CITY COUNCIL AGENDA FORM

REQUESTED COUNCIL MEETING DATE: 07/21/09

SUBJECT: SHORELINE HABITAT RESTORATION & MANAGEMENT PLAN

DEPARTMENT: CITY MANAGER/COMMUNITY REDEVELOPMENT AGENCY

RECOMMENDED MOTION:

To accept the Shoreline Habitat Restoration & Management Plan, as presented.

SUMMARY:

The City of Port Orange is one of several coastal communities within the boundaries of the St. Johns River Water Management District's Northern Coastal Basin program. The City participates in an inter-agency group formed by the District in June 2007, with the goal of developing and demonstrating best management practices for shoreline development and restoration. Under the leadership of Paul Haydt, the District has completed a comprehensive survey of the shoreline in Port Orange, and has identified six (6) areas for pilot restoration projects. To compliment and further the District's efforts, the City employed Denis Frazel, Frazel, Inc., to develop a comprehensive Shoreline Habitat and Restoration Management Plan for the City. This Plan includes the District's recommended shoreline restoration projects, as well as best management practices to guide the City as it develops and redevelops along its shoreline. Modifications to the City's Comprehensive Plan and Land Development Regulations are also recommended to support shoreline habitat restoration and management, and to ensure that required mitigation for shoreline impacts are undertaken within the community. Mr. Frazel will be presenting the final draft of his plan to the City Council.

ATTACHMENTS: ☐ Ordinance ☐ Resolution ☐ Budget Resolution

☒ Other ☐ Support Documents/Contracts

DEPARTMENT Submitted by Date

CITY MANAGER Approved Agenda Item For:

COUNCIL ACTION: **[ ] Approved as Recommended** **[ ] Disapproved**

[ ] Tabled Indefinitely **[ ] Continued to Date Certain** **[ ] Approved with Modification**

Shoreline Habitat Restoration & Management Plan

July 2009

City of Port Orange

Shoreline Habitat Restoration and Management Plan

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Acknowledgements

The Port Orange Shoreline Habitat Restoration and Management Plan project was managed by Donna Steinebach, Assistant to the City Manager of Port Orange. The development and preparation of this plan could not have been completed without the collaborative efforts of staff from the St. Johns River Water Management District (SJRWMD). Special thanks is due to Christy Yates, Environmental Scientist/GIS Analyst for Gannett Fleming, Inc., consultant to the SJRWMD Northern Coastal Basin (NCB) Program, for her extensive technical assistance. Christy collected, collated, and analyzed all of the shoreline transect data. She also provided the GIS maps, as well as much of the background text in this document. Thanks is also due to Paul Haydt, SJRWMD NCB Program Manager, who has been a driving force behind shoreline protection efforts along the Halifax River. He kindly provided early direction on the format of the plan, and coordinated the review of the document with other SJRWMD staff members.

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Cover: A view of the living shoreline in front of the Port Orange Riverside Pavilion. A band of oysters in the foreground provides a wave buffer protecting the intertidal salt mash dominated by the smooth cordgrass, *Spartina alterniflora*. Native Cabbage Palm (*Sabal palmetto*) trees are seen growing along the upland shore.

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Section I. Introduction

The City of Port Orange (City) is a residential and business community of more than 56,000 residents, located in eastern Volusia County, Florida. Established in 1867, the city covers an area of 28 square miles, including nearly 8 miles of shoreline along both sides of the Halifax River. The eastern portions of the City are accessed via the Dunlawton Avenue Causeway.

The Halifax River shoreline is a focal point of the City and provides a variety of ecological, recreational and economic benefits to the community. The City has determined that to maintain these benefits it is important to identify and implement environmental enhancement opportunities as the existing shoreline is developed and re-developed. The concept of a living shoreline is a central theme in development of a shoreline management plan for the City. Figure 1 is an aerial photograph that shows the eastern shoreline and boundaries of the City. Shoreline areas that have been surveyed are outlined in yellow. Unsurveyed shoreline areas are in shown in orange.

Shoreline Management Plan Evolution

The City is one of several coastal communities within the boundaries of the St. John's River Water Management District's Northern Coastal Basin (NCB) program. The NCB extends 100 miles from lower Duval County, south through the coastal wetlands of St. Johns, Flagler, and Volusia Counties to Ponce de Leon inlet near the City of New Smyrna Beach. The City participates in an inter-agency group formed by the District in June 2007 to create a cooperative shoreline initiative in the NCB. The group, consisting of representatives from the City of Port Orange, City of South Daytona, Volusia County Environmental Protection, Guana Tolomato Matanzas National Estuarine Research Reserve (GTM NERR), Florida Department of Environmental Protection (DEP), Florida Park Service, National Oceanic and Atmospheric Administration, Natural Resource Conservation Service and the District, established basic program goals and best management practices (BMPs) guidelines.

The inter-agency shoreline group selected an initial pilot project area along the western edge of the Halifax River within the City of Port Orange because the District, through its NCB Shoreline Management Program, had extensive shoreline characteristic data sets for the site. Also, the City of Port Orange had identified the riverfront as a key redevelopment area that could be used to showcase innovative redevelopment and environmental management techniques. The group developed a format for assigning BMPs to the shoreline and established management goals and objectives for the project area. In November 2008, the group identified six potential project areas along the shoreline in the City of Port Orange. The projects in these areas are intended to demonstrate the effectiveness of BMPs on different shoreline scenarios (Yates and Haydt, in preparation).

The District NCB Shoreline Management Program is part of a basin-wide protection and restoration initiative that was developed as an element of the NCB Surface Water Improvement and Management (SWIM) Plan for the protection and management of important estuarine habitats (Haydt and Frazel 2003). In a separate effort, Volusia County has completed an Intracoastal Island Management Plan covering the spoil islands and natural islands found within the Halifax River and Mosquito Lagoon. The County's plan provides biological data on the islands and classifies best use practices for each island.

Figure 1. Map showing the City of Port Orange project area and Intracoastal Waterway

The City desires to incorporate the information developed by the District and Volusia County into a plan that characterizes the environmental benefits and restoration potential of the shoreline within the City of Port Orange. The goals of this plan are to stabilize shorelines, prevent erosion, maintain, enhance and restore estuary habitat along the shoreline, river, and spoil island areas, and protect water quality within the boundaries of the City. To achieve these goals the following three objectives need to be accomplished:

1. Provide shoreline stability and control erosion;
2. Establish sustainable vegetative communities; and
3. Provide structure-based habitat in the intertidal and submerged tidal zones.

The preferred outcome for the City of Port Orange will be a sustainable "living shoreline". A "living shoreline" provides "living space" for riverine, estuarine, and coastal organisms, accomplished via the strategic placement of native vegetation, sand fill, organic materials, and, if necessary, a small amount of reinforcing rock seeded with oysters (NOAA 2009).

Benefits of a Shoreline Management Plan

The benefits of a shoreline management plan are many and varied. Comprehensive shoreline stabilization and erosion control is perhaps the most critical benefit. Long-term erosion along the Port Orange shoreline is mainly due to wind-generated waves and boat wakes. Control of this erosive wave action minimizes or impedes the destruction of vegetation and benthic habitats, and reduces sedimentation and turbidity of the water. Shoreline stabilization also helps to maintains property values by eliminating land losses.

Ecological enhancement through restoration and maintenance of estuarine habitat in the area is the second component of a healthy, stable shoreline. Shoreline areas that include natural upland and wetland vegetation as part of shoreline stabilization are beneficial as they provide a buffer to protect the estuary from upland runoff. Nutrients from runoff are assimilated by vegetated shoreline communities, and sediments from runoff and other pollutants are trapped in the vegetation, which in return helps protect water quality (Rogers, 1994).

Marsh grasses such as *Spartina alterniflora* (smooth cordgrass) have historically occurred in the intertidal zone along the Port Orange shoreline and the re-introduction of such plants provides critical habitat for juvenile fishes, crustaceans, mollusks, birds, mammals, and other estuarine organisms. The grasses develop a tough root mat after only a few growing seasons, creating a shallow erosion-resistant platform that causes storm waves to break before reaching higher land areas (Rogers, 1994). Marsh grasses are also a more cost-effective method of shoreline stabilization compared to bulkheads and hardened slopes.

Oyster bars, or reefs, have also occurred historically in portions of the intertidal zone of the City shoreline. They too decrease turbidity by trapping sediment and stabilizing erosion. The living oysters themselves, as suspension feeders, remove suspended particulates from the water column. Oyster bars provide hard substrate, refuge and habitat for many other species including ivory barnacles (*Cirripedia* spp.), polychaetes, mud crabs (*Rhithropanopeus harrisii*), blue crabs (*Callinectes sapidus*), and amphipods (Frazel 2008).

All of these ecological components are beneficial to the local fisheries. Recreationally valuable sport fishing species including spotted sea trout (*Cynoscion nebulosus*), weakfish (*C. regalis*), red drum (*Sciaenops ocellata*), black drum (*Pogonias cromis)*, croaker (*Micropogon undulatus*), sheepshead (*Archosargus probatocephalus*), whiting (*Menticirrus americanus*), and flounder (*Paralichthys* spp.) use the marshes and oyster bars throughout part or all of their life cycles. Any enhancement of the estuarine habitat will result in increased fisheries yield.

A natural, vegetated landscape along the shoreline has an intrinsic aesthetic appeal that attracts a variety of users. There is also an increasing recognition that property values benefit more from a landscaped shoreline than one that is hardened, or bulkheaded.

Shoreline enhancement and protection provides other valuable assets for the local community. Ecotourism and recreational uses including boating, picnicking, biking, canoeing, kayaking and nature study are outstanding. Wildlife viewing, especially birds, is excellent along a natural shoreline.

The Port Orange Shoreline

The Port Orange shoreline extends approximately 3.5 miles south along the western side of the Halifax River between the cities of South Daytona to the north and New Smyrna Beach to the south, and nearly 2 miles along the eastern shore of the Halifax River between Daytona Beach Shores to the north and Ponce Inlet to the south (Figure 1). The southern portion of the City borders Rose Bay. The Ponce Inlet section of the Volusia Island Management Project describes all of the islands occurring in the Halifax River within the boundaries of Port Orange. Named islands include, Pelican Island, located to the north of Dunlawton Causeway, and Rookery Island, located to the south of Dunlawton Causeway.

The earliest documentation available on the Port Orange shoreline is a United States Coast Survey (USCS) map dating to the 1870's (Figure 2). The map shows an irregular shoreline with islands and areas of salt marsh throughout that portion of the Halifax River.

Aerial photographs from the 1940's show development of roads along the shore on both sides of the Halifax River. (Figure 3). By super-imposing the 1870 shoreline (blue line) and the 1940 shoreline (red line) on the 1940's aerial photographs, there is evidence of dredging and filling along the southern end of the city. Also, the Intracoastal Waterway (ICW) extending north-south along the eastern edge of the city boundaries, has been dredged by this time. The white areas on the islands along the western edge of the ICW are the dredge spoil mounds from the ICW project. Several boat docks can be seen along the north-western shoreline. Note that the Dunlawton Causeway has yet to be built.

The current Port Orange waterfront is fully developed (Figure 4), with most of the location of the shoreline remaining relatively unchanged since 1940. Most of the waterfront is occupied by private single-family residences. The Dunlawton Causeway has been constructed, and a residential area has been created on the south side.

The northeast area of the City (north of Dunlawton Causeway) has been built on a large area of reclaimed land. A series of four canals provides direct Halifax River access to these property owners.

The major public access to the Halifax River is provided from Causeway Park. This park has three boat ramp lanes, a fishing pier space, restroom facilities, and covered picnic tables. The present Port Orange/South Daytona Chamber of Commerce site, known Riverfront Pavilion Park, park contains a fishing pier, picnic tables, a children's play area and as well as the Chamber of Commerce, the Port Orange Historical Trust and the Halifax Sports Fishing Club. The Causeway Park and Riverside Pavilion Park, together provide approximately 1,713 linear feet of fishing pier space within the City, along with several hundred feet of deep water bulkhead and shoreline areas that are commonly used for fishing. There are also three commercial marinas within the City with a total of 142 slips (65 dry and 77 wet) along with 5 docks.

Figure 2. Map showing the City of Port Orange as depicted on historical land surface maps prepared by the U.S. Coast Survey from the 1870's.

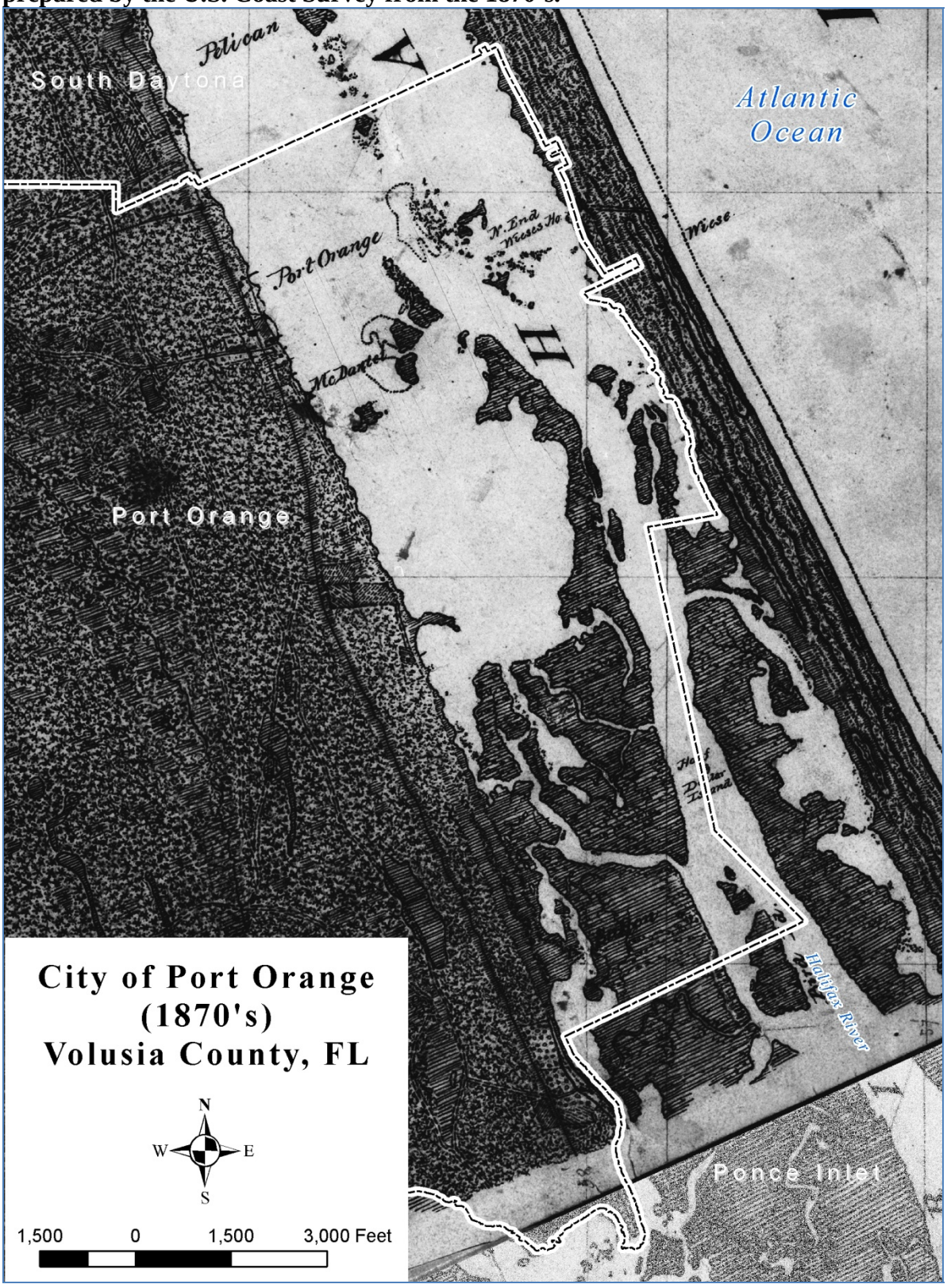


Figure 3. Map showing the City of Port Orange as depicted from aerial photographs from the 1940's.

Figure 4. Map showing the current City of Port Orange shoreline. The 1870 shoreline is outlined in blue.

