulnerability Assessment. The meeting minutes from the project kick-off meeting are included in **APPENDIX A**.

The following data was compiled for use in this vulnerability assessment:

- Miami-Dade County 5-ft DEM
- FEMA Flood Insurance Rate Maps (FIRMs)
- NOAA Atlas 14 Rainfall Data
- NOAA 2022 SLR Projections
- NOAA Tides and Gauges Data
- Critical Asset Inventory

The data collection technical memorandum containing a log of all data collected for this task and their sources can be found in **APPENDIX C**.

### DIGITAL ELEVATION MODEL (DEM)

The 2021 Miami-Dade Data Hub County Digital Elevation Model (DEM) dataset with 5-foot cell size was used as the basis of terrain for this vulnerability assessment. All elevations are relative to NAVD 88. No changes in topography were rectified in this analysis.

Elevations are relatively low throughout the Town east of Collins Avenue and tend to slope downward from east to west. **Figure 2** shows the Digital Elevation Map for the Town.





FIGURE 2: ELEVATION IN SURFSIDE

## NOAA ATLAS RAINFALL DATA

The 100-year/72-hour and 500-year/72-hour rainfall events were collected from the NOAA Atlas 14 tool. **Table 2** shows the rainfall depths evaluated in this analysis.

TABLE 2: NOAA ATLAS 14 RAINFALL DEPTHS

| Rainfall Event   | Rainfall Depth (in) |
|------------------|---------------------|
| 100-year/72-hour | 17.6                |
| 500-year/72-hour | 24.0                |

## SFWMD RAINFALL CHANGE FACTORS

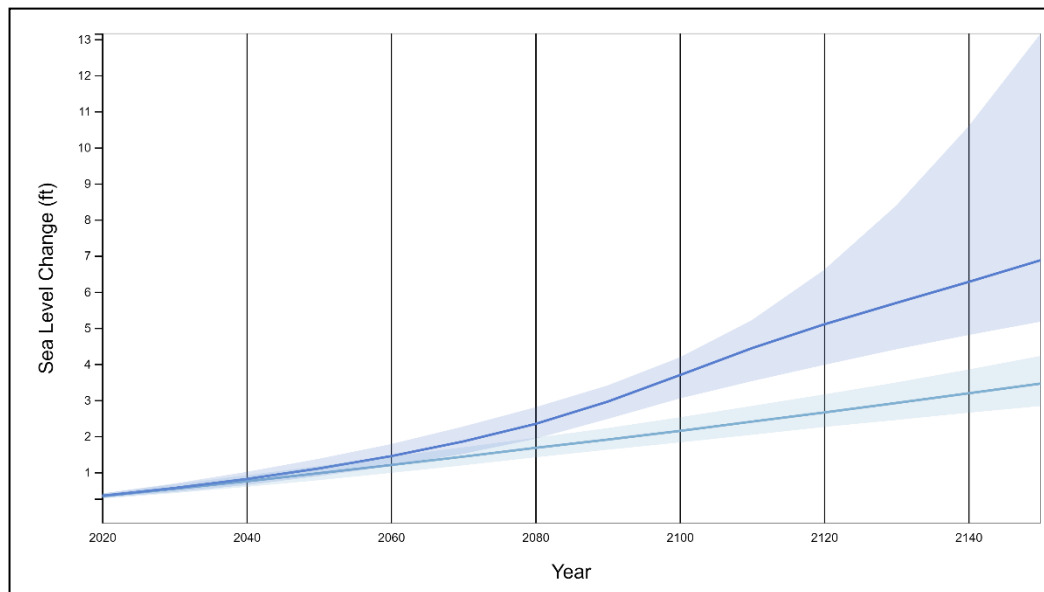
The change factor for the 100-year/72-hour future rainfall event was obtained from SFWMD. The 500-year/72-hour change factor was extrapolated from SFWMD data as no 500-year/72-hour change factor was determined by SFWMD. **Table 3** shows the change factors and future rainfall depths evaluated in this analysis.

**TABLE 3: SFWMD CHANGE FACTORS AND FUTURE RAINFALL DEPTHS**

| Rainfall Event   | Change Factor | Future Rainfall Depth (in) |
|------------------|---------------|----------------------------|
| 100-year/72-hour | 1.21          | 21.3                       |
| 500-year/72-hour | 1.29          | 30.9                       |

## SEA LEVEL RISE DATA

Per s. 380.093(d), F.S., effective July 1<sup>st</sup>, 2024, flood scenario data should make use of the best available information through the Florida Flood Hub for the 2050 and 2080 planning horizons. If Florida Flood Hub data is not available, the 2022 NOAA SLR projection may be used as a substitute. SLR vulnerability assessments must include the 2022 NOAA SLR intermediate-low and intermediate projections for the years 2050 and 2080 as modeled scenarios. The 2022 NOAA SLR projections were pulled from the Miami Beach gauge, the closest gauge with SLR data to Surfside. **Figure 3** the 2022 NOAA SLR projection data collected from the Miami Beach gauge.



**FIGURE 3: NOAA 2022 INTERMEDIATE-LOW AND INTERMEDIATE SLR PROJECTIONS**

In 2022, NOAA released an updated technical report titled “Global and Regional Sea Level Rise Scenarios for the United States”, as part of an interagency task force, which summarizes observed SLR trends and recommended regional SLR projections through the year 2150. This update was intended to support local governments and regional entities in the development of science-based adaptation strategies, policies, and infrastructure design. The Guidance Report discusses five curves for application: the NOAA Low Curve, Intermediate Low Curve, Intermediate High Curve, and the High Curve. The Intermediate Low Curve and Intermediate Curve were considered in this assessment.

While the High SLR projections were not included in this vulnerability assessment, it is suggested that these conditions be evaluated prior to the design phase of any project to evaluate the effectiveness

and assumed planning horizon of any adaptive infrastructure. The SLR projection data used in this vulnerability assessment are outlined in **Table 4**.

**TABLE 4: SLR DATA**

| Scenario                       | Data Source               | Projected Rise (feet) |
|--------------------------------|---------------------------|-----------------------|
| Intermediate-Low 2050 (IL2040) | 2022 NOAA SLR Projections | 0.97                  |
| Intermediate 2050 (I2050)      | 2022 NOAA SLR Projections | 1.10                  |
| Intermediate-Low 2080 (IL2080) | 2022 NOAA SLR Projections | 1.67                  |
| Intermediate 2080 (I2080)      | 2022 NOAA SLR Projections | 2.34                  |

## NOAA TIDES AND CURRENTS GAUGE DATA

Tidal flooding data, such as mean higher high water (MHHW) and flood thresholds, were collected from the NOAA Tides and Currents database and published National Weather Service flooding thresholds. NOAA has determined three coastal flood severity levels, informed by years of monitoring tide gauge data. Variations in flood thresholds exist among NOAA tide gauges due to differences in infrastructure vulnerabilities influenced by factors like topography, land cover, and flood defenses. A flood threshold of 1.71 feet above MHHW is identified by NOAA as the minor flood threshold at the closest tide gauge to the Town (Virginia Key, Biscayne Bay, FL station). Using the MHHW elevation and the NOAA minor flood threshold value, the value of 2.50 feet NAVD88 was used to assess the vulnerability to the current King Tide scenario. The tidal flooding values used are compliant with s. 380.0937(1)(a), F.S. **Table 5** shows the current tidal flooding elevation in Surfside.

**TABLE 5: TIDAL FLOODING DATA**

| Scenario                         | Elevation (NAVD88, ft) |
|----------------------------------|------------------------|
| Current Tidal Flooding Threshold | 2.50                   |
| Mean Higher High Water (MHHW)    | 0.79                   |

## STORM SURGE DATA

Storm surge was sourced from the National Hurricane Center's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model. The data collected is the maximum envelope of high water (MEOW), or (MOM), which provides a worst case scenario for each category storm under "perfect" storm conditions. Category 3 and Category 5 MOM water surface elevations were obtained for this assessment. **Table 6** shows the maximum water surface elevations in the Town of Surfside for the chosen storms. These storm surge values both exceed the 100-year AEP threshold of 6.5 feet NAVD88, based on the current effective FEMA FIRMs covering the Town.

**TABLE 6: SLOSH MAXIMUM WATER SURFACE ELEVATION**

| Scenario               | Maximum Water Surface Elevation (NAVD88, ft) |
|------------------------|----------------------------------------------|
| Category 3 Storm Surge | 7.5                                          |
| Category 5 Storm Surge | 11.4                                         |

## CRITICAL ASSETS INVENTORY

An integral part of the vulnerability assessment was identifying, locating, and categorizing Town assets that may be exposed to threats due to flooding hazards. Asset data was collected using the Miami Dade Open Data Hub GIS portal, FDEP Geospatial Open Data, and additional data provided by the Town. A list of all inventoried Town assets evaluated as a part of this vulnerability assessment is

provided in **Table 7**. This inventory is organized by asset category as defined in s. 380.093, F.S. and only includes assets that are owned or maintained by Surfside.

**TABLE 7: TOWN CRITICAL ASSETS**

| Asset Category                              | Asset Type                                           | Quantity |
|---------------------------------------------|------------------------------------------------------|----------|
| Transportation Assets and Evacuation Routes | Bridges                                              | 1        |
|                                             | Evacuation Routes                                    | 1        |
|                                             | Major Roadways                                       | 25       |
| Critical Infrastructure                     | Communication Facilities                             | 1        |
|                                             | Disaster Debris Management Site                      | 6        |
|                                             | Electric Production and Supply Facility - Substation | 1        |
|                                             | Stormwater Pump Stations                             | 8        |
|                                             | Waste Water Lift Stations                            | 5        |
|                                             | Water Utility Conveyance Systems*                    | 2836     |
| Critical Community and Emergency Facilities | Community Center                                     | 1        |
|                                             | Emergency Operation Center                           | 1        |
|                                             | Law Enforcement Facilities                           | 1        |
|                                             | Local Government Facilities                          | 1        |
|                                             | Private Schools                                      | 1        |
| Natural, Cultural, and Historic Resources   | Historical and Cultural Assets                       | 1        |
|                                             | Park                                                 | 5        |
|                                             | Shorelines                                           | 2        |

\*Pipes are underground and not considered in the exposure analysis.

## TASK 2 – EXPOSURE ANALYSIS

An exposure analysis was performed to assess the extent of flooding experienced by an asset due to various storm scenarios that are likely to occur in the future including rainfall, tidal, and storm surge. The impact of sea level rise in 2050 and 2080 was considered as additional storm scenarios for every source of flooding. The following sections outline the methodology used to perform the exposure analysis for the Town of Surfside. Scenarios were analyzed using a combination of bathtub models and the Townwide drainage model developed as part of the Town's Stormwater Master Plan (SWMP). The Townwide drainage model was developed using ICPR v4.07.04. The model consists of a one-dimensional network of nodes, links, and basins representing the Town's drainage basins and stormwater infrastructure. Modeling the Town's stormwater infrastructure results in more accurate inundation datasets than those produced from a rapid inundation model. Data used to develop the Townwide drainage model was collected as part of the SWMP. The Townwide drainage model was modified to model tidal flow over the Town's seawall as a result of SLR and storm surge. **Table 8** lists the scenarios considered in this analysis. **APPENDIX D** contains the inundation maps for all flooding scenarios evaluated in the exposure analysis.



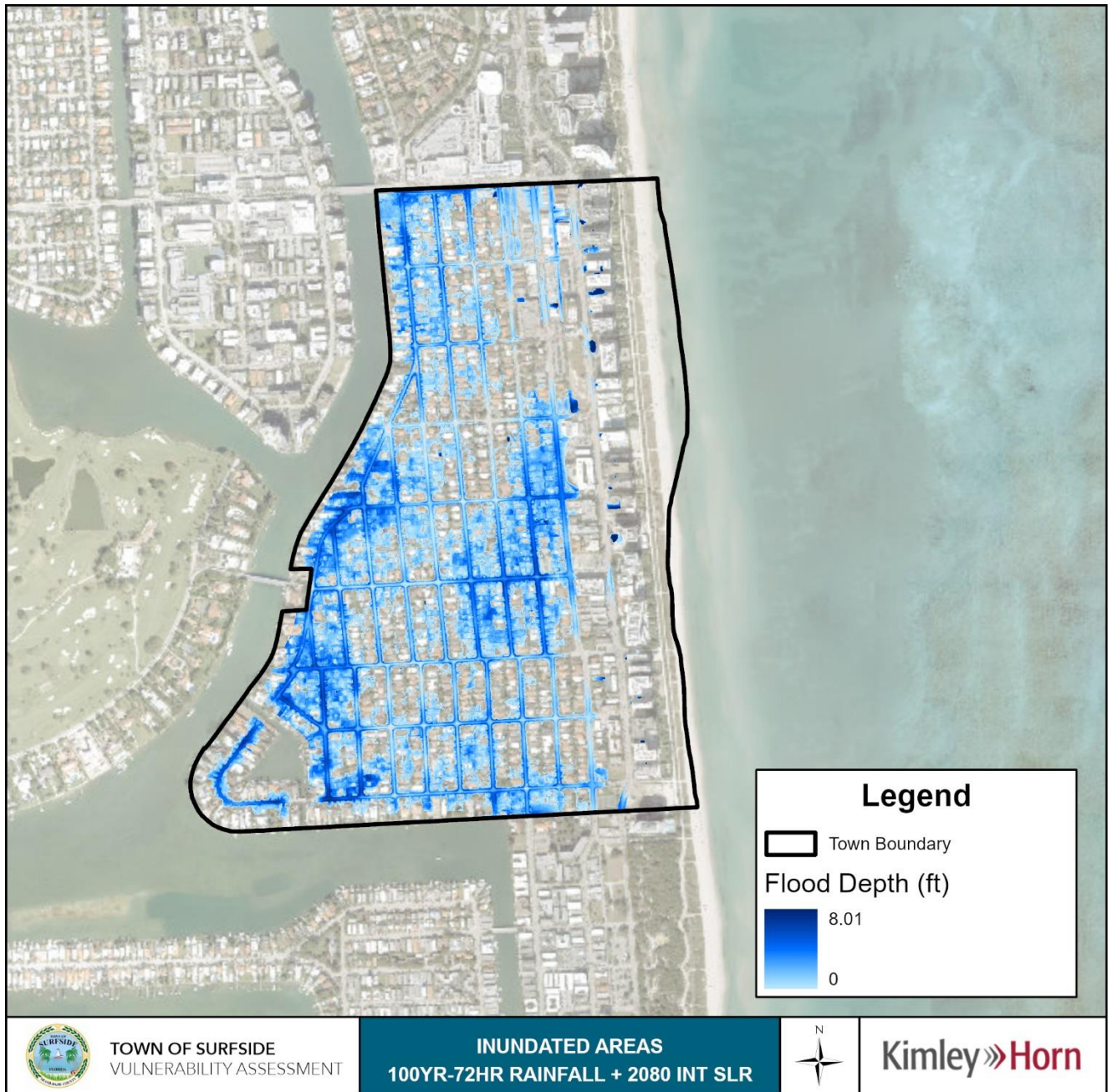
**TABLE 8: SCENARIO DESCRIPTION**

| Scenario | Description                                               | Model   |
|----------|-----------------------------------------------------------|---------|
| 1        | 100-year, 72-hour                                         | SWMP    |
| 2        | 500-year, 72-hour                                         | SWMP    |
| 3        | 100-year, 72-hour + 2050 Intermediate-Low SLR             | SWMP    |
| 4        | 100-year, 72-hour + 2050 Intermediate SLR                 | SWMP    |
| 5        | 100-year, 72-hour + 2080 Intermediate-Low SLR             | SWMP    |
| 6        | 100-year, 72-hour + 2080 Intermediate SLR                 | SWMP    |
| 7        | Category 3 Storm Surge                                    | Bathtub |
| 8        | Category 5 Storm Surge                                    | Bathtub |
| 9        | Category 3 Storm Surge + 2050 Intermediate-Low SLR        | Bathtub |
| 10       | Category 3 Storm Surge + 2050 Intermediate SLR            | Bathtub |
| 11       | Category 3 Storm Surge + 2080 Intermediate-Low SLR        | Bathtub |
| 12       | Category 3 Storm Surge + 2080 Intermediate SLR            | Bathtub |
| 13       | King Tide                                                 | Bathtub |
| 14       | King Tide + 2050 Intermediate-Low SLR                     | Bathtub |
| 15       | King Tide + 2050 Intermediate SLR                         | Bathtub |
| 16       | King Tide + 2080 Intermediate-Low SLR                     | Bathtub |
| 17       | King Tide + 2080 Intermediate SLR                         | Bathtub |
| 18       | 100-year, 72-hour + Category 3 Storm Surge                | SWMP    |
| 19       | 100-year, 72-hour + Category 5 Storm Surge                | SWMP    |
| 20       | 100-year, 72-hour + King Tide                             | SWMP    |
| 21       | 100-year, 72-hour + King Tide + 2050 Intermediate-Low SLR | SWMP    |
| 22       | 100-year, 72-hour + King Tide + 2050 Intermediate SLR     | SWMP    |
| 23       | 100-year, 72-hour + King Tide + 2080 Intermediate-Low SLR | SWMP    |
| 24       | 100-year, 72-hour + King Tide + 2080 Intermediate SLR     | SWMP    |
| 25       | SFWMD Future 100-year, 72-hour                            | SWMP    |
| 26       | SFWMD Future 500-year, 72-hour                            | SWMP    |

## SEA LEVEL RISE SCENARIOS

Sea level rise (SLR) was considered in all flooding scenarios except compound rainfall and storm surge flooding (Scenario 18 and Scenario 19). In scenarios utilizing a bathtub model, SLR was added to the present conditions water surface elevation. In scenarios utilizing the SWMP model, SLR was added to the MHHW or King Tide boundary condition as appropriate. **Table 4** lists the SLR data used to generate the inundation extents for the SLR scenarios.

Results from the SLR inundation scenarios indicate increased flooding impacts to the Town under all evaluated scenarios versus present day conditions. The most extreme increase in flooding extent is seen in the Intermediate 2080 SLR projection. Based on the inundation and flood depths, the current infrastructure is insufficient to prevent flooding in the surrounding areas of these scenarios in the 2080 Intermediate SLR projections. **Figure 4** shows results of the 100-year, 72-hour plus Intermediate 2080 analysis which indicated moderate flooding within the municipal boundary throughout the Town.



**FIGURE 4: FLOODING IN THE 100-YEAR, 72-HOUR RAINFALL PLUS SLR INT 2080 SCENARIO**

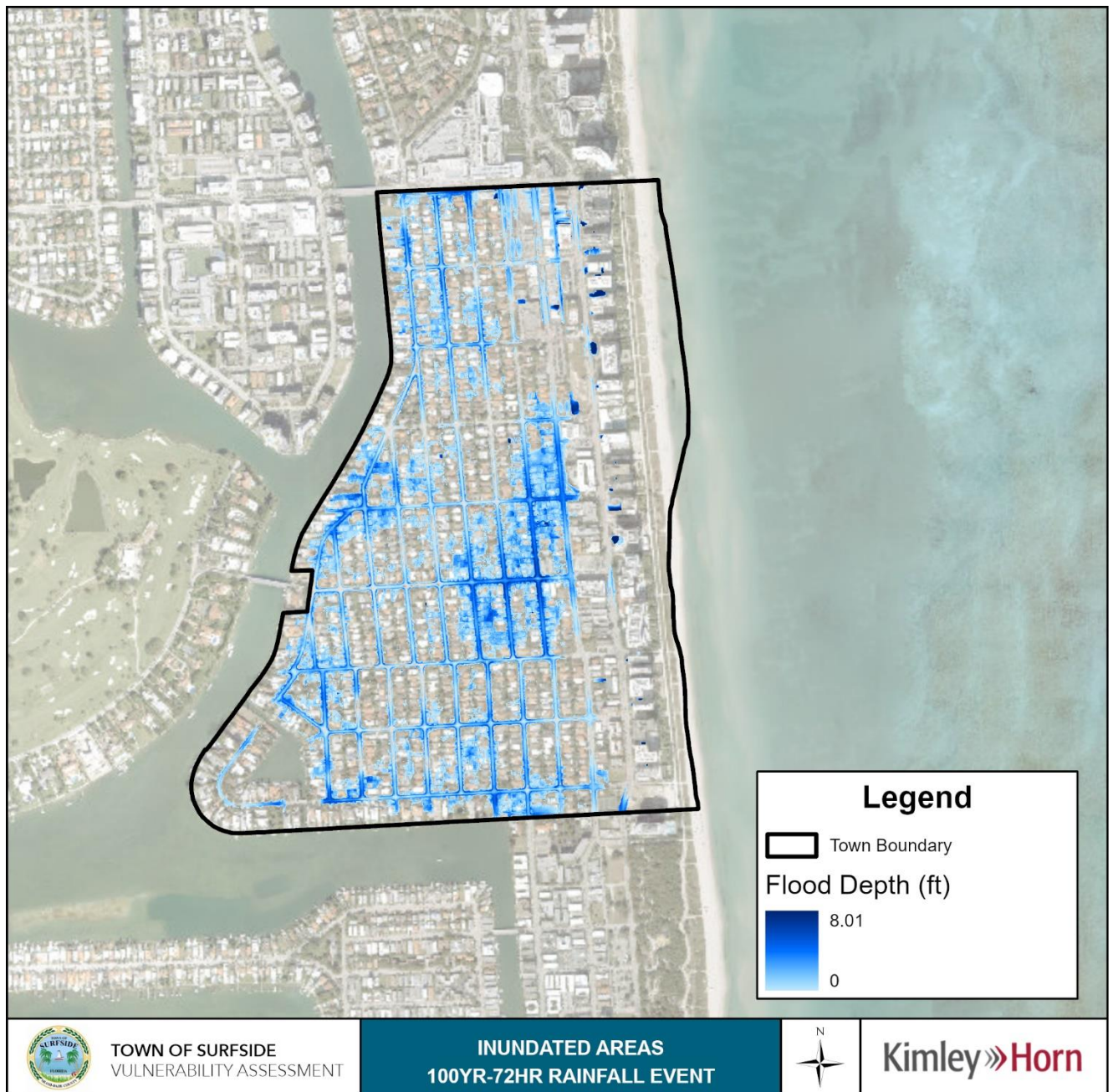
## RAINFALL-INDUCED FLOODING SCENARIOS

Rainfall-induced flooding maps were generated using the Townwide drainage model developed as part of the SWMP. This technology works by routing water over the terrain for the duration of a specified storm event using a set of rules based on water level response to topography and existing water levels. This analysis considers stormwater infrastructure (i.e., pipes and pumps) and infiltration. It is important to note that while all models used in this analysis show the extents of inundation due to low elevation, the model also identifies area where standing water may occur due to *relatively* low elevation (areas bounded by ridges) in a given region.

The 100- and 500-year, 72-hour rainfall events and future rainfall events were modelled to evaluate potential rainfall-induced flooding within the study area. This analysis was based on data collected from the NOAA Atlas 14 tool and SFWMD and is consistent with guidelines set forth in s. 380.093 F.S. for this evaluation. **Table 2** shows the rainfall data used to generate the flood extents of the rainfall scenarios.

Rainfall-induced flooding is consistently observed throughout the Town during both the 100-year and 500-year, 72-hour storm events, with floodwaters predominantly accumulating along road centerlines and dispersing into adjacent neighborhoods. The 500-year event, characterized by a higher rainfall volume, exacerbates these conditions, resulting in an increase in both the spatial extent and depth of flooding compared to the 100-year, 72-hour storm event. Similar results were observed in the future rainfall event scenarios. **Figure 5** shows the extents of flooding in the 100-year, 72-hour storm event.





**FIGURE 5: FLOODING IN THE 100-YEAR, 72-HOUR EVENT**

## TIDAL FLOODING SCENARIOS

Tidal inundation extents were generated using a bathtub modeling technique, which simulates water level rise uniformly across the landscape without accounting for stormwater infrastructure or infiltration. This method assumes that areas below a certain elevation are uniformly flooded when the tidal level reaches that height, akin to filling a bathtub. The current tidal flooding scenario incorporates the MHHW and the NOAA flood threshold, representing king tide conditions. A combination of the NOAA flood threshold and MHHW was necessary to provide a comprehensive understanding of areas prone to consequential flooding events during extreme high tides.

The bathtub modeling technique provides a preliminary visualization of potential flood extents, and the results should be interpreted with caution, recognizing the limitations and potential overestimations.

Results from the tidal flooding scenarios indicate mild to moderate flooding impacts to the Town under current conditions and SLR projections. Flooding extends beyond shorelines, encroaching upon low-lying roads and adjacent neighborhoods throughout the Town. Based on the inundation and flood depths, the current infrastructure is insufficient to prevent flooding in the Town during these scenarios.

**Figure 6** shows the extents of current tidal conditions in Surfside.

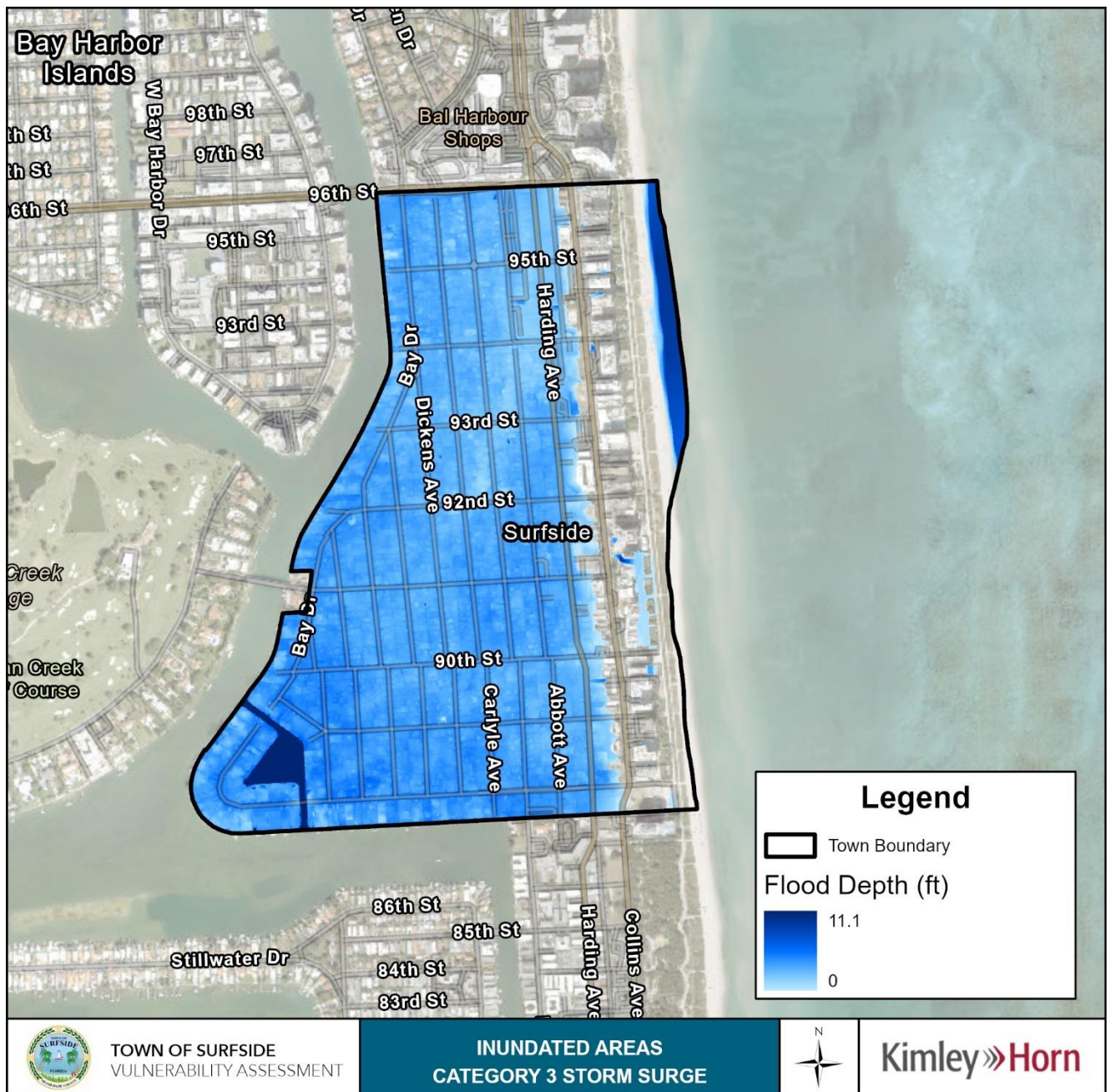


**FIGURE 6: FLOODING IN THE CURRENT TIDAL SCENARIO**

## STORM SURGE FLOODING SCENARIOS

Inundation extents of the storm surge flooding scenarios were generated using a bathtub modelling technique. The analysis did not consider stormwater infrastructure (i.e., pipes) or infiltration and because of this, results as presented may be overstated. Results of the storm surge flooding scenarios reveal extreme flooding across the Town in present and future conditions, with floodwaters affecting all roads and residential neighborhoods. **Figure 7** shows the extents of the Category 3 Storm Surge scenario.





