# Living with Sea Level Rise on the Upper Texas Coast:

## Public Policy Concerns and Opportunities with Comparisons to Florida

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**Cover photo:**

A line of structures in Surfside Beach, Texas is in the surf zone due to extreme erosion.

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## List of Abbreviations

**AAA** .....Adaptation Action Areas
**AVT**.....Ad Valorem Taxes
**BFE**.....Base Floor Elevation
**BEG**.....Bureau of Economic Geology
**CBRA**.....Coastal Barrier Resources Act
**CBS** .....Coastal Boundary Survey
**CEPRA**.....Coastal Erosion Planning and Response Act
**CMP**.....Coastal Management Program
**CWA** .....Clean Water Act
**DPA** .....Dune Protection Act
**DSD** .....Dependent Special Districts
**EIS**.....Environmental Impact Statement
**ELMS**.....Enhanced Local Adaptation Strategy
**EPA**.....Environmental Protection Agency
**EPP** .....Erosion Protection Plan
**ERP** .....Erosion Response Plan
**ES** .....Ecosystem Services
**FEMA**.....Federal Emergency Management Agency
**GBF**.....Galveston Bay Foundation
**GIS**.....Geographic Information System
**GLO**.....Texas General Land Office
**GOM** .....Gulf of Mexico
**HB**.....House Bill
**IPCC**.....Intergovernmental Panel on Climate Change
**IRC**.....Internal Revenue Code
**ISD** .....Independent Special Districts
**LID** .....Low Impact Development
**LiDAR**.....Light Detection and Ranging Data
**LSCNRA**.....Lone Star Coastal National Recreation Area
**LTU** .....Local Taxing Units
**SLR**.....Sea Level Rise
**HB**.....House Bill
**IRC**.....Internal Revenue Code
**M&O**.....Maintenance and Operations
**MHHT**.....Mean Higher High Tide Line
**MSBU** .....Municipal Service Benefit Units
**MSTU** .....Municipal Services Taxing Unit
**MUD**.....Municipal Utility Districts
**NAS**.....National Academy of Sciences
**NFIP**.....National Flood Insurance Program
**NGO**.....Non-Governmental Organization
**NOAA** .....National Oceanographic and Atmospheric Administration
**NWP** .....Nationwide Permit
**NWR**.....National Wildlife Refuge
**PCN**.....Pre-Construction Notification
**PID**.....Public Improvement District
**PSC** .....Permit Service Center
**PSF** .....Permanent School Fund
**RHA** .....Rivers and Harbors Act
**RSLR** .....Relative Sea Level Rise
**SA** .....Special Assessment
**SLB** .....School Land Board
**SLR**.....Sea Level Rise
**SSPEED** .....Center for Severe Storm Prediction, Education, and Evacuation from Disasters
**TCEQ**.....Texas Commission on Environmental Quality
**TCX** .....Texas Coastal Exchange
**TOBA** .....Texas Open Beaches Act
**TPL**.....Trust for Public Lands
**TPWD** .....Texas Parks and Wildlife Department
**ULI** .....Urban Land Institute
**USFWS**.....U.S. Fish and Wildlife Service
**USACE** .....U.S. Army Corps of Engineers
**WCID** .....Water Control and Improvement Districts

# Chapter 1 Introduction

Relative sea-level rise (SLR)[1] rates along the Upper Texas Coast region and in Galveston Bay are some of the highest in the country due to high levels of petrochemical and groundwater extractions. Regardless of the underlying causes, tide gauges and other metrics inarguably indicate that SLR is occurring (Fig. 1). Since 1908, Galveston Island has recorded a rise in relative sea level of about 2 ft. About half of this rise is due to a global increase in ocean water volume caused by the thermal expansion of water and melting polar ice sheets while local land subsidence caused the remainder. The amount of relative SLR across the greater Houston area varies because of differences in how much the land is subsiding. Land subsidence has been and is expected to remain an important component of relative SLR during the next 100 years, and the global component of the rate of SLR is expected to increase. Higher SLR rates along the U.S. Gulf Coast portend higher vulnerability to coastal hazards such as flooding for Texas.

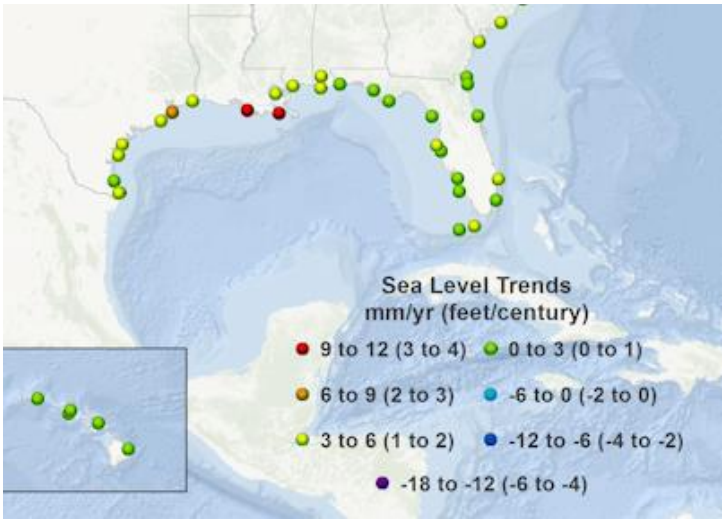


*Figure 1: Relative SLR rates in the Upper Texas Coast are some of the highest in the Gulf region.*

Wetland environments have narrow vertical ranges relative to sea level within which they can exist. A rise in water level of just a few inches, therefore, can cause uplands to convert to wetlands and wetlands to open water. This is due to a small tide range, low elevations, gentle slopes, and lack of sediment accretion to counteract rising water level. In the Houston area, the built environment compounds this problem by creating barriers for upward wetland migration, a situation known as coastal squeeze (Fig. 2). This squeeze results in a degraded natural environment and a built environment more exposed to flooding, storm surges, and erosion.

[1] Sea-level rise is usually discussed as either "global/mean" or "relative." Global/mean" sea-level rise is the globally averaged amount that sea level is increasing while "relative" sea-level rise is the amount of increase in ocean level is a specific place relative to the adjacent land.

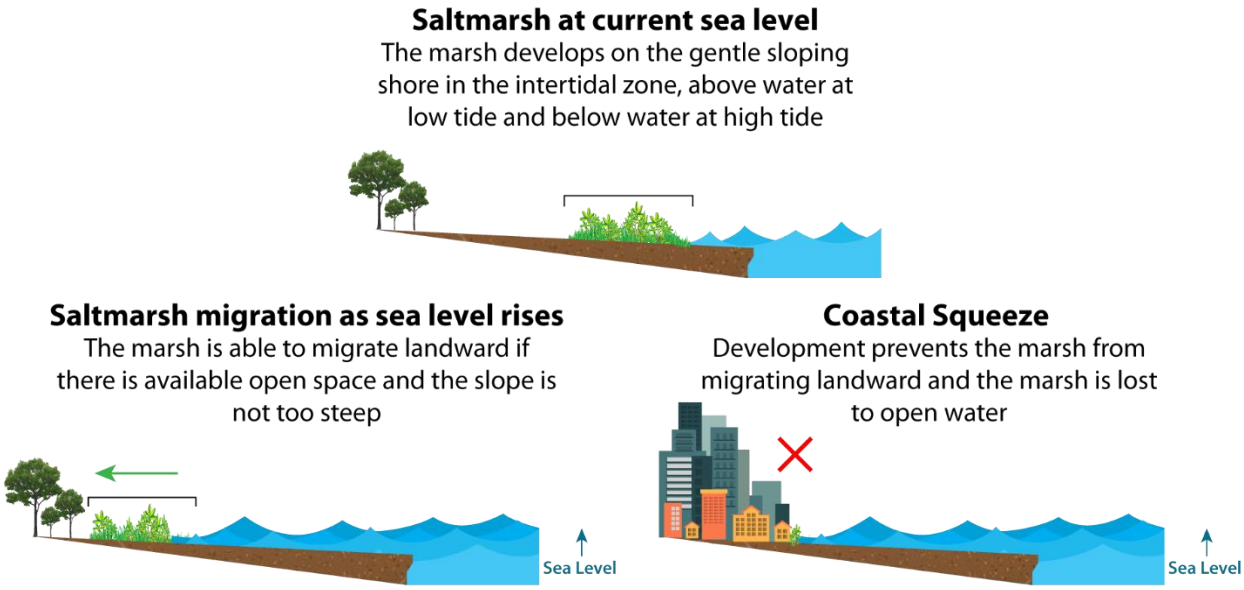


*Figure 2: Coastal squeeze is when wetland environments such as marshes lose their areal extent due to the presence of impervious barriers combined with SLR.* [2]

Shoreline armoring will prevent the inland migration of wetland vegetation and coastal ecosystems as sea level rises.[3] Blocking landward migration of the shore interferes with the public's rights under the public trust doctrine, which establishes the right of the public to fully enjoy public trust lands and waters. Armoring isolates the land from the water, changing marine ecosystems, habitats, plants and animals, negatively impacting environmental functions of the shoreline. The state's tidelands and submerged waters are part of the public trust. Therefore, if shoreline armoring damages the underlying ecosystem or impedes or eliminates coastal access or recreational opportunities, the installation and ongoing maintenance of the armoring could constitute a public trust violation.[4] Armoring the shoreline ultimately causes the beach to narrow and disappear.

Armoring has other drawbacks as well. Armoring disrupts the movement of sediment along beaches by blocking the movement of sand along the shoreline and sequestering sediment that would normally erode to form other beaches. This disrupts the natural processes that replenish

[2] Marissa Dotson, Environmental impacts of sea level rise in the Galveston Bay, Texas region (2016) (published M.S. thesis, Texas A&M University).
[3] Rhode Island Coastal Resources Management Program (a.k.a. Redbook 650-RICR-20-00-10), §§ 1.1.10.A.30.a & 1.2.2.C.1.d (2017), available at http://www.crmc.ri.gov/regulations/RICRMP.pdf.
[4] Molly Loughney Melius & Margaret R. Caldwell, Stanford Law School, Managing Coastal Armoring and Climate Change Adaptation in the 21st Century, 29 (2015), http://law.stanford.edu/wp-content/uploads/2015/07/CalCoastArmor-FULL-REPORT-6.17.15.pdf; *see also* Melissa K. Scanlan, *Shifting Sands: A Meta-Theory for Public Access and Private Property Along the Coast*, 65 S.C. L. Rev. 295, 362 (2013). *See also*, Joseph Sax, *Some Unorthodox Thoughts About Rising Sea Levels, Beach Erosion, and Property Rights*, 11 Vt. J. Envtl. L. 641 (2010) (sometimes the state is both a property owner and regulator).

the shoreline, reducing the natural delivery of sand and gravel to the shoreline.[5] Thus, the placement of hard shoreline structures on beaches will literally drown beaches.[6] Shoreline armoring can actually exacerbate flood risk by disrupting natural floodplain processes. [7] For all these reasons, armoring should be considered the adaptation option of last resort and only used under limited circumstances.

The natural and built infrastructures of the greater Houston area are situated on a low-lying coastal plain that is vulnerable to SLR. This rise will continue to cause protective natural environments to diminish as critical coastal environments, such as coastal wetlands, migrate or convert to open water. Mitigating the impacts warrants proactive planning, policies, and action at the local level. In the interest of protecting their constituents and the high density of valuable infrastructure in the Upper Texas Coast, state and local governments must devise appropriate SLR adaptation strategies. Currently, the population of the greater Houston area has incomplete information on the extent of projected SLR and its socioeconomic, policy, and legal impacts. These information gaps pose a serious threat to the stability of the region's natural and built infrastructure into the next century and could seriously hinder or delay the region's social and economic progress.

This paper explores the opportunities and challenges for Texas communities based on the available and relevant laws, policies, tools, and funding mechanisms. Chapter 2 offers an overview of Texas' already-established legal and policy framework that may be used to deal with SLR at both the state and local levels as well as a discussion of options that Upper Texas Coast communities can use to address SLR. Chapter 3 discusses four large-scale projects that can mitigate SLR damages along the Upper Texas Coast and explores living shorelines, a progressive method to buffer the effects of SLR due to its natural land/sea interface and ability to vertically accrete and thus keep pace with SLR. Chapter 4 explores four Texas case studies and possibilities that each have for responding to SLR. Florida is probably the Gulf state most threatened by SLR, thus it is ahead of other Gulf States in planning for future threats. Because Florida's SLR adaptation strategies and projects may be illuminating in dealing with impending challenges along the Upper Texas Coast, Chapter 5 discusses Florida, within that context, for comparison purposes. Chapter 6 lays out the mechanisms available to fund SLR adaptation or adaptation projects within Texas. Finally, Appendices A and B summarize local governmental policies and ordinances referring to SLR currently in place in cities in Florida and Texas.

This is part of a project that explores SLR along the Upper Texas Coast within a larger context. The larger project includes online resources that map the current status of coastal areas, with the ecological services the natural infrastructure provides, and project likely future changes in the distribution of specific environments. By showing areas that are at risk to the negative impacts of SLR and estimating the environmental and socio-economic costs, Living with Sea

[5]Department of Ecology, State of Washington, Marine Shoreline Armoring and Puget Sound (February 2010) https://fortress.wa.gov/ecy/publications/documents/1006003.pdf.
[6] *See* William A. Stiles, Jr., A "Toolkit" for Sea Level Rise Adaption in Virgina 5 (n.d.), http://perma.cc/G9QU-ZCB2 (arguing that adaptation strategies must be developed now).
[7] Melius & Caldwell, *supra* note 4, at 8.

Level Rise on the Upper Texas Coast provides essential information for planning the conservation, protection, or restoration of coastal environments; informs strategic private and public land acquisitions; identifies new locations for growth and development; analyzes the dynamics of coastal environments over time to determine the design, viability, and lifespan of projects in specific locations; and leverages the included assessment of potential SLR impacts on the greater Houston area to mitigate and adapt to higher sea level during the next 50 to 100 years. This assessment involves projecting the geographic changes that SLR is expected to cause, the economic impact on the natural and built environments, and an analysis of current policies and opportunities for coastal zone management with respect to SLR. Chapter 4 discusses four Upper Texas Coast sites that were modeled using the Sea Level Affecting Marshes Model to quantify how SLR would affect geoenvironments under various shoreline stabilization method scenarios.

Results of this work are disseminated through a data- and information-rich website that enables policy makers, managers, and the community at large to evaluate the impacts or risks of private and public land use decisions with greater precision and accuracy. The website is designed to increase public awareness of the impacts of past and future SLR. It will help policy makers, environmental managers, conservationists, philanthropic organizations, and the business community to evaluate the merits of public policies, community-based adaptation and adaptation activities, and investment decisions in the context of anticipated changes in coastal landscapes and threats. The website includes a map viewer and tools for visualizing data that are accessible by other researchers or members of the public.

By developing and disseminating data and information needed for addressing the impacts of SLR during the next 50 to 100 years, this project seeks to create and inspire opportunity for local innovation in adaptation and adaptation efforts and help people make more informed investments. These investments may be small, such as the purchase of an individual home, or larger scale investments, like the construction of new neighborhoods, schools and business centers, and the private or public funding of a local or regionally based adaptation or adaptation initiative.

## Chapter 2 Texas

Regardless of the underlying causes of climate change, coastal communities are beginning to recognize that they must plan for changing and variable conditions. Across the globe, sea levels are changing as global mean temperatures rise that causes the thermal expansion of ocean water and the melting of massive polar ice sheets. These two processes combined cause eustatic SLR, which occurs as the volume and amount of water in the world's oceans increase. Relative SLR is eustatic SLR combined with any changing elevation of the land relative to a fixed datum. Either the land can rise in a process called uplift or it can sink, a phenomenon known as subsidence. Many areas in the Gulf region have been subsiding due to petrochemical and groundwater withdrawals and urban compaction of soils. SLR already has affected states in the region, and related issues will increase in the future.

The State of Texas has done little rulemaking in the context of SLR despite its vulnerable position along the Gulf Coast. Following the State's inaction, Texas coastal counties and municipalities have done little with what authority they have to protect their citizens from this danger. However, counties and municipalities can use their power to further enforce or create new laws that adapt to the consequences of SLR. Therefore, in order to know how to plan adaptation strategies for SLR, it is essential to understand what the powers and limitations are of the different stratum of the government. This section discusses how Texas could begin planning for and implementing SLR adaptation projects. It begins with a discussion of what agencies could be involved in that process and how the various levels of government have different roles. An exploration of the legal framework, including the differences in strategy for Gulf- and bay-facing shorelines, follows. This information is important to give context as to what actions are permissible and who has the authority to do what.

## 2.1 Agencies

The Texas General Land Office (GLO) takes charge of many duties through delegation from the Legislature including, among other projects and studies, the oversight of the Coastal Management Program[8] (CMP), the Texas Open Beaches Act[9] (TOBA), the Dune Protection Act[10] (DPA), and the Coastal Erosion Planning and Response Act[11] (CEPRA). Each of these programs is discussed below. The GLO controls any construction or significant land modification on state lands and the permitting system for such action.[12] State lands include "submerged lands," and to construct piers, bulkheads, or other structures, one must apply for an easement or lease from the GLO. In addition, such works also require a Section 10 permit from the U.S. Army Corps of Engineers (USACE) when located in "waters of the U.S.," as defined in Section 10 of the federal Rivers and Harbors Act.[13]

Although it is a federal agency, USACEhas authority over all "waters of the U.S." which includes certain wetlands. According to Section 404 of the Clean Water Act may permit development in such areas, and, along with the EPA issues and potential efforts in regards to wetland protection and preservation.[14] Therefore, it has a direct connection with SLR adaptation issues and potential efforts in regards to wetland protection and preservation.

## 2.2 Counties

Counties are divisions of the State, and the Constitution or statutes grant their authority. They cannot pass ordinances by their own power, and, unlike most states, counties in Texas have

[8] Tex. Nat. Res. Code § 33 (2016).
[9] *Id.* at § 61.011.
[10] *Id.* at § 63.
[11] *Id.* at §§ 33.603-608.
[12] John S. Jacob, et. al., Texas A&M University, Anticipated Local Response to Seal Level Rise Along the Texas Coast: A First Approximation 8. (2007).
[13] *Id.*
[14] United States Environmental Protection Agency, CWA Section 404 Enforcement Overview, at http://water.epa.gov/type/wetlands/outreach/fact15.cfm.

negligible zoning power.[15] Some statutes give counties regulatory abilities on environmental issues.[16] For example, per Texas statutes, counties may adopt and enforce land use regulations on development in areas that are determined to be prone to flooding under the National Flood Insurance Act of 1968.[17] While the definition of "flood" does not encompass the idea of SLR, this precedent of requirements for meeting minimum building standards in certain areas could be useful for SLR adaptation.

However, the federal government has established taxpayer-backed subsidized insurance options to allow widespread, affordable insurance coverage against flooding. The insurance rates are kept artificially low and thus do not reflect the true risk, which can lead to land development in potentially hazardous areas.[18] The fact that federal insurance is provided for coastal areas prone to flooding could deter greater SLR adaptation goals. This is because federal insurance supports further development in areas where stronger SLR adaptation strategies could be implemented. Moreover, federally provided insurance in areas known to flood "create[s] perverse incentives for repetitive insurance claims and an unsustainable level of financial exposure for all taxpayers."[19]

Reforming federal and state insurance programs for coastal properties could encourage residents to be more cautious and thoughtful in developing along the coast. It may also motivate implementation and development of SLR adaptation plans, such as the preservation of wetlands and other natural defenses to combat flooding. Based on 2013 Federal Emergency Management Agency (FEMA) data, Texas had 641,653 National Flood Insurance Program (NFIP) policies issued. The total value of insurance coverage in Texas was $162,213,731,200 whereas the total value of premiums paid was $368,060,396.[20] When the NFIP cannot meet the payout costs for major storms through the premiums collected, the program must borrow from the U.S. Treasury; this exposes taxpayers at large, including those who live inland, away from the coastline. After hurricanes Harvey, Irma, and Maria in 2017, Congress forgave $16 billion of NFIP debt so that the NFIP would not run out of borrowing authority just as it needed to begin paying claims for the costliest year of natural disasters to hit the United States. The Biggert-Waters Act of 2012 attempted to increase the cost of flood insurance to reflect the "true risk" of all properties[21]; the Bigger-Waters Act was signed into law, but portions were subsequently

[15] Tex. Const. art. IX, § 1; William Maxwell, et al. Texas Politics Today. 2015-2016 Ed.
[16] Tex. Water Code Ann. §§ 16.311 to 16.3161 (2013).
[17] Tex. Loc. Gov't Code Ann. § 240.901 (West); 36A Tex. Prac., County And Special District Law § 45.4 (2d ed.)
[18] *Cf.* U.S. Government Accountability Office 11-297, FEMA: Action Needed to Improve Administration of the National Flood Insurance Program 5, 49 (2011), https://www.gao.gov/products/GAO-11-297.
[19] Rachel Cleetus, Overwhelming Risk: Rethinking Flood Insurance in a World of Rising Seas, Union of Concerned Scientists (2014), available at https://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/Overwhelming-Risk-Full-Report.pdf.
[20] *Id*.
[21] National Flood Insurance Program, U.S. Dept. of Homeland Security, Changes to Flood Insurance Rates: What They are and How to Explain Them, https://www.fema.gov/media-library-data/1382115115666-0fba8b9a68fef69d546513c6da105bbe/BW12_AgentWhat_to_Know_Say_Sect205_Sept2013.pdf.

altered or repealed due to public outcry over skyrocketing insurance prices.[22] Combined with the inevitable rise in sea level, the low cost of flood insurance does not accurately reflect the true risk faced by property owners, which, in turn, deters more active SLR adaptation strategies.

Other coastal county duties, as mandated by the DPA, include establishing dune protection lines.[23] Overall, however, counties do not have a flexible, overarching mechanism to effectively address SLR.

## 2.3 Municipalities

Texas municipalities are created by incorporation either under the general laws of the State or by the adoption of a home rule charter.[24] Therefore, Texas municipalities can be divided into two categories: home rule municipalities and general law municipalities.[25] Home rule municipalities must have a minimum population of 5,000 residents, and they may adopt or amend an existing charter by a majority vote. Such cities derive their authority from the Texas Constitution and have all the powers of the state; however, their ordinances must not be expressly prohibited or preempted by state law.[26] Conversely, there are three types of general law municipalities. All three only have powers that the State expressly confers on them. As such, they may not initiate action unless under express direction or permission. Municipal ordinances supersede county laws within the cities' jurisdiction.[27]

Population size determines the extent of municipalities' extraterritorial jurisdiction. The larger the population, the further the extraterritorial jurisdiction extends past the city limit boundary line.[28] Both home rule and general law municipalities may regulate to promote public health, safety and welfare within their extraterritorial jurisdiction.

All municipalities may implement their police powers to establish ordinances to promote health, safety, and welfare. Examples include planning and development for flood controls, land use restrictions through zoning and platting ordinances, general nuisance ordinances, and ordinances "protecting and preserving places and areas of historical, cultural, or architectural importance and significance."[29] However, some municipalities do not use a zoning system. Houston, the largest city in Texas and one that exists in the watershed of Galveston Bay, is an

[22] The Center for Insurance Policy and Research, National Association of Insurance Commissioners, National Flood Insurance Program, at https://www.naic.org/cipr_topics/topic_nfip.htm. It is important to note that the Homeowners Flood Insurance Affordability Act of 2014 did not, as many believe, completely repeal the Biggert-Waters Act of 2012. Many of the insurance rate increases in Biggert-Waters are still in place, but they are occurring more slowly than they would have under the Biggert-Waters Act.
[23] Tex. Nat. Res. Code Ann. § 63.011 (2016).
[24] Tex. Loc. Gov't Code Ann. § 5.001 (2013).
[25] Tex. Const. art. XI, § 4, §5
[26] 52 Tex. Jur. 3d Municipal Corporations § 139, 8B Tex. Jur. Pl & Pr. Forms § 176:2 (2d ed.)
[27] 45 Tex. Prac., Environmental Law § 2:18 (2d ed.)
[28] Tex. Loc. Gov't Code Ann. § 42.021 (2013).
[29] Tex. Loc. Gov't Code Ann. §§ 551.001 et seq. (2013); Tex. Loc. Gov't Code Ann. § 211.001 (2005); Tex. Loc. Gov't Code Ann. §§ 217.001 et seq. (2013).

example. This affects its ability, and could affect the ability of similar cities, to promote adaptation for SLR.

## 2.4 Federal and Texas Laws

Under the Submerged Lands Act of 1953, the title of lands beneath state navigable waters vested in the State at the time of entry of the State into the Union.[30] Public ownership of submerged lands is historically based on Roman law and is recognized by the U.S. Supreme Court, which mandates states to hold title to lands beneath navigable waters in trust for the people.[31] The aptly named Public Trust Doctrine applies to the "waters of the U.S." which includes both inland and coastal waters. The public trust doctrine can be used to protect public access to Gulf-facing beaches because the government is obligated to protect public trust resources and defend the public property interest in those resources.[32] The state may not relinquish interest in the public trust. The Public Trust Doctrine protects the land from government action and private interests, and it can support state regulation that purports to protect the public's rights. This doctrine is the basis for current laws and regulations including the Rivers and Harbors Act and the Clean Water Act, and it has the potential to support local coastal governments. While this doctrine has given federal and state agencies the ability to act, neither has directly addressed SLR, and thus local governments need to discuss other bases of action. As sea level continues to rise and enlarge the scope of public trust lands, "state actions [which allow erosion control structures] may unlawfully abdicate the state's duty as trustee."[33] Private landowners abutting Gulf-facing beaches cannot extinguish the right to public trust resources, and it is the responsibility of the state to assure that those private actors do not burden the public trust.[34]

### 2.4.1 Gulf Beaches

With the Public Trust Doctrine, Texas courts interpreted the Texas Open Beaches Act (TOBA) and common law precedent to establish a policy of public "rolling easements" which move with the natural shifting of the shoreline.[35] Because of the Submerged Lands Act, Texas controls all submerged lands that extend 10.35 miles into the Gulf of Mexico.[36] The "wet beach" is the tidally submerged land up to the mean higher high tide line (MHHT), and the state owns it.[37]

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[30] 43 U.S.C.A. § 1301 (2007).
[31] *Illinois Central Railroad v. Illinois*, 146 U.S. 387, 452 (1892).
[32] Margaret E. Peloso & Margaret R. Caldwell, *Dynamic Property Rights: The Public Trust Doctrine and Takings in a* Changing Climate, 30 Stan. Envtl. L.J. 51, 58 (2011); see also Melissa Kwaterski Scanlon, Comment, The Evolution of the Public Trust Doctrine and the Degradation of Trust Resources: Courts, Trustees and Political Power in Wisconsin, 27 Ecology L.Q. 135, 137 (2000) ("The expansion of the public trust doctrine has been a focal point for hopes that the doctrine will be used to curb the degradation of water resources and wildlife."); Joseph Sax, *Some Unorthodox Thoughts About Rising Sea Levels, Beach Erosion, and Property Rights*, 11Vt. J. Envtl. L. 641 (2010).
[33] Peloso & Caldwell, *supra* note 32 at 58.
[34] *Ill. Cent. R.R. Co. v. Illinois*, 146 U.S. 387, 452 (1892).
[35] Richard J. McLaughlin, *Rolling Easements As A Response to Sea Level Rise in Coastal Texas: Current Status of the Law After Severance v. Patterson*, 26 J. Land Use & Envtl. L. 365, 375 (2011).
[36] Texas General Land Office, State Lands, http://www.glo.texas.gov/land/land-management/overview/index.html.
[37] *Luttes v. State*, 324 S.W.2d 167, 187 (1958).

The "dry beach" located above the MHHT, although sometimes submerged, may be privately owned.[38] As the tideline reaches further inland due to SLR or other processes, the newly submerged lands belong to the State. If the shoreline naturally recedes, the emerged lands continue to belong to the state unless properly rebutted by adjacent private property owners.[39] According to Texas common law, the State cannot divest itself of title by adding sand on previously submerged lands.[40]

While all parts of the Gulf, subject to the ebb and flow of the tide, including bays and inlets are property of the State, TOBA only applies to beaches fronting the Gulf of Mexico.[41] TOBA codified a public easement,[42] which ensures the public's right to access beaches along the Gulf of Mexico coast from the line of MHHT to the line of vegetation, even privately owned land.[43] The easement is subject to some limitations including a requirement to show that the public has acquired the right through prescription, dedication, or continuous use.[44] Accomplishing the elements of each of these three has traditionally not been difficult.[45] An amendment to the law includes a requirement that all conveyance contracts for property seaward of the Gulf Intracoastal Waterway must include that the buyer acknowledges an easement up to the vegetation line in the statute's exact language. It also includes a notice that structures on the easement are cause for suit by the State and are potentially subject to removal, the conditions of which are detailed within the law itself.[46] The main provisions of TOBA were voted into the Texas Constitution, giving constitutional status to the public's right to access Gulf beaches.[47]

However, new judicial interpretations of the doctrines of accretion and avulsion have affected the extent of this doctrine. In *Severance v. Patterson*, 2012, the Texas Supreme Court held that rolling easements cannot roll onto previously unencumbered property with avulsive events like sudden storms and hurricanes.[48] Erosion is the slow, almost imperceptible change in the tideline that property boundaries follow whereas avulsion is a sudden, violent change in the waterline, usually caused by major storms or other natural disasters, that does not change property boundaries. Prior to the *Severance* decision in 2012, Texas, like California, had never recognized the doctrine of avulsion on its coastlines; rather, the doctrine of avulsion was limited to application in the riverine context. Nonetheless, in 2012, the court found that, in avulsive events, property boundaries remain legally unchanged despite the waterline change so private owners do not automatically lose their right of exclusion. The State must then carry a

[38] *Porretto v. Texas Gen. Land Office*, 448 S.W.3d 393, 395 (Tex. 2014), *reh'g denied* (Dec. 19, 2014).
[39] *John G. & Stella Kenedy Mem'l Found. v. Dewhurst*, 994 S.W.2d 285, 293 (Tex. App. 1999), reversed on other grounds, *John G. & Marie Stella Kenedy Mem'l Found. v. Dewhurst*, 90 S.W.3d 268 (Tex. 2002).
[40] *Porretto v. Texas Gen. Land Office*, 448 S.W.3d 393, 400 (Tex. 2014), *reh'g denied* (Dec. 19, 2014).
[41] Tex. Nat. Res. Code Ann. §§ 61.001 (2016).
[42] An easement is a right to use land but not to possess it.
[43] Tex. Nat. Res. Code § 61.011(a) (2016).
[44] Tex. Nat. Res. Code sec. 61.011(a) (2016).
[45] Richard J. McLaughlin, *Rolling Easements As A Response to Sea Level Rise in Coastal Texas: Current Status of the Law After Severance v. Patterson*, 26 J. Land Use & Envtl. L. 365, 371 (2011).
[46] Tex. Nat. Res. Code § 61.025 (2016).
[47] Tex. Const. art. 1, §33.
[48] *Severance v. Patterson*, 370 S.W.3d 705, 723 (Tex. 2012).

heavy burden to show the reestablishment of an easement despite the fact that the public had not needed to access the area of beach before the avulsive event.

While the doctrines of accretion and avulsion are relatively distinct in scenarios involving rivers and lakes, Gulf beaches are subject to weather and tides which constantly change the coastline.[49] Therefore, the Texas Supreme Court's decision in *Severance* substantially limited free and open access to beaches, resulting in a loss of public access to some beaches despite the fact that such access is arguably a constitutional right. Because rolling easements are now limited to changes by erosion, there is a difficult technical inquiry as to how a coastal event can be labeled as either erosion or avulsion.

#### *2.4.1a State Programs for Gulf-Facing Beaches*

*Severance* potentially narrowed one of the stronger bases adaptation efforts may have used for a unified approach toward SLR. Although this limitation cripples TOBA's effectiveness when it comes to public beach access, TOBA still strongly affects the policies of local governments on Gulf coastal beaches. The GLO requires local governments to adopt and implement plans called Local Beach Access Plans that address the use of and access to public beaches along the Gulf. They must be consistent with TOBA and DPA.[50]

The DPA protects sand dunes, which create a protective barrier against storms and erosion, from destructive activity. It requires each county that has a barrier island, peninsula, or mainland shoreline on the Gulf to establish a dune protection line no farther inland than 1,000 feet from the mean high tide line that must encompass, at a minimum, "critical dune areas."[51] Some local governments have additionally enacted setback rules in their dune protection plans that prevent development up to a certain number of feet from the line of vegetation to further the purposes of the statutes.[52] Setbacks are considered one of the more viable SLR adaptation options, so such efforts set a good precedent for later municipal action in regards to SLR.

The DPA and TOBA direct county and municipal governments with Gulf-facing beaches to adopt and implement programs for the preservation of dunes. They must integrate these programs into a single plan for the management of the beach and dune system within their jurisdiction.[53] These local governments must have a permitting and approval process that is submitted to the GLO for review and comment.

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[49] *Porretto v. Texas Gen. Land Office*, 448 S.W.3d 393, 395 (Tex. 2014), *reh'g denied* (Dec. 19, 2014), citing *Severance v. Patterson,* 370 S.W.3d 705, 708 (Tex. 2012).

[50] Texas General Land Office. http://www.glo.texas.gov/coast/coastal-management/forms/files/dune-protection-manual-gpb.pdf.

[51] Tex. Nat. Res. Code Ann. § 63.011; § 63.012; § 63.121 (2016).

[52] Richard J. McLaughlin, *Rolling Easements As A Response to Sea Level Rise in Coastal Texas: Current Status of the Law After Severance v. Patterson*, 26 J. Land Use & Envtl. L. 365, 391 (2011); County of Nueces, Order Adopting Amendments to the Nueces County Beach Management Plan, ii (2010).

[53] 31 Tex. Admin. Code § 15.3 (2017).

Prohibited actions within the dune protection line include the operation of recreational vehicles; construction;[54] damaging, destroying, or removing a sand dune or a portion of one; and killing, destroying, or removing any vegetation growing on the dunes.[55] In order to partake in any of these activities, one must obtain a permit. The evaluation of the application for an otherwise prohibited action focuses on whether the activity "will materially weaken" the dune as a protective barrier.[56] Violations of dune protection laws may bring civil penalties, and each day the violation occurs or remains is a separate offense.[57]

#### *2.4.1b Takings Issues*

The Fifth Amendment to the United States Constitution provides, in part, that ". . . private property [shall not] be taken for public use, without just compensation." These few words have spawned thousands upon thousands of legal claims. Over more than two centuries, the nature of property rights protected by this clause—and viewed by courts as deserving of compensation—have evolved in response to changes in society and economics.[58]

##### Development of regulatory takings and early history *(Pennsylvania Coal v. Mahon)*

For most of the U.S. Constitution's history—131 years—the Fifth Amendment's protections were only characterized as protecting property purchasers from government either physically invading land or legally taking title to land. Physical invasion has often included government action that causes flooding of land.[59] Cases taking legal title to land represent government exercising its power of eminent domain.

The focus on physical invasion or legal title changed in 1922 with the case *Pennsylvania Coal v. Mahon*. In the *Pennsylvania Coal* case, the United States Supreme Court, for the first time, stated that a "taking" of private property requiring compensation could occur without physical invasion or government taking title to land. The Supreme Court said that, "if regulation goes too far it will be recognized as a taking."[60]

##### Regulatory Takings

Since the *Pennsylvania Coal v. Mahon* case, "regulatory takings" (also often referred to as either "inverse condemnation" or just "takings") has expanded through case law. A number of cases

[54] Tex. Nat. Res. Code Ann. §63.057, § 63.091, §63.093 (2016).
[55] Tex. Nat. Res. Code Ann. § 63.091 (2016).
[56] Tex. Nat. Res. Code Ann. § 63.054(a)-(b), § 63.056 (2016).
[57] Tex. Nat. Res. Code Ann. § 63.181 (2016).
[58] *See, e*.g. Martin J. Horwitz, The Transformation of American Law, 1780-1860 (1977); Martin J. Horwitz, The Transformation of American Law, 1870-1960 (New York 1992); Eric Freyfogle, The Land We Share: Private Property and the Common Good (Island Press 2003); and Eric Freyfogle, On Private Property: Finding Common Ground on the Ownership of Land (Beacon Press 2007).
[59] *See, e.g.* John Horstmann Co. v. U.S.; Natron Soda Co. v. U.S., 257 U.S. 138 (1921); Arkansas Game and Fish Commission v. U.S., 568 U.S. 23 (2012).
[60] Pennsylvania Coal v. Mahon, 260 U.S. 393, 415 (1922).

established so-called "per se" or automatic takings under certain scenarios.[61] However, most regulatory takings cases result in an analysis under the framework of *Penn Central Transportation Co. v. City of New York* in 1978. The *Penn Central* case set forth that when a taking of property by regulation is claimed, courts should consider: 1) the character of the government action, 2) the economic impact on the claimant, and 3) the "distinct investment-backed expectations" of the claimant.[62] If this sounds abstract and difficult to apply in specific cases, you are correct. Takings law, as will be seen in the discussion below, is fraught with confusion, inconsistencies, and uncertainties as courts have been unable to establish hard and fast rules, relying instead on case-by-case factual inquiries.

### SLR & Takings

As sea levels continue to rise, Texas local governments could potentially experience liability under either eminent domain or regulatory takings. Liability for eminent domain could be claimed when property owners, such as Carol Severance, the plaintiff in *the Severance v. Patterson* case, litigate to stay in their homes as the sea rises and the rolling easement of TOBA moves onto their property and thus, under TOBA, allowing for removal of structures that interfere with the public's right of access. TOBA does not allow individual property owners to build erosion control devices or structures on their Gulf-fronting property.[63] Thus, when a governing authority, under the provisions of TOBA, orders the removal of a structure that interferes with the public's right to use the beach the property owners often bring lawsuits seeking an injunction against the government or compensation for damages.

Government entities in Texas may find also find themselves the targets of takings claims based on "physical invasion" of property due to flooding. Flooding of property has long been a common theme in claims of violations of property rights. Sea-level rise will only exacerbate this. Typically, for a property owner to succeed in a takings claim for flooding against government, the plaintiff must prove: 1) flooding resulted from an authorized government activity; 2) the flooding caused either a permanent or temporary taking by either permanently flooding land or causing inevitably recurring flooding; and 3) the damage must have been either intentional or foreseeable. In addition, a claimant must demonstrate that, under the *Penn Central* criteria noted above, a taking exists.[64]

Government activities that may give rise to takings claims for flooding may include permitting development that contributes to flooding existing development, flooding caused by negligent design of public infrastructure, or flooding caused by failure to maintain infrastructure. This last

[61] *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003, 1016 (1992) (finding a per se taking when regulation extinguishes all value from a property); Loretto v. Teleprompter Manhattan Catv *Corp*., 458 U.S. 419 (1982) (holding that *any* physical invasion, no matter how small, results in a taking requiring compensation; in the case at bar, the minimal intrusion of putting a cable box on the plaintiff's property resulted in compensation of $1).
[62] Penn Central Transp. Co. v. City of New York, 438 U.S. 104, 124 (1978).
[63] Tex. Nat. Res. Code § 61.013(a) (2016).
[64] Note that even though "physical invasion" from flooding sounds like it should be evaluated as a type of eminent domain due to the physical invasion, courts typically evaluate flooding cases under the framework for regulatory takings. *See, e.g.* Arkansas Game & Fish Com'n v. U.S., 568 U.S. 23 (2012).

category presents serious concern for local governments confronting drainage problems due to SLR. As sea levels increase, gravity drainage systems that empty into tidal waters become progressively less efficient at moving water. Without intervention, SLR may cause such systems to fill with water or even transport sea water into neighborhoods during high-tide or storm events. The question then arises, "Is local government liable for flooding that occurs when SLR overwhelms existing drainage infrastructure?" one analysis of this question, in the context of Florida law, concludes that the likely answer is, "No, local government is probably not responsible in that scenario if the system has been properly maintained to its as-built specifications."[65] This likely lack of local government liability resides in courts deferring to local governments in decisions about how and when to *upgrade* infrastructure since this is a legislative function that, under the doctrine of separation of powers, the courts should not unnecessarily insert themselves. However, courts *do* hold local governments liable for mere "ministerial" or "non-discretionary" activities that do not require legislative debate, such as maintenance of drainage systems.

Despite case law and legal analysis indicating that government entities cannot be held liable for harms they do not directly cause through their intentional actions, another troubling thread of case law and academic writing has been developing. This developing thread would dramatically expand the liability of government and taxpayers for harms that government either does not control or cannot reasonably be expected to fix as the climate changes from our historical norms and sea levels rise ever faster. As part of this, a Florida case—*Jordan v. St. Johns County*[66]—found potential liability in a case where the local government could not reasonably fix the problem. In *Jordan*, despite decades of the Atlantic Ocean washing away a road and property purchasers having bought their property with clear evidence of long-term erosion problems with their road, the property owners sued the local government. The court concluded that the *inaction* of local government in maintaining a road could potentially give rise to a taking of private property and that the local government had a duty to maintain the road.[67]

On one level, this may not sound like a watershed moment: after all, government already has a responsibility to maintain drainage infrastructure, or suffer liability for damages when it does not. However, the facts in the *Jordan* case indicate that one fundamental problem with the court's analysis is that the road at issue could not be preserved by anything remotely resembling activities usually thought of as routine (i.e.—legally mandatory) "maintenance." Rather, the local government was already spending more than 25 times as much per mile per year trying to "maintain" the road at issue and was still unable to keep the road in place. To rebuild the road, millions of dollars of beach nourishment would have had to take place first to create dry land on which to site the road that served less than two dozen residential lots.

Drainage problems and the *Jordan* case highlight the legal problem looming in the future for local governments: What legal responsibility do they have to continue to supply infrastructure

[65] Thomas Ruppert & Carly Grimm, *Drowning in Place: Local Government Costs and Liabilities for Flooding Due to Sea-Level Rise*, 87 Fla. Bar J. 29 (2013).
[66] Jordan v. St. Johns Cty., 63 So.3d 835 (Fla. 5th DCA 2011).
[67] *Id.* at 838.

and services to properties in the face of rising waters that make infrastructure and services maintenance ever more expensive and difficult? The U.S. Supreme Court has clearly stated that the Fifth Amendment and other constitutional protections are to protect property owners from government abusing government power over them but that it does not give property owners a legal right to force governmental aid, "even where such aid may be necessary to secure life, liberty, or property interests of which the government itself may not deprive the individual."[68] Similarly, the U.S. Supreme Court has noted that government has no legal liability for failing to stop flooding which the government did not cause.[69]

Nonetheless, some cases find that "inaction" may combine with a "duty" of government to act to then result in potential liability of government for property damage.[70] Strict limits on allowing claims that government has "taken" property for public use without specific action presents serious risks for local government. Such cases, unless strictly limited to very clearly articulated, mandatory duties of local government that may be realistically be achieved, could risk bankrupting governments through the "choice" of either insuring the value of property through provision of services and infrastructure regardless of cost or choosing to pay for failure to do so through legal liability for a taking. To avoid such a conundrum, Texas and its governmental subdivisions should ensure that they only have "duties" that they are able to achieve. In other words, it is safer for statutes, rules, and regulations to *authorize* actions rather than *mandate* actions beyond basic, "normal" maintenance of infrastructure. In addition, more recent federal jurisprudence dramatically undercuts the legal and academic movement towards dramatically expanding government liability under the Fifth Amendment's protections for private property; this more recent federal case law indicates that government is only liable for flooding damages when all the activities of the governmental unit to address flooding, taken as a whole, caused the flood damage.[71]

Local governments in Texas may also find themselves the targets of regulatory takings claims when they limit or do not allow development to occur because, considering SLR, the development may be unsafe or harm resources the state seeks to protect on behalf of all its citizens. In such a situation, the regulating entity should emphasize that its decision seeks to protect citizens and the public from the hazards of flooding as protection from flooding has consistently received some of the greatest deference from courts as a defense when evaluating

[68] *DeShaney vs. Winnebago Dept. of Social Services*, 489 U.S. 189, 196 (1989).
[69] *See, e.g.* United States v. Sponenbarger, 308 U.S. 256, 266 (1939) (noting that "[t]he Government has not subjected respondent's land to any additional flooding, above what would occur if the Government had not acted; and the Fifth Amendment does not make the Government an insurer that the evil of floods be stamped out universally before the evil can be attacked at all.").
[70] Thomas Ruppert, *Castles—and Roads—in the Sand: Do All Roads Lead to a "Taking"?*, 48 ELR ____ (forthcoming 2018) (examining and comparing cases finding "inaction" in the face of a duty as sufficient basis for takings claim with cases specifically requiring state action to plead a taking; arguing for strict limitation of any use of "inaction" as basis to clearly articulated, specific statutory duties or contractual duties).
[71] *St. Bernard Parish Gov't v. U.S.*, 887 F.3d 1354 (Fed. Cir. 2018).

takings claims.[72] Such regulations should strive to maximize the potential economic use of land as part of avoiding a "taking" of property.

Finally, Texas will increasingly have to confront the challenges of continued public use of Texas' Gulf-facing beaches. Long history, case law, statutes, and even a constitutional amendment in Texas had clearly established the right of the public to use the beach seaward of the vegetation line along Gulf-facing beaches in Texas.[73] Just a few years ago, the Texas Supreme Court upended decades of law and declared that the public's right to use the beach seaward of the vegetation line does not necessarily always migrate landward with the beach itself.[74] This holding, combined with SLR, risks extinguishing the public right to use the beach.

SLR is a global problem felt along the entire Texas coast, including the Galveston Bay region. Coastal management tools that states and counties are currently using are insufficient to address this critical issue. Local governments have the legal authority to enact policies that take advantage of TOBA, building setback requirements, and restricting or allowing shoreline armoring. Doing so will save these counties along the coast millions of dollars in the coming decades as sea levels continue to rise and adaptation becomes not only an environmentally useful strategy but also a critical necessity.

### 2.4.2 Bays and Other Texas Lands

Texas bay systems have many fewer protective laws and regulations compared to Gulf-facing beaches. Thus, their accompanying shorelines have less of a foothold for adaptation planning in regards to SLR. There is no guaranteed public access to bay-facing beaches, and the state lacks control above the MHHT, which leaves adaptation options sparse. This means that bulkheads and seawalls may often be built on private property above the MHHT line without regulation. Even below the MHHT, armoring has the capability to thrive, particularly given Nationwide Permit 13[75] that expedites the permitting process for armoring projects. However, some state and federal laws can limit, to an extent, such arguably regressive SLR adaptation strategies in certain bay areas.

