FINAL

ELEVATING THE DISCUSSION OF RISING WATERS

The Report and Recommendations of the Delray Beach Rising Waters Task Force

Prepared for consideration by
The City of Delray Beach Commission

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Prepared by the Delray Beach Rising Waters Task Force
With the assistance of ESA Associates

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More information on the Rising Waters Task Force and its process may be found in the Appendix.

The information contained in this report is intended for planning purposes only.

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Glossary of Terms

Compact – Southeast Florida Regional Climate Change Compact
CRS – Community Rating System
FGBC – Florida Green Building Coalition
Hydraulic head – force exerted on an object due to the combination of the velocity, elevation and pressure of water.
IPCC – Intergovernmental Panel on Climate Change
King Tides – Seasonal high water levels that occur when the Sun and Moon are aligned and simultaneously exert their gravitational influence on the Earth in the same direction.
LWDD – Lake Worth Drainage District
NCAR – National Center for Atmospheric Research
NFIP – National Flood Insurance Program
NHC – National Hurricane Center
RWTF – Rising Waters Task Force
NOAA – National Oceanographic & Atmospheric Administration
RCAP - Regional Climate Action Plan
SFHA – Special Flood Hazard Area
SLR – Sea Level Rise
SFWMD – South Florida Water Management District
USACE – U.S. Army Corps of Engineers
USLRP – Unified Sea Level Rise Projection

1. Introduction

Delray Beach and its neighboring coastal communities are thriving. They constitute an important piece of the Palm Beach County economy, with a robust service-sector base and growing tourism, which fuels leisure and recreation businesses. Visionary and strategic investments in downtown Delray's economic development have transformed it into the jewel of South Florida's Gold Coast, attracting visitors and new businesses. Delray Beach was voted the "most fun small town in America" by Rand McNally in 2012.

This economic strength is a key asset of Delray Beach, one that will be increasingly challenged as the community confronts the various impacts of a changing climate. Managing, mitigating, and preparing for the interrelated hydrological issues caused by sea level rise, intense rain events, tropical storms, coastal and inland flooding, storm surge and saltwater intrusion are critical to maintaining the quality of life that undergirds Delray Beach's success.

Delray Beach has experienced noticeable increases in flooding episodes in recent years, often referred to as *nuisance flooding*. In addition to the notable flooding in the Marina Historic District and low lying areas on either side of the Intracoastal during the Fall and Spring King Tides, impacts from such storms as Hurricane Wilma (2005) and most recently Hurricane Mathew (2016) have resulted in damage along the coastline. The reported damage from Wilma in Delray Beach was between $100 million and $150 million with $8 million of damage to public buildings. While the specific impacts of rising water in Delray Beach require further study, the Southeast Florida Regional Climate Change Compact's Unified SLR Projection, described below, makes clear that nuisance flooding will continue to occur and intensify.

Addressing hydrological issues in Delray will require foresighted planning, public education, public and private investment, and development of public policy to guide action. If actions are implemented in a timely and strategic manner, the results will provide resiliency that will sustain Delray Beach and the region for a prosperous future.

Historically, coastal communities have been reactive to the impacts of natural hazards rather than proactive. However, as the worldwide scientific community forecasts a reliably certain trajectory of change to the global climate, and as disaster response and recovery becomes more expensive, it is imperative to take a proactive stance towards planning, public education, and disaster preparedness. Federal and state policies now mandate pre-disaster mitigation planning to secure mitigation funding. As waters continue to rise in Delray Beach, they will threaten valuable infrastructure and public safety, as well as the economic engine of the leisure and tourism industry. We do not have the luxury of time to wait. We must adapt and prepare now.

The Rising Waters Task Force (RWTF), organized in 2014 at the request of the Delray Beach City Commission, heeded the warning of our scientific and academic partners and worked to initiate further planning and action that will preserve and protect Delray Beach. The RWTF has prepared this report to that end, proposing six key recommendations based on thoughtful study and collaboration, to address the growing frequency and intensity of water-related impacts in our community.

Mission of the RWTF

The mission of the RWTF is to develop recommendations for local action that will reduce the social, environmental, and economic impacts of rising sea levels, storm surge, and more frequent and severe flooding related to climate change.

The RWTF's three primary goals were to (1) Educate elected officials, taxpayers and other stakeholders, (2) Integrate appropriate elements of the Compact's Regional Climate Action Plan (RCAP) into the City's planning policies; and (3) Identify immediate, short- and long-term, actionable initiatives in response to the risks identified.

Task Force Guiding Principles

The RWTF agreed upon the following principles to inform its work, all Task Force members believing that these organizational and practical concepts are basic to the challenging, cross-disciplinary work of planning for a changing climate:

- **Principle 1:** Climate change policies developed now should be considered with a 2060 time horizon, given the typical period of obsolescence for property and infrastructure, and the fact that projections of climate impacts become less reliable in a longer time horizon.
- **Principle 2:** Climate adaptation in the Delray Beach community will require advanced integrated planning on multiple levels to reduce regulatory friction.
- **Principle 3:** The RWTF acknowledges that its role is to suggest and advance actionable initiatives and projects that are visible and create positive momentum, while at the same time putting forth the "big ideas" and new overarching paradigms that ultimately lead to change in local policies and regulations, and the participation of a much wider array of stakeholders.
- **Principle 4:** Climate adaptation in the Delray Beach community will require synergistic coordination of public initiatives and private investment with a focus on innovative types of public and private partnerships, as well as ways to facilitate and incentivize private sectors actions.
- **Principle 5:** All climate adaptation efforts in Delray Beach should promote positive outcomes that lend themselves to a resilient future community and minimize negativity and hopelessness that lend themselves to inaction.

2. Hydrological Challenges in Delray Beach

South Florida's development has always been contingent on actively managing hydrology. Historic development evaded soggy grounds, settling high grounds, accepting punishment from the tropics in the form of fierce storms, and flooding. In the 1940s, the U.S. Army Corps of Engineers (USACE) initiated a new era of hydrological management: miles of canals, which allowed swamps to drain, dikes and pipes that allowed for water supply and waste management, paving the way for extensive urban development. This engineered plumbing system, based on historic patterns of precipitation, tropical storms and ongoing real estate development is now reaching capacity, and new challenges posed by emerging climate trends will, over time, compromise the system's ability to deliver expected levels of service.

Sea Level Rise Projections for Southeast Florida

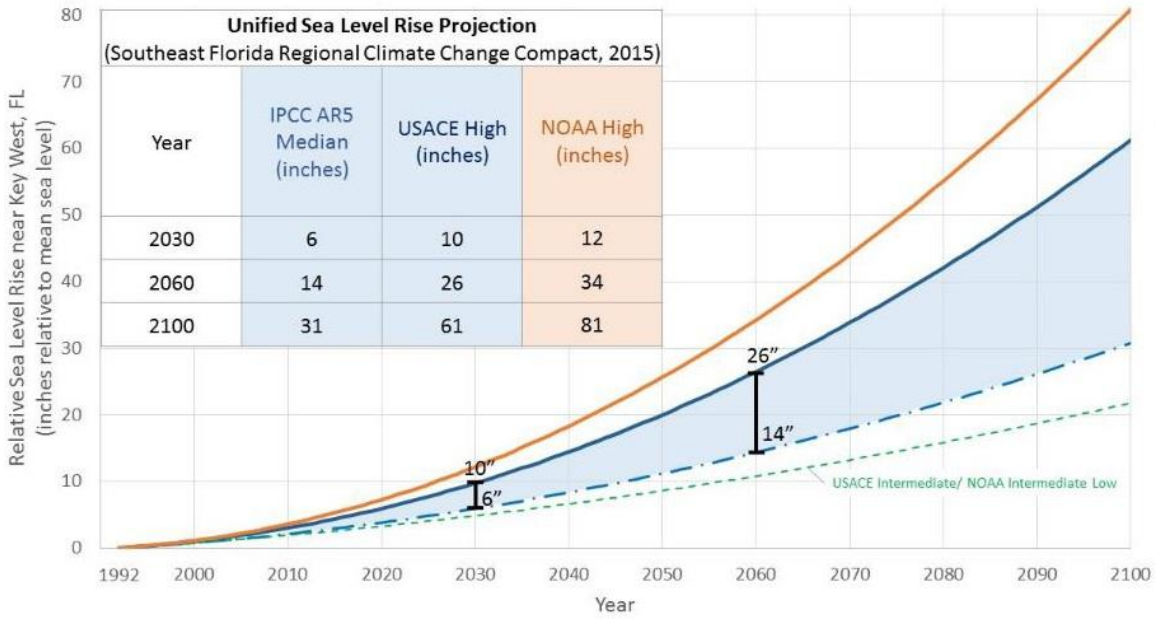
The potential challenges posed by changing climate have been known for decades, but it wasn't until the turn of the century that natural and social scientists, and policy makers began to seriously consider, in research, publications and governance the enormous impacts and implications on modern society. The Southeast Florida Regional Climate Change Compact (the Compact), a voluntary and cooperative partnership, was formed in 2010 among Palm Beach, Broward, Miami-Dade and Monroe Counties to foster unified mitigation and adaptation strategies. The Compact, enlisted elected officials, government staff, scientists from the major research universities in the region, as well as National Oceanographic Atmospheric Administration (NOAA) and USACE to develop common planning tools, and with input from stakeholders created a Regional Climate Action Plan (RCAP), which was completed in 2012. The Climate Action Plan outlines 110 recommendations that help to mitigate and adapt to climate change and increase climate resiliency. Cities that have signed the Mayor's Pledge, which Delray Beach did in early 2014, agreed to proactively advance climate adaption, implementing the appropriate recommendations in their City's planning documents and Capital Improvement Plan (CIP).

Early in the Compact's work, it was determined that all counties and municipalities within the region needed to base their adaptation strategies on one commonly accepted projection of predicted sea level rise in the region. The Compact created a Technical Ad Hoc Working group comprised of experts from numerous local universities, scientists from NOAA and the U.S. Geological Survey (USGS), and civil engineers in public service and together they developed the initial a common projection in 2012. This projection is based on historic tidal information from the tidal gauge in Key West, and independent SLR models by the: (1) USACE, (2) (NOAA and (3) Intergovernmental Panel on Climate Change (IPCC), an international body formed by the United Nations, and (4) the World Meteorological Organization (WMO). Because of the diversity

of the projections, a Technical Ad Hoc Work Group of the Compact, with guidance from USACE, formed to unify the projections, naming upper and lower bounds of expected rise in sea level for the four-county region between the present day and roughly 2060.

