River to Sea

Transportation Planning Organization

Sea Level Rise Vulnerability Assessment

July 2016

Prepared by:

East Central Florida Regional Planning Council
est. 1962

River to Sea Transportation Planning Organization
VISION - PLAN - IMPLEMENT
TPO

Table of Contents

I. Background 1

II. Vulnerability Analysis and Data Disclaimer 3

III. Methodology 3

IV. Vulnerability Analysis 5

Designated Evacuation Routes 5

Major Roadway Network 10

Scenic Byways 13

Railroads 14

Facilities 18

Sidewalks and Trails 22

V. Stormwater Storage Impacts 24

VI. Next Steps 26

Appendix 27

I. Background

Conditions resulting from climate change have included higher temperatures, increased precipitation and/or severe drought, and an overall rise in sea level around the world. Scientific research indicates sea levels worldwide have been rising at a rate of 0.14 inches (3.5 millimeters) per year since the early 1990s (http://ocean.nationalgeographic.com/ocean/critical-issues-sea-level-rise/). It is becoming increasingly clear that this rise in sea level will result in higher tides, increased saltwater intrusion and more severe storm surges causing more extensive and frequent coastal flooding.

Mean elevation for the State of Florida is approximately 100 feet above sea level with the highest point registering at only 345 feet above sea level. In Volusia County, the highest natural point of elevation is 120 feet above sea level and the highest point in Flagler County is recorded at 58 feet above sea level. As sea level rise continues, it is becoming of critical importance to understand the potential vulnerability of flooding on transportation infrastructure, specifically those facilities located in low-lying coastal areas. The purpose of a vulnerability analysis is to provide a preliminary examination of potential sea level rise, erosion, and coastal flooding impacts.

Increased flooding of transportation infrastructure due to tidal activity and heavy rainfall can result in:

- Loss of roadway capacity due to flooding and erosion
- Interruptions to evacuation routes when they are most needed
- Degradation of transportation infrastructure
- Loss of access to/utilization of facilities (fleet fueling/storage; evacuation centers, etc.)
- Insufficient stormwater storage (ponds and groundwater)
- Malfunctioning canals and drainage

By taking a risk-based approach and identifying vulnerable facilities the River to Sea Transportation Planning Organization (R2CTPO) can implement adaptation practices overtime that will protect these facilities and minimize impacts on mobility. The Federal Highway Administration (FHWA) identifies four strategies for adapting to climate change:

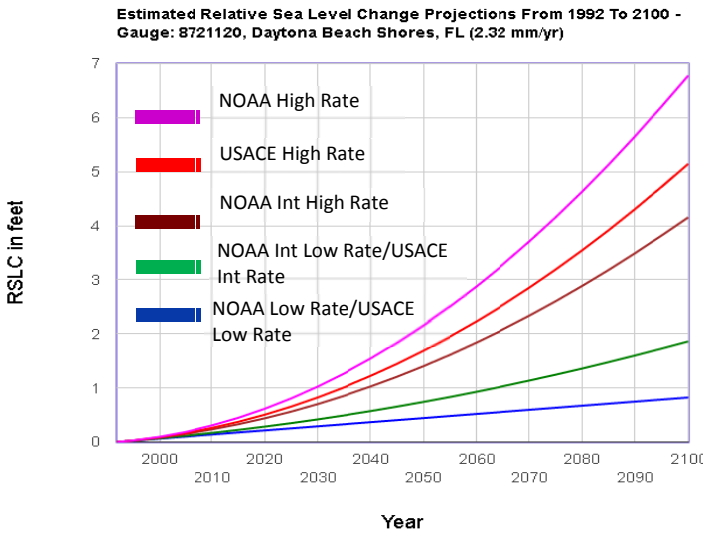
- Know your vulnerabilities
- Use the transportation planning process
- Incorporate climate risks in engineering design; and
- Enhance operations, maintenance, and emergency preparedness.

http://www.fhwa.dot.gov/environment/climate_change/adaptation/publications/infographic/index.cfm

In addition, recent directives include:

- Executive Order 13653 – Preparing the United States for the Impact of Climate Change – November 2013
- Fixing America's Surface Transportation (FAST) Act: expands the focus on the resiliency of the transportation system as well as activities to reduce stormwater runoff from transportation infrastructure; and requires strategies to reduce the vulnerability of existing transportation infrastructure to natural disasters. [23 U.S.C. 134(d)(3) & (i)(2)(G)]
- Florida Statutes, Section 163.3178 - Coastal management strategies, etc., flood, Community Rating System (CRS), etc. With this new law, Florida Statute section 163.3178(2)(f)1. now includes "sea-level rise" as one of the causes of flood risk that must be addressed in the "redevelopment principles, strategies, and engineering solutions" to reduce flood risk.

Figure 1: Comparison between NOAA and USACE Projection Rate Curves



The sea level rise scenarios considered in this report represent an effort to respond to these directives. They're based on current conditions and do not include projections of erosion, detailed hydrologic connectivity, storm surge or precipitation. This work simply provides a preliminary consideration of exposure and identifies a subset of infrastructure within the metropolitan planning area that is most vulnerable. These findings help direct our attention toward areas and assets that require more in-depth research, study of alternatives, and engineering analysis. It is important to use these results to begin further analysis because planning and programming takes time and coordination. Advanced planning will be effective for avoiding potential costs in the future.

According to the National Oceanic and Atmospheric Administration (NOAA), "Given the range of uncertainty in future global sea level rise (SLR), using multiple scenarios encourages experts and decision makers to consider multiple future conditions and to develop multiple response options. Scenario planning offers an opportunity to initiate actions now that may reduce future impacts and vulnerabilities. Thus, specific probabilities or likelihoods are not assigned to individual scenarios in this report, and none of these scenarios should be used in isolation." U.S. Army Corps of Engineers (USACE) also notes that analysts should consider what higher rates of sea level rise may have on design alternatives, risk and others. NOAA also states that the Agency has a very high confidence (greater than 9 in 10 chances) that global mean sea level will rise at least 8 inches but no more than 6.6 feet by 2100. The parameters associated with the NOAA rate curves are found below. (http://cpo.noaa.gov/Home/AllNews/TabId/315/ArtMID/668/ArticleID/80/Global-Sea-Level-Rise-Scenarios-for-the-United-States-National-Climate-Assessment.aspx)

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THE LOWEST SEA LEVEL CHANGE SCENARIO IS BASED ON HISTORIC RATES OF OBSERVED SEA LEVEL CHANGE. THIS SCENARIO SHOULD BE CONSIDERED WHERE THERE IS A HIGH TOLERANCE FOR RISK (E.G. PROJECTS WITH A SHORT LIFESPAN OR FLEXIBILITY TO ADAPT WITHIN THE NEAR-TERM)

THE INTERMEDIATE-LOW SCENARIO IS BASED ON PROJECTED OCEAN WARMING

THE INTERMEDIATE-HIGH SCENARIO IS BASED ON PROJECTED OCEAN WARMING AND RECENT ICE SHEET LOSS

THE HIGHEST SEA LEVEL CHANGE SCENARIO REFLECTS OCEAN WARMING AND THE MAXIMUM PLAUSIBLE CONTRIBUTION OF ICE SHEET LOSS AND GLACIAL MELTING. THIS HIGHEST SCENARIO SHOULD BE CONSIDERED IN SITUATIONS WHERE THERE IS LITTLE TOLERANCE FOR RISK.

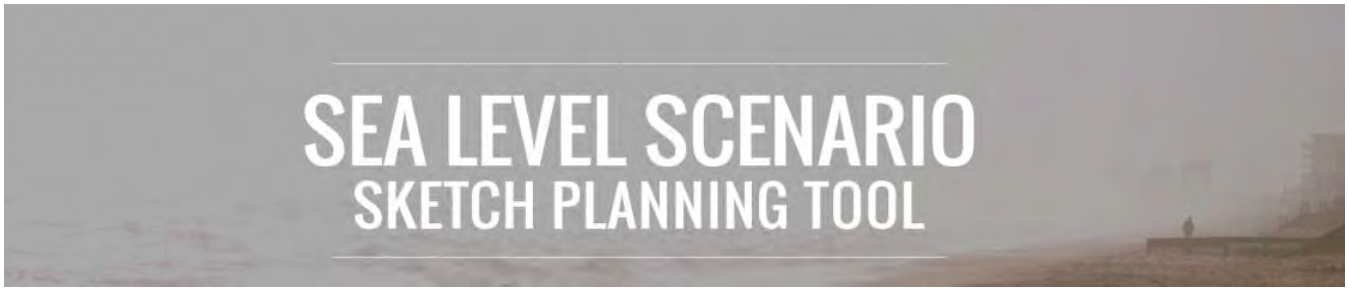
(NOAA, 2016)

II. Vulnerability Analysis and Data Disclaimer

This report provides an initial and conservative assessment of the potential vulnerabilities the River to Sea Transportation Planning Organization (R2CTPO) may face due to rising sea levels. It draws attention to potentially vulnerable transportation assets so that advanced planning can occur. It is not meant to be a comprehensive or regional review and in no way replaces the critical science and engineering studies that should be conducted as part of the development of a more comprehensive adaptation strategy or plan.

These data and maps are for planning, educational, and awareness purposes only and should not be used for site-specific analysis, navigation, and flood rates or permitting. As with all data, all features should be verified with a site visit and surveying. The data and maps in this report are provided "as is".

III. Methodology



This study builds upon modeling and parameters established by previous sea level rise vulnerability assessments conducted by the East Central Florida Regional Planning Council (ECFRPC) and reviewed by the Working Group established for this assessment. The working group consisted of Flagler and Volusia County representatives from emergency management, traffic engineering, transit, planning and development, geographic information system (GIS), and environmental management. The University of Florida GeoPlan Center's *Sea Level Scenario Sketch Planning Tool* served as the primary modeling tool due to its statewide applicability, development under direction from Florida Department of Transportation (FDOT), sea level scenario customization and utilization of a more conservative U.S. Army Corps of Engineers (USACE) high projection rate curve than National Oceanic and Atmospheric Administration (NOAA). The tool, documents, and other associated information, including tool development methodology for the *Sea Level Scenario Sketch Planning Tool* can be found at http://sls.geoplan.ufl.edu/#intro.

As part of this study, the modeling included the following parameters:

- Planning horizons - 2040, 2070 and 2100.
- Projection Rate Curves – USACE Low, Intermediate, High
- Vertical Datum
    - Volusia County – Mean Higher High Water (MHHW) for Atlantic Coastal impacts and Mean High Water (MHW) for Indian River Lagoon hydroconnectivity. The previous analysis determined that due to the low daily tidal variations within the Indian River Lagoon, MHW is more applicable for impacts related to this water source.
    - Flagler County – Mean Higher High Water

PARAMETER DEFINITIONS

MEAN HIGHER HIGH WATER
Average of the elevations of the higher high water off a mixed tide over a specific 19-year period.

MEAN HIGH WATER
Average elevation of all high waters recorded at a particular point or station over a considerable period of time, usually 19 years.

MEAN SEA LEVEL
an average level for the surface of one or more of Earth's oceans from which heights such as elevations may be measured.

Calculations of projected sea level rise and inundation from the Atlantic and Indian River Lagoon (IRL) used the Daytona Beach Shores NOAA tide station's sea level trend values, which incorporate local subsidence or uplift rates. (See table). Hence, the amount of projected sea level change under each scenario is the same for both the Atlantic and Lagoon. What differs is the starting water level as previously mentioned with MHW for the Lagoon in Volusia County and MHHW for the Atlantic. Since Flagler County was not within the recent study area of the Indian River Lagoon study, this data had to be modeled as part of the River to Sea TPO project. In discussion with the Working Group for this project, it was determined to model only MHHW for Flagler County.

Table 1: Projected Sea Level Rise Change (Inches) at Daytona Beach Shores Tidal Gauge by Rate Curve

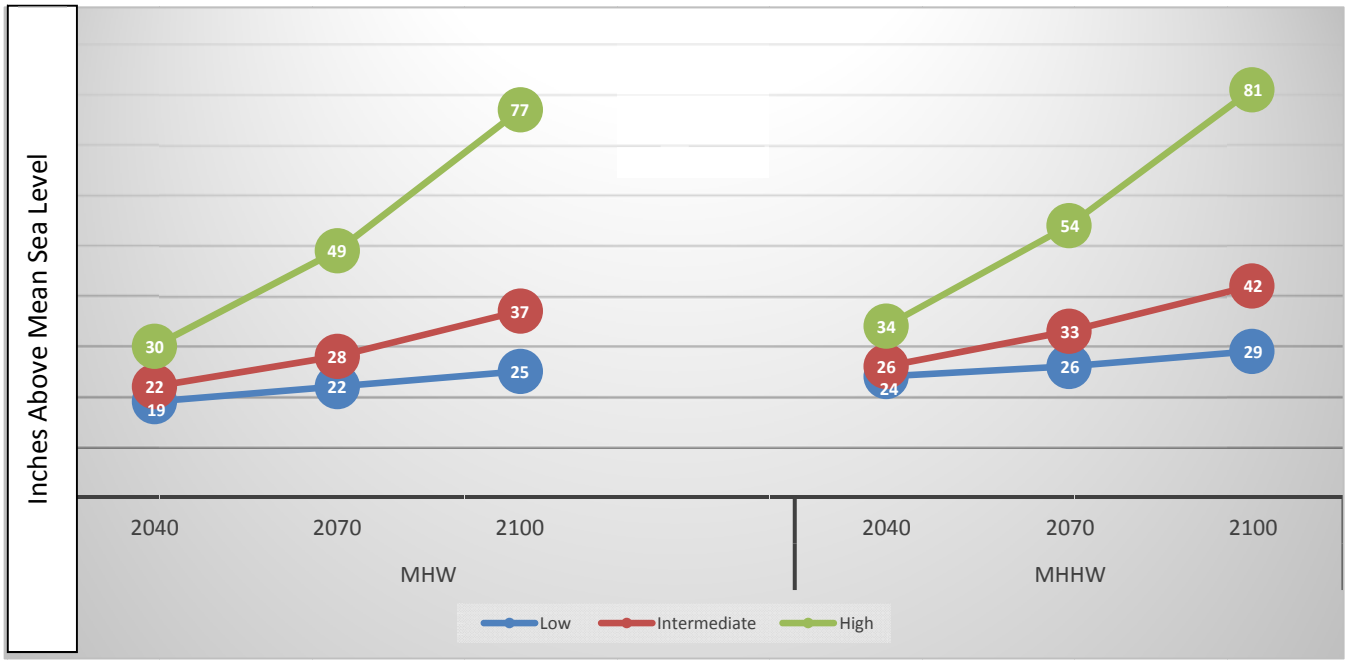
Year	Low	Intermediate	High
2040	4.38	6.84	14.63
2070	7.12	13.62	34.19
2100	9.86	22.31	61.76

Source: UF Geoplan Sea Level Scenario Sketch Planning Tool

Table 1 illustrates the level of sea level rise change at the Daytona Beach Shores Tidal Gauge under each USACE projection Rate Curve. This data was utilized in the model to determine inundation levels on land and the vulnerability assessment.