Both Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act prohibit any development without a permit from the Corps and a lease or easement from the GLO in

[72] *See, e.g. Gove v. Zoning Bd. Of Appeals*, 831 N.E.2d 865, 868 (2005) (the case also notes that the local ordinance creating the conservancy district that limited development was to "maintain[] the ground water supply, protect[] coastal areas, protect[] public health and safety, reduc[e] the risk to people and property from ***'extreme high tides and the rising sea level***,' and conserving natural resources. The town zoning officer testified that the conservancy district serves to mitigate the 'total public safety problem' of coastal flooding, and was specifically intended to protect both residents and public safety personnel." Emphasis added).

[73] Richard J. McLaughlin, *Rolling Easements as a Response to Sea Level Rise in Coastal Texas: Current Status of the Law after Severance v. Patterson*, 26 J. Land Use & Envtl. L. 365 (2011).

[74] *Id.*

[75] United States Army Corps of Engineers, U.S. Dept. of Defense, Decision Document Nationwide Permit 13, (2012), http://www.usace.army.mil/Portals/2/docs/civilworks/nwp/2012/NWP_13_2012.pdf (last visited Feb 15, 2017).

"waters of the United States." "Waters of the United States" includes jurisdictional wetlands.[76] However, absent "waters of the United States" or its jurisdictional wetlands, the surrounding lands may have no development restrictions, and the construction of bulkheads is legal as long as the bulkheads are located on private property.[77] This means that, while Section 404 of the Clean Water Act keep armoring from being used in key wetlands and most state lands, the law fails to protect future wetlands that will form due to SLR, and they are needed to replace the seaward extent of marshes that will be lost due to drowning.

Home rule municipalities may implement their own police power for SLR adaptation ordinances. Such cities may cite public policy against hard armoring as a basis for doing so. For example, municipalities may use zoning and conditional permits to establish some limitation on bulkheads in areas along bays that are within their jurisdiction. A possible drawback, however, is the risk of takings issues associated with passing ordinances, zoning regulations, and permit conditions that may limit private property owners' use of their property. Careful drafting of local ordinances limiting armoring along with a strict variance procedure can dramatically reduce the likelihood of successful takings claims.

Counties may limit development in certain coastal areas using the tools described above. Despite this, federal flood insurance and state wind and hail insurance is available for areas not under the Coastal Barriers Resource Act (CBRA). CBRA identifies key areas with a high risk of hazardous events that should not receive any federal subsidies for current or future development, thus prohibiting subsidies such as federal flood insurance or federally funded beach nourishment. Many locations within CBRA boundaries will still be subjected to private development after their designation in the CBRA program. Areas outside of CBRA, additionally, will continue to be developed, and bay areas will continue to see more armoring efforts and fewer possibilities for adaptation options that would be more viable in less populated areas.[78]

### 2.4.3 Conclusion

Several dichotomies exist in relation to SLR preparations in Texas. First, the laws protecting Gulf-facing beaches, particularly DPA and TOBA, are very progressive and forward thinking. It is important to emphasize, however, that TOBA was not designed to be progressive action against SLR, but rather to protect the public's right to travel along the beach. Further, case law of the past decade has weakened the public access protections of TOBA. DPA, on the other hand, is a natural resource protection law. Citizens are aware of the value of protecting the ecological integrity of dunes systems and public access of Gulf-facing beaches. However, bay-facing shorelines and many existing developed areas lack legal protections at the state level. Counties have limited abilities to implement policies to protect their shorelines from SLR, erosion, and storm surge, but the tools that they do have at their disposal are limited because federally- and state-subsidized flood and hail insurance encourage development in potentially vulnerable

[76] Claudia Copeland, Congressional Research Service, EPA and the Army Corps' Rule to Define "Waters of the United States" (2017), https://fas.org/sgp/crs/misc/R43455.pdf.
[77] *Id*.
[78] *Id*.

areas. Texas municipalities have more autonomy and are arguably the best avenue to pursue SLR adaptation plans. The potential for takings claims by private property owners will always be possible and any SLR adaptation strategies will have to be sensitive to that probability and plan accordingly.

# Chapter 3 SLR Response Options

Each level of government has various options it can use to adapt more effectively to SLR. Additionally, private landowners in Texas can fortify their Bay-facing properties with armoring or utilize more progressive measures such as living shorelines. Furthermore, academic institutions, NGOs, and other entities can research and develop their own projects. Below is a discussion of nature-based and engineered strategies at both large and small scales.

## 3.2 Living Shorelines

Artificial land/water interfaces "disrupt highly diverse and productive plant and animal communities" and cause a loss of wetland habitats and their ecosystem services.[79] Living shorelines, the name given to erosion and flooding control projects that utilize natural materials and vegetation, are an alternative to shoreline armoring on bayside beaches, which encourages the preservation or growth of coastal habitats and allows their migration when sea level rises (Fig. 3). It is an ecologically friendly option, which protects coastlines with few negative effects.[80] Rather than building hard armoring along the shoreline, property owners along the Upper Texas Coast could plant vegetation along the shoreline to protect against coastal erosion.[81] This coastal management strategy reinforces naturally occurring buffer zones and reduces erosion while protecting the shoreline and maintaining coastal habitats.[82] Living shoreline implementation is "noninvasive and environmentally friendly", and is frequently a productive solution to holding back the sea.[83]

[79] Meg Caldwell, & Craig Holt Segall, *No Day at the Beach: Sea Level Rise, Ecosystem Loss, and Public Access Along the California Coast*, 34 Ecology L.Q. 533 (2007).
[80] Carolyn A. Currin, W.S. Chappell, & A. Deaton, *Developing Alternative Shoreline Armoring Strategies: The Living Shoreline Approach in North Carolina*, *in*, Puget Sound Shorelines and the Impacts of Armoring—Proceedings of a State of the Science Workshop, May 2009: U.S. Geological Survey Scientific Investigations Report 2010-5254, p. 91-102. (Shipman, H., Dethier, M.N., Gelfenbaum, G., Fresh, K.L., and Dinicola, R.S., eds., 2010).
[81] Management, Policy, Science and Engineering of Nonstructural Erosion Control in the Chesapeake Bay: Proceedings of the 2006 Living Shoreline Summit 13 (Sandra Y. Erdle et al. eds., n.d.), http://www.vims.edu/cbnerr/_docs/ctp_docs/ls_docs/06_LS_Full_Proceed.pdf.
[82] *See id*.
[83] *See* Management, Policy, Science and Engineering supra, note 80, at 11 ("[L]iving shoreline approaches may not stop erosion altogether, but, if successful, will reduce erosion to an acceptable degree, enhance habitat, and may be substantially less expensive that [sic] high armored endeavors.").


*Figure 3: The difference in armoring projects and living shorelines (McShane, 2012).*

Living shorelines are a complicated subject that have the potential to be one of the best SLR response strategies. While armoring projects aim to prevent erosion through the reflection of wave energy, living shorelines absorb it since vegetation naturally attenuates wave energy through friction.[84] Living shorelines often involve the planting of seagrasses, the use of natural materials, and artificial structures as needed to dissipate wave energy, prevent erosion, and enhance the ecological connectivity of the land/water interface. It is typically visually appealing, improves water quality, and restores or enhances habitats for wetland organisms including birds, fish, and other aquatic species.[85] It maintains or causes the growth of wetland habitats for a given area which can increase biodiversity and ecosystem services.[86] Bagged oyster shells can also be placed in areas where oyster spat can attach and eventually create a reef, and sand and other natural materials can be used to protect the newly created wetland habitats. These oyster bags, reefs, and other materials are also valuable for attenuating wave energy.[87] Studies have shown that they can accrete sediments at a rate that keeps pace with SLR.[88] Additionally, studies have indicated that living shorelines are more resilient than armoring and can protect just as well or better than armoring in certain locations.[89]

Living shorelines create more resilient shorelines than armoring does, and it does not cause down drift erosion like armoring projects often do. They are also self-maintaining once

[84] Moller, I., 2006, Quantifying saltmarsh vegetation and its effect on wave height dissipation—Results from a UK East coast salt marsh: Estuarine Coastal and Shelf Science, v. 69, p. 337–351.
[85] Carolyn A. Currin, W.S. Chappell, & A. Deaton, *supra* note 79, p. 91-102.
[86] Carolyn A. Currin, Priscilla C. Delano, & Lexia M. Valdes-Weaver, *Utilization of a Citizen Monitoring Protocol to Assess the Structure and Function of Natural and Stabilized Fringing Salt Marshes in North Carolina*, 16 Wetlands Ecology and Mgmt. 97 (2007), www.researchgate.net/publication/225549300_Utilization_of_a_citizen_monitoring_protocol_to_assess_the_structure_and_function_of_natural_and_stabilized_fringing_salt_marshes_in_North_Carolina.
[87] Meyer, D.L., Townsend, E.C., and Thayer, G.W., 1997, Stabilization and erosion control value of oyster clutch for intertidal marsh: Restoration Ecology, v. 5, p. 3–99.
[88] Carolyn A. Currin, Priscilla C. Delano, & Lexia M. Valdes-Weaver, *supra* note 85.
[89] National Oceanic and Atmospheric Administration, U.S. Dept. of Commerce, Guidance for Considering the Use of Living Shorelines (2015), https://www.habitatblueprint.noaa.gov/wp-content/uploads/2018/01/NOAA-Guidance-for-Considering-the-Use-of-Living-Shorelines_2015.pdf (last visited Aug. 15, 2018).

established.[90] Implementing living shorelines will improve the Upper Texas Coast's defense against flooding and violent storms.[91] Furthermore, wetlands along the shoreline will assist in filtering out pollutants from runoff water from the city.[92] The installation of living shorelines in appropriate areas along the coast of Galveston Bay will slow coastline loss without compromising the environmental habitat.[93]

Living shorelines often have a lower initial cost than hard engineering projects,[94] and yet a potential drawback is that there may still be significant costs associated with on-going maintenance, especially after a strong erosion event. As such, the direct cost difference between constructing hard armoring projects and living shorelines should be considered in conjunction with the costs of replacement due to storm failure or dilapidation. Living shorelines tend to be much more resilient to storms and they can self-repair, so maintenance costs may be avoided. Additionally, the cost of implementing a living shoreline can be offset by the beneficial services it provides to commercial and recreational activities and the improvement in water quality. These services are maintained or enhanced by the wetlands in living shoreline projects.

The appropriateness and fit of a living shoreline project depends on specific aspects of the property. Site suitability depends on wave energy and presence of vegetation; locations with "low to moderate wave energy with potential for vegetation growth" are better suited for living shoreline designs.[95] "Sites that experience high wave energy and more significant erosion rates may not be suitable for a living shoreline stabilization technique" or they may require a more sturdy design.[96] Critical infrastructure and coastal wetland habitats that are most at risk from future SLR can be identified using predictive tools such as NOAA's SLR Viewer and SLAMM.[97]

The implementation of living shorelines in the Upper Texas Coast needs to account for the fact that living shorelines need to relocate naturally in response to increased sea levels. Where there is heavy development along the coastline, there might not be anywhere for them to relocate, effectively drowning the vegetation by coastal squeeze.[98]

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[90] Rachel K. Gittman *et al.*, *Marshes with and without sill protect estuarine shorelines from erosion better than bulkheads during a Category 1* hurricane, 102 Ocean & Coastal Mgmt. 94 (2014).
[91] *See* Craig Anthony Arnold, Legal Castles in the Sand: The Evolution of Property Law, Culture, and Ecology in Coastal Lands, 61 Syracuse L. Rev. 213, 229 (2011).
[92] *Id*. at 230.
[93] *See* Jessica Grannis, Georgetown Climate Ctr., Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use 1 (2011) at 3, 39-40, http://www.georgetownclimate.org/sites/www.georgetownclimate.org/files/Adaptation_Tool_Kit_SLR.pdf [http://perma.cc/P4R6-XNS3].
[94] *See id*. ("Soft armoring can be less expensive than hard armoring but requires regular maintenance and monitoring."); Shoreline Stabilization Techniques 1 (2010), http://perma.cc/R7Z9-3WAW.
[95] Jason M. Zylberman, Modeling Site Suitability of Living Shoreline Design Options in Connecticut 39 (2016). (M.S. thesis, University of Connecticut), http://digitalcommons.uconn.edu/gs_theses/875.
[96] *Id*.
[97] For a comprehensive list of available predictive tools see https://coast.noaa.gov/digitalcoast/tools/?filter=eyJxdWVyeSI6IiIsImZpbHRlcnMiOlsiR3JlZW4gSW5mcmFzdHJ1Y3R1cmUiXSwiZGF0YXNldHNJbkV4dGVudCI6W119.
[98] Marissa Barnett, *Urbanization, pollution putting health of Galveston Bay at risk,* The Daily News, August 13, 2015, http://www.galvnews.com/news/article_0acf3846-4175-11e5-b91f-677fc4ae037e.html.

### 3.2.1 Permitting for Living Shoreline Projects

Depending on the type of armoring and the selected location's setting, the regulatory process to construct a living shoreline can be lengthy and multilayered or simple with no regulatory oversight. Permits to construct living shorelines historically required much more extensive review than hard armoring methods. Because of this, it was often significantly less expensive and time consuming for landowners to construct bulkheads or other hard armoring projects, even when they would prefer to build more environmentally conscious erosion control structures.[99]

The permitting process for living shorelines can often be confusing. The sequence and timing of the review processes varies since multiple local, state, and federal agencies may be involved, and the number and type of permits varies by location. The criteria that must be met for a national permit is the same countrywide, but each state has an additional, unique permitting process.[100] Furthermore, in addition to the state and federal regulations, local governments may impose planning and zoning policies and construction requirements that increase impediments to living shoreline construction.[101]

### 3.2.2 National-level permitting

At the national level, USACE administers and enforces Section 10 of the Rivers and Harbors Act of 1899[102] (RHA) and Section 404 of the Clean Water Act[103] (CWA). While USACE and the U.S. Environmental Protection Agency (EPA) share administrative responsibility for wetlands under the CWA, USACE is the permitting agency. The National Marine Fisheries Service, U.S. Fish and Wildlife Service, and other affected federal agencies are also consulted during the USACE permit review process. Under RHA Section 10, a permit is required for work or structures in, over or under navigable waters of the United States.[104] Under CWA Section 404, a permit is required for the discharge of dredged or fill material into "the navigable waters of the United States."[105] Many waterbodies and wetlands in the nation are waters of the United States and

[99] Travis O. Brandon, *Nationwide Permit 13, Shoreline Armoring, and the Important Role of the U.S. Army Corps of Engineers in Coastal Climate Change Adaptation*, 46 Envtl. L. Rev. 537, 541 (2016).

[100] *See* Nat'l Research Council of the Nat'l Acads., *supra* note 6, at 88 ("In Virginia, for example, the Chesapeake Bay Preservation Act mandates that local governments amend their building codes, subdivision ordinances, and zoning codes to protect wetlands and other coastal habitats.") and Nat'l Research Council of the Nat'l Acads., *supra* note 6, at 106 ("[Nationwide general permits] do not have universal application because states can impose conditions that are more restrictive than those of the [the Corps]."); see, e.g., MD. Code Ann., Envir. §16-201 (West 2017) (imposing more restrictive conditions on a property owner's right to armor); S.C. Code Ann. § 48-39-30 (2017) (same).

[101] Decision Document, Nationwide Permit 54. (n.d.). Retrieved May 01, 2017, from http://www.usace.army.mil/Portals/2/docs/civilworks/nwp/2017/NWP_54_2017_final_Dec2016.pdf?ver=2017-01-06-125514-560.

[102] Rivers and Harbors Act of 1899, 33 U.S.C. § 403 (2012).

[103] Federal Water Pollution Control Act, 33 U.S.C. §§ 1251-1387 (2012). Section 404 is codified at *id.* § 1344.

[104] 33 U.S.C. 403 (2012).

[105] Under current regulations, "[n]avigable waters of the United States are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce." 33 C.F.R. § 329.4 (2016).

are subject to USACE regulatory oversight. EPA has veto authority over these permits but rarely exercises it.[106]

USACE issues either individual or general permits. Individual permits are issued following case-by-case review of an application, and general permits authorize a category of activities in specific geographical regions or nationwide.[107] General permits, which include Nationwide Permits (NWPs) for specific activities, "must be reevaluated at least every five years if they are to be reissued, and they may contain general conditions applicable to all projects subject to approval."[108] An individual permit is more detailed, and it involves a lengthier process requiring public notification and a 30-day comment period for all interested parties.[109] Depending on the size and design, constructing a living shoreline may be eligible for a NWP or require an individual permit.

NWPs are a type of general permit, and they provide expedited authorization for certain types of activities that are similar in nature and cause only minimal individual and cumulative environmental impacts as determined by the USACE.[110] During Fiscal Year 2016, the mean evaluation time for NWP verifications was 40 days whereas the mean evaluation time for standard individual permits was 217 days.[111] A prospective permittee must satisfy all terms and general conditions required by a NWP for valid authorization to occur.[112] Some NWPs require notification to and confirmation from the USACE that the proposed project is authorized by the permit.[113] Several NWPs can be utilized, depending upon other variables, to permit shoreline stabilization projects.

### *3.2.2a NWP 13*

NWP 13 is used for bank stabilization activities. It authorizes the construction of structures and fills necessary to prevent shoreline erosion—like bulkheads, riprap, or similar hard armoring structures.[114] Under NWP 13, the permittee must notify the USACE before beginning work if the structure is longer than 500 linear feet or uses more than 1 cubic yard of fill material per running foot.[115] Thus, some smaller bank stabilization activities may be constructed without notifying USACE.[116] Landowners can simply proceed with the project so long as they satisfy the requirements of NWP 13.

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[106] Nat'l Research Council of the Nat'l Acads., Mitigating Shore Erosion along Sheltered Coasts 1, 88 (2007).
[107] 33 C.F.R. § 320.1(c) (2016)
[108] Sierra Club v. U.S. Army Corps of Eng'rs, 803 F.3d 31, 39 (D.C. Cir. 2015).
[109] Decision Document, Nationwide Permit 54. (n.d.). Retrieved May 01, 2017, from http://www.usace.army.mil/Portals/2/docs/civilworks/nwp/2017/NWP_54_2017_final_Dec2016.pdf?ver=2017-01-06-125514-560.
[110] 33 C.F.R. § 330(b) (2016).
[111] 82 Fed. Reg. at 1,940.
[112] 33 C.F.R. § 330.4(a) (2016).
[113] 33 C.F.R. § 330.6(a) (2016).
[114] NWP 13 Decision Document, *supra* note 71, at 1.
[115] *Id.*
[116] NAT'L Research Council of the Nat'l Acads., *supra* note 6, at 88.

### *3.2.2b NWP 27*

NWP 27 authorizes activities associated with the enhancement and creation of tidal and non-tidal wetland and riparian areas. The primary use of NWP 27 is for wetland and vegetation restoration activities and construction of oyster habitats over unvegetated bottoms.[117] Prior to 2017, NWP 27 was frequently used for shoreline protection activities because the activities often returned structures, functions, and dynamics to a shoreline that had been damaged or degraded by human activities.[118] However, in 2017 the USACE added a paragraph to NWP 27 to state that aquatic habitat restoration, enhancement, and establishment activities authorized by NWP 27 must be based on ecological references.[119] This change makes it clear that NWP 27 no longer authorizes bank stabilization activities—including living shorelines, especially when breakwaters or stone sills are used, because these structures do not resemble natural shorelines.[120]

### *3.2.2c NWP 54*

NWP 54, issued in 2017, will drastically quicken the permitting process for projects that once fell outside the framework of NWP 13 and 27. While some activities associated with living shorelines have been authorized by NWPs 13 and 27, the construction of living shorelines was usually required to go through the lengthy and complex individual permit process because the structures, labor, and fills did not fall within the terms and conditions of the NWPs. In an attempt to level the playing field, NWP 54 was created to authorize the construction and maintenance of living shorelines. It provides another option for quicker NWP authorization to prevent coastal shoreline erosion.[121] It significantly eases the regulatory burden for landowners seeking the specific benefits that living shorelines can offer.

### *3.2.2d Other Considerations Regarding NWP*

Even though NWP 54 will likely be useful for landowners already committed to constructing a living shoreline[122], it arguably provides several disincentives for building a living shoreline. Unlike NWP 13, NWP 54 requires the submission of a pre-construction notification (PCN) for the construction of any living shoreline.[123] Preparing a PCN is not as burdensome as the requirements for attaining an individual permit, as several projects once required. However, a

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[117] *See* NWP 27 Decision Document, *supra* note 14, at 1.
[118] *See* NWP 54 Decision Document, *supra* note 1, at 17.
[119] NWP 27 Decision Document, *supra* note 14, at 1.
[120] NWP 27 Decision Document, *supra* note 14, at 6.
[121] Issuance and Reissuance of Nationwide Permits, 82 Fed. Reg. 1,860, 1,938 (Jan. 6, 2017) and *See generally* U.S. Army Corps of Eng'rs, Decision Document Nationwide Permit 54, at 1 (2016), available at https://www.usace.army.mil/Portals/2/docs%20/civilworks/nwp/2017/NWP_54_2017_final_Dec2016.pdf?ver=2017-01-06-125514-560.
[122] Travis O. Brandon, Nationwide Permit 13, Shoreline Armoring, and the Important Role of the U.S. Army Corps of Engineers in Coastal Climate Change Adaptation, 46 Envt'l L. Rev. 537, 568 (2016).
[123] *Compare* 82 Fed. Reg. at 1,987 (requiring a PCN for activities under NWP 13 only if certain conditions are met), with 82 Fed. Reg. at 1,998 (requiring a PCN for all activities under NWP 54).

PCN still requires a detailed discussion of the description of the proposed project, of the direct and indirect adverse environmental effects of the activity, and of the potential effects of the project on endangered species and their habitats and any proposed adaptation measures.[124] Facing these requirements, a prospective permittee may reasonably choose to construct a bulkhead or install riprap under NWP 13,[125] which only requires the submission of a PCN for large projects.[126]

Both NWP 13 and NWP 54 require "minimum" discharge or placement of materials into waters of the United States. NWP 54 has additional ecological requirements that are more stringent than those required by NWP 13. For example, projects proposed under NWP 54 must be designed to have "no more than minimal adverse effects on water movement between the waterbody and the shore and the movement of aquatic organisms between the waterbody and the shore."[127] Conversely, bulkheads permitted under NWP 13 routinely prevent water movement to the shore and inhibit the movement of aquatic organisms,[128] but NWP 13 does not require applicants to minimize either of these effects.

Some conservation groups have pushed back against what they view as federal regulatory preference given to hardened shoreline projects through NWP 13.[129] The conservation groups claimed that USACE failed to consider the cumulative environmental impacts of the permit as required by the CWA.[130] In a motion for summary judgment, they contended that in issuing NWP 13, USACE did not respond to compelling scientific evidence that the armoring structures permitted by NWP 13 have a significant cumulative impact on the environment; therefore, issuing the permit was arbitrary and capricious and should be vacated.[131] Ruling on the motion, the court did not render a substantive decision. It instead dismissed the motion, finding that the conservation groups lacked standing partly because the project has already been authorized and constructed.[132] The court stipulated that "the plaintiffs could have standing based on an identified and imminent general permit activity that, if constructed, threatens to cause a concrete and particularized injury."[133] However, because several nationwide permits, particularly NWP 13, do not generally require public notice that construction is imminent, conservation groups are rarely aware that a bulkhead has been authorized until it has already

[124] 82 Fed. Reg. at 2,003 (general condition 32—setting forth the documentation requirements of a PCN).
[125] Travis O. Brandon, Nationwide Permit 13, Shoreline Armoring, and the Important Role of the U.S. Army Corps of Engineers in Coastal Climate Change Adaptation, 46 ENVTL. L. REV. 537, 569 (2016).
[126] 82 Fed. Reg. at 1,986.
[127] 82 Fed. Reg. at 1,988.
[128] Travis O. Brandon, Nationwide Permit 13, Shoreline Armoring, and the Important Role of the U.S. Army Corps of Engineers in Coastal Climate Change Adaptation, 46 Envtl. L. Rev. 537, 569 (2016).
[129] Nat'l Wildlife Fed'n v. United States Army Corps of Eng'rs, 170 F. Supp. 3d 6 (D.D.C. 2016)
[130] CWA, 33 U.S.C. § 1344(e)(1) (2012).
[131] Plaintiff's Motion for Summary Judgment at 19-24, Nat'l Wildlife Fed'n v. United States Army Corps of Eng'rs, 170 F. Supp. 3d 6, 16 (D.D.C. 2016).
[132] For a discussion on standing *see* Lujan v. Defs. of Wildlife, 504 U.S. 555, 560-61 (1992) (the "Constitutional minimum of Article III standing requires satisfaction of three elements: (1) a concrete and particularized and actual or imminent injury-in-fact that is (2) fairly traceable to the challenged action of the defendant . . . and (3) likely to be redressed by a favorable decision.").
[133] Nat'l Wildlife Fed'n v. United States Army Corps of Eng'rs, 170 F. Supp. 3d 6, 16 (D.D.C. 2016).

been constructed.[134] Such a ruling highlights some of the difficulties faced by those challenging nationwide permits under the CWA.

Even if a plaintiff is able to satisfy the jurisdictional hurdle, it will still be difficult to successfully challenge NWP 13 because courts generally grant significant deference to agency determinations.[135] For example, there has been an extensive history of litigation regarding NWP 21, which permits the disposal of fill from mountaintop removal mining.[136] Like NWP 13, it is well documented that activities authorized by NWP 21 have significant negative environmental impacts on aquatic environments, and yet courts continually grant deference to the USACE and uphold their determination that the environmental impact is not "significant" within the meaning of the CWA.[137]

If, however, a plaintiff has standing and a court strikes down NWP 13 for being arbitrary and capricious, landowners would have to go through the individual permitting process before constructing a bulkhead. This would force them to internalize more of the environmental costs of their actions, thus encouraging them to consider more ecologically sensitive approaches to erosion control.[138] However, until NWP 13 is either successfully challenged in court[139] or USACE modifies it to be more restrictive, NWP 54 provides little incentive for undecided landowners to build a living shoreline rather than hard armoring structures.

### 3.2.3 State-level permitting

Texas seeks to ensure that "no permit application is subject to duplicate levels of regulation"[140] and puts no further restrictions on NWP 13, 27, and 54 outside of the leasing, water quality, and wildlife concerns discussed previously.

Most coastal armoring permits are either granted or denied at the state level.[141] States generally impose additional restrictions on the construction of both hard and soft shoreline armoring structures to ensure the state's interests in water quality, wetlands, and wildlife are addressed. In Texas, the Texas Commission on Environmental Quality (TCEQ) reviews

[134] Travis O. Brandon, Nationwide Permit 13, Shoreline Armoring, and the Important Role of the U.S. Army Corps of Engineers in Coastal Climate Change Adaptation, 46 Envtl. L. Rev. 537, 561 (2016).
[135] *See* Chevron U.S.A. v. Natural Res. Def. Council, 467 U.S. 8370 (1984) (holding that deference is due to an agency's reasonable interpretation of a silent or ambiguous statute.).
[136] Travis O. Brandon, Nationwide Permit 13, Shoreline Armoring, and the Important Role of the U.S. Army Corps of Engineers in Coastal Climate Change Adaptation, 46 Envt. L. Rev. 537, 561 (2016).
[137] *See Ohio Valley Envtl. Coal. v. Bulen*, 429 F.3d at 500, 505 (4th Cir. 2005).
[138] Travis O. Brandon, Nationwide Permit 13, Shoreline Armoring, and the Important Role of the U.S. Army Corps of Engineers in Coastal Climate Change Adaptation, 46 Envtl. L. Rev. 537, 572 (2016).
[139] *See* William W. Sapp, April S. Lipscomb & M. Allison Burdette, General Permits: An Environmental Minefield, 46 ENVTL. L. REP. 10,668 (2016) (discussing some of the ways USACE is misusing NWP 13 and how NWP 13 can be challenged.).
[140] Tex. Rev. Civ. Stat. Ann. Art. 5415e-4, § 2(a) (West 2017).
[141] Travis O. Brandon, Nationwide Permit 13, Shoreline Armoring, and the Important Role of the U.S. Army Corps of Engineers in Coastal Climate Change Adaptation, 46 Envtl. L. Reve. 537, 563 (2016).

applications to ensure the shoreline work complies with state water quality standards.[142] Texas Parks and Wildlife Department (TPWD) also reviews applications for wildlife impacts, and they must approve any vegetation that is transplanted into State waters.[143]

Because the number of stakeholders involved in the permitting process is significant, the GLO worked alongside other state and federal agencies to establish the Permit Service Center (PSC) to simplify the permit application process. [144] The PSC is designed to provide assistance and advice to applicants located within the Coastal Management Program Boundary, which encompasses the entire Texas coast.[145] It simplifies the permit application process by consolidating and directing required forms to all responsible state and federal agencies.

The GLO has become increasingly supportive of living shoreline projects and has even constructed a few such projects through their CEPRA program.[146] While NWP 54 will streamline the USACE permitting process on the federal level, the process and cost to construct a living shoreline project on State-owned submerged land is the biggest obstacle.

### *3.2.3a Local-level permitting*

Even though Texas cities and municipalities have the authority to create ordinances concerning the construction of structures on coastal shorelines in their jurisdictions, most rely on the GLO's joint permitting process. The Joint Permit Application was created to minimize redundancies between the USACE and state agencies' application processes; they are typically less confusing and less time-intensive. Local governments rarely create ordinances because their staff and budgets are frequently too small to sufficiently address coastal development concerns, and some may even feel pressure not to enact ordinances because of the threat of litigation.[147]

### *3.2.3b Other Considerations*

The State of Texas owns most coastal land naturally submerged by the Gulf of Mexico.[148] In 1958, the Texas Supreme Court held that the shoreline boundary of State-owned submerged

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[142] *See* Tex. Water Code Ann. § 11.121 (West 2017).
[143] *See* Tex. Parks & Wild. Code Ann. § 12.024 (West 2017).
[144] More information about the Permit Service Center available at http://www.glo.texas.gov/coast/coastal-management/permitting/
[145] *See* http://www.glo.texas.gov/coast/coastal-management/forms/files /CoastalBoundaryMap.pdf
[146] *See* Coastal Erosion Planning & Response Act: A Report to the 85th Texas Legislature, 21-23 (2017), available at http://www.glo.texas.gov/coast/coastal-management/forms/files/CEPRA-Report-2017.pdf; *See also* Coastal Erosion Planning & Response Act: A Report to the 84th Texas Legislature, 8, 11, 13-14 (2015), available at http://www.glo.texas.gov/coast/coastal-management/forms/files/CEPRA-Report-2015.pdf. 8, 11, 1-14
[147] Niki L. Pace, Wetlands or Seawalls? Adapting Shoreline Regulation to Address Sea Level Rise and Wetland Preservation in The Gulf of Mexico, 26 J. Land Use & Envtl. Lawe 327, 353 (2011) ("[c]onsidering the migratory nature of shorelines, legal issues arising from shoreline management are frequently raised in the context of regulatory takings.").
[148] *See* Tex. Nat. Res. Code § 11.012(c) (2012) ("The State of Texas owns the water and the beds and shores of the Gulf of Mexico and the arms of the Gulf of Mexico within the boundaries provided in this section, including all land which is covered by the Gulf of Mexico and the arms of the Gulf of Mexico either at low tide or high tide.").

land is the mean higher high tide line (MHHT), the average of the higher of the two daily high tides computed over the regular tidal cycle of 18.6 years.[149] Land above the MHHT line is mostly privately owned.[150] Privately owned property above the MHHT line is generally not required to comply with Texas' shoreline work permitting processes, but occasionally may be subject to USACE's jurisdiction. Since most submerged lands are State-owned, a landowner must have the land surveyed to determine what is legally his/hers and apply for a lease through GLO to construct any structure on the submerged land fronting his or her coastal property—the lease must be approved by the School Land Board (SLB).[151]

Construction of a bulkhead above the MHHT, and thus on private property, is often quicker, cheaper, and easier because it avoids the multiple layers of federal and state review. All shoreline work taking place under the MHHT line will likely be subject to oversight by the USACE, other federal agencies, and several State agencies (see below). USACE explains that there are fewer "consultants and contractors qualified to design and build living shorelines," especially when compared to those qualified to design and build bulkheads.[152] This likely means that, without further incentive to build living shorelines, many landowners and contractors will continue to build hard structures because it is the quickest and easiest option. Despite this regulatory hurdle, living shorelines are worth pursuing for their many ecosystem service benefits.

In general, NWP 54 will ease the permitting process and shorten the approval time for constructing living shorelines to prevent eroding shorelines. However, landowners who select a shoreline protection alternative that does not encroach into the highly regulated "waters of the United States" can avoid significant transaction costs, lengthy permitting times, and several other aggravations.[153] In many circumstances, these costs create an incentive for the permit applicant to avoid federal permit requirements by siting the erosion control project above the mean high water line and outside of any jurisdictional wetlands, and thus out of USACE jurisdiction.[154] However, living shorelines, by definition, must be below the mean high water line. While state and local land-use permits and regulations must still be satisfied in this situation, an applicant opting for upland hard armoring over a living shoreline has simplified his or her regulatory burden by eliminating federal review.

### Regulatory Difficulties

In 1876, the Constitution of the State of Texas set aside half of Texas' remaining public lands to establish a Permanent School Fund (PSF), to help finance public schools.[155] A primary

[149] *Luttes v. State*, 324 S.W.2d 167, 187 (Tex. June 18, 1958).
[150] *Porretto v. Tex. Gen. Land Office*, 448 S.W.3d 393, 395 (Tex. July 3, 2014)
[151] *See* Tex. Nat. Res. Code Ann. §§ 33.136, *51.302* (West 2017).
[152] *See* Proposal to Reissue and Modify Nationwide Permits, 81 Fed. Reg. 35,186, 35,199.
[153] Nat'l Research Council of the Nat'l Acads., Mitigating Shore Erosion along Sheltered Coasts 1, 88 (2007).
[154] *Id.*
[155] Tex. Const. art. VII, § 2.

responsibility of GLO is to lease this land.[156] Leases are available for a variety of purposes, including oil and gas production, commercial/residential development, and for public recreational purposes. The School Land Board (SLB) is composed of three members and meets as needed on the first and third Tuesdays of every month to, among other things, approve or deny leases of state-owned submerged land.[157]

If a living shoreline project is to be placed on state-owned submerged land, the project owner is required to obtain a lease from the SLB through the GLO for permission to use the land and to compensate the state for the use of the land.[158] The lease rate is negotiable but generally low.[159] The difficulty arises from the requirement that a Coastal Boundary Survey (CBS) must be conducted prior to the authorization of a lease.[160] The CBS determines the pre-project boundary between private uplands and state-owned submerged land. A CBS is typically more expensive than a standard topographic survey as it requires the skills of a Licensed State Land Surveyor. Many coastal landowners who may be contemplating construction of a living shoreline project for the environmental and aesthetic benefits rather than constructing a bulkhead will often opt for a bulkhead because bulkheads are rarely required to satisfy the expensive CBS and lengthy leasing processes.

Living shorelines, to be effective, must almost always be constructed below the MHHT line, thus they rarely escape the GLO leasing and surveying processes. Bulkheads, on the other hand, are commonly constructed above the MHHT line on private property and regularly escape these requirements.[161] However, GLO is currently conducting a study through its Coastal Management Program to inventory all living shoreline projects along the Texas coast to determine how they might be able to bring some relief to owners of small living shoreline projects by exempting the CBS requirement for projects under certain thresholds.[162] GLO hopes to provide the exemption through rule changes, but it may require State legislative action.[163]

### Locations Not Regulated by the State

*Canals*: Texas has minimal statutory or case law regulating the alteration of the coastal shoreline by cutting land canals for small recreational boats or diversionary purposes. While TCEQ and TPWD may regulate the dredging and many other activities in the water,[164] GLO does not have jurisdiction over the submerged land because "[m]an-made or artificial additions" that

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[156] Tex. Nat. Res. Code Ann. §31.0671 (West 2017), summary available at http://www.glo.texas.gov/%20coast/coastal-management/leasing-easements/index.html.

[157] *See* Tex. Admin. Code. § 155.1 (2017), summary available at http://www.glo.texas.gov/the-glo/boards-commissions/school-land-board/index.html.

[158] *See* Tex. Admin. Code. § 155.2(c) (2017).

[159] *See* Tex. Admin. Code. § 155.15(b)(1)(ii)(B) (2017).

[160] *See* Tex. Admin. Code. § 15.43 (2017).

[161] *See* Tex. Nat. Res. Code Ann. § 33.122 (West 2017).

[162] E-mail from Ray Newby, Coastal Geologist, Texas General Land Office, to Austin R. Echols (May 23, 2017, 14:07 CST) (on file with author); *See generally* Coastal Management Program Biennial Report 2015 – 2016, 10 (2016), more information about the Coastal Management Program available at http://www.glo.texas.gov/coast/coastal-management/forms/files/CMP-Biennial-Report-2015-2016.pdf.

[163] *Id.*

[164] Tex. Water Code Ann. § 11.121 (West 2017).

a landowner causes or participates in "do not change the boundaries between his land and the State's."[165] However, the waters within the canal may fall within USACE's definition of navigable waters, thus within the agency's jurisdiction.[166] While living shorelines could be built in these canals without complying with the often lengthy and expensive GLO leasing and surveying requirements, construction of living shorelines in canals is often impracticable.

*Navigation District-Owned Submerged Lands:* Navigation districts generally provide for the construction and improvement of waterways in Texas for the purpose of navigation.[167] Navigation districts are political subdivisions of the State of Texas and differ from an agency in that they have jurisdiction over a portion of the State. Conversely, an agency exercises its jurisdiction throughout the entire State.[168] Some navigation districts are authorized to make improvements for the preservation and conservation of inland and coastal water for navigation.[169] Like canals, using or building on navigation district-owned lands does not require a landowner to have the property surveyed or leased from GLO. Navigation districts have taken advantage of these relaxed requirements and have built several living shorelines, especially along the Upper Texas Coast.[170]

### 3.2.4 Conclusion

NWP 54 will ease the permitting process and shorten the approval time for constructing living shorelines to prevent eroding shorelines. However, landowners who select a shoreline protection alternative that does not encroach into the highly regulated "waters of the United States" or below Texas' MHHT line can avoid significant transaction costs, lengthy permitting times, and several other aggravations. The strong incentive to avoid or minimize encroachment into U.S. and Texas waters has created a bias toward constructing bulkheads and similar vertical structures.[171] Constructing a bulkhead above the MHHT line is often quicker, cheaper, and easier than constructing a living shoreline because it potentially avoids the multiple layers of federal and state review. Despite these permitting obstacles, living shorelines are worth pursuing for their ecosystem service benefits. Therefore, to improve the regulatory environment for living shorelines, regulations at all levels of government should make the construction of hard armoring structures more difficult. [172]

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[165] *Natland Corp. v. Baker's Port, Inc*., 865 S.W.2d 52, 57 (Tex. App. 1993); *accord Brainard v. State,* 12 S.W.3d 6*,* 23 (Tex. 1999); *see* A.G. Op. GA-0407 (2006).

[166] 33 C.F.R. § 329.4 (2016), *supra* note 101.

[167] Chapters 60 through 63 of the Texas Water Code set forth provisions relating to navigation districts.

[168] Jim Kruse, *Overview: Texas Ports and Navigation Districts,* 1*,* available at https://policy.tti.tamu.edu/%20txtransportation-legislation/84i/prc-policy-brief-overview-texas-ports-and-navigation-districts/.

[169] *Id.*

[170] Chambers County Greenprint Final Report, August 2012, at 2 (discussing several living shoreline projects on Chambers-Liberty Counties Navigation District owned land), available at http://www.glo.texas.gov/coastal-grants/_documents/grant-project/10-058-final-report.pdf.

[171] Nat'l Research Council of the Nat'l Acads., *supra* note 6, at 90.

[172] For an example of a state where construction of living shorelines has finally become much easier than constructing a seawall due to the confluence of state limitation on hard armoring and reform to ease permitting for small living shorelines, see Thomas T. Ankersen, Alexandra Barshel, and Valerie Chesnut, Streamlining

It is difficult to get people motivated to change from traditional coastal protection approaches. Some major institutional barriers to living shoreline implementation are institutional inertia; lack of a broader context for shoreline management decisions; lack of an advocate; and the tactical problems facing the design, permitting, and installation of a living shoreline, such as the current complexity of the permitting regime.[173] Some additional concerns with implementing living shorelines are product liability issues. Common legal challenges brought in such cases include breach of warranty, negligence, strict liability, and violation of consumer protection laws.[174] Additional potential issues include personal injury liability and storm damage removal.

Living shorelines are not without drawbacks, but never the less they are one of the strongest options available for SLR adaptation strategies. They minimize erosion through the absorption of wave energy, can keep pace with SLR, and maintain a healthy land/sea interface. Additionally, they are visually appealing and can encourage human interaction with the water and creatures living in the wetlands. For these reasons, they should be pursued in the Upper Texas Coast as a shoreline stabilization technique in light of SLR. An important problem with both armoring and living shorelines, however, is that they encourage property to be developed behind it. Therefore, protecting shorelines, if not done in conjunction with good setback and construction policies and with no commitment to repair and upgrade the protective project, could increase vulnerability over time, especially in light of ongoing SLR.

## 3.1 Nature-Based Landscape-Scale Concepts

Nonstructural solutions which could assist in protecting against SLR include buying out extremely high-risk areas in favor of returning them to their natural conditions, integrating sand dunes, implementing beach nourishment projects, and integrating more natural elements such as oyster reefs and mangroves.[175] The Upper Texas Coast also has vast natural resources. The potential to capitalize and commercialize the value provided by natural ecosystems through their ecosystem services exists. The market for ecological services could financially incentivize landowners to keep their coastal lands in their natural states rather than developing the property. Rather than engineer a system, potential buyers could use a natural system such as a living shoreline or a larger project like the ones described below as protection against SLR.

Furthermore, the Center for Severe Storm Prediction, Education, and Evacuation from Disasters (SSPEED) has developed two landscape-scale concepts for the low-lying, less developed areas of Chambers, Galveston, and Brazoria Counties: the Texas Coastal Exchange (TCX) and the Lone Star Coastal National Recreation Area (LSCNRA). These nonstructural strategies aim to develop

Resiliency: Regulatory Considerations in Permitting Small-Scale Living Shorelines in Florida (Florida Sea Grant Technical Paper 223, 2018), available at http://edis.ifas.ufl.edu/sg155#FOOTNOTE_2.

[173] Living Shorelines: From Barriers to Opportunities- Restore America's Estuaries (p. 25) http://www.oyster-restoration.org/wp-content/uploads/2013/05/RAE-LS-Barriers-Final-Report-2015.pdf

[174] Liability Concerns Association with Living Shorelines by Niki Pace, Mississippi-Alabama Sea Grant Legal Program http://grandbaynerr.org/wp-content/uploads/2014/06/Liability_Pace.pdf.

[175] SSPEED Center, Houston-Galveston Area Protection System Report, September 1, 2015, p. 80, https://rice.app.box.com/s/jvciwu2tpfo0qo9kxibbfckpr4u11cng.

economic activities that align with the natural ecology of the region and thus are more resistant to occasional flooding and SLR.

### 3.1.1 Texas Coastal Exchange

Texas Coastal Exchange (TCX) is a concept that aims to create a market for the buying and selling of ecological services.[176] A common definition of ecosystem services is that of Costanza and Folke (1997): "ecosystem goods and services represent the benefits human populations derive, directly or indirectly, from ecosystem functions."[177] The 2005 Millennium Ecosystem Assessment described ecosystem services more precisely as "provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on earth."[178] The idea for TCX is to make retaining coastal land in its natural state economically competitive with developed property, thus reducing damage caused by SLR and providing resilience.

Examples of systems that could be used in commercial transactions are oyster reefs, coastal marshes, coastal prairies and bottomland forest systems.[179] The benefits are vast. The commercial benefits range from collecting oyster meat, harvesting trees within the bottomland, and grazing cattle on the prairie.[180] Moreover, the ecologic benefits are the sequestration of carbon, the removal of nitrogen and phosphorus, the enhancement of water resources, and the support of fish and wildlife.[181] A GIS database has been developed to allow property owners in the four counties to establish which systems could exist or currently do exist on their land, and this system can also connect sellers of ecological service functions with potential buyers.

One of the main obstacles in preserving natural systems along the coast is the conflict between ecological value and commercial value. TCX is a way of addressing and resolving this apparent tension between these two values. Through the establishment of wetlands banking trusts, marshes could "operate as economically viable preserves that offset tax revenue provided by traditional resort development while producing sustainable long-term ecological and economic benefits to the city and entire region."[182] The creation of new wetlands and expansion of existing ones along the coastline would replenish habitats as well as offer a buffer against shoreline relocation.

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[176] *Id*.

[177] Costanza, R., R. d'Arge, R. de Groot, S. Rarber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. O'Neill, J. Paruelo, and R. Raskin. 1997 "The Value of the World's Ecosystem Service and the Natural Capital." *Nature* 387:253–260.

[178] Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-Being: Current State and Trends.* Washington, DC: Island Press.

[179] SSPEED Center, *Houston-Galveston Area Protection System Report*, September 1, 2015, https://rice.app.box.com/s/jvciwu2tpfo0qo9kxibbfckpr4u11cng.

[180] *Id*.

[181] *Id*.

[182] Christopher Hight et al., *Atlas of Sustainable Strategies for Galveston Island*, pg.47, (Lulu.com, 2010).

The GLO and the USACE are currently working on feasibility studies, the Sabine Pass to Galveston Bay Corps Feasibility Study[183] and the Coastal Texas Study[184], to identify potential measures to address coastal storm risk management and ecosystem restoration within the Texas coastal zone. As part of the engineering, environmental, and economic analyses of these studies, various scenarios for SLR at the 50-year and 100-year timeframes are considered.

### 3.1.2 Lone Star Coastal National Recreation Area

The second landscape-scale concept developed by the SSPEED Center is the Lone Star Coastal National Recreation Area (LSCNRA), a way of organizing and developing the eco-tourism potential of these areas of the Upper Texas Coast. Federal, state and local agencies hold over 200,000 acres of low elevation lands.[185] When combined with reasonable setbacks, protecting shoreline habitats through developing sites and programs to diversity, eco-tourism potential could "produce longer term and sustainable tax revenue that could offset property tax losses and generate jobs for the community that are more desirable than those of the typical tourist service sector."[186] In addition, in the aftermath of environmental disasters, areas that have become uninsurable or uninhabitable could be repurposed as ecotourism destinations. This restoration of damaged areas to their natural ecological state could be a more sustainable and feasible long-term strategy since the areas are so vulnerable to storm damage and shoreline relocation.[187]

The EPA stated that their "single greatest failing" and greatest challenge moving into the future is the "inadequate protection" of ecosystems and their services.[188] The LSCNRA aims to combat this issue. If established, it would be a conglomeration of property owned by a variety of governmental, non-governmental, and private property owners and managed by the National Park Service.[189] It is designed to be a financially self-sustaining nature center that draws tourists and naturalists. LSCNRA is predicted to be visited by two million people per year, generate at least $200 million and create thousands of new jobs within ten years.[190]

LSCNRA would protect the area's natural resources while offering recreational activities to visitors such as bird watching. It would also support Galveston Bay's commercial activities by creating and preserving habitats for commercially-important fish and shellfish species. This project has several key points in regards to preparing for SLR. First, wetlands would be

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[183] GLO Grants. (n.d.). Retrieved May 01, 2017, from http://www.glo.texas.gov/coastal-grants/projects/1523-corps-feasibility-rescoping.html.

