

Funded Through: DEP AGREEMENT NO. CM238

# **Working Towards Resilient Coastal Communities**

## **City of Hallandale Beach** **Vulnerability to Sea Level Rise Assessment Report**



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# City of Hallandale Beach Vulnerability to Sea Level Rise Assessment Report for CM238

## Working Towards Resilient Coastal Communities



This report was funded in part, through a grant agreement from the Florida Department of Environmental Protection, Florida Coastal Management Program, by a grant provided by the Office of Ocean and Coastal Resource Management under the Coastal Zone Management Act of 1972, as amended, National Oceanic and Atmospheric Administration Award No. # *NA11NOS4190073*. 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, NOAA or any of their subagencies.

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# Contents

|   |    |
|---|----|
| Report Summary.....   | 7  |
| Introduction.....   | 7  |
| Municipal Infrastructure Assessments.....                         | 7  |
| Municipal Scale Inundation Maps .....                             | 8  |
| Unified Sea Level Rise Projection .....                           | 11 |
| Vulnerability Assessment Methodology.....                         | 12 |
| Results .....   | 12 |
| Conclusion .....  | 14 |
| Definitions .....   | 14 |
| Bridges.....  | 15 |
| City Arterial Roads.....  | 16 |
| Table of Vulnerable City Arterial Roads.....                      | 17 |
| City Hall.....  | 20 |
| Table of City Hall Accessibility by Sea Level Rise Scenario ..... | 21 |
| City Parks .....  | 23 |
| Table of Vulnerable City Parks.....                               | 23 |
| Community Redevelopment Areas (CRA).....                          | 27 |
| Table of Vulnerable Community Redevelopment Areas (CRA) .....     | 28 |
| Evacuation Routes .....   | 31 |
| Table of Vulnerable Evacuation Routes.....                        | 32 |
| Fire Rescue Stations .....  | 33 |
| Table of Vulnerable Fire Rescue Stations .....                    | 34 |
| Law Enforcement Assets .....                                      | 36 |
| Table of Vulnerable Law Enforcement Assets.....                   | 37 |



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# Report Summary

## *The City of Hallandale Beach Vulnerability Report*

### **Introduction**

In the past century, sea level rise in South Florida rose 8-10 inches. In the future, the rate of sea level rise is expected to accelerate due to processes associated with global climate change. Broward County is highly vulnerable to sea level rise (SLR) due to its low lying topography. As a result, inundation, episodic flooding, drainage issues in low-lying areas and saltwater intrusions are significant threats. This document contains the vulnerability assessment of major municipal infrastructure in the City of Hallandale Beach at one and two foot SLR scenarios using a regional inundation digital elevation model (DEM) which incorporates 2007 LiDAR elevation data. Vulnerable areas are displayed by a grid with a 50 foot cell size, categorized as “possible” and “more likely”:

|   |   |
|---|---|
| <p><b>LEGEND</b></p> <p> Possible</p> <p> More Likely</p> | <p>The individual colors are used to describe the uncertainty associated with the variability of the tidal data measurements and LiDAR elevation measurements. The purple areas have a 75-100% certainty of identifying elevations below the high tide and therefore are “More likely” to be vulnerable. Orange areas have a 25-74% certainty of being at elevations below the high tide and represent areas of “Possible” vulnerability.</p> |
|---|---|

### **Municipal Infrastructure Assessments**

Mapping of different sea level rise scenarios can help to identify areas at potential risk and aid in planning for a sustainable community. This Geographic Information Systems (GIS) based study specifically assessed the following municipal infrastructure for the potential impacts of sea level rise:

1. Airports
2. Bridges
3. City Arterial Roads
4. City Hall
5. City Parks
6. Regional Parks & Nature Centers
7. Community Redevelopment Areas (CRAs)
8. Evacuation Routes
9. Fire Rescue Stations
10. Hospitals
11. Law Enforcement Assets
12. Schools
13. Potable Water Treatment
14. Waste Water Treatment

This work was funded, in part, through a grant agreement from the Florida Department of Environmental Protection, Florida Coastal Management Program.

***Municipal Scale Inundation Maps***

Municipal scale inundation maps provide at-a-glance overviews of areas within the City of Hallandale Beach Municipal boundary that are low lying and likely to be vulnerable to flooding associated with sea level rise. The maps on the following pages show the City of Hallandale Beach overlaid with the inundation grid for a one and two foot SLR scenario. These maps primary purpose is to aid in the assessment of vulnerabilities to sea level rise.

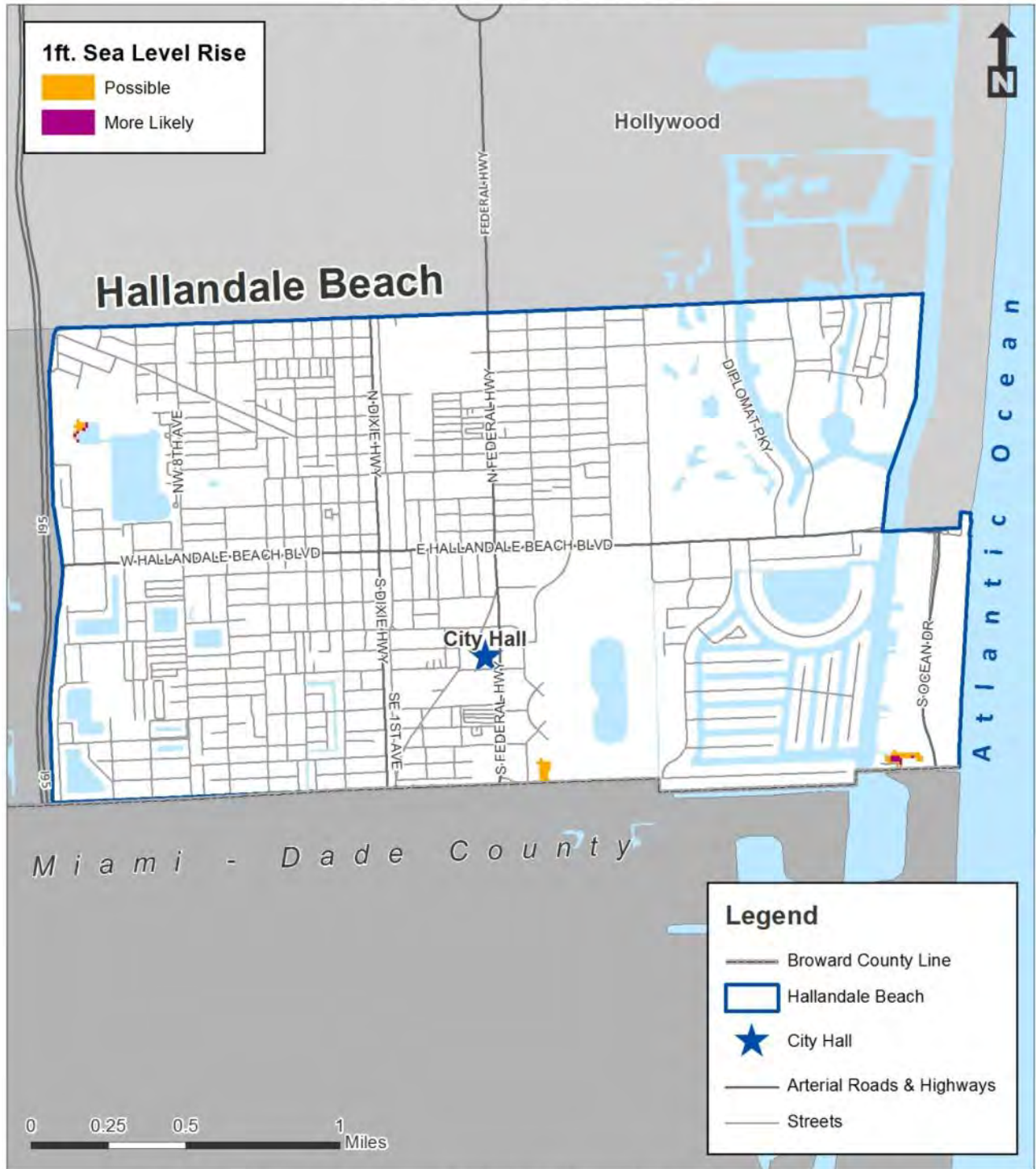
The following table summarizes the area of land (in acres) affected at both the one and two foot scenarios, as shown in the municipal scale inundation maps. The table breaks down the vulnerable acres for each scenario into “more likely,” “possible,” and total. Additionally, the table shows the percentage of the total area of the city that is vulnerable. Note that percent values are rounded to the nearest two decimal places.

| City of Hallandale Beach | Total Area (Acres) | Area Vulnerable at One (1) Foot Scenario (Acres) |          | Total Area Vulnerable at One (1) Foot Scenario (Acres) | Acreage Vulnerable at Two (2) Foot Scenario (Acres) |          | Total Area Vulnerable at Two (2) Foot Scenario (Acres) |
|--------------------------|--------------------|--|----------|--|---|----------|--|
|                          |                    | More Likely                                      | Possible |  | More Likely   | Possible |  |
|                          | <b>2812.66</b>     | 0.86   | 4.24     | 5.10   | 14.80   | 57.50    | 72.30  |
|                          | 0.03%              | 0.15%  | 0.18%    | 0.53%  | 2.04%   | 2.57%    |  |



# CITY OF HALLANDALE BEACH INUNDATION MAP

## One Foot Sea Level Rise



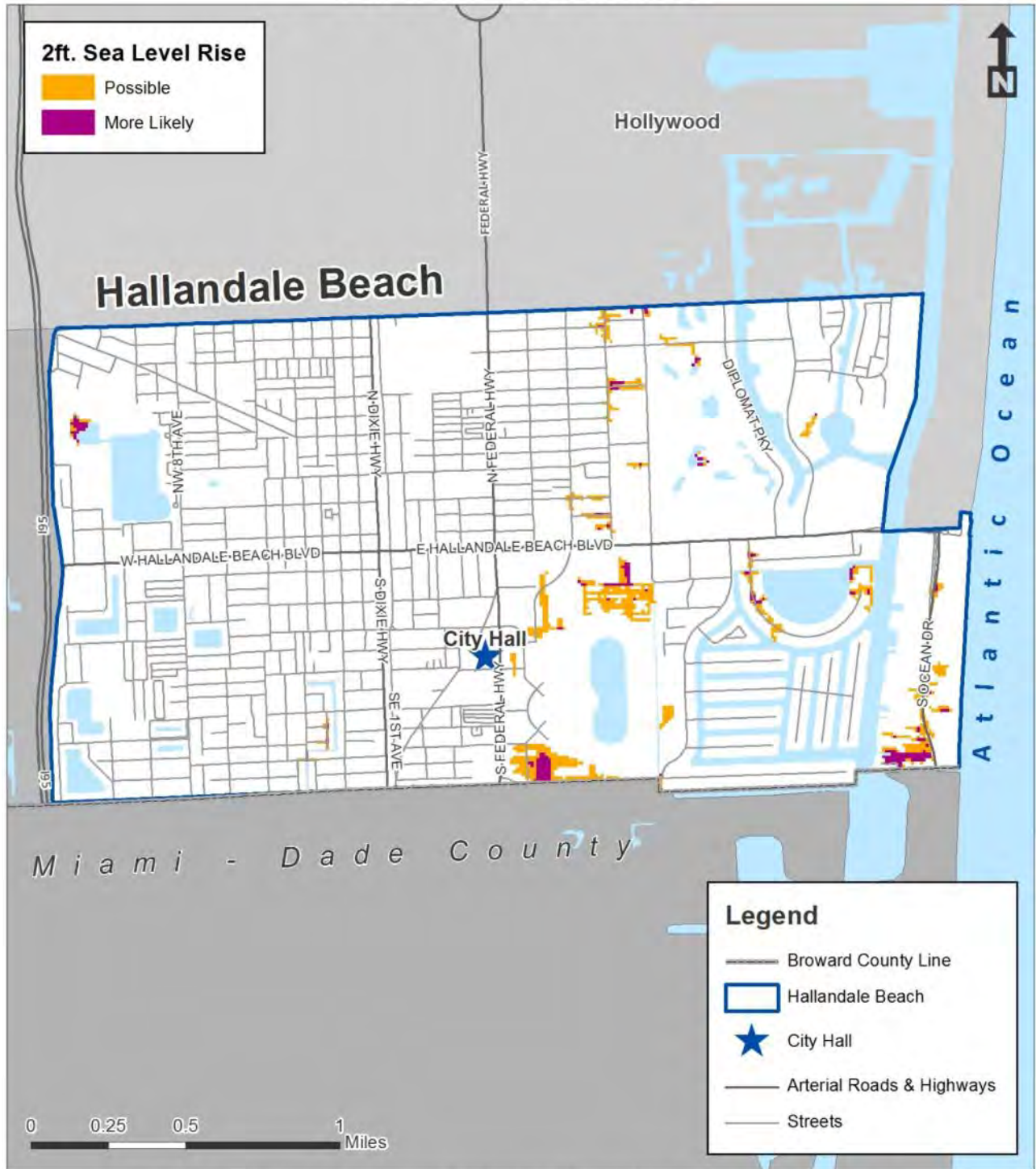
This map is for conceptual purposes only and should not be used for legal boundary determinations.