The sea level rise data in Figure 2 was used to determine the inundation elevations expected to occur based on tidal datum. The figure below shows the potential inundation, above mean sea level (MSL), under the specific planning horizons, datum and rate curves. These data are important for vulnerability analysis.

Figure 2: Inundation Elevations (Inches) Above Mean Sea Level (MSL) by Rate Curve, Year and Vertical Datum



Source: UF Geoplan Sea Level Scenario Sketch Planning Tool

Using these parameters, the ECFRPC utilized the FDOT Sea Level Scenario Sketch Planning Tool plug-in for GIS in order to begin the process of creating highly customized sea level rise shapefiles for each of the counties in the study area. In the model, the input Digital Elevation Model (DEM) used was from the Florida Geographic Data Library (FGDL) and compiled by the University of Florida GeoPlan Center. The DEM cell size (horizontal resolution) is 5.4 meters and the vertical units are inches.

MODELING PARAMETERS

VERTICAL DATUM
MHHW – Flagler County and Volusia County (Atlantic Coast)
MHW—Indian River Lagoon

PROJECTION RATE CURVES
USACE Low, Intermediate and High

PLANNING HORIZONS
2040, 2070, 2100

Shapefiles were developed for each planning horizon with each rate curve and datum. Volusia County resulted in 18 shapefiles and Flagler, having only MHHW datum runs, had nine shapefiles. These resultant sea level inundation files were used to determine impacts to various transportation infrastructure in Flagler and Volusia Counties.

IV. Vulnerability Analysis

Transportation facility and infrastructure data was collected from the Volusia and Flagler Counties as well as Florida Geographic Data Library (FGDL) and available ECFRPC datasets. Facilities that were assessed through this preliminary analysis include:

- Designated Evacuation Routes
- Major Roadway Network
- Fleet Storage Facilities
- Public Works Facilities
- Emergency Management Centers
- Other Storage Facilities necessary for transportation or evacuation purposes
- Sidewalks and Trails

Further details concerning impacts to waterbodies and facilities can be found in the datasets provided with this document.

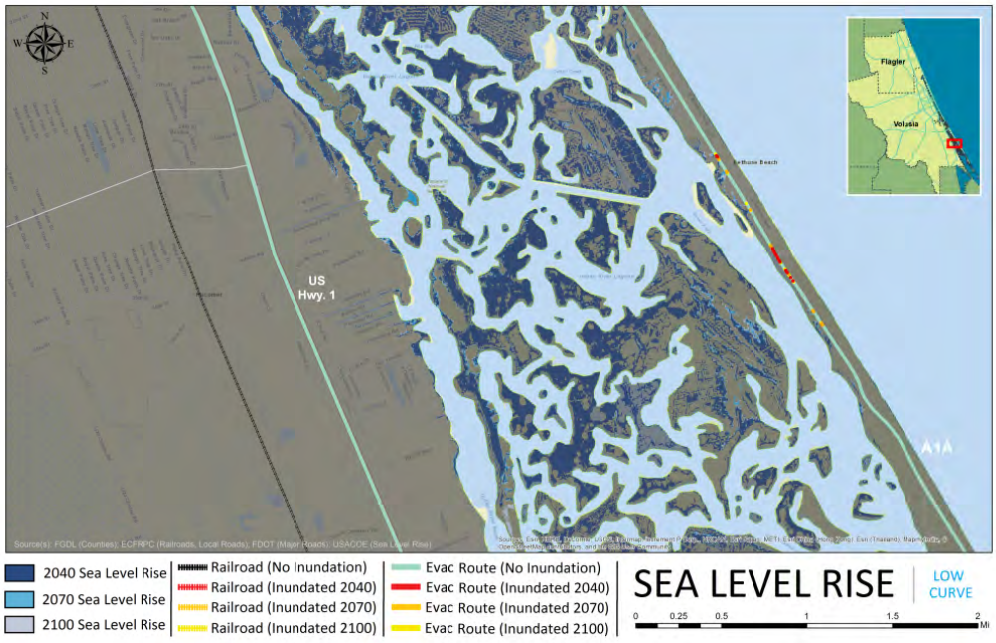
Designated Evacuation Routes

The section below includes an analysis of designated evacuation routes that may be impacted by rising seas. Evacuation routes are of extreme importance for the safety of residents and visitors to Volusia and Flagler Counties in the event of an emergency or evacuation. The tables in this section represent only those routes found to be vulnerable under the parameters of the study. Specific roadway segment information is available in the data files provided with this report. Other considerations include:

- Impacts from storm surge and erosion to these roadways and land areas are not included in this analysis. Erosion and undercutting already occurring in sections of roadway, such as State Highway A1A, may be exacerbated as sea level rises. This, in turn, may elevate the segments priority for further analysis for remediation by the TPO.
- The number of miles below do not represent a solid stretch of roadway vulnerable to inundation but the **total miles** potentially vulnerable to inundation along the roadway within the county. There may be sections of roadway that are not expected to be inundated but may be isolated by the inundation of flanking sections. It is recommended that the TPO further analyze the location of these impacts to determine if larger stretches of roadway may be mitigated due to the distance between the potential impacts.

- As noted in the disclaimer, the Sea Level Scenario Sketch Planning tool is for regional analysis and further on site assessment will need to be conducted to verify elevation and other considerations. These numbers are to provide a preliminary overview of potential impacts to transportation infrastructure.
- Stormwater retention ponds and drainage were not specifically evaluated and further assessment would be required to determine if they adequately to address the impacts from sea level rise.

The Flagler & Volusia Sea Level Rise Atlas 2016 at the end of this report provides maps atlases broken out by scenario, to depict evacuation routes vulnerable to sea level rise. The images below are examples taken from the atlas. Please utilize this atlas for graphic representation of impacts to evacuation routes by year and projection rate curve.



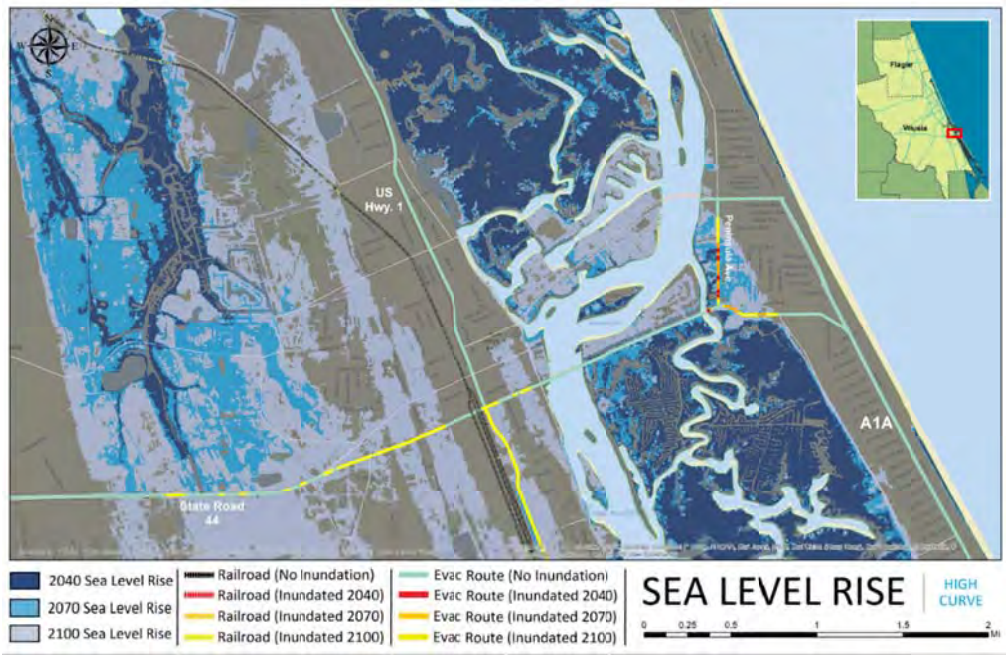
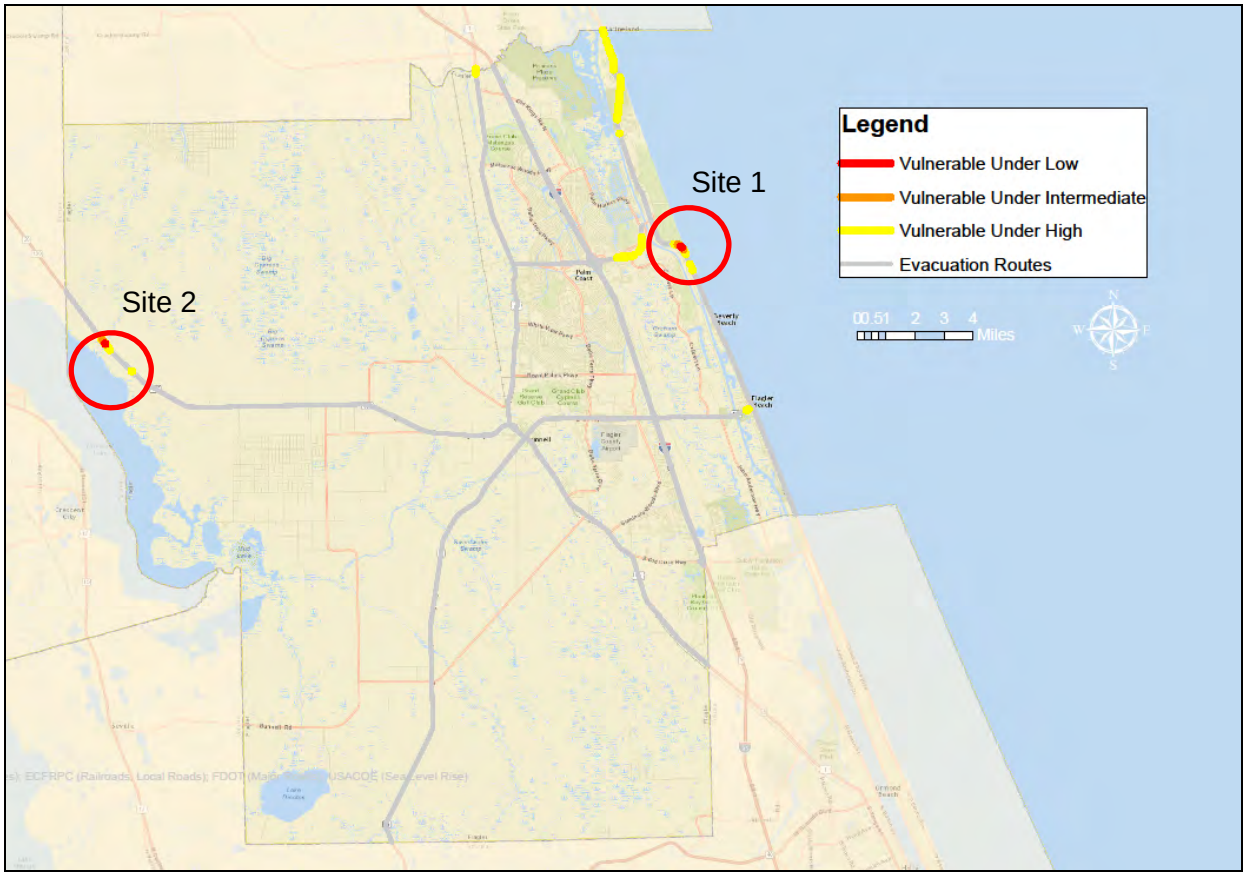


Table 2: Evacuation Route Projected Impacts from Sea Level Rise - Flagler County

Flagler County | Evacuation Routes									
Roadway	Year and Estimated Miles of Potential Inundated *(by Projection Rate Curve)*								
	Low			Intermediate			High		
	2040	2070	2100	2040	2070	2100	2040	2070	2100
Hammock Dunes Parkway									*0.18 mi*
Oceanshore Boulevard									*0.31 mi*
Palm Coast Parkway									*0.58 mi*
State Highway 100/Moody Boulevard			*<0.25 mi*			*<0.25 mi*			*0.9mi*
State Highway 5									*<0.25mii*
State Highway A1A			*<0.25 mi*			*0.3 mi*			*4.31 mi*
Surfview Drive									*0.41 mi*

The analysis of evacuation routes in **Flagler County** indicates that State Highway 100 and SR A1A are most vulnerable to inundation from sea level rise. Inundation in sections of these roadways may begin to be realized under high tide conditions as early as 2040 in each rate project curve. This is important because even under historical sea level rise trends, with no increase in rate of sea level rise (Low Projection Rate Curve), impacts are likely. State Highway A1A is likely to see the greatest impacts by 2100, under the high projection rate curve, with an estimate of over four total miles of roadway segments impacted. The map below illustrates where impacts are likely to occur along evacuation routes, with the largest impacts in the northern portions of the county.

Figure 3: Flagler County Evacuation Routes Vulnerable to Sea Level Rise



The areas highlighted with the red circles are highlighted on page 11.