[184] U.S. Army Corps of Engineers Coastal Texas Protection and Restoration Feasibility Study. (n.d.). Retrieved May 01, 2017, from http://www.swg.usace.army.mil/Missions/Projects/Coastal-Texas-Feasibility-Study/.

[185] *Id*.

[186] *Id*.

[187] *Id*.

[188] Salzman, J., Thompson, B. H., & Daily, G. C. (2001). Protecting Ecosystem Services: Science, Economics and Law. Stanford Environmental Law Journal, 20(309), 309-332. Retrieved from http://scholarship.law.duke.edu/faculty_scholarship/1071/.

[189] Blackburn, J. P., Bedient, P. B., & Dunbar, L. G. (2014). 2014 Report (Rep.). Retrieved http://www.sspeed.rice.edu/sspeed/downloads/HE_Final_Report_2014.pdf.

[190] *Id*.

preserved and potentially even allowed to expand. This would preserve ecosystem services and all the benefits associated with them. Second, by allowing water to flow freely and unrestricted into LSCNRA lands, developed areas would be safer from SLR-related hazards such as storm surge.

## 3.3 Engineered Strategies

There are several proposals to protect portions of Galveston Bay from impending hurricane and tropical storm damage that would have the added benefit of protecting against SLR. In response to Hurricane Ike in September 2008, Texas A&M University has proposed the Ike Dike and SSPEED has put forth the ideas of the Centennial Gate and Mid-Bay Gate. They are both designed to protect Galveston Bay against hurricane storm surges, but they are clearly applicable to SLR adaptation strategies as well.

### 3.3.1 Ike Dike

Dr. William Merrell of Texas A&M University has proposed constructing land-based revetments, which would extend the Galveston Seawall along the beaches of Galveston Island and Bolivar Peninsula. This huge project has been designated the "Ike Dike," and the goal of this project is to increase storm surge protection along the coast in order to minimize future storm surge flooding in Galveston and the Port of Houston.[191] The Ike Dike project has three prongs: 1) strengthen the existing Galveston seawall; 2) protect the rest of Galveston and Bolivar by adding revetments and raising coastal highways; and 3) construct sea gates at the San Luis Pass and Bolivar Road.[192]

Dr. Merrell proposes to extend the Galveston Seawall for another 18 miles to the San Luis Pass on Galveston Island and to construct a 35-mile coastal barrier along the Bolivar Peninsula. This will be achieved either through 17 ft. high coastal barriers along the beach or by raising the existing highway on Galveston Island and the Bolivar Peninsula by 12 ft.[193] The last elements of the proposal are the "Galveston Gates," a set of 17 ft. gated barriers at both Bolivar Roads and San Luis Pass which would remain open except during a hurricane event. In such an event, they would close to prevent storm surge in Galveston Bay.[194] These gates, based on technology used in the design of the Rotterdam floodgates in The Netherlands, are the most expensive aspect of the project. Rough estimates predict that cost of the Galveston Gates will be approximately $3 billion and the entire project will cost between $4 and 6 billion.[195]

[191] William J. Merrell, "Let's Build the Ike Dike", Texas A&M University.
[192] *Id*.
[193] Maria Adey, Proposed Ike Dike Project In Galveston, Texas; Paper Code. No. Adey, 2013; Faculty of Engineering and Applied Science, Memorial University, St. John's, NL, Canada, March, 2013.
[194] William J. Merrell, "The Ike Dike: A Coastal Barrier Protecting the Houston/Galveston Region from Hurricane Storm Surge", Macro-engineering Seawater in Unique Environments, 2011, p 691-716.
[195] Kasper Stoeten, "Applying best practices from the Delta Works and New Orleans to Galveston Bay", Texas A&M University, 2012.

The Ike Dike project has expanded to include a concept called the "coastal spine," inspired by the Dutch and priced between $5-10 billion.[196] The coastal spine would prevent storm surge along the coast with a sixty-mile seawall along Galveston Island and Bolivar Peninsula.[197] An enormous floodgate between the two landmasses would close when a storm is impending. This idea has received the support of several dozen communities, but other counties argue that a mainland levee system would provide the same protection but cost several billion dollars less.[198]

### 3.3.2 Centennial Gate

A rival plan that also claims to have a solution to storm surge in the Galveston Bay area is the "Centennial Gate." The SSPEED Center of Rice University developed it to combat storm surge and rising seas. The Centennial Gate plan includes the installation of massive storm surge gates at the mouth of the Houston Ship Channel as well as a barrier that would protect the most economically and densely populated areas of Galveston. [199] One of the premises underlying the SSPEED Center plan is that the government has limited resources and, in the future, will have to select areas to prioritize for protection projects given limited funds. Because of its costly infrastructure and national importance, the Centennial Gate would protect upstream communities and industries in some areas of Galveston Bay with the most valuable infrastructure.[200]

Planning for Centennial Gate is currently privately funded. Estimated construction costs are about $2.8 billion, and it would protect the chemical industry but not many residential areas.[201] Proponents of the Centennial Gate claim that it does not raise any significant land use conflicts for either one of its alignment options.[202] The Centennial Gate has received technical and strategic criticism from proponents of the Ike Dike.[203] Communities unprotected under its planned location dislike the proposal. Further, some municipalities have gone so far as to pass resolutions opposing it and questioning its strategy.[204]

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[196] Bill King, "Storm surge protection complicated and costly", Houston Chronicle, 2016. http://www.houstonchronicle.com/opinion/outlook/article/King-Storm-surge-protection-complicated-and-7960280.php.
[197] Kiah Collier, "New Houston Hurricane Plan Stirs the Pot," March 10, 2016, https://www.texastribune.org/2016/03/10/new-houston-hurricane-plan-stirs-pot/.
[198] *Id.*
[199] J.B. Blackburn et al., "SSPEED Center 2014 Report". http://sspeed.rice.edu/sspeed/downloads/HE_Final_Report_2014.pdf.
[200] Charles Kuffner. *Ike Dike versus Centennial Gate*. http://offthekuff.com/wp/?p=62070
[201] Harvey Rice, "Legislators want quick action on Ike Dike," August 4, 2014, http://www.houstonchronicle.com/neighborhood/bayarea/news/article/Legislators-want-quick-action-on-Ike-Dike-5668080.php?cmpid=twitter-premium&t=eb70ecb287d90d0955.
[202] J.B. Blackburn, *et. al.*, SSPEED Center 2014 Report. Pg. 9 http://sspeed.rice.edu/sspeed/downloads/HE_Final_Report_2014.pdf.
[203] Dr. William Merrell, "Problems with the SSPEED Center Approach to Surge Suppression Barriers," Tuesday, March 04, 2014, http://guidrynews.com/story.aspx?id=1000059263#sthash.s8fr6WlB.dpuf.
[204] *Id*.

The SSPEED Center has also developed a third option called the Mid-Bay Gate. It would cost about as much as the Centennial Gate but also would protect the heavily developed western side of Galveston Bay. The Mid-Bay Gate would be connected to an extensive network of man-made reefs and island berms, most of which currently exist, to safeguard industry along the Ship Channel as well as homes in rapidly developing areas along the west side of Galveston Bay such as League City.[205] The proposal is to install a storm surge-deterring gate 25 ft. tall across the Houston Ship Channel, which is approximately 700 ft. wide, near the community of San Leon. Jim Blackburn, co-director of the SSPEED Center and one of the lead proponents, said that concerns that the Centennial Gate would not minimize risk for residential areas in Clear Lake triggered the development of this alternative plan.[206]

The proposed location of the Mid-Bay Gate is approximately halfway between the upper-bay Centennial Gate and the lower-bay Ike Dike. By utilizing aspects of the Ike Dike proposal such as new levees, dikes, and elevated roadways, the Mid-Bay Gate could be part of a comprehensive regional flood-reduction plan.[207] Its proposed cost is closer "to the $1.5 billion Centennial Gate than the $4 billion to $8 billion estimate for the Ike Dike."[208]

Not only do some municipalities support Ike Dike, but also some, such as Anahuac, have passed resolutions opposing the Centennial Gate.[209] Furthermore, Dr. Merrell predicts that local property owners will sue the owners or operators of the Gate and build their own protective barriers thus multiplying the armoring and its resulting problems; neighboring properties may compete against one another to have the highest and strongest armoring because whomever is protected with such has the lower levels of risk.[210] The accuracy of these predictions is unclear but signal the intense political and legal controversy associated with all of the large engineered strategies proposed to protect the Upper Texas Coast.

Projects of these magnitudes have substantial, potentially severe, environmental impacts.[211] The Galveston Gates would change the water exchange between the Bay and the Gulf of Mexico, and the extended seawall would alter the coastal landscape on both Galveston Island and Bolivar Peninsula. They might significantly alter the salinity regime, current flow, and

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[205] Eric Berger, "$3 billion floodgate proposed for Galveston Bay," September 1, 2015, http://www.houstonchronicle.com/news/houston-texas/houston/article/3-billion-floodgate-proposed-for-Galveston-Bay-6477405.php?t=5e86c42cba438d9cbb&cmpid=twitter-premium.

[206] *Id*.

[207] David Ruth, "Rice Report Analyzes New Option for Hurricane Protection," September 1, 2015, http://news.rice.edu/2015/09/01/rice-report-analyzes-new-option-for-hurricane-protection-2/#sthash.ZLOBQkl5.dpuf.

[208] Kiah Collier, September 1, 2015, "Group Pitches $2.8 Billion Hurricane Protection Plan" http://www.texastribune.org/2015/09/01/amid-storm-surge-debate-another-option/.

[209] Dr. William Merrell. *Problems with the SSPEED Center Approach to Surge Suppression Barriers*. March, 2014. http://guidrynews.com/story.aspx?id=1000059263

[210] *Id.*; J.B. Blackburn, *et. al*., SSPEED Center 2014 Report. Pg. 9 http://sspeed.rice.edu/sspeed/downloads/HE_Final_Report_2014.pdf.

[211] Maria Adey, Proposed Ike Dike Project In Galveston, Texas; Paper Code. No. Adey, 2013; Faculty of Engineering and Applied Science, Memorial University, St. John's, NL, Canada, March, 2013.

organism mobility within Galveston Bay. The projects have seen no formal support so far from federal or state sources and, therefore, are currently privately funded.[212]

## Chapter 4 Case Studies and Potential Adaptation Strategies

Rising sea levels will combine with subsidence to create major problems for areas surrounding the Bay. "Nuisance flooding" has already dramatically increased,[213] and NOAA predicted in 2015 that nuisance flooding[214] would increase in places along the coast, including Galveston.[215] Nuisance flooding is connected to climate change in general and SLR in particular[216], and nuisance flooding may actually cost more overall than infrequent, severe events.[217] Furthermore, storms will cause problems for bay-facing Galveston, particularly the western edge due to its large economic value, and SLR will cause worse damages. For instance, Galveston suffered significant flooding from its bayside due to Hurricane Ike's winds, which pushed water towards the southern portion of the Bay.[218] While this problem raised concerns for storm surge and flooding, it should also be considered in the context of SLR adaptation strategies.

When considering the abilities and limitations of agencies and local governments as well as the most pertinent laws that could affect adaptation efforts, a few case studies may be posed to anticipate likely legal obstacles and subsequent strategies for certain areas of Texas. According to a NOAA study, thirty or more yearly floods will originate from Galveston Bay by 2041 as a result of SLR.[219] Infrastructure along Galveston Bay's coastline is "at an increasing risk to damage from SLR inundation, extreme astronomical tides, storm surge flooding, hurricanes,

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[212] Jeri Kinnear. *Sunday letters: Storm protection*. June, 2015. http://www.chron.com/opinion/letters/article/Sunday-letters-Storm-protection-6310253.php

[213] Nat'l Oceanic & Atmospheric Admin., U.S. Dept. of Commerce, Sea Level Rise and Nuisance Flood Frequency Changes around the United States Technical Report NOS CO-OPS 073 (June 2014), available at https://tidesandcurrents.noaa.gov/publications/NOAA_Technical_Report_NOS_COOPS_073.pdf; Nat'l Oceanic & Atmospheric Admin., U.S. Dept. of Commerce, 'Nuisance flooding' an increasing problem as coastal sea levels rise, http://www.noaanews.noaa.gov/stories2014/20140728_nuisanceflooding.html. *See also,* Erika Spanger-Siegfried, *et al.*, Union of Concerned Scientists, When Rising Seas Hit Home: Hard Choices Ahead for Hundreds of US Coastal Communities (2017).

[214] (Type of flooding caused by high tides, one or two feet above the local high tide.) John Wayne Ferguson. *NOAA report: More frequent flooding likely by 2041*. December 19, 2014. http://www.galvnews.com/news/local_news/article_2625a3b6-8742-11e4-982d-d392c6af9703.html

[215] Seth Borenstein. *More coastal nuisance flooding forecast for coming months*. September 9, 2015. http://www.galvnews.com/news_ap/texas/article_a5ab359a-91d7-5bd8-a8f6-cb8584d07c7d.html

[216] What is nuisance flooding?, National Ocean Service, http://oceanservice.noaa.gov/facts/nuisance-flooding.html (last visited Feb 15, 2017).

[217] *See, e.g.* Moftakhari, H. R., A. Agha Kouchak, B. F. Sanders, and R. A. Matthew (2017). Cumulative hazard: The case of nuisance flooding, *Earth's Future*, *5*, doi:10.1002/2016EF000494

[218] J.B. Blackburn, et. al., SSPEED Center 2014 Report. Pg. 9 http://sspeed.rice.edu/sspeed/downloads/HE_Final_Report_2014.pdf.

[219] John Wayne Ferguson. *NOAA report: More frequent flooding likely by 2041*. December 19, 2014. http://www.galvnews.com/news/local_news/article_2625a3b6-8742-11e4-982d-d392c6af9703.html.

and other storm events."[220] This risk will only continue to increase because of the continuing growth of coastal cities and tourism. [221] Four case studies are presented in this section in order to more thoroughly explore the ideas introduced above (Fig. 4). Each site has a different natural and built environment as well as different community priorities, thus different adaptation strategies will be most appropriate.


*Figure 4: The locations of the four case studies presented below.*

[220] David Yoskowitz, James Gibeaut, and Ali McKenzie. *The Socio-Economic Impact of Sea Level Rise in the Galveston Bay Region.* June 2009. https://www.edf.org/sites/default/files/9901_EDF_Sea_Level_Rise_Report.pdf

[221] *See, e.g.* Mathew E. Hauer, Jason M. Evans, & Deepak R. Mishra, Millions Projected to Be at Risk from Sea-Level Rise in the Continental United States, 6 Nat. Climate Change 691 (2016) Reference number: 10.1038/nclimate2961; IPCC, 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change pp. 7, 9 [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA.

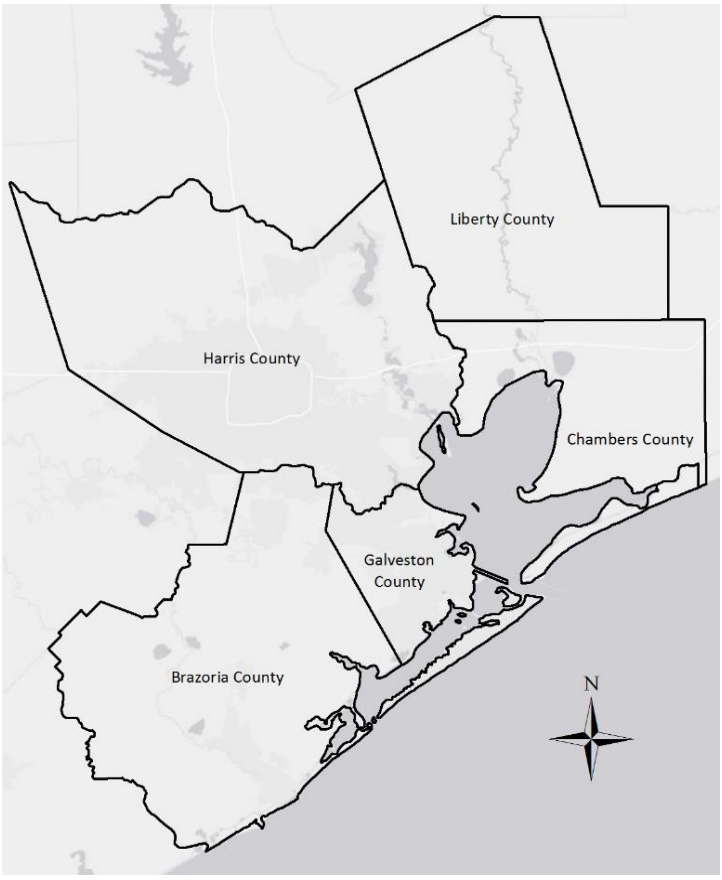


*Figure 5: Counties surrounding Galveston Bay*

This section will examine and analyze the current laws and policies governing coastal zone management in Texas and will describe the obstacles and opportunities available to respond to the threat of SLR. This study will describe the legal and policy implications of several projected SLR scenarios upon four different Upper Texas Coast communities (Table 1). It will compare and contrast the likely impacts of SLR on private and public property located on the Gulf- and Bay-side. It will also determine how these impacts may be adapted to or exacerbated by potential adjustments in state or local legal regimes.

*Table 1: The sites selected represent different built and natural environments.*

| | **Developed** | **Undeveloped** |
|---|---|---|
| **Gulf-Facing** | Galveston | Surfside Beach |
| **Bay-Facing** | Texas City | Anahuac |

## 4.1 Texas City

Texas City, located in Chambers and Galveston Counties, is a very industrial city that borders Galveston Bay. It has a port and is a petroleum refining and petrochemical manufacturing center that is vital to the energy related production process of both the Gulf region and the

United States at large.[222] It has the densest energy infrastructure in the country and the Port of Texas City is the third largest port in Texas and the fifteenth largest in the United States.[223] Its refineries and other infrastructure are necessary to the entire nation, and damages to it from natural disasters such as Hurricane Ike can be catastrophic to the nation.

The Texas City Dike extends almost to Galveston Island and is designed to protect Texas City from storm surges. Texas City also has 18 ft. hurricane levees that protect homes, oil refineries, and chemical plants from storm surge or SLR-induced flooding.[224] The levees were built to protect the city from water levels, tides, and wave energy criteria as calculated in 1987. The region has undergone at least 3 ft. of subsidence since it was completed.[225] According to anecdotal evidence, debris from Hurricane Ike reached the top of the levee, indicating that the levees were almost overtopped.[226] Although some minor damage from Hurricane Ike was repaired, the fundamental problems with the levees continue and will only get worse with time. Little to no municipal attention has been devoted to these issues.[227] In the 2014 SSPEED Center Final Report on the Centennial Gate, a proposal offered two structural adaptation alternatives that would link the Centennial Gate with the Texas City Levee.[228] Whether this would bring the needed attention to the problems with the levee, like the overall project of the Centennial Gate, is uncertain.

Adaptation options in Texas City are limited by the existence of areas of high population and intensive infrastructure development which present extremely difficult challenges to potentially relocate. Typically, armoring should not be considered the first choice for adaptation as armoring may significantly harm natural systems and adjacent properties in the long run.[229]

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[222] T. B. Ryerson, *Effect of petrochemical industrial emissions of reactive alkenes and NOx on tropospheric ozone formation in Houston, Texas*, 108 Journal of Geophysical Research (2003).
[223] Roy Scranton, When the Next Hurricane Hits Texas The New York Times (2016), https://www.nytimes.com/2016/10/09/opinion/sunday/when-the-hurricane-hits-texas.html (last visited Mar 21, 2017); Tonnage of Top 50 U.S. Water Ports, Ranked by Total Tons, Bureau of Transportation Statistics, https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_57.html (last visited Mar 21, 2017).
[224] Dan Feldstein, *Deficiencies found in Texas City's levees*; Houston Chronicle, July 23, 2006. http://www.chron.com/neighborhood/baytown-news/article/Deficiencies-found-in-Texas-City-s-levees-1570534.php; J.B. Blackburn, *et. al*., SSPEED Center 2014 Report. http://sspeed.rice.edu/sspeed/downloads/HE_Final_Report_2014.pdf.
[225] Titus, Barth, *A Challenge For This Generation*; pg. 134; Dan Feldstein, *Deficiencies found in Texas City's levees*; Houston Chronicle, July 23, 2006. http://www.chron.com/neighborhood/baytown-news/article/Deficiencies-found-in-Texas-City-s-levees-1570534.php
[226] J.B. Blackburn, *et. al*., SSPEED Center 2014 Report. Pg. 9 http://sspeed.rice.edu/sspeed/downloads/HE_Final_Report_2014.pdf.
[227] Certification of Texas City Hurricane-Flood Protection Levee System *in accordance with* 44 CFR 65.10 Galveston County, Texas. http://www.galvestoncountytx.gov/Documents/-%20Chapter%200%20-%20Executive%20Summary.pdf
[228] J.B. Blackburn, et. al., SSPEED Center 2014 Report. http://sspeed.rice.edu/sspeed/downloads/HE_Final_Report_2014.pdf.
[229] Living Shorelines: The preferred Approach to Shoreline Erosion Protection, Virginia Department of Environmental Quality (2012),

Armoring projects, such as revetments, seawalls, and jetties, accelerate erosion on adjacent beaches and cause a decrease in the areal extent of wetlands through coastal squeeze.[230] For this and other reasons discussed elsewhere in this paper, armoring should be regarded as the adaptation option of last resort.

However, in areas of high population, it may be the most viable for the inhabitants because of inflexible infrastructure that comes with established cities. For instance, protecting the coastline with armoring can be necessary in areas where there is considerable existing development or critical infrastructure, such as Texas City and its oil refineries. Despite their negative effects, armoring may be necessary to protect Texas City from flooding and SLR-induced damages for some time due to the importance of the infrastructure located there at both the state and national levels.

Texas City has also pursued other avenues of protecting itself from storm surges from hurricanes, and these precedents may bolster the region in regards to SLR preparations. Like most coastal cities, Texas City has embraced flood damage prevention in the form of a floodplain development permit system, detailed in its Code of Ordinances. It references the Flood Control and Insurance Act of Texas, which delegates flood damage prevention power to local governments in order to become eligible for at least participation in NFIP.[231] Texas City's Code requires, among other things, that uses vulnerable to flooding be built with protections already in place.[232] It also controls development, which would increase flood damage, controls alteration of natural protective barriers, and regulates construction of flood barriers that would unnaturally divert or increase flood hazards.[233]

Most municipalities, including Texas City, have enacted ordinances with varying levels of strength. For example, some municipalities and counties have established a higher standard above the NFIP's Base Flood Elevation (BFE) called freeboard, which is a "safety factor," added to protect against unknown variables such as SLR. Freeboard does not rely on previous conditions to set a minimum building elevation but rather acknowledges problems with current information and coming future conditions.[234] While the benefits of cost efficiency and reduced flood insurance premiums are highlighted in a recent FEMA report, freeboard also may delay damage from SLR.[235]

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http://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/Living%20Shorelines%20Fact%20Sheet.pdf (last visited Feb 15, 2017).

[230] *See, supra* Figure 2, p. 2.

[231] Texas Water Code Ann. § 16.315. http://codes.lp.findlaw.com/txstatutes/WA/2/C/16/I/16.315

[232] Texas City Code of Ordinances § 157.04. Methods of reducing flood losses. https://www.municode.com/library/tx/texas_city/codes/code_of_ordinances?nodeId=PTIICOOR_CH58FL

[233] City of Texas City, Texas Code of Ordinances, Sec. 11-4. Methods of reducing flood losses. https://www.municode.com/library/tx/texas_city/codes/code_of_ordinances?nodeId=PTIICOOR_CH58FL

[234] Larry Tanner, *et. al.*, Hurricane Ike in Texas and Louisiana, Mitigation Assessment Team Report. Pg. 2-6. http://www.fema.gov/media-library-data/20130726-1648-20490-1063/757_ch2_final.pdf.

[235] FEMA (September 2015). Reducing Flood Risk to Residential Buildings That Cannot Be Elevated. https://www.fema.gov/media-library-data/1443014398612-a4dfc0f86711bc72434b82c4b100a677/revFEMA_HMA_Grants_4pg_2015_508.pdf.

The federal government set minimum floodplain requirements for participating in the NFIP; however, local governments in Texas still have the option to implement stricter standards. Some communities on Galveston Bay's west side have improved their building codes since Hurricane Ike, and freeboard was one of the improvements.[236] In a 2014 Floodplain Management Association study, 83% of the 294 community responses have adopted a freeboard ordinance of 1 ft. above BFE or more.[237] Galveston County, in which Texas City is located, has a freeboard requirement of 2 feet above existing BFE.[238] However, even with these higher freeboard standards, high-risk areas may still experience flood damage and remain vulnerable to SLR. Therefore, counties and municipalities may enact higher standards in the future with SLR in consideration. Like freeboard, counties and municipalities may enact other requirements and restrictions to address SLR flood damage as long as counties and municipalities are sensitive to the possibility that some types of regulation may impose undue restrictions on private landowners and result in claims of a taking of private property.

## 4.2 Anahuac

According to a 2009 NOAA report investigating inland wetlands of the Texas coast, the Upper Texas Coast has the "most extensive contiguous marshland" in the state, with a large amount of marsh found partially in Anahuac National Wildlife Refuge (NWR).[239] The land cover in this area is freshwater marshes and ponds.[240] The city of Anahuac, which is located between Lake Anahuac and Trinity Bay, and Anahuac NWR, which borders Galveston Bay, are separated by 26 miles. Therefore, they are analyzed separately not only due to the authority that governs them but also because dissimilar geographic contexts could make a difference in SLR adaptation strategies.

Living shorelines present an excellent option for many areas of Anahuac. It will protect the ecosystems and wetlands and is an effective method for sustainable, long-term reduction in damage from flooding and SLR. Some of the concerns with implementing living shorelines in Anahuac are the cost of creation and the maintenance, replacement, or costs to address failure.[241]

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[236] J.B. Blackburn, *et. al*., SSPEED Center 2014 Report. Pg. 9 http://sspeed.rice.edu/sspeed/downloads/HE_Final_Report_2014.pdf.

[237] (The survey is based on 294 responses out of 1,240 communities enrolled in the NFIP). 2014 Freeboard Survey Details. Floodplain Management Association. http://www.tfma.org/search/all.asp?bst=freeboard+%20survey.

[238] 2014 Freeboard Survey Details. Floodplain Management Association. http://www.tfma.org/search/all.asp?bst=freeboard+%20survey.

[239] Thomas A. Tremblay, Thomas R. Calnan. *Status and Trends of Inland Wetland and Aquatic Habitats, Beaumont-Port Arthur Area*. Pg. viii. Final Report prepared for the Texas General Land Office and National Oceanic and Atmospheric Administration. 2009. www.glo.texas.gov/coastal-grants/_documents/grant-project/s-and-t-beaumont-port-arthur-area-2009.pdf+&cd=1&hl=en&ct=clnk&gl=us.

[240] *Id*.

[241] Living Shoreline Implementation: Challenges and Solutions (Summer 2014, Vol. 9, No. 2) http://ccrm.vims.edu/publications/pubs/rivers&coast/RC914.pdf.

### 4.2.1 City of Anahuac

Anahuac is a coastal city with two miles fronting Trinity Bay, a northeastern part of the Galveston Bay system.[242] Anahuac, like many other bay cities in Texas, was devastated in the wake of Hurricane Ike, which swept away private homes and damaged important attributes of its economy. For example, its local alligator population, which supports tourism and local businesses, was also swept away.[243]

Since the storm, Anahuac has been trying to reestablish its infrastructure and its economy with varying levels of success.[244] As a partial solution to the current problems, the city is determined to see the Ike Dike proposal come to fruition.[245] The City of Anahuac is not in favor of the alternate plan, the Centennial Gate. Even with the location change from Highway 146 to the Hartman Bridge because of local opposition, the Centennial Gate will still not protect many cities, including Anahuac.[246] Therefore, some municipalities on the eastern edge of Galveston Bay, including Anahuac, support the Ike Dike plan, which they feel would protect them.[247] On February 9, 2015, the City Council of Anahuac passed a resolution fully embracing and endorsing the Ike Dike project as the best and most viable option to protect communities and its ecosystems.[248]

### 4.2.2 Anahuac National Wildlife Refuge

The federal government established Anahuac NWR in 1963, and today it covers 34,000 acres of marsh and coastal prairie.[249] The U.S. Fish and Wildlife Service (USFWS) manages a Comprehensive Conservation Plan that organizes all the national refuges including Anahuac NWR with the aim to protect certain species, ecosystems, and wetlands.[250]

Hurricane Ike's storm surge inundated Anahuac NWR by more than 10 ft.[251] This completely flooded freshwater wetlands with salt water, causing major habitat damage.[252] Although there was substantial damage and retroactive measures had to be taken to preserve habitats, the

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[242]City Council of Anahuac, Texas. Resolution No. 2015-02-04. http://www.tamug.edu/ikedike/images_and_documents/City%20of%20Anahuac.pdf.

[243] David J. Phillip. *Alligator capital of Texas hit hard by Ike*. September, 2008. http://usatoday30.usatoday.com/news/nation/2008-09-30-ike-alligator_N.htm

[244] *See Archer Group , LLC v. City of Anahuac*, 01-14-00664-CV, 2015 WL 4624249, at *1 (Tex. App.—Houston [1st Dist.] Aug. 4, 2015, no. pet. h.) (In recovery from Ike, Anahuac tries to build a marina with different funding and a dispute occurs over the contract.)

[245] City Council of Anahuac, Texas. Resolution No. 2015-02-04.

[246] Charles Kuffner. *Ike Dike versus Centennial Gate*. http://offthekuff.com/wp/?p=62070

[247] *Id*.

[248] City of Anahuac. http://www.tamug.edu/ikedike/images_and_documents/City%20of%20Anahuac.pdf

[249] Friends of Anahuac National Wildlife Refuge. http://www.friendsofanahuacnwr.com/TheRefuge

[250] The U.S. Fish and Wildlife Services. https://www.fws.gov/refuge/Anahuac/what_we_do/planning.html

[251] Federal Emergency Management Act, Hurricane Ike Storm Surge FEMA High Water Marks Harris County Flood Control District (2009), https://www.hcfcd.org/media/1241/ike_highwatermarks_maps.pdf (last visited Feb 16, 2017).

[252] Friends of Anahuac National Wildlife Refuge. Surge map from Harris County FCD, 2009. http://www.friendsofanahuacnwr.com/HurricaneRecovery.

storm itself caused potential developers to look elsewhere and provided USFWS with the opportunity to expand the refuge by acquiring surrounding lands impacted by the storm.[253]

It should be noted that the LSCRNA includes Anahuac NWR.

## 4.3 Galveston

Galveston is located on a barrier island bordering the Gulf to the southeast and Galveston Bay to the northwest. The east side of the island is urban with an industrial port whereas the west side is suburban with vacation home developments. Like Texas City, Galveston has historically used armoring to protect itself from hurricanes. In response to the deadly Hurricane of 1900, the city began building a 17 ft. tall seawall in 1902. In 2000, Galveston continued this localized armoring by placing geotextile tubes at the shoreline in areas not protected by the seawall.[254] Geotextile tubes are made of earthen material packed in textiles.

The Galveston Seawall, which has now been in place for over a century, provides some protection from SLR on the Gulf-facing side of Galveston Island; however, the seawall does have negative effects. If shoreline armoring is implemented more extensively on Galveston's beach as a way to adapt to the effects of SLR, the beach will be destroyed in a number of ways. Armoring accelerates erosion by causing deflected waves to scour sand away and erode the areas on the sides of the structure, depleting adjacent beaches.[255] Therefore, the construction of a seawall generally leads to the need for another further down the beach; while the seawall will protect one property, the erosion effect is exacerbated and passed along to the neighboring property.[256] Lastly, shoreline armoring might persuade builders that it is safe to develop in the area close behind the bulkhead when it would be better for development to be moving away from the coastline. The seawall thus can create a communal "perception of stability and can lead to an intensification or densification of coastal uses that are dependent on the seawall for protection."[257]

Armoring the shoreline also has social effects. Armoring will ultimately result in the total loss of public beach seaward of the structure in a process known as coastal squeeze, thus limiting beach access and preventing various forms of coastal recreation in the area. Therefore, it permits the desires of private property owners to protect their property to dominate over and

[253] Friends of Anahuac National Wildlife Refuge. http://www.friendsofanahuacnwr.com/HurricaneRecovery

[254] Yoskowitz, Gibeaut, McKenzie, *The Socio-Economic Impact of Sea Level Rise in the Galveston Bay Region: A report for the Environmental Defense Fund;* pg. 15, June 2009. http://www.edf.org/sites/default/files/9901_EDF_Sea_Level_Rise_Report.pdf.

[255] See http://nsglc.olemiss.edu/sglpj/Vol1No1/3Higgins.pdf. See also, Gary A. Klee, The Coastal Environment: Toward Integrated Coastal and Marine Sanctuary Management (1999) at 83-118.

[256] Resource Issues: Coastal Armoring and Erosion, Monterey Bay Nat'l Marine Sanctuary, Nat'l Oceanic & Atmospheric Admin., https://montereybay.noaa.gov/resourcepro/%20resmanissues/coastal.html [http://perma.cc/MKZ8-EN28] ("Armoring also causes deflection of wave energy, which can accelerate erosion of nearby sites, expanding the need for shoreline armoring structures.").

[257] Managing Coastal Armoring and Climate Change Adaption in the 21st Century (2015) http://law.stanford.edu/wp-content/uploads/2015/07/CalCoastArmor-FULL-REPORT-6.17.15.pdf.

potentially damage public trust resources and public access to the beach. A loss of public access raises many issues, such as environmental justice concerns, because "the segment of the public that uses public beaches is typically not the same segment of the public that protects shoreline structures."[258] The important social resources and functions of public beaches as well as critical tourism revenue will no longer exist after shoreline armoring, unless projects such as beach nourishment are implemented.

Armoring can also be damaging to the social fabric of the community because of unpredicted and extensive litigation costs, as neighbors fight neighbors over the end effects of their seawalls. These impacts are important on a larger scale because social cohesion is an important aspect of community resilience.[259] Research after Superstorm Sandy conducted a survey to learn how neighborhood physiognomies and social factors related to recovery and resilience. [260] This survey showed that the level of trust in a community was a crucial signal of resilience and rebuilding. These findings support "extant literature… that factors such as social network connectedness, social cohesion, trust, and community bonds facilitate social interaction and information exchange. This reservoir of social resources can then be drawn upon in the event of a disaster."[261]

Shoreline armoring is expensive to install and requires costly ongoing maintenance. Furthermore, other problems with armoring are well documented: it disrupts the movement of sediment along beaches by blocking the movement of sand along the shoreline and sequestering sediment that would normally erode to form other beaches; it disrupts the natural processes that replenish the shoreline, reducing the natural delivery of sand and gravel to the shoreline; armoring contributes to narrowing and loss of beaches and impedes the public's right to lateral shoreline access; armoring may exacerbate flood risk by disrupting natural floodplain processes; and armoring isolates the land from the water, resulting in habitat loss and altering the amount of marine life.[262]

Galveston has important infrastructure such as Texas A&M University- Galveston and several medical centers. However, its infrastructure is not as dense nor economically important as Texas City. Because of this, it may be best for Galveston to pursue armoring in some areas while leaving others in a more natural state.

TOBA and DPA limit armoring on Gulf-facing beaches and provide legal authority for land planning, setbacks, and the denial of permits. However, the strongest basis for SLR adaptation for Gulf-facing Galveston is not as strong as once supposed. The *Severance* case weakened

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[258] *Id*.

[259] Dooley, Ben. "Community bonds, not seawalls, key to minimizing deaths: 3/11 study." The Japan Times. N.p., n.d. Web. 06 Apr. 2017. < https://www.japantimes.co.jp/news/2014/04/16/national/community-bonds-not-seawalls-key-to-minimizing-deaths-311-study/#.WH0zwVMrLmF>.

[260] *See Resilience in the Wake of Superstorm Sandy* (June 2013), available at http://www.apnorc.org/PDFs/Resilience%20in%20Superstorm%20%20Sandy/AP_NORC_Resilience%20in%20the%20Wake%20of%20Superstorm%20%20Sandy-FINAL_fxd.pdf.

[261] *Id*.

[262] *See, supra* Fig. 2 and notes 3-9 and accompanying text.

TOBA, and as a consequence SLR efforts will be more difficult to implement as a direct result.[263] For example, the GLO canceled a $40 million beach nourishment project on West Galveston in *Severance*'s direct aftermath because of confusion over whether the GLO would be illegally spending public funds on improvements to private land.[264]

TOBA could still be utilized within nourishment efforts, however. Private residents are allowing public access to the newly formed beach, which, in effect, replaces the easement that the *Severance* case denied. In regards to two of the nourishment projects, the USACE is funding the sand while the Galveston Park Board will pay for transportation costs. The Board plans to continue this process annually, and it will be funded by a small sum from sales tax revenue set aside for beach maintenance. Furthermore, the city has stricter building requirements than the minimum standards of federal guidelines.[265] This acknowledges the municipality's need and willingness to take charge of implementing limits in regards to city land use and SLR.

While a very common beach management technique, beach nourishment also has limitations and some negative effects. Beach nourishment really only protects any buildings in the immediate vicinity from erosion; while some sources claim that building up the beach protects it from being eroded away completely, the most sustainable long-term solution may be to move the buildings landward and allow the beach to migrate and thus naturally sustain itself (see organized relocation, pg. 49).[266] The cost to distribute dredged sand along a new or existing beach can be very great, there is an ecological impact of dredging and depositing the sand, and sand can quickly erode.[267] It only temporarily alleviates the problem and it is expensive.[268] Nourished beaches can also damage any coral or oyster reefs offshore as the new sand erodes and buries the reefs. For instance, in Broward County, Florida, sedimentation stress likely killed *Montastrea annularis* colonies measuring up to 10 ft. across that were

[263] For a fuller discussion of the *Severance* case and how it changed the Texas Open Beaches Act (TOBA), *see supra* § 2.4.1 (notes 37-51 and accompanying text).
[264] Neena Satija. *Debating What's More Sacred: Private Land or Public Beaches.* The Texas Tribune. September 28, 2014. http://www.texastribune.org/2014/09/28/open-beaches-law-uncertain/
[265] Marissa Barnett. *Rising seas and shrinking lands*. August 23, 2015. http://www.galvnews.com/news/article_1abf4388-4943-11e5-9bfe-1fbd69552e95.html
[266] Migration of beaches, in the absence of managed inlets/jetties or other significant human intervention, represents a natural phenomenon of sea level, wave energy, and sand supply dynamics that has played out for millions of millennia. Beach migration becomes "erosion" when it threatens human interests. *See, e.g.* Thomas Ruppert *et al.*, Eroding Long-Term Prospects for Florida's Beaches: Florida's Coastal Management Policy 12-13 (2008), at https://www.law.ufl.edu/_pdf/academics/centers-clinics/clinics/conservation/resources/coastal_management_finalreport.pdf
[267] Jeroen Speybroeck *et al*., Beach nourishment: an ecologically sound coastal defence alternative? A review, 16 Aquatic Conservation: Marine and Freshwater Ecosystems 419–435, 419-435 (2006) and Charles W. Finkl, What might happen to America's Shorelines if artificial beach replenishment is curtailed: a prognosis for southeastern Florida and other sandy regions along regressive coasts, 12 Journal of Coastal Research iii-ix, iii-ix (1996).
[268] Meg Caldwell & Craig Holt Segall, *No Day at the Beach: Sea Level Rise, Ecosystem Loss, and Public Access Along the California Coast*, 34 Ecology L.Q. 533, 547 n.76 (2007) ("[Beach nourishment] is costly and not a permanent fix, as adding sand does not change the underlying forces that are eroding the beach.").

approximately 500 years old.[269] Beach nourishment allows for continued use of the beach until it is eroded again, which typically occurs every two to six years.

Texas is moving towards enabling local governments to enact construction setbacks for the barrier islands along the Gulf of Mexico. The state Legislature passed House Bill (HB) 2819 legislation during the 80th session in 2007.[270] HB 2819 amended TOBA and the DPA. Two of the most important focal points of the bill are the setback requirements and increased enforcement abilities of the General Lands Commissioner to maintain an accessible public beach. This bill was an attempt to reduce the cost of storm damage, disaster response, and erosion by authorizing, but not mandating, local jurisdictions to establish building setbacks as part of a local erosion response plan.

HB 2819 authorizes the Commissioner to determine what constitutes an imminent threat to public health and safety or interference with the public beach easement.[271] It also authorizes the Commissioner to order the removal of structures that encroach on the public beach easement and to assess administrative penalties, costs for the removal of structures, or the sale of salvageable parts.[272] Lastly, it encourages local governments to develop erosion response plans that incorporate setback lines for new construction. The Commissioner may consider whether a local government creates a setback that takes into account the erosion rates when awarding funding under the Coastal Erosion Planning and Response Act (CEPRA).

CEPRA will provide $15 million in funding for projects designed to study or minimize erosion between the years of 2015 and 2017. [273] It has no permanent funding source, but rather the Texas Legislature must appropriate funds every two years. CEPRA funds are matched with local-level projects designed to protect or better understand Texas beaches, dunes, and wetlands. These projects not only protect ecosystem services but also Texas' infrastructure and future economic prospects.

At the time of writing, the existing setback distance in Galveston was just 25 ft.[274] In accordance with HB 2819, the GLO proposed Rule 15.16 under which local jurisdictions would have been given the option to require that new buildings be set back by one of three calculations: "[(1)] 60 times the annual erosion rate, measured from the line of vegetation[; (2)] 25 feet landward of the landward toe of the dunes[; or (3)] 300 feet landward of the mean-high-water line."[275]

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[269] Thomas J. Goreau & Dan Clark, Reef Protection in Broward County, Florida, Global Coral (2001), http://www.globalcoral.org/reef-protection-in-broward-county-florida/ (last visited Feb 16, 2017).
[270] 80th Texas Legislature, Regular Session, House Bill 2819, http://www.legis.state.tx.us/tlodocs/80R/billtext/html/HB02819F.htm. Codified at Tex. Nat. Res. Code Ann. § 61.015 (2016).
[271] HB 2819 § 61.0184(b)(1)(A).
[272] HB 2819 § 61.0183.
[273] CEPRA: Coastal Erosion Planning and Response Act, Texas Coastal Program Potential Funding Sources (2015), https://www.fws.gov/southwest/texascoastal/funding.html (last visited Feb 15, 2017).
[274] Leigh Jones, *Locals Still Suspicious of Beach Setback Rules*, Daily News, July 9, 2008, *available at* http://galvestondailynews.com.
[275] Jerry Patterson, *Beach Rule Proposals are Fair and Flexible*, Daily News, June 12, 2008, http://galvestondailynews.com/story.lasso?ewcd=cfbb4eafa36eb920c854 [hereinafter *Beach Rule Proposals*]. The

Galveston officials did not respond positively to this proposal, and the proposed rules in Texas were withdrawn as of November 17, 2008. The ability to make local level decisions is highly valued in Texas, and local counties did not respond well to legislation that would allow a state agency to tell them how far back they must build. Nevertheless, this was a positive step towards increasing the dialogue about erosion and SLR. Since this time, there has been no additional state action or proposals on developing a significantly stronger state setback requirement.

The most comprehensive effort to address the effects of SLR was the legislative requirement for local governments to develop Erosion Response Plans (ERPs). In 2009, the 81st Texas legislature adopted Texas Natural Resources Code §33.607 which required local governments along the Texas coast to develop plans for reducing public expenditures for erosion and storm damage losses. The Land Commissioner would take into consideration whether such a plan was in place as one of several considerations when allocating CEPRA funds. The GLO adopted rules to guide local government preparation of ERPs. The rules were intended to ensure that local governments enact regulations to reduce future storm damage and protect public access to beaches. Provisions such as construction setbacks and other measures to adapt to shoreline erosion and storm damages varied among the local government ERPs. This legislation did not require that setbacks be adopted as part of these plans but rather made inclusion of them optional.

The City of Galveston adopted its ERP in 2012.[276] The plan designated a Dune Conservation Area, defined as "areas along Galveston's Gulf Coast where beachfront dunes naturally occur and where restored, manmade dunes may be located. The Dune Conservation Area shall also include lands within 25 ft. of the north toe of existing or restored (man-made) dunes." The ERP also provides for an Enhanced Construction Zone, defined as "areas immediately landward of the Dune Conservation Area with the potential to be [a]ffected by the long-term effects of erosion." [277] The Enhanced Constructed Zone applies to areas with combined shoreline "Change Rates between -2 and -8 ft. per year." Enhanced Constructed Zone areas are subject to more stringent building and development standards than those outside the zone.[278] Further, amendments to existing regulations "prohibit construction within or seaward of the Dune Conservation Area and provide for exemptions for new construction and renovations of existing structures." [279] Also included in the plan are site and building design instructions, guidelines for large-scale construction, and a requirement that plans must provide evidence that

historical erosion rate used is that determined by the University of Texas at Austin, Bureau of Economic Geology. 33 Tex. Reg. 3885 (proposed May 16, 2008).

[276] City of Galveston Erosion Response Plan, April 12, 2012, http://www.cityofgalveston.org/DocumentCenter/View/1712.

[277] City of Galveston Erosion Response Plan (p. 13).

[278] City of Galveston Erosion Response Plan, Ordinance Number 12-018. April 2012. http://www.galvestontx.gov/AgendaCenter/ViewFile/Item/1427?fileID=4596.

[279] *Id*.; Galveston Code of Ordinances Chapter 29, Article 3, Division 5, Sec. 29-51. https://www.municode.com/library/tx/galveston/codes/code_of_ordinances?nodeId=PTIICOCI_CH29PLEAACDUPRBEFRCO_ARTIIIERREPL_DIV5COSTCO_S29-51AREXPRCOWISEDUCOAR.

