

Analysis of the Vulnerability of Southeast Florida to Sea Level Rise

**South Florida Regional Climate Change Compact Inundation
Mapping and Vulnerability Assessment Work Group**



April, 2011

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Vulnerability to Sea Level Rise - Palm Beach County Overview

Inundation analysis, identifying land at elevations below sea level, highlight areas located near Palm Beach County's coastline and tidal waterways. The geographical representation of flooding shown on the maps is based on a bath tub analysis for the three sea level scenarios of 1', 2' and 3'. The flooding areas shown do not reflect additional flooding impacts as a result of hurricanes or the additional hydrologic losses through canal structures as a result of the rise in the sea level. The justification of those impacts will require a much more detailed study.

Some physical infrastructure in Palm Beach County is at risk beginning at the one foot scenario. While railroads were not inundated, roads were; especially low volume roads and parking areas. The miles of roads vulnerable increased at each scenario however even at the 3 foot sea level we have a minimal amount of inundation with 41 miles of roads. Facilities such as Waste Water, emergency shelters, Landfills, airports, ports and power plants were unaffected thru all three sea level rise scenarios. One school, one landfill site and one hospital will be impacted at the 3 foot sea level rise scenario, all were in surrounding ditch and parking lot areas. While we do not have Evacuation Routes it can be assumed that access to and from the barrier islands are vulnerable due to bridges being inaccessible from local roadway inundation. Impacts to coastal marina remain a concern.

At the one foot scenario, property with a current taxable value of \$396-557 Million was vulnerable. At three feet of sea level rise, properties inundated totaled to taxable valued at \$3.6-4.5 Billion. Future land use affected is minimal at all three sea level rise scenarios with Peanut Island having the highest % loss of Acreage(29.8%). In terms of Land Use Habitat acres inundated, salt water ponds, salt water marshes and mangrove swamp areas are among the major habitats impacted.

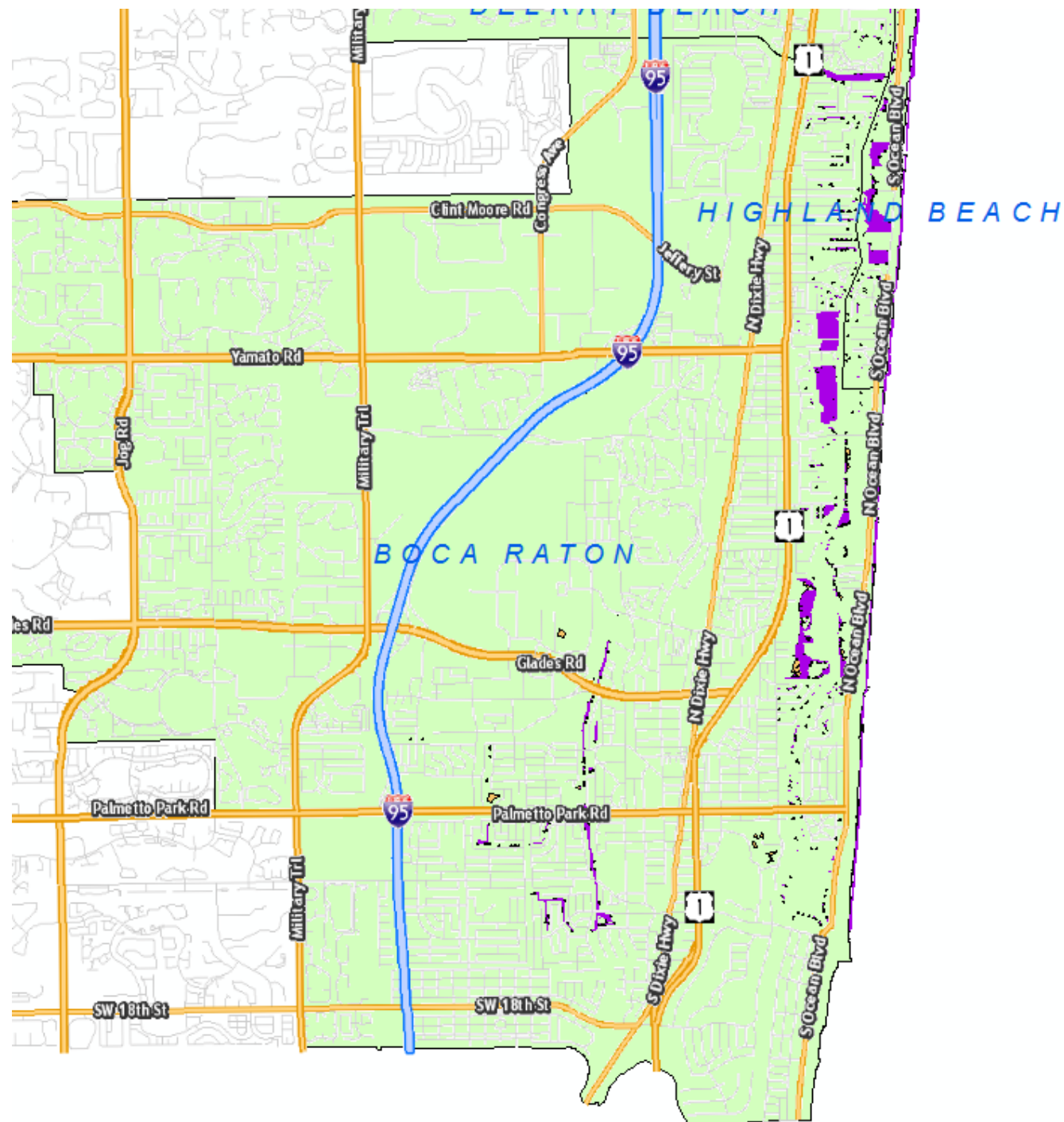
Inundation Mapping and Vulnerability Assessment Work Group Members from Palm Beach County: Kelly Ratchinsky and Beth Norton