Table 3: Evacuation Route Projected Impacts from Sea Level Rise by Projection Rate Curve and Year - Volusia County

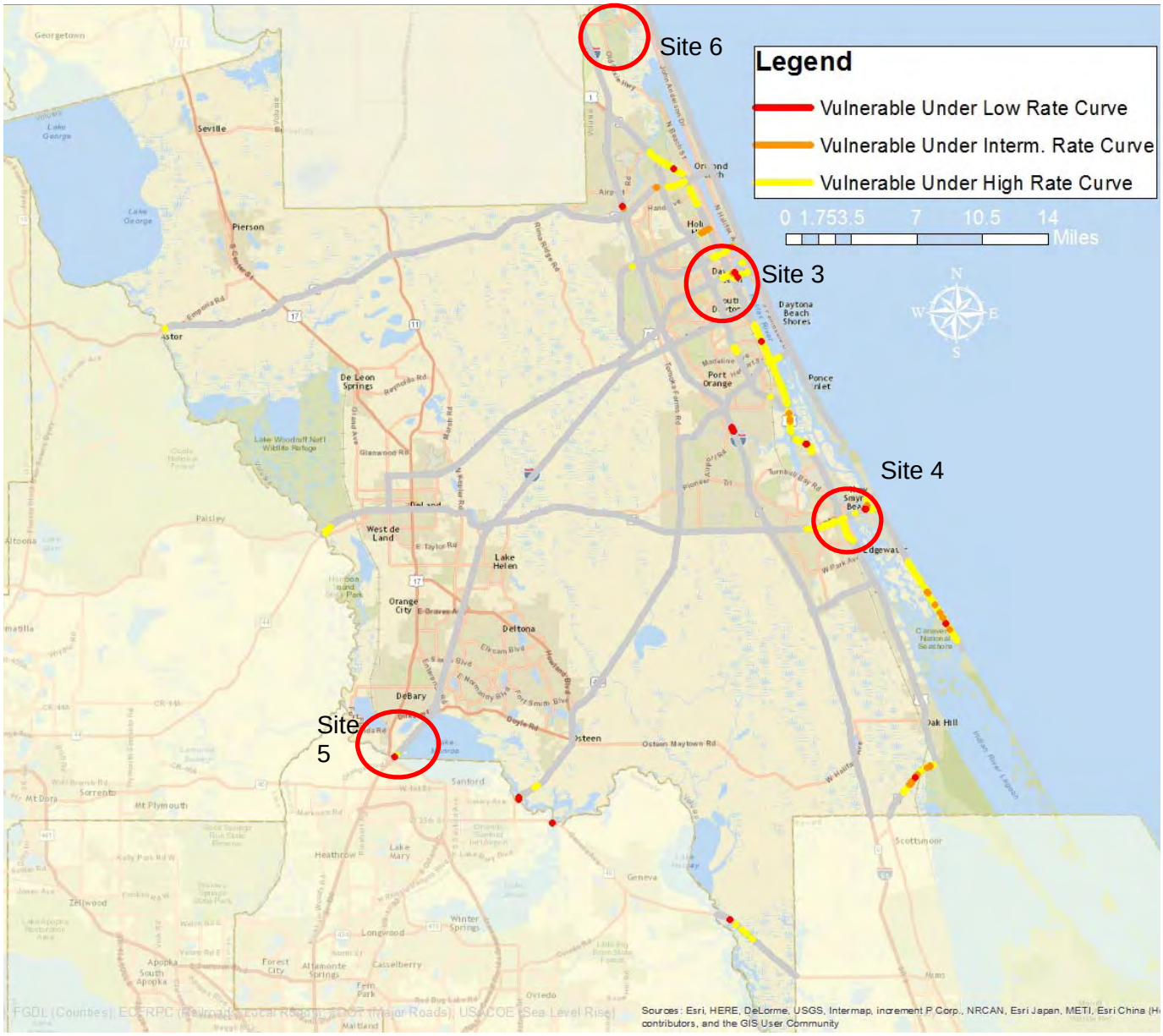
Volusia County | Evacuation Routes									
Roadway	Year and Estimated Miles Inundated *(by Projection Rate Curve)*								
	Low			Intermediate			High		
	2040	2070	2100	2040	2070	2100	2040	2070	2100
CR 4019 (LPGA Blvd.)						*0.2 mi*			*0.6 mi*
CR A1A (Atlantic Ave./Turtlemound)			*<0.25 mi*			*0.9 mi*			*8 mi*
State Highway A1A			*<0.25 mi*			*<0.25 mi*	*0.5 mi*		*8.5 mi*
Interstate 4			*<0.25 mi*			*<0.25 mi*			*0.3 mi*
Interstate 95			*<0.25 mi*			*<0.25 mi*			*0.3 mi*
Silver Beach / Orange Ave.			*<0.25 mi*			*<0.25 mi*			*0.3 mi*
State Road 40						*<0.25 mi*			*0.4 mi*
State Road 415			*<0.25 mi*			*<0.25 mi*			*0.9 mi*
State Road 421									*<0.25 mi*
State Road 430						*<0.25 mi*			*0.8 mi*
State Road 44									*0.7 mi*
State Road 46			*<0.25 mi*			*<0.25 mi*			*<0.25 mi*
State Road 5A									*<0.25 mi*
US Highway 1			*<0.25 mi*			*<0.25 mi*	*<0.25 mi*		*11 mi*
US Highway 92						*<0.25 mi*			*0.5 mi*

The analysis of evacuation routes in **Volusia County** estimate impacts to State Highway/CR A1A, SR 415 and 46, US 1, I–4 and I-95, along with Orange Ave., Pioneer Trail, as early as 2040 under the low projection rate curve, as shown in the table above. The total number of miles impacted greatly increases under the high rate curve, especially between 2070 and 2100 when the rate of sea level increase is highest. Under the high rate curve, State Highway/CR A1A and U.S. 1 are at the greatest risk of inundation as shown in the table above with 8.5 mi and 11 mi of potential inundation respectively.

The map following depicts the evacuation routes that are expected to be impacted under each scenario in Volusia county. As shown on the map, impacts occur on both sides of the county and largely along the north/south routes.

Figure 4: Volusia County Evacuation Routes Vulnerable to Sea Level Rise by the Year 2100.

This map depicts evacuation routes that may be vulnerable to sea level rise under each scenario by the year 2100. Those in red indicate the most vulnerable sections of evacuation routes as they are projected to be impacted under the low projection rate curve.



The areas highlighted with the red circles are highlighted in the following sections.

Major Roadway Network

Tables 3 and 4 provide a summary of the impact sea level rise may have on the major thorough-fare system. Local roadways are not included in this analysis and may be assessed at a later date along with associated assets such as traffic lights. Impacts to the major roadways may impact access to local roadways and the extent of local roadways vulnerable to inundation may exceed that of the major roadways.

Of the 484 miles of major roadways in Flagler County nearly nine miles may be impacted under the USACE high projection rate curve by 2100, while less than a mile of roadway may be inundated under the other rate curves. The most vulnerable roadways are those impacted by 2040 in all three scenarios. Segments of the following roadways which are considered most vulnerable include: State Hwy. 100, SR A1A, CR 305 and CR 305.

In Volusia County, approximately 47 miles of the major roadway network may be impacted under the USACE high projection rate curve by 2100. When analyzing impacts under the low and intermediate projection rate curves, approximately six miles or less may be inundated. The roadways listed below can be considered the county's most vulnerable roadways as sections of these roads may be impacted by 2040 under all three projection rate curves. These roadways include: U.S. 1, Beach Street, Pioneer Tr., SR/CR A1A, East Orange Ave, High Bridge Rd., I-4, I-95, Old Dixie Hwy, SR 415, SR 46, Turnbull Bay Rd., and Walter Boardman Ln.

Site specific assessments should be made for all potential areas of impacts, including bridge elevations, to further refine these impacts.

Table 4: Summary of Major Roads Vulnerable to Sea Level Rise – Flagler County

		Flagler County Infrastructure Inundation | **Major Roads**				
		Total Mileage	**Estimated Inundation**	**% Inundated**		
LOW	**2040**	483.7 *Miles*	<0.25 *Miles*	<0.1%	**2040**	**LOW**
	2070		<0.25 *Miles*	<0.1%	**2070**	
	2100		<0.25 *Miles*	<0.1%	**2100**	
MED	**2040**	483.7 *Miles*	<0.25 *Miles*	<0.1%	**2040**	**MED**
	2070		0.3 *Miles*	0.1%	**2070**	
	2100		0.6 *Miles*	0.1%	**2100**	
HIGH	**2040**	483.7 *Miles*	0.4 *Miles*	0.1%	**2040**	**HIGH**
	2070		1.4 *Miles*	0.3%	**2070**	
	2100		8.6 *Miles*	1.8%	**2100**	

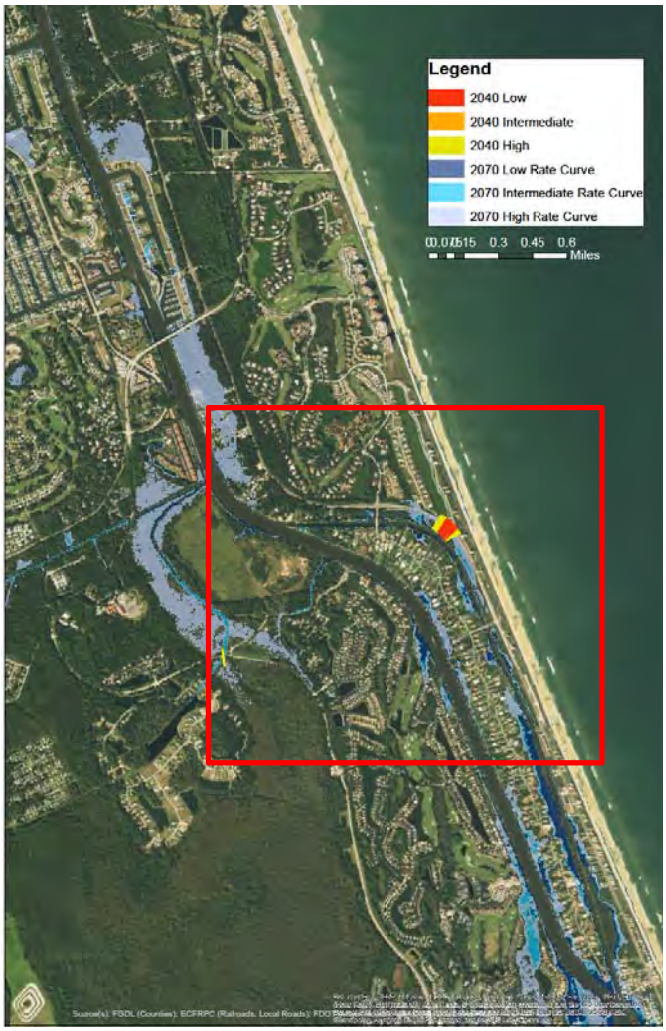
Table 5: Summary of Major Roads Vulnerable to Sea Level Rise- Volusia County

		Volusia County Infrastructure Inundation | **Major Roads**				
		Total Mileage	**Estimated Inundation**	**% Inundated**		
LOW	**2040**	895.1 *Miles*	1.5 *Miles*	0.2%	**2040**	**LOW**
	2070		2.1 *Miles*	0.2%	**2070**	
	2100		2.6 *Miles*	0.3%	**2100**	
MED	**2040**	895.1 *Miles*	2.1 *Miles*	0.2%	**2040**	**MED**
	2070		3.2 *Miles*	0.4%	**2070**	
	2100		5.5 *Miles*	0.6%	**2100**	
HIGH	**2040**	895.1 *Miles*	3.6 *Miles*	0.4%	**2040**	**HIGH**
	2070		11.1 *Miles*	1.2%	**2070**	
	2100		46.6 *Miles*	5.2%	**2100**	

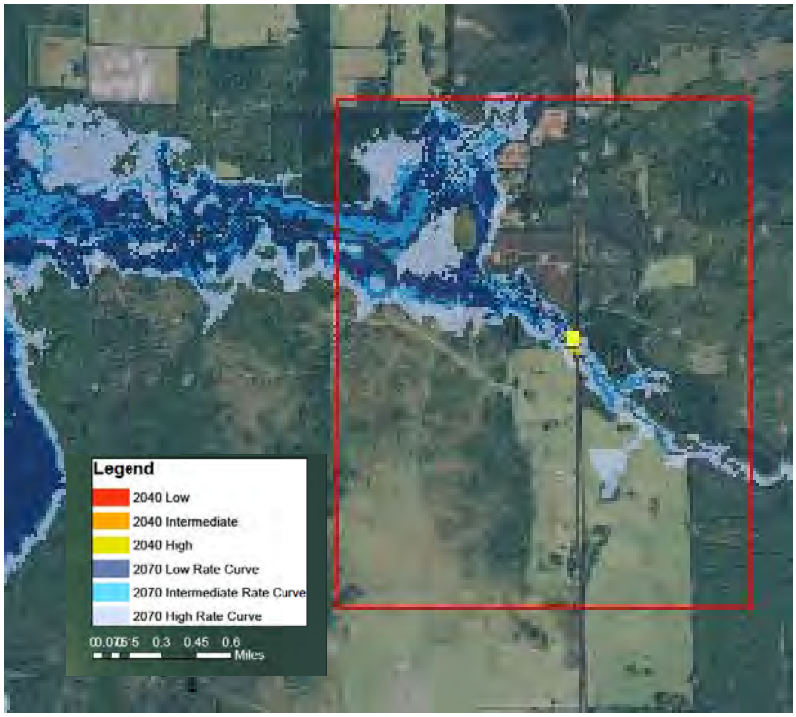
The images below represent some of vulnerable areas in Flagler and Volusia County. The 2070 sea level rise projections for each scenario are shown in the graphics below from dark blue (low rate curve) to light blue (high rate curve). Inundation projections for the year 2070 overlaid with roadways vulnerable to sea level rise impacts by 2040 to provide additional perspective. In the graphics below, red represents segments that may be impacted by the low rate curve, orange by the intermediate rate curve and yellow by the high rate curve. The areas shown below are noted on the previous maps on red circles.

Flagler County

Site 1: State Highway A1A may see impacts just north of Beverly Beach near the Fox Cut creek curve by 2040.



Site 2: Middle Haw Creek runs under CR 305. Further analysis is necessary to refine the extent of potential impacts in this area.

