Report Received by MPPDC 4/25/12

START

Start Adaptation and Response Today

Middle Peninsula Planning District Commission

An inventory of data, case studies and policy options for localities to consider in adapting to climate change and sea level rise impacts

February 2012

Middle Peninsula Planning District Commission
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The views expressed herein are those of the authors and do not reflect the views of the U.S. Department of Commerce, NOAA, or any of its subagencies.

Executive Summary

The Middle Peninsula's adaptive capacity is rooted in the knowledge and acknowledgement of potential impacts of climate change and sea level rise, as well as available adaptation options and strategies. As the Middle Peninsula works to understand associated social, economic and ecologic implications of climate change and sea level rise, the region ultimately has the option of reducing their vulnerability through non regulatory and regulatory action. In the final year of the Virginia Coastal Zone Management Program's Sustainable Communities focal group project, the Middle Peninsula Planning District Commission (MPPDC) has identified a variety of community adaptation strategies and policy options for localities to consider. With the development of this START (Start Adaptation and Response Today) kit emergency managers, county planning staff and local elected officials may choose to implement one strategy/policy or another to meet the needs of the locality.

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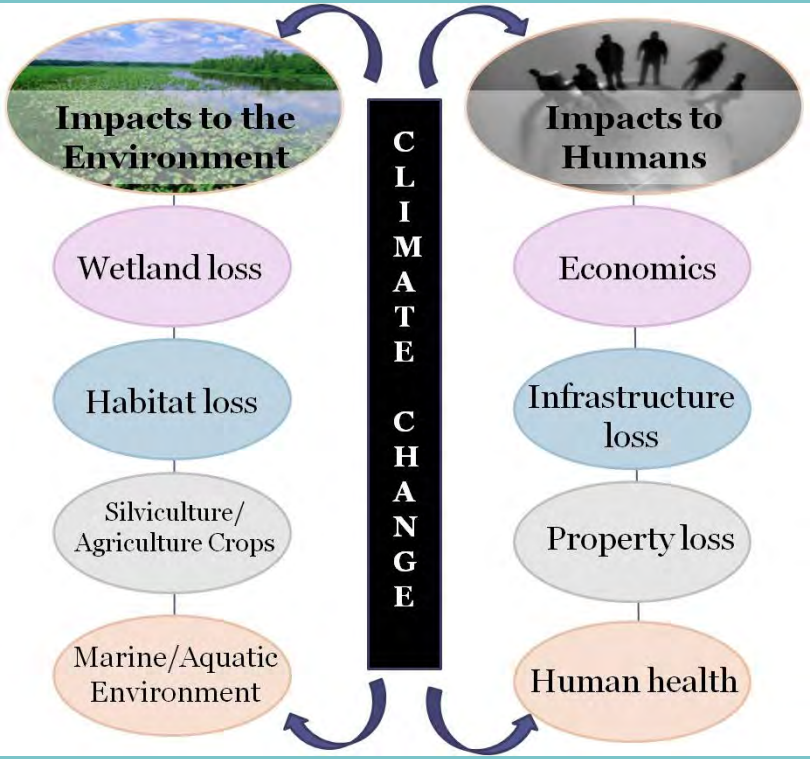
Figure 1: Climate change will have an impact on humans as well as the environment, and the dynamics between the two.



Local governments in the coastal area of Virginia should include projected climate change impacts, especially sea level rise and storm surge, in all planning efforts, including local government comprehensive plans and land use plans. Local governments should revise zoning and permitting ordinances to require projected climate change impacts be addressed in order to minimize threats to life, property, and public infrastructure and to ensure consistency with state and local climate change adaptation plans.

- a recommendation from Virginia Governor Timothy Kaine's Commission on Climate Change, Final Report: A Climate Change Action Plan, 2008

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Introduction

With well over 1,000 miles of shoreline, the vulnerability of coastal communities within the Middle Peninsula to storm surge, flooding and sea level rise is tremendous! Due to the low lying geography of the region such weather related events have historically impacted the region. From the Hurricane of 1933 that increased water levels 6.35 feet above mean high water to Hurricane Isabel in 2003 that increased water levels 5.13 feet above mean high water, Tidewater Virginia is no stranger to extreme weather events. Yet in light of climate (i.e. temperature, humidity, atmospheric pressure, wind and precipitation) change and sea level rise, many of the weather events typically experienced within our coastal area are projected to become exasperated and more frequent.

To understand the potential impacts to humans and the environment due to climate change and sea level rise (Figure 1), the Middle Peninsula Planning District Commission (MPPDC), funded through the Virginia Coastal Zone Management (CZM) Program, began a three year endeavor in 2008 to discuss and assess such impacts.

In Phase 1, a Climate Change Advisory Workgroup, consisting of appointed county representatives and stakeholders from transportation, sanitation, public health, recreation, science, planning, and local businesse sectors, was established. They were tasked with identifying critical impacts to humans and the environment due to climate change and sea level rise to their respective sector as well as to the region (Table 1). A series of monthly meetings with the Workgroup pinpointed specific impacts of concern which were then mapped and assessed through ArcGIS (Geographic Information System) software. Using available topographic data, MPPDC staff quantified the number of structures (e.g. home, business, onsite disposal systems, roads and shoreline hardening) and the amount of wetland acres within selected vulnerable areas throughout the region that would be inundated by 1 ft. of sea level rise by 2050. Figures 2 and 3 demonstrate how MPPDC assessed selected areas. In Figure 2, MPPDC staff counted the structures that would be inundated by 1ft. of sea level rise and then applied an estimated cost of the structure to calculate the total loss of infrastructure for that select area. To take the ecologic impacts into account (Figure 3), MPPDC staff took the estimated acres of wetlands that would inundated and calculated the loss of wetland

Table 1: Summary of impacts to humans and the environmental as identified by the Climate Change Advisory Workgroup (MPPDC, 2008)

Sector	Response - Comment
IMPACTS TO HUMANS	
Recreation	-Public access points -Decreased opportunities for warm season activities -Impacts to recreational fishing -Outdoor activities and heat related health risks
Transportation	-Road washouts and flooding -Travel disruptions, including coastal evacuation routes -Increase of road maintenance and cost
Infrastructure	-Property loss and increased need to protect property -Increased demands on storm water management systems -Frequent flooding -Relief services ability to reach all those in need
Business	-Reduced interest in the region to locate business -Higher insurance rates -Impacts to business infrastructure
Health	-Heath related health risks -Reduced air quality -Increase of water-borne and food-borne disease with increased temperatures -Sanitation concerns as rising groundwater levels and inundate onsite wastewater disposal drainfields.
Emergency Response	-Increased demands = increased costs -Heat and cold related services needed -Retaining qualified volunteer fire and rescue squads as service needs increase
Energy	-Increased demands -Increased load on energy grid during peak months
IMPACTS TO THE ENVIRONMENT	
Hydrology and Water resources	-Impacts to water quality -Increased flooding -Wastewater management -Changes in hydrology impacting local natural resources
Agricultural crops	-Increased demand for irrigation -Changes in crop yield and types of crops planted -Pest control
Biodiversity	- Loss of habitat / loss of species - Shift distribution of species – impacting hunting and fishing activities
Forests (ie. parks)	-Increased forest fires -Loss of productivity
Coastal Resources and ecosystems	-Loss of coastal wetlands and habitat due to sea level rise and erosion -Increased risk of pollution -Wetlands could drown and loss functions to protect infrastructure
Aquatic ecosystems	-Loss of near shore habitat and coastal wetlands -Shift of species and loss of habitat -Losses will impact local economy – Aquatic ecosystems are of High Importance

function (i.e. commercial factors, damage control and recreation opportunities). As this assessment was conducted for each Middle Peninsula locality, MPPDC staff approximated that $187,005,32.10 - $249,451,074.50 worth of infrastructure (i.e. roads, houses, onsite disposal systems, etc) and wetland function may be impacted and/or lost due to sea level rise within the Middle Peninsula. The maps generated during this project also provided a visual for local elected officials to consider public policy implications with regard to secondary road and small bridge elevation issues, septic tanks, the hardening of shorelines, relocation of residential structures, as well as taxing and revenue considerations.

With a grasp on the local issues and potential impacts of climate change and sea level rise, Phase 2 of this project focused on educating and promoting dialogue amongst local elected officials, county staff, and community groups. Through the use of Qwizdom software – an audience response system - MPPDC staff engaged stakeholders on the topic of climate change, sea level rise, and government's role in managing potential impacts. As a result, discrepancies were found within and amongst stakeholder groups regarding their knowledge as well as their perceptions on these issues. While such discrepancies may influence the development of future public policy, understanding these social perceptions are critical in order to move forward. Therefore as MPPDC staff continues to work with county staff and elected officials, discussions have been re-focused on the county's responsibility to protect public health, safety and welfare (VA Code §15.2-1200).

Finally, Year 3 focused on the development of a START (Start Adaptation and Response Today) kit which organized research information that MPPDC staff has collected since the

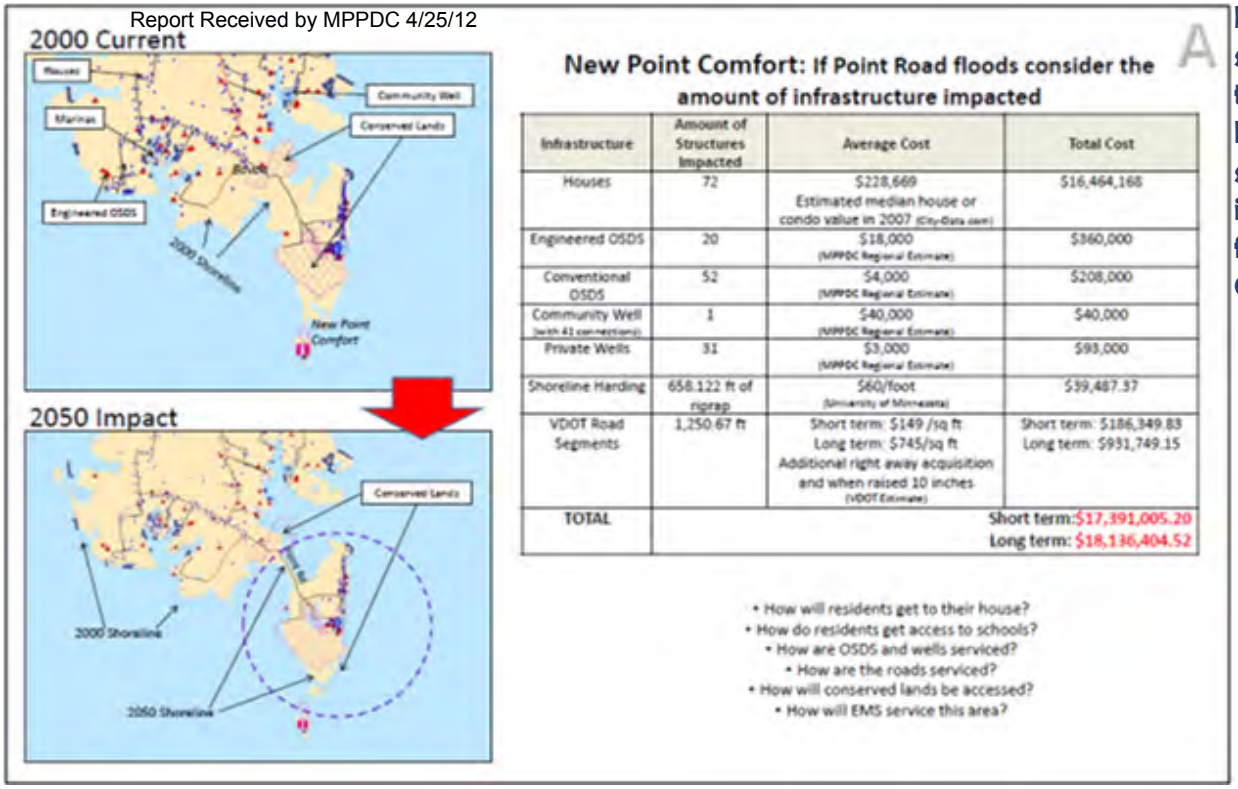


Figure 2: MPPDC staff assessed the impacts to humans due to sea levle rise. This is an example from Mathews County.

beginning of the project. This kit is provides local elected officials, county planners and emergency planners with public policy and land use planning options to address current and pending climate change and sea level rise impacts to Middle Peninsula coastal communities. Thus through a comprehensive approach, MPPDC staff assembled and customized information - including (1) local scientific data, (2) Kaiser-Permanente Natural Hazard Vulnerability Assessments Tool, (3) state, local, national and international case studies, and (4) sample ordinances from coastal communities -that will assist Middle Peninsula localities in adapting to climate change and sea level rise.

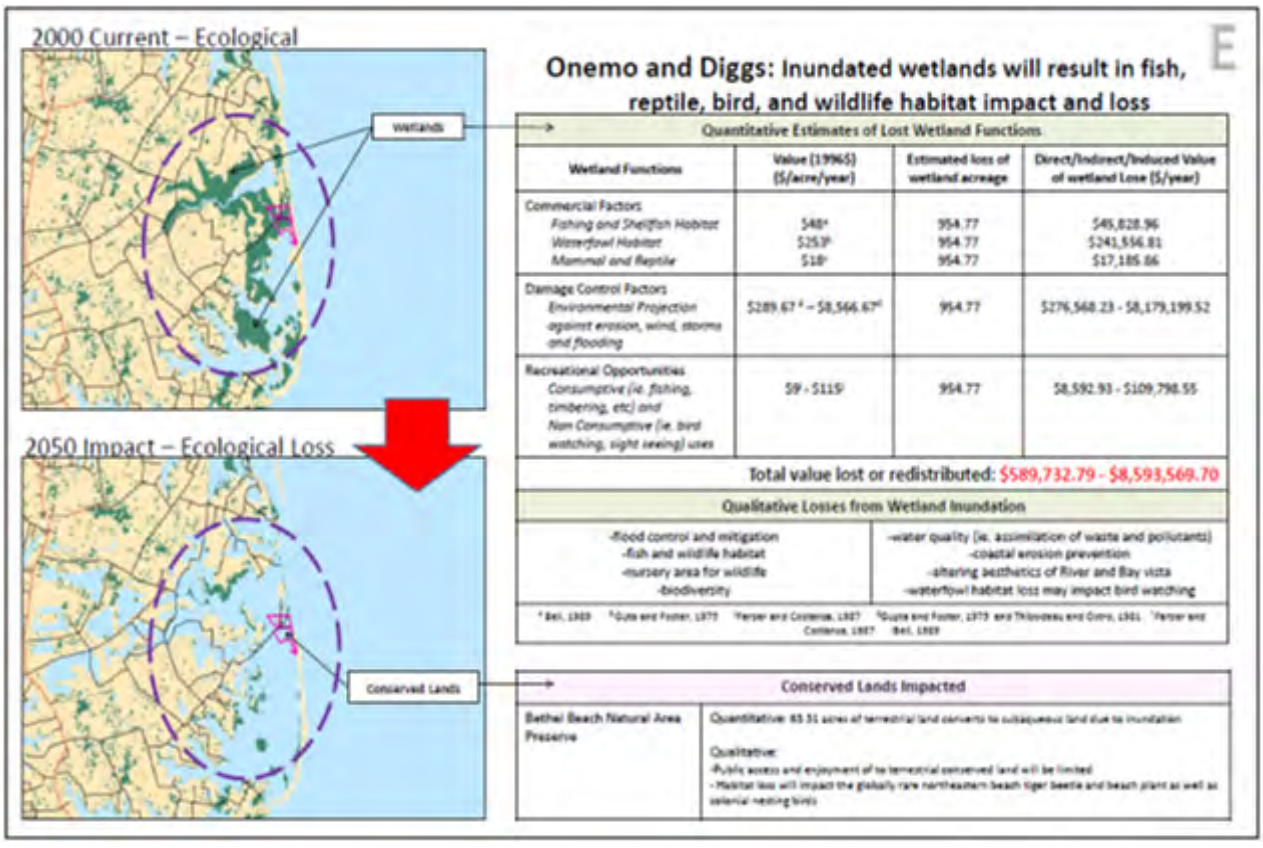
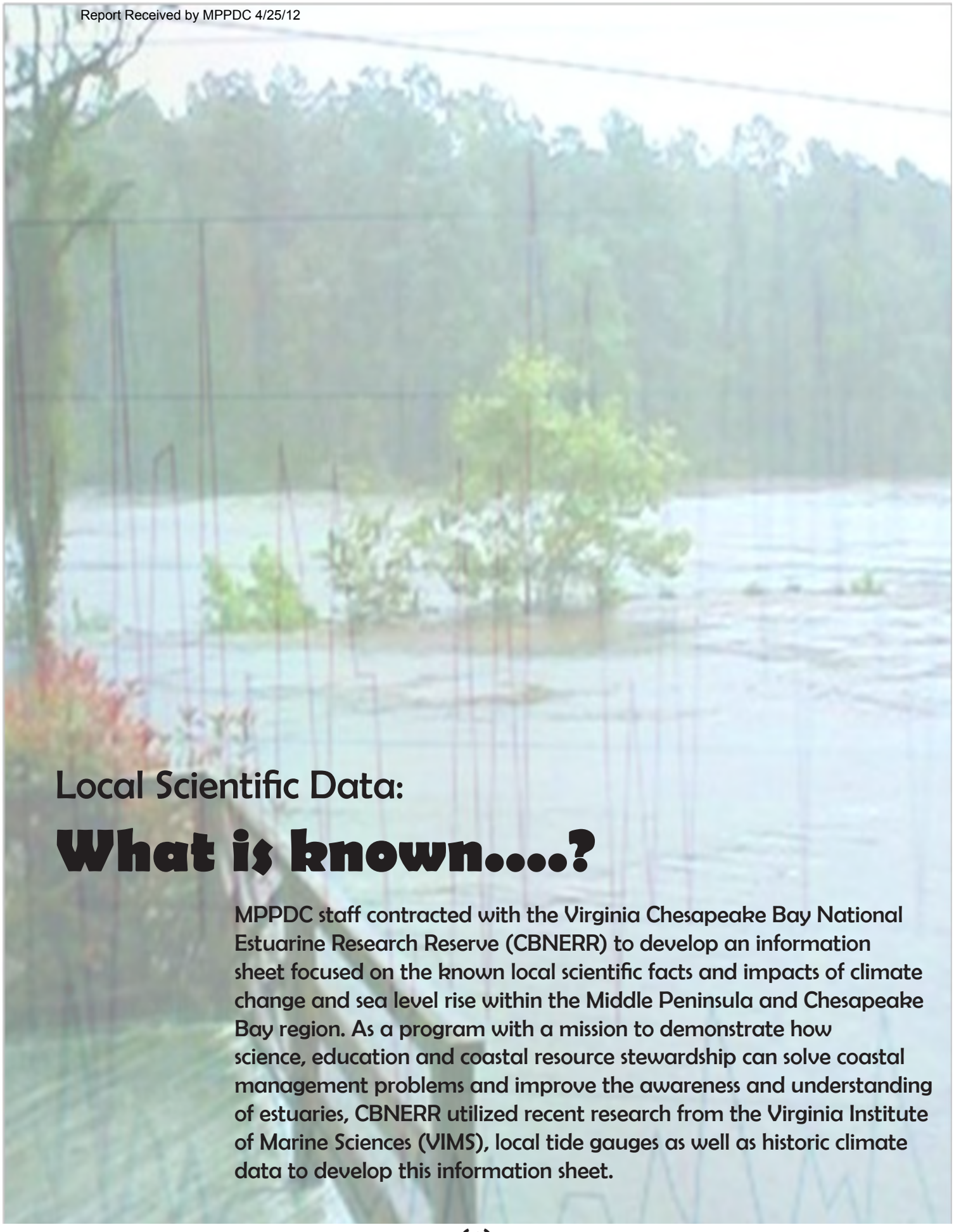


Figure 3: MPPDC staff also assessed the ecologic impacts of sea levle rise. This is an example from Mathews County.



Local Scientific Data:

What is known....?

MPPDC staff contracted with the Virginia Chesapeake Bay National Estuarine Research Reserve (CBNERR) to develop an information sheet focused on the known local scientific facts and impacts of climate change and sea level rise within the Middle Peninsula and Chesapeake Bay region. As a program with a mission to demonstrate how science, education and coastal resource stewardship can solve coastal management problems and improve the awareness and understanding of estuaries, CBNERR utilized recent research from the Virginia Institute of Marine Sciences (VIMS), local tide gauges as well as historic climate data to develop this information sheet.

Sea Level Rise:
Local Fact Sheet for the Middle Peninsula, Virginia

Statement of the Problem

A look at the geologic record of Chesapeake Bay shows a long and dynamic history - from the bolide (asteroid or comet) impact about 35 million years ago which formed the Chesapeake Bay impact crater, to the melting of glaciers beginning about 18,000 years ago, resulting in a continued rise of sea level and drowning of the Susquehanna River valley. Given that the rise in sea level has been occurring for thousands of years and is fundamental to the present formation of the Chesapeake Bay and our local tidal waters, why is there a recent heightened level of concern regarding this phenomenon? Concern is justified given that current and projected rates of sea level rise represent a significant increase over what we experienced during the last century. There is general consensus that rise in sea level will continue for centuries to come, and that human and natural communities within the Middle Peninsula will be vulnerable. Understanding the challenge is vital for local government to develop strategies to reduce the regions vulnerability to sea level rise.

Causes and Current Rates of Local Sea Level Rise

Processes responsible for rising sea levels are complex. To help simplify the matter, it is useful to make a distinction between the concepts of eustatic and relative sea level (RSL) change. Eustatic change, which can vary over large spatial scales, describes sea level changes at the oceanic to global scale that result from changes in the volume of seawater or the ocean basins themselves. The two major processes responsible for eustatic change are the thermal expansion of seawater due to warming and the melting and discharge of continental ice (i.e., glaciers and ice sheets) into the oceans. The global average for current (2003-mid 2011) eustatic sea level change is 0.11 in/yr (2.8 mm/yr) (NOAA Laboratory for Satellite Altimetry) with estimates for the Chesapeake Bay region on the order of 0.07 in/yr (1.8 mm/yr; Boon et al. 2010) for the approximate same time period.

RSL change describes the observed change in water level at a particular location and represents the sum of eustatic sea level change and local vertical land movement (subsidence or uplift) at that location. Within the Chesapeake Bay region, land subsidence represents a significant component of RSL change. Processes contributing to land subsidence include tectonic (movement of the earth's crust) and man-induced impacts (e.g., groundwater withdrawal, hydrocarbon removal). During the last glacial period (maximum extent approximately 20,000 yr BP), the southern East Coast limit of the Laurentide ice sheet coincided with northern portions of Pennsylvania (Mickelson and Colgan 2003). As a consequence, land subsided under the ice load and, in turn, created a fore-bulge or upward displacement of lands south of the ice load. Upon retreat of the glacier, the land continued to redistribute, rebounding in previously glaciated areas and subsiding in the more southern forebulge region. Land subsidence rates on the order of 0.05-0.06 in/yr (1.2-1.4 mm/yr) are attributed to the postglacial forebulge collapse within the Bay region (Douglas 1991). It can take many thousands of years for impacted regions to reach isostatic equilibrium.

At a more local level, overdrafting of groundwater is a significant factor driving land subsidence rates. Within the Eastern Virginia Groundwater Management Area, large industrial and domestic use groundwater withdrawals from the Potomac aquifer series occur in the areas of Franklin, Suffolk and West Point, VA. Elevated subsidence rates, which integrate both regional and local causes, were first observed near the centers of large groundwater withdrawals through repetitive high-precision relevelings and analysis of tide records, and later through studies that directly measured aquifer system compaction. Land subsidence rates within the Middle Peninsula, based on releveling analysis, vary between 0.09-0.15 in/yr (2.4-3.8 mm/

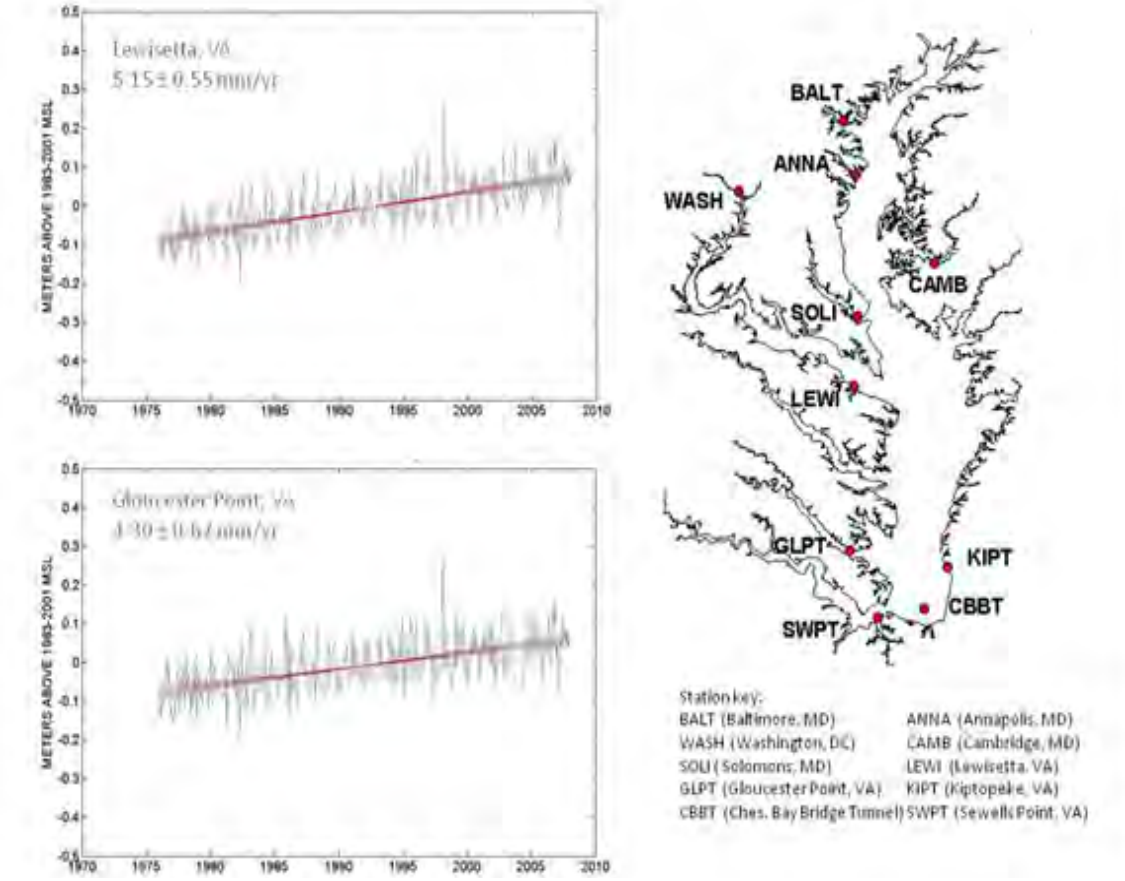


Figure 4. RSL trends and 95% confidence intervals for Lewisetta, VA and Gloucester Point, VA (after removal of seasonal cycle and decadal signal) for the 1976-2007 period and location map for Chesapeake Bay National Water Level Observation Network stations (Boon et al. 2010; reprinted with permission).

yr) with maximum values being observed at West Point (Holdahl and Morrison 1974; Davis 1987). Pope and Burbey (2004) reported average aquifer system compaction rates of 0.06 in/yr (1.5 mm/yr; 1979-1995) and 0.15 in/yr (3.7 mm/yr; 1982-1995) near the Franklin and Suffolk pumping centers, respectively, and that compaction appeared to correlate with groundwater withdrawal; West Point was not included as part of this study. It has been suggested that the Chesapeake Bay impact structure, whose outer rim traverses the lower Middle Peninsula (Powars and Bruce 1999) may contribute to local land subsidence. While observations suggest post impact subsidence at a geologic scale (Johnson et al. 1998), present day influence is currently unknown.

RSL rise rates at the local level are derived from accurate time series of water level measurements spanning several decades or more. A recent analysis of tide gauge data by the Virginia Institute of Marine Science reported RSL rise rates ranging from 0.11-0.23 in/yr (2.9-5.8 mm/yr; period: 1976-2007; 10 stations) within the Chesapeake Bay region, with a number of the values representing the highest rates reported along the U.S. Atlantic coast (Boon et al. 2010). With respect to the Middle Peninsula, the two nearest stations located at Gloucester Point and Lewisetta, VA indicate current RSL rise rates of 0.17 (4.30 mm/yr) and 0.20 in/yr (5.15 mm/yr), respectively (see Figure 4). Although there are no additional adequate tidal records available for the Middle Peninsula's bordering rivers (i.e., York and Rappahannock Rivers), one would expect RSL rise rates to increase as one approached areas of elevated land subsidence such as West Point, VA. Based on land subsidence and eustatic sea level information, the RSL rise rate would be expected to be on the order of 0.22 in/yr (5.6 mm/yr) at or near West Point, VA. Extrapolating current Gloucester Point and Lewisetta rates, RSL would increase by another 0.7-0.8 ft (21-25 cm) by 2050 and 1.4-1.7 ft (43-51 cm) by 2100; this represents a conservative and low-end estimate. There is growing concern that RSL rise rates will accelerate in the future with projections of sea level increases in the Bay region of approximately 2.3-5.3 ft (70-160 cm) by 2100 (Pyke et al. 2008).

Why You Should Care: Examples of Impending Risks

Sea level rise, along with direct influences on inundation of low-lying lands, coastal erosion and flooding from storms, and saltwater intrusion into coastal freshwater/low salinity water bodies and groundwater aquifers represent significant threats to the people, public and private property, and natural resources of the Middle Peninsula.

• Increased Inundation and Land Conversion. The Middle Peninsula is rich in gently sloping, low elevation uplands and wetlands immediately adjacent to or in close proximity to tidal waters. Lands exhibiting these characteristics are at risk to increased frequency of high-tide flooding and gradual inundation from rising sea levels. Within the Middle Peninsula, vulnerable lands include but are not limited to New Point Comfort, Bohannon, Retz, Onemo, Diggs, Roane, Heart Quake Trail area, Deltaville, Locklies, West Point, Romancoke, Winona Park Road, Pamunkey Tribe Reservation, Ware Neck, Nexara, Guinea, Purtan Bay, Catlett Islands, Tappahannock, Gynnfield Subdivision, Lower Essex, Kendall Road, and Layton Peninsula (MPPDC, 2010).

In developed areas, the combined effect of rising sea level and water tables can have profound consequences on underground (e.g., onsite wastewater disposal systems, fuel storage tanks) and ground-level (e.g., building structures, roads, drainage ditches) infrastructure. In contrast to developed areas where some protection measures may be feasible, vast expanses of natural and agricultural areas will remain exposed to the consequences of a rising sea level. Tidal wetlands within the Middle Peninsula region are already responding to sea level rise and associated salt intrusion. Observed responses include elevated erosion rates, inundation of fringing marshes and marsh interiors, transgression of marshes into adjacent coastal forests, and conversion of freshwater to brackish water vegetation communities.

• Increased Storm Damage. Elevated sea levels will intensify storm impacts due to increases in damaging wave energy and risks of severe flooding further inland. Comparisons between two locally relevant storms whose storm surges peaked near high tide illustrate the impact of sea level rise on coastal flooding. The more powerful 1933 hurricane produced a storm surge 1.0 ft (0.3 m) greater than Hurricane Isabel in 2003, yet the high water mark or storm tide elevation (sum of storm surge and astronomical tide), was comparable to Hurricane Isabel's 7.9 ft (2.4 m) above mean lower low water. A rise in sea level over the 70 year period between storms, on the order of 1.0 ft (30 cm), is attributed to allowing the weaker storm to produce an equivalent storm tide (Boon 2005). In light of rising sea levels, significant property and infrastructure damage from erosion, wave action and flooding is likely to occur from severe storm events such as hurricanes and nor'easters, as well as less powerful storm systems.

• Increased Saltwater Intrusion. Rising sea levels and associated saltwater intrusion can raise the salt content of Chesapeake Bay proper, its tidal tributaries and groundwater aquifers. Under various sea level rise scenarios ranging from 0.5-5.5 ft (18-167 cm), Hilton et al. (2008) estimated Chesapeake Bay salinity changes of 0.4-12 by 2100. If such large-scale changes in Bay salinity are realized, both coastal natural resources and society would suffer. Saltwater intrusion is problematic for surface and groundwater domestic, irrigation and industrial water sources. In the Middle Peninsula, where nearly all water for domestic and business use is groundwater sourced, wells have already been contaminated by saltwater to the point of being unusable or requiring expensive reverse osmosis treatment (MPPDC 2010). In addition to saltwater intrusion into freshwater aquifer systems, inundation and storm induced flooding of wellheads and shallow wells can contaminate and jeopardize the dependability of wells and groundwater sources.

Marsh regression into an adjacent low-lying pine forest on the York River. Photo credit: W. Reay.

Storm damage incurred on the York River during Hurricane Isabel, 2003. Photo credit: J. Rickards.

Coastal flooding at Gloucester Point during Hurricane Isabel, 2003. Photo credit: VIMS.

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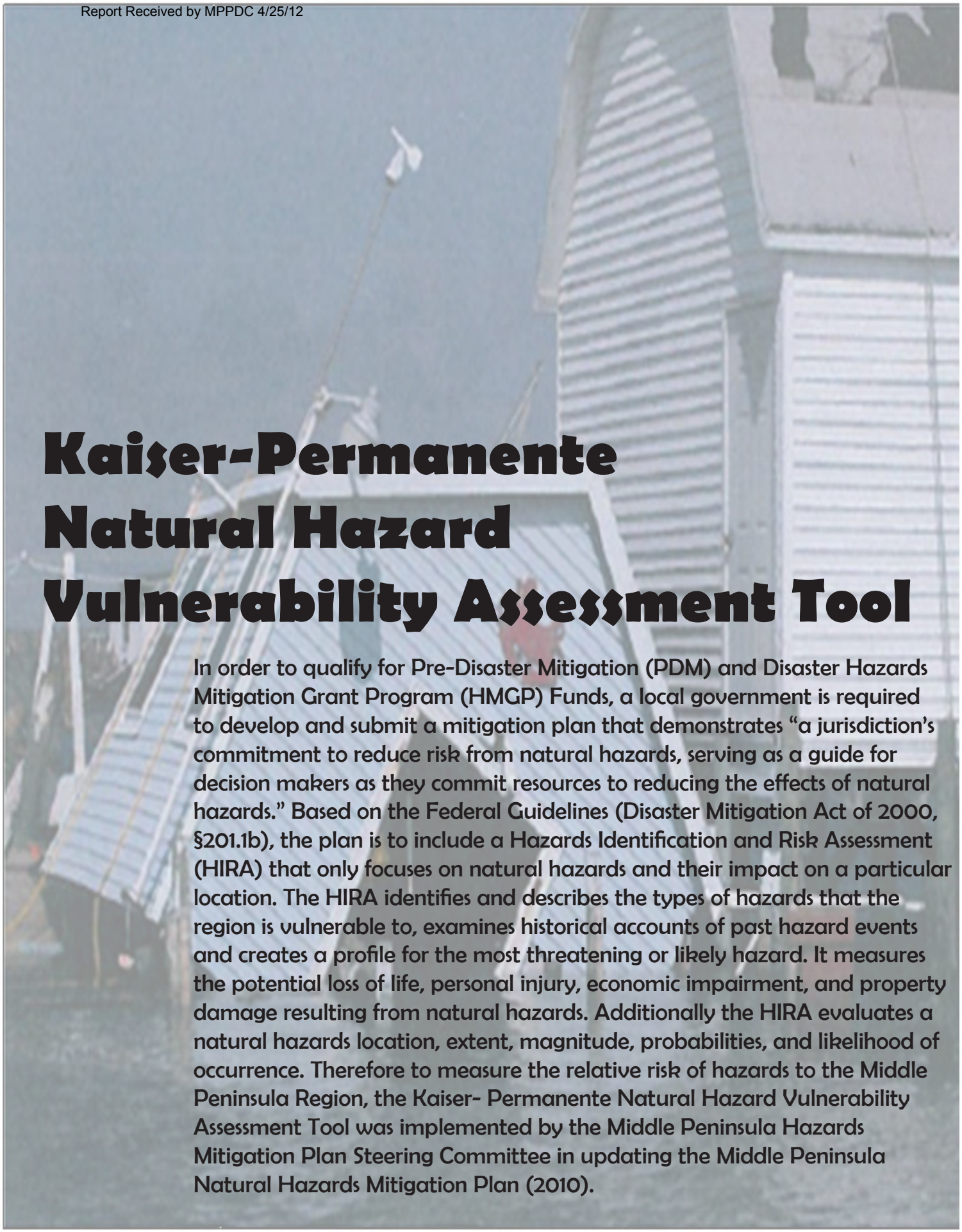


Kaiser-Permanente Natural Hazard Vulnerability Assessment Tool

In order to qualify for Pre-Disaster Mitigation (PDM) and Disaster Hazards Mitigation Grant Program (HMGP) Funds, a local government is required to develop and submit a mitigation plan that demonstrates "a jurisdiction's commitment to reduce risk from natural hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards." Based on the Federal Guidelines (Disaster Mitigation Act of 2000, §201.1b), the plan is to include a Hazards Identification and Risk Assessment (HIRA) that only focuses on natural hazards and their impact on a particular location. The HIRA identifies and describes the types of hazards that the region is vulnerable to, examines historical accounts of past hazard events and creates a profile for the most threatening or likely hazard. It measures the potential loss of life, personal injury, economic impairment, and property damage resulting from natural hazards. Additionally the HIRA evaluates a natural hazards location, extent, magnitude, probabilities, and likelihood of occurrence. Therefore to measure the relative risk of hazards to the Middle Peninsula Region, the Kaiser- Permanente Natural Hazard Vulnerability Assessment Tool was implemented by the Middle Peninsula Hazards Mitigation Plan Steering Committee in updating the Middle Peninsula Natural Hazards Mitigation Plan (2010).

To meet the Federal requirements to qualify for Pre-Disaster Mitigation (PDM) and Disaster Hazards Mitigation Grant Program (HMGP) Funds, Middle Peninsula Planning District Commission (MPPDC) worked with Middle Peninsula localities (ie. Gloucester, Mathews, Middlesex, King William, King &Queen, and Essex County and the Towns of West Point, Urbanna, and Tappahannock) in the development a Hazards Mitigation Plan (HMP). In 2006 the first Regional Hazards Mitigation Plan was created and adopted, however to comply with the federal requirement to review and update the plan within five years of its original adoption, member localities collaborated in 2010 to make the necessary and appropriate updates.

Excerpt 1: 2010 Middle Peninsula Hazard Mitigation Plan Excerpt- Sea Level Rise (pg 54)

4.3.6. Sea Level Rise

Climate change is an on-going process that is measured over an extended period of time. According to the Intergovernmental Panel on climate change, temperature in Virginia are estimated to increase by 3° F in the winter, spring an summer and increase by 4° F in the fall. Precipitation is estimated to increase by 20% in all seasons by 2100.

The National Wildlife Federation predicts that within the Upper Tidewater Region- where the Middle Peninsula is located – sea level will rise 11.2" by 2050 and 27.2" by 2100.

Temperature, precipitation and wind are considered 3 direct factors attributed to climate change and they can create a number of associated impacts including the following:

- The frequency and intensity of flooding events may increase.
- Coastal ecosystems may experience increased coastal erosion and risk of pollution due to inundated infrastructure – a result of sea level rise as well as storm events.
- Increased rates of saltwater intrusion into freshwater resources may also occur.
- Loss of near shore habitats and coastal wetlands as sea level rises.
- Access to the roadway network may become limited as the frequency of flooded roads increase due to sea level rise and intense storms. This will increase the maintenance costs for impacted /damaged roads.
- Infrastructure may be impacted if located within floodplains or low lying coastal areas – causing insurance premiums to increase.
- Emergency response units may have to redefine service areas as roads become flooded due to sea level rise and /or storm events.

These anticipated impacts will have greater impacts for the more southern low-lying areas of the Middle Peninsula region and educational/informational mitigation strategies merit consideration with this update.

The purpose of hazard mitigation planning is for state, local, and Indian tribal governments to identify the natural hazards that impact them, to identify actions and activities to reduce any losses from those hazards, and to establish a coordinated process to implement the plan, while taking advantage of a wide range of federal resources (Section 201.1(b) of FEMA's Interim Final Rule). In accordance with FEMA guidance, a risk assessment must be incorporated in the HMP which includes a description of all natural hazards. However since the Middle Peninsula is a large geographic area with varying topography and population densities, vulnerabilities and risks will not be uniform among jurisdictions within the region. Therefore to assist localities in assessing and ranking hazards and vulnerabilities, the Middle Peninsula HMP Steering Committee, decided to use the Kaiser-Permanente Natural Hazard Vulnerability Assessment Tool. While this tool provides a measure of continuity and consistency between the 2006 HMP and the 2010 HMP update, this tool ultimately establishes a probability of a hazard occurring within the region. Given a low, medium, or high value of occurrence, each hazard is evaluated based on its magnitude (ie. a hazard's impact on people, property, and businesses and mitigation (ie. preparedness, internal response and external response to the hazard).

As the Committee reviewed the 2006 plan, there was extensive dialog and local discussions concerning this list of hazards. Such discussions resulted in the addition of sea level rise as a new natural hazard threat due to the "emerging evidence of it becoming a world-wide phenomena" (See Box 1.1). Therefore the list of hazards approved by the HMP Committee for the 2010 HMP consisted of the following:

- Hurricans
- Tornadoes
- Coastal Flooding/ Nor'easters
- Sea Level Rise
- Land Subsidence/ Karst
- Dam Failure
- Lightning
- Shrink-swell Soils
- Extreme Heat
- Landslices
- Volcanoes
- Ice Storms
- Snow Storms
- Coastal/Shoreline Erosion
- Riverine Flooding
- High Winds/ Windstorms
- Droughts
- Earthquakes
- Extreme Cold
- Wildfires
- Tsunamies

Table 2: Prioritization Criteria for Hazards on the Middle Peninsula (HMP, 2010).

Probability- Frequency of occurrence based on historical data of all potential hazards	
	Level 1 Unlikely (less than 1% occurrence: no events in the last 100 years) 2 Likely (between 1% and 10% occurrence: 1-10 events in last 100 years) 3 Highly Likely (over 10% occurrence: 11 events or more in last 100 years)
Affected Structures - Number of Structures affected	
	Level 0 None 1 Small (limited to 1 building) 2 Medium (limited to 2-10 buildings) 3 Large (over 10 buildings)
Primary Impacts - Based on percentage of damage to a typical structure or industry in the community	
	Level 0 None 1 Negligible (less than 3% damage) 2 Limited (between 3% and 49% damage) 3 Critical (more than 49% damage)
Secondary Impacts - Based on impacts to the community at large Level	
	Level 0 None 1 Negligible (no loss of function, no displacement time, no evacuations) 2 Limited (some loss of function, displacement time, some evacuations) 3 Critical (major loss of loss of function, displacement time, major evacuations)
Mitigation Options - Number of cost effective mitigation options	
	Level 0 None 1 Many (over 3 cost effective mitigation options) 2 Several (2-3 cost effective mitigation options) 3 Few (1 cost effective mitigation option)

In 2006, following the identification of hazards, the HMP Steering Committee established five criteria to rank the hazards from highest to lowest priorities. The five criteria were based on past events, the potential impacts to structures, primary impacts (ie. the percentage of damage to a typical structure or industry in the community), secondary impacts (based on impacts to the community at large), and potential mitigation options. The definitions given in Table 2 were used as the standard for evaluating the hazards.

In 2010, however, Virginia Department of Emergency Management (VDEM) staff provided the HMP Committee with a new and improved version of the Kaiser-Permanente Assessment Tool. The Emergency Services Coordinator/Manger from each Middle Peninsula jurisdiction was asked to complete the vulnerability worksheet for their locality and return it to the MPPDC Regional Emergency Preparedness Planner. The Regional Planner then used the tool to merge the data to create a regional ranking of natural hazards affecting the Middle Peninsula area. These results are shown in Table 3. (It is important to note that the vulnerability of moderately-critical and non-critical hazards were not updated due to the low probability and impact. These was agreed upon by the committee.)

Table 3: This is the evidence of the 2010 Kaiser-Permanente Assessment Tool that assessed the regional vulnerability to certain hazards.

EVENT						UNMITIGATED	
	PROBABILITY	HUMAN IMPACT	PROPERTY AND FACILITY IMPACT	BUSINESS IMPACT	MITIGATION OPTIONS	RISK	RANKING
	Likelihood this will occur	Possibility of death or injury to public and responders	Physical losses and damages	COOP[1] and Interruption of services	Pre-Planning	Relative Threat	Based only on Probability and threat
SCORE	0=N/A 1=Low 2=Moderate 3=High	0=N/A 1=Low 2=Moderate 3=High	0=N/A 1=Low 2=Moderate 3=High	0=N/A 1=Low 2=Moderate 3=High	0=N/A 1=Low 2=Moderate 3=High	0-100%	
Hurricanes	3	3	3	3	2	92%	
Winter Storms (ice)	2	2	2	3	2	50%	
Tornadoes	2	2	2	2	2	44%	
Coastal Flooding	3	2	3	2	2	75%	
Coastal/Shoreline Erosion	3	1	2	1	2	50%	
Sea Level Rise	3	0	2	2	2	50%	
Winter Storms (snow)	2	2	2	2	2	44%	
Wildfire	2	1	1	1	2	28%	
Riverine Flooding	2	2	1	1	2	33%	
High Wind/ Windstorm	2	2	2	1	1	33%	
Dam Failure	2	1	1	1	2	28%	
Drought	2	0	1	2	2	28%	
Lightning	3	1	2	2	1	50%	
Earthquake	1	0	0	0	0	0%	
Shrink-Swell Soils	2	0	1	1	0	11%	
Extreme Cold	1	2	0	0	1	8%	
Extreme Heat	2	2	0	0	1	17%	
Landslides	1	0	0	0	0	0%	
Land Subsidence/ Karst	1	0	0	0	0	0%	
Tsunami	1	0	0	0	0	0%	
Volcano	0	0	0	0	0	0%	
AVERAGE	**2.27**	**1.27**	**1.67**	**1.53**	**1.67**	**25%**	

*Threat increase with percentage
1. Continuity of Operation Plan

UNMITIGATD RISK=	PROBABILITY * IMPACT	
0.25	0.63	0.39

As the outcome of the Kaiser Permanent Assessment, regional hazards were categorized as the following;

a. **"Non-Critical"** – hazards that have occurred very infrequently, or have not occurred at all – based on the available historical records. These hazards are not considered a widespread threat that result in significant losses of property and life in the Middle Peninsula These Non- Critical hazards included:

1. lightning,
2. earthquakes,
3. shrink-swell soils,
4. extreme cold and extreme heat;
5. land subsidence /karst,
6. landslides,
7. tsunami, and
8. volcanoes.

b.**"Moderately-Critical"** - hazards that have historically occurred in the Middle Peninsula. Yet ranked lower than the Critical Hazards in terms of risk during the hazard prioritization exercise. These Moderately – Critical hazards included:

1. snow storms,
2. riverine flooding,
3. wildfire,
4. high wind/windstorms (excluding tornadoes and hurricanes),
5. dam failure,
6. sea level rise, and
7. drought.

c. **"Critical"** - hazards that have the highest relative risk. These Critical hazards included:

1. flooding,
2. hurricanes,
3. coastal flooding,
4. tornadoes,
5. winter ice storms, and
6. soil erosion.

With the critical hazards identified, the 2010 HMP provides a broad and in-depth analysis of such hazards within region. For the purposes of this report the top three critical hazards from the HMP will be summarized, however for more information please refer to the final report of the 2010 Middle Peninsula Natural Hazards Mitigation Plan.

Flooding

Causes of flooding within the Middle Peninsula include the following: (1) Hurricanes, (2) Nor'easters and severe coastal storms, (3) Thunderstorms, and (4) Water releases/overflows from dam impoundments. Therefore resources at potential risk of loss include residential structures, businesses, roads/bridges, essential public community facilities, and electric transmission/service lines.

Hurricanes

Hurricanes that impact Virginia form in the so-called Atlantic Basin - from the west coast of Africa towards the Caribbean Sea and Gulf of Mexico. Hurricanes in this basin generally form between June 1 and November 30 – with a peak around mid-September. In an average season, there are about 10 named tropical storms in the Atlantic Basin with 6 of these likely to develop into hurricanes. The busiest hurricane season in the 20th century was in 1933, which saw 21 hurricanes/ tropical storms. Two of these storms hit the Tidewater Region and caused significant devastation in the Middle Peninsula - known as the "Chesapeake-Potomac Hurricanes of 1933". By contrast, the 1914 season saw no hurricanes and only one tropical storm.

As a hurricane develops, NOAA (National Oceanic and Atmospheric Administration) Hurricane Center in Miami, Florida will to monitor and track the storm's progress. Weather systems with winds at or exceeding 39 mph is designated as a tropical storm, while storms with winds at or exceeding 74 mph is deemed to be a hurricane. NOAA will use then use the Saffir-Simpson Scale to clarify and measure the intensity of each storm, ranging from a Category 1 (minimal) to a Category 5 (catastrophic) hurricane (Table 4). The scale categorizes the intensity of hurricanes using a linear method based upon maximum sustained winds, minimum barometric pressure and storm surge potential, which are combined to estimate the potential flooding and damage to property given a hurricane's estimated intensity. *See the Table 4 for more details on the characteristics of Category 1 through Category 5 hurricanes.*

Hurricanes have the greatest potential to inflict damage as they cross the coastline from the ocean, which is called landfall. Because hurricanes derive their strength from warm ocean waters, they are generally subject to deterioration once they make landfall. The

forward momentum of a hurricane can vary from just a few miles per hour to 40 mph. This forward motion, combined with a counterclockwise surface air flow, makes the right front quadrant of a hurricane the location of the most potentially damaging winds. Hurricanes have the potential to spawn dangerous tornadoes. The excessive rainfall and strong winds can also cause flash floods, flooding and abnormal rises in sea levels known as storm surges. Although a hurricane may cause a tremendous amount of wind and water damage, the accompanying storm surge is much more dangerous to life and property in coastal regions.

Table 4: Descriptions of the Saffir-Simpson Hurricane Scale - Category One through Five - and associated damages.

Category One Hurricane (Sustained winds 74-95 mph, 64-82 kt, or 119-153 km/hr) *Very dangerous winds will produce some damage*	
	Examples of Risks: People, livestock, and pets struck by flying or falling debris could be injured or killed; Older (mainly pre-1994 construction) mobile homes could be destroyed, while newer mobile homes that are anchored properly can sustain damage (ie. Removal of shingle or metal roof covering, vinyl siding, etc.); Some poorly constructed homes can experience major damage (ie. roof covering, porch coverings and awnings); Unprotected windows may break if struck by flying debris; Masonry chimneys can be toppled. Well-constructed homes could have damage to roof shingles, vinyl siding, soffit panels, and gutters; Extensive damage to power lines and poles will likely result in power outages that could last a few to several days
Category Two Hurricane (Sustained winds 96-110 mph, 83-95 kt, or 154-177 km/hr). *Extremely dangerous winds will cause extensive damage*	
	Examples of Risks: Substantial risk of injury or death to people, livestock, and pets due to flying and falling debris; Older (mainly pre-1994 construction) mobile homes have a very high chance of being destroyed and flying debris can shred nearby mobile homes, while newer mobile homes can also be destroyed; Poorly constructed homes have a high chance of having their roof structures removed; Unprotected windows will have a high probability of being broken by flying debris; Well-constructed homes could sustain major roof and siding damage; Many shallowly rooted trees will be snapped or uprooted and block numerous roads; Near-total power loss is expected with outages that could last from several days to weeks; Potable water could become scarce as filtration systems begin to fail.
Category Three Hurricane (Sustained winds 111-130 mph, 96-113 kt, or 178-209 km/hr). *Devastating damage will occur*	
	Examples of Risks: High risk of injury or death to people, livestock, and pets due to flying and falling debris; Nearly all older (pre-1994) mobile homes will be destroyed; Most newer mobile homes will sustain severe damage with potential for complete roof failure and wall collapse; Poorly constructed homes can be destroyed by the removal of the roof and exterior walls; Unprotected windows will be broken by flying debris; Well-built homes can experience major damage involving the removal of roof decking and gable ends; There will be a high percentage of roof covering and siding damage to apartment buildings and industrial buildings; Many trees will be snapped or uprooted, blocking numerous roads; Electricity and water will be unavailable for several days to a few weeks after the storm passes.
Category Four Hurricane (Sustained winds 131-155 mph, 114-135 kt, or 210-249 km/hr). *Catastrophic damage will occur*	
	Examples of Risks: Very high risk of injury or death to people, livestock, and pets due to flying and falling debris; Nearly all older (pre-1994) mobile homes will be destroyed; A high percentage of newer mobile homes also will be destroyed. Poorly constructed homes can sustain complete collapse of all walls as well as the loss of the roof structure; Well-built homes also can sustain severe damage with loss of most of the roof structure and/or some exterior walls; Extensive damage to roof coverings, windows, and doors will occur; Large amounts of wind borne debris will be lofted into the air; Fallen trees and power poles will isolate residential areas; Power outages will last for weeks to possibly months. Long-term water shortages will increase human suffering.
Category Five Hurricane (Sustained winds greater than 155 mph, greater than 135 kt, or greater than 249 km/hr) *Catastrophic damage will occur*	
	Examples of Risks: People, livestock, and pets are at very high risk of injury or death from flying or falling debris, even if indoors in mobile homes or framed homes; Almost complete destruction of all mobile homes will occur, regardless of age or construction; high percentage of homes will be destroyed, with total roof failure and wall collapse; Extensive damage to roof covers, windows, and doors will occur; Nearly all commercial signage, fences, and canopies will be destroyed; Nearly all trees will be snapped or uprooted and power poles downed; Fallen trees and power poles will isolate residential areas; Power outages will last for weeks to possibly months.