**FIGURE 7: FLOODING IN THE CATEGORY 3 STORM SURGE SCENARIO**

## COMPOUND FLOODING SCENARIOS

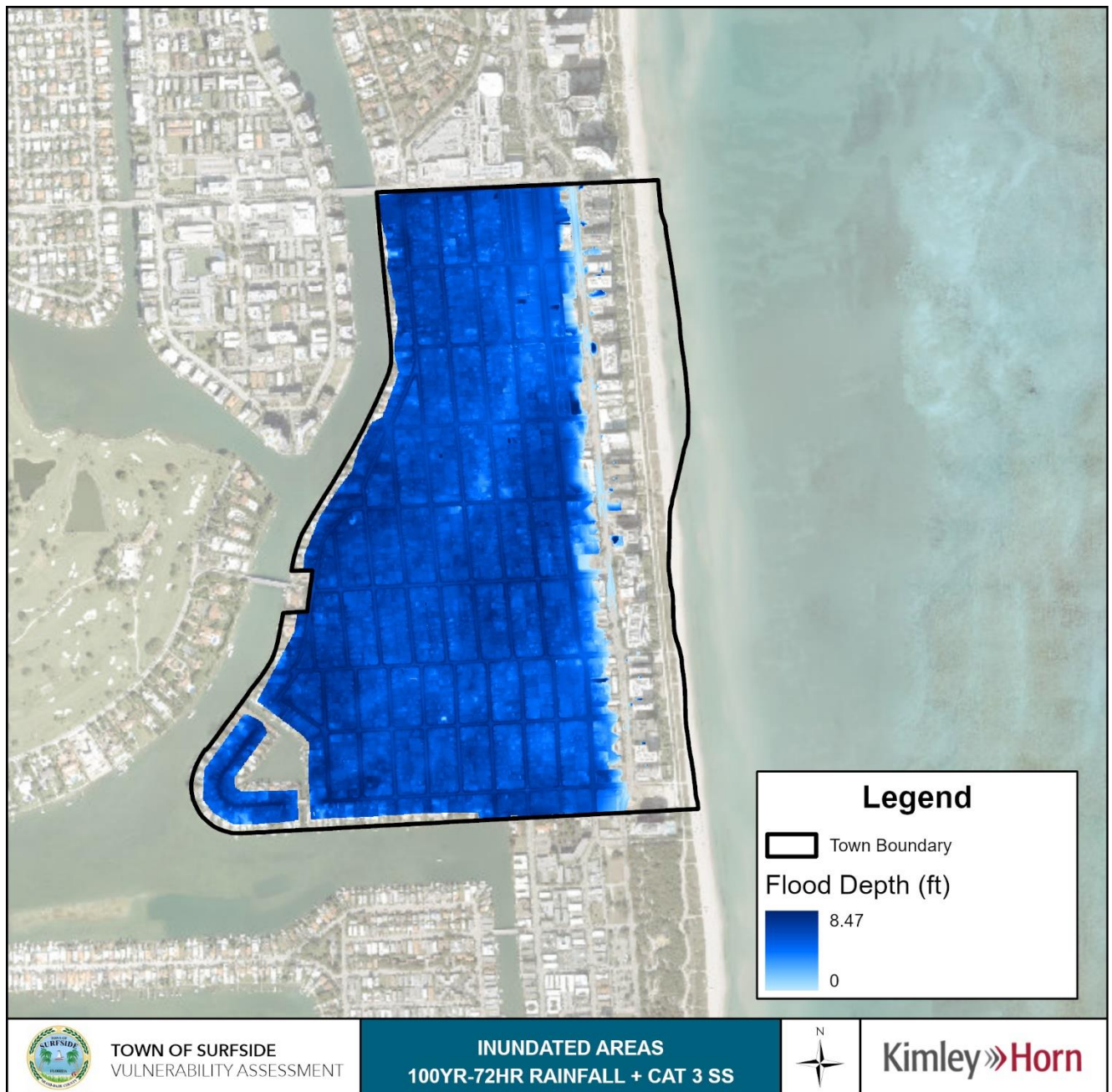
Compounds flooding inundation extents were evaluated using data collected for all storm scenarios and combined with the future SLR projections. Compound flooding extents were generated using bathtub modelling (future tidal and future extreme rainfall with sea level rise) and hybrid bathtub and rapid inundation modelling (rainfall with sea level rise) techniques. The assessment does not consider the potential for storm intensification due to climate change. The compound scenarios selected for review in this analysis are outlined in **Table 9**.

**TABLE 9: COMPOUND FLOODING PARAMETERS**

| Compound Scenario                                         | Projected Elevation (NAVD88, ft) | Rainfall Depth (in) |
|-----------------------------------------------------------|----------------------------------|---------------------|
| 100-year, 72-hour + Category 3 Storm Surge                | -                                | 17.6                |
| 100-year, 72-hour + Category 5 Storm Surge                | -                                | 17.6                |
| 100-year, 72-hour + King Tide                             | 2.5                              | 17.6                |
| 100-year, 72-hour + King Tide + 2050 Intermediate-Low SLR | 3.47                             | 17.6                |
| 100-year, 72-hour + King Tide + 2050 Intermediate SLR     | 3.60                             | 17.6                |
| 100-year, 72-hour + King Tide + 2080 Intermediate-Low SLR | 4.17                             | 17.6                |
| 100-year, 72-hour + King Tide + 2080 Intermediate SLR     | 4.84                             | 17.6                |

### *100-Year, 72-Hour and Storm Surge Flooding*

Results of the rainfall and storm surge flooding analysis indicate extreme flooding within the municipal boundary in localized areas. The compound scenario revealed extreme flooding across the Town in present and future conditions, with floodwaters affecting all roads and residential neighborhoods. **Figure 8** shows the future tidal flooding extents for the 100-year, 72-hour plus category 3 storm surge scenario.

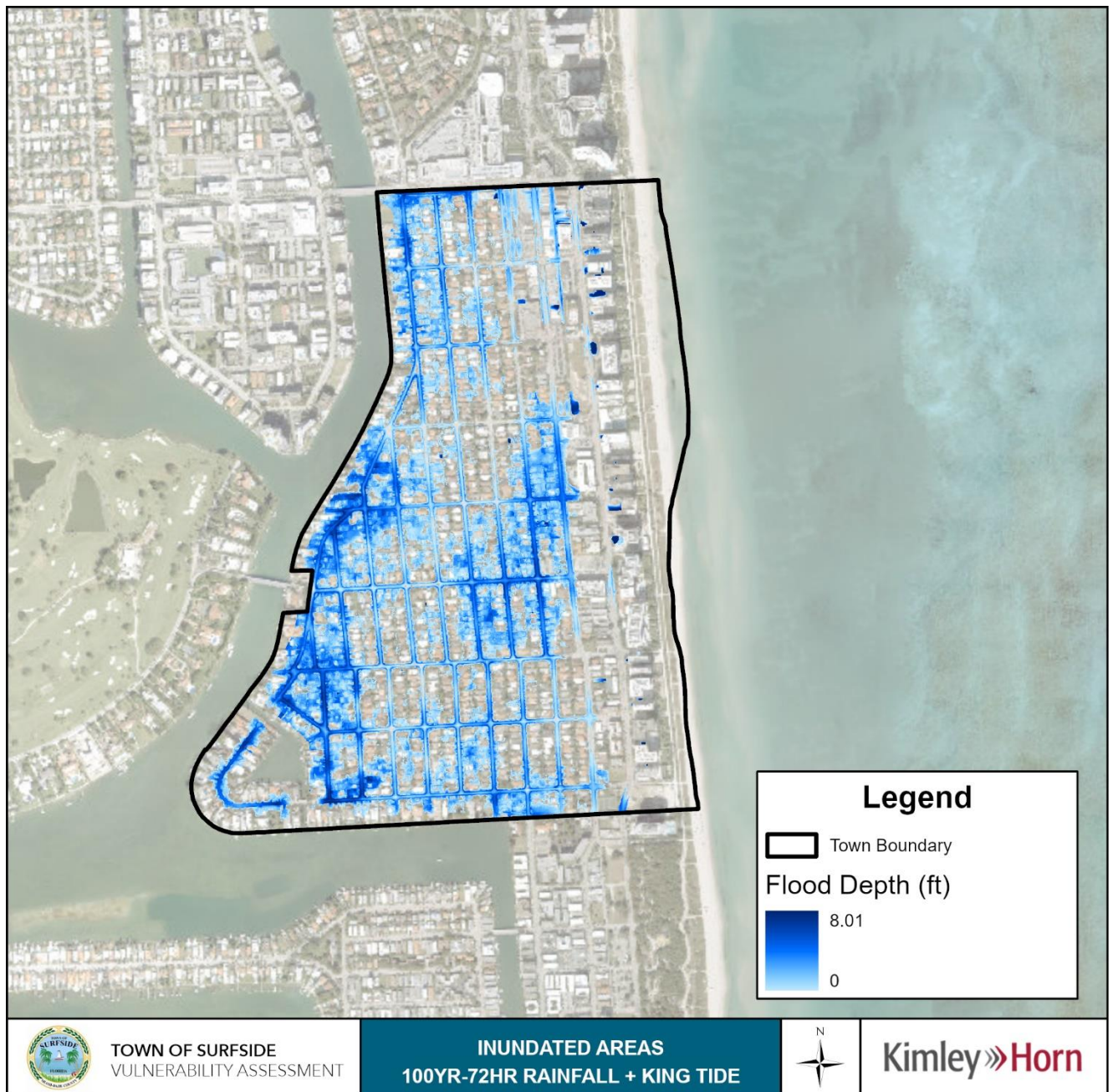


**FIGURE 8: FLOODING IN THE 100-YEAR, 72-HOUR PLUS CATEGORY 3 STORM SURGE SCENARIO**

#### *100YR-72H and King Tide Flooding*

Compound flooding inundation extents were evaluated using data collected for the 100-year, 72-hour rainfall and King Tide scenarios. Results of the compound flooding indicate significant flooding within town, the highest flooding is experienced on road centerlines and within lower lying neighborhoods. The regions of Surfside impacted by the compound rainfall and King Tide scenario are similar to the current King Tide scenarios with increased flood depths. The areas impacted by both rainfall and King Tide with the effect of SLR are far greater, include almost the entire Town's area. **Figure 9** shows the extents of the 100-year, 72-hour rainfall, and King Tide compound flooding scenario.





**FIGURE 9: COMPUND FLOODING WITH 100-YEAR, 72-HOUR RAINFALL AND KING TIDE**

## RESULTS

To assess the extent of flooding by asset type in each scenario, the following criteria was used:

**TABLE 10. EXPOSURE ANALYSIS LEGEND**

| Flood Exposure | Criteria                                        |
|----------------|-------------------------------------------------|
| Low            | 25% or less of critical assets impacted         |
| Medium         | Between 25% and 75% of critical assets impacted |
| High           | More than 75% of critical assets impacted       |

The results of the exposure analysis have been summarized by the percentage each storm impacts each asset class in **Table 11-14**.

**TABLE 11: TRANSPORTATION ASSETS AND EVACUATION ROUTES IMPACTED BY SCENARIOS**

| Asset Class                                 | Asset Owner (s)           | Scenario                                    | Percent Impacted Total Asset Class |
|---------------------------------------------|---------------------------|---------------------------------------------|------------------------------------|
| Transportation Assets and Evacuation Routes | Town of Surfside and FDOT | 100-year, 72-hour                           | 97.7%                              |
|                                             |                           | 500-year, 72-hour                           | 97.7%                              |
|                                             |                           | 100-year, 72-hour + 2050 IL SLR             | 97.7%                              |
|                                             |                           | 100-year, 72-hour + 2050 I SLR              | 97.7%                              |
|                                             |                           | 100-year, 72-hour + 2080 IL SLR             | 97.7%                              |
|                                             |                           | 100-year, 72-hour + 2080 I SLR              | 97.7%                              |
|                                             |                           | Category 3 Storm Surge                      | 97.7%                              |
|                                             |                           | Category 5 Storm Surge                      | 100.0%                             |
|                                             |                           | Cat 3 Storm Surge + 2050 IL SLR             | 98.9%                              |
|                                             |                           | Cat 3 Storm Surge + 2050 I SLR              | 98.9%                              |
|                                             |                           | Cat 3 Storm Surge + 2080 IL SLR             | 100.0%                             |
|                                             |                           | Cat 3 Storm Surge + 2080 I SLR              | 100.0%                             |
|                                             |                           | King Tide                                   | 84.1%                              |
|                                             |                           | King Tide + 2050 IL SLR                     | 95.5%                              |
|                                             |                           | King Tide + 2050 I SLR                      | 95.5%                              |
|                                             |                           | King Tide + 2080 IL SLR                     | 95.5%                              |
|                                             |                           | King Tide + 2080 I SLR                      | 95.5%                              |
|                                             |                           | 100-year, 72-hour + Cat 3 Storm Surge       | 100.0%                             |
|                                             |                           | 100-year, 72-hour + Cat 5 Storm Surge       | 100.0%                             |
|                                             |                           | 100-year, 72-hour + King Tide               | 97.7%                              |
|                                             |                           | 100-year, 72-hour + King Tide + 2050 IL SLR | 97.7%                              |
|                                             |                           | 100-year, 72-hour + King Tide + 2050 I SLR  | 97.7%                              |
|                                             |                           | 100-year, 72-hour + King Tide + 2080 IL SLR | 97.7%                              |
|                                             |                           | 100-year, 72-hour + King Tide + 2080 I SLR  | 98.9%                              |
|                                             |                           | SFWMD Future 100-year, 72-hour              | 98.9%                              |
|                                             |                           | SFWMD Future 500-year, 72-hour              | 98.9%                              |



**TABLE 12: CRITICAL INFRASTRUCTURE ASSETS IMPACTED BY SCENARIOS**

| Asset Class             | Asset Owner (s)  | Scenario                                    | Percent Impacted Total Asset Class |
|-------------------------|------------------|---------------------------------------------|------------------------------------|
| Critical Infrastructure | Town of Surfside | 100-year, 72-hour                           | 61.9%                              |
|                         |                  | 500-year, 72-hour                           | 61.9%                              |
|                         |                  | 100-year, 72-hour + 2050 IL SLR             | 61.9%                              |
|                         |                  | 100-year, 72-hour + 2050 I SLR              | 61.9%                              |
|                         |                  | 100-year, 72-hour + 2080 IL SLR             | 61.9%                              |
|                         |                  | 100-year, 72-hour + 2080 I SLR              | 61.9%                              |
|                         |                  | Category 3 Storm Surge                      | 90.5%                              |
|                         |                  | Category 5 Storm Surge                      | 95.2%                              |
|                         |                  | Cat 3 Storm Surge + 2050 IL SLR             | 95.2%                              |
|                         |                  | Cat 3 Storm Surge + 2050 I SLR              | 95.2%                              |
|                         |                  | Cat 3 Storm Surge + 2080 IL SLR             | 95.2%                              |
|                         |                  | Cat 3 Storm Surge + 2080 I SLR              | 95.2%                              |
|                         |                  | King Tide                                   | 38.1%                              |
|                         |                  | King Tide + 2050 IL SLR                     | 61.9%                              |
|                         |                  | King Tide + 2050 I SLR                      | 81.0%                              |
|                         |                  | King Tide + 2080 IL SLR                     | 81.0%                              |
|                         |                  | King Tide + 2080 I SLR                      | 85.7%                              |
|                         |                  | 100-year, 72-hour + Cat 3 Storm Surge       | 90.5%                              |
|                         |                  | 100-year, 72-hour + Cat 5 Storm Surge       | 95.2%                              |
|                         |                  | 100-year, 72-hour + King Tide               | 61.9%                              |
|                         |                  | 100-year, 72-hour + King Tide + 2050 IL SLR | 76.2%                              |
|                         |                  | 100-year, 72-hour + King Tide + 2050 I SLR  | 81.0%                              |
|                         |                  | 100-year, 72-hour + King Tide + 2080 IL SLR | 81.0%                              |
|                         |                  | 100-year, 72-hour + King Tide + 2080 I SLR  | 85.7%                              |
|                         |                  | SFWMD Future 100-year, 72-hour              | 61.9%                              |
|                         |                  | SFWMD Future 500-year, 72-hour              | 66.7%                              |

**TABLE 13: CRITICAL COMMUNITY AND EMERGENCY FACILITIES ASSETS IMPACTED BY SCENARIOS**

| Asset Class                                 | Asset Owner (s)  | Scenario                                    | Percent Impacted Total Asset Class |
|---------------------------------------------|------------------|---------------------------------------------|------------------------------------|
| Critical Community and Emergency Facilities | Town of Surfside | 100-year, 72-hour                           | 80.0%                              |
|                                             |                  | 500-year, 72-hour                           | 80.0%                              |
|                                             |                  | 100-year, 72-hour + 2050 IL SLR             | 80.0%                              |
|                                             |                  | 100-year, 72-hour + 2050 I SLR              | 80.0%                              |
|                                             |                  | 100-year, 72-hour + 2080 IL SLR             | 80.0%                              |
|                                             |                  | 100-year, 72-hour + 2080 I SLR              | 80.0%                              |
|                                             |                  | Category 3 Storm Surge                      | 80.0%                              |
|                                             |                  | Category 5 Storm Surge                      | 80.0%                              |
|                                             |                  | Cat 3 Storm Surge + 2050 IL SLR             | 80.0%                              |
|                                             |                  | Cat 3 Storm Surge + 2050 I SLR              | 80.0%                              |
|                                             |                  | Cat 3 Storm Surge + 2080 IL SLR             | 80.0%                              |
|                                             |                  | Cat 3 Storm Surge + 2080 I SLR              | 80.0%                              |
|                                             |                  | King Tide                                   | 20.0%                              |
|                                             |                  | King Tide + 2050 IL SLR                     | 80.0%                              |
|                                             |                  | King Tide + 2050 I SLR                      | 80.0%                              |
|                                             |                  | King Tide + 2080 IL SLR                     | 80.0%                              |
|                                             |                  | King Tide + 2080 I SLR                      | 80.0%                              |
|                                             |                  | 100-year, 72-hour + Cat 3 Storm Surge       | 80.0%                              |
|                                             |                  | 100-year, 72-hour + Cat 5 Storm Surge       | 100.0%                             |
|                                             |                  | 100-year, 72-hour + King Tide               | 80.0%                              |
|                                             |                  | 100-year, 72-hour + King Tide + 2050 IL SLR | 80.0%                              |
|                                             |                  | 100-year, 72-hour + King Tide + 2050 I SLR  | 80.0%                              |
|                                             |                  | 100-year, 72-hour + King Tide + 2080 IL SLR | 80.0%                              |
|                                             |                  | 100-year, 72-hour + King Tide + 2080 I SLR  | 80.0%                              |
|                                             |                  | SFWMD Future 100-year, 72-hour              | 80.0%                              |
|                                             |                  | SFWMD Future 500-year, 72-hour              | 80.0%                              |

**TABLE 14: NATURAL, CULTURAL, AND HISTORICAL ASSETS IMPACTED BY SCENARIOS**

| Asset Class                              | Asset Owner (s)  | Scenario                                    | Percent Impacted Total Asset Class |
|------------------------------------------|------------------|---------------------------------------------|------------------------------------|
| Natural, Cultural, and Historical Assets | Town of Surfside | 100-year, 72-hour                           | 37.5%                              |
|                                          |                  | 500-year, 72-hour                           | 37.5%                              |
|                                          |                  | 100-year, 72-hour + 2050 IL SLR             | 37.5%                              |
|                                          |                  | 100-year, 72-hour + 2050 I SLR              | 37.5%                              |
|                                          |                  | 100-year, 72-hour + 2080 IL SLR             | 37.5%                              |
|                                          |                  | 100-year, 72-hour + 2080 I SLR              | 37.5%                              |
|                                          |                  | Category 3 Storm Surge                      | 62.5%                              |
|                                          |                  | Category 5 Storm Surge                      | 75.0%                              |
|                                          |                  | Cat 3 Storm Surge + 2050 IL SLR             | 75.0%                              |
|                                          |                  | Cat 3 Storm Surge + 2050 I SLR              | 75.0%                              |
|                                          |                  | Cat 3 Storm Surge + 2080 IL SLR             | 75.0%                              |
|                                          |                  | Cat 3 Storm Surge + 2080 I SLR              | 87.5%                              |
|                                          |                  | King Tide                                   | 37.5%                              |
|                                          |                  | King Tide + 2050 IL SLR                     | 62.5%                              |
|                                          |                  | King Tide + 2050 I SLR                      | 62.5%                              |
|                                          |                  | King Tide + 2080 IL SLR                     | 62.5%                              |
|                                          |                  | King Tide + 2080 I SLR                      | 62.5%                              |
|                                          |                  | 100-year, 72-hour + Cat 3 Storm Surge       | 62.5%                              |
|                                          |                  | 100-year, 72-hour + Cat 5 Storm Surge       | 75.0%                              |
|                                          |                  | 100-year, 72-hour + King Tide               | 50.0%                              |
|                                          |                  | 100-year, 72-hour + King Tide + 2050 IL SLR | 62.5%                              |
|                                          |                  | 100-year, 72-hour + King Tide + 2050 I SLR  | 62.5%                              |
|                                          |                  | 100-year, 72-hour + King Tide + 2080 IL SLR | 62.5%                              |
|                                          |                  | 100-year, 72-hour + King Tide + 2080 I SLR  | 62.5%                              |
|                                          |                  | SFWMD Future 100-year, 72-hour              | 37.5%                              |
|                                          |                  | SFWMD Future 500-year, 72-hour              | 50.0%                              |

The spatial extent of all flooding scenarios analyzed are in **APPENDIX E**.

### TASK 3 – SENSITIVITY ANALYSIS

A sensitivity analysis was performed to assess the risk posed to each critical asset and rank their vulnerability due to flooding from each of the various storm scenarios that were modelled in the exposure analysis. This section of the vulnerability assessment builds on the previously completed exposure analysis in which flood extents for each scenario were generated for the Town. The following sections outline the methodology used to perform the sensitivity analysis for the Town.

#### METHODOLOGY

##### *Defining Critical Elevation*

Critical assets evaluated in vulnerability assessments funded by the Resilient Coastlines Grant Program are prescribed within s. 380.093, F.S. and are subdivided into four (4) categories including:

- Transportation Assets and Evacuation Routes

- Critical Infrastructure
- Critical Community and Emergency Facilities
- Natural, Cultural, and Historical Resources

The following sections further define asset types within these categories, outline the assets found within the study area, and indicate the data source used to identify location and critical elevation of each asset in this vulnerability assessment.

The critical elevation of an asset in this study was defined as the elevation at which floodwater would disrupt service of the structure. The structures analyzed in this project are unique with regard to level of service; this resulted in varied definitions of critical elevation for each asset class.

Three different methods were used to define critical elevation in this study including:

1. Finished Floor Elevation (FFE) – Data was pulled directly from the as-builts or other survey documentation, such as GIS attribute tables provided by the Town. This method was preferred, when available. Any additional assumptions made using the FFE method are defined when used in the following sections of this report.
2. Cut Profile – Method in which a line feature was used to cut a profile from the DEM and determine lowest elevation along the feature. This method was used for major roadways.
3. Zonal Statistics – Method in which the footprint of an asset was defined and the minimum elevation from the DEM within the footprint was extracted. For any finished structure, the slab-on-grade elevation was assumed to be minimum DEM elevation plus 1-ft.
4. Percent Inundation by Area – Method in which the total area and the total flooded area of an asset are compared to determine the amount of flooding impacting the asset. Results are used in conjunction with critical elevation data to determine vulnerability.

#### *Assigning Risk Sensitivity*

Critical elevations for each asset were compared against flood depths to identify asset vulnerability in each storm event. The degree of flooding was defined by the inundation depth relative to the critical elevation of storm event. The degree of flooding was defined by the inundation depth relative to the critical elevation of the structure. For structures with less concretely defined critical elevation (parks, roads, etc.), flood impacts were evaluated using unique methodology described on a case-by-case basis in the following sections.

The final phase of the analysis was to assign a risk level, or criticality, to each asset in the paired asset-threat matrices. Critical assets were grouped into paired asset-threat matrices for each scenario and a degree of criticality was assigned. Within this analysis, risk considerations were made for the direct impacts of flooding to the asset and the more general operational impacts on the community. For the purposes of this vulnerability assessment, criticality was defined as follows:

- Low- flooding occurs but would cause minimum impact; asset is able to function during or after the event.
- Medium- flooding would cause moderate impact; asset may have limited or impaired function during or after flooding event; repairs may be needed.
- High - flooding would cause complete asset loss; complete shutdown of operation is likely to occur with high cost associated with repair or replacement; potential impact to health and safety.

Paired asset-threat matrices for all critical assets reviewed in the sensitivity analysis can be found in **Appendix F and G**.



The following sections outline the methodology and results of this analysis, broken down by asset group.

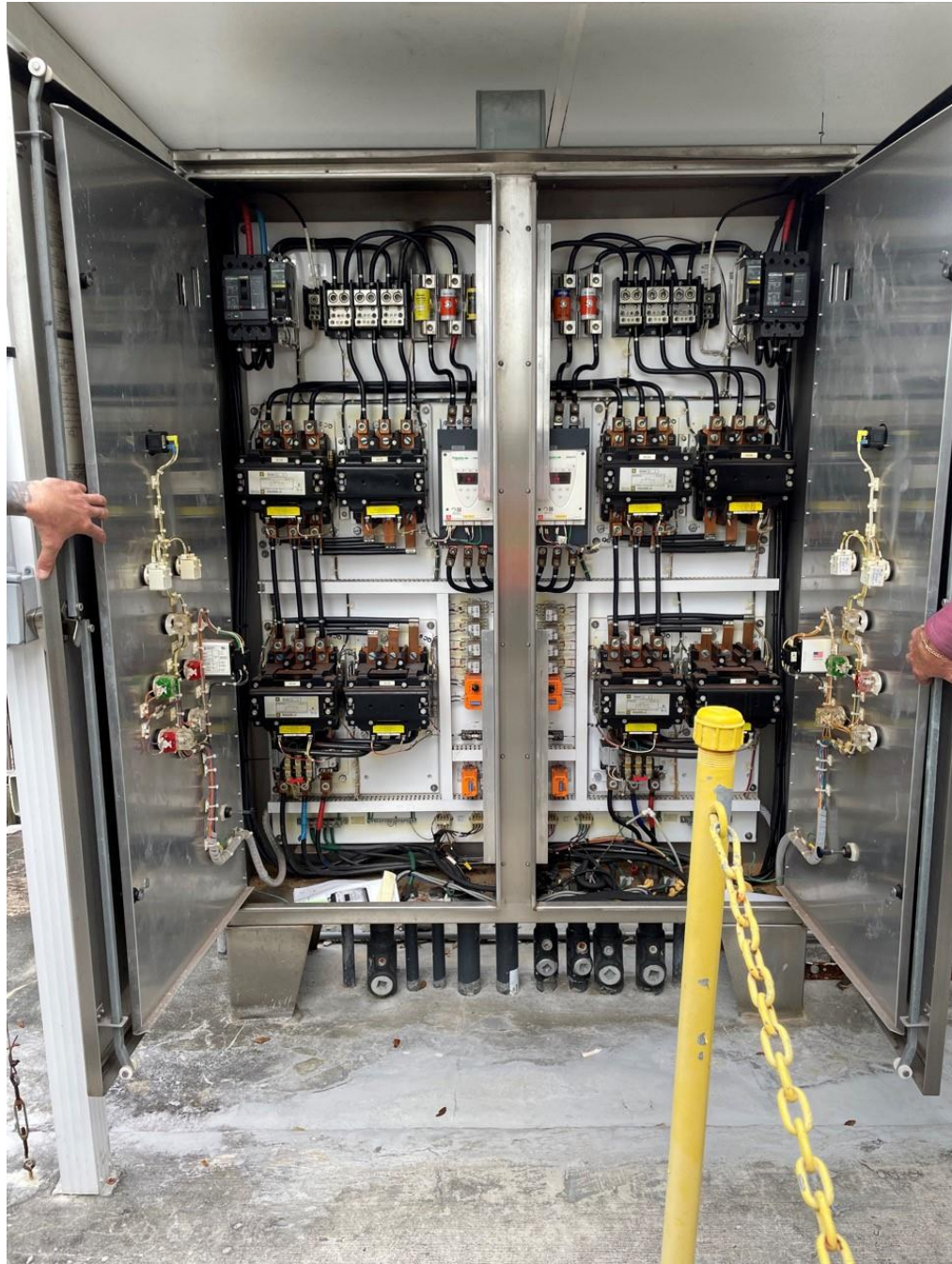
#### *Site Visit*

Kimley-Horn staff conducted a site visit with members of the Town Public Works Department to more accurately determine critical elevations of assets where FFE values were not available. The assets visited are outlined in **Table 15**.

**TABLE 15: SITE VISIT ASSETS**

| Asset Name                         | Asset Type                |
|------------------------------------|---------------------------|
| PS-1                               | Stormwater Pump Station   |
| PS-2                               | Stormwater Pump Station   |
| PS-3                               | Stormwater Pump Station   |
| PS-6                               | Stormwater Pump Station   |
| PS-7                               | Stormwater Pump Station   |
| PS-8                               | Stormwater Pump Station   |
| 0001                               | Wastewater Lift Station   |
| 0002                               | Wastewater Lift Station   |
| The Shul's Child Enrichment Center | School                    |
| Surfside Post Office               | Communications Facilities |

Kimley-Horn collected elevation data at each asset by measuring the height from the ground to the critical elevation of the asset. The critical elevation was defined as the threshold at which flood water would impact an asset. The critical elevation of the stormwater pump stations and wastewater lift stations was determined to be the bottom of the electrical control panel. The critical elevation of schools and communications facilities was determined to be the elevation at the entrance to the structure. The distance between the ground and the critical elevation was added to the ground elevation at each asset to determine a final critical elevation. Pump stations and lift stations utilized the ground measurement directly beneath their electrical panels, while buildings utilized the ground elevation at the curb in front of the building.



**FIGURE 10: WASTEWATER LIFT STATION ELECTRICAL PANEL**

## **TRANSPORTATION AND EVACUATION ROUTES**

Per s. 380.093, F.S. (2)(a) 1., Transportation and Evacuation Routes shall include airports, bridges, bus terminals, ports, major roadways, marinas, rail facilities, and railroad bridges owned and/or maintained emergency response.

All major roads and bridges in the project area were evaluated using data from the Florida Department of Transportation (FDOT) and Miami Dade County GIS Data Hub. Additional information from the same

source was used to identify primary evacuation routes to refine major roads for analysis and define road and bridge centerlines.

The data collected for critical assets defined as “Transportation Assets and Evacuation Routes” per s. 380.093(2)(a), F.S. are outlined in **Table 16**.

**TABLE 16: TRANSPORTATION ASSETS AND EVACUATION ROUTES**

| Asset Type       | Source | Critical Elevation Method |
|------------------|--------|---------------------------|
| Airports         | N/A    | N/A                       |
| Bridges          | FDOT   | Zonal Statistics          |
| Bus Terminals    | N/A    | N/A                       |
| Ports            | N/A    | N/A                       |
| Major Roadways   | FDOT   | Cut Profile               |
| Marinas          | N/A    | N/A                       |
| Rail Facilities  | N/A    | N/A                       |
| Railroad Bridges | N/A    | N/A                       |

### *Bridges*

Typically, bridge flooding would be evaluated using the low chord elevation of the structure. This data was not available for this analysis, thus elevation at the abutments was estimated using the DEM. These values were used as the critical elevation to evaluate bridges in Surfside. To account for this, critical elevations of bridges were determined using the Zonal Statistics tool to extract the lowest elevation at the two foundational ends of the bridge. The minimum elevation from the DEM was used as-is for the critical elevation of each bridge structure. This value was assumed to be the lowest shoulder elevation on the structure and thus, the critical elevation used to determine asset risk.

Critical elevation of bridges defined in this study can be found in **Table 17**.

**TABLE 17: CRITICAL ELEVATION, BRIDGES**

| Asset Name | Asset Class | Critical Elevation (NAVD88, ft) | Critical Elevation Method |
|------------|-------------|---------------------------------|---------------------------|
| 878001     | Bridge      | 5.0                             | Zonal Statistics          |

Criticality for bridges considered the following factors in assigning risk:

- Rainfall flooding is temporary – likelihood of complete asset loss is unlikely.
- Any flood depths greater than 0.5-ft would incur limited function of the bridge during and after the event.
- SLR flooding would cause permanent inundation and would therefore render the bridge asset a complete loss.
- Saltwater corrosion and significant wave action caused by storm surge will require structural evaluation following a storm event.

### *Major Roads*

Major roads were evaluated using a cut profile method in which road centerlines were used to identify the elevation at stations along the route as it passes through the Town. A uniform cross-section across the road centerline was assumed. Once road profiles were cut from the DEM, the flood raster profiles were generated to show any locations where flooding was expected to occur. To account for low points along the road centerline, a threshold of 15% of the road centerline must be inundated for the road to be considered vulnerable.