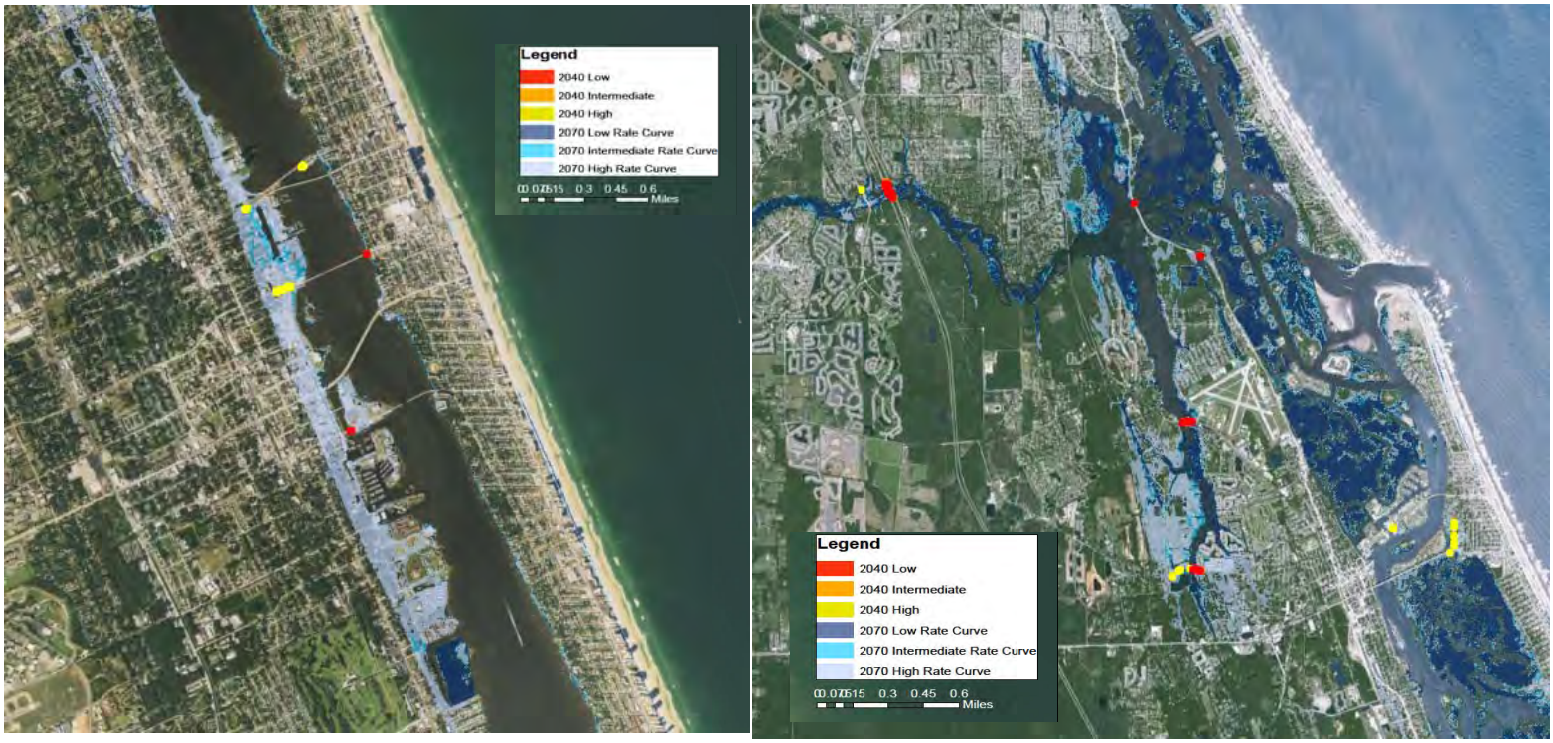


These screenshots illustrates the areas of the major roadways that are vulnerable to sea level rise by 2040. Areas of inundation by 2070 are also shown in blue to provide additional perspective.

Volusia County

Site 3: East/West Routes from the barrier island along Beach Street in Daytona Beach may be impacted by 2040 under the high rate curve. Major impacts may be realized by 2070 under the high projection rate curve.

Site 4: Various areas in the vicinity in New Smyrna Beach, including bridge ramps, will need to be further assessed for inundation impacts. These impacts may be felt by 2040 under the low projection rate curve, as shown below in the areas in red.



These screenshots illustrate the areas of the major roadways that are vulnerable to sea level rise by 2040. Areas of inundation by 2070 are also shown in blue to provide additional perspective.

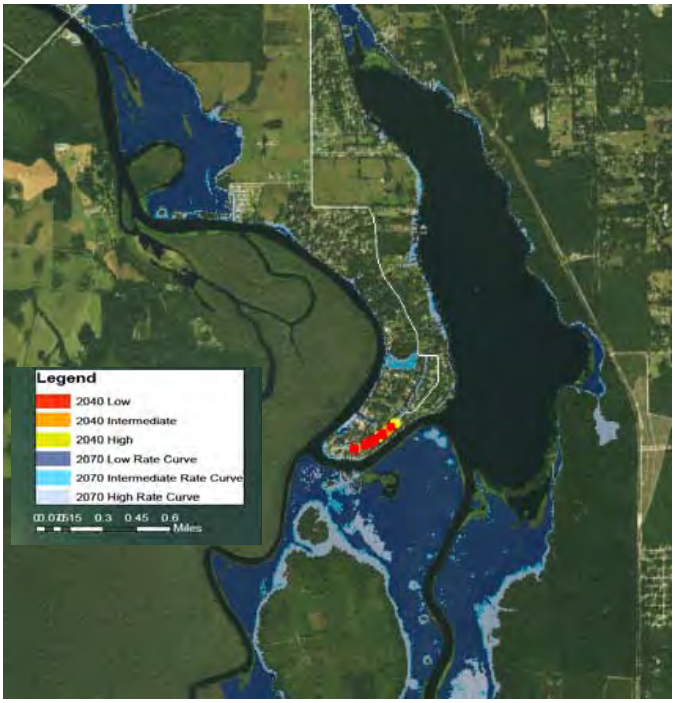
Scenic Byways

Scenic Byways were reviewed to determine potential vulnerabilities to sea level rise. Some of the areas of impact may be covered in the major roadway analysis. In the graphics below, red represents segments that may be impacted by 2040 in the low rate curve, orange by the intermediate rate curve and yellow by the high rate curve.

In Flagler County, at the border of St. Johns County, the Heritage Crossroads: Miles of History Scenic Byway, may be impacted as early as 2040 under the low projection rate curve, especially as the byway crosses Pelicer Creek. As noted in the previous section, inundation impacts to SR A1A Scenic and Historic Coastal Byway may also be experienced as early as 2040 under each project rate curve. The County is already experiencing issues with flooding and erosion along SR A1A. These issues may be exacerbated as sea level rises and may impact SR A1A, especially in northern Flagler County.

Sections of the Ormond Scenic Loop and Trail in Volusia County may be vulnerable to impacts by 2040 in all three scenarios. Most of these impacts are north of the Tomoka Basin along High Bridge Rd., John Anderson Drive and Walter Boardman Rd. On the west side of Volusia County, the River of Lakes Heritage Corridor Scenic Highway (RLHCSH) may be inundated along River Ridge Road on the east side of Lake Beresford. Impacts to the RLHCSH may also occur in Oak Hill along River Dr.

Site 5: The Heritage Crossroads: Miles of History Scenic Byway, may be impacted as early as 2040 under the low projection rate curve.



Site 6: Many segments of the Ormond Scenic Loop and Trail are vulnerable to impacts by 2040 under all three curves, even largely under the low projection rate curve.

These screenshots illustrate the areas of the byways that are vulnerable to sea level rise by 2040. Areas of inundation by 2070 are also shown in blue to provide additional perspective.

Railroads

Tables 5 and 6 provide a summary of railway infrastructure vulnerability to sea level rise under the three projection rate curves in the years 2040, 2070 and 2100. The tables represent active rail line mileage of the Florida East Coast Rail line and the CSX/Amtrak/SunRail Tracks. Rail is an important asset in the region, with freight accessing Port Canaveral, SunRail, and the potential increase in passenger rail along the FEC corridor as part of All Aboard Florida. It will be important to ensure vulnerable rail rights of way are mitigated to maintain their viability. As with any private entity, it will be important for CSX and FEC to assess vulnerability impacts to their infrastructure.

The FEC rail line begins to head north-west, crossing I-95 just before the Volusia/Flagler line resulting in minimal impacts to the rail line in Flagler County. In Volusia County, modeling illustrates there may be impacts to segments of FEC rail line as early as 2040 under the low projection rate curve in the area of Ormond Beach just southeast of Tomoka State Park and sections south of port Orange and Oak Hill. However, as the projection rate increases to intermediate and high, extensive impacts by 2100 are shown to continue south through Daytona Beach and then pick up again in the area near Turnbull and Spruce Creek, which is highly vulnerable to inundation under the high projection rate curve. Impacts by 2040 under the high scenario continue in some segments of the FEC in Edgewater and Oak Hill.

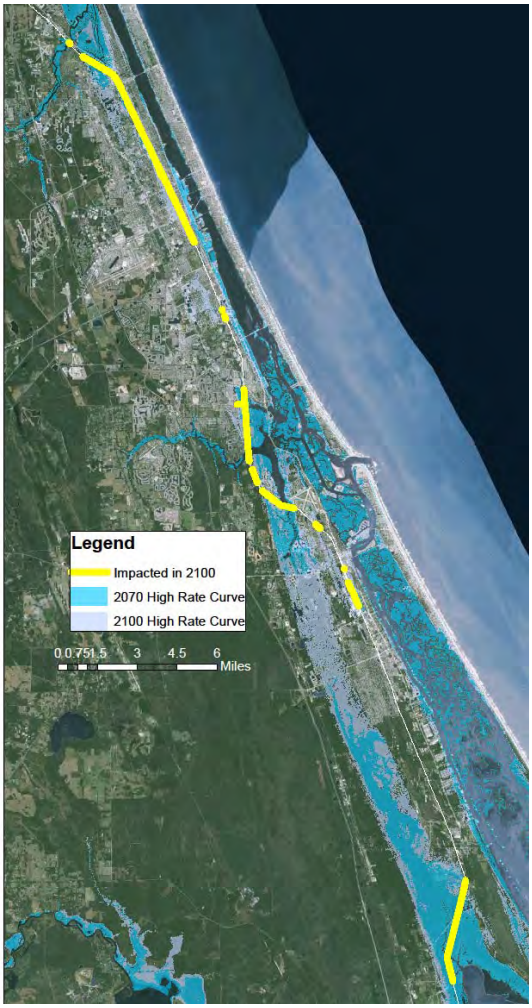
The CSX rail line runs near Lake Monroe Park in western Volusia County, along the Seminole County line. Most of the impacts to the rail lines are expected to occur by the year 2100 under the high projection rate curve (HPRC), again illustrating the tipping point between the 2070 and 2100-year horizon under the HPRC. The majority of these impacts are from Daytona Beach north to Ormond Beach, with additional impacts in southern Volusia County. In western Volusia County, impacts are expected in the vicinity of DeLeon Springs and along Lake Beresford.

Table 6: Summary of Railroad ROW Vulnerable to Sea Level Rise - Flagler County

Flagler County Infrastructure Inundation | **Railroads**						
		Total Mileage	**Estimated Inundation**	**% Inundated**		
LOW	2040	24 *Miles*	< 0.25 *Miles*	< 0.25 %	2040	LOW
	2070		< 0.25 *Miles*	< 0.25 %	2070	
	2100		< 0.25 *Miles*	< 0.25 %	2100	
INTERM	2040	24 *Miles*	< 0.25 *Miles*	< 0.25 %	2040	INTERM.
	2070		< 0.25 *Miles*	0.29%	2070	
	2100		< 0.25 *Miles*	0.33%	2100	
HIGH	2040	24 *Miles*	< 0.25 *Miles*	0.33%	2040	HIGH
	2070		< 0.25 *Miles*	0.33%	2070	
	2100		< 0.25 *Miles*	0.33%	2100	

Table 7: Summary of Railroad ROW Vulnerable to Sea Level Rise- Volusia County

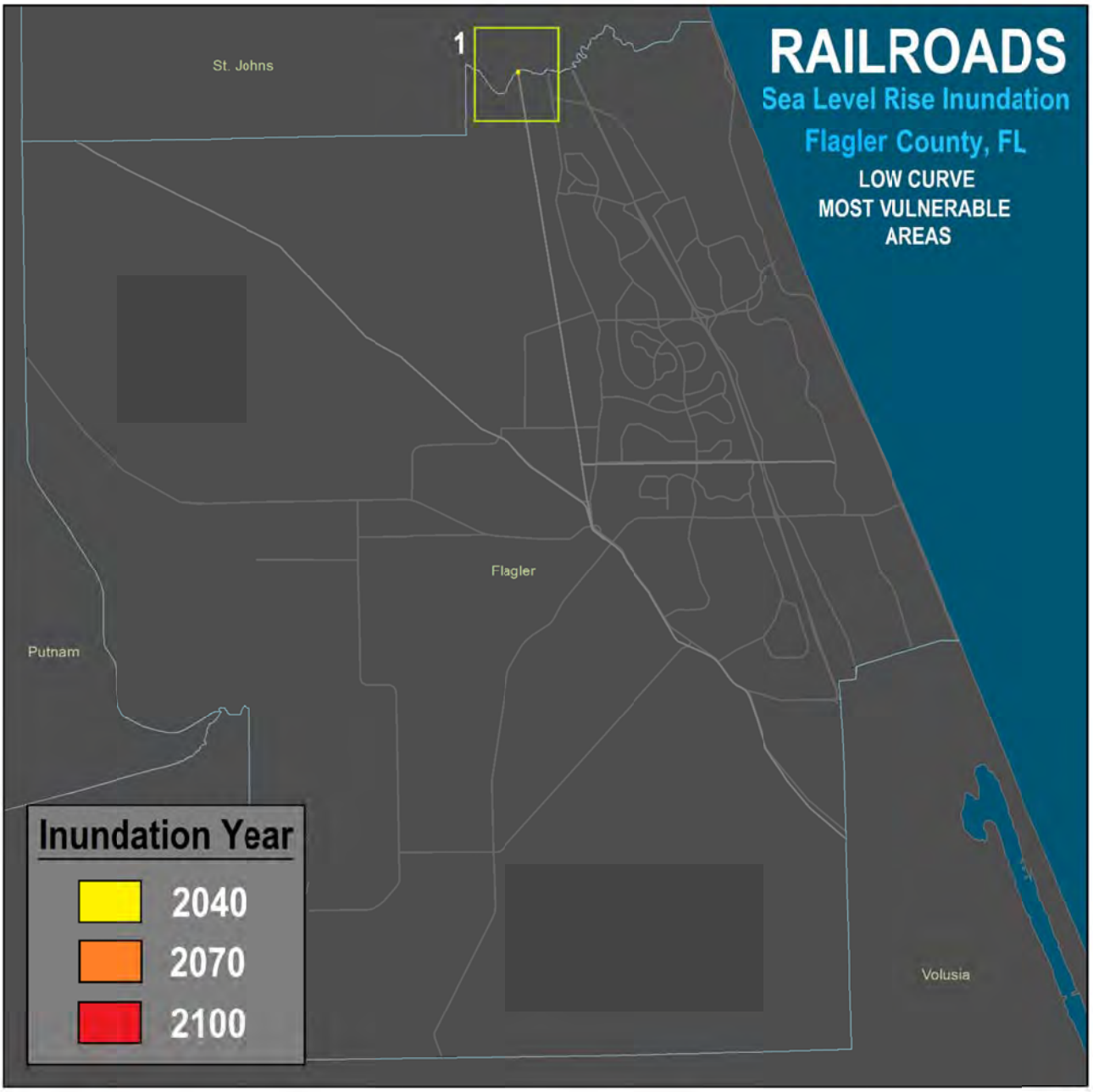
		Volusia County Infrastructure Inundation | **Railroads**				
		Total Mileage	**Estimated Inundation**	**% Inundated**		
LOW	2040	96 *Miles*	0.58 *Miles*	0.6%	2040	LOW
	2070		0.73 *Miles*	0.8%	2070	
	2100		0.87 *Miles*	0.9%	2100	
MED	2040	96 *Miles*	0.73 *Miles*	0.76%	2040	MED
	2070		1.08 *Miles*	1.13%	2070	
	2100		2.45 *Miles*	2.55%	2100	
HIGH	2040	96 *Miles*	1.18 *Miles*	1.23%	2040	HIGH
	2070		1.18 *Miles*	1.23%	2070	
	2100		15.4 *Miles*	16.0%	2100	