Countywide Maps – Palm Beach

1-Foot Sea Level Rise in Palm Beach County

Boca Raton Area

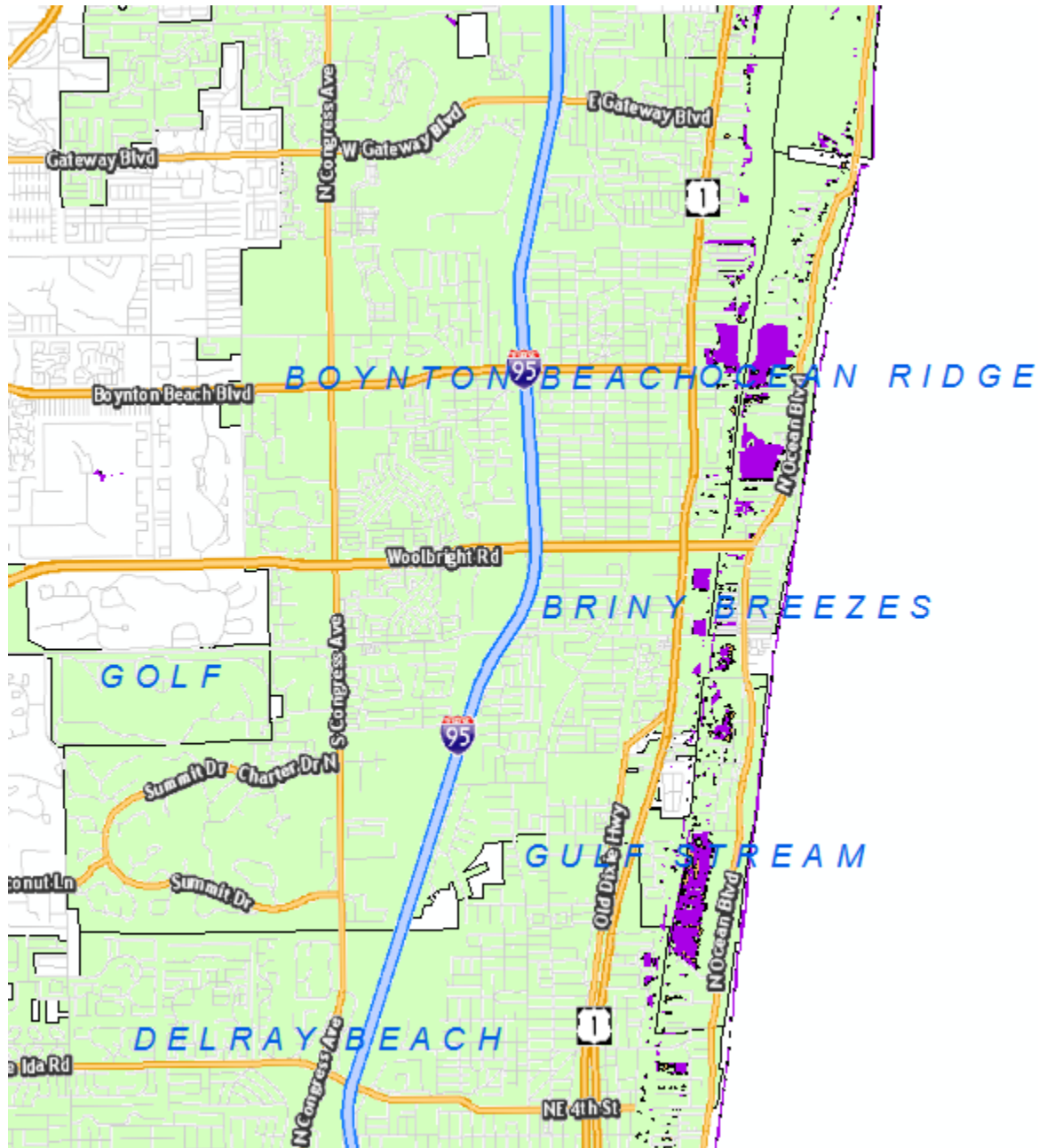
- Area Possible to be Inundated
- Area More Likely to be Inundated



1-Foot Sea Level Rise in Palm Beach County

Boynton Beach Area

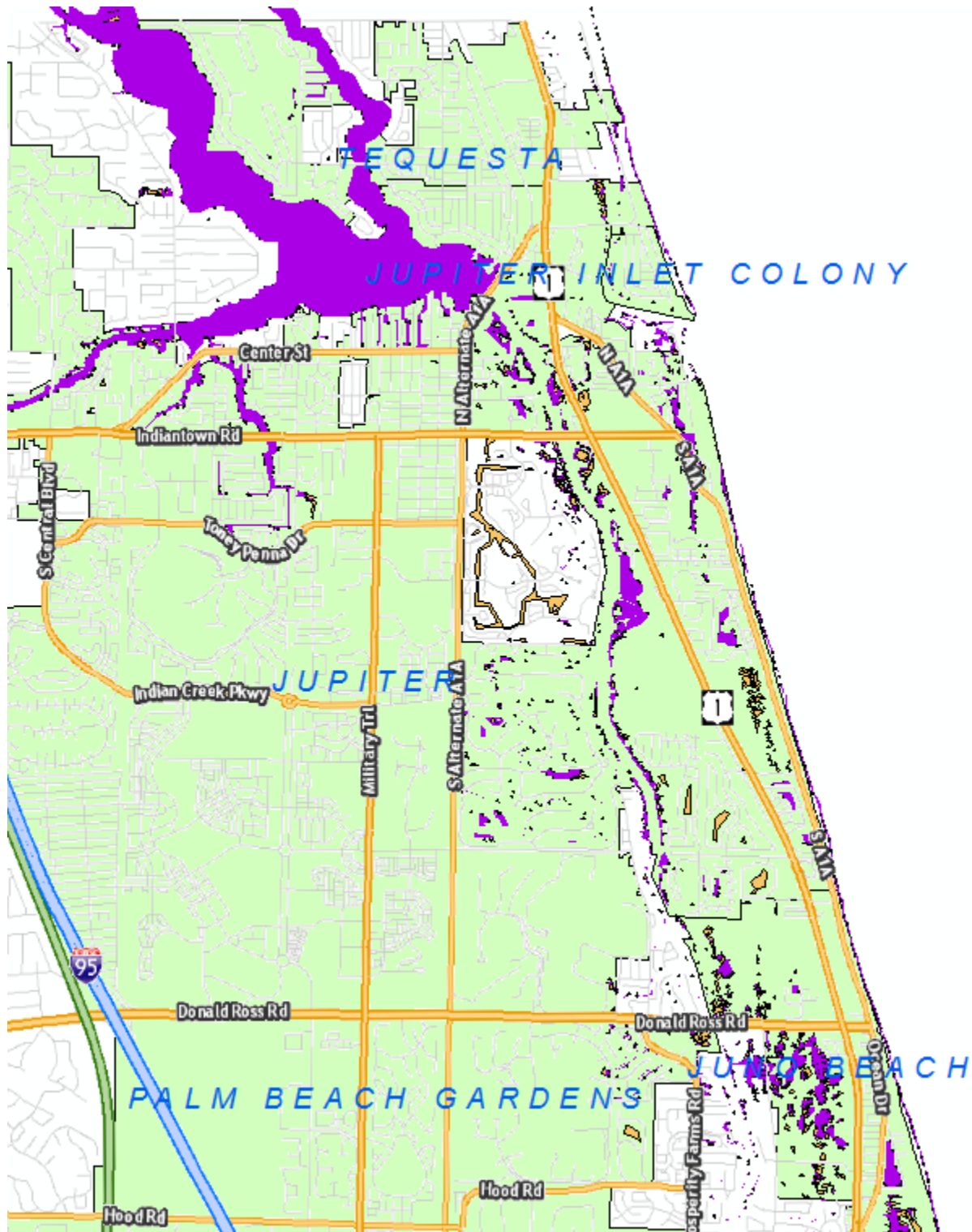
- Area Possible to be Inundated
- Area More Likely to be Inundated