Bathymetry

The tidal range in the vicinity of Port Orange ranges from 0-2 ft., representing changes in the intertidal width of between 0 and 30 ft., depending on shoreline slope. The ICW is the only officially marked navigable waterway extending north-south along the eastern side of the Halifax River. The ICW has a project depth of 12 ft., with a minimum 90 ft. width. There is an unmarked channel that runs roughly east-west just north of the Dunlawton Causeway that provides ICW access. There is also a narrow channel running to the south of the residential development on the south side of Dunlawton Causeway. This channel discharges south into the ICW. In the southern end of the City there are two natural channels bisecting the salt marsh that provide ICW access as well.

Section II. Shoreline Management Issues

The historic (pre-1940) record shows a predominantly natural Port Orange shoreline with few man-made structures and evidence of bands of upland and littoral vegetation. Intermittent near-shore oyster bars also occur. The current shoreline shows signs of erosion, with sparse upland vegetated habitat, extensive bulkheading with no hardened slope, stormwater outfalls discharging untreated runoff, limited vegetated intertidal saltmarsh habitat, and few oyster bars. Resolution of each of these issues can be accomplished through the implementation of remedial actions.

Erosion

Erosion is defined as the group of natural processes, including weathering, abrasion, and transportation by which material is worn away from the earth's surface. Human activities that contribute to or increase the effects of erosion include dredge and fill operations, wetland drainage, boat traffic and channel dredging (National Research Council, 2007). Erosion along the Port Orange shoreline is due to a combination of both wind-driven wave energy and the wave energy produced by boat wakes.

Wave energy is the force a wave is likely to have on a shoreline depending on environmental factors, such as shore orientation, wind, channel width, and bathymetry. Assessing wave energy is critical for determining the best methods for erosion control and shoreline protection. A specific wind-wave analysis has been completed in the Port Orange area. Wind speeds, obtained from Daytona Beach airport, measures of fetch, the distance along open water over which wind blows, and average water depth, were incorporated into a District "SMB" model to estimate wind-wave heights for the Port Orange shoreline (Figure 5).

In addition, the U.S. Army Corps of Engineers (USACOE) has assessed the impacts of waves generated by boat wakes in the Upper Mississippi River System that can be applied to Port Orange. The USACOE study evaluated erosion potential by distance to shore from a navigation channel for a variety of vessels operating at normal cruising speeds. The study showed that large cruisers and medium power boats produce the highest waves between 0 and 300 feet from shore (Table 1). Erosion potential as a function of distance from the navigation channel (Table 2) was medium to high for distances less than 300 feet from the channel.

Table 1. Estimates of wave height (cm) as a function of distance from navigation channel, Upper Mississippi River system.

Vessel Type	Distance from channel in meters (ft)		
	0 – 30 (0-100)	30 - 90 (100 – 300)	90 - 150 (300 – 500)
Jet Skis	8	4	0
Fishing Boats	16	8	4
Pontoon	8	4	4
Medium Power	24	20	10
Large Cruisers	50	40	20
Houseboats	8	4	4

Figure 5. Map showing wind-wave estimated heights along the City of Port Orange shoreline.

Table 2. Classification of bank erosion potential by maximum wave heights at the shore, and distance from navigation channel (USACOE).

Erosion Potential	Maximum Wave Height (cm)	Distance from Navigation Channel Meters (Feet)
High	>35	<30 (< 100)
Medium	20-35	30-90 (100 - 300)
Low	<20	>90 (> 300)

The distance from the shoreline in Port Orange to the channel of the ICW ranges from 110 to 1400 meters. According to the wave heights in Table 1, these shoreline areas would have a "Low" potential of erosion from boat wakes from the ICW. Much of the southern half of the western shoreline is protected from the ICW by natural islands, which buffer the wave energy prior to reaching shore. The distance to which boats come near the shore is an important factor for evaluating the amount of erosion due to boat wakes. Approximately 3,062 meters of the western shoreline is forty meters or less from a navigation channel. However, areas just north and south of the Dunlawton Bridge are exposed to a fairly broad unobstructed fetch and thus have a high potential for erosion as shown in Figure 5.

Under the Volusia County Manatee Protection Plan, most waterways in the Port Orange area have boat speed controls with much of the shoreline area designated as an idle zone. The western channel areas are marked as 25 MPH in the marked channel and slow speed outside the channel. The ICW is marked as 30 MPH during daylight hours and 25 MPH at night. North of Dunlawton Bridge and the Causeway Park, waterways are zoned as 35 MPH during daylight hours and 25 MPH at night.

Because of both the property loss and habitat loss associated with erosion, any areas of severe erosion will be evaluated as a higher priority for restoration. These areas are most important as the loss of property has direct economic impact to property owners and because restoring lands that have been lost is more expensive than simply protecting them from erosion in the first place.

Water Quality

The Halifax River is sampled every other month as part of the St. John's River Water Management District's ambient monitoring program. Ambient water quality monitoring is an integral part of the District's mission to protect and manage water resources. For the Halifax River, total suspended solids, turbidity, total nitrogen, total phosphorus, and chlorophyll concentrations were all higher than typically found in other estuaries. Elevated concentrations of these constituents are often found in estuarine areas where untreated stormwater discharges occur, and where natural habitats have been impacted. As previously noted, Port Orange has several stormwater outfalls that have no pre-treatment prior to discharge and many areas of the shoreline have disturbed natural habitats.

Habitat Loss

Salt marshes, mangrove estuaries and oyster reefs have long been recognized as some of the most productive aquatic environments. Their abundant food supply and varying salinity gradients

make these areas particularly valuable for a variety of species that flourish in both fresh water and marine habitats.

Salt marshes in particular perform many valuable functions. They are a major producer of detritus and provide nursery grounds for numerous commercially and recreationally important species. In addition, salt marshes serve as filters to remove sediments and toxins from the water. Marsh plants break down many pollutants into less harmful forms. Uptake by sediments and burial in the marsh minimize the toxic effects of pollutants. The historic loss of these habitats thus negatively impacts water quality as well as reduces the economic benefits derived from the species that utilize these habitats.

Sea level Rise

Intertidal and sub-tidal ecosystems, such as salt marshes, mangroves and oyster reefs are particularly vulnerable to rising sea level because they are generally within a few feet of sea level (IPCC, 2007). As the sea level rises, the outer boundary of these ecosystems tend to erode, if left unprotected. Restoration of eroded areas, and enhancement of vulnerable areas will not halt sea level rise but it can provide an enhanced level of protection from wave energy and associated erosion.

Section III. District Shoreline Survey

To both qualitatively and quantitatively develop an understanding of which shoreline management issues are most critical on a local level, the District undertook and completed a survey of the Port Orange shoreline. NCB Shoreline Management Program consultant Christy Yates completed the field survey in April 2007. The survey data, summarized in Appendix 1, forms the basis of the Port Orange shoreline characterization. Attribute information was collected describing the condition of the shoreline edge, vegetation, benthic communities, land use and ownership type (public or private), erosion severity, and freshwater influences (canals, outfalls, etc). The field survey consisted of transects taken every 100', extending from the upland edge to the water's edge. A GPS reading was taken at each transect location. The data was collected using a Trimble GeoExplorer GPS data logger. The survey data was post-processed using Trimble's GPS Pathfinder Office and ESRI's ArcGIS 9.2 (excerpted from District's Port Orange Shoreline Habitat Restoration and Management Project document (Yates and Haydt, in prep).

The method of data collection was completed by traversing the shoreline by land, where feasible, and by canoe. The total length of shoreline in surveyed was approximately 7.9 miles (4335 meters). The shoreline edge was categorized into three classes: bulkhead, hardened slope, and no structure (Table 3). The hardened slopes consisted of coquina, rip rap or concrete. 72% of the current shoreline in Port Orange is either bulkheaded or hardened, and much of the bulkheaded areas are also hardened with rip rap.

Table 3. Categorization of Port Orange shoreline edge

Shoreline Edge	Length (meters)	Percent of Total Shoreline
Bulkhead	5916	46
Hardened Slope	3320	26
No Structure	3502	28
Total	12,738	100

The adjacent habitat to the shoreline was also noted (Table 4). Habitat types identified were vegetation, oyster, rock, sand, water, or none. Nearly 60% of the adjacent habitat was vegetation. 28% of the adjacent habitat was either water or not visible because of water depth. Oysters and rock comprised 12% of the adjacent habitat. Bulkheads or hardened slopes were located along all portions of the shore where no vegetation was present.

Table 4. Categorization of Port Orange adjacent habitat

Adjacent Habitat	Length (meters)	Percent of Total Shoreline
Vegetation	7511	59
Oyster and Rock	1582	12
Sand	71	1
Water (or not visible)	3547	28
Total	12,711	100

The type of vegetation and width of each type was also recorded. The width of vegetated areas ranged from 0 to 100 feet. The average width of vegetated areas was nearly 10 feet. The predominant type was *Spartina*, though mangroves, bushy seaside tansy (*Borrichia frutescens*),

black needlerush (*Juncus romerianus*), and saltgrass (*Distichlis spicata*) were also observed. The invasive Brazilian pepper (*Schinus sp*.) was noted in the uplands portions of five different transects.

Erosion severity, depicted in Table 5, was subjectively measured at each transect as severe, moderate, or little to none. Severe erosion included areas eroded greater than one foot in depth and little to no vegetation present, moderate included erosion greater than three inches to less than one foot in depth and little to no vegetation, and little to no erosion included areas eroded less than three inches in depth with vegetation generally present. Little or no erosion was observed in 77% of the shoreline, with 23% of the shoreline showing moderate to severe erosion.

Table 5. Estimates of erosion severity for the Port Orange shoreline

Erosion Severity	Length (meters)	Percent of Total Shoreline
Severe	308	3
Moderate	2590	20
Little to None	9821	77
Total	12,719	100

Analysis of adjacent land use and owner type (public or private) (Table 6) shows that approximately 74% of the total shoreline in Port Orange is developed as commercial or residential property. More than 20% of the shoreline is either natural or parkland, with the remaining 5% either vacant or existing as public right-of-way.

Table 6. Adjacent land uses to the Port Orange shoreline

Adjacent Land Use Type	Length of Shoreline (meters)	Percent of Total Shoreline
Commercial/Industrial	660	5
Residential	8795	69
Natural or Park	2640	21
Vacant/Right-of-way	630	5
Total	12,725	100

The intertidal zone width, which is the area exposed to air during low tide and submerged at high tide was estimated for all transects (Table 7). Approximately 74% of the shoreline has an intertidal zone width of less than 10 feet and 34% of these areas have no vegetation present.

Table 7. Intertidal Zone Width along the Port Orange shoreline

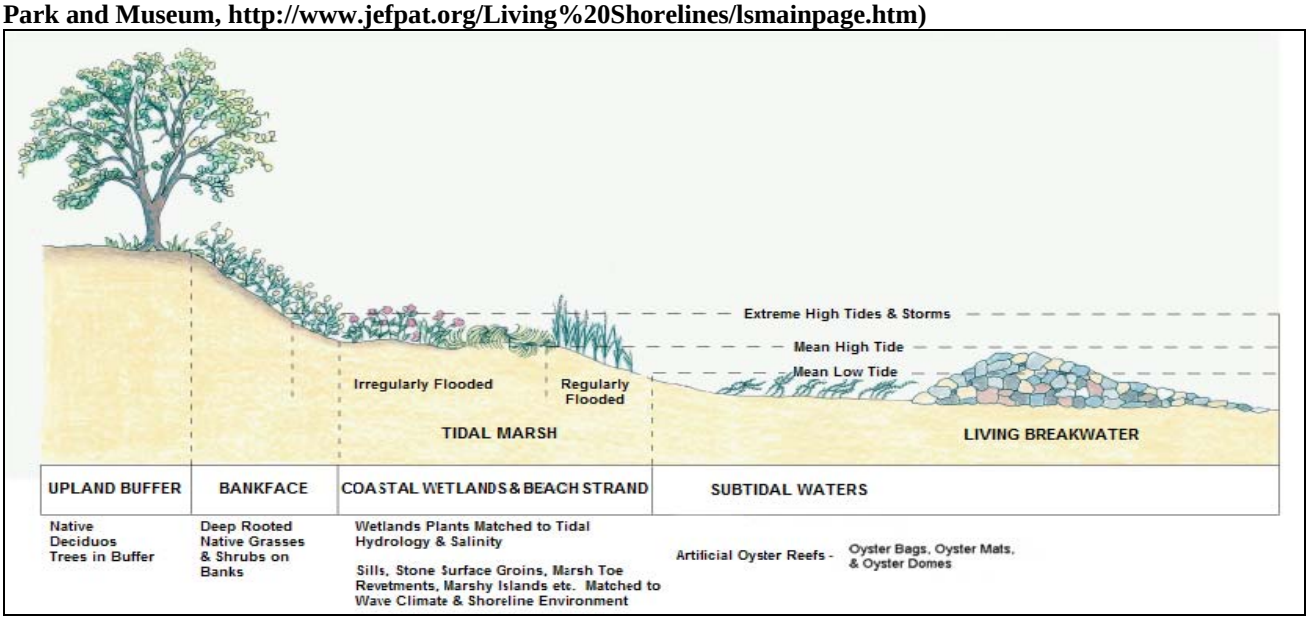
Intertidal Zone Width (ft)	Length of Shoreline (meters)	Percent of Shoreline
< 10	9819	74
11 to 20	1757	13
21 to 30	573	4
31 to 100	1089	8
>100	131	1
Total	13,238	100

Section IV. Strategies for Restoration or Protection

The information collected by the District shows that most of the Port Orange shoreline has been altered through a combination of dredging, filling, and erosion. As a result, intertidal areas that once contained salt marsh and oysters are gone. The benefits of shoreline stabilization that these habitats once provided are also gone. While it is unrealistic to imagine returning the shoreline to a truly natural pre-development state, it is realistic to believe that actions can be taken improve the shoreline environment. The shoreline can be divided into four general areas; upland, slope, intertidal and sub-tidal. Each of these areas has unique characteristics and functions within the shoreline ecosystem.

Figure 6 shows a schematic diagram of a typical living shoreline area. In this example the ideal upland is a natural buffer area between the slope and nearest man-made structure. The upland is stable. There is no erosion and preferably native vegetation exists. The slope side (bankface) is a natural, gently sloping, non-structural shoreline fronted with a wide band of healthy, native vegetation. High marsh grasses are most effective for erosion prevention during higher water levels in this area. The intertidal region (tidal marsh) is comprised of native salt marsh vegetation such as *Spartina alterniflora, Batis maritima, Sarcocornia perennis,* mangrove, etc. This vegetated region should be contiguous to the slope and range in width from 10-30 ft. The sub-tidal region represents the first area to disperse wave energy and provide viable benthic habitat. This area, the living breakwater, is dominated by healthy oyster bars.

Figure 6. Schematic diagram of a living shoreline area. (Diagram courtesy of Jefferson Patterson Park and Museum, http://www.jefpat.org/Living%20Shorelines/lsmainpage.htm)



A local example showing several of the important components of a sustainable living shoreline is shown in Figure 7, an area of the shoreline adjacent to the Riverside Pavilion. A narrow band of oyster reef occurs seaward of the shore, with a small exposed in the area of a remnant dock. There is a healthy a band of *Spartina alterniflora* extending to the slope, with native vegetation occurring in the upland. The photograph on the cover also shows the shoreline seaward of the Riverside Pavilion. In that photograph the band of oyster reef is clearly visible in the foreground.

Figure 7. Photograph of the living shoreline adjacent to the Riverisde Pavilion, facing south.

The existing "typical" shoreline in Port Orange is one in which the upland is developed, and the shoreline slope is either bulkheaded or hardened. The intertidal zone is generally less than 10 ft., with 3-5 ft. of vegetated area. The subtidal zone is only sparsely inhabited by oysters. The "ideal" Port Orange shoreline would be one in which all bulkheaded areas were faced with riprap to reduce scour, some intertidal slope was re-established in areas with little to no existing intertidal area, with wave breaks established to protect intertidal areas thus allowing re-vegetation.

To approximate this "ideal" shoreline situation requires the implementation of specific actions, or "Best Management Practices" to successfully meet the objectives of this plan. Best Management Practices (BMPs) for shoreline protection are measures that have the combined effect of mitigating or minimizing adverse impacts associated with both human and natural activities that negatively affect the shoreline environment.

Listed below are BMPs, and descriptions of those BMPs, for each shoreline area.

Upland Side: Historically, bulkheads were the chosen method for stabilizing upland shorelines because they were the most familiar form of stabilization; but they can be undermined from the continuous movement of water and wave energy striking the vertical structure. Bulkheads can also be overtopped during major storm events, which may cause degradation or erosion behind the structure.