The USACE High Projection Rate Curve models major impacts to the FEC rail line by 2100 from Ormond Beach south into New Smyrna Beach. Additional impacts continue south into Edgewater. As discussed throughout this report, there is a major tipping point within this rate curve from 2070 to 2100 which impacts areas of Volusia County with dense population, infrastructure and assets.

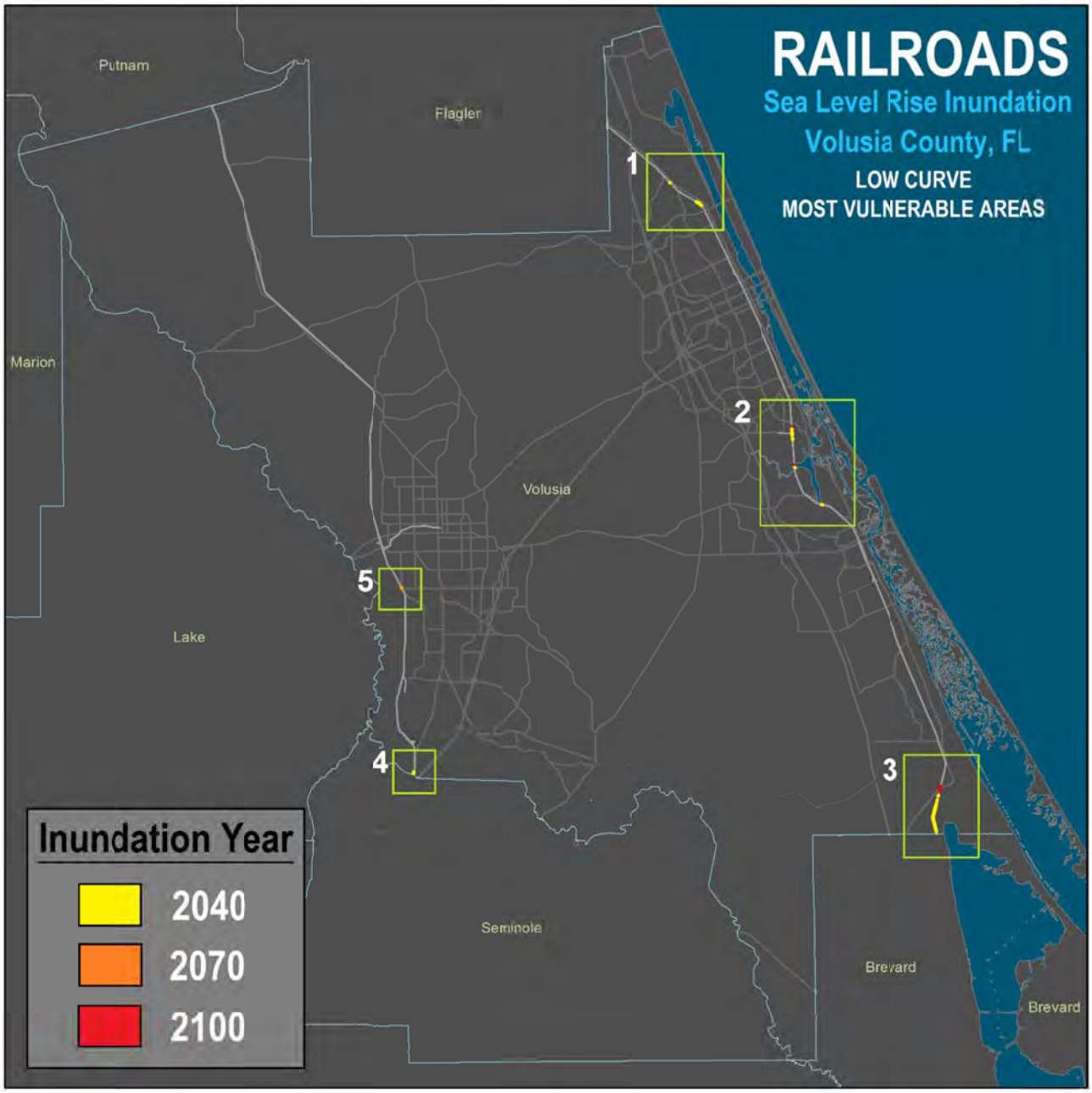
This graphic represents areas of potential inundation and impacts to the FEC rail line in New Smyrna Beach under the high rate curve.

Figure 5: Sections of Railroad ROW or Line that may be vulnerable to inundation from sea level rise under the Low projection rate curve - Flagler



Box Area	Location	Description
1	SW of Marineland	One segment to the south of Pellicer Creek at the county boundary

Figure 6: Sections of Railroad ROW or Line that may be vulnerable to inundation from sea level rise under the Low projection rate curve - Volusia



Box Area	Location	Description
1	Ormond Beach	Multiple locations between the Tomoka River and Halifax Boulevard
2	Port Orange	Multple locations between Nova Road and Spruce Creek
3	South of Oak Hill	Multiple locations between Halifax Avenue and the county boundary
4	South DeBary	One location at the county boundary (St. Johns River)
5	SW of DeLand	One location near the McGregor Road / Fatio Road intersection

Facilities

The facility analysis includes an assessment of fleet storage/barns and public works facilities, emergency management centers and other storage facilities that may be necessary for transportation or evacuation purposes such as airports, the coast guard station and transportation management centers. A list of facilities can be found in the Appendix.

Of the facilities reviewed, none were found to be vulnerable to sea level rise impacts in Flagler County. Additional analysis may be required to determine if these assets may be vulnerable to new storm surge areas that may arise from rising sea levels.

In Volusia County, most impacts may be expected under the high rate curve by the year 2100. Smokey's Heliport could be considered the most vulnerable as under the high rate curve it is expected to be impacted by 2040. Only the Coast Guard Facility in Ponce Inlet and the County's Road and Bridge Building in Holly Hill may be impacted in 2070 under the high projection rate curve. It is important to note that in the County, especially in the Holly Hill/ Daytona Beach area, there may be significant impacts in relation to the tipping point that occurs in the high projection rate curve between 2070 and 2100. At this tipping point, inundation is pushed to the west side of Beach Street and U.S. 1, thus potentially having greater impacts on various transportation and other local facilities.

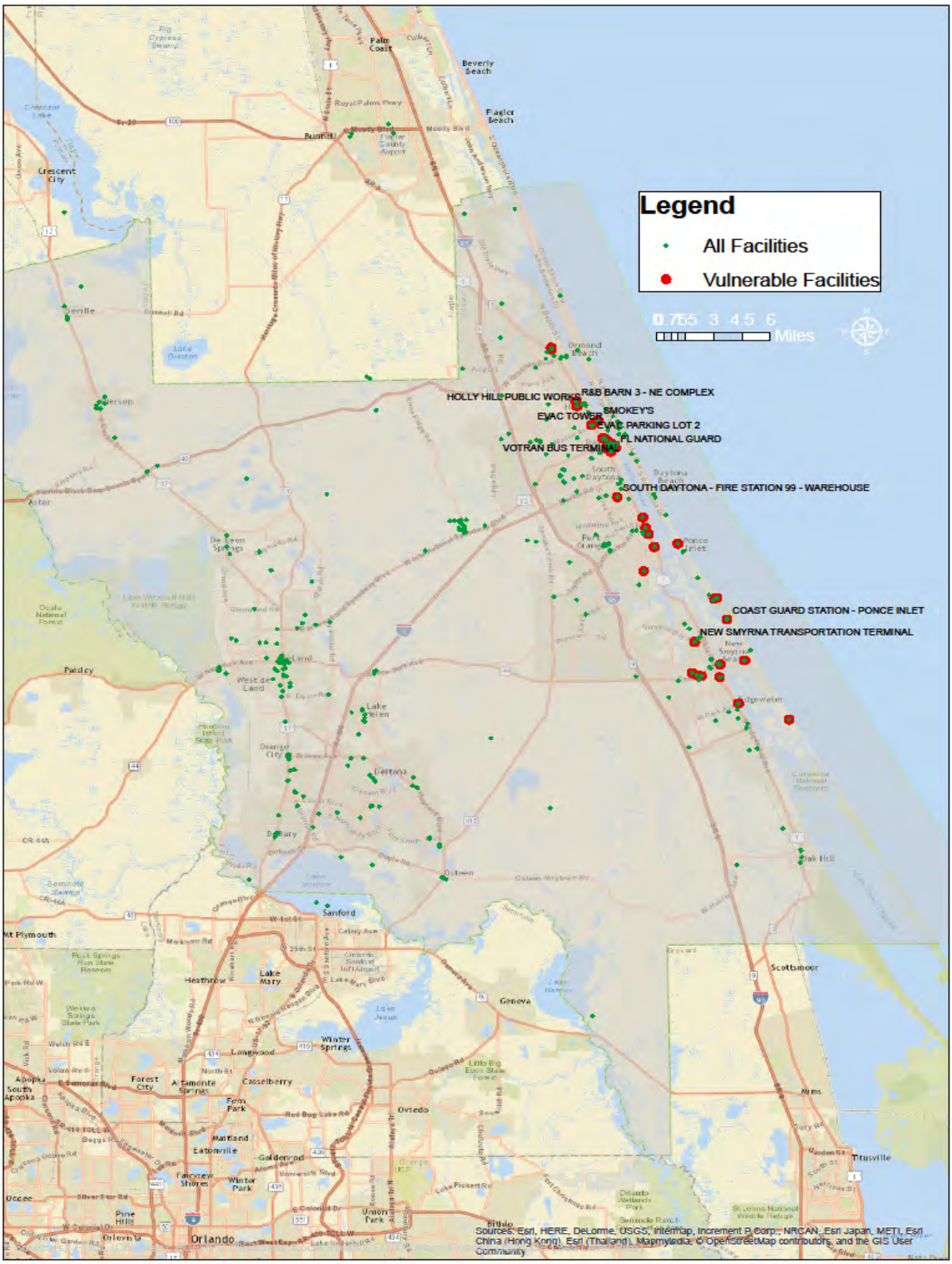
As with Flagler County, additional analysis should be conducted to determine if other facilities may be vulnerable to new storm sure areas that may arise from rising seas.

The following map illustrates the facilities identified in the Volusia County GIS resource file. All vulnerable facilities have been identified in red, however, only those determined to fall within this scope have been labeled.

