# Alligator Point Coastal Resiliency Alternatives Analysis

Completed by:

Apalachee Regional Planning Council and WSP

Funded by the Florida Department of Environmental Protection (Florida Resilient Coastlines Program grant) and the Northern Gulf of Mexico Sentinel Site Cooperative.

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## Acronyms and Abbreviations

| | |
|---|---|
| APVFS | Alligator Point Volunteer Fire Station |
| APWRD | Alligator Point Water Resources District |
| ARPC | Apalachee Regional Planning Council |
| Cat | Category (hurricane strength) |
| E & E | Ecology and Environment, Inc., now WSP USA Inc. |
| FDEP | Florida Department of Environmental Protection |
| FEMA | Federal Emergency Management Agency |
| ft | feet |
| in/yr | inches per year |
| kn | knots |
| lf | linear feet |
| NACCS | North Atlantic Coast Comprehensive Study |
| NOAA | National Oceanic Atmospheric Administration |
| mm/yr | millimeters per year |
| NAVD88 | North American Vertical Datum of 1988 |
| TS | Tropical Storm |
| USACE | U.S. Army Corps of Engineers |
| USGS | United States Geological Survey |
| VFD | Volunteer Fire Department |
| WSP | WSP USA Inc. |

# 1.0 Introduction and Objectives

Under contract to the Apalachee Regional Planning Council (ARPC), WSP USA Inc. (WSP), formerly Ecology and Environment, Inc. (E & E), has completed a high-level vulnerability assessment for Alligator Point, which is in the southeast corner of Franklin County, Florida. The overall intent of this project is to further public discussion regarding potential management strategies to increase the long-term resilience of the Alligator Point community. This report documents work completed to assess vulnerabilities and provides a matrix of the primary strategies available for increasing coastal resilience.

Activities associated with this study included:

1) Compilation of data regarding topography, bathymetry, tidal datums, wind records, and sea level rise; and
2) Characterization of community assets that should be considered.
3) An evaluation of alternatives

See **Figure 1** below for a map of the study area.

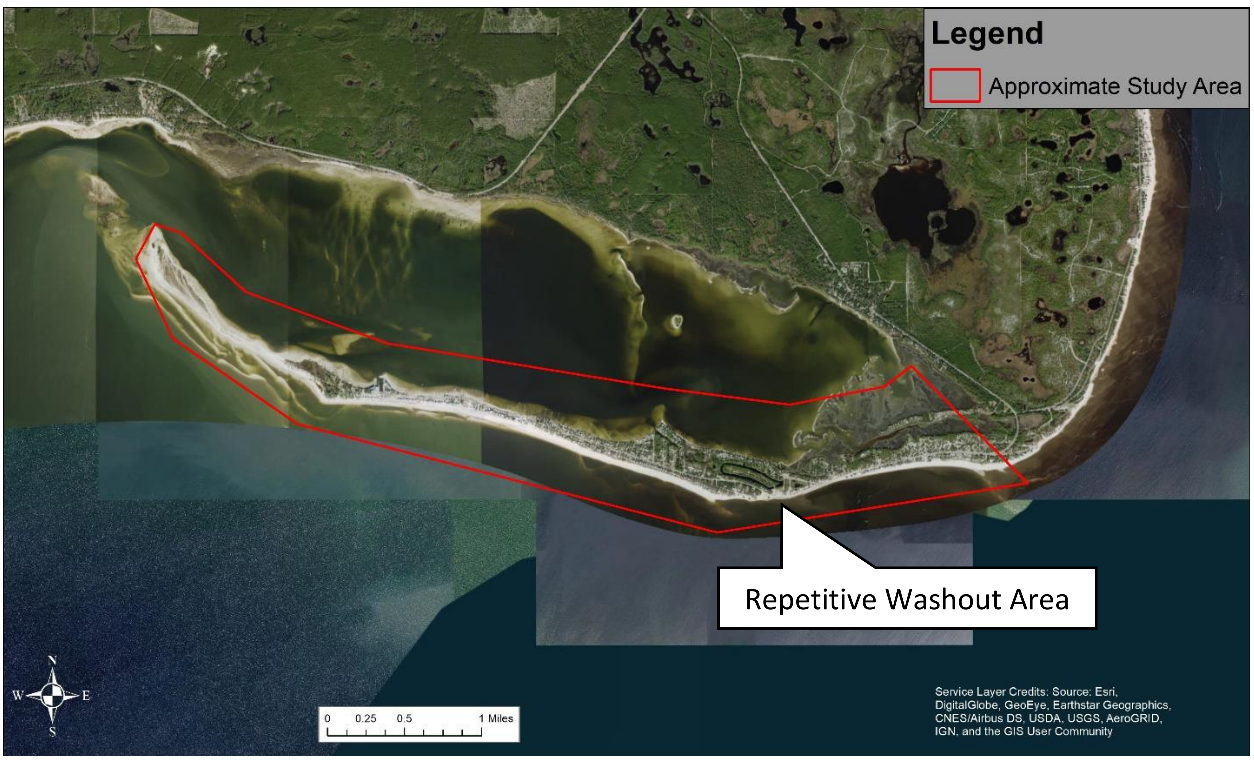



*Figure 1: Map illustrating the boundaries (red line) of the Alligator Point study area, as well as the location where Alligator Drive frequently gets damaged by large storm events.*

# 2.0 Physical Conditions

## 2.1 Elevation

The elevation of the Alligator Point peninsula is relatively low, with most areas being less than 10 feet (ft) above sea level. However, elevation does exceed 14 ft above sea level (yellow line, **Figure 2**) within a few narrow tracts of land within the middle-right regions of the study area (**Figure 3**).

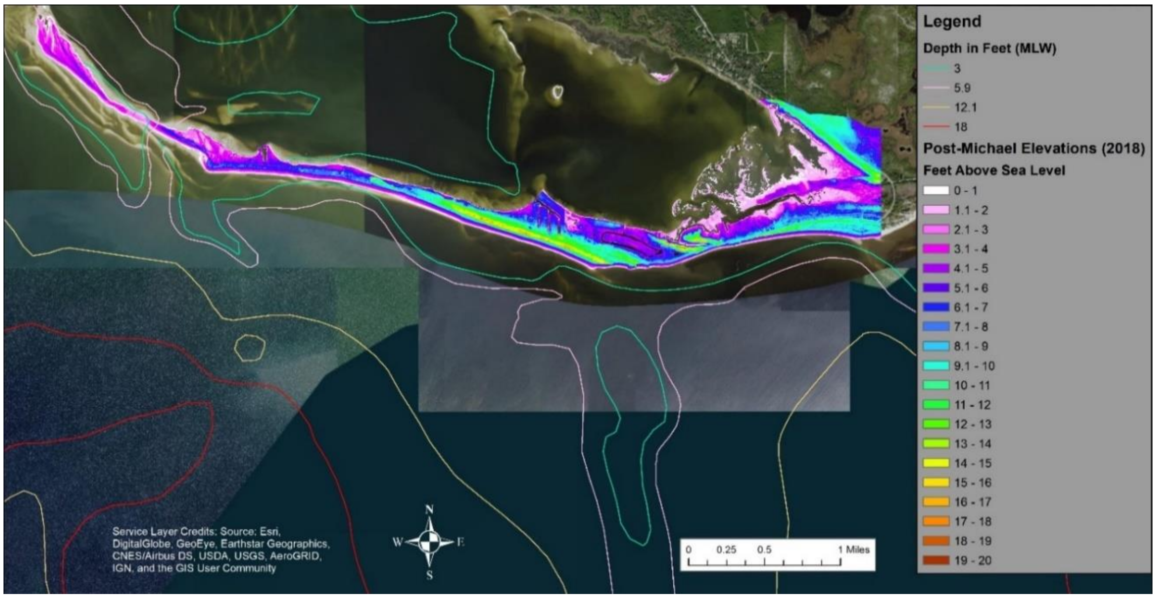



*Figure 2: Elevations of the study area.*

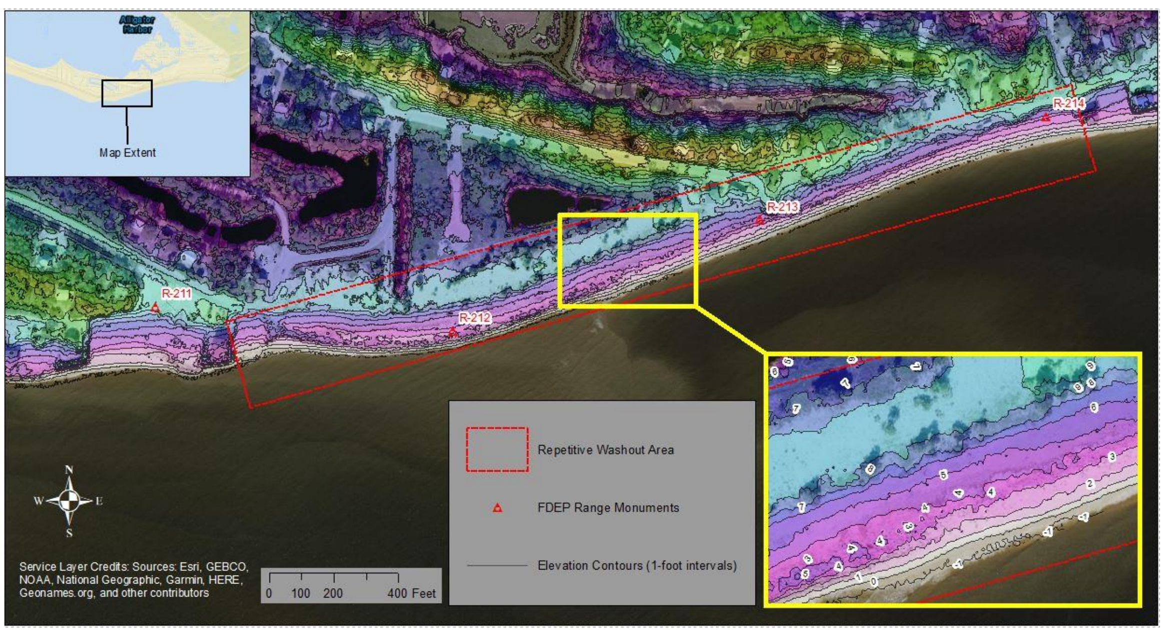



*Figure 3: Repetitive washout area with elevations. Florida Department of Environmental Protection range monuments are also shown (as red triangles).*

## 2.2 Geology

Alligator Point is comprised of unconsolidated sediments (sand/mud), which is frequently reconfigured by wind, waves, and currents. The map in **Figure 4** below shows the soil types that make up the Alligator Point peninsula. The entisols and histosols (soil types) present are mixed materials, typical of sediments that have traveled down rivers and along the coast.

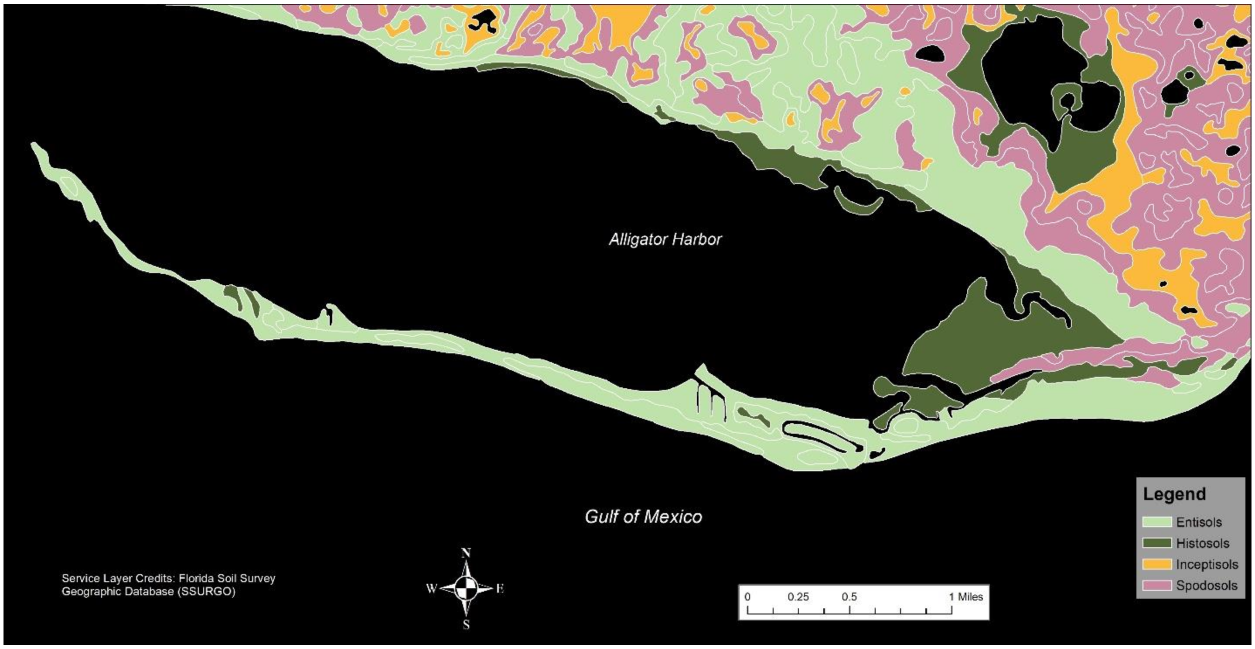



*Figure 4: Map of soil types within the study area.*

## 2.3 Tide Range and Water Levels

Two National Oceanic and Atmospheric Administration (NOAA) tidal benchmarks located in proximity to the study area were used to estimate tidal range and associated water levels:

- Alligator Point, Southwest Cape (Station 8728261) is located on the south shore of Alligator Point, approximately 0.6 miles west of the area of road washout.
- Alligator Point (Station 8728288) is located on the north shore of Alligator Point, at Eastpoint, approximately 2.2 miles west of the area of road washout.

Data were gathered from the NOAA online data repository (https://tidesandcurrents.noaa.gov) for the Epoch 1983-2001 and are summarized in **Table 1**. Station datum data sheets obtained from the website are included in Appendix A.

*Table 1: Water level data representative of study area conditions collected at reference tidal benchmarks to the north (Station: 8728261) and south (Station: 8728288) of the study area from the NOAA online data repository. Data include water level data from each of the reference stations as well as water level datum and associated abbreviation information.*

| Datum (Epoch 1983-2001) | Abbreviation | Alligator Point, Southwest Cape | Alligator Point |
|---|---|---|---|
| Mean Higher-High Water (ft) | MHHW | 2.77 | 2.79 |
| Mean High Water (ft) | MHW | 2.55 | 2.55 |
| Mean Tide Level (ft) | MTL | 1.57 | 1.57 |
| Mean Sea Level (ft) | MSL | 1.49 | 1.49 |
| Mean Diurnal Tide Level (ft) | DTL | 1.38 | 1.4 |
| Mean Low Water (ft) | MLW | 0.58 | 0.61 |
| Mean Lower-Low Water (ft) | MLLW | 0 | 0 |
| North American Vertical Datum of 1988 (ft) | NAVD88 | 1.49 | 1.53 |

Key: ft = feet

## 2.4 Sea Level Rise

Local water level data were unavailable. Therefore, sea level trend analyses utilized data from the Apalachicola tide station (NOAA Station 8728690; https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8728690) which is located approximately 38 miles west of the study area. The average rate of relative sea level rise, as predicted by nearly 50 years of mean sea level data (1967 – 2019), is estimated at 2.56 millimeters per year (mm/yr; 0.10 inches per year [in/yr]) with a 95 percent confidence interval of ± 0.62 mm/yr (± 0.02 in/yr; **Figure 5**).

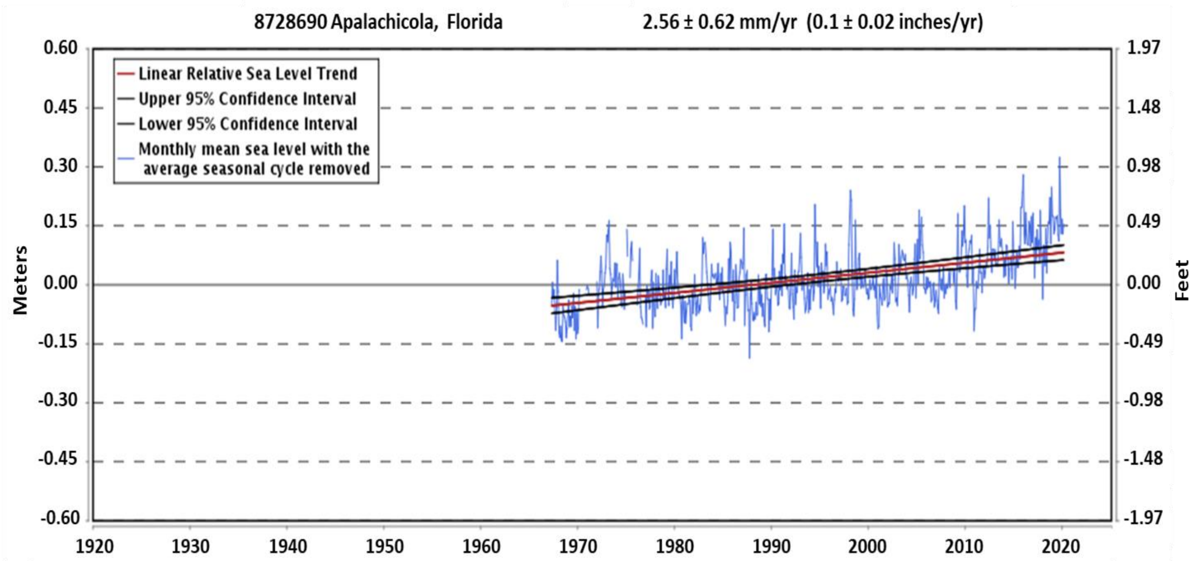



*Figure 5: Sea level rise trends representative of the study area. Long-term (i.e., 55 year) trends from a nearby tide station (Apalachicola, FL, Station 8728690) suggest sea levels are increasing at a rate of 2.56 mm/yr (0.1 in/yr) within the study area. This figure is adapted from the NOAA sea level rise trend tool to reflect water levels in US Standard Units (right y axis).*

## 2.5 Storm Surge

Similar to sea level rise analyses, long-term storm surge trend analysis was conducted using data from the nearby Apalachicola tide station (NOAA Station 8728690). To supplement these data and to obtain a better understanding of historic storm surge, a list of significant tropical storms was compiled from online Federal Emergency Management Agency (FEMA) data to include storms resulting in a major disaster area declaration for Franklin County. This list was later augmented to include additional storms noted within the 2018 Strategic Beach Management Plan, the 2019 Critically Eroded Beach report, and Franklin County records of road maintenance.