- The ideal is a natural buffer area between the slope and nearest structure, impervious surface or fertilized turf or garden area. There is no erosion and preferably native vegetation.
- A bulkhead may be installed to eliminate property loss. If a bulkhead is installed, then riprap slope and marsh vegetation should be installed to help absorb wave energy.

Slope Side:

- A natural, gradual vegetated sloped area is created.
- If a hardened slope is required due to erosion or wave energy, then riprap, using a material that has maximum surface area, is installed. Riprap is a permanent, erosion-resistant layer made of stones. Riprap works by absorbing and deflecting the impact of a wave before the wave reaches the upland. Riprap also provides shelter and habitat for shoreline organisms.

Intertidal Region:

- The land maintains a gradual slope within the tidal range of the area.
- Native salt marsh vegetation such as *Spartina alterniflora, Batis maritima, Sarcocornia perennis*, Mangrove, etc. is planted directly in front of the slope.
- Vegetation bandwidth should be at least 10' wide.
- Walkway planks going over the intertidal zone should be spaced to allow light penetration for vegetation growth.

Sub-tidal Region:

- Healthy oyster bars are established through the use of oyster, mats, oyster domes or bags. An advantage of oyster domes and/or bags is that they provide more natural habitat structure for oyster spat to settle and thrive than other breakwater structures.
    - Oyster mats are 2' or 3' square sections of plastic mesh onto which oyster shells are attached. These mats are then laid end to end in sub-tidal areas. The mats provide a substrate for oyster larvae to settle and grow.
    - Oyster domes are semi-round concrete structures with numerous holes throughout (Figure 8). The domes weaken strong waves that cause erosion. When a wave hits the dome, most of its "energy" goes into the sides of the domes and comes out the top, like a volcano eruption. The holes in the domes provide hiding places for smaller species of fish and crabs who seek escape from larger fish and birds**.** Most importantly, they provide a hard substrate for oyster larvae to settle on. The rough texture of the domes makes it easier for oysters to grow on them.
    - Oyster bags are mesh or ventilated bags containing oyster shell. They too provide a hard substrate for oyster larvae to attach and grow.
- Where wave energy is moderate, high wave breaks or breakwaters can be installed at subtidal depths to dissipate wave energy.
- Floating docks generally disperse wave energy more than fixed structures.
- Oyster bags or baskets attached to docks and piers will provide habitat for oyster renewal and disperse wave energy.
- Baffles and wave boards can be fixed in or deployed from fixed docks to deflect and disperse wave energy.

- Positioning docks at an angle to the shoreline increases the shoreline area that is protected from both wind and boat-induced wave action.

These BMPs are the most preferred, commonly used approaches for shoreline protection and habitat enhancement, and are applicable to Port Orange.

Figure 8. Oyster domes before (left) and after (right) six months placement in the water. (Photo courtesy of Tampa BayWatch)

Port Orange Shoreline Management Recommendations

Specific recommendations for each transect, based on the information collected by the District, are outlined below. The recommendations are based on historical shoreline conditions and the potential for restoration. Figures 9 a-j show both the erosion severity and restoration opportunity for the shoreline within each transect. BMP recommendations are made for all areas.

The transect numbers refer to the survey transects taken every 100', where feasible, along the shoreline. As previously noted, all survey data is provided in Appendix 1. Whenever possible, the survey transects were grouped according to similar shoreline profiles. Each shoreline BMP profile was divided into 4 zones: Upland, Slope, Inter-tidal, and Sub-tidal. Six of these areas have been identified for pilot restoration projects and are discussed in more detail following the individual transect recommendations.

Transects 1 – 31 occur along the Port Orange Riverwalk Redevelopment Project Area. BMP recommendations for this area were provided to Glatting Jackson Kercher Anglin, Inc. the City's consultant responsible for the Riverwalk Park design. Locations of transects 1-32 can be found on Figure 9a. Map 1.

Transect 1-3 Natural Area, no structures, ~15-20' vegetation - not a high priority for management at this time; high wind-wave potential.

Upland side	Monitor.
Slope side	Preserve habitat & clean the shoreline.
Intertidal	Preserve habitat & clean the shoreline.
Subtidal	Enhance benthic habitat; provide wave break.

Transect 4-5 Hardened riprap shoreline with vegetation and oysters. High wind-wave potential.

Upland side	Remove stormwater input.
Slope side	Plant some mangroves.
Intertidal	Maintain and preserve habitat.
Subtidal	Provide wave break, enhance and augment oysters, ex. oyster domes.

Transect 6-8 Area with ~50' of fill on historical wetland (filled after 1940's); bulkhead & rock, no vegetation, moderate erosion, & ~ 10' oyster present; high wind-wave potential.

Upland side	Bring the seawall back to historical location at upland edge.
Slope side	Place a minimal gradual stable coquina hardened slope.
Intertidal	Establish a significant band of natural vegetation.
Subtidal	Enhance benthic/oyster habitat and provide wave break.

Transect 9-10 Recovered filled area, no structure, vegetation & oyster present; moderate wind-wave potential.

Upland side	Maintain/enhance upland habitat.
Slope side	Preserve habitat & clean the shoreline.
Intertidal	Preserve habitat & clean the shoreline.
Subtidal	Enhance benthic/oyster habitat.

Transect 11 Marina (redevelopment area). Moderate erosion & high wind-wave potential.

Upland side	Marina, bulkhead.
Slope side	Provide some gradual sloping areas along shoreline.
Intertidal	Provide some vegetated areas.
Subtidal	Provide benthic/oyster habitat; oyster bags on docks. Place baffles or wave boards along boat slips/docks to deflect and disperse wave energy.

Transect 12-14 Hardened slope with some vegetation & little oyster; moderate wind-wave potential.

Upland side	Vacant parking area.
Slope side	Maintain hardened slope (riprap).
Intertidal	Establish/Preserve vegetative band in front of riprap.
Subtidal	Enhance benthic/oyster habitat.

Transect 15-17 Bulkhead, rock with oysters; Commercial/restaurant area. Prior to 1940's, ~250' of fill, no vegetation present; low to high wind-wave potential.

Upland side	Monitor bulkhead condition.
Slope side	Monitor for erosion.

Intertidal	Monitor.
Subtidal	Establish more oysters, about 10', oyster bags.

Transect 18-19 Hardened slope with riprap. Mangroves behind riprap, no vegetation in front, some oyster & moderate to high wind-wave potential.

Upland side	Monitor.
Slope side	Monitor.
Intertidal	Establish vegetation in front of riprap.
Subtidal	Enhance oyster habitat, oyster domes.

Transect 20-28 Historical bulkhead with 20-40' of vegetation in some areas, some oyster bars present, & high wind-wave potential. Moderate erosion at T27 behind & under bulkhead.

Upland side	- Leave the low bulkhead with vegetation in front.
Slope side	Remove bulkhead along the shoreline with no vegetation and create hardened shoreline.
Intertidal	Plant, restore, and monitor vegetation.
Subtidal	Wave break, oyster domes.

Transect 29-30 Some riprap with 15-25' of vegetation & some oyster. Moderate wind-wave potential.

Upland side	Monitor.
Slope side	Monitor, harden as necessary.
Intertidal	Maintain/monitor vegetation.
Subtidal	Enhance/create oyster habitat.

Transect 31 Hardened shoreline, riprap, and minimal oyster habitat; high wind-wave potential.

Upland side	Monitor/Roadway.
Slope side	Hardened slope (riprap).
Intertidal	Establish vegetation.
Subtidal	Enhance/create oyster habitat and provide wave break.

Figure 9a. Port Orange Shoreline Survey Results. Map 1.

Location of transects 33-68, Figure 9b. Map 2.

Transect 32–68 This shoreline segment has historic bulkhead in good condition in most areas. Area is ~ 1150 meters from the channel of the ICW, with a vegetated island feature ~ 800 meters on average from the shoreline. The island minimizes impacts from boat wakes to the shoreline. Only 1/3 of this shoreline section is vegetated; high wind-wave potential.

Upland Side	Keep historic bulkhead, but make repairs where bulkhead is caving in and crumbling. Stormwater outfall at transects 33, 38, 44, 48, 53, 61, 64 & 68, treat prior to input into the Halifax River.
Slope Side	Remove inappropriate riprap and place large sloping boulders to protect shoreline and bulkhead.
Intertidal	Plant 10 – 15'of salt marsh vegetation in barren areas; fill in front of boulders for *Spartina alterniflora* habitat, if necessary. At stormwater outfalls, plant ~ 20' of *Spartina* around outfall to catch sediments from pipe.
Subtidal	Enhance oyster habitat at MSL or MLW and provide wave breaks. At Transect 68, minimum distance for oyster/wave break should be ~ 20' due to stormwater outfall.

Location of transects 69–94 Figure 9c. Map 3.

Transect 69 Ideal shoreline conditions. Sloping hardened shoreline with ~ 20' vegetation in front and little to no erosion. Moderate wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor vegetation health.
Subtidal	Enhance oyster habitat and provide wave break.

Transect 70 Bulkhead with ~ 5' *Spartina* in front. High wind-wave potential.

Upland Side	Maintain bulkhead.
Slope Side	Monitor and install riprap if necessary.
Intertidal	Extend vegetation width to at least 10'.
Subtidal	Enhance oyster habitat and provide wave break.

Transect 71 Hardened slope with no vegetation, some erosion. High wind-wave potential.

Upland Side	Monitor.
Slope Side	Remove loose riprap and armor hardened slope.
Intertidal	Plant a minimum of 10' of *Spartina*.
Subtidal	-Install off shore oyster habitat and wave break.

Transect 72-73 Bulkhead, no vegetation, and moderate erosion. High wind-wave potential.

Upland Side	Keep existing bulkhead.
Slope Side	Provide gradual sloping riprap hardened shoreline.
Intertidal	Maybe fill in front of riprap, have at least 10' of vegetation.
Subtidal	Provide oyster habitat and wave break.

Figure 9b. Port Orange Shoreline Survey Results. Map 2

Figure 9c. Port Orange Shoreline Survey Results. Map 3

Transect 74 Hardened slope, minimal *Spartina* & moderate erosion. High wind-wave potential.

Upland Side	Remove old, collapsed bulkhead.
Slope Side	Stabilize with gradual sloping riprap.
Intertidal	Plant at least 10' of vegetation.
Subtidal	Provide oyster habitat and wave break.

Transect 75-77 No structure & hardened slope areas, 15 – 20' of vegetation. High wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor vegetation.
Subtidal	Provide oyster habitat and wave break.

Transect 78-79 Hardened slope, no vegetation. Moderate wind-wave potential.

Upland Side	Monitor.
Slope Side	Remove debris, concrete and replace with standard coquina boulders.
Intertidal	If necessary, provide fill to establish at least 10' of vegetation.
Subtidal	Provide oyster habitat and wave break.

Transect 80-81 No structure with a healthy band of vegetation & oyster bar. Low to moderate wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor vegetation.
Subtidal	Provide oyster habitat and wave break to protect north side of salt marsh area extending from shoreline.

Transect 82 Hardened slope, ~ 10' vegetation; Moderate wind-wave potential.

Upland Side	Monitor.
Slope Side	Install a gradual sloping hardened shoreline.
Intertidal	Monitor; plant vegetation.
Subtidal	Enhance oyster habitat at MSL or MLW and provide wave break.

Transect 83-89 Hardened slope with *Spartina* and mangroves and little to no erosion. Moderate wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Plant at least 10' of vegetation between oyster break and riprap in areas with no vegetation.
Subtidal	Provide oyster habitat and wave break.

Transect 90-91 Bulkhead and no structure area, with ~ 10' mangroves & some erosion. Moderate wind-wave potential.

Upland Side	Monitor.

Slope Side	Monitor.
Intertidal	Monitor.
Subtidal	Provide offshore oyster habitat and wave break.

Transect 92-93 No structure with mangroves and *Spartina*, oyster bar, moderate erosion, and a Stormwater outfall. Moderate wind-wave potential.

Upland Side	Stormwater outfall, treat prior to input into the Halifax River.
Slope Side	Harden shoreline with gradual sloping riprap.
Intertidal	Monitor.
Subtidal	Natural wave break is nearby.

Transect 94 Hardened slope with ~ 10' vegetation and oyster bars. Moderate wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor.
Subtidal	Establish oyster bags on docks and provide offshore wave break to protect vegetation.

Location of transects 95-126 can be found on Figure 9d. Map 4.

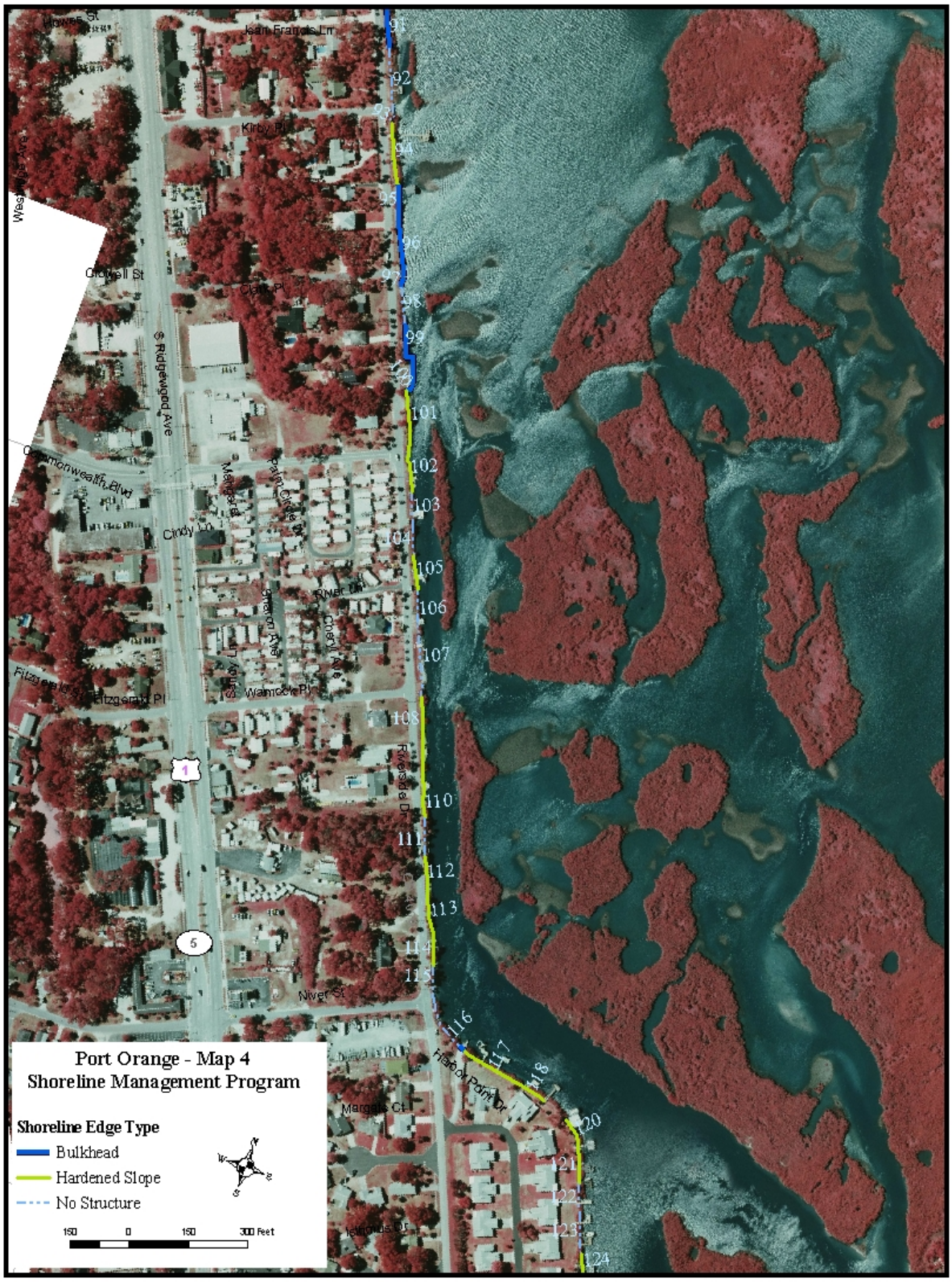
Transect 95-97 Bulkhead with ~ 5' *Spartina*, mangroves and moderate erosion in sections. Stormwater outfall at T95. Moderate wind-wave potential.