1-Foot Sea Level Rise in Palm Beach County

Jupiter Area

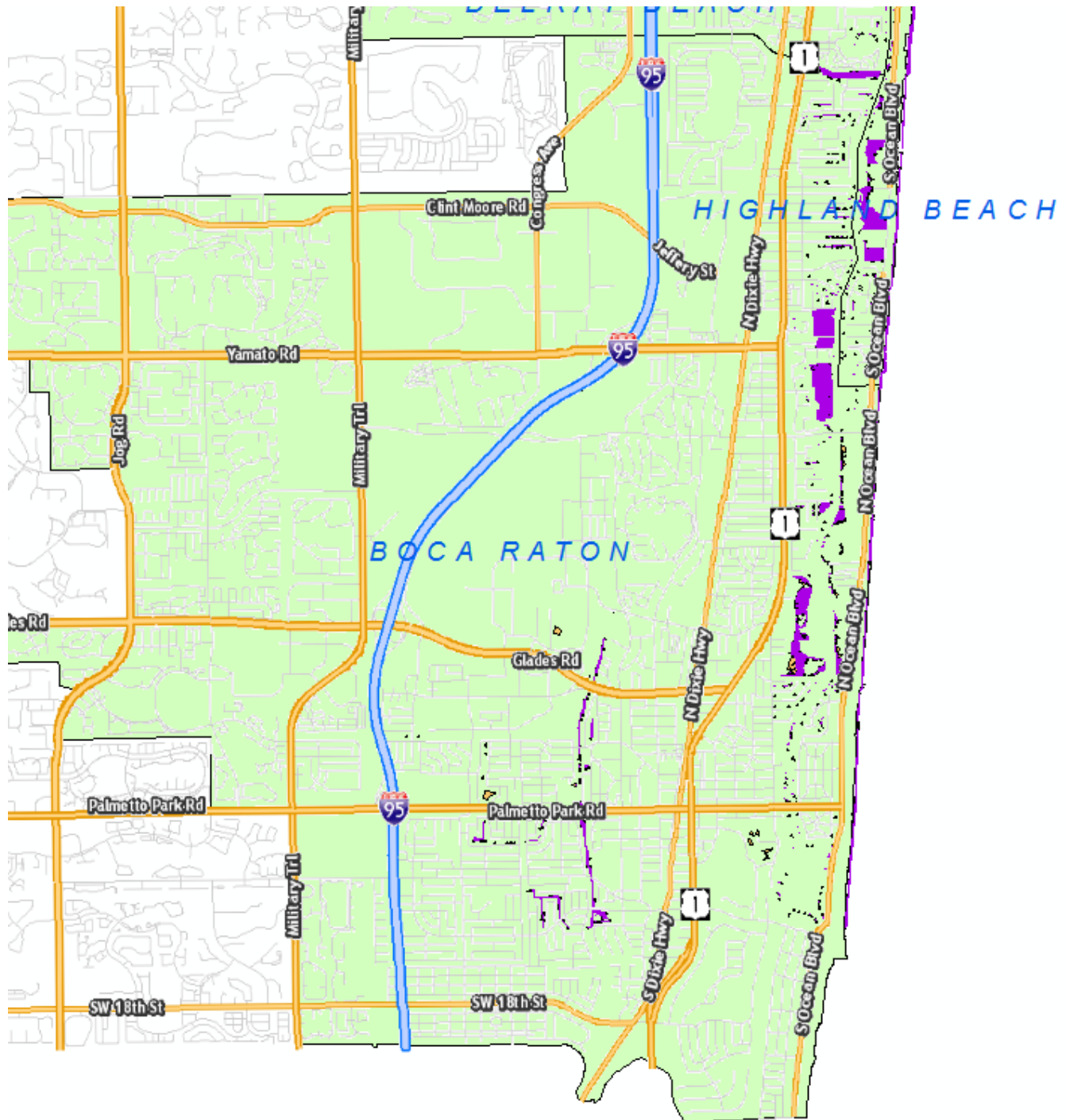
- Area Possible to be Inundated
- Area More Likely to be Inundated