Criticality for major roads considered the following factors in assigning risk:

- Rainfall flooding is temporary – likelihood of complete asset loss is unlikely.
- Any flood depths greater than 0.5-ft would incur limited function of the road during and after the event.
- SLR flooding would cause permanent inundation and would therefore render the road asset a complete loss.
- Saltwater corrosion and significant wave action caused by storm surge may require evaluation following a storm event.

## CRITICAL INFRASTRUCTURE

Per s. 380.093, F.S. (2)(a) 2., Critical Infrastructure shall include wastewater treatment facilities and lift stations, stormwater treatment facilities and pump stations, drinking water facilities, water utility conveyance systems, electric production and supply facilities, solid and hazardous waste facilities, military installations, communications facilities, and disaster debris management sites owned and/or maintained by the Town.

There were no wastewater treatment facilities, stormwater treatment facilities, drinking water facilities, drinking water pump stations, water utility conveyance systems, or military installations located within the Town of Surfside jurisdiction.

Disaster Debris Management Sites, Electric Production and Supply Facilities, Communication Facilities, Wastewater Lift Stations, and Stormwater Pump Stations were the Critical Infrastructure assets identified within the Town of Surfside.

The data collected on critical assets defined as “Critical Infrastructure” per s. 380.093(2)(a), F.S. are outlined in **Table 18**.

**TABLE 18: CRITICAL INFRASTRUCTURE**

| Asset Type                                                | Source                    | Critical Elevation Method       |
|-----------------------------------------------------------|---------------------------|---------------------------------|
| Wastewater Treatment Facilities                           | N/A                       | N/A                             |
| Wastewater Lift Stations                                  | Town of Surfside          | Zonal Statistics and Site Visit |
| Stormwater Pump Stations                                  | Town of Surfside          | Zonal Statistics and Site Visit |
| Stormwater Treatment Facilities (Injection Wells)         | N/A                       | N/A                             |
| Stormwater Treatment Facilities (Pollution Control Boxes) | N/A                       | N/A                             |
| Drinking Water Facilities                                 | N/A                       | N/A                             |
| Drinking Water Pump Stations                              | N/A                       | N/A                             |
| Water Utility Conveyance Systems (Water Mains)            | N/A                       | N/A                             |
| Electric Productions and Supply Facilities                | Miami-Dade County GIS Hub | Zonal Statistics                |
| Military Installations                                    | N/A                       | N/A                             |
| Communications Facilities                                 | Town of Surfside          | Zonal Statistics and Site Visit |
| Disaster Debris Management Sites                          | Miami-Dade County GIS Hub | Zonal Statistics                |

### *Critical Infrastructure*

Critical elevations for Communications Facilities, Disaster Debris Management Sites, Electric Production and Supply Facilities, Stormwater Pump Stations, and Wastewater Lift Stations were



determined using the Zonal Statistics tool to extract the lowest elevation around the structure from the DEM and adding the elevations determined during Kimley-Horn's site visit, where appropriate. The reported value was assumed to be in the critical elevation for these structures and the assumed elevation at which flooding of the system and loss of functionality occurs.

Critical elevations for all critical infrastructure in Surfside are reported in **Table 19**. Values marked with an (\*) indicated elevations were pulled from existing survey or as-built data.

**TABLE 19: CRITICAL ELEVATIONS FOR CRITICAL INFRASTRUCTURE**

| Asset Name                            | Asset Class                               | Critical Elevation (NAVD88, ft) | Critical Elevation Method       |
|---------------------------------------|-------------------------------------------|---------------------------------|---------------------------------|
| Surfside Post Office                  | Communications Facilities                 | 5.8                             | Zonal Statistics and Site Visit |
| 96 <sup>th</sup> Street Park Surfside | Disaster Debris Management Sites          | 2.6                             | Zonal Statistics                |
| Surface Lot South                     | Disaster Debris Management Sites          | 3.8                             | Zonal Statistics                |
| Tennis Courts                         | Disaster Debris Management Sites          | 5.1                             | Zonal Statistics                |
| 8800 Collins Ave Site                 | Disaster Debris Management Sites          | 4.7                             | Zonal Statistics                |
| Surface Lot North                     | Disaster Debris Management Sites          | 3.3                             | Zonal Statistics                |
| Town of Surfside                      | Disaster Debris Management Sites          | 5.5                             | Zonal Statistics                |
| Normandy Beach                        | Electric Production and Supply Facilities | 3.3                             | Zonal Statistics                |
| PS-1                                  | Pump Station                              | 4.0                             | Zonal Statistics and Site Visit |
| PS-2                                  | Pump Station                              | 5.5                             | Zonal Statistics and Site Visit |
| PS-3                                  | Pump Station                              | 4.4                             | Zonal Statistics and Site Visit |
| PS-4                                  | Pump Station                              | 3.2                             | Zonal Statistics and Site Visit |
| PS-5                                  | Pump Station                              | 3.3                             | Zonal Statistics and Site Visit |
| PS-6                                  | Pump Station                              | 4.7                             | Zonal Statistics and Site Visit |
| PS-7                                  | Pump Station                              | 6.1                             | Zonal Statistics and Site Visit |
| PS-8                                  | Pump Station                              | 7.4                             | Zonal Statistics and Site Visit |

| Asset Name | Asset Class                | Critical Elevation<br>(NAVD88, ft) | Critical Elevation<br>Method       |
|------------|----------------------------|------------------------------------|------------------------------------|
| 0001       | Wastewater Lift<br>Station | 5.42                               | Zonal Statistics and Site<br>Visit |
| 0002       | Wastewater Lift<br>Station | 7.1                                | Zonal Statistics and Site<br>Visit |

Criticality for critical infrastructure considered the following factors in assigning risk:

- Rainfall flooding is temporary – likelihood of complete asset loss is unlikely but may affect the functionality of the structures during and following the event.
- Structure flooding is estimated when flood waters are at rim elevation.
- SLR flooding would cause permanent inundation and would therefore render the asset a complete loss.
- Saltwater infiltration and significant wave action caused by storm surge will require evaluation following a storm event.

## CRITICAL COMMUNITY AND EMERGENCY FACILITIES

Per s. 380.093, F.S. (2)(a) 3., Critical Community and Emergency Facilities shall include schools, colleges, universities, community centers, correctional facilities, disaster recovery centers, emergency medical service facilities, emergency operation centers, fire stations, health care facilities, hospitals, law enforcement facilities, local government facilities, logical staging areas, affordable public housing, risk shelter inventory, and state government facilities owned and/or maintained by the Town.

There were no colleges, universities correctional facilities, disaster recovery centers, emergency medical service facilities, fire stations, hospitals, logical staging areas, affordable public housing, risk shelter facilities, or state government facilities located within the Town of Surfside.

Schools, community centers, emergency operation centers, law enforcement facilities, and local government facilities were the Critical Community and Emergency Facility assets identified within the Town of Surfside.

The data collected on critical assets defined as “Critical Community and Emergency Facilities” per s. 380.093(2)(a), F.S. are outlined in **Table 20**.

**TABLE 20: CRITICAL COMMUNITY AND EMERGENCY FACILITIES**

| Asset Type                              | Source           | Critical Elevation Method       |
|-----------------------------------------|------------------|---------------------------------|
| Schools                                 | Town of Surfside | Zonal Statistics and Site Visit |
| Colleges                                | N/A              | N/A                             |
| Universities                            | N/A              | N/A                             |
| Community Centers                       | Town of Surfside | FFE from As-Builts              |
| Correctional Facilities                 | N/A              | N/A                             |
| Disaster Recovery Centers               | N/A              | N/A                             |
| Emergency Medical Service<br>Facilities | N/A              | N/A                             |
| Emergency Operation Centers             | Town of Surfside | FFE from As-Builts              |
| Fire Stations                           | N/A              | N/A                             |
| Hospitals                               | N/A              | N/A                             |
| Law Enforcement Facilities              | Town of Surfside | FFE from As-Builts              |
| Local Government Facilities             | Town of Surfside | FFE from As-Builts              |

| Asset Type                  | Source | Critical Elevation Method |
|-----------------------------|--------|---------------------------|
| Logistical Staging Areas    | N/A    | N/A                       |
| Affordable Public Housing   | N/A    | N/A                       |
| Risk Shelter Inventory      | N/A    | N/A                       |
| State Government Facilities | N/A    | N/A                       |

#### *Critical Community and Emergency Facilities*

The FFE was identified as the critical elevation at which buildings would be considered vulnerable to flooding. Critical elevation for all Town facilities with unreported FFEs were determined using the Zonal Statistics tool to extract the average curb elevation. This value was added to the height of the facility above the curb as determined during a site visit to the Town.

Critical elevations for all critical community and emergency facilities in Surfside are reported in **Table 21**.

**TABLE 21: CRITICAL ELEVATION; CRITICAL COMMUNITY AND EMERGENCY FACILITIES**

| Asset Name                              | Asset Class                 | Critical Elevation (NAVD88, ft) | Critical Elevation Method       |
|-----------------------------------------|-----------------------------|---------------------------------|---------------------------------|
| Surfside Community Center               | Community Centers           | 12.00                           | FFE from As-Builts              |
| Surfside Town Hall                      | Emergency Operations Center | 5.95                            | FFE from As-Builts              |
| Surfside Police Department Headquarters | Law Enforcement Facilities  | 5.95                            | FFE from As-Builts              |
| Surfside Town Hall                      | Local Government Facilities | 5.95                            | FFE from As-Builts              |
| The Shul's Child Enrichment Center      | Schools                     | 10.70                           | Zonal Statistics and Site Visit |

Criticality for Town buildings and facilities considered the following factors in assigning low, medium, or high risk:

- Any flooding greater than 0.5-ft would likely incur damage, accessibility concerns, and limited function of the facility during and after the event.
- SLR flooding would cause permanent inundation and would therefore render the asset a complete loss.
- Saltwater corrosion and significant wave action caused by storm surge will require evaluation following a storm event.

## **NATURAL, CULTURAL, AND RESOURCES**

Per s. 380.093, F.S. (2)(a) 4., Natural, Cultural, and Historical Resources shall include conservation lands, parks, shorelines, surface waters, wetlands, and historical and cultural assets owned and/or maintained by the Town.

The data collected on critical assets defined as “Natural, Cultural, and Historical Resources” per s. 380.093(2)(a), F.S. are outlined in **Table 22**.

**TABLE 22: NATURAL, CULTURAL, AND HISTORICAL RESOURCES**

| Asset Name                     | Asset Class               | Critical Elevation Method |
|--------------------------------|---------------------------|---------------------------|
| Conservation Lands             | N/A                       | N/A                       |
| Parks                          | Miami-Dade County GIS Hub | Zonal Statistics          |
| Shorelines                     | N/A                       | N/A                       |
| Surface Waters                 | N/A                       | N/A                       |
| Wetlands                       | N/A                       | N/A                       |
| Historical and Cultural Assets | Town of Surfside          | Zonal Statistics          |

### *Parks*

In lieu of the critical elevation method, an assessment of percent flooding area was made for parks to evaluate criticality. This assessment utilized the Zonal Statistics method to identify total park area. Total acreage for all parks evaluated can be found in **Table 23**.

**TABLE 23: PARKS, TOTAL AREA**

| Asset Name                                 | Asset Class | Critical Elevation (NAVD88, ft) | Critical Elevation Method |
|--------------------------------------------|-------------|---------------------------------|---------------------------|
| 96 <sup>th</sup> Street Park/Surfside Park | Park        | 1.2                             | Zonal Statistics          |
| Hawthorn Tot Lot                           | Park        | 0.3                             | Zonal Statistics          |
| Paws Up Dog Park                           | Park        | 0.1                             | Zonal Statistics          |
| Surfside Community Center                  | Park        | 1.6                             | Zonal Statistics          |
| Veterans Park and Tennis Center            | Park        | 1.2                             | Zonal Statistics          |

Criticality for parks considered the following factors in assigning low, medium, or high risk:

- Rainfall flooding is temporary – likelihood of complete asset loss is unlikely.
- Any flooding greater than 75% by area would likely to incur significantly limited function of the area during and after the event.
- Significant SLR flooding would cause permanent inundation and would therefore render the park asset a complete loss.

### *Historical, and Cultural Assets*

The only Historical and Cultural Asset in the Town that is not a park is the proposed Surfside Memorial. Since this asset has not yet been designed or constructed, the critical elevation was estimated to be the average road elevation the future site of the memorial. **Table 24** shows the critical elevation of the Future Surfside Memorial.

**TABLE 24: SURFACE WATER, HISTORICAL, AND CULTURAL ASSET CRITICAL ELEVATIONS**

| Asset Name               | Asset Class                    | Critical Elevation (NAVD88, ft) | Critical Elevation Method |
|--------------------------|--------------------------------|---------------------------------|---------------------------|
| Future Surfside Memorial | Historical and Cultural Assets | 9.8                             | Zonal Statistics          |

Criticality for Town buildings and facilities considered the following factors in assigning low, medium, or high risk:

- Any flooding greater than 0.5-ft would likely incur damage, accessibility concerns, and limited function of the facility during and after the event.
- SLR flooding would cause permanent inundation and would therefore render the asset a complete loss.



- Saltwater corrosion and significant wave action caused by storm surge will require evaluation following a storm event.

## DUNE VULNERABILITY

Kimley-Horn coordinated with FDEP to determine an appropriate method of analyzing the vulnerability of the Town's dunes to erosion during coastal flooding events. Kimley-Horn estimated erosion potential by measuring flood depth along the crown of the Town's dune system in flooding scenarios that include storm surge flooding. Tidal and rainfall induced flooding scenarios were not considered as they do not create the shoreline velocities typically associated with beach erosion. Dune vulnerability was analyzed in the scenarios listed in **Table 25**.

**TABLE 25: DUNE VULNERABILITY SCENARIOS**

| Scenario | Description                                        | Model   |
|----------|----------------------------------------------------|---------|
| 7        | Category 3 Storm Surge                             | Bathtub |
| 8        | Category 5 Storm Surge                             | Bathtub |
| 9        | Category 3 Storm Surge + 2050 Intermediate-Low SLR | Bathtub |
| 10       | Category 3 Storm Surge + 2050 Intermediate SLR     | Bathtub |
| 11       | Category 3 Storm Surge + 2080 Intermediate-Low SLR | Bathtub |
| 12       | Category 3 Storm Surge + 2080 Intermediate SLR     | Bathtub |
| 18       | 100-year, 72-hour + Category 3 Storm Surge         | SWMP    |
| 19       | 100-year, 72-hour + Category 5 Storm Surge         | SWMP    |

Dune profile data was based on the proposed dune profile from the Surfside Dune Resiliency and Beautification project. The Dune Resiliency and Beautification project is under review with the U.S. Army Corps of Engineers at the time of this report. The proposed dune profile has a minimum elevation of 10.48 feet NAVD 88. This minimum elevation was used as the critical elevation in the vulnerability analysis of the dune system.

The proposed dune profile is elevated above flood depths in all analyzed scenarios, indicating that the proposed dune system is not vulnerable in these scenarios. Refer to **Appendix E and F** for a summary of the results of the dune sensitivity analysis.

## RESULTS AND DISCUSSION

The sensitivity analysis conducted for the Town of Surfside reveals significant vulnerabilities among various assets to flooding, particularly in scenarios involving storm surge induced flooding and compound flooding. This discussion provides a general overview of the findings, highlighting the most affected areas. Refer to **Appendix E and F** for a summary of results of the sensitivity analysis.

The sensitivity analysis indicates that the majority of assets in Surfside are highly susceptible to flooding during storm surge events (both the Category 3 and Category 5 events) and compound flooding scenarios. These scenarios demonstrated the most widespread impact, with the notable exception of a number of the Surfside Community Center.

The analysis performed on Transportation Assets and Evacuation Route assets (bridges and major roads) identified targeted locations at which road improvements may be focused to improve the Town's resiliency. Most major roads and evacuation routes were found to be vulnerable across all evaluated scenarios. One exception to this trend is Collins Avenue, which is generally not vulnerable due to the higher elevations present east of Harding Avenue. The accuracy of these results could be further improved by obtaining actual lane cross-slopes.

Critical infrastructure within the Town generally demonstrated higher resilience compared in the rainfall scenarios in current and future conditions compared to the other analyzed scenarios. Normandy Beach, Surfside Park, Surface Lot North, PS-4, and PS-5 show vulnerability in compound scenarios considering rainfall and king tide conditions. However, in storm surge and tidal flooding scenarios a majority of critical infrastructure assets were vulnerable.

All Critical Community and Emergency Facilities were found not to be vulnerable in scenarios involving rainfall-induced flooding without compound flooding, and tidal flooding. Storm surge scenarios showed that most critical community and emergency facilities were vulnerable with the exception of the Shul's Child Enrichment Center and the Surfside Community Center. The Shul's Child Enrichment Center was found vulnerable only in the compound 100-year, 72-hour rainfall and Category 5 Storm Surge event.

All Natural, Cultural, and Historical assets aside from the Hawthorne Tot Lot and 96<sup>th</sup> Street Park/Surfside Park were found to be at low risk in rainfall scenarios, high risk in storm surge scenarios and moderate risk in tidal scenarios. The notable exception to this is the Future Surfside Memorial, which is located at a high point in the Town and is at low risk in all scenarios except the compound 100-year, 72-hour rainfall and Category 5 Storm Surge event.

Rainfall induced flooding primarily impacts Transportation Assets and Evacuation Routes and Natural Cultural and Historic Assets, with minimal impact to most other asset classes. King Tide flooding impacts all asset classes except Critical Community and Emergency Facilities. Compound flooding consisting of rainfall and storm surge impacted all asset classes. Compound flooding consisting of rainfall and king tides impacted asset classes similarly to rainfall induced flooding, with minimal impact outside of Transportation Assets and Evacuation Routes and Natural Cultural and Historic Assets. Sea level rise was considered for rainfall induced, king tide induced, and compound rainfall king tide induced flooding scenarios. Sea level rise primarily increased vulnerability in Transportation Assets and Evacuation Routes, and Critical Infrastructure. Storm surge and compound flood scenarios considering storm surge impacted all assets, with most vulnerable assets having a rating of high sensitivity. Overall, this analysis suggests that the greatest threat to critical assets within the Town is storm surge flooding. The results of this analysis can be further refined with better road profile information and more FFE data on Critical Infrastructure.

## **TASK 4 – FINAL VULNERABILITY ASSESSMENT REPORT, MAPS, AND TABLES**

This report contains summaries of all tasks completed for this Vulnerability Assessment. Maps of all flooding scenarios can be found in **APPENDIX D** and results of the sensitivity analysis tables can be found in **APPENDIX F** and **APPENDIX G**.

### **HIGHLY SENSITIVE ASSETS**

At the request of the Town, assets were reviewed to identify highly sensitive assets to guide future improvement projects. For this analysis, highly sensitive assets were selected based on scoring the overall sensitivity of Town owned assets and taking the top 20 highest scoring assets. These assets were then ranked in groups based on their function to the Town. Assets with more critical functions, such as emergency access or flood control, were ranked higher due to the importance of their operation during a storm event. Rankings are not meant to identify assets at risk, rather they are meant to give the Town a guide it can use to assist in allocating funding for future projects. **Table 26** lists the Highly Sensitive Assets identified through this process.

**TABLE 26: HIGHLY SENSITIVE ASSETS**

| Ranking | Asset Name          | Asset Type               | Function                  |
|---------|---------------------|--------------------------|---------------------------|
| 1       | Harding Avenue      | Major Roadways           | Townwide Emergency Access |
| 2       | 91 St/Surfside Blvd | Major Roadways           | Local Emergency Access    |
|         | NE 88 St            | Major Roadways           |                           |
| 3       | PS-4                | Stormwater Pump Stations | Flood Control             |
| 3       | Byron Ave           | Major Roadways           | Townwide Traffic          |
|         | Carlyle Ave         | Major Roadways           |                           |
|         | Abbott Ave          | Major Roadways           |                           |
|         | Bay Dr              | Major Roadways           |                           |
|         | NE 16 Ave           | Major Roadways           |                           |
|         | Dickens Ave         | Major Roadways           |                           |
| 5       | NE 88 St            | Major Roadways           | Local Traffic             |
|         | Hawthorne Ave       | Major Roadways           |                           |
|         | Garland Ave         | Major Roadways           |                           |
|         | Froude Ave          | Major Roadways           |                           |
|         | Emerson Ave         | Major Roadways           |                           |
|         | Eli Lurie Blvd      | Major Roadways           |                           |
|         | Irving Ave          | Major Roadways           |                           |
|         | Isaac Singer Blvd   | Major Roadways           |                           |
| 6       | 96th Street         | Parks                    | Recreation                |
|         | Park/Surfside Park  |                          |                           |
|         | Hawthorne Tot Lot   | Parks                    |                           |

This analysis is consistent with the overall results of **TASK 3 – SENSITIVITY ANALYSIS**, suggesting that roadways make up most of the Town’s most vulnerable assets.

## ADAPTATION STRATEGIES

Kimley-Horn developed potential adaptation strategies for each Asset Type represented in the Highly Sensitive Assets in accordance with the Florida Adaptation Guidebook. The Florida Adaptation Guidebook identifies four categories of adaptation: *Protection*, *Accommodation*, *Retreat*, and *Avoidance*. Adaptation Strategies for the Highly Sensitive Assets identified in this Assessment fall under *Protection* and *Accommodation* strategies. Example projects are included underneath each Adaptation Strategy as potential actions the Town can take to reduce the vulnerability of certain Highly Sensitive Assets. **Table 31** provides feasibility scores for example projects.

### *Protection*

Protection strategies are generally structurally defensive measures that directly protect vulnerable structures, leaving them unaltered. These strategies can be permanent infrastructure projects like stormwater system improvements, or temporary in the case of temporary dry floodproofing measures like flood barriers. Protection strategies that apply to Highly Sensitive Assets within the Town are outlined in **Table 27**.

**TABLE 27: PROTECTION ADAPTATION STRATEGIES**



### Dry Floodproof Pump Stations

- Apply temporary or permanent dry floodproofing techniques to reduce damage to pump stations



### Stormwater Infrastructure Improvements

- Expand the Town stormwater system
- Implement stormwater system upgrades identified in the Town's 2023 Stormwater Master Plan

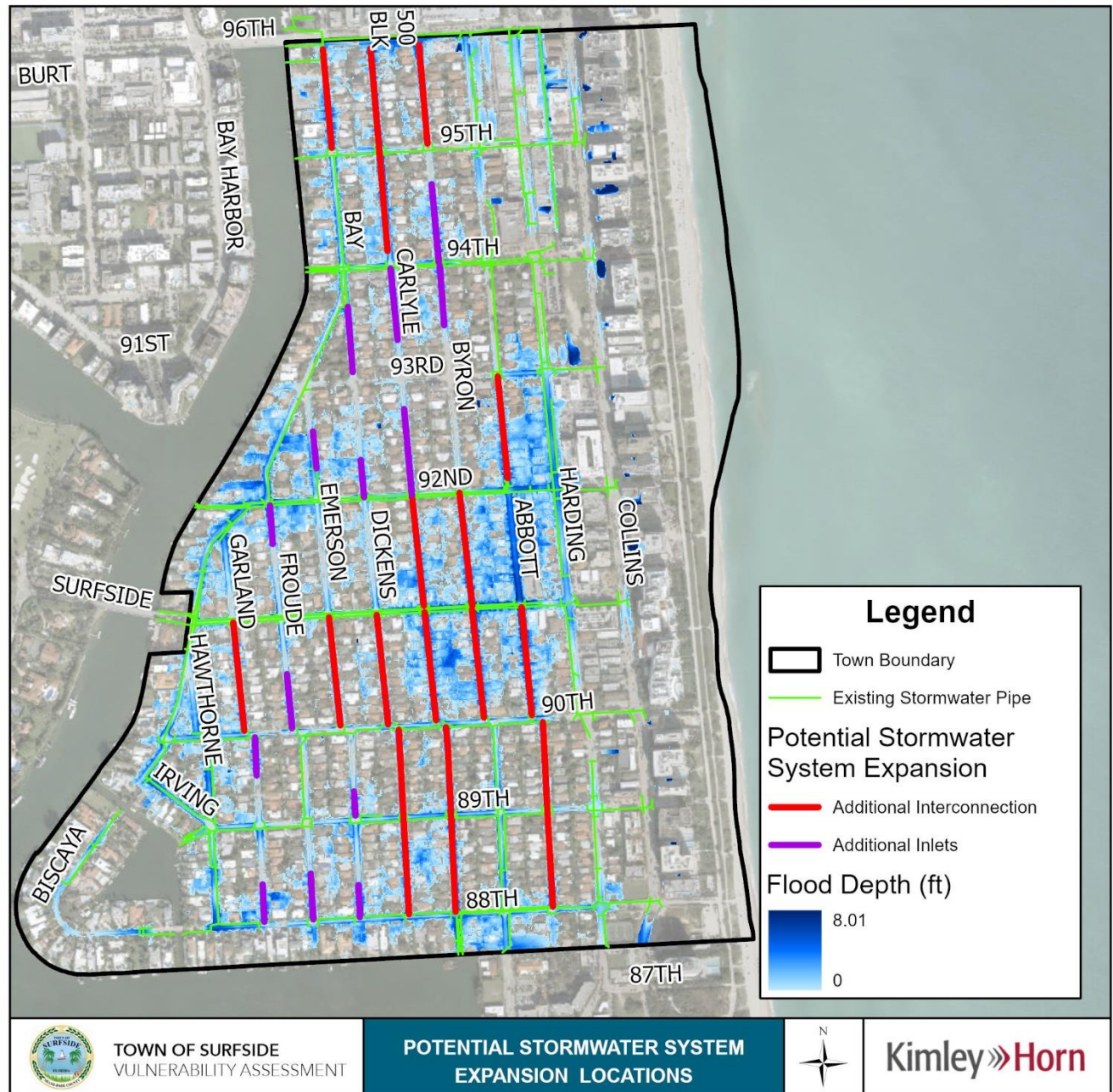
#### Dry Floodproofing

Dry floodproofing primarily applies to the Town's stormwater pump stations and can take the form of permanent or temporary upgrades. Temporary dry floodproofing primarily involves erecting flood barriers around vulnerable pump stations when a flood event is forecasted that threatens the vulnerable asset. Permanent dry floodproofing involves adding waterproof sealing to control panel doors and other openings.

#### Stormwater Infrastructure Improvements

Improving stormwater infrastructure improves resilience by reducing the depth and duration of flooding that assets are exposed to during flood events. The majority of roads running north and south within the Town rely on road grading to convey stormwater to catch basins along east and west running roads. This results in greater vulnerability along these roads, including several identified as Highly Sensitive Assets. The Town's 2023 Stormwater Master Plan included Local Drainage Improvement projects along Bay Drive north of 95<sup>th</sup> Street and Emerson Avenue north of 92<sup>nd</sup> Street to reduce flooding in areas not currently served by stormwater infrastructure. These projects can be expanded to other areas of the Town to address vulnerability in roadways without existing stormwater infrastructure. **Figure 11** shows the locations of potential stormwater system expansions against the Town's existing stormwater network and the 100-year, 72-hour storm event flood depth. Abbott Avenue between 91<sup>st</sup> Street and 92<sup>nd</sup> Street has been excluded from this recommendation as stormwater improvements are already underway in this area.





**FIGURE 11: POTENTIAL STORMWATER SYSTEM EXPANSION LOCATIONS**

Locations for potential expansion were selected by identifying areas without stormwater infrastructure, and with roadway flooding above the crown of the road in the 100-year, 72-hour storm event. Potential expansions are split into two categories: Additional Interconnection and Additional Inlets. Additional Interconnection projects propose expanding the Town’s stormwater system to connect existing east west running stormwater lines with a new north south running line. This additional interconnection will help streets with no existing infrastructure drain into the Town’s stormwater system faster. Additional Inlet projects propose extending existing stormwater lines north or south to collect runoff along sections of streets with no existing infrastructure. **Table 28** identifies the locations of each potential expansion project. Additional Interconnection projects across multiple cross streets may be completed in phases



or as a single project. **Table 31** provides scoring for potential stormwater system expansion (SSE) projects on a street-by-street basis.

**TABLE 28: POTENTIAL STORMWATER SYSTEM EXPANSION LOCATIONS**

| Asset Name  | North Cross Street  | South Cross Street  | Expansion Type             |
|-------------|---------------------|---------------------|----------------------------|
| Abbott Ave  | 93 <sup>rd</sup> St | 92 <sup>nd</sup> St | Additional Interconnection |
|             | 91 <sup>st</sup> St | 88 <sup>th</sup> St | Additional Interconnection |
| Bay Dr      | 96 <sup>th</sup> St | 95 <sup>th</sup> St | Additional Interconnection |
| Byron Ave   | 96 <sup>th</sup> St | 95 <sup>th</sup> St | Additional Interconnection |
|             | 95 <sup>th</sup> St | 94 <sup>th</sup> St | Additional Inlets          |
|             | 94 <sup>th</sup> St | 93 <sup>rd</sup> St | Additional Inlets          |
|             | 92 <sup>nd</sup> St | 90 <sup>th</sup> St | Additional Interconnection |
| Carlyle Ave | 96 <sup>th</sup> St | 94 <sup>th</sup> St | Additional Interconnection |
|             | 94 <sup>th</sup> St | 93 <sup>rd</sup> St | Additional Inlets          |
|             | 93 <sup>rd</sup> St | 92 <sup>nd</sup> St | Additional Inlets          |
|             | 92 <sup>nd</sup> St | 88 <sup>th</sup> St | Additional Interconnection |
| Dickens Ave | Bay Dr              | 93 <sup>rd</sup> St | Additional Inlets          |
|             | 93 <sup>rd</sup> St | 92 <sup>nd</sup> St | Additional Inlets          |
|             | 91 <sup>st</sup> St | 88 <sup>th</sup> St | Additional Interconnection |
| Emerson Ave | 93 <sup>rd</sup> St | 92 <sup>nd</sup> St | Additional Inlets          |
|             | 91 <sup>st</sup> St | 90 <sup>th</sup> St | Additional Interconnection |
|             | 90 <sup>th</sup> St | 89 <sup>th</sup> St | Additional Inlets          |
|             | 89 <sup>th</sup> St | 88 <sup>th</sup> St | Additional Inlets          |
| Froude Ave  | 92 <sup>nd</sup> St | 91 <sup>st</sup> St | Additional Inlets          |
|             | 91 <sup>st</sup> St | 90 <sup>th</sup> St | Additional Inlets          |
|             | 89 <sup>th</sup> St | 88 <sup>th</sup> St | Additional Inlets          |

| Asset Name  | North Cross Street  | South Cross Street  | Expansion Type               |
|-------------|---------------------|---------------------|------------------------------|
| Garland Ave | 91 <sup>st</sup> St | 90 <sup>th</sup> St | Additional Interconnectivity |
|             | 90 <sup>th</sup> St | 89 <sup>th</sup> St | Additional Inlets            |
|             | 89 <sup>th</sup> St | 88 <sup>th</sup> St | Additional Inlets            |

### Accommodation

Accommodation strategies alter physical design to allow the structure or land use to stay in place. Accommodation strategies that apply to the Town's Highly Sensitive Assets are outlined in **Table 29**.