Water level data resolution at the Apalachicola Station is limited to only monthly averages in the years prior to 1990 and, as such, the storm surge analyses considered here included data from 1990 on (i.e., 1990 through 2020; ~30 years). Following FEMA data, 17 tropical storm events were reviewed as summarized in **Table 2** below. For each the storm, the maximum surge (maximum difference between measured and predicted tide level), peak wind, and peak wind gust were noted (hereafter, storm surge data; **Figure 6**). Storms for which data were not available are noted as "N/A."

WSP's review of storm surge data indicated that the highest surge reported within the survey period was associated with Hurricane Michael. During this intense storm, which reached Category 5 status shortly before making landfall with the Florida panhandle, water levels peaked at over 8 ft above predicted tide levels and winds peaked at 54 knots. Hurricane Dennis (a Category 4 storm) resulted in nearly 7 ft of storm surge above predicted water levels with winds peaking at about 41 knots (**Table 2** and **Figure 6**). Other major hurricanes (i.e., Earl, Ivan, and Hermine) each had storm surges estimated at between 4 to 5 ft with winds typically in the range of 30 to 35 knots (**Figure 6**). Interestingly, the maximum differences between the reported storm surge data and the predicted water levels for Hurricane Francis and Irma cases were negative.

*Table 2: Alligator Point Surge During Significant Tropical Events*

| | Category | Date | Max Stage Ft | Peak Wind kn | Peak Gust kn |
|---|---|---|---|---|---|
| Nestor | TS | 10/19/2019 | 3.6 | 26.1 | 31.7 |
| Michael | 5 | 10/10/2018 | 8.4 | 54.0 | 70.2 |
| Irma | 5 | 9/11/2017 | -3.4 | 33.6 | 44.3 |
| Hermine | 1 | 9/2/2016 | 4.1 | 33.8 | 42.8 |
| Collin | TS | 6/7/2016 | 2.3 | N/A | N/A |
| Isaac | 1 | 8/27/2012 | 3.4 | 24.5 | 30.7 |
| Debbie | TS | 6/24/2012 | 3.6 | 38.9 | 51.5 |
| Gustav | 3 | 10/27/2008 | N/A | N/A | N/A |
| Katrina | 5 | 8/4/2005 | N/A | N/A | N/A |
| Dennis | 3 | 7/10/2005 | 6.9 | 40.8 | 56.6 |
| Ivan | 5 | 9/15/2004 | 4.1 | 34.0 | 48.6 |
| Frances | 4 | 9/5/2004 | -3.1 | 30.5 | 40.6 |
| Charlie and Bonnie | TS | 8/12/2004 | 0.9 | 13.4 | 23.7 |
| Georges | 4 | 9/27/1998 | 2.9 | N/A | N/A |
| Earl | 2 | 9/3/1998 | 4.5 | N/A | N/A |
| Opal | 4 | 10/4/1995 | N/A | 27.6 | 43.9 |
| Alberto | TS | 7/8/1994 | N/A | 19.2 | 32.5 |

Key:
kn = knots; Ft = feet; TS = tropical storm

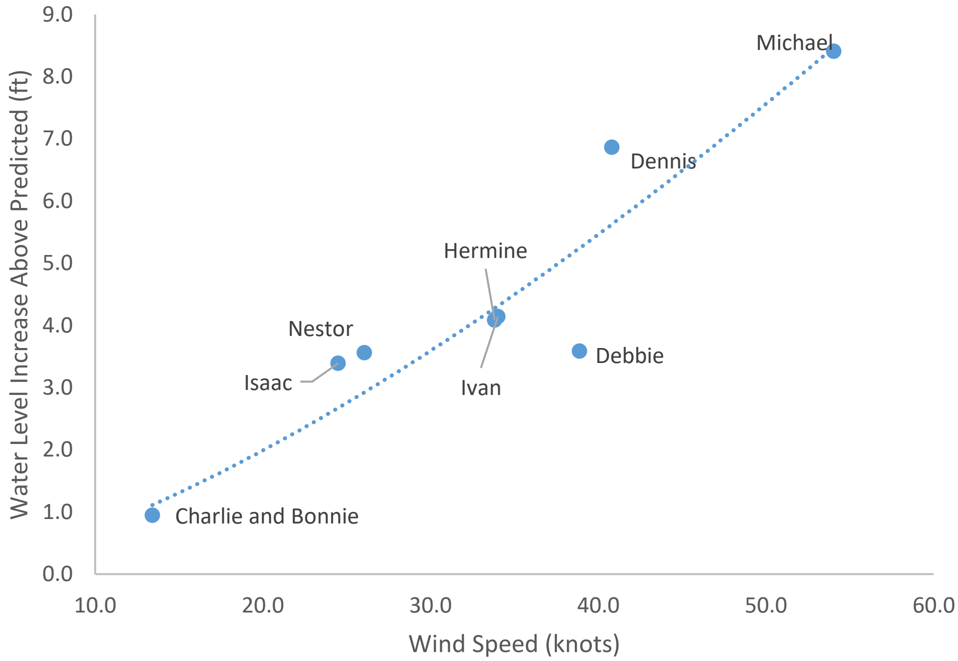



*Figure 6: Relationship between hurricane wind speed and surge level at Apalachicola Station.*

**Figure 7** below presents predicted inundation by storm surge for various storm. Much of the study area will be inundated during a Category 1 hurricane. **Figure 8**, which follows, presents FEMA flood zones. Most of the study area is Coastal High Hazard Area (referred to as the velocity or "VE zone"), which corresponds to areas subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action.

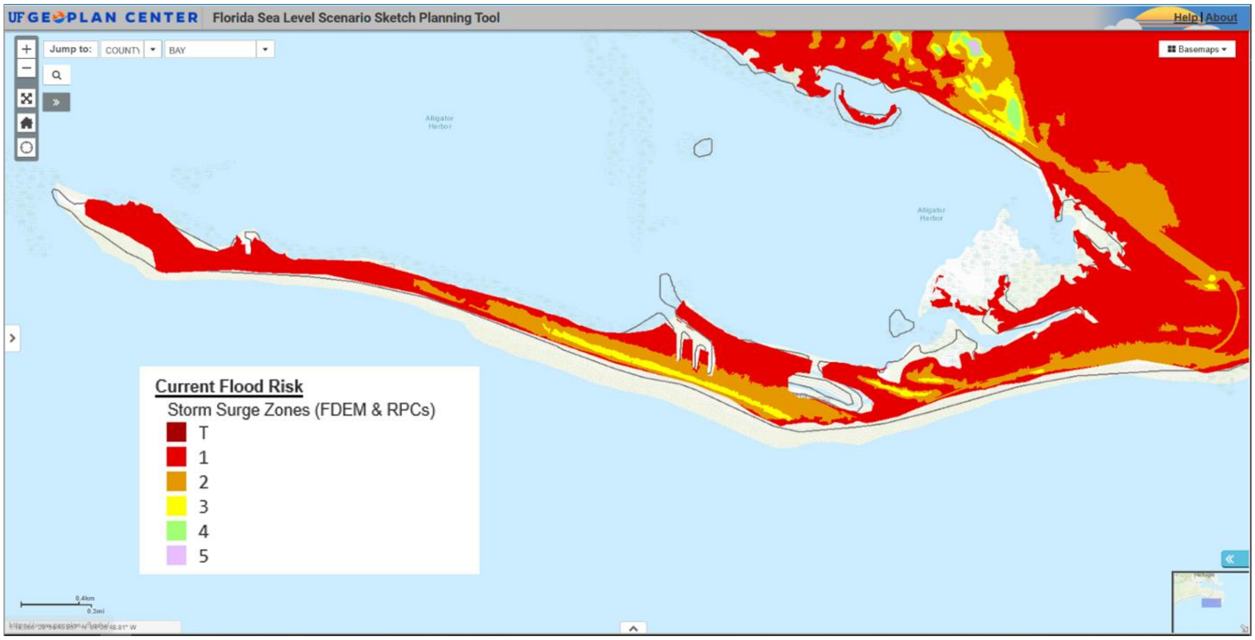



*Figure 7: Predicted inundation by storm surge, based on size of each storm. T= Tropical Storm, number indicates intensity category per the Saffir-Simpson scale. (Source: UF GeoPlan Center, Florida Sea Level Scenario Sketch Planning Tool)*

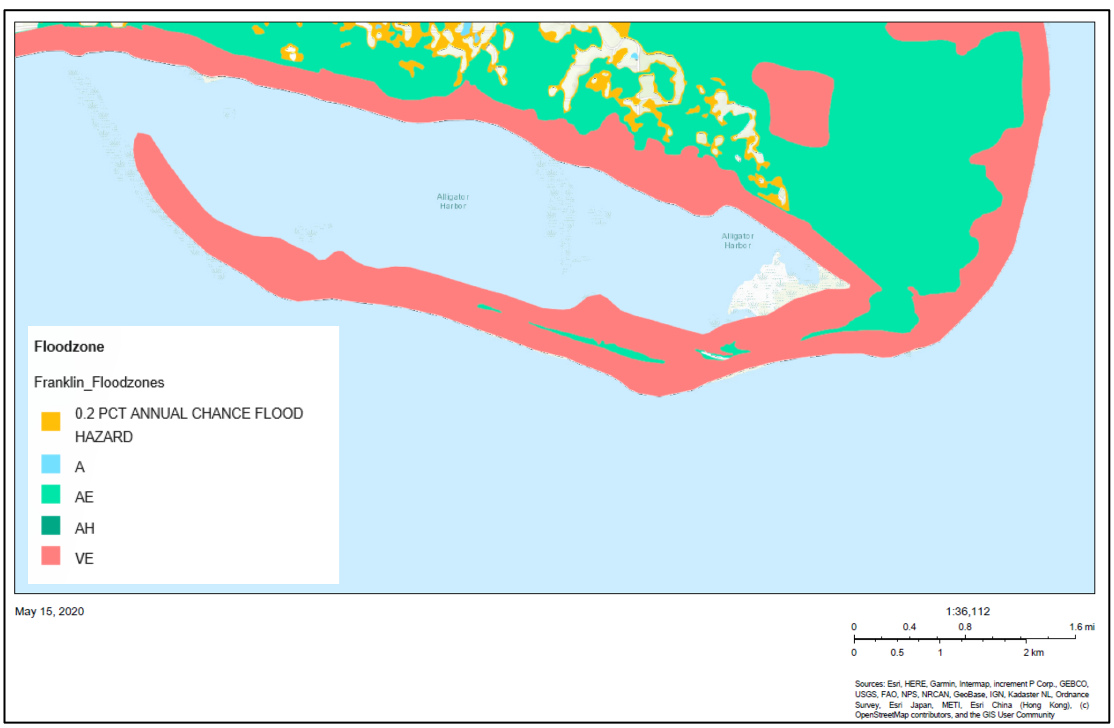



*Figure 8: This map shows the FEMA flood hazard zones for the study area. (Source: ARPC n.d.)*

## 2.6 Tropical Storm Damage

### 2.6.1 Strategic Beach Management Plan, 2018

WSP reviewed the Florida Department of Environmental Protection (FDEP) 2018 Strategic Beach Management Plan for the Panhandle Gulf Region which includes Alligator Point as part of the Ochlockonee Barriers. The plan described the 1.1-mile segment between the Southwest Cape and Lighthouse Point on St. James Island as critically eroded beach. The plan identifies the following events causing significant damage to County Road 370:

- 1985 Hurricanes Elena and Kate: Coastal protection structures destroyed, revetment was constructed using federal and state disaster funds.
- 1994 Tropical Storm Beryl: Further damage, emergency repairs and a revetment extension.
- 1998 Hurricane Earl: Further damage.
- 2005 Hurricane Dennis: Severe erosion, road abandoned between FDEP Range Monuments R212 and R213.

In 2000, a feasibility study was completed on the area between Alligator Point and Lighthouse Point. The feasibility study recommended replacement of beach fill and construction of T-groins. The project included a +13 ft dune and a berm +5 ft (North American Vertical Datum of 1988 [NAVD88]) and 80 to 240 ft wide from R210 to R225. The project was not completed.

The current strategy for the area identified in the 2018 plan is to conduct the beach restoration and monitor.

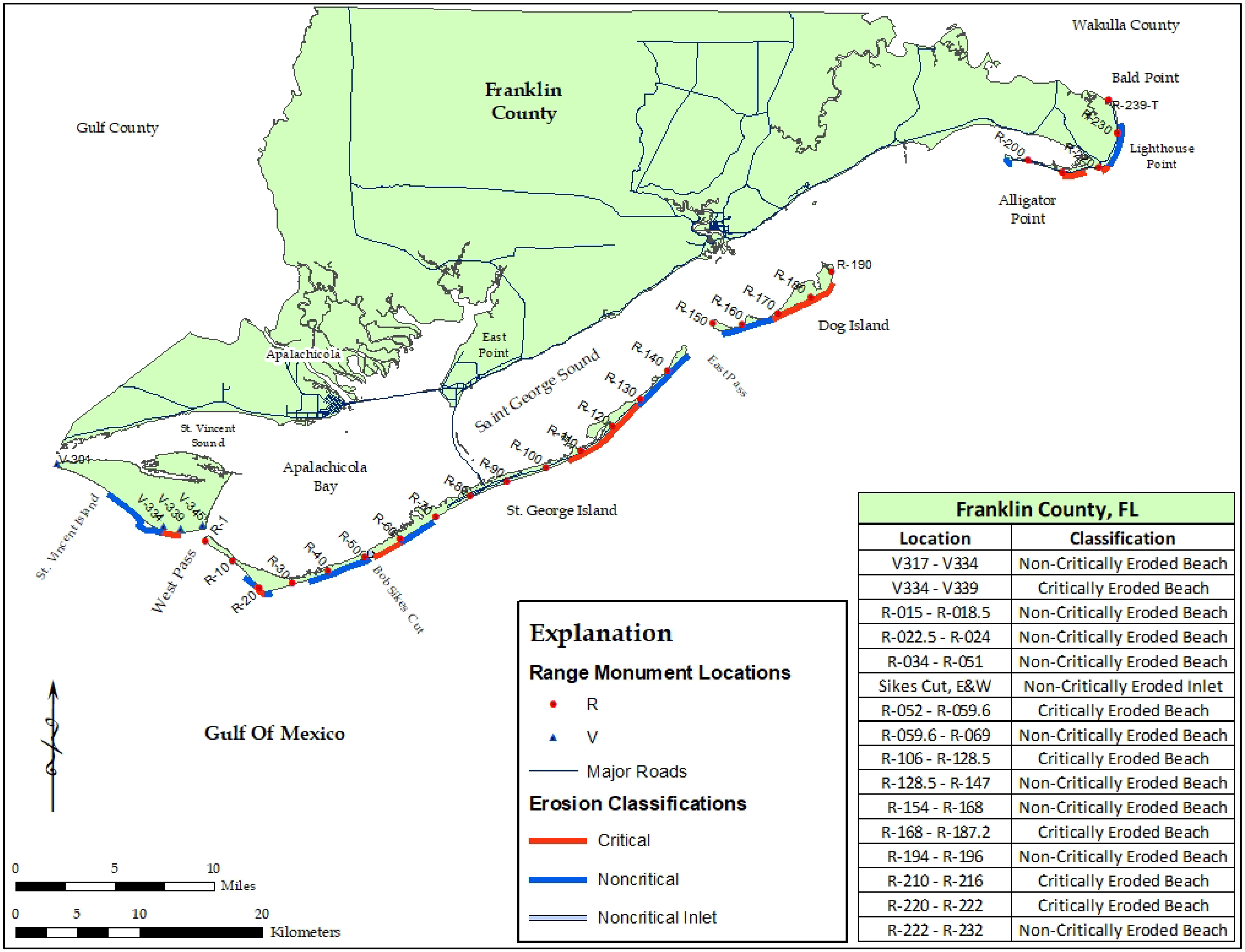
### 2.6.2 FDEP Critically Eroded Beaches, 2019

WSP reviewed the FDEP 2019 report, *Critically Eroded Beaches in Florida*, which provides an inventory of erosion areas along Florida's sandy beaches and coastal barrier tidal inlets. FDEP defines a critically eroded shoreline as:

> *"a segment of the shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost…."* (FDEP 2019)

Two locations on Alligator Point are referenced in the report, the first being the east end of Alligator Point (R210 – R216) between the Southwest Cape and Lighthouse Point. The area is classified as critically eroded for 1.1 miles and it is noted that erosion at the Southwest Cape has destroyed and continues to threaten private development and the adjacent county road. The second area is west end of Alligator Point (R194 – R196), part of the Phipps Preserve, which is noted as severely eroded for 0.4 miles. However, erosion into the Phipps Preserve is not considered a threat to any interests at this time.