2-Foot Sea Level Rise in Palm Beach County

Boca Raton Area

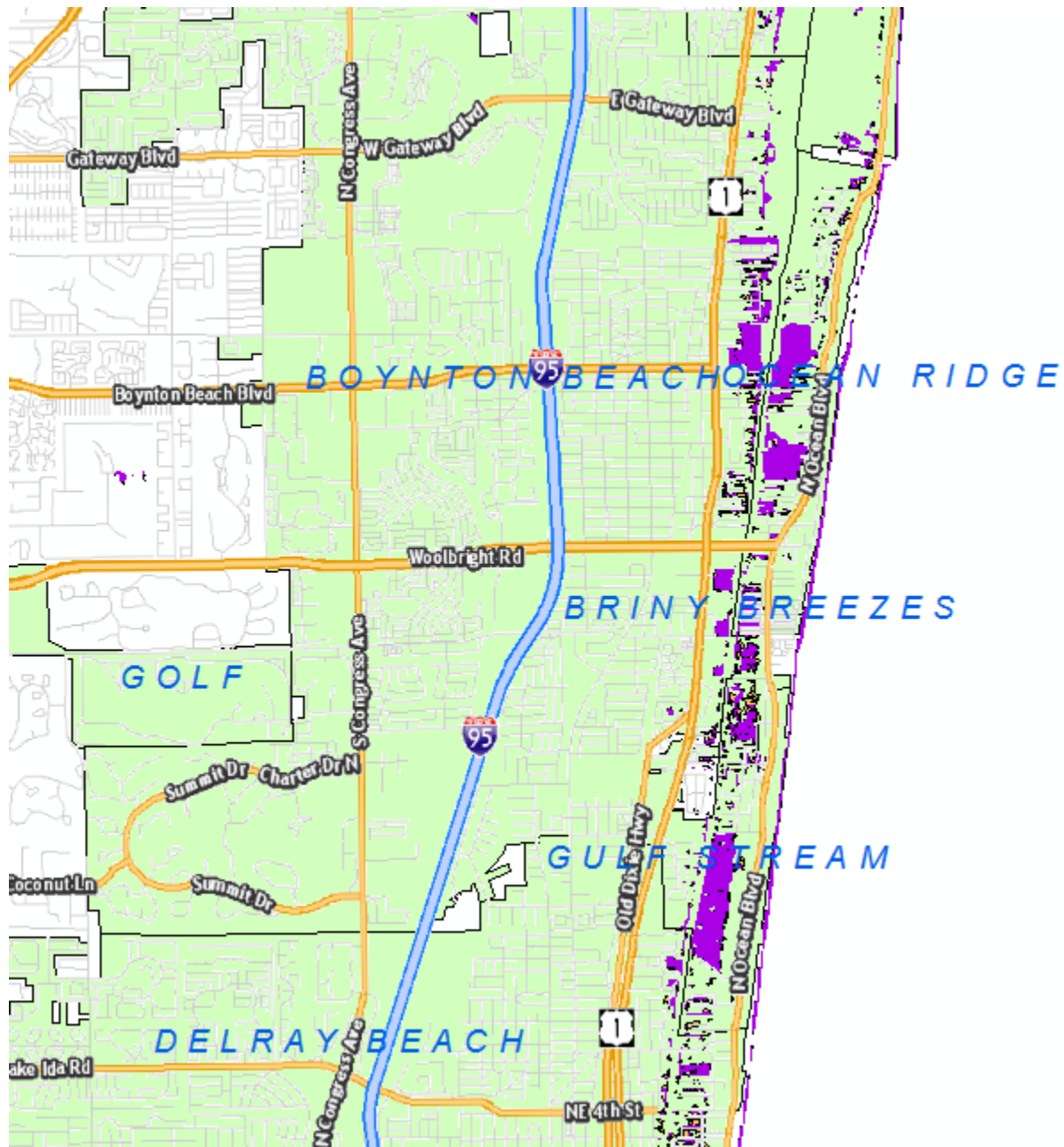
- Area Possible to be Inundated
- Area More Likely to be Inundated



2-Foot Sea Level Rise in Palm Beach County

Boynton Beach Area

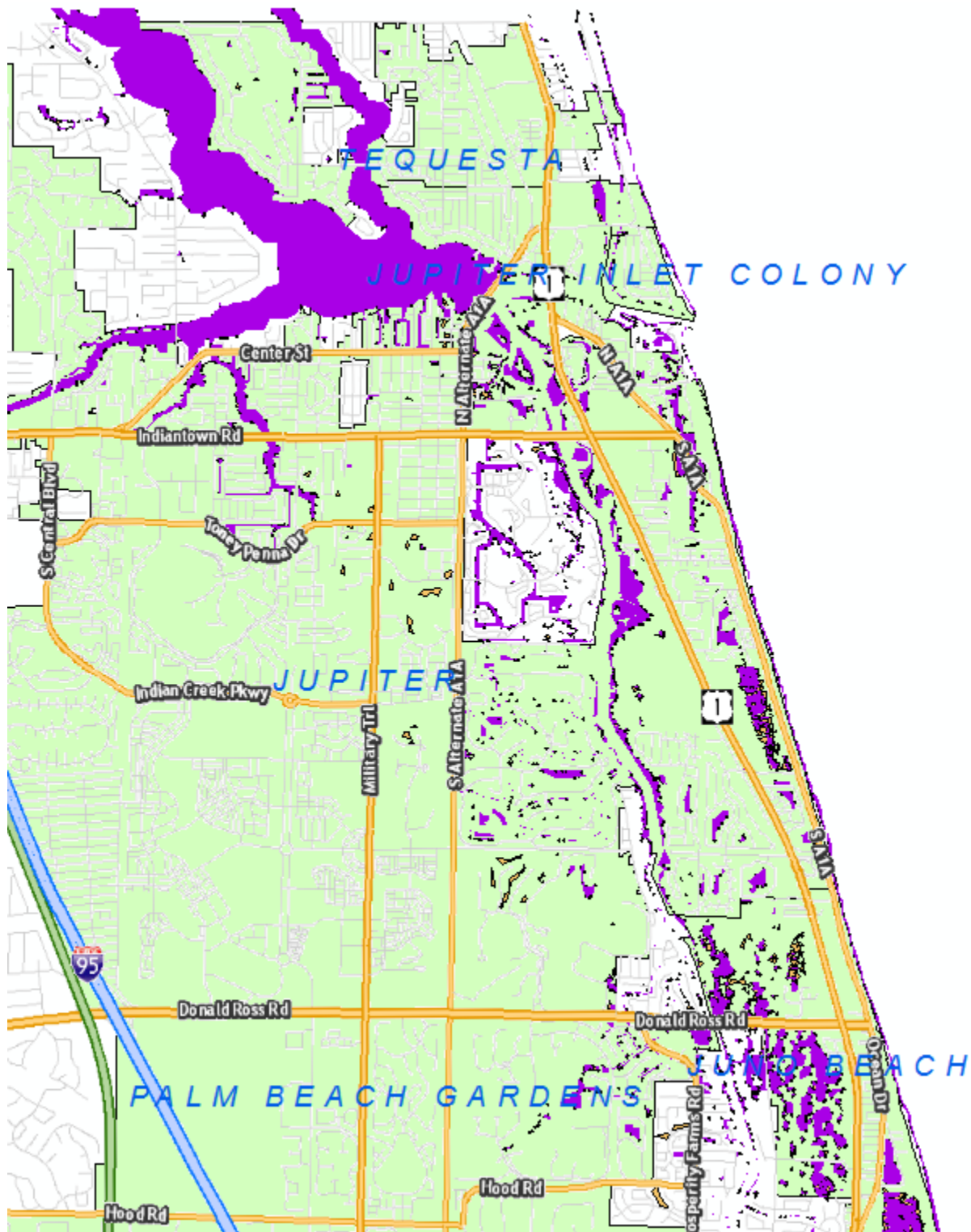
- Area Possible to be Inundated
- Area More Likely to be Inundated