Table 8: Facilities Vulnerable to Sea Level Rise by Year and Projection Rate Curve - Volusia

Volusia County | Facilities						
Facility	Projected Year of Inundated *(by Projection Rate Curve)*					
	Intermediate			High		
	2040	2070	2100	2040	2070	2100
Smokey's Heliport						
Coast Guard Station (Ponce)						
R&B Barn 3 - NE Complex						
Evac Parking Lot 2 - Holly Hill						
Holly Hill Public Works						
New Smyrna Transp. Terminal						
Votran Bus Terminal @Mary McLeod Bethune/Hibiscus						
Florida National Guard						
Holly Hill Evac Tower						
South Daytona Fire Station 99 Warehouse						

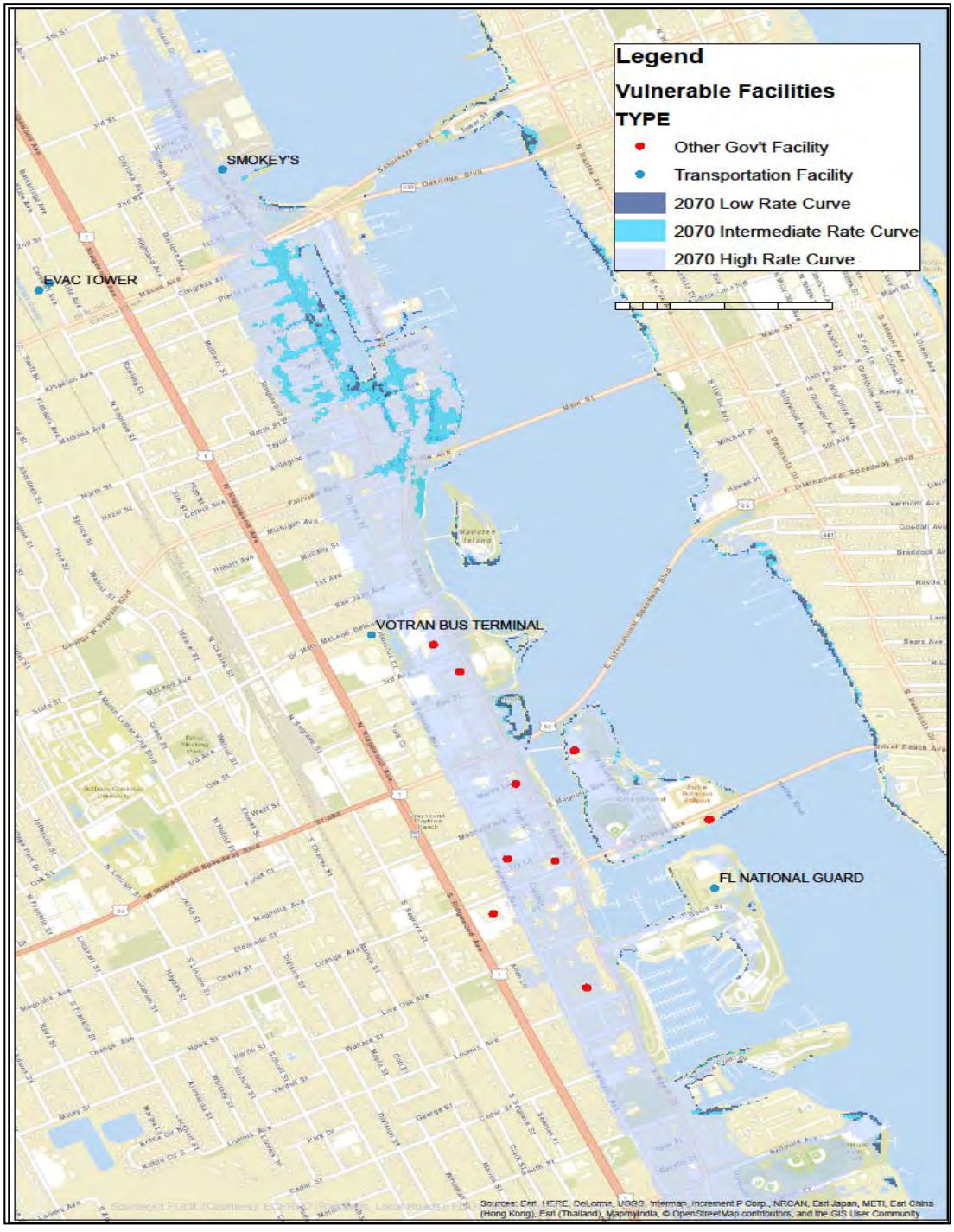
Figure 7: Facilities Vulnerable to sea level rise in Volusia County



The area of Holly Hill and Daytona Beach may experience significant impacts under the 2100 high projection rate curve scenario. Many various government facilities are located in this urban area. Most are impacted under the 2070/2100 high projection rate curve.

The figure below depicts the area of Holly Hill and Daytona Beach vulnerable to inundation in 2070 under each projection rate curve. As illustrated, there is a significant increase in area vulnerable by 2070 under the high rate curve compared to the intermediate rate curve.

Figure 8: Daytona Beach and Holly Hill area vulnerable to potential inundation by 2070 illustrated by each projection rate curve.

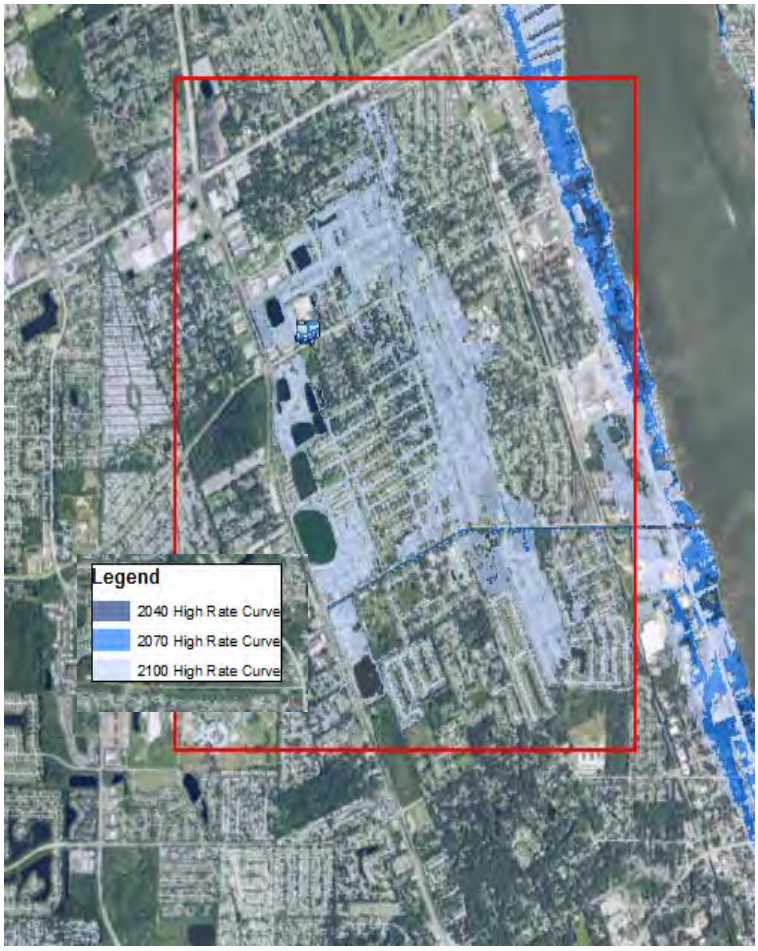


*The County's Road and Bridge Division in **Holly Hill** may be vulnerable to sea level rise by 2070 under the high projection rate curve. Access to this area may also be compromised.*

The figure below illustrates potential impacts in this area under High Rate Curve from 2040- 2100.

*While the Votran facility on **Big Tree Rd** itself may not be inundated under any scenario, the area surrounding the facility may be vulnerable to impacts under the 2100 HPRC as shown below. Other facilities in the Flagler and Volusia County may be subject to similar circumstances that may impact access or increase flooding potential during prolonged rainfall events or tropical storm events.*

The figure below illustrates potential impacts under the High Rate Curve from 2040-2100 in the area of Big Tree Rd.



Sidewalks and Trails

The threat of sea level rise to the multi-use paths and sidewalk networks in Flagler and Volusia County was also completed as part of this effort. A summary of the findings from these analyses is below. Due to the continuous building of sidewalk infrastructure, to maintain a more consistent analysis of impacts, it may be more feasible to first assess the roadways (local and above) that are vulnerable to inundation and use these findings to further assess impacts to sidewalks.

In Flagler County, local roadways in the area north of Moody Blvd. in Flagler Beach vulnerable to inundation from Smith Creek and Silver Lake, in turn, impacting sidewalks in these areas. This inundation may stretch along the entire coastline up to Beverly Beach.

In Palm Coast, in the Bon Terra and Hammock Beach area through The Washington Oaks Gardens State Park to the northern county line, access to neighborhood streets and sidewalks are at a high risk for inundation under the high projection rate curve. Also in this area, sections of the FIND Trail may begin to experience inundation as early as 2040 under all rate curves.

Sections of the FIND Trail in the Palm Coast may be vulnerable to inundation as early as 2040 in the Fox Cut area. The illustration depicts 2070 scenarios.

To the north of Washington Oaks Gardens State Park, Marineland, the county's northernmost area, may be highly susceptible to sea level rise by 2100 under the high rate curve. Facilities along SR A1A may be susceptible to inundation and erosion, as well as the Legacy Trail, along Pellicer Creek.

In Volusia County, a majority of the potentially inundated sidewalks and trails are located along the barrier islands to the east of the lagoon system. Roadway facilities along SR A1A and South Peninsula Drive in New Smyrna Beach are projected to be inundated. A loss or inundation obstruction of sidewalk connectivity along SR A1A, even just under high tides, pose a safety hazard for residents and visitors. In addition to these facilities, a number of off-road trail, boardwalk and sidewalk systems are projected to be inundated to the north and south of Ponce Inlet.

Volusia County's sidewalk and trail system is also vulnerable to the west of the Indian River Lagoon and Halifax River. Projected sea level rise inundation typically stretches 0.2 to 0.5 miles inland from the lagoon system. Because of this, US Highway 1 is among the most vulnerable sidewalk networks. Sidewalk inundation is expected to occur extensively in Daytona Beach, as early as 2040. This could have major economic and safety impacts in the area due to the high tourism industry in Daytona Beach and surrounding areas. Consideration should be given to show how sea level rise may impact tourism, as beach – related tourism is a major traffic generator. If use of the beach is impacted by sea level rise and erosion, the effect on the economy and traffic could be significant. Additionally, impacts may also be realized up to one mile inland, under the high projection rate curve due to the creeks that come in north of Ormond Beach and south of Port Orange. West International Speedway Boulevard, Mason Avenue and LPGA Boulevard – three highly traversed east-west roadways for bicyclists and pedestrians, are projected to have approximately 0.3 miles to 0.5 miles of inundation when measuring inundation under the high curve for the year 2100. Ormond Beach and New Smyrna Beach, as a whole, could also experience considerable sidewalk network obstruction by 2100 under the high rate curve; again illustrating the major tipping point between the 2070 and 2100-year horizon projections.

The Spring to Spring Trail systems are vulnerable to sea level rise along the western border with Lake County near lake Beresford and Blue Springs State Park. Other unpaved and trail and off-road walkways are projected to be inundated as well in these parks and conservation areas. The Coast to Coast Trail may also be impacted as early as 2040 near Lake Monroe and Lake Harney. Sections of the East Coast Greenway between Holly Hill and Port Orange may begin to see impacts as early as 2040 as well as the King's Highway Heritage Trail in Ormond Beach. Many of these impacted areas mimic the sidewalk analysis. Conservation area trails such as the Merritt Island National Wildlife Refuge Trail, Tomoka State Park Trail, Bulow Creek Trail and a large extent of World's Most Famous Beach Trail are extremely vulnerable to sea level rise by 2040 under each curve, as would be expected from the context and location of the trails.

In Daytona Beach, sea level rise is expected to impact transportation infrastructure including sidewalks as early as 2040 as shown below. Red are the most vulnerable as these segments are expected to be impacted under the low rate curve by 2040. Orange represents the intermediate curve and yellow the high. (2070 sea level rise is depicted in blue to provide additional perspective).

V. Stormwater Storage Impacts

Many roadways traverse lower elevations and are more likely to experience flooding during evacuation events. With sea level rise, existing stormwater ponds may fail resulting in additional flooding of roadways. This flooding could be compounded due to rising groundwater tables which may become higher commensurate with sea level rise. It should be noted that this analysis does not take into account the impacts of increased storm surge due to sea level rise and does not include analysis of increases in the water table. This additional analysis is critical in order to maintain the health, safety and welfare of the general public.

The rate at which gravity can drain an area depends, in part, on the difference in elevation between the area being drained and the place to which the water flows. The greater the difference in elevation, the greater the slope of the "hydraulic head" and the faster the water can drain. Lower elevations, particularly populated areas proximate to the coast and the St Johns River, will be more susceptible to tidal flooding with changes to sea levels. This combination can severely hinder natural drainage. Roadways that traverse lower areas or that approach bridges near rivers may be inundated.

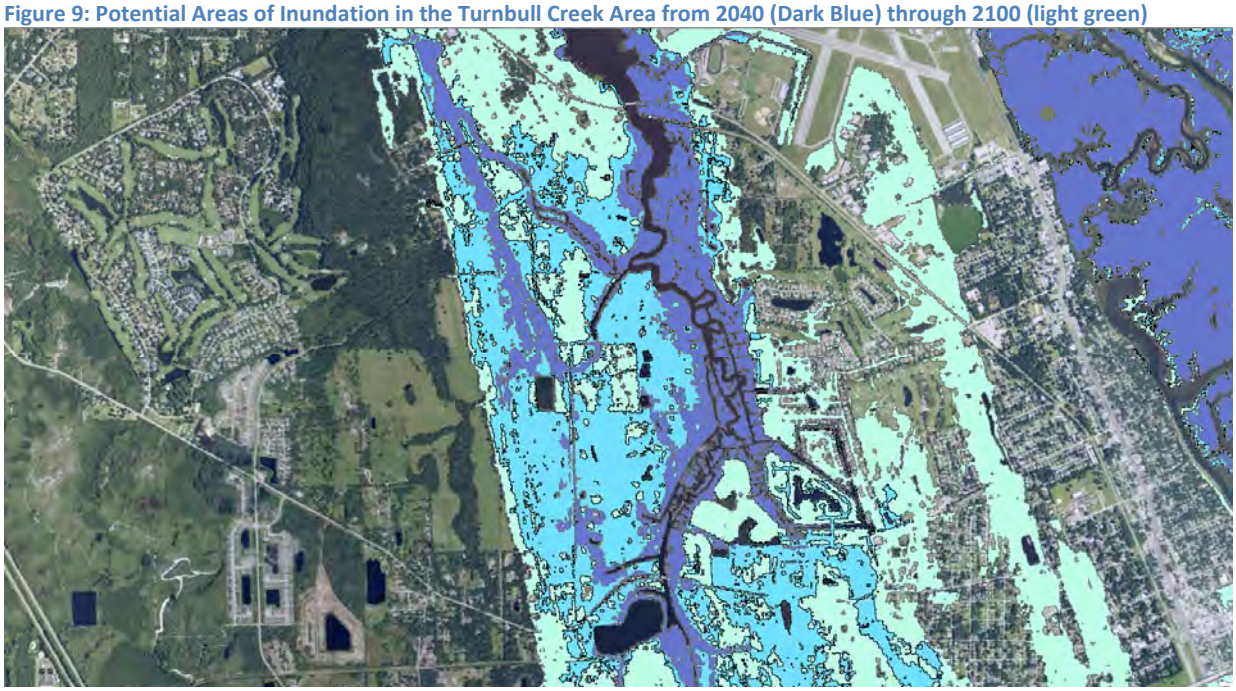
High tides can decrease the difference in elevation and during rain events, saturated soils will prevent permeation, resulting in more standing water. With high storm events, drainage systems can be ineffectual until water levels have subsided. Due to sea level rise, the failure of existing drainage systems will be more common and additional planning and engineering will be needed to ensure that systems work.