The storm surge is a great dome of water typically 50 miles wide that comes sweeping across the coastline near the area where the eye of the hurricane makes landfall. This storm surge, aided by the hammering effect of breaking waves, acts like a giant bulldozer as it sweeps everything in its path. The stronger the hurricane, the higher and more dangerous the storm surge will be. Nine out of ten hurricane fatalities are caused by the storm surge.

Coastal high water is generally attributed to three causes: Astronomical high tides, high water from atmospheric events (such as surface run off from rain), and storm surge (from hurricanes and nor'easters). Astronomical high tides alone do not cause dangerous coastal erosion, but when these tides occur in tandem with a storm surge or onshore winds, coastal flooding and soil erosion is intensified.

In conjunction with a thorough description of hurricanes, the HMP also reviews the history of hurricane action that has occurred within the region. Such an account establishes benchmarks that assists localities in preparing and anticipating future hurricane impact within the region.

As hurricane Isabel in 2003 was one of Virginia's costliest disasters, it caused widespread devastation and disruption to the lives of thousands of citizens – including those living in the Middle Peninsula. This deadly storm was a Category 2 hurricane when it made landfall between Cape Lookout and Cape Hatteras on North Carolina's Outer Banks. By the time it reached Virginia, it was downgraded to a Category 1 hurricane. Even though the storm followed a path west of the City of Richmond, Isabel's destructive effects were felt throughout Tidewater Virginia and the entire Mid-Atlantic Region.

Statewide losses to residential property were estimated to exceed $590 million and businesses reported over $84 million in losses. Thirty-two deaths were directly or indirectly attributed to this storm in Virginia. One of these deaths was in Gloucester County when an individual died of a heart attack after their vehicle was swept up in high water. Hurricane Isabel is considered one of the most significant tropical cyclones to affect portions of northeastern North Carolina and east-central Virginia since Hurricane Hazel in 1954 and the Chesapeake-Potomac Hurricane of 1933 (Beven and Cobb, 2004).

Although the decades since the 1960s have seen fewer hurricanes, numbers have risen since 1995 and may not have reached the predicted peak yet. While experts cannot say that climate change will result in more hurricanes in the future, there is growing evidence and concern that tropical storms that do occur will be more intense than those in the past as the effects of global warming become even more pronounced in future years.

Historical Occurrences

In evaluating localized threats of hurricanes and tropical storms to the Middle Peninsula Region, the HMP analyzes NOAA hurricane tracking data from 1851 to 2008 to identify storms that posed a threat to the region (Table 5). According to this data, 42 storms - including 2 hurricanes, 22 tropical storms, 8 tropical depressions and 10 extra tropical storms - passed within 25 nautical miles of the Middle Peninsula Region. Over the same period of time 60 storms – including 4 hurricanes, 31 tropical storms, 11 tropical and subtropical depression, and 14 extra tropical storms – passed within 50 nautical miles of the region.

General Chronology of Middle Peninsula Coastal Storm Hazard Events

Because of its proximity to the Atlantic Coast and Chesapeake Bay, the Middle Peninsula has been impacted by coastal storms throughout recorded history, and therefore it is no surprise that hurricanes, coastal flooding, nor'easters, and coastal/shoreline erosion were among the top ranked hazards affecting the Middle Peninsula Region as ranked by the Regional Risk Assessment and Mitigation Planning Committee in 2005 and re-affirmed by the Middle Peninsula Flood Mitigation Plan Team Members in 2009.

Historical records are invaluable to researchers trying to understand long-term patterns in the frequency and intensity of coastal storms and such data on storms and weather go back a long time in Virginia, thanks to record keeping by early weather observers such as George Washington, James Madison and Thomas Jefferson as well as journals/articles written by early settlers. The following is a brief synopsis of the major coastal storm events that have impacted the Middle Peninsula Region.

From 1564 to 1799

Hurricanes played an important role during the European exploration and colonization of the Americas. Great storms that besieged Virginia influenced the establishment of new settlements and changed the coastal geography, particularly on the Middle Peninsula. While official weather records did not begin until 1871 in Norfolk, tremendous coastal storms were often recorded through the shipwrecks they induced and in the writings of the early Virginia colonists.

Table 5: Historic Storm Tracts within 50 and 25 nautical miles (nm) radii of the Middle Peninsula between 1851 and 2008.

Type of Storm	Quanity passing within 50 nm	Quantity passing within 25nm
Hurricane – Category 5 (winds >155 mph)	0	0
Hurricane – Category 4 (winds 131-155 mph)	0	0
Hurricane – Category 3 (winds 111-130 mph)	0	0
Hurricane – Category 2 (winds 96-110 mph)	1	1
Hurricane – Category 1 (winds 74-95 mph)	3	1
Tropical Storm (winds 39-73 mph)	31	22
Tropical Depression (winds <38 mph)	10	8
Subtropical Storm (winds 39-73 mph)	0	0
Subtropical Depression (winds <38 mph)	1	0
Extra-tropical Storm (winds <39 mph)	14	10
Total:	**60**	**42**

The records of hurricane and tropical storm occurrences during this era are sparse compared to modern-day accounts, since the colonies were not settled until the early 1600's. The original settlers at Jamestown experienced the wrath of such storms firsthand and it is suggested that the lost colony of Roanoke Island may have been doomed by a coastal storm. The first such storm to be recorded occurred in 1564. Others followed in June 1566, June 1586, August 1587, and August 1591. A September 1667 storm, deemed the "Dreadful Hurry Cane of 1667", destroyed thousands of homes in Virginia (Brinkley 1999). Twelve days of rain was said to have followed this storm, causing the Chesapeake Bay to rise 12 feet. This storm and a July 1788 hurricane may have followed a similar track as the 1933 hurricane, which caused massive devastation to the Middle Peninsula.

The October Hurricane of 1749 was a great disaster for Virginians. It formed Willoughby Spit in Norfolk and put the city streets of Hampton 4 feet below water. The Bay was said to have risen 15 feet above normal, destroying waterfront buildings (Ludlum 1963). At least 50 vessels were driven ashore along the Virginia coast, with a loss of 22 lives. Damage in and around the city of Norfolk was estimated to be at least 30,000 Virginia Pounds (approximately $3 million in today's currency - Brinkley 1999).

The September 8, 1769 hurricane, considered one of the worst storms of the eighteenth century, passed over Williamsburg. Damage was "inconceivable" and crops were destroyed. Many old homes and trees were leveled. Heavy rain ruined tobacco crops and flooded roads. Tobacco in storage warehouses was also damaged. Heavy damage was seen in Chesapeake Bay. High winds tore off the top of a wharf at Yorktown and a schooner rammed a nearby storehouse. Four ships in the York River were driven ashore. Two ships on the James River were also wrecked. A vessel from Norfolk, filled with coal from Williamsburg, was forced up to Jamestown before it went to pieces (Roth and Cobb 2001).

"The Independence Hurricane" of September 1775 ravaged the coast between Currituck, N.C. and Chincoteague on the Eastern Shore. Wharves and storehouses on the waterfront of Norfolk were devastated. Raging waters carried bridges away. At Williamsburg, mill-dams broke and corn stalks were blown flat. . A full blockade of Hampton Roads thereafter brought shipping to a halt for three months. At least 25 died due to a shipwreck. On September 9, 1775, a Williamsburg correspondent of the Virginia Gazette wrote, "The shocking accounts of damage done by the rains last week are numerous; most of the mill-dams are broke, the corn laid almost level with the ground, and fodder destroyed; many ships and

other vessels driven ashore and damaged at Norfolk, Hampton, and York. The death toll in Virginia and North Carolina was 163 lives (Roth and Cobb 2001).

A strong gale played a role in a battle between the Royal Governor of Virginia, Dunmore, and General Lewis of the rebel forces on July 10, 1776. The royal fleet had been injured prior to the storm by General Lewis' forces and was sailing from Gwynn's Island (Mathews County) toward St. George's Island, in the Potomac. The British crew was without water and enduring smallpox when the gale struck. A flour-laden supply ship ran aground. One ship foundered at the Mouth of the Rappahannock, while another was stranded on the Eastern shore (Roth and Cobb 2001).

On October 16, 1781, a storm of "unknown character" struck Virginia. The French Fleet and the Patriot Army, under the command of George Washington, trapped the Earl of Cornwallis at Yorktown. The Earl decided to flee to the north to Gloucester Point under the cover of darkness. A "furious storm" doomed the plan to failure, as seas ran high and every boat was "swamped." He sent forward his flag of truce and surrendered, thus ending the battle (Roth and Cobb 2001).

The "most tremendous gale of wind known in this country" passed over the Lower Chesapeake Bay September 22-24, 1785 and went along a track very similar to the Chesapeake-Potomac Hurricane of 1933 and likely severely impacted the Middle Peninsula. At Norfolk, lower stories of dwellings were flooded. Warehouses were totally carried away by the storm surge, causing large amounts of salt, sugar, corn, and lumber to disappear. A large number of cattle drowned, and people hung onto trees for dear life during the tempest. Vessels floated inland into cornfields and wooded areas (Roth and Cobb 2001).

"George Washington's Hurricane" of July 23-24, 1788, made landfall in Virginia and passed directly over the Lower Chesapeake Bay and Mount Vernon, the home of George Washington. This track is very similar to the track of the Chesapeake-Potomac Hurricane of 1933. At Norfolk, winds increased at 5 p.m. on the 23rd with the wind originating from the northeast. At 12:30 a.m., the wind suddenly shifted to the south and "blew a perfect hurricane, tearing down chimneys, fences, and leveling corn." In addition, large trees were uprooted and houses were moved from their foundations. Port Royal (Caroline County) and Hobb's Hole (Essex County) experienced a violent northeast gale, which drove several vessels ashore. Crops were destroyed and many livestock perished in lower Mathews County. Many plantations saw their houses leveled. Homes were flooded with water six feet deep and several inhabitants drowned. Gloucester County was inundated, and an estimated $400,000 (in 1788 dollars) in damage was incurred (Roth and Cobb 2001).

1800-1899

Great Coastal Hurricane of 1806 (August 23) caught British and French ships off guard, while engaged in the Napoleanic Wars in the U.S. shipping lanes. The British man-of-war L'Impeteax drifted under jury masts for 23 days before finally beaching near Cape Henry. Ships of the two warring nations put in for repair and refitting at the port of Norfolk after the storm. This hurricane, due to its slow movement and consequent erosion of the coastline, completed the creation of Willoughby Spit at Hampton Roads. A seawall built to prevent further erosion at Smith Point lighthouse at the mouth of the Potomac River was damaged (Roth and Cobb 2001).

A severe coastal storm dropped heavy rains on the Fredericksburg area in January 1863. It rained for 30 hours, dropping more than twelve inches, making mud so deep that mules and horses died attempting to move equipment. The rivers became too high and swift to cross, disrupting the Union Army offensive operation in the ill-famed "Mud March" (Watson and Sammler 2004).

The Gale of '78 was one of the most severe hurricanes to affect eastern Virginia in the latter half of the 19th century and struck on October 23, 1878. This hurricane moved rapidly northward from the Bahamas on October 22nd and struck the North Carolina coast later that same day moving at a forward speed of 40 to 50 mph. The storm continued northward passing through east central Virginia, Maryland, and eastern Pennsylvania.

A September 1882 tropical storm, the "protracted and destructive rain storm", swept away four mills near Ware's Wharf along the lower Rappahannock. The brunt of the cyclone only extended fifty miles inland. Heavy rains were also seen at Washington, D.C. (Roth and Cobb 2001).

During an April 1889 Nor'easter, the Tidewater Region had sustained winds from the north of 75 mph measured at Hampton Roads and 105 mph at Cape Henry. Tides at Norfolk reached 8.37 feet above Mean Low Water, which is over 4 feet above flood stage level (Watson and Sammler 2004).

Noteworthy hurricanes or tropical storms also occurred in September 1821 (one of the most violent on record for the 19th century), June 1825, August 1837, September 1846 (which formed Hatteras and Oregon Inlets in North Carolina), August 1850, September 1856, September 1876, August 1879, October 1887, August 1893, September 1894, October 1897 (tides in Norfolk rose 8.1 feet above Mean Lower Low Water), and October 1899 (tide in Norfolk rose 8.9 feet above Mean Lower Low Water).

From 1900 to 1999

A number of coastal storms hit the Tidewater Region in the early part of the 20th century. Hurricanes and tropical storms in October 1903, August 1924, September 1924, August 1926, and September 1928 each brought high winds (in excess of 70 mph measured in Norfolk and in Cape Henry). The 1903 and 1928 storms also raised tides as much as 9 feet and 7 feet, respectively, higher than normal in the region (Roth and Cobb 2001).

The summer of 1933 was the most active storm season for eastern Virginia in the 20th century. Two hurricanes, one on August 23 and one on September 16, struck the North Carolina and Virginia coasts and caused much devastation on the Middle Peninsula. In Chesapeake lore, the "Storm of '33" is recalled by older residents and enshrined in legend as the worst storm in memory (Mountford 2003). The August storm brought winds in excess of 80 mph and a storm surge that forced the tide nearly 10 feet above normal.

The September storm struck the area 24 days later and had sustained winds as high as 88 mph (measured in Norfolk) and the tide reached 8.3 feet above Mean Lower Low Water (Roth and Cobb 2001). Much of the land around the New Point Comfort lighthouse, the third oldest light on the Bay located at the entrance to Mobjack Bay and the mouth of the York River in Mathews County, was washed away and caused the lighthouse to be stranded on a very small island a few 100 yards from the tip of the mainland.

Hurricane Hazel hit eastern Virginia on October 15, 1954. This storm brought with it gusts of 100 mph which is the highest wind speed record at the Norfolk Airport location. A reliable instrument in Hampton recorded 130 mph winds (Roth and Cobb 2001).

A severe nor'easter gave gale force winds (40+ mph) and unusually high tides to the Tidewater Virginia area on April 11, 1956. At Norfolk, the strongest wind gust was 70 mph. The strong northeast winds blew for almost 30 hours and pushed up the tide, which reached 4.6 feet above normal in Hampton Roads. Thousands of homes were flooded by the wind-driven high water and damages were huge. Two ships were driven aground. Waterfront fires were fanned by the high winds. The flooded streets made access by firefighters very difficult, which added to the losses (Watson and Sammler 2004).

The "Ash Wednesday Storm" hit Virginia during "Spring Tide" (sun and moon phase to produce a higher than normal tide) on March 5-9, 1962. The storm moved north off the coast past Virginia Beach and then reversed its course moving again to the south and bringing with it higher tides and higher waves which battered the coast for several days. The storm's center was 500 miles off the Virginia Capes when water reached 9 feet at Norfolk and 7 feet on the coast. Huge waves toppled houses into the ocean and broke through Virginia Beach's concrete boardwalk and sea wall. Houses on the Middle Peninsula also saw extensive tidal flooding and wave damage. The beaches and shorefront had severe erosion (Watson and Sammler 2004).

Hurricane Cleo in September 1964 produced the heaviest coastal rainfall in the area (11.40 inches in 24 hours) since records began in 1871 (Roth and Cobb 2001).

Hurricane Agnes was downgraded to a tropical depression by the time it moved into Virginia in June 1972, but the rainfall produced by Agnes made this storm more than twice as destructive as any previous hurricane in the history of the United States (Roth and Cobb 2001).

In July 1996, Hurricane Bertha passed over portions of Suffolk and Newport News. Bertha spawned 4 tornadoes across east-central Virginia. The strongest, an F1 tornado, moved over Northumberland County injuring 9 persons and causing damages of several million dollars. Other tornadoes moved over Smithfield,

Figure 5: These photos depict the coastal damage in Essex County as a result of Hurricane Isabel (2003).

Gloucester and Hampton (Roth and Cobb 2001).

In September 1999, Hurricane Floyd produced 10 to 20 inches of rain on saturated ground and resulted in a recorded 500-year flood for Franklin, VA. While North Carolina and southeastern Virginia were hit with the brunt of this storm, significant damage from downed trees and localized flooding occurred and all of the counties of the Middle Peninsula were included in the Federal Disaster Declaration (FEMA FEMA-1293-DR, Virginia).

From 2000 to 2009

Hurricane Isabel hit the coasts of North Carolina and Virginia on September 18, 2003. It was a Category 1 hurricane when it made landfall. The highest sustained wind was 72 mph at Chesapeake Light. Storm surge varied significantly across the region. At Sewell's Point in Norfolk, the maximum water level was 7.9 feet above MLLW. This represented a 5-foot storm surge - the biggest in the region since Hurricane Hazel in 1954. Thirty six deaths were attributed to Hurricane Isabel in Virginia, including one in Gloucester County. Total damages for the Hampton Roads area amounted to $506 million.

In 2004, Tropical Storm Gaston caused serious damage to a handful of VDOT Secondary Roads in the Central Garage/ Manquin sections of King William County.

In 2006, Tropical Storm Ernesto caused residential and roadway flooding damage as well as beach erosion damage in Mathews County.

There were an additional 5 named tropical events during this period to hit the Middle Peninsula region resulting in minor severe weather damage.

In 2009 Middle Peninsula coastal localities experienced a significant Nor-Easter with high winds and coastal flooding

Coastal Flooding

Coastal flooding is typically a result of storm surge, wind-driven waves, and heavy rainfall. These conditions are produced by hurricanes during the summer and fall, and/or nor'easters and other large coastal storms during the winter and spring. Storm surges may overrun barrier islands and push sea water up coastal rivers and inlets, blocking the downstream flow of inland runoff.

Thousands of acres of crops and forest lands may be inundated by both saltwater and freshwater. Escape routes, particularly from barrier islands, may be cut off quickly, stranding residents in flooded areas and hampering rescue efforts. Coastal flooding is very dangerous and causes the most severe damage where large waves are driven inland by the wind. These wind driven waves destroy houses, wash away

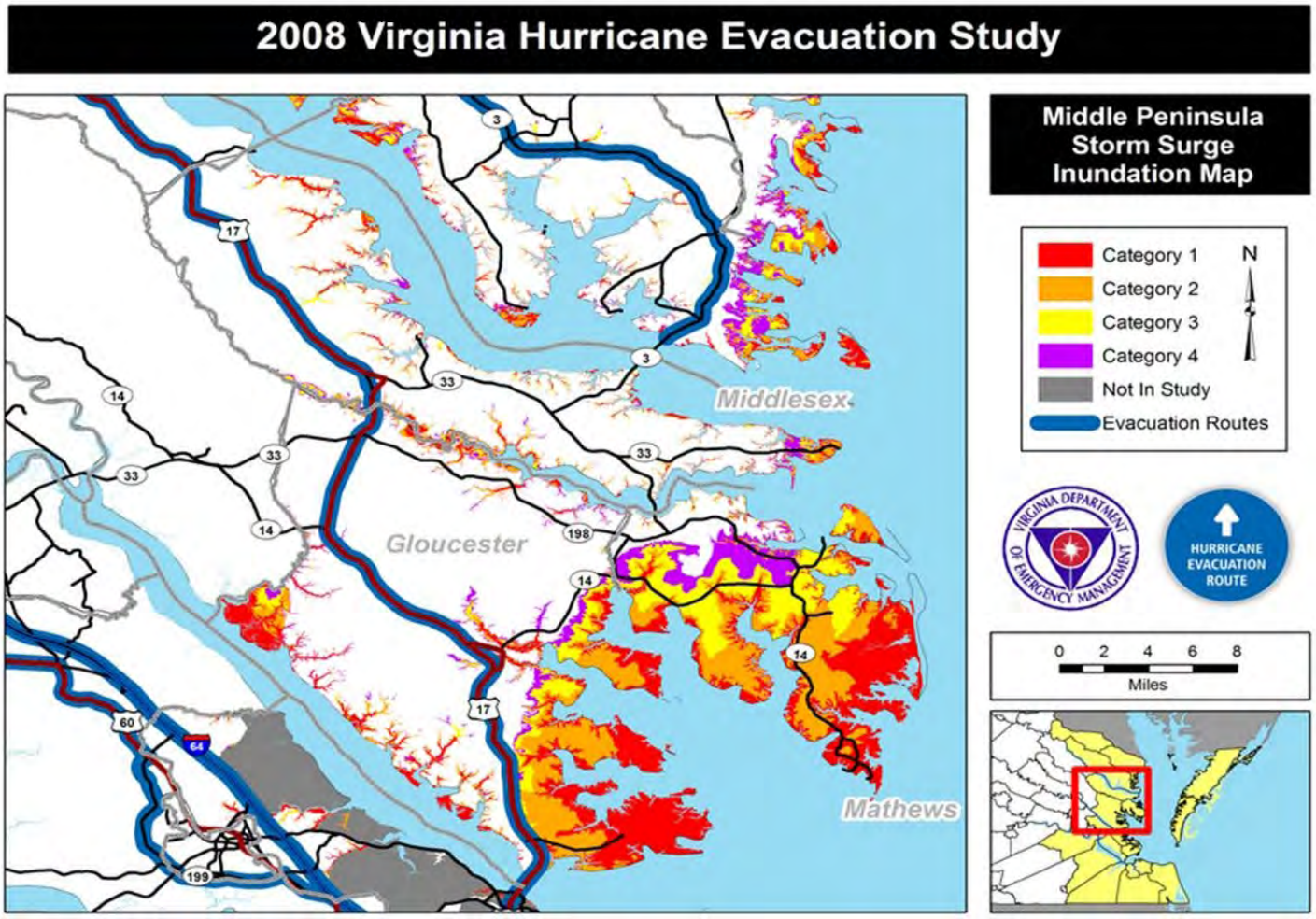


Figure 6: Middle Peninsula Storm Surge Inundation Map (2008).

protective dunes, and erode the soil so that the ground level can be lowered by several feet. Because of the coastal nature of the Middle Peninsula, the region is very susceptible to this type of flooding and resulting damage (Figure 6).

Middle Peninsula Resources at Potential Risk of Loss Floodplain Properties and Structures

While floodplain boundaries are officially mapped by FEMA's National Flood Insurance Program (NFIP), flood waters sometimes go beyond the mapped floodplains and/or change courses due to natural processes (e.g., accretion, erosion, sedimentation, etc.) or human development (e.g., filling in floodplain or floodway areas, increased imperviousness areas within the watershed from new development, or debris blockages from vegetation, cars, travel trailers, mobile homes and propane tanks).

The Flood Insurance Rate Maps (FIRMs) show flooding during a 100-year storm event or, in other words, the storm that has a 1% chance of being equaled or exceeded in any given year. The FIRMs account for both coastal surge driven flooding, as well as flooding generated from rain events. The 1% annual-chance-flood (or the 100-year flood as it is commonly referred to) represents a magnitude and frequency that has a statistical probability of being equaled or exceeded in any given year. Another way of looking at it is that the 100-year flood has a 26% (or a 1 in 4) chance of occurring over the life of a 30-year mortgage on a home (FEMA 2002).

Along with nearly 20,000 communities across the country, all localities in the Middle Peninsula voluntarily participate in the National Flood Insurance Program by adopting and enforcing floodplain management ordinances in order to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities (FEMA 2002). As of 2008, according to the Community Information System, there are a total of 4,021 flood insurance policies

covering Middle Peninsula properties. Table 6 is a summary of flood insurance policy data by locality.

Although not mentioned in the 2010 HMP, it is important to note the FEMA Region 3 (ie. Serving DC, DE, MD, PA, VA, WV) is currently in process of updating Flood Insurance Rate Maps for Mid-Atlantic coastal communities (see http://www.r3coastal.com). This update incorporates a new coastal flood hazard analysis that will utilize an updated 1% annual chance stillwater elevation obtained from a comprehensive storm surge study completed by the U.S. Army Corps of Engineers. This new process will provide more accurate coastal storm surge elevation within the Mid- Atlantic. FEMA expects to have maps complete and ready for public comment in Virginia by spring 2013.

Section Conclusions

As the Middle Peninsula HMP is updated every five years to remain in compliance with federal requirements, it provides a comprehensive insight into the regions vulnerability to natural hazards. Of those hazards categorized as "critical" (HMP, 2010), hurricanes, flooding and coastal flooding have historically had a major social, economic, and ecologic impact to the Middle Peninsula. However as a coastal region, the Middle Peninsula's vulnerability to such events remains high; and according to some sources coastal communities are at risk more than ever before due to potential impacts of climate change and, in particular, rising sea levels. Thus as the HMP has been adopted by each Middle Peninsula localities, it is scheduled to be updated on a yearly basis which will give an opportunity for localities to add emerging information, including updated FEMA Region 3 Flood Insurance Rate Maps (FIRMS), and will help keep pace with coastal hazards (ie. coastal flooding, sea level rise, land subsidence, hurricanes, etc).

For more information please refer to the Middle Peninsula Natural Hazards Mitigation Plan 2010.

Table 6: Summary of flood insurance policy data from Middle Peninsula localities (2008).

Locality	# of Zone V[1] Policies	# of Zone A[2] Policies	Total Policies	# of Claims Since 1978	Total Value of Claims
Essex	0	154	228	230	$6,020,190
Tappahannock	0	3	17	16	$193,571
Gloucester	67	1,038	1,528	1,050	$27,091,827
King and Queen	0	24	40	20	$508,576
King William	0	3	12	6	$142,556
West Point	0	66	102	72	$2,109,280
Mathews	56	1,339	1,647	993	$17,867,100
Middlesex	32	254	419	205	$2,700,774
Urbanna	0	23	28	11	$277,745
Totals	**155**	**2,904**	**4,021**	**2,603**	**$56,911,619**

1. Zone V: Special Flood Hazard Area (SFHA) along coasts subject to inundation by the 100-year flood with additional hazards due to velocity (wave action). Base flood elevations derived from detailed hydraulic analyses are shown within these zones. Mandatory flood insurance purchase requirements apply.

2. Zone A: SFHA subject to inundation by the 100-year flood. Because detailed hydraulic analyses have not been performed, no base flood elevation or depths are shown. Mandatory flood insurance purchase requirements apply.

Report Received by MPPDC 4/25/12

Adaptation Case Studies & Sample Ordinances

Within the planning arena case studies as well as sample ordinances provide a spectrum of approaches and strategies to address specific issues. They offer a guide to assist planning staff, elected officials, and the public in the development of new public policy and/or the tweaking old policies that may not be efficient. During Phase 3 of this project, MPPDC staff as well as Virginia Tech partners researched and compiled local, state, national, and international case studies as well as sample ordinances relating to climate change and sea level rise adaptation efforts. The a comprehensive literature review focused coastal communities with similar social, economic, regulatory, or ecologic characteristics that of Middle Peninsula localities.

Please note that communities have varying opinions about climate change and sea level rise - some remain undecided, others do not believe in this phenomenon, while others have already taken action. Therefore this section provides only a snapshot of adaptation efforts (ie. domestically and internationally) and acts as a resource for those communities who may be interested in addressing climate change, sea level rise, and/or the associated impacts, through land use tools, public policy, or outreach.

In 2007, Governor Timothy M. Kaine established the Governor's Commission on Climate Change. Charged with preparing a plan that identifies ways to reduce greenhouse gas emissions, the Commission worked through 2007 to publish *A Climate Change Action Plan* for Virginia in 2008. As part of the report an inventory of the amount of and contributors to Virginia's greenhouse gas emissions was conducted. While the report evaluated the expected impacts of climate change on Virginia's citizens, natural resources and economy, it also addressed Virginia's need to prepare for these likely impacts. Therefore through a review of climate change approaches being pursued by other states, regions, and the federal government, the Commission identified actions (beyond those identified in the Virginia Energy Plan) needed to be taken to achieve a 30 percent reduction in greenhouse gases.

Although the Commission was a start to address climate change, with the new Virginia administration in early 2010 came limited support for this issue at the State level. However through regional and local efforts throughout the Commonwealth, there continues to be progress in identifying climate change and sea level impacts as well as adaptation and mitigation action needs. For instance, the Virginia Coastal Zone Management Program has coordinated and funded three of Virginia's coastal planning district commissions (PDC) (ie. Middle Peninsula PDC, Hampton Roads PDC, and Northern Virginia PDC) to assess and map the potential impacts of sea level rise and severe storm events to both developed and natural areas. Currently these PDCs are moving toward developing policy in order to establish a framework for local response to these impacts. *More information about these efforts may be found at http://www.deq.state.va.us/coastal/climatechange.htm.*

According to the Code of Virginia, Title 15.2, Chapter 22: Section §15.2- 2223 -"The local planning commission shall prepare and recommend a comprehensive plan for the physical development of the territory within its jurisdiction and every governing body shall adopt a comprehensive plan for the territory under its jurisdiction in the preparation of a comprehensive plan for the territory under its jurisdiction. In the preparation of a comprehensive plan, the commission shall make careful and comprehensive surveys and studies of the existing conditions and trends of growth and of the probable future requirements of its territory and inhabitants. The comprehensive plan shall be made with the purpose of guiding and accomplishing a coordinated, adjusted and harmonious development of the territory which will in accordance with present and probable future needs and resources, best promote the health safety, morals, order, convenience, prosperity and general welfare of the inhabitants, including the elderly and person with disabilities...." As the County's comprehensive plan acts as a guidance document for the development of land use tools and policy, several localities within Virginia have composed and adopted comprehensive plan language which speaks to climate change and/or sea level rise.

Mathews County, VA: In January 2011, Mathews County adopted an updated comprehensive plan, *Mathews County Comprehensive Plan 2030: Preserving and Sustaining the Pearl of the Chesapeake*, which entails a section on Climate Change as well as references to sea level rise throughout the document.

The section on climate change states the following:

Climate Change

In recent years, there has been continued discussion about climate changes that are being experienced around the world. While there are varied opinions on causes and ultimate effects, it is recognized that changing weather patterns may contribute to rising sea levels which could significantly affect both inland and coastal communities. Regardless of the causes of climate change, as well as the pace and magnitude of such changes, it is essential that communities appropriately plan for changing trends and adjust their development patterns to minimize potential adverse impacts.

Possible sea level rise in conjunction with shoreline erosion and coastal subsidence (or sinking) is a concern for coastal Virginia. This is especially important for populated areas in terms of property damage and safety concerns as well as in terms of potential impacts on natural communities responding to changes in vegetative patterns, wildlife populations, and chemical responses due to temperature variation, runoff, varied rainfall, etc. Potential rising sea levels coupled with the potential for stronger storms pose increasing threats to

coastal communities, infrastructure, beaches, wetlands, and sensitive ecosystems. With respect to the mid Atlantic region, rising water levels, erosion and coastal subsidence already are affecting low lying lands, eroding beaches, converting wetlands to open water, and exacerbating coastal flooding. Consequently, the County should consider additional approaches for adapting to a changing coastline. Short term structural solutions (e.g., rip rap revetments, breakwaters, bulkheads, elevating structures, etc.) will not sufficiently address all anticipated changes. Shifts are needed in federal, state and local policies with respect to more long term land use planning and environmental protection and preservation.

Land Use, Development and Redevelopment of Resource and Management Areas

Given development constraints and the potential longterm effects of climate change, future Land development and redevelopment in Mathews County must be carefully planned and coordinated with environmental features. This includes not only new buildings and the rehabilitation of existing structures, but also the development of supporting public infrastructure. The next section on Land Use provides a more detailed analysis of existing land use and development patterns and presents recommendations for addressing outstanding issues and amending land development patterns to meet the goals of the future.

The potential rise in sea level should be one of the factors considered in future development patterns. Over time, it is probably that there will be changes in vegetation, the landscape, and flooding patterns. The projected degree of impact is widely discussed and varies among experts and designated study panels. Thus, to be most effective it is best be conservative when selecting sites for public facilities or permitting development in areas that may be susceptible to rising sea levels. In addition, because the expansive wetlands of Mathews County are important to the physical and ecological attributes of the region, it will be important to ensure that these beneficial communities are not deleted, but rather ported to allow to transition naturally.

Although Mathews County comprehensive plan language still assumes the uncertainty of climate change and sea level rise, they are still acknowledging that things are changes that may impact the future of Mathews County. In a later chapter of the Comprehensive Plan, Mathews County identified policies and strategies for the environment that concern sea level rise:

Sea level rise, shoreline erosion and coastal subsidence over the next several decades are projected to have effects on coastal areas and natural communities. To adequately prepare for possible changes in rising sea levels and weather patterns, development should be carefully reviewed and managed to take into account the potential impacts. Where possible, Conservation measures should be employed to protect natural communities and prevent investment losses in the future.

1. *Promote conservation in the eastern and southern coastal areas of Mathews County that may be most affected by possible rising sea levels and flooding. Amend the County zoning ordinance to address possible sea level changes and develop appropriate use regulations and development standards. Consider amending the zoning ordinance to increase shoreline setback requirements.*
2. *Plan site and develop new public buildings and facilities so that they take into account possible rising sea levels. Require evaluation of impact as part of the governmental contract for services. Locate facilities in the most appropriate areas.*
3. *Protect existing facilities from possible sea level rise through advanced planning and implementation of environmentally acceptable protection methods.*

Other references to sea level rise include pages 4; 7; 12;14; 57; 93; 102; 105; 123; 137-139; 143; 145; 148; 150; 153.

City of Poquoson, VA: Within the most up-to-date Comprehensive Plan of the City of Poquoson, there is a section on climate change, which describes their vulnerability to sea level rise:

Climate Change

The [Governor's Commission on Climate Change] Plan calls for action at both the state and local level to mitigate and adapt to climate change. Among the most troubling issues for Hampton Roads is sea level rise. Sea level rise rates are predicted to accelerate over the next 100 years, inundating low-lying areas and increasing the land area that is vulnerable to storm surge flooding. In particular, Section III.A. contains a discussion of the effects on the built environment and

states the following:

> *"Sea level rise is a major concern for coastal Virginia, particularly the highly populated Hampton Roads region. The Chesapeake Bay Program's Scientific and Technical Advisory Committee projects that sea levels in the Chesapeake Bay region will be 0.7-1.6 meters (2.3-5.2 feet) higher by 2100. Specific impacts will vary by location, depending on changes in land elevation."*

Section 14.C. of the Plan calls on local governments to include climate change in local planning efforts:

> *"Local governments in the coastal area of Virginia should include projected climate change impacts, especially sea level rise and storm surge, in all planning efforts, including local government comprehensive plans and land use plans. Local governments should revise zoning and permitting ordinances to require projected climate change impacts be addressed in order to minimize threats to life, property, and public infrastructure and to ensure consistency with state and local climate change adaptation plans."*

Given Poquoson's vulnerability to flooding, sea level rise rates should be monitored closely and incorporated in future planning efforts. The City's Multi-Hazard Mitigation Plan was updated in September 2009 and includes revised information on climate change and sea level rise. In additional to local planning efforts, work at the regional and state level will provide a framework for local actions. Section 14.K. of the Climate Change Commission's Plan contains the following recommendation:

> *"The Secretary of Natural Resources should lead an inter-agency and intergovernmental effort to develop a Sea Level Rise Adaptation Strategy by January 1, 2011. The Sea Level Rise Adaptation Strategy should encompass the full range of policies, programs, and initiatives that will be required to adapt in the areas of natural resources, economy, and infrastructure and any other area impacted by sea level rise."*

At the regional level the HRPDC is working with the Virginia Coastal Zone Management Program to develop a framework for climate change response in Hampton Roads. These efforts, combined with the development of enhanced storm surge modeling for the Virginia coast, will help to inform response to sea level rise in Poquoson.

Gloucester County, VA: Although Gloucester County is currently in the process of updating their comprehensive plan, the county as recently made efforts to reduce coastal infrastructure vulnerability with the adoption of an amendment to their Floodplain Management Ordinance. As a participant of the FEMA (Federal Emergency Management Agency) Nation Flood Insurance Program (NFIP), Gloucester County originally adopted a Floodplain Management Ordinance in July 1987 to meet the minimum federal requirements. However in 2010 this ordinance was amended to increase the one foot of freeboard to make a two foot free board clearance between the finished floor of a structure in the A and AE zone and the lowest structural member in the V and VE Flood zones. This particular amendment surpasses FEMA requirements but it maintains the County's eligibility to participate in the NFIP.

As Virginia localities forge ahead in addressing climate change and sea level, understanding that Virginia is a Dillon Rule State is pertinent. Being a Dillon Rule State means that (1) local governments may only exercise those powers expressly delegated by the legislature or those that may be fairly or necessarily implied from an express grant of power (City of Virginia Beach v. Hay, 258 Va at 222) and (2) when exercising their authority, local governments must choose a method that is consistent with the statutory. The Virginia General Assembly has granted local governments two tools to regulate land use: comprehensive plans and zoning ordinances.

In a recent paper published by the Georgetown Climate Center, Virginia planning and zoning structure grant local government's clear authority to regulate land use for flood hazards in the following way:

1. In comprehensive plans, local planning commissions can designate flood plain areas.
2. Zoning ordinances may include measures that, among other things, provide for safety from flood, provide adequate flood protection and protect against loss of life and property from flood.
3. Local governments may consider, among other

things, the preservation of flood plains as a purpose for creating a zoning district.
4. Within each district, local governments may regulate the used of land and types of development that may occur and may specifically regulate development in flood plains.

Additionally the paper indicates that local governments can regulate land use to mitigate for future sea level rise impacts using the following methods: (1) increasing regulation in the existing flood plain, (2) expanding the floodplain, or (3) using alternative methods to regulate development in vulnerable areas that do not currently lie in the floodplain. With a clear authority to regulate development in the existing floodplain, their powers are limed outside the existing floodplain.

While Virginia takes steps to address climate change and sea level rise issues, other states, localities, as well as nations have made efforts to mitigate and/or adapt to current and pending changes. To gather a consortium of case studies and sample ordinances that provide a range of land-use tools and public policy options for MPPDC member localities to consider, MPPDC staff looked first to Virginia's neighbors (Maryland and North Carolina). Then MPPDC staff researched other coastal states that have made efforts, as well as international examples of actions. Although each location has an unique political atmosphere, each community highlighted in this section has acknowledged that climate change and sea level rise will impact their jurisdiction in the future; thus, to reduce their risk to such impacts, and to protect their constituents, working to adapt and/or mitigate against potential impacts.

MARYLAND

In 2007 the Governor of Maryland signed an Executive Order Establishing the Maryland Commission on Climate Change (E.O. 01.01.2007.07) and charged the Commission with collectively developing an action plan to address the causes of climate change, prepare for the likely consequences and impacts of climate change to Maryland, and establish firm benchmarks and timetables for implementing the Commission's recommendations. With the release of the Maryland Climate Action Plan (http://www.mdclimatechange.us/MCCC.cfm) in August 2008, the State firmly stood the position that there is sufficient evidence of sea level rise, and therefore adaptive actions should be identified and undertaken. Considering adaptation and mitigation options to address impacts, the Adaptation and Response Work Group targeted efforts on the following: (a) existing built environment infrastructure, (b) future built environment infrastructure, (c) human health, safety and welfare, (d) public awareness, and (e) resources and resources-based industries.

Several coastal localities in Maryland have found it helpful to have the support from the State level to initiate climate change and sea level rise efforts within their jurisdiction.

Somerset County, Maryland: Funded through the Maryland Department of Natural Resources, Somerset County, Maryland assessed their vulnerability to sea level rise, reviewed existing plans, and developed codes, regulations, and laws to ensure the necessary policies and codes to address sea level rise and coastal storms were in place. As a low-lying area, Somerset County is heavily influenced by storms. Although impacts are subtle in the short-term, the County as witnessed several bay-front communities once thriving in the early 1900s being abandoned and several of those areas are now under water. Therefore the driving force behind this project was the anticipated impacts under various sea level rise scenarios (ie. coastal storm flooding, both intensity and frequency of storms, and gradual changes in groundwater levels and drainage).

A major outcome of the project was the development of the *Somerset County, Maryland: Rising Sea Level Guidance* document, that incorporates an assessment of vulnerabilities as well as recommendations to adapt the County's management and codes to best prepare for climate change. Recommendations include:

- Require buildings in floodplains to be on higher foundations (freeboard).
- Recognize increased flooding through 2050 by adopting a 'floodplain planning zone'.
- Adopt Coastal A Zone requirements in areas where waves may be 1.5 feet or higher.
- Redelineate the landward boundary of Conservation Zone to coincide with the 2050 inundation area and reduce the allowed density (retain current zoning for existing villages).
- Recognize that wetlands will migrate inland, groundwater levels will rise, and saltwater intrusion will increase.

- Modify on-site septic requirements to anticipate impaired performance as water table levels rise.
- Require stream/ tributary buffers or conservation easements.
- Require planning for certain roads to anticipate more frequent flooding.
- Anticipate that some buildings will be relocated, elevated on higher

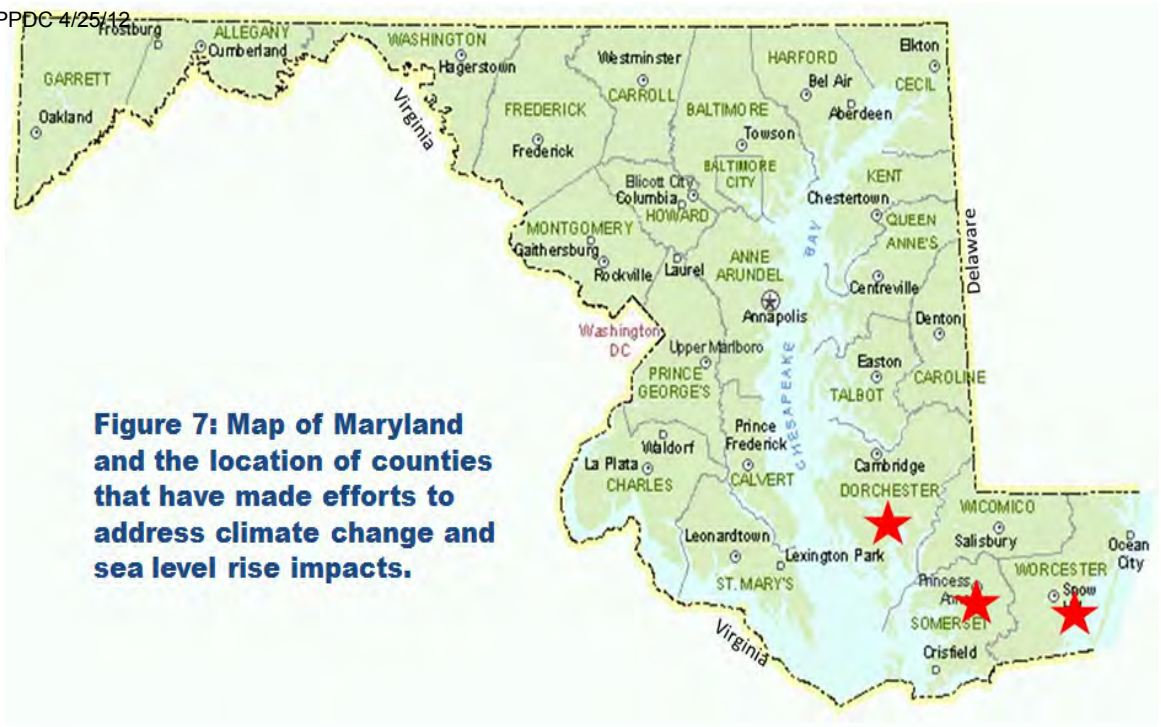


Figure 7: Map of Maryland and the location of counties that have made efforts to address climate change and sea level rise impacts.

Town of Crisfield, Somerset County, MD:
In April 2005, the Town of Crisfield was designated as a Maryland Priority Place, a State program designed to assist communities and facilitate well-planned development and community revitalization. As part of their efforts the town amended their Comprehensive Plan in 2010 with the addition of a Comprehensive Land Use Map and the Land Use / Natural Area Compatibility Chart to guide land use decisions. Crisfield has acknowledged that sensitive natural areas (ie. marshlands and wetlands) play significant roles in the quality and health of Crisfield and help attenuate flooding, dissipate the energy of storm surges, prevent shoreline erosion, improve water quality, while providing protective habitat for native plants and wildlife. Historically, patterns of filling and building on tidal marshes have worsened the effects of flooding and development on very low-lying lands has exposed residents to both regular flooding and severe storm surge events. Thus, to utilize the marshes and wetlands as natural flood and storm surge management tools, City planners determined the natural capability and characteristics of land within its jurisdiction. More specifically, planners classified all the City's land into one of six categories (ie. Resource Projection, Eco-Residential Neighborhood 1, Eco-Residential 2, Residential Conservation , Commercial and Employment, and Waterfront Planning Area) and determined the types of used that were compatible for each category. Refer to Appendix 2 for the Comprehensive Plan language.

Dorchester County, MD (2008): With nearly 60% of Dorchester County lying within the 100-year floodplain, it is by far one of Maryland's most vulnerable counties to sea level rise. This project supported a review of all existing long-range and comprehensive planning documents, county codes, regulations, plans and ordinances to determine whether sea level rise or coastal hazard mitigation has been addressed in any of these documents and, if not, where it could be incorporated. The project also provided guidance and recommendations for public education and outreach, as well as identified financial and technical needs. In particular the project suggests steps the County should consider to develop a Sea Level Risk (SLR) District. The following are a few needs and activities that the SLR will provide for:

- Prohibit new subdivisions;
- Restrict septic disposal facilities to state of the art facilities whose integrity would not be compromised by storm surge;
- Require a minimum two-foot freeboard above base flood elevation;
- Provide for the closure of inundated roads where an alternate route exists;
- Provide for the termination of maintenance for roads that serve only a few occupied residences;
- Provide for the termination of maintenance on roads where the cost to maintain exceeds the Fair Market Value of the properties it serves;

- Identify properties for potential buy-out. Rank them in order of level of immediate risk;
- Assess wetland losses and identify suitable areas to accommodate sea level encroachment and conversion to new wetlands;
- Prohibit investment on new infrastructure in the SLR District; and
- Abandon, relocate, raise, or seal any infrastructure that will sustain damage by inundation.

Worcester County, MD: Following development of the Worcester County Sea Level Rise Inundation Model (2006), the County developed a Sea Level Rise Response Strategy to assess response options for the expected impacts of accelerated sea level rise caused by climate change. To plan for responses to sea level rise impacts on Worester's constiutanats and ecosystems, assumptions of the rate and range of sea level rise were made. Although great progress has been made in understanding climate change and modeling impacts, results of these models are still inconclusive regarding the exact extent of sea level rise and when it will occur. Therefore to account for uncertainty, the report presented several scenarios to assess the impacts of sea level rise on Worcester County over the next century. The report reviews potential responses /adaptation options pertaining to existing development, future development, infrastructure and public facilities, as well as natural systems. Below are some response options reviewed in the report:

1. Structural Protection (ie. shoreline armoring) includes any attempt to stabilize the shore through "hard" erosion control techniques;
2. Non-structural protection includes "soft" technique beach nourishment, the building of sand dunes and marshes, as well as coastal revegetation and favoring hybrid soft/hard techniques that more closely resemble living shorelines;
3. Tidal barriers to control flooding;
4. Rolling Easements: enforces this common law interest by forcing the removal of private structures or charging a temporary rent once the private structure rests on public land;
5. Elevation and Floodproofing Retrofit;
6. Retreat involves allowing sea level rise to take its natural course and avoiding impacts; and
7. Redevelopment restrictions.

As the report reviews provides a list of advantages and disadvantages for each response/adaptation option, Worcester County also developed criteria for a framework that would determine which response options would be most appropriate for adoption and implementation. Ultimately this provides the information necessary for Worcester County decision makers to evaluate and prioritize response options for future implementation

NORTH CAROLINA (Dillon Rule State):
North Carolina's Department of Natural Resources (DENR) established in the 2009-2013 Strategic Plan to respond to climate change using both mitigation and adaptation strategies to reduce vulnerability, increase adaptive capacity and improve resiliency of climate sensitive resources. With the creation of a Climate Change Steering Committee, the team was focused on addressing climate change policy actions at the state, regional and federal levels, while also coordinating strategies with other state, federal, and nongovernmental partners.

As part of their Climate Initiative there are two distinct components - the development of mitigation strategies and the development of adaptation strategies. While mitigation strategies focused on reducing greenhouse gas contributing to climate change, the adaptation strategies identified and addressed potential impacts to the environment and natural resources we are charged with protecting:

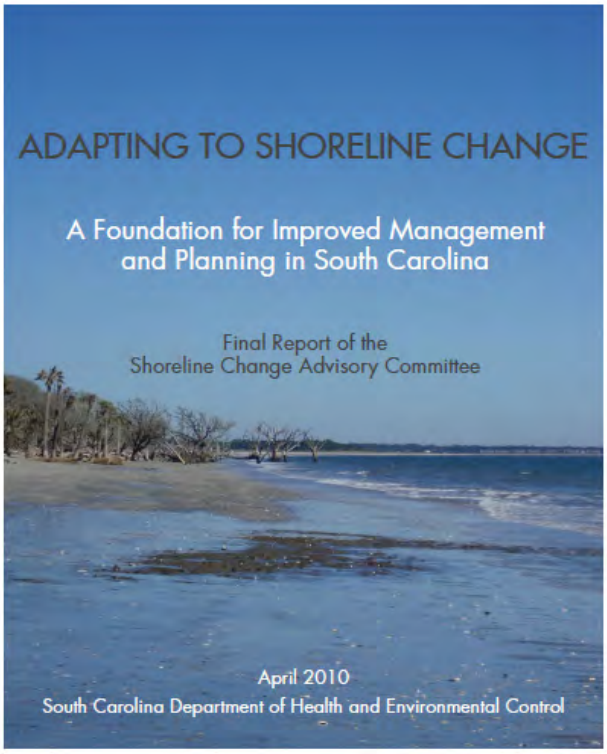
Mitigation Strategies
• Greenhouse Gas Emissions Regulation and Tracking • Greenhouse Gas Emissions Reduction • Green Energy Development • Carbon Sequestration
Adaptation Strategies
• Sea Level Rise Adaptation • Climate-Sensitive Ecosystems • Water Management • Public Health Impacts • Emergency Management Preparedness • Land Use Planning and Development

To date North Carolina has published three reports that summarize the research and recommendations to address the threat:

Climate Action Plan Advisory Group (CAPAG) Report: The Climate Action Plan Advisory Group developed proposed for dealing with climate change, recognizing the profound implications that global warming and climate variation could have on the economy, environment, and quality of life in North Carolina. (http://www.climatechange.nc.gov/PDFs/Part_1_Cover_TOC_Preface_ExSum_Chapters.pdf)

Legislative Commission on Global Climate Change (LCGCC): An in-depth study of issues relates to climate change, including actions taken, Commission's findings, recommendations and legislative proposals (http://www.climatechange.nc.gov/PDFs/LCGCC_Final_Report_05-20-10.pdf)

NC Sea Level Rise Assessment Report: Developed by the N.C. Coastal Resources Commission's Science Panel on Coastal Hazards this report reviews the known state of sea level rise in North Carolina (http://www.climatechange.nc.gov/PDFs/LCGCC_Final_Report_05-20-10.pdf) As an ongoing project, North Carolina continues to collaborate to promote both mitigation and adaptation strategies that address climate change.



SOUTH CAROLINA (Home Rule State)

With the establishment of the South Carolina (SC) Coastal Zone Management Program in 1977 through the Coastal Tidelands and Wetlands Act (SC Code §48-39-10 et seq.), SC's Department of Health and Environmental Control (DHEC) - Ocean and Coastal Resource Management (OCRM) was authorized to administer a permitting program to designate "critical areas" in the coastal zone (ie. coastal waters, tidelands, beaches, and primary oceanfront sand dunes). Since there was limited guidance for decisions on beachfront development and erosion control approaches, in the late 1970's and early 1980's the Coastal Council decided to seek a more comprehensive beach protection policy. Thus in 1986 a citizen committee was appointed to study erosion issues and make long-term recommendations for the improvement of beachfront management in SC.