"[c]onstruction is designed to minimize impacts to natural hydrology."[280] Not every county has a plan, and there are currently no statewide setback requirements for new construction in Texas.[281]

To better understand the threats posed by SLR, the GLO, in coordination with the University of Texas' Bureau of Economic Geology (BEG), Texas A&M University- Corpus Christi, NGOs, and local governments including the City of Galveston worked to produce geohazard maps for Galveston, Mustang, and South Padre Islands.[282] Other than implementing some of the measures identified in the ERPs, the City of Galveston took no other specific actions to change planning and development policies in direct response to the threat of SLR. Some land acquisition of high hazard areas did occur on Galveston Island, but mainly with a focus on wetland habitat conservation.

### 4.3.2 Bay-Facing Galveston

While there have been both federal and local efforts to address climate change and pollution problems, the issues of Galveston Bay have outraced restoration and preservation efforts.[283] In a span of 14 years, the Bay lost almost 400 acres of saltwater and almost 14,000 acrese of freshwater wetlands to development; but this rate of loss has slowed since 2010 due to regulation and local efforts.[284] However, development itself is not the only problem for wetlands. Additionally, the actual structures left over from development prevent wetland survival.[285] When the sea rises, wetlands naturally migrate upland to stay in the same elevation range relative to sea level. Natural wetlands in developed areas such as bay-facing Galveston cannot migrate upland due to impervious surfaces. Without the ability to migrate upwards, marsh is lost due to permanent flooding.[286]

The Galveston Bay Foundation (GBF), a private non-profit organization, has protected and restored over 16,500 acres of wetland habitats.[287] For its East Bay Restoration Project, the GBF joined with the USFWS and other partners to protect the Anahuac NWR's bay shorelines.[288] The GBF's efforts extend to 5,269 acres of land conservation through property purchase, donations, or conservation easements.[289] Potential federal tax incentives, which were recently expanded, are one of the ways the federal government makes conservation easement donations more

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[280] *Id*.
[281] Mark Randall and Hendrik deBoer, "Coastline Construction Restrictions", 2012. https://www.cga.ct.gov/2012/rpt/2012-R-0046.htm.
[282] The Galveston geohazards map can be viewed at: http://geohazards.tamucc.edu/Galveston/GalHazard.html.
[283] Marissa Barnett. *Urbanization, pollution putting health of Galveston Bay at risk*. August 13, 2015. http://www.galvnews.com/news/article_0acf3846-4175-11e5-b91f-677fc4ae037e.html
[284] *Id*.
[285] *Id*.
[286] *Id*.
[287] Galveston Bay Foundation. http://www.galvbay.org/how-we-protect-the-bay/on-the-ground/wetlands-restoration/.
[288] Galveston Bay Foundation. http://galvbay.org/how-we-protect-the-bay/on-the-ground/east-bay-restoration-project/.
[289] Galveston Bay Foundation. http://galvbay.org/how-we-protect-the-bay/on-the-ground/land-conservation/.

attractive.[290] In 2015, Congress made permanent one of the most powerful conservation measures in decades: the enhanced federal tax incentive for conservation easement donations, defined under §170 of the Internal Revenue Code (IRC).[291] A conservation easement, also known as a conservation agreement, is a voluntary and legally binding agreement between a property owner and a land trust or government agency. When a property owner donates an easement to a land trust, she or he is giving away one or more of the rights associated with land ownership such as the right to manage resources, change use, subdivide or develop. The easement permanently restricts uses of the donated parcel in order to protect its conservation values as specified in the IRC § 170(h).[292]

For donations of conservation easements, a deduction of up to 50% of the taxpayer's adjusted gross income can generally be taken. The 50% deduction can be used in the year the donation was made and then carried forward to the succeeding fifteen years.[293] If the individual is a qualified farmer or rancher in the taxable year that the contribution is made, meaning that his or her gross income from the business of agriculture is greater than 50% of the total gross income, he or she can deduct up to 100% of the value of their gift under the deduction rules.[294] Conservation easements enable landowners to protect their resources and lifestyle for future generations whilst maintaining private ownership and preserving the land for outdoor recreation, natural habitats, historic preservation, and scenic enjoyment. The GBF describes conservation easements as "ideal for landowners like farmers or ranchers who want to continue to farm or ranch the property, but forever conserve the property's conservation value."[295]

GBF also offers private owners help in designing, applying for permits, and installing living shorelines as a shoreline stabilization technique. GBF has been very effective in its use of private ownership rights as a lever to address SLR impacts rather than as a barrier. GBF's work demonstrates that private organizations, either with or without federal backing, can play a role in adapting to SLR impacts.

On the State level, the GLO has the potential to direct funding from the Coastal Management Program (CMP) towards SLR adaptation. In the instance of the Upper Texas Coast area wetlands, the GLO has awarded funds from NOAA for a GeoTechnology Research Institute study of efforts to preserve Galveston and Harris counties' wetlands (Fig. 5).[296] The Institute analyzes USACE 404 permit (dredge and fill permits, typically associated with activities in wetlands) records from 2008-2015 to measure success of the sites. This is the result of the Coastal Public Lands Management Act, which directs the GLO commissioner to maintain a comprehensive

[290] *Id.*
[291] Land Trust Alliance, "Income Tax Incentives for Land Conservation," http://www.landtrustalliance.org/topics/taxes/income-tax-incentives-land-conservation.
[292] *Id*. The expanded incentive only applies to gifts that qualify under IRC 170(h)(2).
[293] 26 U.S.C. §170(b).
[294] 26 U.S.C. §2032A(e)(5).
[295] Galveston Bay Foundation, http://www.galvbay.org/ways-to-give/by-donating-or-joining/gifts-of-real-estate/.
[296] Texas General Land Office. http://www.glo.texas.gov/what-we-do/caring-for-the-coast/grants-funding/projects/16-068-toward-wetland-protection.html.

coastal management program and thus efficiently manage coastal natural resource areas.[297] As the CMP has been the framework within which diverse environmental projects have occurred in coastal Texas, it could serve as a source for SLR adaptation efforts. Unfortunately this role remains dramatically curtailed since the CMP is limited to public lands.[298]

Galveston Island State Park has implemented living shorelines. Living shorelines use soft materials to improve the ecologic connectivity between the land and sea while combatting erosion.[299] The Park does not rely on the City of Galveston for its funding nor is it as limited as the city when dealing with erosion and SLR.[300] The Park initially created an artificial dune, which then grew into naturally occurring dunes. The Park also allowed seaweed to remain in place; this is in contrast to the city of Galveston, which rakes it away for aesthetic purposes.[301] The seaweed naturally protects against erosion and the effects of SLR.[302] Living shorelines have the potential to accrete vertically at or more than the rate of SLR[303], and thus it protects against erosion. Houston has started implementing living shoreline projects. [304] However, currently, shoreline armoring projects are much more widely accepted than living shorelines.[305]

## 4.4 Surfside Beach

Surfside Beach is a small, low-lying town in southern Brazoria County located on the Gulf of Mexico. It has a permanent population of less than 1,000 people. Surfside's Gulf average annual shoreline relocation rate is up to 15 feet per year.[306] The region's erosion is caused by both sea level rise and lack of sand, which is due to historical anthropogenic changes to the Brazos River and the dredging of Freeport Harbor Ship Channel.[307] Surfside's subsidence rates are between -3 and -3.2 mm per year.[308] Surfside borders the Gulf, which cannot legally be armored, to the southeast. Because of coastal squeeze and erosion, Surfside beaches have very small dune systems, which increases the vulnerability of the area to SLR.

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[297] Tex. Nat. Res. Code Ann. § 33.051-.053.
[298] Texas General Land Office. http://www.glo.texas.gov/what-we-do/caring-for-the-coast/grants-funding/grants.php.
[299] National Oceanic and Atmospheric Administration's Habitat Blueprint: Living Shorelines. https://www.habitatblueprint.noaa.gov/living-shorelines/.
[300] Tex. Parks & Wild. Code Ann. § 13.004 (2011).
[301] Nathanial Gronewold, E&E Publishing, LLC., Hurricane-smashed Texas barrier island is a magnet for new development; defenses remain pending. http://www.eenews.net/stories/1060014803.
[302] *Id.*
[303] Leslie Middleton, "Living shorelines rising up to offset effects of higher sea levels", Bay Journal, 2015.
[304] Matthew Tresaugue, "Wetland loss slows as 'living shoreline' idea spreads", Houston Chronicle, 2011.
[305] Rachel K Gittman et al., Engineering away our natural defenses: an analysis of shoreline hardening in the US, 13 Frontiers in Ecology and the Environment 301–307, 301-307 (2015).
[306] Conrad Blucher Institute. CEPRA Beach Monitoring Program and Coastal Habitat Restoration GIS: Surfside Beach, http://cbiweb.tamucc.edu/CHRGIS/Surfside-Beach/.
[307] Matthew Tresaugue, *Surfside Beach losing battle against erosion*, Houston Chronicle, July 18, 2009, http://www.chron.com/news/houston-texas/article/Surfside-Beach-losing-battle-against-erosion-1725314.php.
[308] Mukesh Subedee, Marissa Dotson, and James Gibeaut. "Investigating the environmental and socioeconomic impacts of sea level rise in the Galveston Bay, Texas region." Poster presented at Ocean Science Meeting, New Orleans, LA, 21-26 Feb. 2016.

The damage to Surfside from hurricanes has been severe, and its beach is rapidly disappearing. Surfside has historically nourished its beaches in an attempt to protect the built environment against erosion and storms. Beach nourishment projects are arguably effective methods in which to combat erosion and delay SLR impacts. They are temporary abatement measures that could give time for the implementation of other options. The best long-term solution is arguably to relocate away from the shoreline. However, Surfside's residents prefer beach nourishment instead of relocation.

The Village of Surfside and the GLO initiated a shoreline stabilization project in the wake of severe erosion from Hurricane Ike; the project was completed in 2011, following a previous project in response to Hurricane Rita.[309] These projects involved building a revetment and later repairing damages to the revetment resulting from Ike.[310] A revetment is "a facing (as of stone or concrete) to sustain an embankment."[311] Additionally, the GLO began a beach nourishment project on Surfside Beach in May 2015 that involved adding 23,000 cubic yards of sand along 1,200 feet of beach and repairing the same revetment built after Rita.[312] The revetment is "credited with saving tens of millions of dollars' worth of private and public property during Hurricanes Ike and Dolly."[313] However, one could point out that like nourishment, this revetment seems to be a stopgap instead of a real solution to the beach's troubles.

Conversely, relocations further back from the coast provides a much longer-term solution to SLR impacts but remain extremely controversial measures. Rising seas will threaten thousands of coastal communities around the United States in the future; given the limited resources to address SLR impacts, the most important areas will be prioritized. [314] Communities with smaller populations, less costly infrastructure, fewer financial resources, less political clout, and/or less historical importance will be forced to consider relocation due to flooding. For example, Shishmaref, Alaska and the Brownwood subdivision in Baytown, Texas have initiated or have already completed relocation out of threatened areas.[315] Future SLR will exacerbate Surfside's already severe erosion issues. Organized relocation initiated sooner rather than later could ultimately save millions of dollars in beach nourishment projects and, more importantly, could

[309] The Texas General Land Office, Surfside Shoreline Stabilization. http://www.glo.texas.gov/what-we-do/caring-for-the-coast/grants-funding/projects/1471-surfside-shoreline-stabilization.html; FEMA, Final Environmental Assessment, Surfside Beach Shoreline Protection Project, August 2007, http://www.fema.gov/media-library-data/20130726-1606-20490-4233/surfsidebeach_fea.pdf.

[310] The Texas General Land Office, Surfside Shoreline Stabilization. http://www.glo.texas.gov/what-we-do/caring-for-the-coast/grants-funding/projects/1471-surfside-shoreline-stabilization.html.

[311] Merriam-Webster, http://www.merriam-webster.com/dictionary/revetment.

[312] Nathanial Gronewold, E&E Publishing, LLC., Hurricane-smashed Texas barrier island is a magnet for new development; defenses remain pending. http://www.eenews.net/stories/1060014803

[313] *Id.* Quoting the GLO.

[314] Jon Gertner, Should the United States Save Tangier Island From Oblivion? The New York Times (2016), https://www.nytimes.com/2016/07/10/magazine/should-the-united-states-save-tangier-island-from-oblivion.html (last visited Feb 16, 2017).

[315] Merrit Kennedy, Threatened By Rising Seas, Alaska Village Decides To Relocate NPR (2016), http://www.npr.org/sections/thetwo-way/2016/08/18/490519540/threatened-by-rising-seas-an-alaskan-village-decides-to-relocate (last visited Feb 16, 2017); History of Site | Friends of the Baytown Nature Center, http://www.baytownnaturecenter.org/bnc_information/history_of_site.html (last visited Feb 16, 2017).

save human lives when the next great storm hits because the community would be located in a less hazardous area.

However, many residents do not consider relocation a viable option since Surfside already has developed infrastructure along its coastline. A typical setback law requires that homes and other buildings must be constructed a certain distance from the street, but the same is true for coastal properties. [316] Setback laws can be enacted in expectation of potential future SLR, requiring development to be constructed further back from the coast in expectation of future SLR. Surfside's governing authority could enact setback regulations through referencing the changing rate of erosion in that area.[317] This would ensure that setback policies would take into account contemplated SLR.

Typically, setbacks are used to protect coastal development and coastal ecosystems. However, the U.S. Supreme Court has also upheld the use of setbacks "to further the goals of open space and access to light and air."[318] Through the use of building setbacks, Surfside can avoid having to repeatedly repair and rebuild structures along the coastline and can reduce the need for coastal armoring to protect such structures. This will help protect the natural beach ecosystem. Building setbacks can minimize new development in low-lying areas. Another way to engage in relocation might be through disinvestment or removal of existing infrastructure. This, however, might raise takings issues.[319] Businesses might divest to save on repair and restoration costs and reduce the inevitable repair and restoration costs as the result of flooding and SLR. It would be a positive consequence for the environment for businesses to begin moving away from building along the coastline. However, community members and investors might not see it that way. For instance, the government's choice to "discontinue maintenance of a shore-side road that is eroding away might lead those dependent on that road for access to their land to assert a taking by denial of access."[320]

Regulatory measures such as setbacks that are enacted in Surfside in anticipation of climate change-induced SLR and that restrict options of coastal property owners will likely be challenged in court. [321] Lawsuits could be based on state and federal constitutional provisions prohibiting governmental takings of property through burdensome land use and environmental regulations. Such actions are typically brought directly under the Fifth Amendment of the

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[316] Setback, Black's Law Dictionary (10th ed. 2014).

[317] *See* Oceanfront Construction Setback Factors, N.C. Div. Coastal Mgmt. [http://perma. cc/S2AM-ADMS] ("North Carolina's oceanfront construction setback factors are calculated using the long-term . . . average annual shoreline change rates").

[318] *Id*. *See Gorieb v. Fox*, 274 U.S. 603 (1927).

[319] Climate Change and Existing Laws: A Survey of Legal Issues, Past, Present, and Future by Robert Meltz (August 20, 2014). See also Travis M. Brennan, Redefining the American Coastline: Can the Government Withdraw Basic Services From the Coast and Avoid Takings Claims?, 14 Ocean & Coastal L. J. 101 (2008).

[320] *See*, e.g., *Jordan v. St. Johns County*, 63 So. 3d 835 (Fla. App.), rev. denied, 77 So. 3d 647 (Fla. 2011); *Jordan v. Canton*, 265 A.2d 96 (Me. 1970). *But see* St. Bernard Parish Gov't v. U.S., 887 F.3d 1354 (Fed. Cir. 2018) (noting that claims concerning maintenance sound in tort, not takings, and that government inaction will typically not support a taking claim).

[321] Douglas M. Halsey & Tina Liebscher, "Consequences of sea level rise – what role for the courts?" http://reports.thomsonreuters.com/susty7/catastrophe/legal-implications-sea-level-rise.

United States Constitution or similar state constitutional provisions seeking just compensation for the taking of property. The Fifth Amendment to the United States Constitution states that "private property [shall not] be taken for a public purpose without payment of just compensation." However, property owners should anticipate regulatory changes where "their rights are 'subordinate' to the government's ability to protect the rights afforded to the public."[322] Fixed setbacks may deprive property holders of all economic use of their property,[323] though courts have noted that property seldom loses all value.[324]

If Surfside does not implement more restrictions on development of the eroding shoreline, emergency responders will continue to spend a large amount of time evacuating coastline residents who live in unsafe areas.[325] This puts the lives of emergency responders at risk since more people will be stranded, injured, or trapped in case of hurricanes or flooding. Therefore, in regions along the coast that are particularly susceptible to erosion and increased flooding due to SLR, there will be higher costs in emergency response time and resources. As coastal development continues to expand, Surfside is "economically exposed to impacts from natural hazards."[326] With the sea level continuing to rise, "governments increasingly will be forced to spend more to respond to emergencies, rebuild flooded infrastructure, and pay insurance claims."[327] The current situation does not alleviate these issues because development in coastal communities is not being discouraged.[328]

As SLR occurs, Surfside's property will be harmed, partially as a result of human actions. If nothing is done by Surfside's government to combat SLR, many residents will turn to tort law to address the harm to their property, as harm caused by human activity is the basis of tort law. The most common environmental tort is public nuisance, which is "an act or omission which obstructs or causes inconvenience or damage to the public in the exercise of rights common to all."[329] The common law action for public nuisance has grown as a way to recover for monetary and other damages; both public officials and private citizens commonly use such suits.[330] Such

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[322] *Slavin v. Town of Oak Island*, 160 N.C. App. 57 (2003) (plaintiff oceanfront property owners brought claim against town seeking compensation for limiting littoral right of access to the ocean as a result of a beach renourishment project).

[323] The Resilient Coast: Policy frameworks for adapting the Built Environment to climate change and growth in coastal areas of the U.S. Gulf of Mexico (p. 30) http://tcwp.tamu.edu/files/2012/06/TheBuiltEnvironment08-sm_000_3.pdf.

[324] *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003, 1034 (1992) (Kennedy, J., concurring).

[325] *See* John Rudolf *et al*., Hurricane Sandy Damage Amplified by Breakneck Development of Coast, HUFFINGTON POST (Nov. 15, 2012), http://www.huffingtonpost.com/2012/11/12/hurricane- sandy-damage_n_2114525.html [http://perma.cc/DM7S-TBBL]. New York City Mayor Michael Bloomberg warns, "If you refuse to evacuate, you're not only putting yourself at risk, but also the first responders who will have to assist you in an emergency."

[326] *See* J. Peter Byrne & Jessica Grannis, Coastal Relocation Measures, *The Law of Adaption to Climate Change: U.S. and International Aspects*, 267 (Michael B. Gerrard & Katrina Fischer Kuh eds., 2012).

[327] *Id*.

[328] *See id.* ("Armoring . . . induces additional development. People build behind armoring with a false sense of safety and as a result, when storms hit and levees fail, people and properties are in harm's way.").

[329] William L. Prosser, Handbook of the Law of Torts § 72, at 570 (1st ed. 1941).

[330] James R. Drabick, *"Private" Public Nuisance and Climate Change: Working Within, and Around, the Special Injury Rule*, 16 Fordham Envtl. L. Rev. 503, 519 (2005) (In the 1960s, 57 public nuisance suits were brought nationwide to

an approach might be used in response to SLR.[331] In determining the unreasonableness of the interference, courts consider: (1) whether the conduct involves significant interference with public health, safety, peace, comfort or convenience; (2) whether a statute or other law makes the conduct unlawful; and (3) whether the conduct is continuous or has a long-lasting effect, and whether the actor knows the conduct to have a significant effect on the public's rights.[332] Under current law, a plaintiff would face a stiff battle to impose liability on a government entity for harms to their private property occasioned by SLR that the government entity failed to stop.[333] However, as law evolves and changes, it may become more likely that governments could become liable for failure to design and construct infrastructure that takes into account SLR impacts. Despite some commentators' assertions to the contrary,[334] it appears unlikely that government entities will anytime soon become liable to be insurers of property owners' property.[335] A more plausible, if still frightening prospect, is that government could be held liable for failure to be able to maintain infrastructure suffering the effects of climate change or SLR[336]

## 4.5 Conclusion

The case studies selected for discussion represent different environments and community values, and as such, comparisons can be drawn about how different communities choose to prepare, or not prepare, for SLR. Environmental parameters and unique social values will determine the best course of action for each community. Highly developed hubs that are vital to the state and national economy, such as Texas City, may be best to continue armoring. Less developed areas such as Galveston may want to pursue a hybrid solution that includes green spaces as well as armoring to protect their most important infrastructure. Lightly developed areas such as Anahuac may want to continue pursuing living shorelines, while lightly developed

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remedy environmental harms. That number increased to 150 in the 1970's, 252 in the 1980's, and 362 in the 1990s).

[331] *Id.* at 518, 535.

[332] *Id*.

[333] For a comprehensive discussion of potential liability issues associated with SLR see, Proceedings From the Symposium on Sea Level Rise and Property Rights, 26 Journal of Land Use & Environmental Law 239-501 (2011).

[334] *See*, *e.g.*, Christopher Serkin, *Passive Takings: The State's Affirmative Duty to Protect Property*, 113 Mich. L. Rev. 345 (2014); Michael Pappas, A Right to Be Regulated?, 24 Geo. Mason L. Rev. 99 (2016).

[335] *See*, *e.g.*, DeShaney v. Winnebago Dep't of Soc. Servs., 489 U.S. 189, 195-96 (1989) ("[Constitutional protections] generally confer no affirmative right to governmental aid, even where such aid may be necessary to secure life, liberty, or property interests of which the government itself may not deprive the individual," and "[l]ike its counterpart in the *Fifth Amendment*, the *Due Process Clause of the Fourteenth Amendment* was intended to prevent government 'from abusing [its] power, or employing it as an instrument of oppression,' . . . Its purpose was to protect the people from the State, not to ensure that the State protected them from each other. The Framers were content to leave the extent of governmental obligation in the latter area to the democratic political processes." (internal citations omitted)). *See also United States v. Sponenbarger*, 308 U.S. 256, 260 (1939) ("[T]he "Fifth Amendment does not make the Government an insurer that the evil of floods be stamped out.").

[336] *See, e.g.* Jordan v. St. Johns County, 63 So. 3d 835, 839 (Fla. Dist. Ct. App. 2011) and Thomas Ruppert, *Castles—and Roads—in the Sand: Do All Roads Lead to a "Taking"?*, 48 ELR ____ (forthcoming 2018). *But see, St. Bernard Parish Gov't*, 887 F.3d 1354 (Fed. Cir. 2018).

areas with severe erosional issues like Surfside Beach may want to consider an organized relocation.

## Chapter 5 Comparisons to Florida

Florida has "more to lose than almost anywhere else in the world" when it comes to SLR damages.[337] Accordingly, they had to get ahead of the issue. Texas can thus look to them for examples of strategies to combat SLR impacts. As SLR and climate change become part of the lexicon of local governments, many have begun assessing their vulnerability to these phenomenon.[338] Some local governments have moved beyond just initial assessments and are working to implement policies and strategies aimed at making them more resilient to the challenges of SLR and climate change in general. This white paper focuses specifically on SLR, though some of the challenges associated with SLR may be exacerbated by climate change. An obvious example of this presents itself in drainage: even as SLR may decrease the effectiveness of existing gravity-based storm water drainage systems, increased intensity of rainfall events due to climate change may place higher demands on an already stressed system.

As local governments seek to adapt to SLR, frequently people default to the assumption that governments will focus on designing and building engineered solutions that "protect" virtually all existing public and private development.[339] Financial considerations likely will eventually limit this approach in some areas since protection strategies such as sea walls, extensive stormwater pumping systems, and elevating infrastructure may cost more than some local governments can spend.[340] However, no one doubts that local governments, with strong political support from their constituents, will seek to protect the community and private and

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[337] Ruggeri, Amanda. "Miami's fight against rising seas." BBC - Future. N.p., 4 Apr. 2017. Web. 06 Apr. 2017.

[338] See, e.g. Randall W. Parkinson and Tara McCue, Assessing municipal vulnerability to predicted sea level rise: City of Satellite Beach, Florida. Climatic Change (2011) 107:203–223, available at http://research.fit.edu/sealevelriselibrary/documents/doc_mgr/446/Municipal_Vulnerability_&_SLR_-_Parkinson_&_McCue_2011.pdf. *See also, e.g.* Inundation Mapping and Vulnerability Assessment Working Group, Southeast Florida Climate Compact, Analysis of the Vulnerability of Southeast Florida to Sea Level Rise (2012), available at http://research.fit.edu/sealevelriselibrary/documents/doc_mgr/446/Southeast_Fl_Vulnerability_to_SLR_-_SFRCCC_2012.pdf. *See also,* sea-level rise vulnerability assessments of municipalities in Broward County, Florida at http://www.broward.org/NaturalResources/ClimateChange/Documents/ResilientCoastalComm/vulnerability-assessment.pdf.

[339] *See generally*: Cela, M., J. Hulsey, and J.G. Titus 2010. "South Florida." In James G. Titus, Daniel L. Trescott, and Daniel E. Hudgens (editors). The Likelihood of Shore Protection along the Atlantic Coast of the United States. Volume 2: New England and the Southeast. Report to the U.S. Environmental Protection Agency. Washington, D.C., available at http://risingsea.net/ERL/shore-protection-and-relocation-sea-level-rise-South-Florida.pdf.

[340] *See, e.g.* "Rising tide in Norfolk, Va." PBS, William Brangham, April 27, 2012, available at http://www.pbs.org/wnet/need-to-know/environment/rising-tide-in-norfolk-va/13739. A recent design competition for Louisiana's coast resulted in the top three proposals all agreeing that certain parts of the Mississippi Delta in Louisiana and the communities there cannot realistically be saved over the long term and that discussions about how to relocate out of these areas should begin. See, e.g. "Experts: Talk now about drastic changes, or deal with coastal crisis later," available at http://thelensnola.org/2015/09/15/coastal-planners-talk-now-about-drastic-changes-or-deal-with-crisis-later.

public assets for as long as possible. To accomplish this will require funding, potentially massive amounts of funding.

Just as adapting to SLR bears strong resemblance in many instances to "normal" efforts to make a community more resilient and resistant to flooding, storms, and storm surge, financing adaptations to SLR will often resemble existing financing for various types of current local government activities. This section surveys methods local governments might use for financing adaptation to SLR with particular attention to four areas for each financing tool discussed: 1. The legal authority, 2. Examples of current uses of the financing tool, 3. Potential legal issues or challenges associated with the tool, and 4. The pros and cons of each tool.

Before looking at specific financing mechanisms, a brief discussion of potential policy considerations is in order. Two varying approaches to protecting people and property from SLR and other coastal hazards present themselves. A local government can utilize funding streams that have no direct impact on the properties requiring protection. This arguably has the benefit of preserving the value of the property and spreading the cost around. Another school of thought, however, would suggest that the people and property most vulnerable to SLR and other coastal hazards should bear the bulk—if not all—the extra costs necessary to protect them. Those supporting this approach reason that those that choose to own property in the most vulnerable areas should not be able to push the costs of their choice onto property owners, citizens, or taxpayers that have made decisions to live in less vulnerable places. Some go so far as to argue that this is all about beaches and the rich people that live on the beaches. While in some places this may have an element of truth, it certainly is not the case in all communities. Many very low-lying areas subject to impacts from SLR are not full of wealthy people living in large, expensive homes; an example of this is New Orleans, whose vulnerable population was obvious in the aftermath of Hurricane Katrina.

Supporters of charging more to properties that need protection from SLR or other coastal hazards also justify this by asserting that it supports a proper free market signal for the risk of the property. Because maintaining the property requires protection that may be very expensive to supply, that property should pay its fair share of that cost so that potential purchasers of the property can see that the vulnerability of the property is a cost to be considered in their market transaction. In market terminology, this means that the property internalizes the cost of local-government-based protection activities rather than externalizes them.

Many more arguments for and against making hazardous properties pay all their own costs present themselves, but this paper presents a simplified overview of the main contender on each side of the argument. A more nuanced view would have to incorporate many other issues, such as socio-economic class and environmental justice issues. Making vulnerable properties pay their own way for protection could be a death knell for poor or modest communities while being little more than an annoyance for very wealthy property owners.[341] The challenge of

[341] *See, e.g.* Jeremy Martinich, James Neumann, Lindsay Ludwig, & Lesley Jantarasami. *Risks of sea level rise to disadvantaged communities in the United States,* 18 Mitigation and Adaptation Strategies for Global Change 169

incorporating socio-economic and environmental justice issues into SLR adaptation often bears strong resemblance to the challenges these issues present in reducing and eliminating subsidies in flood insurance under the National Flood Insurance Program.

Next, this paper addresses multiple existing potential sources of revenue sources that local governments could use to pay for the expensive projects and infrastructure that they need to protect areas from rising seas. Because such an endeavor offers limited utility to local governments when done in the abstract and local government financing law is an inherently state issue, this white paper focuses specifically on the state law of Florida in providing examples of potential revenue sources for SLR adaptation.

## 5.1 Ad Valorem Taxes and Municipal Service Taxing Units

### 5.1.1 Authority

Since they are both taxes, both ad valorem taxes and Municipal Services Taxing Units (MSTUs) are treated together in this section. While multiple statutes provide authority for MSTUs, Florida Statute section 125.01 ranks primary above these as it provides the governing body of the county (Board of County Commissioners) the power to "[e]stablish, and subsequently merge or abolish . . . municipal service taxing . . . units for any part or all of the unincorporated area of the county."[342] The governing body may also "[l]evy and collect taxes, both for county purposes and for the providing of municipal services within any municipal service taxing unit . . . ; borrow and expend money; and issue bonds, revenue certificates, and other obligations of indebtedness."[343] The governing body may also "identify a service or program rendered specially for the benefit of the property or residents in unincorporated areas and financed from countywide revenues and petition the board of county commissioners to develop an appropriate mechanism to finance such activity for the ensuing fiscal year, which may be by taxes, special assessments, or service charges levied or imposed solely upon residents or property in the unincorporated area, by the establishment of a municipal service taxing . . . unit pursuant to paragraph (1)(q)."[344]

MSTUs could generate revenue to address SLR due the existing public policy set forth in Florida Statute section 161.088 (2000), in which the Legislature states that because beach erosion is "a serious menace to the economy and general welfare of the people of this state and has advanced to emergency proportions, it is hereby declared to be a necessary governmental responsibility to properly manage and protect Florida beaches."[345] The Legislature has also declared that "such beach restoration and nourishment projects, as approved pursuant to Florida Statute section 161.161, are in the public interest."[346] Because MSTUs must serve a

(2013) (finding that areas of higher social vulnerability are much more likely to be abandoned than protected from sea-level rise).

[342] Fla. Stat. § 125.01(2)(q) (2015).

[343] *Id.*

[344] *Id.*

[345] Fla. Stat. §161.088 (2015).

[346] *Id.*

public purpose, this clear language is favorable in addressing SLR. The State Legislature also calls for both local and state funds to be used "since local beach communities derive the primary benefits from the presence of adequate beaches."[347] The requirement of local funds makes MSTUs plausible sources for SLR adaptation funding.

### 5.1.2 Potential Legal Issues/ Legal Challenges

MSTUs are typically limited in how much money they can raise. The Florida Constitution, in article VII, section 9 directs millage rates for ad valorem taxes. MSTUs were discussed at length in *Gallant v. Stephens*.[348] In *Gallant*, the Florida Supreme Court was tasked with reviewing the constitutionality of Florida Statute section 125.01 and the authorization of counties to create MSTUs as a form of ad valorem tax without voter approval.[349] Ultimately, the Court found that the statute in question was constitutional and that counties in Florida do have the authority to create MSTUs as a taxing tool to provide municipal services within the 10 mill limit for municipal purposes without voter approval. This case seems to mean that MSTUs are authorized without voter approval, so long as the funds levied are used for municipal purposes and adhere to millage limits. It also would appear that millage limitations can be overcome so long the proceeds are used in accordance with the exceptions appearing in Article VII, Section 9(b) of the Florida Constitution.

Since a local government can use taxes for essentially any function of the government meant to benefit the citizenry or run the government, few legal issues should arise with ad valorem taxes and MSTUs used for SLR adaptation. The key for local governments will be to ensure that they do not exceed the millage limitations for county and/or municipal services unless they fall under the exceptions laid out in Article VII, Section 9(b) of the Florida Constitution.

One potential legal issue that could arise for a county, though, deals with a situation in which a county decides to use ad valorem taxes or MSTUs levied in municipalities. In such a situation, the county must be able to show that there is a real and substantial benefit to the municipal properties being taxed.[350] Should a county decide to use their taxing authority to raise funds from those in unincorporated areas *and* municipalities, the county must ensure that those properties being taxed in any municipality also get a real and substantial benefit from the services that the county has provided.[351] This is important should a county attempt to use tax funding for SLR adaptation, though under certain circumstance it would appear possible for a county to show benefits of increased erosion control, drainage improvements, and storm protection for properties in municipalities.

[347] Fla. Stat. §161.101 (2015).
[348] *Gallant v. Stephens*, 358 So.2d 536 (Fla. 1978).
[349] *Id*. at 537.
[350] *See Alsdorf v. Broward County*, 333 So.2d 457,458 (Fla. 1976); *see also* Fla. Const. Art. 8 §1(h).
[351] *See, e.g. City of St. Petersburg v. Briley*, Wild & Assoc., Inc., 239 So.2d 817 (Fla. 1970).

### 5.1.3 Strengths and Weaknesses

The most glaring weakness of ad valorem taxes and MSTUs is that they are normally quite restricted in their ability to raise much more funding than what municipalities and counties already levy because of millage limitations.[352] If a municipality or county is already at or near the millage caps, and if there is not an exception met to go above the millage limitation, then attempting to fund SLR adaptation strategies with ad valorem taxes and MSTUs may not be fruitful depending on how much the local government already utilizes this funding mechanism.

Although potentially limited by how much can be levied, ad valorem taxes and MSTU funds levied have an advantage in that they may be spent more broadly and used for many county or municipal purposes. The flexibility afforded by ad valorem taxes is highly desired by local governments as they try to garner funding for all of their needs in tougher and tougher economic times, and due to the language of Florida Statute Chapter 161 stating that erosion and beach restoration are in the public interest, these funds seemingly are appropriate for use in dealing with those issues. Still, counties need to keep in mind that if an MSTU is levied on municipal properties, the county must be able to show a "real and substantial benefit from the services that the county has provided."[353] Note, however, that this "real and substantial benefit" is not limited to being conferred to the taxed properties specifically. Thus, if there is a benefit to public safety and welfare for people in the municipality, that should likely suffice as a "real and substantial benefit."

Another benefit of ad valorem taxes and MSTUs is there is no requirement that there be any direct, special benefit to the real property from which the tax is levied. This essentially means that a local government may justify the levy in much broader applications by tying it to benefits to real property, citizens, or the county as a whole. Since these funds have broader potential applications, it allows maximum flexibility for local governments looking to address SLR.

One final strength of MSTUs is that there is no need for a referendum for a county to establish an ad valorem tax for any MSTU[354], with certain exceptions.[355] The importance of this may grow as local governments find themselves with greater demands on the funds that are levied through various mechanisms, because property owners may not vote to approve the levy of assessments or other funding tools when they feel they are already being charged too much for the services being provided. If this does happen, local governments will find the MSTU provides a method of funding that does not require voter approval so long as it meets millage limitations, unless there is an exception provided by law.

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[352] *See* Florida Constitution, Art. 7, section 9 for millage limits.

[353] *See Alsdorf v. Broward County*, 333 So.2d 457,458 (Fla. 1976); see also Fla. Const. Art. 8 §1(h).

[354] Fla. Stat. §125.01(r) (2015).

[355] There would be a referendum required if the funds were to be used for bond financing, see Part IV, infra, or if the funds were going to be raised above the millage cap limitations.

### 5.1.4 Summary of Appropriateness for Use in SLR Adaptations

While ad valorem taxes and MSTUs would seem to be appropriate for use in SLR adaptation due to the public purpose of erosion control, beach nourishment, and projects of similar nature, the potential millage limitations coupled with the issue of local governments already being near those millage caps should provide hesitation that MSTUs will be effective at significantly funding SLR adaptation.

## 5.2 Special Assessments and Municipal Service Benefit Units (MSBU)

### 5.2.1 Authority

Municipalities and counties have statutory authority to levy special assessments.[356] The governing body is given considerable discretion when determining county improvement projects and their costs. Florida Statute section 170.201 states that "the governing body of a municipality may levy and collect special assessments to fund capital improvements and municipal services, including, *but not limited to*, fire protection, emergency medical services, garbage disposal, sewer improvement, street improvement, and parking facilities" (emphasis added). Costs may be determined either by "the front or square footage of each parcel of land," or "an alternative methodology, so long as the amount of the assessment for each parcel of land is not in excess of the proportional benefits as compared to other assessments on other parcels of land."[357] Special assessments are a "revenue source used to construct and maintain capital facilities and to fund certain services."[358] A valid special assessment requires that "the property assessed must derive a direct, special benefit from the service provided and that the assessment must be fairly and reasonably apportioned among properties that receive the special benefit."[359] In order to show that that a property receives a direct and special benefit "there should be a logical relationship between the provided service and the benefit to [that] real property."[360]

[356] Fla. Stat. §170.201 (1) (2015); Fla. Stat. §125.01 (1) (2015).
[357] Fla. Stat. §170.201 (2015).
[358] The Florida Legislature's Office of Economic and Demographic Research, *Local Gov't Financial Information Handbook 2011*-"Special Assessments", http://edr.state.fl.us/content/local-government/reports/lgfih11.pdf, Page 15.
[359] *Donnelly v. Marion County*, 851 So.2d 256, 259 (Fla. 5th DCA 2003) (citing City of North Lauderdale v. SMM Props, Inc., 825 So.2d 343 (Fla. 2002)); Workman Enters., Inc. v. Hernando County, 790 So.2d 598 (Fla. 5th DCA 2001).
[360] *Morris v. City of Cape Coral*, 163 So. 3d 1174, 2015 Fla. LEXIS 987, 40 Fla. L. Weekly S 237 (Fla. 2015) ("In evaluating whether a special benefit is conferred to property by the services for which the assessment is imposed, the test is not whether the services confer a "unique" benefit or are different in type or degree from the benefit provided to the community as a whole; rather, the test is whether there is a 'logical relationship' between the services provided and the benefit to real property." Citing Lake County v. Water Oak Mgmt. Corp., 695 So. 2d 667 (Fla. 1997)). Florida Legislature's Office of Economic and Demographic Research, *Local Gov't Financial Information Handbook 2011*-"Special Assessments", http://edr.state.fl.us/content/local-government/reports/lgfih11.pdf, Page 15.

Of important note in Florida to local governments are municipal services benefit units, or MSBUs. These are statutorily created tools that may be utilized to raise funds for various capital improvements and municipal services,[361] including beach erosion control, street and sidewalk construction and upkeep, and "other essential facilities and municipal services,"[362] so long as it meets the requirements of a special assessment.

### 5.2.2 Potential Legal Issues/Legal Challenges

"Special assessments may be levied only for the purposes enumerated in this section and shall be levied only on benefited real property at a rate of assessment based on the special benefit accruing to such property from such improvements when the improvements funded by the special assessment provide a benefit which is different in type or degree from benefits provided to the community as a whole."[363] Enumerated uses include roads, sidewalks, lighting, landscaping, signage or other amenities; swales, sanitary sewers, storm sewers, canals, drains, water bodies, marshlands; water supply; relocation of utilities; parks/recreation facilities; seawalls; drainage and reclamation of land; parking; mass transit; and navigation.[364]

An issue that may arise when a special assessment or MSBU is utilized for the purpose of funding adaptation to SLR is whether the service and capital facilities being provided by the levies are actually special assessments, or whether they are taxes. There is a fine line between a local government funding a general government service and a government service that specially benefits properties, and this fine line may distinguish whether the levy is a tax or a special assessment. To see the distinction, it is easiest to use law enforcement as an example.[365] It has been held in Florida that law enforcement is essential to the public welfare, and counties and municipalities must fund these services for their citizenry.[366] However, law enforcement services are meant to provide a benefit to the community as a whole, so a local government will fund those services through ad valorem taxation. In other words, it would be inappropriate for a local government to attempt to use a special assessment to fund law enforcement services because there would be no logical connection to a direct, special benefit provided to the real property being assessed.

This is different from an example that came up in *Water Oak Management*.[367] In that case, the Florida Supreme Court had to decide whether fire protection services could be funded by a county's special assessment levies.[368] Ultimately, the court held that "although fire protection

[361] Fla. Stat. §170.201 (1) (2015).
[362] Fla. Stat. §125.01 (q) (2015).
[363] Fla. Stat. §170.01(2) (2015).
[364] Fla. Stat. §170.01 (2015).
[365] The Florida Legislature's Office of Economic and Demographic Research, *Local Gov't Financial Information Handbook 2011*-"Special Assessments", http://edr.state.fl.us/content/local-government/reports/lgfih11.pdf, Page 15.
[366] *See Whisnant v. Stringfellow*, 50 So.2d 885 (Fla. 1951); see also *Lake County v. Water Oak Management Corp*., 695 So.2d 667, 669 (Fla. 1997).
[367] *Lake County v. Water Oak Management Corp*., 695 So.2d 667 (Fla. 1997).
[368] *Id.*

services are generally available to the community as a whole, the greatest benefit of those services is to owners of real property" when they upheld the county's contention that fire protection services do have a logical relationship to the special benefits provided to the properties served.[369] What this entails for local governments is that they must be able to show that the services provided are not just general services that afford no special benefit to the real property being assessed, but are actually providing a special benefit to real property. So long as the local government entity makes sure that the assessment focuses on real property in benefits provided[370], and follows the two-prong test provided above, then the special assessment should be held to be valid by Florida courts.

### 5.2.3 Strengths and Weaknesses

The biggest strength of special assessments for SLR adaptation is that since they are not taxes, they are not subject to the millage limitations set forth in the Florida Constitution.[371] This means that as long as local government complies with the rules for special assessments, the local government will not be hampered by millage limitations on taxes, potentially allowing local governments to raise large sums of money for adaptation activities.38

A potentially serious weakness of MSBUs and special assessments is that they cannot be levied on either school boards or on any of Florida's twenty-eight public colleges without the consent of the school board or a Florida college.[372] Thus, a local government should evaluate how much the statutory exemption from a special assessment for school districts and public colleges would cost prior to deciding whether and how to utilize this tool.

While it initially might seem a weakness of special assessments and MSBUs, the need to demonstrate a direct, special benefit to the real property assessed may actually be a strength. In many cases, a special benefit should be easy to demonstrate. For example, if part of a neighborhood with a single access road is frequently inaccessible due to flooding during the highest tides of the year, properties that need the road for access would clearly receive a "special" benefit from a project to elevate or otherwise protect the road.

The need for a relationship between special assessments and benefits to properties should be very carefully considered from multiple perspectives before a local government embarks on assessing properties. One such consideration is whether there is a temporal aspect to the relationship between a special benefit and the assessment? For example, if a local government were to specially assess a group of properties for an infrastructure improvement that specially benefited their land, and the local government decided that a special assessment of 'x' amount

[369] *Id.* at 669.

[370] This is a large reason why services like law enforcement aren't eligible for special assessment funding—they focus on non-real property benefits, such as benefits to the owners, people in the community, etc... Special assessments must always have that special benefit related to the real property being assessed.

[371] Fla. Stat. §197.3632 (1)(d) (2015). While this section defines specifically 'non-ad valorem assessments,' special assessments are merely a sub-type of non-ad valorem assessments, so the definition still applies.

[372] Fla. Stat. §1013.51(2) (2015). This includes the twenty-eight institutions in the Florida College System (formerly the Community College System), not the twelve public universities in the Florida State University System.

over a period of twenty-five years would cover the costs, the local government could potentially be in a conundrum should the benefit of the infrastructure improvement only last fifteen years resulting in no special benefit being bestowed upon the properties for the final ten years. If there is no special benefit being given to the real property during the last ten years of the assessment period, might courts rule that the assessment is no longer valid? At this point this example is purely hypothetical, and courts may rule in the given example that there is no requirement that the benefit be constant for the term of the assessment. Regardless of how the potential issue would be decided, it is important for local governments considering using special assessments or MSBUs to fund SLR adaptation to take into account all the rules associated with what constitutes a special assessment, use the funds according to statutory direction, and try to plan so that that the benefits to property funded by an assessment last at least as long as any assessment to fund such benefits.

Similarly, local governments must carefully ensure that assessment for each specially benefited property is proportional to the benefit to that property. Historically the two primary methods for ensuring this relationship is to use either the front-footage of each property[373] or the surface area of each property as a method to ensure a relationship between the amount of benefit and the amount assessed to individual properties.[374] In the context of planning for SLR, it may be that new ways of assessing property based on special benefits could be developed. For example, just as a stormwater MSBU might operate on the basis of the impermeable area of included properties,[375] if a pumped drainage system benefits an entire area but has more benefit to the lowest-lying properties, it might be possible to incorporate elevation as one of the elements that helps apportion assessments among properties.

Another consideration is how involved the process can be for local governments. Depending on how the special assessment funds are used, the level of involvement and processes can be a deterrent for a local government needing a simple solution.[376] It may help local governments to prospectively develop clear and concise methods and guidelines for implementation of special assessments before they are ultimately needed as this can make it easier and quicker for local government to act once a situation requiring special assessment funding arises.

### 5.2.4 Summary of Appropriateness for Use in SLR Adaptations

MSBUs present an appropriate funding mechanism for SLR so long as the property assessed derives a direct, special benefit from the service provided and the assessment is fairly and reasonably apportioned among properties that receive the benefit. If these thresholds can be met, then MSBUs and special assessments offer flexibility to local governments in addressing funding issues for SLR adaptation.

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[373] Fla. Stat. §170.02 (2015).
[374] *Cf. e.g. City of Boca Raton v. State*, 595 So.2d 25, 31 (1992).
[375] *Cf. City of Gainesville v. State*, 863 So. 2d 138 (Fla. 2003).
[376] See Fla. Stat. §153.05 (2015) for an example. See also, Okaloosa County MSBU/MSTU Policy (2014), available at http://www.co.okaloosa.fl.us/sites/default/files/doc/dept/public_works/roads/msbu.pdf.