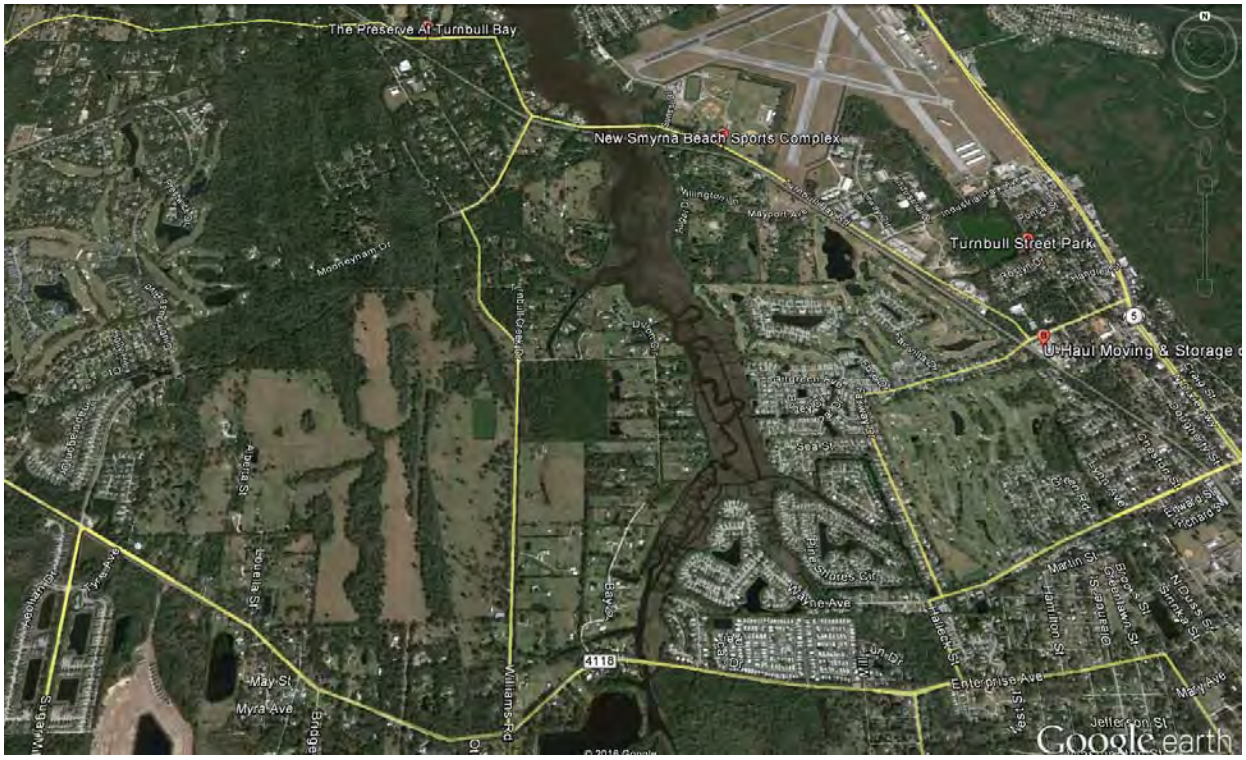
According to the Journal of Water Resources Planning and Management, there are three general strategies to address these issues: enhanced gravity drainage, forced drainage and adaptation to increased flooding. Gravity drainage can be improved by using larger pipes or wider drainage channels. Communities with drainage systems in place can either install supplemental pipe systems or replace old pipes with larger ones. Setbacks from canals and waterways can be increased to prevent flooding and to allow for dredging to increase volumes. Locks and flap gates may be useful to allow drainage during low tides and prevent back flow during surges or high tide events. Some critical areas may need to install forced pumping systems in lieu of gravity systems. Detention basins can be enlarged and other techniques such as infiltration trenches, porous pavement, rooftop detention, storage in playgrounds and parking areas, etc. are other options. Additional detention basins higher in the drainage basin may help deter the accumulation of water in lower areas and reduce the peak discharge.

Evacuation routes and critical infrastructure can be mitigated against higher waters by elevating roads, relocating critical buildings out of lower areas or flood proofing buildings. Federal or state funding may be available for these purposes, and should be considered when building or expanding facilities. Planners and engineers should be considering the impacts of climate change, surge events and sea level rise to lessen future costs from storm events. Also, the counties should work with the SJRWMD to determine vulnerable ground water storage and identify areas where mitigation ponds can be located.

The screenshots below illustrate the potential need for additional stormwater facilities or other strategies adjacent to Turnbull Creek. In the model screenshot, several areas may be impacted by the year 2040 (dark blue), and more widespread areas may be impacted by 2070 (blue) and 2100 (light green). Planning for these areas could include hydrological solutions or comprehensive plan changes that may lessen potential impacts to the area (Google Earth screenshot).

Figure 9: Potential Areas of Inundation in the Turnbull Creek Area from 2040 (Dark Blue) through 2100 (light green)





VI. Next Steps

The ECFRPC recommends that the R2CTPO to consider the following actions in order to fulfill directives such as FAST Act and Executive Order 13653 and to collaborate with local jurisdictions in order to address new Comprehensive Plan legislation pertaining to sea level rise and resiliency, including HB 720 and SB 1094.

- The agency will benefit from compiling case studies of how other coastal transportation planning organizations have addressed resiliency strategies. While one size does not fit all, the case studies may present creative and viable tools, strategies and recommendations for the R2CTPO.

- Continue discussions that will lead to the establishment of a standardized assessment of projects, programs and other transportation efforts and adopt a base sea level rise modeling scenario inclusive of projection rate curve year as well as probability modeling. This would provide a standard base level assessment for reviewing current and future projects for vulnerability, mitigation efforts and costs.

- Continue discussions that will lead to a determination of the vulnerability horizon and probability appropriate for projects included in the next LRTP to minimize the potential impacts from sea level rise.

- Review and consistency in TPO plans, programs and procedures, such as Corridor Improvement Plans and the Long Range Transportation Plan, is important as the TPO establishes policies and programs towards resiliency.

- Further identify and analyze impacts to storm water ponds to determine if additional countermeasures are appropriate to ensure functionality.

- Continue collaboration and coordination with other agencies, organizations and jurisdictions in outreach efforts, data collection, policy development, planning, floodplain management and other efforts that reduce impacts of sea level rise and flooding.

- Further analyze Low Impact Development (LID) and Green Streets Infrastructure techniques that provide innovative methods to lessen the impacts of stormwater runoff and to preserve recharge areas that may assist in the reduction of existing and future flooding.

Appendix

The Evacuation Routes and connections and ramps associated with these routes that were analyzed are below.

VOLUSIA COUNTY – ROAD NAME	
BEVILLE RD	I-95 SB LPGA OFF RAMP
BEVILLE WB I-95 NB ON RAMP	I-95 SB SR 44 EB OFF RAMP
BEVILLE WB I-95 SB ON RAMP	I-95 SB SR 44 OFF RAMP
DEBARY I-4 EB ON RAMP	I-95 SB SR442 OFF RAMP
DIRKSEN I-4 WB ON RAMP	I-95 SB US 92 OFF RAMP
DUNLAWTON AV	LPGA BLVD
DUNLAWTON BLVD	LPGA EB I-95 NB ON RAMP
DUNLAWTON EB I-95 ON RAMP	LPGA EB I-95 ON RAMP
DUNLAWTON I-95 NB ON RAMP	LPGA WB I-95 NB ON RAMP
DUNLAWTON I-95 ON RAMP	LPGA WB I-95 SB ON RAMP
DUNLAWTON WB I-95 ON RAMP	LYTLE AV
E GRANADA BLVD	MASON AV
E INTL SPEEDWAY BLVD	N ATLANTIC AV
E NEW YORK AV	N CR 415
E ORANGE AV	N DIXIE FREEWAY
E SR 40	N NOVA RD
FLAGLER AV	N RIDGEWOOD AV
GRANADA BLVD	N SPRING GARDEN AV
GRANADA I-95 ON RAMP	N SR 415
I-4	N US 1
I-4 EB DEBARY OFF RAMP	N WILLIAMSON BLVD
I-4 EB I-95 NB ON RAMP	N YONGE ST
I-4 EB I-95 SB ON RAMP	NEW YORK AV
I-4 EB SR44 OFF RAMP	NOVA RD
I-4 EB US 92 ON RAMP	OCEAN SHORE BLVD
I-4 WB DIRKSEN OFF RAMP	ORANGE AV
I-4 WB SR44 OFF RAMP	RIDGEWOOD AV
I-95	S ATLANTIC AV
I-95 GRANADA OFF RAMP	S CAUSEWAY
I-95 NB BEVILLE OFF RAMP	S DIXIE FREEWAY
I-95 NB DUNLAWTON EB RAMP	S NOVA RD
I-95 NB DUNLAWTON OFF RAMP	S PENINSULA AV
I-95 NB DUNLAWTON WB RAMP	S RIDGEWOOD AV
I-95 NB I-4 ON RAMP	S SR 415
I-95 NB LPGA EB OFF RAMP	S US 1
I-95 NB LPGA OFF RAMP	S YONGE ST
I-95 NB LPGA WB OFF RAMP	SEABREEZE BLVD
I-95 NB SR 44 OFF RAMP	SILVER BEACH AV
I-95 NB SR 442 OFF RAMP	SR 40
I-95 NB US 92 OFF RAMP	SR 44
I-95 SB BEVILLE ON RAMP	SR 44 EB I-95 ON RAMP
I-95 SB DUNLAWTON EB RAMP	SR 44 WB I-95 ON RAMP
I-95 SB DUNLAWTON OFF RAMP	SR 442 EB I-95 ON RAMP
I-95 SB DUNLAWTON WB RAMP	SR 442 WB I-95 ON RAMP
I-95 SB I-4 ON RAMP	SR 46

SR A1A	US 92 WB I-95 SB ON RAMP
SR44 I-4 EB ON RAMP	US 92 WB I-95 NB ON RAMP
SR44 I-4 WB ON RAMP	US 92 WB I-95 SB ON RAMP
TAYLOR RD	W GRANADA BLVD
TOMOKA FARMS RD	W INDIAN RIVER BLVD
TURTLEMOUND RD	W INTL SPEEDWAY BLVD
US 92 EB I-95 ON RAMP	W NEW YORK AV
US 92 WB I-4 ON RAMP	W SR 40
US 92 WB I-95 NB ON RAMP	US 92 WB I-95 SB ON RAMP
US 92 WB I-95 ON RAMP	

VOLUSIA COUNTY- ROAD NAMES		
I 95	I-4 EB SR44 OFF RAMP	S SR 15A
US Hwy 1	I-4 EB US 92 ON RAMP	S TYMBER CREEK RD
US HWY 1	I-4 FRONTAGE RD	S VOLUSIA AV
US HWY 1 (DIXIE FREEWAY N)	I-4 W	S WILLIAMSON BLVD
US HWY 1 (DIXIE FREEWAY S)	I-4 WB DIRKSEN OFF RAMP	SAXON BLVD
US HWY 1 (RIDGEWOOD AV N)	I-4 WB ORANGE CMP OFF RMP	SAXON EB I-4 WB ON RAMP
US HWY 1 (RIDGEWOOD AV S)	I-4 WB SAXON EB OFF RAMP	SAXON I-4 EB ON RAMP
US HWY 1 (RIDGEWOOD AV)	I-4 WB SAXON WB OFF RAMP	SAXON WB I-4 WB ON RAMP
US HWY 1 (YONGE ST N)	I-4 WB SR 472 OFF RAMP	SERVICE RD
US HWY 1 (YONGE ST S)	I-4 WB SR44 OFF RAMP	SILVER BEACH AV
US HWY 1 N	I-95 N	SPRING GARDEN AV
US HWY 1 S	I-95 NB BEVILLE OFF RAMP	SPRING GARDEN RANCH RD
10TH ST	I-95 NB DUNLAWTON EB RMP	SPRUCE CREEK RD
5TH AV E	I-95 NB DUNLAWTON OFF RMP	SR 11
AIR PARK RD	I-95 NB DUNLAWTON WB RMP	SR 40
AIRPORT RD	I-95 NB GRANADA OFF RAMP	SR 40 (GRANADA BLVD E)
ARREDONDO GRANT RD	I-95 NB I-4 ON RAMP	SR 40 (GRANADA BLVD W)
ATLANTIC AV S	I-95 NB LPGA EB OFF RAMP	SR 40 E
BEACH ST	I-95 NB LPGA OFF RAMP	SR 40 W
BEACON LIGHT RD	I-95 NB LPGA WB OFF RAMP	SR 400 (BEVILLE RD)
BELLEVUE AV	I-95 NB OLD DIXIE OFF RMP	SR 415 N
BERESFORD AV EXT PH I	I-95 NB SR 44 OFF RAMP	SR 415 S
BERESFORD AV EXT PH II	I-95 NB SR 442 OFF RAMP	SR 421 (DUNLAWTON AV)
BEVILLE RD	I-95 NB US 92 OFF RMP	SR 430
BEVILLE WB I-95 NB ON RMP	I-95 NB US1 OFF RAMP	SR 430 (MASON AV)
BEVILLE WB I-95 SB ON RMP	I-95 PARALLEL RD	SR 430 (OAKRIDGE BLVD)
BIG TREE RD	I-95 S	SR 430 (SEABREEZE BLVD)
BLUE LAKE AV S	I-95 SB BEVILLE ON RAMP	SR 44
BROADWAY AV	I-95 SB DUNLAWTON EB RMP	SR 44 (LYTLE AV)
BUNNELL RD	I-95 SB DUNLAWTON OFF RMP	SR 44 (NEW YORK AV E)