The Advisory Committee established four broad goals to improve shoreline management in South Carolina and guide actions. Goal 1, "Minimize Future Risks to Beachfront Communities," proposes solutions to limit future exposure to losses of infrastructure, properties, and economic and natural resources that rely on a healthy beach/dune system; and to reduce the need for erosion control solutions. Goal 2, "Improve the Planning of 1 Beach Renourishment Projects," presents opportunities for improved coordination and decision making with regard to renourishment projects and other "soft" solutions to beach erosion. Goal 3, "Limit the Use of Hard Stabilization Structures," reinforces existing prohibitions on seawalls and revetments, and recommends improved guidance for the siting, design, and use of groins, breakwaters, and temporary structures. Goal 4, "Enhance the Management of Sheltered Coastlines" presents parallel issues facing estuarine and sheltered coastlines of SC, and policy and management recommendations for, addressing those issues. As a result, the Committee's three possible approaches to beach management were described –armoring, nourishing, and retreating: "We believe that a combination of the three approaches, depending upon site specific factors, may be the most realistic policy. We have already tried armoring the shoreline... carefully planned nourishment is certainly a more desirable approach (and) can be effectively utilized at locations where the benefits justify the costs...it is anticipated that the cost of nourishment will rise as the sea level rises and could ultimately become extremely expensive."

The Committee therefore concluded that the "only practical approach" was a gradual retreat from eroding beaches "over a thirty year transition period, in combination with selective beach nourishment...a retreat implemented over 30 years will allow owners of structures sited too close to the beach to realize the economic life of their structures and adjust their plans over a reasonable 30-year time period. This retreat

must be based on sound state and local comprehensive beach management plans." The Committee's report assisted in the development of legislative proposals by the SC General Assembly, including the phasing out of beachfront seawalls, revetments, and bulkheads over time; removal of structures within the beachfront critical area if damaged beyond repair; establishing of setbacks based on a moving average of historic erosion rates, limitation of the size of new structures, and restriction on new structures seaward of the primary dune or baseline (SCBRC, 1988). The report also fostered the amending of the South Carolina Beachfront Management Act of 1988 which clarified beachfront policies, expanded state jurisdiction, and established a new permitting and planning support through the SC Coastal Council. The new law, included, among other elements:

- Enacted a 40-year policy of "retreat" from eroding beaches;
- Established a new jurisdictional area for permitting between a "baseline" (generally the primary dune crest or historical inlet shoreline position) and a "setback" line (based on a multiplier of 40 times the local, annual rate of erosion);
- Limited construction would be allowed within a 20 foot restricted zone landward of the baseline, and construction would be prohibited seaward of the baseline;
- Within the setback area:
  - -No new erosion control devices are allowed, and existing seawalls were to be replaced with sloping structures over time;
  - -New structures are limited to 5,000 square feet of heated space;
  - -Homes damaged beyond repair must be rebuilt farther landward;
- Created standards for state and local comprehensive beach management plans; and
- Established real estate disclosure requirements for beachfront property transactions.

To stay current with coastal management efforts, in 2007 South Carolina's Department of Health and Environmental Control (DHEC) - Ocean and Coastal Resource Management (OCRM) led a Shoreline Change initiative to organize existing data, identify additional research needs, and formulate policy options to guide the management of South Carolina's estuarine and beachfront. DHEC established an external panel of 23 scientists, agency researchers, municipal officials, and stakeholders, called the Shoreline Change Advisory Committee (SCAC). This Committee discussed the past two decades of experiences under the SC Beachfront Management Act and how to proceed with beachfront and estuarine shoreline management for the coming decades.

The Advisory Committee reaffirmed the SC Beachfront Management Act (Appendix 3) while encouraging the state to renew its commitment to the state's retreat policy. Currently SC's retreat policy does not provide for the immediate, active relocation of structures from the beach/dune system; however, by gradually eliminating erosion control structures, it ensures abandonment of property to allow the natural, inland migration of a healthy beach/dune system, if or when renourishment becomes unsustainable for a specific area or community. Therefore the Committee urges state and local governments to enact policies to ensure that sufficient space is provided for the natural migration of the beach/dune system and that the related risks to private and public resources are minimized.

The State continues to comprehensively address coastal changes, while strongly suggesting that local governments are integral in the implementation of shoreline management in South Carolina.

RHODE ISLAND

In January 2008, the Coastal Resource Management Council (CRMC) adopted a new section of the Rhode Island Coastal Resources Management Program titled *Climate Change and Sea Level Rise*. Including scientific findings and providing historic data supporting climate change and sea level rise, this section serves as a tool to better management concerns related to this phenomenon. CRMC looked to develop issues, key priorities, and potential impacts to buildings, infrastructure, and shoreline habitat, while developing and adopting policies and regulations needed to manage the state's coastal resources and property while protecting human life in the face of hazards resulting from sea level rise. The CRMC is also authorized to work with the State Building Commission to incorporate freeboard calculations based on sea level rise scenarios into new development guidelines in order to ensure that buildings protected from inundation. As the CRMC plans to "accommodate a base rate of expected 3 to 5 foot rise in sea level by 2100 in siting, design, and

implementation of public and private coastal activities" (Section 145), the CRMC also acknowledged that the 3-5 foot range may not be enough. *Please refer to Appendix 4 for the full Climate Change and Sea Level Rise Policy.*

NEW BRUNSWICK, CANADA

The Canadian Province of New Brunswick faces many of the same economic and environmental impacts of sea level rise as the Middle Peninsula. With a natural resource based economy, an aging demographic, and pressured by coastal development, New Brunswick has adopted a coastal management approach based on sensitivity to impact. According to the Coastal Areas Protection Policy for New Brunswick: "A number of factors, from human activity to changes in our global climate have placed stresses on coastal areas, creating greater risk to public safety and structural damage, affecting important agricultural lands, and threatening the bio-diversity of plant and wildlife which have sustained coastal regions for centuries. Our present challenge is to ensure future viability of coastal areas in terms of economic and community growth through advances in environmental protection"

More specifically, to limit future vulnerability of coastal areas, New Brunswick has developed a coastal policy that divides the coastal area into three sensitivity zones.

Zone A - the areas closest to the water known as the coastal lands core area (Figure 8a)
Zone B - the areas beyond Zone A which provide a further buffer (Figure 8b), and
Zone C - the areas beyond Zone B that form a transition from coastal to inland areas.

This approach enables Government, development officers, municipal officials and land-owners to clearly identify where one zone ends and another begins, and allows for different management of the three zones to reflect sensitivity, with least activity in Zone A and progressively more activity through Zones B and C.

Prior to implementation, the policy will propose an review mechanism which uses defined criteria as the appropriate way to assess the varying levels of sensitivity in Zones A, B, and C.
This zoning approach - core, buffer and transition - is the same approach used by the United Nations for the UNESCO (United Nations Educational, Scientific and Cultural Organization) Biosphere Reserves.

ZONE A - COASTAL LANDS CORE AREA

Zone A, the most sensitive zone, includes beaches, dunes, rock platforms, coastal marshes and dyked lands found between the Higher High Water Large Tide (HHWLT) and the Lower Low Water Large Tide (LLWLT) plus dunes extending beyond the HHWLT. Due to the extreme sensitivity and the very high risk of danger/ damage from storm surges, fewer development activities would be acceptable in Zone A.

Acceptable Activities In Zone A

- The maintenance or enhancement of the coastal feature, e.g. sand fencing or planting native dune grasses to protect sand dunes.
- Acceptable erosion control structures.
- Development associated with access and interpretation for educational or research purposes.
- A development or undertaking to protect a coastal feature while providing approved public or private access to a shoreline, e.g. a boardwalk.
- On coastal marshes that have been historically dyked for agricultural purposes:
  - Carry out agricultural practices.
  - Construct agricultural storage buildings for activities related to the use of that land, e.g. hay storage (provided no hazardous materials are stored).

  Note: the intent would be to minimize structures that would be damaged by flooding during storm surges. This would also reduce the investment that would need to be considered when determining whether to allow a dyked coastal marsh to revert to a natural eco-system.
- Allow dyked marshlands to naturally revert to salt water marshes by removing control structures and subject to review the conversion of dyked marshlands to freshwater marshes.

  Note: Activities that require operation in Zone A (such as commercial fisheries, transportation etc.) or infrastructure or development deemed to be in the public interest would be considered for exemption under the policy, providing appropriate analysis had been undertaken.

ZONE B - COASTAL LANDS BUFFER AREA

Zone B is the land immediately adjacent to the coastal features. Zone B would consist of an area 30 meters landward from the inland edge of Zone A. In the case of coastal marshes, a 30-metre buffer is essential for maintaining the integrity of the marsh. While development activities in Zone B would continue to

Protected Area A

sensitive coastal features

(beaches, dunes, coastal wetlands, dyked lands, rock cliffs and inter-tidal areas)

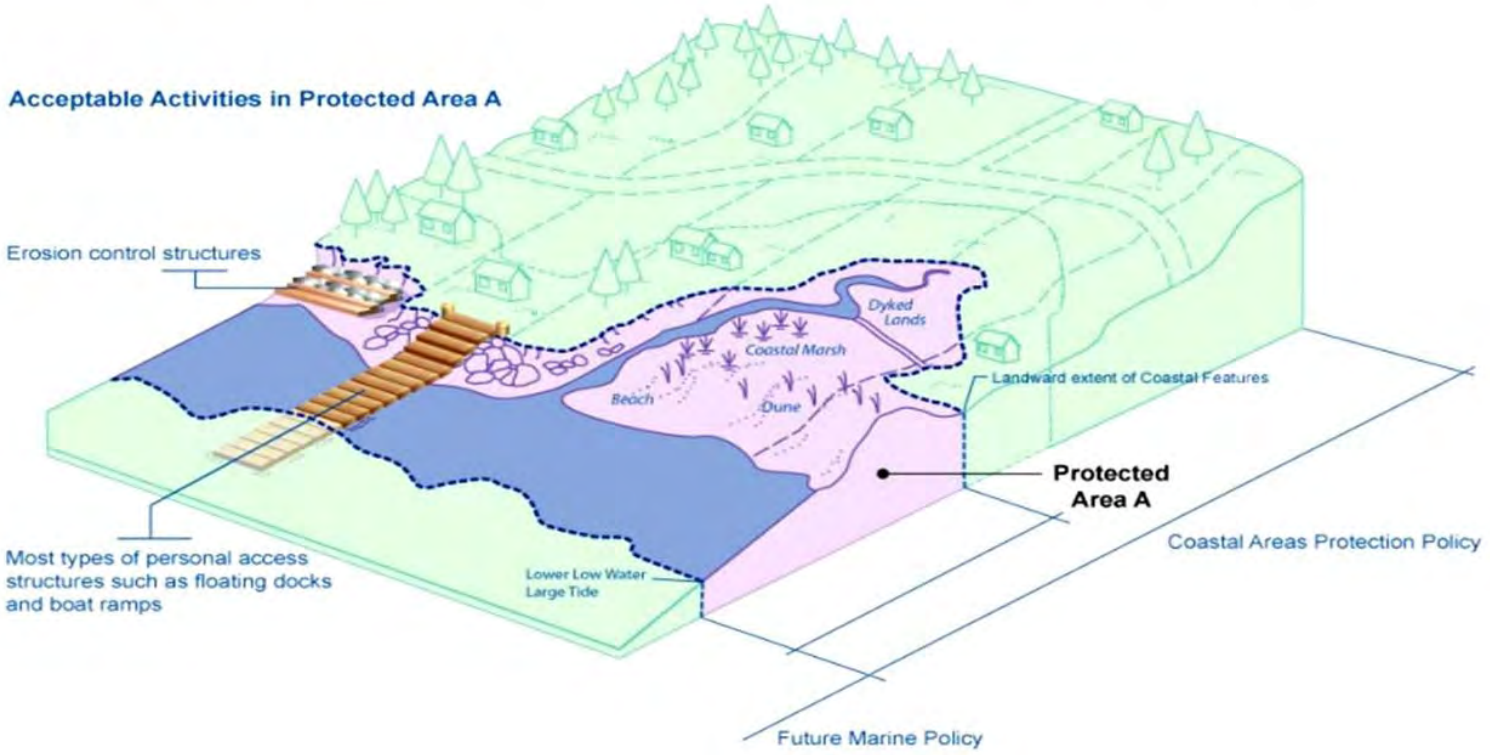
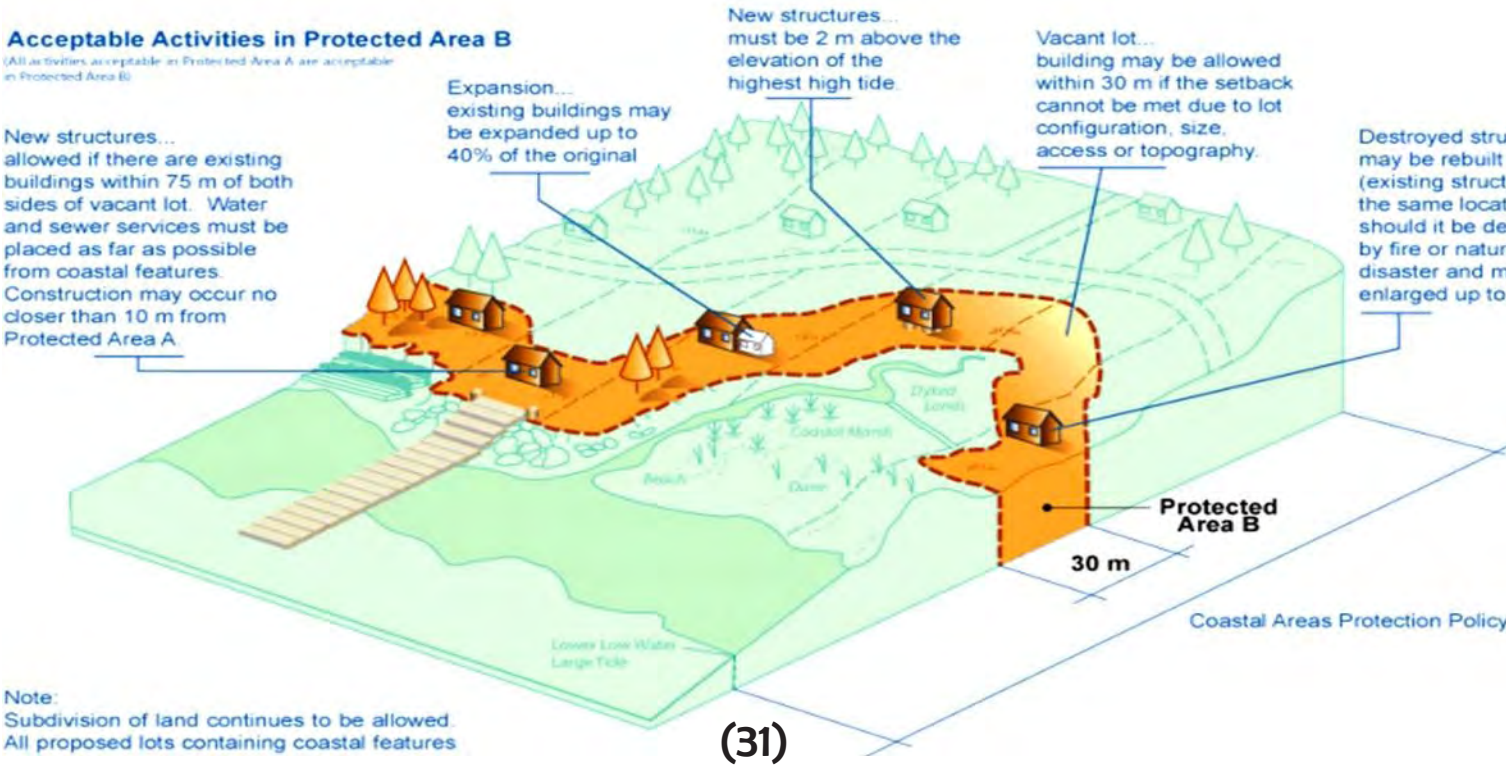


Figure 8a: Above is a depiction of Zone A as described by the Coastal Areas Protection Policy for New Brunswick, Canada. Figure 8b: Below is a depiction of Zone B as described by the Coastal Areas Protection Policy for New Brunswick, Canada (2002)

Protected Area B

30 metre limited activity and development buffer



have a direct impact on the coastal features and expose people to storm damage, the impacts in most cases would be somewhat less due to the protection afforded by both the natural features and prohibitions in Zone A. As such, a slightly greater range of activities would be acceptable.

The Zone B lands adjacent to a coastal marsh are an integral component of the marsh. Only those activities that would be allowed in the marsh itself would be acceptable in the Zone B adjacent to the marsh.

Acceptable Activities In Zone B

- All of the activities acceptable in a Zone A are acceptable in a Zone B.
- The construction of a new single family residence if it meets conditions related to:
  - existing residences on either side of lot,
  - proximity to the boundary of Zone A,
  - size of structure, and
  - ability to meet other regulatory requirements, e.g. septic system, and elevation as noted above.

Note: Multi-family residences, hotels and apartments will not be considered for this Zone. Commercial and industrial developments are subject to the same restrictions as in Zone A: they must be coastal location essential and are subject to assessment.

The following may be allowed, pending a review and exemption process -

- The repair, expansion or replacement of existing structures with the following conditions:
  - That this activity is no closer to Zone A than the existing building,
  - That the total increase in size of the building does not exceed 40% of the existing building, and
  - That in the case of new or rebuilt structures, the habitable portion of the structure is at least 2 meters above the HHWLT (Higher High Water Large Tide) elevation.

Note: Activities that require operation in Zone B (such as commercial fisheries, transportation etc.) or infrastructure or development deemed to be in the public interest would be considered for exemption under the policy, providing appropriate analysis had been undertaken.

ZONE C - COASTAL TRANSITION AREA

A further zone, which will not be part of the initial Coastal Areas Protection Policy, but will be adopted in the future, is referred to as - Zone C. It would extend from the outside of Zone B landward. The sensitivity to impact, and to storm damage, would vary considerably in Zone C depending primarily on topography, elevation and the erodibility of the land. As such, a precise distance for Zone C has not been established at this stage in the development of the policy.

Acceptable Activities In Zone C

- All activities that are acceptable in zones A and B are acceptable in the transition Zone. There will be greater variability in the sensitivity of this zone. Rather than trying to list all the potentially acceptable activities, the activities will be reviewed based on established criteria. There are two basic categories of criteria:
  1. The susceptibility for the development to storm surges (In addressing susceptibility to storm surges, elevation, topography and erodibility (geomorphology) are key considerations.), and
  2. The biophysical impact on the coastal ecosystem of the development. (In addressing the impact of the development on coastal ecosystems, issues such as the potential to contaminate (hazardous materials storage, septic tanks/sewage), harmful disruption of the habitat, and disruption of natural coastal processes (e.g. littoral drift) are key considerations.)

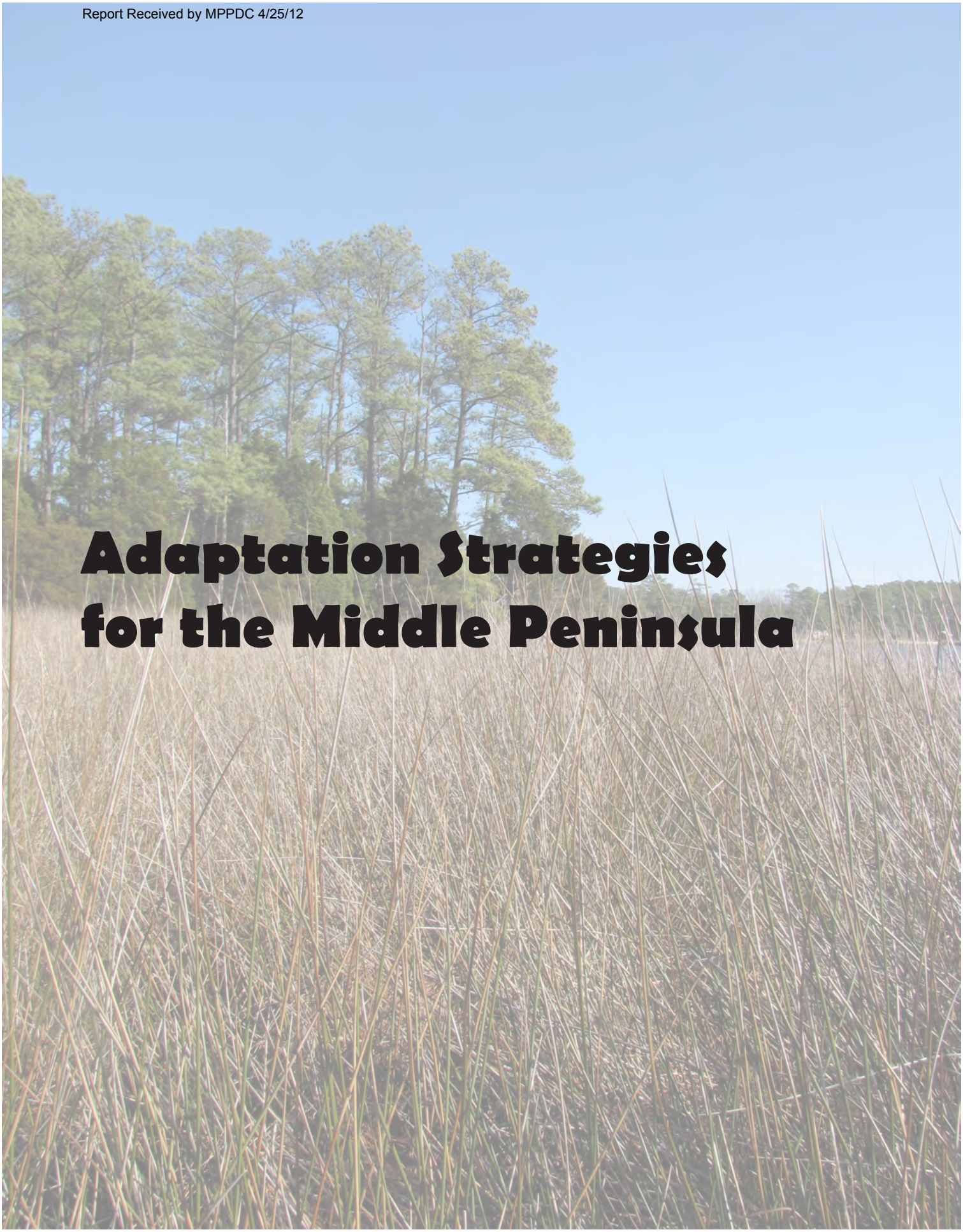
  Note: As a general rule, all permanent structures should be built at an elevation 2 meters above HHWL, to provide a margin of safety from storm surges and flooding.

ACTIVITIES PROHIBITED IN ALL ZONES

There are some activities that are inherently unacceptable in any zone, these include:

- Groins - rigid structures built out from a shore to protect the shore from erosion, to trap sand or to redirect a current.
- Infilling.
- Dredging, excavation and associated spoil disposal activities except with an Ocean Disposal Permit from the Federal Government.
- Beach quarrying.
- Causeways, where a bridge is a technically feasible alternative.

As this section offers a collection of case studies as well as sample ordinacnes, the MPPDC now has a range of adaptation approaches from coastal communities that may assist in future adaptation and/or mitgation efforts and action within the region.



Adaptation Strategies for the Middle Peninsula

In late 2010, Virginia Polytechnic Institute and State University (VTech) was funded through Virginia Sea Grant to partner with the Middle Peninsula Planning District Commission to develop a report focused on delivering a set of options and policy/regulatory strategies targeted to meet the climate adaptation needs of the Middle Peninsula. To improve the long-term community resilience and capacity for climate change adaptation within the region, VTech organized the project into three phases:

Phase I-
State of the Planning District Review:
Synthesize available relevant data and literature to assess current and future climate change impacts specific to the MPPDC communities. Then based on this assessment identify, needs, vulnerabilities and strengths in the MPPDC, as well as match these traits with appropriate case studies.

Phase II –
Portfolio of Coastal Climate Change Case Studies:
Determine common characteristics between the Virginia Coastal Communities and various other coastal communities within the United States and abroad, from which best climate change adaptation practices can be gathered and applied within the MPPDC.

Phase III-
Portfolio of Strategy Options and Tools:
Synthesize the results for Phase I and Phase II into a portfolio of best climate change adaptation practices that are suited to the Middle Peninsula region.

In this section of the START kit the full VTech report, *Building Resilience to Climate Change: Developing Climate Adaptation Strategies for Virginia's Middle Peninsula*, is available. However MPPDC staff has summarized the adaptation measures identified within the report.

SUMMARY:
Local Government Tools for Addressing Sea Level Rise in Virginia

compiled by Nicholas Dumais and Abbey Bucher Ness, Institute for Environmental Negotiation, University of Virginia, December 2011.

Land-Use Planning Strategies

1. Update the local Comprehensive Plan to: (a) Establish the rate of estimated sea level rise and time period over which it may occur; (b) Designate areas vulnerable to sea level rise; (c) Site future public infrastructure and capital improvements out of harm's way; (d) Provide the scientific basis to justify changes in land use decision-making, including an analysis of likely sea level rise hazards (inundation, flooding, erosion), and vulnerabilities (to specific areas, populations, structures and infrastructure); (e) Plan responses to sea level rise.[1]

2. Update existing or designate new inundation zones or flood plain areas using potential sea level rise and predicted flooding data.[2]

3. Integrate vulnerability assessments and sea level rise considerations into the locality's existing Wetlands Ordinance.[3]

4. Revise local zoning and permitting ordinances to require that projected climate change impacts be addressed to minimize threats to life, property, and public infrastructure and ensure consistency with state and local climate change adaptation plans.[4]

[1]Georgetown Climate Center, Stemming the Tide: How Local Governments Can Manage Rising Flood Risks – Review Draft 3 11 (May 2010), on file with author.
[2]See *Id.* at 9-10.
[3]Virginia Polytechnic Institute and State University ("Virginia Tech"), Building Resilience to Change: Developing Climate Adaptation Strategies for Virginia's Middle Peninsula – DRAFT 16 (October 2011), on file with author.
[4]L. Preston Bryant, Jr., Governor's Commission on Climate Change, Final Report: A Climate Change Action Plan 35 (Dec. 15, 2008), on file with author.

Land-Use Planning Strategies (continued)

5. Use overlay zoning to protect shorelines and other vulnerable areas. Overlay districts could prohibit shoreline protection structures, implement shoreline setbacks, restrict future development, lower non-conforming use thresholds, or raise "free board" building code requirements. Shoreline overlay districts could take the form of either:

   a. A fixed-distance zone along the shoreline that would extend across all existing shoreline zoning districts; or
   b. A variable, resource-based zone, based on a scientific inventory of existing shoreline resources. The zone would vary in distance from the water line according to the identified resources.[5]

6. Designate specific thresholds of land disturbance in square footage or acres that trigger a Water Quality Inventory Assessment.[6]

7. Under section §15.2-2286 of the Virginia Code, offer tax credits to landowners who agree to voluntarily "downzone" their property.[7]

8. Offer Use Value Assessments for owners who preserve shoreline property as open space or Wetlands Tax Exemptions to owners who agree to preserve wetlands and riparian buffers. These strategies are authorized under Virginia Code sections §58.1-3230 and §58.1-3666, respectively.[8]

9. Enter into voluntary agreements with landowners to establish "rolling easements" with boundaries that shift as the mean low sea level rises. These would allow landowners to continue with their current land uses until sea level rise actually occurs. At this time, the concept of "rolling easements" is still relatively new.[9]

10. Extend Resource Protection Area and Resource Management Areas under the Chesapeake Bay Preservation Act (CBPA) ordinance. These areas can be extended if specific performance criteria that contribute to the stated goals of the CBPA (pollution reduction, erosion and sediment control, stormwater management) are established.[10]

Erosion Prevention and Water Quality Strategies

1. Prevent the erosion of storm water canals and shoreline by regularly removing trash, vegetation, sands, and other debris.[11]

2. Restore prior-converted wetlands to provide storage and filtration and mitigate storm flows and nutrient loading.[12]

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[5] Virginia Tech, *supra* note 2 at 13, 32, 43.
[6] *Id.* at 16.
[7] Georgetown Climate Center, *supra* note 1 at 18.
[8] Virginia Tech, *supra* note 3 at 43.
[9] Id. at 36, 43; see also Georgetown Climate Center, *supra* note 1 at 19-23.
[10] Virginia Tech, *supra* note 1 at 43.
[11] Institute for Environmental Negotiation ("IEN"), Sea Level Rise in Hampton Roads: Findings from the Virginia Beach Listening Sessions, March 30-31, 2011, Final Report 61, available at http://www.virginia.edu/ien/docs/Sea_Level_Rise%20final%20report%207-19.pdf.
[12] Virginia Tech, *supra* note 3 at 27.

Erosion Prevention and Water Quality Strategies (continued)

3. Require new landscaping to incorporate flood and salt-water tolerant species and focus on creating buffers and living shorelines to reduce erosion.[13]

4. Continue implementing beach replenishment and nourishment efforts.[14]

5. Where possible, adopt shoreline protection policies that encourage the use of living shorelines rather than shoreline hardening.[15]

6. Where this is not feasible, protect land and buildings from erosion and flood damage using dikes, seawalls, bulkheads, and other hard structures.[16]

7. Encourage shoreline property owners to implement shoreline management practices, including managing marshland and constructing stone sills, breakwater systems, revetments, and spurs.[17]

8. Expand the adoption of accepted soil-conservation agricultural management practices to reduce erosion and polluted runoff.[18]

9. Institute engineering strategies to mitigate saltwater intrusion into freshwater aquifers, including the construction of subsurface barriers, tide control gates, and artificially recharging aquifers.[19]

Infrastructure and Flood Management Strategies

1. Develop climate change action plans for critical local infrastructure. If existing transportation infrastructure is at risk, "develop plans to minimize risks, move infrastructure from vulnerable areas when necessary and feasible, or otherwise reduce vulnerabilities."[20]

2. Implement an early warning system for flooding that would monitor rainfall and water levels and notify relevant government agencies and the general public in the event of an emergency.[21]

3. Improve the ability of local infrastructure to efficiently handle drainage in the event of increased flooding. This could involve minimizing the construction of new impervious surfaces in flood-prone areas.[22]

4. Amend existing zoning ordinances to require increased building elevations and setbacks, flood-proofing, and reduced density for new construction within flood zones.[23]

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[13]EN, *supra* note 11 at 57.
[14]*Id.* at 59, 65.
[15]See Bryant, *supra* note 4 at 36.
[16]Virginia Tech, *supra* note 3 at 35.
[17]*Id.* at 42.
[18]*Id.* at 28.
[19]*Id.* at 13.
[20]Bryant, *supra* note 4 at 35; see also IEN, *supra* note 2 at 64-65.
[21]See Virginia Tech, *supra* note 3 at 22.
[22]IEN, *supra* note 11 at 57, 61.
[23]*Id.* at 43; Georgetown Climate Center, *supra* note 1 at 11.

Infrastructure and Flood Management Strategies (continued)

5. Improve and enhance traffic rerouting and emergency evacuation protocols related to flooding events.[24]

6. Ensure that hospitals, evacuation refuge sites, fire and emergency rescue facilities, and key transportation routes are outside of inundation zones or are secured against projected flooding.[25]

7. Redirect new infrastructure development away from low-lying neighborhoods and other at-risk areas, and elevate and armor existing critical infrastructure.[26]

8. Require private sector owners of infrastructure to conduct climate change vulnerability assessments and develop their own climate change adaptation plans as a condition for permit approval.[27]

9. Encourage the graduated repurposing of structures that are rendered unsuitable for their current use by sea level rise.[28]

10. Gradually withdraw public services in flooded areas.[29]

Economic Strategies

1. Involve businesses in the planning process to prevent the loss of shoreline business and to mitigate the impacts of increased flooding and sea level rise.[30]

2. Establish a Transfer of Development Rights program to allow the owners of at-risk shoreline properties to sell development rights to upland landowners.[31]

3. Permit the use of Onsite Density Transfers, which allow developers to subdivide lots into smaller and denser parcels if they preserve a portion of the lot as open space and cluster the subdivided parcels.[32]

4. Purchase flooded property from landowners.[33]

5. Organize coastal businesses and homeowners to appeal to insurance companies for affordable rates and deductibles.[34]

6. Organize coastal businesses and homeowners to petition local, state, and federal politicians to address sea level rise.[35]

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[24]William A. Stiles, "A 'Toolkit' for Sea Level Rise Adaptation in Virginia" 4.1.3, on file with author.
[25]*Id.*
[26]*Id.* at 3.1.
[27]Bryant, *supra* note 4 at 35.
[28]IEN, *supra* note 11 at 60.
[29]*Id.* at 81.
[30]*Id.*at 27.
[31]Georgetown Climate Center, *supra* note 1 at 17.
[32]Virginia Tech, *supra* note 3 at 40.
[33]IEN, *supra* note 11 at 81.
[34]*Id.* at 58-59.
[35]*Id.* at 60.

Economic Strategies (continued)

7. Require realtors to disclose the threat of sea level rise and the responsibilities of shoreline owners to potential purchasers of shoreline properties.[36]

8. Implement special taxing districts that cover the real, life-cycle costs of providing government services in high-risk flood zones, resulting in higher taxes for property-owners in those zones.[37]

9. Use a financial regulatory program to discourage increasingly risky investments along the shoreline. Examples of existing programs with similar aims include:

a. The state regulation of the property loss insurance sector to reflect higher risk from sea level rise, and
b. Placing conditions on economic development to require the completion of a long-range vision and plan that addresses sea level rise and flood risk.[38]

First Steps and Data Gathering

1. Craft a "Community Resilience" policy statement emphasizing the need for science-based vulnerability assessments, adaptation planning, education and public engagement, and the development of flexible regulatory and non-regulatory strategies for addressing climate change and sea level rise.[39]

2. Compile a climate change and sea level rise impact assessment. This is often a long-term, multi-phase effort. Steps can include:

a. Assembling an advisory workgroup.[40]
b. Identifying flood zones and at-risk populations.
c. Mapping regional and county sea level rise predictions to show impacts to existing development and natural areas; and
d. Assessing and prioritizing economic and ecological vulnerabilities to sea level rise.[41]

3. Create adaptation plans for areas at early risk from sea level rise.[42] This could involve an evaluation of adaptation strategies implemented by other U.S. jurisdictions and by foreign governments.[43]

4. Investigate how to address climate change in other planning strategies, including transportation plans, regional economic development plans, and regional hazard mitigation.[44]

5. Identify the financial resources needed to meet adaptation needs.[45]

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[36] *Id.* at 63.
[37] Stiles, *supra* note 24 at 4.1.2.
[38] *Id.* at 4.1.4.
[39] Virginia Tech, *supra* note 3 at 34.
[40] IEN, *supra* note 11 at 57.
[41] Stiles, *supra* note 24 at 3.1.; Virginia Tech, *supra* note 3 at 8.
[42] See generally Stiles, supra note 24; Virginia Tech, *supra* note 3 at 2.
[43] IEN, *supra* note 11 at 57.
[44] See Stiles, *supra* note 24 at 4.1.1.
[45] *Id.* at 3.2.

Public Outreach Strategies

1. Hold a series of meetings with stakeholder groups to discuss and gauge potential climate change and sea level rise impacts to the region or locality.[46]

2. Educate local elected officials on climate change, sea level rise, and the predicted impacts to the region or locality.[47]

3. Present data in easily-understood terms, such as X acres will be flooded, X homes lost, and X impacts to wildlife.[48]

4. Consider re-labeling the term "climate change" to something more locally specific.[49]

5. Extend media coverage to issues related to sea level rise to increase public awareness and to help citizens prepare for emergencies. This can include the use of social media, such as Facebook, as well as traditional media, including radio, television, and newspapers.[50]

6. Increase public outreach, including press conferences, information sessions, community events, public meetings, and exhibits on climate change and sea level rise at libraries, aquariums, and museums.[51]

7. Using modern technologies such as GIS mapping software, develop education programs for residents as well as students in local and regional schools.[52]

8. Educate residents about the role that fertilizing, vegetation removal, and litter play in increasing flooding, erosion, and property damage.[53]

9. Provide landowners with accurate data on the current and future vulnerability of their property to sea level rise as well as best managing practices for mitigating the effects of increased flooding.[54]

10. Raise public awareness of areas prone to flooding through increased signage.[55]

[46] Virginia Tech, *supra* note 3 at 7-8.
[47] *Id.* at 9. For specific training and funding opportunities, see id. at 44-45; see also IEN, *supra* note 11 at 67
[48] IEN, *supra* note 11 at 64.
[49] *Id.* at 80.
[50] *Id.* at 66, 68.
[51] See *id.* at 62-63, 66-67.
[52] See Virginia Tech, *supra* note 3 at 45.
[53] IEN, supra note 11 at 63.
[54] *Id.* at 59; Bryant, *supra* note 4 at 37.
[55] IEN, *supra* note 11 at 57.

Ecosystem Preservation Strategies

1. Establish and maintain corridors of contiguous habitat along natural environmental corridors to provide for the migration and local adaptation of species to new environmental conditions.[56]

2. Develop a price-based accounting system for ecosystem services.[57]

3. Provide local businesses with information on the importance of maintaining the health of shorelines.[58]

4. Remain aware of the effects that flood mitigation strategies, such as beach replenishment, have on wildlife.[59]

Amongst the options presented within the VTech report, a few are currently being integrated into local policies, while the current political climate, regional values, as well as the sheer legislative structure of the Commonwealth may limit other options from being pursued. For instance, rolling easements - policies that allow for coastal development but prohibit property owners from holding back the sea - may be complicated to implement due to strong personal property right sentiment within the Middle Peninsula. It is quite possible that constituents may consider this a "takings". In comparison, a few of the infrastructure and flood management strategies could potentially be viable only after the development, adopting and implementation of a solid local flood management/ climate change/sea level rise policy – specific strategy suggestions include (1) requiring private sector owners of infrastructure to conduct climate change vulnerability assessments and develop their own climate change adaptation plans as a condition for permit approval, (2) encourage the graduated repurposing of structures that are rendered unsuitable for their current use by sea level rise, and (3) gradually withdraw public services in flood areas. None the less, with this comprehensive review of regulatory and non-regulatory options to adapt to climate change and sea level rise impacts within the region, considering the "First Steps and Data Gathering" strategies and "Public Outreach" strategies first and for most will establish an informational baseline that may build community support and local action.

The adaptation strategies identified in this report will be presented to the Middle Peninsula Planning District Commission in detail. MPPDC staff will assist member localities in conveying this information to local planning commissions for coordination and integration into local policies. For those localities not interested in taking action, this report will be an informational resource for, if and when, they choose to develop public policy to respond to climate change and/or sea level rise impacts.

[56]IEN, *supra* note 11 at 64.
[57]Virginia Tech, *supra* note 3 at 21.
[58]IEN, *supra* note 11 at 61.
[59]*Id.* at 64.

Report Received by MPPDC 4/25/12

Building Resilience to Change:

Developing Climate Adaptation Strategies for Virginia's Middle Peninsula

Tommi Godwin
John Randolph
Virginia Polytechnic Institute and State University
February 2012

This study, *Change Adaptation Strategies for Middle Peninsula Counties in the Virginia Coastal Community*, was partially funded by the Virginia Sea Grant Program , Virginia Institute of Marine Science, School of Marine Science, College of William & Mary.

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List of Acronyms

Acronym	Full Name
Virginia Agencies, Committees, Organizations	
CCAC	Climate Change Advisory Committee
CELCP	Coastal and Estuarine Land Conservation Plan
CPT	Coastal Policy Team
DCR	Department of Conservation and Recreation
DEQ	Department of Environmental Quality
DGIF	Department of Game and Inland Fisheries
MRC	Marine Resources Commission
VCZMP	Virginia Coastal Zone Management Program
VIMS	Virginia Institute of Marine Science
VNRLI	Virginia Natural Resources Leadership Institute
Federal	
CBPA	Chesapeake Bay Preservation Act
CBRA	Coastal Barrier Resources Act
CCSP	U.S. Climate Change Science Program
COE	U.S. Army Corps of Engineers
CZMA	Coastal Zone Management Act
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FWS	U.S. Fish and Wildlife Service
HMGP	Hazard Mitigation Grant Program
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
OCRM	Office of Ocean and Coastal Resource Management
OMB	Office of Management and Budget
Miscellaneous	
CCAW	Climate Change Advisory Workgroup (MPPDC)
CRS	Community Rating System
DEM	Digital Elevation Model
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
ISCC	International Scientific Congress on Climate Change
LID	Low Impact Development
LIDAR	Light Detection and Ranging
MLWL	Mean Low Water Line
MPPD	Middle Peninsula Planning District
MPPDC	Middle Peninsula Planning District Commission
RPA	Resource Protection Areas
RMA	Resource Management Areas
SLR	Sea level rise
CBNERR	Chesapeake Bay National Estuarine Research Reserve
CTP	Coastal Training Program

Executive Summary

With over 1000 miles of coastal shoreline and many low lying areas, Virginia's Middle Peninsula is vulnerable to coastal storms and flooding, which will be made worse by climate change and sea level rise. In collaboration with current planning efforts of the Middle Peninsula Planning District Commission (MPPDC), this project report has two primary goals:

1. To synthesize adaptation planning principles and practice that are applicable to the MPPD;
2. To develop a planning framework and strategies to build resilience to natural hazards and climate change impacts; and
3. To present findings that are useful to MPPD and other coastal communities working to begin or expand climate change adaptation planning efforts.

Adaptation is defined as a process, action, or outcome in a system in order for the system to better cope with, manage, or adjust to a changing condition, risk, or opportunity. A system's capacity for adaptation or resilience is its ability to absorb perturbations without being undermined or becoming unable to adapt, self-organize and learn. Effective adaptation, then, must be anticipatory, identify vulnerabilities, stress preparedness for change, and build capacity for resilience among those likely affected by change.

This report summarizes existing studies and plans by the MPPDC and others on the anticipated climate change impacts in the region and the state of the Middle Peninsula's preparation for those impacts (chapter 2), synthesizes some general climate change adaptation planning principles applicable to the Middle Peninsula (chapter 3), reviews and gleans lessons from case examples of state and local adaption and resilience plans (chapter 4), and based on those principles and cases, formulates a planning framework and a portfolio of strategies appropriate to the Middle Peninsula that may help MPPD jurisdictions better prepare for existing and expected hazards and impacts (chapters 5 and 6).

The potential impacts of climate change are widespread across many sectors in the Middle Peninsula, vulnerabilities are significant, and uncertainties complicate public engagement and commitment to action. The MPPDC has been active in developing natural hazard mitigation plans , performing a vulnerability assessment and community involvement about climate change impacts as well as adaptation strategies. These current planning efforts by the MPPDC and by some localities provide a foundation for hazard mitigation, climate change adaptation, and building community resilience. An assessment of current local plans and ordinances identified some positive actions among localities but also common gaps in effectiveness and opportunities for improvement.

Principles of climate change adaptation gleaned from four extensive studies on the topic include five basic steps: (1) identifying current and future climate impacts, (2) assessing vulnerabilities and risks to climate impacts, (3) developing a risk-based, prioritized adaptation strategy, (4) implementing the strategy, and (5) monitoring and evaluating the implemented strategy. Additionally the four studies emphasize the use of best available science, a collaborative planning approach, and priority setting.

A review of selected state and local adaptation plans revealed a number of lessons for the Middle Peninsula, including (1) establishing a policy framework for addressing vulnerability and change under the theme of Community Resilience; (2) expanding science-based assessments of vulnerability and risk, mapping and evaluating high hazard and impact areas; (3) engaging local leaders and citizens in dialogue, planning, decision-making, and action about vulnerability, change, and resilience; (4) incorporating vulnerability and change into District-wide and county comprehensive plans; (5) within such plans, adopting a protection-accommodation-retreat approach, applying adaptive management and flexibility to manage uncertainty, taking a place-based approach, and considering co-benefits of actions taken; and (6) giving priority to action strategies that improve economic and social well-being.

The climate adaptation strategies developed in this study apply these principles and experiences to the situation of the Middle Peninsula. The approach includes a basic framework for policy, planning, public engagement, and vulnerability assessment. The portfolio of strategies that should emerge from this framework includes regulatory and non-regulatory programs that range from floodplain management and overlay zones to infrastructure permitting and investment to land conservation easements to tax policies to education and outreach.

Climate change is real and happening, yet the magnitude of its local consequences and their timing are uncertain. This uncertainty complicates appropriate actions which may require changing behavior, changing patterns of land use, changing property values, and changing infrastructure investments. Even without uncertainty, change is hard and needed investment for change is hard to come by. But the most costly, damaging, and disruptive approach in the face of the vulnerability of the Middle Peninsula is to do nothing.

Localities within the Middle Peninsula must continue to build their community resilience to disruptive events and changing conditions. Their current efforts vary, and a more consistent regional strategy coordinated by the MPPDC is recommended. Given uncertainties and current public sentiments, such a regional strategy and its local implementation should begin with a public engagement program that includes local fact-finding and vulnerability assessment, and the collaborative learning it generates. Plans and strategies should be flexible, adaptive, and incremental, allowing for modification over time as conditions, resources, and sentiments change and uncertainties are resolved.

This iterative approach to reduce vulnerability and build resilience should be integrated into the PDC's and localities' existing planning framework, which includes comprehensive planning, natural hazard mitigation, land use zoning, building codes, floodplain management, stormwater management, Chesapeake Bay regulations, land conservation, and transportation and water/wastewater infrastructure plans. These programs will continue to be the foundation for efforts to reduce vulnerability over time.

Chapter 1: Introduction

Climate change may increase the likelihood of extreme weather events such as floods, coastal storm surges, droughts and heat waves, as well as more gradual changes in temperature, precipitation, and sea level rise. Climate change is a global phenomenon, which compels local decision makers to develop adaptation strategies that secure and promote public safety, health and welfare by reducing vulnerability to existing hazards and impacts that are expected to be exacerbated by climate change.

2010 Census for Middle Peninsula	
Total Population	90,826
Growth Rate	9%
Population Density *(persons/square mile)*	71

Although one of the least densely populated areas in the state, the Middle Peninsula did see a population increase of 7.9% from the 2000 Census. The Middle Peninsula contains 3.2% of Virginia's land mass but only 1.1% of the state's total population.

Population Trends by County			
Locality	Total Population		Population Growth from 2000-2010
	2000	2010	
Essex	9,989	11,151	12%
Gloucester	34,780	36,858	6%
King & Queen	6,630	6,945	5%
King William	13,146	15,935	21%
Mathews	9,207	8,978	-2%
Middlesex	9,932	10,959	10%
Town of Tappahannock	2,138	2,375	11.1%
Town of Urbanna	543	476	-12.3%
Town of West Point	2,866	3,306	15.4%

Figure 1.1 Middle Peninsula Regional Profile. Source: MPPDC (June 2011).

The Middle Peninsula Planning District (MPPD) of the Virginia Commonwealth is located on the Chesapeake Bay. Occupying 1,387 square miles (888,064 acres) the MPPD consists of the Counties of Essex, Gloucester, King and Queen, King William, Mathews, and Middlesex Counties and the Towns of Tappahannock, Urbanna, and West Point (Figure 1.1). The shoreline of the Middle Peninsula reaches 1,055 miles, and the MPPD is one of the least densely populated areas of the state with a population density of only 71 persons per square mile at the time of the 2010 U.S. Census (MPPDC, 2011).

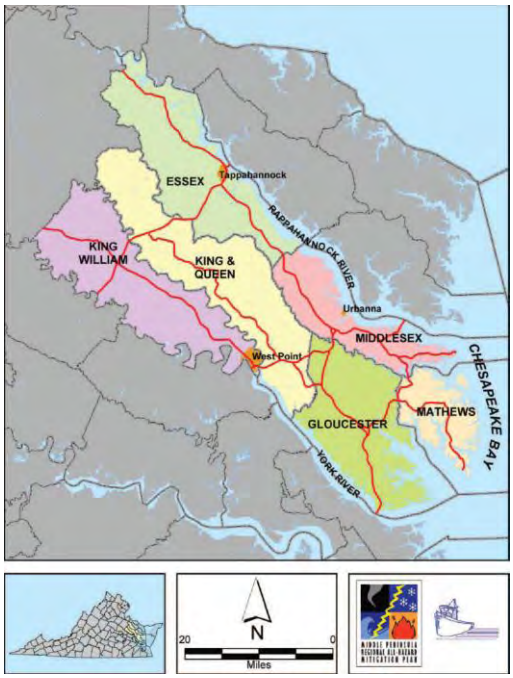

Figure 1.2 The Middle Peninsula Region (Source: MPPDC, 2005)

As reported by the MPPDC in 2011, regional population growth rate for the Middle Peninsula was nine percent (9%) as of the 2010 U.S. Census. The Counties of Essex, King William, and Middlesex all had growth rates exceeding ten percent during that period while Gloucester, King & Queen, and Mathews experienced slower growth (6%, 5%, and -2%, respectively).

The Middle Peninsula is already vulnerable to flooding and coastal storms which are projected to worsen as a result of climate-change-induced weather variability and sea level rise. Additional community aspects at risk to climate impacts include natural habitats and biodiversity, agriculture, infrastructure, as well as economic and social

disruption. With its extensive shoreline, a considerable amount of coastal land and low lying areas in the Middle Peninsula is vulnerable to climate change impacts. In collaboration with current planning efforts of the Middle Peninsula Planning District Commission (MPPDC), this project report has two primary goals:

1. To gather and summarize examples of adaptation planning principles and practice that are applicable to the MPPD; and
2. To present findings in such a manner that can be useful to MPPD and other coastal communities working to begin or expand climate change adaptation planning efforts.

Project Scope

Climate change planning – often referred to as "climate action" planning – is comprised of both climate change mitigation (i.e. reduction of carbon emissions) and climate change adaptation (i.e. preparing for and responding to the effects of climate change). These two aspects of climate action planning are inextricably linked and often overlap in application. As stated by John Holdren, Director of the White House Office of Science and Technology Policy, "We only have three choices: adaptation, mitigation and suffering, and we are going to need a lot of the first two in order to avoid a lot of the third" (Tollefson, 2010).

Climate adaptation planning is the central focus of this report. Adaptation can be defined as:

> a process, action, or outcome in a system in order for the system to better cope with, manage, or adjust to changing condition, risk, or opportunity. A system's capacity for adaptation or resilience is its ability to absorb perturbations without being undermined or becoming unable to adapt, self-organize and learn. Effective adaptation, then, must be anticipatory, identify vulnerabilities, stress preparedness for change, and build capacity for resilience among those likely affected by change. (Randolph, 2011)

Achieving effective adaptation planning requires coordination across many sectors of planning: community development, economic development, emergency preparedness, hazard mitigation, infrastructure and service planning, and natural resources planning. Resulting adaptation plans, then, often resemble a strategic plan or hazard mitigation plan. The National Research Council's report, *Adapting to the Impacts of Climate Change* suggests that the adaptation process is "fundamentally a risk management strategy" (NRC 2010).

In collaboration with the MPPDC, the focus of this study is on adaptation planning for impacts of "climate change and sea level rise." The impacts are more complex than simply slow rising waters, since the major effects will be felt in more intense and frequent flooding and storm surge events, saltwater intrusion and rising water tables that impact wells and septic systems, extreme heat events, and the disruptions created by hazards and changing conditions.

The principle aim of this report is to summarize existing studies and plans by the MPPDC and others on the anticipated climate change impacts in the region and the state of the Middle Peninsula's preparation for those impacts (chapter 2), synthesize some general climate change adaptation planning principles applicable to the Middle Peninsula (chapter 3), review and glean lessons from case examples of state and

local adaption and resilience plans (chapter 4), and based on those principles and cases, formulate a planning framework and a portfolio of strategies appropriate to the Middle Peninsula that may help MPPD jurisdictions better prepare for existing and expected hazards and impacts (chapters 5). First, this chapter introduces expected climate change impacts in the MPPD and reviews recent efforts by the PDC and member jurisdictions in hazard mitigation and vulnerability assessment.

Chapter 2: The State of Community Resilience to Climate Change in the Middle Peninsula

The Middle Peninsula PDC has been active in planning to reduce vulnerability to impacts of hazards and climate change in the region. Still, the state of hazard mitigation and adaptation planning within the MPPD varies among jurisdictions. Recent planning studies include the current PDC climate adaptation studies, as well as natural hazard and floodplain planning, water quality assessments and Total Maximum Daily Load (TMDL) development, inventory of current and projected alternative onsite sewage disposal systems (OSDS) and water supply planning. Planning and mapping efforts are not uniform for all Middle Peninsula localities, and for most, ordinances have yet to incorporate proactive measures that address likely future hazard and climate scenarios.