**BROWARD COUNTY** FLORIDA  
 Prepared By: Hannes Ziegler  
 Environmental Protection and Growth Management Department  
 Natural Resources Planning and Management Division

Date: 12/31/2013  
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# CITY OF HALLANDALE BEACH INUNDATION MAP

## Two Foot Sea Level Rise



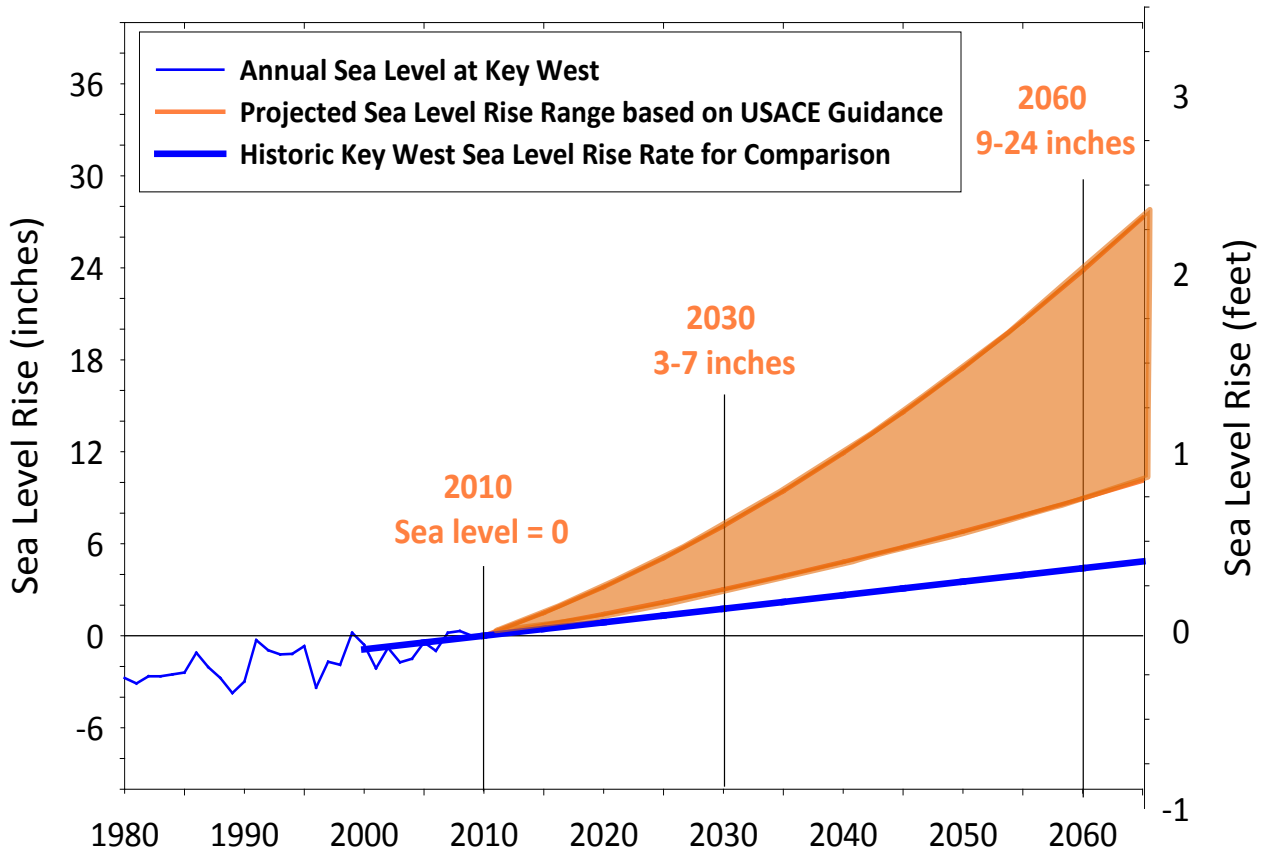
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### Unified Sea Level Rise Projection

The Southeast Florida Regional Climate Change Compact, collaboration among Monroe, Miami-Dade, Broward and Palm Beach Counties, convened a group of scientists and local experts to develop the Unified Southeast Florida Sea Level Rise Projection. This projection allows us to assign timeframes to the given sea level rise scenarios with a one foot sea level rise projected to occur between 2040-2070 and a two foot rise likely to occur between 2060 – 2115.



**Unified Southeast Florida Sea Level Rise Projection for Regional Planning Purposes** - This projection uses historic tidal information from Key West and was calculated by Kristopher Esterson from the United States Army Corps of Engineers using USACE Guidance (USACE 2009) intermediate and high curves to represent the lower and upper bound for projected sea level rise in Southeast Florida. Sea level measured in Key West over the past several decades is shown. The rate of sea level rise from Key West over the period of 1913 to 1999 is extrapolated to show how the historic rate compares to projected rates.

## ***Vulnerability Assessment Methodology***

Municipal infrastructure (fire rescue stations, schools, city owned arterial roads, etc.) was overlaid with the sea level rise inundation grid to review which infrastructure may be located at or below projected sea levels at a one or two foot scenario. This process was expedited with the creation of a python script that quickly locates infrastructure which may be vulnerable at a given sea level rise scenario. Each location was reviewed visually for confirmation. The report uses inundation maps developed in collaboration with the Southeast Florida Regional Climate Change Compact with vulnerability methods and oversight by the GIS Section of the Planning and Redevelopment Division. All measurements of area and length are based on GIS datasets of the county and depend on these for accuracy. Additionally, measurements and percent values given in this report are rounded, which may contribute to minor inconsistencies.

## ***Results***

The following findings pertain to the vulnerability assessments performed for each of the City of Hallandale Beach municipal infrastructure in the list. Detailed maps and tables follow.

1. Airports:  
There are no airports in the City of Hallandale Beach.
2. Bridges:  
Included is a map that provides the location of all four bridges located in the City of Hallandale Beach overlaid by the inundation grid. The idea is to provide at-a-glance overviews of the vulnerability of bridges with the understanding that most navigable bridges are located on tidally influenced water bodies. Sea level will reduce the clearance under these bridges thereby reducing the number and size of craft that can pass under them.
3. City Arterial Roads:  
Two segments of arterial roads maintained by the City of Hallandale Beach are potentially vulnerable to sea level rise. One segment has an area below projected sea levels at a one foot scenario. Two segments showed vulnerabilities at the two foot scenario. The affected roadways are Atlantic Shores Blvd and NE 14<sup>th</sup> Ave. Included is an overview map of the City of Hallandale Beach with the locations of all vulnerable arterial road segments, a table to assess each vulnerable segment, and large-scale maps of the vulnerable segments.
4. City Hall:  
Streets within a 1000-foot radius of the Hallandale Beach City Hall may become affected by sea level rise starting at a two foot scenario. Inundated streets are likely to cause access issues.
5. City Parks:  
A total of two city-owned parks in the City of Hallandale Beach were found to be potentially vulnerable to sea level rise. No parks were found to be vulnerable at the one foot scenario. Two parks were vulnerable at the two foot scenario. Included in this report is an overview map of the City of Hallandale Beach with the locations of the two vulnerable city parks, a table to assess each vulnerable park, and large-scale maps of the vulnerable parks.

6. Regional Parks & Nature Centers:  
There are no regional parks or nature centers in the City of Hallandale Beach
7. Community Redevelopment Areas (CRA):  
The Hallandale Beach CRA has areas with elevations at or below sea level during both the one and two foot scenarios. Parking, streets, several building footprints, and open spaces are among the structures found in areas that may be vulnerable. Included is an overview map of the City of Hallandale Beach with the location of the vulnerable CRA, a table to provide information on the effected CRA, and large-scale maps of the CRAs at a one and two foot scenario.
8. Evacuation Routes:  
There is one designated evacuation route within the City of Hallandale Beach with land at or below projected sea levels, Ocean Drive (A1A). Included is an overview map of the City of Hallandale Beach with the location of the vulnerable evacuation route segments, and a table to provide information on the effected routes.
9. Fire Rescue Stations:  
Fire Rescue Stations and streets within a 1000-foot radius of stations were analyzed for potential vulnerability to one and two foot sea level rise scenarios. Inundated streets are likely to cause access issues. One fire rescue station, Fire Rescue 60, has roadways located at or below projected sea levels. The affected roadway, A1A, has sections at or below projected sea levels during a two foot scenario. The area was not affected during a one foot scenario. Included is an overview map of the City of Hallandale Beach with the location of fire rescue stations, a table to provide information on the vulnerable station, and a large-scale map of the affected area.
10. Hospitals:  
There are no hospitals in the City of Hallandale Beach.
11. Law Enforcement Assets:  
Law Enforcement Assets and streets within a 1000-foot radius of aforementioned assets were analyzed for potential vulnerability to one and two foot sea level rise scenarios. Inundated streets are likely to cause access issues. Two streets near the Hallandale Police Department contain areas at or below projected sea level rise. The two streets are Gulfstream Way and Breeze Way. The area was not affected during a one foot scenario. Included is an overview map of the City of Hallandale Beach with the location of the Hallandale Police Department, a table to provide information on the vulnerable asset, and a large-scale map of the affected area.
12. Schools:  
No school building footprints of schools in the City of Hallandale Beach were affected during a one and two foot sea level rise scenario.
13. Potable Water Treatment:  
No potable water treatment plants in the City of Hallandale Beach showed potential vulnerability to sea level rise at the one and two foot scenario.
14. Waste Water Treatment:  
There are no waste water treatment plants in the City of Hallandale Beach.

## ***Conclusion***

The information contained in this report is intended to be used for planning purposes to begin to identify and address municipal infrastructure at risk. Understanding that a one foot rise could occur in the next 30 years, adaptation strategies should be developed for locations identified as vulnerable in the first scenario. In addition to the vulnerability of infrastructure identified to lie at or below projected sea levels up to a two foot scenario; the municipality may also be at risk due to secondary threats such as flooding events and ponding, storm drainage, erosion, bridge clearance, etc. Sea level may continue to rise beyond two feet. The Hallandale Beach municipal authorities should begin the development of policies to address these risks and institutionalize the consideration of climate issues for adaptation strategies.