Upland Side	Where bulkhead is failing, pull wall back. Provide treatment for stormwater prior to input in ICW.
Slope Side	nstall sloping riprap in front of bulkhead.
Intertidal	Establish at least 10' *Spartina* in front of riprap.
Subtidal	Provide offshore oyster habitat and wave breaks.

Transect 98 No structure with a few mangroves and moderate erosion; small mangrove island and oyster bars ~ 20 meters east of the shoreline. Moderate wind-wave potential.

Upland Side	Monitor.
Slope Side	Harden shoreline to minimize erosion.
Intertidal	Plant *Spartina* and mangroves in front of hardened shoreline.
Subtidal	Natural wave break nearby.

Figure 9d. Port Orange Shoreline Survey Results. Map 4.



Transect 99-100 Bulkhead, no vegetation and moderate erosion. Boat channel adjacent to shoreline. Low wind-wave potential.

Upland Side	Remove bulkhead and concrete structures.
Slope Side	Install gradual sloping hardened slope.
Intertidal	Plant a minimum of 10' of *Spartina* in front of hardened slope.
Subtidal	Provide offshore oyster habitat.

Transect 101-116 Area with hardened slope and no structure with some vegetation and stormwater input; erosion characterized from mainly moderate to a few severe. Boat channel adjacent to shoreline. Low wind-wave potential.

Upland Side	Monitor upland; Stormwater outfall at T102, T107, & T115. Treat prior to input into the Halifax estuary.
Slope Side	Monitor and stabilize slope in eroded areas where considered necessary.
Intertidal	Monitor and plant vegetation in areas without.
Subtidal	Natural wave break, island east of shoreline.

Transect 117 Hardened slope with vegetation and little to no erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor.
Subtidal	Provide offshore oyster habitat.

Transect 118 Hardened slope with some mangroves and moderate erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Plant *Spartina* and/or mangroves in exposed areas.
Subtidal	Provide offshore oyster habitat.

Transect 119-121 Areas with no structure and hardened slope, 10 to 15' vegetation and little to no erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor vegetation.
Subtidal	Provide offshore oyster habitat.

Transect 122-123 Areas with no structure, ~ 10' vegetation, including Brazilian Pepper, and little to moderate erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor and remove exotics.
Subtidal	Provide offshore oyster habitat.

Transect 124-126 Areas with hardened slope, 10 to 15' vegetation and little to moderate erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor.
Subtidal	Provide offshore oyster habitat.

Location of transects 127-152 can be found on Figure Figure 9e. Map 5.

Transect 127-130 Areas with no structure, 10-15' vegetation, including Brazilian Pepper, and little to moderate erosion. Low wind-wave potential.

Upland Side	Monitor & provide stormwater treatment to outfall at T130.
Slope Side	Monitor.
Intertidal	Monitor and remove exotics.
Subtidal	Provide offshore oyster habitat.

Transect 131 Bulkhead and no structure with ~ 10' mangroves and little to moderate erosion. Brazilian Pepper present. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor and remove exotics.
Subtidal	Provide offshore oyster habitat.

Transect 132 Hardened slope with ~ 10' vegetation and little to no erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor.
Subtidal	Provide offshore oyster habitat.

Transect 133-136 Areas with no structure, 10-15' vegetation, including Brazilian Pepper, and little to moderate erosion. Low wind-wave potential.

Upland Side	Monitor & provide stormwater treatment to outfall at T136.
Slope Side	Monitor.
Intertidal	Monitor and remove exotics.
Subtidal	Provide offshore oyster habitat.

Transect 137 Area with no structure, 10' vegetation, and severe erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Stabilize slope in eroded area and harden to prevent future erosion.
Intertidal	After slope is stabilized, plant at least 10' of vegetation.
Subtidal	Provide offshore oyster habitat.

Figure 9e. Port Orange Shoreline Survey Results. Map 5.

Transect 138-142 Areas with no structure and hardened slope, 10-15' vegetation, including Brazilian Pepper, and little to moderate erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor and stabilize eroded areas.
Intertidal	Monitor and remove exotics.
Subtidal	Provide offshore oyster habitat.

Transect 143 Bulkhead with mangroves and little to no erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor.
Subtidal	Provide offshore oyster habitat.

Transect 144-145 No structure with 10' vegetation, moderate erosion and a stormwater outfall. Low wind-wave potential

Upland Side	Stormwater outfall, treat prior to input into the Halifax estuary.
Slope Side	Stabilize eroded areas and monitor.
Intertidal	Monitor.
Subtidal	Provide offshore oyster habitat.

Transect 146-148 No structure with < 10' vegetation and moderate to severe erosion. Low wind-wave potential. **Priority restoration area and potential pilot project area**.

Upland Side	Monitor.
Slope Side	Harden shoreline to prevent erosion, stabilize currently eroded areas and protect the road from being undermined in storm events.
Intertidal	Maybe provide some fill if necessary and plant a minimum of 10' of *Spartina* and/or mangrove.
Subtidal	Provide offshore oyster habitat and wave break.

Transect 149-150 Bulkhead with some vegetation and little to no erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Establish at least 10' of vegetation in front of bulkhead.
Subtidal	Provide offshore oyster habitat.

Transect 151 Bulkhead with no vegetation. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Plant at least 10' of *Spartina* and/or mangroves in front of bulkhead.
Subtidal	Provide offshore oyster habitat.

Transect 152 Bulkhead with minimal vegetation. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.

Intertidal	Establish at least 10' vegetation in front of bulkhead.
Subtidal	Provide offshore oyster habitat.

Location of transects 153-169 can be found on Figure 9f. Map 6.

Transect 153 **Potential pilot project area;** City Park. Hardened slope with minimal vegetation and moderate erosion. Stormwater outfall, treat prior to input into the ICW. Low wind-wave potential.

Upland Side	Clean park area and remove concrete, PVC debris. Provide stormwater treatment.
Slope Side	Armor slope with gradual sloping hardened shoreline.
Intertidal	Plant at least 10' of salt marsh vegetation.
Subtidal	Provide offshore oyster habitat and wave break just beyond outfall.

Transect 154-160 Bulkhead, hardened slope areas with some vegetation and little to no erosion. Low wind-wave potential

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Plant at least 10' of *Spartina* and/or mangroves in front of bulkheads & riprap with no vegetation present.
Subtidal	Provide offshore oyster habitat and wave break parallel to dock line to protect shoreline and vegetation.

Transect 161 **Potential pilot project area**; City Park with possible location for kayak launch. Hardened slope with ~5' vegetation and severe erosion. Moderate wind-wave potential.

Upland Side	Clean upland area.
Slope Side	Stabilize eroded areas; Remove loose-fitting/small riprap and harden shoreline with gradual sloping coquina riprap.
Intertidal	Plant at least 10' of *Spartina* and/or mangroves in front of riprap.
Subtidal	Provide offshore oyster habitat and wave break, if possible.

Transect 162–163 Bulkhead with some *Spartina* and little to no erosion. Low wind-wave potential.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Plant at least 10' of *Spartina* and/or mangroves in front of bulkheads & riprap with no vegetation present.
Subtidal	Provide offshore oyster habitat and wave break with in dock line to protect shoreline and vegetation.

Figure 9f. Port Orange Shoreline Survey Results. Map 6.

Transect 164 Mainly bulkhead with a city-owned parcel with no structure; some *Spartina* and mangroves with little to no erosion. Moderate wind-wave potential.

Upland Side	Monitor; Stormwater outfall at city owned parcel, treat prior to input into the Halifax estuary.
Slope Side	Monitor.
Intertidal	Plant at least 10' of *Spartina* and/or mangroves in front of bulkheads & riprap with no vegetation present.
Subtidal	Provide offshore oyster habitat and wave break with in dock line to protect shoreline and vegetation.

Transect 165-169 Bulkhead, hardened slope, some vegetation and little to no erosion. Low wind-wave potential.

Upland Side	Monitor and provide stormwater treatment to outfall at T169.
Slope Side	Monitor.
Intertidal	Plant at least 10' of *Spartina* and/or mangroves in front of bulkheads & riprap with no vegetation present.
Subtidal	Provide offshore oyster habitat and wave break parallel to dock line to protect shoreline and vegetation.

Location of transects 170-230 can be found on Figure 9g. Map 7.

Transect 170–178 **High Priority Area**. County Park. Bulkhead with riprap, little vegetation.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Plant at least 10' of *Spartina* in front of riprap.
Subtidal	Provide offshore oyster habitat and wave break.

Transect 179-190 Area with no structure and a boat ramp, oyster and vegetation present.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor and clean debris, old tires/pipes.
Subtidal	Monitor.

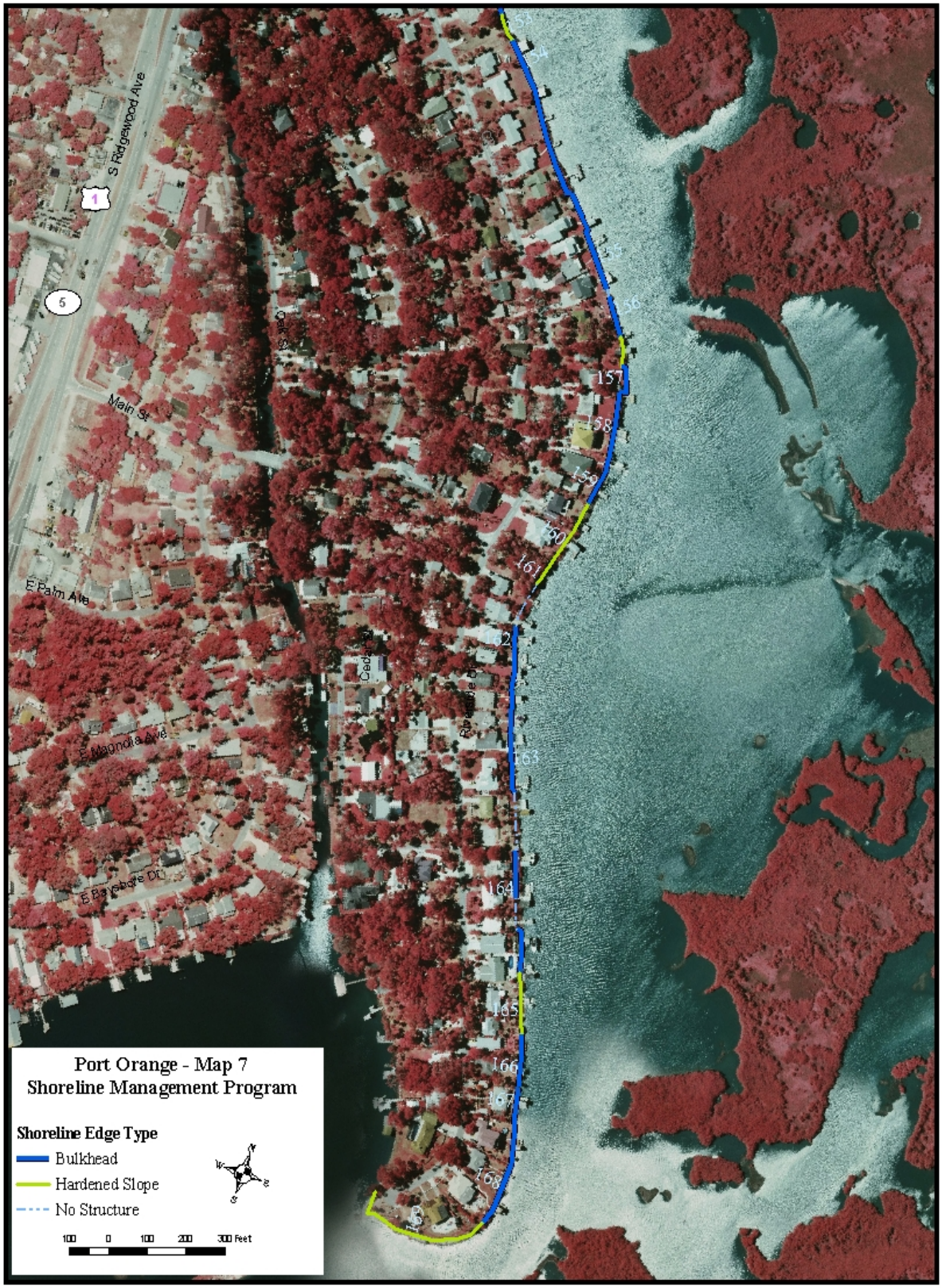
Transect 191-192 No structure with wide band of mangroves.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Plant a band of *Spartina* in front of mangroves.
Subtidal	Enhance oyster habitat.

Transect 193-197 Hardened slope with vegetation behind the riprap. Boat channel between riprap and spoil island to the north.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor.
Subtidal	Monitor.

Figure 9g. Port Orange Shoreline Survey Results. Map 7.



Transect 198-199 Hardened slope with little vegetation and severe erosion.

Upland Side	Monitor; Stormwater outfall, provide treatment prior to input into the ICW.
Slope Side	Monitor and stabilize eroded areas without riprap.
Intertidal	Monitor.
Subtidal	Monitor.

Transect 200-201 Bulkhead and hardened slope; large boat ramp.

Upland Side	Monitor; Stormwater outfall, provide treatment prior to input into the ICW.
Slope Side	Monitor.
Intertidal	Monitor.
Subtidal	Monitor.

Transect 202-207 No structure with vegetation and some erosion.

Upland Side	Monitor.
Slope Side	Monitor and stabilize eroded areas.
Intertidal	Plant at least 10' of *Spartina* and/or mangroves in areas with no vegetation.
Subtidal	Provide offshore oyster habitat and wave break.

Transect 208-217, 223-230 Designated to become condominiums; below are BMPs recommended for new condominium development.

Upland Side	If bulkhead/seawall is constructed, place the structure back from existing hardened slope.
Slope Side	Place gradually sloping riprap in front of bulkhead.
Intertidal	Plant a protective band of *Spartina*/mangroves at least 10' wide.
Subtidal	Provide offshore oyster habitat and wave break at mean high water (MHW).

Transect 218-222 No structure with vegetation and some erosion.

Upland Side	Monitor; Stormwater outfall, provide some type of treatment prior to input into the Halifax estuary.
Slope Side	Monitor and stabilize eroded areas.
Intertidal	Plant at least 10' of *Spartina* and/or mangroves in areas with no vegetation present.
Subtidal	Provide offshore oyster habitat and wave break.

Location of transects 231-248 can be found on Figure 9h. Map 8.

Transect 231-248 High-energy area, with low priority for implementing BMPs. Implement changes to shoreline if necessary, after damages from storm events or if redeveloped.

Upland Side	- Monitor and make repairs to damaged bulkhead areas; provide treatment to stormwater outfalls at T234, T242, & T248.
Slope Side	Monitor and install hardened shoreline to provide more protection to upland.

Intertidal	Monitor and plant *Spartina* in areas with no vegetation present.
Subtidal	Provide offshore oyster habitat and wave break at dock line, where possible.

Location of transects 249-261 can be found on Figure 9i. Map 9.

Transect 249-261 Much of shoreline protected from wave energy by islands west of shoreline.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor and protect any viable existing habitat; plant *Spartina* in areas with no vegetation.
Subtidal	Monitor.

Location of transects 262-272 can be found on Figure 6j. Map 10.

Transect 262-272 Low energy area; Shoreline protected from ICW wave energy by mangrove islands between shore and ICW.

Upland Side	Monitor.
Slope Side	Monitor.
Intertidal	Monitor and plant *Spartina* in areas with no vegetation.
Subtidal	Monitor.

Figure 9h. Port Orange Shoreline Survey Results. Map 8.

Figure 9i. Port Orange Shoreline Survey Results. Map 9.