**TABLE 29: ACCOMMODATION ADAPTATION STRATEGIES**



#### Elevate Critical Infrastructure

- Elevate infrastructure such as pump stations and roads as high as is feasible and provide the necessary stormwater improvements to prevent impacts to adjacent areas



#### Utilize Green Space for Sponge Areas

- Create sponge areas in existing parks in order to reduce flooding impacts to courts and other hardscape

### Elevate Critical Infrastructure

Elevating assets can completely mitigate their vulnerability to most flooding events when elevated above critical flood elevations. In cases where this is not feasible, such as roadways, elevating assets can reduce vulnerability in extreme storm events and eliminate it in smaller events. Raising roadways can keep them operational for longer for emergency services and return to operational status faster as flood waters recede. Raising Town-owned pump stations can reduce their vulnerability during flooding events, especially when combined with dry floodproofing.

Roadways that are vital for emergency access and evacuation are candidates for roadway elevation projects. **Figure 12** shows the locations of roadways that are potential candidates for elevation projects.



**FIGURE 12: ROAD ELEVATION LOCATIONS**

91<sup>st</sup> St/Surfside Blvd is the only road in and out of Indian Creek Village and it is the main east west running road serving the Town. 91<sup>st</sup> St has low spots along the length of the road crown where water can gather.

Harding Ave is the southbound portion of Florida State Road A1A and serves as the primary route for traffic into and out of the Town along with Collins Ave. The Town does not have its own emergency services, so it relies on the ability for emergency services to enter the Town via roads like Harding Ave, making it critical that the road remains operational during and after storm events. A portion of Harding

Ave roughly from 90<sup>th</sup> St to 93<sup>rd</sup> St is lower than adjacent sections of the road, allowing water to gather on the road crown.

NE 88<sup>th</sup> St is the only road in and out of Biscaya Island, a portion of the road crown immediately east of the bridge to Biscaya Island is up to 1 foot lower than adjacent road crown elevations, creating a depressional area for water to gather. Raising the low points of these roads reduces the amount of inundation along the road crown, making the road less vulnerable during storm events.

#### Utilize Green Space for Sponge Areas

Utilizing green space to create sponge areas within existing parks provides additional storage during storm events. Sponge areas include bioswales, rain gardens, and grass depressional areas that serve as flood storage when wet and recreation space when dry. These sponge areas hold runoff and slowly infiltrate it into the ground. This can help reduce flooding on courts and other hardscapes within a park. Sponge areas can also reduce flooding in adjacent areas such as roadways when designed with enough storage capacity to serve the park and adjacent areas. Sponge areas can also provide aesthetic value by creating areas of natural habitat using native plants that thrive within the Town's environment. Native grasses and trees that are salt resistant are good candidates for planting within any proposed sponge areas. Both parks identified in **Table 26** contain open space that can be converted in to sponge areas.

The Hawthorne Tot Lot consists of a playground surrounded by green space with areas of landscaping. These green spaces can be incorporated into a future sponge area without encroaching on the playground, providing additional flood storage while preserving the function of the park. **Figure 13** shows the Hawthorne Tot Lot and the potential sponge areas around it.

Surfside Park consists of hardscape on its northern half including a basketball court, and the southern half is an open field. The field appears to serve multiple uses, including a space for soccer matches. A portion of this field around its perimeter can be converted to a sponge area while keeping the functionality of the field largely intact. **Figure 14** shows Surfside Park and the potential sponge area location.





**FIGURE 13: HAWTHORNE TOT LOT POTENTIAL SPONGE AREAS**





**FIGURE 14: SURFSIDE PARK POTENTIAL SPONGE AREAS**

#### *Example Project Scoring*

Example projects, grouped by adaptation strategy, were scored using the criteria outlined in **Table 30**. Scoring was based on how a strategy increases resilience, the financial feasibility of the strategy, the public benefit of the strategy, and the time required to implement the strategy. Example project feasibility scores weigh the potential benefits of a strategy against roadblocks. Creating a unified score for each project allows the Town to identify strategies that can be rapidly implemented while showing which strategies require new allocation of funding or take longer to implement. Total scores are meant to rank the current feasibility of a project rather than the priority of one project over another. For example, a large multi-year roadway improvement project may score lower than a local drainage

improvement. The large project results in greater benefit to the Town, but it is harder to implement and requires more funding, resulting in a lower total score.

**TABLE 30: EXAMPLE PROJECT FEASIBILITY SCORING CRITERIA**

| <b>Resilience Criteria</b>                          |                                                                                                 |
|-----------------------------------------------------|-------------------------------------------------------------------------------------------------|
| 5                                                   | Aim to increase resiliency by hardening against Category 3 Storm Surge                          |
| 4                                                   | Aim to increase resiliency by hardening against the 100-year, 72-hour storm event               |
| 3                                                   | Aim to increase resiliency or reduce flooding by improving overall functionality of an asset    |
| 2                                                   | Existing conditions maintained and/or integrity of asset for use or accessibility maintained    |
| 1                                                   | Minimal benefit to resiliency                                                                   |
| <b>Implementation Costs (Financial Feasibility)</b> |                                                                                                 |
| 3                                                   | Town has funding allocated for design and construction                                          |
| 2                                                   | Town has partial funding for design and construction                                            |
| 1                                                   | Town is still in need of additional funding                                                     |
| <b>Public Benefit Criteria</b>                      |                                                                                                 |
| 3                                                   | High Public Benefit                                                                             |
| 2                                                   | Moderate Public Benefit                                                                         |
| 1                                                   | Low Public Benefit                                                                              |
| <b>Implementation Time Criteria</b>                 |                                                                                                 |
| 3                                                   | Can be implemented 1-2 years; minimal permitting, coordination, or design required              |
| 2                                                   | Can be implemented in 2-5 years; moderate permitting, coordination, or design required          |
| 1                                                   | Requires 5+ years to implement extensive planning, permitting, multi-agency coordination needed |

Feasibility scores for example projects are provided in **Table 31**.

**TABLE 31: ADAPTATION STRATEGY SCORING**

| Adaptation Strategy Type | Project                                  | Increase Resilience | Financial Feasibility | Public Benefit | Implementation Time | Total |
|--------------------------|------------------------------------------|---------------------|-----------------------|----------------|---------------------|-------|
| Protection               | Permanently Dry Floodproof Pump Stations | 5                   | 2                     | 2              | 3                   | 12    |
|                          | Temporarily Dry Floodproof Pump Stations | 4                   | 2                     | 2              | 3                   | 11    |
|                          | SSE Abbott Ave                           | 4                   | 1                     | 3              | 2                   | 10    |
|                          | SSE Bay Drive                            | 4                   | 1                     | 1              | 3                   | 9     |
|                          | SSE Byron Ave                            | 4                   | 1                     | 3              | 2                   | 10    |
|                          | SSE Carlyle Ave                          | 4                   | 1                     | 3              | 2                   | 10    |
|                          | SSE Dickens Ave                          | 4                   | 1                     | 3              | 2                   | 10    |
|                          | SSE Emerson Ave                          | 4                   | 1                     | 2              | 2                   | 9     |
|                          | SSE Froude Ave                           | 4                   | 1                     | 2              | 2                   | 9     |
|                          | SSE Garland Ave                          | 4                   | 1                     | 2              | 2                   | 9     |
|                          | Elevate Pump Stations                    | 4                   | 1                     | 2              | 2                   | 9     |
| Accommodation            | Elevate 91 <sup>st</sup> St              | 4                   | 1                     | 3              | 2                   | 10    |
|                          | Elevate 88 <sup>th</sup> St              | 4                   | 1                     | 2              | 2                   | 9     |
|                          | Elevate Harding Ave                      | 4                   | 1                     | 3              | 1                   | 9     |
|                          | Surfside Park Sponge Area                | 3                   | 1                     | 1              | 3                   | 9     |
|                          | Hawthorne Tot Lot Sponge Area            | 3                   | 1                     | 1              | 3                   | 9     |

# **APPENDIX A**

## **KICKOFF MEETING MINUTES**





## Town of Surfside Vulnerability Assessment

### KICK-OFF MEETING AGENDA

PROJECT: Vulnerability Assessment

DATE: July 31, 2024 TIME OF MEETING: 3:00 PM

PLACE OF MEETING: Virtual KH Proj No.: 143332009

A. Introduction

**Attendees:**

- *Town of Surfside (Town): Andre Eugent, Mark Blumstein, Ana Gonzalez*
- *Kimley-Horn (KH): Matt Brosman, Jaime Ghitelman, Angelo Sciabarassi*

B. Presentation

C. Questions/ Discussion

a. Historical/ Cultural Assets?

- i. *Memorial site to be completed in 2025.*

b. Additional critical infrastructure assets?

- i. *Abbott Avenue pump station project to enter construction soon.*

c. For what projects do you envision applying for Resilient Florida grants?

- i. *Kimley-Horn will work with the Town to target projects for Resilient Florida grants.*

d. Goals of next meeting

- i. *Data gap review*

D. Action Items

- a. *KH will share presentation and meeting agenda.*
- b. *KH will establish monthly progress meetings.*
- c. *KH will begin data collection.*
- d. *Next meeting goal is to review data gaps.*

# **APPENDIX B**

## **DATA COLLECTION TECHNICAL MEMORANDUM**





Town of Surfside – Vulnerability Assessment

## Task 1: Acquire Background Data

Prepared for:

Town of Surfside

9293 Harding Avenue

Surfside, Florida 33154

Prepared by:

Kimley-Horn and Associates, Inc. 8201 Peters Road, Suite 2200 Plantation, FL 33324

© Kimley-Horn and Associates, Inc.  
Registry No. 696  
Plantation, Florida 143332009

This document, together with the concepts and designs presented herein, as an instrument of service, is intended only for the specific purposes and client for which it was prepared. Reuse of and improper reliance on this document without written authorization and adaptation by Kimley-Horn and Associates, Inc. shall be without liability to Kimley-Horn and Associates, Inc.

TABLE OF CONTENTS

TABLE OF CONTENTS..... 2

LIST OF APPENDICES..... 2

1. INTRODUCTION..... 3

2. OBJECTIVE..... 3

3. BACKGROUND..... 3

4. DATA COLLECTION ..... 4

4.1. PROJECT KICKOFF ..... 4

4.2. ACQUIRE BACKGROUND DATA..... 4

4.2.1 Critical/Regionally Significant Assets Inventory ..... 4

4.2.2 Topographic Data..... 4

4.2.3 Flood-Scenario Related Data ..... 5

        Precipitation Data..... 5

        Groundwater Level Data ..... 5

        Sea Level Rise (SLR) Projections..... 6

        Tidal Datums and Tidal Flooding ..... 6

        Storm Surge..... 6

        Land Use Data ..... 6

        FEMA FIRM Information ..... 6

4.3 DATA GAP ANALYSIS ..... 7

APPENDIX A ..... 9

APPENDIX B ..... 10

LIST OF APPENDICES

- APPENDIX A – KICK-OFF MEETING AGENDA APPENDIX
- APPENDIX B – DATASET REGISTER



## 1. INTRODUCTION

The Town of Surfside (referred to as the “Town”) received funding from the Florida Department of Environmental Protection through the Resilient Coastlines Program to conduct a Townwide Vulnerability Assessment. In support of this project, the Town contracted on June 6, 2024, with Kimley-Horn and Associates Inc. (herein referred to as Kimley-Horn) to deliver the Vulnerability Assessment pursuant to Florida Statute 380.093. The first deliverable under this project is a Technical Memorandum for Task 1 - Acquire Background Data and is included herein.

This technical report provided by Kimley-Horn shall contain a review of the actions taken to collect data for this project as well as provide recommendations to address data gaps and actions taken to rectify them, where applicable. The collected data will provide Kimley-Horn with the information necessary to understand the area of interest and proceed with the assessment and analysis of exposure and sensitivity related to flooding extents and critical infrastructure within the Town.

## 2. OBJECTIVE

The objective of the Town of Surfside Vulnerability Assessment Project is to identify and prioritize regionally significant areas at risk of flooding within the Town and specify the scenarios in which these areas are vulnerable.

## 3. BACKGROUND

The Town of Surfside is a coastal municipality located in east Miami Dade County, Florida, approximately 0.6 square miles in area. The Town is bounded by the Atlantic Ocean to the east, the City of Miami Beach to the south, Bal Harbour Village, and Biscayne Bay to the west. Refer to **Figure 1** for a site map.

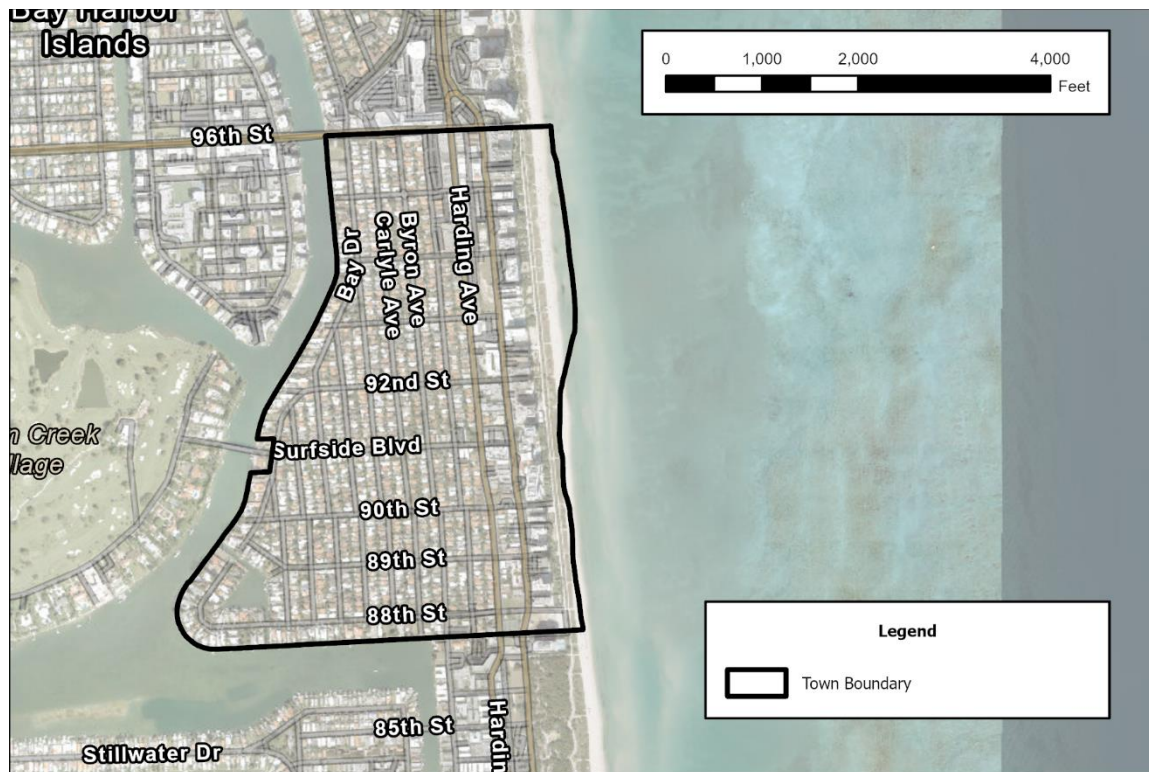


Figure 1. Surfside Vulnerability Assessment Project Area

## 4. DATA COLLECTION

### 4.1. PROJECT KICKOFF

Kimley-Horn met virtually with employees of the Town of Surfside to commence the project kick-off meeting on July 31, 2024. During this meeting, the project scope and schedule was reviewed. Kickoff meeting notes can be found in **Appendix A**.

### 4.2. ACQUIRE BACKGROUND DATA

Kimley-Horn, in coordination with the Town when applicable, researched and compiled the data needed to perform the vulnerability assessment based on the requirements defined in s. 380.093, F.S. The three main categories required to perform the assessment are as follows:

1. Critical/regionally significant assets
2. Topographic data
3. Flood scenario-related data

#### *4.2.1 Critical/Regionally Significant Assets Inventory*

Kimley-Horn requested and reviewed available information such as existing Town asset inventories, including:

- Municipal Boundary
- Town Stormwater Utility Inventory
- Town Water and Wastewater Utility Inventory
- Town Natural and Cultural Assets (Parks, Shorelines)
- Town Critical Infrastructure (Comm. Facilities, Lift Stations, Waste Facility, etc.)
- Transportation Assets (Roads, Rail, Bus Stops, Bridges)

Kimley-Horn developed a dataset register to summarize all data collected. The dataset register is included in **Appendix B**.

#### *4.2.2 Topographic Data*

Topographic data was sourced from the 2021 Miami-Dade County 5-foot DEM in NAVD88. **Figure 2** shows the elevation map for the Town.

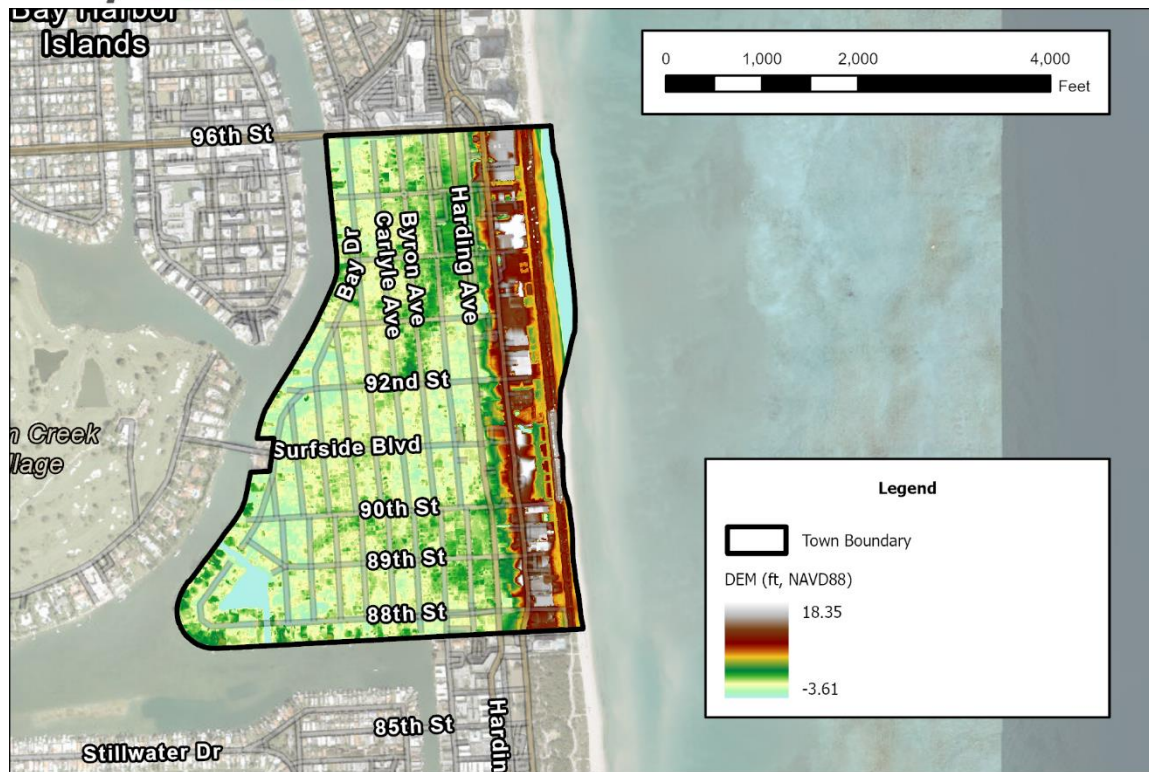


Figure 2. Elevation in Town Boundary

#### 4.2.3 Flood-Scenario Related Data

Consistent with s. 380.093, F.S. as of the time of this report, including the July 2024 revisions to the Resilient Florida Program, the following flood-scenario related data was included.

#### Precipitation Data

Precipitation values from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 tool was collected to be used for the rainfall induced scenario. **Table 1** shows the rainfall-depths for the 100-year and 500-year, 72-hour events that will be evaluated in this analysis.

Table 1. NOAA Atlas 14 Rainfall-Depths

| Rainfall Event    | Depth (ft) |
|-------------------|------------|
| 100-year, 72-hour | 17.6       |
| 500-year, 72-hour | 24.0       |

Future rainfall values were determined using data from the South Florida Water Management District (SFWMD). SFWMD approved change factors for Miami-Dade County for storm events up to the 100-year storm event. Kimley-Horn used available data to extrapolate a change factor for the 500-year storm event. Shows the change factors that will be applied to the rainfall depths in **Table 1**.

Table 2. SFWMD Change Factors

| Rainfall Event    | Depth (ft) |
|-------------------|------------|
| 100-year, 72-hour | 1.21       |
| 500-year, 72-hour | 1.29       |

## Groundwater Level Data

Groundwater flooding can be prevalent in low communities where sea-level rise has raised the groundwater level in the topmost aquifer. Groundwater levels determine an aquifer's storage capacity and can impact soil infiltration rates and should be studied where there are shallow water table conditions, as it is in the Town.

Groundwater level data is not available for the Town of Surfside. Groundwater levels are assumed to match tidal levels.

## Sea Level Rise (SLR) Projections

The latest version NOAA SLR projections were published in 2022. The projection includes five curves for application: the NOAA High Curve, the NOAA Intermediate High Curve, the NOAA Intermediate Curve, the NOAA Intermediate Low Curve, and the NOAA Low Curve. For this assessment, the NOAA Intermediate Low and Intermediate Curve were used for the planning year of 2050 and 2080.

*Table 3. Sea Level Rise Projections.*

| Year | NOAA 2022<br>Int-Low (ft) | NOAA 202<br>Int (ft) |
|------|---------------------------|----------------------|
| 2050 | 0.97                      | 1.1                  |
| 2080 | 1.67                      | 2.34                 |

## Tidal Datums and Tidal Flooding

Tidal datums and tidal flooding data was obtained for the Virginia Key station (ID: 8723214) from the NOAA Tides and Currents website. A mean higher high water (MHHW) level of 0.79 feet NAVD 88 was obtained from the station. A flood threshold of 1.71 feet above MHHW is identified by NOAA as the minor flood threshold at the Virginia Key, Biscayne Bay, FL and was assumed for the Town.

## Storm Surge

Storm surge data was sourced from the National Hurricane Center's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model. The data collected is the maximum of the maximum envelope of high water (MEOW), or (MOM), which provides a worst-case scenario for each category storm under "perfect" storm conditions. Category Three and Category Five MOM water surface elevation were obtained for this assessment.

## Land Use Data

Land use data collected in November 2022 by Miami Data County was used as the basis for the Town land use data. To account for current and future land use changes, data was compared against future land used projections from the Town of Surfside Planning Department. By accounting for future land use, potential changes to inundation depths can be accounted for.

## FEMA FIRM Information

FEMA flood insurance rate maps (FIRMs) were obtained for the Town. The FIRMs show Special Flood Hazard Areas (SFHAs) on them, which represent areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. **Figure 3** shows the FEMA SFHAs within the Town.



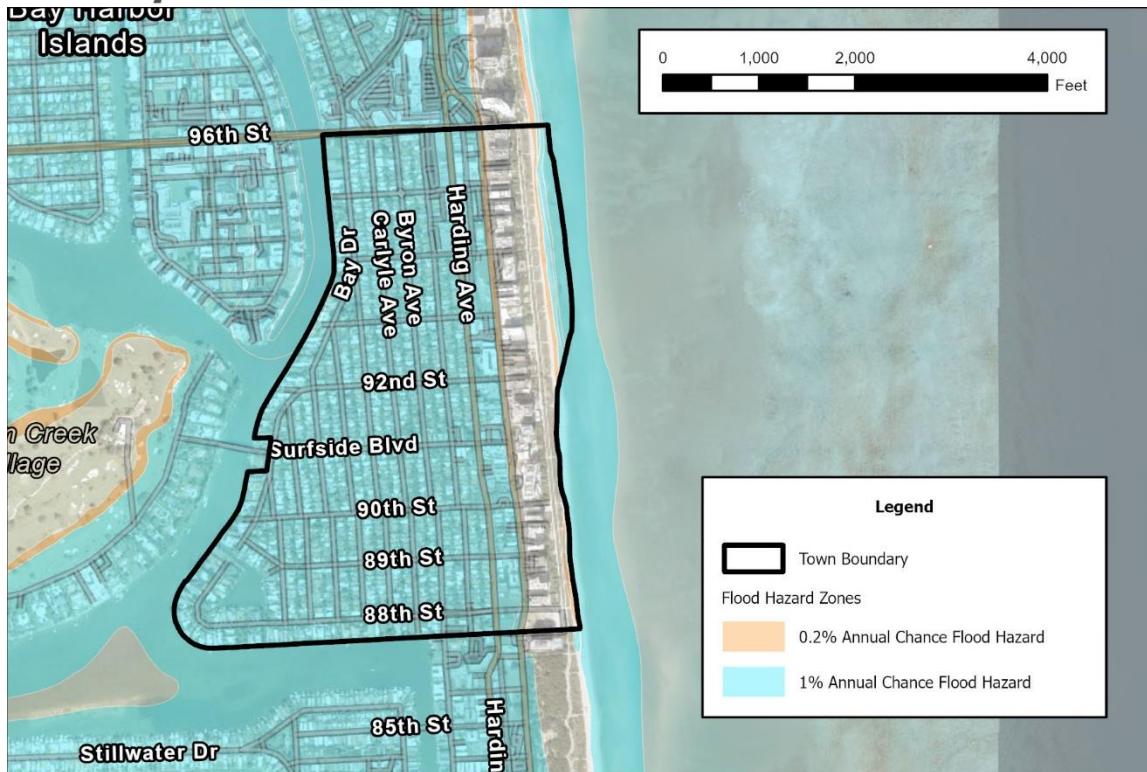


Figure 3. FEMA FIRM 100-Year Floodplain, Effective August 2014

## 4.3 DATA GAP ANALYSIS

Kimley-Horn conducted a data gap analysis of the provided information to check for completeness and applicability of the data. The data gap analysis performed indicated that missing data includes:

- Finished floor elevation for Town buildings.
  - In lieu of this data from as-builts or survey, the minimum elevation from the 2021 Digital Elevation Model within the asset footprint will be extracted using the Zonal Statistics GIS tool. For any finished structure, the slab-on-grade elevation will be assumed to be the minimum DEM elevation plus 1-foot. An example is shown in the figure below.



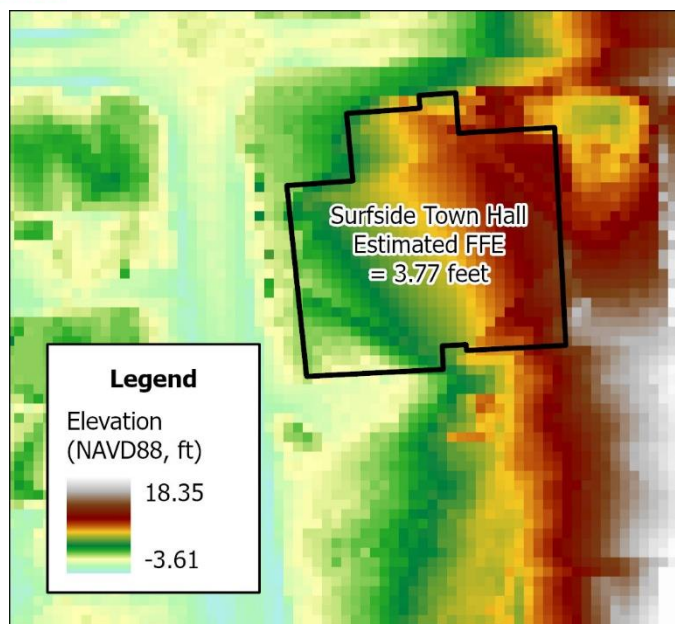


Figure 4. Estimated FFE for Surfside Town Hall using Zonal Statistics method.

**APPENDIX A**  
KICK-OFF MEETING AGENDA



## Town of Surfside Vulnerability Assessment

### KICK-OFF MEETING AGENDA

PROJECT: Vulnerability Assessment

DATE: July 31, 2024 TIME OF MEETING: 3:00 PM

PLACE OF MEETING: Virtual KH Proj No.: 143332009

A. Introduction

**Attendees:**

- *Town of Surfside (Town): Andre Eugent, Mark Blumstein, Ana Gonzalez*
- *Kimley-Horn (KH): Matt Brosman, Jaime Ghitelman, Angelo Sciabarassi*

B. Presentation

C. Questions/ Discussion

a. Historical/ Cultural Assets?

- i. *Memorial site to be completed in 2025.*

b. Additional critical infrastructure assets?

- i. *Abbott Avenue pump station project to enter construction soon.*

c. For what projects do you envision applying for Resilient Florida grants?