Middle Peninsula localities and the Planning District Commission (PDC) face multiple challenges, including scarce funding, economic development needs, provision of services to higher-risk areas, stewardship of natural and cultural resources, and varying political perspectives on the need for climate-change planning. Opportunities to address climate adaptation exist within the regulatory framework enabled by the Virginia Commonwealth, as well as ongoing efforts promoting interagency collaboration in the areas of natural resource planning, public access to waterways, shoreline protection decisions, floodplain management, and natural hazard mitigation. The MPPDC has been active in acquiring planning funds through federal and state sources toward such endeavors.

This chapter presents the state of Middle Peninsula resilience to climate change. It summaries existing climate change impact and vulnerability studies and hazard mitigation plans, and identifies challenges and opportunities within the MPPD for adaptation planning, including local-level strategies. To put the Middle Peninsula in context, Appendix 2.A to this chapter provides a short literature review of climate change impacts in the Chesapeake Bay Region.

Middle Peninsula Planning District Hazard and Climate Change Planning

Middle Peninsula Natural Hazard Mitigation Plan (2010)

The Middle Peninsula Planning District Commission has been active in planning to reduce vulnerability to impacts of hazards and change in the region. In 2010, the PDC completed the Middle Peninsula Natural Hazards Mitigation Plan (NHMP) Revision 1, which updated the hazard identification, prioritization and goals from the 2006 NHMP. The NHMP assessed vulnerability and risk from 21 natural hazards including weather-related events and geologic hazards. All of the 21 hazards identified are likely to be exacerbated by climate change, with the exception of land subsidence resulting from karst terrain (Figure 2.1). In addition to vulnerability assessment, the plan assessed local capabilities and outlined a hazard mitigation strategy to prevent future hazard related losses, to improve community emergency management capability, and to increase public awareness of vulnerability to hazards.

Revision 1 of the NHMP made noteworthy additions to the previous plan, such as consideration of Sea Level Rise as a “Moderately-Critical Hazard” to the Middle Peninsula and recommendation of public outreach to mitigate risk to riverine flooding and lightning strikes.

MIDDLE PENINSULA HAZARD AND VULNERABILITY ASSESSMENT TOOL
NATURAL HAZARDS -- SUMMARY SHEET

EVENT	PROBABILITY	HUMAN IMPACT	PROPERTY AND FACILITY IMPACT	BUSINESS IMPACT	Mitigation Options	UNMITIGATED RISK	UNMITIGATED RANKING
	Likelihood this will occur	*Possibility of death or injury to public and responders*	*Physical losses and damages*	*COOP and interruption of services*	*Pre-Planning*	*Relative Threat*	*Based only on probability and threat*
SCORE	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 - 100%	
Hurricanes	3	3	3	3	2	92%	
Winter Storms (Ice)	2	2	2	3	2	50%	
Tornados	2	2	2	2	2	44%	
Coastal Flooding	3	2	3	2	2	75%	
Coastal/Shoreline Erosion	3	1	2	1	2	50%	
Sea Level Rise	3	0	2	2	2	50%	
Winter Storm (Snow)	2	2	2	2	2	44%	
Wildfire	2	1	1	1	2	28%	
Riverine Flooding	2	2	1	1	2	33%	
High Wind/Windstorms	2	2	2	1	1	33%	
Dam Failure	2	1	1	1	2	28%	
Drought	2	0	1	2	2	28%	
Lightning	3	1	2	2	1	50%	
Earthquake	1	0	0	0	0	0%	
Shrink-Swell Soils	2	0	1	0	1	11%	
Extreme Cold	1	2	0	0	1	8%	
Extreme Heat	2	2	0	0	1	17%	
Landslides	1	0	0	0	0	0%	
Land Subsidence/Karst	1	0	0	0	0	0%	
Tsunami	1	0	0	0	0	0%	
Volcano	0	0	0	0	0	0%	
AVERAGE	2.27	1.27	1.67	1.53	1.67	25%	

*Threat increases with percentage.

UNMITIGATED RISK=		PROBABILITY * IMPACT	
	0.25	0.63	0.39

KAISER PERMANENTE

Figure 2.1 Priority Risks Identified in MPPDC Natural Hazard Mitigation Plan (2010)

Middle Peninsula Climate Adaptation (2008-11)

In addition to the NHMP, the MPPDC is in the midst of a three year endeavor funded through the Virginia Coastal Zone Management Program to work with member localities and stakeholder groups to assess and discuss potential climate change and sea level rise impacts to the region. In particular, Phase I of this project focused on the collection, assessment and analysis of potential ecologic and anthropocentric impacts of climate change, specifically due to sea level rise. The information gathered during Phase I acted as a foundation to develop an educational program for local elected official and the general public in Phase II.

The MPPDC staff procured best-available geographical information systems (GIS) data to produce maps of land vulnerable to future coastal flooding and sea level rise. To connect Phase I vulnerability analysis with actionable planning strategies, the MPPDC administered a public outreach and education phase of

their program. Stakeholder meetings produced numerous opportunities for discussion of potential impacts and adaptation priorities.

As climate change and sea level rise still remain a very unsettled issue amongst Middle Peninsula constituents and local elected officials, MPPDC staff developed an educational program to continue dialogue about this issue and to begin to discuss local government's role in managing potential impacts. Through the use of Qwizdom software, an audience response system that utilizes hand held remotes and an interactive tablet to engage the audience, stakeholder feedback was gathered and summarized in a cumulative findings report. The report demonstrates discrepancies between stakeholder group knowledge and beliefs with regard to climate change and sea level. The MPPDC intends to use community perceptions to improve effectiveness of future educational outreach efforts and policy development. The following sections provide some detail on Phases I and II.

Middle Peninsula Climate Adaptation Impact Assessment Phase I (Year 1: 2008-09)

Phase I of the climate adaptation project focused on the collection, assessment and analysis of potential ecologic and anthropocentric impacts of climate change specifically due to sea level rise (SLR). MPPDC staff produced a 37-page report, detailing key vulnerabilities within the planning district. The assessment report divides assets into two categories: Infrastructure and Wetland Functions. Infrastructure subcategories include houses, onsite sewage disposal systems (OSDS), wells, shoreline hardening, roads and railroads. Wetland functions include Commercial Factors (fishing and shellfish habitat, waterfowl habitat, mammal and reptile), Damage Control Factors (environmental protection against erosion, wind, storms, flooding), and Recreational Opportunities (consumptive and non-consumptive). The report cites several methodologies for estimating values of ecological functions and, therefore, offers a range of potential loss whenever employing more than one assessment method.

The MPPDC distributed Year One efforts across the following five phases:

1. **Introduce the issue** of climate change and SLR to the MPPDC
2. **Assemble a Climate Change Advisory Workgroup** (CCAW) to identify anthropogenic and ecological vulnerabilities within the Middle Peninsula
3. **Educate the CCAW** on the topic of climate change, current regional impacts, and survey of current adaptation practices, domestically and internationally
4. **Map regional and county SLR predictions** to depict impacts on structures and wetlands
5. **Assess and prioritize** economic and ecological vulnerabilities to SLR

In March 2009, MPPDC staff presented an overview of current domestic and international practices entitled "Responses to Climate Change Impacts." The presentation addressed three general categories: 1) Mitigating SLR Impacts on Coastal Property, 2) Mitigating SLR Impacts to Coastal Infrastructure, and 3) Land Use Responses to Other Climate Change Impacts. To build on this work, a variety of additional land use strategies can be added to the overview for future use by local decision makers (e.g. density transfers, conservation easement programs, and extension of Resource Protection/Management Areas under the Chesapeake Bay Preservation Act). This report addresses those adaptation strategies in detail in subsequent chapters.

Maps were created for the whole Middle Peninsula region as well as focus areas within various member jurisdictions. Impact assessments were presented to stakeholder groups in the form of focus-area map

accompanied by cost estimates. The cost estimates were based on inundation and therefore estimated losses – infrastructure, ecosystem function, and wetlands – as total loss. The calculation methods employed in these estimates were well documented and presented as potential ranges for loss. The MPPDC vulnerability assessment comprises a robust set of test scenarios against which to measure adaptation strategies as they are developed.

MPPDC staff conducted a sector-wise brainstorming session of climate change impacts, using the following sectors: Recreation, Transportation, Infrastructure, Business, Health, Emergency Response, Energy, Hydrology and Water Resources, Agriculture, Biodiversity, Forests, Coastal Resources and Ecosystems, and Aquatic ecosystems. Impacts and vulnerabilities identified in this process are summarized in the Challenges section later in this chapter.

Middle Peninsula Climate Change Adaptation Phase II: Discussions with Local Elected Officials and the General Public (Year 2: 2009-10)

Maps and educational materials from the Middle Peninsula vulnerability assessment were disseminated to all counties within the MPPD. A Coastal Zone Management (CZM) grant for Year 2 funded a series of Qwizdom-facilitated meetings intended to assess existing knowledge and preferences regarding climate change, sea level rise, and government services. MPPDC staff developed a sixteen-question presentation: six questions each on Climate Change and Sea Level Rise, four questions on Government Services. The questions were then posed to representative members of three target groups: Local Elected Officials (i.e. MPPDC Board Members), County Staff, and General Public.

Findings for this report are in narrative form, generally with the following themes:

- **Belief in Climate Change:** A high majority of those polled believe climate change is occurring – 87 percent, 91 percent and 91 percent – Local Elected Officials, County Planning Staff, and General Public, respectively

- **Sea Level Rise:** High majorities of those polled agree there has been an increase in Mean SLR over the past 20-30 years (87/100/83 for PDC Board/Planners/Public) and non-conflicting views of the past rate of SLR in the Middle Peninsula

- **Government Services:** A narrow majority of local planners and the general public agree that a property owner has the right to build anywhere they can obtain the required permits (55 and 50 percent, respectively with one general public respondent not answering), while 60 percent of Local Elected Officials answered 'No' to the same question

- **Increased Cost of Government Services:** Multiple-choice answers for how to address increased cost of government services (due to climate change) were "Develop a High-hazard district," "Levy additional county-wide public service tax," or "Set aside general fund revenues." A majority of all respondents selected High-hazard district (60/91/71 for Elected Officials/Local Planners/ General Public, respectively)

In a brief concluding statement to their Year 2 report, MPPDC discuss Year 3 development of a START (Start Adaptation and Response Today) kit, to include local scientific data, Kaiser-Permanente natural

hazard vulnerability assessment results, relevant case studies, and sample ordinances from communities that have adopted adaptation planning policies. This report is intended to supplement the case study and strategy options portion of the START kit.

Challenges Facing Middle Peninsula Climate Adaptation

As local communities are responsible for land-use planning, they "bear the majority of responsibility to plan, implement, and enforce adaptation strategies…in a changing environment" (Culver, et al., 2010). The Middle Peninsula faces considerable challenges to manage existing natural hazards and vulnerabilities and these and other impacts are expected to increase with advancing climate change.

Impacts are wide-reaching

In its Phase I study and its NHMP, the MPPDC assessed potential impacts of hazards and climate change on the Middle Peninsula. Region-specific assessments completed by the National Research Council (2010) round out the list of potential impacts (covered in greater detail in Chapter 3). The following summarizes these natural hazard and climate change impacts by sector.

Agriculture & Forestry. Loss of farmland occurs where extreme weather events combine with land subsidence to leave some areas water-logged and no longer able to produce. Disease pressure on crops and livestock increases with earlier springs and warmer winters, allowing higher survival of pathogens and parasites (NRC, 2010), and point and nonpoint source pollution from agriculture practices could increase.

Fisheries. Negative impacts on fisheries can cause economic losses. Fecal coliform occurrence in drainage ditches was very high following Hurricane Isabel in 2003. Leaking septic tanks are more frequent as a result of storm surge and coastal flooding, flowing into drainage ditches and adjacent bodies of water, negatively impacting fish populations.

Recreation. Rising sea level or erosion may continue to decrease the area available for public parking and public water access. This trend, combined with increased summer season length could result in increased burden on existing public access facilities. In turn, the redistribution of season lengths has the potential to increase use conflicts between recreational users and marine-based fishing and commerce users (Karl et al, 2009).

Transportation. Travel disruptions are associated with road washouts and flooding. Property values may diminish based on impaired road access to businesses and residences due to road washouts and flooding. Increased maintenance costs of impacted/damaged roads are likely in vulnerable areas. Coastal storm surge and flooding reduces water-based navigation availability in some areas, impacting commercial and recreational boating. Road damage from increased flooding is likely. Some areas are cut off from evacuation or assistance due to flooding, washouts, or damage to bridges.

Infrastructure. Sea level rise increases risk of surface water reservoir contamination, shellfish habitats impairment, and increased risk of harmful algal blooms. There is increased likelihood of loss of private and public infrastructure due to storm surge and coastal flooding: water and sewer systems, power lines, and roads.

Water. Increasing frequency of coastal and riverine flooding poses a threat to buildings and infrastructure located in the floodplain and storm surge areas. Water quality becomes more challenging to maintain with increased flooding and storm water runoff, which carries harmful pollutants. Existing water infrastructure and treatment capacity may be insufficient to handle failure due to storm surge.

Saltwater Intrusion. Saltwater can contaminate freshwater aquifers and make them unsuitable for human consumption, or even for agricultural uses. The intrusion of saltwater can also be a risk to shallow freshwater aquifers that may be pushed upwards causing contamination risks from septic tanks and runoff pollution (Bailey, Deyle & Matheny, 2007). The point at which the fresh and saltwater meet is called the salt front, and it can move up freshwater rivers (NRC, 1987). This will spoil uses of freshwater and negatively impact recreation opportunities.

Health. Rises in summer temperatures can lead to more heat related strokes and reduced air quality. Climate change causes distribution of vector-borne and zoonotic diseases and may also cause re-emergence of diseases such as malaria and dengue fever. Heat causes increase in ground level ozone concentrations which can cause lung injury and increase severity of respiratory diseases. Rising groundwater levels will inundate drain fields impairing function for both disposal and soil treatment.

Ecological Impacts. Sea level rise and coastal flooding affects water quality in the Middle Peninsula. Changes in crop yields occur where there is an increased risk of heat stress, pest outbreaks, and weeds due to damp conditions. Coastal flooding and storm surge have also led to habitat loss for coastal species. Erosion causes damages to coastal infrastructure, dunes, beaches and other natural resources. Salt water intrusion occurs in coastal aquifers due to sea level rise, and there may be increased risk of pollution from coastal hazardous waste sites due to storm surge and flooding.

Energy. Rises in average and peak temperatures during warmer months, in addition to longer warm seasons, lead to increased demand for cooling and fewer months requiring heat energy. Extreme weather events along the coast may potentially disrupt energy conversion, generation, and transportation. Energy infrastructure in at-risk areas may suffer damage or require high frequency of maintenance due to coastal flooding and storm surge.

Vulnerabilities are significant

The existing Multi-Hazard Mitigation Plan (MHMP) for the Middle Peninsula includes Coastal Flooding and Coastal/Shoreline Erosion, outranked only by Hurricanes, Wind Storms, and Tornadoes in the MPPDC's risk assessment. Scoring and ranking criteria are clearly identified in the MHMP, and a similar framework can be adapted to a risk-based analysis and prioritization of coastal vulnerabilities in the future. A challenge of using the hazard mitigation planning framework as a model is that hazard probability is based on historic frequency of the event. In the case of coastal flooding and erosion, past rates of occurrence alone are insufficient to calculate future likelihood. With changing climate, future sea level, storm surges, and erosion rates will be different from the past. Future hazard probability should be based on calculations that incorporate current science-based formulas to determine future rates of coastal

storm surge, flooding, and erosion. For example, FEMA is currently in process of updating Flood Insurance Studies for mid-Atlantic coastal communities (see http://www.r3coastal.com) , which will base in part on a recent storm surge study completed by the U.S. Army Corps of Engineers (see http://www.r3coastal.com/home/storm-surge-study). These studies should incorporate future scenarios of sea level rise and resulting impacts on flood elevations.

Uncertainties complicate public perceptions and commitment to action

Climate change is real and happening, yet the magnitude of its local consequences and their timing are uncertain. This uncertainty complicates appropriate actions which may require changing behavior, changing patterns of land use, changing property values, and changing infrastructure investments. Even without uncertainty, change is hard and needed investment for change is hard to come by.

These uncertainties influence public perceptions about the need for action. In recent years, the MPPDC has experienced a range of local reactions to planning efforts that incorporate the concept of "climate change," from invested stakeholder support to staunch stakeholder resistance. Beyond the physical challenges posed by vulnerability, local planners and decision makers face the political challenge of incorporating all citizen input into the planning process. This can be difficult when facilitating politically polarized stakeholder groups. Local planners and community officials may consider the following three recommendations, developed by Culver et al (2010): [1], "show leadership and recognize the need to act, [2] organize stakeholders to identify key values and develop a common vision for the future of the community, and [3] partner with neighboring communities to leverage resources and support comparability" (Culver, et al., 2010).

Under the Dillon rule, Virginia localities must have delegated authority for specific actions

In Virginia, local government authority is limited by the Dillon rule, meaning that localities may exercise only those powers specifically delegated by the General Assembly and may use only those methods consistent with state statute. It is possible that Middle Peninsula localities could choose to implement a climate change adaptation strategy but lack the authority to do so.

In 2010, the Georgetown Climate Center conducted a case study of Virginia and specifically analyzed the authority of Virginia localities to use existing land use powers to adapt to climate change impact based on both statutory language and case law. The study concluded that the "Virginia Code delegates broad authority to local governments, which reasonably permits consideration of sea level rise," including comprehensive planning and land use regulations (setbacks, transfer of development rights) and non-regulatory measures (tax incentives and open space easements) in vulnerable areas (Silton and Grannis, 2010, p. 23). Localities also have broad authority to regulate development in flood prone areas (15.2-2283) and riparian areas under the Chesapeake Bay Preservation Act (10.1-2108).

Opportunities for Community Resilience

Opportunities for reducing vulnerability and building resilience to change require a comprehensive approach including policy statements, vulnerability assessments, citizen engagement, and development of appropriate strategies. Whatever strategies that are developed should build on current land use policies

and regulations. This section provides a general discussion of strategies that serve as a first step and foundation for a more comprehensive approach for community resilience. These include floodplain mapping and management and land use ordinances. The following section assesses current plans and ordinances in MP localities through the lens of climate change adaptation.

Comprehensive Plans

The Code of Virginia (§ 15.2-2223) states that all Virginia local governments shall prepare a comprehensive plan that reflects a 40-50-year vision for the community and describes means to achieve that vision. The plan should be updated about every five years. The plan generally contains several elements including land use, transportation, infrastructure, natural environment, hazard mitigation, housing, economic development, and others. Chesapeake Bay localities need to incorporate goals, objectives, and strategies to meet requirements of the Chesapeake Bay Preservation Act. The plan involves a process of public engagement, technical analysis, and elected official adoption, so it carries some public and political authority.

Floodplain Management

Floodplain mapping is an important aspect of flood hazard mitigation. It is used to identify properties that fall within flood hazard areas, for zoning and development purposes, and for the Federal Emergency Management Agency (FEMA) National Flood Insurance Program, which offers subsidized flood insurance. One-hundred year floodplain maps developed by FEMA represent areas with a 1% statistical chance of flooding in a given year, and are created based on historical data. As more extensive and accurate data becomes regularly available, updated floodplain maps can be combined with best-known estimates of mean sea level change (using annual tide data) for the purpose of future planning and climate change adaptation, these maps should also account for future expected sea level rise. As sea level changes occur, it is expected that "higher floods will happen more often, and the boundaries of flood zones and hurricane storm surge vulnerability zones for storms of a given return frequency will move higher and further landward (Bailey, Deyle & Matheny, 2007)."

Counties should not only work to ensure that floodplain maps are as up to date and accurate as possible, reflecting the potential for sea level rise, but also to ensure that landowners and residents are familiar with these maps and aware of changes made by making the data easily accessible. It is likely that updates reflecting the potential for sea level rise will identify new areas of land within the 100-year floodplain. This may have implications for existing structures which were not previously located within the floodplain. These structures may require alterations in order to be elevated above the new flood levels.

Other Ordinances: Overlay Districts

A regulatory tool used in land use planning, overlay zoning, is a tool that allows for additional land use regulations to be applied to existing land use regulations. This tool allows for great variability across different land use types and allows for specific resource protection or development within the selected area (CLE, 2005). While reviewing the comprehensive plans of the MPPDC we noticed that there was no significant reference to the use of overlay zoning for future land use planning in the context of climate variability adaptation. The chart provided in the beginning of this document shows what counties we believe to have reviewed the use of overlay zoning techniques versus the ones that have not.

Overlay zoning represents an important land use tool aimed at protecting shoreline and flood prone areas. Shoreline overlays will not alter the existing zoning practices, but instead provide extra support by protecting property values, preventing environmental degradation, and maintaining natural vegetation and local wildlife (MLUI, 2001). Before overlay zones can be established however, localities are recommended to extend their current boundaries of the regulated flood plain to include flood prone areas farther inland. These changes will allow for a proper overlay zone that accounts for future estimated flood levels. The MPPDC counties are recommended to follow two general options for the implementation of shoreline overlays.

The first option is a fixed-distance boundary. This is a line that is drawn parallel to the shoreline or ordinary high water mark at a fixed distance. It should extend across all zoning districts along the shoreline. The distance a community selects is discretionary, although 500 feet is generally recognized as a minimum distance to protect coastal features. This one-distance-fits-all boundary may leave some valuable shoreline resources unprotected if they fall further than the fixed distance from shore. However, this is the simplest and most inexpensive approach to establishing a shoreline overlay boundary (MLUI, 2001).

The second option is a resource-based variable shoreline protection overlay boundary. A resource-based variable boundary is a line based on a scientific inventory of natural shoreline features, such as wetlands, dunes, bluffs, critical habitat, etc. The resource-based variable boundary approach maps all important shoreline resources, and establishes the boundary line sufficiently landward of them (approximately 200 feet) to ensure that any development near these resources is within the overlay boundary. The local government generally conducts the resource inventory with the assistance of a qualified naturalist or biologist. This approach is more expensive and requires more complex mapping, but is also more effective at protecting resources, and fairer to property owners (MLUI, 2001). We believe that the counties of the MPPDC can use a combination of the above options to create adequate shoreline protection.

To strengthen the shoreline protection even further, there are additional land use techniques available. One such technique is the use of setbacks within the overlay zone that restrict certain development, but not all economic potential, in order to avoid a “takings” issue. To work with the newly proposed overlay zones, the MPPDC counties could create a dynamic coastal setback program. In coordination with the Chesapeake Bay Preservation Act, which already requires a 100ft buffer measured inward from the shoreline areas, setbacks proposed outside this 100ft region will accommodate future sea level rise (Silton & Grannis, 2010).

Assessment of Middle Peninsula Localities’ Plan and Ordinance for Climate Change Adaptation

Localities within the Middle Peninsula are currently at various stages of the planning cycle. The ordinance assessment given in Table 2.1 and summarized below, represents an inventory of existing plan elements and ordinances that describe the current status of measures related to climate-change-adaptation strategies.

“Gaps” are indicated in the matrix and discussed below; these Gaps highlight possible priority areas to apply recommended strategies not currently addressed. “Opportunities” given below identify possible

next steps that are already justified by existing governing documents (e.g. bringing the Flood Ordinance into alignment with stated goals in the Comprehensive Plan).

For those localities that have recently completed Comprehensive Plan Updates (Gloucester, Mathews, and Middlesex Counties), considerable opportunities exist to bring zoning, flood, and CBPA ordinances into alignment with community resilience-building principles.

Comprehensive Plans

- **Common Gaps**: Policy statement, designating vulnerable areas, risk-based analysis;
- **Good start**: Gloucester (2011), King William (2003), Mathews (2011)
- **Opportunities**: Middlesex has the flood ordinance framework to support coastal flooding consideration in comprehensive plan, but it is still absent.

Flood Ordinance

- **Common Gaps**: incorporation of coastal flooding beyond that designated on FIRMs, inclusion of coastal flood hazard districts; specification of setbacks and development restrictions in these areas.
- **Good start**: Gloucester, Middlesex.
- **Opportunities**: Mathews now has leverage in new comprehensive plan to develop more relevant flood ordinance.

Chesapeake Bay Preservation Areas

- **Common Gaps**: using boilerplate definitions of RPAs and RMAs (e.g. missing or modest definitions of "highly erodible" soils and "steep" slopes).
- **Good start**: King William (designated all land in county outside of RPA as RMA), King and Queen, Middlesex (designate 15% as "steep" rather than 25%), Gloucester, King and Queen (require WQIA for all land disturbing activities within the RPA), Middlesex (mentions detailed requirements for landscape plan, stormwater management plan, plant selection in development requirements).
- **Opportunities**: all localities may benefit by revisiting specific performance measures and thresholds. Base decisions in these areas on scientific data for the region.

Locality	Comprehensive Plan	Flood Ordinance	Free board	CBPA	Wetlands Ordinance	Nonconforming threshold	Zoning - Other	Plans - Other
Essex - Town of Tappahannock	(2006) **GAPS**: policy statement; designation of vulnerable areas; incorporate risk-based analysis of hazards	**GAPS**: incorporation of coastal flooding beyond FIRMs		100' RPA; 25% slopes RMA; 50-acre land disturbance threshold for WQIA		75 percent		
Gloucester	(2001/ 2011 pending) Future Land use includes coastal considerations (Bayside Residential, Bayside Rural Resources, and Conservation) **GAPS**: policy statement;	inclusion of "Coastal High Hazard District (V and VE zones)"; no new development in floodway	Two feet	100' RPA; Environmental Inventory required for all dev in RPA; WQIA required for all land disturbance in RPA	specified list of allowable actions in wetlands; no land disturbing activities allowed			
King and Queen	(2005) **GAPS:** "resilience" policy statement; incorporate risk-based analysis of hazards		N/A	100' RPA; additional 250' RMA; 15% slopes; WQIA req for all land disturbance (Z.A. determines "minor" or "major")		50 percent	includes Dragon Run Conservation District overlay; Rural Residential Cluster	
King William	(2003) mention of coastal hazard consideration, flooding, erosion; incorporation of shoreline management **GAPS:** "resilience" policy statement	**GAPS:** incorporation of coastal flooding beyond FIRMs	12 inches	100' RPA; all lands w/in county outside of RPA designated as RMA;	specified list of allowable actions in wetlands; no land disturbing activities allowed	50 percent		
Mathews	(2011) mentions sea level rise, coastal flooding, and erosion up front; incorporates shoreline management; explicit goals at front of plan **GAPS:** "resilience" policy statement	**GAPS:** incorporation of coastal flooding beyond FIRMs		100' RPA; "highly erodable soils" explicitly defined	specified list of allowable actions in wetlands; no land disturbing activities allowed			Mathews County Shoreline Management Plan
Middlesex	(2009) **GAPS:** "resilience" policy statement; incorporate risk-based analysis of hazards; coastal considerations only in wetlands context	Inclusion of Coastal A Zone and Coastal High Hazard Area; Dev allowed landward of MHT		100' RPA; additional 150' RMA; 15% slopes + highly erodable soils; requires landscape plan, stormwater management plan for development	specified list of allowable actions in wetlands; no land disturbing activities allowed	50 percent		includes Dragon Run Conservation planning

Table 2.1 Review of existing plans across Middle Peninsula localities, 2011.

Wetlands Ordinance

- **Common Gaps**: All localities may benefit by integrating existing vulnerability assessments and coastal considerations into their Wetlands Ordinance

Other Considerations

- **Setbacks.** Each comprehensive plan can specify land uses and areas for which special considerations for development are required. Within the corresponding ordinance, setbacks may be implemented to reduce vulnerability to coastal hazards. For example, flood plain management ordinance, stream corridor ordinances, and CBPA RPA extensions (all discussed in chapter 5) use setbacks from streams and flood prone areas for hazard mitigation and riparian zone protection.
- **Nonconforming Use Thresholds.** The percentage of a given structure's fair market value (FMV) above which repair/redevelopment must bring it into full compliance with current building code. For values set very high (75%), an existing structure in the floodway, for example, could sustain damage constituting fifty percent (50%) of its FMV and repair the damage without complying with new building code (e.g. freeboard requirement for structures in the coastal zone).
- **Water Quality Inventory Assessment (WQIA).** Localities may designate specific thresholds of land disturbance in square footage or acres that trigger a WQIA requirement. Localities should make purposeful data-driven decision about what thresholds are appropriate for their locality.

Summary

This chapter discussed some of the challenges and opportunities related to community resilience facing the Middle Peninsula and reviewed and assessed the current status of planning and ordinances to meet those challenges. The MPPDC has been active in developing natural hazard mitigation plans and performing vulnerability assessment and community involvement about climate change impacts and adaptation strategies.

The potential impacts of climate change are widespread across many sectors in the MP, vulnerabilities are significant, and uncertainties complicate public engagement and commitment to action. Current planning efforts by the MPPDC and some localities provide a foundation for hazard mitigation, climate change adaptation, and building community resilience. This chapter assessed current local plans and ordinances and identified positive actions, common gaps in effectiveness, and opportunities for improvement.

Chapter 3: Adaptation Planning Principles

Growing numbers of states and localities are developing climate change adaptation plans for their jurisdictions. Online clearinghouses continue to emerge, aiming to convey current science, case study listings and best practices to citizens and decision makers. Various public and private agencies have produced guidebooks and manuals on climate change adaptation.

Available adaptation planning guidebooks and reports share many common principles, including interagency coordination, inter-jurisdictional collaboration, stakeholder involvement, application of the best available science, hazard mitigation, ecosystem-based management, and coordination of economic development with natural resource management. While some such themes are already universal to local planning practices, others are less intuitive. For example, how do we better incorporate climate change resilience into local and regional plans such as water supply management, economic development, and future land use? This chapter reviews some general principles for climate adaptation planning drawn from studies by the U.S. Fish and Wildlife Service (FWS), the Heinz Center, and U.S. Global Change Program, and then presents a more applied adaptation framework developed by the National Research Council (NRC).

The reports and guidebooks selected for review are among more than a dozen similarly themed publications of recent years. Publications discussed herein capture the spectrum of definitions, guiding principles, and strategies applicable to effective climate change adaptation planning at the local level. While this chapter identifies and summarizes broad climate adaptation planning principles, the next chapters reviews application of these principles in state and local climate adaptation plans and gleans lessons for the Middle Peninsula.

U.S. Fish and Wildlife Service (FWS): Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change (2011)

This 2011 U.S. Fish and Wildlife Service (FWS) report offers a summary of adaptation planning principles within the context of rapidly changing and uncertain climate conditions. FWS provides overarching guidelines, which may help state and local governments promote resilience within their respective planning frameworks. A sense of urgency pervades the 32-page document, beginning with the epigraph, "We must act now, as if the future of fish and wildlife and people hangs in the balance – for indeed, all indications are that it does."

FWS Climate Change Principles may be considered as "Adaptation Planning Principles" for use at the local and regional planning level:

Priority-Setting. Continually evaluate priorities and approaches, make difficult choices, take calculated risks and adapt to climate change.

Partnership. Commit to a new spirit of coordination, collaboration and interdependence with others.

Best Science. Reflect scientific excellence, professionalism, and integrity in all our work.

Landscape Conservation. Emphasize the conservation of habitats within sustainable landscapes, applying our Strategic Habitat Conservation framework.

Technical Capacity. Assemble and use state-of-the-art technical capacity to meet the climate change challenge.

Global approach. Be a leader in national and international efforts to address climate change.

FWS presents three major strategies to guide Adaptation Plan goals, objectives, and actions that may be applied at the local level:

Adaptation. Minimize the impact of climate change through the application of cutting-edge science

Mitigation. Reduce levels of greenhouse gases in the earth's atmosphere

Engagement. Join forces with others to seek solutions to the challenges and threats posed by climate change

Within the FWS strategic plan, adaptation is divided into four approaches: Resistance, Resilience, Response and Realignment.

- **Resistance** is the act of working against the effects of climate change as they occur. It most closely describes current and traditional adaptation approaches, which often aim to maintain current or restore historical conditions. The resistance strategy is decreasingly available as the rate of climate variability accelerates.
- **Resilience** is the ability of a system to return to a desired condition after disturbance. Resilience adaptation actions build capacity toward the ability to cope with disturbance.
- **Response** adaptation actions manage toward future, less certain conditions by predicting and working with the effects of climate change. Response actions mimic, assist or enable ongoing natural adaptive processes in order to encourage gradual transition to inevitable change.
- **Realignment** stands in contrast to the resistance approach in the FWS framework. Realignment is essentially future-oriented "restoration" of ecosystems that can sustain in the future, not the past. This approach also anticipates uncertainty by having multiple alternative goals and trajectories for unpredictable endpoints.

According to FWS, planning practitioners can benefit from identifying which approach or combination thereof that best address the challenge at hand. For example, shoreline hardening might be considered *resistance adaptation*; raised buildings to accommodate flood patterns falls into *resilience adaptation*; *response adaptation* might best describe Living Shorelines programs; and long-range land use planning that moves development landward might fall under *realignment adaptation*.

The FWS strategic plan also points out that "adaptation approaches to climate change can be implemented in a reactive manner or an anticipatory manner," and then quotes the IPCC to define the terms:

Reactive adaptation takes place after impacts have been observed.

Anticipatory adaptation takes place before impacts are observed.

Finally, as the plan promotes explicit and consistent adaptation planning methods, the plan acknowledges that "an inappropriate response or a series of inconsistent responses can result in large expenditures of time, energy, and resources with questionable or insufficient outcomes" (U.S. Fish and Wildlife, 2011). Therefore, by taking such a position, local governments may explicitly affirm their stewardship of the public trust and likely bolster community support.

Heinz Center: Resilient Coasts: A Blueprint for Action (2009)

Published in 2009, this Heinz Center report addresses resilience to climate change while incorporating economic and cost-benefit analyses. The Heinz Center is a non-profit research center and the report was funded in part by the Travelers Group and other commercial insurance interests, with a stated goal to improve accuracy of coastal hazards assessments in order to reduce risk. The report discusses many conceptual and a few applied strategies for achieving economically viable and resilient coastal development.

"Resilient Coasts" was published with a national focus; however, the majority of principles identified in the report apply to local adaptation planning, namely the following:

- **Identify and fill critical gaps** in scientific understanding and develop the tools and methodologies necessary for incorporating climate change into risk assessments and risk mitigation decisions
- Require **risk-based** land use planning
- Design **adaptable infrastructure and building code** standards to meet future risk
- **Strengthen ecosystems** as part of a risk mitigation strategy
- Develop **flexible adaptation** plans
- Integrate climate change impacts into **due diligence for investment and lending**

The report also makes a few recommendations specific to local strategies for adaptation planning:

- Designate no-build and no-rebuild zones
- Provide property owners with incentives to relinquish property or development rights in these areas (i.e. land exchanges, land banks, TDR)
- Establish incentives or regulations to make ecosystem preservation and enhancement part of adaptation funding, risk-based land use planning, and post-disaster rebuilding

Additionally, the authors acknowledge the urgent need for updated and accurate flood, shoreline and inundation maps, noting that current maps do not accurately reflect current risks, let alone future risks (Heinz Center, 2009).

U.S. Global Change Program: Global Climate Change Impacts in the United States (2009)

This 2009 U.S. Global Change Program (GCP) report "" serves as a "state of the knowledge" report to the President and Congress, with a stated goal of better informing public and private decisions at all levels in the United States (Karl et al, 2009).

Ten key findings introduce the report. Subsequent content is comprised mostly of weather and climate impacts in the United States, first by sector and then by geographic focus regions. Key findings include (Karl et al, 2009):

1. Global warming is unequivocal and primarily human-induced.
2. Climate changes are underway in the United States and are projected to grow.
3. Widespread climate-related impacts are occurring now and are expected to increase.
4. Climate change will stress water resources.
5. Crop and livestock production will be increasingly challenged.
6. Coastal areas are at increasing risk from sea-level rise and storm surge.
7. Risks to human health will increase.
8. Climate change will interact with many social and environmental stresses.
9. Thresholds will be crossed, leading to large changes in climate and ecosystems.
10. Future climate change and its impacts depend on choices made today.

Report recommendations are broad and generalized, conveying national goals, which may be down-scaled for application at a local level. Karl et al (2009) list six recommendations at the conclusion of the report:

1. Expand understanding of climate change impacts.
2. Refine ability to project climate change, including extreme events, at local scales.
3. Expand capacity to provide decision makers and the public with relevant information on climate change and its impacts.
4. Improve understanding of thresholds likely to lead to abrupt changes in climate or ecosystems.
5. Improve understanding of the most effective ways to reduce the rate and magnitude of climate change, as well as unintended consequences of such activities.
6. Enhance understanding of how society can adapt to climate change.

Two themes emerge from the report's concluding recommendations: 1) a roadmap of future products to assist the local adaptation planning process, and 2) the local-scale implications for recommended action that can be taken immediately. The U.S. Global Change Program reports climate change impacts in great detail, but the report is not intended to provide adaptation strategies.

National Research Council: America's Climate Choices: Adapting to the Impacts of Climate Change (2010)

The National Research Council (NRC) 2010 report provides a range of options for adapting to both climate variability and extremes. The report is part of a four part series produced by NRC; the others

address climate change science, mitigation or greenhouse gas emissions reduction, and informing effective decisions on climate change. The NRC adaptation study distinguishes between changes in climate averages versus changes in climate extremes, pointing out that comprehensive adaptation planning will address the full risk spectrum between high-probability-low-risk events and low-probability-high-risk events, by measuring the cost of adaptation options against the cost of impacts they are designed to avert (NRC, 2010).

The NRC prescribes the following steps in the adaptation planning process:

1. **Identify current and future climate changes** relevant to the system
2. **Assess the vulnerabilities** and risk to the system
3. **Develop an adaptation strategy** using risk-based prioritization schemes
4. **Identify opportunities for co-benefits** and synergies across sectors
5. **Implement** adaptation options
6. **Monitor and reevaluate** implemented adaptation options

The NRC report provides federal, state, and local/regional recommendations for adaptation planning. Of their ten overarching recommendations, below are four paraphrased recommendations that are directly applicable at the local level:

- **Identify vulnerabilities** to climate change impacts and both short- and longer-term **adaptation options** for each
- **Develop and implement climate change adaptation plans** pursuant to the national climate adaptation strategy, in consultation with community stakeholders
- Actively engage and partner with appropriate governmental adaptation planning efforts to help **build adaptive capacity**
- **Take adaptation action now** to address current known climate change impacts in order to provide effective risk management at a relatively low cost

The NRC report divides climate impacts and their respective adaptation actions into seven sectors: Ecosystems, Agriculture and Forestry, Health, Transportation, Water, Energy, and Coastal Areas. Much of the report is comprised of tables, which identify climate related changes by sector, impacts, and possible adaptation actions for each. All “possible adaptation actions” from federal, state, local, private and NGO/individual and all U.S. geographic regions are presented in one table per climate impact sector. Appendix A contains a pared-down version of the NRC tables, to include only local adaptation actions for regionally specific impacts to the Mid-Atlantic and Chesapeake Bay, while brief descriptions of the tables are below.

Impacts to **Ecosystems** include changes to the hydrologic cycle, loss of key native species, and introduction of invasive species (National Research Council, 2010). Broadly stated, recommendations for ecosystem adaptation actions include: developing price-based accounting system for ecosystem services, increased hydrologic management (e.g. managing groundwater recharge and water surpluses), and sustained promotion of biodiversity. Also important is a more consistent use of currently recognized best practices within ecosystem management such as monitoring change, managing for multiple ecosystem benefits, and keeping disturbance at acceptable scales (National Research Council, 2010).

Impacts to **Agriculture and Forestry** within the Mid-Atlantic may be addressed through adaptation actions recommended by local and regional government, and implemented at the individual and/or neighborhood levels. Some impacts to be addressed include increased precipitation and consequently increased runoff and demand for nutrient management. Regional shifts in plant productivity and sensitivity to fertilizer and pesticides will affect livestock operations and introduce an increased demand for integrated pest management. The NRC report (2010) highlights potential tradeoffs and synergies between agricultural adaptation and water- and ecosystem-sector adaptation in the areas of irrigation and pest management. The report encourages collaborative action at a local and regional scale.

Health concerns due to climate change are evident through increased frequency of climate-related extreme events such as heat waves and water-borne diseases. Recommended adaptation actions focus on augmenting and improving current public health programs. Short-term actions focus on public outreach, early warning systems and emergency response plans. Longer-term actions focus on improving decision support such as educational programs for health care professionals and incorporating future climate impacts into zoning and infrastructure decisions. Most adaptation recommendations for the health sector will improve health generally, so the primary tradeoff concern is economic. According to the NRC (2010), costs of public health adaptation actions can be minimized through a proactive, cost-effective planning approach.

Local impacts to **Transportation** involve erosion, flooding and increased stress on existing infrastructure where limited resources exist for structural improvements. The National Research Council (2010) encourages transportation planners to incorporate climate change in infrastructure planning and design cycles, which usually span several decades. Additionally, the Federal Highway Administration (FHA) encourages and funds inclusion of climate change into metropolitan planning organization (MPO) activities. Adaptation actions recommended by the NRC (2010) are primarily engineering and maintenance solutions, which are costly and require a planning horizon of several decades (e.g. vulnerable pavement replacement, improvement of hydraulic structures such as culverts, or elevating critical infrastructure). The report also suggests a few policy-based options such as stricter land use planning (e.g. floodplain development restrictions and setbacks).

Water sector impacts include changes in precipitation, runoff and pollution, and saline intrusion. Changes in water supply will likely occur, particularly in flood-prone or low-lying areas. Possible adaptation actions involve both engineering approaches (e.g. dams and water delivery infrastructure, underground/ aquifer storage and recovery systems) and conservation adaptations (e.g. changes in behavior, water-saving technology). The NRC report (2010) also highlights tradeoffs and synergies among sectors – agriculture, ecosystems, energy, recreation, transportation and domestic use, citing unexpected drought conditions and potential strain on water supply, as well as more positive synergies such as natural functions of ecosystems to buffer public water supply.

Electricity demand is likely to increase, resulting in a number of **Energy** sector impacts. According to Karl et al (2009), demand for cooling in buildings increases 5 to 20 percent and demand for heating drops by 3 to 15 percent for every 1.8° F of warming. The aggregate result across the United States is a likely increase in electricity demand and decrease in demand for natural gas and fuel oil (Karl et al, 2009). The NRC report (2010) states that adaptation planning for vulnerable coastal energy facilities will likely be protection-oriented in the short term (i.e. flood walls, levees, and other protective barriers), but long-term investment strategies for new infrastructure might include relocating facilities to less vulnerable areas.

One local adaptation strategy for both short- and long-term planning is to reduce overall energy demand. Strategies for doing so include incentive programs, public outreach, and consolidation of water and energy conservation programs.

The NRC report (2010) designates **Oceans and Coasts** as a separate sector, citing increased adaptation efforts over recent years and high-priority efforts in coastal states to address flooding, shoreline erosion, and coastal storms. The NRC categorizes state-level adaptation efforts to-date into six categories of policies, focused primarily on sea level rise impacts: 1) public infrastructure siting, 2) site-level project planning and design, 3) wetland conservation and restoration policies, 4) shoreline stabilization, 5) setbacks, and relocation policies, encouraging adaptive development designs (e.g. additional flood-height tolerance), and 6) incorporation of climate-change adaptation into other state, regional, and local plans. Possible local adaptation options within this sector involve a focus on building code, zoning ordinance, and land use planning that incorporates climate change modeling into the planning process. With respect to sea level rise, the NRC report recommends development of three to four sea level rise scenarios, including one that assumes continuation of historic sea level rise and two additional scenarios with moderate and substantial acceleration of sea level rise, respectively.

Summary

Although each report reviewed for this chapter takes a different approach to climate change adaptation, each offers a variety of definitions, recommendations and strategies that may assist planners and decision makers as they address the challenges and uncertainties of climate change. However, "Different local conditions will dictate different climate ready responses. It is critical to recognize that different local conditions – including the immediacy and certainty of actual or projected climate impacts and community understanding and support – will, understandably, lead to different climate adaptation and mitigation responses and intensity of engagement. A one-size-fits-all approach to climate readiness will not be effective (USEPA Climate Ready Water Utility Toolkit, 2010)."

The four reports summarized in this chapter complement and reinforce adaptation planning concepts in each other. Common steps for climate change adaptation planning amongst the reports include (1) identifying current and future climate impacts, (2) assessing vulnerabilities and risks to climate impacts, (3) developing a risk-based, prioritized adaptation strategy, (4) implementing the strategy, and (5) monitoring and evaluating the implemented strategy. Additionally the four reports emphasize the use of best available science, a collaborative planning approach and priority setting.

While the U.S. Fish and Wildlife Strategic Plan identifies principles that often appear in existing state and regional adaptation planning literature (i.e. priority setting, partnership, best science, conservation, building technical capacity, global [regional] approach), the Heinz Center publication "Resilient Coasts" demonstrates the importance of risk-based cost-benefit analysis for decision makers addressing short- and long-term climate impacts and potential response actions. Finally, as the U.S. Global Change Program and National Research Council reports take similar approaches in dividing likely climate impacts into sectors, the NRC report then lists and discusses research-based adaptation options, sorted by geographic region and echelon of government. Collectively, these four reports create a framework within which to develop the local climate adaptation planning process.

Planners and decision makers face several challenges and uncertainties in the field of climate adaptation planning, but uncertainty is not cause for inaction if the cost of inaction outweighs the cost of planned adaptation strategies. As the NRC report demonstrates (2010), there is potential for both negative tradeoffs and positive co-benefits ("synergies") between adaptation strategies for various sectors. In order to achieve potential synergy and avoid "foreclosure of future options," collaboration across planning sectors is necessary (NRC 2010; Karl et al, 2009). The following chapter examines adaptation planning case studies at the state, regional and local level within the United States. Both short- and long-range adaptation strategies are identified and discussed. Some specific adaptation actions are applicable to the Middle Peninsula; in other areas, the planning process in general can serve as a model for future efforts in the MPPD.

Chapter 4: Adaptation Planning in Practice

Climate change adaptation planning is in its infancy. Relatively few climate change adaptation plans have been implemented anywhere in the world (National Research Council, 2010) with the majority of existing adaptation plans initiated since 2005. Adaptation planning is complicated by the long-term nature of climate change, as well as the uncertainties about the timing, location, and extent of impact.
This chapter reviews some current adaptation planning efforts in the United States and suggests possible lessons and implications of this experience for the MPPD.

As discussed in previous chapters, adaptation, in the context of climate change, can be defined as a process, action, or outcome in a system in order for the system to better cope with, manage, or adjust to a changing condition, risk or opportunity. A system's capacity for adaptation or resilience is its ability to absorb perturbations without being undermined or becoming unable to adapt, self-organize and learn. Effective climate change adaptation, then, must be anticipatory, identify vulnerabilities, stress preparedness for change, and build the capacity for resilience among those likely affected by change (Randolph 2011).

Thus far, adaptation to climate change has focused on two general objectives:

1. *Lessening the impacts using technology and planning*, such as seawalls to fend off sea-level rise and resulting storm surges, expanded irrigation to counter more frequent droughts, and more dams and reservoirs to contain flood flows and store water to compensate for drought periods.
2. *Anticipating impacts, and changing the patterns of human settlement and agriculture now, so we can live with those impacts in the future*, including relocating vulnerable populations and adopting climate adapting development designs.

State-level Adaptation Planning

Several states are beginning to develop adaptation plans. The level of activity depends on the state's perceived vulnerability to climate change. The following is a list of state-level adaptation efforts, according to the Pew Center on Global Climate Change (2011), but even the completed plans range widely in specificity.

- **Adaptation Plan Recommended in State Climate Action Plan:** Arizona, Colorado, Iowa, Michigan, North Carolina, South Carolina, Utah, Vermont
- **Adaptation Plan in Progress:** Connecticut, Massachusetts, Minnesota, Pennsylvania
- **Adaptation Plan Completed:** Alaska, California, Florida, Maine, Maryland, New Hampshire, New York, Oregon, Virginia, Washington, Wisconsin

This section first reviews Virginia's framework for climate adaptation planning, then summarizes some relevant state plans.

A Note on Dillon's Rule

Local planners and government officials within the Commonwealth of Virginia may be quick to point out the limiting effect of Dillon's Rule on local government autonomy. The Rule is named after Judge John F. Dillon of mid-1800s Iowa, and today thirty-nine states within the United States apply his principle of clearly recognizing the state legislature as the sovereign power and local government as subordinate (Richardson, 2011). In his 2011 *Publius* article "Dillon's Rule is from Mars, Home Rule is From Venus:

Local Government Autonomy and the Rules of Statutory Construction," Jesse Richardson deconstructs the implication that local governments in Dillon's Rule states (such as Virginia) lack autonomy.

- **Local government autonomy**. "No consensus exists as to how to identify or measure the concept" (Richardson, 2011). Using a measure such as whether a state is Dillon's Rule is not a reliable measure of local autonomy.
- **States grant varying levels of autonomy.** Local governments within Dillon's Rule states are only as autonomous as is enabled by the state legislature. In some states, local governing authority is widely enabled.
- **Not all Dillon's Rule states are created equal.** Note that the existence of local governing practice in a Dillon's Rule state other than Virginia, California for instance, does not necessarily mean that governing practice would be enabled in the Commonwealth of Virginia. The set of governance practices enabled by the sovereign state legislatures vary from state to state and are, therefore, incomparable.

For the purpose of determining which adaptation strategies may be adopted by Virginia localities, it is recommended that a locality examine what is already enabled within Virginia and work to incorporate recommended strategies into the existing local and regional planning framework. Opportunities for this type of incorporation are discussed at greater length in Chapters 5 and 6.

Virginia: Existing framework

Dillon's Rule State.Virginia's framework for climate adaptation planning includes recommendations of the 2009 Virginia Commission on Climate Change (VCCC), actions by the Coastal Zone Management Program (VCZMP), as well as non-climate-change-specific plans, policies, and regulations related to flooding, beach erosion, coastal storm surges, wetland and critical habitat protection, saltwater intrusion, on-site wastewater, stormwater, transportation and infrastructure, all of which are expected to be impacted by climate change and sea level rise.

The VCCC called for a state strategy for climate change adaptation led by a sub-cabinet of Climate Change Response, and a science-based process to determine best estimates of end points (*at least* 3.1^{o}C temperature increase, sea level rise of *at least* 2.3 feet, and increased intensity of storms and rain events); evaluate impacts to natural systems, infrastructure, and the economy; assess changes needed in government programs and regulations; and develop appropriate responses within state and local governments. The McDonnell administration, however, stated in June 2011 that it will not revive the VCCC, and the General Assembly has not acted on its recommendations for climate change adaptation.

The VCZM program has funded planning efforts in the coastal zone for 25 years. It funded the three-year Hampton Roads climate change study described below. In February 2011, its Coastal Policy Team prioritized Focal Areas for its funded projects. Coastal Resiliency, with special attention to climate change, natural resource datasets, and state tools to inform local planning, received the most votes and highest priority (REF). It is unclear how this may translate into increased state attention to climate change adaptation planning.

For the moment, Virginia's response to climate change impacts rests on this VCZM attention to Coastal Resiliency and on its existing framework of plans, policies and programs related to Chesapeake Bay

Preservation Act (CBPA), natural hazards mitigation, especially flooding and coastal storms, wetlands and other land conservation, stormwater management, and other coastal resource issues. CBPA implementation Virginia localities, is discussed under Regional and Local Adaptation Planning section below.

Maryland (2008)

Dillon's Rule State.

The Commission on Climate Change produced its Climate Action Plan in August 2008 and one component was the Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change produced by the Adaptation and Response Working Group (ARWG). The ARWG Phase I Adaptation Strategy (2008) made recommendations for reducing risk related to sea level rise and coastal storms, including 18 policy actions to avoid or reduce impact to existing and future built environment; shifting to sustainable economies and investment; avoiding financial risk of development in hazardous coastal areas; enhancing preparedness and emergency planning; and protecting and restoring Maryland's natural protective shoreline. The Phase II Strategy emphasized building societal, economic, and ecological resilience to climate change impacts. It made a series of recommendations to reduce impacts on human health, population growth and infrastructure, agriculture, water resources, and forest/terrestrial and bay/aquatic ecosystems. In October 2010, Maryland Department of Natural Resources established the policy "to make sound investments in land and facilities and to manage its assets and natural resources so as to better understand, mitigate and adapt to climate change" (MDNR 2010).

California (2009)

Dillon's Rule State, except for charter cities.