The Compact updated the Unified Sea Level Rise Projection (USLRP) in 2015, merging new independent scientific projections and newly observed and published data into one practical and coherent model for our region, in an effort to facilitate coordinated action. This projection delineates intermediate and high forecasts for sea level rise (SLR), measured at Key West, which will range from six to ten inches of rise (above the 1992 mean sea level) from 2015 to 2030, and fourteen to twenty-six inches from 2030 to 2060. The long-term sea level rise prediction is 31 to 61 inches by 2100, as noted in **Figure 1**.

Figure 1: Unified Sea Level Rise Projection



Source: A Unified Sea Level Rise Projection for Southeast Florida, published by the Compact in 2011

This regional sea level rise projection is consistent with, *though may outpace*, global forecasts for sea level rise. The National Aeronautics and Space Administration Jet Propulsion Laboratory have reported the average global sea level has risen almost 3 inches between 1992 and 2015 based on satellite measurements. Sea level rise in South Florida has been of similar magnitude over the same period (NOAA, 2015), but is anticipated to outpace the global average due to ongoing variations in the Florida currents and Gulf Stream. Methodology and details are available in the "Unified Sea Level Rise Projection: Southeast Florida" [1]

The Sea Level Rise Work Group recommends interpreting the projection as follows for infrastructure or other investment planning purposes:

- The lower boundary of the projection (blue dashed line) can be applied in designing low risk projects that are easily replaceable with short design lives, are adaptable and have limited interdependencies with other infrastructure or services. (For example, docks.)
- The shaded zone between the IPCC AR5 Median curve and the USACE High is recommended to be generally applied to most projects within a short-term planning horizon. It reflects that the Work Group projects will most likely be in the range of sea level rise for the remainder of the 21st Century. (For example, buildings.)
- The upper curve of the projection should be utilized for planning of high risk projects to be constructed after 2060 or projects which are not easily replaceable or removable, have a long design life (more than 50 years) or are critically interdependent with other infrastructure or services. (For example, water treatment plants.)

Understanding the magnitude of the anticipated sea level rise and the time horizon is fundamental to framing an appropriate scaled response, both in terms of policy and public investment in adaptations measures. While the variability in the range introduces some uncertainty, the type of interrelated impacts we must address are well known. The following text describes concerns about different types of flooding, storm surge, variable precipitation and saltwater intrusion that are directly linked to "rising waters".

Flooding

Sea-level rise is just one adaptation challenge facing Delray Beach and the surrounding region, but one that is inextricably tied to several interrelated hydrological challenges. The first of these challenges is flooding.

Rising sea levels will very gradually inundate low lying areas of coastal communities. In Miami Beach and areas south, communities have experienced severe "sunny day" flooding for several years, forcing the City to install one-way valves and new pumps as part of their stormwater system to not just stop ocean water from backing up through the storm drains and flooding

[1] Source: Southeast Florida Regional Climate Change Compact, Regional Climate Action Plan (RCAP), 2015, http://www.southeastfloridaclimatecompact.org/wp-content/uploads/2014/09/regional-climate-action-plan-final-ada-compliant.pdf

streets[2] but force water out into the bay as gravity driven systems are no longer sufficient. In parts of Fort Lauderdale, high tides have breached seawalls, flooding streets and yards. This "nuisance flooding" is more prevalent in Monroe, Miami Dade and Broward County, where urbanized areas site less than 2-feet above sea level, but also occurs periodically in Delray Beach, as well as in other Palm Beach County locations. Since 2014, flooding associated with King Tides of the fall season have been documented along Marina Way, Veteran's Park and low lying areas on either side of the Intracoastal, but residents of these areas have also noted coastal flooding regularly for years. The Marina Historic District is particularly prone to extreme flooding – reportedly as much as 10 inches on public and private property – during the fall King Tide event.

The fact that Delray Beach is at slightly higher elevation may "buy our community more time", but it does not alter the future of rising sea level and increased extreme rain events. This "extra time" should not lead to complacency, but rather to more strategic and thoughtful action.

While rising sea level threatens to gradually inundate coastal communities, it also diminishes the capacity of our complex stormwater management system to effectively drain inland areas to the west. The diminished capacity results from the smaller "head" – the difference in water level between the stormwater on the landward side of the canal's water control gate and the water level on the seaward side of the water control system. Canals which drain stormwater to the ocean utilize simple gravity. When a control structure is closed, water rises on the land side of the canal. When the tide is low on the ocean side, the South Florida Water Management District (SFWMD) opens the control structure and the water draws through. As seas rise, there will be less of a differential, less "head" between the land side and the ocean side of the control structure, thus diminishing that rate of drainage. The control structure must be kept closed so saltwater doesn't flood inland if the ocean levels are higher than the canal levels. If water levels meet and surpass the elevation of the 'SFWMD's pumping stations during future flood events, this infrastructure must use pumps to push fresh water from the canal to the seaward side. As climate change increases the frequency of heavy rain falls, the compounded impacts of high precipitation and higher sea-levels will create a greater risk of both inland and coastal flooding.

A third type of flooding stems from the rising water table, which will lead to flooding in low-lying inland areas. As rain saturates the ground and raises the water table, retention basins will have less capacity to hold runoff. The fact that Delray Beach is at a slightly higher elevation may "buy our community more time", but it does not alter the future of rising sea level and increased extreme rain events. This "extra time" should not lead to complacency, but rather to more strategic and thoughtful action.

The SFWMD, supported by the work of the Compact, is currently engaged in planning to prioritize infrastructure upgrades to address these future hydrological challenges for the whole region. Delray Beach is located in the Lake Worth Drainage District (LWDD) as well as the coastal drainage area managed by SFWMD. As the City depends on the effectiveness of the Lake

[2] Source: Clark, Bruce J., "The Battle for Miami Beach", Public Works, August 25, 2016. http://www.pwmag.com/water-sewer/stormwater/the-battle-for-miami-beach_o

Worth Drainage District infrastructure for drainage in designated coastal areas, it will have to be an active partner with both SFWMD and LWDD to ensure that appropriate adaptation measures will be taken.

Figure 2: SFWMD Flood Control Structure, Boynton Spillway

SFWMD operates and maintains the regional water management system known as the Central and Southern Florida Project, which was authorized by Congress more than 60 years ago to protect residents and businesses from floods and droughts. This primary system of canals and natural waterways connects to community drainage districts and hundreds of smaller neighborhood systems to effectively manage floodwaters during heavy rain. As a result of this interconnected drainage system, flood control in South Florida is a shared responsibility between the District, county and city governments, local drainage districts, homeowners associations and residents. [3]

Storm Surge and Storm Intensity

The Southeast Florida coastline is less susceptible to storm surge than other portions of the state due to the close proximity to deeper water (National Hurricane Center). However the magnitude of storm surge is predicted to increase on average along Florida's east coast by 2030 from 0.6m (1.96ft) for a 10 year return period storm, to 1.05m (3.44ft) for a 100 year return period storm, and by 2050 from 0.8m (2.62ft) for a 10 year return period storm, to 1.25m (4.76ft) for a 100 year return period storm. This will mean the average storm surge along the southeast coast of Florida will likely double by 2050. Furthermore, the Palm Beach County area has historically been sheltered to a degree by the Bahama Islands. With the predicted increase in storm surge levels, much of the Bahamas may be under water, offering the mainland less protection from storm

surge. In turn, this will lead to an increased chance of barrier island overwash by storm surge, and a higher chance for inundation along the mainland coastline. It should be noted that not only will storm surge impact be felt on the beachside but through the Intracoastal Waterway as well, as storm surge water passes through inlets and raises water levels in the Intracoastal Waterway.

In an article about the Tebaldi Storm Surge Study by the National Center for Atmospheric Research (NCAR) it was stated there will be, "likely changes in storm-surge return levels and frequency of coastal storm surges in the next decades." [3]

These estimates, depending on the location, may significantly alter risk assessment related to high water levels and should be considered a relevant result for stakeholders and policy makers involved in decisions about coastal infrastructure and environmental protection decisions. [5]

Tebaldi states that what was once referred to as the "storm of the century" is likely to become a "storm of the decade" in the future. Also of note, this study looked at only first-order effects of sea level rise on storm surge (water levels only) and did not take into account the compounding effects on storm surge of increased storm intensity due to climate change. For example, a 1ºC increase in atmospheric temperature increases water vapor by 7%, making storms wetter. In other words, looking to our past experience of storms – and of storm surge - is no longer a sufficient way to form expectations about storm activity in the coming decades.

Precipitation Variability

Global warming is not only affecting temperatures in southeast Florida, but warmer temperatures mean more intense storms and rainfall. This will not only affect tropical storms and hurricanes, but summer thunderstorms and seasonal rainfall patterns as well. On January 12, 2014, a storm dumped 12-18 inches of rain on the Delray Beach area in just 24 hours. The resulting flooding caused a dozen patients at Delray Beach Medical Center to be relocated.[4] The event was particularly unusual for Delray Beach because the average rainfall of the entire month of January is 3.13 inches.[5] This is just one example of the increase in rainfall from a storm that occurred during what is typically the dry season for Florida.

In an attempt to predict what effect climate change would have on storm frequency and rainfall patterns, researchers from the NCAR, "looked at how storms that occurred between 2000 and

3 Source: NCAR, 2012 National Center for Atmospheric Research/University Corporation for Atmospheric Research. "Extreme downpours could increase fivefold across parts of the US: Warming climate would also boost individual storm intensity." ScienceDaily, 5 December 2016.

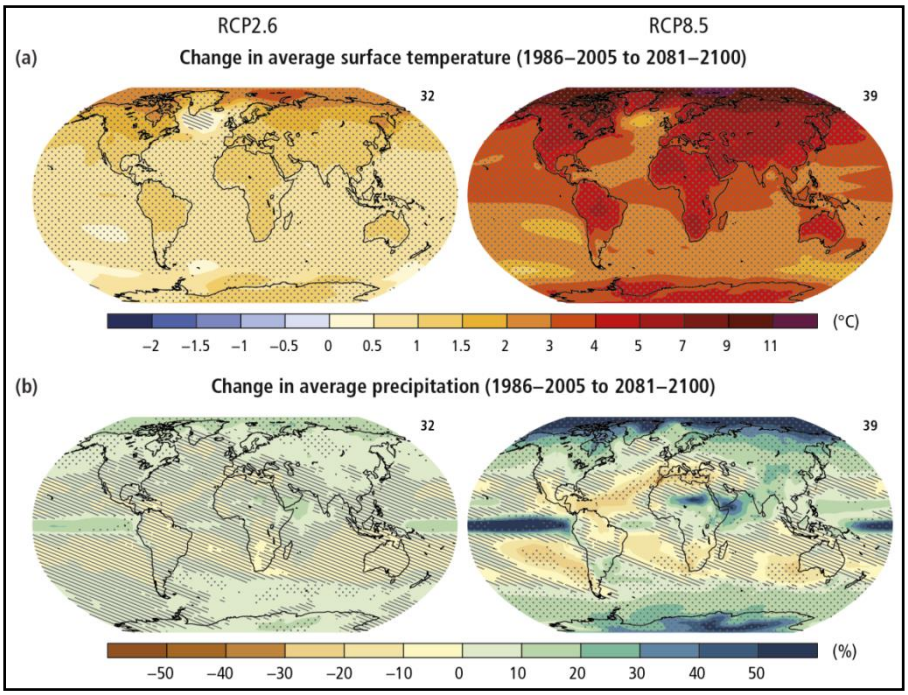
5 Source: Tebaldi, C., Strauss, B. H., & Zervas, C. E. (2012). Modelling sea level rise impacts on storm surges along US coasts. Environmental Research Letters, 7(1), 014032.