**Figure 9** presents a map of Franklin County Critically eroded beaches.




| Franklin County, FL | |
|---|---|
| **Location** | **Classification** |
| V317 - V334 | Non-Critically Eroded Beach |
| V334 - V339 | Critically Eroded Beach |
| R-015 - R-018.5 | Non-Critically Eroded Beach |
| R-022.5 - R-024 | Non-Critically Eroded Beach |
| R-034 - R-051 | Non-Critically Eroded Beach |
| Sikes Cut, E&W | Non-Critically Eroded Inlet |
| R-052 - R-059.6 | Critically Eroded Beach |
| R-059.6 - R-069 | Non-Critically Eroded Beach |
| R-106 - R-128.5 | Critically Eroded Beach |
| R-128.5 - R-147 | Non-Critically Eroded Beach |
| R-154 - R-168 | Non-Critically Eroded Beach |
| R-168 - R-187.2 | Critically Eroded Beach |
| R-194 - R-196 | Non-Critically Eroded Beach |
| R-210 - R-216 | Critically Eroded Beach |
| R-220 - R-222 | Critically Eroded Beach |
| R-222 - R-232 | Non-Critically Eroded Beach |

*Figure 9: Critically eroded shoreline in Franklin County (FDEP 2019).*

Based on a review of 2020 imagery, significant damage is evident along an approximate 0.9-mile length of shoreline as shown in the **Figure 10** below.


*Figure 10: Alligator Point Existing Eroded Shoreline*

### 2.6.3 Franklin County Maintenance Records Review

The portion of Alligator Drive (County Road 370) from Southwest Cape to Lighthouse Point has historically presented a challenge to Franklin County due to its repetitive damage resulting from storm events. WSP received from the County a history of maintenance costs related to storm damage for the period from 1985 through 2016. The information is summarized by year in **Table 3**. The memorandum received from the County is included as Appendix B. Data were incomplete for the period from 1999 to 2003, thus the values reflected in the table are County estimates. In addition, the post- Hermine repair cost for a project, including a sheet pile sea wall, was not completed by the time Hurricane Michael caused additional damage. The current County estimate for repair of the road is about $4.7 million.

*Table 3: Summary of Road Maintenance Costs*

| Year | Road Maintenance Cost ($) | Events |
|---|---|---|
| 1990 | $0 | |
| 1991 | $125,000 | Non Declared Events |
| 1992 | $75,000 | Non Declared Events, Andrew |
| 1993 | $155,000 | Non Declared Events, Winter Storm |
| 1994 | $960,000 | Alberto, Beryl |
| 1995 | $100,000 | Opal |
| 1996 | $10,000 | Josephine |
| 1997 | $0 | |
| 1998 | $35,000 | Earl, Georges |
| 1999 | $40,000 (est.) | |
| 2000 | $40,000 (est.) | |
| 2001 | $40,000 (est.) | |
| 2002 | $40,000 (est.) | |
| 2003 | $40,000 (est.) | |
| 2004 | $315,000 | Non-Declared Events, Ivan |
| 2005 | $1,000,000 | Dennis |
| 2006 | $0 | |
| 2007 | $0 | |
| 2008 | $683,000 | Gustav |
| 2009 | $0 | |
| 2010 | $0 | |
| 2011 | $0 | |
| 2012 | $142,000 | Debbie |
| 2013 | $0 | |
| 2014 | $0 | |
| 2015 | $0 | |
| 2016 | $3,000,000 (est.) | Hermine |
| 2017 | $0 | |
| 2018 | $4,700,000 (est.) | Michael |
| 2019 | $0 | |
| 2020 | $0 | |

Maintenance costs identified in **Table 3** reflect costs at the time of the damage. These values were related current (2020) dollars assuming a 2.27 percent inflation rate (the average from 1990 through 2020). Both annual and cumulative damage costs are presented graphically in **Figure 11**. Review of the data indicates that relatively minor repairs were required annually in response to smaller events from 1990 to about 2005. These annual costs seemed to have been mitigated following Hurricane Dennis, when it is reported that the road was relocated and a revetment installed. However, mitigation measures proved inadequate against larger storms, particularly hurricanes Hermine and

Michael. If the post-Hermine repairs had been completed, damage caused by Hurricane Michael may have been less.

Over the past 30 years, over 14 million dollars (in 2020 dollars) in damages to Alligator Drive occurred as a result of storms. Average annual damages have been about $470,000. See **Figure 11** below.

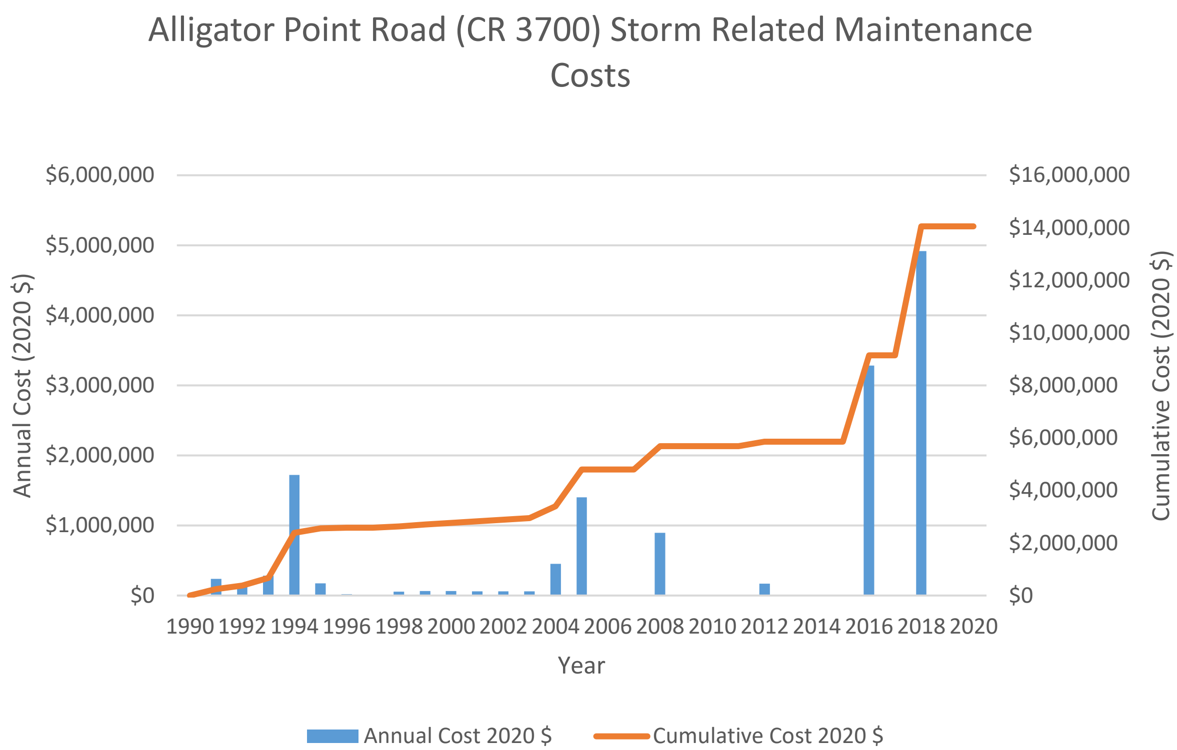



*Figure 11: This graph presents the recorded maintenance costs associated with road repairs for Alligator Drive since 1990.*

### 2.6.4 Damage Timeline

The above information was compiled to construct a timeline of damage events as presented on **Figure 12**.

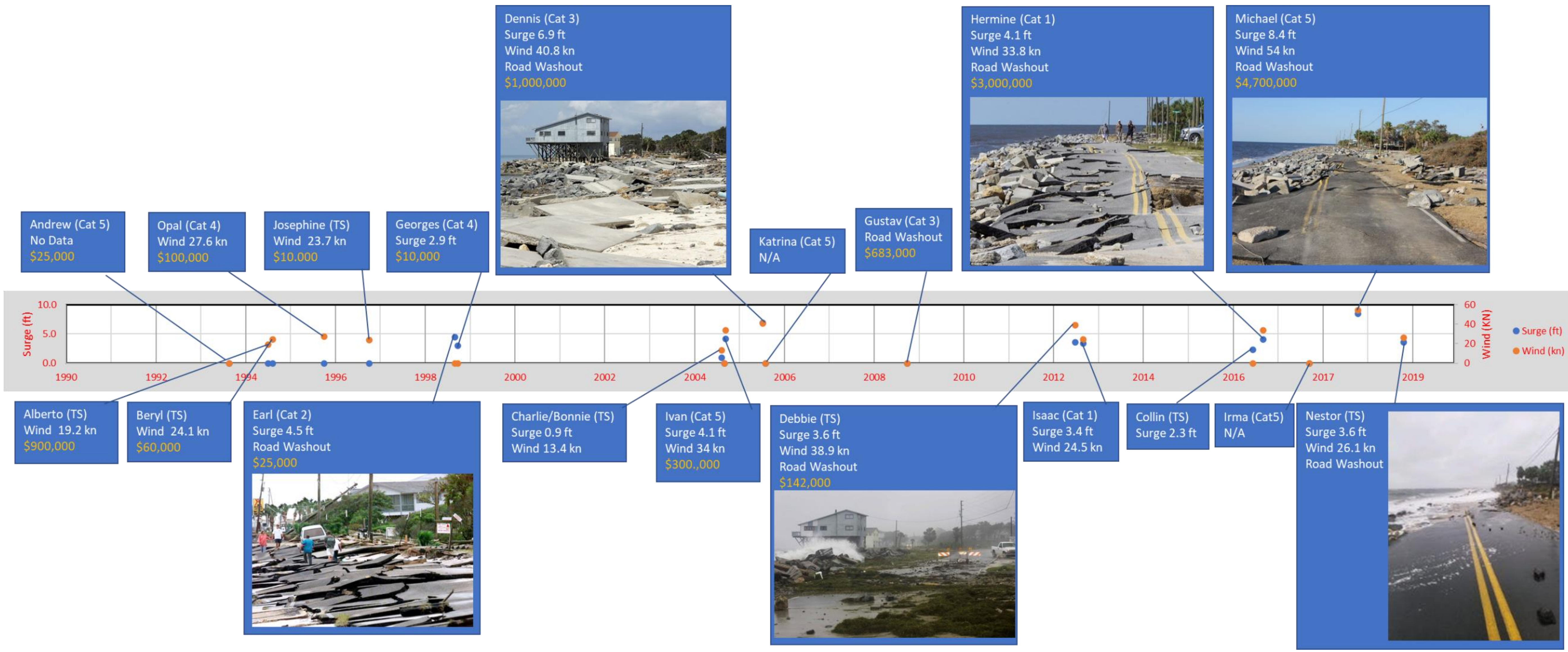



*Figure 12: Here is a summary of storm impacts to Alligator Drive since 1993. When available, wind and surge data, as measured by the tide gauge at the City of Apalachicola, is provided. Approximate repair costs are also provided (in orange text).*

## 2.7 Shoreline Changes

The shoreline along Alligator Point is extremely dynamic (**Figure 13**). Some shoreline segments to the east and west of study area are accreting sediments (**Figure 13**). Other segments, however, have suffered severe erosion. This erosion is particularly problematic along the segment between FDEP Range Monuments R-210 and R-214, which has receded nearly 1200 ft from historical markers and, in some spots, approximately 100 ft in the last 20 years (**Figure 14**). Appendix B shows the approximate historic shorelines based on aerial imagery since 1994 (accessed via Google Earth).

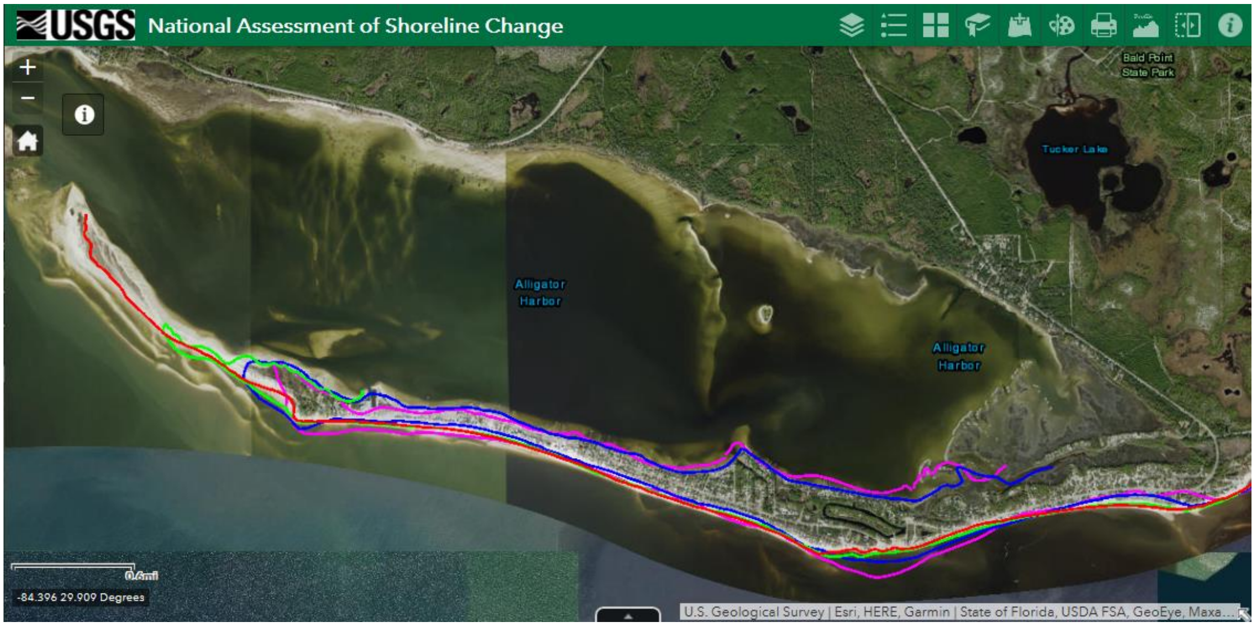



*Figure 103: Shoreline position has changed over the years, indicating the highly dynamic nature of Alligator Point's coastline (USGS n.d.[a]).*


*Figure 114: The segment of shoreline shown on this map has eroded significantly, as evidenced by historical map data. These lines show the approximate shoreline position over time, with the 1858 shoreline shown in purple (farthest from land) and the 2001 shoreline shown in red (closest to land). (USGS n.d.[b])*

# 3.0 Land Use and Ownership

## 3.1 Land Use

Land use refers to the activities on and uses of physical property. The State of Florida has established a number of laws and programs intended to direct growth management. The Florida Community Planning Act (Florida Statutes sections 163.3161 – 163.3248) is intended to strengthen the roles, processes, and powers of local governments in creating and implementing comprehensive planning programs to guide and manage future development.

Most of the developed parcels on Alligator Point are currently used for residential purposes, with many of them used as vacation rental properties. See **Figure 15** below. Of particular concern is the western portion of the peninsula that becomes inaccessible (by road) whenever Alligator Drive is severely damaged during tropical storm events. Alligator Drive is classified as a Minor Collector County Road and is owned by Franklin County. The road provides the primary access for the land area of Alligator Point.

According to 2017 Florida Department of Revenue parcel data, there were 540 parcels located west of the constriction shown on **Figure 16**. Of the parcels constricted by limited access after storms, nearly all (97 percent) were residential. Only 87 of the developed residential parcels west of the constriction had homestead exemptions in 2017, suggesting that the remainder (over 75 percent of dwellings) were used as second homes and/or vacation rentals. See pie charts in **Figure 17** for more details.