## 5.3 Local Option Tourist Development Tax

### 5.3.1 Authority

In Florida, one of the main economic drivers is the tourism industry. To capitalize on this, the Legislature has ensured that counties have a way to increase revenues, through tourism taxes, from those non-permanent residents that utilize state resources while they boost local economies.[377] The "Local Option Tourist Development Act" authorizes a county to impose a tax on short-term rentals (less than 6 months) of living quarters or accommodations within the county.[378] Under Florida Statute section 125.0104, tourist development tax proceeds are allowed to be used only for the purposes enumerated in that statute.[379] Of particular importance for our purposes is the allowance of the tourist development tax "[t]o finance beach park facilities or beach improvement, maintenance, nourishment, restoration, and erosion control . . . ."[380]

### 5.3.2 Potential Legal Issues/Legal Challenges

The statute authorizing the tourist development tax spells out numerous parameters that must be followed. So long as the statutory requirements are followed and the funds are only used for the purposes enumerated in the statutory language, legal challenges should not arise. The case that has the most significance to environmental issues and the tourist development tax is *Lozier v. Collier County*.[381] In that case, the Florida Supreme Court found that tourist tax revenues could be used to pay off bonds that were previously issued by Collier County for beach nourishment and erosion control projects.[382] This may be important for a county that has already issued bonds to fund projects dealing with beaches and erosion control, since they are allowed to use tourist tax revenues to pay off those bonds instead of applying the tourist tax revenues directly to the projects themselves. This would mean that a county is able to more quickly pay off the bond debt that it may accrue when dealing with SLR and impacts on beaches and erosion.

### 5.3.3 Strengths and Weaknesses

The most apparent strength of this funding is that it naturally seems to align with the SLR adaptation actions of beach nourishment and beach erosion control since these appear in the statutory language. In fact, tourism development funding is already sometimes a source of part of the local portion of funding in beach nourishment projects in Florida.[383] Nonetheless, use of

[377] Fla. Stat. §125.0104 (2015) provides the statutory authority whereby counties may institute tourism taxes.
[378] *Id.*
[379] Fla. Stat. §125.0104 (5)(a-c) (2015) and Fla. Stat. §125.0104 (3)(l, n) (2015).
[380] Fla. Stat. §125.0104 (5)(a)(5) (2015).
[381] *Lozier v. Collier County*, 682 So.2d 551 (Fla. 1996).
[382] *Id.* at 553.
[383] *See, e.g.* Julie Murphy, Funding shored up for beach, dune projects in Flagler, The Daytona Beach News-Journal (noting that "Flagler County will fund its portion of the design work [for beach nourishment] with bed-tax money that comes through the Tourist Development Council."), available at http://www.news-

the tourism development tax as a significant source of funding for adaptation to SLR faces several challenges.

First, the purposes for which the funding can be used is relatively narrow, as defined by statute. Only "beach nourishment, maintenance, preservation, restoration, erosion control" appear as real forms of SLR adaptation. In addition, since the tourism industry is so large in Florida, there may be strong pressure for the funds from the tax to go into advertisement and major capital expenditures for stadiums, convention centers, etc. as authorized by the statute.[384]

Second, the income stream from the tourist development tax is limited as the tax is limited to between 2-6% on short-term rental transactions,[385] with the tax potentially available for beach maintenance, erosion, and related beach activities limited to a 2-3% tax, depending on the county. In addition, Florida Statute section 125.0104 (5) specifies the ways that tourism taxes may be spent by a county.[386] Depending on the level of tax being created by the tourism tax, it would seem that counties will be faced with significant expenditure decisions and may face pressure from industry to spend the funds on advertising and capital expenditures for tourism attractions instead of beach infrastructure relating to preparing for SLR. While the beach maintenance portion of tourist tax funding aligns with SLR adaptation in a natural way, the question remains whether SLR adaptation can become enough of a priority among counties to garner much needed funds from this type of taxation.

An inherent weakness for the tourist development tax is that it statutorily requires a referendum.[387] While this isn't a major hurdle for most counties due to the nature of the tax being on short-term rentals, it still leaves the power of this tax in the hands on the citizens and takes certainty away from local government elected leaders when they seek to plan out definite funding streams for various projects.

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journalonline.com/article/20140525/NEWS/140529633/-1/BUSINESS0501?p=2&tc=pg. Also, in Sarasota County, the "Tourist Development Tax" is a 5% tax on overnight rentals less than 6 months. Thirty-four percent (34%) is for beach improvement, cleanup, renourishment, maintenance, preservation, restoration, and erosion control. Ten percent (10%) is for sports stadiums and ancillary facilities; 10% for Aquatic Nature Center and ancillary facilities; 33.5% for advertising and promotion; 10% for cultural and fine arts; and 2.5% for tourism activities and attractions. Sarasota County Post-Disaster Redevelopment Plan, table 10.1, p. 87 (undated), available at https://www.scgov.net/PDRP/Documents/PDRP.pdf.

[384] http://www.orlandoweekly.com/orlando/how-the-tourism-industry-and-politicians-keep-floridas-tax-money-from-being-spent-where-we-need-it-most/Content?oid=2244501. While this article appears to have an agenda/bias, it is true that tourism taxes can't be used for lifeguards on the very beaches that draw tourists here; instead, that money is spent on major capital projects. See also http://articles.orlandosentinel.com/2013-04-23/business/os-bed-tax-for-lifeguards-20130422_1_hotel-taxes-tourism-industry-beach-patrol and http://dor.myflorida.com/dor/taxes/local_option.html#tourist_impact.

[385] Florida Statute section 125.0104 sets the parameters for the "basic" tourist development tax as well as additional 1% increments that may be added under other scenarios, up to an aggregate maximum of 6%.

[386] Fla. Stat. § 125.0104 (5) (2015).

[387] Fla. Stat. § 125.0104 (6) (2015).

### 5.3.4 Summary of Appropriateness for Use in SLR Adaptations

This funding mechanism offers an option for the beach management portions of SLR adaptation. Depending on the county, this tax can raise substantial amounts of funds. Any county seeking to use this tax for SLR adaptation will need to follow the statutory guidelines and to prioritize that portion of the funds available for beach nourishment and related activities as possible.

## 5.4 Stormwater & Drainage Fees

### 5.4.1 Authority

Florida law provides broad authority over drainage to local governments[388] and even requires local governments to establish stormwater management programs as part of their land development regulations.[389] Florida law recognizes that local governments share stormwater management responsibilities with the water management districts and the Department of Environmental Protection through development of compatible stormwater plans.[390] In addition to any other legally available funding mechanism they might have, local governments have three additional options created by the Legislature.[391] Local governments may"[c]reate one or more stormwater utilities and adopt stormwater utility fees sufficient to plan, construct, operate, and maintain stormwater management systems,"[392] "[e]stablish and set aside, as a continuing source of revenue, other funds sufficient to plan, construct, operate, and maintain stormwater management systems set out in the local program,"[393] or create one or more stormwater management system benefit areas.[394]

### 5.4.2 Potential Legal Issues and Challenges

Since counties and municipalities have options as to how they will fund their stormwater management systems, it is important that they think through possible issues that may arise with each one. Should a municipality decide to establish a Stormwater Management System Benefit Area per the process in section 403.0893(3), the local government should be certain to comply with all of the information for special assessments in section III. Special Assessments and Municipal Service Benefit Units *supra*. In addition, the local government should ensure that

[388] *See, e.g.* Fla. Stat. §170.01(1)(a) & (b) (2015) ("Any municipality of this state may, by its governing authority…provide for the…guttering, and draining of streets, boulevards, and alleys…[o]rder the construction, reconstruction, repair, renovation, excavation, grading, stabilization, and upgrading of greenbelts, swales, culverts, sanitary sewers, storm sewers, outfalls, canals, primary, secondary, and tertiary drains, water bodies, marshlands, and natural areas, all or part of a comprehensive stormwater management system, including the necessary appurtenances and structures thereto and including, but not limited to, dams, weirs, and pumps.").
[389] Fla. Stat. § 163.3202 (2)(d) (2015); Fla. Stat. § 403.0891 (2015).
[390] Fla. Stat. § 403.0891 (2015).
[391] Fla. Stat. § 403.0893 (2015).
[392] Fla. Stat. § 403.0893(1) (2015).
[393] Fla. Stat. § 403.0893 (2) (2015).
[394] Fla. Stat. § 403.0893 (3) (2015).

if there are various land uses, property types, or differing stormwater uses or benefits, that these fluctuations are accounted for within the program, likely via subareas.[395]

If instead of these two methods a municipality decides to create a stormwater utility that charges fees, it should set a differential fee that relates use of the service to the property. However, such fees need not correspond exactly to the use of the service by the property. Local governments typically base the stormwater utility fee on the square footage of impervious cover on a developed parcel of land within the utility area.[396] For example, a local government may assess fees for commercial property based upon the parcel's actual square footage of impervious surface but have a different rate structure for residential properties due to the high administrative cost of developing an individualized rate based on analysis of all residential properties in the service area. Thus, local governments usually reserve for commercial properties the more expensive process of calculating varied fees[397] and use either a flat rate for residential properties or use an "equivalent residential unit" or other averaged measure to charge residential properties. Charging all residential properties equally despite the need for a fee to be commensurate with use of the service led to such practices being challenged as an illegal tax.[398] Courts have upheld the use of "equivalent residential units" and other similarly uniform charges since stormwater, unlike potable water and electricity, is not susceptible to exact measurement.[399]

### 5.4.3 Strengths and Weaknesses

An interesting strength of stormwater management plans in coastal regions is that "[t]he department and the Department of Economic Opportunity, in cooperation with local governments in the coastal zone, shall develop a model stormwater management program that could be adopted by local governments [and] shall contain dedicated funding options, including a stormwater utility fee system based upon an equitable unit cost approach. Funding options shall be designed to generate capital to retrofit existing stormwater management systems, build new treatment systems, operate facilities, and maintain and service debt."[400] What this

[395] Fla. Stat. § 403.0893 (3) (2015); Also see *Pinellas Apartment Ass'n, Inc. v. City of St. Petersburg*, 294 So.2d 676 677 (Fla. 2nd DCA 1974), wherein it was stated that factors considered in the setting of utility rates by municipalities might include: "cost of service, the purpose for which the service or the product is received, the quantity or the amount received, the different character of the service furnished, the time of its use or any other matter which presents a substantial difference as a ground of distinction."

[396] *City of Gainesville v. State*, 863 So. 2d 138 (Fla. 2003).

[397] *Id.*

[398] Article VII, section 1 of the Florida Constitution preempts local government authority to impose taxes other than those allowed by general law.

[399] *See, e.g. City of Gainesville v. Fla. Dept. of Transp*., 778 So.2d 519, 525 (1st DCA 2001). See also, *Morris v. City of Cape Coral*, 163 So. 3d 1174, (Fla. 2015) (quoting *Boca Raton v. State*, 595 So. 2d 25 (Fla. 1992) that "No system of appraising benefits or assessing costs has yet been devised that is not open to some criticism. None have attained the ideal position of exact equality, but, if assessing boards would bear in mind that benefits actually accruing to the property improved in addition to those received by the community at large must control both as to the benefits prorated and the limit of assessments for cost of improvement, the system employed would be as near the ideal as it is humanly possible to make it.").

[400] Fla. Stat. §403.0891 (6) (2015).

means is that local governments would not be venturing into uncharted waters when deciding which method of funding stormwater systems is best because there are governmental agencies that will help walk them through the process and will have models available for the local government to compare and adopt if necessary.

Another strength is that the fees raised by stormwater utilities can be set quite high, as the bar is "enough to meet the system's capital requirements, as well as to defray operating expenses."[401] Essentially what this means is that a local government may be able to use these funds to raise capital for future outlays, meaning that coastal communities could start raising funds now that might not be needed until adaptation strategies for stormwater and drainage have been finalized in the future.[402] This may be exceedingly important as municipalities run into limits on what they may charge with other potential funding mechanisms, because these fees may still be considered 'just and equitable[403]' so long as the municipality can point to the funds being needed to meet the system's capital and operating requirements.[404]

It is important to keep in mind that there is a difference between the options provided by Florida Statute section 403.0893 and the strengths they provide. Of note, under option one—setting up a stormwater utility—the municipality would not need to show any direct or special benefits to the property in order to charge the fee. This would not seem to be the case if option two or three-- stormwater management system benefit areas or 'other funding options' such as special assessments—were chosen because with those it is likely that the local government would need to show that there was a direct benefit to the property being charged, and the amount of money reasonably in proportion to the benefit received. Due to this, it might be simpler for a local government to set up a utility under Florida Statute section 403.0893 (1).

There are weaknesses with this type of funding as well. The most glaring of these is that these funds will be quite limited in broad adaptability applications. Since it is important that these fees be tied to the capital and operating requirements of stormwater and drainage systems statutorily mandated, these funds will need to be tied to these systems. While these systems will undoubtedly be impacted by SLR, the impact level will vary greatly so that relying primarily on these funds will not be feasible if a municipality is to be able to raise funding for other areas of adaptation, such as roadway infrastructure.

Even if a local government wants to use a stormwater utility and stormwater utility fee structure exclusively to address adaptation of the stormwater system, another weakness of the fee is that agencies of the state that fail to pay a valid user fee for a stormwater system may

[401] *Id.* at 319.
[402] *Id.* at 320.
[403] Fla. Stat. § 180.13 (2) states that the municipality "may establish just and equitable rates or charges to be paid to the municipality for the use of the utility by each person, firm or corporation whose premises are served thereby . . .".
[404] *Id.* at 319.

assert sovereign immunity in any court action to collect the fees owed to the stormwater utility if the agency did not have a contract with the utility.[405]

### 5.4.4 Summary of Appropriateness for Use in SLR Adaptations

While the various options within stormwater and drainage fees may vary the appropriateness of this funding mechanism, it is likely that this is not a source for major SLR adaption funding broadly speaking. While this funding mechanism may be an important aspect that local governments use to address certain impacts of SLR, the funding mechanism is simply too limited to be of use in broad SLR adaptation strategies.

## 5.5 Bonds

### 5.5.1 Authority

For Counties: Florida Statutes §125.01(r) states that counties may "issue bonds, revenue certificates, and other obligations of indebtedness, which power shall be exercised in such manner, and subject to such limitations, as may be provided by general law." There are many types of bonds that may be issued by a county, such as ad valorem, general obligation, water system/district, sewage system/district, revenue, improvement, and refunding. While all of these bonds would require an ordinance or resolution as part of the issuance, ad valorem bonds and general obligation bonds also impose the special burden of having a referendum.[406] This requirement arises since property taxes are not directly tied to bonds and indebtedness unless the electorate states they approve those measures through a referendum with regards to ad valorem bonds. This is similar for general obligation bonds since the county would be pledging their full faith and credit as collateral for the bonds such that the electors should have a vote in whether creditors have recourse against their government's credit and general fund.

Bond law for municipalities functions similarly. Florida Statutes Chapter 166 contains information regarding municipal borrowing through the bond process. Municipalities have the authority to issue bonds "to finance the undertaking of any capital or other project . . . and may pledge the funds, credit, property, and taxing power of the municipality for the payment of such debts and bonds."[407] There are many types of bonds that municipalities are allowed to enter into general obligation bonds, ad valorem bonds, revenue bonds, improvement bonds, and refunding bonds.[408] Municipal bonds "shall be authorized by resolution or ordinance of the governing body and, if required by the State Constitution, by affirmative vote of the electors of the municipality."[409] This means that generally the governing body of the municipality has the

[405] *City of Gainesville v. State of Florida*, 920 So.2d 53 (Fla. 1st DCA 2005). See also *City of Key West v. Fla. Keys Cmty. College*, 81 So. 3d 494 (Fla. 3d DCA, 2012) (noting that the Florida Keys Community College enjoyed sovereign immunity from suit by the City of Key West for payment of the City's stormwater fee).
[406] See Fla. Stat. §153.07 (2015), Fla. Stat. §130.03 (2015), *State v. Orange County*, 281 So.2d 310 (Fla. 1973), *Town of Medley v. State*, 162 So.2d 257 (Fla. 1964), and Fla. Const. Art. 7, Sect. 12.
[407] Fla. Stat. §166.111 (2015).
[408] Fla. Stat. §166.101 (2015).
[409] Fla. Stat. §166.121 (2015).

authority and power to issue a bond by resolution or ordinance, unless a vote of the electorate is required such as when the municipality is issuing an ad valorem bond or is pledging the full faith and credit of the municipality for the payment of the debt.[410]

### 5.5.2 Potential Legal Issues/Legal Challenges

Bond issuances are potentially subject to challenge if the issuance is not of a type clearly established by prior use and precedent or there are any procedures that do not follow legal requirements. In case of any doubt on these issues by local government, such as might be the case in using a bond issuance to fund SLR adaptation, a local government might choose to validate the bond issuance, as per the process in Florida Statutes Ch. 75,to ensure that they have the right and authority to issue those bonds and ensure there is no attack on the authority to issue the bonds, which could undermine the value of the bonds.[411]

If a county or municipality initiates a proceeding to have a court validate the bond issuance, a property owner or interested party may intervene to challenge the bond issuance. As the Florida Supreme Court has held, "A petition for validation of governmental securities brings into question the right and authority of the taxing unit to issue the bonds, together with all proceedings taken in connection with their issue."[412] Even if the court should validate the bond, a challenger may still appeal that decision, but such appeal is directly to the Florida Supreme Court and takes place on an expedited schedule so that bond issuances are not unduly delayed.[413]

One other potential concern that arises with bonds is the purposes for which they may be used. While statutes list out various uses, from constructing highways and public buildings to funding the outstanding indebtedness of the local government, a local government should have a strong argument that home rule powers allow the bonds. For counties, "[t]he provisions of this section shall be liberally construed in order to effectively carry out the purpose of this section and to secure for the counties the broad exercise of home rule powers authorized by the State Constitution."[414] Essentially, so long as a local government can point to a public purpose for a capital project, then they should have a strong argument that home rule powers enable them to bond for that purpose since it is necessary to carry out the government.

In *Miami Beach Redevelopment Agency*, the Florida Supreme Court ruled on a case where one of the issues dealt with whether the proposed bonds at issue were payable from ad valorem taxation, which would mean there was a requirement of a vote of the electorates.[415] While the State argued that since ad valorem taxes would be funneled into the repayment fund then

[410] Fla. Const. Art. 7, Sect. 12 and Art. 7, Sect. 11.
[411] *City of Oldsmar v. State*, 790 So.2d 1042, 1049 (2001) ("By invoking the protective provisions of chapter 75, a governmental entity can ensure the marketability of the proposed bonds or certificates of indebtedness by thereafter foreclosing an attack on their validity.").
[412] *Speer v. Olson*, 367 So.2d 207,210 (Fla. 1978).
[413] *City of Oldsmar v. State*, 790 So.2d 1042 (2001).
[414] Fla. Stat. §125.01 (3)(b) (2015).
[415] *State v. Miami Beach Redevelopment Agency*, 392 So.2d 875, 893 (Fla. 1980).

there should be a vote required for the bonds, the Agency argued that the bonds avoided the referendum requirement because there was no pledge of the county and city ad valorem tax power and there merely a promise to pay the bonds from general operating revenue which might include ad valorem tax funds.[416] The Court, after a lengthy analysis, held "[w]hat is critical to the constitutionality of the bonds is that, after the sale of bonds, a bondholder would have no right, if the redevelopment trust fund were insufficient to meet the bond obligations and the available resources of the county or city were insufficient to allow for the promised contributions, to compel by judicial action the levy of ad valorem taxation" and therefore the issuance of the bonds without referendum was valid.[417] This case is very important in that it shows the distinction between a direct pledge of ad valorem taxing power to secure a bond and merely contributing ad valorem tax revenues to pay a bond. The key for a local government looking to avoid a referendum is to not pledge their ad valorem taxing power, as that would require a referendum because the public would need to have a say since the bondholder would be able to compel the levy of ad valorem taxation, potentially even above millage caps through mandamus.[418] The simplest way to do this would be to expressly have written in bond bids of the local government that the government's ad valorem taxation powers will not be able to be compelled by the bondholder, but that instead the bond is secured by general revenues of the government entity.

### 5.5.3 Strengths and Weaknesses

One of the biggest weaknesses of bonds, both for counties and municipalities, is that there may be a referendum required. While not all bonds require a referendum, there are two specific types that do: ad valorem bonds and general obligation bonds pledged with faith and credit. Ad valorem bonds require there to be a referendum since ad valorem taxes are going toward the debt.[419] General obligation bonds require there to be a referendum as well, since the pledging of faith and credit of the local government as collateral opens up to the creditor the ability to compel the government to raise taxes and obtain funds to pay off the indebtedness, potentially even above millage limits.[420] This is in direct contrast to something like a revenue bond that doesn't pledge faith and credit, but is merely payable from the revenue stream produced, and therefore doesn't require a referendum vote for the government to issue the bond.[421]

One of the strengths of bonds is that they are fairly broad in what they can be used for, so long as it is a capital or other projects serving a public purpose.[422] This is quite important for local governments looking for ways to raise significant funds for SLR adaptation, since as has already been addressed earlier, SLR adaption likely falls into the category of "public purpose."

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[416] *Id.* at 894.
[417] *Id.* at 898-899.
[418] *Id.* See also *Miccosukee Tribe of Indians of Florida v. South Florida Water Management Dist*., 48 So.3d 811 (Fla. 2010); *Strand v. Escambia County*, 992 So.2d 150 (Fla. 2008); *State ex rel. Gillespie v. Vickers*, 148 So. 526 (Fla. 1933).
[419] Fla. Const. Art. 7, Sect. 12.
[420] Fla. Stat. §200.181(1) and (3) (2015).
[421] Fla. Stat. §159.04(2) (2015).
[422] Fla. Stat. §166.101(8) (2015).

### 5.5.4 Summary of Appropriateness for Use in SLR Adaptations

Bonding is appropriate for use in SLR adaptation strategies and projects. Since these projects are in the public interest, there should not be an issue with bonds being used for these purposes. In addition, the broadness of application afforded by various types of bonds is useful for local governments trying to adapt to SLR. The key for local governments will be to choose the bond type carefully, keeping in mind their duty to manage public funds wisely.

## 5.6 Special Districts

### 5.6.1 Authority

There are two general types of special district that are utilized in Florida: dependent and independent special districts (DSD and ISD). Each has various requirements and processes associated with it, so it is best to view them separately for the purposes of this section. Dependent special districts are those that meet at least one of the following: the governing body of the DSD is identical to that of county or municipality, all members of the governing body are appointed by the governing body of the county or municipality, during the governing body's members terms they are subject to removal at will by governing body of the county or municipality, or the DSD has a budget that requires approval through affirmative vote or can be vetoed by the governing body of the county of municipality.[423] Independent special districts are defined as "[those] not a dependent special district as defined . . . [a] district that includes more than one county is an independent special district unless the district lies wholly within the boundaries of a single municipality."[424] Florida Statutes Chapter 189.012(6) states "'Special district' means a unit of local government created for a special purpose, as opposed to a general purpose, which has jurisdiction to operate within a limited geographic boundary and is created by general law, special act, local ordinance, or [by the] Governor and Cabinet."

#### *5.6.1a Dependent Special Districts*

Florida Statutes Chapter 189.02 states that dependent special districts are developed by ordinance of a county or municipality. The procedure and requirements of this ordinance for both dependent and independent special district are laid out in the statute, and include that the district must be within the boundary lines of the respective county or municipality.[425] Dependent Special Districts, since they are essentially an extension of either the county or municipality which has created them, are still subject to statutorily defined maximum millage, which is done by adding the DSD millage to the millage of the governing body to which it is dependent.[426]

#### *5.6.1b Independent Special Districts*

[423] Fla. Stat. §189.012(2) (2015).
[424] Fla. Stat. §189.012(3) (2015).
[425] Fla. Stat. §189.02 (2015).
[426] Fla. Stat. §200.001(8)(d) (2015).

Florida Statues Chapter 189.031 deals with the creation of independent special districts. This chapter gives the authorization for municipalities, counties, and the governor and cabinet to create independent special districts according to the criteria laid out.[427] Independent Special Districts also have some rules concerning millage levied. The ISD millage "shall not be levied in excess of a millage amount authorized by general law and approved by vote of the elects pursuant to s. 9(b), Art. VII of the State Constitution, except for those [ISD] levying millage for water management purposes as provided in that section and municipal service taxing units as specified in s. 125.01(q) and (r).[428]

### 5.6.2 Potential Legal Issues/Legal Challenges

In *Forsythe*, the Florida Supreme Court decided a case dealing with the distinctions of special independent districts and special dependent districts.[429] Longboat Key, a municipality stretching across two separate counties, decided to use an ordinance to create a dependent special district.[430] The special district they created decided to seek court approval to issue $14,000,000 in general obligation bonds, which was challenged by property owners claiming that the district had been mischaracterized because it was actually an independent special district that could only be created by the legislature and not by municipal ordinance or resolution.[431] The Florida Supreme Court held that even though Longboat Key was a special case because of being situated across two counties, the language of Chapter 189 Florida Statutes was clear that any special district spanning multiple counties is an independent special district that must be created by the legislature.[432]

Another Florida Supreme Court case dealing with special districts is *Hernando County*.[433] There, Hernando County had created three special districts prior to Florida law that mandated all special districts to either be designated as dependent or independent.[434] Once Hernando County designated these districts as dependent, they were challenged that Hernando County's millage rate was above the statutory limit of 10 mills due to the millage being levied in the three districts.[435] The Florida Supreme Court ultimately held that dependent special districts, since their actions are de facto controlled by a single county or municipal government, are subject to the 10 mill-cap when looking at the overall millage rate of the county or municipality.[436]

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[427] Fla. Stat. §189.031 (4)(a-d) (2015) for authorization according to guidelines laid out in Fla. Stat. §189.031(3).
[428] Fla. Stat. §200.001(8)(e) (2015).
[429] *Forsythe v. Longboat Key Beach Erosion Control Dist*., 604 So.2d 452 (Fla. 1992).
[430] *Id.* at 452.
[431] *Id.* at 453.
[432] *Id.* at 455-456.
[433] Board of County Com'rs, *Hernando County v. Florida Dept. of Community Affairs*, 626 So.2d 1330 (Fla. 1993).
[434] *Id.* at 1331.
[435] *Id.* at 1332.
[436] *Id.* at 1332-1333.

### 5.6.3 Strengths and Weaknesses

One key weakness for special districts is that they are still bound by millage limitations and the processes involved for getting around those restrictions. If it is the case that a county or municipality is already using the full amount of the millage cap space allotted them by the legislature, then the millage levied by a special district cannot exceed that cap unless there is a referendum by the electors. This isn't a bad thing at all, but it does take away the control and sureness of the funding that might come from these special districts.

A key strength of special districts is that they are geared toward helping property and owners for a specific purpose. This would lend itself directly to application of SLR adaptation strategies of local governments, since "special districts serve a necessary and useful function by providing services to residents and property in the state . . . [and] serve a public purpose" and "special districts [should] cooperate and coordinate their activities with the units of general-purpose local government in which they are located."[437] This public purpose fits SLR adaptation, and the cooperation with local governments should allow for increased efficiency, transparency, and good will from the community that is part of special districts.

### 5.6.4 Summary of Appropriateness for Use in SLR Adaptations

Due to the public purpose of SLR adaption, and the Legislature's intent that special districts be used in furtherance of public purposes by serving a necessary and useful function to provide services to both residents and property, it would seem that special districts are a useful mechanism for local governments in SLR adaptation. The major issue is how much funding can be raised from these special districts, since it would seem their ability to utilize ad valorem taxes is impeded by millage limitations absent a referendum, though it should be possible for these special districts to utilize other taxes and service charges that might make them an attractive offer to local governments dealing with SLR adaptation.

## 5.7 Other Potential Funding Mechanisms

This paper is not meant to be an exclusive list of means for local governments to finance SLR adaptation; Florida Statutes contain twenty-five chapters under Title XIV—Taxation and Finance. Many of the tax regimes and the revenue sharing are extremely complex, so this paper has focused on some of those revenue streams most important and relevant in the view of the authors. Furthermore, wide variations in the importance of revenue streams appear from county to county and municipality to municipality. But, on average during the fiscal year 2012-13, county governments in Florida received about 32% of their revenues from charges for services and about 30% from taxes.[438] However, while not treated with the same depth as

[437] Fla. Stat. §189.011 (2) and (3) (2015).
[438] The Florida Legislature, Office of Economic & Demographic Research, Statewide Expenditures and Revenues by Category and/or Fund Type – Counties, Municipalities, and Independent Special Districts (MS Excel spreadsheet), available at http://edr.state.fl.us/Content/local-government/data/revenues-expenditures/index.cfm.

those above, some other financing options deserve mention as possible sources of revenue for SLR adaptation include:

### 5.7.1 Local Government Infrastructure Surtax

This option allows for a county to levy a 0.5 or 1.0 percent tax pursuant to an ordinance of a Board of County Commissioners, so long as there is a majority vote of the electors in a referendum.[439] The ballot of this referendum must include a general description of the project to be funded by the surtax.[440] The funds levied by this tax may be used to "finance, plan, and construct infrastructure" and to "acquire land for . . . protection of natural resources".[441] This option seems like a great resource for local governments to raise funds meant to go towards construction of infrastructure or acquisition of land. Since SLR adaptation will likely entail both of these projects, this surtax seems like a viable financing option.

### 5.7.2 Electric Franchise Fee

Many local governments receive a fee from local electric service providers in exchange for use of rights-of-way; this is direct revenue from a local-government-owned utility. Others may see significant revenue from a utility owned by the local government. These revenues are too diverse in structure, amount, and use to be adequately summarized here and must be considered on a case-by-case basis as sources for potential SLR adaptation.

### 5.7.3 Communications Services Tax[442]

State law mandates collection of a communications tax,[443] part of which is returned to local governments.[444] State statutes also allow imposition of a local communications tax by local governments.[445]

### 5.7.4 Small County Surtax

If dealing with a county that has a population of 50,000 or less as of April 1, 1992, the local government may levy a "discretionary sales surtax of 0.5 percent or 1 percent".[446] These funds may be used for operating expenses if there is an extraordinary vote of the Board of County Commissioners; however, if the funds are used for bonds, then the tax must be approved by a majority of electors in a referendum.[447] Just like the infrastructure tax, there must be a brief general description of the project to be funded by the surtax.[448]

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[439] Fla. Stat. §212.055 (2) (2015).
[440] *Id.*
[441] Fla. Stat. §212.055 (2)(d) (2015).
[442] Fla. Stat. ch. 202 (2015).
[443] Fla. Stat. §202.12 (2015).
[444] *See* Fla. Stat. §202.18 (2015).
[445] Fla. Stat. §202.19 (2015).
[446] Fla. Stat. §212.055 (3)(a) (2015).
[447] *Id.*
[448] *Id.*

The proceeds of the surtax may be expended for operational expenses associated with "any infrastructure or for any public purpose authorized in the ordinance under which the surtax is levied" if done by an extraordinary vote of the Board of County Commissioners.[449] If instead the surtax was approved by referendum, the funds may be used to service "bond indebtedness to finance, plan, and construct infrastructure and to acquire land for . . . conservation or protection of natural resources."[450]

### 5.7.5 Charter County and Regional Transportation System Surtax

If a county meets the requirements, the county may levy a discretionary sales surtax that is subject to approval by majority vote of the electorate in a referendum.[451] The amount levied may be up to 1.0 percent, and may be used for various uses of road and bridge infrastructure, both construction and maintenance, within the county.[452] As long as a county were to follow the guidelines laid out in the statutory language, this option would be good to address maintenance concerns for existing transportation infrastructure being impacted by SLR.

## 5.8 Conclusion

Since climate change and SLR became common topics in Florida beginning in 2008, local governments have shifted dramatically in their response. Denial of the immensity of the problem was initially common, which then gave way to despair about how bad SLR would be, followed by arrival at levels of optimism that might themselves not be realistic. Now is the time for local governments to grapple with SLR adaptation strategies, including the economic consequences that are so fundamental to it, more pragmatically. In doing so, they must look to funding mechanisms available presently so that SLR adaptation can be integrated into planning and outlook forecasts.

Of the options listed above, no one funding mechanism serves as a silver bullet for Florida locak governments. All options have both pros and cons; however, there are certain mechanisms that seem to be more appropriate for local government funding of SLR adaptation. MSBUs are seemingly a great way for a county to levy funds from property that is adversely impacted by SLR, since that real property will then be shown to receive a direct and special benefit when the local government creates the MSBU to help alleviate those SLR issues. Bonds are another great way for local governments to fund SLR adaptation since their application is so broad, but care must be shown in choosing how these debt instruments are to be secured. While stormwater fees may be an important aspect of funding, it must be realized that the application will be used narrowly when talking about SLR adaptation in the broadest sense of capital projects. Finally, it would seem that tourist taxes may be a viable option for those on the coast, and since these areas are more likely to see disparate impacts from SLR sooner, these taxes would seem to lend themselves to being used for SLR adaption of coastal areas.

[449] Fla. Stat. §212.055 (3)(d).
[450] Fla. Stat. §212.055 (4).
[451] Fla. Stat. §212.055 (1)(a).
[452] Fla. Stat. §212.055 (d)(2-4).

# Chapter 6 Funding Local SLR Interventions in Texas

Implementing projects and programs to address SLR will require local governments to raise significant and reliable funding streams. Just as in Florida, Texas law provides a number of funding mechanisms for counties and cities, but they also can be rather prescriptive in terms of the purposes funding may be used for, rates and allocations, and how much debt a government may sustain. A review of the funding mechanisms currently available and that may be applicable to SLR adaptations follows, along with an analysis of applicability and potential pitfalls associated with each one.

## 6.1 Ad Valorem Taxes

Ad valorem taxes (AVTs) are governed by the Texas Constitution, the Tax Code, and the tax administrative rules in the Texas Administrative Code.[453] The Texas Constitution and the Property Tax Code specifically govern ad valorem property taxes, which tax a percent of the property's value.[454]

Although the Texas Constitution bans a statewide property tax, "local taxing units" (LTUs) level them annually for local purposes.[455] The Texas Constitution or local, special, or general law creates these LTUs.[456] LTUs are varied and may overlap. They can include county and municipality LTUs as well as other types of LTUs including school districts and special purpose districts.[457]

The Texas Constitution and the Property Tax Code set the standard for an LTU adoption of a property tax and controls how the process works, including timetables, debt limits, and rate limits. An appraisal district determines the value of a property for tax assessments.[458] However, the governing body of each LTU decides its budget and sets the tax rate as well as the amount required to meet the chosen budget.[459] LTUs utilize ATVs to cover their debt and to finance a

[453] Facts at a Glance: Texas Taxes Overview and Glossary. Pg. 7. Texas Legislative Council. January 1999. http://www.tlc.state.tx.us/pubspol/txtaxes.pdf.
[454] Facts at a Glance: Texas Taxes Overview and Glossary. Pg. 15. Texas Legislative Council. January 1999. http://www.tlc.state.tx.us/pubspol/txtaxes.pdf; Facts at a Glance: Texas Taxes Overview and Glossary. Pg. 24. Texas Legislative Council. January 1999. http://www.tlc.state.tx.us/pubspol/txtaxes.pdf.
[455] Tex. Const. art. VIII, § 1-e; Charles E. Gilliland, *et. al*. The Texas Property Tax System. Pg. 4. Real Estate Center at Texas A&M University. https://assets.recenter.tamu.edu/documents/articles/1192.pdf.
[456] Tex. Tax Code Ann. § 1.04[12] (West) .
[457] *Id.*; Overview of Local Taxes in Texas: Prepared for the Senate Committee on Finance. Pg. 1. TLC Research Division. November 2002. http://www.tlc.state.tx.us/pubspol/localtaxes.pdf.
[458] Charles E. Gilliland, *et. al*. The Texas Property Tax System. Pg. 1. Real Estate Center at Texas A&M University. https://assets.recenter.tamu.edu/documents/articles/1192.pdf; (the taxable value of the property is determined by the property's appraisal district, generally one per county).
[459] Facts at a Glance: Texas Taxes Overview and Glossary. Pg. 26. Texas Legislative Council. January 1999. http://www.tlc.state.tx.us/pubspol/txtaxes.pdf. Tax rates are usually expressed as the dollar amount of a tax for each $100 of property value (rate = (levy /value) x 100). Charles E. Gilliland, et. al. The Texas Property Tax System. Pgs. 2-3, 47. Real Estate Center at Texas A&M University. https://assets.recenter.tamu.edu/documents/articles/1192.pdf.

wide range of public services.[460] Both municipal and county LTUs' various AVT schemes may be used for funding SLR adaptation strategies because they may use property tax funds for water related services including water conservation, wastewater services, and flood water control.[461]

Moreover, coastal local governments may use AVTs specifically for coastal protection. Section 8 of Art XI of the Texas Constitution recognizes that coastal counties and cities are "subject to calamitous overflows". In Section 7, it authorizes all coastal counties and cities, if allowed by the vote of the people, to incur debt and levy and collect taxes "for the construction of sea walls, breakwaters or sanitary purposes as may now or may hereafter be authorized by law…"[462]

In addition to the Constitution XI, Sec. 7 and 8's authorization, the Local Government Code authorizes coastal counties and cities to incur debt particularly to:

> (1) establish, construct, extend, maintain, or improve a seawall, breakwater, levee, floodway, or drainway; (2) improve, maintain, or beautify a boulevard erected in connection with the seawall, breakwater, levee, floodway, or drainway; and (3) for purposes of implementing Subchapter H, Chapter 33, Natural Resources Code: (A) participate as a qualified project partner for an erosion response project undertaken by the General Land Office, as those terms are defined by Section 33.601, Natural Resources Code; and (B) undertake or contribute to the funding of: (i) beach nourishment on public beaches, as defined by Section 61.012, Natural Resources Code; or (ii) any other erosion response project as defined by Section 33.601, Natural Resources Code, on waterways, bays, and bay shorelines.[463]

While the constitution did not set a ceiling for its tax authorization, the Local Government Code imposed a limit of $0.50 per $100 valuation of AVTs.[464] This authorization is in addition to the constitution's basic county tax authorization. Article VIII, Section 9's authorization is up to "$0.80 on the $100 valuation in any one year for general fund, permanent improvement fund, road and bridge fund and jury fund purposes." This may be levied without voter approval if it amounts to a permanent improvement.[465] Furthermore, counties may supplement a seawall tax by its authority to tax for flood control, which is up to $0.30 on the $100. This is in addition to all other AVTs authorized by the Texas Constitution.[466]

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[460] "Laws relating to a taxing unit's authority to borrow money often require that the unit account separately for expenditures that it will make to pay its debts from expenditures that it makes for other purposes. The truth in taxation laws refer to property tax levies used for debt payments as "debt" or "Interest and Sinking Fund" levies. Levies for all other purposes are called "Maintenance and Operations", sometimes abbreviated M&O."
Charles E. Gilliland, *et. al*. The Texas Property Tax System. Pg. 2, 47. Real Estate Center at Texas A&M University. https://assets.recenter.tamu.edu/documents/articles/1192.pdf.

[461] Overview of Local Taxes in Texas: Prepared for the Senate Committee on Finance. Pg. 10. TLC Research Division. November 2002. http://www.tlc.state.tx.us/pubspol/localtaxes.pdf.

[462] Tex. Const. art. XI, § 7, 8.

[463] Tex. Loc. Gov. Code Ann. § 571.002 (West); Nat. Resources Code. § 33 (West).

[464] Tex. Loc. Gov. Code Ann. § 571.006 (West).

[465] Tex. Const. art. VIII, § 9.

[466] Tex. Const. art. VIII, § 1-a

The Legislature sought to provide AVT funding to help solve the overflow dilemma. Indeed, Section 7 of Article XI has been amended only twice since its creation and both times it was to lessen voter approval requirements to allow local governments to more easily seek AVT funding for protection against flooding.[467]

SLR adaptation efforts could fit into one of the many categories laid out in the Constitution because seawalls are already considered one adaptation strategy and, furthermore, "sanitary purpose" has never been definitively defined.[468] Furthermore, Section 571.002 of the Local Government Code could cover SLR adaptation strategies in the name of any of its accepted purposes, including erosion response and beach nourishment. This is all on top of the normal AVTs allowed to regular municipalities and counties.

### 6.1.1 Potential Legal Issues/ Legal Challenges

For all LTUs, there are generally limitations to AVT increases including rollback tax rates and limitations on levy increases. A rollback tax rate may be used to overturn a tax rate increase. It sets a threshold rate by dividing overall property taxes into two categories: debt service and maintenance and operations (M&Os). It permits the same amount of M&O levy that was raised in the prior year with an 8% cushion, but allows debt services to rise as high as necessary to cover debt expenses.[469]

To adopt new tax rates, a LTU must publish a notice, hold two public hearings, and publish a notice of a meeting; this can be done when a proposed tax rate exceeds the effective tax rate or the rollback rate.[470] If the adopted rate exceeds the rollback rate, the taxpayers may petition for a rollback election within 90 days of its adoption. If a valid petition has sufficient signatures, the election must be ordered. If the proponents win, the taxes are rolled back to the rolled back tax rate.[471] Therefore, funding through AVTs would be gradual and must grow by relatively small increments.

All municipalities' AVT power purposes must be expressed in either state laws or its home rule charter.[472] A municipality may exercise only expressly granted powers or those reasonably implied from granted powers, or those essential to the original purpose for the municipality's creation.[473] Therefore, unless it can be shown that a adaptation project is reasonably implied or essential to a city's original purpose, it may fail. However, because waterworks is one of the main

[467] 36 Tex. Prac., County And Special District Law § 38.2 (2d ed.)
[468] *Id.*
[469] Charles E. Gilliland, *et. al.* The Texas Property Tax System. Pg. 48. Real Estate Center at Texas A&M University. https://assets.recenter.tamu.edu/documents/articles/1192.pdf.
[470] "The taxing unit's effective tax rate is generally equal to the prior year's taxes divided by the current taxable value of properties that were also on the tax roll in the prior year (Sec. 26.04)." Charles E. Gilliland, *et. al.* The Texas Property Tax System. Pgs. 48-49. Real Estate Center at Texas A&M University. https://assets.recenter.tamu.edu/documents/articles/1192.pdf.
[471] Charles E. Gilliland, *et. al.* The Texas Property Tax System. Pg. 49. Real Estate Center at Texas A&M University. https://assets.recenter.tamu.edu/documents/articles/1192.pdf.
[472] *Anderson v. City of San Antonio*, 123 Tex. 163, 165, 67 S.W.2d 1036 (1934)
[473] *Id.* (citing *Davis v. City of Taylor*, 123 Tex. 39, 42, 67 S.W.2d 1033, 1034 (1934)) .

services of a municipality, there may be a strong argument that adaptation efforts are reasonably implied if it is not an already granted power.[474]

Furthermore, although home-rule municipality and a Type A general-law municipality do not have a limit on amount for property taxes, Type B general-law municipalities are limited to $0.25 for each $100 of property valuation for annual property taxes.[475] Therefore, it matters what type of municipality is involved when it comes to funding adaptation projects with AVTs.

### 6.1.2 Strengths and Weaknesses

AVTs are inherently limited. Although adaptation efforts would most likely fit into the allowable projects that the Texas Constitution and laws state may be funded by municipal and county ad valorem property taxes, funding is a percentage of property market value, of a set number of taxpayers, owning property in their jurisdiction. Furthermore, cities and counties must fund other necessary projects so AVTs for these LTUs must be spread more thinly and cannot focus all their efforts and funds to SLR issues. In addition, a municipality must provide for funds to pay for a debt while at the same time incurring debt. Counties must either pay out of current revenues or immediately controlled funds, or a county must create a debt with a provision for the payment of interest and at least 2% of the principal each year at the time it incurs the debt. These services and debt limits hobble both types of local governments in regard to how quickly they may fund a project.[476] Additionally, there are the rollback tax rate and levy limitations that prevent substantial increases which slows the ability to fund adaptation projects. However, the authority is already in place for municipalities and counties to deal with water and flexibility in the language of the various provisions for municipal and county taxing could be used to set aside funding for adaptation projects subject to AVT limitations.

### 6.1.3 Summary of Appropriateness for Use in SLR Adaptations

Municipal and county AVTs would be a reasonable way to fund adaptation efforts despite limited resources because the authority to implement such projects already lies with these local governments. This means there will be no additional effort to hurdle any substantial barriers against such undertakings. This is especially true for local governments due to their expanded ability to tax for issues that pertain to SLR.

## 6.2 Special Purpose Districts

In addition to general municipal and county LTUs, water districts are likely candidates for funding adaptation strategies. Water districts are a type of special purpose districts. Special purpose districts are areas of a political subdivisions that provide their own infrastructure and levy taxes for a limited purpose.[477] Water districts are just those that deal specifically with water. Water

[474] Tex. Tax Code Ann. § 302.001 (West) .
[475] *Id.*
[476] 60 Tex. Jur. 3d Public Securities and Obligations § 29.
[477] Invisible Government: Special Purpose Districts in Texas. Research Spotlight. Pg. 2. A Publication of the Texas Senate Research Center. October 2008. http://www.senate.state.tx.us/SRC/pdf/SL-SpPurposeDistricts.pdf ;

districts must comply with the Tax Code.[478] It derives its power from two different sources. Either it must pass election as a "general law" or the legislature must create it as a "special law". General law districts are created by the Texas Constitution and derive their powers and duties from Title 4 of the Water Code.[479] Special law districts are passed as bills by the legislature and may have more or less powers than general law districts.[480]

Chapter 49 of the Water Code pertains to all general and special law districts and contains general administrative provisions.[481] It requires a district to hold an election within its proposed boundaries on whether it would be established and, if required by law, an election of directors.[482] Additionally, Chapter 49 requires a district to receive a majority of votes before it levies M&O taxes.[483] Therefore, voting for both its creation and taxing ability are steps that a district must take before being able to fund a adaptation strategy. Other steps vary according to the type of district involved because of their different sources of authorization and purposes.

For some water law districts including WCIDs and Municipal Utility Districts (MUDs), general law districts differ according to their constitutional and statutory authority. Either they fall under the Texas Constitution's Section 52, Article III or Section 59, Article XVI.[484] WCIDs may be either under Section 52 or 59, whereas all MUDs are under Section 59.

Section 52's allowed purposes include:

(1) The improvement of rivers, creeks, and streams to prevent overflows, and to permit of navigation thereof, or irrigation thereof, or in aid of such purposes.
(2) The construction and maintenance of pools, lakes, reservoirs, dams, canals and waterways for the purposes of irrigation, drainage or navigation, or in aid thereof.
(3) The construction, maintenance and operation of macadamized, graveled or paved roads and turnpikes, or in aid thereof.[485]

Section 59's allowed purposes include:

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Overview of Local Taxes in Texas: Prepared for the Senate Committee on Finance. Pg. 6. TLC Research Division. November 2002. http://www.tlc.state.tx.us/pubspol/localtaxes.pdf.

[478] TCEQ. Texas Water Districts: A General Guide. Pg. 2. https://www.tceq.texas.gov/publications/gi/gi-043.html.