4 Source: WPTV Web Team WPTV News Channel 5 Web Article - http://www.wptv.com/news/region-s-palm-beach-county/delray-beach/delray-medical-center-flooding-12-patients-moved and https://rainfall.weatherdb.com/l/6904/Delray-Beach-Florida, data provided by NOAA

5 Source: WeatherDB.com, NOAA WeatherDB – Average Rainfall for US Cities, https://rainfall.weatherdb.com/l/6904/Delray-Beach-Florida, data provided by NOAA

2013 might change if they occurred instead in a climate that was 5 degrees Celsius (9 degrees Fahrenheit) warmer -- the temperature increase expected by the end of the century if greenhouse gas emissions continue unabated." The research concluded that, "At century's end, the number of summertime storms that produce extreme downpours could increase by more than 400 percent across parts of the United States -- including sections of the Gulf Coast, Atlantic Coast, and the Southwest". [6] Some areas, like the Caribbean, decreased in average rainfall, but for Florida it was a wetter outlook. The IPCC reported in their Climate Change 2014 Synthesis Report that the average increase in annual rainfall ranged from 10%-20%, by 2100.

Figure 3: Global Predictions for Temperature and Precipitation



Source: ICCP, 2014

Community Impacts: The increase in frequency and intensity of storms, as well as the chances of prolong drought, will put a greater strain on municipal services. We are well aware that hazard events trigger an increased cost for emergency services during storms including, Fire, EMT, Police and hospital services on a local level. This is followed by increases in demand for FEMA Disaster Response funding, and support for state and county government. But less severe storm events, those that don't trigger emergency declaration, have a multitude of interrelated impacts on local government's level of service for storm water/flood control, water supply and wastewater infrastructure. Primary drainage canals may not be able to function without the aid of pumps to

6 Source: NCAR, 2012 National Center for Atmospheric Research/University Corporation for Atmospheric Research. "Extreme downpours could increase fivefold across parts of the US: Warming climate would also boost individual storm intensity." ScienceDaily, 5 December 2016.

offset the effects of sea level rise.[7] The interior portions of the City that have not historically experienced flooding issues may become vulnerable with the diminished capacity to convey storm water to the ocean. Storm water infrastructure, including swales and pipes may not have sufficient capacity to handle the water run-off. Swales may have to be widened or deepened, and aging pipes will require upgrading. Even wastewater systems may need additional capacity to handle water seeping in through aging pipes or communities will have to sleeve or replace entire pipelines. In areas with septic tanks, leeching fields can get saturated, causing sewage to contaminate backyards. While Delray Beach was foresighted to eliminate septic tanks, environmental contamination from other communities could be felt indirectly.

Overall, health and wellness after the storms pass will also come under siege. Shallow puddling that fails to drain and dry can be the ideal environments for bacteria to grow and for mosquitos to lay eggs, spreading water-borne illnesses and viral diseases like Zika. A report by FAU professor Frederick Bloetscher (2016) indicated that there are correlations between socially vulnerable populations and health, but as sea level rose these vulnerable populations not only grew spatially in southeast Florida, but the number of cases increased within the current boundaries. Bloetscher explains that some climate change related health projections are a challenge because new infectious diseases may develop, or previous disease thought to be eradicated may reappear.[8]

Intense storm water run-off also raises the specter of blue-green algae blooms. The run-off from intense rain carries with it fertilizers from lawns and farming activities. As the Florida sun warms storm water in slow moving canals and retention ponds, it creates favorable conditions for algae growth. Some forms of algae are toxic to humans and pets, algae increases the incidence of asthma, can cause skin irritations, and even neurological damage, if ingested.

Saltwater Intrusion

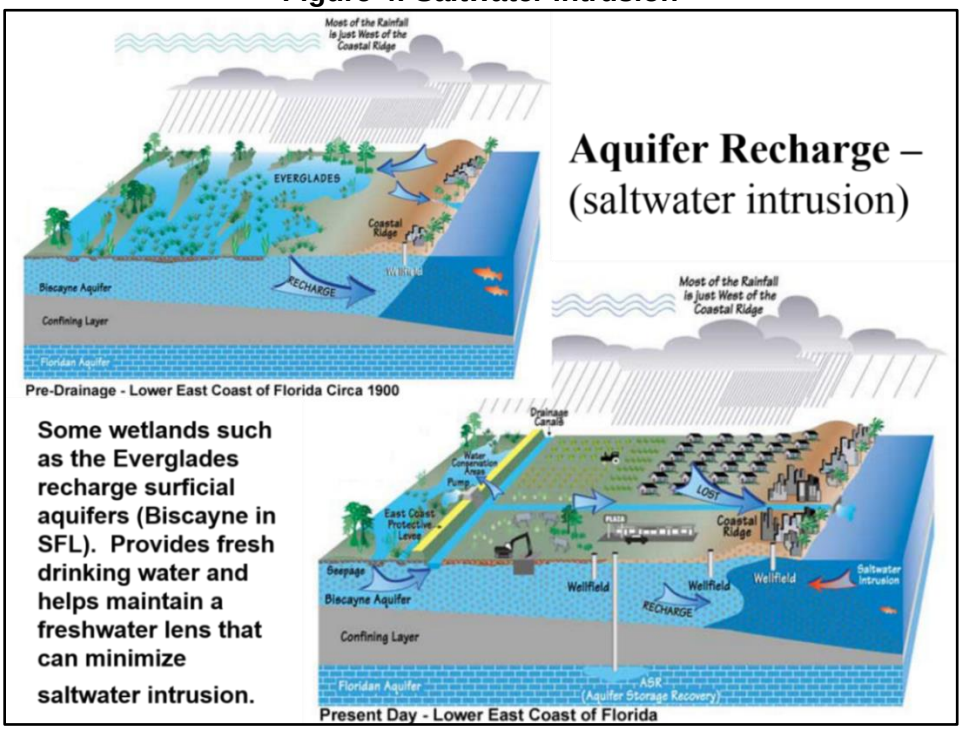
Southeast Florida is at greater risk of saltwater intrusion than other areas of the state, due to the dense population along our coast and the permeability of the Biscayne Aquifer. The Biscayne Aquifer is a shallow lens of freshwater saturating a porous limestone base under the ground surface. It is bounded by saltwater from the Atlantic Ocean that extends under the land mass and abuts the aquifer on the bottom and sides. Where they meet, a narrow area called the dispersion zone, there is a mix of salt and fresh water and it is not geographically fixed. The boundary is dependent on the amount of freshwater recharge from precipitation that filters into the aquifer, and creates a head of pressure that keeps the saltwater at bay. Wells tap the aquifer and continually draw water. This depletion of freshwater can change the head pressure, allowing the dispersion zone and saltwater line to move landward.

7 Source: Obeysekera, J. S. 2009. Climate Change & Water Management: Planning for Sea-level rise. Presentation to Broward Climate Change Task Force, Science & Technology Subcommittee. Fort Lauderdale, Florida

8 Source: Bloestcher, F. 2016, Can We Project the Health Impacts of Sea Level Rise? Conference Paper · May 2016 DOI: 10.1061/9780784479865.021

Balancing the demand and supply, while maintaining water quality is a challenge. Population growth increases the demand for quality potable water for drinking, bathing, and even non-essential functions like lawn irrigation. Concurrently, land development, including buildings, parking lots, streets and driveways create more non-permeable surfaces, reducing the area for rainfall to infiltrate the ground and recharge the aquifer. As consumption increases with population growth, and recharge decreases, the well fields draw inward on this boundary and saltwater replaces the freshwater. [9]

Figure 4: Saltwater Intrusion



Source:http://dreamingreen.org/why-everglades-restoration-matters-the-importance-of-maintaining-ecosystems-in-a-human-dominated-landscape/ and SFWMD

The projected sea level rise and predicted variability in precipitation patterns, which may result in drier dry seasons and wetter wet seasons, pose more complex challenges to our region's fresh water. After an intense rainfall during the wetter months, the excess rain is conveyed out to sea by the stormwater systems to avoid flooding, thereby eliminating the chance for the surface water to recharge the aquifer. During the extended dry periods of the winter months, the lack of rain limits recharge and the steady draw lowers the aquifer's supply, allowing the saltwater boundary to move landward. The problem is exacerbated in South Florida because the population increases with tourists and seasonal residents during the dry season, thus increasing the demand for potable water from November to May, when rainfall is at a minimum. [10]

9 Source: Terrazas, Michael, "Saltwater Intrusion: Florida's underground movement", American City & County, Feb 1, 2000, http://americancityandcounty.com/mag/government_saltwater_intrusion_floridas

10 Source: Terrazas, Michael, "Saltwater Intrusion: Florida's underground movement", American City & County, Feb 1, 2000, http://americancityandcounty.com/mag/government_saltwater_intrusion_floridas

According to the U.S. Geological Survey, the line of saltwater spreading inland comes close to or reaches cities from Jupiter to Florida City, including West Palm Beach, Delray Beach, Boca Raton, Fort Lauderdale, Hollywood and Miami (Reid 2011). Several coastal municipalities have resorted to drilling wells further west in the County and converting their water treatment plants to reverse osmosis and nanofiltration technology to combat saltwater intrusion, at great cost to the taxpayer.

The City of Boca Raton's Glades Water Treatment Plant was upgraded in 2005 with reverse osmosis technology at a cost of $54 million.[11] Their 2009/2010 budget included $3 million for "design, sighting, and construction of three new raw water wells in the City's western wellfield area. These wells will help offset withdrawals from wells that have been decommissioned in the eastern wellfield to ensure the reduction in potential saltwater intrusion" [12]. Palm Beach County's 2015 Capital Improvement Plan calls for $210 million to be spent by 2020 in the southern portion of the county on water and wastewater infrastructure. Half of the overall county capital improvement focuses on water utilities in the County's southern communities.