2-Foot Sea Level Rise in Palm Beach County

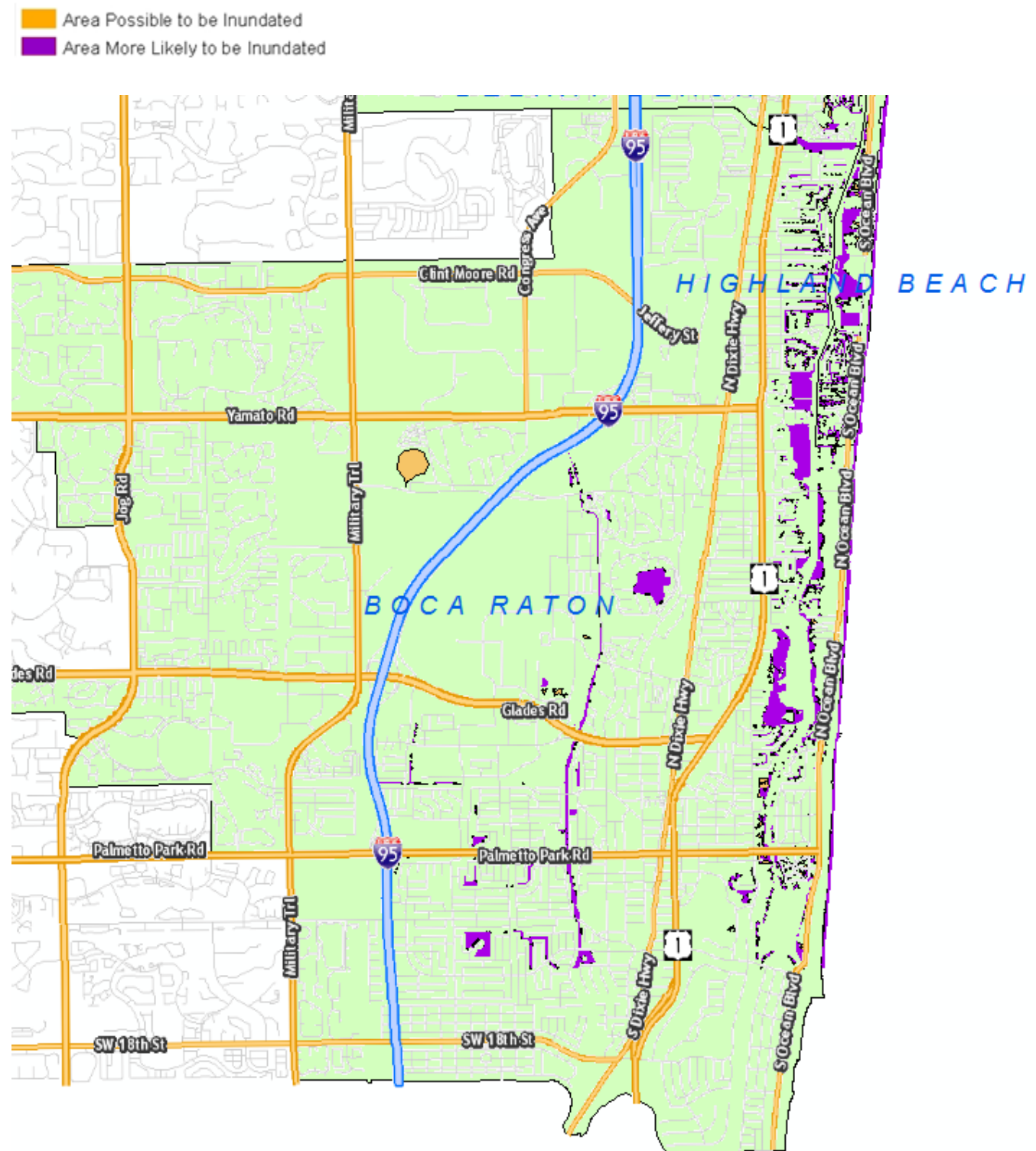
Jupiter Area

- Area Possible to be Inundated
- Area More Likely to be Inundated



3-Foot Sea Level Rise in Palm Beach County

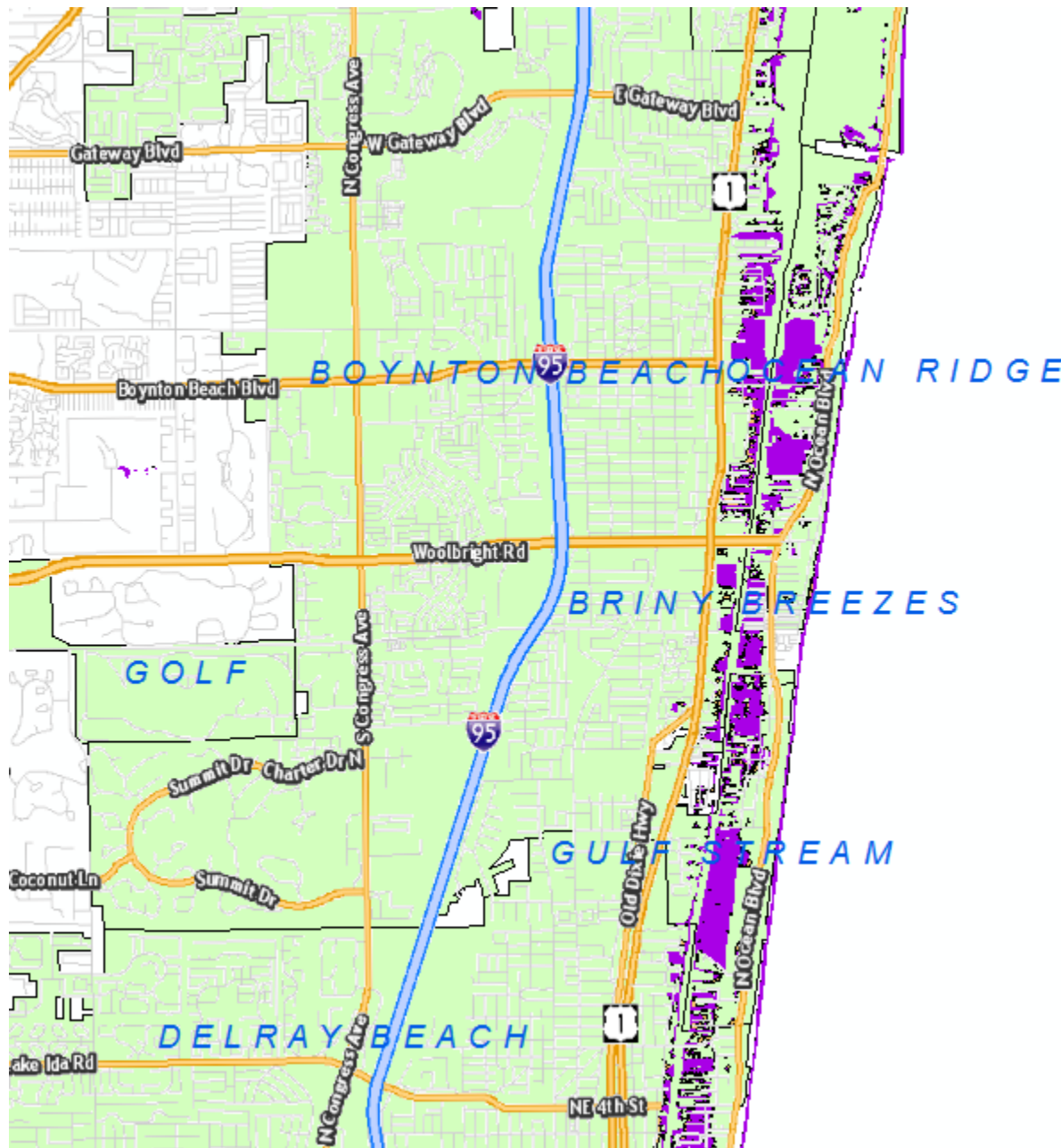
Boca Raton Area



3-Foot Sea Level Rise in Palm Beach County

Boynton Beach Area

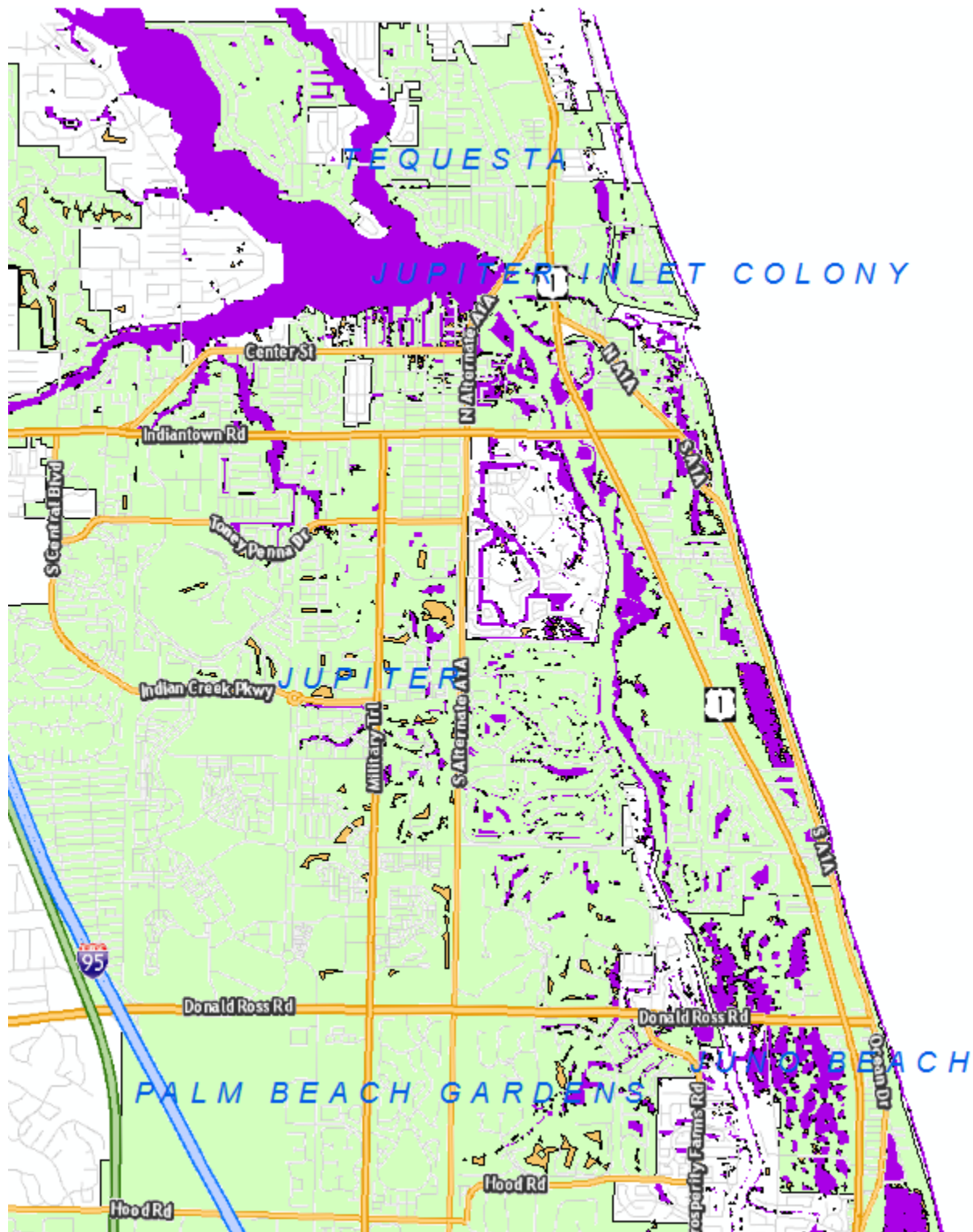
- Area Possible to be Inundated
- Area More Likely to be Inundated



3-Foot Sea Level Rise in Palm Beach County

Jupiter Area

- Area Possible to be Inundated
- Area More Likely to be Inundated



Analysis of Physical Features

Ports and Airports

One of the areas determined by the group to be critical was our ports and airports. There is no inundation at 1, 2 or 3 foot sea level rise scenarios.

Water/Wastewater Treatment Plants

The Wastewater Treatment Plants in Palm Beach County were not affected even at the 3-foot level. Water treatment plants were left out intentionally from the analysis due to Homeland Security concerns about publicizing their locations. There is no inundation at 1, 2 or 3 foot sea level rise scenarios.

Power Plants

There is no inundation of FPL Riviera Beach, Lake Worth Utilities, Western County FPL (20 mile bend), Okeelanta Cogeneration plant at 1, 2 or 3 foot sea level rise scenarios.

Emergency Shelters

There is no inundation at 1, 2 or 3 foot levels

Railroads

No inundation at the 1 and 2 foot levels.

3 foot inundation

Owner Name (Three foot, feet)	More Likely (feet of track)	Possible (feet)	Total Inundation	Percent Inundation
CSX	0.0	0.0	0.0	0.00
FEC	720.0'	0.0	720.0'	0.05

Landfills

Inundations for all levels of Sea Level Rise were primarily in retention or natural areas surrounding the North County Landfill, Lantana Rd/441 & Dyer Dump. The trash transfer station show below is the only site that shows any inundation at the 3 foot level.