## **Definitions**

ArcGIS: Software for working with maps and geographic information.

Arterial Roads: A major or main road, but not a highway.

DEM: Digital Elevation Model – A digital model or 3D representation of a terrain’s surface using topographic information.

Geographic Information Systems (GIS): A system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.

LiDAR: A remote sensing technology whereby elevation is measured by illuminating a target with a laser and analyzing the reflected light.

PPA: Priority Planning Areas – Identifies areas influenced by tidal water bodies at increased risk of inundation under a 2 foot sea level rise scenario, projected to occur as soon as 2060.

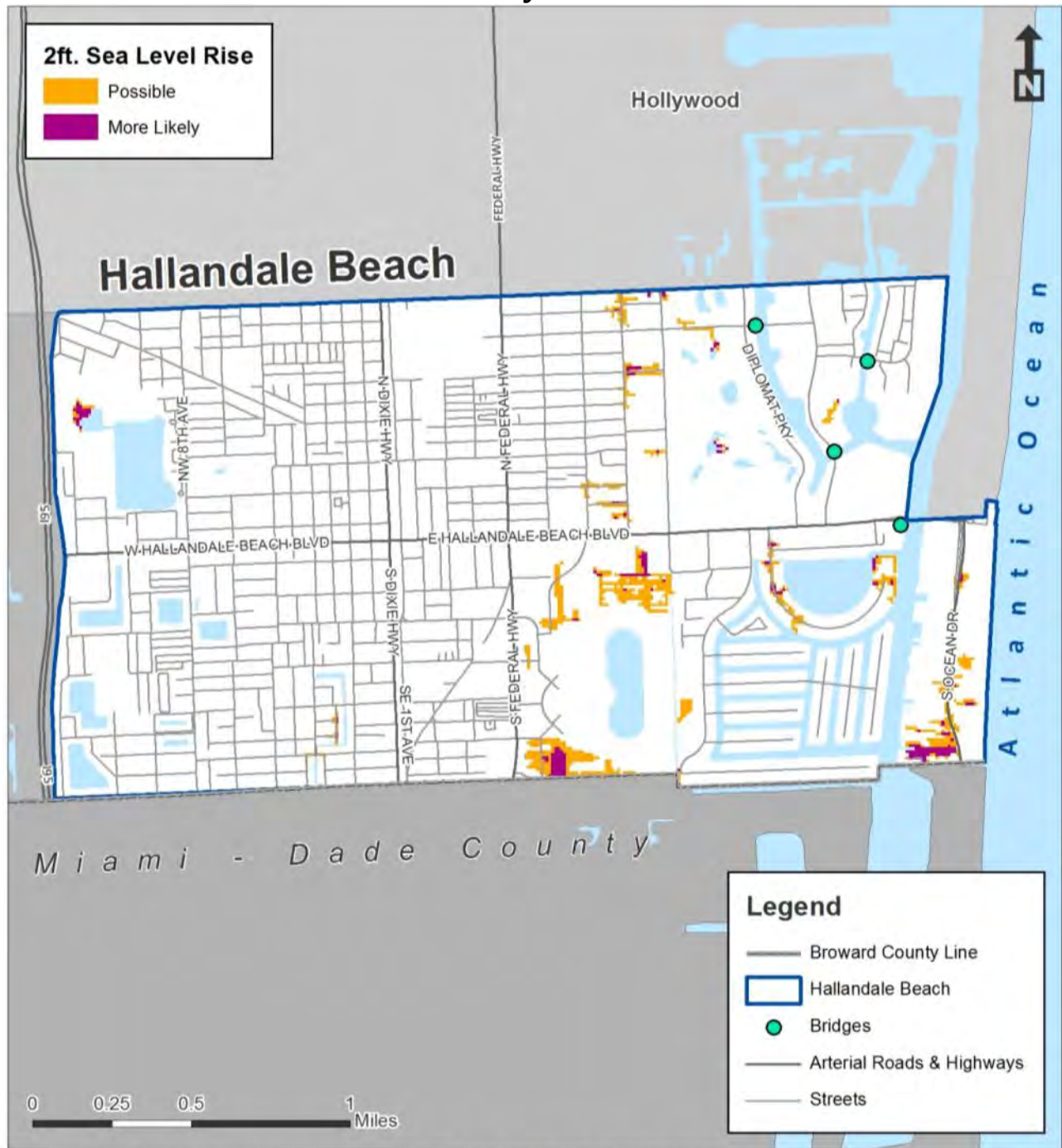
Python Script: A widely-used general purpose programming language. It is used in ArcGIS to automate processes whereby new geographic information is created from existing data.

SLR: sea level rise grid

- “More Likely”: areas that have a 75-100% certainty of identifying elevations below the high tide and therefore are “More likely” to be vulnerable
- “Possible”: Orange areas have a 25-74% certainty of being at elevations below the high tide and represent areas of “Possible” vulnerability.

Vulnerable Area: The phrase “Vulnerable Area” as used in this document refers to land elevation at or below a given sea level rise scenario (one to two foot) as determined by the unified sea level rise projection grid.

# Bridges Vulnerability Assessment



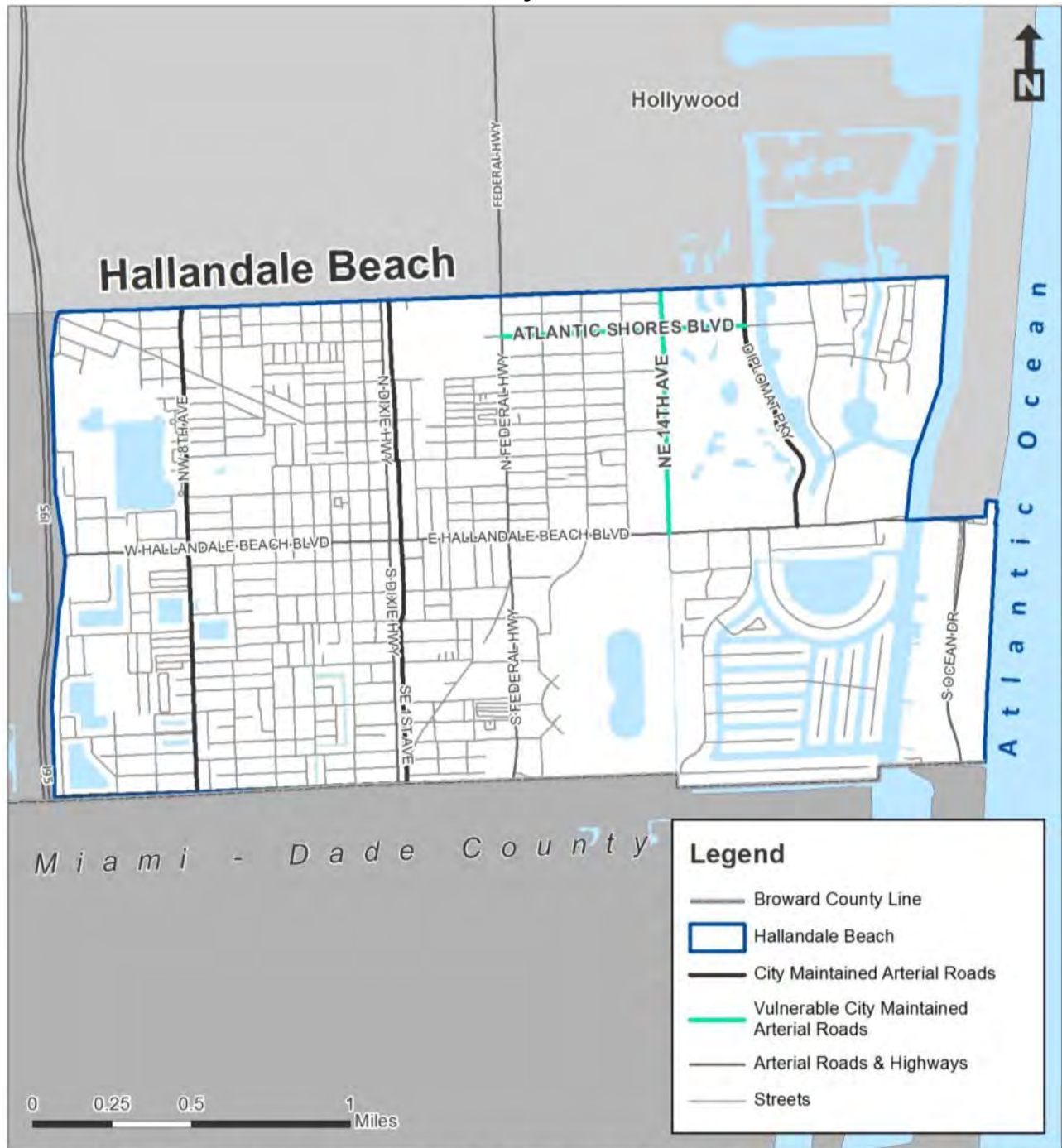
**This Map identifies areas at increased risk of inundation up to a two foot sea level rise scenario, projected to occur as soon as 2060.**

This map is for conceptual purposes only and should not be used for legal boundary determinations.

**BROWARD COUNTY**  
FLORIDA  
Prepared By: Hannes Ziegler  
Environmental Protection and Growth Management Department  
Natural Resources Planning and Management Division

Date: 12/31/2013  
DEP Agreement No. CM238 DEP 55-236(08/11)

# City Arterial Roads Vulnerability Assessment



**This Map identifies areas at increased risk of inundation up to a two foot sea level rise scenario, projected to occur as soon as 2060.**

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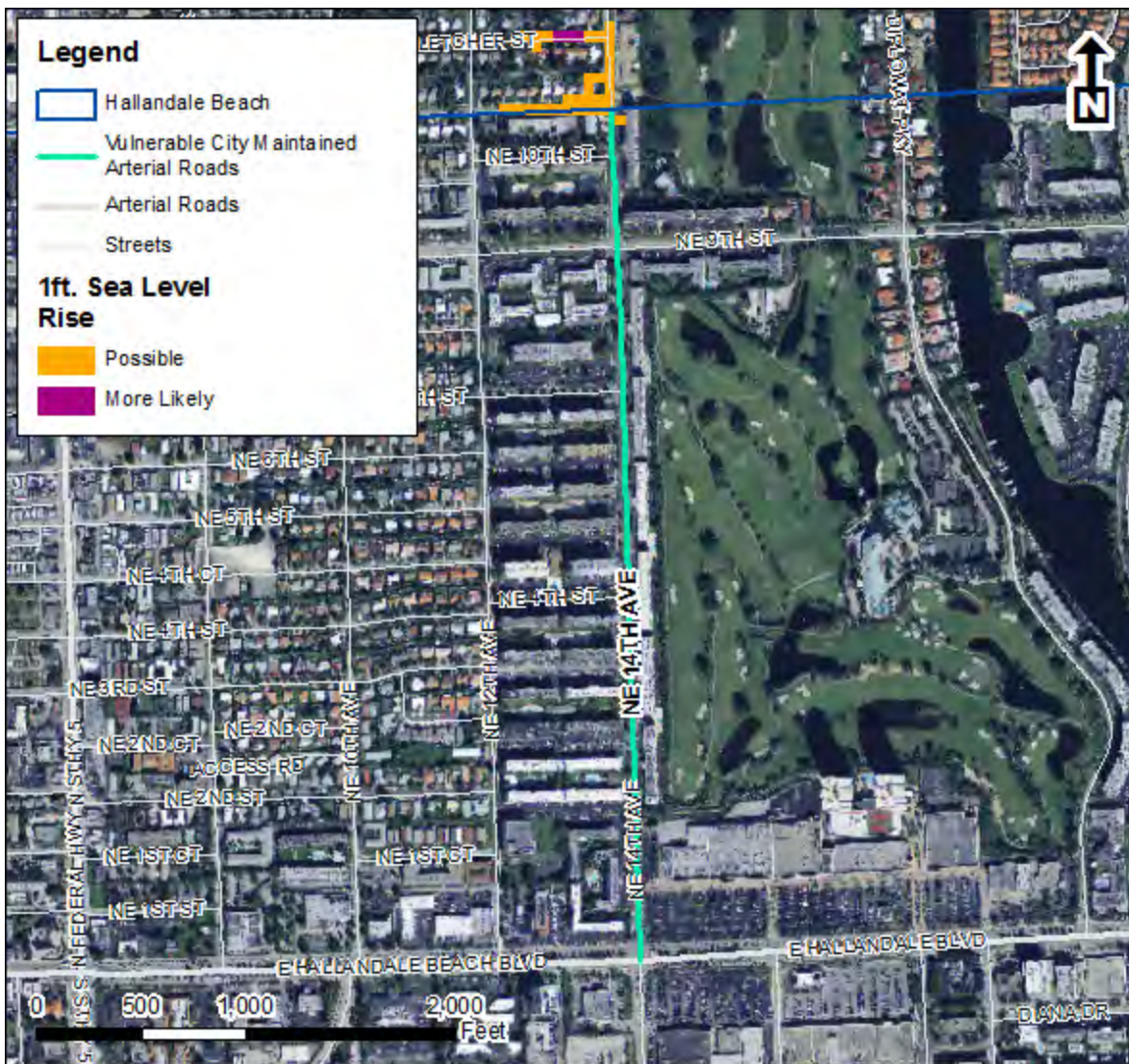
### ***Table of Vulnerable City Arterial Roads***