Some communities do not have the funds to dig deeper wells or move them westward. They can use expensive technology to remove the salt and chlorides, but many may resort to buying water from other utilities at a cost of around $2 per 1,000 gallons. In Broward County, the cities of Hollywood, Hallandale and Dania have abandoned certain wells close to the coast and have contracted with the county to tie into some of Broward's inland wellfields. [12] The experiences of surrounding communities should serve to alert Delray Beach of the water supply issues and investments we will need to address in the coming decade.

11 Source: Pool & Kent Project Profiles, http://www.pkflorida.com/case-studies/publicgovernment-utility/membrane-softening-process-addition-glades-road-water-treatment-plant/

12 Source: City of Boca Raton Water Supply Facilities Work Plan, adopted October 2010.

3. The Economic Challenges of Rising Waters

Hydrological challenges have multiple indirect economic impacts that must be given serious consideration beyond the physical impacts of rising waters on the built and natural environment and availability of abundant and high quality water. It is not possible to describe all of the economic ramifications to each sector, as they are numerous and some may not even be known at the moment. This report highlights issues related to public revenue and public finance, as these are of direct concern to local government. The following is a brief discussion of issues relating to: 1) the risks to the city's tax-base and public revenue; 2) potential impacts to municipal bond finance; 3) availability and cost of property insurance, a lynchpin to the health of the real estate market, and; 4) future land use considerations, Vigilance within all of these important areas is vital to strategizing for a prosperous future.

Property Tax-base at Risk

In Southeast Florida, the Compact sought to better understand the number and value of assets at risk of damage from flooding or gradual inundation. An Inundation Mapping and Vulnerability Assessment Work Group comprised of professionals and resources from the South Florida Water Management District (SFWMD), local universities, and NOAA Coastal Services Center (CSC) experts was assembled to perform a macro scale regional vulnerability analysis. This study determined that the four-county region was vulnerable to $4 billion of financial impact by 2040 in the one-foot rise scenario, and more than $31 billion once SLR reaches three feet, if no adaptation measures are taken.

The regional scope of the Compact's mapping and analysis does not account for specific, community-level topographic detail or local infrastructure with respect to future water-related impacts. As a result, the exact extent of Delray's vulnerability cannot be specified from this study, but the analytic approach can be borrowed and applied to Delray Beach.

The RWTF endeavored to sketch a very preliminary picture of the value of assets at risk. Using a basic bathtub model, which simply looks at which coastal geography would be potential flooded by sea level, but does not take into account storm surge, secondary inland flooding and the cumulative economic impacts, we identified 317 parcels in the city that may experience flooding by 2030. This represents approximately $350 million in assessed taxable value, primarily residential homes along the Intracoastal Waterway. It includes about $2 million in public assets, including the community center in Veteran's Park and the Public Marina. By 2060, this number climbs to 762 parcels, with an assessed value of approximately $771 million. (*See maps in appendix)*

These crude estimates were made using the more conservative sea level projections that the Compact put forth in 2012. The new data, which suggests slightly higher sea level rise estimates of up to 10 inches over the 1992 levels by 2030 and 26 inches over 1992 levels by 2060, would yield even higher impacts. The potential for depreciation of our tax base is of critical concern as this is the very source of public revenue that is needed to fund climate readiness efforts or disaster **response.**

TABLE 1
"BATHTUB" MODEL OF DELRAY BEACH

	2030 3- 7 Inches	**2060 9-24 Inches**
Total Number of Parcels Impacted	317	762
Assessed Tax Value of Parcels	$349,387,887	$771,467,425
Public Revenue at Risk	$2,607,796 (2.5% of 2014-2015 budget)	$5,758,156 (5.6% of 2014- 2015 budget)
Number of Residential Parcels	313	737
Assessed Tax Value of Parcels	$316,034,356	$687,557,850
Number of Commercial Parcels	4	24
Assessed Tax Value of Parcels	$40,925,554	$117,456,714
Number of Publicly Owned Improved Sites	17	25
Acres of Public Open Space Impacted	42	84

The high degree of vulnerability along the coast relates to the fact that much of the City's building stock was constructed under building codes and practices that did not consider climate change impacts. Finished floor elevation requirements, standards for windows, roofs and doors, specifications for seawalls, location requirements for mechanical utilities, etc., have all been based on a prior set of expectations of what is required to ensure safe, habitable and durable structures. The difficult fact facing our community is that those expectations have changed significantly. Much of our existing building stock – including a culturally valuable array of beautiful architecture -is vulnerable to various future impacts: many houses, offices and other buildings sit too low and lack necessary protective design features. Current building codes and practices – as effective as they have been to date - are not adequate to ensure that future development will be built to a standard that is climate ready. To better prepare, the specifics need to be understood at a more granular, parcel-by-parcel basis. The first step is a formalized Climate Change and Sea Level Rise Vulnerability Assessment, as suggested in the recommendations section. Planners evaluating the City's future challenges and needs should avail themselves of new, non-proprietary technological tools that are now more flexible, user friendly and capable of integrating many factors and variables. Such technology supports scenario-based planning and creation of a Climate Adaptation and Resiliency Plan.

Public Finance and Bond Rating

Delray Beach will likely need to fund new climate-resistant infrastructure and respond when future weather disasters strike. While some projects can be paid for by allocation from the Capital Improvement Budget, the largest of these are likely to be funded through bond offerings. Given that bonding is a long-term financial obligation, use of this financing tool must carefully consider if the project addresses climate adaption needs and is climate resilient.

Maintaining the highest bond rating is very important to keeping the cost –interest -- of these funds down. The Compact's "*Reducing Climate Risk and Creating Economic Opportunity*" resource document warns that "consideration of sea level rise and flood risks in the municipal bond market is currently low. Disclosure requirements do not yet include tidal flooding, so rates have not incorporated the additional risk." The lack of climate awareness will eventually disappear, so Delray Beach must consider how it can position itself advantageously to be able to borrow in the municipal bond market.

Maintaining ample cash reserves and demonstrating sound financial management are the primary ways to stay in good standing with rating agencies. Investing in resiliency and documenting how resiliency measures protect the city and secure its ability to pay bond holders may also maintain or elevate the city's bond rating going forward. Additionally, where bonding is not feasible, there may also be innovative ways to leverage funding streams across different divisions of local government to bring projects to fruition. Raising fees or creating special assessment districts are just two possibilities.

New Orleans' experience after Hurricane Katrina, of a city that was 80% submerged in water, offers us an important lesson. After the disaster, New Orleans' bond rating plummeted, further hampering its recovery process as it was unable to rally funds to rebuild. If climate considerations had been integral to bond disclosure requirements at the front end – as well as a greater part of capital investment planning - perhaps New Orleans's prior mitigation investments would have been more strategic and forestalled such a financial and social disaster.

Insuring Private and Public Assets

Home and business owners in Delray Beach, as well as elected officials and City staff responsible for public assets, depend on the insurance risk management assessment processes for response to severe weather events. Unfortunately, insurance rates are not currently set with adequate consideration for climate factors or for the longer time horizon of climate change. Further, with a growing number of federally declared disasters nationwide, federal resources like the National Flood Insurance Program (NFIP), upon which many financed property owners in South Florida depend, are likely to become increasingly strained. As a community, we will need to take new steps to prepare for the risk within our City limits.

In this section, we will discuss three important issues related to insurance and climate change: (1) the availability and cost of private residential property insurance; (2) the rising cost of flood insurance, with special attention to the relevance of NFIP flood mapping; and (3) the problem of dwindling FEMA resources and competition for resources for public disaster relief and

preparation. We will explore the opportunity to create reserves and thus move towards greater self-reliance and "self-insurance", while also making better use of existing resources such as NFIP's Community Rating System (CRS) to reduce premiums.

Availability and Cost of Private Homeowners Insurance

As many Florida homebuyers and owners know, there are a limited number of options to obtain private property insurance and it can be very costly. The volatile and high rates can be a heavy burden and markedly impact real estate sales. For those who live on fixed incomes, the high cost of homeowner insurance and the additional flood insurance can become untenable and many choose to reduce or abandon it, leaving them underinsured in the face of catastrophe. Being underinsured is a tenuous situation for the homeowner and strains FEMA resources upon which they rely when disaster strikes. Ultimately, taxpayers carry the economic burden for those underinsured, through the provision of disaster relief funds, clean-up costs and even unemployment compensation, as the economic ripple is felt throughout the local economy.

The Volatility and Rising Cost of Flood Insurance

NFIP's flood insurance rates have become somewhat volatile and may become more so. Rate changes directly impact the affordability of privately-financed homes for homeowners and homebuyers alike. Given the wider understanding of the changing South Florida climate, rates are likely to rise, and perhaps suddenly rather than gradually, as risks associated with sea level rise and climate change are more accurately tied to insurance rates.

New flood maps will be published and insurance rates will go into effect for Palm Beach County after March 2017. This is the first map revision for the area since the 1980s. Preliminary maps released by FEMA in 2013 added 62,000 properties to high risk flood zones. Map revisions (many in the western parts of the County) based on new data provided to FEMA since 2013 have reduced that number of high risk properties by over half, but a substantial amount of coastal properties will see increases in their flood insurance rates. [13]

The real estate market of Delray Beach may be directly impacted by these private property insurance and flood insurance sector issues now or in the future. Local home values will understandably decline if mortgage-backed buyers are driven to purchase elsewhere by the high cost and difficulty of insuring a residential property. Reliance on cash buyers alone is not adequate to build and maintain a diverse and long lasting homeowner tax base. Also, lower property values mean lower property taxes.

13 Source: Hurtibise, R., "FEMA: New Palm Beach County flood maps should be in effect by spring 2017" http://www.sun-sentinel.com/business/consumer/fl-pbc-fema-flood-map-update-20160426-story.html

Public Resources for Disaster Preparation and Relief

With the incidence of federally declared disasters on the rise, it is reasonable to expect that FEMA resources will become more strained over time and there will be increased competition for the resources. In turn, our City may find itself more on its own in guarding against, planning for, and recovering from severe weather impacts and rising waters. In anticipation, Delray Beach might consider maintaining cash reserved as a form of self-insurance for our public assets. Funding this reserve may compete with other funding needs in an already strained fiscal budget but it emphasizes the importance of preserving our tax base. Failure to insure our public assets means they may not be repaired or rebuilt after a disaster event.