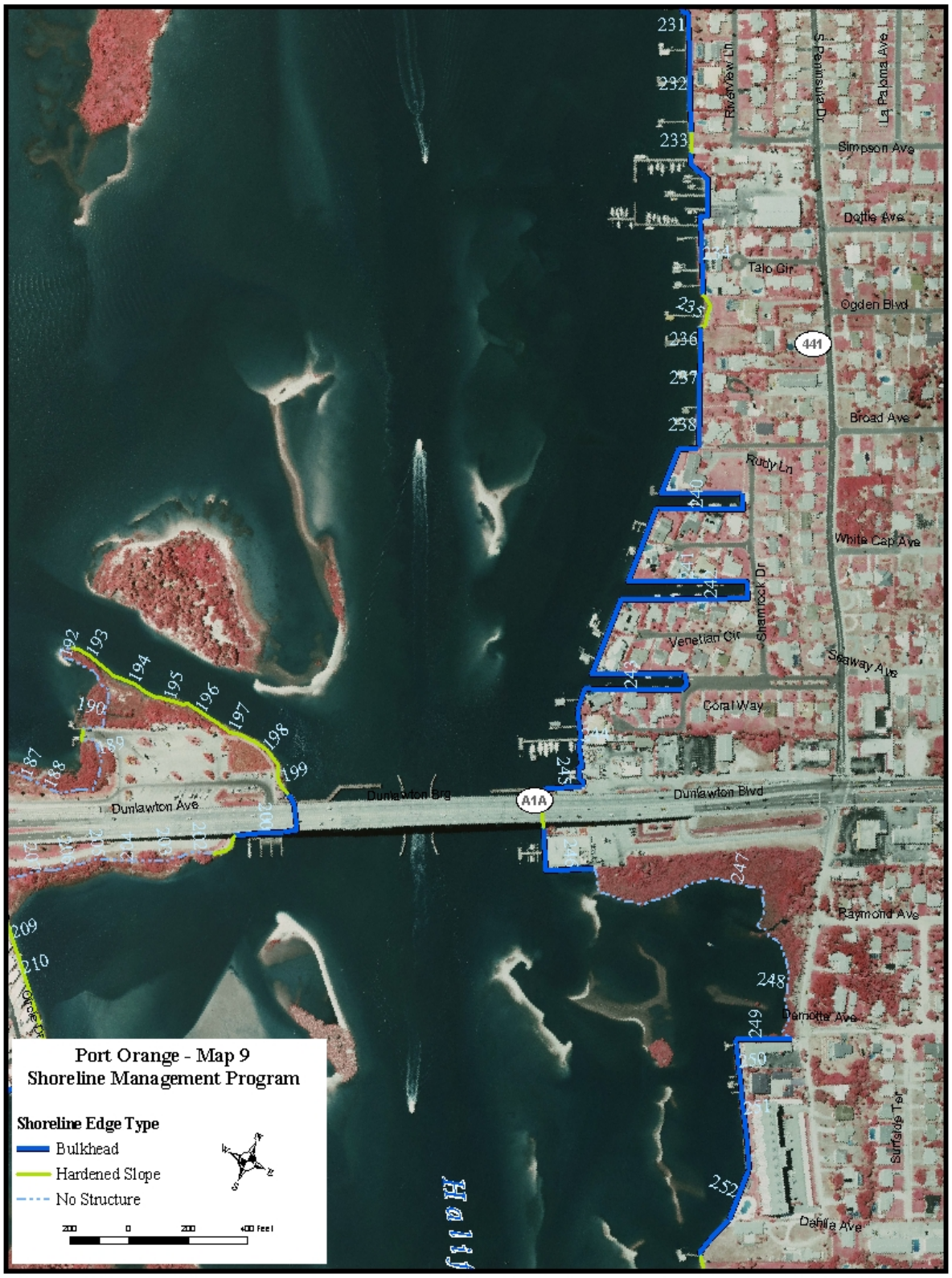


Figure 9j. Port Orange Shoreline Survey Results. Map 10.

Pilot Projects

Based on the results of the shoreline survey, six areas have been identified for pilot restoration projects (Figure 10). As previously noted, the projects in these areas are intended to demonstrate the effectiveness of BMPs on different shoreline scenarios. Five of these areas are publicly owned by the City of Port Orange. Each have moderate to severe erosion occurring along the shoreline or no existing vegetative buffer nor viable oyster habitat. The areas are all easily accessible.

Area 1 is an existing redevelopment area located on the north side of the Dunlawton Causeway covering transects 1-31. This 2,500 foot shoreline area falls within the City's Riverwalk Redevelopment Project Area. Riverwalk is a planned mixed-use redevelopment anchored by a 6+ acre waterfront public park and 200 +/- slip public marina.

BMP recommendations have been provided to the City's design consultants for the Riverwalk area-and the City has required that these be incorporated in the conceptual design of the park and marina. Further refinement of the park and marina plans prior to bidding offers additional opportunities to maximize BMP's into the overall waterfront design for Riverwalk.

Recommendations:

a. Provide treatment (baffle box, etc.) to all stormwater outfalls.
b. If hardening shoreline with a bulkhead, then place gradual sloping riprap in front.
c. Plant native salt marsh vegetation, such as *Spartina alterniflora,* along entire shoreline length, in front of bulkhead and riprap, and around all outfalls to trap any sediments.
d. Place oyster mats in low wave energy areas; position oyster domes in non-marina areas.
e. Place oyster bags on docks in any exposed marina areas.
f. Place baffle boards along docks to provide wave breaks.
g. Consider placing boardwalk up to 30' offshore.

Area 2 consists of transects 32-68. This is a residential area south of Dunlawton Causeway. There is approximately 3,500 feet of shoreline with historical bulkhead, some of which has been in place since the 1940's. Much of the bulkhead is in need of repair and reinforcement due to undermining and deterioration. Only about 1/3 of this area is vegetated leaving the bulkhead and shoreline exposed to erosive wave energy. There are eight stormwater outfalls along this area inputting fresh water into the Halifax River. Figures 11-13 show representative photographs of the area.

Figure 10. Port Orange Pilot Project Area Locations.

Figure 11. Transect 32 South View. The bulkhead appears stable, though there is some erosion apparent behind the bulkhead. There is no salt marsh vegetation or oyster habitat in the vicinity.

Figure 12. Transect 46 South. - Inappropriate riprap and no salt marsh vegetation or oyster habitat.

Figure 13. Transect 57 South View – Bulkhead is deteriorating. Inappropriate riprap and no salt marsh vegetation or oyster habitat.

Recommendations:

a. Provide treatment to stormwater from outfalls.
b. Clean upland and shoreline areas, remove trash/debris.
c. Stabilize areas behind bulkhead where erosion is occurring.
d. Make repairs to bulkhead where feasible; otherwise remove failing bulkhead.
e. Remove inappropriate riprap, concrete; place gradual sloping riprap along entire length, to protect shoreline and bulkhead.
f. Plant a wide band of *Spartina alterniflora* along non-vegetated shoreline areas and around outfalls to trap sediments.
g. Put down oyster mats in low wave energy areas and place oyster domes to provide habitat and wave break.
h. Place oyster bags on docks to knock down wave energy.

Area 3 is adjacent to Riverside Drive and includes transects 146-148. Figure 14 shows that the shoreline is very close to the roadway and has moderate to severe erosion. The property is approximately 400 feet in length with a single outfall discharging from property across Riverside Dr.

Figure 14. Transect 146 South. The shoreline is close to roadway; little salt marsh vegetation present.

Recommendations:

a. Remove any exotic vegetation.
b. Harden shoreline with gradual sloping riprap to prevent erosion and protect nearby road from being undermined.
c. Stabilize currently eroded areas by filling with soil and provide some filled area for planting vegetation.
d. Plant a wide band of *Spartina alterniflora* along shoreline.
e. Provide offshore oyster habitat and wave break.

Area 4 consists of Transect 153 (Figure 15). It is a small area, with only approximately 70 feet of shoreline adjacent to city owned parcel (park). The park contains benches and a small parking area. The shoreline has some erosion and is littered with large concrete blocks and PVC material. There is a single stormwater outfall present, with moderate erosion along shoreline on both sides of the outfall.

Figure 15. Transect 153 looking west. The area contains a large stormwater outfall, and eroded shoreline with large concrete debris

Recommendations:

a. Enhance park amenities; more benches, trash can.
b. Provide treatment to stormwater from outfall.
c. Clean upland and shoreline, remove trash, concrete/PVC debris.
d. Restore eroded shoreline area; harden shoreline with a gradual sloping riprap revetment.
e. Plant a wide band of *Spartina alterniflora* along shoreline and around outfall to trap sediments.
f. Provide offshore oyster habitat and wave break just beyond outfall.
g. Refit outfall with manatee excluder.

Area 5 consists of transect 161 (Figure 16). Area 5 is also a city owned park with benches, an outdoor basketball court, and a small parking area. There is severe erosion nad scattered riprap, with approximately 110 feet of shoreline.

Figure 16. Transect 161 South - Severely eroded shoreline with scattered riprap. Some *Spartina* present.

Recommendations:

a. Clean upland and shoreline areas.
b. Enhance park amenities. Provide small dock with kayak launch site.
c. Stabilize eroded areas.
d. Harden shoreline with a gradual sloping riprap.
e. Plant a wide band of *Spartina alterniflora* in front of riprap.
f. Provide offshore oyster habitat and wave break.

Area 6 consists of transects 170-178 (Figure 17, 18). The area consists of the City-owned Port Orange Causeway park, located on the north side of Dunlawton Causeway. This park includes boat ramps, a fishing pier, benches, as well as other amenities. There is approximately 780 feet of shoreline in need of vegetation and oyster habitat with wave breaks. The area has a bulkhead with large granite rip rap boulders in front.

Recommendations:

a. Clean upland and shoreline areas.
b. Plant 10 to 20 feet of *Spartina alterniflora* in all non-vegetated areas, in front of riprap.
c. Place oyster mats at *Spartina* edge and provide offshore oyster habitat and wave break.

Figure 17. Transect 172 East - Bulkhead with riprap. There is a small patch of salt marsh vegetation.

Figure 18. Transect 173 West View- Bulkhead with riprap. No salt marsh vegetation or oyster habitat.

Regulatory coordination

The successful implementation of shoreline BMPs requires coordination amongst a number **of** governmental entities. Various federal, state, regional and local agencies have direct regulatory jurisdiction and/or review and approval authority for activities that take place along or adjacent to the Halifax River shoreline. At the federal level, the USACOE regulatory program currently

encompasses the review of dredge and fill in waters of the United States, and construction and/or dredging in navigable waterways Work can include placing fill in wetlands or other waters of the United States and/or the placement or construction of a structure in navigable waters. The Florida Department of Environmental Protection (FDEP) Office of Submerged Lands and Environmental Resources may require an Environmental Resource Permit (ERP) before beginning any construction activity that would affect wetlands, alter surface water flows, or contribute to water pollution. A "Submerged Lands Authorization" by FDEP is also required for any construction on or use of submerged lands owned by the State. Any construction or improvements related to boating activity falls under the jurisdiction of FDEP.

The Water Management Districts, under delegation by FDEP implement the ERP program for projects that include upland development. The Districts use the ERP as a tool for managing the effects of land use changes on water quantity, water quality, and wetland habitat. As part of the FDEP/WMD ERP permitting process comments are solicitied from USACOE, Florida Fish and Wildlife Conservation Commission, Florida Department of Agriculture and Consumer Services (shellfish), Florida Department of State (historical resources), Department of Community Affairs, and FDEP Division of State Lands.

The Volusia County Manatee Protection Program (MPP) has a boat facility siting component which establishes boat slip to shoreline ratios throughout the County, mandates the use of specific siting criteria, and creates mitigation fees that support the new Manatee Conservation Fund for additional on-the-water manatee speed zone enforcement and conservation. Any new dock construction with boat slips must comply with the MPP. The City of Port Orange is also considering the adoption of its own manatee protection program to further manatee protection education and enforcement.

Section V. Action Steps to Meet Restoration or Protection Objectives

Specific locations have been identified and prioritized for restoration or protection through analysis of the survey results. Meeting the objectives of the plan requires the completion of Citywide steps as well as particular action steps to complete each project as outlined below:

Public education & advocacy

The City has already demonstrated a leading role in the promotion of living shorelines. The City hosted the first living shorelines workshop in northeast Florida on May 28, 2009. The workshop brought together more than 100 regulatory staff, environmental professionals, consultants, engineers, and the public to learn about living shorelines, shoreline research, and shoreline restoration projects.

The City has developed what is termed the “Green Initiative” that focuses on making "going green" easier, leading by example, and building technical expertise. Living shorelines concepts could easily be incorporated into this program and may be a logical next step.

Virtually all of the Port Orange shoreline is owned by private or commercial entities, therefore developing an understanding and appreciation for living shorelines concepts by the public is critical for implementation of this plan. The creation of a citizen’s shoreline restoration action group similar to the NCB inter-agency team would be useful in promoting local shoreline restoration at a grassroots level. An important area of focus for such a group would be the promotion and installation of oyster balls, or oyster bags. A citizen’s group could also coordinate with the City to provide brochures and /or fact sheets to residents.

Port Orange TV, aka “pogTV“, broadcasts to over 20,000 local homes with programming that consists of City Council meetings, community events, concerts, and general information. This would be a viable outreach mechanism to promote living shorelines in the City.

Project specific steps

This plan has evaluated the condition of the Port Orange Shoreline, described the BMPs necessary to improve the shoreline, and identified specific potential priority restoration areas. The series of steps below is a checklist of the actions needed to bring shoreline restoration projects, such those presented for priority Areas 1-6, to successful completion.

- Select particular project to undertake from prioritized list
- Estimate project cost - Section 6a discusses the costs associated with each BMP. Specific project costs can be extrapolated from these estimates based on the size of each project.
- Identify funding source and secure funding commitment - Section 6b discusses a variety of funding sources for the implementation of shoreline BMPs
- Identify project team and set responsibilities – completion of each project will be accomplished through the coordinated efforts of specific individuals. Identification of these individuals and their responsibilities is critical for timely project delivery. Team members may include city environmental, stormwater, engineering or public works staff, paid contract personnel, and regulatory agency representatives.
- Establish a timeline for completion

- Assess permitting requirements and secure necessary permits
- If project is to be completed via outside contract, then bid documents and an RFP (request for proposals) needs to be developed for each project.
    - Announce RFP
    - Select contractor
- Complete planning, engineering and design
- Proceed with project development

Other activities

Figure 1 showed a number of shoreline areas that were not surveyed as part of the SJRWMD effort. These include some of the islands on the northern and east side of the Halifax River, the southern section of the saltmarsh area along the western side of the Halifax River, and the Rose Bay shoreline. Surveys of these areas should be a priority to complete shoreline status in Port Orange.

An assessment of potential BMP activities for the salt marsh areas within the center part of the Halifax River, as well as the spoil islands along west side of the ICW, should be coordinated with either Volusia County and/or the Florida Inland Navigation District. While these areas are not under the direct ownership of the City they do fall within City boundaries, and the ecological health and stability of these areas is of importance to the City.

There are numerous outfalls along the City's shoreline that discharge stormwater into the Halifax River. Any of those that do not provide some sort of water quality treatment should be prioritized for retrofitting. Water quality treatment should be mandated for new discharge sites.

Section VI. Funding

Successful implementation of this plan is wholly dependent on sufficient funds to pay for any actions that are undertaken. Each restoration strategy has an associated cost that must be determined before a particular funding source can be identified.

BMP Costs
Cost estimates for the BMPs will vary by project. The Chesapeake Bay Foundation (CBF) has completed extensive shoreline restoration projects has published a range of cost estimates for BMP implementation (CBF 2009). Relevant cost estimates upland, slope and intertidal regions are extracted from CBF document. BMP costs within the sub-tidal region were obtained from independent contractors as listed.

Upland Side:

- Bulkhead installation, including revetments, stone reinforcing, groins and jetties: $500-1,200 per linear foot

Slope Side:

- Riprap installation (consistent with stone reinforcing): $500-1,200 per linear foot

Intertidal Region:

- Some structural grading with re-planting of salt marsh vegetation: $350-$500 per foot
- Re-planting of saltmarsh vegetation: $50-100 per foot

Sub-tidal Region:

- Oyster mats: Mat materials $3 per mat, production and installation labor is typically volunteer, with shell locally provided locally by restaurants. (Alshouse & Associates, 2009)
- Oyster bags: Bag material $3-5 per bag, production and installation labor is typically volunteer (Alshouse & Associates, 2009)
- Oyster ball planters capable of holding mangroves $40-$45 (Alshouse & Associates, 2009)
- Mangrove seedlings $2-$4(Alshouse & Associates, 2009)
- Wave baffles: $5 per linear foot (materials and labor) (Certified Marine Construction, Inc. 2009)
- Concrete floating docks: $38-60 per square foot (F&A Marine Construction, 2009)

Implementation of any of these BMPs will entail additional costs of planning, design, permitting, and project coordination. Specific costs for these activities will be determined in conjunction with project-specific scopes of work.

Funding sources
Funding for restoration projects is available from a variety of both private and public sources. These are typically competitive grants with varying funding availability from year to year. Listed below are applicable funding sources from all levels of government and some private entities.