- i. *Kimley-Horn will work with the Town to target projects for Resilient Florida grants.*

d. Goals of next meeting

- i. *Data gap review*

D. Action Items

- a. *KH will share presentation and meeting agenda.*
- b. *KH will establish monthly progress meetings.*
- c. *KH will begin data collection.*
- d. *Next meeting goal is to review data gaps.*

**APPENDIX B**  
DATASET REGISTER

| 1. Critical/ Regionally Significant Assets Inventory |           |                                             |                                           |                                                                                                    |                          |                                |                                                     |                                                                                                                                                                  |
|------------------------------------------------------|-----------|---------------------------------------------|-------------------------------------------|----------------------------------------------------------------------------------------------------|--------------------------|--------------------------------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ref No.                                              | Data Type | Asset Category                              | Name                                      | Description                                                                                        | From                     | Data Received/ Data Downloaded | File Name                                           | File Location                                                                                                                                                    |
| 1.1                                                  | SHP       | Transportation Assets and Evacuation Routes | MajorRoadways                             | Line shapefile of roads in the Town of Surfside                                                    | Miami-Dade Open Data Hub | 9/1/2024                       | CriticalAsset_MajorRoadways                         | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\1. Transportation Assets and Evacuation Routes\CriticalAsset_MajorRoadways.shp"     |
| 1.2                                                  | SHP       |                                             | Evacuation Route                          | A line shapefile of Broward County Evacuation Routes within the Town boundary                      | Miami-Dade Open Data Hub | 9/1/2024                       | CriticalAsset_EvacuationRoutes                      | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\1. Transportation Assets and Evacuation Routes\CriticalAsset_EvacuationRoutes.shp"  |
| 1.3                                                  | SHP       |                                             | Bridges                                   | A line shapefile of the 88 <sup>th</sup> Street bridge                                             | Miami-Dade Open Data Hub | 9/1/2024                       | CriticalAsset_Bridges                               | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\1. Transportation Assets and Evacuation Routes\CriticalAsset_Bridges.shp"           |
| 2.1                                                  | SHP       | Critical Infrastructure                     | Water Utility Conveyance Systems          | A line shapefile of water utility lines within Surfside                                            | Miami-Dade Open Data Hub | 9/1/2024                       | CriticalAsset_WaterUtilityConveyanceSystems         | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\2. Critical Infrastructure\CriticalAsset_WaterUtilityConveyanceSystems.shp"         |
| 2.2                                                  | SHP       |                                             | Wastewater Lift Stations                  | Point files of locations of lift stations around Surfside                                          | Miami-Dade Open Data Hub | 9/1/2024                       | CriticalAsset_WastewaterLiftStations                | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\2. Critical Infrastructure\CriticalAsset_WastewaterLiftStations.shp"                |
| 2.3                                                  | SHP       |                                             | Disaster Debris Management Sites          | A point shapefile including the solid waste disaster debris management sites                       | Miami-Dade Open Data Hub | 9/1/2024                       | CriticalAsset_DisasterDebrisManagementSites         | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\2. Critical Infrastructure\CriticalAsset_DisasterDebrisManagementSites.shp"         |
| 2.4                                                  | SHP       |                                             | Electric Production and Supply Facilities | A point shapefile of a substation located between the Town of Surfside and the City of Miami Beach | Miami-Dade Open Data Hub | 9/1/2024                       | CriticalAsset_ElectricProductionandSupplyFacilities | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\2. Critical Infrastructure\CriticalAsset_ElectricProductionandSupplyFacilities.shp" |
| 2.5                                                  | SHP       |                                             | Communication Facilities                  | A point shapefile of the Town post office                                                          | Miami-Dade Open          | 9/1/2024                       | CriticalAsset_CommunicationsFacilities              | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\2. Critical Infrastructure\CriticalAsset_CommunicationsFacilities.shp"              |



|                                |     |                                           |                                |                                                                   |                                 |            |                                           |                                                                                                                                                                          |
|--------------------------------|-----|-------------------------------------------|--------------------------------|-------------------------------------------------------------------|---------------------------------|------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                |     |                                           |                                |                                                                   | Data Hub                        |            |                                           |                                                                                                                                                                          |
| 2.6                            | SHP |                                           | Stormwater Pump Stations       | A point shapefile of all stormwater pumps within the Town         | Town of Surfside                | 12/21/2022 | CriticalAsset_StormwaterPumpStations      | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\2. Critical Infrastructure\CriticalAsset_StormwaterPumpStations.shp"                        |
| 3.1                            | SHP | Critical Community and Emergency Facility | Emergency Operation Centers    | Point files of the Town EOC                                       | Town of Surfside                | 9/1/2024   | CriticalAsset_EmergencyOperationCenters   | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\3. Critical Community and Emergency Facilities\CriticalAsset_EmergencyOperationCenters.shp" |
| 3.2                            | SHP |                                           | Law Enforcement Facility       | Point shapefile of the Town police station                        | Town of Surfside                | 9/1/2024   | CriticalAsset_LawEnforcementFacilities    | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\3. Critical Community and Emergency Facilities\CriticalAsset_LawEnforcementFacilities.shp"  |
| 3.3                            | SHP |                                           | Schools                        | A point shapefile of schools within the Town of Surfside          | Miami-Dade Open Data Hub        | 9/1/2024   | CriticalAsset_Schools                     | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\3. Critical Community and Emergency Facilities\CriticalAsset_Schools.shp"                   |
| 3.4                            | SHP |                                           | Local Government Facility      | A point shapefile of Town Hall                                    | Town of Surfside                | 9/1/2024   | CriticalAsset_LocalGovernmentFacilities   | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\3. Critical Community and Emergency Facilities\CriticalAsset_LocalGovernmentFacilities.shp" |
| 3.5                            | SHP |                                           | Community Centers              | A point shapefile of the Town Community Center                    | Town of Surfside                | 9/1/2024   | CriticalAsset_CommunityCenters            | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\3. Critical Community and Emergency Facilities\CriticalAsset_CommunityCenters.cpg"          |
| 4.1                            | SHP | Natural, Cultural, and Historical Assets  | Parks                          | Polygon shapefile of parks in the Town                            | Town of Surfside                | 9/1/2024   | CriticalAsset_Parks                       | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\4. Natural, Cultural, and Historical Assets\CriticalAsset_Parks.shp"                        |
| 4.2                            | SHP |                                           | Shorelines                     | Line shapefile of shorelines maintained by the Town               | Miami Dade County Open Data Hub | 9/1/2024   | CriticalAsset_Shorelines                  | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\4. Natural, Cultural, and Historical Assets\CriticalAsset_Shorelines.shp"                   |
| 4.3                            | SHP |                                           | Historical and Cultural Assets | Point shapefile of historical and cultural assets within the Town | Town of Surfside                | 9/1/2024   | CriticalAsset_HistoricalandCulturalAssets | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\4. Natural, Cultural, and Historical Assets\CriticalAsset_HistoricalandCulturalAssets.shp"  |
| 5.1                            | SHP | Boundary                                  | Surfside Boundary              | Polygon shapefile of the Town boundary                            | Town of Surfside                | 9/1/2024   | TownBoundary                              | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\6. Town Boundary\TownBoundary.shp"                                                          |
| 2. Topographic Data            |     |                                           |                                |                                                                   |                                 |            |                                           |                                                                                                                                                                          |
| 6.1                            | TIF | 2021 Miami Dade County DEM 5ft            | Lidar collected from 2021      | Miami Dade County                                                 |                                 | 9/1/2024   | Surfside_DEM                              | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\5. DEM\Surfside_DEM.tif"                                                                    |
| 3. Flood-Scenario Related Data |     |                                           |                                |                                                                   |                                 |            |                                           |                                                                                                                                                                          |

| Scenario                        | 100YR,24HR | 500YR,24HR | Current Condition | Intermediate-Low (IL2050) | Intermediate (I) 2050 | IL2080 | I2080 | From                  | Data Downloaded | File Name                           | File Location                                                                                                                                          |
|---------------------------------|------------|------------|-------------------|---------------------------|-----------------------|--------|-------|-----------------------|-----------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Precipitation Data              | 17.6       | 24.0       | -                 | -                         | -                     | -      | -     | NOAA Atlas 14         | 9/4/2024        | Precipitation Frequency Data Server | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\7. Scenario Data\Precipitation Frequency Data Server.pdf"                 |
| SFWMD Future Precipitation Data | 21.3       | 30.9       | -                 | -                         | -                     | -      | -     | SFWMD Change Factors  | 12/10/2024      | SFWMD Technical Memorandum          | apps.sfwmd.gov/sfwmd/gsdocs/TPubs/2022_SFWMD_TM_Adoption_of_Future_Extreme_Rainfall_Change_Factors_for_Resiliency_Planning_in_South_Florida_rev2.0.pdf |
| Sea Level Rise Projections      | -          | -          | -                 | 0.97                      | 1.1                   | 1.67   | 2.34  | NOAA 2022             | 9/1/2024        | FloodScenarioData                   | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\7. Scenario Data\FloodScenarioData.xlsx"                                  |
| Tidal Flooding                  | -          | -          | 2.5               | 3.47                      | 3.6                   | 4.17   | 4.84  | NOAA Tides and Datums | 9/4/2024        | FloodScenarioData                   | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\7. Scenario Data\FloodScenarioData.xlsx"                                  |
| Storm Surge                     | -          | -          | 7.5               | 8.47                      | 8.6                   | 9.17   | 9.84  | SLOSH                 | 9/1/2024        | Cat3_stormSurge                     | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\7. Scenario Data\Cat3_stormSurge.tif"                                     |
| Storm Surge                     | -          | -          | 11.4              | 12.37                     | 12.5                  | 13.07  | 13.74 | SLOSH                 | 9/1/2024        | Cat5_stormSurge                     | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\7. Scenario Data\Cat5_stormSurge.tif"                                     |
| Land Use                        | -          | -          | -                 | -                         | -                     | -      | -     | Town of Surfside      | 9/1/2024        | LandUse                             | "K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\8. Land Use\LandUse.shp"                                                  |
| Soils                           | -          | -          | -                 | -                         | -                     | -      | -     | NRCS                  | 9/1/2024        | NRCS_Soils                          | K:\FTL_GIS\00_Project_Files\HH_143332009 - Surfside VA\Task1_DataCollection\8. Land Use\NRCS_Soils.shp                                                 |

# APPENDIX C

## FEMA FIRMS





## NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NGVD 29). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Florida State Plane east zone (FIPSZONE 0901). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

NGS Information Services  
NOAA, NNGS12  
National Geodetic Survey  
SSM-C-3, #9202  
1315 East-West Highway  
Silver Spring, Maryland 20910-3282  
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov>.

**Base map** information shown on this FIRM was provided in digital format by the Miami-Dade County Information Technology Department. These data were compiled at a scale of 1:3,600 from digital orthophotography dated 2001. Additional base map information was provided by the Cities of Aventura, Coral Gables, and Homestead, the Town of Cutler Bay, and Miami-Dade County.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to confirm to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at <http://msc.fema.gov>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov>.

## COASTAL BARRIER RESOURCES SYSTEM (CBRS) LEGEND

### 11-16-1990 CBRS Area

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER NOVEMBER 16, 1990, IN DESIGNATED CBRS AREAS.

### 11-16-1991 Otherwise Protected Area (OPA)

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER NOVEMBER 16, 1991, IN DESIGNATED OPAs WITHIN THE CBRS.

Boundaries of the John H. Chafee Coastal Barrier Resources System (CBRS) shown on this FIRM were transferred from the official CBRS source map(s) for this area and are depicted on this FIRM for informational purposes only. The official CBRS maps are enacted by Congress via the Coastal Barrier Resources Act, as amended, and maintained by the U.S. Fish and Wildlife Service (FWS). The official CBRS maps used to determine whether or not an area is located within the CBRS are available for download at <http://www.fws.gov>. For an official determination of whether or not an area is located within the CBRS, or for any questions regarding the CBRS, please contact the FWS field office for this area at (772) 562-3909.

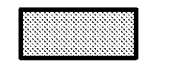
## LEGEND

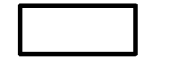
 SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

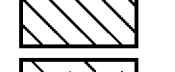
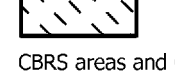
The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.  
**ZONE AE** Base Flood Elevations determined.  
**ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.  
**ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.  
**ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently identified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.  
**ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.  
**ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.  
**ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

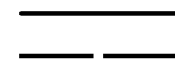
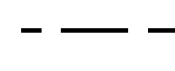
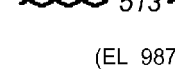
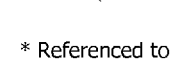
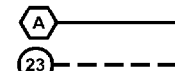
 FLOODWAY AREAS IN ZONE AE  
The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

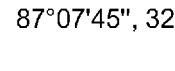
 OTHER FLOOD AREAS  
**ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

 OTHER AREAS  
**ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.  
**ZONE D** Areas in which flood hazards are undetermined, but possible.

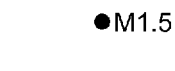
 COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS  
 OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

-  Floodplain boundary  
 Floodway boundary  
 Zone D boundary  
 CBRS and OPA boundary  
 Boundary dividing Special Flood Hazard Area zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.  
 Base Flood Elevation line and value, elevation in feet\*  
 Base Flood Elevation value where uniform within zone; elevation in feet\*

\* Referenced to the National Geodetic Vertical Datum of 1929  
 Cross section line  
 Traverse line  
87°07'45", 32°22'30"  
27°6'00"N  
17  
1000-meter Universal Transverse Mercator grid values, zone

600000 FT  
5000-foot grid ticks: Florida State Plane coordinate system, East zone (FIPSZONE 0901), Transverse Mercator projection

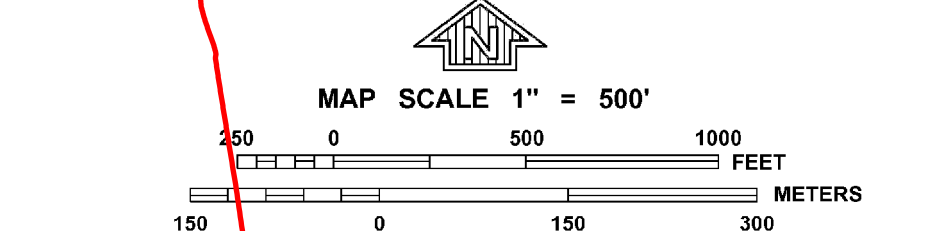
 Bench mark (see explanation in Notes to Users section of this FIRM panel)  
 River Mile

 MAP REPOSITORY  
Refer to listing of Map Repositories on Map Index.  
EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP  
January 20, 1993

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL  
March 2, 1994 - May 16, 1994 - July 17, 1995 - for description of revision, see Notice to Users page in the Flood Insurance Study Report.  
September 11, 2009 - to reflect revised shoreline, to incorporate previously issued Letters of Map Revision, to reflect updated topographic information, to add and change Base Flood Elevations, to update corporate limits, to change zone designations, to add roads and road names, and to add and change Special Flood Hazard Areas

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0144L

## FIRM FLOOD INSURANCE RATE MAP

MIAMI-DADE COUNTY, FLORIDA AND INCORPORATED AREAS

PANEL 144 OF 1031

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

### CONTAINS:

| COMMUNITY                                                        | NUMBER | PANEL | SUFFIX |
|------------------------------------------------------------------|--------|-------|--------|
| BAL HARBOUR VILLAGE                                              | 120636 | 0144  | L      |
| TOWN OF BAY HARBOR ISLANDS, TOWN OF INDIAN CREEK VILLAGE         | 120637 | 0144  | L      |
| VILLAGE OF MIAMI - DADE COUNTY                                   | 120638 | 0144  | L      |
| NORTH MIAMI BEACH, CITY OF NORTH MIAMI, CITY OF SURFIDE, TOWN OF | 120639 | 0144  | L      |

\* NOTE: - THIS MAP INCLUDES BOUNDARIES OF THE COASTAL BARRIER RESOURCES SYSTEM ESTABLISHED UNDER THE COASTAL BARRIER RESOURCES ACT OF 1962 AND/OR SUBSEQUENT ENABLING LEGISLATION.  
Notice to User: The Map Number shown below should be used when placing map orders. The Community Number shown above should be used on insurance applications for the subject community.



MAP NUMBER  
12086C0144L

MAP REVISED  
SEPTEMBER 11, 2009

Federal Emergency Management Agency











## NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NGVD-29). ~~Users of this FIRM~~ should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Florida State Plane east zone (FIPSZONE 0901). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

NGS Information Services  
NOAA, N/NGS12  
National Geodetic Survey  
SSMC-3, #9202  
1315 East-West Highway  
Silver Spring, Maryland 20910-3282  
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov>.

**Base map** information shown on this FIRM was provided in digital format by the Miami-Dade County Information Technology Department. These data were compiled at a scale of 1:3,600 from digital orthophotography dated 2001. Additional base map information was provided by the Cities of Aventura, Coral Gables, and Homestead, the Town of Cutler Bay, and Miami-Dade County.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at <http://msc.fema.gov>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov>.



## LEGEND

**SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

**FLOODWAY AREAS IN ZONE AE**

Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

**OTHER FLOOD AREAS**

- ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

**COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**

**OTHERWISE PROTECTED AREAS (OPAs)**

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet\*
- Base Flood Elevation value where uniform within zone; elevation in feet\*

- \* Referenced to the National Geodetic Vertical Datum of 1929
- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
- 1000-meter Universal Transverse Mercator grid values, zone 17
- 5000-foot grid ticks; Florida State Plane coordinate system, East zone (FIPSZONE 0901), Transverse Mercator projection
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- River Mile

**MAP REPOSITORY**  
Refer to listing of Map Repositories on Map Index.

**EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP**  
January 20, 1993

**EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL**  
March 2, 1994 - May 16, 1994 - July 17, 1995 - for description of revision, see Notice to Users page in the Flood Insurance Study Report.  
September 11, 2009 - to reflect revised shoreline, to incorporate previously issued Letters of Map Revision, to update corporate limits, to add and change Base Flood Elevations, to change zone designations, to add roads and road names, to add and change Special Flood Hazard Areas, and to reflect updated topographic information

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

**MAP SCALE 1" = 500'**

**FIRM FLOOD INSURANCE RATE MAP**

**MIAMI-DADE COUNTY, FLORIDA AND INCORPORATED AREAS**

**PANEL 326 OF 1031**  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

| CONTAINS             |        |       |        |
|----------------------|--------|-------|--------|
| COMMUNITY            | NUMBER | PANEL | SUFFIX |
| MIAMI - DADE COUNTY  | 120635 | 0326  | L      |
| MIAMI BEACH, CITY OF | 120651 | 0326  | L      |
| SURFIDE, TOWN OF     | 120659 | 0326  | L      |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER**  
12086C0326L

**MAP REVISED**  
SEPTEMBER 11, 2009

Federal Emergency Management Agency



# **APPENDIX D**

## **EXPOSURE ANALYSIS INUNDATION MAPS**





# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

-  Town Boundary





Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

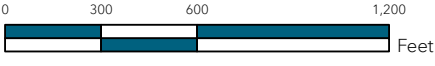
- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0

Town Boundary



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

RAINFALL-INDUCED FLOODING  
500-YEAR, 72-HOUR EVENT



Kimley»Horn

FIGURE  
A-2







# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

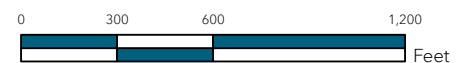
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

-  Town Boundary



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

RAINFALL-INDUCED FLOODING  
100-YEAR, 72-HOUR EVENT + 2050 INT SLR



Kimley»Horn

FIGURE  
A-4



# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

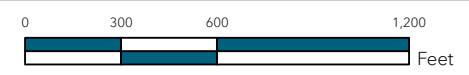
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

-  Town Boundary



**TOWN OF SURFSIDE**  
VULNERABILITY ASSESSMENT

**RAINFALL-INDUCED FLOODING**  
**100-YEAR, 72-HOUR EVENT + 2080 INT-LOW SLR**



Kimley»Horn

FIGURE  
A-5



# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

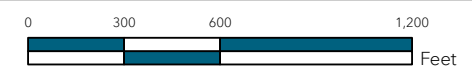
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

-  Town Boundary



**TOWN OF SURFSIDE**  
VULNERABILITY ASSESSMENT

**RAINFALL-INDUCED FLOODING**  
**100-YEAR, 72-HOUR EVENT + 2080 INT SLR**



Kimley»Horn

FIGURE  
A-6



Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

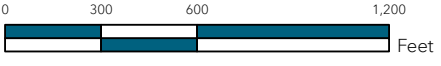
- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0

Town Boundary



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

STORM SURGE FLOODING  
CATEGORY 3 HURRICANE



Kimley»Horn

FIGURE  
A-7



Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

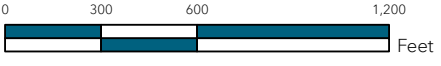
- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0

Town Boundary



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

STORM SURGE FLOODING  
CATEGORY 5 HURRICANE



Kimley»Horn

FIGURE  
A-8



# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

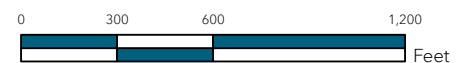
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

 Town Boundary



**TOWN OF SURFSIDE**  
VULNERABILITY ASSESSMENT

**STORM SURGE FLOODING**  
**CATEGORY 3 HURRICANE + 2050 INT-LOW SLR**



Kimley»Horn

FIGURE  
A-9



Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

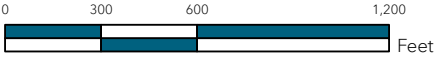
- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0

Town Boundary



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

STORM SURGE FLOODING  
CATEGORY 3 HURRICANE + 2050 INT SLR



Kimley»Horn

FIGURE  
A-10



# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

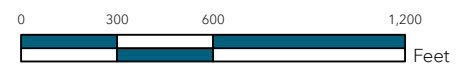
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

 Town Boundary



**TOWN OF SURFSIDE**  
VULNERABILITY ASSESSMENT

**STORM SURGE FLOODING**  
**CATEGORY 3 HURRICANE + 2080 INT-LOW SLR**



Kimley»Horn

FIGURE  
A-11



Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

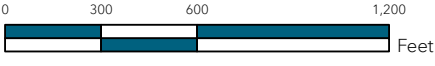
- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0

Town Boundary



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

STORM SURGE FLOODING  
CATEGORY 3 HURRICANE + 2080 INT SLR



Kimley»Horn

FIGURE  
A-12



Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

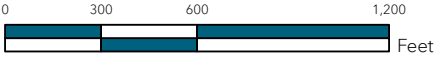
- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0

Town Boundary



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

TIDAL FLOODING  
KING TIDE



Kimley»Horn

FIGURE  
A-13







Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0





Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

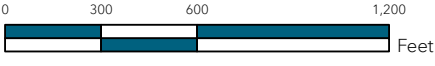
- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0

Town Boundary



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

TIDAL FLOODING  
KING TIDE + 2080 INT-LOW SLR



Kimley»Horn

FIGURE  
A-16



# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

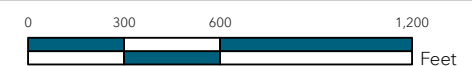
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

 Town Boundary



**TOWN OF SURFSIDE**  
VULNERABILITY ASSESSMENT

**TIDAL FLOODING**  
KING TIDE + 2080 INT SLR



Kimley»Horn

FIGURE  
A-17







Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

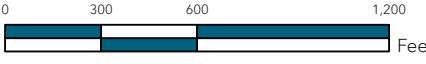
- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0

Town Boundary



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

COMPOUND FLOODING  
100-YEAR, 72-HOUR EVENT + CATEGORY 5 HURRICANE



Kimley»Horn

FIGURE  
A-19



Legend

Transportation Assets & Evacuation Routes

- Bridges
- Evacuation Routes
- Major Roadways

Critical Infrastructure

- Communications Facilities
- Disaster Debris Management Sites
- Electric Production and Supply Facilities
- Stormwater Pump Stations
- Wastewater Lift Stations

Critical Community & Emergency Facilities

- Community Centers
- Emergency Operations Center
- Law Enforcement Facilities
- Local Government Facilities
- Schools

Natural, Cultural, & Historic Resources

- Shorelines
- Parks
- Historical and Cultural Assets

Flood Depth (ft)

- < 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1.0 - 1.5
- 1.50 - 2
- > 2.0

Town Boundary





# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

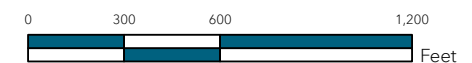
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

 Town Boundary



**TOWN OF SURFSIDE**  
VULNERABILITY ASSESSMENT

**COMPOUND FLOODING**  
100-YEAR, 72-HOUR EVENT + KING TIDE + 2050 INT-LOW SLR



Kimley»Horn

FIGURE  
A-21



# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

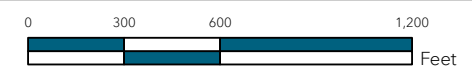
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

 Town Boundary



**TOWN OF SURFSIDE**  
VULNERABILITY ASSESSMENT

**COMPOUND FLOODING**  
100-YEAR, 72-HOUR EVENT + KING TIDE + 2050 INT SLR



Kimley»Horn

FIGURE  
A-22



# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

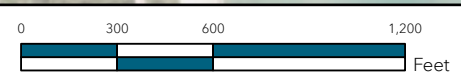
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

-  Town Boundary



**TOWN OF SURFSIDE**  
VULNERABILITY ASSESSMENT

**COMPOUND FLOODING**  
100-YEAR, 72-HOUR EVENT + KING TIDE + 2080 INT-LOW SLR



Kimley»Horn

FIGURE  
A-23



# Legend

## Transportation Assets & Evacuation Routes

-  Bridges
-  Evacuation Routes
-  Major Roadways

## Critical Infrastructure

-  Communications Facilities
-  Disaster Debris Management Sites
-  Electric Production and Supply Facilities
-  Stormwater Pump Stations
-  Wastewater Lift Stations

## Critical Community & Emergency Facilities

-  Community Centers
-  Emergency Operations Center
-  Law Enforcement Facilities
-  Local Government Facilities
-  Schools

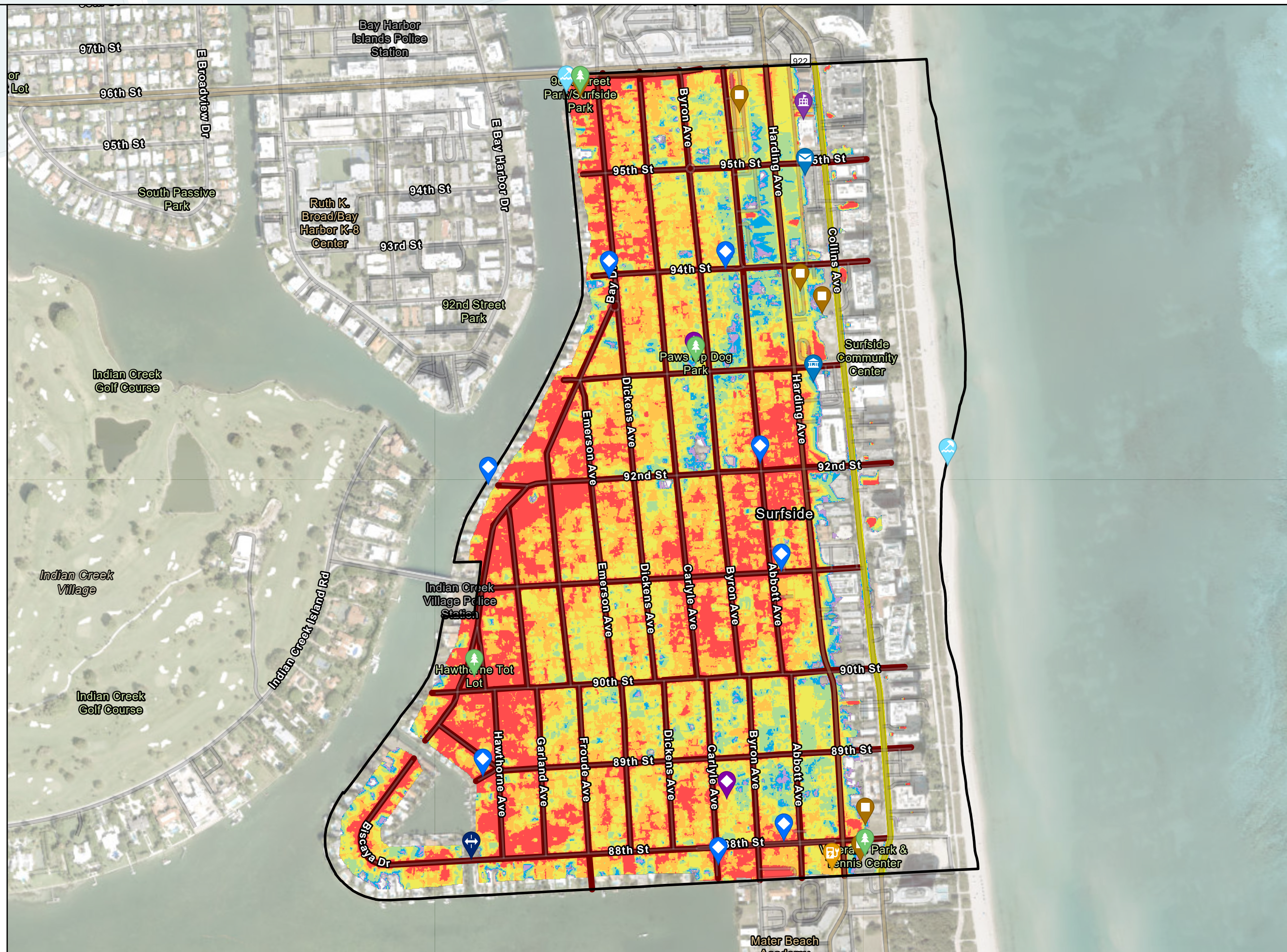
## Natural, Cultural, & Historic Resources

-  Shorelines
-  Parks
-  Historical and Cultural Assets

## Flood Depth (ft)

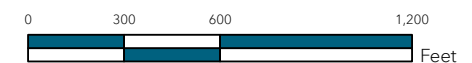
-  < 0.25
-  0.25 - 0.50
-  0.50 - 1
-  1.0 - 1.5
-  1.50 - 2
-  > 2.0

 Town Boundary



**TOWN OF SURFSIDE**  
VULNERABILITY ASSESSMENT

**COMPOUND FLOODING**  
100-YEAR, 72-HOUR EVENT + KING TIDE + 2080 INT SLR



Kimley»Horn

FIGURE  
A-24

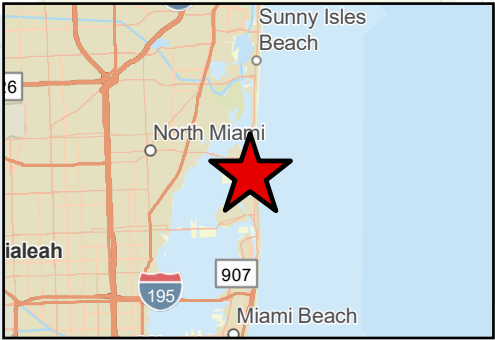


# APPENDIX E

## SENSITIVITY ANALYSIS MAPS







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

Historical and Cultural Assets

Parks

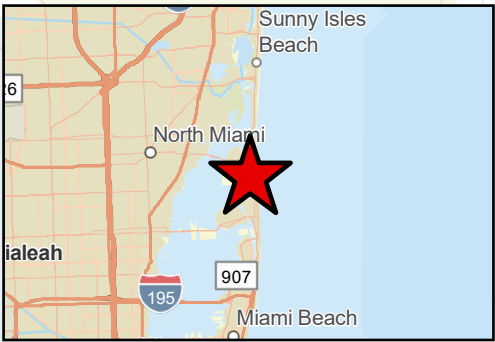
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Mangagement Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historal Assets**