California released its *2009 California Climate Adaptation Strategy* in response to a 2008 Governor's Executive Order (California Natural Resources Agency 2009). The plan focused on seven critical impact areas, and a relevant state agency was charged with taking the lead in each, so all of state government was involved. Here are the impact areas:

1. *Public health*: Higher mortality and morbidity, increased air pollution, increased allergens, spread of disease vectors, decreased food security, reduced water availability.
2. *Biodiversity and habitat*: Barriers to species migration, temperature rise impacts on aquatic habitat, increased invasive species, threats to endangered species, loss of ecosystem services.
3. *Ocean and coastal resources*: Increased temperature and extreme events, higher runoff and flood risk, sea-level rise and risk of flooding, erosion, and saltwater intrusion.
4. *Water management*: Reduced supply from Sierra snowpack, changes in water quality, increased evapotranspiration, soil moisture deficits, increased irrigation needs.
5. *Agriculture*: Crop yield changes; new weed, disease, and pest invasions; flooding, heat waves and heat stress, drought.
6. *Forestry*: Changes in forest productivity, tree mortality, invasive species, moisture deficits, increased wildfire risk.
7. *Transportation and energy infrastructure*: Increased cooling demands, less hydropower generation; impacts on seaside airports, roads, railroads, and docks.

The guiding principles for the strategy include the following:

- Use the best available science in identifying climate change risks and adaptation strategies. Understand that knowledge about climate change is still evolving. As such, an effective adaptation strategy is "living" and will itself be adapted.
- Involve all relevant stakeholders in identifying, reviewing, and refining the state's adaptation strategy. Establish and retain strong partnerships with federal, state, and local governments, tribes, private businesses, landowners, and NGOs to develop and implement adaptation strategy recommendations over time.
- Give priority to adaptation strategies that initiate, foster, and enhance existing efforts that improve economic and social well-being, public safety and security, public health, environmental justice, species and habitat protection, and ecological function.
- Understand the need for adaptation policies that are effective and flexible enough for circumstances that may not yet be fully predictable.
- Ensure that climate change adaptation strategies are coordinated with other local, state, national, and international efforts to reduce GHG emissions.

Among the recommendations are: establishing a climate adaptation advisory panel; water conservation requirements to achieve a 20% reduction in per capita water use; avoiding development in vulnerable areas; ensuring communities are healthy in order to build resilient responses to the spread of disease and temperature increases; incorporating assessments of climate change impacts, vulnerability, and risk-reduction strategies in local general plans; and implementing a major public outreach effort, using a new CalAdapt website to synthesize climate impact research and statewide and local climate change scenarios.

Wisconsin (2011)

Dillon's Rule State.

Although Wisconsin is not an ocean state subject to sea level rise, it has developed one of the most recent state adaptation plans. It recommends a number of strategies relevant to coastal Virginia, including the following:

1. Water resources
   a. Restore prior-converted wetlands to provide storage and filtration and mitigate storm flows and nutrient loading.
   b. Promote integrated water management planning including long term projections of supply and demand tied to land use, economic growth, and climate change.
   c. Incorporate water management strategies based on climate projections into farm-based nutrient management, TMDL, and other water quality plans.
   d. Provide local units of government with technical and financial assistance to assess and mitigate their vulnerabilities to high water conditions caused by today's and future climates.
   e. Account for changing water levels in planning and zoning standards for shoreline development.
   f. Improve systems for monitoring surface and groundwater levels, storm surges and stream flows.
2. Ecological resources
   a. Engage in adaptive management to respond to changing conditions through forest and land cover management, coastal and aquatic ecosystem management, agricultural land management, ecological and riparian buffer zones, and watershed land use practices.
   b. Protect and restore integrity of wetland hydrologic regimes.

   c. Establish and maintain corridors of contiguous habitat along natural environmental corridors to provide of migration and local adaptation.
   d. Build a stronger relationship with the public to establish a critical mass of ecological knowledge in the community.
3. Agriculture
   a. Expand the adoption of accepted soil-conserving field practices to reduce erosion and polluted runoff.
   b. Expand watershed-based educational programming efforts with appropriate targeting of hydrologic units, farms and fields.
4. Coastal Resources
   a. Move buildings and roads back from the coastal edge. Counties and municipalities should re-examine their setback ordinances to account for changing conditions.
   b. Growth and development planning (zoning, redevelopment restrictions, compact community design), property protection (acquisition, relocation, setbacks, building codes, infrastructure protection), shoreline management (regulation and removal of shoreline protection structures, living shorelines, beach nourishment, rolling easements)
5. People and Environment
   a. Policy makers should weigh the impacts of infrastructure investment decisions on human impact and capacity to adapt to climate change.
   b. Identify locations that are vulnerable to climate impacts and apply more stringent design criteria.
   c. Flood proof vulnerable buildings and infrastructure.
   d. Educate communities about the hazards of building in areas prone to high water.

In addition to these strategies, the Wisconsin plan provides some principles for adaptation to consider when citizens, businesses, agencies, and policy leaders are formulating specific actions:

1. Triage approach: Determine which actions to implement first. These will be those that are most effective as well as those that can provide lessons in an adaptive management framework.
2. Adaptive management: Build flexibility into management practices. "Learn as we go, learn by doing." Designing experiments and monitoring results serve as the basis for learning. Flexibility provides opportunity for modification of practices based on learning.
3. "No regrets" strategies: Choose strategies that increase resilience and provide benefits across all future climate change scenarios.
4. Precautionary principle: Where vulnerability is high, it is better to be safe than sorry.
5. Adapting to variability in a changing climate: Expect variability and work with it.
6. Place-based considerations: Consider the restrictions and special circumstances of place-based impacts and solutions, including environmental, cultural and political factors.

Florida (2008)

Dillon's Rule status unclear, due to conflicting authority (Richardson, 2011).

Florida is one of the most vulnerable states to the impacts of climate change and sea level rise. It began its attention to climate change in 2006 and by 2008 produced "Florida's Resilient Coasts: A State Policy Framework for Adaptation to Climate Change." The framework focused on five necessary characteristics,

stating that state adaptation policy must be disciplined, comprehensive, purposeful, strategic, and efficient. The framework calls for state monitoring of climate adaptation science, climate-sensitive planning and decision making (especially for land use and building regulation, water resources, transportation and other infrastructure, land and marine conservation, beach management, emergency preparedness), and insurance. Most implementation has occurred at the local and regional level such as the 2009 Southeast Florida Regional Climate Change Compact of Miami-Dade County and Broward, Palm Beach, and Monroe counties, who agreed to develop a coordinated regional strategy for responding to climate change (Southeast Florida, 2009). A 2011 white paper developed a unified sea level rise projection for Southeast Florida of 9-24 inches by 2060 and 23-67 inches by 2110 (Southeast Florida 2011).

Individual communities within the counties have developed their own studies to adapt to sea level rise.

- The study for Satellite Beach, Florida, concluded that 25% of the city would be submerged at a 4 foot SLR and that "protect' and "retreat" options because engineering solutions would not work because of soil permeability and porosity and there is no available higher elevation lands to retreat to. The study suggests that the city respond to the threats imposed by rising sea level through adaptive management, or an on-going and iterative process that specifies one or more essential actions necessary to reduce the vulnerability of built and natural environments to rising seas. "The overall plan and each specific action are monitored and adjusted as outcomes from management action(s) and other events (i.e. accelerated ice sheet melting) become better understood. Initial actions may be limited to: (1) the development of a timeline describing future actions and (2) implementing no-regret or low-regret policies. Reactive measures may be formulated and subsequently triggered by specific tipping points built into the plan. As uncertainty diminishes, consequences become palpable and quantifiable, and consensus emerges, more robust plans, programs, and proactive measures are implemented" (Parkinson, 2010).
- The Compact also cites a study from southwest Florida. The City of Punta Gorda prepared a climate change adaptation plan in 2009 (Southwest Florida Regional Planning Council, 2009). In the course of the study, the city identified 246 climate change management adaptations to address various vulnerabilities, of which 104 acceptable actions were identified and prioritized during public workshops. Among the top adaptations are
    - constraining locations for certain high risk infrastructure,
    - explicitly indicating in the comprehensive plan which areas will retain natural shorelines, and
    - seagrass protection and restoration.

Governors' South Atlantic Alliance (North Carolina, South Carolina, Georgia, Florida) (2010)

Governors from the four states signed the Alliance Action Plan on four priority issues: healthy ecosystems, working waterfronts, clean coastal and ocean waters, and disaster-resilient communities. Specific strategies stressed the need to understand, assess and prepare for impacts due to climate change, including the need for retreat of human communities from vulnerable shorelines.

Regional and Local Adaptation Planning

Hampton Roads Planning District Commission (2011)

One of the few climate change adaptation studies in Virginia is being prepared by the Hampton Roads PDC, funded by a 3-year grant from the VCZM. Its second year (Phase II) report was issued in June 2011. In addition to a discussion of sea level rise in Hampton Roads, datasets, and case studies, the report

describes public outreach efforts and planning frameworks and adaptation options available for responding to sea level rise. The public outreach program included 18 presentations to municipal boards and various groups. In addition, in March 2011 four listening sessions were held in Virginia Beach where facilitated small group discussions allowed residents to share their views and experiences about sea level rise and flooding in the city. The Phase II report concluded with a short general discussion of policy options, noting that planning for sea level rise is difficult because of inherent uncertainties, and the report suggested hazard mitigation planning and scenario planning as the most effective approaches with the current state of knowledge. The third year of the project will focus on additional data needs and policy research assisted by working groups in the region.

Virginia Chesapeake Bay Localities and CBPA Implementation

Virginia: Dillon's Rule State.

While few Virginia localities have developed climate change adaptation plans, many have used the tools available under Virginia statutes to mitigate natural hazards, protect natural waters, and conserve land resources. These tools include the requirements and opportunities under the Chesapeake Bay Preservation Act (CBPA).

The CBPA requires all localities in the state subject to tidal influence, which include all localities roughly east of I-95, to comply with the Act's requirements for planning, zoning, and designation of protection areas. New development is prohibited in Resource Protection Areas (RPAs) which are comprised of tidal wetlands, tidal shores, nontidal wetlands connected to tidal wetlands or water bodies, and other areas with intrinsic water quality value. Resource Management Areas (RMAs) are areas outside RPAs that have the potential for causing water quality degradation if improperly disturbed or developed. A third category, Intensely Developed Areas (IDAs), includes those already developed areas which would likely be in RPA or RMA if undeveloped. Regulations for redevelopment are specified in the CBPA regulations. CBPA localities are required to designate and map RPAs, RMAs, and IDAs, and formulate land use regulations for them that conform to CBPA regulations at a minimum. They also have the opportunity to extend the RPA district over time.

This latter approach has been used by several jurisdictions to enhance their protection of natural waters and control stormwater pollution. This action also has co-benefits of reducing developed areas potentially exposed to flooding from upland flows and storm surges. Fairfax County, for example, approved a major extension of its RPAs in 2003-04 as shown in Figure 3.1. Other localities continue to make changes to their CBPA implementation strategies. Chesapeake now requires RPA and RMA tree canopy requirements and low impact design standards for IDA redevelopment projects (Chesapeake 2007).

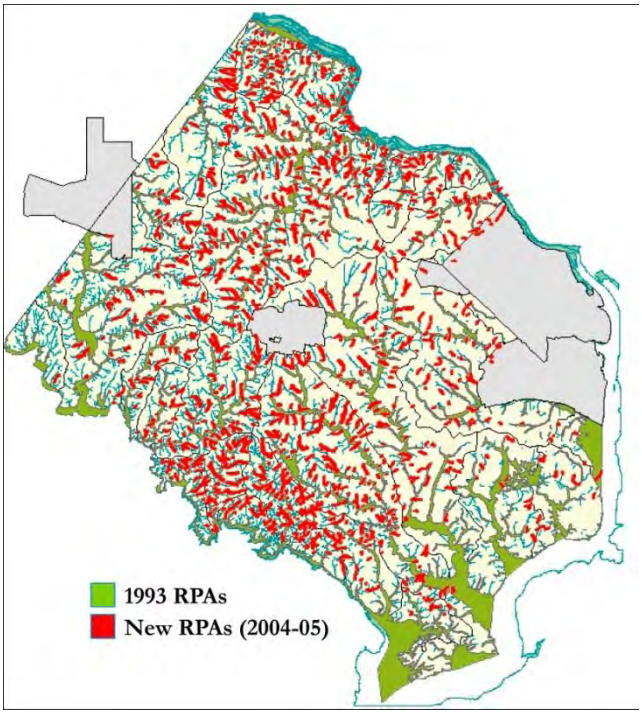

Figure 4.1. Fairfax County CBPA Resource Protection Area extension, 2004-05 (Source: Rose 2010, Fairfax County)

Worcester County, Maryland (2010)

Maryland: Dillon's Rule State.

In 2008, Worcester County on Maryland's Eastern Shore developed a Sea Level Rise Response Strategy. The strategy assessed sea level rise scenarios; projected impacts on private development, infrastructure and public facilities, and coastal environments; identified adaptation response options; and set priorities for sea level rise response.

The response options include protection, retreat, and accommodation for existing development, future development, infrastructure and the natural environment. **Protection** measures include both structural seawalls and bulkheads) and non-structural (living shorelines, beach nourishment). **Accommodation** measures recognize retreat is inevitable but prolongs the life of existing development and sets rules for eventual retreat. It focuses on emergency preparedness to protect public safety and on transitional mechanisms for retreat, such as rolling easements and restrictions on septic systems using overlay zoning. **Retreat** measures include two basic approaches: first, proactive property acquisition and relocation, and second, restrictions on shoreline protection and redevelopment that eventually would lead to retreat. Retreat of future development is more easily controlled through land use controls on setbacks and buffers, overlay zoning, cluster zoning, and transfer of development rights, and other regulations like septic system restrictions. For infrastructure and public facilities, a detailed vulnerability assessment of above and below-ground facilities, including stormwater systems, water and wastewater systems, and roads and bridges. Public investments should be restricted or prohibited for facilities in vulnerable areas.

The prioritization was based on several criteria: legal authority, institutional feasibility, consistency with community vision, political feasibility, benefits exceeding costs including opportunity costs, positive or

neutral environmental impact, equity, effectiveness, and resource availability. The strategy concluded with implementation recommendations, including the following:

- identify protection, accommodation, and retreat zones based on impacts of the 2100 worst-case scenario;
- apply prioritized response options to these zones;
- begin a public education campaign;
- identify selected options addressing the Steady State 2025 impacts that can be implemented quickly; and
- adopt the selected response strategy and identify funding sources.

Dorchester County, Maryland

Maryland: Dillon's Rule State.

Dorchester County, also on Maryland's eastern shore, is very vulnerable to sea level rise from climate change. Already 60% of the County is in the 100-year floodplain and more than 50% lies below 4.9 feet above sea level. The adaptation guidelines developed for Dorchester County following the four strategies identified in the State's adaptation response plan: vulnerability assessment; long-range comprehensive planning; codes and development standards, and public outreach.

Climate change and sea level rise are nothing new to Dorchester County. Its 2006 Comprehensive Plan addressed sea-level rise, and it recommends several actions including the following:

a. adopt standards requiring two or more feet of freeboard in tidally influenced floodplains
b. update the 1972 tidal wetland maps and critical area boundaries
c. expand the critical area buffer width in areas experiencing greater than 2 feet of erosion per year
d. align smart growth strategies to reflect population growth and development patterns in relation to areas vulnerable to sea level rise
e. delineate the predicted extent of seal level rise over the next 25 years on county zoning maps to alert prospective land purchasers

Regarding codes and standards, the guidelines recommend creating a Sea Level Risk District and implementing codes governing activities within it, including restrictions on new subdivisions, major renovations, septic systems, and wells, and requirement for two-foot freeboard above base flood elevations.

Long Island, NY: Local Land Use Response to Sea Level Rise

New York: Dillon's Rule State.

Long Island is a far different place from Maryland counties or Virginia's Middle Peninsula. However, this study by the Land Use Law Center at Pace University and the Nature Conservancy on Long Island provides a useful array of local response plans, regulations, and strategies for New York localities that are applicable elsewhere. These local planning and regulatory strategies include:

1. Policy

   a. Sea level rise and storm hazard resolutions, policy statements, or executive orders can set the stage for adaptation planning.
2. Studies, research training, education
   a. Create a task force to oversee studies and research specific to the locality.
   b. Hold workshops and training sessions to educate and engage community leaders and citizens.
3. Planning
   a. Incorporate Sea level rise and storm hazard mitigation into Comprehensive Plan process.
   b. Links to other plans, such as local waterfront redevelopment plan, natural hazard mitigation plans, etc.
4. Regulations
   a. Create new zoning or overlay districts for sea level rise and storm hazard mitigation that identifies no build zone, limited development zone, high hazard zone, limited hazard zone, highly sensitive environmental area, flood prone area, etc.
   b. Subdivision regulations and site plan approval
   c. Project review local planning board
   d. Transfer of development rights
   e. Post-disaster moratoria on building permits to assess hazard mitigation plans
   f. Intergovernmental approaches to coordinate actions of neighboring jurisdictions

Lessons for the Middle Peninsula

These case examples offer a number of lessons for the Middle Peninsula.

1. Establish a policy framework for addressing vulnerability and change under the theme of Community Resilience.
2. Expand science-based assessments of vulnerability and risk, mapping and evaluating high hazard and impact areas.
3. Engage local leaders and citizens in dialogue, planning, decision-making, and action about vulnerability, change, and resilience.
4. Incorporate vulnerability and change into District-wide and county comprehensive plans.
5. Within policy framework and comprehensive plans consider approaches used by others, including
   a. Protection, Accommodation, Retreat approach
   b. Triage to prioritize vulnerable areas for action
   c. Adaptive management and flexibility that expect variability and uncertainty and offer opportunity to learn and change course
   d. Take a place-based approach that best-fits plans and strategies to the social, economic, environmental, and political context of communities
   e. Consider co-benefits of actions to reduce vulnerability that improve water quality, enhance wetlands and ecological systems, reduce flooding and storm hazards, and revitalize existing communities.
6. Consider a wide range of adaptation strategies giving priority to those that initiate, foster, and enhance existing efforts that improve economic and social well-being, public safety and security, public health, and environmental and ecosystem health. These strategies should

a. use and enhance existing Virginia-specific programs and tools, including VCZMP planning grants, CBPA RPA/RMA/IDA requirements, flood plain management, wetlands protection, land conservation easements, and stormwater regulations;
b. consider other innovative regulatory strategies that could be effective to reduce vulnerability, including transfer of development rights, freeboard height requirements, rolling easements, critical area buffers;
c. consider present and future vulnerability when making public investments for infrastructure;
d. develop contingency plans for existing vulnerable infrastructure including roads, bridges, water and wastewater facilities, and power and communication systems.

Chapter 5: A Framework and Strategies for Community Resilience in the Middle Peninsula

This chapter outlines a basic framework and a portfolio of strategies that can be applied at the local level to develop resilience to vulnerability and change in the Middle Peninsula. Because Virginia is a Dillon Rule state, strategies must be assessed for delegated local authority. But as discussed in Chapter 2, Virginia localities have fairly broad existing authority for regulations to preserve floodplains and riparian areas through setbacks and zoning, for transfer of development rights, and for open space easements and tax incentives.

The framework and portfolio function as a structure for planning and decision making, an inventory of common strategies among U.S. localities, and a resource guide to best practices that may be implemented by Middle Peninsula member jurisdictions. For each of these strategies, a tiered approach is necessary to carry a locality from monitoring and analyzing data to identifying appropriate strategies to implementing actions to reduce vulnerability, toward what Quay (2010) calls "anticipatory governance." Quay's approach calls for flexible, "no-regrets" strategies to reduce future impacts, strategies that distribute costs over time by phased and adaptive implementation.

As presented in Chapter 4, lessons from a number of state and local studies and plans for climate change adaptation indicate the need for a policy framework to develop local resilience to change. That framework includes a policy statement and plans, vulnerability assessment, public engagement and education, and flexible and adaptive strategies. Some climate adaptation strategies have clear sub-components that are easily incorporated into an anticipatory governance framework. In most cases, local planning officials, stakeholders and decision makers need to identify an appropriate distribution of actions over time for their specific locality. In every case, a tiered approach that includes both detailed short-range components and a flexible long-range plan is appropriate.

A Planning Framework for Building Community Resilience

Anticipatory governance is more than a set of strategies to reduce vulnerability to hazards and change. It involves a clear policy to guide necessary planning, analysis, engagement, strategy development, and implementation. statement and integration into district-wide and comprehensive planning; vulnerability and hazard assessment; mechanisms for community dialogue, engagement, and education; and appropriate place-based strategies to reduce vulnerability that are flexible and adaptive, emphasize economic and social well-being, and consider co-benefits to communities and natural systems.

1. Policy Statement

To set the stage for planning and action to build resilience to vulnerability and change, both the Middle Peninsula PDC and member jurisdictions should formulate a policy statement for Community Resilience. Although there is considerable uncertainty about the extent of vulnerability the future will hold, even today there are significant existing coastal and inland hazards for which the region should be better prepared. These hazards are likely to be exacerbated in the future. The policy statements can take the form of resolutions or specific statements in comprehensive or hazard mitigation plans. The statements should emphasize the need for science-based vulnerability assessment, planning and scenario

development, education and public engagement, and development of flexible and adaptive regulatory and non-regulatory strategies to build community resilience.

2. Vulnerability Assessment

Vulnerability assessment applies the best scientific understanding of future natural hazards and other impacts to the scale of the Middle Peninsula and its jurisdictions. Location-specific scenarios of future change and impacts are required to identify potential vulnerabilities, engage stakeholders and the public, and to formulate strategies that respond to those scenarios. Vulnerability assessment often includes a task force to oversee studies and research specific to the region or locality and workshops and training sessions to engage community leaders and citizens.

3. Public Engagement

It is important to engage local leaders, agency and elected officials, and citizens in all phases of building community resilience to change. Studies have shown that social capital developed through community dialogue and interaction is an essential ingredient of a community's resilience to disaster, crisis, and change (Randolph 2011). Local knowledge, community values, and political perspectives are important considerations in developing policy statements, assessing vulnerability, and formulating plans and strategies.

4. Planning

The results of vulnerability assessment and scenarios should be integrated into regional and local plans, including regional and local multi-hazard mitigation plans, local comprehensive plans, Chesapeake Bay preservation plans, stormwater management plans, transportation plans, and water and wastewater infrastructure plans. The Virginia Coastal Zone Management Program has identified Community Resilience as a program priority and may be a source of funding support for such planning efforts.

5. Regulatory and Non-regulatory Strategies

Based on vulnerability assessment, public engagement, and planning, action strategies should be formulated to respond to vulnerabilities and build resilience. The strategies may emerge from the related plans listed above, but they should be integrated into a comprehensive set of community resilience actions that can be implemented and monitored over time. They may include land use regulations and other regulations or restrictions, as well as non-regulatory and voluntary strategies including land conservation easements, public infrastructure investments, and landowner stewardship. A portfolio of strategy options is presented in the next section.

Portfolio of Strategy Options

Coastal adaptation responses to climate change are commonly divided into the categories of *protection, accommodation,* and *retreat*. Consensus among climate change adaptation reports is that retreat is both the most cost effective long-range option and the most difficult to enact in the local planning process (Cahoon et al, 2009; Stiles, 2008; Titus, 2009; Titus et al, 2011). Sea level rise adaptation strategies (Titus et al, 2011):

1. *Shore Protection*.
    a. ***Shoreline armoring.*** Protect land and buildings from erosion and flooding using dikes, seawalls, bulkheads, and other hard structures. Wetlands and beaches are eliminated as they are squeezed between the rising sea and the shoreline armoring.
    b. ***Elevation of land surfaces.*** Elevate land and buildings as the sea rises. Efforts to protect oceanfront communities usually involve beach nourishment, which elevates the surface of the beach. In theory, the land surfaces of wetlands can also be elevated, though shore protection projects along wetland shores rarely do so.
2. ***Accommodation.*** Do not try to prevent tidal inundation, erosion, or flooding. But instead of moving people out of harm's way, develop coping strategies that enable continued human habitation. Wetlands and beaches migrate inland, though they may be impaired by the presence of homes on pilings. Accommodation "may imply either deferring the decision whether to protect or retreat, or a conscious policy to allow individual owners to decide whether to abandon their property or continue to occupy an increasingly wet coastal zone" (Titus et al, 2011).
3. ***Retreat.*** Allow wetlands, beaches, and other coastal habitats to migrate naturally as the sea encroaches inland; move people out of harm's way; and prevent new construction in vulnerable areas.

In *Rolling Easements* (2011), Titus et al demonstrate that accommodation is not feasible in the long-term (i.e. structures rarely remain viable for use once they are standing in open water), leaving the fundamental question: "Which communities will be *protected* and where will people have to *retreat*?" The study, which was published as a comprehensive primer by the Climate Ready Estuaries program further states that "regulatory and property rights approaches are not mutually exclusive" and that in most cases rolling easements on private coastal parcels result in negligible property value reduction because changes occur in small increments over long periods of time. Many climate adaptation strategies discussed herein fall within the definition of rolling easements as broadly defined in the 2011 primer.

> "A **rolling easement** is a legally enforceable expectation that the shore or human access along the shore can migrate inland instead of being squeezed between an advancing sea and a fixed property line or physical structure. The term refers to a broad collection of legal options, many of which do not involve easements. Usually, a rolling easement would be either (a) a law that prohibits shore protection or (b) property right to ensure that wetlands, beaches, barrier islands, or access along the shore moves inland with the natural retreat of the shore" (Titus et al, 2011).

The law of property offers many different ways for a parcel owner to transfer some ownership rights to someone else. Many of those approaches can create a rolling easement. Though the end result is generally the same, methods may emphasize the absence of shore protection, migration of property line, or preserving public access to the shore.

In Virginia, lands seaward of the mean low water line are public lands and are subject to a rolling public trust easement in favor of the Commonwealth. While Virginia localities do not have authority to require rolling easements, they can implement a voluntary program to acquire recordable easements in which property owners agree to limit development on shoreline property in exchange for compensation (Silton and Grannis, 2010).

Strategies by Impact Sector

In "America's Climate Choices: Adapting to the Impacts of Climate Change," (2010) the National Research Council published a comprehensive list of climate adaptation strategies. Appendix 5.A of this report includes a set of adaptation strategy matrices modified from the NRC report, which are applicable to the Middle Peninsula. The list of strategies included is comprehensive, addressing a broader range of issues than are covered in the main body of this report. The matrices are intended to provide a strategic framework within which local and regional agencies can identify overlapping plan elements and co-benefits of a collaborative planning approach. The strategies selected and refined from the NRC model are put forth specifically for consideration by Middle Peninsula localities, citizens, businesses, and partner agencies.

The following selections for the portfolio of strategy options focus on applied local and regional tools that merit priority consideration by Middle Peninsula localities.

Comprehensive Plans

Local governments can incorporate coastal flooding, erosion, and sea level rise into the comprehensive planning process (Stilton and Grannis, 2010):

- Establish estimated rate of sea level rise and the time period over which it may occur
- Designate vulnerable areas
- Site future infrastructure and capital improvements outside of vulnerable areas
- Provide scientific data to justify land use decision-making
- Use risk-based analysis of likely hazards and vulnerabilities to inform land use decisions
- Plan responses to sea level rise

Public Access Management

Middle Peninsula stakeholders identified diminished public access due to gradually migrating shoreline as a future impact of concern during Phase I of the project (MPPDC, 2009). Public access effectively migrates inland either by preventing new construction and requiring removal of old structures that impair access locally, or by amending state law so that it is clear that public access migrates inland regardless of how the public access was obtained (Titus et al, 2011). The Open Beaches Act in Texas provides an example of rolling easement legislature, though such a program would only apply to subaqueous areas beyond the Mean Low Water (MLW) line in Virginia. The Texas state statute's explicit prohibition of hard structures, procedures for removal of homes seaward of the vegetation line, and explicit recognition of the inland migration of public access are all characteristics of a "rolling easement," a phrase Texas courts have often used to narrowly refer to the inland migration of the public right to access along the privately owned dry beach.

As a low-water state, Virginia protects private coastal property rights extending to the low-tide mark of the shoreline, so the shoreline can only migrate inland wherever public lands or easements enable it to do so. Local long-range planning for inland migration of public access should include prioritizing inland areas for public use or conservation, which are likely to be future shoreline areas as a result of erosion and

sea level rise. Long-range policy should include consideration for buildings and infrastructure that are eventually located shoreward of tidal vegetation and those eventually left in open water.

For the Middle Peninsula, the Middle Peninsula Chesapeake Bay Public Access Authority (MP-PAA) is responsible to promote and manage public access "for all types of recreational activities important to our economy and to the citizens of the Commonwealth of Virginia" (MP-PAA, 2011). Created by the General Assembly in 2002, the MP-PAA is charged with the following duties:

The Middle Peninsula Public Access Authority is charged with the following duties:

1. Identify land, either owned by the Commonwealth or private holdings, that can be secured for use by the general public as a public access site;
2. Research and determine ownership of all identified sites;
3. Determine appropriate public use levels of identified access sites;
4. Develop appropriate mechanisms for transferring title of Commonwealth or private holdings to the Authority;
5. Develop appropriate acquisition and site management plans for public access usage;
6. Determining which holdings should be sold to advance the mission of the Authority; and
7. Perform other duties required to fulfill the mission of the Middle Peninsula Chesapeake Bay Public Access Authority.

A Working Waterfront Master Plan is currently under development by the MP-PAA. The Working Waterfront Master Plan provides an opportunity to coordinate planning efforts with the local comprehensive planning process to protect and improve access to shoreline waters. The Master Plan should consider sensitive natural resource areas and other areas vulnerable to climate impacts.

Regulating Shoreline Protection

As discussed above, public access and shoreline protection are interrelated in that prioritizing areas that require public access management drives priorities for shoreline protection structures. Equally important is the process of planning for areas that should be discouraged from employing shoreline protection in the future. Publications from United States Environmental Protection Agency (USEPA), National Oceanic and Atmospheric Administration (NOAA) and Virginia Natural Resources Leadership Institute (VNRLI) emphasize the importance of purposeful delineation of areas that will require shoreline protection in the long run and those areas where efforts to "hold back the sea" – such as beach nourishment, revetments, and armoring – may be prohibited.

In order to implement such a plan, specific areas may be designated in the comprehensive plan. Localities then include one or more overlay zones, which specify prohibited shoreline protection activities. Justification for the zone includes: public access planning, flood protection, natural hazard mitigation, and natural resource (wetlands) preservation.

Floodplain Management

In Virginia, local governments have explicit authority to zone and plan for "one of the primary impacts of sea level rise: flooding" (Silton and Grannis, 2010). From a legal standpoint, then, the Code of Virginia grants local governments broad authority to consider flood risks when planning and zoning:

- Zoning ordinances may be designed to provide for safety from flood, provide adequate flood protection, and protect against loss of life and property from flood (Virginia Code §15.2-2223, §15.2-2283).
- Local governments may consider "preservation of floodplains" when creating zoning districts (Virginia Code §15.2-2284).
- Local governments can regulate the use and development of land and may specifically regulate development in flood plains (Virginia Code §15.2-2280).

Writing for the Georgetown Climate Center (2010), Silton and Grannis point out that the Code "provides no guidance or criteria for how flood risks should be assessed; flood plains are simply defined as 'those areas…which are likely to be covered by floodwaters.' The Code does not specify the boundaries of the flood plain nor the method by which flood risks should be calculated. Thus, consistent with the Dillon Rule, localities can choose any *reasonable method* for assessing flood risks, so long as the chosen method is consistent with the statue's purpose of mitigating flood impacts" (Silton and Grannis, 2010; Virginia Code §10.1-600).

Flood maps developed by FEMA, called Flood Insurance Rate Maps (FIRMs), do not account for future risks and are therefore not an accurate designation of future landward migration of the shoreline. To the extent that local GIS mapping efforts can depict future projection of historic sea level rise as a baseline scenario, they may be able to extend the regulated flood plain as enabled under flood protection statutes.

Chesapeake Bay Preservation Act (CBPA)

The CBPA makes it possible for localities to designate appropriate Resource Protection Areas (RPAs), as discussed in Chapter4. Fairfax County and Chesapeake, Virginia, serve as examples of localities providing specific buffers and performance criteria as enabled by the Virginia Code. Both RPAs and Resource Management Areas (RMAs) must be designated in local ordinances. Within the Middle Peninsula, Mathews County has designated the RMA as an additional 150-foot buffer from the boundary of the RPA. Examples of performance criteria, which may be included in local Chesapeake Bay Preservation ordinances:

- Stormwater management requirements
- Erosion and sediment control
- Septic system maintenance
- Environmental Impact Assessment

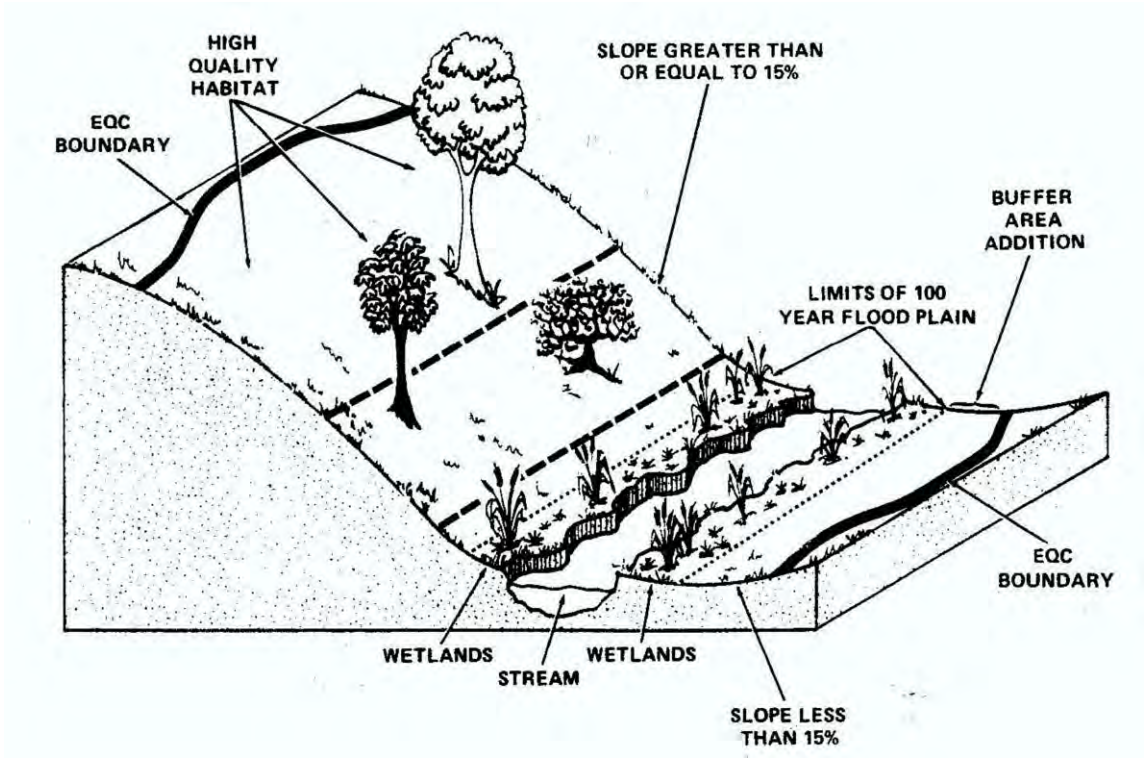

Figure 5.1. Fairfax County, Virginia. Environmental Quality Corridors. (Source: Fairfax County, 1990)

The Environmental Quality Corridor program in Fairfax County demonstrates a set of policies enabled by the local comprehensive plan to "preserve natural resource areas and provide passive recreation" within corridors that include stream valleys, wildlife habitats, and wetlands (Kaplan, 2008).

Market-based strategies (TDR/PDR)

Virginia allows localities to authorize the transfer of development rights (TDR) [Code of Virginia §15.2-2316.2], which also enables localities to keep development and redevelopment out of areas at high risk of inundation (VNRLI, 2011). The "TDR statute" of the Virginia Code (Title 15.2, Article 7.1) expressly permits local governments to create TDR programs:

- Receiving areas and sending areas must be designated in the comprehensive plan
- A TDR Ordinance is required, providing for the creation of "instruments that sever the development rights and allow for their transfer and use by other parties" (§15.2-2316.2(B)(1)-(4))
- Sending areas and receiving areas for the transfer of development rights must be designated in the zoning ordinance
- Land owners of the "sending" properties must grant an easement limiting the use and development of the sending property, which is binding on future owners

TDR programs work very well where market demand exists. Administration of the program is the responsibility of individual localities. Since the selling and purchasing of development rights is a voluntary act, this tool is not sufficient on its own to preserve vulnerable areas.

Site-level Density Transfers

Site-level density transfers, sometimes called "onsite density transfers," may be used to direct development in the coastal zone. Figure 5.2 illustrates the incentive zoning concept. In Isle of Wight County, Virginia, developers have options for open space design in a zone with a permitted density of 1 unit per 10 acres and a requirement for 50% permanent open space. The first option (Option 'A') is an onsite density transfer that provides the 50% open space and ten 5-acre lots. The second option provides 70% open space and gives a density bonus of 100%, allowing 20 lots of 1.5 acres each.

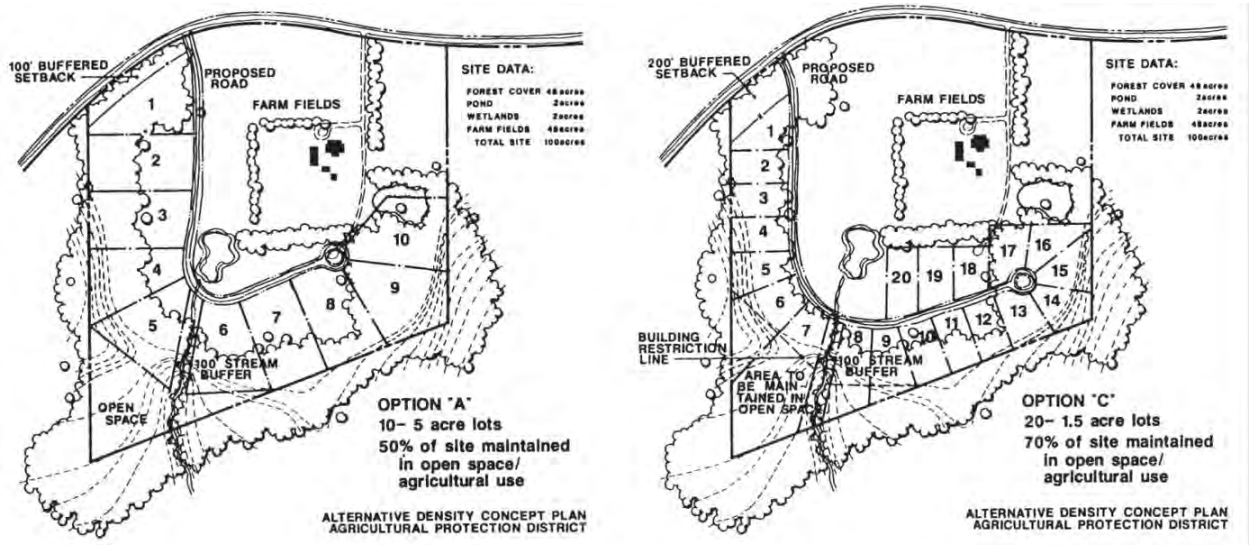

Figure 5.2. Density Bonus Options in Isle of Wight County, Virginia. Base zoning provides 1 unit per 10 acres and requires 50% open space. B: Increasing open space to 70% gives a 100% density bonus. (Source: Randall Arendt, Rural by Design, 1994. Chicago: American Planning Association)

Infrastructure Planning

Strategies exist to allow localities to steer future infrastructure toward areas free of flood risk and other coastal hazards. As discussed in Chapter 4, Dorchester County, Maryland, designated a Sea Level Risk district, where certain standards and restrictions apply (septic systems, wells, freeboard).

On-site Sewage Disposal Systems (OSDS)

The Middle Peninsula Planning District completed a study entitled "MPPDC Inventory of Non Traditional Onsite Sewage Disposal Systems and Impacts on Land Use Patterns" (2008), intended to explore the land use impact of alternative/engineered septic systems following regulatory changes in 2000. Feasibility of septic system on a given parcel is fundamental to whether the lot is developable or not. Within the Middle Peninsula, local governments have not previously needed regulations that restrict development in areas where septic systems were already not feasible.

The Virginia Department of Health (VDH) regulatory change left local governments responsible to provide services to several areas previously assumed to be not feasible for development. Moving forward, local government options are to create comprehensive planning and zoning policies that designate coastal hazards, flood protection, and water quality protection. Currently local governments cannot regulate OSDS within their jurisdictions. Some Virginia localities continue to seek clarification from the Commonwealth of Virginia about overlapping and conflicting requirements between the Clean Water Act and allowance of engineered OSDS. Albemarle County, Virginia, drafted a resolution in January 2011 requesting that the General Assembly reaffirm local zoning and land use authority to manage the location and timing of engineered OSDS installations (Albemarle County, 2011).

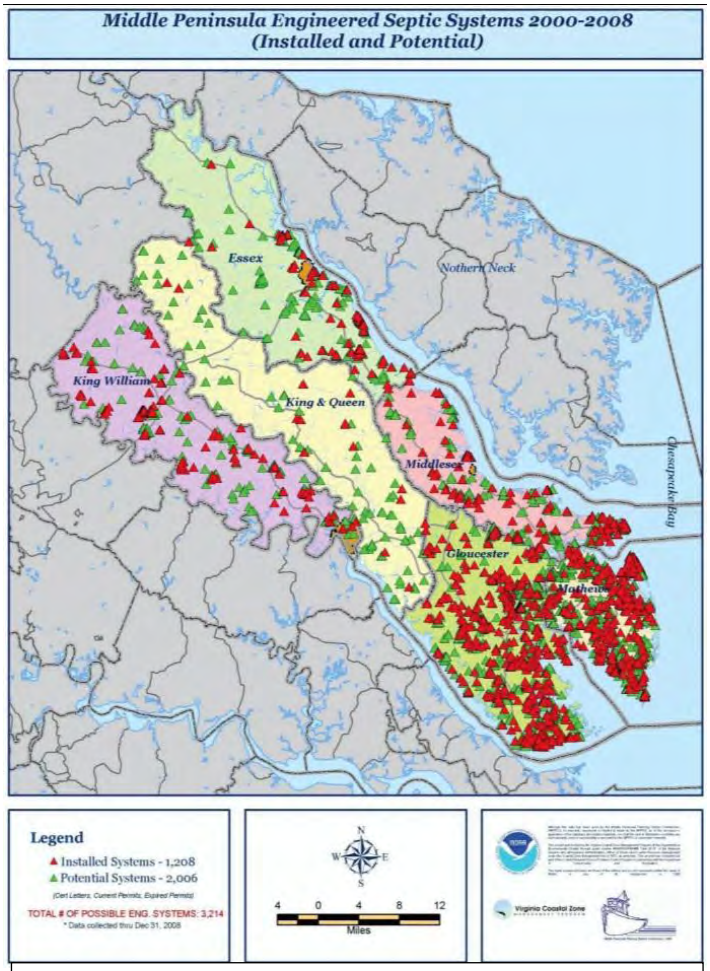

Figure 5.3. Current and Future Planned OSDS

Figure 5.3 illustrates current and future planned engineered OSDS, many in areas that had previously been assumed to be not suitable for development.

Conservation Easements

Conservation easements on coastal properties may be structured with relatively modest restriction, such as prohibiting shore protection structures or activities that change the elevation of the coastal land surface. The purpose of such easements is to allow gradual migration of shoreline and coastal wetlands inland, allowing the property owner to engage all other uses of his property unless/ until the sea reclaims it. Property value studies by the U.S. Global Change Program and USEPA demonstrate a relatively small impact to property values in such instances, ranging from one to five percent (Karl et al, 2009; Titus et al, 2011). Conservation easements may be arranged by local government programs or land trusts.

National, state, and regional land trusts may be engaged by private land owners for the purpose of allowing natural inland migration of the shoreline over time. Local government's role in this process is to develop land use plans for coastal areas that incorporate risk-based planning and designate appropriate

areas for holding back the sea and areas where shoreline protection is prohibited. In the Middle Peninsula, the Middle Peninsula Land Trust (MPLT) has participated in regional conservation planning, facilitating conservation easements for local land owners and promoting continued public access through land acquisition (MPLT, 2011).

In a 2011 brief published by the Virginia Natural Resources Leadership Institute entitled "Climate Change and Public Policy," authors highlight conservation easements as a means to keep shorelines open in Virginia: "Virginia offers generous tax treatment for Land Preservation Tax Credits generated under these programs [Code of Virginia §58.1-512]: a tax credit equal to 50% of the value of any conservation easement donated by a Virginia taxpayer over land in Virginia (providing that the easement qualifies as a charitable contribution under IRC §170h) up to $600,000. The tax treatment would encourage landowners along shorelines to donate their lands into conservation easements and consequently, keep the shoreline lands open" (VNRLI, 2011).

A correlation certainly exists between diminished property values and tax revenue for local government. Concern over diminished revenues due to conservation easements is one reason localities are not often quick to embrace conservation as a planning tool. A study published by the MPPDC in 2010 addresses this concern, concluding that the local tax revenue impact of conservation easements was less than a half percent (< 0.50%). The report attributes the low figures to a corresponding reduction of a given locality's "composite index" with reductions in the Total Value of Land Book (TVLB), which results in more state aid funding to schools (MPPDC, 2010). The MPPDC "Conservation Easements" report is the first year output of the MPPDC Conservation Corridors program. The MPPDC is slated to develop regional Priority Conservation Area maps during subsequent phases of the program (MPPDC, 2011). The Conservation Corridors program is an opportunity for the MPPDC to incorporate existing climate impact maps into their decision model for priority conservation areas.

Shoreline Management Plans

Coastal habitat preservation is an implicit goal of climate adaptation recommendations offered by federal programs such as USEPA and the U.S. Climate Change Science Program, as discussed in Chapter 1 of this report. Living Shorelines, a strategy employed by the state of Maryland, involves coastal property owners in active shoreline management in order to allow the sea to naturally advance inland over time.

In the Middle Peninsula, Mathews County has completed a Shoreline Management Plan (Mathews County, 2010). Shoreline management should be based on the types of coastal habitats and wetlands present, exposure to coastal storm events, and resulting erosion issues. Mathews County works with coastal property owners to employ the following shoreline management strategies:

- Marsh management
- Add sand with groins
- Stone sills
- Breakwater system
- Revetments
- Spurs

The plan notes that site-specific decisions should be made, and Mathews County has been proactive in developing public outreach materials to inform property owners of early detection techniques to identify erosion and be aware of response options. The plan discusses the need to balance wetlands encroachment resulting from shoreline management practices. Shoreline management focused on aspects of the coastal zone other than erosion may be more appropriate for other localities. Mathews' shoreline management project was completed through a funded endeavor with the Virginia Institute of Marine Science (VIMS).

Tax Incentives

Multiple sections of the Virginia Code permit local governments to use tax incentives to regulate land use (Silton and Grannis, 2010).

- **Use Value Assessments.** Localities may offer lower tax assessments for owners who volunteer to preserve property as open space. Rather than assessing taxes based on the property's full potential for development ("fair market value" (FMV)), "use value" tax assessments account for restrictions on the property's use (Virginia Code §58.1-3230). Local governments could use this incentive to encourage coastal property owners to preserve portions of their land. As with conservation easements, the resulting reduction in tax revenue to the local government is < 0.5%, but there is no resulting impact to the composite index for this voluntary program.
- **Wetlands Tax Exemptions.** Localities may offer tax exemptions to owners who agree to preserve wetlands and riparian buffers (Virginia Code §58.1-3666). A tax exemption could be offered under an environmental quality corridor policy similar to the current EQC program in Fairfax County discussed previously in this chapter.

Zoning and Ordinance Strategies

Local climate adaptation strategies may include regulatory strategies in the comprehensive planning process. Best practices address a range of possible future scenarios and encourage a mix of shoreline protection and planned retreat, depending on existing coastal land use in each jurisdiction.

1. **Coastal Overlay (Rolling Easement) Zoning**. Create an overlay zone for areas subject to eventual inundation. Within the coastal zone overlay, each separate zoning classification may be designated as either "protection" or "accommodation" (for example, residential single-family protection (RSP) and residential single-family accommodation (RSA)). Determination of "protection" or "accommodation" status depends on which areas decision makers deem appropriate for holding back the sea or planned retreat, respectively. Titus et al (2011) cite overlay zoning in Prince George's County, Maryland, as an example of this sort of practice (Prince George's County Zoning Code §27-441).
    a. **Possible Themes/Titles for the Overlay:** Coastal Hazards, Shoreline Protection, Shoreline Preservation, Sea Level Risks, Coastal Flooding, Coastal Zone – Protection/Accommodation
    b. **Possible Characteristics of Coastal Overlays:**
        i. Prohibit shoreline protection structures
        ii. Implement shoreline setbacks
        iii. Restrict future development
        iv. Lower non-conforming use threshold

v. Raise building code "free board" requirements

2. **Setbacks**. Setbacks make it more likely that an eroding shore will be allowed to retreat (Climate Change Science Program, 2009; Beatley et al, 2002). Shoreline setbacks may be applied to an existing zoning classification or included in an overlay zone. Setbacks are building restrictions that establish a distance from a boundary line where land owners are prohibited from building structures. With coastal properties, the boundary line is often the shoreline (specifically the mean low water line (MLWL) in Virginia).
3. **CBPA.** Extend Resource Protection Area and Resource Management Areas under the Chesapeake Bay Preservation Act ordinance. This can be accomplished by establishing specific performance criteria that contribute to stated goals of the CBPA (pollution reduction, erosion and sediment control, stormwater management).
4. **Floodplain Ordinance**. Update floodplain maps and GIS layers to account for future vulnerabilities. Extend floodplain restrictions currently in place to include areas mapped for future flood vulnerability. Revisit and revise development restrictions where appropriate to discourage development in areas vulnerable to current and future coastal flooding.

Table 1. Example Sea Level Rise Plan for Various Zoning and Land-Use Categories

Zoning	Existing Land Use	Planned Response to Sea Level Rise		
		Protect[1] Shore	Accommodate[2]	Retreat[3]
Commercial Mixed Use	High-Density	✓		
Commercial Mixed Use	Residential	✓		
Residential Single Family	Residential	✓		
Residential Single Family	Agriculture		✓	
Rural Estate	Residential	✓		
Rural Estate	Agriculture			✓
Agriculture	Agriculture			✓
Conservation/Open Space	Conservation/Open Space			✓

Source: See text.

1. Shore protection could be either shoreline armoring (e.g., dikes and bulkheads) or grade elevation (including beach nourishment).
2. Accommodation implies neither shore protection nor a specific effort to return lands to nature. It may imply either deferring the decision whether to protect or retreat, or a conscious policy to allow individual landowners to decide whether to abandon their property or continue to occupy an increasingly wet coastal zone. In the latter case, rolling easement zoning may be appropriate.
3. Rolling easement zoning would be appropriate in an area where retreat is planned.

Figure 5.4 Sea Level Rise Planning. Source: Titus, et al 2011

Figure 5.4 shows an example of zone-by-zone designation in the planning process of which mode of shoreline management is selected (protect, accommodate, retreat). For each selection the designation can then be incorporated into the zoning code, including applicable overlay zones for high-hazard or coastal flooding areas.

Education and Funding Opportunities

A tiered approach is necessary for building community resilience. The process should be built on a framework that includes data gathering, knowledge building, and community participation. All of these actions take time, resources, and good will. Various training and funding is available to help local governments and their stakeholders become familiar with climate change issues, gather data to help determine vulnerability to risks, and develop location-specific goals and strategies.

Education

- **"Introduction to Climate Science"** (Office of Environmental Education, DEQ). This training product is provided to help local governments and stakeholders better understand the science behind climate variability, including levels of certainty and uncertainty. Two options are offered for the training: 1) the presentation can be sent out to the local offices with accompanying script,

or 2) arrangements can be made for an education representative to conduct the training. The point of contact for this training is David Ruble, Community Education Specialist, Virginia DEQ at David.Ruble@deq.virginia.gov, or visit www.vanaturally.com.