Local

Ad valorem tax revenues, special district fees, community redevelopment district fees, special bond proposals and legislative initiatives are local sources for restoration funding. Private local organizations may also provide funds for restoration. Examples of local organizations include the Audubon Society, the Sierra Club, Rotary, fishing or boating clubs. These organizations, as well as school groups, Boy Scouts, Girl Scouts and others are also a good source for volunteer labor.

Regional

SJRWMD SWIM Program

The NCB SWIM program provides cooperative funding for local government stormwater subprojects through the state legislative initiative program. This program is also capable of providing technical and grant writing assistance.

SJRWMD Stormwater Cost-share Program

The priority of this program is to support stormwater management projects that contribute toward the improvement of water quality by achieving a pollutant load reduction goal (PLRG) or total maximum daily load (TMDL) allocation for identified priority pollutants. SJRWMD may also consider projects that protect or preserve water quality for those areas identified by the Surface Water Improvement and Management (SWIM) Act. Funding amounts are discretionary and vary from year-to-year. (*http://sjrwmd.com/costshare/pdfs/cs_stormwater_info.pdf*)

State

Section 319(h) Nonpoint Source Management Program

The FDEP Nonpoint Source Management Section, which administers grant money received from the U.S. Environmental Protection Agency (EPA) through Section 319 of the Federal Clean Water Act, manages the 319 program. Section 319 grant funds are used to implement projects to reduce nonpoint sources of pollution. Example projects include stormwater treatment facilities, demonstration projects for agricultural best management practices (BMPs), and training and education programs to reduce nonpoint pollution.

State and local governments and agencies, colleges, universities, nonprofit organizations, public utilities and state water management districts may apply for Section 319 funding. Descriptions of funded projects, and proposal ranking information, may be found on the FDEP Web site at *dep.state.fl.us/water/nonpoint/319h.htm.*

Florida Boating Improvement Program

The Florida Fish and Wildlife Conservation Commission's Florida Boating Improvement Program (FBIP) provides funding through competitive grants for boating access projects and other boating-related activities on coastal and/or inland waters of Florida. Eligible program participants include county governments, municipalities and other governmental entities of the state of Florida. *(myfwc.com/boating/grants/fbip.htm*)

Eligible uses of program funds include:

- Boat ramps, lifts and hoists, marine railways and other public launching facilities
- Piers, docks and other mooring facilities
- Recreational channel marking and other uniform waterway markers

- Derelict vessel removal
- Boater education
- Economic development initiatives that promote boating
- Other local boating-related activities that enhance boating access for recreational boaters

Waterfronts Florida Partnership Program

The Department of Community Affairs (DCA) Waterfronts Florida Partnership Program is available for coastal communities to apply for Waterfronts Florida Partnership designation. The statewide program provides technical assistance, training and small planning grants to working waterfront communities to assist in revitalization efforts.

Eligible applicants include local governments that are required to include a coastal element in their comprehensive plan. The community must recognize the waterfront as a special place and be committed to developing policies that encourage the preservation of recreational and commercial working waterfronts. Additional requirements are outlined in the application. Information is available by contacting the program coordinator at (850) 921-4801.

Florida Communities Trust 2009 Florida Forever Funding Cycle

The Florida Communities Trust (FCT) provides grants to local governments and environmental nonprofit organizations to acquire land for conservation, open space and outdoor recreation purposes. Information on the program can be found at *floridacommunitiestrust.org*.

Florida Recreation Development Assistance Program

County governments, incorporated municipalities and other local government entities responsible for the provision of outdoor recreational sites and facilities for the public are eligible to submit grant applications under the Florida Recreation Development Assistance Program.

Funds may be used for the development or acquisition of land for public outdoor recreational purposes. www.dep.state.fl.us/parks/OIRS.

Wildlife Grants

The Florida Fish and Wildlife Conservation Commission (FWC) manages the Florida State Wildlife Grants Program. This is a federally funded matching grants program, providing financial support for projects that address conservation needs identified in Florida's Comprehensive Wildlife Conservation Strategy.
MyFWC.com/wildlifelegacy/ApplyForGrant.html.

Federal

Five Star Restoration Matching Grants Program

The National Association of Counties, the National Fish and Wildlife Foundation, and the Wildlife Habitat Council, in cooperation with the U.S. Environmental Protection Agency (EPA), and corporate partners (Southern Company and Pacific Gas and Electric Company), sponsor the Five-Star Restoration Matching Grants Program. The Five-Star Restoration Program provides financial assistance on a competitive basis to support community-based wetland, riparian and coastal habitat restoration projects that build diverse partnerships and foster local natural

resource stewardship through education, outreach and training activities. Contact person is Amanda Bassow, program director, Chesapeake Programs, at Amanda.Bassow@nfwf.org.

Recovery Act: Habitat Restoration at Work
This program funds projects that will restore coastal and marine habitats under the American Recovery and Reinvestment Act of 2009. Program may fund a variety of habitat restoration projects – including wetlands restoration, dam removals, shellfish restoration, and coral reef restoration. Applicants must demonstrate that their project can achieve significant ecological benefits, maximize jobs creation/preservation, and are "shovel-ready."
(*http://www.nmfs.noaa.gov/habitat/restoration/funding_opportunities/funding_ser.html*)

NOAA/Southeast Aquatic Resources Partnership
The NOAA Restoration Center partnership with SARP seeks to fund projects that will result in on-the-ground restoration of aquatic habitats to benefit living marine resources, including NOAA trust resources.
(*http://www.nmfs.noaa.gov/habitat/restoration/projects_programs/crp/partners/SARP.html*)

NOAA/FishAmerica Foundation
The NOAA Restoration Center partnership with the American Sportfishing Association's FishAmerica Foundation provide funds to fund community-based fisheries habitat restoration projects.
(*http://www.nmfs.noaa.gov/habitat/restoration/projects_programs/crp/partners/fishamerica.htm*)

NOAA/Marine Debris Prevention and Removal Project Grants
This program funds individual grass-roots marine debris prevention and removal projects that benefit coastal habitat like wetlands and coral reefs, as well as fisheries, marine mammals, sea turtles and waterways.
(*http://www.nmfs.noaa.gov/habitat/restoration/projects_programs/crp/partners_funding/callforprojects2.html*)

Coastal Wetlands Protection
The U.S. Fish and Wildlife Service (USFWS) manages the National Coastal Wetlands Conservation Grant Program. This program was established to acquire, restore and enhance wetlands in coastal states through competitive matching grants to state agencies. The primary goal of the program is the long-term conservation of coastal wetland ecosystems.
The National Coastal Wetlands Conservation Grant Program provides states with a means of protecting and restoring these valuable resources. Projects can include: (1) acquisition of a real property interest (e.g., easement or fee title) in coastal lands or waters (coastal wetlands ecosystems) from willing sellers or partners for long-term conservation, or (2) the restoration, enhancement or management of coastal wetlands ecosystems for long-term conservation.
(*ecos.fws.gov/coastal_grants*)

Section VII. Long-term Shoreline Management

The analyses of the shoreline survey identifies immediate restoration and protection steps that can be undertaken to resolve existing structural and habitat deficiencies, but they do not set forth the mechanisms or steps necessary to provide for the long-term protection of the shoreline. There are already approved PUDs that will impact the future shoreline with new marinas, boat slips and upland construction. However, since none of these PUDs have begun construction, there is an opportunity to direct this future development in a way that promotes a living shoreline.

A review of regulations is also needed to ensure that the rules effectively protect the shoreline over the long-term. Enabling provisions, protective covenants and policies within the City's comprehensive plan and land development regulations in the land development code may need updating to address the living shoreline, so that future development is harmonious with the objective of the shoreline plan.

Future Development
The City is considering construction of a dredged 50 ft. wide boat channel that will roughly extend north-south along the western shoreline, beginning at the South Daytona/Port Orange boundary and extending to south of the Dunlawton Causeway. The channel will connect with similar channel being proposed by South Daytona. The channel will provide uniform boat access within the re-development areas on either side of the Causeway. If constructed, the minimum channel distance from shore should 100 ft. The channel should be a marked idle speed zone to minimize erosive boat wake action.

Prospective pilot project Areas 1 and 2 occur within the City's re-development area and some of the properties are existing Planned Urban Developments (PUDs). Development proposals for these areas should include a living shorelines assessment based on the information provided in specific transect analyses in this plan. Incorporation of living shorelines BMPs should be considered for all future shoreline development. Any site evaluation should consider the re-establishment of intertidal areas and planting of emergent vegetation. New marina or dock facilities should extend at least 30 ft. offshore, and include wave dampers such as baffle boards or oyster bags. Native vegetation planting should be encouraged in upland areas. No untreated stormwater discharges should be allowed. Low impact development techniques should be encouraged.

Development Regulation
Clear regulations on shoreline development are vital to protecting the City's shoreline habitat. These regulations are implemented through the City's Land Development Code, based on directives provided in the Comprehensive Plan.

<u>Comprehensive Planning</u>
The Coastal Zone Management and Conservation Elements of the Comprehensive Plan both contain Goals, Objectives, and Policies (GOPs) relative to development such that natural resources, including the shoreline are protected, though concept of a living shoreline has not been previously considered. Appropriate language should be included in both Elements to not only consider protection of the shoreline, but include policies pertaining to living shoreline

development. As part of recommended changes, the definitions for both "living shorelines" and "nonstructural shoreline stabilization measures" should be added to the List of Definitions as follows:

- "*Living shorelines" or "Living shoreline"* means a suite of stabilization and erosion control measures that preserve the natural shoreline and are designed to minimize shoreline erosion, maintain coastal processes, and provide aquatic habitat. Measures must include marsh plantings and may include the use of sills, sand containment structures, breakwaters or other natural components.

- *Nonstructural shoreline stabilization measures* means shore erosion control and restoration practices using only plantings or organic materials to restore, protect or enhance the natural shoreline environment.

Listed below are the relevant GOPs for each Element as well as recommendations designed to better direct and integrate development and re-development along the Port Orange shoreline.

- Coastal Zone Management (CZM) Element

The first goal of the CZM Element, Coastal Resources is to "*conserve, protect, and manage the coastal resources of the city including the wetland and upland ecosystem so as to maintain and enhance native habitats, floral and faunal species diversity, water quality, and natural surface water characteristics*".

Existing policy 1.1.6 of the Coastal Resources goal discusses development adjacent to shorelines but does not discuss how shorelines may be developed.

Policy 1.1.6: Development adjacent to estuarine and riverine shoreline areas shall maintain a buffer zone to protect or conserve the canopy, understory and ground cover of native upland vegetation and wetlands, in accordance with the provisions of the Conservation Element.

A new policy, listed below, is recommended for insertion after Policy 1.1.6 as follows:

New Policy 1.1.??.: New development or re-development adjacent to estuarine and riverine shoreline areas shall consider living shorelines concepts and nonstructural shoreline stabilization measures in their design.

The second goal of the CZM Element, Land Use, is "*to conserve, protect, and restore coastal resources by managing growth and land use so as not to damage or destroy those resources.*

Objective 2.3 states that *" Priorities for shoreline land use shall be given to water-dependent uses over water-related land uses and shall be based on type of water-dependent use, adjacent land use, water quality, impact on habitat and impact on coastal resources*".

The following existing policy related to the shoreline is intended to accomplish Objective 2.3.

Policy 2.3.5: Resource management plans such as aquatic preserve management plans or Surface Water Improvement Management (SWIM) plans shall be utilized in developing standards for marina siting or water-dependent uses.

Policy 2.3.5 should be revised to include consideration of the information provided in this Plan as indicated by the bold text as follows:

Revised Policy 2.3.5: Resource management plans such as aquatic preserve management plans, **the City's Shoreline Habitat Restoration and Management Plan,** or Surface Water Improvement Management (SWIM) plans shall be utilized in developing standards for marina siting or water-dependent uses.

The third goal of the CZM element, Water Quality, is "*to protect, enhance, and improve the quality of the estuarine environment throughout Volusia County*".

Policy 3.1.14 (G) of the Water Quality Goal states that: "*The City, Volusia County and the other coastal municipalities shall continue their commitment to improve and enhance water quality and estuarine conditions through intergovernmental cooperation by a variety of mechanisms such as:*

> *G. Implementing the policies or recommendations of the Aquatic Preserve Management Plans*".

The policy should revised to include consideration of the information provided in this Plan as indicated by the bold text as follows:

Policy 3.1.14 (G). Implementing the policies or recommendations of the Aquatic Preserve Management Plans **and the City's Shoreline Habitat Restoration and Management Plan**".

CZM Policy 7.3.4 (F). is identical to CZM Policy 2.1.14 (G) and should be similarly revised.

In addition, a new policy under the Water Quality Goal is recommended that specifically relates the concept of living shorelines to water quality, as follows:

New Policy 3.1.16: Encourage the establishment of living shorelines and the use of nonstructural shoreline stabilization measures within the estuarine environment to promote natural water quality improvement.

<u>Conservation Element</u>
The first goal of the Conservation Element is the "*conservation of air, water, and soil resources*".
Policy 1.2.9 under this goal states that *"The City shall support and promote programs to improve the natural tidal flushing action of adjacent water bodies, such as the Halifax River and Rose Bay, as a way to restore and maintain ambient water quality.*

This policy addresses water quality in the Halifax River, but a new policy to be inserted after Policy 1.2.9., is recommended to encourage living shorelines development as follows:

New Policy 1.2.??. The City shall encourage the establishment of living shorelines and the use of nonstructural shoreline stabilization measures to promote natural water quality improvement.

There are a variety of other policy options to encourage the utilization of living shoreline concepts. These include:

- Establishment of a local shoreline mitigation bank.
    - Where shorelines are well-developed, shoreline armoring may be necessary. In these areas, mitigation can be required to compensate for these lost uses and functional values. Property owners could pay into a mitigation bank which is then used to fund local shoreline restoration efforts.

Conservation Element Policies 2.2.4 and 2.2.5 already consider mitigation in conjunction with wetlands impacts. However, these polices may be amended to address mitigation banks, and/or incorporate shoreline impacts into the evaluation process.

- Permit waivers, reduced permit fees, or a streamlined application process for projects that include living shorelines concepts.
- Tax credits or assessment waivers for the increased property taxes associated with the installing a living shoreline.
- Revise subdivision ordinances to allow the inclusion of living shorelines principles for rezoning projects that involve tidal areas.
- Add the utilization of living shoreline concepts as a Low Impact Development (LID) strategy
- Encouraging cost share opportunities for property owners installing living shorelines.
- Creation of a special zoning overlay district to help enforce development and/or shoreline stabilization restrictions along the shore.
    - This overlay district can be incorporated in to the CRA and used to require greater set-back or buffer standards, prevent clearing of native vegetation within the buffer zone, incorporation of living shorelines concepts into development design, or stipulate nonstructural shoreline stabilization measures that would be allowable.

- Land Development Code

There are several elements of the City's Land Development Code that relate to development or protection of the shoreline. These include Chapter 9 (Environmental Protection), Articles I - Wetlands Protection, and III - Shoreline Protection Regulations; and Chapter 10 (Clearing, Grading , and Stormwater Management), Article II, Stormwater Management. Modification of these Articles may be necessary if any of the previously recommended policies are adopted. It is difficult to recommend revisions to the existing regulations without knowing the appropriate underlying policies. However, Section 26 of the Shoreline Protection Regulations could be amended as it provides general standards. A new part (c) could be added as follows:

Section 26: General shoreline development standards.

(a) New development or substantial improvements to existing development at a shoreline shall apply for a wetlands alteration permit from the city and receive approval of this application from the administrative official.
(b) Compliance with the best management practices specified in chapter 10, article II of this code shall be necessary for all shoreline development, to limit chemical and sediment pollutant discharge to the adjacent water body.

New(c) New Development or substantial improvements to existing development at a shoreline shall comply with the best management practices as specified in the Port Orange Shoreline Habitat Restoration and Management Plan.

Section VIII. Summary

These analyses show positive aspects of the Port Orange shoreline, but also identify some deficiencies. More than three-quarters of the shoreline showed little or no erosion. This is important because erosion is the primary cause of habitat loss. On its face, the limited erosion is a good outcome. However, many of those areas are also bulkheaded, with little or no adjacent habitat or intertidal area, because of the bulkhead. In terms of a living shoreline, that is a deficiency. The fact that nearly 60% of the adjacent habitat has some form of vegetation is encouraging, though there is relatively little subtidal oyster habitat (12%), and over 70% vegetated areas are less than 10 ft. is width.