The following table lists the two vulnerable segments of arterial roads maintained by the City of Hallandale Beach. For each segment, the table provides the miles of vulnerable roadway and the total length with vulnerability expressed in percent for both the one and two foot sea level rise (SLR) scenarios.

| <b>ATLANTIC SHORES BLVD, from US 1 to Diplomat Pky</b>       |          |             | Total Miles   |
|--|----------|-------------|---------------|
|  |          |             | 0.77          |
| SLR Scenario   | Possible | More Likely | Percent Total |
| 1 Foot   | 0.00     | 0.00        | 0%            |
| 2 Foot   | 0.06     | 0.00        | 8%            |
| <b>NE 14TH AVE, from Hallandale Beach Blvd to Moffett St</b> |          |             | Total Miles   |
|  |          |             | 0.78          |
| SLR Scenario   | Possible | More Likely | Percent Total |
| 1 Foot   | 0.01     | 0.00        | 1%            |
| 2 Foot   | 0.01     | 0.02        | 3%            |

# NE 14<sup>th</sup> Ave

## One Foot Sea Level Rise Scenario



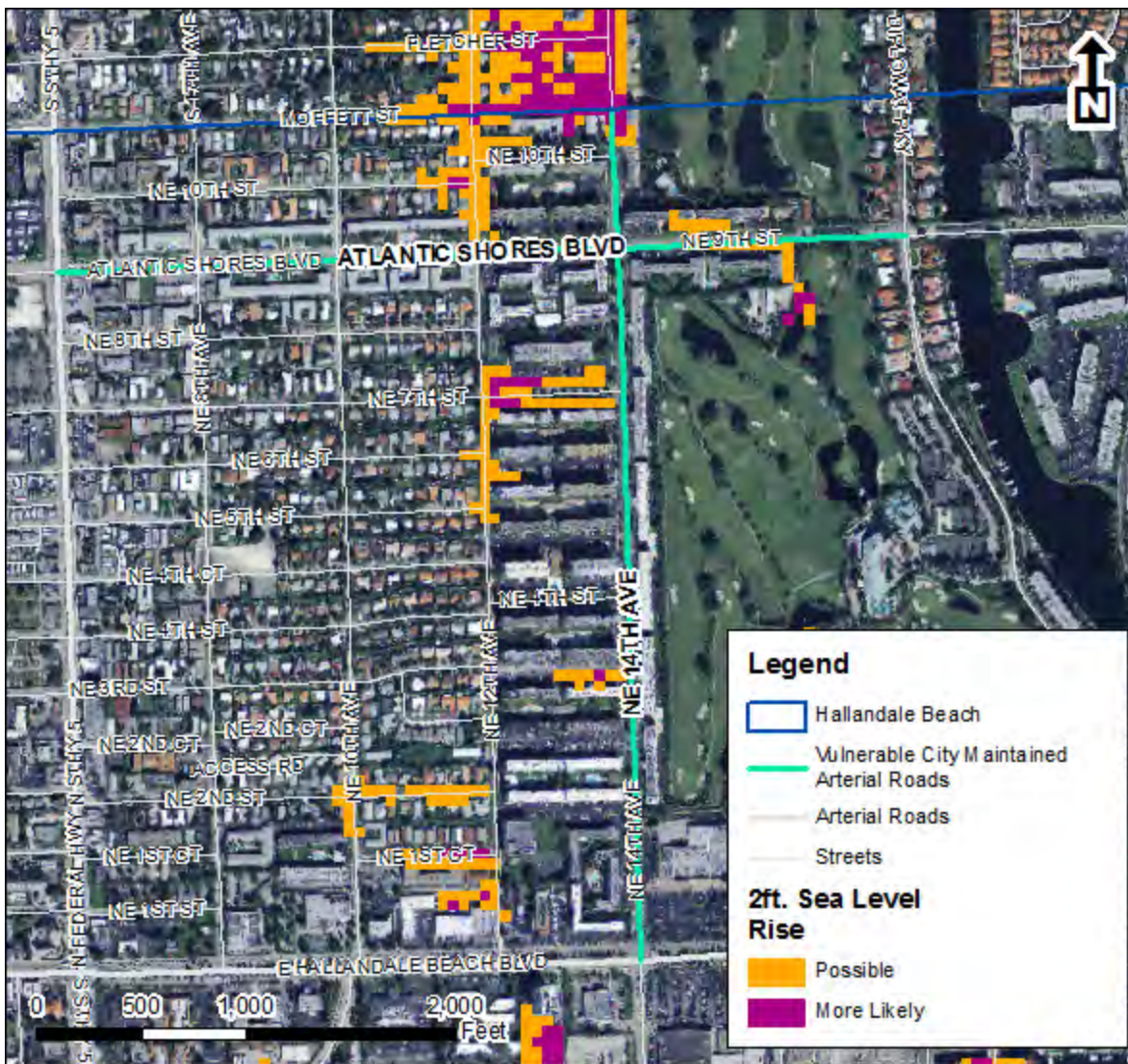
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 Natural Resources Planning and Management Division

Date: 2/21/2014  
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This Map provides a view of NE 14<sup>th</sup> Ave During the one foot scenario, up to 1% of the 0.78 mile stretch of NE 14<sup>th</sup> Ave may be affected.

## Atlantic Shores Blvd & NE 14<sup>th</sup> Ave Two Foot Sea Level Rise Scenario



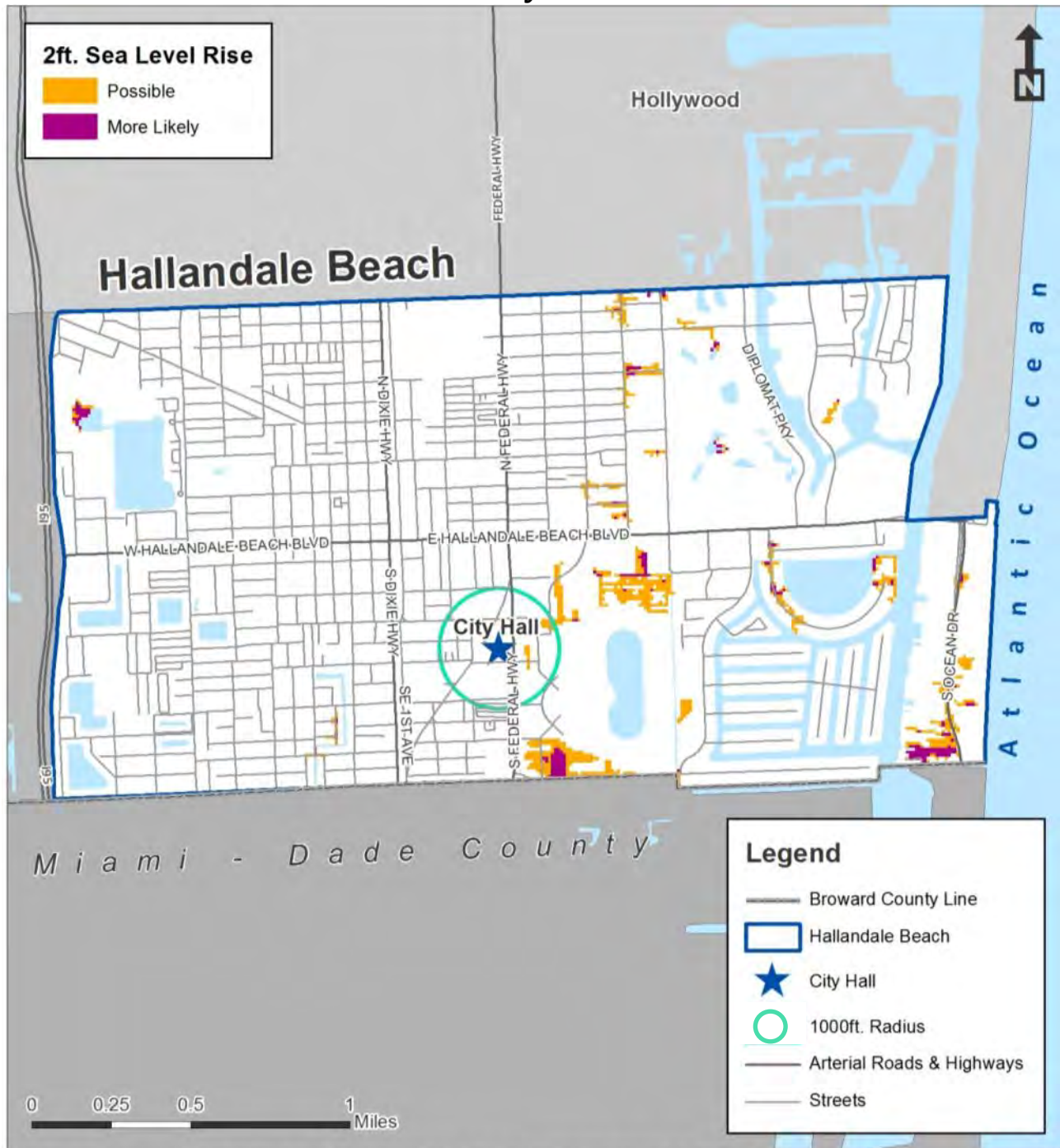
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**BROWARD COUNTY**  
Prepared By: H. Ziegler  
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Natural Resources Planning and Management Division

Date: 2/21/2014  
DEP Agreement No. CM238 DEP 55-236 (08/11)

This Map provides a view of Atlantic Shores Blvd and NE 14<sup>th</sup> Ave. During the Two foot sea level rise scenario, up to 3% of the 0.78 mile stretch of NE 14<sup>th</sup> Ave may be affected. Up to 8% of the 0.77 mile Atlantic Shores Blvd may become affected during the two foot scenario.