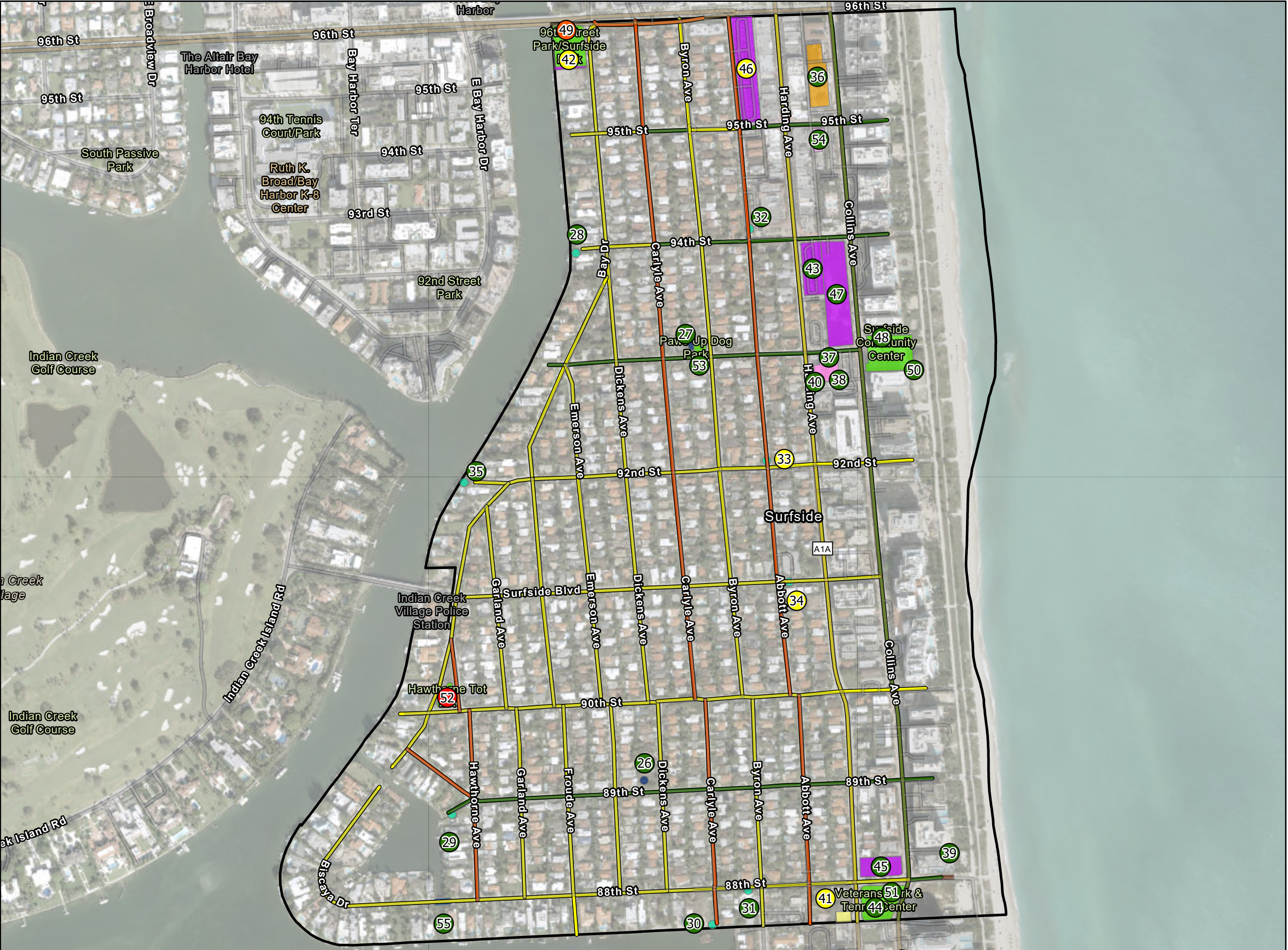
Historical and Cultural Assets

Parks

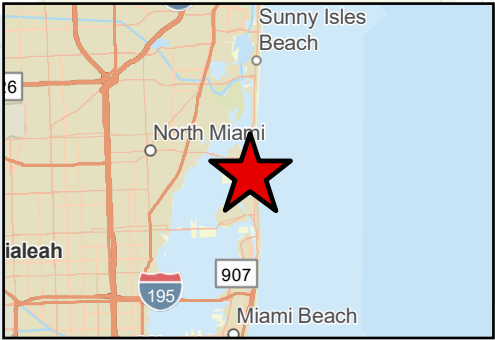
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

●

 None

●

 Low

●

 Medium

●

 High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

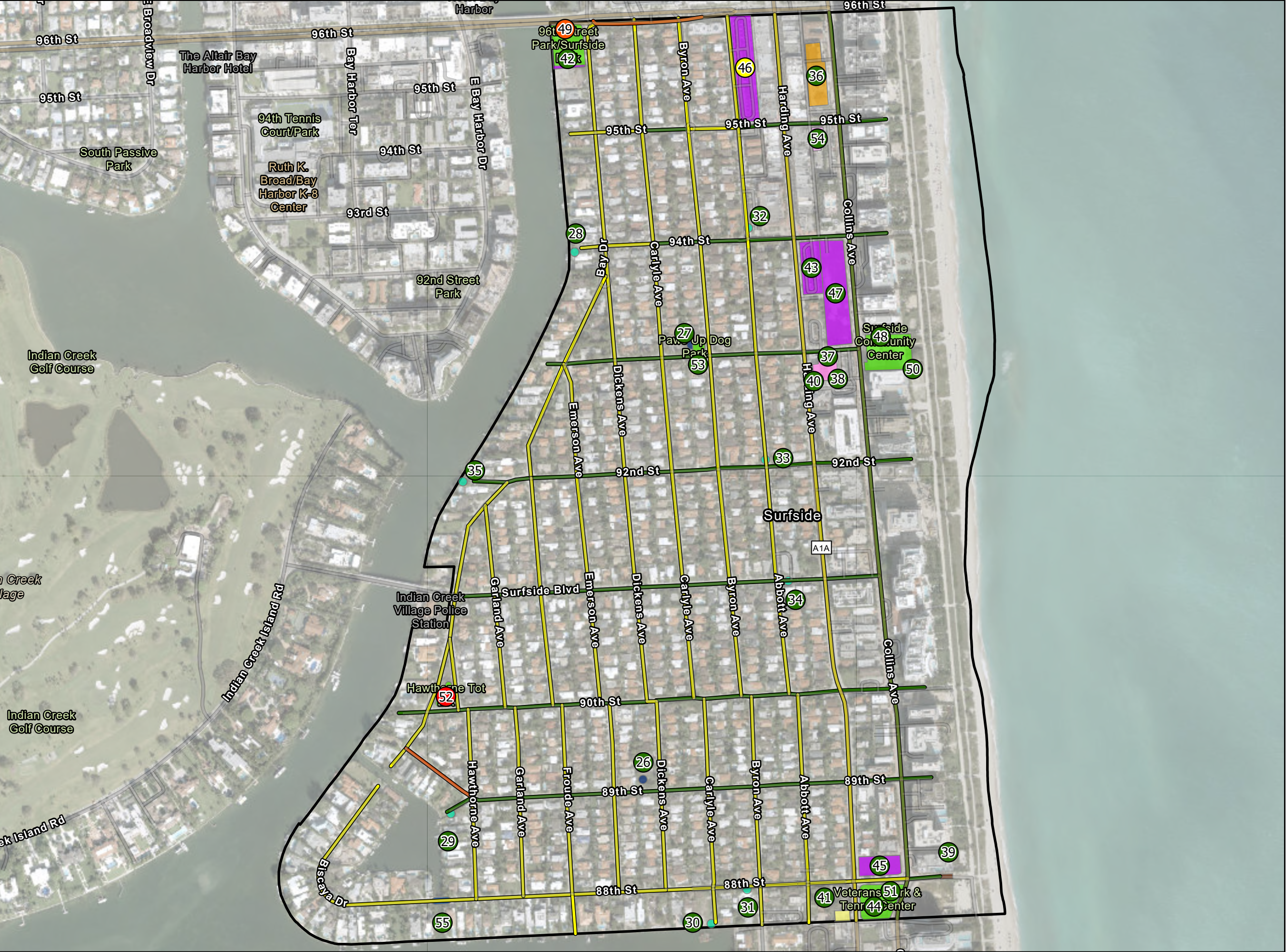
Historical and Cultural Assets

Parks

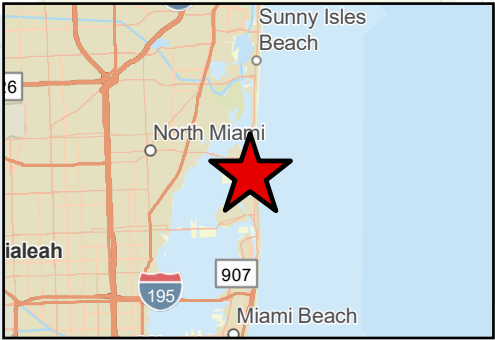
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

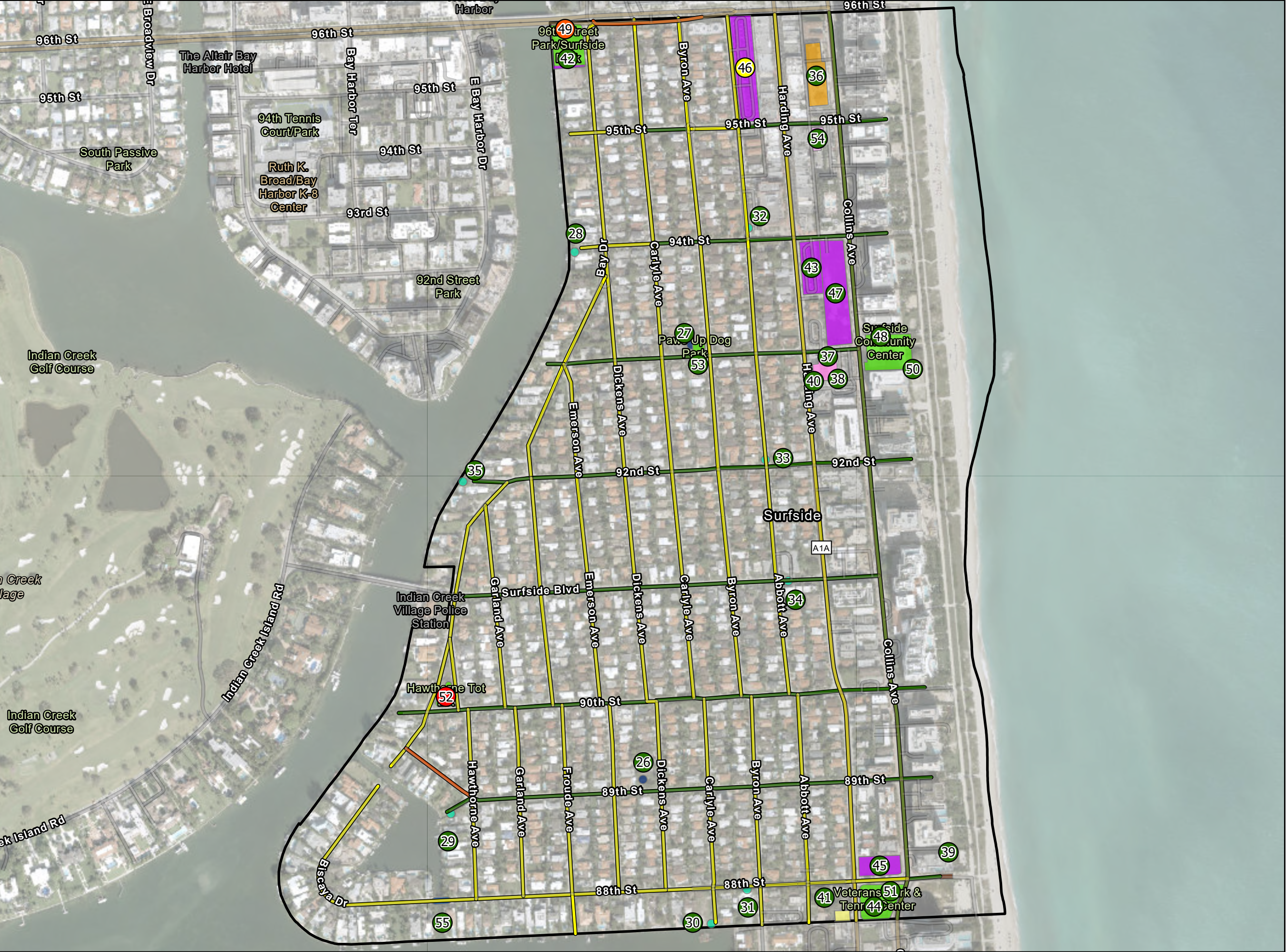
Historical and Cultural Assets

Parks

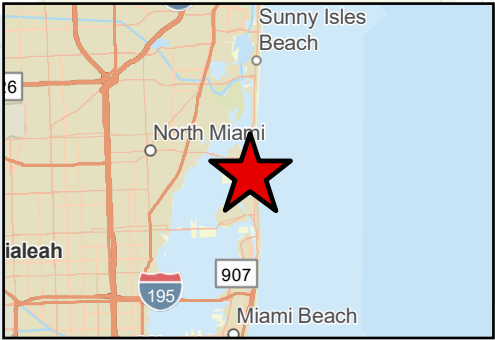
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

Historical and Cultural Assets

Parks

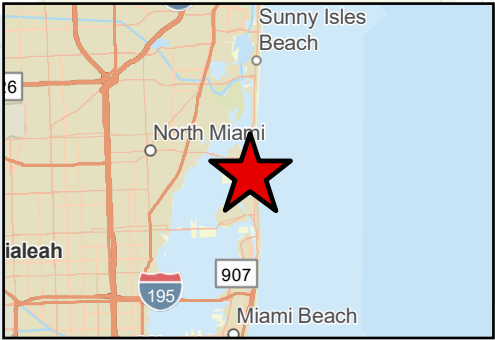
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

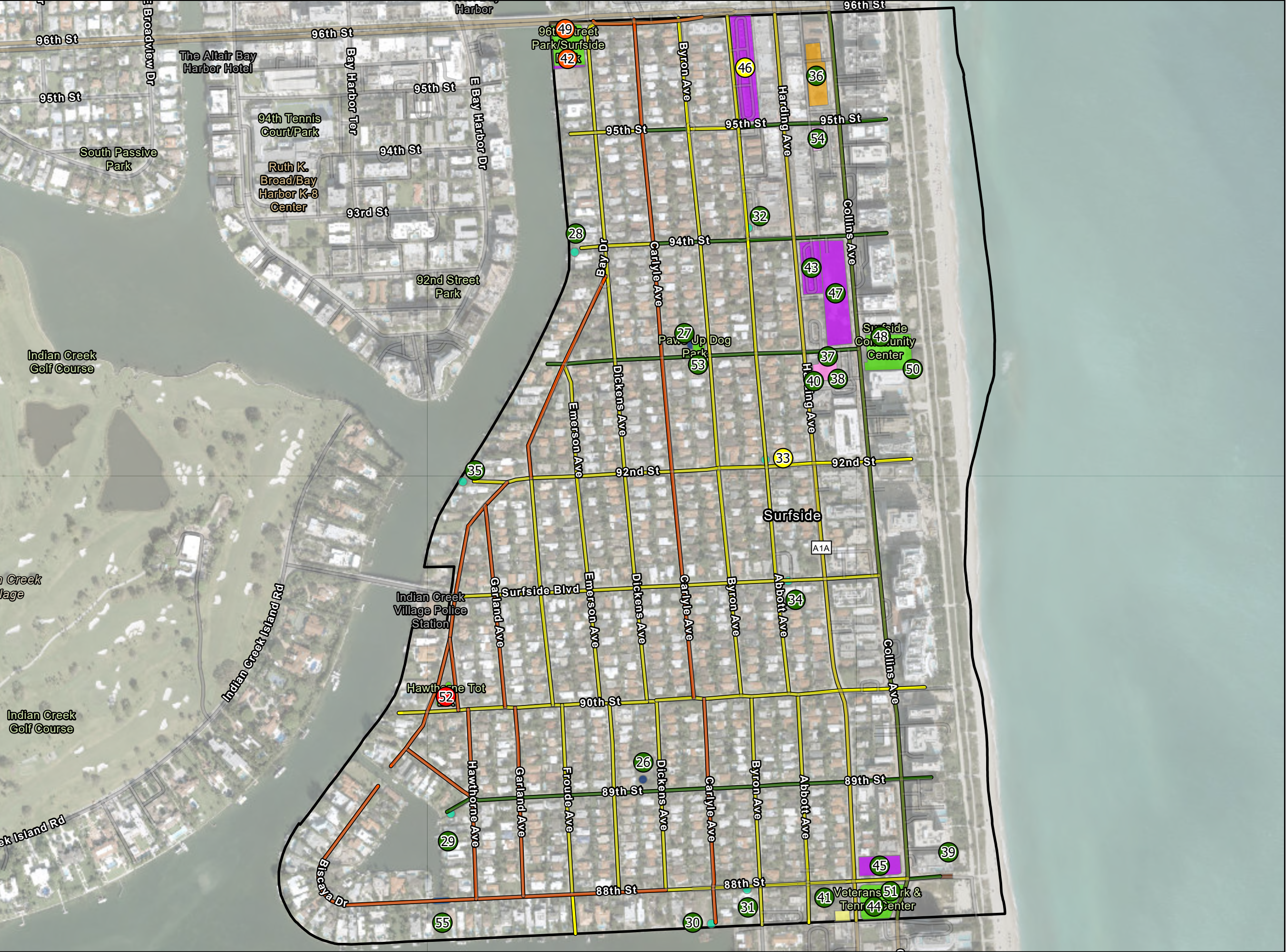
Historical and Cultural Assets

Parks

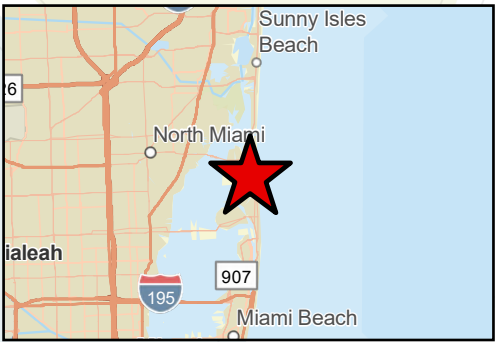
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Mangagement Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historal Assets**

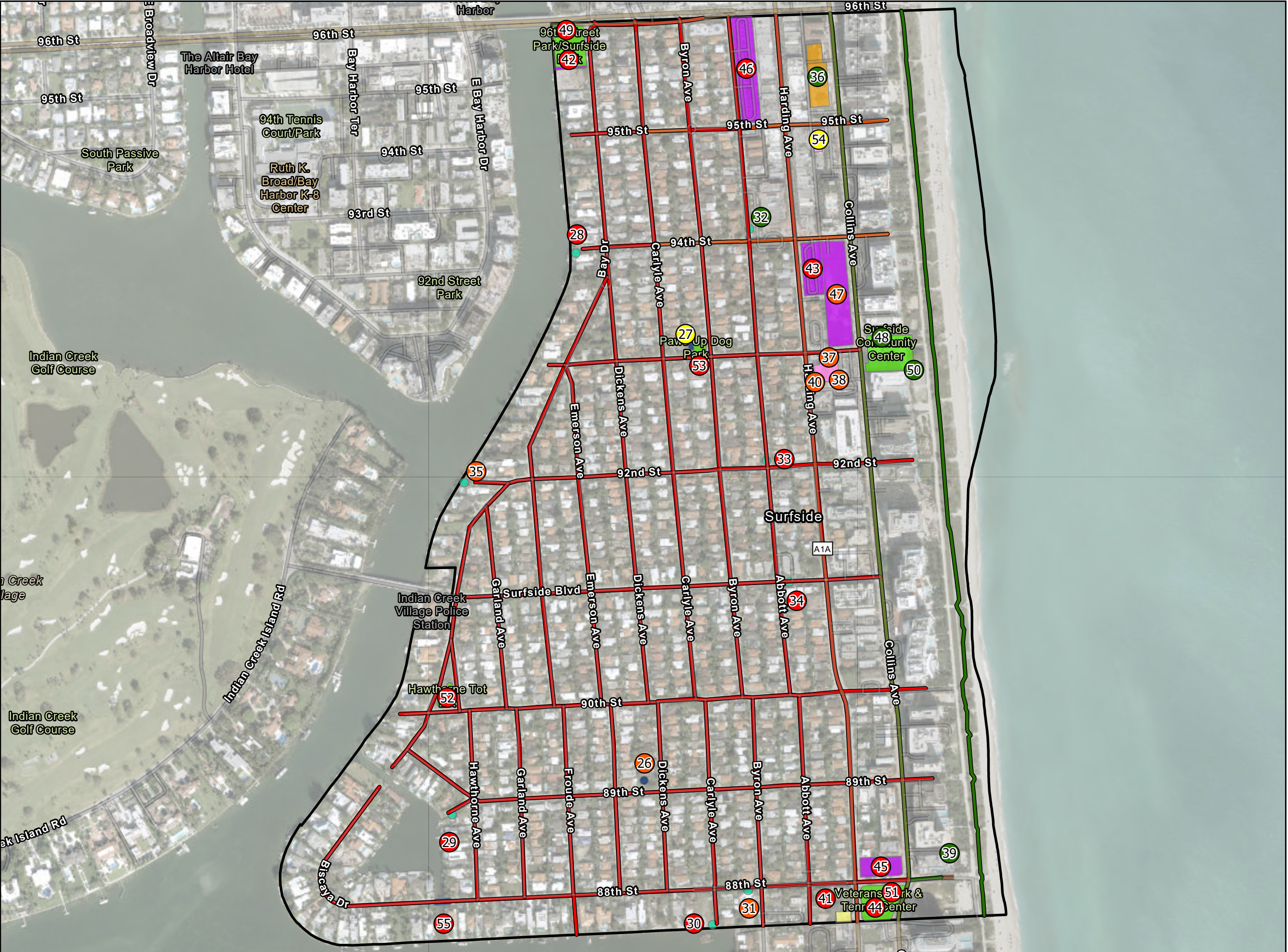
Historical and Cultural Assets

Parks

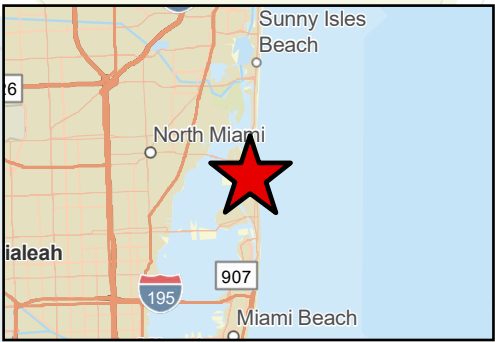
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID

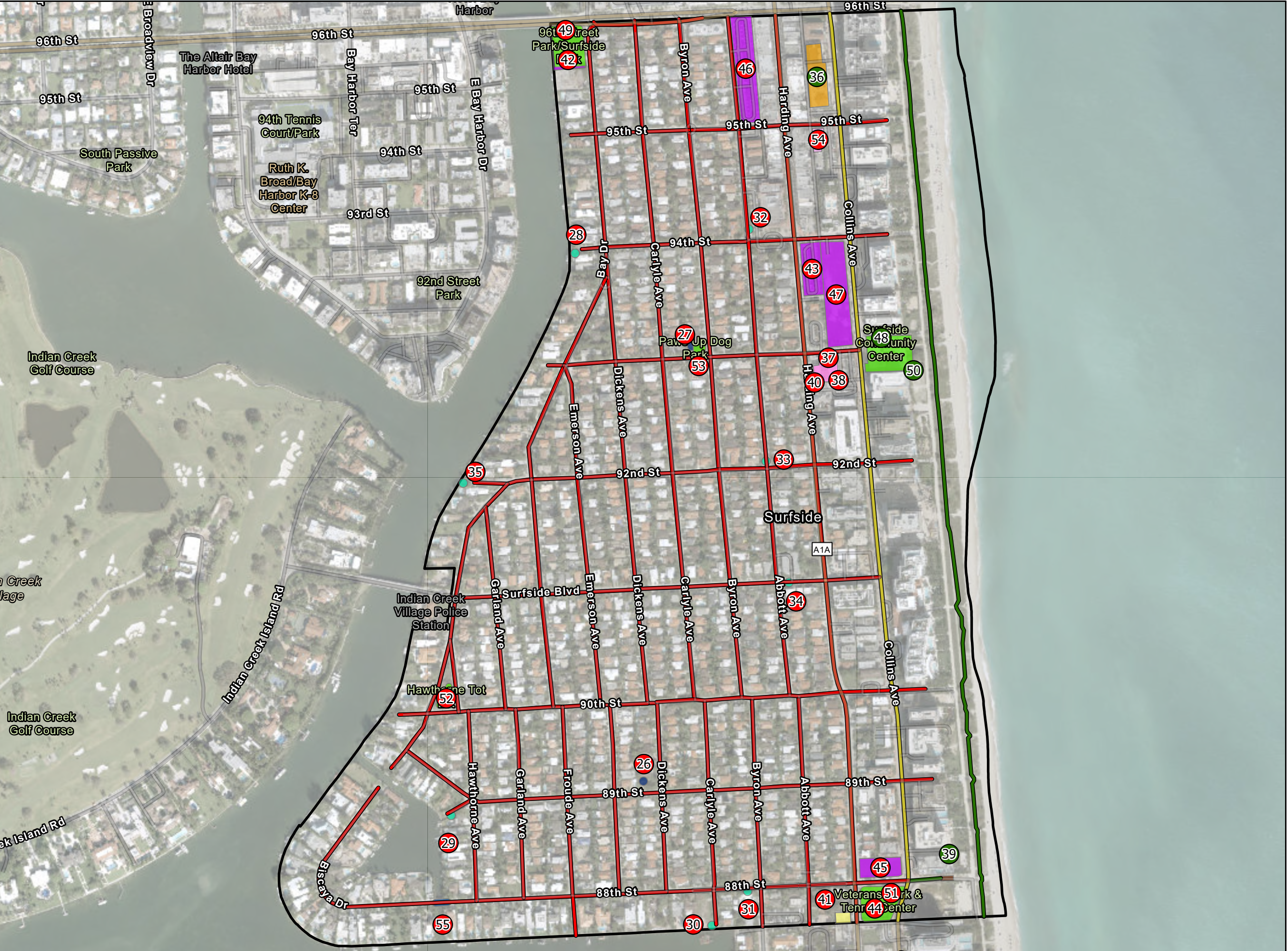






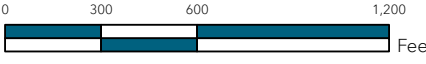
- Legend**
- Criticality**
- None
  - Low
  - Medium
  - High
- Critical Community and Emergency Facilities**
- Community Centers
  - Emergency Operations Centers
  - Law Enforcement Facilities
  - Local Government Facilities
  - Schools
- Critical Infrastructure**
- Wastewater Lift Station
  - Stormwater Pump Stations
  - Disaster Debris Management Sites
  - Electric Production and Supply Facilities
  - Communications Facilities
- Natural Cultural and Historical Assets**
- Historical and Cultural Assets
  - Parks
- Transportation Assets and Evacuation Routes**
- Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID



TOWN OF SURFSIDE  
VULNERABILITY ASSESSMENT

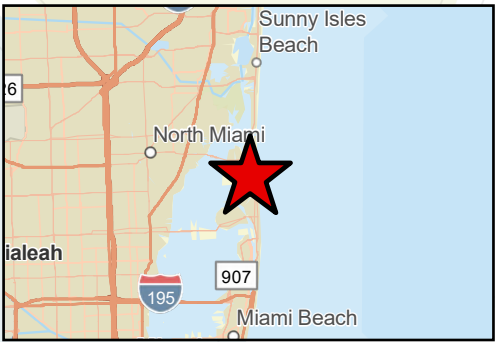
STORM SURGE FLOODING  
CATEGORY 5 HURRICANE



Kimley»Horn

FIGURE  
B-8





### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

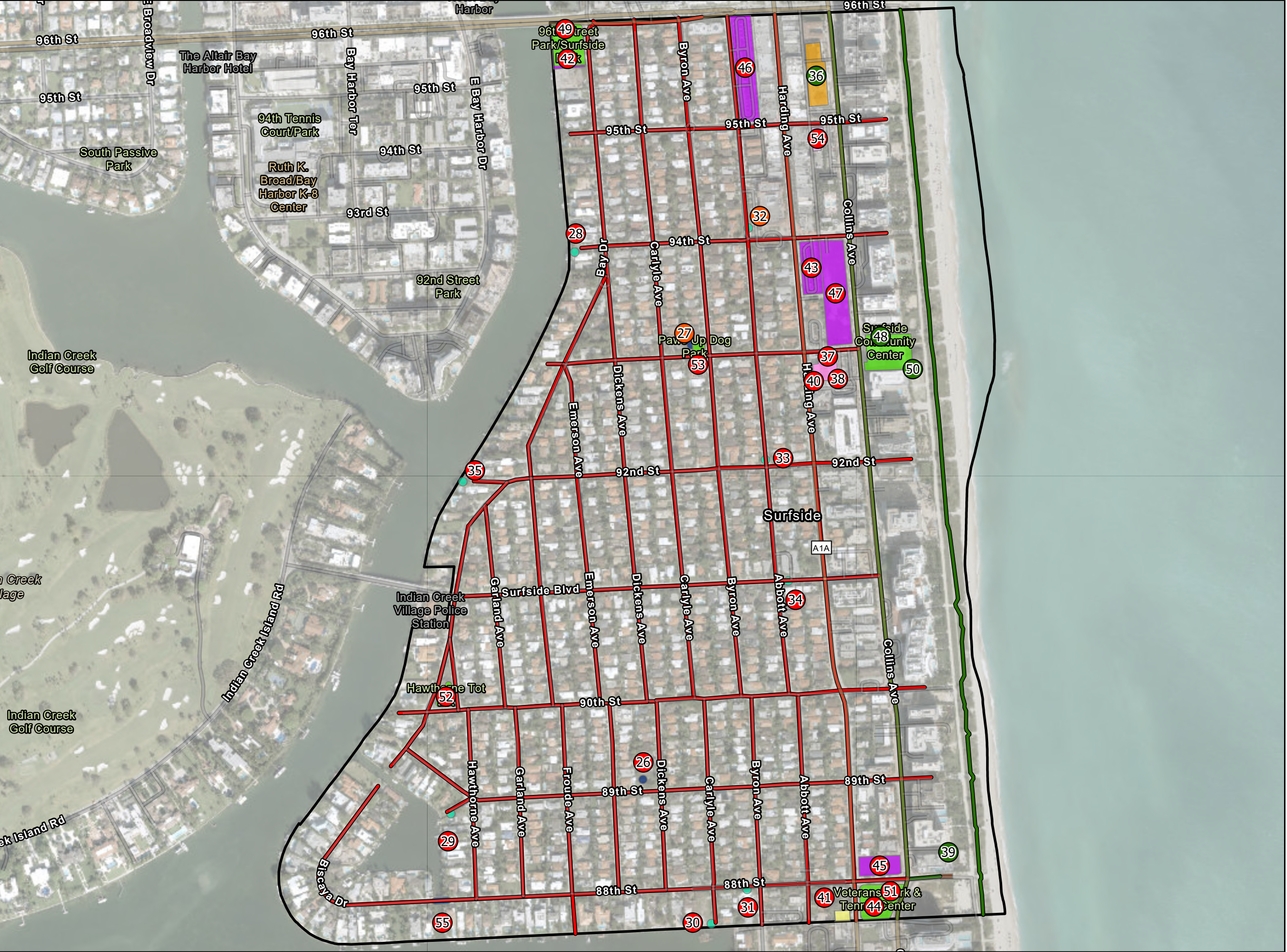
Historical and Cultural Assets

Parks

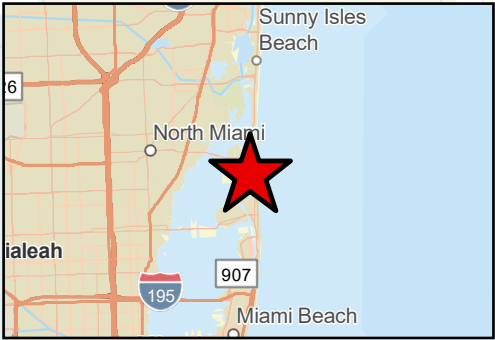
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