CANAL ST	I-95 SB DUNLAWTON WB RMP	SR 44 (NEW YORK AV W)
CASSADAGA RD	I-95 SB GRANADA OFF RAMP	SR 44 EB I-95 ON RAMP
CAUSEWAY N	I-95 SB I-4 ON RAMP	SR 44 WB I-95 ON RAMP
CHILDRENS WAY	I-95 SB LPGA OFF RAMP	SR 441 (PENINSULA DR S)
CLYDE MORRIS BLVD	I-95 SB SR 44 EB OFF RAMP	SR 442 (INDIAN RIVER BLVD W)
COW CREEK RD	I-95 SB SR 44 OFF RAMP	SR 442 EB I-95 ON RAMP
CR 2002 (OLD DIXIE HWY)	I-95 SB SR442 OFF RAMP	SR 442 WB I-95 ON RAMP
CR 4009 (WILLIAMSON BLVD N)	I-95 SB US 1 OFF RAMP	SR 46
CR 4019 (LPGA BLVD)	I-95 SB US 92 OFF RAMP	SR 472
CR 4068 (BELLEVUE AV)	I-W EB US 92 ON RAMP	SR 472 I-4 EB ON RAMP
CR 4075 (ATLANTIC AV S)	INDIAN RIVER BLVD E	SR 472 I-4 WB ON RAMP
CR 4101	JACOBS RD	SR 472 ON-OFF RAMP
CR 4106 (VOORHIS AV E)	JOHN ANDERSON HWY	SR 472 US 17-92 OFF RAMP
CR 4116 (MAIN ST W)	JOSEPHINE ST	SR 472 US 17-92 SB OFF RMP
CR 4116 (ORANGE CAMP RD)	KICKLIGHTER RD	SR 483 (CLYDE MORRIS BLVD N)
CR 4118 (PIONEER TR)	LAKE HELEN OSTEEN RD	SR 483 (CLYDE MORRIS BLVD S)
CR 4139	LAKE WINONA RD	SR 5A (NOVA RD N)
CR 4146 (SAXON BLVD)	LAKESHORE DR	SR 5A (NOVA RD S)
CR 415 (TOMOKA FARMS RD)	LPGA BLVD	SR 5A (NOVA RD)
CR 415 N	LPGA EB I-95 NB ON RAMP	SR A1A
CR 4162 (DEBARY AV)	LPGA EB I-95 ON RAMP	SR A1A (3RD AV)
CR 4162 (DIRKSEN DR)	LPGA WB I-95 NB ON RAMP	SR A1A (ATLANTIC AV N)
CR 4162 (DOYLE RD)	LPGA WB I-95 SB ON RAMP	SR A1A (ATLANTIC AV S)
CR 4164 (FLORIDA AV)	MACY AV	SR A1A (CAUSEWAY S)
CR 4164 (HALIFAX AV W)	MADELINE AV	SR A1A (DUNLAWTON AV)
CR 4164 (MAYTOWN RD)	MADELINE AV EXT	SR A1A (DUNLAWTON BLVD)
CR 4164 (NEW SMYRNA BLVD)	MAIN ST	SR A1A (LYTLE AV)
CR 4164 (OSTEEN MAYTOWN RD)	MAIN ST I-4 EB ON RMP	SR A1A (OCEAN SHORE BLVD)
CR 421 (TAYLOR RD)	MARION ST	SR44 I-4 EB ON RAMP
CR 430 (MASON AV)	MARSH RD	SR44 I-4 WB ON RAMP
CR 483 (CLYDE MORRIS BLVD S)	MAYBERRY AV	STAGECOACH RD
CR 483 (CLYDE MORRIS BLVD)	MCGREGOR RD	SUGAR MILL DR
CR A1A (ATLANTIC AV S)	MERCERS FERNERY RD	TAYLOR BRANCH RD
CR A1A (TURTLEMOUND RD)	MIDWAY AV	TAYLOR RD

DAUGHARTY RD	MISSION DR	TURNBULL BAY RD
DEBARY AV	N AIRPORT RD	TURTLEMOUND RD
DEBARY I-4 EB ON RAMP	N AMELIA AV	TYMBER CREEK RD S
DIRKSEN DR	N BEACH ST	US 1 I-95 NB ON RAMP
DIRKSEN I-4 WB ON RAMP	N BLUE LAKE AV	US 1 NB I-95 SB ON RAMP
DR MARTIN L KING JR BTWY	N CLYDE MORRIS BLVD	US 17-92 SR 472 ON RAMP
DUNLAWTON EB I-95 ON RMP	N COUNTY RD 3	US 92 EB I-95 ON RAMP
DUNLAWTON I-95 NB ON RMP	N GARFIELD AV	US 92 WB I-4 ON RAMP
DUNLAWTON I-95 ON RMP	N HILL AV	US 92 WB I-95 NB ON RAMP
DUNLAWTON WB I-95 ON RMP	N KEPLER RD	US 92 WB I-95 ON RAMP
DUNN AV	N PREVATT AV	US 92 WB I-95 SB ON RAMP
DUNN AV EXT	N SAMSULA DR	US HWY 1 (RIDGEWOOD AV)
E BERESFORD AV	N SPRING GARDEN AV	US HWY 1 S
E FAIRVIEW AV	N STONE ST	US HWY 17-92 (CHARLES R BEALL BLVD N
E GRAVES AV	N SUMMIT AV	US HWY 17-92 (CHARLES R BEALL BLVD S)
E KICKLIGHTER RD	N TOMOKA FARMS RD	US HWY 17-92 (VOLUSIA AV N)
E MINNESOTA AV	N TYMBER CREEK RD	US HWY 17-92 (VOLUSIA AV S)
E ORANGE AV	N VOLUSIA AV	US HWY 17-92 (WOODLAND BLVD N)
E PLYMOUTH AV	N WILLIAMSON BLVD	US HWY 17-92 (WOODLAND BLVD S)
E TAYLOR RD	O POSSUM CAMP RD	US HWY 17 (CENTER ST N)
E VOORHIS AV	OLD DIXIE HWY	US HWY 17 (CENTER ST S)
EMPORIA RD	OLD DIXIE I-95 SB ON RAMP	US HWY 17 (WOODLAND BLVD N)
ENTERPRISE AV	OLD KINGS RD	US HWY 17 N
ENTERPRISE OSTEEN RD	OLD MISSION RD	US HWY 17 S
ENTERPRISE RD	OLD NEW YORK AV	US HWY 92 (INTL SPEEDWAY BLVD E)
FAIRVIEW AV	ORANGE AV	US HWY 92 (INTL SPEEDWAY BLVD W)
FATIO RD	ORANGE CAMP RD	VETERANS MEMORIAL PKWY
FLAGLER AV	ORANGE CMP I-4 WB ON RMP	VOLCO RD
FRENCH AV	PARK AV	VOLUSIA AV
GARFIELD RD	Penninsula	W BERESFORD AV
GEORGE W ENGRAM BLVD	PIONEER TR	W FRENCH AV
GLENWOOD RD	PONCE DELEON BLVD	W INTL SPEEDWAY BLVD
GRANADA I-95 NB ON RAMP	PREVATT AV	W MAIN ST
GRANADA I-95 SB ON RAMP	PROVIDENCE BLVD	W MINNESOTA AV
GRAND AV	REED CANAL RD	W OHIO AV
GRAVES AV	REED ELLIS RD	W PARK AV

HALLECK ST	RETTA ST	W PLYMOUTH AV
HAMILTON AV	REYNOLDS RD	W RHODE ISLAND AV
HAND AV	RHODE ISLAND AV	W TAYLOR RD
HAZEN RD	RICHARD PETTY BLVD	WALLACE RD
HIGHBRIDGE RD	ROSEWOOD AV	WALTER BOARDMAN LN
HOWLAND BLVD	S ATLANTIC AV	WASHINGTON ST
I-4 E	S BERESFORD RD	WAYNE AV
I-4 EB DEBARY OFF RAMP	S BLUE LAKE AV	WESTSIDE PARKWAY
I-4 EB I-95 NB ON RAMP	S COUNTY RD 3	WESTSIDE PKWY
I-4 EB I-95 SB ON RMP	S GRAND AV	WILLIAMSON BLVD
I-4 EB MAIN ST OFF RMP	S HILL AV	WILLIAMSON BLVD S
I-4 EB SAXON EB OFF RAMP	S KEPLER RD	WILLOW RUN BLVD
I-4 EB SAXON WB OFF RAMP	S LAKEVIEW DR	YORKTOWN BLVD
I-4 EB SR 472 OFF RAMP	S PREVATT AV	
	S SPRING GARDEN AV	

FLAGLER COUNTY EVACUATION ROUTES	
E Highway 100	S US Highway 1
E State Road 100	SR 100
Hammock Dunes Pkwy	St Rd 100
I 95	State Hwy 100
I-95	State Hwy 11
Moody Blvd	State Hwy 20
N Oceanshore Blvd	State Hwy 5
N US Highway 1	State Hwy A1A
N US Hwy 1	Surfview Dr
Oceanshore Blvd	US Highway 1
Palm Coast Pkwy	US Hwy 1
S Oceanshore Blvd	W Highway 100
	W Moody Blvd

FLAGLER COUNTY -ROAD NAMES	
Belle Terre Pkwy	Old Dixie Hwy
Bird of Paradise	Old Kings Rd
Central	Otis Stone Hunter
Citation	Palm Coast Pkwy
Colbert Ln	Palm Harbor
County Hwy 201	Parkview
County Road 13	Pine Grove
County Road 205	Pine Lake
County Road 302	Point Pleasant
County Road 304	Pritchard
County Road 305	Royal Palms Pkwy
Dupont Rd	Rymefire
E Highway 100	S Oceanshore Blvd
E State Road 100	S Old Dixie Hwy
East Hampton	S US Highway 1
Eric	Seminole Woods Blvd
Exit 278	Sesame
Exit 284	SR 100
Exit 289	St Rd 100
Farmsworth	State Hwy 100
Florida Pkwy Dr	State Hwy 11
Forest Grove Dr	State Hwy 13
Hammock Dunes Pkwy	State Hwy 20
Hargrove	State Hwy 5
I 95	State Hwy A1A
Lakeview	State Road 11
London	Surfview Dr
Londonberry	Town Center
Mahogany Blvd	US Hwy 1
Main	W Highway 100
Matanza Woods Pkwy	W Moody Blvd
Moody Blvd	Wellington
N Oceanshore Blvd	Whippoorwill
N US Hwy 1	White View Pkwy
Oceanshore Blvd	Wynnfield

Below is a list of facilities that were assessed. All facilities in the Volusia County Facilities File available were reviewed, however, below only includes the facilities assessed per this study. Rufus

TYPE	FACILITY NAME		TYPE	FACILITY NAME
AIRPORT	FLAGLER COUNTY AIRPORT		EOC	SALVATION ARMY
AIRPORT	LEFFLER		EOC	EOC-SOUTH DAYTONA CITY HALL / PD
AIRPORT	EAGLES NEST AERODROME		EOC	VOLUSIA COUNTY SCHOOL DISTRICT
AIRPORT	SKINNERS WHOLESALE NURSERY		EOC	DAYTONA BEACH POLICE DEPT
AIRPORT	DAYTONA BEACH INTL		EOC	EOC-OAK HILL POLICE DEPT
AIRPORT	SPRUCE CREEK		EOC	EOC-HOLLY HILL POLICE DEPT
AIRPORT	DELAND MUNI-SIDNEY H TAYLOR FIELD		EOC	EOC-PORT ORANGE POLICE DEPT
AIRPORT	BRADSHAW FARM		EOC	FOC- SOUTH DAYTONA CITY HALL
AIRPORT	PINE LAKES FARM		EOC	EOC-DELTONA CITY HALL
AIRPORT	DEEP WOODS RANCH		EOC	DAYTONA BEACH SHORES POLICE DEPT
AIRPORT	NORTH EXUMA		EOC	EMERGENCY MANAGEMENT
AIRPORT	BOB LEE FLIGHT STRIP		EOC	ADMINISTRATIVE CENTER-PAO-ESF19
AIRPORT	LAFAYETTE LANDINGS		EOC	ADMINISTRATIVE CENTER-PURCHASING-ESF7
AIRPORT	SOUTHERLAND STRIP		FLEET SERVICES	FLAGLER COUNTY FLEET SERVICES
AIRPORT	CEDAR KNOLL FLYING RANCH		FLEET SERVICES	FLAGLER SCHOOLS FLEET SERVIES
AIRPORT	NEW SMYRNA BEACH MUNI		FLEET SERVICES	VOLUSIA SCHOOL DISTRICT TRANSPORTATION TERMINAL
AIRPORT	MASSEY RANCH AIRPARK		HELIPORT	SMOKEY'S
AIRPORT	HIGHLANDER		HELIPORT	HALIFAX HOSPITAL MEDICAL CENTER
AIRPORT	BLUE RIDGE FLIGHTPARK		HELIPORT	WEST VOLUSIA MEMORIAL HOSPITAL HELISTOP
AIRPORT	ORMOND BEACH MUNI		HELIPORT	FLORIDA HOSPITAL-FISH MEMORIAL
AIRPORT	BIG 'G'		HELIPORT	BUDD DARLING
AIRPORT	CROSS CREEK FARMS		HELIPORT	DOAN
AIRPORT	PIERSON MUNI		HELIPORT	COAST GUARD STATION - PONCE INLET
AIRPORT	TRADEWINDS AERODROME		OTHER	HOLLY HILL EVAC TOWER
EOC	FLAGER COUNTY EOC		OTHER	FLORIDA NATIONAL GUARD
EOC	EOC-WATER TREATMENT CENTER		PUBLIC WORKS	FLAGLER COUNTY PUBLIC WORKS
EOC	FOC-FIRE STATION 57		PUBLIC WORKS	VOLUSIA COUNTY PUBLIC WORKS AND BARNS
EOC	CITY OF ORMOND		PUBLIC WORKS	JURISDICTIONAL PUBLIC

	BEACH EOC			WORKS
EOC	CITY OF DEBARY EOC		PUBLIC WORKS	PALM COAST PUBLIC WORKS
EOC	CITY OF DELAND EOC		SEAPLANE BASE	ALLIGATOR DRINK
EOC	EOC-NEW SMYRNA BEACH STATION 51		SEAPLANE BASE	SANFORD
EOC	FOC-PORT ORANGE PUBLIC WORKS		SEAPLANE BASE	SANFORD
			TRANSIT	VOTRAN FACILITIES

River to Sea

Transportation Planning Organization

Sea Level Rise Vulnerability Assessment

July 2016

Prepared by:

East Central Florida Regional Planning Council
est. 1962

River to Sea Transportation Planning Organization
VISION - PLAN - IMPLEMENT
TPO