[479] Robert B. Neblett. The Intersection Between Texas Condemnation Law and Water Rights. Pg. 3. Jackson Walker L.L.P. http://images.jw.com/com/publications/1761.pdf; TCEQ. Texas Water Districts: A General Guide. Pg. 2. https://www.tceq.texas.gov/publications/gi/gi-043.html

[480] Robert B. Neblett. The Intersection Between Texas Condemnation Law and Water Rights. Pg. 4. Jackson Walker L.L.P. http://images.jw.com/com/publications/1761.pdf.

[481] Invisible Government: Special Purpose Districts in Texas. Research Spotlight. Pg. 18. A Publication of the Texas Senate Research Center. October 2008. http://www.senate.state.tx.us/SRC/pdf/SL-SpPurposeDistricts.pdf.

[482] *Id.*

[483] *Id.*

[484] Overview of Local Taxes in Texas: Prepared for the Senate Committee on Finance. Pg. 10. TLC Research Division. November 2002. http://www.tlc.state.tx.us/pubspol/localtaxes.pdf.

[485] Tex. Const. Art. III, § 52.

The conservation and development of all of the natural resources of this State, and development of parks and recreational facilities, including the control, storing, preservation and distribution of its storm and flood waters, the waters of its rivers and streams, for irrigation, power and all other useful purposes, the reclamation and irrigation of its arid, semi-arid and other lands needing irrigation, the reclamation and drainage of its overflowed lands, and other lands needing drainage, the conservation and development of its forests, water and hydro-electric power, the navigation of its inland and coastal waters, and the preservation and conservation of all such natural resources of the State are each and all hereby declared public rights and duties…[486]

The districts are authorized not only by the constitution but also by the Water Code that states their specific purposes. MUDs are authorized by Chapter 54 of the Water Code under and subject to Section 59, Article XVI of the Texas Constitution. Chapter 54 states that a MUD is created for:

(1) the control, storage, preservation, and distribution of its storm water and floodwater, the water of its rivers and streams for irrigation, power, and all other useful purposes;
(2) the reclamation and irrigation of its arid, semiarid, and other land needing irrigation;
(3) the reclamation and drainage of its overflowed land and other land needing drainage;
(4) the conservation and development of its forests, water, and hydroelectric power;
(5) the navigation of its inland and coastal water;
(6) the control, abatement, and change of any shortage or harmful excess of water;
(7) the protection, preservation, and restoration of the purity and sanitary condition of water within the state; and
(8) the preservation of all natural resources of the state.[487]

Water Control and Improvement Districts (WCIDs) are authorized by Chapter 51 of the Water Code under and subject to either Section 52, Article III or Section 59, Article XVI of the Texas Constitution. Chapter 51 lists the purposes of a WCID:

(a) A water control and improvement district organized under the provisions of Article III, Section 52, of the Texas Constitution, may provide for:

> (1) the improvement of rivers, creeks, and streams to prevent overflows, to permit navigation or irrigation, or to aid in these purposes; or
> (2) the construction and maintenance of pools, lakes, reservoirs, dams, canals, and waterways for irrigation, drainage, or navigation, or to aid these purposes.

(b) A water control and improvement district organized under the provisions of Article XVI, Section 59, of the Texas Constitution, may provide for:

> (1) the control, storage, preservation, and distribution of its water and floodwater and the water of its rivers and streams for irrigation, power, and all other useful purposes;

[486] Tex. Const. Art. XVI, § 59.
[487] Tex. Water Code § 54.012.

(2) the reclamation and irrigation of its arid, semiarid, and other land which needs irrigation;
(3) the reclamation, drainage, conservation, and development of its forests, water, and hydroelectric power;
(4) the navigation of its coastal and inland water;
(5) the control, abatement, and change of any shortage or harmful excess of water;
(6) the protection, preservation, and restoration of the purity and sanitary condition of water within the state; and
(7) the preservation and conservation of all natural resources of the state.
(c) The purposes stated in Subsection (b) of this section may be accomplished by any practical means.[488]

Any WCID among other types of districts authorized by Section 59 may be converted to a MUD passing of a resolution by the governing body, the holding of a hearing by the TCEQ, and the determination that it would be in the best interest of the district.[489]

Beyond WCIDs and MUDs, other water districts could levy AVTs, issue bonds and incur debt, and charge for certain services to pay for water issues. These include Fresh Water Supply Districts, Water Improvement Districts, Drainage Districts, Levee Improvement Districts, Irrigation Districts, Regional Districts, Special Utility Districts, and Stormwater Control Districts among others.[490]

An additional special purpose district is a Public Improvement District (PID) but it is authorized under a different code: Chapter 372 of the Local Government Code. It is an improvement district. It is also different because instead of AVTs, PIDs use special assessments (discussed below) to fund their projects which usually involve infrastructure improvements such as water and sewer lines.[491]

### 6.2.1 Potential Legal Issues/ Legal Challenges

Water districts have some legal issues when it comes to implementing a SLR adaption project. All water districts are subject to the Water Code's Chapter 49 general administration rules which require voting for both the creation and funding levels.[492] These voting requirement laws could

[488] Tex. Water Code § 51.121.
[489] Invisible Government: Special Purpose Districts in Texas. Research Spotlight. Pg. 20. A Publication of the Texas Senate Research Center. October 2008. http://www.senate.state.tx.us/SRC/pdf/SL-SpPurposeDistricts.pdf.
[490] Invisible Government: Special Purpose Districts in Texas. Research Spotlight. A Publication of the Texas Senate Research Center. October 2008. http://www.senate.state.tx.us/SRC/pdf/SL-SpPurposeDistricts.pdf.
[491] Tex. Local Gov. Code § 372; Invisible Government: Special Purpose Districts in Texas. Research Spotlight. Pg. 31. A Publication of the Texas Senate Research Center. October 2008. http://www.senate.state.tx.us/SRC/pdf/SL-SpPurposeDistricts.pdf.
[492] Invisible Government: Special Purpose Districts in Texas. Research Spotlight. Pg. 18. A Publication of the Texas Senate Research Center. October 2008. http://www.senate.state.tx.us/SRC/pdf/SL-SpPurposeDistricts.pdf.

be a potential problem since it could stop the district before it had the opportunity to consider SLR.

District-allowed purposes vary according to which section under which they are organized. Firstly, Section 52 limits the amounts of bonds a district may issue. They may be no greater than one-fourth of the assessed value of real property in the district, but they do not limit the property tax to pay off the bonds. Section 59 neither limits the amount of bonds a district may issue nor its tax rate.[493] Furthermore, the types of districts can differ by their authorized purposes under both Section 52 and Section 59. Section 59 districts' purposes include providing control, storage, and distribution of its waters for useful purposes including the abatement of harmful excess of water[494] whereas Section 52's purposes include improvement of rivers, construction of waterways for drainage, among other purposes.

Whether it is organized under Sections 52 or 59 of the Texas Constitution, a district's proposed action must be used to further the purpose for which it was created under the Texas Constitution and the Water Code in order "to be justified and constitutional."[495] Therefore, in order to enact a SLR adaptation effort for an existing water district, the action must further a purpose for which that district was created. Although a power may be listed in the Water Code, it does not mean that the district may conduct that action whenever it wants.

An example is *Harris County Water Control & Improvement District v. Texas Water Rights Commission*. The court held that a municipal utility district's (MUD's) proposed recreational facilities did not further the MUD's purpose for which it was created, therefore it was unauthorized by law.[496] The MUD involved was created under Section 54 of the Water Code, therefore the recreational facilities must have furthered one of its purposes (listed above). The appellants did not show any evidence on how the facilities furthered any Section 54.012 purposes or those in Section 59 of the Constitution, so their recreational facility project failed.

*Parker v. San Jacinto County WCID No. 1* is an example of a successful attempt by a water district to fulfill its original purpose in a proposed action. This case involved a WCID that was delegated the power to build and operate a sewage disposal plant under Section 59 of the Constitution. The court found that the action did further the purpose for which the WCID was created; namely, it connected the purification of water action to the purposes of both the Constitution and the Water Code by the hydrological cycle.[497]

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[493] Overview of Local Taxes in Texas: Prepared for the Senate Committee on Finance. Pg. 10. TLC Research Division. November 2002. http://www.tlc.state.tx.us/pubspol/localtaxes.pdf.

[494] Invisible Government: Special Purpose Districts in Texas. Research Spotlight. Pg. 18. A Publication of the Texas Senate Research Center. October 2008. http://www.senate.state.tx.us/SRC/pdf/SL-SpPurposeDistricts.pdf.

[495] *Harris County Water Control & Imp. Dist. No. 110 v. Texas Water Rights Com.,* 593 S.W.2d 852, 854 (Tex. Civ. App.—Austin 1980, no writ) (holding that even though a power may be listed in the Water Code it must coincide with the purpose for which the district was created; therefore, building public recreational facilities is not a proper power to use in order to carry out a MUD's purpose delineated in the Water Code and Texas Constitution).

[496] *Harris County Water Control & Imp. Dist. No. 110 v. Texas Water Rights Com*., 593 S.W.2d 852, 854, 1980 Tex. App. LEXIS 2981, *6 (Tex. Civ. App. Austin 1980) .

[497] *Parker v. San Jacinto County Water Control and Improvement District No. 1*, 154 Tex. 15, 273 S.W.2d 586 (Tex. 1958).

Both the *Harris County* and *Parker* cases show that even though a water district must show that its actions further the purpose for which the water district was originally created, it is not extremely difficult to make the connection. The problem in the *Harris County* case is that the appellant did not connect the action to the purpose of the MUD at all and then made a completely misapplied erroneous argument. In the *Parker* case, the legislature made the perhaps tenuous argument that, because a sewer disposal system returns water to the hydrologic cycle rather than destroying it, it fulfills the water conservation and protection purposes of Section 59 of the Texas Constitution. Arguably, SLR adaptation effort actions by a water district would be just as easily connected if not more so than a sewage disposal plant.

### 6.2.2 Strengths and Weaknesses

The strengths of water districts are that they may focus on the specific problem of SLR, and special purpose districts are relatively easy to form.[498] Special law water districts have the capacity for greater power than general law districts although the legislature must first be persuaded to name and bind a district by a standalone act. However, they are easier to form than general law districts because they only need to manage to convince the legislature on one bill passage and once done they don't require any further approval.[499]

Although the creation of general law districts must have voter support, this has not been a major hindrance to organized groups.[500] MUD formation is smooth ending in an election, the outcome of which usually is in favor of creation even if it is against public opinion.[501] Because it is such an easy and straightforward process, water districts have been exploited by those with a myriad of purposes, usually for financial gain. However, it would seem that a group aiming for a MUD specifically for adaptation efforts in a certain area would succeed even if its goal varies from the norm. Moreover, once a MUD is formed, voter participation is weak in bonding elections, so it is probable that voters would not stand in the way of financing adaptation activities once the MUD is formed.[502]

MUDs, by all their above explained features, encourage some of the roadblocks that SLR adaptation efforts usually encounter. Traditional MUDs encourage urban sprawl by allowing developers to avoid municipal exactions and pay for the MUD's infrastructure by its bonding and taxing power.[503] Urban sprawl in turn leads to less land that could be used for green infrastructure and conservation easements. However, if implemented with SLR in mind, a MUD could become a powerful tool that would prohibit more roadblocks from forming.

Furthermore, it may seem limiting that general law water districts must stick to the purposes for which they were originally created and conduct actions that are among the water district's listed

[498] Sara C. Galvan, *Wrestling with Muds to Pin Down the Truth About Special Districts*, 75 Fordham L. Rev. 3041, 3049 (2007).
[499] *Id.*
[500] *Id.*
[501] *Id.*
[502] *Id.*
[503] *Id.*

powers, but this should not be a problem. The Texas Constitution and the Water Code's most relevant purposes include controlling storm water, the reclamation of over-flowed lands, preservation of natural resources, improvements to prevent overflows, and the construction of dams and canals to aid in drainage among other purposes. SLR adaptation strategies further those purposes basically as a rule or else it would likely not even be considered SLR adaptation.

Furthermore, water districts are not just reactionary; they can look to future flooding issues and aim AVT revenues to prevent them.[504] Therefore, adaptation strategies could prevent future SLR damage. Therefore, existing water districts, especially MUDs and WCIDs, are excellent avenues to take when looking to fund and initiate adaptation strategies for SLR.

### 6.2.3 Summary of Appropriateness for Use in SLR Adaptations

AVTs by water districts would be a reasonable way to fund SLR efforts because the power to take adaptation action fits with the original purposes of these local governments. Additionally, they may levy AVTs solely to fund such actions with little threat of interference.

## 6.3 Special Assessments

"A special assessment (SA) is a lien on all property included in the improvement district."[505] Rather than benefitting the general public, SAs provide improvements specific to private property. The SA's purpose is public, but it has a local aspect such as increasing the value of the neighboring property instead of profiting the whole area.[506] A city could undertake flood-protection measures financed by levying a SA on property owners who would be especially benefitted (and establish a Public Improvement District, see below, to undertake the project).[507]

SAs are not taxes as defined in our constitution and statutes, but they are still categorized as an exercise of the taxing power.[508] SAs must confer a specific benefit on the land burdened by the assessment. Conversely, a tax does not need to give any specific benefit but rather generally benefit the LTU's residents.[509]

The main differences between a SA and a tax:

(1) a special assessment can be levied only on land;

(2) a special assessment cannot be made a personal liability of the person assessed;

(3) a special assessment is based wholly on benefits; and

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[504] *See Harris County Flood Control Dist. v. Mann*, 135 Tex. 239, 243, 140 S.W.2d 1098, 1100 (1940).
[505] 70C Am. Jur. 2d Special or Local Assessments § 168.
[506] 89 Am. Jur. Proof of Facts 3d 421 (Originally published in 2006) .
[507] Texas State Historical Association. Water Agencies and Programs. https://tshaonline.org/handbook/online/articles/mpw01 .
[508] 70C Am. Jur. 2d Special or Local Assessments § 6.
[509] 89 Am. Jur. Proof of Facts 3d 421 (Originally published in 2006).

(4) a special assessment is exceptional both as to time and locality.[510]

Due to different types of local governments and municipalities, there are varying sources for authority for SAs. The Texas Constitution or a city charter may give a home rule municipality the ability to levy SAs; therefore, legislative action is not required.[511] However, for other local governments, the legislature may delegate its power to impose SAs to them, subject to limitations set forth in the Texas Constitution.[512] Although local governments are not deemed to have the power inherently, there is case law that indicates it is a "municipal affair" to undergo local improvements and the collect their costs.[513] Furthermore, the state legislature may delegate the power to other entities including public corporations, existing agencies or ones newly created for that purpose, and to nonprofit associations for maintenance when they control properties one may use as part of his ownership.[514] Unless prohibited by law, levying SAs is a continuing power after it has been delegated to a municipality or district and may be exercised more than once.[515]

Public Improvement Districts, known as PIDs are the structures created to levy SAs. Chapter 372 of the Local Government Code authorizes cities and counties to levy SAs on properties that are within the city or its extraterritorial jurisdiction by the creation of a PID. PIDs are used to promote economic growth; to improve wastewater, health and sanitation; drainage improvements; the expansion of affordable housing; and/or other improvements.[516] The municipality or county must initiate or receive a petition which complies with Chapter 372, requesting the establishment of a PID in order to exercise this power.[517]

According to Chapter 372, a PID may include these improvements:

(9) acquisition, construction, or improvement of water, wastewater, or drainage facilities or improvements;

(11) projects similar to those listed in Subdivisions (1)—(10);

(13) special supplemental services for improvement and promotion of the district, including services relating to advertising, promotion, health and sanitation, water and wastewater, public safety, security, business recruitment, development, recreation, and cultural enhancement…[518]

Counties have a limitation involving home rule municipalities. If such a municipality objects within 30 days of a county's action to approve a PID within the municipality's corporate limits or

[510] *Id.*
[511] 70C Am. Jur. 2d Special or Local Assessments § 7.
[512] *Id.*
[513] *Id.* (citing *Raisch v. Myers*, 27 Cal. 2d 773, 167 P.2d 198 (1946)).
[514] *Id.*
[515] *Id.*
[516] Texas Ahead. Special Assessments and Other Incentives: Public Improvement Districts (PIDs). http://texasahead.org/tax_programs/pubimprovement/ .
[517] Tex. Local Gov. Code § 372.002.
[518] Tex. Local Gov. Code § 372.003.

extraterritorial jurisdiction, that county's PID will fail.[519] Therefore, limits and jurisdiction are important to note in an effort to establish a PID. Municipalities with populations of more than one million and those with a council-manager form of government, located wholly or partly in a county with a population of more than two million, there is an expansion of authority involving projects that confer a special benefit on areas that share a common characteristic or use. They may be noncontiguous.[520] For the expansion, such a municipality must have a PID "solely composed of territory in which the only businesses are hotels with 100 or more rooms ordinarily used for sleeping."[521] If such a project is undertaken by such a municipality, according to Chapter 372 of the Local Government Code it may:

(1) adopt procedures for the collection of assessments under this chapter that are consistent with the municipality's procedures for the collection of a hotel occupancy tax under Chapter 351, Tax Code; and

(2) pursue remedies for the failure to pay an assessment under this chapter that are available to the municipality for failure to pay a hotel occupancy tax under Chapter 351, Tax Code.[522]

Additionally, PIDs are different from MUDs similar to the way that SAs are different from taxes. Apart from the way they are financed[523], the main difference between a PID and a MUD is that a PID may finance more types of improvements than a MUD. Furthermore, while a MUD may only finance water, sewer and flood control facilities unless granted road district powers, a PID can finance almost all types of improvements including those of the MUD.[524] Additionally, the public bidding requirement of a MUD is not necessary for a PID, and a PID may be established anywhere within a county. Conversely, MUDs are restricted to certain types of municipalities, either within such a city or in its extra-territorial zone.[525]

### 6.3.1 Potential Legal Issues/ Legal Challenges

A property owner may claim that the SA is actually a taking. However, SAs are not an exercise of the power of eminent domain but rather are a police power. Instead of directly attempting to take the property, there is an exaction of a sum according to the benefit bestowed on the property.[526] However, if the exaction is materially greater than the benefit conferred or on any other basis than benefits conferred, it would amount to a taking without just compensation.[527]

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[519] Tex. Local Gov. Code § 372.003(d).
[520] Tex. Local Gov. Code § 372.0035.
[521] *Id.*
[522] *Id.* (The same authority lies with municipalities with populations between six hundred and fifty thousand and two million with hotels with 100 or more rooms or between three hundred and twenty five thousand and less than six hundred twenty five thousand with hotels of 75 or more rooms).
[523] (MUD by ad valorem taxes and a PID by limited and fixed assessments on each parcel).
[524] David Taussig & Associates. Public Improvement District Bond Financing in Texas. http://www.taussig.com/consulting/public-improvement-districts-texas/index.html.
[525] David Taussig & Associates. Public Improvement District Bond Financing in Texas. http://www.taussig.com/consulting/public-improvement-districts-texas/index.html
[526] 60 Tex Jur Public Improvements and Special Assessments § 1 (3rd ed. 2014).
[527] *City of Houston v. Blackbird*, 394 S.W.2d 159 (Tex. 1965).

Therefore, the municipality, county, or other entity must be careful in the process of valuing the benefits conferred on properties. Otherwise, there are few legal challenges that may be brought against the creation of an improvement district, the levying of an assessment, or how a benefit is assessed. Once an improvement district is established without any proceedings taken to question its validity within the specified time, it is conclusive against collateral attack.[528] For an assessment that has not violated rights assured by fundamental law, "the courts will not interfere with:

(1) the legislative determination of necessity;

(2) the policy involved in ordering an assessment;

(3) the apportioning of the assessment;

(4) the making of necessary rules and regulations regarding assessments; or

(5) the establishment of the agencies to be employed in the collection of the assessment."[529]

A municipality granted full power or a legislature's determination that certain lands will benefit from an improvement is conclusive.[530] Additionally, property owners do not have a right to be heard on the question of whether the improvement is beneficial. However, if a statute provides for a district to be created by voter petition and if the statute does not limit the actions of petitioners in selecting property to be assessed, it is unconstitutional unless it can be reasonably construed as to providing for a hearing as to benefits and boundaries.[531] In conclusion, there are very few angles in which to challenge a levying of an assessment from the creation of its district to the determination of benefits.

### 6.3.2 Strengths and Weaknesses

A major strength is that SAs, if done properly, are largely bulletproof. For example, a court will interfere only if an assessment was a taking without due process of law or shown to be arbitrary and unreasonable. This is a low standard to meet and, therefore, this is a strength of a SA. So far, as long as the local government avoids a taking or a completely unsubstantiated assessment, a SA cannot be challenged. The same principal goes for when an improvement district is created and benefits are determined.

However, the local government must have the power to levy in the first place. Therefore, one weakness of an SA is that local authorities' power to levy is derived from statutory or charter provisions and that power does not exist if it is not plainly given except for home rule

[528] 60 Tex. Jur. Public Improvements and Special Assessments § 14 (3rd ed. 2014) (citing *Wilmarth v. Reagan*, 242 S.W. 726 (Tex. Comm'n App. 1922); *Preston v. Anderson County Levee Improvement Dist. No. 2*, 3 S.W.2d 888 (Tex. Civ. App. Texarkana 1928), writ refused, (Oct. 24, 1928); *Hester & Roberts v. Donna Irr. Dist., Hidalgo County, No. 1*, 239 S.W. 992 (Tex. Civ. App. San Antonio 1922), writ refused).
[529] 60 Tex Jur Public Improvements and Special Assessments § 6 (3rd ed. 2014).
[530] 60 Tex Jur Public Improvements and Special Assessments § 32 (3rd ed. 2014).
[531] *Id.*

municipalities.[532] Because home rule municipalities derive their power from the Texas Constitution or their charters, they may self-govern by levying SAs unless their charter, the constitution, or general law clearly restricts that power.[533]

Additionally, unless there is clear legislative authorization, no local government has the power to levy a SA against state property, at least if it is not using or contemplating any use of the allegedly benefited land and has neither requested nor received any services rendered by the assessing agency.[534] There is an exemption for independent school districts as well, but it is relatively narrow. Without consent, it cannot be subject to liability for SAs for paving streets abutting the school property, where a statute prohibits any expenditures except for enumerated purposes or those necessary in the conduct of public schools.[535] These restrictions could affect the viability of funding adaptation projects in certain areas; however, these barriers do not seem problematic for a majority of potential projects.

When considered against AVTs, SAs have strengths just by their contrasts from the former. SAs are not limited by the values of properties and a set budget of a LTU; they are merely limited by the amount of benefit they provide. They may collect this levy even before the benefit is conferred, but it must have obligated itself or another to construct the improvement.[536]

PIDs have greater range in potential locations than MUDs because they may be outside municipalities and they have a greater range of public purposes because they are not governed by the Water Code. Additionally, PIDs do not need public voter support as MUDs do, and there is little law on what specific purposes may or may not be funded by SAs and that law includes flood control among other water purposes.

However, a weakness when considered against AVTs is that a SA may only be levied against those who are benefitted instead of all property owners of a LTU. One may argue, however, that this is outweighed by the other strengths of SAs.

[532] 60 Tex Jur Public Improvements and Special Assessments § 4 (3rd ed. 2014) (citing *Dallas Consol. Electric St. Ry. Co. v. City of Dallas*, 260 S.W. 1034 (Tex. Comm'n App. 1924); *Connor v. City of Paris*, 87 Tex. 32, 27 S.W. 88 (1894); *Foxworth-Galbraith Lumber Co. v. Realty Trust Co.*, 110 S.W.2d 1164 (Tex. Civ. App. Amarillo 1937),dismissed; *City of Dallas v. Johnson*, 54 S.W.2d 1024 (Tex. Civ. App. Dallas 1932)).
[533] 60 Tex Jur Public Improvements and Special Assessments § 4 (3rd ed. 2014) .
[534] 60 Tex Jur Public Improvements and Special Assessments § 19 (3rd ed. 2014).
[535] 60 Tex Jur Public Improvements and Special Assessments § 20 (3rd ed. 2014).
[536] 60 Tex Jur Public Improvements and Special Assessments § 33 (3rd ed. 2014).

### 6.3.3 Summary of Appropriateness for Use in SLR Adaptations

SAs and PIDs may be useful to funding SLR projects. Once properly established, they are practically invincible to attack, they do not have many recognizable restrictions when it comes to types of projects they may fund, and they have those who would benefit from them most directly pay for part or all of their construction and so there would likely be very little opposition to their implementation.

## 6.4 Bonds

Bonds may be issued only if there is statutory authority to do so. Both the Texas Constitution and the Texas Government Code authorize bonds for Texas Counties and Municipalities.[537] Bonds must be approved by voters and may be used only for the propositions approved.[538]

County bonds may be issued to "build a county courthouse or jail, purchase sites in the county to construct buildings for homes or schools for dependent or delinquent children, establish county facilities for needy or indigent persons in the county, purchase and construct bridges for public purposes in the county or to cross a stream serving as the county's boundary line, or improve and maintain public roads in the county."[539] Counties have also been found to have authority to issue bonds for reclamation and irrigation projects including reservoirs, dams, canals, waterways, lakes, seawalls and breakwaters.[540]

Municipalities "may issue bonds payable from ad valorem taxes in the amount it considers expedient to construct or purchase permanent improvements inside municipal boundaries including, public buildings waterworks or sewers, construct or improve the streets and bridges of the municipality or construct or purchase building sites or buildings for the public schools and other institutions of learning inside the municipality if the municipality has assumed exclusive control of those schools and institutions."[541] *See* Town of Freeport v. Sellers 190 S.W.2d 813 (1945) (holding that "sewers" includes drainage improvements).

A home rule municipality may issue bonds "on the credit of the municipality to make permanent public improvements for other public purposes in the amount of and to the extent provided by its charter."[542]

There are two primary types of bonds used in Texas and they are distinguished by the source of their repayment.[543] Revenue bonds are payable from the revenue generated by a specific facility that is constructed with the bond proceeds.[544] These types of bonds are not payable from taxes,

[537] *See Texas* Constitution Art 3 Section 52 & Texas Constitution Art 11 Section 3.
[538] 35 Tex. Prac., County And Special District Law § 17.1 (2d ed.).
[539] Texas Government Code 1301.001.
[540] Tex. Govt. Code 1474.001, 1477.051; Tex. Constitution Art. XI Sec. 7, Local Govt. Code 571.
[541] Texas Government Code 1331.001.
[542] Texas Government Code 1331.052.
[543] 35 Tex. Prac., County And Special District Law § 17.1 (2d ed.).
[544] *Id.*

but instead are secured by revenue derived from the operation of municipal utility systems such as electricity and water.[545] The second type of bond is known as a general obligation bond and is payable from revenue received from ad valorem taxation, which in Texas is usually in the form of property tax.[546] However, these bonds can be repaid by any source of revenue and are not limited to the project undertaken like revenue bonds. These bonds go by various names: general obligation bonds, full faith and credit bonds, tax bonds, or guaranteed bonds.[547]

### 6.4.1 Potential Legal Issues/Challenges

Because bonds must be issued pursuant to the specific purposes listed in their authorizing statutes, they are subject to challenge if the purpose is not a type allowed in the statute. If a municipality seeks to finance SLR adaptation strategies with the use of bonds it may be challenged on the basis that the project does not fall within listed purposes. Additionally, in the issuance of bonds, a municipality can act only through the city council, and that body can act only by resolution or ordinance.[548] Bonds that are not authorized by ordinance or resolution of the council are void.[549] This lengthy process may also present challenges to the approval bonds used for SLR adaptation. Further, a home rule municipality may issue bonds in the amount fixed by its charter, but it may not issue bonds under this statutory provision unless the bonds have been authorized by a majority of the qualified voters of the municipality voting at an election held for that purpose.[550] By subjecting a politically sensitive topic such as SLR to the electorate, bonds for these purposes may face the challenges of differing opinions and possible disapproval.

### 6.4.2 Strengths and Weaknesses

The requirement that bonds be of a type listed in the authorizing statute is a weakness overcome by home rule municipalities. Although these bonds must be approved by vote, home rule municipalities have the authority to issue bonds for general public purposes. Because SLR adaptation would serve to protect citizens as well as prevent economic damage along the coast, it is likely that it would be found to be a public purpose for bond issuance.

### 6.4.3 Summary of appropriateness for use in SLR adaptations

Bonds may be appropriate for use in SLR adaptation because it is for the benefit of the public welfare, and likely a public purpose. Home rule municipalities may have greater discretion to issue bonds for these purposes. If a municipality seeks to use bonds to finance SLR adaptation projects it must be sure to use the correct type. General Obligation Bonds are best suited for a major capital project where the commissioners court or city council believes that it is important

[545] 23 Tex. Prac. Municipal Law and Practice 12.13 (2d ed.).
[546] *Id.*
[547] 35 Tex. Prac., County And Special District Law § 17.1 (2d ed.).
[548] 60 Tex. Jur. 3d Public Securities and Obligations § 38.
[549] *Id.*
[550] 60 Tex. Jur, 3d Public Securities and Obligations §5.

to have the voters have the opportunity to pass upon the project.[551] General Obligation Bonds would be appropriate for SLR adaptation use because SLR and climate change are sensitive political topics that would affect a large a number of people, thereby necessitating a vote. Revenue bonds may prove to be too limiting for SLR project because bond proceeds can only be spent for the purposes for which they were issued and most counties generally do not have projects that will support revenue bonds.[552] It is unlikely that a SLR adaptation project will generate its own revenue sufficient to repay the debt of a revenue bond. Rather, a municipality may institute a SLR adaptation project, for the public welfare, and repay the debt of a general obligation bond from any available resource.

In addition to SLR adaptation projects constituting a public purpose, Article X1 Section 7 of the Texas Constitution permits all counties and cities bordering the Gulf of Mexico, upon a vote, to collect taxes for the construction of sea walls and breakwaters, which are a few forms of SLR adaptation. These counties and cities are authorized under the same provision to create a debt for the work and issue bonds. Counties and municipalities also have authority under the Texas Local Government Code 571.002 to construct or improve seawalls, levees, or drainways and may participate as a partner in an erosion response project undertaken by the General Land Office. They may also undertake or contribute to the funding or beach nourishment on public beaches or any other erosion response project on waterways bays and bay shorelines. Cities and municipalities may impose a tax to pay the debt incurred by these projects and may issue bonds for the payment of the debt.[553]

## 6.5 Local Option Tourist Development Tax (Texas "Local Hotel Occupancy Tax")

In Texas, the Local Hotel Occupancy Tax provides for the imposition and collection of taxes on a person who pays for the use or possession of a hotel. This tax may be imposed at the state, county, or municipal level.[554] Additionally, this tax must be levied by ordinance,[555] while counties must levy the tax by resolution or order[556]. Revenue collected from the Local Hotel Occupancy Tax may only be used "to promote tourism and the convention and hotel industry."[557] Chapter 351.101 of the Texas Tax Code states that revenues are allowed to only be used toward the specific purposes enumerated therein.[558] A municipality may also pledge the revenue derived from the hotel occupancy tax for the payment of bonds.[559]

However, important to the SLR adaptation analysis, certain "eligible coastal municipalities" are allowed additional uses. A home rule municipality that borders the Gulf of Mexico may use all

[551] Thomas M. Pollan, *Public Finance Issues For Cities Counties and Special Districts in Texas*.
[552] Texas Public Finance Handbook**
[553] Tex. Local Govt. Code 571.006.
[554] V.T.C.A. Tax Code 351.002, 352.001, 156.
[555] V.T.C.A 351.002.
[556] *Id.*
[557] V.T.C.A. 351.101.
[558] *Id.*
[559] V.T.C.A 351.102.

or any portion of the revenue to "clean and maintain beaches in the municipality."[560] Additionally under Chapter 156.2512 an "eligible barrier island coastal municipality" may use revenues received to clean and maintain public beaches and bay shores, and for an erosion response project.[561] An erosion response project is further defined in chapter 33.601 of the Natural Resources Code as "an action intended to address or mitigate coastal erosion, including beach nourishment, sediment management, beneficial use of dredged material, creation or enhancement of a dune, wetland, or marsh, and construction of a breakwater, bulkhead, groin, jetty, or other structure."

### 6.5.1 Potential Legal Issues/Legal Challenges

As discussed, the hotel occupancy tax is not used for general revenue purposes. *See* 22 Tex. Prac., Municipal Law and Practice § 9.26 (2d ed.) ("unlike sales tax…hotel tax is not used for general revenue purposes. Generally, hotel tax revenue is used only to promote tourism and the convention and hotel industry."). However, under 156.2511 of the Texas Tax Code, eligible municipalities may use these taxes only to clean and maintain public beaches in that municipality. The issue would be whether SLR adaptation falls within the definition of clean and maintained as required by section 61.063 of the Natural Resources Code.

"Every expenditure of the hotel occupancy tax must clearly fit into one of nine statutorily provided categories for expenditure of local hotel occupancy tax revenues."[562] If the revenue collected fits into those categories described, there should be no legal challenges.

### 6.5.2 Strengths and Weaknesses

A core strength of utilizing hotel occupancy tax revenues for SLR adaptation strategies in the Gulf of Mexico, is the explicit statutory language allowing for typical adaptation strategies. However, this seemingly wide range of uses is limited to municipalities. Regarding coastal counties, hotel occupancy tax revenue may be used to clean public beaches.[563] *See* 35 Tex. Prac., County And Special District Law § 13.19 (2d ed.) ("The revenue derived from the county hotel occupancy tax can be used only for civic center and related facilities, and various cultural, historical, and promotional programs."). The statutory language does not provide for an extensive list of beach nourishment options available to municipalities and may prohibit a county from pursuing SLR adaptation strategies. Additionally, hotel occupancy tax rates are capped. The state tax rate is capped at 6% per room, counties range from 2-4%, and municipalities generally at 7%. The question then arises whether these revenues will be sufficient in funding SLR projects, or if they will need to be supplemented by an additional revenue stream.

[560] V.T.C.A 351.1055.
[561] V.T.C.A. 154.2512.
[562] http://www.tml.org/legal_pdf/Admin-localHotelTax.pdf.
[563] V.T.C.A. 352.1033.

### 6.5.3 Summary of appropriateness for use in SLR adaptations

A municipality seeking to use hotel occupancy tax revenues for SLR adaptation strategies must be sure to follow the statutory guidelines. As discussed, counties may face challenges when attempting to use hotel occupancy tax revenue for SLR adaptation. Counties may however find recourse in Chapter 156 of the Tax Code authorizing the State to impose and collect these taxes and use the revenues for SLR adaptation purposes.

## 6.6 Conclusion

In regards to SLR preparations, Texas lags far behind Florida. Florida's municipalities have begun tackling the challenges that SLR will present. Conversely, Texas's municipalities have, in some instances, begun to acknowledge SLR, but none have truly begun to combat it. While Texas has not implemented any strategies for directly addressing SLR, the state does have preexisting mechanisms that may be used to fund SLR adaptations. Each of these options has benefits and drawbacks and are appropriate in different situations.

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# Introduction to the Appendix

Living with Sea Level Rise in the Upper Texas Coast is a large project of which this paper is but a part. It was written for readers who are interested in the practical details of what actions our government can take, the pros and cons of each action, and when each may be most appropriate. Law students researched legal and planning documents that apply to coastal municipalities and counties in Texas and Florida, providing references that pertain to SLR and climate change within this paper. Through outreach activities and online resources, the authors aim to inform all stakeholders, with particular emphasis on Upper Texas Coast residents and local decision-makers who can implement public policy solutions.

This report was written primarily for Texans, to help them and their communities adapt in the face of SLR- a public policy arena where Texas lags far behind- and to illustrate the risks that warrant proactivity. Florida leads the nation in local action on that front and so provides a useful example. To facilitate comparison, each chapter begins with Texas and follows with corresponding information on Florida. However, Florida is presented first in the Appendix with Texas following. In this way, the reader can read what steps local governments have taken in Florida and consider new approaches to reduce risk in Texas, a departure from the inaction that currently prevails.

While it is not possible to guarantee that there are not comprehensive plan or other local government documents in Florida or Texas that reference SLR that were missed during this research, the research was structured to identify those plans and documents reasonably available via electronic format.

## Disclaimer

In using the information provided, please note these limitations and restrictions. This research was completed in 2015, and it may not be current now. The information provided may have been omitted, modified, or added subsequent to the completion of the research. The research was based on keyword searches of terms, and thus it may not include every potential reference to SLR. While substantial effort went into researching and providing useful information, the authors recommend referencing original sources. No warranties are expressed or implied.

## I.1 Florida

The research occurred in three main parts. First, researchers identified that subset of local governments in Florida considered “coastal” as defined by the requirement to prepare a “coastal management element” in the local government’s required comprehensive plan. This resulted in a total of 195 local governments identified (161 municipalities and 34 counties).

Next, researchers accessed the Municipal Code Corporations website (www.municode.com) to determine how many of these local governments had their comprehensive plan and/or code of ordinances available via Municode (133 of 161 municipalities and 30 of 34 counties). Those

available were searched for multiple terms ("sea level rise," "SLR," and "sea"); when SLR or a relevant variant, the text was copied into a separate electronic document along with the reference for the document in which it appeared. Next, researchers searched another legal database—American Legal Publishing Corporation (http://www.amlegal.com/) –for local governments not available via the Municipal Code Corporation's website (8 municipalities and 0 counties). Again, researchers conducted searches for terms and excerpted relevant portions.

Finally, for local governments not available at one of these databases, researchers sought a link to comprehensive plan documents on the local government's website or via an internet search engine. In some cases searching of comprehensive plans via the local government's website presented the obstacle that it would appear in separate pdf files for each chapter of the plan, thus requiring numerous searches across numerous documents for a single local government. Only 5 of 195 local government comprehensive plans were not able to be located. Two additional plans were located piecemeal but were old and not available for electronic searches, thus precluding their inclusion in this work.

## I.2 Texas

The inventory catalogs were searched for coastal counties and municipalities' ordinances, comprehensive plans, and other documents that contained language deemed applicable to SLR planning and adaptation. This was based on a thorough internet search and includes relevant language gleaned from documents. Where available, links to the documents that were reviewed are included (see footnotes). The excerpts provided are intended to be useful, but readers should refer to the original documents to ensure they are both current and properly interpreted in their original context.

# Appendix A Florida

SLR is occurring. Credible scientific evidence has resulted in a consensus that SLR will not only continue but that it will increase dramatically for the foreseeable future. Florida, as a low-lying state with extensive coastline, ranks as one of the most at-risk states for SLR impacts. Thus, it might be assumed that Florida would be on the forefront of addressing the impacts of and adaptation to SLR. However, this has not been the case across the state. While some segments of state government have some focus on the issue (i.e.—the Florida Fish and Wildlife Conservation Commission and the Florida Department of Economic Opportunity), recent press has discussed accusations that state employees have been instructed to not use the terms "climate change" and "SLR."

Now, much of this may be set to change. On May 21, 2015, Governor Rick Scott signed into law CS/CS/CS Senate Bill 1094[564]. The bill focuses on flooding. The first section of the bill contains additions to Florida's comprehensive planning law. The bill modified Florida Statute section 163.3178(2)(f). This section of statutes has long required that coastal management elements of comprehensive plans include a "redevelopment component which outlines the principles which shall be used to eliminate inappropriate and unsafe development in the coastal areas when opportunities arise." With this new law, Florida Statute section 163.3178(2)(f)1. now includes "SLR" as one of the causes of flood risk that must be addressed in the "redevelopment principles, strategies, and engineering solutions" to reduce flood risk.

Previously the only mention of SLR in the comprehensive planning chapter of Florida Statutes was the permissible language allowing local governments to incorporate "Adaptation Action Areas" into the coastal management element of their comprehensive plans (Fla. Stat. §163.3177(6)(g)10. (2014)) and a definition for "adaptation action area" in Florida Statute section 163.3164(1).

The addition of another reference to SLR, especially one that is mandatory in nature, highlights the realization that SLR represents an important challenge to consider in the long-term resilience of Florida communities. While the inclusion of SLR as a mandatory part of comprehensive planning represents an advance at the state level in Florida, much of the impacts and costs of SLR still fall to local governments. Considering that Florida has almost 1,200 miles of shoreline, including over 650 miles of beaches and extensive, low-lying areas, it remains surprising how few local governments have yet explicitly added SLR to their comprehensive plans or otherwise considered SLR. With almost 500 local governments—research for this document did not include the more than 1,000 special districts in the state—and almost 200 of those required by state statute to prepare "coastal management elements" for their comprehensive plans, it seemed appropriate to assess how many of the "coastal" counties and municipalities had addressed SLR in their comprehensive plans.

[564] http://laws.flrules.org/2015/69

To assess this, extensive online research was conducted as well as some personal communications with knowledgeable individuals around the state to find local government documents that discuss SLR. The main focus of research sought to identify SLR in local government comprehensive plans, but in several instances other important local government documents that mention SLR are also included. Though not the focus of this particular project, researchers also often excerpted local government language that addressed climate change or adaptation of climate change rather than just SLR.

Due to a desire to limit the length of language cut and pasted from local government documents and to focus on SLR, many of the excerpted portions of language appear below separate from other language that might be relevant. Thus, if readers are particularly interested by language from a local government, it is strongly advisable to go to the original source material and examine whether excerpted language requires the context of other provisions in the documents where they appear to be fully understood. For example, the City of Satellite Beach only has two sections of its Coastal Management-Conservation Element that explicitly mention SLR (Objective 1.12A and Policy 1.21A.2). Yet the ordinance (#1066, passed March 3, 2013) that added these references contains a larger framework of changes to the comprehensive plan to address SLR. In the section on Satellite Beach, below, sections added at the same time via the same ordinance as the SLR references were added to the text for this fuller context of how Satellite Beach links flooding issues, SLR, resilience, and flood insurance costs.

Another note is in order regarding comprehensive plans. All local governments included in this research are required to have comprehensive plans. When SLR language appears in a comprehensive plan and indicates that a local government "shall" do something (e.g. the local government "shall work with Nassau County and state and regional entities as appropriate to develop strategies for responding to SLR, including . . . Consideration of the effects of SLR on potable water sources, saltwater intrusion, septic systems, wastewater treatment facilities, and the water table."), such language is often not self-executing. This may result in situations in which comprehensive plan language appears more proactive than the tangible actions of a local government in day-to-day operations. This research was not able to separately evaluate the level of implementation of language for each local government that has SLR language in its documents.

After review of the assembled comprehensive plan language or ordinances, a list of 14 types of activities was created based on the contents of the local government documents. Each activity or mention of SLR was given a code, and the frequency of the occurrence in local government comprehensive plans or ordinances was assessed. The results are in the following table:

| # of occurrences | KEY FOR CODES: |
|---|---|
| 13 | PI= Providing information on SLR |
| 10 | DA= Doing analysis of SLR |
| 1 | CA= Coordinating activities related to SLR |
| 1 | ID infra = Identify public infrastructure and assets at risk of SLR impacts |
| 4 | STRMWTR = Add SLR to stormwater design and planning |
| 3 | RISK = Designate areas at risk for SLR impacts |
| 2 | Fut.RISK = Discourage density increases in places of future SLR-induced vulnerability (this often may be present in comprehensive plans that this research did not review because the plans lacked explicit reference to SLR or may be in parts of plans that were reviewed, but not in the sections reviewed and included here; this is very likely as Florida Statutes require this to be part of comprehensive plans, Fla. Stat. §§ 163.3177(6)(g)4, 6, & 7; 163.3178(2), though implementation may be lacking in many communities) |
| 2 | InfraRR = Consider SLR in infrastructure replacement and for potential relocation |
| 9 | CNSDR = "Consider" SLR in particular decision making |
| 4 | DEV = Support increased development in safer coastal areas not at risk from SLR |
| 5 | AAA = Develop Adaptation Action Areas |
| 4 | MON = Monitor SLR and potential impacts |
| 10 | CC/GHG = mention of climate change and/or greenhouse gases |
| 16 | MENT = SLR mentioned but no specific action/policy implemented or req'd |

Based on the local government language identified through this research, a few local governments stand out for how carefully they have spelled out what they will do in response to SLR. The best examples of detailed analysis and incorporation of SLR include Miami-Dade County, Broward County, and Fort Lauderdale. Each of these three plans contains many similarities:

- They seek to ensure coordination of activities between the local government and other local government units, the state and federal governments, as well as with educational or non-profit institutions that can offer assistance.
- All three are based on extensive supporting materials, so they all are doing extensive analysis of climate change and SLR impacts and will continue to monitor the science on SLR. This allows all three to really understand current risk as well as potential future risk.
- Each of them specifically mentions infrastructure—including specific references to stormwater drainage; the best ones actually ensure that *any* infrastructure decisions include SLR in the decision-making process. Each of the three analyzes to understand what infrastructure is at risk from SLR. Fort Lauderdale and Miami-Dade go as far as indicating the need to analyze when and whether infrastructure should be relocated due to SLR.
- Two of the three specifically indicate that future development and density increases should be focused in the safest areas.
- Two of the three also discuss development of criteria to identify "Adaptation Action Areas" as noted in Florida Statute sections 163.3164(1) and 163.3177(6)(g)(10).

While these three have the most extensive and complete comprehensive plan references to SLR and the planning actions and policies for SLR, some other local governments also address SLR and deserve special mention. For example, St. Lucie County indicates that it will monitor SLR science and plan accordingly for long-term infrastructure and capital improvement expenditures as well as for resource protection. Fort Pierce, in the same county, has language which indicates that it will monitor SLR science and consider measures to protect or relocate critical public facilities in areas at risk of future SLR. Pinecrest, which is not even required to have a coastal management element, has an excellent and quite comprehensive CC/SLR element it added in 2015 to its comprehensive plan.

Key West, in the Florida Keys, has quite extensive references to both SLR and CC; this includes a requirement that the City Planner and City Engineer review SLR predictions and recommend any action needed to address it in current or future projects. Key West also has an innovative draft ordinance allowing exceptions to Key West's strict building height limitation. Historically Key West has sought to maintain its character by imposing strict building height limitations. However, it became apparent after the 2012 changes to the National Flood Insurance Program that the height restrictions could actually deter or prohibit adaptation of flood damage to existing structures and prohibit sufficient elevation of new structures to ensure longer-lasting flood protection and lower flood insurance premiums. After passage of a referendum on the

issue with over 80% support[565], the City of Key West is working to finalize a draft ordinance that was included with the referendum[566]. This process can serve as a model for other communities seeking to balance small-town historical character with the need for flood adaptation and lower flood insurance rates.