In the interim period, it is in the best interest of public and private property owners to advocate for greater inclusion of weather and climate factors in the risk assessment process, as this makes the costs of insurance more predictable and equitable. In a resource document published by the Compact entitled "Reducing Climate Risk and Creating Economic Opportunity" (2016), risk management professionals advise public and private property owners to *"advocate for risk evaluations that account for climate factors from the outset"* and to "*embrace new non-proprietary technological tools to help evaluate and plan strategic public investments*". They encourage local government, when possible, to *"secure multi-year insurance packages that add predictability by smoothing out budgetary fluctuations and provide rebates when losses have been averted"* and to *"use Enterprise Risk Management insurance instruments where and when possible, to gain fuller coverage."*

Leveraging Existing Resources to Manage Premiums

Maximizing participation in the NFIP's Community Rating System (CRS) is an important means of managing insurance cost and taking climate-readiness action steps. The CRS, a voluntary program, recognizes floodplain management and outreach activities performed by communities that exceed the NFIP minimum standards. Active participation in the CRS program can reduce the cost of flood insurance premiums by 5 to 45 percent depending on the rating level achieved by the municipality. Delray Beach currently holds a CRS Class 8 rating, which equates to a 10% reduction of premiums in the Special Flood Hazard Areas (SFHA). In comparison, the City of Boynton currently holds a CRS Class 7 rating, which allows a 15% reduction in premiums, and Palm Beach County, a CRS Class 5, which allows for a 25% reduction, according to The Florida Division of Emergency Management (FDEM).

The CRS recognizes 19 creditable activities organized under four categories: Public Information, Mapping and Regulations, Flood Damage Reduction, and Warning and Response. Delray Beach could readily undertake activities in these categories to improve its standing in the CRS program, reduce (SFHA insurance premiums, and remain competitive with other communities in attracting and retaining residents.

TABLE 2
CRS CREDIT POINTS AND ASSOCIATED FLOOD INSURANCE PREMIUM REDUCTIONS

Credit Points	CRS Class	SFHA	NON-SFHA
4,500+	1	45%	10%
4,000 - 4,499	2	40%	10%
3,500 - 3,999	3	35%	10%
3,000 - 3,499	4	30%	10%
2,500 - 2,999	5	25%	10%
2,000 - 2,499	6	20%	10%
1,500 - 1,999	7	15%	5%
1,000 – 1,499	8	10%	5%
500 – 999	9	5%	5%
0 – 499	10	0	0

(Source: www.floridadisaster.org)

The City should be mindful that CRS-approved activities are subject to a 5-year CRS review cycle (for Class 6 to 9). Work to identify which of the 19 creditable activities, including possible future land use, building code changes and enforcement that could be converted to action items should be undertaken. While the City has already engaged a CRS consultant, some of the action items will require capital investment and public support. These projects should be considered as part of the broader community vulnerability assessment that this report recommends.

The costs of preparing and implementing adaptation techniques before severe damage occurs are much lower than recovering after significant storm events and then implementing the needed changes. An example of one such City program already in place is the very successful system of vegetated dunes. Before the beach renourishment and dune restoration program was initiated in the 1970's and 1980's, storms frequently washed out Ocean Boulevard and caused property damage further inland. Recently, Hurricanes Sandy and Mathew have impacted Delray Beach, but our beaches and dunes did their job in absorbing the shock of the storm and saved the road, infrastructure, and properties further inland. The earlier investment in the beach and dune system paid off for Delray Beach.

Future Building and Land Use Considerations

New construction can affect the economic well-being of Delray Beach either positively or negatively, depending on how successfully the City prepares for predicted future storms and rising water. Well placed and well-built structures and infrastructure will give our community a competitive advantage, safeguarding people and property and fostering resiliency. Poorly planned development will very likely result in individual and collective financial losses.

Now is the time to put in place strong incentives for more resilient development. Presently the city codes allow buildings at the Base Flood Elevation (BFE) of 6 feet NAVD. A more prudent approach required by Executive Order13690 in January of 2015, mandates that buildings using federal funds to be constructed at BFE +12 inches or more. To be prudent, Delray Beach may consider more than 12" Building at higher elevation is perhaps the most straightforward development strategy in the face of rising water. Comprehensive land use planning is the best means to achieving higher density development in strategic, high-elevation sites, while discouraging development in low elevation locations. Building codes and judicious enforcement are the best means to encouraging storm-ready and climate resilient construction.

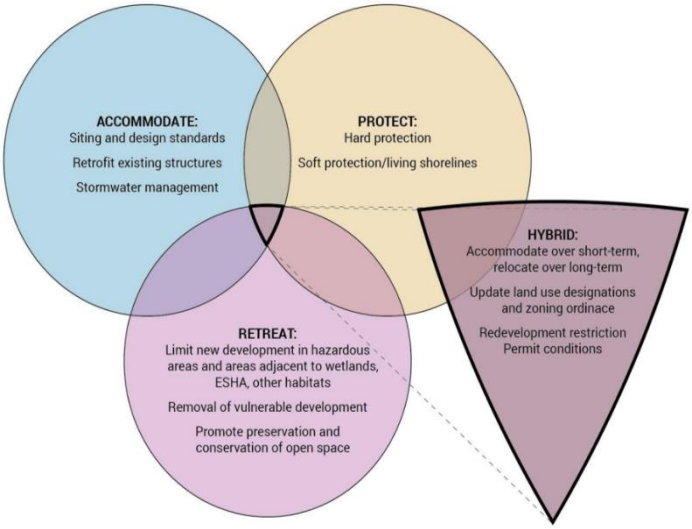
However, there are other tools. Delray Beach can also make use of a standards set by the Florida Green Building Coalition (FGBC), a state-wide organization that promotes sustainability in the built environment. Its certification process assures that buildings are constructed to climate-resistant (and other environmentally sustainable) standards. FGBC applies Florida climate-specific standards that address future water impacts in their independent evaluations. The Florida Statutes named FGBC as the one of the three acceptable standards for the construction of new government buildings. To the extent that FGBC-certified "green building" can be strongly encouraged in Delray Beach, any new housing stock, commercial construction or public facilities built will be better ready to stand the test of time and the elements.

> *[Designing for risk reduction] not only makes sense, but...also makes money for developers and owners. Resilience plays out not just in managing risk, but also in maintaining value... The payback...can be measured in cost savings from preventing damages and reducing operating costs, as well as revenue enhancements from improved marketing, company brand, and project image.*[1]

Ultimately, increasing the use of "green" building standards, including base flood elevation standards that respond to the Compact's Unified SLR forecast, will be important elements in the community's approach to future flood management. Whether in the realm of public or private development, Delray Beach should encourage developers to collaborate in the creation of climate-resistant buildings and infrastructure. Private developers stand to profit from the increased demand for such products, a demand will certainly grow over time.

4. Recommendations of the RWTF

Communities around the world have taken a variety of approaches to sea level rise preparation, ranging from doing what is needed to stay in place, to retreating from inundated lands. As shown in the graphic, approaches are of three types: Accommodate, Protect, or Retreat, but aspects of each overlap, allowing one to frame a hybrid approach. In a blended approach, policymakers pick and choose from an array of options, based on the specificities of location, vulnerability, tolerance for risk, political and public will to invest resources and assign cost and benefits. Policymaking is messy. Climate adaptation policies are especially challenging due to the long timeframe, the magnitude of uncertainties, and most importantly, the desirability and value of coastal resources.



The City of Delray Beach has an opportunity now to choose how it will remain resilient. The six recommendations and associated action steps of this RWTF report put forth ideas that accommodate and protect against "rising waters" in the community. The RWTF urges the City of Delray Beach to account for flooding and higher coastal waters in its land use planning and development codes and also build (or modify) critical infrastructure to standards that protect against water inundation. Doing so will support a future in which Delray Beach continues to be a desirable place to live, work and visit.

Recommendation 1: Be Proactive and Process Driven

The RWTF recommends establishing a formal, proactive plan to mitigate and adapt to climate change impacts, including extreme rain events, increased tidal flooding, storm surge and sea level rise. A formal, proactive approach means accelerating the adaptation planning process by dedicating sufficient staffing and monetary resources needed to:

- Conduct a comprehensive climate vulnerability assessment;
- Vet alternative adaptation measures in terms of cost, effectiveness and feasibility of implementation;
- Determine what measurable indicators will trigger timely sequencing of implementation (Ref: Miami-Dade Sea Level Rise Task Force);
- Enact planning policies that will enable appropriate planning intervention; and
- Put in place mechanisms that will provide funding for both planning and implementation of these measures.

Justification: The RWTF met for over 18 months, listened to numerous topic experts, participated in workshops, reviewed sea level rise, storm surge, and flood maps, evaluated quantitative and qualitative data, and collected examples of adaptation planning from cities around the country. It became clear that the highest quality plans and approaches were created by organizations with paid resources. To create an actionable plan, data must be purchased and experts hired to analyze data, evaluate options, engage in a substantive public participation/engagement process and work alongside city staff to guide the process to fruition. As this task force is comprised of voluntary members and supported by one city staff person, the RWTF is best positioned to review best practices and inform, but not execute, a formal proactive planning approach. The task force can, however, outline some action steps and a process.

1.A Action Step: Align funding and appropriate staffing for a multi-step climate adaption planning.

• Refine job responsibilities in appropriate city departments to engage a variety of municipal staff in aspects of adaptation.
• Reorganize staffing so that the Sustainability Officer reports directly to the City Manager, and create a Department of Sustainability and Resiliency with resources to develop and implement adaptation recommendations.
• Optimize climate change training for city staff and align training with continuing education credit requirements for professionals. This includes sending employees (again) for NOAA training, and sending staff to appropriate conferences and workshops at the county, regional, state and federal and international level. For instance, we can learn from the Netherlands and from island nations.
• Seek and hire qualified consultants to research, craft and help implement climate adaptation initiatives. The appropriate consultant should have multi-disciplinary planning and engineering skills, as well as local knowledge. We suggest avoiding firms that provide ‘cookie cutter’ plans and organizations that represent a disciplinary perspective such as real estate, insurance, or engineering. It may be optimal to create a “team” of small firms and individuals rather than contract one large national or regional firm.
• Collaborate with university researchers as a case study and engage university students as interns that can support the city’s departments and the consultant’s work. These need not only be local universities, but rather nationally recognized Tier I research institutions.

1.B Action Step: Conduct a Vulnerability Assessment (Vulnerability = Exposure x Risk) – A quality vulnerability analysis must be conducted by experts in the field of climate risk with best available data.