Hospitals

Only one hospital showed any flooding at 3 foot sea level rise (Good Samaritan) Infrastructure does not appear to be affected.



Schools

No schools are impacted at the one or two foot sea level rise scenarios. At a 3 foot sea level rise, only one building, Palm Beach Elementary School, appears to be in jeopardy.



Emergency Shelters

All emergency shelters in Palm Beach County are located in schools. There is no inundation risk at 1-foot, negligible risk at 2-foot and some inundation of open spaces along the edges of school properties in the water retention areas. No emergency shelter structures are affected at any of the sea level rise scenarios.

Evacuation Routes

Evacuation Routes to and from the barrier islands are vulnerable due to bridges being inaccessible from local roadway inundation.

Marinas

All marina facilities are located on or next to water features, east of all salinity control structures to give easy access to the ocean. The assumption is that all will be affected in some way, although the extent is indeterminable with this current analysis. It is assumed that those docks with fixed infrastructure will be inundated while floating docks will rise with sea levels.

Results of Analysis (Tables)

Geographic analysis was performed on four items for Palm Beach County:

- Taxable value of property
- Miles of road by Florida Department of Transportation category
- Future Land Use
- Habitat / Land Use Land Cover

Taxable Value of Property

The analysis of property values was done using an aggregated parcel methodology in which a 150-foot grid was created and then overlaid on the parcel features to aggregate property values within each grid cell. In the table below, the low end of the range represents the areas more likely to be below the mean high-high water levels with 1-, 2- or 3-foot sea level rise. The high end of the range represents property with at least a possible chance to be inundated in these scenarios.

Level of Inundation	Range of Taxable Value
One Foot	\$396,618,089.00 - \$556,659,447.00
Two Foot	\$1,251,877,561.00 - \$1,921,207,483.00
Three Foot	\$3,559,471,158.00 - \$4,495,511,757.00

Roads by FDOT Category

All Roadways for Palm Beach County are summarized by Functional Class in miles. High volume categories include sections of roadway where bridges were removed from the LiDAR data and represented bare earth rather than the actual roadways.

1-Foot Sea Level Rise – 50% Percent Inundation = Whole Segment Affected

Functional Class	Total Inundation (Miles)	Total Coverage (Miles)
1 – high volume, maximum speed	0	99
2 – high speed, channels traffic to FC1	0	288
3 – high speed, lower mobility, connects to FC2	0	539
4 – moderate speed, through neighborhoods	0	749
5 – low volume, i.e. access roads, parking lanes	0	6166
Total		

2-Foot Sea Level Rise – 50% Percent Inundation = Whole Segment Affected

Functional Class	Total Inundation (Miles)	Total Coverage (Miles)
1 – high volume, maximum speed	0	99
2 – high speed, channels traffic to FC1	0	288
3 – high speed, lower mobility, connects to FC2	0	539
4 – moderate speed, through neighborhoods	2	749
5 – low volume, i.e. access roads, parking lanes...	13	6166
Total		

3- Foot Sea Level Rise – 50% Percent Inundation = Whole Segment Affected

Functional Class	Total Inundation (Miles)	Total Coverage (Miles)
1 – high volume, maximum speed	0	99
2 – high speed, channels traffic to FC1	0	288
3 – high speed, lower mobility, connects to FC2	0	539
4 – moderate speed, through neighborhoods	8	749
5 – low volume, i.e. access roads, parking lanes...	41	6166
Total		

Acres of Future Land Use

The three tables on this page represent numbers of acres that could be impacted with some flooding for the types of land uses shown for each of the three sea level rise scenarios. Coverage of Future Land Use was provided by Planning Zoning and Building and was updated on May 11, 2011 and covers the unincorporated area of Palm Beach County. Data was summarized by Land Use type and probability and reported in acres.

1-foot Sea Level Rise:

Land Use	More Likely (acres)	Possible (acres)	Total Inundation (acres)	Total Coverage (acres)	Percent Inundation
HIGH RESIDENTIAL, 12 UNITS PER ACRE	0.36	0	0.36	4192.49	0
LOW RESIDENTIAL, 1 UNIT PER ACRE	282.48	1.01	283.49	10777.6	2.63
LOW RESIDENTIAL, 2 UNITS PER ACRE	190.93	0	190.93	16192.7	1.17
LOW RESIDENTIAL, 3 UNITS PER ACRE	28.07	53.34	81.42	20206.83	0.4
MEDIUM RESIDENTIAL, 5 UNITS PER ACRE	4.4	0.64	5.05	23681.19	0.02
PARK	12.38	5.15	17.53	5810.73	0.3
SPOIL (Peanut Island)	11.22	0	11.22	42.82	26.2
Total	529.84	60.14	590	80904.36	0.72

2-foot Sea Level Rise:

Land Use	More Likely (acres)	Possible (acres)	Total Inundation (acres)	Total Coverage (acres)	Percent Inundation
HIGH RESIDENTIAL, 12 UNITS PER ACRE	0.49	0	0.49	4192.49	0.01
LOW RESIDENTIAL, 1 UNIT PER ACRE	290.6	1.84	292.44	10777.6	2.71
LOW RESIDENTIAL, 2 UNITS PER ACRE	218.97	10.51	229.48	16192.7	1.41
LOW RESIDENTIAL, 3 UNITS PER ACRE	102.01	13.58	115.59	20206.83	0.57
MEDIUM RESIDENTIAL, 5 UNITS PER ACRE	7.74	5.89	13.62	23681.19	0.05
PARK	22.76	2.56	25.32	5810.73	0.43
SPOIL (Peanut Island)	11.73	0	11.73	42.82	27.39
Total	654.3	34.38	688.67	80904.36	0.85

3-foot Sea Level Rise:

Land Use	More Likely (acres)	Possible (acres)	Total Inundation (acres)	Total Coverage (acres)	Percent Inundation
HIGH RESIDENTIAL, 12 UNITS PER ACRE	4.58	0.27	4.49	4192.49	0.1
INDUSTRIAL	2.5	0	2.5	13867.02	0.01
LOW RESIDENTIAL, 1 UNIT PER ACRE	300.06	6.03	306.1	10777.6	2.84
LOW RESIDENTIAL, 2 UNITS PER ACRE	257.77	26.56	284.37	16192.7	1.75
LOW RESIDENTIAL, 3 UNITS PER ACRE	139.13	22.21	161.35	20206.83	0.79
MEDIUM RESIDENTIAL, 5 UNITS PER ACRE	55.22	5.35	60.57	23681.19	0.25
PARK	30.47	5.84	36.31	5810.73	0.62
SPOIL (Peanut Island)	12.77	0	12.77	42.82	29.82
Total	802.5	66.26	868.46	94771.38	0.91

Acres of Habitat Type / Land Use Land Cover

The tables on this page and pages 18 & 19 represent the number of acres of habitat type listed that could be impacted with some flooding for each of the three sea level rise scenarios. Spatial data was provided by the South Florida Water Management District and is dated 2009 V 0.3.0. The data is reported in acres.