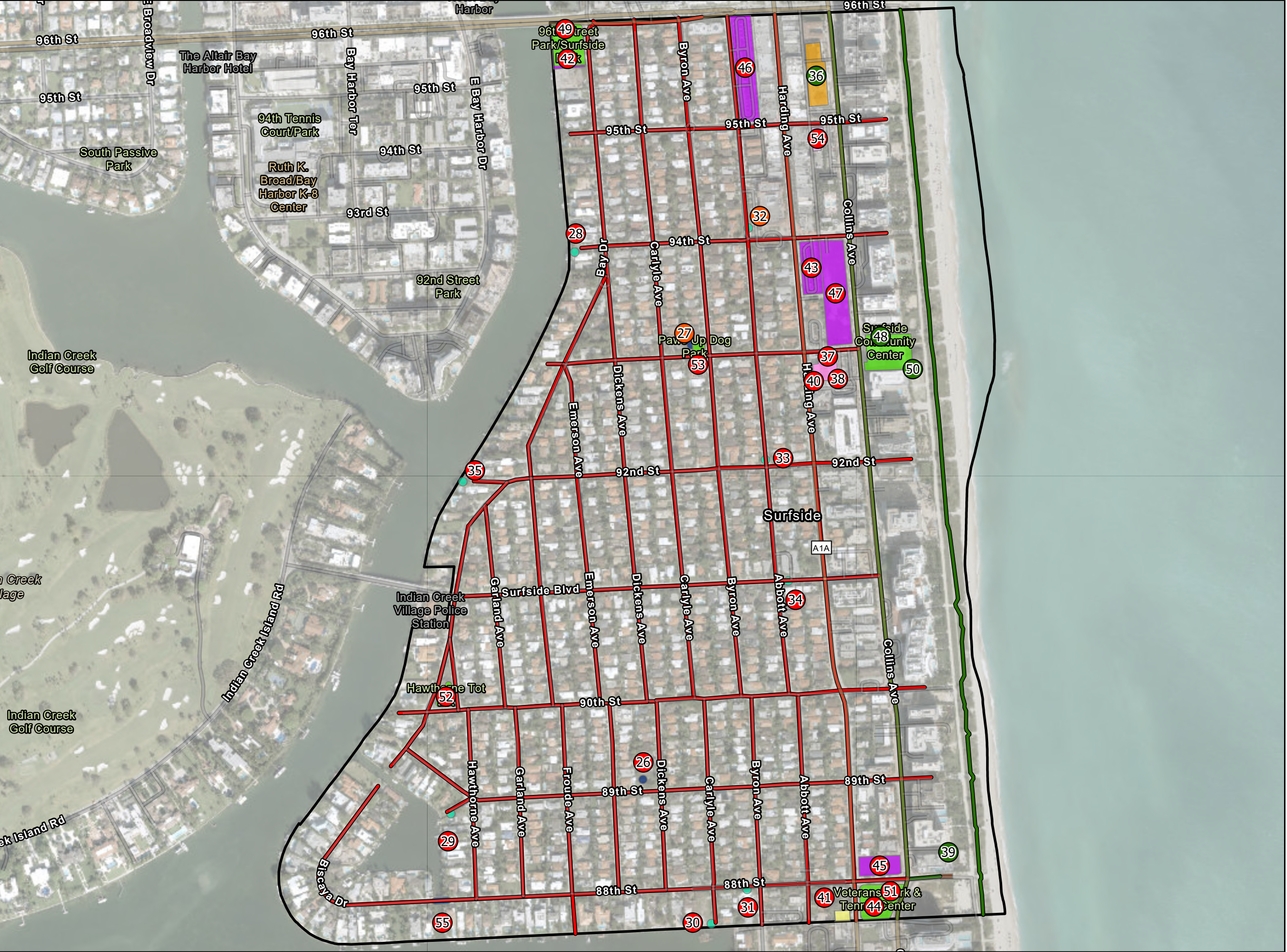
Historical and Cultural Assets

Parks

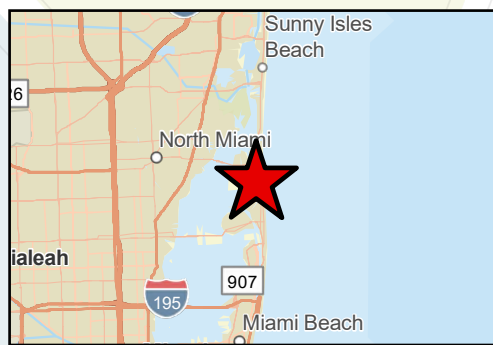
**Transportation Assets and Evacuation Routes**

Bridges

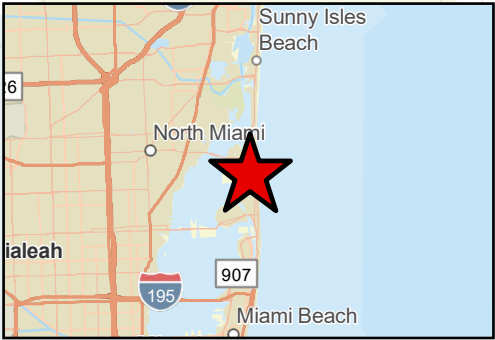
Refer to Appendix G to view Asset Name associated with the labeled Asset ID





FIGURE  
3-10





### Legend

Criticality

None

Low

Medium

High

Town Boundary

Critical Community and Emergency Facilities

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

Critical Infrastructure

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Mangagement Sites

Electric Production and Supply Facilities

Communications Facilities

Natural Cultural and Historal Assets

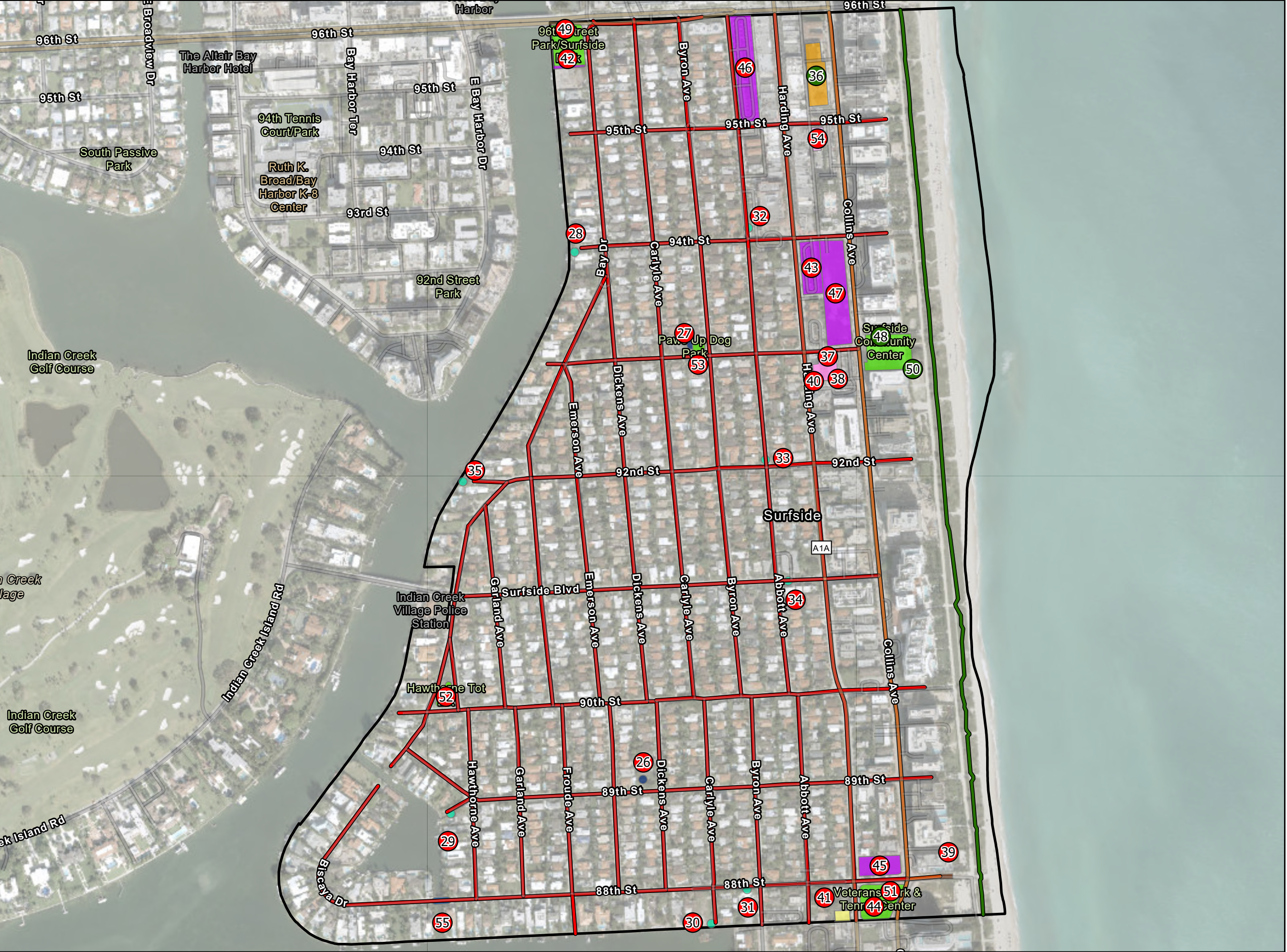
Historical and Cultural Assets

Parks

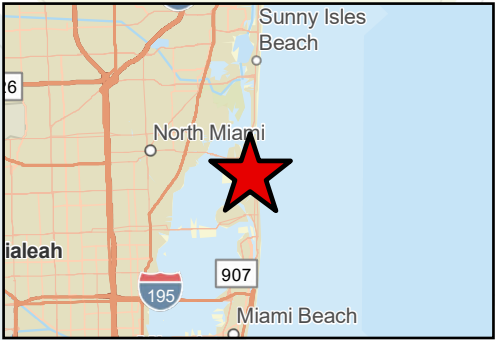
Transportation Assets and Evacuation Routes

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

Criticality

None

Low

Medium

High

Town Boundary

Critical Community and Emergency Facilities

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

Critical Infrastructure

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Mangagement Sites

Electric Production and Supply Facilities

Communications Facilities

Natural Cultural and Historal Assets

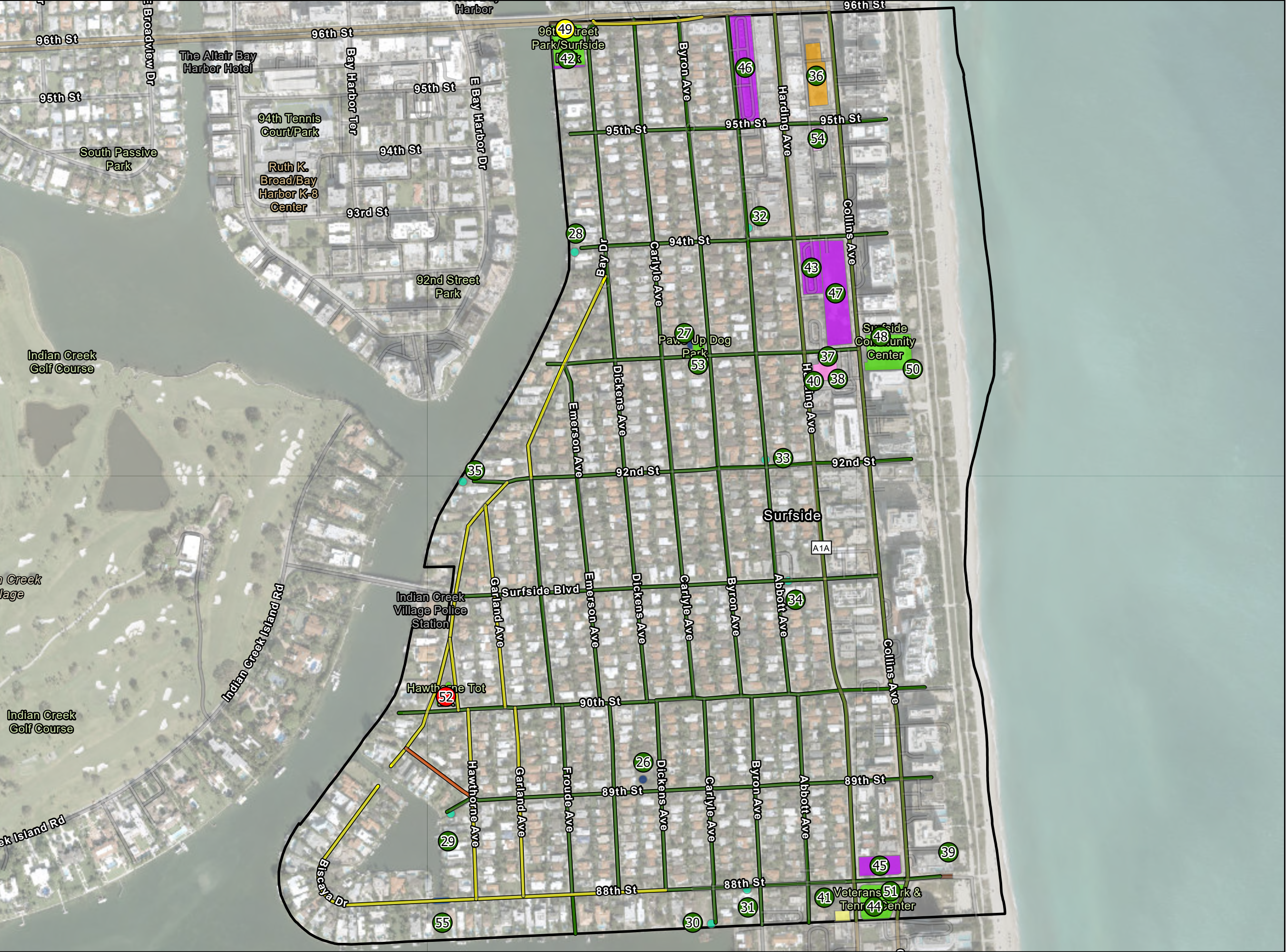
Historical and Cultural Assets

Parks

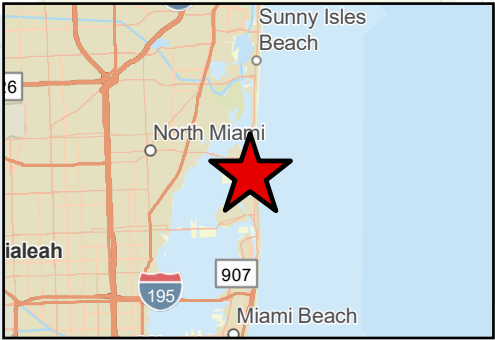
Transportation Assets and Evacuation Routes

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

Historical and Cultural Assets

Parks

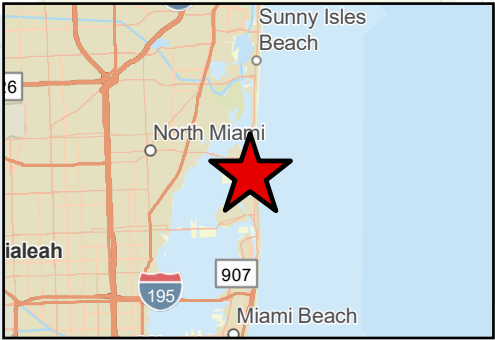
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Mangagement Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historal Assets**

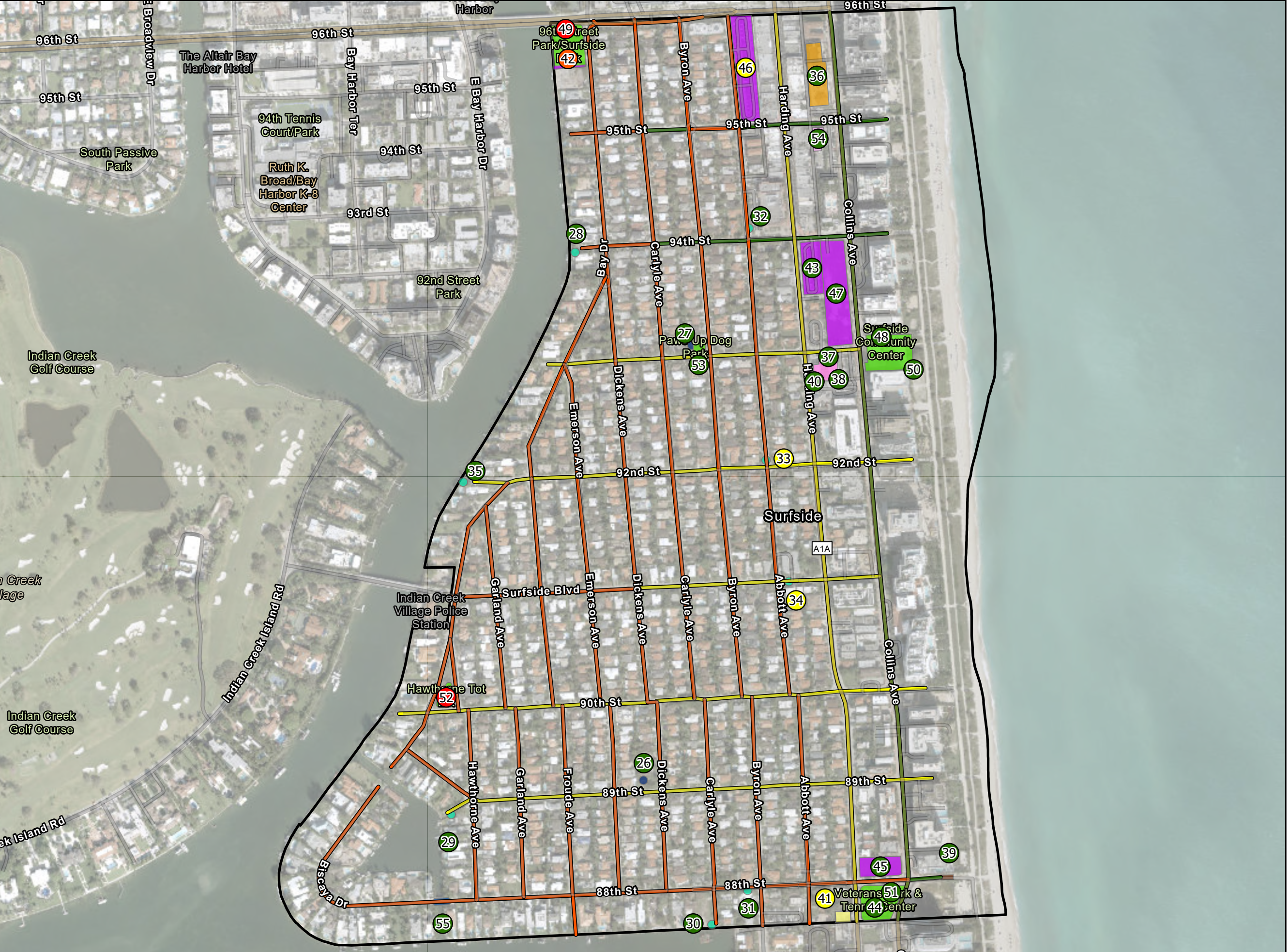
Historical and Cultural Assets

Parks

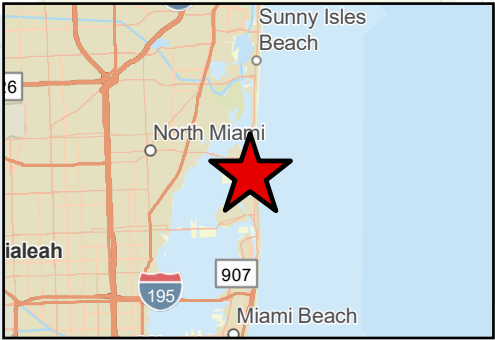
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Mangagement Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historal Assets**

Historical and Cultural Assets

Parks

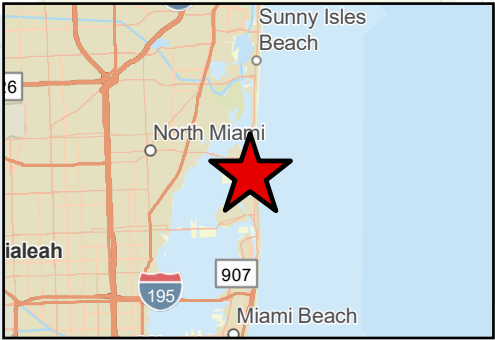
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Mangagement Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historal Assets**

Historical and Cultural Assets

Parks

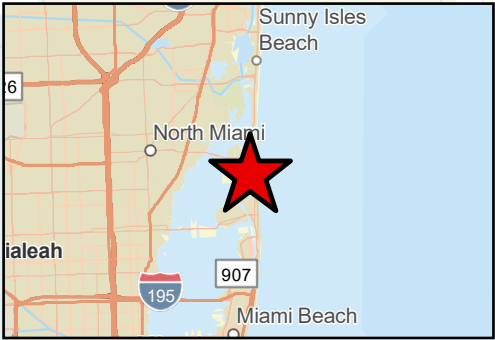
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

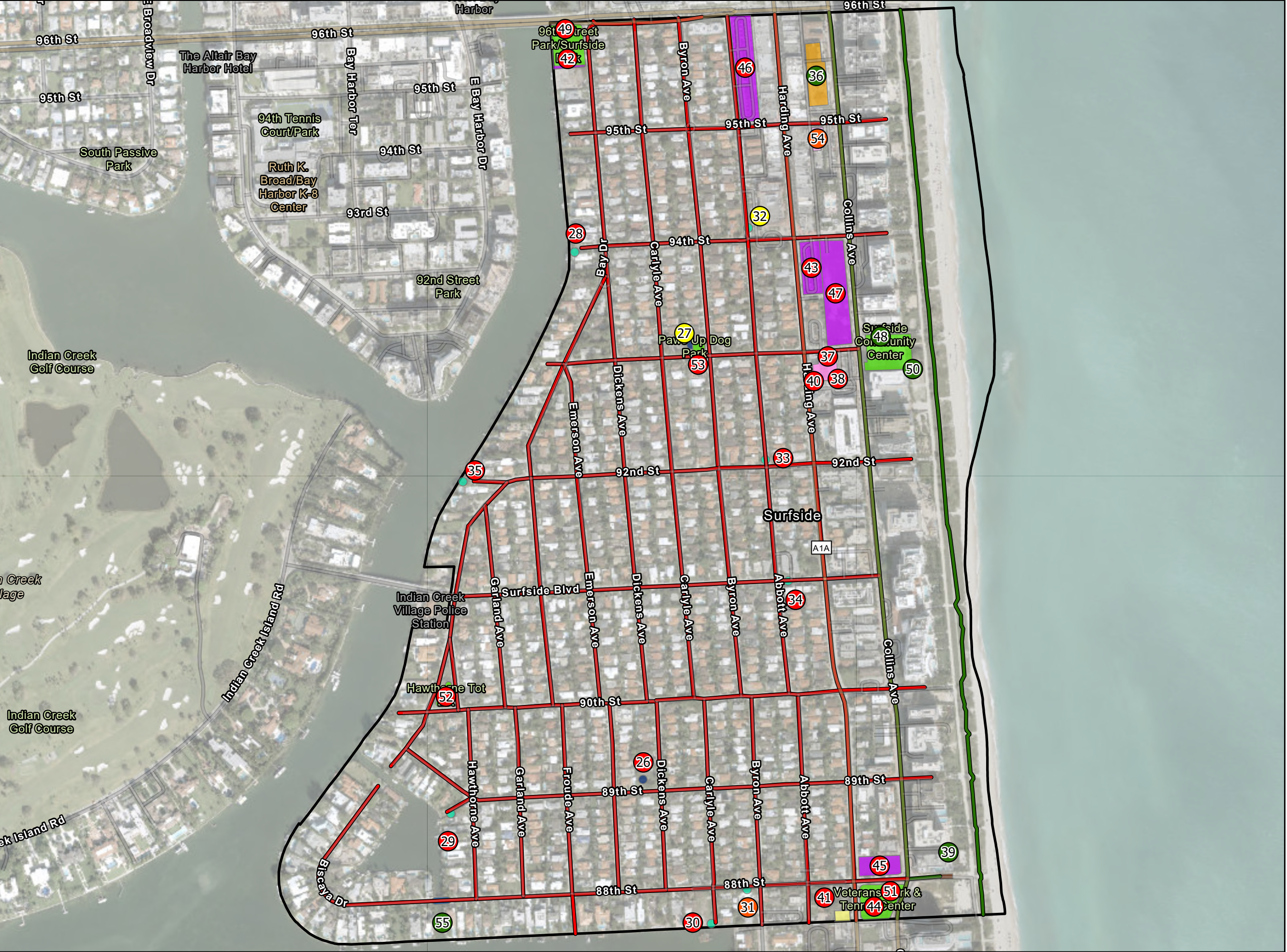
Historical and Cultural Assets

Parks

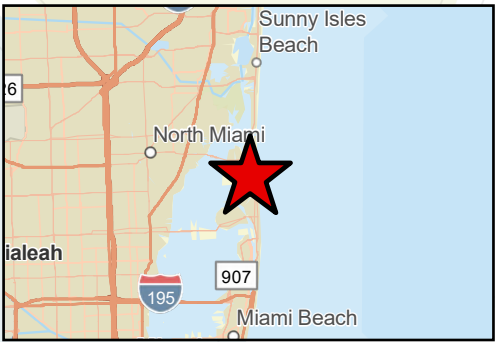
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

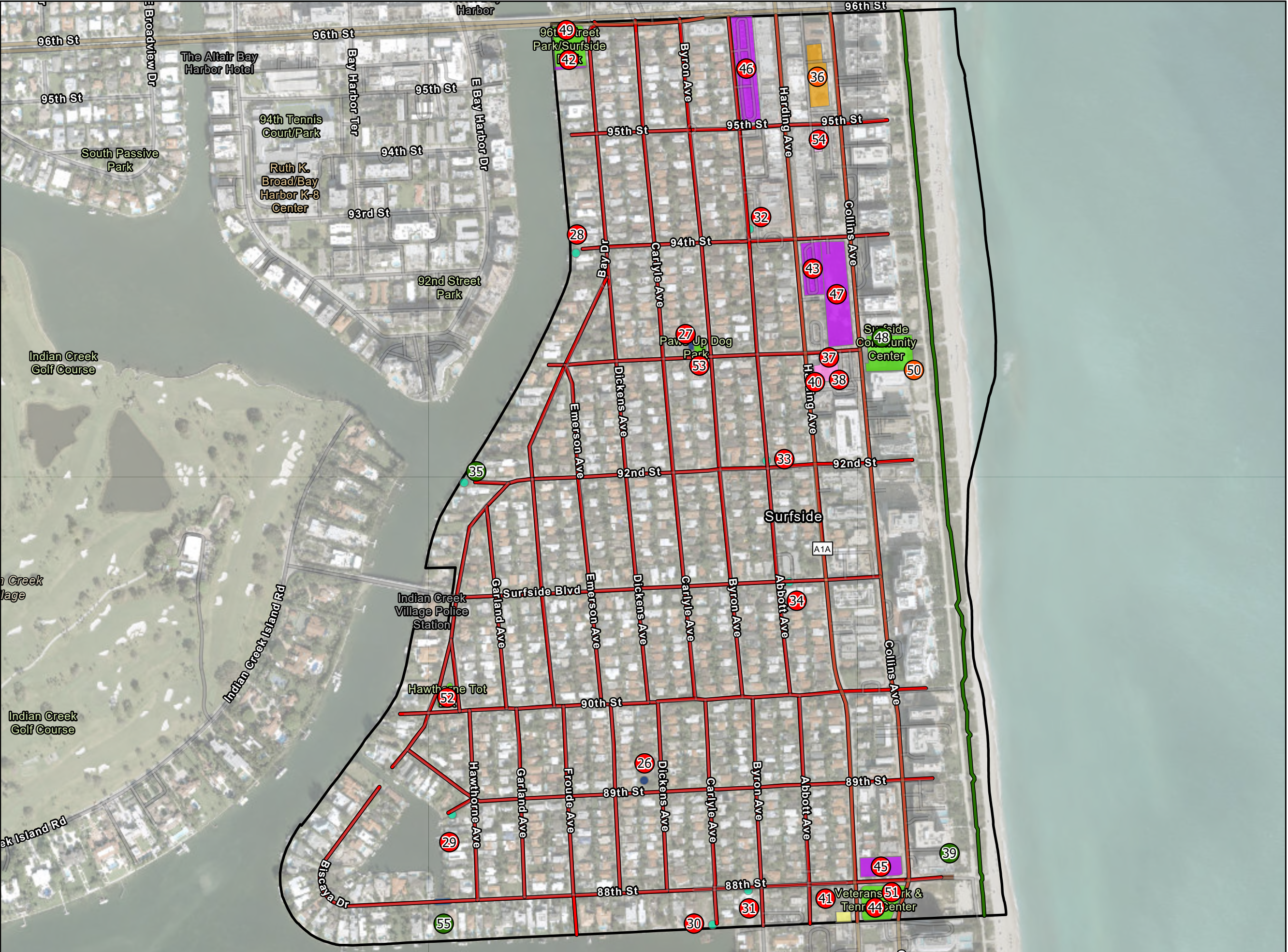
Historical and Cultural Assets

Parks

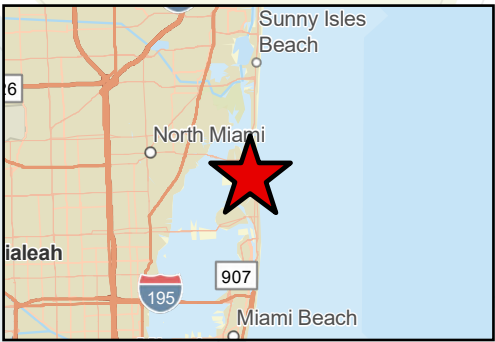
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

●

 None

●

 Low

●

 Medium

●

 High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

Historical and Cultural Assets

Parks

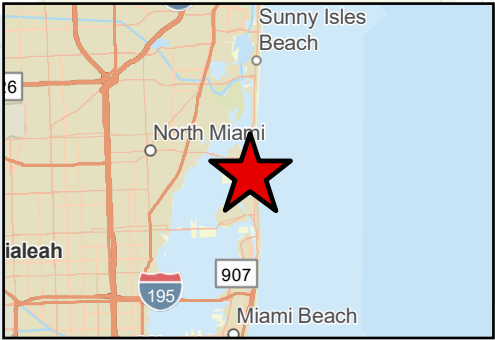
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