- **Coastal Training Program (CTP)**, Chesapeake Bay National Estuarine Research Reserve (CBNERR) at the Virginia Institute of Marine Science (VIMS). This program was recommended by facilitators at the Sea Level Rise and Inundation Community Workshop in late 2009 (Culver, et al., 2010). It is a national initiative to address critical resource management issues by providing up-to-date, science-based information, access to technologies, and skill-building opportunities to key professionals responsible for making decisions about coastal resources. Programs range from seminars and hands-on skill training to participatory workshops and technology demonstrations. Training topic areas are: wetlands and riparian buffers, shoreline management, water quality and water management. The CTP's target audience is local and state agency staff involved with land-use planning, marine resources and environmental protection. All programs are offered at no to low cost. Information about the CTP can be found at http://www.vims.edu/cbnerr/coastal_training/index.php.
- **Stakeholder Engagement Strategies for Participatory Mapping**, NOAA Coastal Services Center. This 20-page guide is a decision-making tool for communities to help engage stakeholders in mapping exercises. The community mapping program helps to identify community resources, perspectives, and priorities. The program has the potential to reduce resistance to planning strategies that address vulnerability to climate change. The guide is available for download at http://www.csc.noaa.gov/participatory_mapping. The NOAA Coastal Services Center also offers assistance to communities interested in undertaking a participatory mapping exercise, ranging from phone calls that answer questions to "an extra pair of hands dedicated to [the local government's] program." Contact the Center for more information - csc.info@noaa.gov.
- **Virginia Natural Resources Leadership Institute (VNRLI)**, Institute for Environmental Negotiation at the University of Virginia (UVA). The VNRLI Mission is to develop leaders throughout Virginia who can help groups involved in "contentious natural resources issues" move beyond conflict toward consensus building and collaborative problem solving. Training offered through VNRLI is comprised of six three-day sessions over a span of nine months. The cost of enrollment is $2500 (scholarships available). Application and scholarship deadlines are in the month of June each year. For enrollment and curriculum information, visit the VNRLI website: http://www.virginia.edu/ien/vnrli/index.html. VNRLI has developed several "issue briefs," which are available for download, including: Chesapeake Bay, Low Impact Development, Sustainable Agriculture, Forest Management and Policy Issues, and Climate Change. VNRLI's strong emphasis on consensus building could help identify strategies to engage diverse stakeholder groups in the midst of challenging local political tensions.

Funding

The Virginia Coastal Zone Management Program (CZM), Virginia DEQ, administers several funds, initiatives, and projects as funded through the National Oceanic and Atmospheric Administration (NOAA) under the federal Coastal Zone Management Act (CZMA). Current funding for this program throughout the Commonwealth of Virginia is approximately $3 million annually. The MPPDC and the Middle Peninsula Chesapeake Bay Public Access Authority (MP-PAA) have been successful in acquiring

funding over recent years. Each year, funding is made available through Virginia's CZM Program under the following categories:

- Implementation of the Virginia CZM
- Acquisition and Construction Projects
- Creation of New Enforceable Coastal Policies
    - Virginia Coastal Needs Assessment and Strategy
    - Special Area Management Planning
    - Living Shorelines
- Implementation of the Virginia Nonpoint Source Pollution Program

Though the Focal Area of the CZM Program changes every three years, MPPDC and member jurisdictions can have some confidence that all strategies recommended herein support the goals of the federal CZMA program and are, therefore, likely to be eligible for funding as long as the CZMA program continues to be federally funded. A complete list of funding categories, descriptions, and requirements is available online through the Virginia CZM Program page within the DEQ website (http://www.deq.state.va.us/coastal/funding.html).

Summary

This chapter has presented a policy and planning framework and a portfolio of strategies to help move the MPPDC and its member jurisdictions forward to adapt to the challenges posed by natural hazards and other impacts of climate change, and build their resilience to change.

As with most planning endeavors, the adaptation planning process should define goals and objectives and then examine options to meet those goals in terms of their impacts on different stakeholders. "A fundamental issue to address is whether pre-existing strategic goals will continue to be appropriate or feasible in light of anticipated climate change impacts, or whether these former priorities will need to be modified. This centers around whether adaptation will allow the goals to be met as before or whether goals need to be adjusted because climate change alters the feasibility of achieving them" (National Research Council, 2010).

Chapter 6: A Recommended Pathway for the Middle Peninsula to Reduce Vulnerability

Climate change is real and happening, yet the magnitude of its local consequences and their timing are uncertain. This uncertainty complicates appropriate actions which may require changing behavior, changing patterns of land use, changing property values, and changing infrastructure investments. Even without uncertainty, change is hard and needed investment for change is hard to come by. But the most costly, damaging, and disruptive approach in the face of the vulnerability of the Middle Peninsula is to do nothing.

Localities within the Middle Peninsula must continue to build their community resilience to disruptive events and changing conditions. Their current efforts vary, and a more consistent regional strategy coordinated by the MPPDC is recommended. Given uncertainties and current public sentiments, such a regional strategy and its local implementation should begin with a public engagement program that includes local fact-finding and vulnerability assessment, and the collaborative learning it provides. Plans and strategies should be flexible, adaptive, and incremental, allowing for modification over time as conditions, resources, and sentiments change and uncertainties are resolved.

This iterative approach to reduce vulnerability and build resilience should be integrated into the PDC's and localities' existing planning framework, which includes comprehensive planning, natural hazard mitigation, land use zoning, building codes, floodplain management, stormwater management, Chesapeake Bay regulations, land conservation, and transportation and water/wastewater infrastructure plans. These programs will continue to be the foundation for efforts to reduce vulnerability over time.

In addition, the PDC and its localities should adopt an iterative and deliberative process called "anticipatory governance" that assesses vulnerability, monitors change and uncertainty, and engages stakeholders. Building community resilience is an iterative process that requires purposeful local planning over time and continual collaborative engagement that builds social capital that can be relied on in times of disaster or disruptive change. This collaborative engagement can evolve from fact-based vulnerability assessment. And the purposeful planning should consider regulatory and non-regulatory strategies based on this assessment. The sections below elaborate on this anticipatory governance approach, the comprehensive planning process, and priority strategies.

Anticipatory Governance

The MPPDC and member localities should engage anticipatory governance to build a framework for community resilience. There are six basic elements of this approach:

1. Formulate a Policy Statement for Community Resilience
2. Conduct a vulnerability assessment to identify location-specific vulnerabilities to future change and impacts
3. Engage local leaders, agency and elected officials, and citizens during all phases of building community resilience to change
4. Integrate vulnerability assessment results into regional and local plans

5. Formulate action strategies based on vulnerability assessments, public engagement, and planning steps
6. Adopt a comprehensive set of community resilience actions that can be implemented and monitored over time

Comprehensive Planning

Local governments within the Middle Peninsula should incorporate vulnerability assessment results into the comprehensive planning process. The Policy Statement for Community Resilience should be included or referenced in local comprehensive plans. Within that framework, local governments and stakeholders can use scientific data to perform risk-based analysis of likely hazards and vulnerabilities, which inform land use decisions. Vulnerable areas should be designated within the comprehensive plan, and future infrastructure and capital improvements should be sited outside of vulnerable areas.

Adopted principles of community resilience actions should be incorporated into regional and local plans within the Middle Peninsula: multi-hazard mitigation plans, local comprehensive plans, Chesapeake Bay preservation plans, stormwater management plans, transportation plans, and water and wastewater infrastructure plans.

Outreach and Collaborative Engagement

As discussed in Chapter 5, community involvement at every step of the planning process is itself a strategy to build community resilience. The MPPDC and member localities should incorporate outreach to solicit involvement, joint fact-finding, and collaborative learning and to disseminate information. Localities can consider establishing a working group for that purpose or amending the mission of an existing group.

Considerable knowledge is available among member localities in the Middle Peninsula. The MPPDC can facilitate regional stakeholder engagement to share perspectives, local knowledge, and ideas. Technical assistance, leadership and training workshops, and scientific data assistance are available from state, federal, and nonprofit agencies. The MPPDC can work with member jurisdictions to coordinate opportunities. The MPPDC may also assist in the follow-up process, providing technical assistance to localities that wish to incorporate new lessons into their existing planning framework (e.g. providing recommendations for how to apply new scientific data or community outreach opportunities).

Non-regulatory Strategies

The MPPDC and member jurisdictions should use vulnerability assessments to prioritize non-regulatory strategies best suited for their communities. Chosen strategies should aim to reduce vulnerability to coastal hazards while promoting opportunities for property owners to retain the most use and value from their property. Chapter 5 discusses the details of conservation programs, use value tax incentives, and shoreline management strategies, which fall into this category. Localities should also base infrastructure planning and capital investment decisions on vulnerability assessments. Planning strategies should incorporate changing vulnerabilities into the decision process to determine where future development will occur.

Regulatory Strategies

Comprehensive plans drive opportunities and constraints on the capacity of local ordinances to build community resilience to change. Priority should be given to strategy development within areas already supported by the Comprehensive Plan, particularly applicable regulatory mandates in the Commonwealth of Virginia:

- Flood Ordinance
- Chesapeake Bay Preservation Ordinance
- Wetlands Ordinance
- Stormwater regulations

Vulnerability assessments and scientific data gathering should drive refined location-specific decisions within each of these areas (e.g. designation of RPAs and RMAs, setbacks and nonconforming use thresholds within the floodplain). The result should be a local regulatory framework that is not reactive but defined by anticipation of changing conditions and vulnerabilities.

Conclusion

Planning for community resilience to climate change should be founded upon **location-specific scientific data**, **stakeholder-driven**, and **supported by the local Comprehensive Plan**. The process necessary to build community resilience is ongoing and should be approached in a strategic, tiered fashion. Localities in close proximity to one another can benefit by exchanging information, strategies, and lessons learned. Process is important in all planning, but especially in building community resilience in the face of uncertainty. Resolving uncertainty requires monitoring conditions and learning over time, and an engaged public must be part of that process. Involving stakeholders and the public in these activities also builds social capital that can be relied on to enhance resilience at times of disaster, disruption, and change.

The MPPDC and local governments should continually seek opportunities to receive technical assistance and funding in order to drive an anticipatory approach to adaptation planning. With purposeful community involvement and planning, this planning process will secure longevity and resilience for the entire community.

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Appendix 2.A Understanding Climate Change Impacts in Chesapeake Bay Region

The effects of sea-level rise are not necessarily obvious in the short term, though the most visible effects are seen in changing coastal landscapes through flooding, inundation, and coastal erosion. Additionally, alteration or loss of coastal habitats, wetlands, bays and estuaries has negative impacts on many plant and animal species. According to Titus et al (2009), coastal flooding in Virginia and throughout the Chesapeake Bay Region is increasing and will continue to do so over the coming decades. Sea levels along Virginia's coasts are projected to rise 2.3 to 5.2 feet by the year 2100 (Titus et al, 2009), with relative sea level rise for Virginia coasts higher than the national average due to land subsidence, the condition of sinking land due to groundwater withdrawal and tectonic activity (Pyke et al 2008).

Coastal Elevations

Coastal vulnerability to sea level rise is commonly modeled by layering future sea level rise scenarios with coastal elevations to project areas subject to future inundation. Inundation will be the primary result of sea level rise only in some areas; in other areas, long-term erosion of beaches and cliffs or drowning wetlands will alter the coastal landscape, resulting in land loss. In "Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region" (Titus et al, 2009), coastal response to sea level rise is distributed across the following broad categories:

- Land loss by inundation of low-lying lands
- Land loss due to erosion (removal of material from beaches, dunes, and cliffs)
- Barrier island migration, breaching, and segmentation
- Wetland accretion and migration
- Wetland drowning (deterioration and conversion to open water)
- Expansion of estuaries
- Saltwater intrusion (into freshwater aquifers and surface waters)
- Increased frequency of storm flooding (especially of uplands and developed coastal lands)

Mapping efforts completed by the MPPDC in collaboration with the Virginia Institute of Marine Science (VIMS) are derived from best available digital elevation models (DEM) using USGS contours between 5 and 10 feet. As light detection and ranging (LIDAR) data is now becoming available for the majority of Tidewater Virginia, vulnerability mapping has the potential to become even more detailed and more accurate in future iterations.

Water Resources

Climate change impacts to water resources may include reduction of water in some areas, too much water in other areas, and degraded water quality. Water cycle changes observed over the past several decades include (Karl et al, 2009):

- Changes in precipitation patterns/ intensity
- Changes in incidence of drought

- Widespread melting of snow and ice
- Increasing atmospheric water vapor
- Increasing evaporation
- Increasing water temperatures
- Reductions in lake and river ice
- Changes in soil moisture and runoff

Changes to the water cycle are expected to continue in coming decades (Milly et al, 2005). Precipitation increased by an average of 7 percent during the past century in the United States, and the heaviest 1 percent of rain events increased by nearly 20 percent (Gutowski et al, 2008). Some coastal regions, including the Chesapeake Bay, have seen greater than a 50 percent increase in the heaviest 1 percent of all precipitation events over the same period (Karl et al, 2009).

Both surface water quality and groundwater quantity may be affected by changing climate conditions. Increased temperatures in surface waters – streams, lakes, reservoirs – leads to reduced dissolved oxygen, which in turn stresses aquatic animals such as cold-water fish, insects and crustaceans (Bates et al, 2008). Surface water quality is negatively impacted by the effects of water pollution – increased sediment, nitrogen, disease pathogens, pesticides, herbicides and thermal pollution – which are amplified with increased precipitation (Karl et al, 2009). Also, harmful blooms of algae and bacteria have already been observed in the Chesapeake Bay, due in part to increases in polluted runoff (Karl et al, 2009).

As sea level encroaches upon coastal property and infrastructure, saltwater intrusion into freshwater aquifers becomes more common. Karl et al (2009) states that shallow groundwater aquifers that exchange water with streams are the component of the groundwater system likely to be most sensitive to climate change. As with many adaptation considerations, planning for the past or present status-quo will most likely not accommodate changes projected to water cycle and water resource management demands over the next several decades.

Energy Supply and Use

According to the U.S. Energy Information Administration (EIA, 2008) about 87 percent of U.S. greenhouse gas emissions come from energy production and use. Other recent population and housing trends may result in increased demand for energy in both commercial and residential sectors: population shifts to areas where air conditioning use is high, increase in square footage built per person, increased electrification of the residential and commercial sectors and increased market penetration of air conditioning (Wilbanks et al, 2007).

The Chesapeake Bay region is not likely to see reduction in water supply for the purpose of power plant electricity production (Karl et al, 2009). However, siting of new future energy facilities could be restricted by sea level rise, exposure to extreme events and increased capital costs resulting from the need to provide greater protection from extreme weather events (Bull et al, 2007). The electrical grid itself is vulnerable to temperature changes and severe weather events; specifically, electric power supply can experience disruptions when power transformers fail under the strain of temperature spikes (Bull et al, 2007).

Transportation

Coupling sea level rise with storm surge is an important consideration for assessing impacts of sea level rise on infrastructure. In the United States, an estimated 60,000 miles of coastal highway are already exposed to periodic flooding from coastal storms and high waves (National Research Council, 2008). According to the MPPDC map analysis, there are over 62,000 feet of VDOT road segments across member jurisdictions, which are vulnerable to a one-foot increase in sea level. These vulnerability estimates are possibly low, given the fact that storm surge was not incorporated into the model (Gill et al, 2009). An increase in coastal storms could mean more frequent and potentially more extensive emergency evacuation. The lifetime of highways that have been exposed to flooding is expected to decrease (Kafalenos et al, 2008). In the MPPD U.S. Highway 17 is a designated evacuation route, portions of which are vulnerable to periodic flooding.

Higher seas and storm surges will likely erode road base and undermine bridge supports, in addition to reducing clearance under some waterway bridges for boat traffic (Karl et al, 2009). Areas where flooding is already common are projected to face more frequent and severe problems. Planners have generally relied on past weather extremes as a guide for future forecasting (e.g. "100-year flood"), but those events are likely to become more frequent (National Research Council, 2008). These changes add to the challenge of predicting frequency and intensity of events that can affect transportation.

Coastal Wetlands

Dwindling wetland resources is an established concern in the United States. The U.S. Fish and Wildlife Service (FWS) reported to Congress in 1990 an estimated fifty percent loss of all wetlands of the United States between 1780 and 1980, including coastal wetlands. The Commonwealth of Virginia lost an estimated 42 percent of its original 1.8 million acres of wetlands during the same period (Dahl, 1990). According to "Wetland Sustainability," the report submitted by Cahoon et al (2009) to the U.S. Climate Change Science Program, landward migration of wetlands (wetland accretion) in the Mid-Atlantic region can keep pace with the twentieth century rate of 3 to 4 millimeters (or 1/8 inch) annual sea level rise. Wetland accretion can sustain sea level rise acceleration of 2 millimeters per year (1/16 inch) only under optimal hydrology and sediment supply conditions, and a scenario of 7 millimeter (1/4 inch) acceleration of annual sea level rise would likely destroy coastal wetlands with few localized exceptions.

The MPPD lies within the Chesapeake Bay watershed and is under jurisdiction of Virginia's Chesapeake Bay Preservation Act (CBPA). Tidewater jurisdictions, including the MPPD, are required to designate Resource Protections Areas (RPA) and Resource Management Areas (RMA), which collectively are referred to as Resource Preservation Areas. The base guideline for RPA designation is a 100-foot riparian buffer, landward of all surface waters. As part of the 2011 workshop for the Chesapeake Bay Program's Science and Technical Advisory Committee (STAC), Skip Stiles presented findings on sea level rise adaptation in Virginia. He cited an estimated two feet of sea level rise over the next 100 years, resulting in a 50 to 80 percent loss of tidal wetlands in Virginia during that time (Stiles, 2011).

Since wetland accretion modeling is still limited in its ability to predict localized conditions (McFadden et al, 2007), localities are left to work with rough-estimate benchmarks through the planning process. The

model developed by Nicholls et al (2007) estimates wetlands losses on a global scale relative to three broad environmental drivers: 1) ratio of relative sea level rise to tidal range, 2) sediment supply and 3) lateral accommodation space. This model suggests global wetland area losses of 33 and 44 percent for 36- and 72-centimeter (14.2- and 28.3-in) rises in sea level, respectively, noting that Atlantic and Gulf of Mexico coasts will be among the most severely impacted (McFadden et al, 2007; Nicholls et al, 2007).

Ecosystems and Coastal Habitats

Coastal ecosystems consist of tidal marshes, tidal forests, aquatic vegetation beds, tidal flats, beaches and cliffs. Tidal marshes and associated submerged aquatic vegetation are important spawning, nursery, and shelter areas for fish and shellfish, including commercially important species. Where tidal marshes become submerged or eroded, the expected overall loss of wetlands may cause wetland-dependent species of fish and birds to have reduced population sizes. Any sea level rise rate exceeding landward migration capability places these critical resources at risk (Shellenbarger Jones et al, 2009). Intertidal marshlands are not likely to adapt to sea level rise where existing development prevents landward migration or where armored shorelines disconnect them from their natural drainage system (Weinstein et al, 2005).

Agriculture

As the United States population increases, increased agricultural productivity of food, feed, fuel and livestock products will be necessary. According to Karl et al (2009), U.S. agriculture is likely to see increased challenge due to changing temperatures and climate in coming decades in the form of changes in growth season length, irrigation supply, and temperature spikes (Hatfield et al, 2008).

In the case of regional temperature increases, optimum latitude for crops move northward as localized temperatures exceed maximum level for pollen viability in a particular plant (Hatfield et al, 2008). When crops are exposed to extreme events such as heavy downpours and droughts, they suffer reduced yield. As more frequent and extreme events are projected to increase in the Chesapeake Bay region, it is possible that existing crop and livestock yields will be reduced (Karl et al, 2009). Recent historical data available for the MPPD shows, for example, a reduction of more than 4,000 acres of Barley Harvested for Grain from 2002 to 2007, which contributed to a net decrease of approximately 493,700 acres throughout the United States (NASS, 2008). During the same period, Middle Peninsula counties experienced a 6,000 acre decrease in Soybeans Harvested for Beans (NASS, 2008b). These available maps and data do not explicitly state a correlation to shifting temperature patterns; however, past trends can be considered when planning for adaptation actions among regional agriculture interests: shifting crop varieties, seasonal calendar considerations and livestock planning.

Shifting precipitation patterns in the Chesapeake Bay region may result in increased extremes for downpour events, negatively impacting spring planting opportunities and overall plant growth (Karl et al, 2009). Hatfield et al (2008) also note that weeds benefit more than cash crops from higher temperatures and carbon dioxide levels, and northward expansion of invasive weeds is likely if climate warming continues. Current annual weed-control costs in the United States are more than $11 billion, and this number is likely to increase as temperatures and carbon dioxide levels rise (Karl et al, 2009).

Forage quality of pastures and rangelands for cattle production is likely to decrease if carbon dioxide concentrations increase; this effect is due to carbon dioxide’s impact on plant nitrogen and protein

content. Specifically, as carbon dioxide concentrations increase, forage quantity increases, but plant protein concentrations are reduced and, in many cases, digestibility of the forage plants as well(Hatfield et al, 2008). Finally, livestock productivity will likely decrease if temperatures and humidity increase, causing stress, discomfort and increased mortality for livestock (Hatfield et al, 2008).

Human Health

Human health is likely to undergo increased vulnerability under various future climate change scenarios. Possible impacts include increased frequency and spikes in heat waves, reduced air quality, physical and mental health challenges from extreme weather, and increased likelihood of food-, water- and insect-borne diseases.

Hazard-related deaths in the United States number 19,958 for the years 1970 through 2004 (National Climatic Data Center, 2008). Of that total, the category "heat/drought" ranks highest followed by "severe weather," with 19.6 and 18.8 percent, respectively. Gutowski et al (2008) suggest that currently rare extreme heat waves will experience increased probability over coming decades, joined by a parallel reduction in winter season cold snaps. As to the projected impact of these seasonal changes on mortality, Medina-Ramon and Schwartz (2007) found that cold snaps and heat waves trigger disproportionate spikes in overall mortality rates (1.6 and 5.7 percent, respectively), meaning the cumulative effect is increased mortality since the projected increase in heat-related deaths will exceed the likely decrease in cold-related deaths.

Air pollution impacts are a concern for much of the Chesapeake Bay region, but the localities facing the highest challenge will be urban areas located outside of the MPPD. Current air quality conditions reported by the American Lung Association (2011) for study areas closest to the MPPD are "Good," the best rating available.

The U.S. Global Change Program (USGCP; Karl et al, 2009) aptly summarizes changing impacts in disease-causing agents, which have been correlated to changing climatic conditions. The report draws largely from several recent scientific reports about human health in the United States, including a synthesis and assessment report to the United States Environmental Protection Agency (EPA; Ebi et al, 2008). The following is the list of impacts to disease-causing agents (pathogens) commonly transmitted by food, water, or animals included in the USGCP report (Karl et al, 2009):

- Cases of food poisoning due to *Salmonella* and other bacteria peak within one to six weeks of the highest reported ambient temperatures.
- Cases of waterborne *Cryptosporidium* and *Giardia* increase following heavy downpours. These parasites can be transmitted in drinking water and through recreational water use.
- Climate change affects the life cycle and distribution of the mosquitoes, ticks and rodents that carry West Nile virus, equine encephalitis, Lyme disease, and hantavirus. However, moderating factors such as housing quality, land use patterns, pest control programs, and a robust public health infrastructure are likely to prevent the large-scale spread of these diseases in the US.
- Heavy rain and flooding can contaminate certain food crops with feces from nearby livestock or wild animals, increasing the likelihood of food-borne disease associated with fresh produce.
- *Vibrio* sp. (shellfish poisoning) accounts for 20 percent of the illnesses and 95 percent of the deaths associated with eating infected shellfish, although the overall incidence of illness from

Virbrio infection remains low. There is a close association between temperature, *Vibrio* sp. Abundance, and clinical illness. The U.S. infection rate increased 41 percent from 1996 to 2006, concurrent with rising temperatures.

- As temperatures rise, tick populations that carry Rocky Mountain spotted fever are projected to shift from south to north.

Future reduction in human health vulnerability will require incorporation of planned adaptation into long-term municipal and public service planning, including health services to the MPPD.

Appendix 5.A Adaptation Strategies and Implementing Agents by Impact

		Impact	Possible Adaptation Action	Who?	How?
Water	Higher temperatures and reduced precipitation	**Insufficient Water Supplies**	Increase system redundancy to ensure backup supplies, sharing integrated facilities between jurisdictions and sectors, obtain portfolio of multiple water sources, including reuse of municipal wastewater (IPCC4; IPCC3; USGS; NRC; CCAWS)	Citizens, Local Governments, Water Authority	water supply planning
			Participate in water supply protection through watershed management, including protecting surface water sources and groundwater recharge zones	Nat Resource Managers, Local Govt	water supply planning, land use planning, overlay zoning
	Storm surges, sea level rise and increasing intensity of precipitation	**Increased frequency of coastal and**	Evaluate risks to infrastructure and develop and apply new design standards for water, wastewater, and drainage systems (USGS).	Local Governments	infrastructure planning, stormwater management
			Enhance regulation of floodplain development; change design standards to allow floods to pass under buildings (e.g. pilings); encourage relocation of infrastructure from areas where flooding and erosion are likely and retreat from damaged areas after flooding (USGS; IPCC3)	Local Governments	floodplain mgmt/ ordinance, CBPA, coord. transportation & utility infrastructure projects; Bldg Code
			Redesign floodprone areas to allow natural attenuation processes, reduce hard surfaces, allow natural channel movement, etc.	Local Governments, private developers	floodplain management, impervious surface threshold, CBPA
			Protect vulnerable land from development through land use planning	Conservation Agencies, Local Governments	outreach, conservation easements, overlay zoning
		Increased levels of pollutants in runoff	Enhance flood retention and buffer requirements, enhance natural filtration capacity, biological removal of pollutants; rain gardens (CALI)	Local Governments	floodplain/ stormwater management
		Increased storm water runoff	Require treatment of urban storm water runoff, manage land uses to require on-site retention in areas where pollutants are generated	Local Governments	floodplain/ stormwater management
	Sea level rise	**Saline intrusion, aquifers**	Insert sea water barrier injection wells (to limit migration of salt water aquifers inland) e.g. with reclaimed water (CALI)	Local Governments, State agencies	water supply planning, habitat conservation plan
	General climate change	**Outdated management practices**	Encourage collaborative regional water supply planning to address multiple stresses including climate change	Local Gov, State Agencies	water supply plan

Sources were abbreviated in the tables to conserve space. The abbreviations refer to the following publications: 5-1 = CCSP, 2008d; IPCC3 = IPCC, 2001; IPCC4 = IPCC, 2007a; CALI = California Department of Water Resources, 2008; NRC = NRC, 2007; USGS = Brekke et al., 2009; CCAWS = Ludwig et al., 2009; CUWCC = California Urban Water Conservation Council, 2008; FPB = Young & McColl, 2008; WWF = WWF, 2003

		Impact	Possible Adaptation Action	Who?	How?
Energy	**Average Temperature Rise**	**Increased demand for cooling, reduced demand for heating**	Lead by example - Government agencies can weatherize buildings and manage energy use to reduce cooling demands (CADGS)	Local Govt	outreach, weatherize
		More frequent and/or longer heat waves	Ensure that energy requirements of especially vulnerable populations are met, especially during heat waves (4-5)	Local Govt, Nonprofit partners	outreach, assistance funds
	Changes in intensity, timing, and location of extreme weather events	**Disruption of energy conversion and generation du to extreme events (RFF-PI)**	Increase resilience to energy interruptions and other threats. Expand redundancy in electricity transmission capacity and energy storage capacity	Local Govt	outreach, emergency mgt, infrastruc plan
		Disruption of energy transmission and transportation due to	Assess regional energy sector vulnerability and communicate vulnerabilities; advocate responsible contingency planning	Local Govt, Nonprofit partners	outreach, infrastruc plan
			Prepare for supply interruptions, e.g. backup systems for emergency facilities, schools, etc.	Local Govt, Nonprofit partners, Emergency Mgrs	outreach, emergency mgt
	Sea level rise	**Risks to infrastructures in vulnerable coastal areas**	Conduct regional analysis of vulnerability of coastal infrastructure to sea level rise, advocate responsible land use planning and contingency planning	Local Govt	infrastruc plan, land use planning, overlay zoning

Sources were abbreviated in the tables to conserve space. The abbreviations refer to the following publications: 4-5 = CCSP, 2007; RFF-PI = Neumann & Price, 2009; CADGS = California Energy Commission, 2009

		Impact	Possible Adaptation Action	Who?	How?
Transportation	Long-term sea level rise	**Permanent flooding of coastal land**	Build or enhance levees/dikes for protection	Local Govt, property owners	overlay zoning - protection
			Elevate critical infrastructure that is at risk to sea level rise	Local Govt	infrastruc plan, hazard mitigation plan
		Impacts on infrastructure such as bridges or harbors	Raise bridge heights and reinforce or relocate harbor infrastructure	Local Govt	infrastruc plan, hazard mitigation plan
	More intense precipitation	**Change to hydraulics**	Review hydraulic structures for deficiencies - culverts, drainage channels	Local Govt	stormwater mgmt, infrastruc plan
		More frequent flooding	Institute better land use planning for flood plain development including prohibition in some instances	Local Govt	land use planning, overlay zoning, redev threshold
			Replace vulnerable bridges and other facilities	Local Govt	infrastruc plan, hazard mitigation plan
			Harden infrastructure and port facilities	Local Govt, private sector	infrastruc plan, hazard mitigation plan
	Greater coastal storm strength with sea level rise	**More extreme, more frequent coastal flooding**	Require climate change assessments in long range transportation planning in floodplains, land use planning in flood-prone coastal areas	Local Govt	land use planning, overlay zoning, floodplain mgt
			Identify and take constructive action to provide and protect emergency evacuation routes	Local Govt	Emergency Mgmt
			Abandon or relocate infrastructure and facilities	Local Govt	infrastruc plan, hazard mitigation plan

Sources were abbreviated in the tables to conserve space. The abbreviations refer to the following publications: RFF-PI = Neumann & Price, 2009

		Impact	Possible Adaptation Action	Who?	How?
Health	Changes in frequency, intensity, and duration of extreme weather events	**Increased risk of injuries, illnesses, and death**	Develop scientific and technical guidance and decision support tools for early warning systems and emergency response plans, including appropriate individual behavior (Ebi)	Citizens, Nonprofit partners, Comm Hlth, Emergency Mgrs	Outreach, Emergency Mgt plan
			Conduct education and outreach on emergency preparedness and response, including mental health needs following a disaster (Ebi; Frumkin)	Nonprofit partners, Comm Hlth, Emergency Mgrs	Outreach, Emergency Mgt plan
			Conduct early warning system and response plan tests before events (Ebi)	Local Govt, Emergency Mgmt	Emergency Mgmt plan
	Increases in frequency, intensity, and	**Increased risk of heat-related illnesses and deaths**	Conduct education and outreach on preparedness during a heat wave. Develop education and training programs for health professionals on risks and appropriate actions during heat waves (J and S; Ebi).	Nonprofit partners, Comm Hlth, Emergency Mgrs	Outreach, Emergency Mgt plan
	Climate change generally	**Institutional challenges**	Modify public health programs and activities focused on climate-sensitive health outcomes to take climate change into account (J and S)	Nonprofit partners, Comm Hlth	Outreach
			Enhance education of health care professionals to understand the health and risks of climate change, including diagnosis and treatment for health outcomes that may become more prevalent (J and S)	Nonprofit partners, Comm Hlth	Outreach

Sources were abbreviated in the tables to conserve space. The abbreviations refer to the following publications: Ebi = Ebi et al., 2008; Frumkin = Frumkin et al., 2008; J and S = Jackson & Shields, 2008

		Impact	Possible Adaptation Action	Who?	How?
Ecosystems	Altered hydrologic regime	**Flow effects on rivers**	Plant flood-adapted species to reduce peak flows & erosion. More effective storm-water infrastructure	Citizens, Nat Resource Mgrs, Local Govt	outreach, volunteers, practitioners
			Reforest riparian areas with native species to create shaded thermal reduces for fish species	Natural Resource Managers	outreach, volunteers, practitioners
	Climate Change Generally	**Degradation of ecosystems**	Use conservation easements & buffers around refuges to foster population & species variability & to provide room for species dispersal & landscape interactions	Citizens, Conservation Agencies, Local Governments	outreach, conservation easements
			Remove dispersal barriers, including dams, establish dispersal bridges & connect landscapes that support migration of native species in response to climate change; identify species or habitats that are likely to migrate out of areas	VDOT, Local Governments, Habitat Managers	plan, combining capital/ infrastructure improvements or maintenance with barrier removal
		Threats to ecosystem	Conserve & manage lands suitable for carbon sequestration & other climate feedbacks	Citizens, Conservation Agencies, Local Governments	outreach, volunteers, practitioners
		Outdated management	Remove structures that harden the coastlines, impede natural regeneration of sediments, & prevent natural inland migration of sand & vegetation in response to climate change; restore or create coastal wetlands, barrier islands & other	VDOT, Local Governments, Habitat Managers	habitat conservation plan, combining capital/ infrastructure improvements or maintenance with

Sources were abbreviated in the tables to conserve space. The abbreviations refer to the following publications: NEC = Glick et al., 2009; CCAL = Theoharides et al., 2009; 4-4 = CCSP, 2008b; OIGCC = Parmesan & Galbraith, 2004; WWF = WWF, 2003; DOI-LW = Department of Interior, 2008b

		Impact	Possible Adaptation Action	Who?	How?
Agriculture & Forestry	Increased Evaporation & Changes in Precipitation	**Greater Irrigation Requirements**	Adopt irrigatioin best practices (e.g. drip irrigation, laser leveling); Switch to crops with greater drought-resistance (IPCC).	farmers, Nonprofit partners	Outreach
		Increased yields of rain-fed agriculture	Manage to prevent waterlogging, erosion, and nutrient leaching in areas with rainfall increases (IPCC). Develop flood resistant crops.	farmers, soil & water conservation district	outreach, stormwater mgmt
	Increased Temperature - effects on pests	**Disease pressure on crops and livestock will increase with earlier springs and warmer winters, allowing low proliferation and higher survival of pathogens and parasites (4-3)**	Develop and use disease resistant varieties.	farmers, Nonprofit partners	Outreach
	Extreme Events	**Point and non-point source pollution from agriculture practices could increase**	Use buffers, adjust fertilizer and pesticide applications, and adopt other best practices to limit pollution impacts on water resources.	Farmers, Local Govt, Nonprofit partners	outreach, stormwater mgmt, overlay zoning

publications: 4-1 = CCSP, 2009b;
4-2 = CCSP, 2009a; 4-3 = CCSP, 2008c; NRC = NRC, 1992; IPCC = IPCC, 2007a; Millar = Millar et al.,

		Impact	Possible Adaptation Action	Who?	How?
Oceans and Coasts	Accelerated Sea Level	Gradual inundation of low-lying land; loss of coastal habitats, especially coastal wetlands; saltwater intrusion into coastal aquifers and rivers; increased shoreline erosion and loss of barrier islands; changes in navigational conditions	Site and design all future public works projects to take into account projections for sea level rise	Local Govt	Infrastruc plan, overlay zoning
			Develop strong, well-planned, shoreline retreat or relocation plans (public infrastructure and private properties), and post-storm redevelopment plans	Local Govt	Infrastruc plan, overlay zoning, Redev thresholds
			Use natural shorelines, setbacks, and buffer zones to allow inland migration of shore habitats and barrier islands over time (e.g. dunes and forested buffers mitigate storm damage/ erosion)	Nat Resource Mgrs, Local Govt, Citizens	setbacks, overlay zoning
			Encourage alternatives to shoreline "armoring" through "living shorelines" (NRC)	Mgrs, Local Govt, Citizens	setbacks, overlay zoning
	Increased intensity/ frequency of coastal storms	Increased storm surge and flooding; increased wind damage; sudden costal/ shoreline alterations	Strengthen and implement building codes that make existing buildings more resilient to storm damage along the coast	Local Govt	Bldg Code, overlay zone
			Increase building "free board" above Base Flood Elevation	Local Govt	Bldg Code, overlay zone
			Identify and improve evacuation routes in low-lying areas (e.g. causeways to coastal islands)	Local Govt, Emergency Mgrs	Emergency Mgmt Plan, Hazard Mitigation Plan

Sources were abbreviated in the tables to conserve space. The abbreviations refer to the following publications: NRC = NRC, 2007c; Limiting = ACC: Limiting the Magnitude of Future Climate Change, NRC 2010c

Resources

With such an abundance of information and research with regards to climate change, sea level rise, the impacts, and adaptation approaches, the Middle Peninsula Planning District Commission Staff, in partnership with Wetlands Watch has organized the research materials into six categories:

- *Climate Change and Sea Level Rise Impacts:* This section will reference reports and documents that will provide general information with regard to climate change, sea level rise and the impacts.

- *Climate Change and Sea Level Rise specific to Virginia:* This section references documents that will provide background of the progress made within Virginia addressing climate change, sea level rise, and the impacts. Additionally there are specific references to regional and county plans to address pending impacts.

- *General Adaptation Measures and Guides:* This section will reference documents that introduce adaptation and general guidelines to adaptation.

- *Adaptation Measures and Guides specific to the Mid-Atlantic:* This section will reference documents that introduce adaptation within the Mid-Atlantic region and a guidelines to adaptation.

- *Social Perceptions:* This section provides references to reports and research that focus on social perceptions of climate change and sea level rise. In particular the research reflects how such perceptions may impact the implementation of public policy.

- *Web-based resources:* Lists a variety tools that may be accessed over the internet .

Within these given categories, research materials have been briefly summarized to provide direction for future research from readers.

Report Received by MPPDC 4/25/12

Regional Climate Change and Sea Level Rise Impacts

The Chesapeake Bay and Global Warming: A Paradise lost for Hunters, Anglers, and Outdoor Enthusiasts (2007)

The National Wildlife Federation summarizes how impacts of climate change and sea level rise may impact the Chesapeake Bay as well as associated outdoor recreation with in the region, including hunting and fishing. (http://www.nwf.org/~/media/PDFs/Global-Warming/Reports/chesapeake_bay_full.ashx)

Climate Change and the Chesapeake Bay: Challenges, Impacts, and the Multiple Benefits of Agriculture Conservation Work (2007)

The Chesapeake Bay Foundation assesed the stresses of climate change impacts in the Chesapeake Bay system. This papers offers cost-effective agricultural conservation practices that may be implemented to achieve the pollution reductions necessary to remove the Chesapeake Bay and its tributaries from the nation's "dirty waters" list. Agricultural practices are also offered as an option to sequester substantial amounts of carbon from the atmosphere. (http://www.cbf.org/document.doc?id=140)

Climate Change and the Chesapeake Bay: State-of-the-Science Review and Recommendations (2008)

This report, from the Chesapeake Bay Program science and Technical Advisory Committee, provides current climate change impacts on the tidal Chesapeake Bay as identified by the U.S. Environmental Protection Agency's Chesapeake Bay Program Scientific and Technical Advisory Committee (STAC). This report also identifies knowledge gaps, research priorities, and resource management decision needs as it relates to climate change. (http://www.chesapeake.org/stac/Pubs/climchangereport.pdf)

Climate Change: Mastering the Public Health Role (2011)

This guidebook is a translation of six-part webinar series hosted by the American Public Health Association (APHA) and the Centers for Disease Control and Prevention (CDC) and is intended to be a useful tool to help prepare the public health community for the challenges of climate change. (http://www.apha-environment.org/pdf/APHA_ClimateChg_guidebook.pdf)

Coastal Dead Zones & Global Climate Change: Ramifications of Climate Change fro Chesapeake Bay Hypoxia (2007)

This case study from the Pew Center,examines how both climate variability and potential climate change can affect hypoxia in the Chesapeake Bay and can present additional challenges to ongoing ecosystem restoration. Multiple influences of climate on hypoxia and consequences to the ecosystem are examined. (http://www.c2es.org/docUploads/Regional-Impacts-Chesapeake.pdf)

Future Consequences of Climate Change for the Chesapeake Bay Ecosystem and Its Fisheries (2002)

This proceedings volume represents the culmination of a multi-agency effort, organized by American Fisheries Society, Sea Grant, and others, to bring together scientists from U.S. and Canadian governmental agencies and universities to discuss fisheries and climate change. Additionally some chapters detail the impacts of climate change on aquatic ecosystems and fisheries policy and management. (http://www.umces.edu/sites/default/files/pdfs/db_Future.pdf)

Global Climate Change Impacts in the United States (2009)

The report, from the U.S. Global Change Reserach Program, summarizes the science and the current and pending impacts of climate change in the United States. Specifically it focuses on climate change impacts in various US regions. Southeastern US impacts may be found on page, 111 of the report. (http://www.globalchange.gov/what-we-do/assessment/previous-assessments/global-climate-change-impacts-in-the-us-2009)

Sea-Level Rise an d Coastal Habitats in the Chesapeake Bay Region (2008)

The National Wildlife Federation conducted a region-by-region analysis of inundation using the Sea Level Affecting Marshes Model (SLAMM) to estimate wetlands shifts at various ranges of sea level rise. (http://www.nwf.org/~/media/PDFs/Global-Warming/Reports/FullSeaLevelRiseandCoastalHabitats_ChesapeakeRegion.ashx)

Synthesis and Assessment Product 4.1 - Coastal Sensitivity to Sea Level rise: A Focus on the Mid-Atlantic Region (2009)

This report from the US Climate Change Science Program identifies and reviews the potential impacts of future sea level rise based on current scientific data.

It evaluates several aspects of sea level rise impacts to the natural environment and examines the impact to human land development along the coastal. Finally this report addresses adaptation strategies. 9http://downloads.climatescience.gov/sap/sap4-1/sap4-1-final-report-all.pdf)

Climate Change and Sea Level Rise specific to Virginia

A Coastal Floodplain Management Plan for Gloucester County, VA (2009)
Gloucester County is a low-lying county and includes climate change/sea level rise in its latest floodplain management plan. (see pg. 9) (http://www.gloucesterva.info/Portals/0/es/documents/floodplainManagementPlanAdoptedSeptember2009.pdf)

Accomack County Comprehensive Plan (2008)
The Accomack Comprehensive plan has a section on sea level rise starting at page 2-67. Approved in 2008, this Comprehensive plan was one of the first in Virginia to discuss the issue. (http://www.co.accomack.va.us/Planning/2008_comprehensive_plan_update.html)

Adapting to Sea Level Rise in Virginia Beach (2011)
This is a presentation developed by Wetlands Watch provides Virginia specific examples of climate change, sea level rise and adaptation. (http://www.virginia.edu/ien/docs/listening_sessions_skip.pdf)

Citizen's Guide to Planning a Zoning in Virginia (2003)
A report by the Chesapeake Bay Foundation, this provides an overview of land use tools that can be used in climate change adaptation. This document is useful for outreach to informed citizens. (http://www.cbf.org/document.doc?id=150)

City of Portsmouth, Virginia Floodplain Management Plan And Repetitive Loss Plan (2010)
An advance on other floodplain management plans, with extensive discussion of sea level rise risk, parcel-specific maps of repetitive loss properties, and maps of potential inundation from various heights of sea level rise. (discussion at pg. 38). Beyond this document, the city of Portsmouth has an interactive flood map down to the parcel level, a very innovative development. (http://www.portsmouthva.gov/planning/images/2010%20Final%20Draft%20Floodplain%20Management%20Plan_sm1.pdf)

Final Report: A Climate Change Action Plan (2008):
This final report of the Virginia Commission on Climate Change provides a list of recommendations focused on (1) achieving a 30% reduction of greenhouse gas (GHG) emissions and the cost effectiveness of such recommendations and (2) strategies that will guide Virginia's response to climate change, including how the state should plan for and adapt to changes that are likely unavoidable. (http://www.deq.state.va.us/export/sites/default/info/documents/climate/CCC_Final_Report-Final_12152008.pdf)

Hampton Roads Planning District Commission Climate Change Report (2008-2009)
The HRPDC is one of three planning districts in Virginia awarded grants from the Virginia Coastal Zone Management Program to study climate change impacts. These three-year grants are producing solid impacts and adaptation options for coastal Virginia. (http://www.deq.state.va.us/export/sites/default/coastal/documents/task12-03-08.pdf)

Hampton Roads Planning District Commission Climate Change Report (2009-2010)
This report builds on the previous collection and analysis of information on climate change and associated ramifications, an initial attempt to identify economic and infrastructure impacts, development of a set of draft policy recommendations and development of a framework for both mitigating and adapting to climate change within the region. (http://www.deq.state.va.us/export/sites/default/coastal/documents/task12-04-09.pdf)

Managing Growth and Development in Virginia: A Review of the Tools Available to Localities
A 2009 revision of the Virginia chapter of the American Planning Association's guide to growth management tools in Virginia. The approaches discussed in this document apply directly to toolkits for local governments developing climate change adaptation strategies. (http://apavirginia.org/documents/legislation/Growth%20Tools%20Revised%2010-09_final.pdf)

2030 Mathews County Comprehensive Plan (2011)
The Draft Mathews County Draft Comprehensive Plan makes extensive mention of climate change and produced maps showing potential inundation areas

in the county with rates of sea level rise. (http://www.co.mathews.va.us/Modules/ShowDocument.aspx?documentid=1433)

Key Waterway of PRC Level 2

Middle Peninsula Planning District Commission Report (2008-2009)

Funded through the Virginia Coastal Zone Management Program, MPPDC staff and the region's Climate Change Advisory Workgroup identified critical impacts of climate change and sea level rise to the region. Additionally an economic and ecological assessment was conducted to understand the impacts of sea level rise. (http://www.mppdc.com/articles/reports/MP_Climate_Change_Adaptation_I.pdf)

Middle Peninsula Planning District Commission Report (2009-2010)

This report to the Coastal Zone Management Program focused on social perceptions of local elected officials and constituents within the Middle Peninsula of climate change and sea level rise. Additionally it shares outreach efforts. (http://www.deq.state.va.us/export/sites/default/coastal/documents/task12-05-09.pdf)

New Directions: Land Use, Transpiration, and Climate Change in Virginia

This report focuses on presenting options to land use, transportation and climate change in the face of growth in Virginia in order to sustain and enhance Virginia's economy, communities, health, and environment.

Northern Virginia Regional Commission Report Vision Hampton Roads (2008-2009)

This project inventoried of existing data resources and policies for natural and man-made resources to support in the identification of data gaps, and to understand current local shoreline management plans and regulations. Additionally, a project workgroup was developed (http://www.deq.state.va.us/export/sites/default/coastal/documents/task12-06-08.pdf)

Northern Virginia Regional Commission Report (2009-2010)

Focused on refining the sea level rise and storm surge vulnerability map in Northern Virginia by filling data gaps identified through Phase I. Also, Phase II will begin the development of adaptation strategy recommendations, informed by a survey of waterfront property owners, for integration into local comprehensive planning documents and tools.