Some of the data can be "mined" from existing sources; other data will need to be generated specifically for the City of Delray. It is recommended that Delray Beach seek information from Palm Beach County. Below is a detailed checklist of the components a Vulnerability Analysis should include:

Determine:
• Areas subject to sea level rise at 1 to 2 feet, along with a table identifying the number of assets, the value impacted.
• Areas subject to storm surge, including the number of assets and the value.
• Areas subject to inland flooding including number of assets, value and areas not directly impacted, left inaccessible due to an event.
• Critical assets mapped over different types of inundation risk
• Potential impact to vulnerable populations.
• Potential influx of "climate refugees" from areas south.
• Areas along the ridge, at higher elevation, to receive increased density development
• Areas subject to sea level rise at 1 to 2 feet, along with a table identifying the number of assets, the value impacted.
Identify:
• Commercial and residential property (number of units and value, insured risk, taxable value).
• Public facilities (fire, police, schools, art/culture, marina).
• Infrastructure (wells, electrical substations, transportation nodes, outflow valves, septic from neighboring areas).
• Natural resources, beaches and open space and the impact on tourism.
• Social or demographic population risks, including the elderly and less affluent, cohesion of the social fabric and civic engagement, and consideration of the potential for displacement or gentrification.
• Commercial and residential property (number of units and value, insured risk, taxable value).
Provide:
• Analysis of relative location geographically and topographically, including maps of elevation with LIDAR specifically and key hydrological features (canals, Lake Ida, water table).
• Digital building footprints and ground floor elevations for all structures, if possible, or at minimum, high risk areas.
• Forecasts for sea-level rise 10-year and 30-year horizon.
• Nuisance tidal flooding and nuisance precipitation flooding.
• Saltwater intrusion assessment.
• Creation of elevation and groundwater maps, along with flood zones, to provide to homeowners and buyers.

1.C Action Step: Based on Vulnerability Assessment, Begin vetting different engineering solutions for applicability to Delray Beach.

Cost/benefit should use full cost accounting methodology, feasibility of implementation, appropriate scheduling and identification of funding. These include for example: flood protection, flex valves, hard and soft armoring, road and bridge designs, new bio-swale retention areas, cisterns for water capture, etc.)

Specifically, the RWTF suggests to:
• Continue the dune management program and enlist cooperation of private property owners in adjacent parcels.
• Evaluate beach restoration program and its funding needs. Plan for projects in an era of diminishing federal and state resources.
• Require new or replacement/upgraded sea walls to be at a minimum elevation of 5 feet (NAVD88) following the policy of Miami Beach and Gulf Stream, and based on the Southeast Florida Regional Climate Change Compact Sea Level Rise Projections. Ensure that code enforcement can evaluate and cite the lack of maintenance of a sea wall.
• Consider investments in soft armoring. New living shoreline building techniques should be evaluated before hard armoring, and an integrative approach might be best.
• Develop methodology for prioritizing adaptation responses to specific rising water threats. Decisions will hinge on public tolerance for impact, cost, and what falls into public versus private investment.
• Devise a participatory community engagement process.
• Evaluate assets and develop a ranking of projects.
• Integrate priority projects in the City's Capital Improvement Program.

Recommendation 2: Plan Adaptation Comprehensively

Incorporate climate change impacts and adaption into all policy and planning documents that impact the city's physical fabric and economic growth. This begins with adding climate impacts and resilience strategies to goals and objectives in all applicable elements of the Comprehensive Plan, including future land use, coastal element, parks, transportation, and infrastructure. At the time that the Comprehensive Plan is updated, a *climate resiliency chapter* should be added. Simultaneously, climate adaptation projects and funds for these initiatives must be in the Capital Improvements Plan (CIP). Climate impacts and policies must be incorporated in the Post-Disaster Redevelopment Plan, and appropriate changes made to the city's Building Code. These efforts should be implemented by the City's Planning and Zoning Department and the Environmental Services Department and coordinated by the City's Sustainability Officer.

Justification: Florida has a multi-layered planning process that is woven through several agencies at different levels of government. Additionally, because of our long history of addressing weather-related natural hazards events, the city, county and state government have a relatively robust hazard mitigation policy framework and event preparedness and response approach. Ideally these efforts are synergistic, and together they provide a platform on which to advance a comprehensive climate change adaptation planning process. The RWTF acknowledges the power of these planning tools and believes that they can be strengthened to advance best practices with respect to climate adaption. Following are ideas the Task Force believes should be considered relative to each plan.

2.A Action Step - Review and Amend Comprehensive Plan.

In the Future Land Use Element:
• Establish policies and incentives to discourage development in high-risk areas.
• Identify land for acquisition related to climate risk and water storage.
• Identify resilience zones to which growth should be redirected and develop policies that encourage responsible, compact, eco-friendly development. Engage the CRA in encouraging development of resiliency zones.
• Use the State's new Adaptation Action Area (AAA) designation to delineate areas requiring specific planning attention and investment. When implementing AAAs it's helpful to create a revenue generating mechanism to fund resilience projects in the AAA.
• Consider creation of an innovative Transfer of Development Rights (TDR) program for repositioning assets in resilient locations.
In the Coastal Element:
• Add sea-level rise scenario projections to the plan.
• Assess beach management and dune management needs with consideration of dwindling federal and state resources.
• Identify how to coordinate with private property owners for effective interventions of shoreline and dune preservation.

• Develop a "rolling easement"[14] tool that can help manage rising water and erosion issues on private property.
• Forge regional cooperation to consider floodgate protection of ocean inlets against storm surge.
• Develop policies and outline a plan for eventually dismantling the built environment when retreat is the desired option.
In the Economic Development Element:
• Market Delray Beach as *climate forward* and use this branding to encourage companies to locate here.
• Recruit companies that create and provide climate resilient products and services.
• RFPs for development must have a green infrastructure component and weight is placed on this aspect in the selection process.
• Incentivize action on resilient features in private development through rebates/tax credit.
• Address the potential gentrification issues related to climate-related relocation and investments away from affluent coastline areas to lower-income higher-inland areas.
• Explore innovative community-based or pooled insurance mechanisms that mitigate risk and reduce costs. (see recommendation #4)
In the Infrastructure Element:
• Assess the validity of the assumptions in the storm water management plan.
• Assess design standards for roadways and sidewalks considering a future with intense precipitation.
• Prioritize investment in infrastructure that prevents flooding and has positive cost/benefit outcomes (valves, pumps).
• Identify areas where public infrastructure will be abandoned.
• Invest in long-term infrastructure in safe areas, thus directing development to these more resilient locations.
In the Conservation Element:
• Create new conservation easements for water storage.
• Optimize land conservation and parkland for water retention with appropriate landscape.
• Require additional onsite water storage elements, swale, rain gardens, green roofs, water barrels.
• Promote xeriscape in both public and private (commercial and residential) projects.
• Require/incentivize shading and foliage to reduce heat island effect of urban areas.
• Expand the capacity of the "reclaimed" "grey" water infrastructure.

2.B Action Step - Capital Improvement Plan (CIP).

In assessing the costs and benefit of projects to be put into the Capital Improvement Plan, the city should use an environmental full cost accounting method (EFCA), incorporating indirect cost and benefit of each mitigation approach. Capital investment projects should consider climate change projections, assuring that investments retain functionality for the complete expected lifespan of the project.

The CIP must list all types of mitigation projects needed, as grant and funding applications often require the project to be already listed on a city's CIP to be eligible for consideration. The City's CIP must include

14 http://papers.risingsea.net/rolling-easements.html

raising the height of seawalls on public lands, and assistance or policy initiatives for private seawall throughout the city's coastal boundaries.

2.C Action Step – Modify Post-Disaster Plan.

Review and rewrite post-disaster redevelopment policies D-3.2, D-3.3 and D-3.5 contained in the coastal element of the Comprehensive Plan so that we do not sanction rebuilding of assets to standards of the previous building that was destroyed. Rather, buildings that are more than 50% destroyed by a flooding event – or perhaps even 40% - should incorporate new "best practice" regulations. The additional cost to the owner should be incentivized though a tax credit mechanism.

Identify climate adaptation related projects that can be submitted to the county for funding as part of the Local Mitigation Strategy Document and have a steady representation on the County's LMS Committee. This is important, as only projects approved on the LMS are eligible to receive FEMA Mitigation Grants.

2.D Action Step – Revamp LDR and Building Code.

New standards are needed for future building construction. We would be wise to examine and modify our LDRs and update building codes to provide consistent and clear guidance to builders and developers, including a forward-looking base flood elevation (BFE). These codes - and this BFE - should reflect a long term, reasonable forecast of sea level rise, such as can be found in the Compact's Unified Sea Level Rise Projection adopted by the four counties of the Compact in 2015.

- Re-evaluate building codes in vulnerable areas and Adaptation Action Areas (AAAs).
- Implement a Climate Change Preparedness and Resiliency Checklist for New Construction.
- Plan for and incorporate water retention infrastructure in the building code for new construction.[15]
- Create fast tract approaches for building changes to existing structures that increase resiliency. The City's complex board review may need to be streamlined for changes regarding resiliency.
- Assess building height restrictions that impede raising buildings. Incentivize higher freeboard (12 or more inches) which raises buildings above the required BFE.
- Review and change if necessary regulations regarding the location of building mechanicals.
- Create ordinance that requires landlords to provide air conditioning in buildings.
- Require redundant critical infrastructure (generators, pumps, etc.) in certain types of facilities.
- Facilitate xeriscaping by making sure the City's Landscaping LDRs and HOAs allow it. Offer educational workshops on the topic through our community garden network.
- Revaluate and discourage underground uses (including parking and storage) in inappropriate locations.

[15] The City of Boston, has done this and their document can serve as a starting point. http://www.bostonredevelopmentauthority.org/planning/planning-initiatives/climate-change-preparedness-and-resiliency

3

Recommendation 3: Allocate Monetary Resources

Develop a strategy for addressing the monetary costs of adaptation. The City or public sector will require budget allocations or grants, while homeowners or businesses might require public incentives to motivate investments in adaptation. Thus, the City must consider strategies for creating a dedicated pool of funds that can grow over time and be available in the future for infrastructure improvements, retrofitting, or to off-set tax-incentives related to climate adaptation.

Justification: 'Sunny day' planning and retrofitting is often more cost effective than emergency response. Managing the impacts of rising waters will require investment in some 'engineered solutions'; things like backflow prevention valves on discharge pipes, raising roadways, bridges and sidewalk, retrofitting draining systems, and some 'land planning" solution, such as purchase of land, conservation easements and development rights. The ability to execute any type of project in a timely manner is often dependent on having public funds available and earmarked for these types of projects.