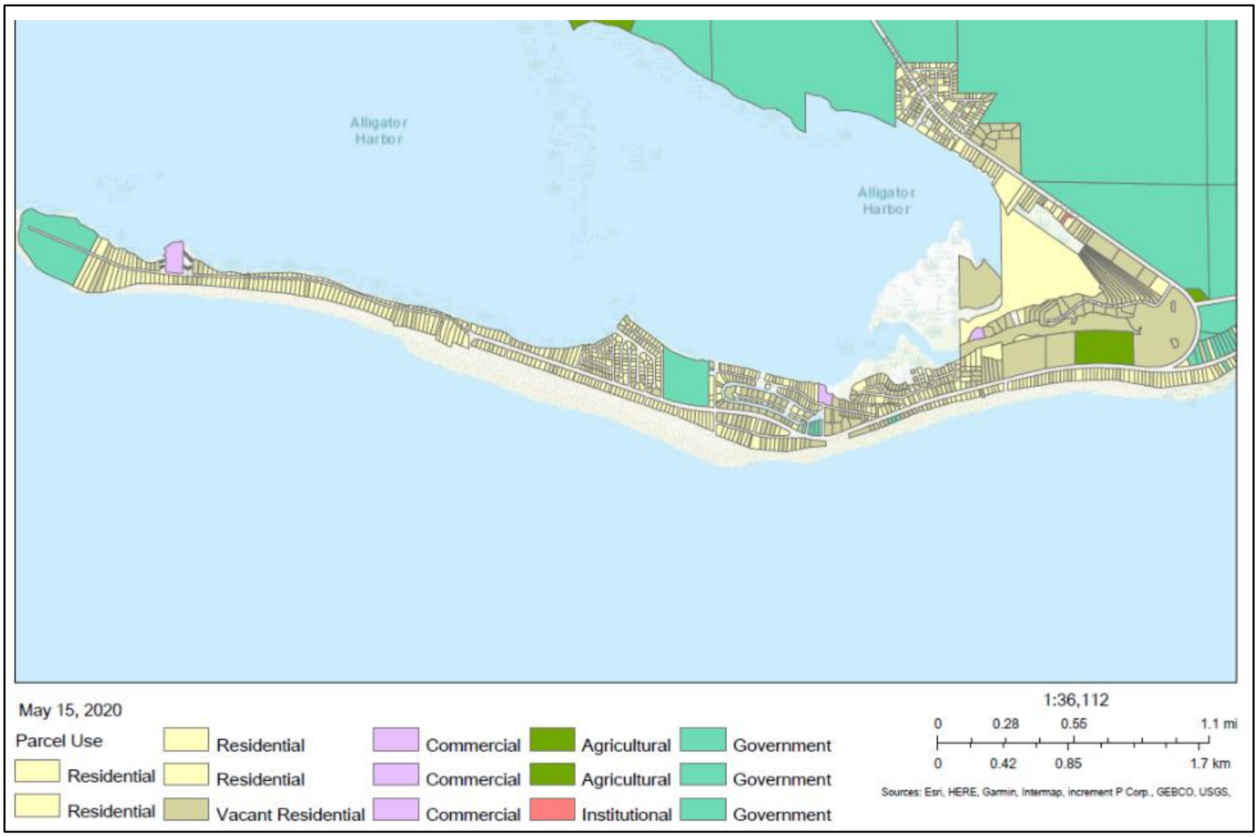



*Figure 125: This map shows the existing land use category for parcels within the study area (Franklin County n.d.)*

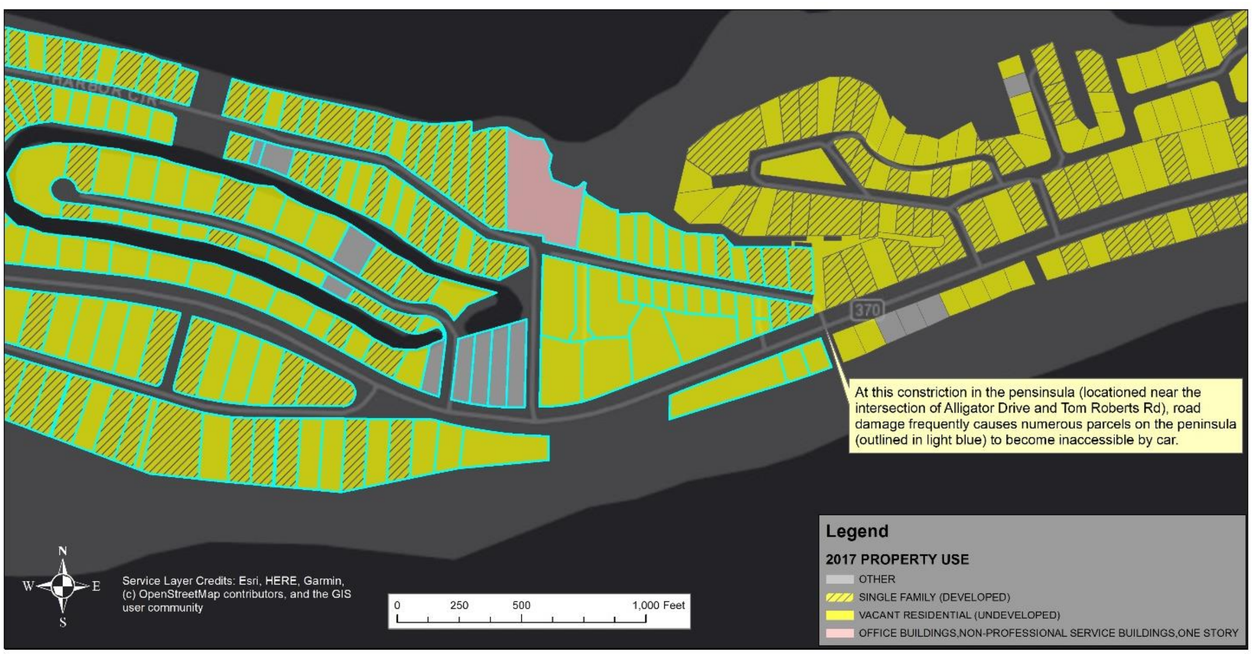



*Figure 136: This map shows the portion of the Alligator Point peninsula where vehicle access typically gets disrupted due to storm damage. As a result, numerous residential properties frequently become inaccessible.*

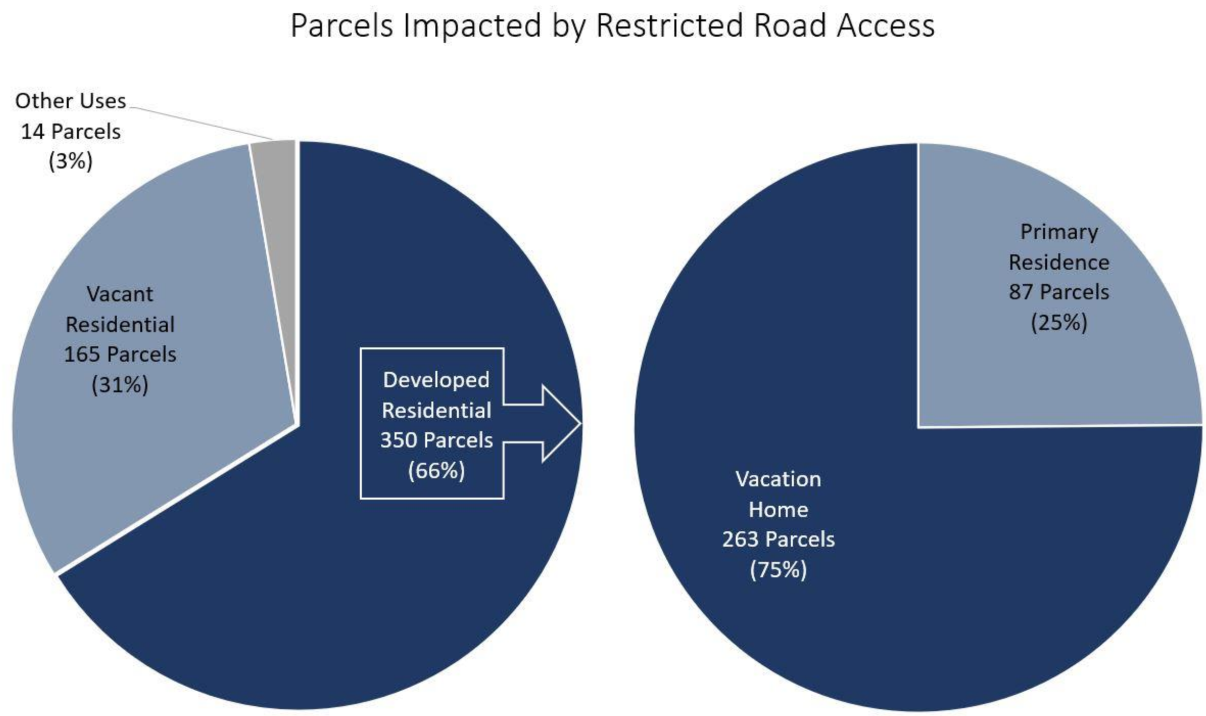



*Figure 17: Here is a summary of the parcels located beyond (west of) the location where road access is frequently restricted. The pie chart on the left shows that nearly all parcels (97 percent) are designated for residential use, with about one third being vacant lots, while the other two thirds are developed. The pie chart on the right illustrates that the majority (75 percent) of developed residential parcels are used for vacation homes.*

## 3.2 Local Economy

Alligator Point's economy is built around the many recreational fishing and ecotourism opportunities both within the study area and within Bald Point State Park bordering the northern reach of the study area. Local businesses supporting these activities include various vacation rental property services (e.g., Harbor Point Realty) and the Alligator Point Marina, a large marina complex that offers dry boat storage and maintenance, wet slips, and various supplies to support recreational fishing (e.g., ships store, bait, and tackle). The marina also offers access to inshore and offshore fishing guides and charters and other tourism-based businesses, such as sailing lessons, rentals, and entertainment (e.g., within-marina Tiki Bar).

In addition to the economic benefits these businesses provide, several residents stress the importance of local businesses in providing other valuable community services. For example, stakeholder feedback collected following a recent public meeting indicated that Harbor Point Realty provides scanning and printing services, notary service, and referrals for licensed contractors in the area (e.g., electricians, plumbers, roofers, etc.).

Potable water infrastructure (**Figure 18**) is critical to support tourists, residents, and businesses within the Alligator Point community. Original infrastructure within the Alligator Point Water Resources District (APWRD), including the elevated water tank, began development circa 1963, but has since been expanded to include two additional ground source tanks to support increasing community needs. In total, the APWRD provides service to nearly 640 customers, 30 percent of whom are full time residents. Not surprisingly, local business centers including Harbor Point Realty and Alligator Point Marina are among customers generating the greatest water usage rates within the district. A portion of this water main that feeds this system extends along Alligator Drive in the area where significant erosion has been occurring.


*Figure 148: The water system that serves Alligator Point is a critical asset to the local community (ARPC 2018).*

Other assets valuable or needed to support the local economy include the Volunteer Fire Department (VFD) and public beach access. According to feedback, ambulance call response times can often exceed 45 minutes. Therefore, as a local entity, the VFD often provides many lifesaving services as first responders to emergency calls.

Beach access, and especially the limited infrastructure and facilities therein, is a contentious issue among residents. However, stakeholder feedback following public meetings generally indicates that the use of public beach access points by tourists has increased significantly recently. The growing use of these access points lends credence to the importance of these facilities to the local economy.

Community assets most at risk are the roadways. This includes approximately 3,250 linear feet (lf) of Alligator Drive and approximately 1,140 lf of Chip Morrison Drive. It is important to note the eastern approximate 1200 ft of the at-risk portion of the Alligator Drive provides the only roadway access connecting the eastern portions of Alligator Point. The volunteer fire station is located on the western side; thus, in the event this road is inaccessible, first responders located on Alligator Point will not be able to respond to the needs of residents on the eastern portion of Alligator Point. Furthermore, Alligator Drive is the designated evacuation route of Alligator Point.

# 4.0 Conceptual Alternatives

## 4.1 Conceptual Basis

Our review of the present and historical conditions within Alligator Point (Section 2), showed that most of the Peninsula, and especially within the region near Southwest Cape, has experienced chronic erosion during high intensity storms. Of interest to the community and indeed a motivating factor supporting this assessment, is a segment of Alligator Drive traversing a nearly 1 mile stretch of shoreline that supports important community infrastructure (i.e., local real estate and economy; Section 3) and is subject to intense erosion (**Figure 10**) from mostly natural processes. Over the past 30 years, the road has washed out repetitively resulting in an average of $500,000/year (estimated 2020 dollars) in damages. At present, the road remains un-repaired from damages sustained during Hurricane Hermine in 2016. In its current state, the road is more susceptible to further damage and represents an impending threat to the community as a whole.

Road damage is related to the relatively low elevation of the road itself and to the waves and storm surge associated with tropical storm events. Our review of storm-driven road damages suggests that damages occur when storm surge exceeds 3.5 ft (**Figure 11**). At this point, much of the roadway is completely inundated due to the low elevation that characterizes this area (≤ 5 ft NAVD88; **Figure 3**). Storm surge associated with different events varied from 0.9 to 8.4 ft (**Figure 11**), but typical storm designations (i.e., Tropical Storm and Hurricane Categorical designations) are often misleading in terms of the conditions and subsequent damages they create. For example, damaging storm surge is possible with even low-intensity tropical storms, such as Tropical Storms Debbie and Nestor, and Hurricane Hermine (Category 1), which produced 3.6 to 4.1 ft of storm surge and caused over $3 million in road damage (**Figure 11**). Still, higher-intensity storms are typically associated with higher storm surge and subsequent damages, such as the case with Hurricane Michael (Category 5) which resulted in 8.4 ft of storm surge and over $4.5 million in damages. Unfortunately, the frequency of these high intensity storms is expected to increase following trends in increasing sea surface temperatures while increasing sea levels may also lower the relative elevation of the roadway. Hence, the convergence of these factors leaves the roadway and surrounding community increasingly vulnerable to further damages.

Another factor increasing the roadway vulnerability is that the shoreline supporting it is naturally retreating. Historical shoreline markers clearly show the trajectory of this process since initial estimations (1,858; **Figure 14**), while land gain elsewhere suggests these sediments are deposited at different locations within the peninsula that are more protected, such as near Phipps Preserve to the west and within Alligator Harbor. While solutions to sediment deficits appear straightforward, addressing this problem is not often a simple endeavor. For example, longshore migration of sediments is a natural process and any attempted mitigation of this process could deprive adjacent areas of needed sediments and, in effect, simply create a sediment deficiency problem elsewhere. On the other hand, simple re-nourishment of beach sediments will be lost naturally following the processes already underway. Therefore, adequate consideration and design accounting for these processes (e.g., using sediment transport models) is critical for future plans aiming to improve the resiliency of this roadway and the community as a whole.

While the road serves as the primary means of access to the western portion of the Cape, it is also vital for maintaining public safety in the community. First, the Alligator Point Volunteer Fire Station (APVFS) is currently located to the west of the washout area. APVFS is vital to the community because the volunteer firefighters often provides time-sensitive and life-saving services as a first responders for the entire peninsula. Second, as the road represents the only point of access for western residents, it is also the primary evacuation route for those residents in emergency situations. Protection of the road is, therefore, vital as a matter of general public safety.

Protecting the roadway and the general washout area is also important for other reasons. Chief among these is the water main supporting the APVFS and several western residential properties, which is collocated with the roadway in the washout area. To date, there have been no reports of storm-related damages to the water main. This is likely because the main has been protected by the road and has sufficient cover soil providing additional protection. However, should the roadway remain unprotected and erosion continue in this area, the water main will most certainly be impacted eventually. The roadway also supports two pillars of the local economy: access to vacation rental properties and public access beaches. From an ecological perspective, Alligator Point beaches, including those shoreward of the troubled roadway, also provide critical beach habitat for sea turtles. These additional issues should be considered as part of a holistic approach to solving access and general safety concerns associated with the roadway.

Considering the impending threats to the community including public safety, economic and ecological concerns, this assessment focused on the approximate 1-mile stretch of beach fronting the roadway subject to repetitive washout. This focus area is also further delineated in order to evaluate the relative urgency and risk level associated with different segments along this stretch that are useful for setting project priorities. The limits of the evaluation area are shown on **Figure 19**.


*Figure 159: Alligator Point Critically Eroded Beach Segments*

For purposes of this evaluation, this approximate 1 mile of threatened roadway will be discussed in terms of priority and urgency of needed protection for three segments of severely eroded shoreline:

- Segment 1 (red): This approximately 1,200-ft-long segment of Alligator Drive extends close to the shore within the area east of Tom Roberts Road and experiences the greatest erosion relative to other segments. This segment is the only roadway connecting the eastern and western portions of Alligator Point and is the only means of evacuation and access for emergency responders. The water main servicing Alligator Point also runs along this portion of Alligator Drive.
- Segment 2 (blue): This approximately 2,130-ft segment of shoreline fronts 10 residences and includes portions of Alligator Drive and approximately 1,140 ft of Chip Morrison Drive which provides access to 5 residences.
- Segment 3 (green): This approximately 1,500-ft-long segment of shoreline represents the lowest priority in terms of community assets as compared to the other segments. In addition, this segment fronts a relatively undeveloped area that may present an opportunity for an alternative route that supports access, evacuation, and emergency response.

## 4.2 Concept Objectives

At a minimum, an approach to solve roadway issues should provide an effective and relatively permanent means of safe and reliable road passage connecting the eastern and western portions of Alligator Point and should be readily implementable and at a reasonable cost. In addition, the proposed solution would ideally restore lost beach area for its habitat and recreation value, and as a means of protection for existing residences. To further define what it means to be effective or implementable, the following evaluation criteria have been developed to provide a basis for comparing the concepts proposed that is consistent with the overall objective.

Effectiveness

1. Road Protection: This criterion considers the ability of proposed improvements to reduce the likelihood of required road maintenance following a major storm. For the purposes of this evaluation, we define a major storm as a 100-year storm event as it is a typical benchmark for similar projects.
2. Beach Protection: This criterion considers the ability of proposed improvements to increase the likelihood that the beach would remain in place over time and not continue to retreat. Protection includes protection provided for the road, beach front residences, and considers other factors such as recreation and habitat value.
3. Public Safety: This criterion considers the ability of proposed improvements to enhance the public safety. Increasing public safety is achieved by providing a safe and reliable road access from one side of the Alligator Point to the other.
4. Resiliency: This criterion considers the ability for the proposed improvements to withstand and respond to varying environmental conditions predicted as a result of climate change, including sea level rise and increasing frequency of high-intensity storms.
5. Ancillary Impact/Benefits: This criterion considers the other impacts the proposed approach may bring, either positive or negative, within or outside the limits of the proposed project.

Implementation

1. Permitability: This criterion considers the ability to easily obtain the required permits to construct the proposed improvements.
2. Design/Construction: This criterion considers the ease in which the proposed improvements can be designed and constructed. For most approaches considered, standard methodologies and criteria are well established.
3. Maintenance: This criterion considers the ease in which the proposed improvements can be properly maintained.

Cost

1. Capital: This criterion is a qualitative assessment of the expected level of capital investment needed to complete the proposed improvements.
2. Operation and Maintenance: This criterion is a qualitative assessment of the expected level of annual investment needed to properly maintain the proposed improvements.