Poquoson Hazard Mitigation Plan (2009)

The City of Poquoson (max elevation is 7 ft above mean sea level) begins to include sea level rise into its hazard mitigation planning. This hazard mitigation plan is required by the Federal Emergency Management Agency (FEMA) prior to a locality receiving coverage under the Flood Insurance Program or any FEMA post-hazard mitigation programs. (see pg. 55) (http://www.poquoson-va.gov/sites/default/files/City%20of%20Poquoson%20FINAL%20to%20FEMA%20RIII%20091409.pdf)

Virginia Beach Comprehensive Plan

This 2009 Comprehensive Plan has an extensive discussion of climate change and sea level rise. The community involvement part of this plan was very robust with the appointment of a "Green Ribbon Commission" to help frame the environmental issues. (http://www.ourfuturevb.com/citywideelements/environment/Documents/7_EnvironmentalStewardship.pdf)

Virginia Case Study: Stemming the Tide: How Local Governments Can Manage Rising Flood Risks

This case study analyzes the authority of Virginia Local governments to use existing land use regulations to adopt to sea level rise impacts. Specifically, this study looks at local authority to implement policy options identified in the Virgin's Climate Action Plan. (http://www.georgetownclimate.org/sites/default/files/Va-Case-Study(1).pdf)

Virginia Commission on Climate Change Adaptation and Sequestration Workgroup Meeting Summary (2008)

A summary of the relevant adaptation provisions of the Report – with a flow chart on how the adaptation program was envisioned to work. Prepared by Wetlands Watch. (http://www.deq.state.va.us/export/sites/default/info/documents/climate/Adaptation_Meeting_Summary_091008.pdf)

2035 Virginia Surface Transportation Plan (2010)

Developed by the The Virginia Department of Transportation (VDOT) and Virginia Department of Rail and Public Transportation (DRPT) have developed this plan provides long-term multi modal transportation suggestions for the Commonwealth. It mentions that future land use decisions an investments in transit, as well as passenger and freight rail will address climate change. (http://www.vtrans.org/2035_surface_plan.asp)

Vulnerability of Hampton Roads, Virginia to Storm-Surge Flooding and Sea-Level Rise (2006)
A published study looking at sea level rise and storm surge impacts in Hampton Roads. (http://www.cara.psu.edu/about/publications/2006-Kleinosky%20et%20al.pdf)

General Adaptation Measures and Guides

An anatomy of adaptation to climate change and Variability (Canada) (2000)
Adaptation to changes in the climate is important for both impact assessments and for policy development. Prepared by the University of Guelph, proposes a system for adaptation efforts based on three questions (i) adapt to what?, (ii) who or what adapts?, and (iii) how does adaptation occur. (http://www.uoguelph.ca/gecg/images/userimages/Smit%20et%20al.%20(2000)_Climatic%20Change.pdf)

Adaptation Planning – What U.S. state and localities are doing? (2008)
This paper from the PEW Center provides a national overview adaptation actions- including the preparation of risk and vulnerability assessments, prioritization of projects, funding and allocation of both financial and human resources, solution development and implementation, and rapid deployment of information sharing and decision-support tools - taken by each state. (http://www.c2es.org/docUploads/state-adapation-planning-august-2009.pdf)

Adaptation to Climate Change in the Context of Sustainable Development and Equity (2007)
From the Intergovernmental Panel on Climate Change Workgroup II report, this chapter reviews the advantages of adaptation in reducing the adverse impacts of climate change. Planned, anticipatory adaptation has the potential to reduce vulnerability and realize opportunities associated with climate change effects and hazards. (http://www.ipcc.ch/ipccreports/tar/wg2/pdf/wg2TARchap18.pdf)

Cities Preparing for Climate Change: A Study of Six Urban Regions (2007)
The Clean Air Partnership summarizes the efforts of six cities around the world that are addressing climate change – NYC, Boston, Seattle are featured. (http://www.nrcan.gc.ca/earth-sciences/projdb/pdf/171e_e.pdf)

Climate Change Adaptation 101 (2009)
Short Summary of Climate Change Adaptation Basics developed by the Pew Center. (http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Global_warming/Adaptation_0.pdf)

Climate Change Adaptation Actions for Local Government (Australia) (2010)
Published by the Australian Government's Department of Climate Change and Energy Efficiency, this report identifies climate change adaptation actions that are applicable to Australia's climatic conditions and climate impact risks as currently predicted and that can be implemented by Australian local governments. Six local functions are addressed: infrastructure and property series, provision of recreation facilities, health services, planning and development approvals, natural resource management, and water and sewerage services. (http://www.climatechange.gov.au/what-you-can-do/~/media/publications/local-govt/localadaption_localgovernment.pdf)

Climate Change Adaptation in Rural, Natural Resource-Dependent Communities (2010)
This paper, written by the Rural Voices for Conservation Coalition, emphasizes an all-lands approach to climate change adaptation for rural, natural resource dependent communities. Specifically it makes recommendations for measures that state and federal land management agencies can take to help facilitate adaptation planning, implementation and monitoring in and around rural communities. (http://www.americanforests.org/wp-content/uploads/2012/01/RVCC-2010-Paper.pdf)

Climate Change and Rural Communities in the US
Written by the Rural Policy Research Institute, this document reviews the impacts of climate change to rural communities within the U.S. as well as policy responses (i.e. National, State and Local Policies) and opportunities (i.e. Renewable energy, green jobs and collaboration) to consider. (http://www.rupri.org/Forms/Climate_Change_Brief.pdf)

Climate Change Impacts and Risk Management: A guide for business and government (Australia) (2006)
Published by the Australian Government Department of the Environmental and Heritage, this guide integrates climate change impacts into risk management and other strategic planning activities in Australian public and private sector organizations. In particular this document was developed to assist Australian businesses and organizations to adapt to climate change. (http://www.climatechange.gov.au/community/~/media/publications/local-govt/risk-management.ashx)

Coastal Communities and Climate Change: Maintain Future Insurability
This document focuses on how the insurability of coastal homes and businesses will be affected by increases in risk due to climate change. (http://www.commerce.state.ak.us/dca/planning/pub/coastalcommunitiesandclimatechange_maintainingfutureinsurability.pdf)

Coastal No Adverse Impacts Handbook (2007)
An document by the National Association of Floodplain Managers looking into the concept of better coastal protection – very applicable to adaptation planning. Strong discussion on issue of takings of personal property versus the "public trust doctrine." (http://www.floods.org/NoAdverseImpact/CNAI_Handbook/CNAI_Handbook.pdf)

Confronting Climate Change: An Early Analysis of Water and Wastewater Adaptation Costs (2009)
Prepared by Association of Metropolitan Water Agencies, this report describes an assessment of climate change impacts to drinking water and wastewater services in the U.S. through 2050 intended to help policy makers begin to understand challenges and associated costs. (http://www.amwa.net/galleries/climate-change/ConfrontingClimateChangeOct09.pdf)

General Accountability Office Report on Adaptation (2009)
The U.S. Government Accountability Office reported on adaptation planning – the first part contains a general overview of local government efforts at mitigation and adaptation. Of interest to local governments is the polling work starting at pg. 31 detailing challenges of adaptation planning. (http://www.gao.gov/assets/300/296526.pdf)

Local Land use Response to Sea Level Rise
Prepared by the Land Use Law Center, Pace University School of Law for The Nature Conservancy on Long Island, this report includes regulations, ordinances and plans of varying degrees from a variety of states that address the impacts of sea level rise. (http://www.csc.noaa.gov/digitalcoast/inundation/_pdf/Pace_Final_Report.pdf)

National Climate Adaptation Summit (2010)
This report summarizes the proceedings of the National Climate Adaptation Summit in May 2010. (http://www.joss.ucar.edu/events/2010/ncas/ncas_report.pdf)

New Frameworks for Managing Dynamic Coasts: Legal and Policy Tools for Adapting U.S. Coastal Zone Management to Climate Change (2008)
A Sea Grant Law and Policy Journal article that lays out an outline of some approaches to climate change adaptation along the coastline. (http://nsglc.olemiss.edu/SGLPJ/Vol1No1/2Nichols.pdf)

Planning for Climate Change Adaptation – A Primer
Summary of Adaptation Issues from Virginia Tech Climate Change Planning Studio. (http://www.deq.state.va.us/export/sites/default/info/documents/climate/Adapt_EnvPlanningStudio_PrimerCHD-1.pdf)

Policy Tools for Local Adaptation to Sea Level Rise (2009)
The Marine Policy Institute at Mote Marine Laboratory summarizes climate-associated sea level rise, vulnerabilities in Florida communities and options for dealing with those vulnerabilities moving forward. (http://www.mote.org/clientuploads/MPI/Synopsis-Policy%20Tools%20for%20Local%20Adaptation%20to%20Sea%20Level%20Rise(fin).pdf)

The role of Coastal Zone Management Program in Adaptation to climate Change: Second Annual Report of the Coastal States Organizations Climate Change Workgroup (2008)
As the Coastal States Organization's Climate Change Work Group continues to explore the current and future roles of state coastal zone management programs, this report focuses on sharing results of the CSO Climate Change Work Group's 2008 Adaptation Survey within respective coastal states, Commonwealths or territories. (http://www.coastalstates.org/wp-content/uploads/2010/07/CSO-2008-Climate-Change-Report2.pdf)

Shaping Climate Resilient Development (2009)
A general, globally focused guide for a systematic approach to climate change adaptation from the Economics of Climate Adaptation Working Group (an international partnership between the Global Environment Facility, McKinsey & Company, Swiss Re, the Rockefeller Foundation, Climate Works Foundation, the European Commission, and Standard Chartered Bank.) (http://www.clintonglobalinitiative.org/media/Shaping_Climate_Resilent_Development.pdf)

Technical Manual for Coastal Land use Planning: A "How-to" Manual for addressing the coastal resources Commission's 2002 Land Use planning Guidelines
In a partnership between North Carolina Department of Environmental and Natural Resources and the State of North Carolina, new code requirements were reviewed and it offers analytical approaches and suggested policy development processes for addressing the new planning requirements. (http://dcm2.enr.state.nc.us/planning/techmanual.pdf)

We All Share the Coast: A Workshop on Coastal Access (Canada)
This report summarizes the results of the workshop, We All Share the Coast: A Workshop on Coastal Access. The workshop marked the third event in a series of public events and strategic workshops in Nova Scotia. (http://www.ecologyaction.ca/files/images/file/Coastal/We%20All%20Share%20the%20Coast%20Report.pdf)

Adaptation Measures and Guides specific to the Mid-Atlantic

A Sea Level Rise Response Strategy for the State of Maryland (2000)
Written for the Maryland Department of Natural Resources Coastal One Management Program this report includes adaptation strategies regarding four components: outreach and engagement; technology, data and research support;critical application; and statewide policy initiatives. (http://www.ecy.wa.gov/climatechange/PAWGdocs/ci/071007Clsealevelstrategy.pdf)

Crisfield, Maryland Comprehensive Land Use Plan
This section of the 2007 Crisfield Comprehensive Plan illustrates use of elevation above sea level as a land use condition – see land use policies discussion starting at p35 of the document. (http://greatersalisbury.org/userfiles/files/Crisfield%202007a.pdf)

Economic Impacts of Climate Change on North Carolina (2008)
Economic impact study of climate change impacts on NC done by a consortium of North Carolina researchers. (http://www.cier.umd.edu/climateadaptation/North%20Carolina%20Economic%20Impacts%20of%20Climate%20Change%20Full%20Report.pdf)

Land Subsidence and Sea Level Rise on the Atlantic Coastal Plain of the United States (2010)
Written by Boon, et al. from Virginia Institute of Marine Science, this paper explains the importance of considering land subsidence when predicting future changes in sea level. In particular this article e explores how land subsidence will increase the impacts of sea level rise experienced by the Atlantic Coastal Plain. (http://www.springerlink.com/content/l18584555k627686/)

Maryland Climate Change Impacts (2009)
This is a report from the Maryland Commissionon Climate Change that provides updates about climate chagne adaptation efforts throughout the state. (http://www.mde.state.md.us/programs/Air/ClimateChange/Pages/Air/climatechange/legislation/index.aspx)

Sea level Rise: Technical Guidance for Dorchester County (2008)
The County of Dorchester reviews the county's vulnerablities to level rise andsea level rise response strategies. (http://www.dnr.state.md.us/dnrnews/pdfs/Dorchester.pdf)

Somerset County, Maryland: Rising Sea Level Guidance (2008)
Somerset County, Maryland assessed the County's vulnerability to sea level rise, reviewed existing plans, and developed codes, regulations, and laws to ensure the necessary policies and codes to address sea level rise and coastal storms. The report included a vulnerability assessment as well as recommendations on how to adapt the county's management and codes to best prepare for climate change. (http://www.dnr.state.md.us/irc/docs/00014600.pdf)

Virginia Case Study—Stemming the Tide: How local

Governments can Manage Rising Flood Risks (2010)
A case study from the Georgetown Climate Center that analyzes the authority of Virginia localities to use existing land use tools to adapt to sea level rise. (http://www.georgetownclimate.org/sites/default/files/Va-Case-Study(1).pdf)

Social Perceptions

Climate of Opinion: What Virginians' believe about climate change and policy Options? (2008)

Conducted by the University of Virginia/Bookings institution and Miller Center for Public Affairs and Mulenberg College this study captured the option of four states, including Virginia. Within Virginia 660 respondents were surveyed and their responses were compared with the rest of the nation. (http://vaseagrant.vims.edu/wp-content/uploads/2011/03/vss_climate_opinion.pdf)

Virginia Environmental Attitudes Survey: A focus on Climate Change (2009)

Christopher Newport University's Center for pubic Policy assessed what Virginians know about climate change, their personal environmental behaviors and their views on public policy related to climate change. Through a series of question it was found that Virginians (1) are largely pessimistic about the state's natural environment, (2) are more concerned about the natural environment and the natural beauty than their own health, and (3) respond positively to policy proposals designed to change their behavior in ways that would be beneficial to the state's environment. (http://www.cnu.edu/cpp/pdf/VEAS2009Report.pdf)

Web-based Resources

Delaware Sea Level Rise Adaptation Effort

http://www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx

EPA Adaptation Website

http://www.epa.gov/cre/vulnerability.html#risk

Existing Built Environment and Infrastructure

http://www.mdclimatechange.us/ewebeditpro/items/O40F17262.pdf

Future Built Environment and Infrastructure

http://www.mdclimatechange.us/ewebeditpro/itemsO40F17211.pdf

Maryland Adaptation and Response Working Group Documents

http://www.mdclimatechange.us/twg.cfm

National Climate Adaptation Summit – May 2010

http://www.joss.ucar.edu/events/2010/ncas/index.html

National Research Council Adaptation Website (new publication coming)

http://americasclimatechoices.org/paneladaptation.shtml

NOAA Climate Change Adaptation Website

http://community.csc.noaa.gov/climateadaptation/

North Carolina Sea Level Rise Study

http://www.ncsealevelrise.com/

US Army Corps of Engineers: Response to Climate Change

http://corpsclimate.us/

VIMS Climate Change and Costal Stressors

http://ccrm.vims.edu/coastal_zone/climate_change/index.html

Wetlands Watch

http://www.wetlandswatch.org/

White House Adaptation Task Force

http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation

Appendix 1

Gloucester County Floodplain Management Ordinance Amendment

GLOUCESTER COUNTY BOARD OF SUPERVISORS
PUBLIC HEARING NOTICE
AN ORDINANCE AMENDING CHAPTER 8.5 – FLOODPLAIN MANAGEMENT OF THE GLOUCESTER COUNTY CODE

The Gloucester County Board of Supervisors will conduct a Public Hearing on August 3, 2010 beginning at 8:00 p.m. in the Colonial Courthouse located at 6504 Main Street, Gloucester, Virginia, to consider the following:

AN ORDINANCE AMENDING CHAPTER 8.5 – FLOODPLAIN MANAGEMENT OF THE GLOUCESTER COUNTY CODE

Gloucester County has adopted and enforces the Virginia Uniform Statewide Building Code (VUSBC), and Gloucester County Code Chapter 8.5-Flood Plain Management (Chapter 8.5), which contain requirements for buildings that are constructed or substantially improved in areas that are within federally designated flood plain boundaries and prone to flooding. To the benefit of property owners within federally designated floodplain boundaries, the County has participated in the Department of Homeland Security's Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) since adoption of Chapter 8.5 on July 7, 1987, revised September 6, 1994. FEMA has completed a new Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) for the County, both which will become effective on September 17, 2010. The FEMA Regional Office is required to approve legally enforceable floodplain management measures adopted by the County by September 17, 2010 to continue the County's eligibility for participation in NFIP. County staff has drafted changes to Chapter 8.5 to effect the requirements of FEMA. County staff has recommended and included within the proposed revisions an additional one (1) foot of freeboard clearance to the existing elevation requirements for new or substantially improved structures within the flood zones designated by the FIRM.

A complete copy of the proposed ordinance amendment is available and may be reviewed at the Gloucester County Administrator's office at 6467 Main Street, Gloucester, Virginia, on the web at www.gloucesterva.info and at both branches of the Gloucester County Library - Main Branch: 6920 Main Street, Gloucester, Virginia - Gloucester Point Branch: 1720 George Washington Memorial Hwy, Gloucester Point, Virginia.

All interested parties are invited to attend the hearing to express their views. Persons requiring assistance to attend the hearing should contact the Gloucester County Administrator's office at (804) 693-4042.

Brenda G. Garton
County Administrator

At a meeting of the Gloucester County Board of Supervisors held on August 3, 2010 in the Colonial Courthouse, located at 6504 Main Street, Gloucester, Virginia: On a motion duly made by _____, and seconded by _____ the following Ordinance was adopted by the following vote:

Carter M. Borden, ____
Robert A. Crewe, ____
John H. Northstein, ____
Michelle R. Ressler, ____
Christian D. Rilee, ____
Louise D. Theberge, ____
Gregory Woodard, ____

AN ORDINANCE AMENDING CHAPTER 8.5 – FLOODPLAIN MANAGEMENT OF THE GLOUCESTER COUNTY CODE

WHEREAS, Gloucester County has adopted and enforces the Virginia Uniform Statewide Building Code (VUSBC), and Gloucester County Code Chapter 8.5-Flood Plain Management (Chapter 8.5), which contain requirements for buildings that are constructed or substantially improved in areas that are within federally designated flood plain boundaries and prone to flooding; and

WHEREAS, to the benefit of property owners within federally designated floodplain boundaries, the County has participated in the Department of Homeland Security's Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) since adoption of Chapter 8.5 on July 7, 1987, revised September 6, 1994; and

WHEREAS, FEMA has completed a new Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) for the County, both which will become effective on September 17, 2010; and

WHEREAS, the FEMA Regional Office is required to approve legally enforceable floodplain management measures adopted by the County by September 17, 2010 to continue the County's eligibility for participation in NFIP; and

WHEREAS, County staff has drafted changes to Chapter 8.5 to effect the requirements of FEMA; and

WHEREAS, County staff has recommended and included within the proposed revisions an additional one (1) foot of freeboard clearance to the existing elevation requirements for new or substantially improved structures within the flood zones designated by the FIRM; and

WHEREAS, as required, the State Department of Conservation and Recreation (DCR) has approved the proposed changes to Chapter 8.5; and

WHEREAS, for the health and safety of the citizens of Gloucester County, the Board is desirous of revising the Gloucester County Code to effect this program and the Board is desirous of amending Chapter 8.5 of the Gloucester County Code to reflect the code provisions required by FEMA, and recommended by County staff; and

WHEREAS, a public hearing was held on August 3, 2010 to receive public comment regarding these proposed amendments to the Gloucester County Code; and

WHEREAS, once the proposed amendments to the Gloucester County code are adopted, FEMA must review and approve the code amendment by September 17, 2010.

NOW THEREFORE BE IT ORDAINED AND ENACTED that Chapter 8.5 – Floodplain Management be amended, as follows:

Chapter 8.5 FLOODPLAIN MANAGEMENT

Article I. In General

§ 8.5-1. Title.
§ 8.5-2. Definitions.
§ 8.5-3. Statement of intent.
§ 8.5-4. Authority.
§ 8.5-5. Purpose.
§ 8.5-6. Applicability.
§ 8.5-7. Compliance required.
§ 8.5-8. Abrogation and greater restrictions.
§ 8.5-9. Existing structures in floodplain district.
§ 8.5-10. Penalties.
§ 8.5-11. Warning and disclaimer of liability.
§ 8.5-12. Severability.

Article II. Establishment of Floodplain Districts

§ 8.5-21. Basis of districts.
§ 8.5-22. Official floodplain map.
§ 8.5-23. District boundary changes.
§ 8.5-24. Interpretation of district boundaries.
§ 8.5-25. Designated official.
§ 8.5-26. Submitting technical data.

Article III. District Provisions

§ 8.5-36. General requirements.
§ 8.5-37. Floodway District ~~(AE zones)~~.
§ 8.5-38. Flood-fringe and approximated floodplain districts (AE and A zones).
§ 8.5-39. Coastal high hazard area district (V and VE zones).
§ 8.5-40. Critical facilities.
§ 8.5-41. Specific Standards.

Article IV. Administrative Provisions

§ 8.5-51. Permit requirements.
§ 8.5-52. Variances.

ARTICLE I. IN GENERAL

Sec. 8.5-1. Title.

This chapter shall be known and may be cited as the Floodplain Management Ordinance of Gloucester County, Virginia.

Sec. 8.5-2. Definitions.

For the purposes of this chapter:

Area of special flood hazard **means land in the community flood plain subject to a one (1) percent or greater chance of flooding in any given year. The area may be designated as Zone A, AE, V, or VE on the official Flood Insurance Rate Map (FIRM) for Gloucester County.**

Base flood elevation (BFE) means the Federal Emergency Management Agency designated one-hundred-year water surface elevation plus ~~one (1)~~ **two (2)** more ~~foot~~ **feet** for new construction only.

Base flood/one hundred-year flood means a flood that, on the average, is likely to occur once every one hundred (100) years, or that has a one (1) percent chance of occurring each year, although the flood may occur in any year.

Basement means any area of a building having its floor subgrade (below ground level) on all sides.

Board of contractor appeals means the board appointed to review appeals made by individuals with regard to decisions of the building official in the interpretation of this chapter, as defined by section 5-35, et seq., of this Code.

Breakaway wall means a wall that is not part of the structural support of the building and is intended through its design and construction to collapse under specific lateral loading forces, without causing damage to the elevated portion of the building or supporting foundation system.

Buffer modification means an approved reduction of the one-hundred-foot resource protection area buffer, as defined by section 5.5-3 of this Code.

~~***Chesapeake Bay Preservation Ordinance Administrative Board*** **means a group of five (5) county employees appointed by the county administrator that evaluates buffer modification and reserve drainfield waiver requests, pursuant to Chapter 5.5 of the Gloucester County Code.~~

Coastal high hazard area means an area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources.

Critical facility means those structures or facilities which produce, use or store highly volatile, flammable, explosive, toxic and/or water-reactive materials; hospitals, nursing homes and housing which are likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a flood event; police stations, vehicle and equipment storage facilities and emergency operations centers which are needed for flood response activities before, during and after a flood event; and public and private utility facilities which are vital to maintaining or restoring normal services to flooded areas before, during and after a flood event. Structures used solely for private residential purposes are excluded from this definition.

Development means any man-made change to improved or unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations or storage of equipment or materials.

Flood means a temporary inundation of normally dry land areas.

Flood-related erosion means the collapse or subsidence of land along the shore of a lake or other body of water as a result of undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an

unanticipated force of nature, such as a flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding.

Flood-related erosion area or *flood-related erosion prone area* means a land area adjoining the shore of a lake or other body of water, which due to the composition of the shoreline or bank and high water levels or wind-driven currents, is likely to suffer flood-related erosion damage.

Floodplain means (1) a relatively flat or low land area adjoining a river, stream or watercourse which is subject to partial or complete inundation; **or** (2) an area subject to the unusual and rapid accumulation or runoff of surface waters from any source.

Floodproofing means any combination of structural and nonstructural additions, changes or adjustments to properties and structures which reduce or eliminate flood damage to lands, water and sanitary facilities, structures and contents of buildings.

Floodway fringe means the area between the floodway and one hundred-year floodplain boundaries. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water surface elevation of the one hundred-year flood by more than one (1.0) foot at any point (shown on FIRM).

Freeboard means a factor of safety usually expressed in feet above a flood level for purposes of floodplain management.

Functionally dependent use means a use which cannot perform its intended purpose unless it is located or carried out in close proximity to water. The term includes only docking facilities, port facilities that are necessary for the loading and unloading of cargo or passengers, and shipbuilding and ship repair facilities, but does not include long-term storage or related manufacturing facilities.

Highest adjacent grade **means the highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure.**

Historic structure **means any structure that is:**

(a) Listed individually in the National Register of Historic Places;

(b) Certified or preliminarily determined by the Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district;

(c) Individually listed on the Virginia inventory of historic places; or

(d) Individually listed on the local inventory of historic places that has been certified by and approved by the state program.

Land development means (i) the improvement of one (1) lot, or two (2) or more contiguous lots, tracts, or parcels of land for any purpose involving (a) a group of two (2) or more buildings, or (b) the division or allocation of land or space between or among two (2) or more existing or prospective occupants by means of, or for the purpose of, streets, common areas, leaseholds, condominiums, building groups or other features; **or** (ii) a subdivision of land.

Lowest floor means the lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor; provided, that such enclosure is not built so as to render the structure in violation of the applicable nonelevation design requirements of this chapter.

***Manufactured home* means a structure subject to federal regulation, which is transportable in one or more sections; is eight body feet or more in width and forty body feet or more in length in the traveling mode, or is 320 or more square feet when erected on site; is built on a permanent chassis; and is designed to be used as a single-family dwelling, with or without a permanent foundation, when connected to the required utilities.**

Mean sea level means, for purposes of the National Flood Insurance Program, the National Geodetic Vertical Datum (NGVD) of ~~**1929**~~ **1988** or other datum, to which base flood elevation shown on a community's flood insurance rate map are referenced.

New construction means **for the purposes of determining insurance rates, structures for which the "start of construction" commenced on or after August 4, 1987, and includes any subsequent improvements to such structures. For flood plain management purposes, new construction means** structures for which the start of construction as herein defined commenced on or after the effective date of this chapter **and includes any subsequent improvements to such structures**. ~~**This term**~~

~~**does not apply to any work on a structure existing before the effective date of this chapter**~~.

Nonconforming structure~~**s**~~ means a structure or use of a structure or premises which lawfully existed before the enactment of these provisions.

Principally above ground means where at least fifty-one (51) percent of the actual cash value of a structure, less land value, is above ground.

Recreational vehicle means a vehicle which is built on a single chassis; contains four hundred feet (400) square feet, or less, when measured at the largest horizontal projection**; is** designed to be self-propelled or permanently towable by a light duty truck**;** and **is** designed primarily not for use as a permanent dwelling but as temporary living quarters for recreational camping, travel, or seasonal use.

Regulatory floodway means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height (one (1) foot).

Resource protection area (RPA) means lands at or near the shoreline that have an intrinsic value to water quality due to the ecological and biological processes they perform, or are sensitive to impacts which may result in significant degradation to the quality of state waters. This definition includes tidal wetlands, tidal shores, non-tidal wetlands adjacent to tidal wetlands, and a one hundred (100) foot buffer area adjacent to and landward of the components listed above, and along both sides of any perennial stream, all as defined in section 5.5-3 of this Code.

Structure means a walled and roofed building, including a gas or liquid storage tank, that is principally above ground, as well as a manufactured home.

Subdivision means the division or redivision of lots, tracts, or parcels of land by any means into two (2) or more lots, tracts, parcels, or other divisions of land, including a change in existing lot lines for the purpose, whether immediate or future, of lease, transfer of ownership, or building, or lot development.

Substantial damage means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal

or exceed fifty (50) percent of the market value of the structure before the damage occurred.

Substantial improvement means any repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds fifty (50) percent of the market value of the structure either (a) before the improvement or repair is started, or (b) if the structure has been damaged and is being restored, before the damage occurred. For the purposes of this definition**,** "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor, or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure. The term does not, however, include either (1) any project for improvement of a structure to comply with existing state or local health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions, or (2) any alteration of a structure listed on the National Register of Historic Places or a state inventory of historic places.

Variance means a grant of relief by a community from the terms of a floodplain management regulation.

Violation **means the failure of a structure or other development to be fully compliant with Gloucester County's flood plain management regulations.**

Water dependent use or facility means a development of land that cannot exist outside of the resource protection area (RPA) and must be located on the shoreline because of the intrinsic nature of its operation. These facilities include, but are not limited to, ports, the intake and outfall structures of power plants, water treatment plants, sewage treatment plants, and storm sewers, as well as marinas, boat docking structures, beaches and other public water orientated recreation areas, and fisheries and other marine resource facilities.

Sec. 8.5-3. Statement of intent.

These regulations shall apply to all property located within an area identified as being subject to inundation by water of the one hundred-year flood event, and as such shall supplement the regulations of the zoning district within which such property is located. These regulations are intended to ensure the health, safety and general welfare of the public by ensuring that inhabitants and property within a designated floodplain

area are safe from damage **due** to flooding ~~**and will not endanger others**~~. This chapter complies with the requirements of the National Flood Insurance Program (42 U.S.C. 4001--4128) of the Federal Insurance Administration. These regulations are necessary in order for all property owners within the county to be eligible for the National Flood Insurance Program and thereby purchase such insurance at nominal rates. Where these regulations are at variance with the general regulations of the county, it is intended that these regulations shall apply.

Sec. 8.5-4. Authority.

This chapter is adopted pursuant to the authority granted by ~~**Title 62.1, Chapter 3.5, sections 62.1-44.108 through 62.1-44.112 of the Code of Virginia, 1950, as amended**~~ **Va. Code Sections 15.2-2280 and 10.1-600 et seq., and all amendments thereto.**

Sec. 8.5-5. Purpose.

The purpose of these provisions is to prevent the loss of property and life, the creation of health and safety hazards, the disruption of commerce and governmental services, the extraordinary and unnecessary expenditure of public funds for flood protection and relief, and the impairment of the tax base by:

(1) Regulating uses, activities and development which, acting alone or in combination with other existing or future uses, activities and development, will cause unacceptable increases in flood heights, velocities and frequencies;

(2) Restricting or prohibiting certain uses, activities and development from locating within areas subject to flooding;

(3) Requiring all those uses, activities, and developments that do occur in flood-prone areas to be protected and/or flood-proofed against flooding and flood damage;

(4) Protecting individuals from buying lands and structures which are unsuited for intended purposes because of flood hazards.

Sec. 8.5-6. Applicability.

These provisions shall apply to all lands within the jurisdiction of Gloucester County, Virginia, and identified as areas subject to inundation by water of the one hundred-year flood event.

Sec. 8.5-7. Compliance.

No land shall hereafter ~~**by**~~ **be** developed and no structure shall be located, relocated, constructed, reconstructed, enlarged, or structurally altered except in full compliance with the terms and provisions of this chapter and any other applicable ordinances and regulations.

Sec. 8.5-8. Abrogation and greater restrictions.

This chapter supersedes any ordinance currently in effect in flood-prone areas. However, any underlying ordinance shall remain in full force and effect to the extent that those provisions are more restrictive.

Sec. 8.5-9. Existing structures in floodplain district.

A structure or use of a structure or premises which lawfully existed before the enactment of these provisions, but which is not in conformity with these provisions**,** may be continued subject to the following conditions:

The modification, alteration, repair, reconstruction or improvement of any kind to a structure and/or use regardless of its location in a floodplain district to an extent or amount of fifty (50) percent or more of its market value shall be undertaken only in full compliance with the provisions of the Virginia Uniform Statewide Building Code and this chapter.

Sec. 8.5-10. Penalties.

Any person who fails to comply with any or all of the requirements or provisions of this chapter or direction of the building official or any other authorized employee of the county shall be guilty of an offense and, upon conviction, shall pay a fine to the County of Gloucester, Virginia, of not less than twenty-five dollars ($25.00) nor more than one thousand dollars ($1,000.00). Each day during which any violation of this chapter continues shall constitute a separate offense. In addition to the above penalties, all other actions are hereby reserved including an action ~~**in equity**~~ for the proper enforcement of this chapter. The imposition of a fine or penalty for any violation of, or noncompliance with, this chapter shall not excuse the violation or noncompliance or

permit it to continue; and all such person[s] shall be required to correct or remedy such violations or noncompliances within a reasonable time. Any structure constructed, reconstructed, enlarged, altered or relocated in noncompliance with this chapter may be declared by the board of supervisors to be a public nuisance and abatable as such.

Sec. 8.5-11. Warning and disclaimer of liability.

The degree of flood protection required by the floodplain management ordinance of Gloucester County, Virginia, is considered reasonable for regulatory purposes and is based on engineering and scientific methods of study. Larger floods may occur on rare occasions. Flood heights may be increased by man-made or natural causes. This chapter and the districts established hereby shall not create liability on the part of the county or any officer, agency or employee thereof for any flood damage that results from reliance on this chapter or any administrative decision lawfully made hereunder.

Sec. 8.5-12. Severability.

If any section, subsection, paragraph, sentence, clause, or phrase of this chapter shall be declared invalid for any reason whatsoever, such decision shall not affect the remaining portions of this chapter. The remaining portions shall remain in full force and effect, and for this purpose, the provisions of this chapter are hereby declared to be severable.

ARTICLE II. ESTABLISHMENT OF FLOODPLAIN DISTRICTS

Sec. 8.5-21. Basis of districts.

The various floodplain districts shall include areas subject to inundation by waters of the one hundred-year flood. The basis for the delineation of these districts shall be the Flood Insurance Study (FIS) **and the Flood Insurance Rate Map (FIRM)** for Gloucester County prepared by the Federal Emergency Management Agency, Federal Insurance Administration, dated ~~**August 4, 1987**~~ **September 17, 2010**, as amended.

(1) The floodway district ~~**(AE zones)**~~ is delineated, for purposes of this chapter, using the criterion that certain areas within the floodplain must be capable of carrying the waters of the one hundred-year flood without increasing the water surface elevation of that flood more than one (1) foot at any point. The areas included in this district are specifically defined in

Table 5 of the above-referenced flood insurance ~~[~~**study**~~]~~ and shown on the accompanying flood insurance rate map.

(2) The flood-fringe district (AE zones) shall be that area of the one hundred-year floodplain not included in the floodway district. The basis for the outermost boundary of the district shall be the one hundred-year flood elevations contained in the flood profiles of the above-referenced flood insurance study and as shown on the accompanying flood insurance rate map.

(3) The approximated floodplain district (A zones) shall be that floodplain area for which no detailed flood profiles or elevations are provided, but where a one hundred-year floodplain boundary has been approximated. Such areas are shown as Zone A on the maps accompanying the flood insurance study. For these areas, the one hundred-year flood elevations and floodway information from federal, state, and other acceptable sources shall be used, when available. Where the specific one hundred-year flood evaluation cannot be determined for this area using other sources of data, such as the U.S. Army Corps of Engineers Floodplain Information Reports, U.S. Geological Survey Flood-Prone Quadrangles, etc., then the applicant for the proposed use, development and/or activity shall determine this elevation in accordance with hydrologic and hydraulic engineering techniques. Hydrologic and hydraulic analysis shall be undertaken only by professional engineers or others of demonstrated qualifications, who shall certify that the technical methods used correctly reflect currently accepted technical concepts. Studies, analyses, computations, etc., shall be submitted in sufficient detail to allow a thorough review by Gloucester County ~~O~~**o**ffice of ~~**Community Development and C**~~**c**odes ~~C~~**c**ompliance.

(4) Coastal high-hazard areas district (V and VE zones) shall be those portions of land within the coastal floodplain subject to inundation by high velocity waters and wave action.

Sec. 8.5-22. Official floodplain map.

The boundaries of the floodplain districts are established as shown on the flood insurance rate maps which are declared to be a part of this chapter and which shall be kept on file at the county office of ~~**community development and**~~ codes compliance.

Sec. 8.5-23. District boundary changes.

The delineation of any of the floodplain districts may be revised by the board of supervisors where natural or man-made changes have occurred and/or more detailed studies conducted or undertaken by the U.S. Army Corps of Engineers or other qualified agency or individual documents the need for such change. However, prior to any such change, approval must be obtained from the Federal Insurance Administration.

Sec. 8.5-24. Interpretation of district boundaries.

Initial interpretation of the boundaries of the floodplain districts shall be made by the director of ~~**community development and**~~ codes compliance. Should a dispute arise concerning the boundaries of any of the districts, the board of contractor appeals shall make the necessary determination. The person questioning or contesting the location of the district boundary shall be given a reasonable opportunity to present his case to the board of contractor appeals and to submit his own technical evidence if he so desires.

Sec. 8.5-25. Designated official.

The director of ~~**community development and**~~ codes compliance is designated to coordinate the implementation of this article and to submit an annual report to the administrator of the National Flood Insurance Program concerning such implementation.

Sec. 8.5-26. Submitting technical data.

The county's base flood elevations may increase or decrease resulting from physical changes affecting flooding conditions. As soon as practicable, but not later than six months after the date such information becomes available, the county shall notify the Federal Insurance Administrator of the changes by submitting technical or scientific data. Such submission is necessary so that upon confirmation of those physical changes affecting flooding conditions, risk premium rates and floodplain management requirements will be based upon current data.

ARTICLE III. DISTRICT PROVISIONS

Sec. 8.5-36. General requirements.

(a) All uses, activities and development occurring within any floodplain district shall be undertaken only upon the issuance of a building permit. Such development shall be undertaken only in strict compliance with the provisions of this chapter and with all other applicable codes and ordinances such as the Gloucester County Zoning Ordinance, the Gloucester County Wetlands Zoning Ordinance [Chapter 20], the Gloucester County Soil and Erosion Sedimentation Control Ordinance [Chapter 7.5], the Gloucester County Site Plan Ordinance [Chapter 15.5], the Gloucester County Subdivision Ordinance [Chapter 15], the Gloucester County Chesapeake Bay Preservation Ordinance [Chapter 5.5], and the Virginia Uniform Statewide Building Code [Chapter 5, Article I]. Prior to the issuance of any such permit, the building official shall require all applications to include compliance with all applicable state and federal laws.

(b) Under no circumstances shall any use, activity, and/or development adversely affect the capacity of the channels or floodways of any watercourse, drainage ditch, or any other drainage facility or system.

(c) Prior to any proposed alteration or relocation of any channels or of any water course, stream, etc., within this jurisdiction, an approved permit shall be obtained from the U.S. Army Corps of Engineers, the Virginia Department of Environmental Quality (DEQ), and the Virginia Marine Resources Commission (a joint permit application is available from any of these organizations or from the ~~O~~o**ffice of ~~Development Community and~~ ~~C~~c**odes ~~C~~c**ompliance). Furthermore, notification of the proposal shall be given by the applicant to all affected adjacent jurisdictions, the Department of Conservation and Recreation (Division of Soil and Water Conservation) and the Federal Insurance Administration.

(d) All proposals for the subdivision of land and/or new development shall include a plan drawing showing the location of all existing and proposed public and private utilities, facilities and drainage structures. If the one hundred-year flood elevation has been determined by the flood insurance study or other reliable source approved by the County of Gloucester, Virginia, such flood elevation shall be delineated on the proposed plan, provided that the more stringent elevation data shall control. In addition, within the approximated floodplain district, flood and

floodway information from federal, state, or other acceptable sources shall be used when available. If the proposal is greater than fifty (50) lots or greater than five (5) acres, whichever is the lesser, and the one hundred-year flood elevation has not been determined for the land area, the developer shall determine the one hundred-year flood elevation and delineate such flood elevation on the proposed plan. **Until a regulatory floodway is designated, no new construction, substantial improvements, or other development, including fill, shall be permitted within Zone AE on the FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.** All plans shall be certified by a registered professional engineer and shall be reviewed by the subdivision agent to assure that:

(1) All such proposals are consistent with the need to minimize flood damage**;**

(2) All necessary permits have been received from the State of Virginia and appropriate federal agencies**;**

(3) All public and private utilities and facilities (including sewer, water, telephone, electric, gas, etc.) are located and constructed to minimize or eliminate flood damage. **New and replacement sanitary sewage systems are to be designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into flood waters as approved and permitted by the State Health Department for private systems and the Gloucester County department of public utilities for public systems;**

(4) Adequate drainage is provided to reduce exposure to flood hazard. Storm drainage facilities shall be designed to convey the flow of stormwater runoff in a safe and efficient manner. The system shall ensure proper drainage along streets, and provide positive drainage away from buildings. The system shall also be designed to prevent the discharge of excess runoff onto adjacent properties**; and**

(5) Adequate measures have been taken to minimize the adverse environmental impacts of the proposed development.

(e) Recreational vehicles placed on sites **shall** either: (1) be on the site for fewer than one hundred eighty (180) consecutive days **and** be fully licensed and ready for highway use, or (2) meet the permit requirements for placement and the elevation and anchoring requirements for manufactured homes as contained in the Uniform State**wide** Building Code. A recreational vehicle is ready for highway use if it is on its wheels or jacking system, is attached to the site only by quick disconnect type utilities and security devices, and has no permanently attached additions.

(f) All new buildings must be constructed on properly designed and compacted fill (ASTM D-698 or equivalent) that extends beyond the building walls before dropping below the base flood elevation and has appropriate protection from erosion and scour. The design of the fill or the fill standard must be approved by a registered engineer.

(g) Where a nonresidential structure is intended to be made watertight below the base flood level, (i) a registered professional engineer or architect shall develop and/or review structural design, specifications, and plans for the construction, and shall certify that the design and methods of construction are in accordance with accepted standards of practice for meeting the applicable provisions of this chapter, and (ii) a record of certificate which includes the specific elevation (in relation to mean sea level) to which such structures are floodproofed shall be maintained with the director of ~~**community development and**~~ codes compliance.

(h) Man-made alterations to sand dunes that would increase potential flood damage are prohibited.

Sec. 8.5-37. Floodway district ~~(AE zones).~~

In the floodway district, no encroachments, including fill, new construction, substantial improvements, or other development shall be permitted unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with

standard engineering practice that the proposed encroachment would not result in any increase in the one hundred-year flood evaluation.

Sec. 8.5-38. Flood-fringe and approximated floodplain districts (AE and A zones).

In the flood-fringe and approximated floodplain districts, the development and/or use of land shall be permitted in accordance with the regulations of the underlying area, provided that all such uses, activities, and/or development shall be undertaken in strict compliance with the floodproofing and related provisions contained in the Virginia Uniform Statewide Building Code and all other applicable codes and ordinances.

Within the approximated floodplain district, the applicant shall also delineate a floodway area based on the requirement that all existing and future development not increase the one hundred-year flood elevation more than one (1) foot at any one (1) point. The engineering principle--equal reduction of conveyance--shall be used to make the determination of increased flood heights.

Within the floodway area delineated by the applicant, the provisions of section 8.5-37 shall apply.

Sec. 8.5-39. Coastal high hazard district (V and VE zones).

In the coastal high hazard area district (V and VE zones), the following regulations shall apply in addition to the regulations cited in sections 8.5-36 through 8.5-38:

(1) No land below the level of the one hundred-year flood event may be developed unless the new construction or substantial improvement is located outside the resource protection area (RPA) (measured landward one hundred (100) feet from the mean high tide or associated tidal wetlands) or a buffer modification to the RPA requirement has been granted by the Chesapeake Bay Preservation Ordinance Administrative Board. This one hundred-foot buffer requirement excludes water dependent uses as defined;

(2) All manufactured homes to be placed or substantially improved within V or VE zones shall comply with the same standards as set forth for conventional housing in V or VE zones.

(3) There shall be no fill used as structural support.

(4) Existing nonconforming uses and/or structures located on land below the level of the one hundred-year flood event shall not be expanded.

(~~5~~) **~~Within V zones on the flood insurance rate map, obtain and record the elevation (in relation to mean sea level) of the bottom of the lowest horizontal structural member of the lowest floor (excluding pilings and columns) of all new and substantially improved structures, and whether or not such structures contain a basement on permit applications.~~**

(5) All new construction and substantial improvements in Zones V and VE shall be elevated on pilings or columns so that:

a. the bottom of the lowest horizontal structural member of the lowest floor (excluding the pilings or columns) is elevated two feet above the base flood level; and

b. the pile or column foundation and structure attached thereto is anchored to resist flotation, collapse, and lateral movement due to the effects of wind and water loads acting simultaneously on all building components.

Sec. 8.5-40. Critical facilities.

The building of critical facilities in the five hundred-year floodplain is prohibited.

Sec. 8.5-41. Specific Standards.

In all special flood hazard areas where base flood elevations have been provided in the Flood Insurance Study or in the case of areas for which no detailed flood profiles or elevations are provided, the one hundred (100) year flood elevations and floodway information from federal, state, and other acceptable sources shall be used when available. All new construction and substantial improvements shall be designed (or modified) and adequately anchored to prevent flotation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, and be constructed by methods and practices that minimize flood damages using materials that are resistant to flood damage, with the electrical, heating, ventilation, plumbing, and air conditioning equipment and other services so designed and/or located so as

to prevent water from entering or accumulating within the components during conditions of flooding. The following provisions shall apply:

(1) Residential Construction

New construction or substantial improvement of any residential structure (including manufactured homes) shall have the lowest floor, including basement, elevated no lower than two feet above the base flood elevation.

(2) Non-Residential Construction

New construction or substantial improvement of any commercial, industrial, or non-residential building shall have the lowest floor, including basement, elevated to no lower than two feet above the base flood elevation. Buildings located in all A or AE zones may be flood–proofed in lieu of being elevated, provided that all areas of the building components below the base flood elevation are water tight with walls substantially impermeable to the passage of water, and use structural components having the capability of resisting hydrostatic and hydrodynamic loads and the effect of buoyancy. A registered professional engineer or architect shall certify that the standards of this subsection are satisfied. Such certification, including the specific elevation to which such structures are floodproofed, shall be maintained in the codes compliance office.

(3) Elevated Buildings

Fully enclosed areas of new construction or substantially improved structures, which are below the regulatory flood protection elevation, shall:

a. Not be designed or used for human habitation, but shall only be used for parking of vehicles, building access, or limited storage.

b. Be constructed entirely of flood resident materials below the regulatory flood protection elevation.

c. **Include in Zones A and AE measures to automatically equalize hydrostatic flood forces on walls by allowing for the entry and exit of floodwaters. To meet this requirement, the openings must be certified by a professional engineer or architect, or meet the following minimum design criteria:**

- **i.** **Provide a minimum of two openings on different sides of each enclosed area subject to flooding.**
- **ii.** **The total net area of all openings must be at least one (1) square inch for each square foot of enclosed area subject to flooding.**
- **iii.** **If a building has more than one enclosed area, each area must have openings to allow floodwaters to automatically enter and exit.**
- **iv.** **The bottom of all required openings shall be no higher than one (1) foot above the adjacent finished grade.**
- **v.** **Openings may be equipped with screens, louvers, or other opening coverings or devices, provided they permit the automatic flow of floodwaters in both directions.**
- **vi.** **The inside finished grade of each enclosed area must be as high or higher than the outside finished grade.**
- **vii.** **Foundation enclosures made of flexible skirting are not considered enclosures for regulatory purposes, and therefore, do not require openings. Masonry or wood underpinning, regardless of structural status, is considered an enclosure and requires openings as outlined above.**

d. **In Zones V and VE, a registered design professional engineer or architect shall develop and seal the structural design, specifications and plans for the construction, and shall certify that the design and methods of construction to be used are in**

accordance with accepted standards of practice for meeting the provisions of Article III, Sec. 8.5-39.

i. The space below the lowest floor shall be either free of obstruction or constructed with nonsupporting breakaway walls, open wood-lattice work, or insect screening intended to collapse under wind and water loads without causing collapse, displacement, or other structural damage to the elevated portion of the building or supporting foundation system;

ii. Breakaway walls shall collapse from water loads that are less than that which would occur during the base flood; and,

iii. The elevated portion of the building and supporting foundation shall not be subject to collapse, displacement or other structural damage due to the effects of wind and water loads acting simultaneously on all building components. Water loading values used shall be those associated with the base flood. Wind loading shall be those required by the Virginia Uniform Statewide Building Code (USBC). The enclosed space below the lowest floor shall be used solely for parking of vehicles, building access, or storage.

(4) Standards for Manufactured Homes

a. Individual Lots. All manufactured homes placed, or substantially improved, on individual lots or parcels must meet all of the elevation requirements for new construction. They shall be placed on reinforced piers or other equivalent foundation elements and anchored to prevent flotation, collapse, or lateral movement. Methods of anchoring may include, but are not limited to, use of over-the-top or frame ties

to appropriate ground anchors. This standard shall be in addition to and consistent with manufacturers' requirements for resisting wind forces.

b. Manufactured Home Parks. All manufactured homes placed or substantially improved in an existing manufactured home park in which a manufactured home has not incurred substantial damage as the result of a flood shall be elevated so that either:

i. the lowest floor of the manufactured home is elevated no lower than two (2) feet above the base flood elevation; or

ii. the manufactured home chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than 36 inches in height above adjacent grade, and be securely anchored to an adequately anchored foundation system to resist flotation, collapse and lateral movement.

ARTICLE IV. ADMINISTRATIVE PROVISIONS

Sec. 8.5-51. Permit requirements.

A permit is required for all development (including, but not limited to, the subdivision of land, construction of buildings and structures, placement of manufactured homes, fill or any combination of these) in the floodplain district and shall be granted only after necessary permits from all applicable local, state and federal agencies have been obtained. **The director of codes compliance or his designee shall review all proposed development to assure it is reasonably safe from flooding.**

(1) The application for a building permit shall contain information including, but not limited to, the following:

a. Name and address of applicant. The applicant must be the owner or any authorized agent of the owner.

b. Name and address of owner of land on which construction is proposed.

c. Name and address of contractor.

d. Site location.

e. A plan of the site showing the size and location of the proposed construction as well as any existing buildings or structures.

f. Summary description of proposed work and estimate cost.

g. Topographic information showing existing and proposed ground elevations.

h. Depending on the type of structure involved, the following information shall also be included in the application:

For the structures to be elevated above the one hundred-year flood elevation, the plans shall show:

1. The size of the proposed structure(s) and its relation to the lot where it is to be constructed.

2. The elevations of the proposed final grading and lowest floor, and the existing ground and one hundred-year flood elevation as certified by a registered professional engineer, surveyor or architect.

3. The method of elevating the proposed structure, including details of proposed fills, pile structures, retaining walls, foundations, erosion protection measures, etc. These plans shall be prepared by a registered professional engineer or architect.

(2) Upon completion of construction and prior to the issuance of the occupancy permit, the elevation certificate shall be completed and submitted to the building official who shall ensure that construction is in accordance with this chapter. If the structure has been floodproofed, the elevation to which the structure has been floodproofed shall also be supplied. **Records of actions associated with the administration of**

this chapter shall be kept on file and maintained by the director of codes compliance.

Sec. 8.5-52. Variances.

(a) *Appeal procedure.* Whenever any person is aggrieved by a decision of the building official with respect to the provisions of this chapter, it is the right of that person to appeal to the board of contractor appeals for a variance. Such appeal must be filed, in writing, within thirty (30) days after the determination by the building official. Upon receipt of such an appeal, the board of contractor appeals shall set a time and place for the purpose of hearing the appeal, which shall be not less than ten (10) nor more than thirty (30) days from the date of receipt of the appeal. Notice of the time and place of the hearing ~~if~~ **of** the appeal shall be given to all parties at which time they may appear and be heard. The determination by the board of contractor appeals shall be final in all cases.

(b) *Consideration and issuance of variances.*

(1) In passing upon applications for variances, the board of contractor appeals shall ~~satisfy~~ **consider** the following factors:

a. The danger to life and property due to increased flood heights or velocities caused by encroachments. No variance shall be granted for any proposed use, development or activity within any floodway area that will cause an increase in the one hundred-year flood elevation.

b. The danger that materials may be swept on to other lands or downstream to the injury of others.

c. The proposed water supply and sanitation systems and the ability of these systems to prevent disease, contamination, and unsanitary conditions.

d. The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owners.

e. The importance of the services provided by the proposed facility to the community.

f. The requirements of the facility for a waterfront location.

g. The availability of alternative locations not subject to flooding for the proposed use.

h. The compatibility of the proposed use with existing development and development anticipated in the foreseeable future.

i. The relationship of the proposed use to the comprehensive plan and floodplain management program for the area.

j. The safety of access to the property in time of flood of ordinary and emergency vehicles.

k. The expected heights, velocity, duration, rate of rise, and sediment transport of the floodwaters expected at the site.

l. The repair or rehabilitation of historic structures upon a determination that the proposed repair or rehabilitation will not preclude ~~the~~ **any** structure's continued designation as a historic structure and the variance is the minimum necessary to preserve the historic character and design of the structure.

m. **A showing of good and sufficient cause and S**~~s~~uch other factors which are relevant to the purposes of this chapter.

(2) The board of contractor appeals may refer any application and accompanying documentation pertaining to any request for a variance to any engineer or other qualified person or agency for technical assistance in evaluating the proposed project in relation to flood heights and velocities, and the adequacy of the plans for protection and other related matters.

(3) Variances shall only be issued after the board of contractor appeals has determined that the granting of such will not result in (a) unacceptable or prohibited increases in flood heights, (b) additional threats to public safety, (c) extraordinary public expense, (d) ~~create~~ **the creation of** nuisances, (e) ~~cause~~ fraud or victimization of the public, or (f) conflict with local laws or ordinances.

(4) **A v**ariance~~s~~ shall only be issued after the board of contractor appeals has determined that the variance will be the minimum relief to any hardship.

(5) The board of contractor appeals shall notify the applicant for a variance, in writing, that the issuance of a variance to construct a structure below the one hundred-year flood elevation (a) increases risks to life and property, and (b) will result in increased premium rates for flood insurance.

(6) A record of the above notification as well as all ~~**variable**~~ **variance** actions, including justification for their issuance, shall be maintained in the office of ~~**community development and**~~ codes compliance, and a record of all variances which are issued shall be noted in the annual report submitted to the Federal Insurance Administrator.

A copy teste:

_____
Brenda G. Garton, County Administrator

Town of Crisfield, Maryland Comprehensive Land-Use Map and Land-Use /Natural Area Compatibility Chart

Appendix 2

SECTION 4 –THE COMPREHENSIVE PLAN RECOMMENDATIONS

This Comprehensive Plan focuses development and conservation policy on the issues facing Crisfield through the foreseeable future. The principles, objectives, and polices, to the extent possible, relate directly to the built and natural environments. This is very important. Future generations will judge the lasting worth of our vision by observing the City and the physical changes that will have occurred under guidance of this Plan.

The Plan is long-range and comprehensive. It provides the organizing framework for more detailed planning and design work. The Plan is a guide for the City and its residents. It is a guide for land developers. It is a guide for outside agencies and units of government. The Plan is a compilation of what is most important to Crisfield as it contemplates growth and change. It is a compelling image of the future. The Plan envisions capable city planning and engineering, a citizen population engaged in formulating and implementing growth and development polices, and consistent outreach to agencies of government with the resources and expertise to advance the interests the City shares with others.

The Plan implements the "visions" set forth in Article 66B of the Maryland Annotated Code.

1. Quality of Life and Sustainability: A high quality of life is achieved through universal stewardship of the land, water, and air resulting in sustainable communities and protection of the environment.

2. Public Participation: Citizens are active partners in the planning and implementation of community initiatives and are sensitive to their responsibilities in achieving community goals.

3. Growth Areas: Growth is concentrated in existing population and business centers, growth areas are adjacent to these centers, or strategically selected new centers.

4. Community Design: Compact, mixed-use, walkable design consistent with existing community character and located near available or planned transit options is encouraged to ensure efficient use of land and transportation resources and preservation and enhancement of natural systems, open spaces, recreational areas, and historical, cultural, and archeological resources.

5. Infrastructure: Growth Areas have the water resources and infrastructure to accommodate population and business expansion in an orderly efficient, and environmentally sustainable manner.

6. Transportation: A well-maintained, multi-modal transportation system facilitates the safe, convenient, affordable, and efficient movement of people, goods, and services within and between population and business centers.

7. Housing: A range of housing densities, types, and sizes provides residential options for citizens of all ages and incomes.

8. Economic Development: Economic development and natural resource-based businesses that promote employment opportunities for all income levels within the capacity of the State's natural resources, public services, and public facilities are encouraged.

9. Environmental Protection: Land and water resources, including the Chesapeake and Coastal Bays, are carefully managed to restore and maintain healthy air and water, natural systems, and living resources.

10. Resource Conservation: Waterways, forests, agricultural areas, open space, natural systems, and scenic areas are conserved.

11. Stewardship: Government, business entities, and residents are responsible for the creation of sustainable communities by collaborating to balance efficient growth with resource protection.

12. Implementation: Strategies, policies, programs, and funding for growth and development, resource conservation, infrastructure, and transportation are integrated across the local, regional, state, and interstate levels to achieve these visions.

The objectives and policies set forth below are drawn from the research and analyses presented in Sections 1 through 3 of this report and public input provided throughout 2005 at multiple Planning Commission workshops. The Comprehensive Plan integrates the elements required by State planning law under five main themes.

- Redevelopment and Ecological Restoration
- Redevelopment Consistent With Community Character
- Development in Balance with Community Facilities and Services
- Planning in Concert with Regional Priorities
- The People of Crisfield: Reinvigorating Neighborhoods

Each theme is organized in the following way:

Statement of theme- including a brief description of the benefit to Crisfield.

Background – a summary of the main findings from the baseline studies provided in Sections 2 and 3.

Guiding Principles –fundamental tenets adopted by the City from which flow the Plan's polices. These principles, while universal, address the basic physical planning issues present in Crisfield.

Objectives – goal statement pertaining to the theme phrased in an affirmative way.

Policies – the recommended courses of action to be pursued by Crisfield in achievement of the goals.

Actions – specific tasks to be undertaken to implement the policies.

The Planning Commission prepared this Comprehensive Plan as called for by Article 66B of the Annotated Code of Maryland, combining the elements required of comprehensive plans into a coherent set of policies. Article 66B requires that a comprehensive plan contain the following: a statement of goals, a land use element, a transportation element, a community facilities element, an element that contains the Commission's recommendations for land development regulations to implement the plan, a sensitive areas element and a mineral resources element. The later element, mineral resources, has been determined through the study to be not applicable to the Crisfield Comprehensive Plan, though a soils evaluation is presented in Section 2.

4.1 REDEVELOPMENT AND ECOLOGICAL RESTORATION

As development or redevelopment occurs, the people of Crisfield will benefit from acknowledging the presence of natural resources and systematically promoting their re-emergence.

Background

Crisfield is a coastal community. It is built in a floodplain. Much of its land is less than three feet above sea level. Apart from the ridge that runs along Somerset Avenue, land rising above three feet in elevation is fill or made land. Flooding is a normal occurrence in Crisfield. Severe flooding and strong storm surge occur. Sea levels in the Chesapeake Bay region are rising. The frequency and severity of today's flooding events will be surpassed by those of future decades.