As more municipalities face the need to implement adaptation responses, one can anticipate increased competition for grant funding from state and federal sources. Moreover, grants often require "matching" funds. Municipalities that have already dedicated funding allocations for adaptation will find it easier to obtain additional resources, especially if the amounts sought are smaller. Thus, planning by identifying revenue sources in the present term and allowing reserves to grow will allow the City to address mitigation activities more easily in the future.

3.A Action Step – Reinvest savings obtained by improving CRS rating.

Use the savings on insurance obtained by lowering the City's the CRS rating to create a pool of funds for future adaptive projects. If City enjoys a reduction in the premium costs of insurance on public property, then funds from CRS program savings may be re-deployed for adaptation. While the City currently only holds three policies with a total 2016 premiums of $8673, that would benefit from a CRS rate reduction, the $1,300 savings gained from a 15% premium reduction could fund small public education outreach efforts, at a minimum.

3.B Action Step – Today's capital improvement projects and maintenance investment should already take into account higher standards.

Begin incremental adaption by making sure capital projects built today achieve higher standards needed to address climate impacts in the long term. Achieving the higher standard may be slightly more expensive, but will be more cost effective than replacing things before they've reached their maximum lifecycle. All expenditures made from dedicated sources should consider climate adaptation as criteria.

3.C Action Step – Look at fees and taxes that can be funneled for adaptation reserve funds.

The city's budgets are already tight, but it may be prudent to create a climate adaptation fund. Otherwise, we might use existing funds and sources, such as the Special Revenue funds to creatively advance adaptation goals. The Recreation Impact Fee can be used for land purchase of retention areas, Public Art Program can install public art that raises awareness of climate impacts.

Recommendation 4: Leverage Insurance Products

In conjunction with the need to develop financial instruments that facilitate adaption responses, we urge the city to examine and address the important role insurance can play in mitigating risks of rising water events. Insurance rates and availability can catalyze action on adaption by private property owners, or conversely, stifle economic prosperity if rates rise precipitously, or insurance becomes unattainable.

Justification: The inability to obtain insurance coverage, either because companies will not underwrite, or costs are too high, can hamper commercial financing and property transactions. A thorough analysis of the insurance issue, including the impact of rising NFIP Flood Insurance rates, the availability of property insurance and commercial insurance products, like Business Interruption Insurance is needed. This analysis might entice the city to considering the following actions, or reveal new cutting edge approaches.

4.A Action Step – More education outreach regarding insurance.

Request that the City's economic development professions organize an education outreach program for residents, property owners and business owners on climate resilience and insurance.

4.B Action Step - Develop ways to document resilience efforts and preparedness.

Support development of a "model resilience plan" for use by businesses owner/commercial property owners. Having a plan may assuage insurance companies' concerns of climate impact risk and permit them to issue policies and contain the cost of the policies.

4.C Action Step – Consider innovative insurance tool that are emerging in response to climate impacts.

Explore the feasibility of creating a Delray Beach "self-insurance" or local pooled risk, for public buildings.

Recommendation 5: Educate the Public

Raise public awareness of climate impacts through targeted climate education programs and broader public outreach events. Outreach must occur at multiple levels including: homeowners, neighborhood associations, property managers, business owners, real estate professionals, civic organizations, youth, public servants and city employees.

Justification: It is important for the city to support efforts for public education on climate change impacts. Informed citizens make better personal choices regarding their properties, vote more responsibly and more likely to support necessary decisions made by city leaders. Adapting to rising waters will require investment, both public and private, and modification of regulations at various levels. Citizens will be reluctant to support new regulations, public investment, or revenue generating initiatives unless they fully understand the ramifications of inaction and the benefit of proactive adaption. Likewise, public officials and employees of the city must be "climate smart", enabling them to consider climate impacts in their day to day decision making. Awareness and education is a critical step to garner ongoing support. If these efforts are organized under a formal Public Information Program, this will also improve the City's CRS rating.

5.A Action Step – Identify and sponsor climate education programs.

Develop and host public programs at the library or in town hall format, as well as symposiums or workshops that might be held in the city. Programs could also be developed thorough the public schools or by the Parks and Recreation Department or by the City's Sustainability Officer. City employees should receive climate education though local universities, or by attending relevant conference/workshops programs.

5.B Action Step - Raise awareness at public events in Delray Beach.

Public outreach can be organized around existing events, including the King Tides, Earth Day, and the beginning and end of Hurricane Season. Climate education could also be coordinated during the weeks leading up to elections, when referendums on development, fees, and taxes are on the ballot.

5.C Action Step – Improve the city's parcel database and make it accessible.

The City should create and maintain free, publicly available information regarding parcel elevation, groundwater levels, and flood zones for homeowners and businesses.

5.D Action Step - Support innovative data collection that engages citizens.

Set up publically visible monitoring points in vulnerable areas to measure and evaluate changes. Engage the public in the effort through photographs, collection of quantitative measures of rainfall or tide rise, and qualitative data including oral history of long term residents.

5.E Action Step – Work with the real estate community on proactive solutions regarding disclosure.

Work with the real brokerage community to explore how building elevation, flood risk, and storm surge risk might be disclosed during the due diligence period, prior to closing on real estate transactions.

5.F Action Step – Post floor elevation placards for all public buildings (similar to capacity numbers used in public meeting spaces).

Recommendation 6: Harness Economic Development

Leverage the City's commitment to being a pro-active adaptation leader as a strategy for additional economic development, including recruiting business focused on sustainability, encouraging adaptive tourism, and obtaining grant money.

Justification: As only a handful of localities have taken substantive steps to mitigate climate impacts and rising waters, there is still an opportunity to be recognized as a "leader" in the field. Establishing this reputation can contribute to the city's economic growth; making it easier to obtain grants and resources, as well as preserve the city's bond rating. Cities that are at the forefront of adaptation may be considered "safer", and thus a desirable destination for companies looking at the South Florida Market. It may also be possible to attract companies that focus on adaptation technologies and materials. Additionally, in the realm of grant funding, it is important to be an innovative early adopter, and it is easier to get funding once you already have a track record and momentum. Delray Beach is well positioned to obtain federal, state and private grants on climate adaptation or education, especially if we maintain and empower a resilience/sustainability officer, we document a track record of innovation and implementation, and we have matching funds for projects.

6.A Action Step – Send City staff to participate and present on climate at professional functions.

Make sure that the city is represented, both by attending and by sending a speaker to major conferences where climate adaptation is discussed. These could include: American Planning Association, EPA workshops, NOAA, League of Cities and others. Ft. Lauderdale is an excellent example of how city professionals can bring recognition to a city regarding climate adaptation.

6.B Action Step – Use press and media to generate positive image of City's commitment to climate education.

Publicize climate education initiative in the local press and make sure that local reporters cover news related to adaptation projects in the city.

5. Conclusion

Rising waters, both from sea level rise and intense storm events, pose a danger to the health of coastal populations and property locally and around the world. These dangers are dramatically apparent during tropical storms and hurricanes, when storm surge and inland flooding cause loss of life and billions of dollars of damage. Even the minor inconveniences of nuisance tidal flooding will, over the long term, cause serious problems as their frequency and severity increase.

Delray Beach will face increased flooding, storm surge and intensity, precipitation variability and saltwater intrusion in the decades to come. The City is fortunate to learn from other Florida locations that are experiencing these impacts now. This should not lead us to complacency. Adaptation techniques are being developed regionally, nationally, and globally to deal with the threats posed by rising waters. We must adapt as well.

The costs of preparing and implementing adaptation now is lower than the cost of recovery and responding to problems once they occur. Investments in adaptation will need to be defined in 15, 30, and 50 year time horizons, or roughly the lifecycle of various municipal infrastructure elements and private property buildings. Budget reserves must be considered with similarly long time horizons, thereby allowing funding mechanisms to accumulate those reserves. The investment amounts are NOT staggering if viewed over these long time horizons. The amount of infrastructure costs and reserves needed over the long haul will require buy-in from the City's taxpayers into a long-term sustainability program, which can only be accomplished through a serious, continuous, and transparent public engagement program.

The RWTF was guided by principles that include ideals such as foresight, cooperation, synergy, resiliency and hope. We have presented the Recommendations of this report with the intention of engaging the leadership of our current and future city commissions. As a small city, we need to employ innovative tools from the public and private sectors to advance our goal to remain a vibrant and resilient community.

The time to begin the work of climate adaptation is now!

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APPENDIX A
The Rising Waters Task Force (RWTF)

The term "waters" was adopted to connote all types of flooding impacts from sea level rise, precipitation, storm surge, etc.

Origin of the RWTF

The Rising Waters Task Force (RWTF), a concerned citizen's group comprised of Delray Beach residents and representatives of local non-profit organizations, was organized by Ms. Nancy Schneider, at the request of City Commission in 2014. The charge of the Task Force was to examine issues of inland and coastal flooding in Delray Beach in the context of the climate change forecast. The group's name reflects a simple truth that "waters are rising" due to the extreme rain events and higher sea levels. The RWTF accepts the factual basis of forecasts made by esteemed meteorological scientific institutions that have been adopted collectively by leaders of the Southeast Florida region as well as the factual documentation of changes we are experiencing in our climate. These forecasts provide a reliable and reasonable trajectory that we will experience in our local climate. Ocean levels are in fact rising and will continue to rise. This rise, and intensification of storm events and rainfall, will worsen existing water hazards in our roadways, public and private spaces, infrastructure, and prized cultural and touristic assets. These changes pose a direct threat to our economy and quality of life.

Task Force Goals

Goal 1: Education

To educate elected officials, residents, taxpayers and other stakeholders about how rising waters threaten the immediate and longer term economic, social, and physical vitality and viability of Delray Beach and its nearby communities.

Goal 2: Southeast Florida Compact Regional Climate Action Plan Integration

To integrate the elements of the Southeast Florida Regional Climate Change Compact (The "Compact") Regional Climate Action Plan (RCAP) that are appropriate for Delray Beach into the Green Task Force Report, Comprehensive Plan, Capital Improvement Plan (CIP) and implementing ordinances and regulations, where and when appropriate and financially feasible. (The RWTF will fulfill its first objective towards this goal by submitting this RWTF Report and Recommendations for consideration by the City Commission.)

Goal 3: Identify Actions

To identify immediate (0 - 2 years), short term (0 – 5 years) and longer term actions that Delray Beach should take to address rising waters, based on best practices gleaned from the RCAP, on the expertise of the National Oceanic Atmospheric Agency (NOAA) and other governmental agencies and scholarly institutions, as well as from the experiences of other communities.