New Smyrna Beach, a town of only about 23,000 in Volusia County, has comprehensive plan language that commits the town to working with Volusia County on many issues, including development of data, analysis of the geographic extent of possible SLR risk, impacts on natural systems and structures, and evaluation of locating public facilities in areas projected to be impacted by SLR. Another small town on the Atlantic Coast, Satellite Beach, has also been active in incorporating SLR into their comprehensive plan. After several years of activity, in 2013 Satellite Beach finally passed a comprehensive plan amendment that focuses on development and redevelopment that protects life and property from SLR, seeks to lower flood insurance costs, initiates a public process to identify Adaptation Action Areas per Florida Statutes, and encourages population concentrations away from known or predicted high hazard areas.

It is important to note that comprehensive plans are not the only document that can house significant SLR or CC policies. While the comprehensive plan has the force of law, many times, more detailed, non-binding documents lead to development of comprehensive plan language, local government policies, and ordinances. Two examples for relatively small communities are Punta Gorda's extensive adaptation plan document[567] and the Monroe County Climate Action Plan[568]. The Punta Gorda plan helps guide work at the local level to integrate adaptation more fully into the comprehensive plan, ordinances, and other local government documents. For an impressive document from a larger local government, see Fort Lauderdale's "Fast Forward Fort Lauderdale, Vision 2035" [569] that specifically addresses SLR.

This work may have missed relevant SLR language in some local government documents due to the scope of the project and sometimes limited availability of documents through online sources. Additionally, it was written in 2015 and local governments have been moving rapidly on this topic, meaning that new examples are now available. However, this does not undermine the purpose of this section in highlighting the steps that Florida's local-level governments have taken to prepare for SLR.

## A.1 Counties

1. Brevard County
    a. Comprehensive Plan

[565] http://www.cityofkeywest-fl.gov/topic/index.php?topicid=77
[566] http://www.cityofkeywest-fl.gov/egov/documents/1415296724_93106.pdf
[567] http://www.cakex.org/sites/default/files/Punta%20Gorda.pdf
[568] http://www.monroecounty-fl.gov/documentcenter/view/5971
[569] http://www.fortlauderdale.gov/home/showdocument?id=4202

i. Chapter X, Coastal Management Element, Policy 4.9: "Brevard County shall continue to collect and make available to the public information related to sea level changes."
ii. Chapter X, Coastal Management Element, Policy 10.3H: "The impact of SLR and the projected 30-year erosion line shall also be analyzed."

2. Broward County
   a. Climate Change Action Plan
      i. Natural Systems Objective #18- " Delineate anticipated habitat transition zones and expand zones through land use changes to protect environmentally-sensitive greenways and reserves for migrating species."
   b. Comprehensive Plan
      i. Conservation Element- "Policy 13.1.16. Broward County shall develop a county-wide Climate Change Program to mitigate and adapt to the consequences of climate change in coordination with other local governments, private businesses, other governmental agencies and the State of Florida. This program will focus on mitigating the causes and consequences of greenhouse gas emissions in a cost-effective and efficient manner that preserves the County's economic competitiveness."
      ii. Climate Change Element-"Policy 19.2.2. Broward County shall continue to support and coordinate with local municipalities to further mixed land uses which promotes functional, walkable mixed use development designs and projects by providing flexibility in development review for these projects, revising the zoning and land development codes to support such projects, and promoting the adoption of specific goals in local Comprehensive Plans to support and establish sustainable development patterns, especially in areas at reduced risk to SLR, as defined by the Priority Planning Areas for SLR Map in the Broward County Land Use Plan."
      iii. Climate Change Element-"Policy 19.2.6. Broward County should assist in coordinating transportation-related adaptation policies across jurisdictional boundaries and ensure consistency among broader planning and plan implementation efforts. Specifically, strategies for preparing for SLR, such as increasing road surface elevation standards, subsurface stabilization, stormwater management and drainage, and adjustment of bridge heights to allow for navigation, should be collaboratively assessed and implemented."
      iv. Climate Change Element-"Policy 19.3.3. Broward County shall continue to review policies and promote programs which advance greenhouse gas reduction and energy conservation strategies; promote compact, transit-oriented, pedestrian-friendly development; further green construction practices and the design of climate sensitive and energy efficient buildings; encourage cluster development in order to retain or create native vegetative communities; and address the resilience and survivability of buildings and infrastructure to rising sea levels, tropical

storms, storm surge, and other climate change impacts, consistent with the Community Design Guidebook and the Urban Design, Housing, and Future Unincorporated Area Land Use Elements of the County's Comprehensive Plan."

v. Climate Change Element-"Policy 19.3.4. Broward County shall identify public investments and infrastructure at risk from SLR and other climate change related impacts by 2015, and update this assessment every 5 years. Specifically, the County shall analyze vulnerability to facilities and services, including but not limited to: buildings; water and wastewater treatment plants, transmission lines and pumping stations; stormwater systems; roads, rail, bridges, and all transportation and transit infrastructure; power generation facilities and power transmission infrastructure; critical airport and seaport infrastructure; hospitals; city halls, police and fire stations."

vi. Climate Change Element-"Policy 19.3.7. Broward County shall continue to improve analysis and mapping capabilities for identifying areas of the County vulnerable to SLR, tidal flooding, and other impacts of climate change. Acquire increasingly accurate Light Detection And Ranging (LiDAR) data, or other state-of-the-art elevation data, and other necessary modeling data and programs every 5 years to update the Priority Planning Area for SLR Map in the County's Land Use Plan and improve available information needed to make informed decisions regarding adapting to the impacts of climate change."

vii. Climate Change Element -"Policy 19.3.8. Broward County shall, by 2015, develop new 100 year stormwater elevation projections in the Broward County 100 year flood map for use in stormwater management permitting and other planning processes, which incorporate current and projected conditions for SLR."

viii. Climate Change Element-"Policy 19.3.9. Broward County, in conjunction with its municipalities and partner agencies, shall work to ensure that adaptation to climate change impacts, especially SLR, is incorporated into the planning, siting, construction, replacement and maintenance of public infrastructure in a manner that is cost effective and that maximizes the use of the infrastructure throughout its expected life span."

ix. Climate Change Element-"Policy 19.3.12. Broward County shall by 2012, designate areas that are at increased risk of flooding due to, or exacerbated by, SLR over the next 50 years within the Broward County Land Use Plan Priority Planning Areas for SLR Map, and work to make these areas more climate resilient by discouraging density increases and encouraging the use of adaptation and adaptation strategies."

x. Climate Change Element -"Policy 19.3.13. Broward County shall by 2017, work with its local municipalities to designate Adaptation Action Areas, per Florida State Law, using the Priority Planning Areas for SLR Map as a basis for identifying areas especially vulnerable to SLR, in order to

develop policies for adaptation and enhance the funding potential of infrastructure adaptation projects."

xi. Climate Change Element -"Policy 19.3.14. Broward County shall encourage local municipalities to develop policies to improve resilience to coastal and inland flooding, salt water intrusion, and other related impacts of climate change and SLR in their Comprehensive Plans, Sustainability Action Plans, Vision Plans, Stormwater Master Plans, Adaptation Action Areas Plans, Climate Change Plans and other city-wide plans."

xii. Climate Change Element -"Policy 19.4.12. Broward County, in cooperation with its municipalities and appropriate local agencies, shall evaluate water and stormwater management operation strategies in the context of SLR..."

xiii. Climate Change Element -"Policy 19.4.15. Broward County should support the efforts of state environmental and planning agencies to jointly develop, assess, and recommend a suite of planning tools and climate change adaptation strategies for local municipalities to maximize opportunities to protect the beach and dune systems, coastal wetlands, and other coastal resources from the impacts of SLR."

xiv. Climate Change Element -"Policy 19.5.7. Broward County shall support recurring and continued development of local integrated models and continuous data collection, to help predict and track the impacts of SLR on groundwater levels, saltwater intrusion, and drainage infrastructure through enhanced development and application of local hydrologic models and the use of down-scaled climate models."

xv. Climate Change Element -"Policy 19.5.13. Broward County shall study whether to build, modify or relocate water, wastewater and stormwater transmission infrastructure to allow for strategic retreat from areas at risk to SLR."

xvi. Climate Change Element -"Policy 19.6.2. Broward County shall coordinate regionally with other Southeast Florida counties, academia, and state and federal government agencies in the analysis of SLR, drainage and hurricanes impacts and the planning of adaptation measures."

xvii. Climate Change Element -"Policy 19.7.5. Broward County shall work with the Florida Division of Emergency Management and other agencies to incorporate SLR and increasing storm surge impacts into the remapping of potential hazard areas in coastal zones by 2015. Revised hazard area designations should better reflect the risks to communities associated with climate change and allow reevaluation of suitability for development or redevelopment in these areas."

xviii. Climate Change Element -"Policy 19.7.6. Broward County shall cooperatively develop model codes and policies to encourage posthazard redevelopment in areas with less vulnerability to storm surge,

inundation, flooding, SLR and other impacts of climate change, and incentivize locally appropriate adaptation and adaptation strategies."

xix. Climate Change Element -"Objective 19.3. Improve the climate resiliency and energy-efficiency of new and existing buildings and public infrastructure, and develop adaptation strategies for areas vulnerable to climate change-related impacts."

xx. Climate Change Element -"Policy 19.5.9. Broward County shall work to protect existing well fields, surface or subsurface storage facilities, control structures, water and wastewater treatment plants and transmission infrastructure from increased coastal flooding, SLR, saltwater intrusion, and other potential future climate change impacts, and plan for infrastructure replacement and relocation as needed."

xxi. Climate Change Element -"Policy 19.7.4. Broward County shall work to encourage dialogue between residents, businesses, insurance companies and other stakeholders, through public education campaigns and workshops, in order to increase understanding regarding the potential impacts of climate change on our coastal communities and evaluate the shared costs of action or inaction in human, ecological and financial terms."

xxii. Climate Change Element -"Policy 19.7.5. Broward County shall work with the Florida Division of Emergency Management and other agencies to incorporate SLR and increasing storm surge impacts into the remapping of potential hazard areas in coastal zones by 2015. Revised hazard area designations should better reflect the risks to communities associated with climate change and allow reevaluation of suitability for development or redevelopment in these areas."

xxiii. Climate Change Element -"Policy 19.7.6. Broward County shall cooperatively develop model codes and policies to encourage posthazard redevelopment in areas with less vulnerability to storm surge, inundation, flooding, SLR and other impacts of climate change, and incentivize locally appropriate adaptation and adaptation strategies."

xxiv. Climate Change Element -"Policy 19.8.5. Broward County shall consider the public health consequences of climate change, such as extreme temperatures and vector-borne diseases, and take steps to build capacity to respond to or prevent those consequences. Specifically, the County should: a) Encourage research to better understand the public health consequences associated with climate change in Broward County... Create a community-wide public health climate change adaptation plan... Raise the awareness of policy makers, community leaders, businesses, institutions, health care providers, and the general public about the public health significance and related costs of climate change..."

xxv. Support Document-Admin. Element-"The Climate Change Element is unique because it has three planning horizons. The short-term is five years, the mid-term is 10-20 years and the long-term is approximately 50

years to be consistent with the Southeast Florida Climate Change Compact's regionally agreed upon Unified SLR Projection."

xxvi. Support Document-Admin. Element-"There has been widespread international scientific consensus that climate change is occurring. Southeast Florida is extremely vulnerable to SLR and storm surge in extreme weather events. Local impacts related to climate change, especially SLR, are already happening. Critical public infrastructure including beaches, roadways and especially stormwater drainage treatment and conveyance systems have already begun to show vulnerabilities to the current rate of rise of sea level, extreme rainfall and seasonal high tides. Coastal communities have begun to seek infrastructure improvements to address mounting drainage concerns. The predicted accelerated rate of SLR will further exacerbate the impact of saltwater intrusion of our source of drinking water and on coastal habitats. Recognizing these facts, the Broward County Board of County Commissioners (Board) has made planning for the effects of climate change a priority, and on February 12, 2013, adopted the Climate Change Element as part of the Broward County Comprehensive Plan."

xxvii. Support Document-Future Land Use-"'Smart Growth,' Energy Efficient Development and Land Use Patterns. In order to discourage urban sprawl, create energy efficient land use patterns and help meet Greenhouse gas reduction goals; Objective 2.9 was adopted. The reduction of Greenhouse gas emissions has become very important in light of widespread international scientific consensus that climate change is occurring. Broward County is highly vulnerable to SLR and violent weather patterns which the burning of fossil fuels may be contributing to. Therefore it is critical to act locally to reduce Greenhouse gas emissions. "Smart Growth" principles provide a blueprint for reducing Greenhouse gas emissions and developing more energy efficient land use patterns."

xxviii. Support Document-Future Land Use-"The five "green" action areas that Broward County has focused on are air quality, recycling, land preservation, water conservation and climate change, more information is available at http://www.broward.org/gogreen/Pages/Default.aspx. The County government has been proactive in preparing for the effects of SLR and climate change. The Broward County Climate Change Task Force was established to develop recommendations for a coordinated countywide strategy in mitigating the causes, and addressing the local implications, of global climate change. The task force produced the Broward County Climate Change Action Plan which is currently being implemented."

xxix. Support Document-Deep Water Port- "SLR and coastal flooding. Changes in sea level have the potential to massively reconfigure geomorphology, change tidal variation, alter salinity patterns, and impact ecological processes in South Florida's coastal habitats, including wetlands, mangrove forests, and seagrass beds. Though SLR rates have historically

been measured from 5 to 10 centimeters per 100 years, that rate has accelerated tenfold in the past hundred years. With the influences of global climate change, sea levels are predicted to rise 0.5 feet by 2050 and 1.1 feet by 2100. The effects of that rate of change may not be inherently visible within the context of the Port's 20-Year Vision Plan, but it is imperative that long-term planning strategies look toward the future. To anticipate the eventual effects of global climate change on the Port's shoreline, BCEP&GMD mapped the incremental effects of sea level increases adjacent to the Port, identifying areas at risk for SLR in one foot increments; up to three feet. Most of the areas shown affected by the rise are low-lying with existing vegetation, including mangroves, in the environmentally protected areas. Also affected by SLR are the shallow seagrass beds present in various locations in the vicinity of the Port."

xxx. Support Document-Deep Water Port-"SLR and seagrasses. A major impact on seagrasses of changes resulting from SLR will be the redistribution of existing habitats. Distribution changes will result from the effects of salinity change on seed germination, propagule formation, photosynthesis, growth, and biomass (Short and Neckles, 1999). Changes in water depth also impact the flow patterns and deposition of sediments in and around seagrass beds. Alteration of the sediment composition is expected to cause shifts in community structure. Some species have been shown to persist in nutrient-rich sediments high in organic content, whereas others occur in patches characterized by more sandy sediments. An increase in the deposition of sandy beach and offshore sediments in seagrass beds can be expected to promote a shift in species composition. Increased water depth will impact the amount of light reaching existing seagrass beds, thereby affecting productivity, and could result in community decline." ee. Support Document-Deep Water Port-"SLR and underground stormwater systems. Other areas that could be affected by the rise in sea level are the underground stormwater management systems consisting of exfiltration piping and trenches that are used to filter surface water runoff. These systems need to be above the water table to filter pollutants from the stormwater runoff. Underground exfiltration systems are typically used in paved parking areas and container storage yards to maximize the paved area for use by Port operations."

xxxi. Support Document-Deep Water Port-"SLR and mangroves. Mangrove communities are highly productive systems, providing valuable habitat for fisheries, shorebirds, marine mammals, snakes, and crocodiles. Many of the world's marine species, including important coastal fisheries, rely on coastal wetlands for at least part of their life cycle. The complex root systems of mangroves serve as refuge for large numbers of species, as well as providing stabilization for sediments, thereby reducing coastal erosion and improving water clarity. Coastal mangrove tracts can provide

protection from storm surges to adjacent land and human populations, and prevent damage to freshwater ecosystems and agricultural areas from saltwater intrusion. As sea levels rise, the seaward and landward margins of the mangrove community migrate inland to maintain their preferred environmental conditions, including period, frequency, and depth of inundation; and salinity. Depending on the ability of mangrove species to colonize new habitat at a rate that keeps pace with the rate of relative SLR, the slope of adjacent land, and the presence of obstacles to landward migration such as seawalls and other shoreline protection structures, some sites will revert to a narrow mangrove fringe or lose the mangrove community altogether (Gilman et al., 2006). SLR has a direct impact on the frequency and duration of inundations and drying periods of coastal mangrove wetlands, which support a community of small marsh fishes critical as a food source to wading birds such as wood storks, egrets, and roseate spoonbills. Regular periods of water level recession serve to concentrate the fish assemblages in densities adequate to support wading bird nesting. Landward salinity intrusion is another impact of higher sea levels in coastal wetlands. It is a major factor limiting distribution and abundance of various fish species, submerged aquatic vegetation, and estuarine alligator and crocodile populations. Based on BCEP&GMD's analysis, a one-foot rise in sea level will impact the vast majority of mangrove communities in the Port area. Development of the land surrounding the mangrove pockets in Port Everglades prevents the natural landward migration of the mangrove communities with rising sea levels; however, the projected time frame for a one-foot SLR exceeds that of even the 20-Year Vision Plan."

xxxii. Support Document-Climate Change-"While railroads were not particularly vulnerable, many roads were; especially low volume roads and parking areas. The miles of roads vulnerable increased by a magnitude at each scenario with almost 300 miles of roads inundated at 3 feet of SLR."

xxxiii. Support Document-Climate Change-"While no wastewater facility appears to be impacted at the one foot SLR scenario, the Hollywood and Ferncrest facilities were among the most vulnerable at the two and three foot scenarios."

xxxiv. Support Document-Climate Change-"Additionally, SLR from climate change is threatening the Florida Everglades, the backbone of our natural resource system."

xxxv. Support Document-Climate Change-"Additionally, The Broward County 2012 Enhanced Local Adaptation Strategy (ELMS) includes a new subsection on climate change and SLR in the Risk Assessment chapter, and utilizes wind, flood, and SLR hazard risk information in a new Economic Vulnerability chapter. Analysis concludes that the County is likely to continue to be vulnerable to SLR, with the level of impacts being moderate to severe."

xxxvi. Support Document-Climate Change-"Unfortunately, climate change impacts, especially SLR, are already occurring in our County, making adaptation efforts also necessary."

xxxvii. Support Document-Climate Change-"A substantial increase in SLR within this century is likely and may occur in rapid pulses rather than gradually."

3. Charlotte County
    a. Comprehensive Plan
        i. FLU Policy 2.4.7: "Short-term Actions to Address the Effects of Climate Change: The County shall consider amending the Code of Laws and Ordinances within one year of the effective date of this comprehensive plan to require that all proposed development address ways to minimize damage from coastal erosion, 100-year floods, tidal surges from hurricanes and coastal storms, and a projected year 2050 0.5 meter SLR (FLUM Series Map #15). These measures may include elevating structures on pilings and elevating roadways to mitigate the impacts of anticipated storm surges, flooding, and SLR."
4. Collier County
    a. Land Development Code (Municode)
        i. 3.03.05 - SLR "An analysis shall be required demonstrating the impact of a six (6) inch rise in sea level for development projects on a shoreline. This requirement shall be met by inclusion of this analysis in an environmental impact statement (EIS). This requirement shall be waived when an EIS is not required. This analysis shall demonstrate that the development will remain fully functional for its intended use after a 6 inch rise in sea level. In the event that the applicant cannot meet this requirement, a list shall be provided by the applicant of the changes necessary in order for the development to meet the standard."
5. Dade County
    a. Climate Change Action Plan
        i. Resolution R=451-14: Requires all infrastructure projects (new, maintenance, etc.) to consider SLR projections and potential impacts over 50 years or the life of the project. Also mandates setting priorities for adapting existing infrastructure at risk from SLR.
        ii. Rules of Procedure of County Commission (MuniCode)
        a. Section 2.01-Rule 5.09: "For all agenda items brought to the Board that relate to the planning, design and/or construction of County infrastructure projects, including but not limited to, County building elevation projects, County installation of mechanical and electrical systems, County infrastructure modifications and County infrastructure renovations, the Mayor or Mayor's designee shall include a statement in the item that the impact of SLR has been considered in the project."
    b. Comprehensive Plan
        i. LU-3E. "By 2017, Miami-Dade County shall initiate an analysis on climate change and its impacts on the built environment addressing development

standards and regulations related to investments in infrastructure, development/redevelopment and public facilities in hazard prone areas. The analysis shall consider and build on pertinent information, analysis and recommendations of the Regional Climate Change Action Plan for the Southeast Florida Regional Climate Change Compact Counties, and will include the following elements: a) an evaluation of property rights issues and municipal jurisdiction associated with the avoidance of areas at risk for climate hazards including SLR; b) an evaluation of the current land supply demand methodology to consider and address, as appropriate, the risk associated with infrastructure investments in flood prone areas; and c) an evaluation of the CDMP long-term time horizon in relation to addressing projected long-range climate change impacts."

ii. LU-3F. "By 2017, Miami-Dade County shall develop a Development Impact Tool or criteria to assess how proposed development and redevelopment project features including location, site design, land use types, density and intensity of uses, landscaping, and building design, will help mitigate climate impacts or may exacerbate climate related hazards. The tool would also assess each development's projected level of risk of exposure to climate change impacts, such as inland flooding."

iii. LU-3G. "Miami-Dade County shall, by 2017, analyze and identify public infrastructure vulnerable to SLR and other climate change-related impacts. This analysis shall include public buildings, water and waste water treatment plants, transmission lines and pump stations, stormwater systems, roads, rail, bridges, transit facilities and infrastructure, airport and seaport infrastructure, libraries, fire and police stations and facilities."

iv. LU-3H. "In order to address and adapt to the impacts of climate change, Miami-Dade County shall continue to improve analysis and mapping capabilities for identifying areas of the County vulnerable to SLR, tidal flooding and other impacts of climate change."

v. LU-3K. "By 2017, Miami-Dade County shall determine the feasibility of designating areas in the unincorporated area of the County as Adaptation Action Areas as provided by Section 163.3177(6)(g)(10), Florida Statute, in order to determine those areas vulnerable to coastal storm surge and SLR impacts for the purpose of developing policies for adaptation and enhance the funding potential of infrastructure adaptation projects."

vi. TE-1H. "Transportation agencies developing their transportation plans for Miami-Dade County shall take into consideration climate change adaptation and adaptation strategies through project review, design, and funding for all transportation projects. Transportation agencies should consider extending their planning horizons appropriately to address climate change impacts."

vii. TC-6D. "New roadways shall be designed to prevent and control soil erosion, minimize clearing and grubbing operations, minimize storm

runoff, minimize exposure and risk of climate change impacts such as increased flood conditions, and avoid unnecessary changes in drainage patterns."

viii. CM-9H. "Rise in sea level projected by the federal government, and refined by the Southeast Florida Regional Climate Change Compact, shall be taken into consideration in all future decisions regarding the design, location, and development of infrastructure and public facilities in the County."

ix. ICE-5G. "All County departmental master plans and strategic business plans shall include and prioritize climate change adaptation and adaptation strategies. Climate change related amendments shall be recommended through the next feasible, regularly scheduled amendment process or departmental master plan update for each respective planning document. a) Each County department shall consider extending planning horizons (i.e. 30, 50, 75-year plans) as appropriate to adequately address the projected longterm climate change impacts into resource allocation recommendations. b) All new departmental climate change policies and programs shall be monitored for effectiveness."

6. Monroe County
    a. Comprehensive Plan
        i. Policy 212.2.1 "Minimum coastal construction setbacks currently in use in Monroe County shall be reviewed in coordination with DNR and FGFWFC. Setbacks shall be identified which will accomplish the following... (4) protect structures from the effects of long-term SLR ..."
    b. Land Development Code (MuniCode)
        i. Sec. 118-12. - Shoreline setback. (a) Purpose. "The purpose of this section is to allow for reasonable access between the land and water, provide secure boat storage, ensure good water quality, provide an appearance consistent with community character, protect structures from the effects of long term SLR, protect beaches and shores from erosion, protect over-water views, avoid adverse impacts on navigation, and protect marine and terrestrial natural resources."
    c. Monroe County Climate Action Plan (2013) (County is currently developing comprehensive plan policies to help implement portions of the Climate Action Plan)
7. Palm Beach County
    a. Comprehensive Plan
        i. Page 10: "SUB-OBJECTIVE 1.1.1 Climate Change Palm Beach County shall adopt, implement, and encourage strategies which increase community resiliency and protect property, infrastructure, and cultural and natural resources from the impacts of climate change, including SLR, changes in rainfall patterns, and extreme weather events.
        ii. Policy 1.1.1-e: "Palm Beach County shall, by 2017, consider the use of Adaptation Action Areas as provided by section 163.3177(6)(g)(10),

Florida Statutes, as a tool to identify areas vulnerable to coastal storm surge and SLR impacts, for the purpose of developing policies for adaptation and enhancing funding potential of infrastructure adaptation projects."

iii. "Changes along the Palm Beach County shoreline are a consequence of natural and manmade factors that include storm effects, SLR, inlet/navigation project impacts, and shoreline structures for the protection of coastal development."

8. Pinellas County
    a. Comprehensive Plan
        i. Planning to Stay Element, Governing Principles, Prepare for Disasters and Climate Change: "Principle 1: Planning for development must respect the restrictions imposed by the County's susceptibility to natural disasters, and should anticipate potential alterations to the urban and natural environment induced by long-term changes in the climate."
        ii. Coastal Mgmt. Element, Introduction, p. 6-3: "Site differences, the potential enormity of the issue and the far-reaching human and environmental effects of SLR response are all important reasons why it is necessary to begin planning and considering all options."
        iii. Coastal Mgmt. Element, Introduction, p. 6-2: "As sea levels encroach further onto the land, there are three broad response scenarios, as defined by the Coastal Zone Management Subgroup of the Intergovernmental Panel on Climate Change Response Strategies Working Group. Those scenarios are: retreat, accommodation and protection."
    b. Compendium of Goals
        i. Nat. Res. & Cons. Element: 7.2.3. Policy: In association with the update to the Land Development Code, determine whether there is a need to further amend the Comprehensive Plan and land development regulations to protect public and private coastal infrastructure and investment from the inland advancement of coastal waters, and to coordinate land use planning decisions with the expectations of SLR.
        ii. Coastal Mgmt. Element: 4.6. Objective: In an effort to ensure the long term viability and sustainability of its coastal resources and land uses, Pinellas County will remain apprised of, and plan where appropriate for rising sea levels.
        iii. Coastal Mgmt. Element: 4.6.1. Policy: Pinellas County will evaluate the data and findings regarding SLR on at least a five-year basis.
        iv. Coastal Mgmt. Element: 4.6.2. Policy: Based on the evaluations directed by Policy 4.6.1, Pinellas County will continue to refine and incorporate long-term planning strategies, and amend land development regulations as necessary, to responsibly plan for the effects of rising sea levels.
        v. Coastal Mgmt. Element: 4.6.3. Policy: Pinellas County recognizes the potential need for adequate coastal buffering in its response to future

SLR, and will give preference to low environmental impact methods of shoreline protection, such as beach nourishment, where feasible and appropriate.

vi. Coastal Mgmt. Element: 4.6.4. Policy: Pinellas County will encourage, and participate in, coordinated intergovernmental and interagency efforts to develop responsible strategies for addressing the potential negative effects of rising sea levels.

vii. Coastal Mgmt. Element: 4.6.5. Policy: Pinellas County will share information with local municipalities regarding the implications of SLR and development decisions along the coast and other vulnerable areas.

9. Sarasota County
    a. Comprehensive Plan
        i. Environmental Chapter
        ii. --"Both natural and man-induced processes can cause beach erosion. Natural causes include: □ Storm waves; □ Sediment supply to the littoral zone; □ Wave and storm surge overwash; □ Deflation (i.e., wind erosion of loose sands from the beach); □ Longshore sediment transport; □ Sorting of beach sediment; and □ SLR. A recent study by the United States Environmental Protection Agency predicts that global sea level is likely to rise 5.9 inches (15cm) by the year 2050 as a result of human-induced climate warming (Berger and Iams 1996)."
        iii. --"SLR Global temperature has increased approximately 1 degree Fahrenheit in the last century as a result of natural [e.g., the earth experiences periodic cycles (Milankovitch cycles) of global warming and cooling] and anthropogenic factors (e.g., greenhouse gas emissions). As temperatures increase, climactic changes occur, seawaters expand and glaciers melt. Changes in relative sea level will alter the position and morphology of our coastline, causing coastal flooding, waterlogged soils, and a loss or gain of land. Eustatic (worldwide) sea levels are expected to increase 40 to 65 cm (1.3 to 2.1 feet) by the year 2100. These changes may also create or destroy coastal wetlands and salt marshes, inundate coastal sediments, and induce water saltwater intrusion into aquifers, leading to salinization of groundwater. Further inland intrusion of saltwater along our shorelines will affect the health, composition, and aerial coverage of our coastal ecosystems and habitats (Source: National Park Service). Changing sea level will also have effects on coastal construction. Scientists estimate that 70 percent of the world's sandy beaches are affected by coastal erosion induced by relative SLR (Berger and Iams 1996). How our community responds to these changes may very well determine whether we will have beaches or hardened shorelines in their stead."
        iv. --"Information regarding the historic and predicted SLR and projected shoreline changes should also be considered in the development of a

bay-wide management plan and in the adoption of management guidelines."

v. Policy 1.2.3.: "By 2015, develop a Beach and Inlet Management strategy with a monitoring program for Sarasota County, incorporating regional coordination and interaction, to: □ assess the nature and extent of coastal erosion; □ monitor the effectiveness of beach restoration programs; □ determine the effect of storm events on sand movement; □ identify dominant coastal processes which would aid in evaluating permit applications and coastal decision making; □ incorporate the long-term effects of SLR within the management policies."

10. St. Lucie County
    a. Comprehensive Plan
        i. Coastal Management Element Policy 5.1.1.10 – "The County shall continue to monitor all credible climate change and SLR data and what direct and potential effects this has on the coastal system natural resources. Based on this data the County shall evaluate and update the resource protection standards of the Land Development Code and this plan as necessary."
        ii. Coastal Management Element Policy 5.2.1.6 – "The County shall consider the most current and credible SLR data when planning long term infrastructure and capital improvement expenditures and land use amendments in areas less than 10 feet in elevation."
        iii. Conservation Element Policy 6.1.12.12 – "The County shall continue to monitor all credible climate change and SLR data and what direct and potential effects this has on natural resources. Based on this data the County shall evaluate and update the resource protection standards of the Land Development Code and this plan as necessary."
11. Volusia County
    a. Comprehensive Plan
        i. Coastal Management Element 11.4.1.21 "Volusia County should continue to monitor SLR science to determine how SLR will affect the County. Based on pertinent data, the County will act accordingly."

## A.2 Municipalities

1. Fernandina Beach
    a. 2030 Comprehensive Plan, Goal 5: Conservation & Coastal Management Element (available at http://www.fbfl.us/DocumentCenter/View/13133) Policy 5.04.10. The City recognizes SLR as a potential coastal hazard, and shall work with Nassau County and state and regional entities as appropriate to develop strategies for responding to SLR, including:
        i. Analysis of the estimated SLR and its effects on estuaries, wetlands, beaches, and uplands;
        ii. Identification of structures and areas of possible risk;

iii. Determination of additional data and research needed;
iv. Assistance from state and federal agencies;
v. Analysis of City and County buffer requirements and whether additional buffering should be required;
vi. Evaluation of locating public facilities in areas projected to be affected by rising sea level;
vii. Consideration of the effects of SLR on potable water sources, saltwater intrusion, septic systems, wastewater treatment facilities, and the water table; and
viii. Creation of Adaptation Action Areas, as permitted by state statute.

2. Fort Lauderdale
    a. Comprehensive Plan amendment
        i. Coastal Mgmt. Element, Goal 3: "Increase the City's resiliency to the impacts of climate change and rising sea levels by developing and implementing adaptation strategies and measures in order to protect human life, natural systems and resources and adapt public infrastructure, services, and public and private property."
        ii. Coastal Mgmt. Element, Objective 3.1: "Develop and implement adaptation strategies for areas vulnerable to coastal flooding, tidal events, storm surge, flash floods, stormwater runoff, salt water intrusion and other impacts related to climate change or exacerbated by SLR, with the intent to increase the community's comprehensive adaptability and resiliency capacities." & "Evaluation Measure: Collaborating with regional partners, City shall identify public investments, infrastructure and assets at risk from rising sea levels by 2018. Thereafter, this assessment will be performed every five (5) years."
        iii. Coastal Mgmt. Element, Policy 3.1.1: "Identify public investments and infrastructure at risk to SLR and other climate related impacts. Assess the vulnerability to public facilities and services, including but not limited to water and wastewater facilities, stormwater systems, roads, bridges, governmental buildings, hospitals, transit infrastructure and other assets."
        iv. Coastal Mgmt. Element, Policy 3.1.2: "Adaptation strategies may include, but not be limited to:
            1. Public infrastructure planning, siting, construction, replacement, operation and maintenance
            2. Emergency management
            3. Stormwater management
            4. Land development regulations
            5. Building codes
            6. Comprehensive planning
            7. Other strategies"
        v. Coastal Mgmt. Element, Policy 3.1.3: "Adaptation strategy options may include the designation of Adaptation Action Areas. As per Section

163.3164(1) and Section 163.377(6)(g)(10), Florida Statutes, an AAA is an optional designation within the coastal management element of a local government's comprehensive plan which identifies one or more areas that experience coastal flooding due to extreme high tides and storm surge, and that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure and adaptation planning."

vi. Coastal Mgmt. Element, Policy 3.1.4: "AAAs' adaptation strategy options may include, but not be limited to:
    1. Protection
    2. Accommodation
    3. Managed retreat
    4. Avoidance
    5. Other options"

vii. Coastal Mgmt. Element, Policy 3.1.5: "Considerations for AAAs designation may include, but not be limited to:
    1. Areas which experience tidal flooding, storm surge, or both
    2. Areas which have an hydrological connection to coastal waters
    3. Locations which are within areas designated as evacuation zones for storm surge
    4. Other areas impacted by stormwater/flood control issues"

viii. Coastal Mgmt. Element, 3.1.6: "As a basis for the designation of AAAs, the City will utilize the best available data and resources, such as the Unified SLR Projection for Southeast Florida and Broward County's Priority Planning Areas for SLR Map, in order to identify and understand the risks, vulnerabilities and opportunities to formulate timely and effective adaptation strategies,"

ix. Coastal Mgmt. Element, Policy 3.1.7: "As deemed to be in the best interest of the City, the City Commission may designate or remove designation by means of, but not limited to, the following mechanisms:
    1. Comprehensive Plan via location description or map, and in accordance with applicable Florida Statutes
    2. City Commission Resolution or Ordinance
    3. Community Investment Program (Capital Improvement Plan)
    4. Other mechanisms as appropriate"

x. Coastal Mgmt. Element, Policy 3.1.8: "Potential funding sources for the implementation of AAA's associated adaptation strategies include, but are not limited to:
    1. Federal and State grants and technical expertise assistance (in-kind)
    2. Local Stormwater Utility Fees and Community Investment Program (Capital Improvement Plan) prioritization
    3. Public/Private Partnerships
    4. Other sources"

xi. Coastal Mgmt. Element, Policy 3.1.9: "Integrate AAAs into existing and future City processes and city_wide plans and documents which may include, but not be limited to:
    1. Community Investment Program
    2. Local Adaptation Strategy
    3. Strategic Plan
    4. Sustainability Action Plan
    5. Stormwater Master Plan
    6. Comprehensive Emergency Management Plan
    7. Unified Land Development Regulations
    8. Other related processes, plans and documents."

xii. Coastal Mgmt. Element, Policy 3.1.10: "Align and be consistent with, to the extent possible, relevant and current national, state, and regional adaptation strategy documents such as the Broward County Climate Action Plan, Southeast Florida Regional Climate Action Plan and The President's Climate Action Plan as well as other regional strategic plans, disaster adaptation plans, water management plans, transportation/transit plans, and climate change plans."

xiii. Coastal Mgmt. Element, Policy 3.1.11: "Participate in, when appropriate, coordinated governmental, non_governmental and other appropriate agencies' proposed application requests for funding adaptation implementation projects."

xiv. Coastal Mgmt. Element, Policy 3.1.12: "Collaborate and coordinate with appropriate local, regional and state governmental agencies, to the extent possible, toward the implementation of AAA adaptation strategies."

xv. Coastal Mgmt. Element, Policy 3.1.13: "Based on evolving rising seas data and associated vulnerabilities, to allow for flexible adjustments, preserve future strategic adaptation implementation options to maintain maximum resiliency in response to new risks and vulnerabilities. The City will take advantage of new emerging data and technological opportunities."

xvi. Coastal Mgmt. Element, Policy 3.1.14: "Continue to foster effective collaborations, partnerships and coordination with national, state, regional and local partners to identify risks, vulnerabilities and opportunities associated with coastal hazards and the impacts from SLR."

xvii. Admin. & Implementation Element (VII. Definitions): "Priority Planning Areas for SLR Map, Broward County: Map which identifies and illustrates vulnerable areas within Broward County that are at increased risk of flooding due to, or exacerbated by, seal level rise over the next fifty (50) years. Broward County generated this map in partnership with the South Florida Water Management District and the National Oceanographic and Atmospheric Administration."

xviii. Admin. & Implementation Element (VII. Definitions): "Protection: Strategies that involve "hard" and "soft" structurally defensive measures to mitigate impacts of rising seas in order to decrease vulnerability while allowing structures and infrastructure to remain unaltered. Two examples are shoreline armoring and beach nourishment[OBJ] [OBJ]For Rising Sea Levels, South Florida Regional Planning Council, 2013)." Rising Sea Levels, South Florida Regional Planning Council, 2013)."

xix. Admin. & Implementation Element (VII. Definitions): "Accommodation: Strategies that do not act as a barrier, but rather alter the design through measures such as elevation or stormwater improvements, to allow the structure of infrastructure system to stay intact. Rather than preventing flooding or inundation, these strategies aim to reduce potential risks. (Adaptation Action Areas: Policy Options for Adaptive Planning For Rising Sea Levels, South Florida Regional Planning Council, 2013)."

xx. Admin. & Implementation Element (VII. Definitions): "Managed Retreat: Strategies that involve the actual removal of existing development, their possible relocation to other areas, and/or prevention of further development in high_risk areas. (Adaptation Action Areas: Policy Options for Adaptive Planning For Rising Sea Levels, South Florida Regional Planning Council, 2013)."

xxi. Admin. & Implementation Element (VII. Definitions): "Avoidance: Strategies that involve ensuring development does not take place in areas subject to coastal hazards associated with SLR or where the risk is low at present but will increase over time. (Adaptation Action Areas: Policy Options for Adaptive Planning For Rising Sea Levels, South Florida Regional Planning Council, 2013)."

3. Fort Pierce
    a. Comprehensive Plan
        i. 5.1.10 Policy: "The City shall maximize protection of coastal and marine resources by evaluating the potential impact identified by the applicant and other public entities having jurisdiction over the impacted resources. The development review process shall ensure compliance with levels of service and policies of the Plan and shall evaluate the following: ... 'Protection of structures from the effects of long-term SLR...'"
        ii. 5.8.11 Policy: "The City shall continue to monitor updates to sea level rise forecasts and predictions and consider measures to protect or relocate all critical public facilities that are located in areas projected to be impacted by SLR in the next 50 years."
4. Hallandale (Beach)
    a. Comprehensive Plan
        i. "Sediment erosion and transport is a natural phenomenon that will continue if not increase (because of rising sea levels), and continued beach management will be required in the future if existing beach resources are to be maintained."

5. Hollywood
    a. Comprehensive Plan
        i. SLR - "In a presentation to the Water Resource Advisory Board and Technical Advisory Committee on September 21, 2006, Dr. Hal Wanless of the University of Miami predicted a SLR for Broward County of 1 foot in the next 100 years. This is in addition to the 0.7 foot rise established to have occurred in the past 70 years. Rising sea levels will lead to local water problems such as worse drainage for flood events, more harm from beach erosion and hurricanes, more saltwater intrusion, loss and alteration of salt and fresh wetlands, along with building siting and preparation issues in anticipation of higher base water levels. Current and credible SLR data should be considered when planning long term infrastructure and capital improvements activities, and in future land use decisions."
6. Islamorada
    a. Code of Ordinances (Municode)
        i. Sec. 30-1543. Shoreline environmental and development criteria.(a) The purpose of this section is to allow for reasonable access between the land and water, protect marine and terrestrial natural resources, assure good water quality, provide a consistent community character, protect structures from the effects of long-term SLR, protect beaches and shores from erosion, avoid adverse impacts on navigation and provide secure boat storage.

7. Key West
    a. Comprehensive Plan
        i. Definitions: "Climate Change – Long-term changes in temperature, precipitation, wind and all other aspects of the Earth's climate that cause increasingly severe natural disasters."
        ii. Definitions: "Climate Change Adaptation – Adjustments to natural or human systems in response to actual or expected climatic factors or their effects, including SLR, more frequent and intensified storm events, and changes in rainfall."
        iii. Future Land Use Element, "Policy 1-1.1.14: Prepare for Future SLR. The City, together with the private sector, shall consider proactive steps and pilot programs to adapt for SLR and storm surges, including but not limited to preserving transportation options, increasing residential building resiliency and indoor air quality, preserving landscaping and residential building aesthetics, and preserving water quality."
        iv. Future Land Use Element, "Policy 1.1.4.6: Increase Resilience of General Landscaping. The City shall use best available science and predictions for SLR and other climate change related issues to guide the long term health and appearance of landscape plantings. By 2014, the City shall work with SLR and native plant experts to create a "Climate Adaptation Planting

Plan" ordinance to affect landscaping plans. This plan shall be reviewed every other year to stay up to date with climate change predictions."

v. Future Land Use Element, "Objective 1-1.12: CONSIDER APPLICATION OF INNOVATIVE LAND AND WATER RESOURCE MANAGEMENT, CLIMATE ADAPTATION, AND ENERGY CONSERVATION CONCEPTS. The City of Key West shall maintain Land Development Regulations, which incorporate concepts for managing land, water, and energy resources, are responsive to unique development and conservation issues identified in the City's Comprehensive Plan. The City of Key West shall adopt Land Development Regulations which incorporate concepts for managing land, water, and the built environment which are responsive to climate change issues including but not limited to SLR and increased frequency of intense rainfall events..."
vi. Future Land Use Element, "Objective 1-1.12: The City's Land Development Regulations shall incorporate climate adaptation techniques which have been demonstrated to be successful and cost effective in adapting to climate change issues including but not limited to SLR ..."
vii. Future Land Use Element, "Policy 1.1.12.5: Increased Height: The City shall consider allowing increased heights for new construction or redevelopment if such additional height is justified based on adopted Coastal High Hazard Maps and Storm Surge Flood Maps in order to promote safe new development and redevelopment based on SLR predictions. Such additional height must be compatible with surrounding development."
viii. Transportation Element, "Policy 2-1.3.4: Climate Change Preparedness. The City shall consider current science and predictions for SLR and other climate change issues in planning future roadway improvements."
ix. Conservation Element, "Policy 6-1.12.1: Review the Impact of Changing Conditions on Conservation Policy. The City shall monitor and evaluate significant changes, including climate change, in the characteristics of natural resources within the City. Policy implications of such changes shall be examined and corrective measures shall be pursued. Conservation policies shall be refined as needed in order to remain responsive to evolving problems and issues."
x. Conservation Element, "Objective 6-1.14: CARBON SEQUESTRATION THROUGH PLANTS. As part of an overall landscaping plan to increase beautification and walkability, the City shall incorporate greenhouse gas sequestration goals and priorities to meet the City's Climate Action Plan goals."
xi. Capital Improvements Element--Climate Change Preparation, section 9-3(14): The City Planner and City Engineer shall review the latest science and predictions for SLR and other climate change related issues and

recommend any needed action to address currently scheduled or future projects."

xii. Coastal Management Element, "Policy 5-1.5.3: Adaptation Action Areas. For hazard adaptation purposes, the City may create Adaptation Action Areas which identify one or more areas that experience coastal flooding due to extreme high tides and storm surge, and that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure needs and adaptation planning."

8. Lauderdale-by-the-Sea
    a. Comprehensive Plan
        i. Policy 6.4.8: "The Town shall implement measures that supports adaptation and sensitivity to the impacts of climate change in coordination with other municipalities, Broward County, private businesses, other governmental agencies and the State of Florida. This program will focus on mitigating the causes and consequences of greenhouse gas emissions in a cost-effective and efficient manner that preserves the Town's overall values and quality of life."
        ii. Greenhouse Gas Emissions: Greenhouse Gas Emissions "According to the "Ecological Impacts of Climate Change" by the National Academy of Sciences (NAS), the world's climate is changing, and it will continue to change throughout the 21st century and beyond. Rising temperatures, new precipitation patterns, and other changes are already affecting many aspects of human society and the natural world. A relatively rapid increase in temperature has been documented during the past century, both at Earth's surface and in the oceans."
        iii. Page IV-15: "The State of Florida with almost 1,350 miles of shoreline and the associated coastal population concentrations is particularly susceptible to rising sea levels associated with climate change."
        iv. Page IV-14: "Under a 'business-as-usual' greenhouse gas emissions scenario, models indicate that sea levels could rise 2 feet or more by 2100 compared to 1990 levels."
9. Miramar
    a. Comprehensive Plan
        i. Policy 9.11: "Miramar shall coordinate with the county-wide Climate Change Program to mitigate and adapt to the consequences of climate change in coordination with other local governments, private businesses, other governmental agencies and the State of Florida. This program will focus on mitigating the causes and consequences of greenhouse gas emissions in a cost-effective and efficient manner that preserves the City of Miramar economic competitiveness."
10. Neptune Beach
    a. Comprehensive Plan
        i. Page E-10: "The marsh was examined at several locations by a biologist in March 1988 and appears to be in reasonably good condition. There are

scattered dead or dying cabbage palms in the Hopkins Creek marsh which are probably evidence of SLR or culturally induced salinity increases, or both."

ii. Page E-11: "The single greatest cause of beach erosion has been and will continue to be offshore sediment transport, which results from the rising sea level. Studies have shown that sea level has been rising at an average rate of 0.7 to 1.0 foot per century. For every foot in rise there is a loss of 30 feet of beach due to erosion. Therefore, a potential loss of 3.6 feet of beach per year exists solely from SLR."