Based on these analyses, and the individual transect evaluations, some restoration estimates can be made. First, the transect analyses show that over 13,000 meters of shoreline was evaluated. Out of that, roughly 7,300 meters, or 56 % of that shoreline was subjectively determined to have some restoration opportunity, regardless of whether an area is bulkheaded or hardened. The length of shoreline restored may thus be an indicator of restoration success.

The many variables to consider with shoreline restorations, including the political climate, funding, permitting and the willingness of private landowners to permit restoration activities, make estimating timeframes for success extremely difficult. In the short-term, the completion of a least one project over a two-year period, regardless of the size of that project, should be considered a success.

The learning curve with the completion of that initial project should be such that future efforts should be less time demanding. Between two and five years out, a restoration rate of 1% of the restorable shoreline seems reasonable. At between three, but not later than five years, this plan should be updated to reflect the knowledge gained from these initial restoration efforts. The updated plan could include longer five to ten year projections of the amount of shoreline restored. One would expect that the percentage of shoreline restored per year should increase over time. Performance measures such as number of oyster bags or balls, square feet of *Spartina*, or square feet riprap installed could be monitored, in addition to length of shoreline restored.

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Appendix 1. Port Orange Shoreline Survey Data

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
1	No Structure		Vegetation	5	111>240	Public	Residential	3		11-20'	129.67
2	No Structure		Vegetation	10	240*111	Public	Park	3		31-100'	95.05
3	No Structure		Vegetation	10	240*111	Public	Park	3		11-20'	168.30
4	Hardened Slope	Rip Rap	Vegetation	10	210	Public	Park	3		31-100'	87.81
5	Hardened Slope	Rip Rap	Vegetation	8	210	Public	Park	3		0-10'	111.80
6	Bulkhead		Oyster	10		Public	Residential	2	Yes	0-10'	91.50
7	Bulkhead		Oyster	4		Public	Residential	2	Yes	0-10'	103.91
8	Bulkhead		Oyster	12		Public	Residential	2	Yes	11-20'	174.34
9	No Structure		Vegetation	5	111*231:123	Public	ROW	3		11-20'	108.60
10	No Structure		Vegetation	10	233	Private	Commercial	3		21-30'	105.94
11	Bulkhead		Water			Private	Commercial	2	Yes	0-10'	173.70
12	Hardened Slope	Rip Rap	Vegetation	10	111:112	Private	Commercial	3	Yes	11-20'	97.78
13	Hardened Slope	Rip Rap	Vegetation	10	210	Private	Commercial	3	Yes	0-10'	109.22
14	Hardened Slope	Rip Rap	Oyster	5		Private	Commercial	3	Yes	0-10'	94.19
15	Bulkhead		Oyster	2		Private	Commercial	3	Yes	0-10'	102.81
16	Bulkhead	Rip Rap	Rock	2		Private	Commercial	3	Yes	0-10'	78.41
17	Bulkhead		Water			Private	Commercial	3	Yes	0-10'	150.40
18	Hardened Slope	Rip Rap	Oyster	2		Private	Vacant	3	Yes	0-10'	108.43
19	Hardened Slope	Rip Rap	Oyster	4		Private	Vacant	3	Yes	0-10'	164.43
20	Bulkhead		Rock	2		Private	Vacant	2	Yes	0-10'	56.51
21	Bulkhead		Water			Public	Park	3	Yes	0-10'	143.21
22	Bulkhead		Vegetation	30	210*111	Public	Park	3	Yes	21-30'	82.92
23	Bulkhead		Vegetation	20	220*111	Public	ROW	3	No	21-30'	78.12
24	Bulkhead		Vegetation	40	220:111*210	Private	Residential	3	No	31-100'	93.52
25	Bulkhead		Vegetation	40	220:111*210	Public	ROW	3	No	31-100'	128.83
26	Bulkhead		Vegetation	20	111>210	Public	ROW	3	No	11-20'	126.02

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
27	Bulkhead		Water			Private	Residential	2	Yes	0-10'	125.70
28	Bulkhead		Vegetation	20	210	Private	Vacant	2	Yes	11-20'	55.26
29	No Structure		Vegetation	15	240>111	Private	Vacant	3	No	21-30'	169.50
30	Hardened Slope	Rip Rap	Vegetation	15	210*111	Public	ROW	3	No	21-30'	21.61
31	Hardened Slope	Rip Rap	Oyster	2		Public	ROW	3	Yes	0-10'	214.81
32	Bulkhead		Water			Private	Commercial	3	Yes	0-10'	136.28
32	Bulkhead		Water			Private	Residential	3	Yes	0-10'	82.03
32	No Structure		Vegetation	8	130	Private	Commercial	3		0-10'	115.38
33	Bulkhead		Water			Private	Commercial	3	Yes	0-10'	87.16
34	Bulkhead		Water			Private	Residential	3	Yes	0-10'	123.06
35	Bulkhead		Rock	4		Private	Residential	2	Yes	0-10'	98.95
36	Bulkhead		Water			Private	Residential	3	Yes	0-10'	95.06
37	Bulkhead		Water			Private	Residential	3	Yes	0-10'	105.40
38	Bulkhead		Vegetation	10	210	Private	Residential	3	No	0-10'	81.20
39	Bulkhead		Vegetation	8	111	Private	Residential	3	No	21-30'	127.55
40	Bulkhead		Vegetation	5	210	Private	Residential	3	No	0-10'	80.67
41	Bulkhead		Water			Private	Residential	3	Yes	0-10'	102.88
42	Bulkhead		Rock	3		Private	Residential	3	Yes	0-10'	106.20
43	Bulkhead		Rock	5		Private	Residential	3	Yes	0-10'	99.42
44	Bulkhead		Rock	3		Private	Residential	3	Yes	0-10'	77.88
45	Bulkhead		Rock	4		Private	Residential	3	Yes	11-20'	87.64
46	Bulkhead		Rock	5		Private	Residential	3	Yes	0-10'	65.24
47	Bulkhead		Vegetation	10	210	Private	Residential	3	Yes	0-10'	136.30
48	Bulkhead		Vegetation	10	111	Private	Residential	3		21-30'	65.18
49	Bulkhead		Vegetation	12	210	Private	Residential	3		11-20'	90.88
50	Bulkhead		Vegetation	5	111	Private	Residential	2	Yes	11-20'	128.87
51	Bulkhead		Vegetation	30	210	Private	Residential	3	Yes	21-30'	113.29
52	Bulkhead		Vegetation	5	233	Private	Residential	3		21-30'	95.37
53	Bulkhead		Water			Private	Residential	2	Yes	0-10'	67.54
54	Bulkhead		Water			Private	Residential	3	Yes	0-10'	86.58
55	Bulkhead		Rock	10		Private	Residential	3	Yes	0-10'	120.48

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
56	Bulkhead		Rock	5		Private	Residential	2	Yes	0-10'	108.43
57	Bulkhead		Rock	2		Private	Residential	1	Yes	0-10'	102.28
58	Bulkhead		Rock	12		Private	Residential	2	Yes	11-20'	67.07
59	Bulkhead		Water			Private	Residential	3	Yes	0-10'	110.04
60	Bulkhead		Water			Private	Residential	3	Yes	0-10'	131.86
61	Bulkhead		Rock	4		Public	ROW	3	Yes	0-10'	45.33
62	Bulkhead		Rock	5		Private	Residential	3	Yes	0-10'	102.74
63	Bulkhead		Water			Private	Residential	2	Yes	0-10'	60.65
64	Bulkhead		Rock	2		Private	Residential	3	Yes	0-10'	129.14
65	Bulkhead		Rock	4		Private	Residential	3	Yes	0-10'	99.65
66	Bulkhead		Rock	4		Private	Residential	3	Yes	0-10'	89.37
67	Bulkhead		Rock	5		Private	Residential	3	Yes	0-10'	96.73
68	Bulkhead		Water			Public	ROW	3	Yes	0-10'	96.92
69	Hardened Slope	Rip Rap	Vegetation	20	210	Private	Residential	3		11-20'	143.45
70	Bulkhead		Vegetation	5	210	Private	Residential	3		0-10'	63.13
71	Hardened Slope	Rip Rap	Water			Private	Residential	2	Yes	0-10'	148.55
72	Bulkhead		Water			Private	Residential	2	Yes	0-10'	94.34
73	Bulkhead		Rock	3		Private	Residential	2	Yes	0-10'	90.24
74	Hardened Slope	Rip Rap	Vegetation	2	210	Private	Residential	2	Yes	0-10'	72.22
75	No Structure		Vegetation	10	233	Public	ROW	2	Yes	21-30'	54.30
75	No Structure		Vegetation	10	233	Private	Residential	2	Yes	21-30'	59.04
76	No Structure		Vegetation	10	240	Private	Residential	2	Yes	11-20'	115.59
77	Hardened Slope	Coquina	Vegetation	15	210	Private	Residential	2	Yes	11-20'	146.83
78	Hardened Slope	Rip Rap	Water			Private	Residential	3	Yes	0-10'	78.24
79	Hardened Slope	Rip Rap	Water			Private	Residential	3	Yes	0-10'	69.70
80	No Structure		Vegetation	60	111>230	Private	Residential	3		>100'	207.95
81	No Structure		Vegetation	15	123	Private	Residential	3		31-100'	151.41
82	Hardened	Coquina	Vegetation	5	220	Private	Residential	3		0-10'	70.45

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
	Slope										
83	Hardened Slope	Coquina	Vegetation	2	111	Private	Residential	3		0-10'	95.31
84	Hardened Slope	Coquina	Water			Private	Residential	3	Yes	0-10'	116.55
85	Hardened Slope	Coquina	Vegetation	2	210	Private	Residential	3	Yes	0-10'	102.14
86	Hardened Slope	Coquina	Water			Private	Residential	3	Yes	0-10'	115.31
87	Hardened Slope	Coquina	Vegetation	5	210	Private	Residential	3		0-10'	89.56
88	Hardened Slope	Coquina	Vegetation	8	210	Private	Residential	3		0-10'	68.09
89	Hardened Slope	Coquina	Vegetation	5	220	Private	Residential	3		11-20'	159.96
90	No Structure		Vegetation	10	111	Private	Residential	2	Yes	0-10'	38.02
91	Bulkhead		Vegetation	8	111	Private	Residential	3		0-10'	114.43
92	No Structure		Rock	<1		Private	Residential	2	Yes	11-20'	171.03
93	No Structure		Vegetation	8	111	Private	Residential	2	Yes	0-10'	24.81
94	Hardened Slope	Rip Rap	Vegetation	10	111	Private	Residential	3	Yes	0-10'	155.98
95	Bulkhead		Vegetation	3	210	Private	Residential	2	Yes	0-10'	78.49
96	Bulkhead		Vegetation	5	210	Private	Residential	3		0-10'	148.22
97	Bulkhead		Vegetation	5	112:111	Public	ROW	2	Yes	0-10'	26.41
98	No Structure		Rock	5		Private	Residential	2	Yes	0-10'	90.66
99	Bulkhead		Water			Private	Residential	2	Yes	0-10'	173.98
100	Bulkhead		Rock	5		Private	Residential	2	Yes	0-10'	23.57
101	Hardened Slope	Concrete	Vegetation	5	112>123	Private	Residential	2	Yes	0-10'	147.94
102	Hardened Slope	Concrete	Vegetation	10	210	Private	Residential	2	Yes	0-10'	109.33
103	No Structure		Vegetation	4	123	Private	Residential	3		0-10'	80.92
104	No Structure		Rock	<1		Private	Residential	2	Yes	0-10'	77.20
105	Hardened Slope	Concrete	Vegetation	2	123	Private	Residential	2	Yes	0-10'	85.54

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
106	No Structure		Vegetation	2	231	Private	Residential	3	Yes	0-10'	108.33
107	No Structure		Rock	2		Public	ROW	2	Yes	0-10'	159.34
108	Hardened Slope	Rip Rap	Vegetation	4	110	Private	Residential	2	Yes	0-10'	125.78
109	Hardened Slope	Rip Rap	Vegetation	6	111	Private	Residential	2	Yes	0-10'	105.67
110	Hardened Slope	Rip Rap	Vegetation	2	111	Private	Residential	2	Yes	0-10'	69.72
111	No Structure		Vegetation	10	123	Private	Vacant	2	Yes	0-10'	93.92
112	Hardened Slope	Other	Water			Private	Residential	2	Yes	0-10'	91.41
113	Hardened Slope	Rip Rap	Vegetation	5	123	Private	Residential	2	Yes	0-10'	103.77
114	Hardened Slope	Rip Rap	Vegetation	2	123	Private	Residential	1	Yes	0-10'	79.82
115	No Structure		Vegetation	4	210	Public	ROW	1	Yes	0-10'	92.00
116	No Structure		Vegetation	10	111	Public	ROW	3		0-10'	127.86
117	Bulkhead		Water			Private	Residential	3		0-10'	20.95
117	Hardened Slope	Concrete	Vegetation	4	210>123	Private	Residential	3	N/A	0-10'	158.46
118	Hardened Slope	Coquina	Sand	2		Private	Residential	2	Yes	0-10'	77.30
120	Hardened Slope	Coquina	Vegetation	10	111	Private	Residential	3	N/A	11-20'	75.66
121	Hardened Slope	Coquina	Vegetation	5	123	Private	Residential	3	N/A	11-20'	90.38
122	No Structure		Vegetation	3	240>123	Private	Residential	2	N/A	0-10'	70.31
123	No Structure		Vegetation	10	BRA PEPP>112	Private	Residential	3	N/A	11-20'	102.27
124	Hardened Slope	Coquina	Vegetation	10	210	Private	Residential	2	N/A	11-20'	51.01
125	Hardened Slope	Coquina	Vegetation	5	210*110	Private	Residential	3	N/A	0-10'	85.46
126	Hardened Slope	Other	Vegetation	2	231*123	Private	Residential	3	N/A	0-10'	89.03

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
127	No Structure		Vegetation	5	BRA PEPPER	Private	Residential	3	N/A	11-20'	129.62
128	No Structure		Vegetation	15	111:112	Private	Residential	3	N/A	11-20'	80.91
129	No Structure		Vegetation	3	123	Private	Residential	3	N/A	11-20'	113.90
130	No Structure		Vegetation	10	111	Private	Residential	2		0-10'	69.40
131	Bulkhead		Vegetation	10	110	Private	Park	3		0-10'	73.85
131	No Structure		Vegetation	3	BRA PEPPER	Private	Park	1	Yes	0-10'	40.07
132	Hardened Slope	Coquina	Vegetation	2	123	Private	Residential	3	N/A	11-20'	255.07
133	No Structure		Vegetation	10	110	Private	Residential	3	N/A	0-10'	50.89
134	No Structure		Vegetation	10	111	Private	Residential	2	Yes	0-10'	115.56
135	No Structure		Vegetation	10	111	Private	Residential	2	N/A	11-20'	121.09
136	No Structure		Vegetation	10	110*210	Private	Residential	3	N/A	0-10'	148.65
137	No Structure		Vegetation	10	123>sarc	Private	Residential	1	Yes	0-10'	78.53
138	No Structure		Vegetation	7	123 sarc	Private	Residential	2	Yes	11-20'	111.20
139	Hardened Slope	Rip Rap	Vegetation	5	BRA PEPPER	Private	Residential	3		0-10'	51.94
140	No Structure		Vegetation	10	110	Private	Residential	3	N/A	0-10'	105.17
141	Hardened Slope	Coquina	Vegetation	10	112	Private	Residential	2	Yes	0-10'	164.93
142	Hardened Slope	Coquina	Vegetation	10	112>210	Private	Residential	3	N/A	0-10'	97.62
143	Bulkhead		Vegetation	8	112	Private	Residential	3	N/A	0-10'	171.47
144	No Structure		Vegetation	5	110	Private	Residential	2	No	0-10'	93.14
145	No Structure		Vegetation	5	110	Private	Residential	3	Yes	0-10'	71.95
146	No Structure		Vegetation	5	111:123	Public	ROW	2	Yes	0-10'	129.05
147	No Structure		Vegetation	10	palms	Public	ROW	1	Yes	0-10'	78.77
148	No Structure		Vegetation	4	210	Public	ROW	2	Yes	0-10'	161.25
149	Bulkhead		Vegetation	5	112	Private	Residential	3	N/A	0-10'	26.72
150	Bulkhead		Vegetation	5	112	Private	Residential	3	No	11-20'	209.43
150	Bulkhead		Vegetation	10	112:210	Private	Residential	3	Yes	0-10'	128.83
150	Bulkhead		Vegetation	5	112	Private	Residential	3	No	11-20'	25.11
151	Bulkhead		Sand			Private	Residential	3		0-10'	87.53