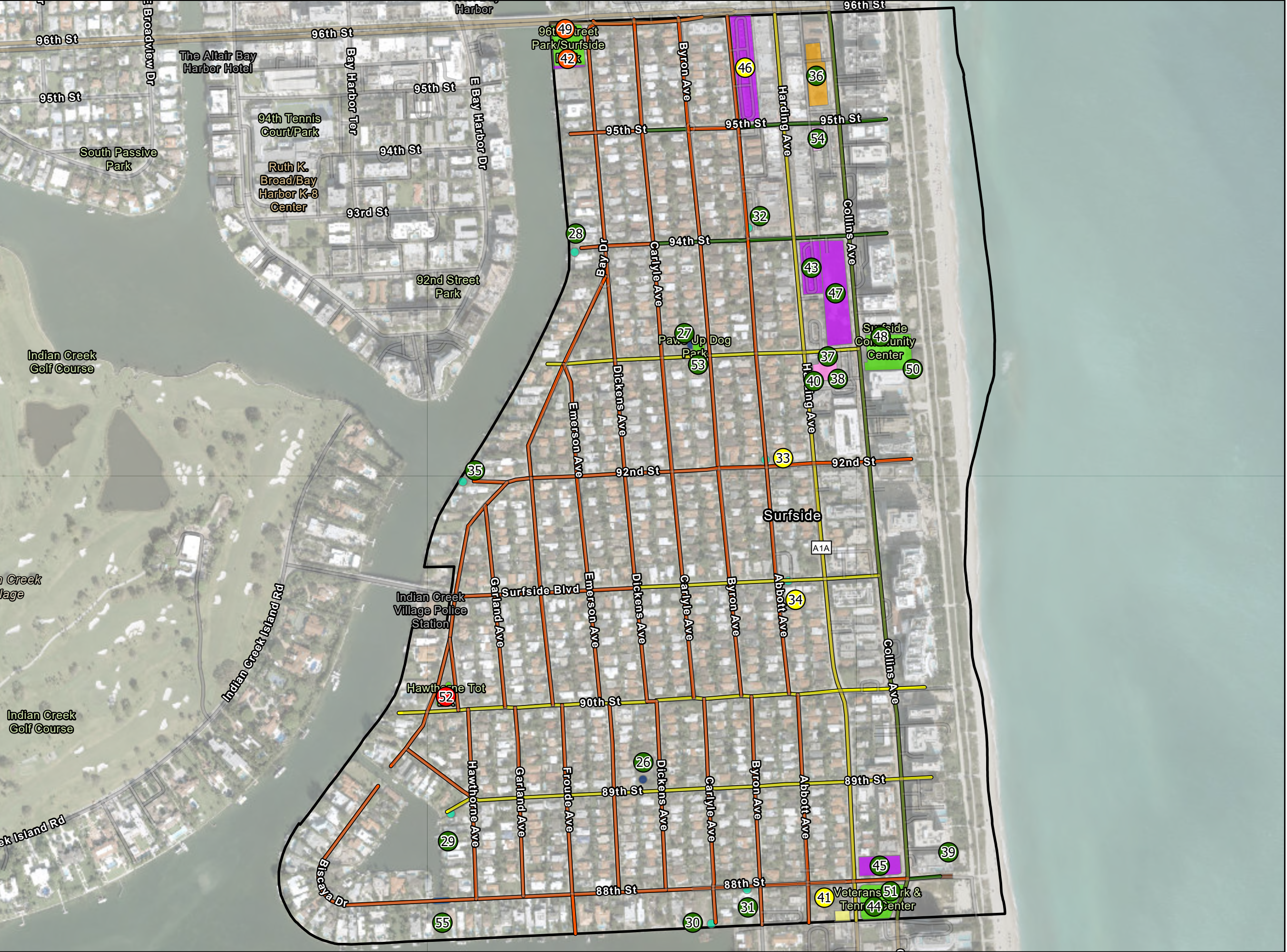
Historical and Cultural Assets

Parks

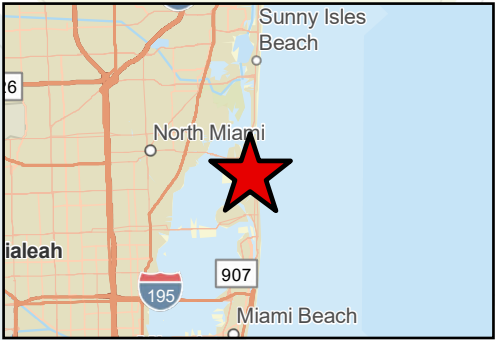
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Mangagement Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historal Assets**

Historical and Cultural Assets

Parks

**Transportation Assets and Evacuation Routes**

Bridges

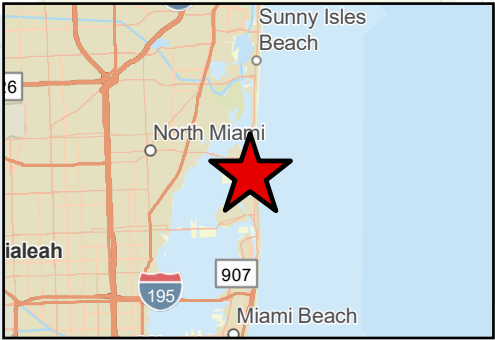
Refer to Appendix G to view Asset Name associated with the labeled Asset ID











### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

Historical and Cultural Assets

Parks

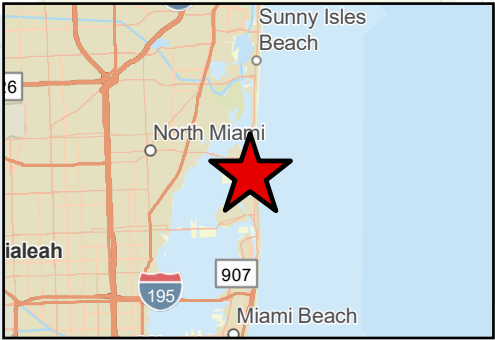
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

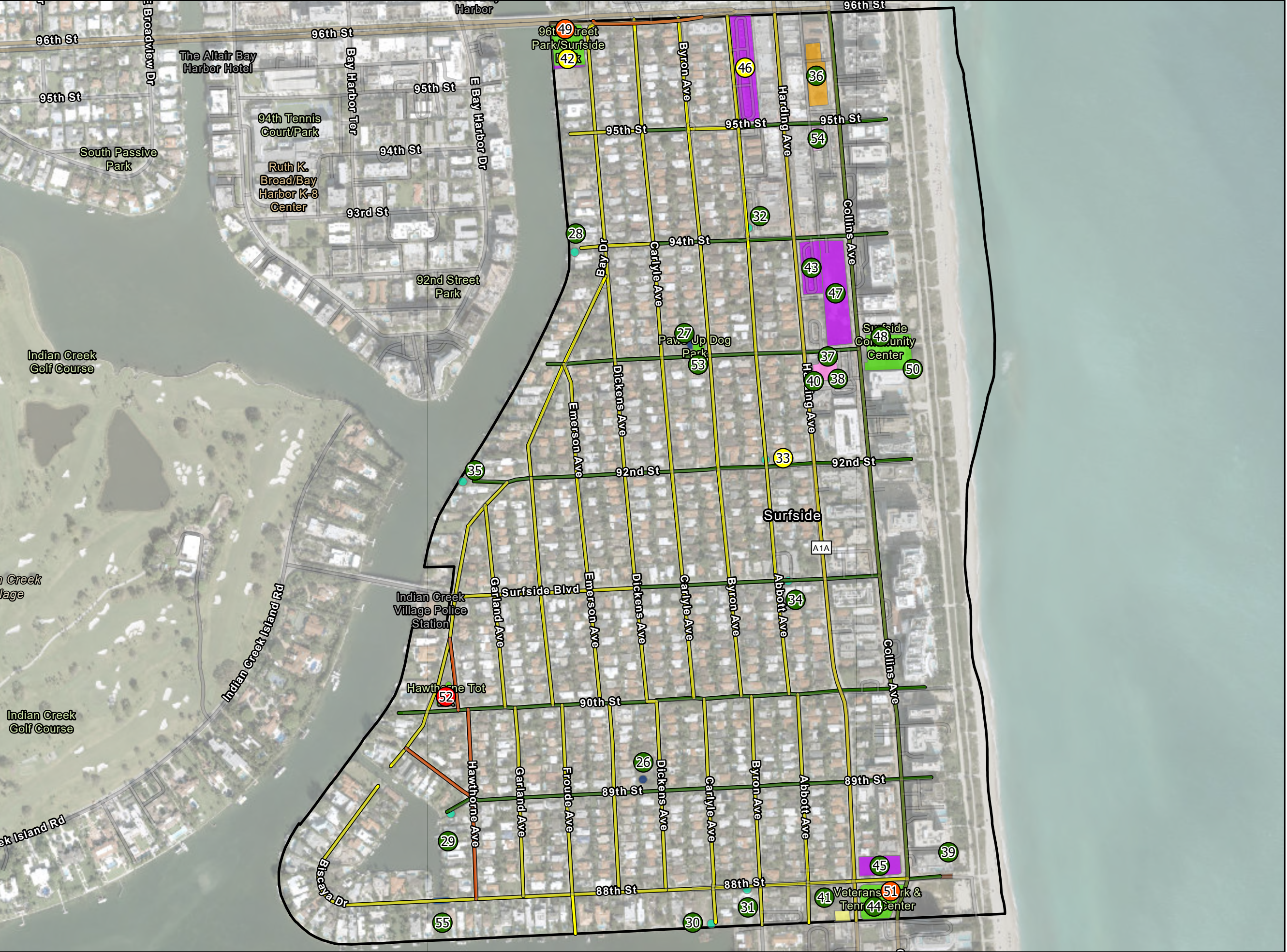
Historical and Cultural Assets

Parks

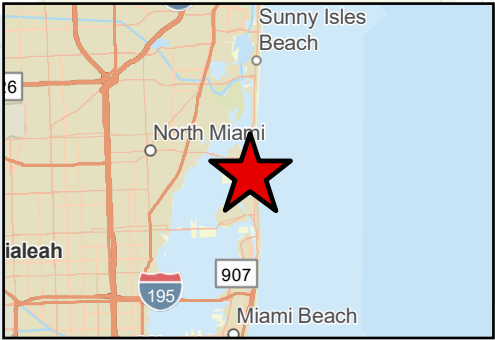
**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID







### Legend

**Criticality**

None

Low

Medium

High

**Town Boundary**

Town Boundary

**Critical Community and Emergency Facilities**

Community Centers

Emergency Operations Centers

Law Enforcement Facilities

Local Government Facilities

Schools

**Critical Infrastructure**

Wastewater Lift Station

Stormwater Pump Stations

Disaster Debris Management Sites

Electric Production and Supply Facilities

Communications Facilities

**Natural Cultural and Historical Assets**

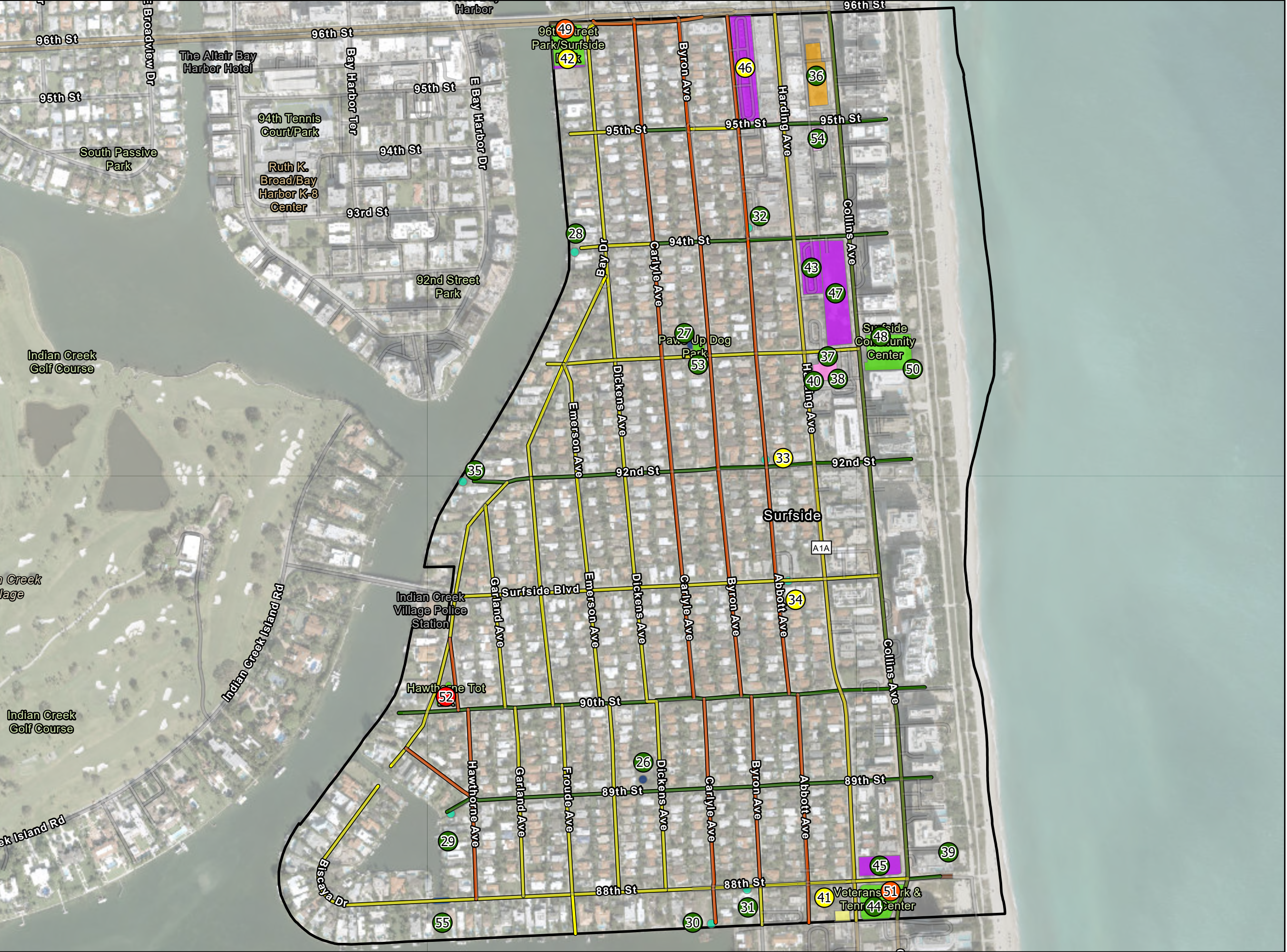
Historical and Cultural Assets

Parks

**Transportation Assets and Evacuation Routes**

Bridges

Refer to Appendix G to view Asset Name associated with the labeled Asset ID





# **APPENDIX F**

## **SENSITIVITY ANALYSIS PAIRED ASSET-THREAT MATRICES**





| Legend (Transportation Assets and Evacuation Routes) |                                                  |
|------------------------------------------------------|--------------------------------------------------|
| Low                                                  | Flood Depths < 0.5 feet*                         |
| Medium                                               | Flood Depths > 0.5 feet and < 2 feet*            |
| High                                                 | Permanent (SLR) Flooding, Flood Depths > 2 feet* |

\*A minimum of 15% of the road centerline must be inundated for the road to be considered impacted

Table F-1. Paired Asset-Threat Matrix for Transportation Assets and Evacuation Routes

| ID | Asset Name        | Asset Type     | Scenario Criticality |         |                   |                   |                   |                   |                                 |                                 |                                           |                                           |                                           |                                           |           |                     |                     |                     |                     |                                                          |                                                          |                                       |                                                 |                                                 |                                                 |                                                 |                           |                           |   |   |
|----|-------------------|----------------|----------------------|---------|-------------------|-------------------|-------------------|-------------------|---------------------------------|---------------------------------|-------------------------------------------|-------------------------------------------|-------------------------------------------|-------------------------------------------|-----------|---------------------|---------------------|---------------------|---------------------|----------------------------------------------------------|----------------------------------------------------------|---------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|---------------------------|---------------------------|---|---|
|    |                   |                | 100Y72H              | 500Y72H | 100Y72H<br>IL2050 | 100Y72H<br>IL2050 | 100Y72H<br>IL2080 | 100Y72H<br>IL2080 | Storm<br>Surge<br>Category<br>3 | Storm<br>Surge<br>Category<br>5 | Storm<br>Surge<br>Category<br>3<br>IL2050 | Storm<br>Surge<br>Category<br>3<br>IL2050 | Storm<br>Surge<br>Category<br>3<br>IL2080 | Storm<br>Surge<br>Category<br>3<br>IL2080 | King Tide | King Tide<br>IL2050 | King Tide<br>IL2050 | King Tide<br>IL2080 | King Tide<br>IL2080 | Compound<br>100Y72H<br>+<br>Storm<br>Surge<br>Category 3 | Compound<br>100Y72H<br>+<br>Storm<br>Surge<br>Category 5 | Compound<br>100Y72H<br>+<br>King Tide | Compound<br>100Y72H<br>+<br>King Tide<br>IL2050 | Compound<br>100Y72H<br>+<br>King Tide<br>IL2050 | Compound<br>100Y72H<br>+<br>King Tide<br>IL2080 | Compound<br>100Y72H<br>+<br>King Tide<br>IL2080 | FWMD<br>Future<br>100Y72H | FWMD<br>Future<br>500Y72H |   |   |
| 1  | Harding Avenue    | Major Roadways | L                    | L       | L                 | L                 | L                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | L                   | L                   | M                   | M                   | H                                                        | H                                                        | L                                     | L                                               | M                                               | M                                               | M                                               | M                         | L                         | L |   |
| 2  | 91 St/Surfside St | Major Roadways | -                    | L       | -                 | -                 | -                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | L                                     | L                                               | M                                               | M                                               | M                                               | M                         | L                         | L |   |
| 3  | Dickens Ave       | Major Roadways | L                    | L       | L                 | L                 | L                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | L                                     | L                                               | M                                               | M                                               | M                                               | M                         | L                         | L |   |
| 4  | Ne 16 Av          | Major Roadways | M                    | M       | M                 | M                 | M                 | M                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | L         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | L                                     | M                                               | M                                               | M                                               | M                                               | H                         | M                         | M |   |
| 5  | Ne 88 St          | Major Roadways | L                    | L       | L                 | L                 | L                 | M                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | L         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | L                                     | L                                               | M                                               | M                                               | M                                               | H                         | L                         | L |   |
| 6  | Collins Ave       | Major Roadways | -                    | -       | -                 | -                 | -                 | -                 | L                               | -                               | -                                         | L                                         | M                                         | -                                         | -         | -                   | -                   | -                   | -                   | H                                                        | -                                                        | L                                     | -                                               | -                                               | -                                               | -                                               | -                         | -                         | - |   |
| 7  | Isaac Singer Blvd | Major Roadways | L                    | L       | L                 | L                 | L                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | L                   | M                   | M                   | M                   | M                                                        | H                                                        | H                                     | L                                               | M                                               | M                                               | M                                               | M                         | L                         | L |   |
| 8  | Byron Ave         | Major Roadways | L                    | L       | L                 | L                 | L                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | M                   | M                   | M                   | M                   | M                                                        | H                                                        | L                                     | M                                               | M                                               | M                                               | M                                               | M                         | L                         | M |   |
| 9  | 93Rd St           | Major Roadways | -                    | -       | -                 | -                 | -                 | -                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | L                   | L                   | M                   | M                   | H                                                        | H                                                        | -                                     | L                                               | L                                               | M                                               | M                                               | -                         | L                         | - |   |
| 10 | 94Th St           | Major Roadways | -                    | -       | -                 | -                 | -                 | -                 | M                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | -                   | -                   | -                   | L                   | H                                                        | H                                                        | -                                     | L                                               | -                                               | -                                               | L                                               | M                         | -                         | - |   |
| 11 | 92Nd St           | Major Roadways | -                    | L       | -                 | -                 | -                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | L                   | L                   | M                   | M                   | H                                                        | H                                                        | L                                     | M                                               | M                                               | M                                               | M                                               | M                         | -                         | - |   |
| 12 | Abbott Ave        | Major Roadways | L                    | M       | L                 | L                 | L                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | L                                     | M                                               | M                                               | M                                               | M                                               | M                         | H                         | L | M |
| 13 | Irving Ave        | Major Roadways | L                    | M       | M                 | M                 | M                 | M                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | M         | M                   | M                   | M                   | H                   | H                                                        | H                                                        | M                                     | M                                               | M                                               | M                                               | M                                               | H                         | M                         | M |   |
| 14 | Carlyle Ave       | Major Roadways | L                    | M       | L                 | L                 | L                 | M                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | M                                     | M                                               | M                                               | M                                               | M                                               | M                         | H                         | L | M |
| 15 | 88Th St           | Major Roadways | -                    | -       | -                 | -                 | -                 | -                 | -                               | -                               | -                                         | L                                         | M                                         | -                                         | -         | -                   | -                   | -                   | -                   | H                                                        | -                                                        | -                                     | -                                               | -                                               | -                                               | -                                               | -                         | -                         | - |   |
| 16 | 95Th St           | Major Roadways | -                    | -       | -                 | -                 | -                 | -                 | M                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | -                   | -                   | -                   | -                   | H                                                        | H                                                        | -                                     | -                                               | -                                               | -                                               | -                                               | L                         | -                         | - |   |
| 17 | Bay Dr            | Major Roadways | L                    | L       | L                 | L                 | L                 | M                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | L         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | L                                     | L                                               | M                                               | M                                               | M                                               | H                         | L                         | L |   |
| 18 | 89Th St           | Major Roadways | -                    | -       | -                 | -                 | -                 | -                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | -                   | L                   | M                   | M                   | M                                                        | H                                                        | H                                     | -                                               | L                                               | L                                               | M                                               | M                         | -                         | - |   |
| 19 | 90Th St           | Major Roadways | -                    | L       | -                 | -                 | -                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | -                   | L                   | M                   | M                   | H                                                        | H                                                        | L                                     | L                                               | M                                               | M                                               | M                                               | M                         | -                         | - |   |
| 20 | Hawthorne Ave     | Major Roadways | L                    | M       | L                 | L                 | M                 | M                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | L         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | L                                     | M                                               | M                                               | M                                               | M                                               | H                         | M                         | M |   |
| 21 | Eli Lurie Blvd    | Major Roadways | L                    | L       | L                 | L                 | L                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | L                                     | M                                               | M                                               | M                                               | M                                               | H                         | L                         | L |   |
| 22 | Froude Ave        | Major Roadways | L                    | L       | L                 | L                 | L                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | M                   | M                   | M                   | M                   | M                                                        | H                                                        | L                                     | M                                               | M                                               | M                                               | M                                               | M                         | L                         | L |   |
| 23 | Emerson Ave       | Major Roadways | L                    | L       | L                 | L                 | L                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | M                   | M                   | M                   | M                   | M                                                        | H                                                        | L                                     | L                                               | M                                               | M                                               | M                                               | M                         | L                         | L |   |
| 24 | Surfside Blvd     | Major Roadways | -                    | L       | -                 | -                 | -                 | L                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | L                   | L                   | M                   | M                   | H                                                        | H                                                        | L                                     | L                                               | L                                               | L                                               | M                                               | M                         | -                         | L |   |
| 25 | Garland Ave       | Major Roadways | L                    | L       | L                 | L                 | L                 | M                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | L         | M                   | M                   | M                   | M                   | H                                                        | H                                                        | L                                     | M                                               | M                                               | M                                               | M                                               | H                         | L                         | L |   |
| 55 | 878001            | Bridges        | -                    | -       | -                 | -                 | -                 | -                 | H                               | H                               | H                                         | H                                         | H                                         | H                                         | -         | -                   | -                   | -                   | -                   | -                                                        | -                                                        | -                                     | -                                               | -                                               | -                                               | -                                               | -                         | -                         | - |   |



| Legend (Critical Infrastructure) |                                                 |
|----------------------------------|-------------------------------------------------|
| Low                              | Flood Depths < 0.5 feet                         |
| Medium                           | Flood Depths > 0.5 feet and < 2 feet            |
| High                             | Permanent (SLR) Flooding, Flood Depths > 2 feet |

Table F-2. Paired Asset-Threat Matrix for Critical Infrastructure

| ID | Asset Name                | Asset Type                                | Scenario Criticality |         |                   |                  |                   |                  |                                 |                                 |                                        |                                       |                                        |                                       |           |                     |                    |                     |                    |                                                          |                                                          |                                       |                                                 |                                                |                                                 |                                                |                            |                            |
|----|---------------------------|-------------------------------------------|----------------------|---------|-------------------|------------------|-------------------|------------------|---------------------------------|---------------------------------|----------------------------------------|---------------------------------------|----------------------------------------|---------------------------------------|-----------|---------------------|--------------------|---------------------|--------------------|----------------------------------------------------------|----------------------------------------------------------|---------------------------------------|-------------------------------------------------|------------------------------------------------|-------------------------------------------------|------------------------------------------------|----------------------------|----------------------------|
|    |                           |                                           | 100Y72H              | 500Y72H | 100Y72H<br>IL2050 | 100Y72H<br>I2050 | 100Y72H<br>IL2080 | 100Y72H<br>I2080 | Storm<br>Surge<br>Category<br>3 | Storm<br>Surge<br>Category<br>5 | Storm<br>Surge<br>Category 3<br>IL2050 | Storm<br>Surge<br>Category 3<br>I2050 | Storm<br>Surge<br>Category 3<br>IL2080 | Storm<br>Surge<br>Category 3<br>I2080 | King Tide | King Tide<br>IL2050 | King Tide<br>I2050 | King Tide<br>IL2080 | King Tide<br>I2080 | Compound<br>100Y72H<br>+<br>Storm<br>Surge<br>Category 3 | Compound<br>100Y72H<br>+<br>Storm<br>Surge<br>Category 5 | Compound<br>100Y72H<br>+<br>King Tide | Compound<br>100Y72H<br>+<br>King Tide<br>IL2050 | Compound<br>100Y72H<br>+<br>King Tide<br>L2050 | Compound<br>100Y72H<br>+<br>King Tide<br>IL2080 | Compound<br>100Y72H<br>+<br>King Tide<br>L2080 | SFWMF<br>Future<br>100Y72H | SFWMF<br>Future<br>500Y72H |
| 41 | Normandy Beach            | Electric Production And Supply Facilities | -                    | L       | -                 | -                | -                 | -                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | L                   | L                  | M                   | M                  | H                                                        | H                                                        | L                                     | L                                               | M                                              | M                                               | M                                              | -                          | L                          |
| 42 | 96TH Street Park Surfside | Disaster Debris Management Sites          | -                    | L       | -                 | -                | -                 | M                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | M                   | M                  | M                   | H                  | H                                                        | H                                                        | L                                     | M                                               | M                                              | M                                               | H                                              | L                          | L                          |
| 43 | Surface Lot South         | Disaster Debris Management Sites          | -                    | -       | -                 | -                | -                 | -                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | L                   | M                  | H                                                        | H                                                        | -                                     | -                                               | -                                              | L                                               | M                                              | -                          | -                          |
| 44 | Tennis Courts             | Disaster Debris Management Sites          | -                    | -       | -                 | -                | -                 | -                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | -                   | -                  | H                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | -                                              | -                          | -                          |
| 45 | 8800 Collins Ave Site     | Disaster Debris Management Sites          | -                    | -       | -                 | -                | -                 | -                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | -                   | L                  | H                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | L                                              | -                          | -                          |
| 46 | Surface Lot North         | Disaster Debris Management Sites          | L                    | L       | L                 | L                | L                 | L                | L                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | L                   | L                  | M                   | M                  | H                                                        | H                                                        | L                                     | L                                               | L                                              | M                                               | M                                              | L                          | L                          |
| 47 | Town Of Surfside          | Disaster Debris Management Sites          | -                    | -       | -                 | -                | -                 | -                | M                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | -                   | -                  | H                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | -                                              | -                          | -                          |
| 54 | Surfside Post Office      | Communications Facilities                 | -                    | -       | -                 | -                | -                 | -                | L                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | -                   | -                  | M                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | -                                              | -                          | -                          |
| 26 | 0002                      | Wastewater Lift Stations                  | -                    | -       | -                 | -                | -                 | -                | L                               | H                               | M                                      | M                                     | M                                      | H                                     | H         | -                   | -                  | -                   | -                  | L                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | -                                              | -                          | -                          |
| 27 | 0001                      | Wastewater Lift Stations                  | -                    | -       | -                 | -                | -                 | -                | M                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | -                   | -                  | H                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | -                                              | -                          | -                          |
| 28 | PS-1                      | Stormwater Pump Stations                  | -                    | -       | -                 | -                | -                 | -                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | L                   | M                  | H                                                        | H                                                        | -                                     | -                                               | -                                              | L                                               | M                                              | -                          | -                          |
| 29 | PS-3                      | Stormwater Pump Stations                  | -                    | -       | -                 | -                | -                 | -                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | -                   | L                  | H                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | L                                              | -                          | -                          |
| 30 | PS-6                      | Stormwater Pump Stations                  | -                    | -       | -                 | -                | -                 | -                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | -                   | L                  | H                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | L                                              | -                          | -                          |
| 31 | PS-7                      | Stormwater Pump Stations                  | -                    | -       | -                 | -                | -                 | -                | M                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | -                   | -                  | M                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | -                                              | -                          | -                          |
| 32 | PS-8                      | Stormwater Pump Stations                  | -                    | -       | -                 | -                | -                 | -                | -                               | H                               | M                                      | M                                     | M                                      | M                                     | H         | -                   | -                  | -                   | -                  | L                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | -                                              | -                          | -                          |
| 33 | PS-4                      | Stormwater Pump Stations                  | -                    | L       | -                 | -                | -                 | L                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | L                   | L                  | M                   | M                  | H                                                        | H                                                        | L                                     | L                                               | M                                              | M                                               | M                                              | L                          | L                          |
| 34 | PS-5                      | Stormwater Pump Stations                  | -                    | L       | -                 | -                | -                 | -                | H                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | L                   | L                  | M                   | M                  | M                                                        | H                                                        | L                                     | L                                               | L                                              | M                                               | M                                              | -                          | L                          |
| 35 | PS-2                      | Stormwater Pump Stations                  | -                    | -       | -                 | -                | -                 | -                | M                               | H                               | H                                      | H                                     | H                                      | H                                     | -         | -                   | -                  | -                   | -                  | M                                                        | H                                                        | -                                     | -                                               | -                                              | -                                               | -                                              | -                          | -                          |



| Legend (Critical Community and Emergency Facilities) |                                                 |
|------------------------------------------------------|-------------------------------------------------|
| Low                                                  | Flood Depths < 0.5 feet                         |
| Medium                                               | Flood Depths > 0.5 feet and < 2 feet            |
| High                                                 | Permanent (SLR) Flooding, Flood Depths > 2 feet |

Table F-3. Paired Asset-Threat Matrix for Critical Community and Emergency Facilities

[illegible]



| Legend (Natural Cultural and Historical Assets) |                                            |
|-------------------------------------------------|--------------------------------------------|
| Low                                             | Inundation < 25% and > 10%                 |
| Medium                                          | Inundation > 75% and < 25                  |
| High                                            | Permanent (SLR) Flooding, Inundation > 75% |

Table F-4. Paired Asset-Threat Matrix for Natural Cultural and Historical Assets

[illegible]