11. New Smyrna Beach
    a. Comprehensive Plan
        i. Future Land Use Goals and Policy: "Explore various funding opportunities to assist in developing City GHGs emissions baseline data, in order to set GHG emission goals, to develop strategies to reduce climate change and to mitigate and adapt to its impacts."
        ii. Future Land Use Goals and Policy: "Continue to provide educational materials regarding energy efficiency, sustainable design, and climate change that encourage community residents and business owners to invest in energy-efficiency improvements through community outreach efforts."
        iii. Coastal Management Policy: "Work with Volusia County to develop strategies for responding to SLR, including:
            1. Analysis of the estimated SLR and its effects on estuaries, wetlands, barrier islands, and uplands.
            2. Identification of structures and areas of possible risk.
            3. Determination of additional data and research needed.
            4. Assistance from state and federal agencies.
            5. Analysis of Volusia County environmental buffer requirements and whether dune buffers should be required.
            6. Evaluation of locating public facilities in areas projected to be affected by rising sea level.
            7. Consideration of the effects on potable water sources, saltwater intrusion, septic systems, wastewater treatment facilities, and the water table."
12. Ormond Beach
    a. Comprehensive Plan
        i. Policy 2.6.11. and 1.3.3: "Provide educational materials regarding energy efficiency, sustainable design, and climate change that encourage community residents and business owners to invest in energy-efficiency improvements through community outreach efforts, such as the City's Website."
13. Palm Beach Shores
    a. Comprehensive Plan

i. 06.01.01.05 “The Town shall implement a Climate Change Program that supports adaptation and sensitivity to the impacts of climate change in coordination with other municipalities, Palm Beach County, private businesses, other governmental agencies and the State of Florida. This program will focus on mitigating the causes and consequences of greenhouse gas emissions in a cost-effective and efficient manner that preserves the Town’s overall values and quality of life.”

14. Pinecrest
    a. Note: The Village of Pinecrest presents an interesting scenario since it is not, according to the State of Florida, a local government that is even required to have a coastal management in their comprehensive plan and they do not, in fact, have a coastal management element in their comprehensive plan. Nonetheless, the Village of Pinecrest has a very comprehensive approach to SLR built into this addition to its comprehensive plan. Despite the fact that Pinecrest does not directly abut the ocean, it is very, very close. This combines with the low-lying, flat topography of the area to mean that Pinecrest is smart to plan for the impacts of SLR on the community.
    b. Comprehensive Plan: Climate Change Element (copy on file with principal author)
        i. Policy 9-1.2.2: Complete a Vulnerability Assessment for the Identification of Property and Infrastructure at Risk from SLR. The Village of Pinecrest shall complete a vulnerability assessment to further identify property, public investments and infrastructure at risk from SLR, storm surge, groundwater contamination and other climate change related impacts by 2016, and shall update this assessment periodically as new SLR projections are published. Specifically, the Village shall complete a stormwater vulnerability assessment to further analyze vulnerability to facilities and services, including but not limited to: property; buildings; water and sewer lines; stormwater systems; roads, bridges, and all transportation infrastructure; electric sub stations; and municipal offices and facilities.
        ii. Objective 9-1.6: ADAPTATION ACTION STRATEGIES. Develop and implement adaptation strategies for the Village of Pinecrest to address impacts associated with coastal flooding, tidal events, storm surge, flash floods, stormwater runoff, salt water intrusion and other impacts related to climate change or exacerbated by SLR with the intent to increase the Village’s comprehensive adaptability and resiliency capacities.
        iii. Policy 9-1.6.1: Options. Adaptation Action Areas adaptation strategy options may include but not be limited to:
            1. Protection
            2. Accommodation
            3. Managed Retreat
            4. Avoidance
            5. Other Options

iv. Policy 9-1.6.2: Collaborate with the South Florida Water Management District in the Review of Policies Regarding Operation of Flood Control Structures. Work in collaboration with the South Florida Water Management District to review, develop and implement strategies to address impacts of rising sea levels on and adjust policies related to the operation of the flood and salinity control structures at the S22 and S123 outfalls, and to consider policies and protocol regarding forward pumping as a means of reducing and controlling stormwater flooding levels during periods of inundation.

v. Policy 9-1.6.3: Backflow Preventers. Consider the installation of backflow preventers on drainage systems that discharge to Biscayne Bay or drainage canals, coordinating with Miami-Dade County DERM as necessary or required.

vi. Policy 9-1.6.4: Reassess the Village's Required Minimum Base Flood Finished Floor Elevation. Consider increasing the minimum required base flood finished floor elevation of all new structures within designated Adaptation Action Areas by one additional foot (freeboard).

vii. Policy 9.1.6.6: Collaborate with Governmental Agencies In The Implementation of Adaptation Strategies. Collaborate and coordinate with appropriate local, regional, and state governmental agencies including the City of Coral Gables, Miami-Dade County, the South Florida Water Management District, and the South Florida Regional Planning Council toward the implementation of Adaptation Action Area adaptation strategies.

viii. Policy 9.1.6.9: Review the County's established Salt Barrier Line. Coordinate with Miami-Dade County in the review of the Salt Barrier Line as previously established for the segment of the line located between the Village and Biscayne Bay in an effort to determine whether the legislation needs to be amended due to increases in sea level and to help identify measures and improvements necessary to protect against salt water intrusion in the area of the established line.

ix. Objective 9-1.7: ADAPTATION ACTION AREAS. The Village of Pinecrest shall continue to identify and designate Adaptation Action Areas as provided by Section 163.3164(1), Florida Statute, and develop policies for adaptation as required for the protection of areas and facilities in the Village of Pinecrest that are vulnerable to the impacts of rising sea levels and climate change.

x. Policy 9-1.7.1: Areas For Consideration. Consideration of Adaptation Action Areas designation shall include but shall not be limited to:

1. Areas which have a hydrological connection to coastal waters and are vulnerable to flooding.
2. Locations which are within areas designated as evacuation areas for storm surge.
3. Other areas impacted by stormwater/flood control issues.

xi. Policy 9-1.7.2: Basis For Designation. As the basis for the designation of Adaptation Action Areas, the Village will continue to utilize the best available data and resources such as the Unified SLR Projection for Southeast Florida in order to identify the risks and vulnerabilities associated with climate change and SLR and opportunities to formulate timely and effective adaptation strategies.
xii. Policy 9-1.7.3: Adaptation Action Areas Identified. Those Areas as identified in Figure 11 of the data, Inventory and Analysis, Adaptation Action Areas, that are projected to be impacted by 6 or More Inches of Flooding, are hereby adopted and designated as Adaptation Action Areas.
xiii. Objective 9-1.8: INTERAGENCY COORDINATION. Continue to coordinate with Governmental agencies within the South Florida region and other non-governmental entities and academic institutions in the ongoing assessment of existing and projected conditions related to our changing climate and rising sea levels, and continue to collaborate as necessary in the identification and development of effective solutions and strategies to adapt and improve resiliency.
xiv. Policy 9-1.8.2: Continue To Coordinate With Other Governmental and Academic Entities In The Ongoing Analysis of SLR. The Village of Pinecrest shall continue to coordinate regionally with Southeast Florida counties and municipalities, academia, and state and federal government agencies in the analysis of SLR, drainage, storm surge and hurricane impacts and the planning of adaptation and adaptation measures.
xv. Policy 9-1.8.3: Continue To Monitor And Coordinate With The Southeast Florida Regional Climate Change Compact. The Village of Pinecrest shall continue to actively monitor the Southeast Florida Regional Climate Change Compact, and shall coordinate with neighboring municipalities to make our community more climate change resilient by sharing technical expertise, assessing regional vulnerabilities, advancing agreed upon adaptation and adaptation strategies, and developing policies and programs./

c. Also see, "Exhibit B" to Ordinance No. 2015-4 (April 14, 2015), "Climate Change Element Data, Inventory and Analysis.

15. Palm Coast
    a. Local Adaptation Strategy (as of June 2015, Palm Coast is working on a rewrite of their Local Adaptation Strategy and intend to add SLR as a recognized hazard; may contact Denise Bevan for more info as well as Laura Nelson, Flagler County Emergency Manager who is leading the rewrite. More info at http://www.flagleremergency.com/pages.php?pid=62.
16. Pompano Beach
    a. Comprehensive Plan
        i. Land Use: "The warmer temperatures not only cause glaciers and land ice to melt (adding more volume to oceans) but also cause seawater to expand in volume as it warms. The global average sea level rose by just

under .07 inches per year during the 20th century, but that number has risen to .12 inches per year since the early 1990s. Under a 'business-as-usual' greenhouse gas emissions scenario, models indicate that sea levels could rise 2 feet or more by 2100 compared to 1990 levels."

ii. Transportation: "The State of Florida with almost 1,350 miles of shoreline and the associated coastal population concentrations is particularly susceptible to rising sea levels associated with climate change. In response to the climate change threats, Governor Charlie Crist signed three (3) Executive Orders on July 13, 2007 establishing immediate actions to reduce greenhouse gas emissions within Florida."

iii. Conservation 09.01.02: "The City shall implement a Climate Change Program that supports adaptation and sensitivity to the impacts of climate change in coordination with other municipalities, Broward County, private businesses, other governmental agencies and the State of Florida. This program will focus on mitigating the causes and consequences of greenhouse gas emissions in a cost-effective and efficient manner that preserves the City's overall values and quality of life."

17. Port Orange
    a. Comprehensive Plan
        i. Policy 1.1.1: "Explore various funding opportunities to assist in developing City GHGs emissions baseline data, in order to set GHG emission goals, to develop strategies to reduce climate change and to mitigate and adapt to its impacts."
        ii. Policy 1.1.13: "Continue to provide educational materials regarding energy efficiency, sustainable design, and climate change that encourage community residents and business owners to invest in energy-efficiency improvements through community outreach efforts, such as the City's Green Initiative Website."
18. Port St. Lucie
    a. Comprehensive Plan
        i. Policy 5.1.1.3: "The City may continue to monitor all credible climate change data and what direct and potential effects this may have on the coastal planning area and natural resources. Based on this data the City may evaluate and update the resource protection standards of the Land Development Code and this plan as necessary."
19. Punta Gorda
    a. Comprehensive Plan
        i. Conservation & Coastal Management Element: "Objective 2.4.2: Address the impact of SLR, and seek strategies to combat its effects on the shoreline of the City."
        ii. Conservation & Coastal Management Element: "Policy 2.4.2.: The City will work with the Southwest Florida Regional Planning Council to determine the potential SLR impacts on the Coastal Planning Area."

b. City of Punta Gorda Adaptation Plan. This plan list numerous adaptations identified through a public process, including seagrass protection and restoration, Florida Friendly Landscaping, explicitly indicate in local master plans which areas will retain natural shorelines, build road and sidewalks of porous materials, improved flood plain management/regulation, increase stormwater capacity, constrain location of certain infrastructure, restrict fertilizer use, promote green building alternatives, and drought preparedness planning.

20. Satellite Beach
    a. Comprehensive Plan
        i. Coastal Mgmt/Conservation: Objective 1.12A "Development and redevelopment within the City shall be permitted only when consistent with sound planning practices that shall protect life and property from the effects of coastal erosion, flooding, SLR, or damage to environmental systems."
        ii. Coastal Mgmt/Conservation: Policy 1.12A.1 – The City of Satellite Beach designates the Coastal High Hazard Area as "the area defined by the SLOSH model to be inundated from a Category 1 Hurricane".
        iii. Coastal Mgmt/Conservation: Policy 1.12A.2 "The City of Satellite Beach designates the Adaptation Action Area as that area which includes the CHHA and other areas of the City as may be identified by the City Council in the future as being subject to coastal erosion, flooding, SLR, or damage to environmental systems."
        iv. Coastal Mgmt/Conservation: Objective 1.3 The City shall continue to limit use of public funds and discourage use of funds by other levels of government that subsidize new, private development or redevelopment in the Coastal High Hazard Area.
        v. Coastal Mgmt/Conservation: Policy 1.3.2 - The City shall coordinate with service providers to replace and mitigate damaged infrastructure within the Coastal High Hazard Area and other parts of the Adaptation Action Area consistent with other policies of the Comprehensive Plan. (Refer to Policy 1.12A.2 in which the Adaptation Area is established.)
        vi. Coastal Mgmt/Conservation: Objective 1.4A The City shall strive to reduce the exposure of human life and public and private property to natural hazards while reducing the cost of flood insurance.
        vii. Coastal Mgmt/Conservation: Policy 1.4A.1 - The City shall initiate a public process to identify Adaptation Action Areas in accordance with Sections 163.3164(1) and 163.3177(6)(g)10 Florida Statutes. The purpose of the AAAs is to increase grant and other funding opportunities and identify creative solutions to achieve the following goals:
            - Protect the health, safety and welfare of residents,
            - Prevent damage to public and private property, and
            - Reduce National Flood Insurance Program premiums to property owners.

viii. Coastal Mgmt/Conservation: Policy 1.4C.3 - The City shall encourage population concentrations away from known or predicted coastal high hazard areas consistent with the goals, objectives and policies of the Future Land Use Element in the Satellite Beach Comprehensive Plan. This policy is not intended to prohibit or discourage maintenance or replacement of existing development within the CHHA.

21. West Palm Beach
    a. Sustainability Action Plan (specifically pages 39-43)
        i. Role of Cities in Climate Change – The City is on the front lines of climate change impacts such as sea level rise and increased hurricane intensity. Recognizing the need to simultaneously mitigate GHGs attributable to energy use and prepare for the gradual, but accelerating, impacts of climate change, the City has already proactively taken several actions.
        ii. The Planning Process - One of Florida's greatest threats associated with a changing climate is sea level rise. Per South Florida Water Management District (www.sfwmd.gov), by 2060, the water surrounding Florida's coastlines are projected to rise between 5 to 20 inches from current levels. This can have devastating effects on our built environment including water and sewer infrastructure, coastal erosion leading to property loss, and salt water intrusion into our drinking water supply. In addition to sea level rise the South Florida region will likely experience a change in rainfall and evaporation patterns which could have devastating effects.
22. Yankeetown
    a. Coastal Change Adaptation Study (this was conducted by a team from the University of Florida and *is not* a local government document)

## A.3 Conclusion

While this research revealed that only 26 of 195 local governments in Florida explicitly mention or address SLR in their comprehensive plans, this number will likely grow very rapidly over the next few years as further research takes place and the "early adopters" provide the inspiration, direction, models, and resources other local governments need to move forward. The local governments that have been most active provide some excellent examples of how to integrate consideration of SLR into local government planning. A summary of salient points from these include:

- The local government is actively seeking out information on SLR and helping ensure that the public is aware of it and has access to SLR information;
- The local government is promoting a dialogue with and among citizens about the hazards of SLR and ways that it can be addressed at the local level;
- The local government is developing public involvement processes to evaluate potential adaptation strategies to current and projected SLR impacts;

- The local government collaborates with other local governments in development of regional models and resources;
- The local government is coordinating with other entities on issues such as transportation, water supply, and other critical infrastructure potentially at risk from SLR;
- The local government is itself conducting or using another entity's analysis of SLR impacts under various scenarios to: o Identify public infrastructure and public facilities at risk and to guide long-term capital investments in infrastructure,
    - Risk to homes and businesses,
    - Help guide planning to avoid putting more people at risk to SLR, to Revise land use, zoning, and hazard maps,
    - Integrate SLR into floodplain management and National Flood Insurance Program and Community Rating System activities as means to both minimize flood damage and to save constituents money,
    - Develop Adaptation Action Areas that may help address short- to medium-term infrastructure needs,
    - Create strategies to promote denser development in areas safest from SLR impacts,
    - Specifically add SLR to stormwater master planning, and to Integrate SLR generally into resilience planning at the local level;
- The local government is integrating SLR and SLR vulnerability analysis results into all relevant local government documents, such as Post-Disaster Redevelopment Plans, Comprehensive Plans, Stormwater Master Plans, Comprehensive Emergency Management Plans, the Local Adaptation Strategy, the Capital Improvements Plan, and others as appropriate;
- The local government is evaluating the potential impact of SLR on established "levels of service" for all potentially affected services (i.e.--water, sewer, transportation, etc.);
- The local government is using one or more planning horizons, at least one of which extends to at least 50 years into the future;
- The local government requires proposed development in an area at risk of SLR to explicitly indicate how the development's design takes this risk into account;
- The local government is integrating SLR into management and planning for natural resources such as wetlands, marshes, bays, mangroves, and beaches; and
- The local government is integrating SLR into calculations of potential storm surge and tidal flooding.

# Appendix B Texas

Texas' coastal areas are vital to both the national and state economy. Nearly one quarter of Texas' population lives in its coastal counties.[570] Houston, located on Galveston Bay, is the fourth largest city in the United States. Texas's 21 ports handled 563 million tons of cargo in 2015, nearly a quarter of all U.S. port tonnage, which generated almost $370 billion in economic activity.[571]

Simultaneously, Texas' coastal areas are exposed to potentially severe environmental challenges. The process of subsidence is lowering many areas of Texas' Gulf coast, exasperating the effects of global sea level rise. Despite the high probability of harm to coastal communities, Texas' municipalities and counties are far behind Florida when it comes to preparing for future risks.

While Florida's county and municipal governments tend to have specific plans to combat SLR, Texas' governments merely mention it. Florida also has more local governments discussing SLR than Texas does, despite the fact that Texas is much bigger in area than Florida.

| **# of occurrences** | **KEY FOR CODES:** |
|---|---|
| 5 | PI= Providing information on SLR |
| 11 | DA= Doing analysis of SLR |
| 0 | CA= Coordinating activities related to SLR |
| 0 | ID infra = Identify public infrastructure and assets at risk of SLR impacts |
| 0 | STRMWTR = Add SLR to stormwater design and planning |
| 0 | RISK = Designate areas at risk for SLR impacts |

[570] http://greatertexasfoundation.org/wp-content/uploads/2011/03/Gulf-Coast-Short-Research-Loop-FINAL.pdf
[571] http://www.txdot.gov/inside-txdot/division/maritime/ports.html

| | |
|---|---|
| 1 | Fut.RISK = Discourage density increases in places of future SLR-induced vulnerability (this often may be present in comprehensive plans that this research did not review because the plans lacked explicit reference to SLR or may be in parts of plans that were reviewed, but not in the sections reviewed and included here; this is very likely as Florida Statutes require this to be part of comprehensive plans, Fla. Stat. §§ 163.3177(6)(g)4, 6, & 7; 163.3178(2), though implementation may be lacking in many communities) |
| 1 | InfraRR = Consider SLR in infrastructure replacement and for potential relocation |
| 1 | CNSDR = "Consider" SLR in particular decision making |
| 1 | DEV = Support increased development in safer coastal areas not at risk from SLR |
| 1 | AAA = Develop Adaptation Action Areas |
| 0 | MON = Monitor SLR and potential impacts |
| 2 | CC/GHG = mention of climate change and/or greenhouse gases |
| 0 | MENT = SLR mentioned but no specific action/policy implemented or req'd |

Twelve counties/municipalities resulted in the twenty-three codes. Importantly, only one city- Corpus Christi- had DEV, ID infra, Fut.RISK, and CNSDR. The majority of counties/municipalities only mentioned or provided information on SLR. This stands in stark contrast to Florida, which in many instances explicitly details how they will prepare.

Galveston had lots of talk about what they “will” or “should” do. If they had actually implemented those plans, it would have fallen under DA, CA, Id infra, RISK, CNSDR, and MON. That would be quite a comprehensive approach to tackling their SLR issues, but instead of planning, they only talked about planning. Nevertheless, this is ahead of most of the other counties/municipalities that did not mention it at all.

## B.1 Counties

1. Calhoun County
    a. Shoreline Access Plan

i. Geology. “The evolution of the Calhoun County shorelines is associated with the deposition of several river deltas in the last 125,000 years. This deposition was a response to the sea level changes that occurred in the Gulf of Mexico as the result of climatic variations, and the response of the rivers interacting with a changing coast… The changes in the sea level curve in the Gulf of Mexico for the past 125,000 years reflect the transgressions (sea level moving up) and regressions (sea level moving down), which developed the coastal morphological features of Calhoun County. Figure B1 shows the geology of the county, which is manifested by different types of sediments as a response to these SLR adjustments. According to the geologic models forecasting the relative SLR, it is expected that the process of coastal change will continue in the future years. Although, in the short-term these changes are not expected to be noticeable by the public, they will be noticeable in the medium-term in respect to adaptation of human activities and natural habitats.”

ii. Shoreline Access and Environmental Recommendations. Geographical Distribution. Zone E. Shoreline Erosion, Sediment Issues, and Environmental Recommendations. Marshes in Cox and Carancahua Bays. “The shorelines on these bays are composed mainly of hard clays with cliffs and marsh systems (Figure B1). Comparison of historic aerial photos of the bay shorelines show that these marshes are quickly disappearing due to erosion and relative SLR.”

2. Cameron County
   a. Erosion Protection Plan
      i. Cameron County Erosion Protection Plan (EPP). 2.8. “Shoreline change rates are indicators of beach stability or erosion and are helpful for planning and managing coastal projects. Previous studies have combined aerial photography and beach profiles to determine shoreline change over time periods ranging from short term -1970’s to 1980’s… These publications provide the trends for particular time periods but those trends may change as the shoreline is in constant flux due to the dynamics of sediment supply, long-term relative SLR, and episodic storm events.”
   b. Erosion Protection, Public Beach Access, Coastal Construction and Dune Protection and Beach Management Plan
      i. Introduction. The Erosion Protection Plan Component. “Land loss associated with shoreline retreat along the beach, resulting from a combination of regional subsidence, erosion, and relative SLR, has increasingly challenged the beach management efforts of government agencies and coastal communities.”
   c. Hazard Adaptation Plan
      i. Section 4: Risk Overview. Natural Hazards and Climate Change. “Climate change is defined as a long-term hazard which can increase or decrease the risk of other weather hazards, and also directly endangers property

due to SLR and biological organisms due to habitat destruction. While SLR is a natural phenomenon and has been occurring for several thousand years, the general scientific consensus is that the rate has increased fourfold in the past 200 years, from .5 millimeters per year to 2 millimeters per year. With a higher sea level, storm surges will be bigger and coastal erosion will accelerate… Texas also has thousands of miles of coastline that are highly vulnerable to the combined impact of SLR and the potential increase of storm intensity. Paleoclimate records also show that the climate over Texas had large swings between periods of frequent mega-droughts and the periods of mild droughts that we are currently experiencing. We do not know clearly what caused them, but we can anticipate that such change could occur again and it might already be occurring… Several processes contribute to chronic (long-term) or episodic (storm-induced) shoreline erosion. These processes include climate, tides, relative sea-level change, subsidence, tropical storms, and the amount and rate of sediment supply. Coastal erosion affects both Gulf and bay shorelines, resulting in the loss of agricultural, industrial, residential land, critical infrastructure, and wetlands. Erosion is attributable to relative SLR and to the fact that sediment removal by wave energy exceeds that supplied to the beach by currents. Climatic changes (from wetter to drier) have decreased the volume of sediments carried to the Texas coast by rivers."

ii. Section 8. Hurricane Wind. Hazard Description. "Texas has some of the highest coastal erosion rates in the country, eroding at an average rate of 2.3 feet per year, according to the Texas General Land Office. Coastal erosion is caused by large storms, flooding, SLR, and human activities that wear away the beaches and bluffs along the ocean."

d. Commissioners' Court Regular Meeting Agenda (Thursday, January 19, 2012)
   i. CONSENT ITEMS: GGG. "PARKS STAFF (1): JAVIER MENDEZ TO TRAVEL TO CORPUS CHRISTI, TEXAS ON 1123/12 TO ATTEND THE ADAPTIVE PLANNING FOR SLR WORKSHOP."
e. Dune Protection Committee Agenda (December 9, 2014)
   i. Notice: "The stated purpose of the GLO sponsored forum is to raise awareness of the tools available to community leaders and planners and to promote collaboration among resiliency practitioners. The forum is touted as a wonderful opportunity to highlight planning tools which will help identify risks associated with severe storms and SLR, and will allow local leaders to start crafting solutions to better prepare and respond to those threats. Storms and SLR and the risks thereof are of interest to the Cameron County Dune Protection Committee. Resiliency issues and dune protection and shoreline protection and related issues may be discussed."

3. Galveston County

   a. Dune Protection and Beach Access Plan[572]
      i. Galveston County Erosion Response Plan. 2-D. References and Sources: "Around the nation, America's coasts are shrinking. This loss of valuable coastal resources is due to a combination of many factors including subsidence, sediment loss, SLR, impacts from storms and unsustainable development (human factor)."
4. Jefferson County
   a. Hazard Adaptation Plan
      i. Storm Surge. Definition of a Storm Surge. Hazard "Storm surges occur when the water level of a tidally influenced body of water increases above the normal high tide. Storm surges occur with coastal storms caused by massive low-pressure systems with cyclonic flows that are typical of hurricanes. Changes in the earth's surface also contribute to the effects of surges. Rising seas and erosion have led to the deterioration of the State's barrier islands and marsh, important shields against storm surge."
5. Matagorda County
   a. Flood Adaptation Plan
      i. 2.4 Known Flood Hazards. SLR. "SLR has been an ongoing problem on the Texas Gulf Coast. As recorded in the Bureau of Economic Geology June 2000 Final Report… the upper Texas coast has a rate of relative SLR of 0.022 ft/yr (about 1 foot in 46 years) as measured by the Pier 21 tide gauge on Galveston Island. Figure 2 (Figure 17 below)… The publication's Figure B-6 (Figure 18 below)… Climate research by the Intergovernmental Panel on Climate Change (IPCC) predicts continued and accelerated global warming for the 21 Century and possibly beyond, which will cause a continued or accelerated rise in global sea level. Impacts to coastal and estuarine zones caused by sea-level change must be considered in all phases of Civil Works programs… The Circular provides USACE guidance for incorporating the direct and indirect effects of projected future sea-level change in managing, planning, engineering, design, constructing, operating and maintaining USACE projects and systems of projects."
      ii. 3.6 Wetlands, Riparian Areas, and Sensitive Areas. Amount of Coastal Wetlands and Wetlands Loss in Texas. "For example, on Matagorda Island, tidal flats declined from some 5,500 acres in the 1950s to some 2,250 acres by 2001, much of which can be explained by a rising sea level, a trend also reported on Mustang Island and San Jose Island."
      iii. 3.6 Wetlands, Riparian Areas, and Sensitive Areas. Amount of Coastal Wetlands and Wetlands Loss in Texas. Figure 27: Estimate Loss of Wetlands by Source in Galveston Bay: "Cause: Subsidence and SLRs (aquifer overpumping); Type of Wetland Affected: Estuarine bay marshes; Net Loss 1950-1990 (Acres): 24,600."

[572] http://www.glo.texas.gov/what-we-do/caring-for-the-coast/open-beaches/beach-access-plans.html

iv. 3.6 Wetlands, Riparian Areas, and Sensitive Areas. Threats to Wetlands. Threats to Wetlands. "Like estuaries, wetlands are subject to a variety of threats. Subsidence of land along the coast and the loss of coastline caused by soil erosion and a rising sea level have contributed to the loss of coastal wetlands. Each year, 225 acres of gulf shoreline wash into the sea."
v. 3.6 Wetlands, Riparian Areas, and Sensitive Areas. Threats to Wetlands. Threats to Wetlands. Figure 28: Causes of Coastal Wetland Loss: "Natural Causes: Subsidence (including natural rise of sea level)…"
vi. 6.0 Draft Action Plan (CRS Activity 511.8). Flood Damage Reduction (F). F-6 Adopt "Higher Standard" Coastal Flood Damage Prevention Ordinances and Standards (Coastal High Hazard Areas – Zone VE and Coastal A Zones). "Several coastal "higher standards" were evaluated by the Committee including compensation for SLR and coastal erosion: New construction, in coastal areas subject to a high erosion rate, would be required to be set back from the waters edge to compensate for future erosion based on a retreat rate reported by the Texas General Land Office; New construction in Coastal High Hazard Areas (Zone VE) would be required to be elevated a minimum of two feet above the base flood elevation, based on existing conditions, to compensate for projected SLR over a 50-year period; Require new construction in designated Coastal A Zones to comply with Zone VE construction requirements; Construction in Coastal Barrier Resource Act Zones will be discouraged and prohibited if allowable by law."

6. Liberty County
    a. State of Community Report, 23rd July 2015
        i. Most of the lands in Liberty County, which are located in the estuary of Trinity River at Trinity Bay, belong to Surge category 3 with a maximum sustained wind speed of 130 mph and extensive damages (see table 8.3). The county is affected by SLR since it is exposed to storm surge. Extensive damages means that well-built framed homes may incur major damage or removal of roof decking and gable ends, many trees will be snapped or uprooted, blocking numerous roads, and electricity and water will be unavailable for several days to weeks after the storm passes.
7. Nueces County
    a. Erosion Response Plan
        i. Executive Summary: "The Erosion Response Plan addresses… Review of scientific studies concerning storm surge, coastal erosion, and SLR."
        ii. Introduction. "As a part of this review staff obtained scientific assistance from local, state and national experts and or studies of SLR and coastal erosion."
        iii. Projected Shoreline. "The map exhibits in Appendix 2, contain the Bureau of Economic Geology's projected 2060 shoreline that incorporates predicted erosion rates and SLR data."

iv. Federal Emergency Management Agency and the National Oceanic and Atmospheric Administration. “Other factors to consider when assessing the risk to development in island areas are the potential impact from hurricane storm surge and SLR.”
v. Figure 11: Bob Hall Pier Sea Level 1958-2006. “The major findings of this study concerning the foredune ridge are: … That there is a 47 year historical trend of SLR of approximately 1.14 feet per 100 years.”
vi. Useable Public Beach. “SLR on the Gulf of Mexico over the last 20 years has been estimated to be 1.6 millimeters per year for a total SLR of 32 millimeters or 1.2598 inches. Given the prediction of continued SLR and the erosion of the public gulf beach, a minimum desired standard for public beach width is also established by this plan.”
vii. Footnote 8. “Sea level history of the northern Gulf of Mexico coast and SLR scenarios for the near future, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL 32306, USA, Joseph F. Donoghue.”

## B.2 Municipalities

1. Corpus Christi
    a. Comprehensive Plan. Element 5. Resilience and Resource-Efficiency.
        i. Summary. “Strategies and Actions for Resilience and Resource-Efficiency Include: Develop a Corpus Christi Resilience Plan for long-term guidance about adaptation to SLR, extreme storm events, and other stresses and shocks.”
        ii. A. Goals and Policies. “Corpus Christi has a holistic community standard of resilience that adapts to changing conditions such as storm hazards, high winds, and SLR.”
        iii. B. Findings. Resilience. “SLR projections for the Texas Gulf Coast range from one to six feet by the year 2100. Records from Rockport show the sea level rising 22 inches in the last 100 years. Current rates of SLR are expected to accelerate by the year 2100… The Corpus Christi Integrated Community Sustainability Plan includes a map and illustrations of potential inundation by 2100 of parts of the city under scenarios of low, medium, and high SLR. North Padre Island and Mustang Island would be affected more than any other parts of the city.”
        iv. E. Strategies and Actions to Achieve the Goals. “Goal 1: Corpus Christi has a holistic community standard of resilience that adapts to changing conditions such as storm hazards, high winds, and SLR. Policies: Support periodic review of resilience planning and implementation to adapt to changing conditions. Promote public understanding of risk and the responsibilities of individual households, as well as the city, state, and federal governments. Strategies: … B. Develop a Corpus Christi Resilience Plan for long-term guidance about adaptation to SLR, extreme storm

events, and other climate stresses and shocks… Actions: … 2. Identify areas expected that will likely be subject to SLR in the future and limit new construction and new public infrastructure in these areas. C. Continue to monitor readiness and develop a public information campaign through community organizations to raise public awareness about risk and probability related to SLR and storm hazards. The risks of SLR and storm hazards may be more obvious in some locations, such as North Beach and Padre Island, than in others. For example, extreme storm surge conditions that combine high tide with the high winds of a hurricane, could produce some flooding as far west as Weber Ave in the Southside. D. Provide standards, guidelines, and best design practices to promote resilient development practices, amending regulations as necessary. Actions: 1. Modify the building code and the UDC as needed to ensure safe and flood-proof construction in areas that become increasingly vulnerable to SLR. 2. Develop a catalogue of example design solutions to assist property owners in flood proofing and raising buildings in areas at risk of flooding and SLR. E. Work with legislators and others to ameliorate the rising cost of wind and flood insurance for property owners. All housing costs are rising in Corpus Christi because of increased demand and the increasing cost of wind and flood insurance is becoming a burden for many property owners. As the data on SLR in the Gulf of Mexico and predictions of more extreme storm events become more evident, the cost of living in hazardous areas will increase. The rise in coastal insurance is happening in every coastal state, especially on the Atlantic and Gulf Coasts, where SLR is increasing faster. State legislatures are working with insurers to seek ways to resolve issues around prohibitive insurance costs.

2. Galveston
    a. Comprehensive Plan
        i. Natural Resource Element, Objective 2.2: Review and Update Zoning and Subdivision Regulations to Protect the Integrity and Function of Galveston's Natural Resources. " [T]he City's existing development standards offer little direct guidance regarding ways to protect sensitive resources and mitigate the effects of geological processes such as SLR, land subsidence, erosion, storm-surge flooding, and wash-over. To promote more resilient and resource-sensitive development on the Island, the City will accomplish the following: Resource References & Mapping: Use resources such as the Galveston Island Geohazards Map as public information tools and references during the review of development proposals; Continue to incorporate data layers provided by the City's environmental partners as part of the City's geographic information system (GIS) database and make available to the public for review; Use geohazard and sensitive resource information as resources in the development of future specialized plans and policies. Regulatory

Strategies: Investigate regulatory strategies, including cluster zoning, Low Impact Development (LID), and others, to promote more sustainable and resilient development, especially in areas with sensitive environmental resources; Reference recently completed plans and land use studies such as the City's *Hazard Adaptation Plan*, the Trust for Public Land's (TPL) *West Galveston Island Greenprint for Growth*, and the Urban Land Institute's (ULI) *Sustainable Neighborhoods for Galveston* in the process of crafting new development regulations; Address the effects of common development practices on the Island's natural resources, such as the practice of filling sites to meet elevation requirements."

ii. Natural Resources Element, Objective 3: Preserve and Protect the Wetlands of Galveston. "The Island's freshwater and coastal wetlands provide a number of natural functions vital to the health of the Galveston Bay Estuary. These functions include flood control, filtering pollutants from the Bay, and providing vital habitat for many species of plants, fish, birds, and wildlife. Wetland loss is a major threat to the Galveston Bay Estuary. Losses on Galveston Island have been the result of man-induced subsidence and related SLR, erosion, filling, and dredge-and-fill activities."

iii. Natural Resources Element, Objective 4: Respond Proactively to Land Loss on Galveston Island. "Land loss associated with shoreline retreat along the Island's beach and bay, resulting from a combination of regional subsidence, erosion, and relative SLR, has increasingly challenged government agencies and coastal communities…Without continued intervention, land loss on Galveston Island will not be reversed in the life span of this document. The impact of global SLR is anticipated to be greatest on low-lying barrier islands, such as Galveston Island. The City of Galveston did not create these regional or global circumstances, but given the disproportionate impact they have on this community, it is incumbent on the City to continue to respond proactively. The City has taken important first steps toward such a response, but much remains to be done to ensure that any future development on the Island is sustainable and resilient."

iv. Natural Resources Element, Objective 4.4: Research and Implement Innovative Projects to Promote Shoreline Stabilization. "Methods to respond to coastal erosion are continuing to evolve and improve and the City must monitor the availability of new methods to protect the Island's coastline. Projects should be considered and implemented where scientific research supports feasible projects for coastal erosion control. Examples for projects to be considered include, but are not limited to, the following: … Climate adaptation strategies for SLR…"

v. Disaster Planning Element, Objective 2.5: Continue to Explore Other Adaptation Projects. "The City should continue to consider appropriate methods to reduce erosion on both the beach and bay fronts. Further,

the City should develop a climate adaptation plan to address other issues such as rising temperatures, changing precipitation patterns, SLR, and extreme natural events."

b. Dune Protection and Beach Access Plan
    i. Erosion Response Plan. 1. Introduction, 1.3 Relationship to Other City Plans, Objective NR-4: Respond Proactively to Land Lost on Galveston Island. "Land loss associated with shoreline retreat along the Island's beach and bay, resulting from a combination of regional subsidence, erosion, and relative SLR, has increasingly challenged government agencies and coastal communities… Without continued intervention, land loss on Galveston Island will not be reversed in the life span of this document. The impact of global SLR is anticipated to be greatest on low-lying barrier islands, such as Galveston Island."
c. Adaptation Action Plan
    i. Table 9.3.3-1. Goal 1: Improve education and outreach efforts, specifically to the public, elected officials, municipal employees and local businesses, regarding the potential impacts of hazards and the identification of specific measures that can be taken to reduce those impacts. Objective 1.1: Educate the public and others on actions they can take to prevent or reduce loss or life or property damage from all hazards. Hazard(s) addressed: … sea level change… Proposed Actions: provide hazard and disaster awareness and preparedness information to the public, both residents and visitors; use internet to provide information to residents and visitors regarding the natural disasters, preparation, and protection, purchase and distribute NOAA All-Hazard radios or other public notification devices to public facilities, schools… and large public gathering places; increase on-island CERT capability and capacity."
    ii. Table 9.3.3-1. Goal 2: Improve capabilities, coordination and opportunities at the municipal level to plan and implement hazard adaptation projects, programs and activities, especially through the use of GIS, coordination with universities and colleges, and public/private partnerships. Objective 2.1: Acquire and maintain detailed data regarding vulnerabilities, including critical facilities and historic assets, so that these resources can be prioritized and assessed for adaptation actions. Hazard(s) addressed: … sea level change… Proposed Actions: Work cooperatively with NOAA and other agencies to conduct workshop/study on SLR in Galveston; Development of Sustainability Plan/Program Implementation; Development of Greenprinting Plan for areas east of West End study; Develop proposed land use mapping to allow easier consideration of hazards in future development; Consider/Contract for historic property adaptation study to determine best practices for adaptation of homes on larger scale; Digitalization of paper records, city-wide for access post-disaster (mitigate data loss and allow for continuity

of operations/government); Develop detailed inventory of critical facilities, to include elevations, square footage and contents inventory."

iii. Table 9.3.3-1. Goal 3: Develop hazard adaptation policies and programs designed to reduce the impact of natural and human caused hazards to people and property. Objective 3.1: Seek ways to reduce losses to the National Flood Insurance Program, and to increase participation in and compliance with the NFIP. Hazard(s) addressed: … sea level change… Proposed Actions: Consider joining the NFIP's Community Rating System; Consider adoption and enforcement of freeboard requirement into City's Flood Damage Prevention Ordinance; Increase number of floodplain managers in the building division through training and certification. Objective 3.2: Consider measures to ensure that modifications to existing development, as well as any future development, will not put people or property in harm's way, or will not increase threats to existing properties. Hazard(s) addressed: … sea level change… Proposed Actions: Support aggressive beach nourishment program to address critical erosion areas; Restore destroyed dune systems to decrease/ mitigate damage to public and private property; Install shoreline protection devices in areas subject to coastal erosion to reinforce dune systems.

iv. Table 9.3.3-1. Goal 4: Identify and implement hazard adaptation projects to reduce the impact of hazard events and disasters. Objective 4.1: Pursue opportunities to mitigate identified Repetitive Loss and Severe Repetitive Loss properties. Hazard(s) addressed: … sea level change… Proposed Actions: Elevation, acquisition or other adaptation of identified Repetitive Loss and Severe Repetitive Loss properties. Objective 4.2: Pursue opportunities for structural adaptation projects and other projects to protect infrastructure from hazards. Hazard(s) addressed: … sea level change… Proposed Actions: Exposed concrete and rebar on public beaches – remove debris and threat to public and private property – reducing property damage during hazard events; Elevate coastal roads to better protect public during evacuation and to protect the roads from flood damage, where technically feasible; Implement improved drainage projects and better maintenance program for clearing drainage ditches; Elevation of structures at risk from flooding; Install security/surveillance equipment at all municipal facilities; Purchase tent equipment for local cable channel (Complete); Identify and purchase needed vehicles and equipment for public safety departments; Harden facility and improve security at unmanned municipal utility facilities; Acquisition and demolition of structures damaged by flooding, including abandoned structures; Elevation or other flood protection of historic structures at risk from flooding; Study, evaluate, design and construct flood control methods, with particular emphasis on the protection of critical facilities and critical infrastructure; Identify critical facilities and other necessary public buildings that require emergency power generation – Purchase

and install emergency power generators and related housing and connection equipment at all critical facilities and other necessary public buildings; Design and construct a Safe Room (using FEMA 361 design guidance) to house emergency personnel and first responders who must remain on the island during evacuations; Perform retrofits of public utilities (including sanitary sewer and drinking water systems), which may include the following: inflow guards on manhole covers, elevated electrical components, flood proof or elevate utility structures within SFHAs, ring berms around critical facilities that cannot feasibly be elevated, watertight manhole covers, tied down fuel storage tanks; Investigate ways to harden and protect facilities and infrastructure belonging to Gulf Coast Water Authority (Sole source provider of potable water to City) – Implementing projects as funding becomes available; Rehabilitate the 1894 Bayline, for use as emergency water connection in the event of failure or damage of water main; Implement plans for elimination of on-site sewer treatment; Investigate and implement hardening of IT and phone (communication) infrastructure, to include offsite/ remote facilities; Increase capacity/ hardening for internal department communication; Develop a standby application for post-disaster code enforcement (includes building, compliance, planning, public works, etc.)

3. Jamaica Beach
    a. Erosion Response Plan (Approved for Submission, July 16, 2012)
        i. 3.1.2 Annual Sand Volume Losses: “Data regarding the magnitude of sand deficits and surpluses at locations along the City’s beachfront is useful to inform any discussion of reasonable alternative actions to address shoreline retreat and reduce future public expenditures due to erosion and storms. The BEG shoreline change rates provide a basis for a planning-level estimate of the volume of sand needed to offset the sand deficit within the City whether due to erosion or relative SLR – a term that describes the combined effects of land subsidence and absolute rising sea level… [T]he effect of relative SLR is already included in the BEG long-term erosion rates… [O]ver the long-term, more sand has entered Jamaica Beach than has departed, but relative SLR has slightly overcome this influx causing a modest rate of shoreline retreat. Further, BEG analysis of water level records for Galveston Island indicates that recent (since about 1990) relative sea level change rates have been among the lowest on record. If rates revert to higher historical averages, the City can expect greater shoreline retreat rates that has recently been experienced… [E]pisodes of large storm-related changes are separated by potentially long periods of recovery moderated by rising relative sea level. In Jamaica Beach, the balance of these effects has been a slight landward retreat over the long term.

ii. 3.4.3 Vulnerability: "The City, including its public infrastructure and private property, is vulnerable to the effects of beach erosion and storm events in several ways including the following: … Relative SLR – The natural response of a barrier island to progressive SLR is for the island to "roll over" as washover deposits raise elevations on the bayside and the Gulfside areas are submerged. This process is ongoing on Galveston Island despite the presence of development."
iii. 3.61 Federally-declared Disaster: "As noted above, Jamaica Beach has a long-term net influx of sand that is slightly overtaken by the effects of relative SLR. The frequency and characteristics of individual storms (and intervening periods) vary widely and cannot be generalized."
iv. 4.2.2 Necessary Average Annual Sand Volume: "As described in Section 3, the long-term average annual sand volume required to offset the shoreline erosion is about 0.5 cy/ft of beach. This number is the difference between the roughly 2 cy/ft/yr required to offset relative SLR and the net influx of 1.5 cy/ft/yr sand from outside of Jamaica Beach. In round numbers, the san deficit is approximately 2,000 cubic yards of sand per year for the entire length of Jamaica Beach. Given the present post-Ike condition of the dune complex, a volume adequate to restore the dunes to health must be considered in addition to this long-term average amount."

b. No other reference found.

4. Port Aransas
   a. Erosion Response Plan
      i. 2. Geomorphology. "The natural geological setting of the Mustang/North Padre Island coast has created a shoreline that is low in sand supply and that is undergoing long-term relative SLR. For these reasons the shoreline will continue to undergo long term retreat unless human intervention prevails."
5. South Padre Island
   a. Comprehensive Plan
      i. Chapter 5. Parks & Resources. Issues. 3. Sustainability of habitats and valuable, native flora and fauna. "Coastal wetlands are valuable natural resources that provide many ecological and economic benefits, e.g., flood control, improved water quality, erosion control, wildlife habitat, and recreation. However, they are disappearing due to erosion, subsidence, rising sea level, and/or being filled in and built over to accommodate development."

## B.3 Conclusion

Texas county and municipality governments tend to mention SLR, and no plans have actually been implemented to begin preparing for future hazards. Texas needs to get ahead of the issue,

and certain communities had more dialogue than others did. A summary of significant points from the documents outlined in Sections B.1 and B.2 is summarized here:

- There is a recognition that SLR is historic. It shaped our coastline and shoreline features, but the rate has increased in the last hundred years as recorded by tidal gauges and other metrics.
- Local governments note that the Texas shoreline is vulnerable to SLR, and SLR will make storm surges worse.
- Local governments acknowledge that SLR is contributing to land loss, particularly marshes, due to relative SLR, eustatic SLR, subsidence, and a limited sand supply or a sand supply whose rate is lower than relative SLR.
- Local governments acknowledge the importance of preserving and protecting wetlands because of their ecosystem services. SLR endangers property and organisms through coastal squeeze.
- Local governments recognize that SLR is a driver of shoreline change rates, and that there is a need for "innovative" projects to minimize erosion.
- Local governments see a need to plan for SLR, and they consider setbacks, creating a resilience plan, modifying building code to ensure safe construction in vulnerable locations, limiting construction, and zoning. They acknowledge that coastal areas must plan for SLR in order to be "holistic."
- There is a recognition that local governments did not create the issue, but never the less they have to deal with it.
- Local governments use SLR predictions (particularly BEG maps) to identify the most risky areas. There is a need for detailed vulnerability maps including critical facilities and historic assets.
- Local governments use public outreach to raise awareness of the issue, and they can offer solutions of flood proofing to property owners as examples for how properties can be made more resilient to SLR.
- Flood insurance is recognized as needing reform. One municipality emphasized that rates should be more affordable, while another wants to reduce NFIP's monetary losses. Local governments have considered joining NFIP's Community Rating System, placing a freeboard requirements, and minimizing the number of Repetitive Loss and Severe Repetitive Loss properties.

Florida is "ground zero" for SLR, so governments had to begin implementing actions steps earlier than other locations across the country.[573] Indeed, of the 4.2 million American residents living at an elevation of 4 feet or less, 2.4 million are in South Florida. [574] Since Texas is now feeling the effects of SLR, we can look to the "early adopters" identified in Appendix B for inspiration and guidance moving forward.

[573] Ruggeri, Amanda. "Miami's fight against rising seas." BBC - Future. N.p., 4 Apr. 2017.
[574] Air Worldwide. "The growing value of U.S. coastal property at risk." 23 Apr. 2015. Web.

# Living With Sea Level Rise in Texas: Public Policy Concerns and Comparisons to Florida

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