## 4.3 Conceptual Options

### 4.3.1 Hold the Line

The "Hold the Line" concept involves providing adequate hard protection at or near the existing roadway right of way. This approach should provide relatively permanent protection to the road even when completely inundated. It has also been investigated previously (i.e., dated July 2019) at Segment 1 in preliminary designs by Dewberry as commissioned by Franklin County. The proposed improvements, as depicted in **Figures 20 and 21**, include:

- Approximately 1,250 ft of restored roadway constructed within the existing right of way to an elevation of about 10 ft NAVD88.
- Drainage improvements on the north side of Alligator Drive.
- Relocation of the water main to the north side of the drainage swale.
- Approximately 1,200 ft of the restored road would include sheet pile walls on either side of the roadway, a concrete cap in the area between the roadway shoulder at the pile cap, and riprap protection on the south side of the seawall.

**HOLD THE LINE**

PROS

- Design will provide relatively permanent protection against wave erosion for the roadway in its current location
- Low maintenance cost

CONS

- Will not protect the beach and erosion will continue until only the protected roadway will remain

This design should provide adequate protection, even in the event of high surge level and complete roadway inundation. However, the actual level of protection used as a design criterion was not available (e.g., 100-year, 50-year, etc.). If properly installed (i.e., deep enough to avoid undermining during dynamic events), the sheet pile seawall will provide the primary means of protection and will be further protected by riprap. The concrete cap will prevent surface erosion in the area between the roadway pavement and the pile cap. While the surface cap and pavement may sustain some level of damage during storm inundation, the sheet pile should keep the road bed intact, thereby reducing repairs.

The cost of this project has been estimated at $4.7 million, resulting in a unit rate of about $3,920 per linear foot. It remains unclear, however, whether or not this cost includes the riprap revetment depicted in the drawing as it is listed as "design by others." Maintenance costs associated with this approach would be those typical of ordinary roadway maintenance.

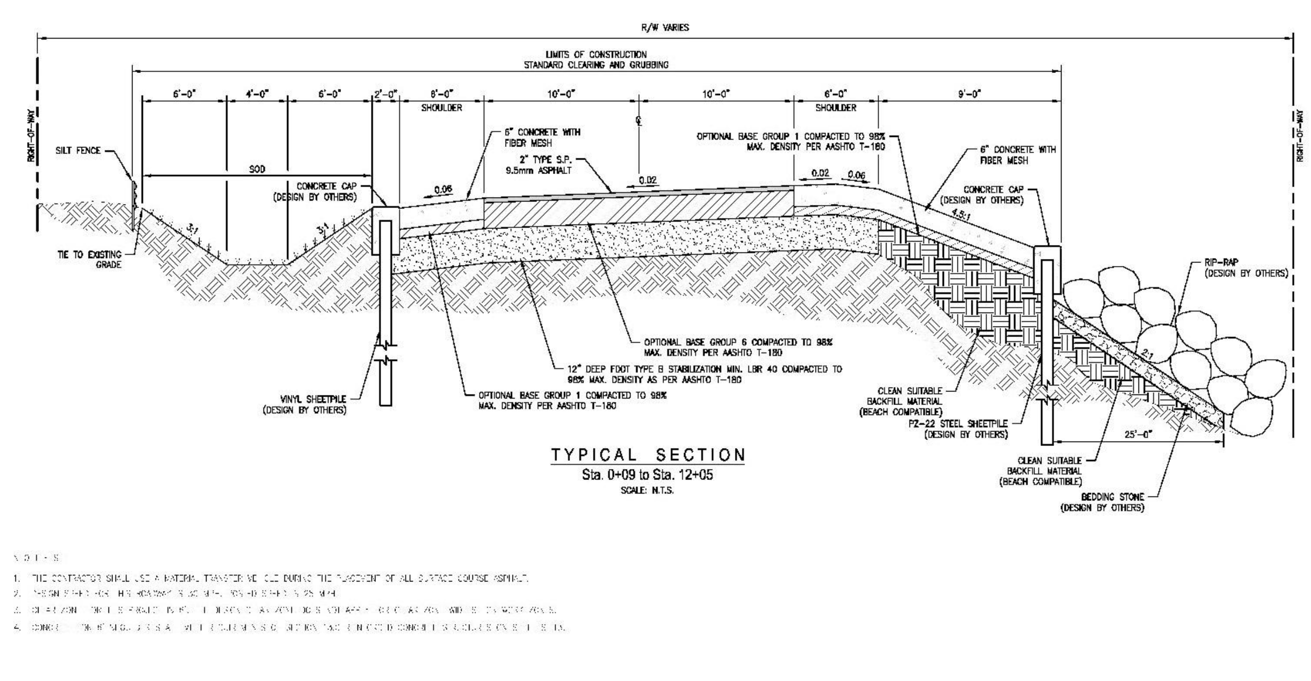



*Figure 20: Previously Proposed Segment 1 Design Section*

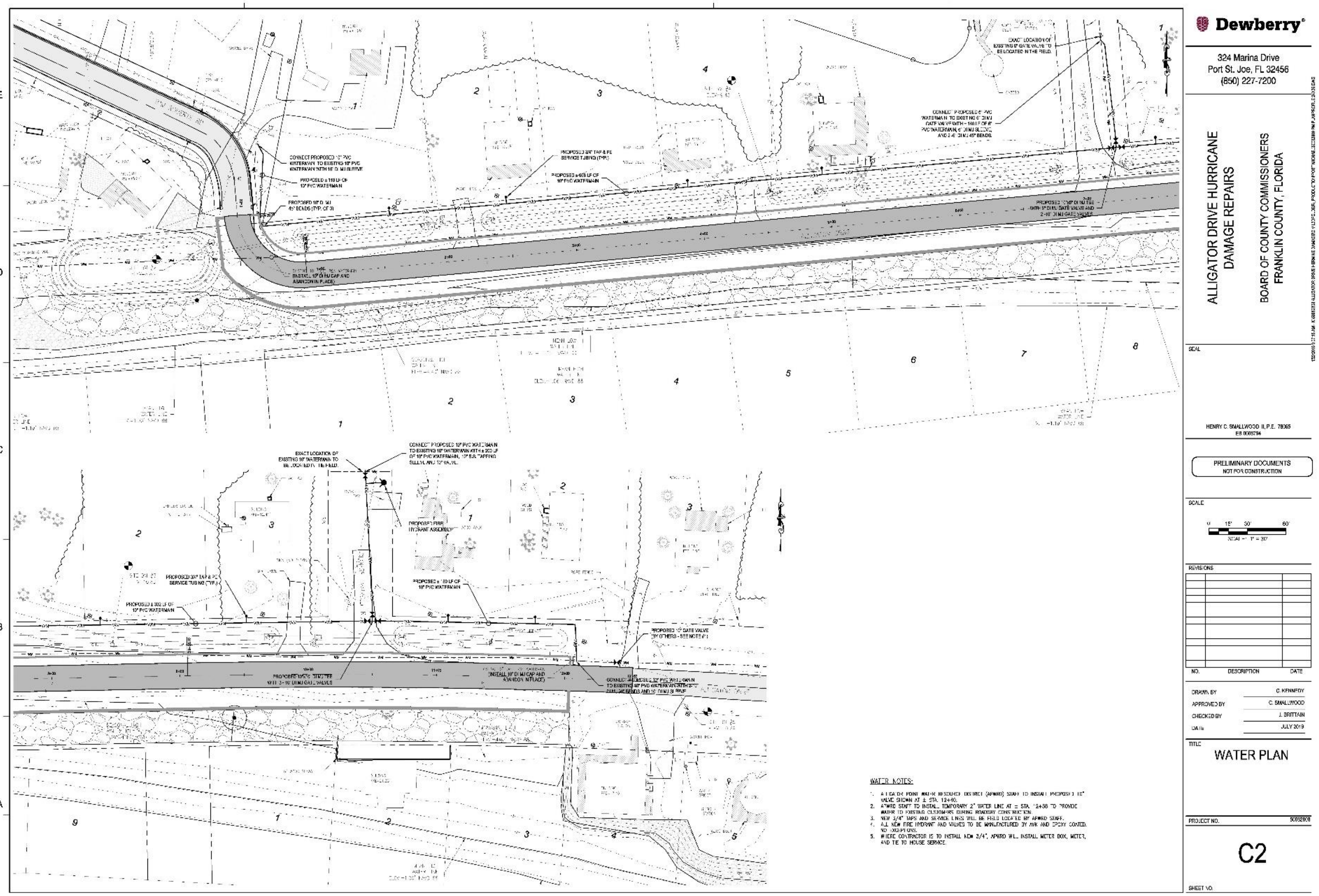



*Figure 21: Previously Proposed Segment 1 Design Layout*

**Figure 22** below provides an example of a typical revetment design adopted from the U.S. Army Corps of Engineers (USACE) North Atlantic Coast Comprehensive Study (NACCS) of the approximate dimensions needed in this case. The cost for this revetment is identified as about $250/lf (USACE 2015).

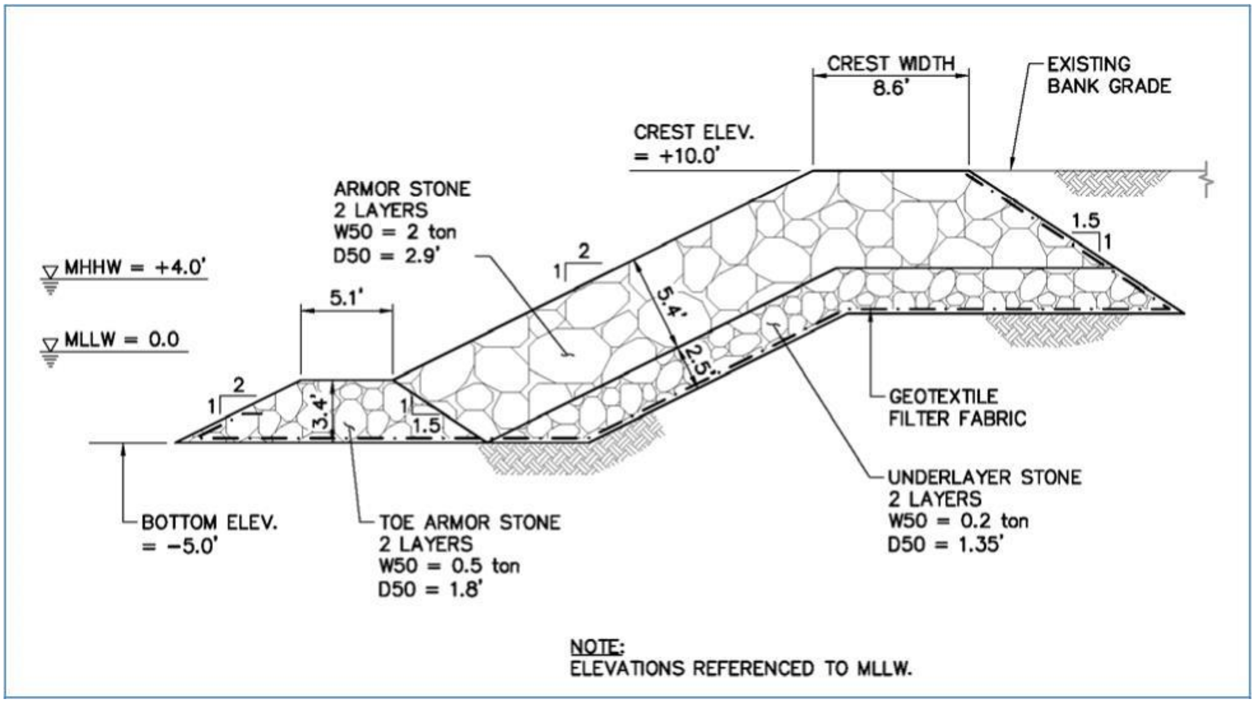



*Figure 22: Typical Revetment Design, USACE 2015*

### *Concept Evaluation*

The proposed design should provide adequate protection to maintain safe and reliable road passage in most cases. It will not, however, protect the existing beach, which will likely continue to erode until the shoreline reaches the riprap feature of the design. When this happens, some amount of riprap will be susceptible to storm damage and may require replacement. Still, the presence of the steel sheet pile wall should be adequate to protect the road during these storm events. However, beach loss will continue and will have negative impacts to the economic and ecological value of the area due to losses of recreational opportunities and wildlife habitat. The approach could be adapted to accommodate current best estimates of sea level rise but is only moderately resilient, given the uncertainty associated with sea level rise projections and lack of living components incorporated (e.g., oyster reefs and vegetation). This project does benefit from having already been designed (preliminary) and permitted and, thus, the project can be readily advanced to implementation for Segment 1 and could be adapted further to include Segments 2 and 3. In addition, no special construction equipment is required (e.g., dredge equipment, barges, etc.) and construction methods are well established and standardized. Finally, maintenance should be limited to typical road maintenance and occasional riprap replacement following high-intensity storm damage.

### 4.3.2 Avoid the Danger Zone

As an alternative to the Hold the Line concept detailed above, the road could be reconstructed further inland in a less vulnerable location, i.e., the "Avoid the Danger Zone" concept. A conceptual road realignment is shown in **Figure 23** below. There are some challenges associated with this strategy, however. To start, this alignment would require the acquisition of at least a portion of 12 separate properties and likely include the demolition of five private residences. Even then, the alternative road alignment for Segment 1 is limited by a waterway that parallels Tom Roberts Road. As such, a portion of the proposed road realignment will traverse through a relatively narrow land mass (approximately 200 ft wide). In terms of road protection design and construction, the proposed project would require elements similar to those described in the Hold the Line strategy. However, while the present strategy would not require a sheet pile wall and would require substantially less fill and drainage improvements as compared to the Hold the Line concept, it would require moving the water main running along Segment 1.

AVOID THE DANGER ZONE

PROS

- Should provide a protected roadway with a lesser design

CONS

- Unlikely to gain community acceptance
- Will not curtail erosion, eventually the same issue may reoccur

Relocation of Alligator Drive along Segment 3 was not considered for this concept because this area is mostly undeveloped and, thus, access is not required. However, a water main does extend along the north side of Alligator Drive in this area. This water main could be relocated within the right of way of Tom Roberts Road and Harbor Circle. While no damages to this stretch of water main have been reported to date, relocation is strongly advised as the beach in this area will continue to erode in the future. This concept also does not consider road relocation for the portion of Segment 2 that follows Chip Morrison Road as this road provides access to only a few residences and relocation would require additional residential acquisitions.

Based on the Franklin County Tax Map, the assessed value of the 12 impacted properties is $1,220,289. This is roughly the same as the cost of the sheet pile wall component of the Hold the Line concept, based on a conceptual level seawall cost of about $1,250 per linear foot or about $1,500,000.


*Figure 23: Segment 1 Alternative Road Alignment*

### *Concept Evaluation*

The proposed concept involves a less robust design than that proposed for the Hold the Line concept and eliminates the need for a sheet pile seawall. However, the trade-off is that a right-of-way for the new road alignment will have to be acquired and some homes will need to be demolished. While the assessed value of affected properties could be slightly less than the costs associated with sheet pile construction, they may not reflect the true market value or account for premiums involved in acquisition. Considering these potential disparities and other potentially complicating factors associated with property ownership (e.g., sentimental value, shared ownership interests), public support of this concept could be limited. More importantly, however, this approach alone does not address beach erosion, which is expected to continue without additional preventative measures. As the shoreline retreats, additional land will be lost before termination at the concept design's riprap feature, leaving the relocated roadway and water main vulnerable to storm damages. In short, without additional measures to mitigate beach erosion, the same issues currently facing the community are expected to reoccur. As with the Hold the Line concept, the uncertainty associated with sea level rise projections only further questions the long-term resiliency of this concept as it does not include any adaptable living elements. However, portions of the proposed roadway realignment may traverse at a higher relative elevation, which may not increase the resiliency of the roadway, but may buy enough time to make additional improvements.

### 4.3.3 Feed the System

The "Feed the System" concept involves replacing sediments lost to erosion and reconstruction of the beach to provide protection for a newly constructed road to replace the road previously lost. In addition, a berm and dune complex would be added to provide protection during storms with high surge and wave energy. Sediments lost from the area previously could be recovered from the inlet to Alligator Point using a hydraulic dredge and transported to the project area to supplement dune and beach construction. These sediments are currently choking the inlet and, thus, removing them for beach and dune construction would have the added benefit of providing needed harbor channel maintenance.

The configuration of the berm and dune system follows standard methods that are based on the rate of shoreline retreat and other key parameters, such as existing beach slope, mean higher-high water (MHHW) and the magnitude of common storm events (i.e., 1-percent storm event). In general, berms are constructed 6 ft above MHHW and dunes are constructed high enough to withstand wave action during a 1-percent storm event. A generalized template design illustrating typical berm and dune configurations, as developed by the USACE for the NACCS, is presented in **Figure 24** below. This illustration shows the overall design profile and an additional profile indicating advance fill, which is the amount of sediment needed in future system renourishment maintenance (as determined by the rate of shoreline retreat expected in a defined time interval). In addition, this general design provides for a berm elevation of 8 ft NAVD88 and a dune height of 10 ft above that (i.e., 18 ft NAVD88) which is a reasonable approximation of the configuration needed for this design concept and is more than sufficient for comparisons with other concepts.