# City Hall Vulnerability Assessment



**This Map identifies areas at increased risk of inundation up to a two foot sea level rise scenario, projected to occur as soon as 2060.**

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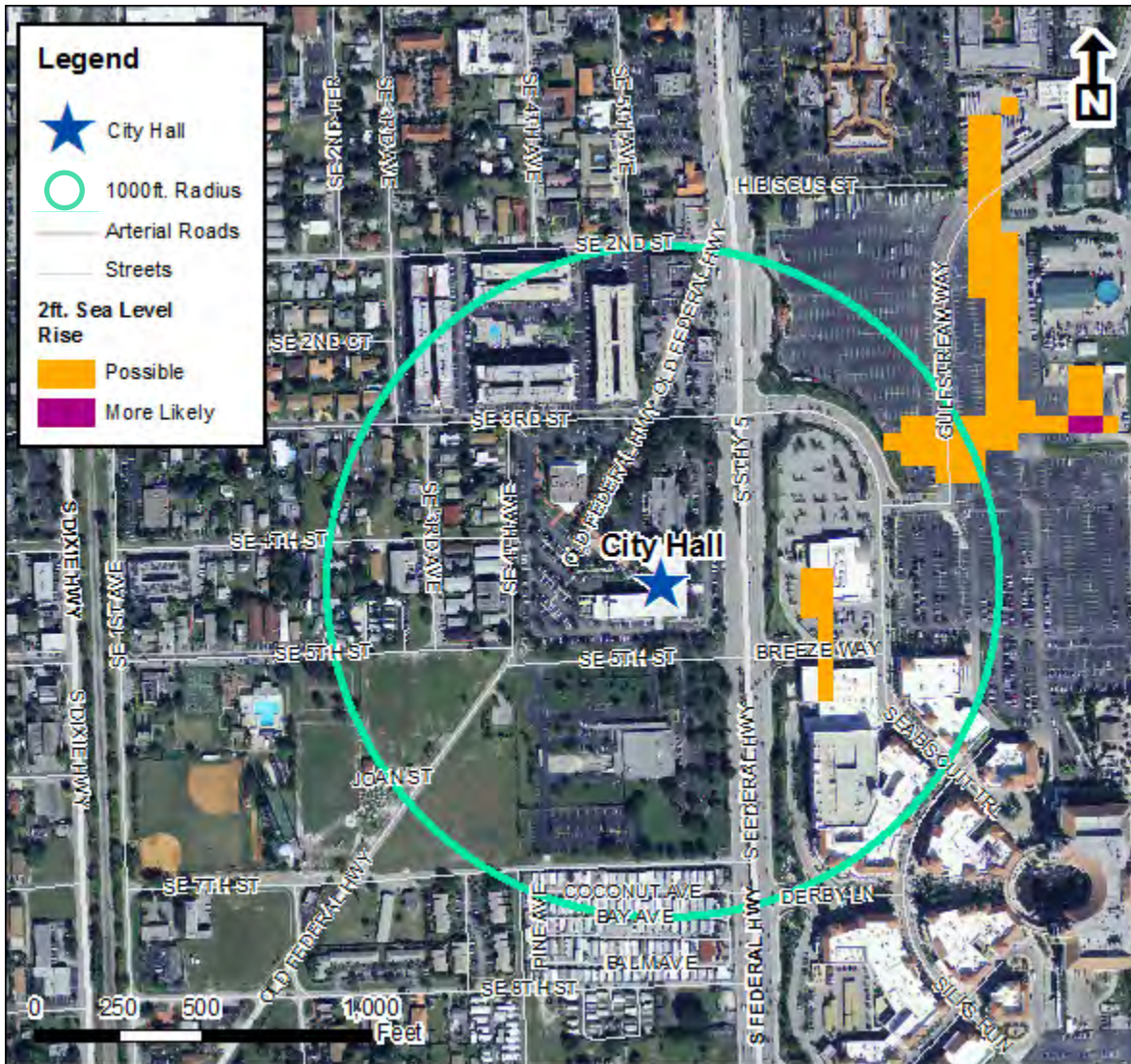
### ***Table of City Hall Accessibility by Sea Level Rise Scenario***

The following table details at which sea level rise scenario (one and two foot) street inundation may cause access issues within a 1000 foot radius of the Hallandale Beach City Hall.

| Hallandale Beach City Hall | One Foot Scenario<br>(Y/N) | Two Foot Scenario<br>(Y/N) |
|----------------------------|----------------------------|----------------------------|
|                            | <b>N</b>                   | <b>Y</b>                   |

**Key:** For Y/N, Y = Yes, N = No

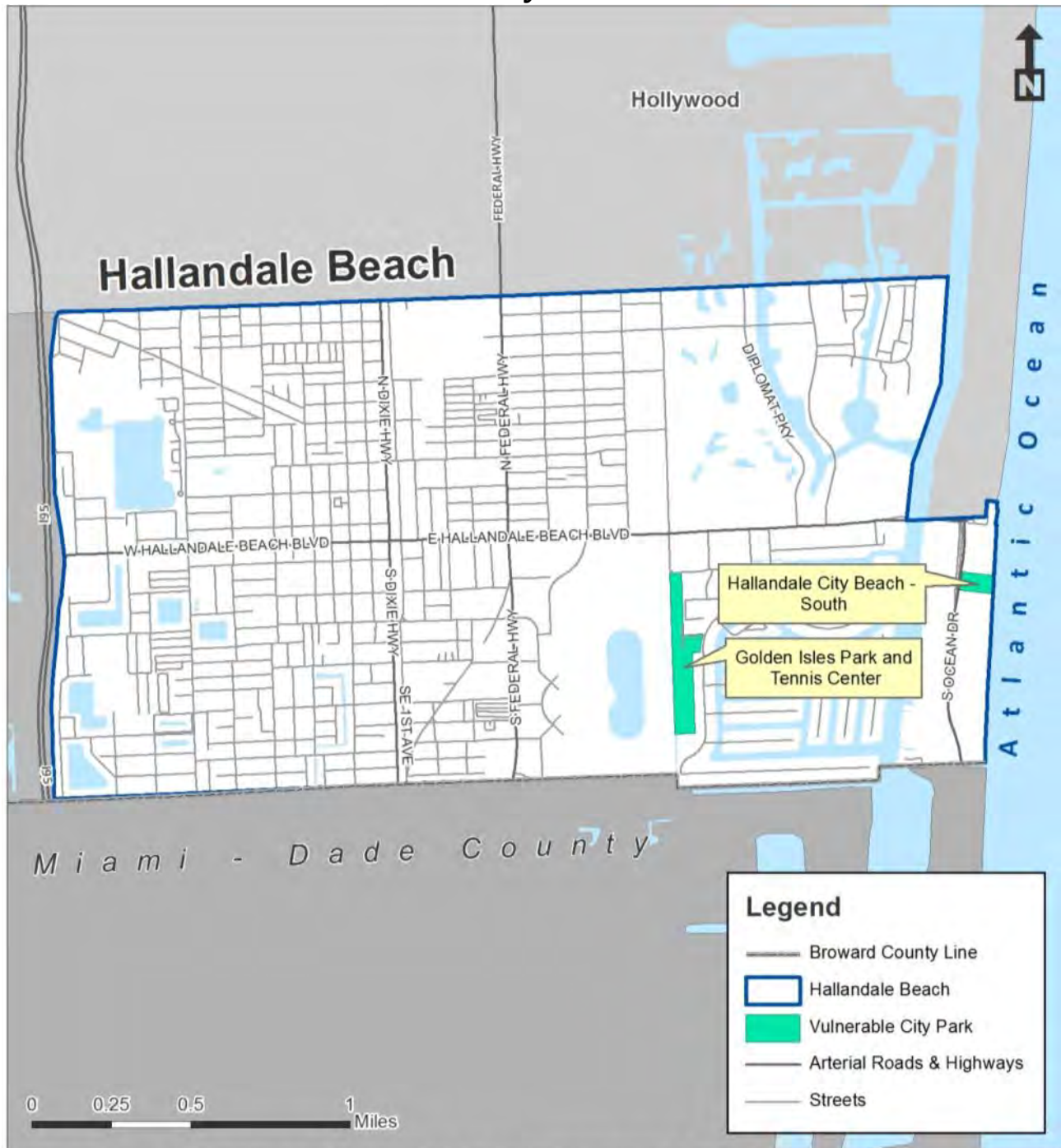
**Hallandale Beach City Hall**  
**400 S Federal Hwy**  
**Two Foot Sea Level Rise Scenario**



This map is for conceptual purposes only and should not be used for legal boundary determinations.  
 Prepared By: H. D. Egler  
 Environmental Protection and Growth Management Department  
 Broward County  
 Natural Resources Planning and Management Division  
 Date: 12/31/2013  
 DEP Agreement No. CM238 DEP 55-236(08/11)

This map provides a view of the Hallandale Beach City Hall with a 1000ft radius. Streets overlaid by the inundation grid show where access issues for the City Hall may occur within this 1000ft radius. During a two foot scenario, Breeze Way and Gulfstream Way have areas which lie at or below projected sea levels. No streets are affected during a one foot sea level rise scenario.

# City Parks Vulnerability Assessment



**This Map identifies areas at increased risk of inundation up to a two foot sea level rise scenario, projected to occur as soon as 2060.**

This map is for conceptual purposes only and should not be used for legal boundary determinations.

### ***Table of Vulnerable City Parks***

The following table lists the two city-owned parks within the City of Hallandale Beach with vulnerabilities. No parks were affected during a one foot scenario. Two parks were affected during a two foot scenario. For each park the table provides the acreage of vulnerable area, and the total area of the park with vulnerability expressed in percent. These estimates are based on the area of the entire park and the inundation grid and do not subtract the area of water bodies within the park to determine the percent value.


| <b>Golden Isles Park And Tennis Center</b> |          |             | Total Acres   |
|--|----------|-------------|---------------|
|  |          |             | 18.22         |
| SLR Scenario                               | Possible | More Likely | Percent Total |
| 1 Foot                                     | 0.00     | 0.00        | 0%            |
| 2 Foot                                     | 1.55     | 0.00        | 8%            |
| <b>Hallandale City Beach - South</b>       |          |             | Total Acres   |
|  |          |             | 3.92          |
| SLR Scenario                               | Possible | More Likely | Percent Total |
| 1 Foot                                     | 0.00     | 0.00        | 0%            |
| 2 Foot                                     | 0.38     | 0.07        | 11%           |