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
152	Bulkhead					Private	Residential	3		0-10'	472.97
152	No Structure		Vegetation	5	112	Public	ROW	3	No	0-10'	62.55
153	Hardened Slope	Rip Rap	Sand	2		Public	Park	2	Yes	0-10'	69.56
154	Bulkhead		Vegetation	5	210*112	Private	Residential	3	N/A	0-10'	329.51
154	Bulkhead		Vegetation	10	112*210	Private	Residential	3		0-10'	89.08
155	Bulkhead					Private	Residential	3	Yes	0-10'	257.20
156	Bulkhead		Vegetation	10	112	Private	Residential	3		0-10'	104.93
156	Hardened Slope	Rip Rap	Vegetation	10	110*210	Private	Residential	3		0-10'	74.45
156	No Structure		Vegetation	5	112	Private	Residential	3	N/A	0-10'	16.92
157	Bulkhead		Vegetation	2	210	Private	Residential	3	N/A	0-10'	89.96
158	Bulkhead		Rock	2		Private	Residential	3	No	0-10'	100.75
158	Bulkhead		Vegetation	10	110	Private	Residential	3		0-10'	82.92
159	Bulkhead		Vegetation	4	123>210	Private	Residential	3		0-10'	103.65
160	Hardened Slope	Rip Rap	Vegetation	10	112*210	Private	Residential	3	N/A	0-10'	162.22
161	Hardened Slope	Rip Rap	Vegetation	5	210	Public	Park	1	Yes	0-10'	77.97
161	No Structure		Vegetation	10	112	Private	Residential	3		0-10'	60.30
161	No Structure		Vegetation	10	112	Private	Residential	3		0-10'	57.14
162	Bulkhead		Vegetation	8	210	Private	Residential	3		0-10'	53.54
162	Bulkhead	Other	Vegetation	5	210	Private	Residential	3	N/A	0-10'	105.13
163	Bulkhead		Rock	4		Private	Residential	3	N/A	0-10'	109.13
163	Bulkhead		Rock	2		Private	Residential	3		0-10'	147.34
164	Bulkhead		Vegetation	10	112*210	Private	Residential	3		0-10'	118.98
164	Bulkhead		Water			Private	Residential	3		0-10'	114.91
164	No Structure		Vegetation	15	123:210	Private	Residential	3	N/A	11-20'	40.26
164	No Structure		Vegetation	15	123:210	Public	Park	3	N/A	11-20'	110.84
164	No Structure		Vegetation	10	110>210	Private	Residential	3		0-10'	76.32
165	Bulkhead		Rock	3		Private	Residential	3	No	0-10'	40.84
165	Hardened Slope	Rip Rap	Vegetation	5	110	Private	Residential	3		0-10'	151.36

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
166	Bulkhead					Private	Residential	3		0-10'	89.40
167	Bulkhead		Rock	3		Private	Residential	3		0-10'	94.34
168	Bulkhead					Private	Residential	3	Yes	0-10'	263.87
169	Hardened Slope	Rip Rap				Private	Residential	3		0-10'	379.89
170	Hardened Slope	Rip Rap	Oyster	1		Public	Park	3	No	0-10'	67.33
170	Hardened Slope	Rip Rap	Water			Public	ROW	3	No	0-10'	109.19
171	Bulkhead	Rip Rap		0		Public	Park	3	Yes	0-10'	119.51
172	Bulkhead	Rip Rap		0		Public	Park	3	Yes	0-10'	71.29
173	Bulkhead	Rip Rap		0		Public	Park	3	Yes	0-10'	127.87
174	Bulkhead	Rip Rap	Vegetation	5	111	Public	Park	3	Yes	11-20'	101.16
175	Bulkhead	Rip Rap	Vegetation	4	123	Public	Park	3	No	0-10'	98.31
176	Bulkhead	Rip Rap	Vegetation	5	111	Public	Park	3	Yes	0-10'	89.64
177	Bulkhead	Rip Rap	Vegetation	3	111	Public	Park	3	Yes	0-10'	87.03
178	Bulkhead	Rip Rap	Vegetation	3	111	Public	Park	3	No	0-10'	77.44
179	Hardened Slope	Rip Rap	Vegetation	20	210	Public	Park	3	No	11-20'	57.68
180	No Structure		Vegetation	5	111	Public	Park	2	Yes	21-30'	111.27
181	No Structure		Vegetation	45	111	Public	Park	2	Yes	31-100'	54.94
182	No Structure		Vegetation	40	111	Public	Park	3	Yes	31-100'	31.09
183	No Structure		Vegetation	60	111>230	Public	Park	3	No	31-100'	48.67
184	No Structure		Vegetation	100	110>123	Public	Park	3	Yes	>100'	85.99
185	No Structure		Vegetation	100	110>123	Public	Park	3	Yes	>100'	134.91
186	No Structure		Vegetation	10	110	Public	Park	3	Yes	21-30'	112.44
187	No Structure		Vegetation	15	110	Public	Park	3	Yes	21-30'	101.30
188	No Structure		Vegetation	25	110	Public	Park	3	Yes	31-100'	133.79
189	Hardened Slope	Concrete	Water			Public	Park	3		0-10'	40.60
189	No Structure		Vegetation	60	110	Public	Park	3	Yes	31-100'	261.07
190	No Structure		Vegetation	40	110	Public	Park	3	No	31-100'	157.65
191	No Structure		Vegetation	50	110 232	Public	Park	3	Yes	31-100'	96.01

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
192	No Structure		Vegetation	20	110	Public	Park	3	Yes	31-100'	195.37
193	Hardened Slope	Rip Rap	Vegetation	20	110>232	Public	Park	3	Yes	11-20'	150.16
194	Hardened Slope	Rip Rap	Vegetation	40	110	Public	Park	2	Yes	31-100'	200.71
195	Hardened Slope	Rip Rap	Vegetation	30	110>220	Public	Park	3	Yes	31-100'	94.62
196	Hardened Slope	Rip Rap	Vegetation	10	110	Public	Park	3	No	11-20'	120.85
197	Hardened Slope	Rip Rap	Vegetation	8	110*123	Public	Park	3	Yes	0-10'	135.33
198	Hardened Slope	Rip Rap	Vegetation	5	110*123	Public	Park	1	Yes	0-10'	122.17
199	Hardened Slope	Rip Rap	Vegetation	5	110>123	Public	Park	1	Yes	0-10'	101.58
200	Bulkhead	Rip Rap	Oyster	3		Public	ROW	3	Yes	0-10'	174.46
200	Bulkhead	Rip Rap	Water			Public	Park	3	No	0-10'	168.84
201	Hardened Slope	Rip Rap	Vegetation	2	123	Public	Park	2	Yes	0-10'	105.24
202	No Structure		Vegetation	10	bp	Public	Park	1	Yes	0-10'	103.26
203	No Structure		Vegetation	10	110	Public	Park	2	Yes	11-20'	127.81
204	No Structure		Vegetation	15	110	Public	Park	3	Yes	21-30'	116.28
205	No Structure		Vegetation	15	110	Public	Park	3	Yes	21-30'	107.82
206	No Structure		Vegetation	20	110	Public	Park	3	No	31-100'	97.28
207	No Structure		Vegetation	20	110	Public	Park	3	No	21-30'	165.07
208	Bulkhead		Vegetation	20	110>123	Private	Residential	3	No	31-100'	152.35
209	Hardened Slope	Rip Rap	Oyster	1		Private	Residential	3	Yes	0-10'	109.60
210	Hardened Slope	Rip Rap		0		Private	Residential	3	Yes	0-10'	144.06
211	Hardened Slope	Coquina	Vegetation	8	210>111	Private	Residential	2	Yes	0-10'	122.17
212	Hardened Slope	Rip Rap	Oyster	25		Private	Residential	2	Yes	21-30'	113.87
213	Hardened	Rip Rap	Vegetation	5	112	Private	Residential	3	Yes	0-10'	87.35

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
	Slope										
214	Bulkhead		Rock	2		Private	Residential	3	Yes	0-10'	169.68
215	Bulkhead		Rock	2		Private	Residential	3	Yes	0-10'	143.04
216	Bulkhead		Vegetation	10	210*230	Private	Residential	3	Yes	0-10'	159.21
217	Bulkhead	Rip Rap	Oyster	2		Private	Residential	2	Yes	0-10'	180.64
217	Bulkhead	Rip Rap	Oyster	2		Private	Residential	2	Yes	0-10'	206.32
217	Hardened Slope	Rip Rap	Oyster	2		Private	Residential	2	Yes	0-10'	61.96
218	No Structure		Vegetation	15	112 210	Public	Park	1	Yes	11-20'	132.08
219	No Structure		Vegetation	30	110	Public	Park	3	No	31-100'	235.94
220	No Structure		Vegetation	10	110	Public	Park	3	Yes	0-10'	187.78
221	Hardened Slope	Rip Rap	Vegetation	5	110	Public	Park	2	Yes	11-20'	227.04
222	Hardened Slope	Rip Rap	Vegetation	5	110	Public	Park	2	Yes	0-10'	281.59
223	Bulkhead		Oyster	1		Private	Commercial	3	Yes	0-10'	125.66
224	Bulkhead	Rip Rap	Oyster	2		Private	Residential	3	Yes	0-10'	47.32
224	Hardened Slope	Rip Rap	Vegetation	2	110	Private	Residential	3	Yes	0-10'	147.95
225	Hardened Slope	Rip Rap		0		Private	Residential	2	Yes	0-10'	207.31
226	Hardened Slope	Rip Rap		0		Private	Residential	3	Yes	0-10'	130.56
226	Hardened Slope	Rip Rap	Vegetation	4	210	Private	Residential	3	Yes	0-10'	58.19
227	Hardened Slope	Rip Rap		0		Private	Residential	3	Yes	0-10'	116.60
228	Hardened Slope	Rip Rap	Other	2		Private	Residential	3	Yes	0-10'	73.16
229	Hardened Slope	Rip Rap	Vegetation	2	110 210	Private	Residential	2	Yes	0-10'	145.76
230	Hardened Slope	Rip Rap	Vegetation	10	110 210	Private	Residential	3	No	0-10'	178.60
231	Bulkhead	Concrete	Vegetation	4	210*110	Private	Residential	3	Yes	0-10'	129.63
232	Bulkhead	Rip Rap		0		Private	Residential	3	Yes	0-10'	70.66

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
232	Bulkhead	Rip Rap	Vegetation	3	111	Private	Residential	3	No	0-10'	233.89
233	Hardened Slope	Rip Rap		0		Public	ROW	2	Yes	0-10'	71.35
234	Bulkhead		Vegetation	5	110	Private	Residential	2	Yes	0-10'	216.94
234	Bulkhead					Private	Marina	3	No	0-10'	305.31
235	Hardened Slope	Rip Rap	Vegetation	10	210	Private	Residential	3	N/A	0-10'	129.63
236	Bulkhead	Rip Rap		0		Private	Residential	3	Yes	0-10'	88.58
237	Bulkhead	Rip Rap		0		Private	Residential	2	Yes	0-10'	110.02
237	Bulkhead			0		Private	Residential	2	Yes	0-10'	64.50
238	Bulkhead		Vegetation	3	210	Private	Residential	3	Yes	0-10'	136.59
240	Bulkhead			0		Private	Residential	3	Yes	0-10'	505.19
240	Bulkhead			0		Private	Residential	3	Yes	0-10'	349.50
241	Bulkhead			0		Private	Residential	3	Yes	0-10'	603.84
241	Bulkhead		Vegetation	5	110:210	Private	Residential	3	Yes	0-10'	185.38
242	Bulkhead			0		Private	Residential	3	Yes	0-10'	949.03
242	Bulkhead			0		Private	Residential	3	Yes	0-10'	64.93
243	Bulkhead			0		Private	Residential	2	Yes	0-10'	304.72
243	Bulkhead			0		Private	Residential	2	Yes	0-10'	98.67
244	Bulkhead			0		Private	Residential	2	Yes	0-10'	96.21
244	Bulkhead					Private	Marina	3	No	0-10'	174.58
245	Bulkhead	Rip Rap		5		Public	Park	3	Yes	0-10'	151.55
245	Hardened Slope	Rip Rap	Vegetation	5	bp	Public	Park	2	Yes	0-10'	107.22
246	Bulkhead			0		Private	Commercial	3	Yes	0-10'	306.32
247	No Structure		Vegetation	40	110	Public	Natural	3	No	31-100'	675.67
248	No Structure		Vegetation	20	210	Public	Natural	3	Yes	31-100'	578.97
249	Bulkhead			0		Private	Residential	3	Yes	0-10'	213.74
250	Bulkhead		Vegetation	5	110	Private	Residential	3	No	0-10'	132.58
251	Bulkhead		Vegetation	10	110*210	Private	Residential	3	No	0-10'	181.13
252	Bulkhead	Rip Rap		0		Private	Residential	3	No	0-10'	171.30
252	Bulkhead			0		Private	Residential	3	No	0-10'	111.12
252	Bulkhead			0		Private	Residential	3	No	0-10'	158.25

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
253	Hardened Slope	Rip Rap		0		Private	Residential	2	Yes	0-10'	83.29
254	No Structure		Vegetation	15	110*210	Private	Residential	3	No	11-20'	370.16
255	Hardened Slope	Rip Rap	Vegetation	15	111>210	Private	Residential	3	No	11-20'	324.20
255	No Structure		Vegetation	10	210>110	Private	Residential	3	No	0-10'	235.63
256	Bulkhead		Vegetation	25	110>210	Private	Residential	3	No	21-30'	78.07
257	Hardened Slope	Rip Rap	Vegetation	20	110:210	Private	Residential	3	No	11-20'	186.59
258	No Structure		Vegetation	10	110>210	Private	Residential	3	No	0-10'	259.56
258	No Structure		Vegetation	5	210>110	Private	Residential	3	No	0-10'	129.36
258	No Structure		Vegetation	10	110	Private	Residential	3	No	0-10'	84.23
259	Bulkhead		Vegetation	10	110>210	Private	Residential	3	No	0-10'	196.89
259	Hardened Slope	Rip Rap				Private	Residential	3	Yes	0-10'	121.35
260	Bulkhead		Vegetation	2	110	Private	Residential	3	Yes	0-10'	358.91
261	Bulkhead	Rip Rap				Private	Residential	3		0-10'	92.84
261	Hardened Slope	Rip Rap				Private	Residential	3	No	0-10'	84.40
261	No Structure		Vegetation	5	110	Private	Residential	3	No	0-10'	61.29
262	Hardened Slope			0		Private	Residential	2	Yes	0-10'	69.86
262	No Structure		Water			Private	Residential	3		0-10'	150.05
263	Hardened Slope	Rip Rap	Vegetation	2	110	Private	Residential	3	Yes	0-10'	231.76
264	Hardened Slope	Rip Rap		0		Private	Residential	3	Yes	0-10'	181.79
265	No Structure		Vegetation	20	110*230	Private	Residential	3	No	11-20'	161.30
266	No Structure		Vegetation	8	210*110	Private	Residential	3	No	0-10'	188.17
267	No Structure		Vegetation	5	210>110	Private	Residential	3	No	0-10'	182.36
268	No Structure		Vegetation	6	210>110*123	Private	Residential	3	No	0-10'	158.00
269	No Structure		Vegetation	20	210*110	Private	Residential	3	No	11-20'	204.11
270	Bulkhead		Vegetation	5	210>110	Private	Residential	3	No	0-10'	85.30
270	Hardened	Rip Rap	Vegetation	10	110>210	Private	Residential	3	No	0-10'	110.02

Transect No	Edge Type	Hardened Slope	Adjacent Habitat	Habitat Width	Vegetation Type	Adjacent Owner	Adjacent Land Use	Erosion Severity	Restoration Opportunity	Intertidal Width	Distance (feet)
	Slope										
270	No Structure		Vegetation	15	110	Private	Residential	3	No	11-20'	108.63
270	No Structure		Vegetation	10	110*210	Private	Residential	3	No	0-10'	179.56
271	Bulkhead	Rip Rap	Vegetation	10	210	Private	Residential	3	No	0-10'	105.18
271	No Structure		Vegetation	10	210*110	Private	Residential	3	No	0-10'	118.34
272	Bulkhead			0		Private	Residential	3	Yes	0-10'	102.92
272	Bulkhead			0		Private	Residential	3	Yes	0-10'	107.64