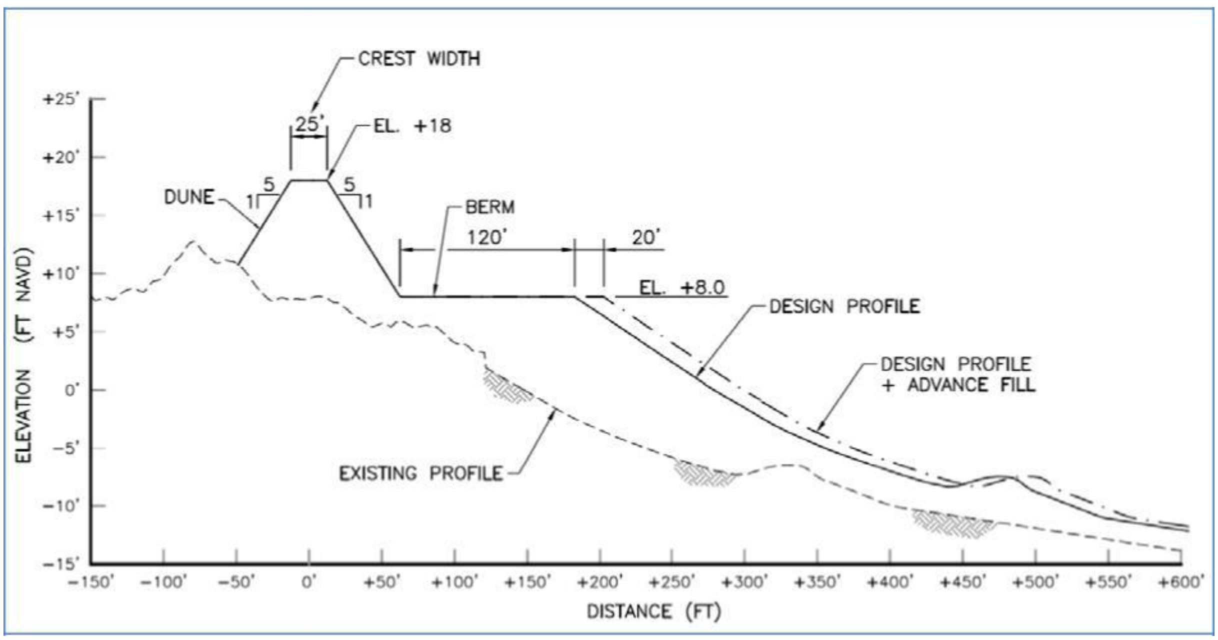



*Figure 24: Generic Beach Nourishment Profile (NACCS 2020)*

Using these generalized design features and the average project costs of similar projects, the NACCS estimates the cost of initial beach restoration at about $3,534 per linear foot. This estimate includes engineering and design, construction management, and sand fill (including costs associated with mobilization and demobilization of dredge equipment). The latter is the most significant and accounts for nearly two thirds of the total estimated costs. However, the relative cost of dredge mobilization can be improved if a larger area is incorporated (i.e., better economy of scale) or by using more cost-effective dredging equipment (e.g., smaller dredges).

Additional annual costs are also expected to maintain the beach. These costs vary as a function of site-specific erosion rates, but average nearly $1,200 per linear foot for beach sand renourishment and maintenance. Our analysis of shoreline imagery from 1994 to 2018 indicates that the shoreline receded approximately 110 ft over that period which would translate to an erosion rate of about 4.7 ft per year. At this rate, renourishment would be required every four years. Therefore, beach restoration along the current, approximate 1-mile roadway would require nearly $17 million for initial construction and over $1.4 million annually for maintenance. Over a ten-year period, the total cost of the project would exceed $30 million. Considering the cost of beach restoration would be in addition to those necessary for road reconstruction, drainage improvements and potential water main relocation, the high costs associated with this concept may be prohibitive. Further, this concept will not reduce the amount of erosion, but rather feeds the system (as its name suggests) by adding to the overall sediment budget.

FEED THE SYSTEM

PROS

- Will provide a protected roadway
- Provides beach for habitat value and recreation
- Possible added benefit of harbor maintenance

CONS

- High initial cost
- High recurring cost
- Needs to be completed on a large scale due to high mobilization costs

Seeding the dune complex with sea oats or other dune plants may add some additional initial costs to the project but may also have other benefits. Planting costs will vary depending the on the initial effort required for planting and the type plant materials used (e.g., seeds, cuttings or whole plants of various sizes). However, dune planting may also provide an avenue for community engagement through team planting events. Events like this could help to raise awareness of community values and goals and would have the added benefit of reducing project labor costs. As plant roots can help to bind dune sediments, substantial reductions in long-term sediment renourishment costs are also possible if plants successfully establish and further colonize dunes. Plant communities enhance the resiliency of this concept via the same mechanism and may also provide valuable wildlife habitat.

*Concept Evaluation*

If properly maintained, this approach could provide an effective means of protecting the adjacent reconstructed Alligator Drive. The beach will be restored in an aesthetically pleasing manner and will provide more open beach or “towel space” for recreation that may have the added benefit of increased tourism to the area, and may also provide critical habitat for sea turtles and other wildlife. Added sediments will provide protection to upland infrastructure and supply needed beach sediments to adjacent areas along the shoreline as sediments migrate to these locations. Improvements to Alligator Harbor will also be realized if it can be used as a borrow source for the beach sediments. Still, this approach may be cost prohibitive as it involves significant initial and recurring costs that are compounded by other needed infrastructure improvements. In addition, as sediment loss is inherent in this design, it is also particularly sensitive to the frequency and magnitude of storm events, which may vary substantially over even short time scales. Even as dune plantings may increase the resiliency of this design, beach sediments will require recurring renourishment to maintain the integrity of the beach and protective dune structures.

### 4.3.4 Build Up Defense

The “Build Up Defense” concept involves construction of a breakwater and/or groin structure complex designed to reduce wave energy and enhance sediment accretion. Besides the protection they provide against waves and erosion, these structures have the added benefit of providing complex habitat for many intertidal organisms including oysters, crabs, fish, and other wildlife. Further, designs may incorporate and encourage the establishment of healthy oyster reefs that can substantially increase the resiliency of these structures. For example, oysters, as living organisms, can adapt to changing environmental conditions (e.g., sea level rise) and can quickly reestablish following damaging storm events where traditional hardened structures will require redesign, construction, or maintenance. Regardless of components and materials used, careful consideration of the overall area sediment budget is essential for breakwater/groin complex design so that adjacent areas are not subsequently sediment starved. It is also important to recognize that these complexes alone do not protect the road during storm events in the near term. For example, sedimentation behind complexes may take years to accrete to levels adequate to protect upland infrastructure. Therefore, these complexes are often constructed in conjunction with beach restoration (described above). Hence, beach restoration and breakwater/groin complex construction are both critical components of the current concept. As such, this combination provides many of the same benefits while also reducing

*Figure 25: Aerial Photo of Typical Groin Protection*

recurring costs associated the beach maintenance.

### *Groins*

Groins are structures that extend perpendicular from the beach at various lengths and terminating as a straight-line or branching out in a "T" shape nearshore. In general, these structures are designed to limit longshore sediment transport (i.e., sediment movement along the shore) and can be designed to create pocket beaches (i.e., tombolo formations) or sawtooth-shaped beaches (as pictured above; **Figure 25**), depending on spacing and specific design. As mentioned, groins themselves do not prevent erosion from other process (i.e., onshore-offshore sediment transport, storm events). However, longshore sediments trapped by groins are often enough to make up for losses from storm events or offshore movement. This sediment trapping ability must be carefully balanced in groin designs to prevent deficient sediment transport to adjacent areas. As a result, these structures can be difficult to permit or may require substantial background investigations to meet permitting requirements.

*Figure 26 Aerial Photo of Nearshore Breakwater Protection*

### *Breakwaters*

Breakwaters are structures positioned parallel to the shoreline that help to reduce onshore-offshore sediment transport by reducing wave energy and subsequent sediment suspension, and by trapping suspended sediments on the shoreward side of the structure. Just as with groin structures, the spacing and design of breakwaters can lead to varying shaped beaches or shorelines. For example, segmented breakwaters such as those pictured to the right (**Figure 26**) positioned nearshore and with adequate spacing can behave like groins, forming pocket beaches or tombolo formations. In general, however, the magnitude and frequency of these hump-shaped formations including the smaller (i.e., salient formations) and larger (i.e., tombolo formations) sized humps along the shoreline vary as a function of breakwater length and gap spacing. As with groins, breakwaters may promote sediment accretion over longer time scales but are not immune to losses during storms and as a result of longshore sediment transport.

The individual use or combination of breakwater and/or groin structures that would be used in this concept would be developed through more detailed design analysis including comprehensive sediment transport modeling. However, for the purposes of developing project costs for this concept, we have assumed that a segmented breakwater installation along the approximately 1-mile stretch of troubled shoreline would be sufficient to dissipate waves and stabilize the added beach restoration component of this concept.

Typical breakwater design includes an 18-ton armor stone over a core of smaller material to withstand a 100-year storm event. A generic breakwater section obtained from the USACE NACCS is presented in **Figures 27 and 28** below and provides an appropriate template for this high-level analysis.

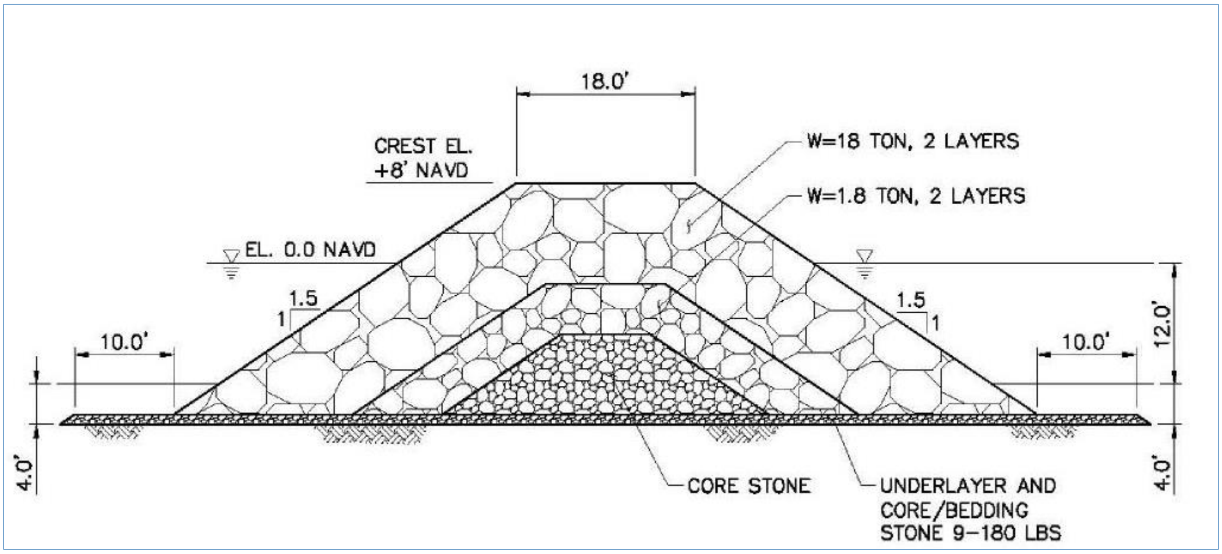



*Figure 27: Generic Breakwater Section*

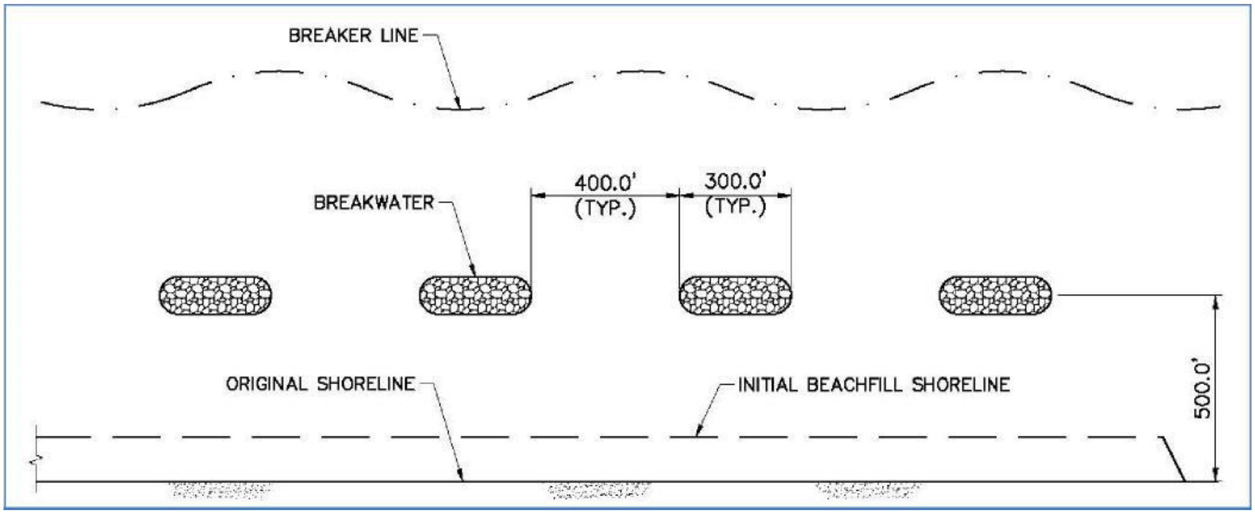



*Figure 28: Generic Breakwater Layout*

The amount of sediment trapped is a function of the spacing of breakwater segments (i.e., gap spacing) and the distance between individual segments and the shoreline (discussed above). In this high-level analysis, we adapt the generic spacing specifications described in the NACCS as shown in **Figure 28**. When paired with the beach restoration component of this concept, this breakwater design retains 65 percent of sediments lost to longshore sediment transport, and would reduce the frequency of necessary beach renourishment/maintenance by two years (i.e., from every four to six years). As with the Feed the System concept described above, however, renourishment/maintenance schedule will depend on several factors, including structure design features, the quantity and extend of advance fill sediments, and the frequency and magnitude of storm events. Working out the details of projected annual beach loss with or without breakwaters can be estimated by sediment transport modeling. While this modeling can be costly, these details are necessary for optimal design that favors sediment retention and reduces the frequency of necessary renourishment/maintenance.

BUILD UP DEFENCES

PROS

- Should provide a protected roadway
- Provides beach for habitat value and recreation
- Possible added benefit of harbor maintenance
- Reduced recurring cost

CONS

- High initial cost

The added costs to include breakwaters to the beach restoration or Feed the System concept can exceed $9,200 per linear foot (as estimated in the NACCS), nearly triple that of the beach restoration alone. However, as the added breakwater structure reduces the frequency of renourishment/ maintenance, it is a likely a more cost-effective option than the beach restoration alone in the long term.

*Concept Evaluation*

This approach brings all the benefits of the Feed the System concept but with a reduced long-term cost associated with the frequency of renourishment/maintenance of the beach. If properly maintained, this approach could provide an effective means of protecting the adjacent reconstructed Alligator Drive. The restored beach will provide more space for recreation and habitat for plants and wildlife and the breakwater complex will increase habitat for other species. In particular, in addition to providing complex habitat for crabs and fish, breakwaters can provide substrate for oyster colonization which may increase the resiliency of the structure while also providing several other natural benefits. In addition, the combined breakwater and restored beach approach will provide a recurring supply of beach sediments that will benefit the project area while also protecting and supplying sediments to adjacent areas along the shoreline. Like the Feed the System concept, improvements to Alligator Harbor are possible if it is used as a borrow source for beach sediments. This approach will still involve significant recurring renourishment/maintenance costs, but may be more cost-effective over the long run as a result of breakwater effects on sediment retention. This influence on sediments, coupled with the potential oyster recruitment to breakwater structures, enhance the resiliency of this concept, especially in the face of changes resulting from climate change (i.e., increased frequency of high-intensity storms and sea level rise).

### 4.3.5 Soft Repairs (No Action)

This concept assumes that no action is taken to protect upland infrastructure, including the main and adjacent roads and water line. Nature will be allowed to take its course, causing further erosion of the beach and existing roadway. Maintenance would be minimal and would involve only those actions necessary to allow access to western properties by off-road (i.e., four-wheel drive) vehicles. For example, the area would be cleared of debris following storm events. As the beach continues to erode, the number of affected residences will increase and will require individual site protection or armoring. The length of shoreline significantly impacted will likely expand and eventually Alligator Point will be inaccessible from the mainland without the construction of a bridge. Given the limited accessibility concerns and the critical nature of Segment 1, this concept may be considered a public health and safety risk. As such, significant investment in public utilities (i.e., emergency response vehicles) may be required to account for anticipated public needs. These costs are outside of the scope of this report. However, the costs of this Soft Repairs (No Action) concept are nearly negligible compared to those discussed above.

An additional consideration to Soft Repairs (No Action) is the legal implications of addressing needs for the roads. In the State of Florida, a county has a duty to keep roads in good order and provide reasonable levels of maintenance that affords meaningful access as long as the road remains public and has not been officially abandoned (Jones 2019). Local governments can often be in difficult positions with their duty to maintain roads and the need to make adaptive choices (e.g., repair, upgrade, and/or abandon a road).

In Florida, there has been case law that has shown government responsibility toward maintaining roads, though there can be variations depending on the history of the area, local laws, and the situation at hand. If a local government declines to make upgrades to a road that would improve its ability to withstand sea level rise, it has not necessarily breached its responsibility to repair a road under state law.

As noted in *Roads to Nowhere in Four States: State and Local Governments in the Atlantic Southeast Facing Sea-Level Rise*, in Florida, a governmental entity could be liable for injuries and damages resulting from conditions created by sea level rise and coastal flooding if that hazard can, at least partially, be traced to a failure to maintain the existing infrastructure. An example of this is where a Florida District Court of Appeals found that, to establish liability, it is not necessary to demonstrate that the government created the hazard that caused an injury, so long as “the hazard could be attributed in part to the government’s failure to maintain an existing improvement.” However, a government entity may not be liable in Florida if it performs whatever maintenance deemed reasonably possible, or if it took measures to warn or notify the public of the road hazard. (Jones 2019)

Other case studies or examples can be used from Florida where policy action was taken, but not physical action/construction. An example of this includes a case study identified in Monroe County, Florida in 2017, that adopted a resolution (Monroe County, Fla., Resolution No. 028-2017 [Feb. 16, 2017]) that required design criteria to include elevation and account for sea level rise projections for the life of the road. This acting standard gives the county time to assess the resiliency and or vulnerability of the road/infrastructure (Jones 2019). A second example occurred in St. Johns County. The County created an ordinance pertaining to "natural degradation" of roads where the County's minimum design criteria may not be feasible. In such areas, users could experience unpaved roads, lane closures, and times when the road is submerged, among other occurrences. This ordinance established that certain roads may be in poor quality on a regular basis (Jones 2019).