1-foot Sea Level Rise:

Land Use Type	More Likely (acres)	Possible (acres)	Total Inundation (acres)	Total Coverage (acres)	Percent Inundation
Australian Pine	1.17	0	1.17	393.84	0.29
Channelized Waterways - Canals	13.2	29.37	42.57	14913.41	0.28
Coastal Shrub	1.17	0	1.17	745.41	0.15
Golf Course	45.07	0	45.07	22283.82	0.2
Mangrove Swamp	278.85	13.3	292.15	583.4	50.07
Mixed Shrubs	5.56	2.17	7.73	42953.57	0.01
Mixed Wetland Hardwoods	13.96	0	13.96	4097.98	0.34
Natural River - Stream - Waterway	950.89	0	950.89	9271.11	10.25
Parks and Zoos	2.32	0	2.32	6202.88	0.03
Pine Flatwoods	1.95	0	1.95	51933.25	0
Reservoirs	73.12	26.08	99.2	28818.39	0.34
Saltwater Marshes / Halophytic Herbaceous Prairie	11.87	0	11.87	21.04	56.41
Saltwater Ponds	2.4	0	2.4	2.49	96.38
Upland Hardwood Forests	3.91	0	3.91	1115.26	0.35
Upland Mixed Coniferous / Hardwood	4.52	0	4.52	3500.98	0.12
Upland Shrub and Brush land	0.26	0	0.26	3388.66	0
TOTAL	1410.22	70.92	1481.14	190225.49	0.77

2-foot Sea Level Rise:

Land Use Type	More Likely (acres)	Possible (acres)	Total Inundation (acres)	Total Coverage (acres)	Percent Inundation
Australian Pine	2.51	0	2.51	393.84	0.63
Channelized Waterways - Canals	46.68	0	46.68	14913.41	0.31
Coastal Shrub	16.74	0	16.74	745.41	2.24
Freshwater Marshes / Graminoid Prairie - Marsh	0.92	0.42	1.34	166842.68	0
Golf Course	151.77	0	151.77	22283.82	0.68
Mangrove Swamp	371.84	0	371.84	583.4	63.73
Mixed Shrubs	28.77	0	28.77	42953.57	0.06
Mixed Wetland Hardwoods	25.11	0	25.11	4097.98	0.61
Multiple Dwelling Units - Low Rise	20.54	0	20.54	24136.14	0.08
Natural River - Stream - Waterway	972.2	0	972.2	9271.11	10.48
Parks and Zoos	7.94	1.96	9.9	6202.88	0.15
Pine Flatwoods	3.15	0	3.15	51933.25	0
Reservoirs	137.79	62.76	200.55	28818.39	0.69
Saltwater Marshes / Halophytic Herbaceous Prairie	16.62	0	16.62	21.04	78.99
Saltwater Ponds	2.48	0	2.48	2.49	99.59
Upland Hardwood Forests	5.69	0	5.69	1115.26	0.51
Upland Mixed Coniferous / Hardwood	10.15	0	10.15	3500.98	0.28
Upland Shrub and Brushland	4.23	0	4.23	3388.66	0.12
Wet Melaleuca	12.78	0	12.78	861.42	1.48
Wetland Forested Mixed	29.6	0	29.6	3473.97	0.85
TOTAL	1867.51	65.14	1932.65	385539.7	0.5

3-foot Sea Level Rise:

Land Use Type	More Likely (acres)	Possible (acres)	Total Inundation (acres)	Total Coverage (acres)	Percent Inundation
Australian Pine	3.15	0	3.15	393.84	0.79
Channelized Waterways - Canals	65.14	0.3	65.44	14913.41	0.43
Coastal Shrub	19.24	0	19.24	745.41	2.58
Commercial and Services	55.8	0	55.8	18379.96	0.3
Disturbed Land	2.85	0	2.85	4697.63	0.06
Educational Facilities	4.39	0	4.39	6344.25	0.06
Fixed Single Family Units	114.35	0	114.35	88060.87	0.12
Freshwater Marshes / Graminoid Prairie - Marsh	2.31	11.81	14.12	166842.68	0
Golf Course	253.49	0	253.49	22283.82	1.13
Institutional	0	0.68	0.68	3351.63	0.02
Mangrove Swamp	402	0	402	583.4	68.9
Melaleuca	1.97	0	1.97	1305.86	0.15
Mixed Shrubs	69.09	0	69.09	42953.57	0.16
Mixed Units - Fixed and Mobile Home Units	2.45	0	2.45	100.83	2.42
Mixed Wetland Hardwoods	34.65	0	34.65	4097.98	0.84
Mobile Home Units	15.77	0	15.77	3338.3	0.47
Multiple Dwelling Units - High Rise	30.81	0	30.81	5674.32	0.54
Multiple Dwelling Units - Low Rise	50.17	1.78	51.95	24136.14	0.21
Natural River - Stream - Waterway	976.77	0	976.77	9271.11	10.53
Open Land	2.66	0	2.66	3892.44	0.06
Parks and Zoos	68.42	2.43	70.85	6202.88	1.14
Pine Flatwoods	29.26	0	29.26	51933.25	0.05
Reservoirs	235.75	100.22	335.97	28818.39	1.16
Saltwater Marshes / Halophytic Herbaceous Prairie	17.96	0	17.96	21.04	85.36
Saltwater Ponds	2.48	0	2.48	2.49	99.59
Upland Hardwood Forests	28.67	0	28.67	1115.26	2.57
Upland Mixed Coniferous / Hardwood	13.87	0	13.87	3500.98	0.39
Upland Shrub and Brushland	8.29	0	8.29	3388.66	0.24
Wet Melaleuca	17.95	0	17.95	861.42	2.08
Wetland Forested Mixed	91.91	0	91.91	3473.97	2.64
TOTAL	2621.62	117.22	2738.84	520685.79	0.52