## Golden Isles Park and Tennis Center Two Foot Sea Level Rise Scenario



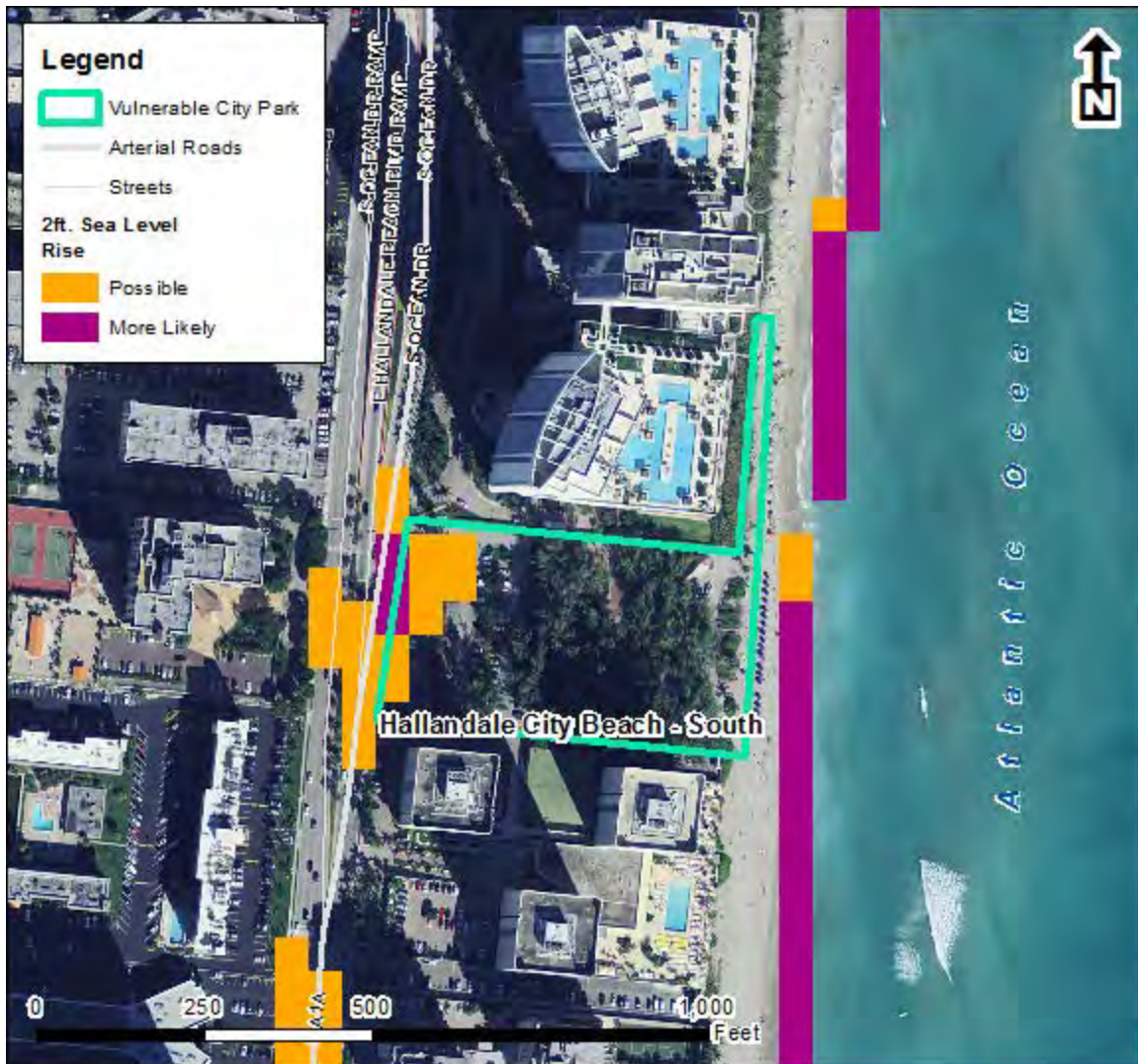
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 Natural Resources Planning and Management Division

Date: 2/6/2014  
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This map provides a view of Golden Isles Park and Tennis Center during a two foot sea level rise scenario. The Park may have up to 8% of land at or below projected sea levels during the two foot scenario, but is likely not affected during a one foot scenario. Note that these estimates are based on the area of the entire park and do not subtract the area of water bodies within the park to determine the percent value. The park is located near a branch of the tidally influenced Intracoastal Waterway.

## Hallandale Beach South Park Two Foot Sea Level Rise Scenario



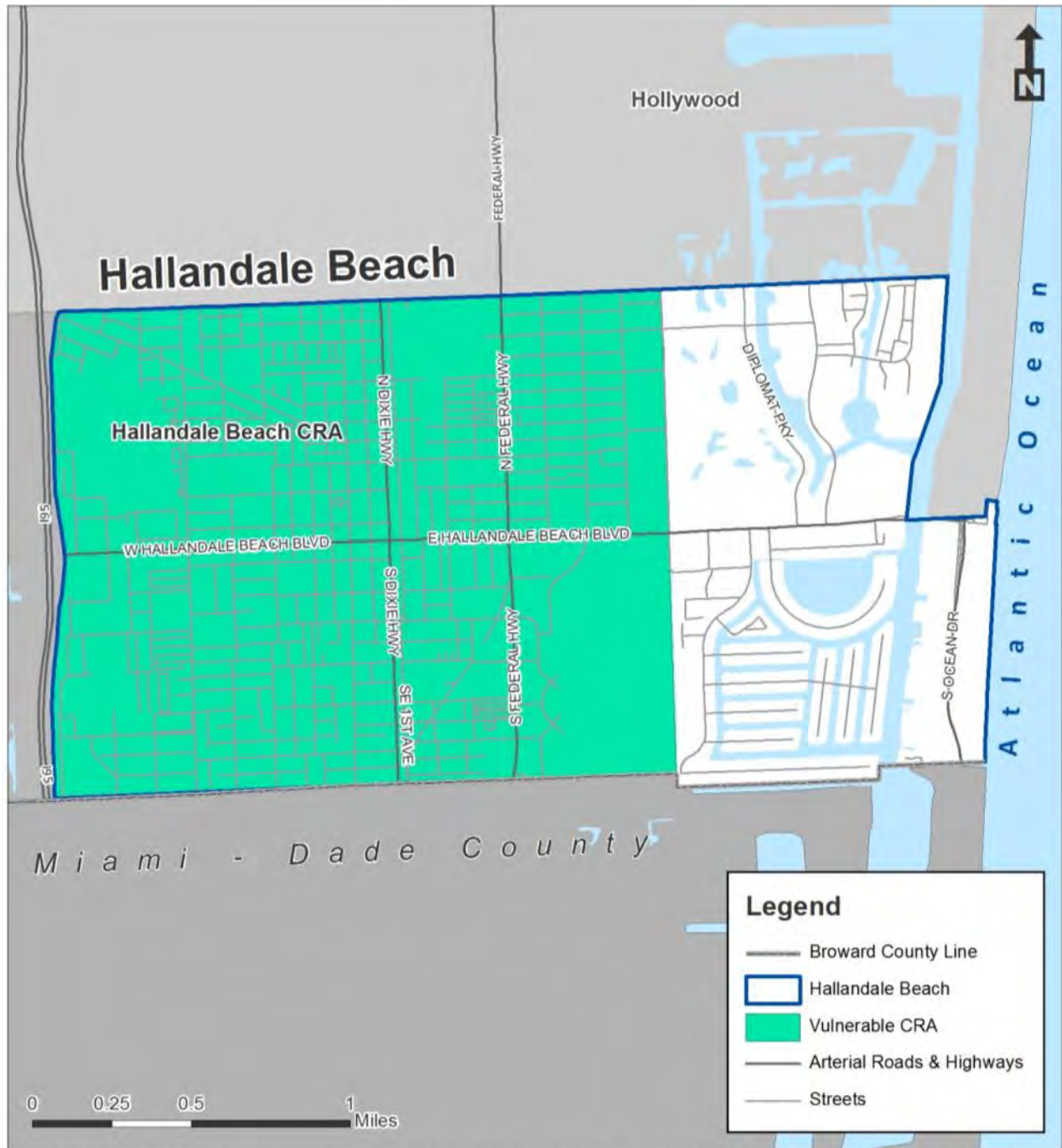
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This map provides a view of the Hallandale City Beach – South park access area during a two foot sea level rise scenario. The Park may have up to 11% of land at or below projected sea levels during the two foot scenario, but is likely not affected during a one foot scenario.

# Community Redevelopment Areas (CRA) Vulnerability Assessment



**This Map identifies areas at increased risk of inundation up to a two foot sea level rise scenario, projected to occur as soon as 2060.**

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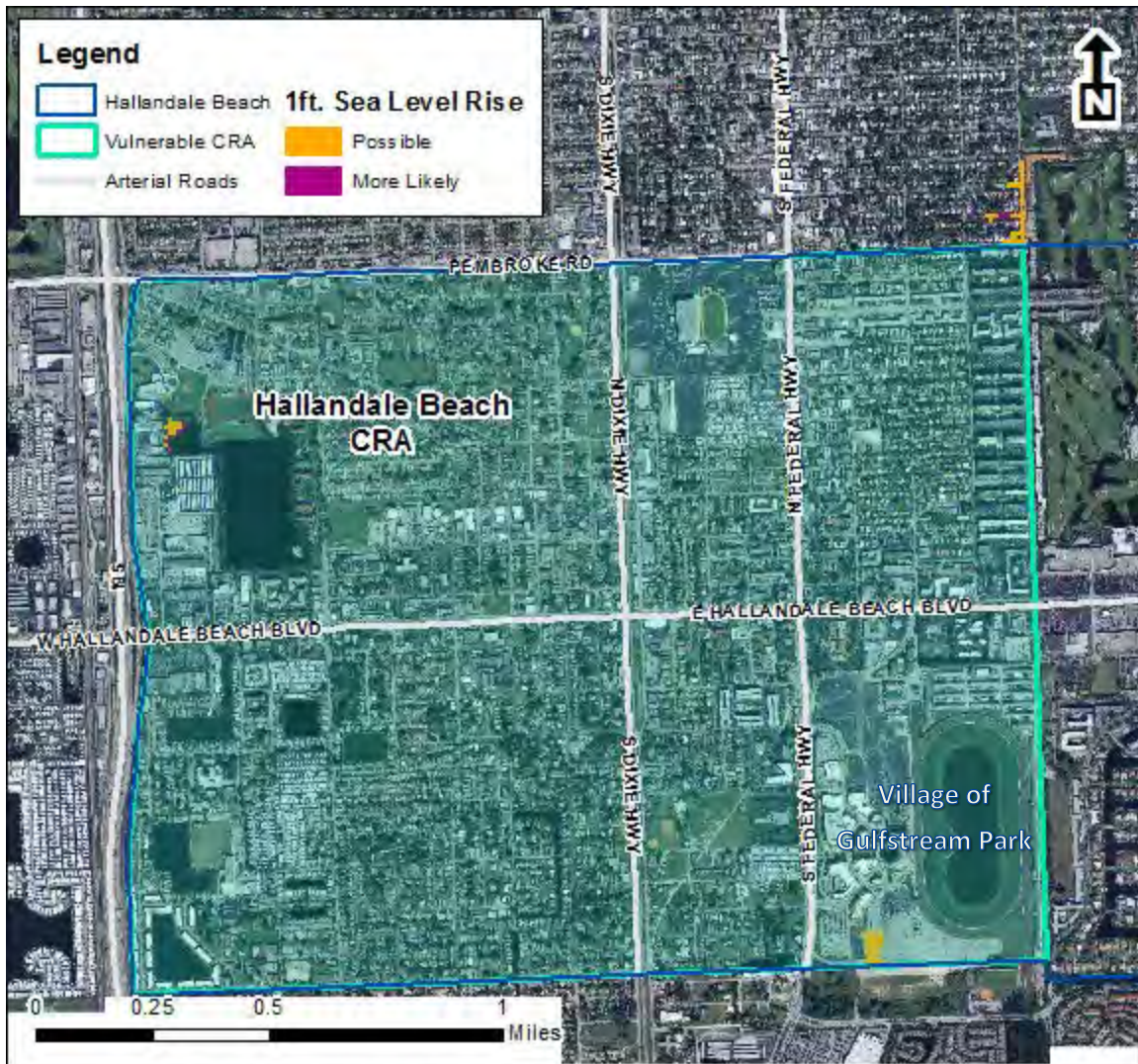
### ***Table of Vulnerable Community Redevelopment Areas (CRA)***

The following table lists CRAs within the City of Hallandale Beach that have areas affected at a one or two foot sea level rise scenario. There is only one CRA in the City of Hallandale Beach, the Hallandale Beach CRA, and it is affected at both the one and two foot scenarios.

| Hallandale Beach CRA | One Foot Scenario<br>(Y/N) | Two Foot Scenario<br>(Y/N) |
|----------------------|----------------------------|----------------------------|
|                      | <b>Y</b>                   | <b>Y</b>                   |