# 5.0 Comparative Analysis

This section discusses the applicability of the five alternative concepts described above for each of the three shoreline segments under consideration. While this analysis considers road segments individually, it is important to note that an economy of scale can be achieved by implementing a comprehensive solution that includes all segments as a whole. The potential for reduced costs by addressing segments comprehensively is especially true for beach restoration where the cost of dredge equipment mobilization is similar for both large and small projects. In addition, whereas the most immediate threat occurs at Segment 1, all segments are at risk in the future. Thus, a comprehensive approach offers greater long-term protection and stability for community assets.

To begin to understand the pros and cons of each of the proposed concepts, we prepared a suitability matrix (**Table 4**) which serves as a summary of the information presented above. In this matrix, each concept is evaluated against the objectives described in Section 4.2 (i.e., Effectiveness, Implementation, and Cost) using a qualitative ranking of "High," "Moderate," or "Low."

**Segment 1** is the most critical. The absence of a passable road for evacuation and access for emergency response presents a public safety risk and, thus, a robust solution is required. The "Hold the Line" concept (Option 1) proposes construction of a sea wall following the design previously prepared for community. This approach would provide an immediate and adequate level of protection, but does not address beach erosion. As such, erosion of the beach will continue, which will result in the loss of additional residences and may pose a threat to other sections of Alligator Drive in the future. The next alternative, or "Avoid the Danger Zone" concept (Option 2), would provide a similar, temporary level of protection and at a comparable cost. Again, however, erosion will continue, creating similar infrastructure problems at some point in the future. Both the "Feed the System" and the "Build up Defense" concepts (Options 3 and 4, respectively) would protect the road while also providing additional economic and natural benefits. Option 4, in particular, combines beach restoration (Option 3) with construction of a breakwater complex that would protect the beach against wave energy and subsequent erosion while also providing recreational beach space and complex habitat for oysters, crabs, fish and other wildlife. The incorporation of these living elements improves the natural environment, protects upland infrastructure, and provides the most resilient option to changing environmental conditions expected in the future. These added benefits and improved project resiliency must be balanced with the higher overall initial cost required to implement Option 4, as compared to Option 3, and weighed with long-term project costs. For example, while Option 4 requires a greater initial investment as compared to Option 3, the protection it provides decreases the frequency of renourishment/maintenance operations necessary to maintain the restored beach and, thus, lowers recurring project costs. A potential drawback of implementing Options 3 or 4 at Segment 1 only is that beach restoration over such a short section (i.e., 1,000 ft) would be subject to similar or even enhanced erosion from the west by waves and currents. Lastly, Option 5 or the "Soft Repairs (No Action)" concept is not appropriate for this segment as it is currently considered a public safety risk. Further, without immediate action, the condition of this segment will continue to deteriorate over time.

**Segment 2** is critical point of access to a limited number of residences (5) adjacent the road along the shoreline. Part of Option 1 includes an investment in protecting Chip Morrison Drive (north of Segment 2) which could provide access to the five residences most at risk. However, this investment is considered temporary as these properties will be lost eventually with continued beach erosion (i.e., when these residences are lost, the need to preserve Chip Morrison Drive no longer exists). Option 2 recommends relocating the roadway, which would also improve access to the five at-risk residences. However, while it may improve access, it does so by purchasing residences elsewhere in less vulnerable locations and, hence, is also not practical; it would be more practical and effective to simply acquire the five at-risk residences. Options 3 and 4 would provide protection for at-risk residences and Chip Morrison Drive, but at a significantly high cost for implementation in this segment. However, depending on design, these costs could be ameliorated if constructed as part of a multi-segment comprehensive approach and if consideration is given to the long-term costs of other alternatives. Option 5 is potentially viable provided the at-risk property owners are agreeable to off-road access to residences in vehicles equipped with four-wheel drive. Each of the five at-risk residences are within about 500 ft of roadways that have so far avoided significant damages.

**Segment 3** is the least critical of the three segments. In this area, a shoreline road is not needed as roadway access is available elsewhere. As such, Option 5 could be an acceptable solution, but one that would allow erosion in the area to continue, which would result in losses at some county and private properties. As the least at-risk segment, any of the other proposed alternative options would also be suitable, but at a much greater cost.

Based on our review of alternatives, two general approaches emerge as the most viable. The first involves a limited approach: protecting approximately 1,200 ft of Alligator Drive with installation of a seawall and leaving other areas as is. This approach would require only minor maintenance (e.g., grading, debris removal) after storms to clear portions of Chip Morrison Drive that provide access to most western residences, but five at-risk property owners may require four-wheel drive vehicles to access residences. Taking this approach would address short-term public safety issues, but significant erosion (i.e., 5 ft/year) would continue in this area of Alligator Point, which would eventually threaten additional upland assets, including the 12-inch water main which would require relocation along the Tom Roberts Road right-of-way. The second approach is a comprehensive beach restoration project involving the entire 0.9 miles of critically eroded beach. This approach would bring many additional benefits, including protection of at-risk properties, recreational space for residents and tourists, and important habitat for fish and wildlife. However, these benefits would require a significantly greater initial investment, which could be ameliorated using breakwaters that would also increase habitat provisioning and potentially result in a more resilient project over longer time scales.

*Table 4: Alternatives Suitability Matrix*

| | | Effectiveness | | | | | Implementation | | | Cost | | Summary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Roadway Protection | Beach Stabilization | Public Safety | Resiliency | Ancillary Benefits/ Impacts | Permitting | Design/Construction | Maintenance | Capital | O&M | |
| **Hold the Line** | | High | Low | High | Moderate | Negative | High | High | High | $$ | $ | Awaiting funding from FEMA |
| Armor Roadway in Existing Right-of-Way | Reconstruct road with revetment and seawall | If properly designed, should provide adequate protection where it is located | Will limit erosion at road, but beach will continue to erode | Will meet current public safety needs | Can be designed to accommodate current estimates of sea level rise | Beach will continue to be lost with recreational and habitat value diminished | Already permitted | Already designed | Only typical road maintenance required | | | Additional cost may be required for revetment |
| **Avoid the Danger Zone** | | Moderate | Low | Moderate | Low | Negative | High | Low | High | $$ | $ | |
| Relocate Roadway | Franklin County has been discussing acquisition of land to relocate the roadway | Erosion will continue and eventually threaten the relocated roadway | Will not limit any further erosion, nor offer any additional protection to adjacent properties | Erosion will continue and eventually threaten the relocated roadway | Continued erosion will worsen with sea level rise | As shoreline continues to recede, impacts to adjacent area will worsen. | May be difficult to acquire land | | | | | Unlikely to receive community acceptance; benefits may only be temporary as erosion will be allowed to continue |
| **Feed the System** | | High | Moderate | High | High | Positive | High | High | Low | $$$ | $$$ | |
| Nourish Beach and Dune System | Involves adding sand to highly eroded section of beach | | Does not alter erosion rate and continued maintenance required | | | Lost sediments will benefit adjacent areas | Already permitted | Already designed | Continued renourishment will be required | | | Far down the priority list for state funding (it will not likely be funded for at least a few years) |
| | Dune system is installed and stabilized with vegetation to provide protection for road | | | | | Alligator Harbor maintenance, if sediments are usable | | | | | | |
| **Build Up Defense** | | High | High | High | High | Negative | Low | Moderate | Moderate | $$$ | $$ | |
| Riprap Breakwater, Revetment and Groin Complex | Offshore breakwaters reduce wave action, thereby reduce erosion | | Provides protected beach | | | May prevent natural migration of sediments causing erosion issues for adjacent area | May be difficult or impossible to permit and likely will require nourishment | | | | | |
| | Sand accumulates behind the breakwater to provide further protection | | | | | | | | | | | |
| **Soft Repairs** | | Low | Low | Low | Low | Negative | High | High | Low | $ | $$ | |
| Plan for 4x4 Only Access | Involves no action, regrade road for 4X4 access, as necessary | | | | | As shoreline continues to recede, impacts to adjacent area will worsen. | | | | | | |

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———— n.d.[b] The National Assessment of Shoreline Change: A GIS Compilation of Vector Shorelines and Associated Shoreline Change Data for the U.S. Gulf of Mexico. USGS Open File Report 2004-1089. Accessed at: https://pubs.usgs.gov/of/2004/1089/gis-data.html.

# Appendix A
# Benchmark Sheets for Nearby Tide Stations

**NOTICE:** All data values are relative to the MLLW.

## Elevations on Mean Lower Low Water

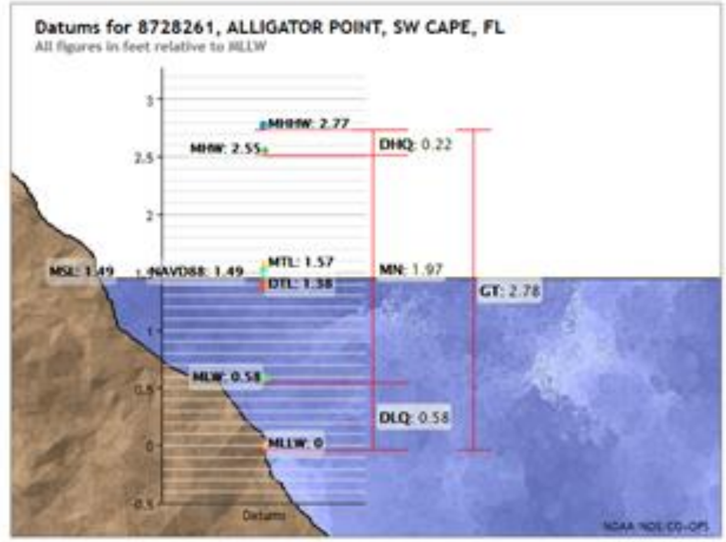
**Station:** 8728261, ALLIGATOR POINT, SW CAPE, FL
**Status:** Accepted (Apr 16 2004)
**Units:** Feet
**Control Station:** 8727520 Cedar Key, FL

**T.M.:** 75
**Epoch:** 1983-2001
**Datum:** MLLW

| Datum | Value | Description |
|---|---|---|
| MHHW | 2.77 | Mean Higher-High Water |
| MHW | 2.55 | Mean High Water |
| MTL | 1.57 | Mean Tide Level |
| MSL | 1.49 | Mean Sea Level |
| DTL | 1.38 | Mean Diurnal Tide Level |
| MLW | 0.58 | Mean Low Water |
| MLLW | 0.00 | Mean Lower-Low Water |
| NAVD88 | 1.49 | North American Vertical Datum of 1988 |
| STND | -1.91 | Station Datum |
| GT | 2.78 | Great Diurnal Range |
| MN | 1.97 | Mean Range of Tide |
| DHQ | 0.22 | Mean Diurnal High Water Inequality |
| DLQ | 0.58 | Mean Diurnal Low Water Inequality |
| HWI | 6.83 | Greenwich High Water Interval (in hours) |
| LWI | 0.58 | Greenwich Low Water Interval (in hours) |
| Max Tide | | Highest Observed Tide |
| Max Tide Date & Time | | Highest Observed Tide Date & Time |
| Min Tide | | Lowest Observed Tide |
| Min Tide Date & Time | | Lowest Observed Tide Date & Time |
| HAT | | Highest Astronomical Tide |
| HAT Date & Time | | HAT Date and Time |
| LAT | | Lowest Astronomical Tide |
| LAT Date & Time | | LAT Date and Time |

**Tidal Datum Analysis Periods**

02/01/1977 - 07/31/1977




Showing datums for

8728261 ALLIGATOR POINT,...

Datum

MLLW

Data Units ◉ Feet
○ Meters

Epoch ◉ Present (1983-2001)
○ Superseded (1960-1978)

Submit

NOTICE: All data values are relative to the MLLW.

## Elevations on Mean Lower Low Water

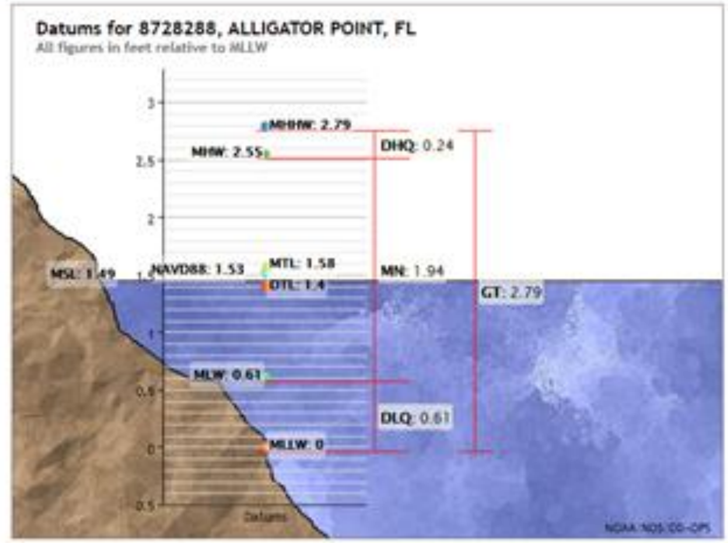
**Station:** 8728288, ALLIGATOR POINT, FL
**Status:** Accepted (Apr 15 2004)
**Units:** Feet
**Control Station:** 8728229 SHELL POINT, WALKER CREEK, FL

**T.M.:** 75
**Epoch:** 1983-2001
**Datum:** MLLW

| Datum | Value | Description |
|---|---|---|
| MHHW | 2.79 | Mean Higher-High Water |
| MHW | 2.55 | Mean High Water |
| MTL | 1.58 | Mean Tide Level |
| MSL | 1.49 | Mean Sea Level |
| DTL | 1.40 | Mean Diurnal Tide Level |
| MLW | 0.61 | Mean Low Water |
| MLLW | 0.00 | Mean Lower-Low Water |
| NAVD88 | 1.53 | North American Vertical Datum of 1988 |
| STND | -0.86 | Station Datum |
| GT | 2.79 | Great Diurnal Range |
| MN | 1.94 | Mean Range of Tide |
| DHQ | 0.24 | Mean Diurnal High Water Inequality |
| DLQ | 0.61 | Mean Diurnal Low Water Inequality |
| HWI | 6.86 | Greenwich High Water Interval (in hours) |
| LWI | 1.04 | Greenwich Low Water Interval (in hours) |
| Max Tide | | Highest Observed Tide |
| Max Tide Date & Time | | Highest Observed Tide Date & Time |
| Min Tide | | Lowest Observed Tide |
| Min Tide Date & Time | | Lowest Observed Tide Date & Time |
| HAT | | Highest Astronomical Tide |
| HAT Date & Time | | HAT Date and Time |
| LAT | | Lowest Astronomical Tide |
| LAT Date & Time | | LAT Date and Time |

**Tidal Datum Analysis Periods**

10/01/1975 - 11/30/1975




Showing datums for

8728288 ALLIGATOR POINT, ...

Datum

MLLW

Data Units (•) Feet ( ) Meters

Epoch (•) Present (1983-2001) ( ) Superseded (1960-1978)

Submit

# Appendix B
# County Memo Regarding Road Maintenance for Alligator Drive

# FRANKLIN COUNTY

REPLY TO: □
BOARD OF COUNTY COMMISSIONERS
33 MARKET STREET, SUITE 203
APALACHICOLA, FL 32320
(850) 653-8861, EXT. 100
(850) 653-4795 FAX

REPLY TO: X
PLANNING & BUILDING DEPARTMENT
34 FORBES STREET, SUITE 1
APALACHICOLA, FL 32320
(850) 653-9783
(850) 653-9799 FAX

History of Public Funds Spent Repairing Alligator Point Drive
(CR 370)

Below is a history compiled from records of the Franklin County and FEMA from 1985 to 2015. The non-declared events represent expenditures of county funds.

| YEAR | FUNDS SPENT |
|---|---|
| 1985 – Hurricane Juan | $100,000 |
| 1985- Hurricane Elena | $100,000 |
| 1985- Tropical Storm Kate | $250,000 |
| 1987- August 26-28- non-declared event | $ 50,000 |
| 1987- Sept. 21-23- non-declared event | $ 50,000 |
| 1988- Sept. 9- non-declared event | $ 10,000 |
| 1989- June 27-29- non-declared event | $ 25,000 |
| 1991- January 7-12- non-declared event | $ 50,000 |
| 1991- March 4-6- non-declared event | $ 50,000 |
| 1991- April 1-4- non-declared event | $ 25,000 |
| 1992- July 27-30- non-declared event | $ 25,000 |
| 1992- Hurricane Andrew | $ 25,000 |
| 1992- October 3-8- non-declared event | $ 25,000 |
| 1993 – March Winter Storm | $150,000 |
| 1993- October 30- non-declared event | $ 5,000 |
| 1994- Tropical Storm Alberto | $900,000 |
| 1994- Tropical Storm Beryl | $ 60,000 |
| 1995- Hurricane Opal | $100,000 |
| 1996 Tropical Storm Josephine | $ 10,000 |
| 1998- Hurricane Earl | $ 25,000 |
| 1998 –Hurricane Georges | $ 10,000 |

| | |
|---|---|
| 1999-2003 Data incomplete (County estimate) | $200,000 |
| 2004- February- non-declared event | $ 5,000 |
| 2004- June- non-declared event | $ 10,000 |
| 2004- Hurricane Ivan | $300,000 |
| 2005- Hurricane Dennis | $1,000,000 |
| 2008- Hurricane Gustav | $ 683,000 |

(The county had a FDOT grant to resurface all of All Pt Road, not just the section that was damaged so the county utilized the FDOT grant and not the authorized PW, but the funds were expended repairing the road from storm damage.)