The Task Force Process

The RWTF started meeting in late April of 2014 at the Delray Beach Environmental Resource Building. Meetings were held twice monthly for the first 18 months, during which time the RWTF, invited various subject experts to present materials on relevant topics. These experts included Jayantha Obeysekera from the South Florida Water Management District, Chris Bergh from the Nature Conservancy, Rhonda Haag and Erin Deady, who have develop climate strategies for Monroe County, and Mitchel Chester, an attorney involved in climate change advocacy in South Florida. The public was invited to attend, and at times various members of the community attended and were engaged with the Task Force in follow up meetings and events. Members of the Task Force also participated in training offered by the University of Miami's Rosensteil School, and an intensive two-day climate vulnerability workshop offered by NOAA in January of 2015.

The RWTF engaged and supported groups in outreach and education activities in support of its goals. This included participation in the King Tide events, which received media coverage, Delray Beach Earth Day events, including the 2015 High Water Line project, and the creation of a short video on Florida's Adaptation Action Areas.

Task Force Members

In alphabetical order:

Kristine de Haseth

Kristine de Haseth is the Executive Director of the Florida Coalition for Preservation. The Coalition is grass roots organization that promotes responsible growth management and seeks to preserve the quality of life for residents on the barrier island and coastal communities. Beach and dune preservation, along with judicious water management are key components to promoting a robust and sustainable environment on the barrier island.

Robert Ganger

Bob Ganger is Chairman and Co-Founder of the Florida Coalition for Preservation. Until recently, he was the Vice Mayor of Gulf Stream, Florida. His interest in coastal issues dates to the 1970s when he was involved in Delray's first beach re-nourishment project.

Andrew Katz, Ph.D.

Dr. Katz has been a Delray Beach resident for many years, involved in issues related to the city's beach community. He served as Senior Scientist and Washington Operations Manager for Technology Service Corporation, a high-tech consulting organization specializing in radar and other sensor systems for 17 years, and was an Adjunct Professor in the science department of Palm Beach State College prior to retiring. Dr. Katz holds an M.S. and Ph.D. degrees in Astrophysics from the University of Wisconsin.

Giulia Pace

Giulia Pace is a Manager at HealthCare Appraisers, Inc. in Delray Beach, which provides Fair Market Value (FMV) consulting and valuation services to the healthcare and life sciences communities. At the time of the RWTF meetings, she was an active member of the City's Green Implementation Advancement Board.

Ana Puszkin-Chevlin, Ph.D.

Dr. Puszkin-Chevlin is the Sustainability Officer for Delray Beach as well as an Urban Planner in private practice with more than 20 years of experience in sustainable urban development, the last 10 with a focus on Florida coastal communities and issues of resiliency. A resident of Delray Beach since 2003, Dr. Puszkin-Chevlin previously worked and taught at Florida Atlantic University's Center for Urban and Environmental Solutions, and at Columbia University's Earth Institute and their Graduate Program's in Urban Planning in New York. Dr. Puszkin-Chevlin holds a Master and Ph.D. in Urban Planning from Columbia University.

Nancy Schneider, MA, MBA

Nancy Schneider is Senior Program Officer with the Institute for Sustainable Communities and works as secretariat specialist for the Southeast Florida Regional Climate Change Compact. She has 10 years' experience in local government sustainability and climate change resilience. Living in Delray Beach since 2001, she has served on the City's Parking Board, as Chair of the Green Task Force and was a member of the Green Implementation Advancement Board.

Kevin Warner

Kevin Warner, retired, had multi-faceted career which included 11 years of service teaching in the Palm Beach County School District, 25 years in business both in Wall Street's capital markets, managing a small business, and, early in his career, had numerous years of service as an environmental engineer, including with the U.S. Environmental Protection Agency.

Additional Assistance to RWTF

Assistance to the RWTF in the final stages of the effort was provided by Environmental Science Associates (ESA). ESA's Coastal Engineer in Tampa, Florida, Mr. Bryan Flynn is a graduate of Delray's Atlantic Community High School and his family still resides in the area. Scientific contributions were made by ESA's Ms. Lindsey Sheehan, Coastal Engineer Specializing in SLR Modeling, as well as Dr. Mitch Marken and Ms. Karla Ebenbach AICP, Urban Planning Consultant, who were both recruited by Task Force member Nancy Schneider to help finalize the RWTF recommendations and prepare the final report. ESA has offices in Orlando and Tampa, Florida.

NORTH

NOT TO SCALE

LAKE IDA RD
N CONGRESS AVE
INTERSTATE 95
N FEDERAL HWY
N OLD DIXIE HWY
OLD DIXIE HWY
GEORGE BUSH BLVD
NE 4TH ST
NE 5TH AVE
NE 6TH AVE
W ATLANTIC AVE
E ATLANTIC AVE
SE 5TH AVE
SE 6TH AVE
S OCEAN BLVD
N OCEAN DR
S MILITARY TRL
LINTON BLVD
S CONGRESS AVE
LINTON BLVD
E LINTON BLVD
S DIXIE HWY
FEDERAL HWY
OLD DIXIE HWY

Legend

Parcels_1ftslr

PROPUSE

- AIRPORT/MARINA
- DISTRICTS
- MULTIFAMILY < 10 UNI
- MUNICIPAL
- OUTDR REC/PARK LAND
- R/W - BUFFER
- RIVER/LAKES
- SINGLE FAMILY
- TOWNHOUSE
- VACANT
- ZERO LOT LINE

Parcels_Condo_1ftslr

PROPUSE

- CONDOMINIUM
- COOPERATIVE
- STORE/OFF/RES CONDO

RISING WATERS TASK FORCE MAP
INUNDATED AREAS 1ft RISE (Per Bathtub Model Only)

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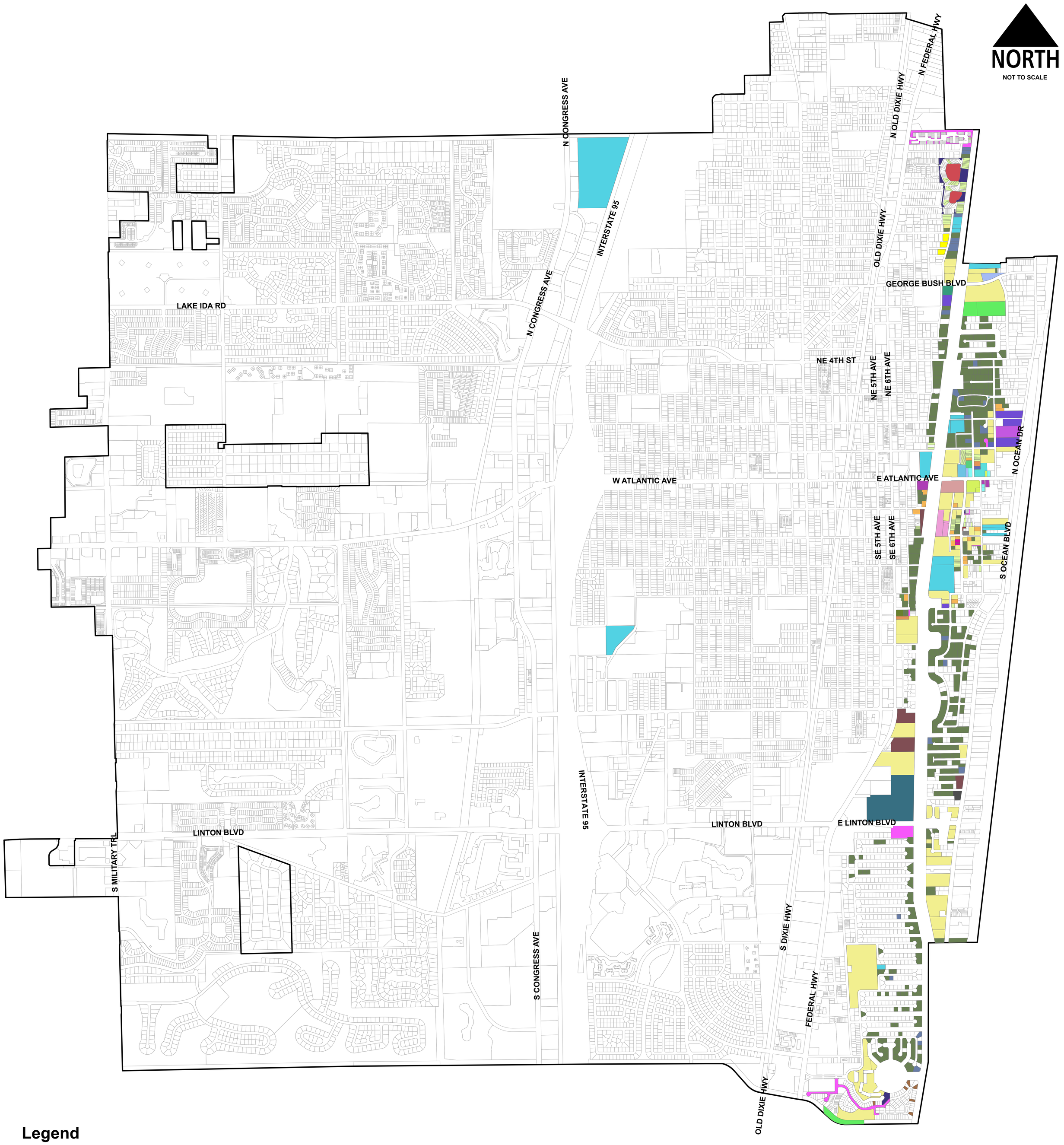

Legend

Parcels_2ftslr

PROPUSE

- AIRPORT/MARINA
- CITY INC NONMUNI
- DISTRICTS
- FINANCIAL
- FOREST/PK/REC
- LIFE CARE HX
- MOTEL
- MULTIFAMILY
- MULTIFAMILY < 10 UNI
- MUNICIPAL
- OFFICE MULTISTORY
- OUTDR REC/PARK LAND
- PKG LT / MH PK
- PROF OFFICES
- R/W - BUFFER
- RIVER/LAKES
- SINGLE FAMILY
- SINGLE FAMILY-COMM Z
- SINGLE FAMILY-IMP NO
- STORE/OFFICE/RESIDEN
- STORES
- TOWNHOUSE
- VACANT
- VACANT COMMERCIAL
- VACANT TOWNHOUSE
- WORKING WATERFRONT
- ZERO LOT LINE

Condo_2ftslr

PROPUSE

- CONDOMINIUM
- COOPERATIVE
- MOTEL
- PROF OFFICES CONDO
- SINGLE FAMILY
- STORE/OFF/RES CONDO
- TIMESHARE

RISING WATERS TASK FORCE MAP
INUNDATED AREAS 2ft RISE (Per Bathtub Model Only)

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