**Key:** For Y/N, Y = Yes, N = No

## Hallandale Beach Community Redevelopment Area (CRA) One Foot Sea Level Rise Scenario



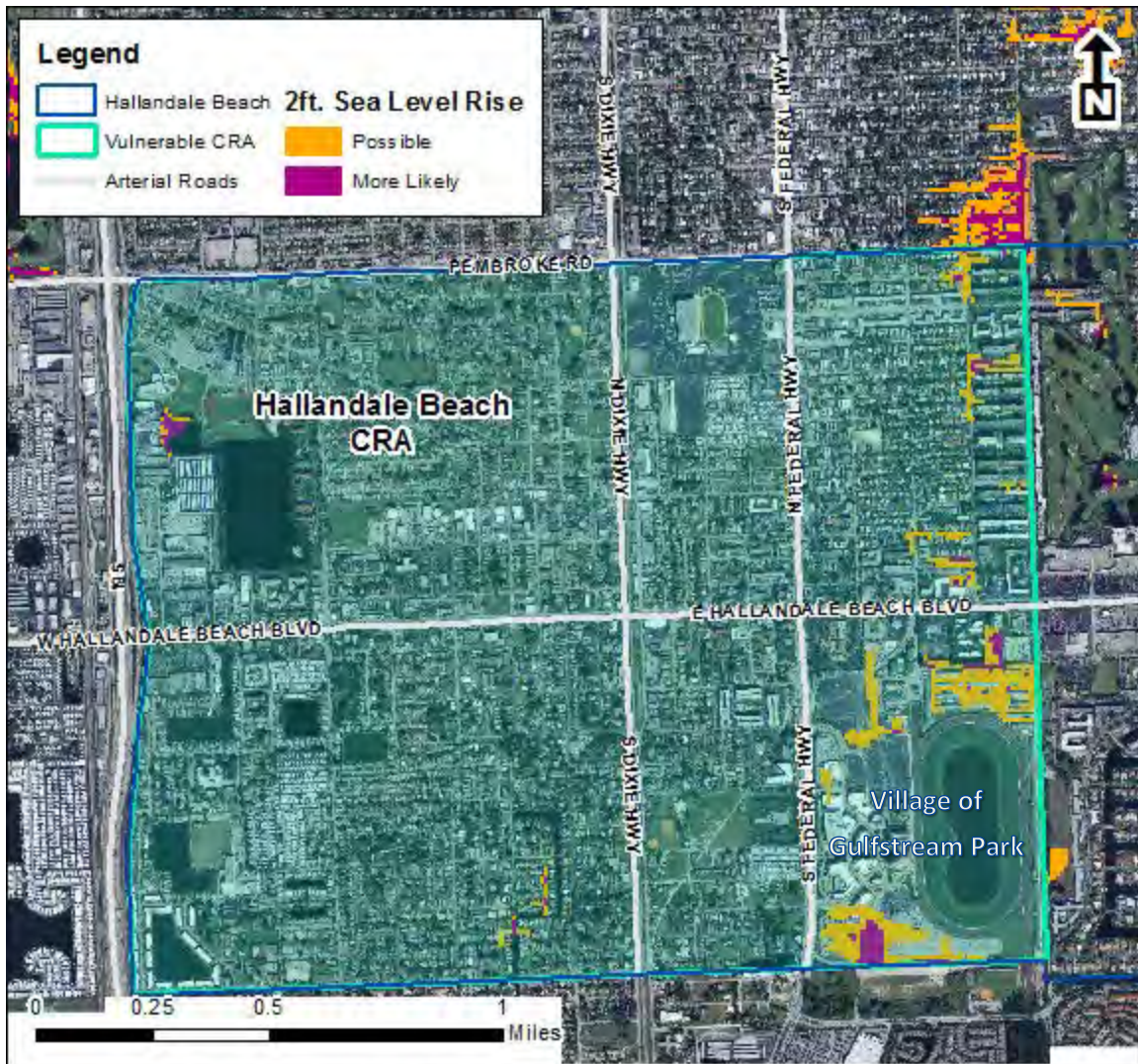
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 Natural Resources Planning and Management Division

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This map shows the Hallandale Beach CRA overlaid by the one foot sea level rise scenario. Parking and open spaces at the Village of Gulfstream Park shopping plaza and racetrack may have areas at or below projected sea levels during this scenario.

## Hallandale Beach Community Redevelopment Area (CRA) Two Foot Sea Level Rise Scenario



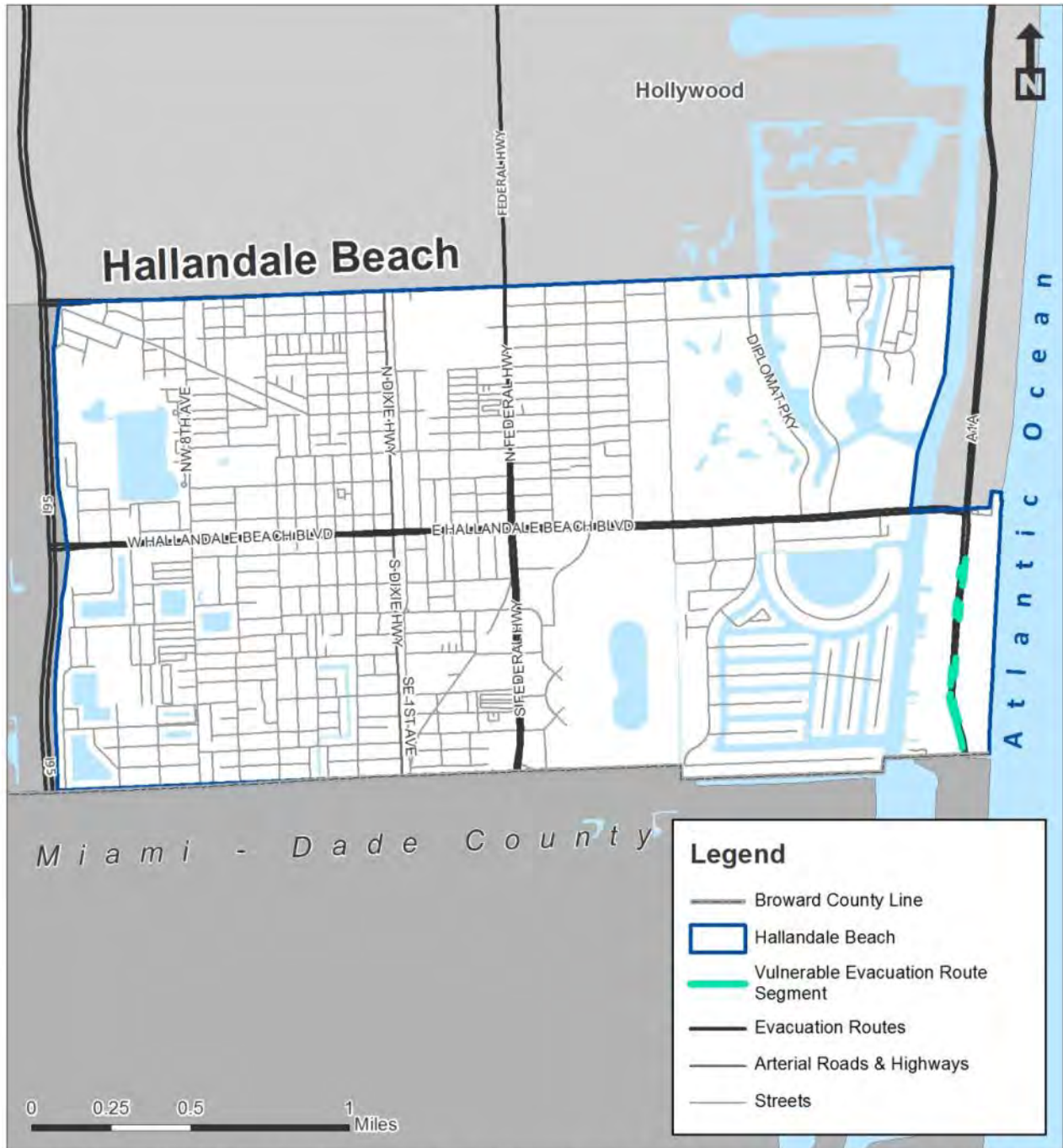
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This map shows the Hallandale Beach CRA overlaid by the two foot sea level rise scenario. During this scenario, parking at the Village of Gulfstream Park shopping plaza and Racetrack are likely to be below projected sea levels. Streets, several building footprints, and open spaces within the CRA are also at or below projected sea levels.

# Evacuation Routes Vulnerability Assessment



**This Map identifies areas at increased risk of inundation up to a two foot sea level rise scenario, projected to occur as soon as 2060.**

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### ***Table of Vulnerable Evacuation Routes***

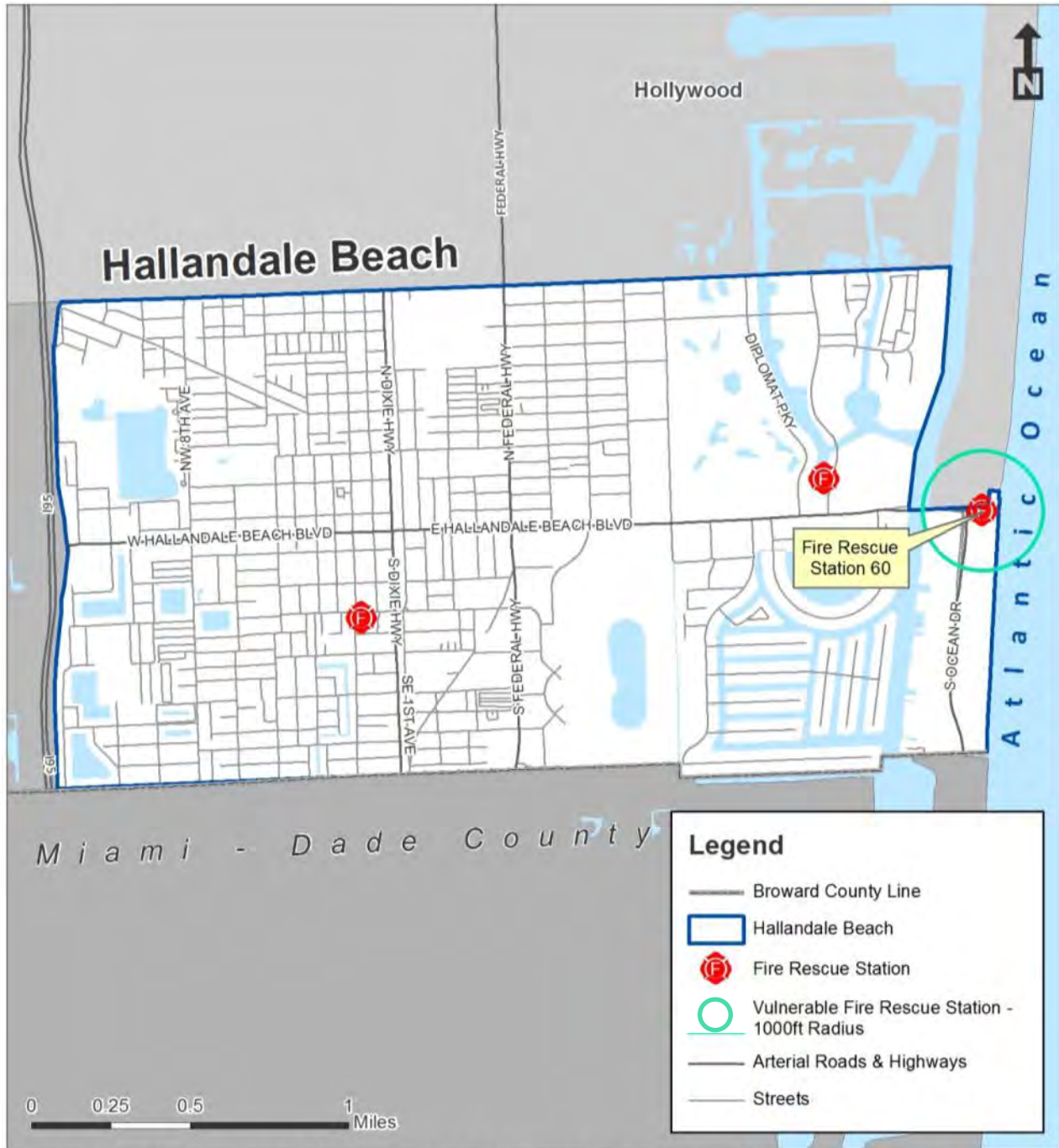
The following table lists road names for all evacuation routes within the City of Hallandale Beach that have areas affected at a one or two foot sea level rise scenario. For each scenario, affected routes receive a Y for yes, or an N for no.