2009-2011- There are no identified expenditures on Alligator Drive. There was a lull in severe weather activity, and the most vulnerable section of the road was relocated. Once the road was relocated the frequency of repairs dropped dramatically.

| | |
|---|---|
| 2012 Tropical Storm Debbie | $142,000 |

2013-2015- There are no identified expenditures on Alligator Drive. The most vulnerable section of the road had been relocated, and the second most vulnerable section of the road was protected by an enhanced rock revetment.

| | |
|---|---|
| Total Expenditure of Public Funds (1985-2015) | $4,390,000 |

*********************************************************************

| | |
|---|---|
| 2016 Estimated Cost of Repairing Road From Hurricane Hermine | $3,000,000 |

(The repair costs include the consideration of vertical sheetpile seawall to replace the rock revetment, as erosion has caused the toe of the revetment to be below mean high tide and a revetment is not as protective as a vertical seawall.)

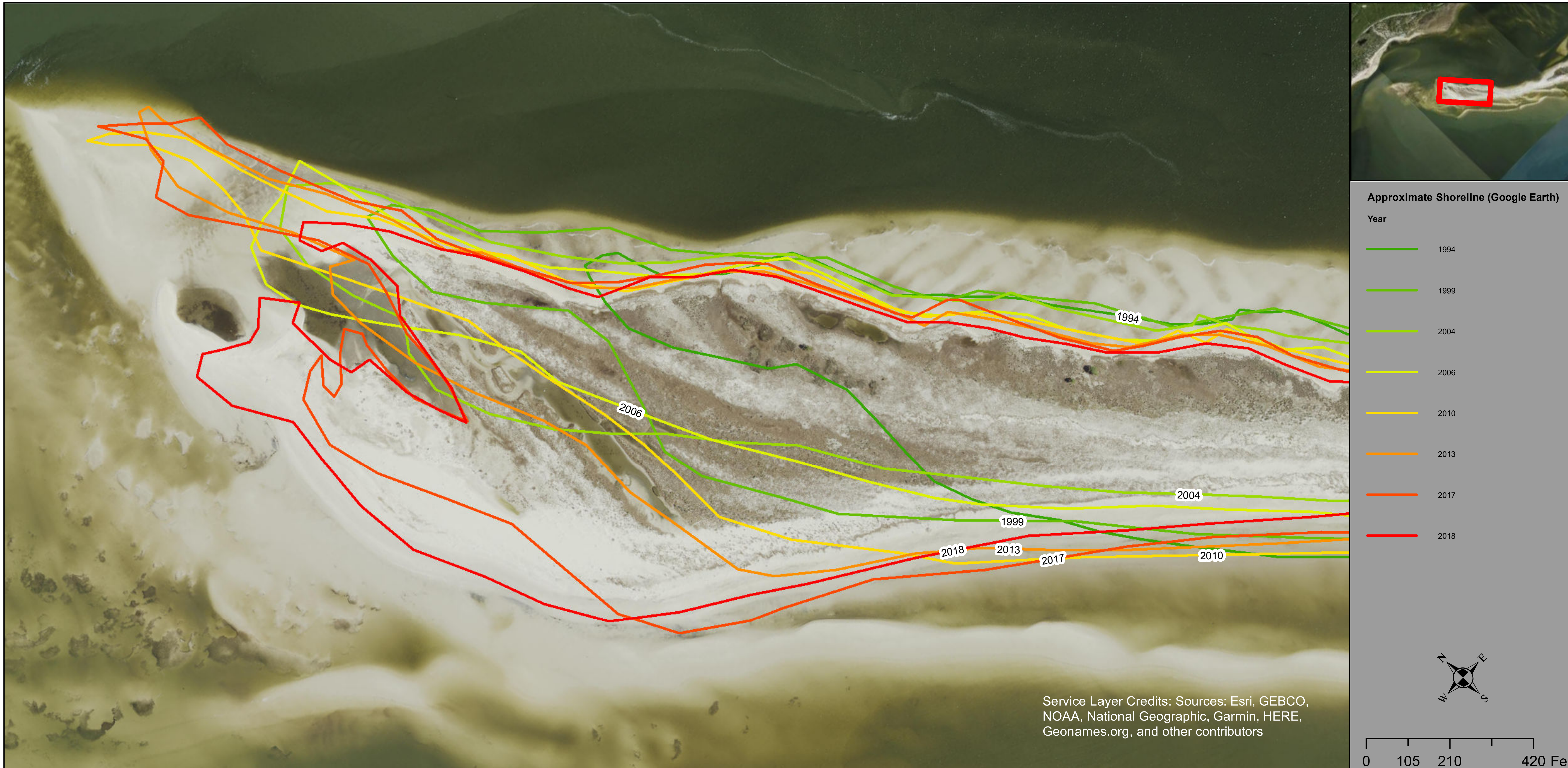
(Erosion continues to work on Alligator Point and it is possible additional sections of Alligator Drive will suffer future damage.)

Compiled by Alan Pierce, RESTORE Coordinator
Dec. 28, 2016 (Revised Jan, 30, 2017)

# Appendix C
# Historic Shoreline Locations
# (Based on Google Earth Imagery)

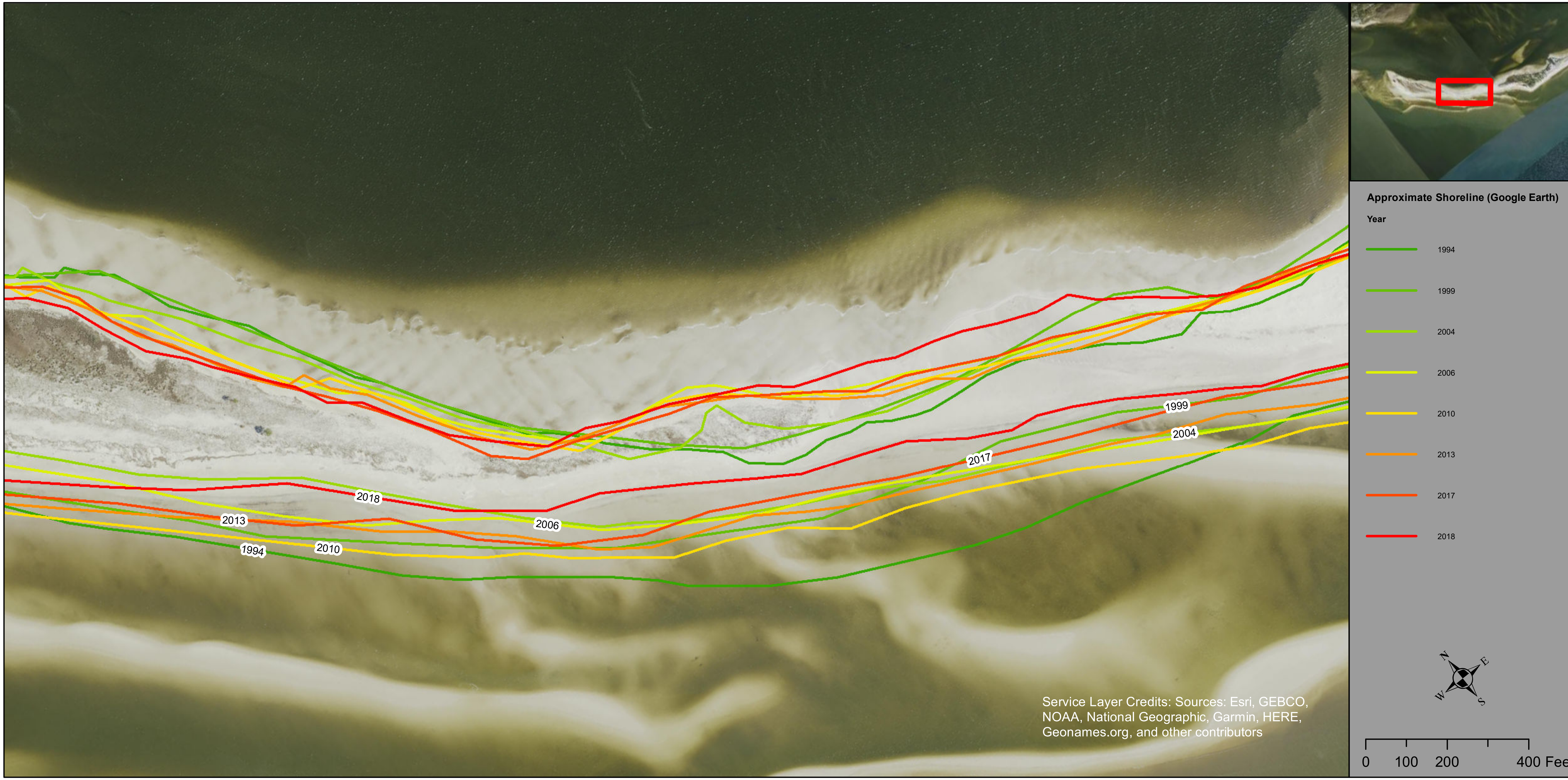
# Alligator Point - Approximate Historic Shoreline Locations





# Alligator Point - Approximate Historic Shoreline Locations





# Alligator Point - Approximate Historic Shoreline Locations

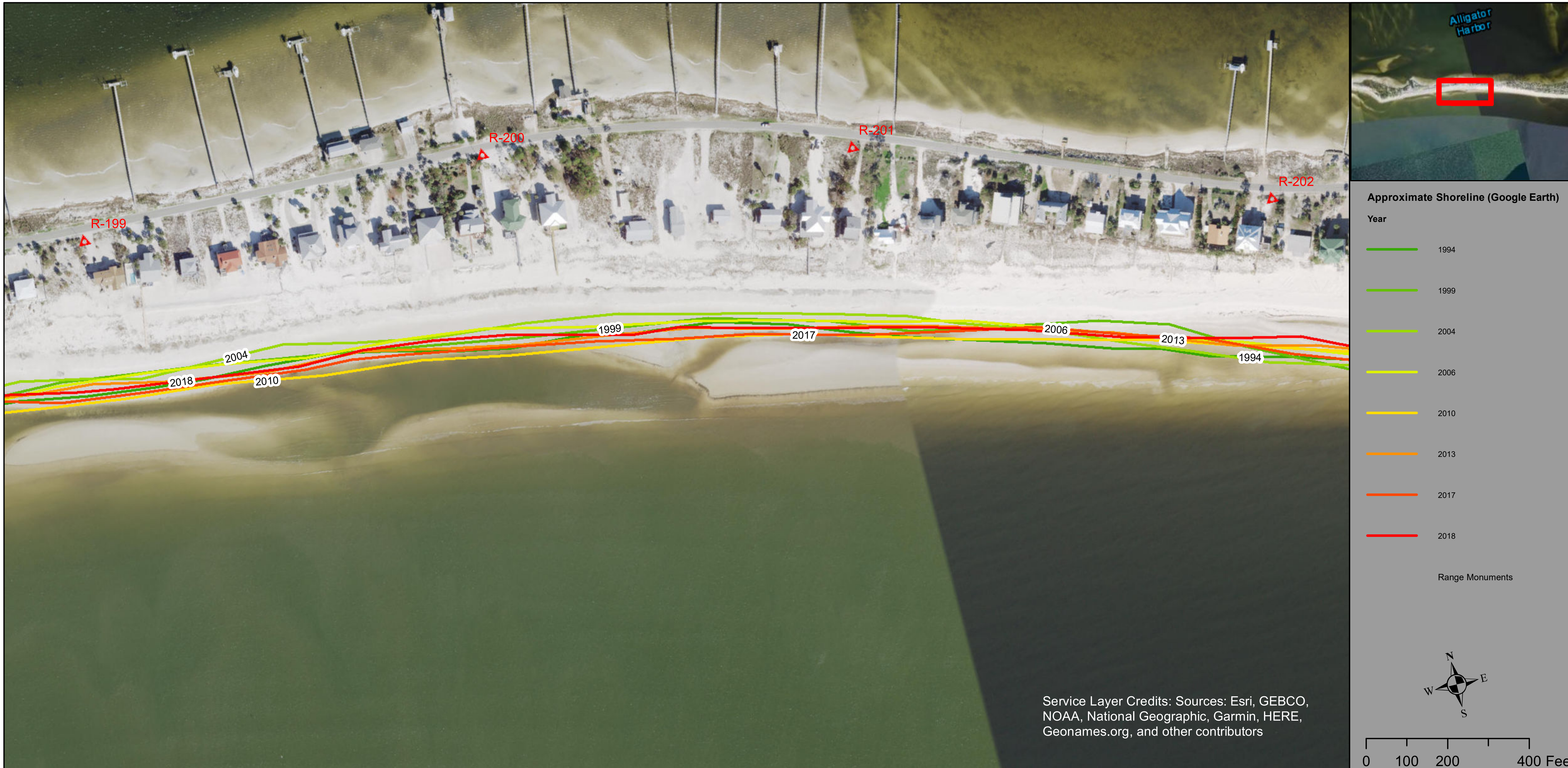


# Alligator Point - Approximate Historic Shoreline Locations



# Alligator Point - Approximate Historic Shoreline Locations





# Alligator Point - Approximate Historic Shoreline Locations

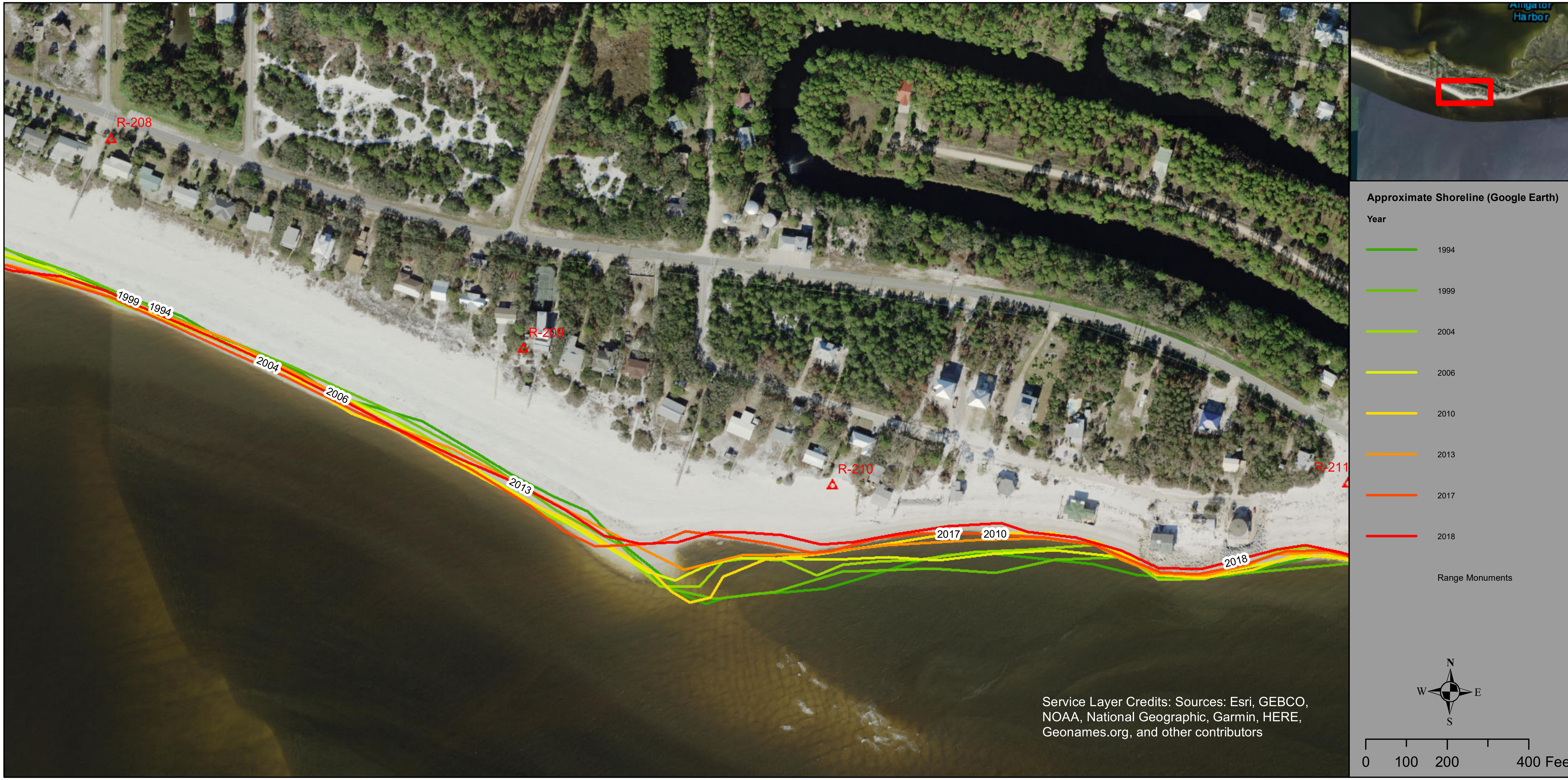


# Alligator Point - Approximate Historic Shoreline Locations



# Alligator Point - Approximate Historic Shoreline Locations





# Alligator Point - Approximate Historic Shoreline Locations

Page 9 of 11

# Alligator Point - Approximate Historic Shoreline Locations



# Alligator Point - Approximate Historic Shoreline Locations