| <b>Evacuation Routes Affected by Sea Level Rise within the City of Hallandale Beach</b> |                                |                                |
|---|--------------------------------|--------------------------------|
| <b>Evacuation Route</b>   | <b>One Foot Scenario (Y/N)</b> | <b>Two Foot Scenario (Y/N)</b> |
| A1A   | <b>N</b>                       | <b>Y</b>                       |

**Key:** For Y/N, Y = Yes, N = No



# Fire Rescue Stations Vulnerability Assessment



**This Map identifies areas at increased risk of inundation up to a two foot sea level rise scenario, projected to occur as soon as 2060.**

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Environmental Protection and Growth Management Department  
Natural Resources Planning and Management Division

Date: 12/31/2013  
DEP Agreement No. CM238 DEP 55-236(08/11)

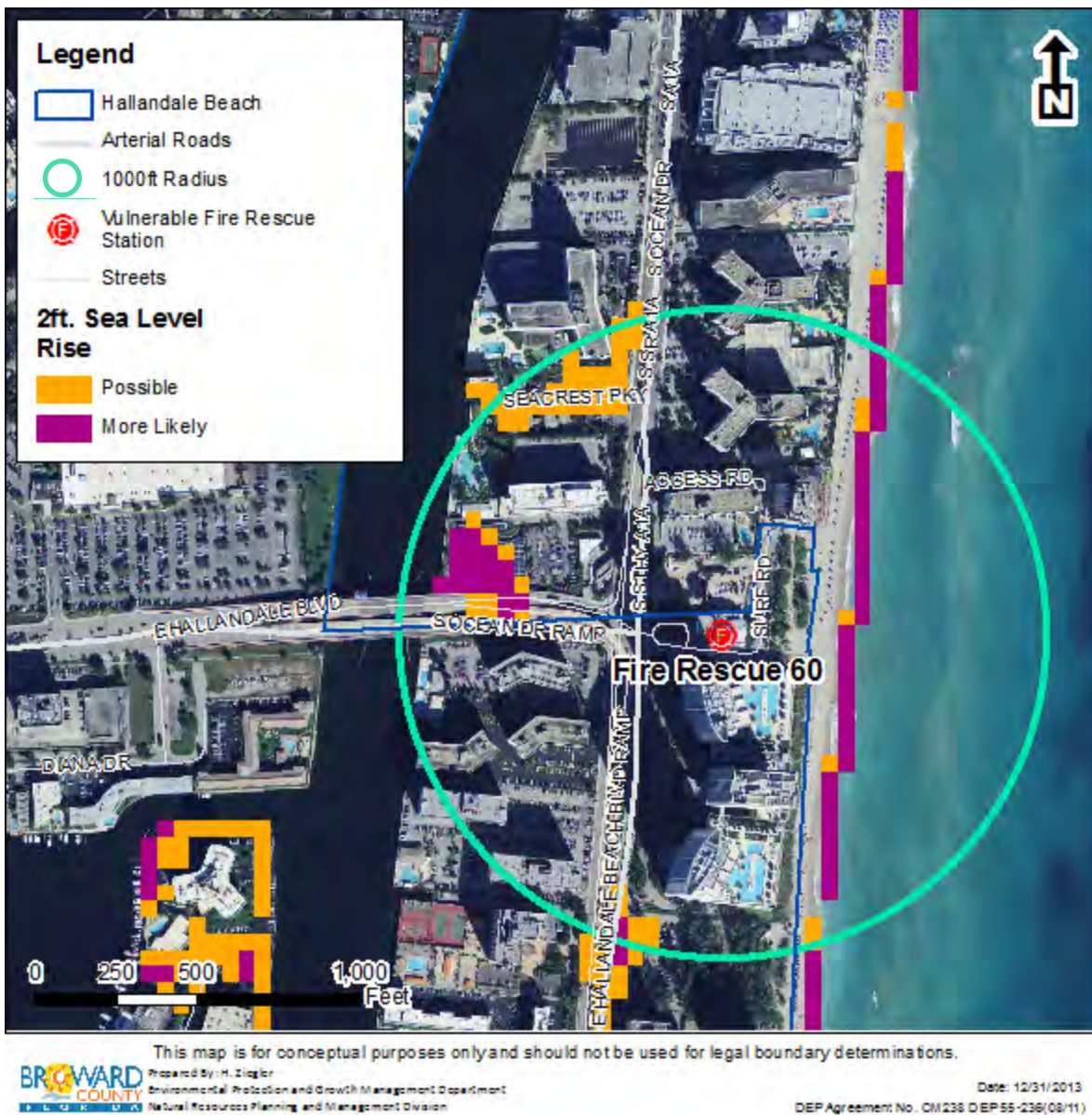
### ***Table of Vulnerable Fire Rescue Stations***

The following table lists fire rescue stations in the City of Hallandale Beach that have areas affected at a one or two foot sea level rise scenario. One station, Fire Rescue 60, is affected during the two foot scenario. For each scenario, affected assets receive a Y for yes, or an N for no.

| <b>Fire Rescue Stations Affected by Sea Level Rise<br/>City of Hallandale Beach</b> |                                    |                                    |
|---|------------------------------------|------------------------------------|
| <b>Station</b>  | <b>One Foot Scenario<br/>(Y/N)</b> | <b>Two Foot Scenario<br/>(Y/N)</b> |
| Fire Rescue 60  | <b>N</b>                           | <b>Y</b>                           |

**Key:** For Y/N, Y = Yes, N = No

## Fire Rescue Station 60 Two Foot Sea Level Rise Scenario



This map shows the areas within a 1000-foot radius of Fire Rescue Station 60 overlaid by the two foot sea level rise scenario. A1A contains areas at or below sea levels during a two foot scenario. No streets are affected during a one foot scenario.

# Law Enforcement Assets Vulnerability Assessment



**This Map identifies areas at increased risk of inundation up to a two foot sea level rise scenario, projected to occur as soon as 2060.**

This map is for conceptual purposes only and should not be used for legal boundary determinations.



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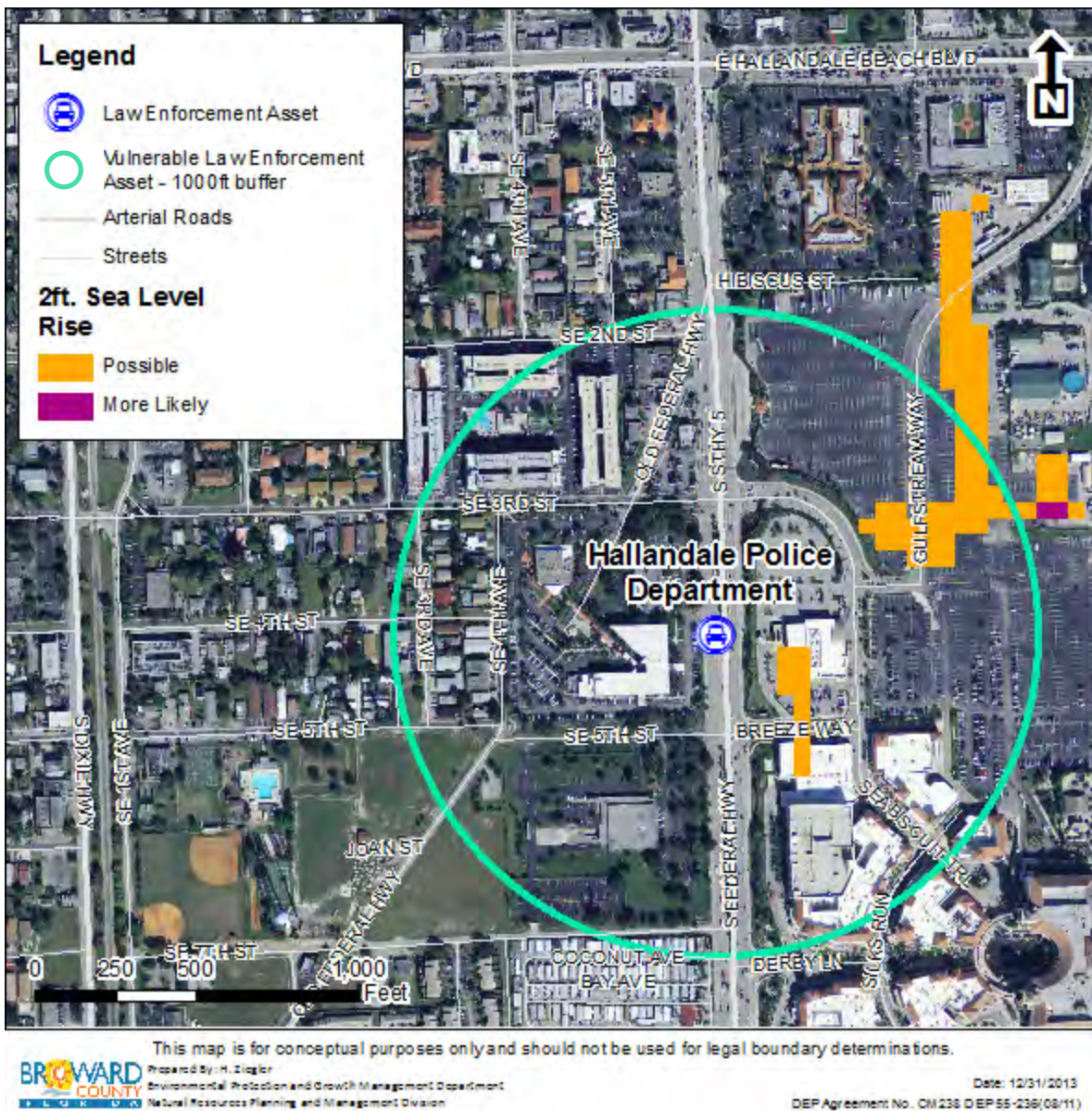
### ***Table of Vulnerable Law Enforcement Assets***

The following table lists law enforcement assets in the City of Hallandale Beach that have areas affected at a one or two foot sea level rise scenario. One asset, Hallandale Police Department, is affected during the two foot scenario. For each scenario, affected assets receive a Y for yes, or an N for no.

| <b>Law Enforcement Assets Affected by Sea Level Rise<br/>City of Hallandale Beach</b> |                                    |                                    |
|---|------------------------------------|------------------------------------|
| <b>Station</b>  | <b>One Foot<br/>Scenario (Y/N)</b> | <b>Two Foot<br/>Scenario (Y/N)</b> |
| Hallandale Police Department  | <b>N</b>                           | <b>Y</b>                           |

**Key:** For Y/N, Y = Yes, N = No

## Hallandale Police Department Two Foot Sea Level Rise Scenario



This map shows the areas within a 1000-foot radius of the Hallandale Police Department overlaid by the two foot sea level rise scenario. Two streets, Gulfstream Way and Breeze Way contain areas at or below sea levels during a two foot scenario. Inundated streets may cause access issues for the police station. No streets are affected during a one foot scenario.