Historically, the City has been built on lands not well suited to development. Tidal marshes have been filled and wetlands and their natural drainage channels have been disconnected from the water. Oyster shells and other fill material have been used to establish new lands for building. Recent development projects have placed high-density residential development on lands historically suited to maritime uses.

The remaining marshlands and low-lying areas are vital buffers protecting neighborhoods from flooding. They are important now, but will be even more so in decades to come. The projected increases in sea levels will worsen the effect of storm surge and regular flooding events. Regulations and procedures regarding natural resources and sensitive areas are embodied in the City's adopted Chesapeake Bay Critical Area Ordinance.

Guiding Principles

- Sensitive natural areas play significant roles in the quality and health of Crisfield. Marshlands and wetlands help attenuate flooding, dissipate the energy of storm surges, prevent shoreline erosion, improve water quality, and provide protective habitat for native plants and wildlife. Wetlands help convey and store floodwaters and provide habitat for fish, birds, and other wildlife.

- Natural areas provide form to urban development. They define the edges of intensely developed areas and they provide wide, open spaces. Together these resources add to scenic beauty. Natural areas can connect various parts of a City and in so doing can become useful elements in City planning; they become environmental corridors--natural areas for stormwater management, flood control, and recreation.

- The underlying qualities of the land help determine which uses are viable. To the extent possible, the natural capability and characteristics of the land should guide land use development. Certain uses are incompatible with underlying natural conditions. Development in sensitive areas can cause irreparable harm for future generations. As an example, the historic pattern of filling and building on tidal marshes has worsened the effects of flooding in Crisfield. Development on very low-lying lands has exposed residents to both regular flooding and severe storm surge events.

- When an historic settlement pattern prevents certain underlying sensitive areas from fulfilling their natural functions, it is often preferable to continue that development pattern while seeking to restore some degree of those natural functions. Several conditions should be met before redeveloping in naturally sensitive areas: public health and safety should be ensured; adverse impacts to other resource areas should be minimized; the proper stormwater, flood control, and shoreline protection measures and infrastructure should be in place, and other important public needs or objectives should be met. Over the long-term, redevelopment in those sensitive areas already impacted by development should enhance the underlying natural areas.

- Sea levels are rising in the Chesapeake Bay region as described in Section 3 of this report. In areas prone to severe flooding, today's capital facility planning and development must recognize the need to locate investments where they will be secure from flooding decades into the future.

- Flooding impacts the lives and living standards of people. Flooding prevents people from getting to work on time or from attending religious services, for example. Regular flooding reduces the imperative to invest in property upkeep and affects business investment. Flooding and poor drainage cause structural damage to buildings. Dampness in the walls and foundations of buildings create unhealthy living conditions.

- Combining redevelopment and ecological restoration means rebuilding upon the City's historic settlement pattern while repairing past resource damage and improving the functions of the underlying natural systems.

Objectives

- The remaining natural environmental features and sensitive areas, and the key roles each play in sustaining life and property in and around Crisfield, are protected from development and its impacts.
- A community of landscaped and natural spaces is developed over time, which knits together Crisfield as it grows.
- Gradually, key natural functions of the floodplain reemerge as land is thoughtfully redeveloped.
- Overall time, the total amount of impervious surface area within the existing borders of Crisfield is reduced.
- Through thoughtful redevelopment and an improvement in flooding conditions, an overall improvement in living standards is attained.

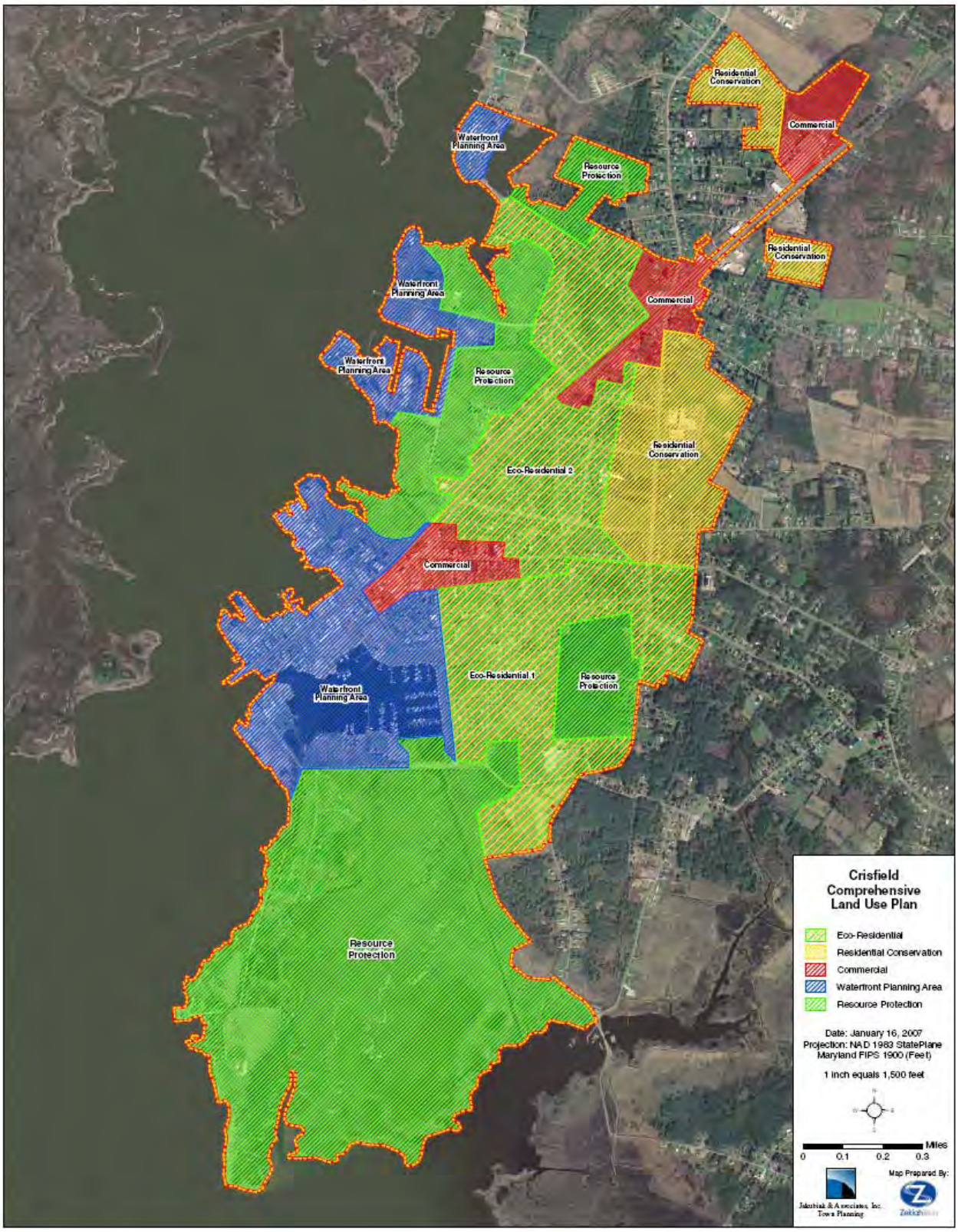
Policies

1. The Comprehensive Land Use Map and the Land Use / Natural Area Compatibility Chart will guide land use decision-making. The land use categories shown on the map are summarized in the table below and described in more detail in policy no. 2.

Summary of Land Use Plan Categories: Crisfield Comprehensive Plan

Resource Protection		
Primary Emphasis	Character and Purpose	Primary Example Uses
Environmental protection and conservation	Protect natural resources, promote recreational opportunities	Nature preserve, parkland, trails recreational trails, institutions, open space.
Eco-Residential Neighborhood 1		
Primary Emphasis	Character and Purpose	Primary Example Uses
Equal emphasis on residential rehabilitation and environmental restoration	Promote and safeguard residential setting protected from environment hazard while promoting reemergence of natural resource functions. No net increase in development density.	Multiple housing types, institutions, recreation, nature preserve, open space.
Eco-Residential 2		
Primary Emphasis	Character and Purpose	Primary Example Uses
Residential rehabilitation, infill, and environmental restoration, neighborhood commercial acceptable	Promote and safeguard residential setting. Promote Infill on vacant lots. No net increase in density (except through single-family infill).	Single-family housing, institutions, low impact commercial uses, open space.
Residential Conservation		
Primary Emphasis	Character and Purpose	Primary Example Uses
Residential conservation and infill.	Promote residential and institutional setting. Infill on vacant lots.	Predominately single-family residential types, institutions.

Commercial and Employment		
Primary Emphasis	Character and Purpose	Primary Example Uses
Shopping, working.	Development and/or revitalization of commercial and employment uses.	Retail, office, light industrial, residential above commercial
Waterfront Planning Area		
Primary Emphasis	Character and Purpose	Primary Example Uses
Working, recreation, tourism related.	Economic development, revitalization, economic restructuring.	Water-dependent uses, water-related uses, public recreation, resource preservation.


Residential Conservation
Commercial
Waterfront Planning Area
Resource Protection
Residential Conservation
Waterfront Planning Area
Commercial
Waterfront Planning Area
Resource Protection
Residential Conservation
Eco-Residential 2
Commercial
Eco-Residential 1
Resource Protection
Waterfront Planning Area
Resource Protection
Crisfield Comprehensive Land Use Plan
Eco-Residential
Residential Conservation
Commercial
Waterfront Planning Area
Resource Protection
Date: January 16, 2007
Projection: NAD 1983 StatePlane Maryland FIPS 1900 (Feet)
1 inch equals 1,500 feet
Miles
0 0.1 0.2 0.3
Map Prepared By:
Jakubiak & Associates, Inc. Town Planning

Land Use / Natural Area Compatibility

Land Use	Primary Sensitive Area (See Crisfield Elevation Map): 0-2 feet above sea level	2.1 to 3 feet above sea level	3.1+ feet above sea level	Remaining Natural Shoreline	Tidal Marsh / Non-Tidal Wetlands	Remaining Intact Woodlands
Waterfront Planning Area						
Conservation of Existing Development						
Water-dependent uses	●	●	●	-		-
Non-water dependent uses	○	◐	●	-	○	-
New Development / Redevelopment						
Water-dependent uses	●	●	●	○	○	-
Non-water dependent uses	○	○	◐	○	○	-
Recreation						
Active (involves some land development)	◐	●	●	○	○	-
Passive	●	●	●	●	●	-
Resource Conservation	●	●	●	●	●	-
Outside of Waterfront Planning Area						
Conservation of Existing Development						
Neighborhood Conservation	○	◐	●	-	-	-
Neighborhood Infill (Limited to Vacant Lots)	○	◐	●	-	-	-
Commercial Revitalization	○	○	●	-	-	-
New Development / Redevelopment						
Residential, Neighborhood Redevelopment	○	◐	●	○	○	○
New Urban Development (non-residential)	○	◐	●	○	○	○
Recreation						
Active (involves some land development)	◐	●	●	○	○	○
Passive	●	●	●	◐	◐	●
Resource Conservation	●	●	●	●	●	●

Key

○ Incompatible

◐ Limited Compatibility

● Full Compatibility

2. The basis purpose of each land use designation on the Comprehensive Plan Use Plan Map is described below.

Resource Preservation

Lands designated as resource preservation should be off-limits to development and protected from development impacts.

Eco Residential-1

The Eco Residential-1 category encompasses parts of the City prone to severe and regular flooding. The designation recognizes that these land areas are vulnerable to regular flooding and the storm surge associated with major storm events, that the natural condition of this area was tidal marsh, that the underlying soils and hydrological conditions are not well suited to intense urban uses, that wetlands and drainage channels are present but artificially isolated from surrounding tidal marshland, and that streets which could serve as evacuation or rescue routes are inundated by flood waters during storm events.

Redevelopment for residential use in the Eco Residential-1 areas is acceptable but only if it restores natural functions and open spaces, links isolated wetlands and natural areas together to provide flood protection and aesthetic benefits, improves infrastructure to benefit living conditions; and provides a broad mix of housing across the affordability range. Redevelopment should not increase overall development density or the footprint of development.

Eco Residential-2

The area designated Eco Residential-2 is also vulnerable to both major storm events and regular flooding. Infill, increased housing/zoning code enforcement, and rehabilitation of houses are preferred means of redevelopment.

A similar focus on environmental management is warranted and both natural and structural improvements to mitigate flooding should be identified and implemented. Again, because of the area is vulnerable to flooding, no net increase in development density should occur, except through infill on vacant single-family residential parcels.

Residential Conservation

Land areas with the Residential Conservation designation are located at relatively higher elevations above sea level primarily on the ridge that runs along Somerset Avenue (see the Crisfield Elevation Map in Section 2). While the bulk of this area is also in the 100-year flood plain, because of its higher elevation and position in-land, it is more apt to be protected by severe storm surges (see Storm Surge Threat Map in Section 2). The area is developed largely in a low-density pattern with ample open space and institutional uses.

Commercial/Employment

Lands designated Commercial / Employment include both the central business district and the commercial area located near the intersection of Somerset Avenue and MD Route 413. Modest expansion of land devoted to commercial use near the intersection of MD Route 413 and Somerset Avenue is acceptable. Both areas should allow for a mix of residential and commercial uses.

Waterfront Planning Area

This designation recognizes that this area is a unique resource to Crisfield, that the land use changes that have occurred and are occurring present challenges to compatibility in land use, architectural design and resource conservation. The waterfront planning area should be the subject of detailed planning and urban and environmental design.

3. The following are the recommended elements of the waterfront plan:

   A. A land use component showing the land use category for each parcel.

   B. Recreational element that provides for broad public access to and public parklands along the waterfront, including a public walkway plan.

   C. A cohesive set of architectural design standards for new buildings.

   D. The identification and preservation of scenic vistas.

   E. Design of standards for stormwater management, shoreline erosion, and flood control.

   F. A plan for linking the marina into the central business district and heart of the downtown area.

   G. A plan for the marina area, which should contain recommendations for broad public access to and throughout the site.

Decisions regarding the appropriate land use and redevelopment of the waterfront area could impede the progress of a waterfront plan. Therefore, this Comprehensive Plan sets forth the City's principal polices regarding the Waterfront Planning Area:

   A. The shoreline is a public resource and it should be managed to benefit the greatest number of people in the best way possible. Extensive and coordinated physical and visual access to the water's edge for the public should be attained.

   B. The Waterfront Planning Area has long been a working waterfront and is now also recognized as a catalyst for economic development and urban revitalization in Crisfield.

   C. The plan should establish a comprehensive shoreline access strategy to coordinate physical and visual public access.

   D. Water dependent uses—uses that could not exist except on the water--such as commercial fishing, some seafood processing, boat yards, ferry terminals, marinas, tug and barge companies, etc.--should be given the highest priority in locating and expanding. This recognizes that competition from other land uses has the effect of inflating land values to a point where such essential water dependent uses can become obsolete. These uses should be given full potential to capitalize on waterfront locations and should be protected from incompatible non-water-related uses, such as housing. By allowing non-water dependent uses on waterfront sites, the City loses the potential for uses that require a water access.

   E. Water related uses–those uses that benefit from a waterfront location, but are not dependent on it such as—resorts, restaurants, certain seafood processing and warehousing, should be permitted, but not necessarily directly on the shoreline.

   F. Suitable sites for developing non-water related uses, including housing, should be identified as part of the plan.

   G. No new residential development should be approved in the Waterfront Planning Area until the City adopts a waterfront plan. Upon completing the waterfront plan, the City should adopt specific zoning and design standards for the waterfront area.

4. In addition to any specific site planning, subdivision, and zoning requirements, the City Planning Commission should evaluate all redevelopment projects against the following ecological restoration criteria as part of its review:

   - Has an acceptable floodwater impact study been conducted to measure the extent of flooding under pre and post-development conditions?

   - Does the project advance best management principles in the non-structural management of stormwater, as a first priority before the use of structural improvements.

   - How does the project respond to the underlying natural resource base and its functions? Does the project provide for the reemergence of natural flood attenuation areas, for example?

   - To what extent does the project reduce impervious surface area over pre-existing conditions and include the planting of native vegetation.

   - Is the project accessible by at least one evacuation route in the event of major flooding (see Section 4.3 Action 1)? Are all structures built to the highest standards of flood protection?

   - To what extent does the project contribute to citywide infrastructure and ecological restoration improvements aimed at mitigating flooding. Does the project contribute funding to offset the impact of development in the floodplain?

   - Does the project conform to the Land Use / Natural Area Compatibility Chart and Generalized Land Use Plan Map.

5. Every development or redevelopment project within the floodplain should reduce impervious surface area over pre-existing conditions.

6. All remaining natural shorelines will be protected from the impacts of development.

7. The City will follow a policy of ecological restoration through redevelopment. All new development will contribute funds to offset their impact and hence protect the community from flooding. Projects will include: marshland and wetland restoration, improved floodgates, shoreline repair, and the design, construction and planting of wetland mitigation and flood conveyance corridors.

8. Future development will occur primarily through the expansion of the City northeastward. Lands shown to be inundated by the storm surge of a Category 1 hurricane (see Storm Surge Threat Map in Section 2) should not be put to an urban use. Instead, they should be used only for very low density uses, agriculture, or resource conservation.

Actions

1. Use the Town Zoning Ordinance and Subdivision Regulations to ensure that, where possible, development and its impacts avoid sensitive areas, including the submerged aquatic vegetation.

2. Review site plans for proposed development projects to ensure that all reasonable measures are taken to protect sensitive areas both during and after development.

3. In redeveloping waterfront areas, to the extent possible, establish buffer areas between the water’s edge and buildings or parking. Plant the buffer areas in native vegetation to improve water quality and scenic beauty.

4. Seek land conservation and protection easements over tidal marshes and natural areas located roughly between Seventh Street and Lori Quinn Drive.

5. On lands planned for residential development, cluster new home sites on the least environmentally sensitive areas. When clustering, rely on the overall dwelling unit density rather than rigid minimum lot sizes to determine the number of homes that may be built. It is possible under this approach to reduce individual lots sizes and thereby avoid unnecessary impacts to natural resource areas. This flexibility should be used in preserving woodland areas, flood prone areas, drainage ways, scenic vistas, etc.

6. Institute a native species-planting program aimed at substantially increasing land area with vegetative cover. Use the State's forest conservation fee-in-lieu funds to meet planting goals.

7. Establish a per-capita public green open space goal and seek to achieve the goal though land acquisition, developer contributions, and cooperation with state agencies of government.

8. Consider creating a shoreline protection district wherein those properties that would directly benefit from creating and maintaining shoreline erosion and flood control improvements would contribute to the cost of those improvements.

9. Eliminate the R-4 zoning district from the Zoning Ordinance and bring the zoning map and ordinance into compliance with the Comprehensive Generalized Land Use Map.

4. 2 REDEVELOPMENT CONSISTENT WITH COMMUNITY CHARACTER

As redevelopment occurs, Crisfield will benefit from pursuing thoughtful infill and revitalization strategies that respect community character: the traditional layout of neighborhoods and streets, scenic vistas, local building styles, and regional vernacular architecture.

Background

The Zoning Ordinance permits a level of land use and architectural incompatibility that is changing the character of historic maritime areas. In the waterfront area, high-density residential uses, which are now permitted, by special exception, in the Tourist Maritime district are incompatible with a working waterfront. The size, scale and positioning of the buildings has reduced visual access to the water, the potential for public physical access along the water, and defined a new skyline for the City. A strong demand for vacation homes or second homes in the region may continue to make Crisfield a center of development. Much of this development will take the form of redevelopment or infill—that is, the use or reuse of vacant or underutilized parcels of land.

Guiding Principles

- Infill development and/or redevelopment can occur in a manner that respects the size, scale, and use of existing and historic development patterns. Successful infill maintains and/or restores spatial continuity to streetscapes; strengthens neighborhoods; respects historic preservation, existing vistas, and natural resources; and introduces compatible uses that complement existing community attributes and needs.

- Growing in balance with community character for Crisfield means accommodating new development opportunities in a way that reinforces the small town maritime character.

Objectives

- High standards of design and aesthetics guide property development and redevelopment within Crisfield.

- The major vistas remain open and available for future generations to enjoy.

South Carolina Beachfront Management Act

Appendix 3

Section 145
Climate Change and Sea Level Rise

A. Definitions

1. Climate is the long-term weather average observed within a geographic region, and climate change refers to fluctuations in the Earth's climate system as a result of both natural and anthropogenic causes. Currently the long term climate change trend is evidenced by rising global temperatures; increasing extremes within the hydrologic cycle resulting in more frequent floods and droughts; and rising sea level.

2. Sea level rise refers to the change in mean sea level over time in response to global climate and local tectonic changes. Sea level is the height of the sea with respect to a horizontal control point, or benchmark (e.g., The National Geodetic Vertical Datum of 1929 or NGVD 29; The North American Vertical Datum of 1988 or NAVD 88).

3. Vertical datums are either fixed benchmarks such as NGDV 29 and NAVD 88 or site specific tidal datums such as mean high water, mean low water and mean sea level. NGVD 29 is based on the local mean sea level in 1929, which has changed over time. NAVD 88 is now the official civilian vertical datum for surveying and mapping activities in the United States. The conversion to NAVD 88 should be accomplished on a project-by-project basis. Tidal datums, such as mean sea level (MSL) or mean high water (MHW) vary according to the specific location, and represent the mean heights observed over the National Tidal Datum Epoch. Conversions between the datums can be made at www.tidesandcurrents.noaa.gov or calculated through the US Army Corps of Engineers CORPSCON, http://crunch.tec.army.mil/software/corpscon/corpscon.html.

4. Sea level rise includes *eustatic* contributions - global changes responsible for worldwide variations in sea level (e.g., thermal expansion of seawater, melting glacial ice sheets), and *isostatic* effects - regional changes in land surface elevations that are related to the tectonic response to ice or sediment loading, and land subsidence due to extraction of water or oil. The combination of eustatic and isostatic effects at a particular location is known as relative sea level rise.

B. Findings

1. On very long (geologic) time scales, sea level naturally fluctuates in response to variations in astronomical configurations that cause changes in the Earth's climate system. Since the Last Glacial Maximum (approximately 20,000 years ago), global sea level has risen by over 390 feet (120 meters), as water that was previously trapped in continental ice sheets has made its way into the global ocean.

2. Sea level rise is a direct consequence of global climate change. Greenhouse gas emissions to the atmosphere increase surface warming, which in turn increases the volume of ocean waters due to thermal expansion, and accelerates the melting of glacial ice. Atmospheric greenhouse gas concentrations are already higher than levels at the last interglacial period, when sea levels were 13 to 19 feet (4 to 6 meters) higher than at present (Overpeck et al., 2006). Greenhouse gas concentrations are expected to continue to increase through 2100.

3. Human activities and increased concentrations of greenhouse gasses in the atmosphere have *accelerated* the historic rate of eustatic sea level rise. Over the last 100 years, sea levels have risen 0.56 feet (0.17 m) globally. The average rate of rise during the years between 1961 and 2003 was 0.071 inches per year (1.8 mm/yr), and between 1993 and 2003 the rate nearly doubled to 0.12 inches per year (3.1 mm/yr) (IPCC, 2007).

4. In addition to rising global sea levels, the land surface in Rhode Island is subsiding at a rate of approximately 6 inches (15 cm) per century (Douglas, 1991). The combination of these two effects is evident from the long-term trend recorded by the Newport tide gauge (Figure 1), which indicates a rate of 10.1 in +/- 1.2 in (25.7 cm +/- 3.1 cm) of relative sea level rise over the last century.

5. The rate of sea level rise is accelerating. Future sea level rise, like the recent rise, is not expected to be globally uniform or linear. Some regions will become more substantially inundated than the global average, and others less. Of foremost concern is the trend in eustatic rise as observed from tide-gauge records over the past century. The rate of rise during the past 20 years is 25% faster than the rate of rise in any 20 year period that exists in the instrumental record (Church and White, 2006; Rahmstorf et al., 2007).

6. Model-simulated projections of global sea level over the 21st century also clearly demonstrate accelerated progression. Predictions have ranged from 4 inches (10 cm) to several feet above current levels by the year 2100. As a rule, sea level estimates are increasing as the science of modeling becomes more developed.

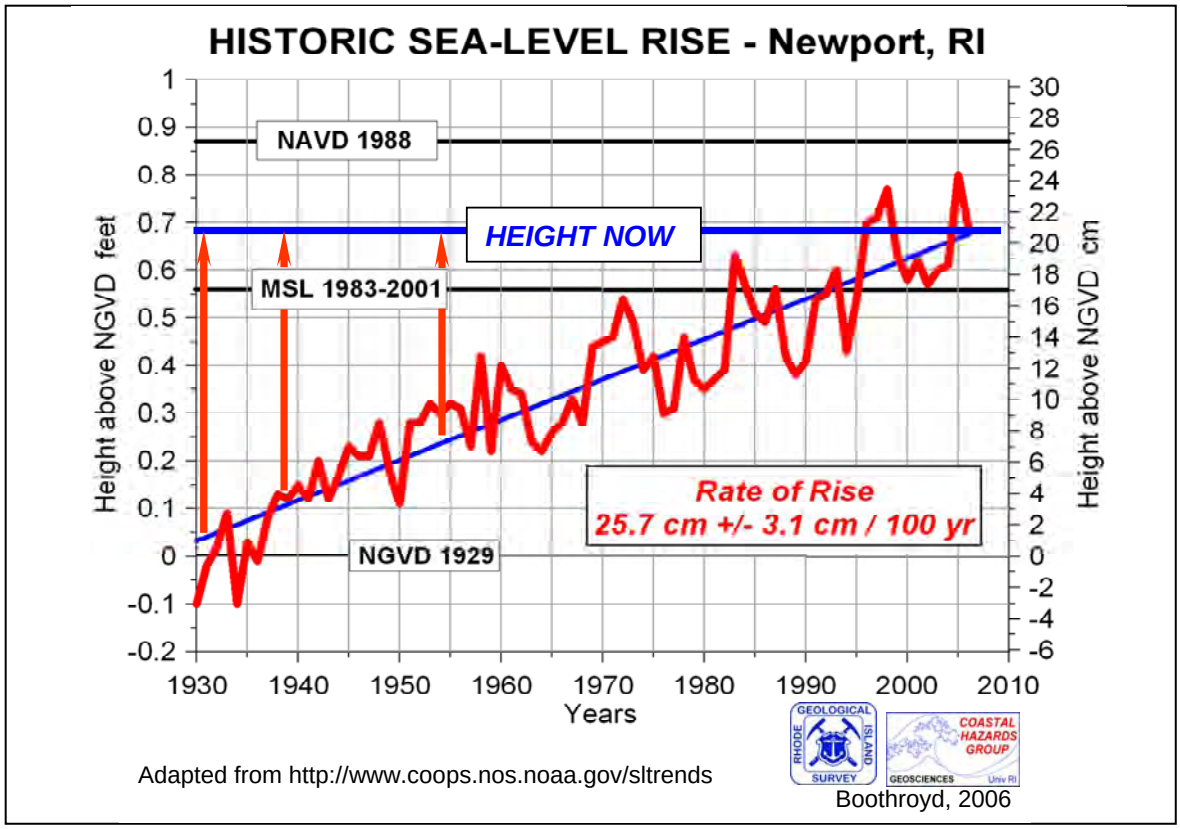


Figure 1 – Historic Sea Level Rise in Newport, RI shows an increase of approximately 0.64 feet between 1930 and 2006

7. When compared with actual observations, modeling scenarios can be quite conservative, as recently observed rates of continental ice melt are greater than those used to generate estimates of sea level rise over the coming century. Since 1990, sea level has been rising faster than the rate predicted by models used to generate IPCC (2001) estimates (Rahmstorf et al., 2007).

8. Higher global temperatures indicate a greater risk of destabilizing the Greenland and West Antarctic ice sheets, yet a great amount of uncertainty remains as to the overall contribution from ice sheet melting. The recent and much publicized Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007) projects 7 to 23 in (18 to 59 cm) of eustatic sea level rise in the coming century. These estimates do not include contributions of ice flow dynamics or local subsidence.

9. The most recent science (Rahmstorf, 2007) correlates global sea level rise to global mean surface temperature, which is a good approximation for observations of the 20th century. When this relationship is applied to 21st century warming scenarios, eustatic rise is projected between 1.6 to 4.6 feet (50 to 40 cm) above 1990 levels. Accounting for regional isostatic effects, this estimate suggests that by 2100 sea level in Rhode Island could rise approximately 2 to 5 feet (65 to 155 cm).

10. Climate change will result in wide scale systematic changes in the terrestrial and marine environments. These changes will result in ecosystem shifts that will challenge natural resource managers' efforts to cope and adapt to the new regime.

11. Future increases in relative sea level will displace coastal populations, threaten infrastructure, intensify coastal flooding and ultimately lead to the loss of recreation areas, public space, and coastal wetlands.

12. Coastal infrastructure will become increasingly susceptible to complications from rising sea levels, as the upward trend continues. Residential and commercial structures, roads, and bridges will be more prone to flooding. Sea level rise will also reduce the effectiveness and integrity of existing seawalls and revetments, designed for historically lower water levels.

13. Higher sea levels will result in changes in surface water and groundwater characteristics. Salt intrusion into aquifers will contaminate drinking water supplies and higher water tables will compromise wastewater treatment systems in the coastal zone.

14. Future increase in relative sea level will increase the extent of flood damage over time. Lower elevations will become increasingly susceptible to flooding as storm surge reaches further inland due to both sea level rise in concert with a probable increase in the frequency and intensity of storms predicted from climate change. As a result, more coastal lands will be susceptible to erosion.

15. At historic rates of sea level rise, the relative surface elevation of a salt marsh is maintained through the process of accretion (the build-up of live and decaying plant parts and inorganic sediments). Yet, at high rates of relative sea level rise as predicted by Ramstorf (2007), accretive processes in coastal wetlands cannot keep pace. These habitats can become submerged, resulting in a loss of salt marsh vegetation and an alteration of habitat types. This has been demonstrated by the rapid salt marsh loss in coastal Louisiana. As salt marshes and other coastal habitats become submerged, they migrate inland. However, coastal development has decreased the amount of upland open space adjacent to these habitats, limiting their ability to migrate landward. Thus, an increase in the rate of relative sea level rise will likely result in significant losses of coastal habitat.

16. The average annual temperature of southern New England coastal waters, including Narragansett Bay, has risen approximately two (2) degrees Fahrenheit since the 1960's. This warming trend is implicated in the change of species composition and abundance in Narragansett Bay waters (Nixon, et al., 2003).

17. Increased water temperatures due to climate change will work synergistically with high nutrient levels to stress eelgrass beds. Eelgrass grows best in cool, clean waters. Even as nutrient levels in the Bay are reduced from wastewater treatment plants, if Bay and coastal waters continue to warm due to climate change, it will adversely impact eelgrass beds (Bintz, et al., 2003).

18. Barrier islands are forced landward with rising sea levels. Increased frontal erosion and retreat of the barriers will cause Rhode Island's south shore to migrate continuously landward with rising sea levels.

19. Due to the timescales associated with climate processes and feedbacks, anthropogenic warming and sea level rise will continue for centuries regardless of steps taken to curb greenhouse gas emissions (IPCC, 2007).

20. Pursuant to R.I.G.L. § 46-23-6, the Council is authorized to develop and adopt policies and regulations necessary to manage the coastal resources of the state and protect life and property from coastal hazards resulting from projected sea level rise and probable increased frequency and intensity of coastal storms due to climate change. The Council is also authorized to collaborate with the State Building Commissioner and adopt freeboard calculations (a factor of added safety above the anticipated flood level), in accordance with R.I.G.L. § 23-27.3-100.1.5.5.

C. Policies

1. The Council will review its policies, plans and regulations to proactively plan for and adapt to climate change and sea level rise. The Council will integrate climate change and sea level rise scenarios into its operations to prepare Rhode Island for these new, evolving conditions and make our coastal areas more resilient.

2. The Council's sea level rise policies are based upon the CRMC's legislative mandate to preserve, protect, and where possible, restore the coastal resources of the state through comprehensive and coordinated long-range planning.

3. The Council recognizes that sea level rise is ongoing and its foremost concern is the accelerated rate of rise and the associated risks to Rhode Island coastal areas today and in the future. Accordingly, for planning and management purposes, it is the Council's policy to accommodate a base rate of expected 3 to 5 foot rise in sea level by 2100 in the siting, design, and implementation of public and private coastal activities and to insure proactive stewardship of coastal ecosystems under these changing conditions. It should be noted that the 3-5 ft. rate of sea level rise assumption embedded in this policy is relatively narrow and low. The Council recognizes that the lower the sea level rise estimate used, the greater the risk that policies and efforts to adapt sea level rise and climate change will prove to be inadequate. Therefore, the policies of the Council may take into account different risk tolerances for differing types of public and private coastal activities. In addition, this long term sea level change base rate will be revisited by the Council periodically to address new scientific evidence.

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Climate Change and Sea Level Rise Policy from the Rhode Island Coastal Resource Management Program

Appendix 4

Beachfront Management Act from the S.C. Code of Laws

Title 48 - Environmental Protection and Conservation

CHAPTER 39.

COASTAL TIDELANDS AND WETLANDS

SECTION 48-39-250. Legislative findings regarding the coastal beach/dune system.

The General Assembly finds that:

(1) The beach/dune system along the coast of South Carolina is extremely important to the people of this State and serves the following functions:

(a) protects life and property by serving as a storm barrier which dissipates wave energy and contributes to shoreline stability in an economical and effective manner;

(b) provides the basis for a tourism industry that generates approximately two-thirds of South Carolina's annual tourism industry revenue which constitutes a significant portion of the state's economy. The tourists who come to the South Carolina coast to enjoy the ocean and dry sand beach contribute significantly to state and local tax revenues;

(c) provides habitat for numerous species of plants and animals, several of which are threatened or endangered. Waters adjacent to the beach/dune system also provide habitat for many other marine species;

(d) provides a natural healthy environment for the citizens of South Carolina to spend leisure time which serves their physical and mental well-being.

(2) Beach/dune system vegetation is unique and extremely important to the vitality and preservation of the system.

(3) Many miles of South Carolina's beaches have been identified as critically eroding.

(4) Chapter 39 of Title 48, Coastal Tidelands and Wetlands, prior to 1988, did not provide adequate jurisdiction to the South Carolina Coastal Council to enable it to effectively protect the integrity of the beach/dune system.

Consequently, without adequate controls, development unwisely has been sited too close to the system. This type of development has jeopardized the stability of the beach/dune system, accelerated erosion, and endangered adjacent property. It is in both the public and private interests to protect the system from this unwise development.

(5) The use of armoring in the form of hard erosion control devices such as seawalls, bulkheads, and rip-rap to protect erosion-threatened structures adjacent to the beach has not proven effective. These armoring devices have given a false sense of security to beachfront property owners. In reality, these hard structures, in many instances, have increased the vulnerability of beachfront property to damage from wind and waves while contributing to the deterioration and loss of the dry sand beach which is so important to the tourism industry.

(6) Erosion is a natural process which becomes a significant problem for man only when structures are erected in close proximity to the beach/dune system. It is in both the public and private interests to afford the beach/dune system space to accrete and erode in its natural cycle. This space can be provided only by discouraging new construction in close proximity to the beach/dune system and encouraging those who have erected structures too close to the system to retreat from it.

(7) Inlet and harbor management practices, including the construction of jetties which have not been designed to accommodate the longshore transport of sand, may deprive downdrift beach/dune systems of their natural sand supply. Dredging practices which include disposal of beach quality sand at sea also may deprive the beach/dune system of much-needed sand.

(8) It is in the state's best interest to protect and to promote increased public access to South Carolina's beaches for out-of-state tourists and South Carolina residents alike.

(9) Present funding for the protection, management, and enhancement of the beach/dune system is inadequate.

(10) There is no coordinated state policy for post-storm emergency management of the beach/dune system.

(11) A long-range comprehensive beach management plan is needed for the entire coast of South Carolina to protect and manage effectively the beach/dune system, thus preventing unwise development and minimizing man's adverse impact on the system.

SECTION 48-39-260. Policy statement.

In recognition of its stewardship responsibilities, the policy of South Carolina is to:

(1) protect, preserve, restore, and enhance the beach/dune system, the highest and best uses of which are declared to provide:

(a) protection of life and property by acting as a buffer from high tides, storm surge, hurricanes, and normal erosion;

(b) a source for the preservation of dry sand beaches which provide recreation and a major source of state and local business revenue;

(c) an environment which harbors natural beauty and enhances the well-being of the citizens of this State and its visitors;

(d) natural habitat for indigenous flora and fauna including endangered species;

(2) create a comprehensive, long-range beach management plan and require local comprehensive beach management plans for the protection, preservation, restoration, and enhancement of the beach/dune system. These plans must promote wise use of the state's beachfront to include a gradual retreat from the system over a forty-year period;

(3) severely restrict the use of hard erosion control devices to armor the beach/dune system and to encourage the replacement of hard erosion control devices with soft technologies as approved by the department which will provide for the protection of the shoreline without long-term adverse effects;

(4) encourage the use of erosion-inhibiting techniques which do not adversely impact the long-term well-being of the beach/dune system;

(5) promote carefully planned nourishment as a means of beach preservation and restoration where economically feasible;

(6) preserve existing public access and promote the enhancement of public access to assure full enjoyment of the beach by all our citizens including the handicapped and encourage the purchase of lands adjacent to the Atlantic Ocean to enhance public access;

(7) involve local governments in long-range comprehensive planning and management of the beach/dune system in which they have a vested interest;

(8) establish procedures and guidelines for the emergency management of the beach/dune system following a significant storm event.

SECTION 48-39-270. Definitions.

As used in this chapter:

(1) Erosion control structures or devices include:

(a) seawall: a special type of retaining wall that is designed specifically to withstand normal wave forces;

(b) bulkhead: a retaining wall designed to retain fill material but not to withstand wave forces on an exposed shoreline;

(c) revetment: a sloping structure built along an escarpment or in front of a bulkhead to protect the shoreline or bulkhead from erosion.

(2) Habitable structure means a structure suitable for human habitation including, but not limited to, single or multifamily residences, hotels, condominium buildings, and buildings for commercial purposes. Each building of a condominium regime is considered a separate habitable structure but, if a building is divided into apartments, then the entire building, not the individual apartment, is considered a single habitable structure. Additionally, a habitable structure includes porches, gazebos, and other attached improvements.

(3) Department means the Department of Health and Environmental Control.

(4) Beach nourishment means the artificial establishment and periodic renourishment of a beach with sand that is compatible with the existing beach in a way so as to create a dry sand beach at all stages of the tide.

(5) The beach/dune system includes all land from the mean highwater mark of the Atlantic Ocean landward to the setback line described in Section 48-39-280.

(6) A standard erosion zone is a segment of shoreline which is subject to essentially the same set of coastal processes, has a fairly constant range of profiles and sediment characteristics, and is not influenced directly by tidal inlets or associated inlet shoals.

(7) An inlet erosion zone is a segment of shoreline along or adjacent to tidal inlets which is influenced directly by the inlet and its associated shoals.

(8) Master plan means a document or a map prepared by a developer or a city as a policy guide to decisions about the physical development of the project or community.

(9) Planned development means a development plan which has received local approval for a specified number of dwelling and other units. The siting and size of structures and amenities are specified or restricted within the approval. This term specifically references multifamily or commercial projects not otherwise referenced by the terms, master plan, or planned unit development.

(10) Planned unit development means a residential, commercial, or industrial development, or all three, designed as a unit and approved by local government.

(11) Destroyed beyond repair means that more than sixty-six and two-thirds percent of the replacement value of the habitable structure or pool has been destroyed. If the owner disagrees with the appraisal of the department, he may obtain an appraisal to evaluate the damage to the building or pool. If the appraisals differ, then the two appraisers must select a third appraiser. If the two appraisers are unable to select a third appraiser, the clerk of court of the county where the structure lies must make the selection. Nothing in this section prevents a court of competent jurisdiction from reviewing, de novo, the appraisal upon the petition of the property owner.

(12) Pool is a structure designed and used for swimming and wading.

(13) Active beach is that area seaward of the escarpment or the first line of stable natural vegetation, whichever first occurs, measured from the ocean.

SECTION 48-39-280. Forty-year retreat policy.

(A) A forty-year policy of retreat from the shoreline is established. The department must implement this policy and must utilize the best available scientific and historical data in the implementation. The department must establish a baseline which parallels the shoreline for each standard erosion zone and each inlet erosion zone.

(1) The baseline for each standard erosion zone is established at the location of the crest of the primary oceanfront sand dune in that zone. In standard erosion zones in which the shoreline has been altered naturally or artificially by the construction of erosion control devices, groins, or other manmade alterations, the baseline must be established by the department using the best scientific and historical data, as where the crest of the primary oceanfront sand dunes for that zone would be located if the shoreline had not been altered.

(2) The baseline for inlet erosion zones that are not stabilized by jetties, terminal groins, or other structures must be determined by the department as the most landward point of erosion at any time during the past forty years, unless the best available scientific and historical data of the inlet and adjacent beaches indicate that the shoreline is unlikely to return to its former position. In collecting and utilizing the best scientific and historical data available for the implementation of the retreat policy, the department, as part of the State Comprehensive Beach Management Plan provided for in this chapter, among other factors, must consider: historical inlet migration, inlet stability, channel and ebb tidal delta changes, the effects of sediment bypassing on shorelines adjacent to the inlets, and the effects of nearby beach restoration projects on inlet sediment budgets.

(3) The baseline within inlet erosion zones that are stabilized by jetties, terminal groins, or other structures must be determined in the same manner as provided for in item (1). However, the actual location of the crest of the primary oceanfront sand dunes of that erosion zone is the baseline of that zone, not the location if the inlet had remained unstabilized.

(4) Notwithstanding any other provision of this section, where a department-approved beach nourishment project has been completed, the local government or the landowners, with notice to the local government, may petition an administrative law judge to move the baseline as far seaward as the landward edge of the erosion control structure or device or, if there is no existing erosion control structure or device, then as far seaward as the post project baseline as determined by the department in accordance with Section 48-39-280(A)(1) by showing that the beach has been stabilized by department-approved beach nourishment. If the petitioner is asking that the baseline be moved seaward pursuant to this section, he must show an ongoing commitment to renourishment which will stabilize and maintain the dry sand beach at all stages of the tide for the foreseeable future. If the administrative law judge grants the petition to move the baseline seaward pursuant to this section, no new construction may occur in the area between the former baseline and the

new baseline for three years after the initial beach nourishment project has been completed as determined by the department. If the beach nourishment fails to stabilize the beach after a reasonable period of time, the department must move the baseline landward to the primary oceanfront sand dune as determined pursuant to items (1), (2), and (3) for that section of the beach. Any appeal of an administrative law judge's decision under this section may be made pursuant to Title 23 of Chapter 1.

(B) To implement the retreat policy provided for in subsection (A), a setback line must be established landward of the baseline a distance which is forty times the average annual erosion rate or not less than twenty feet from the baseline for each erosion zone based upon the best historical and scientific data adopted by the department as a part of the State Comprehensive Beach Management Plan.

(C) The department, before July 3, 1991, must establish a final baseline and setback line for each erosion zone based on the best available scientific and historical data as provided in subsection (B) and with consideration of public input. The baseline and setback line must not be revised before July 1, 1998, nor later than July 1, 2000. After that revision, the baseline and setback line must be revised not less than every eight years but not more than every ten years after each preceding revision. In the establishment and revision of the baseline and setback line, the department must transmit and otherwise make readily available to the public all information upon which its decisions are based for the establishment of the final baseline and setback line. The department must hold one public hearing before establishing the final baseline and setback lines. Until the department establishes new baselines and setback lines, the existing baselines and setback lines must be used. The department may stagger the revision of the baselines and setback lines of the erosion zones so long as every zone is revised in accordance with the time guidelines established in this section.

(D) In order to locate the baseline and the setback line, the department must establish monumented and controlled survey points in each county fronting the Atlantic Ocean. The department must acquire sufficient surveyed topographical information on which to locate the baseline. Surveyed topographical data typically must be gathered at two thousand foot intervals. However, in areas subject to significant near-term development and in areas currently developed, the interval, at the discretion of the department, may be more frequent. The resulting surveys must locate the crest of the primary oceanfront sand dunes to be used as the baseline for computing the forty-year erosion rate. In cases where no primary oceanfront sand dunes exist, a study conducted by the department is required to determine where the upland location of the crest of the primary oceanfront sand dune would be located if the shoreline had not been altered. The department, by regulation, may exempt specifically described portions of the coastline from the survey requirements of this section when, in its judgment, the portions of coastline are not subject to erosion or are not likely to be developed by virtue of local, state, or federal programs in effect on the coastline which would preclude significant development, or both.

(E) A landowner claiming ownership of property affected who feels that the final or revised setback line, baseline, or erosion rate as adopted is in error, upon submittal

of substantiating evidence, must be granted a review of the setback line, baseline, or erosion rate, or a review of all three. The requests must be forwarded to the department board in accordance with Section 44-1-60 and the final decision of the board may be appealed to the Administrative Law Court as provided in Chapter 23 of Title 1.

SECTION 48-39-290. Restrictions on construction or reconstruction seaward of the baseline or between the baseline and the setback line; exceptions; special permits.

(A) No new construction or reconstruction is allowed seaward of the baseline except:

(1) wooden walkways no larger in width than six feet;

(2) small wooden decks no larger than one hundred forty-four square feet;

(3) fishing piers which are open to the public. Those fishing piers with their associated structures including, but not limited to, baitshops, restrooms, restaurants, and arcades which existed September 21, 1989, may be rebuilt if they are constructed to the same dimensions and utilized for the same purposes and remain open to the public. In addition, those fishing piers with their associated structures which existed on September 21, 1989, that were privately owned, privately maintained, and not open to the public on this date also may be rebuilt and used for the same purposes if they are constructed to the same dimensions;

(4) golf courses;

(5) normal landscaping;

(6) structures specifically permitted by special permit as provided in subsection (D);

(7) pools may be reconstructed if they are landward of an existing, functional erosion control structure or device;

(8) existing groins may be reconstructed, repaired, and maintained. New groins may only be allowed on beaches that have high erosion rates with erosion threatening existing development or public parks. In addition to these requirements, new groins may be constructed and existing groins may be reconstructed only in furtherance of an on-going beach renourishment effort which meets the criteria set forth in regulations promulgated by the department and in accordance with the following:

(a) The applicant shall institute a monitoring program for the life of the project to measure beach profiles along the groin area and adjacent and downdrift beach areas sufficient to determine erosion/accretion rates. For the first five years of the project, the monitoring program must include, but is not necessarily limited to:

(i) establishment of new monuments;

(ii) determination of the annual volume and transport of sand; and

(iii) annual aerial photographs.

Subsequent monitoring requirements must be based on results from the first five-year report.

(b) Groins may only be permitted after thorough analysis demonstrates that the groin will not cause a detrimental effect on adjacent or downdrift areas. The applicant shall provide a financially binding commitment, such as a performance bond or letter of credit that is reasonably estimated to cover the cost of reconstructing or removing the groin and/or restoring the affected beach through renourishment pursuant to subsection (c).

(c) If the monitoring program established pursuant to subsection (a) shows an increased erosion rate along adjacent or downdrift beaches that is attributable to a groin, the department must require either that the groin be reconfigured so that the erosion rate on the affected beach does not exceed the pre-construction rate, that the groin be removed, and/or that the beach adversely affected by the groin be restored through renourishment.

(d) Adjacent and downdrift communities and municipalities must be notified by the department of all applications for a groin project.

(e) Nothing in the section shall be construed to create a private cause of action, but nothing in this section shall be construed to limit a cause of action under recognized common law or other statutory theories. The sole remedies, pursuant to this section, are:

(i) the reconstruction or removal of a groin; and/or

(ii) restoration of the adversely affected beach and adjacent real estate through renourishment pursuant to subsection (c).

An adjacent or downdrift property owner that claims a groin has caused or is causing an adverse impact shall notify the department of such impact. The department shall render an initial determination within sixty (60) days of such notification. Final agency action shall be rendered within twelve months of notification. An aggrieved party may appeal the decision pursuant to the Administrative Procedures Act.

A permit must be obtained from the department for items (2) through (8).

(B) Construction, reconstruction, or alterations between the baseline and the setback line are governed as follows:

(1) Habitable structures:

(a) New habitable structures: If part of a new habitable structure is constructed seaward of the setback line, the owner must certify in writing to the department that the construction meets the following requirements:

(i) The habitable structure is no larger than five thousand square feet of heated space. The structure must be located as far landward on the property as practicable. A drawing must be submitted to the department showing a footprint of the structure on the property, a cross section of the structure, and the structure's relation to property lines and setback lines which may be in effect. No erosion control structure or device may be incorporated as an integral part of a habitable structure constructed pursuant to this section.

(ii) No part of the building is being constructed on the primary oceanfront sand dune or seaward of the baseline.

(b) Habitable structures which existed on the effective date of Act 634 of 1988 or constructed pursuant to this section:

(i) Normal maintenance and repair of habitable structures is allowed without notice to the department.

(ii) Additions to habitable structures are allowed if the additions together with the existing structure do not exceed five thousand square feet of heated space. Additions to habitable structures must comply with the conditions of new habitable structures as set forth in subitem (a).

(iii) Repair or renovation of habitable structures damaged, but not destroyed beyond repair, due to natural or manmade causes is allowed.

(iv) Replacement of habitable structures destroyed beyond repair due to natural causes is allowed after notification is provided by the owner to the department that all of the following requirements are met:

a. The total square footage of the replaced structure seaward of the setback line does not exceed the total square footage of the original structure seaward of the setback line. The linear footage of the replaced structure parallel to the coast does not exceed the original linear footage parallel to the coast.

b. The replaced structure is no farther seaward than the original structure.

c. Where possible, the replaced structure is moved landward of the setback line or, if not possible, then as far landward as is practicable, considering local zoning and parking regulations.

d. The reconstruction is not seaward of the baseline unless permitted elsewhere in Sections 48-39-250 through 48-39-360.

(v) Replacement of habitable structures destroyed beyond repair due to manmade causes is allowed provided the rebuilt structure is no larger than the original structure it replaces and is constructed as far landward as possible, but the new structure must not be farther seaward than the original structure.

(2) Erosion control devices:

(a) No new erosion control structures or devices are allowed seaward of the setback line except to protect a public highway which existed on the effective date of this act.

(b) Erosion control structures or devices which existed on the effective date of this act must not be repaired or replaced if destroyed:

(i) more than eighty percent above grade through June 30, 1995;

(ii) more than sixty-six and two-thirds percent above grade from July 1, 1995, through June 30, 2005;

(iii) more than fifty percent above grade after June 30, 2005.

(iv) Damage to seawalls and bulkheads must be judged on the percent of the structure remaining intact at the time of damage assessment. The portion of the structure or device above grade parallel to the shoreline must be evaluated. The length of the structure or device parallel to the shoreline still intact must be compared to the length of the structure or device parallel to the shoreline which has been destroyed. The length of the structure or device parallel to the shoreline determined to be destroyed divided by the total length of the original structure or device parallel to the shoreline yields the percent destroyed. Those portions of the structure or device standing, cracked or broken piles, whalers, and panels must be assessed on an individual basis to ascertain if these components are repairable or if replacement is required. Revetments must be judged on the extent of displacement of stone, effort required to return these stones to the prestorm event configuration of the structure or device, and ability of the revetment to retain backfill material at the time of damage assessment. If the property owner disagrees with the assessment of a registered professional engineer acting on behalf of the department, he may obtain an assessment by a registered professional engineer to evaluate, as set forth in this item, the damage to the structure or device. If the two assessments differ, then the two engineers who performed the assessments must select a registered professional engineer to perform the third assessment. If the first two engineers are unable to select an engineer to perform the third assessment, the clerk of court of the county where the structure or device lies must make the selection of a registered professional engineer. The determination of percentage of damage by the third engineer is conclusive.

(v) The determination of the degree of destruction must be made on a lot by lot basis by reference to county tax maps.

(vi) Erosion control structures or devices must not be enlarged, strengthened, or rebuilt but may be maintained in their present condition if not destroyed more than the percentage allowed in Section 48-39-290(B)(2)(b)(i), (ii), and (iii). Repairs must be made with materials similar to those of the structure or device being repaired.

(c) Erosion control structures or devices determined to be destroyed more than the percentage allowed in Section 48-39-290(B)(2)(b)(i), (ii), and (iii) must be removed at the owner's expense. Nothing in this section requires the removal of an erosion

control structure or a device protecting a public highway which existed on the effective date of Act 634 of 1988.

(d) The provisions of this section do not affect or modify the provisions of Section 48-39-120(C).

(e) Subitem (a) does not apply to a private island with an Atlantic Ocean shoreline of twenty thousand, two hundred ten feet of which twenty thousand, ninety feet of shoreline is revetted with existing erosion control devices and one hundred twenty feet of shoreline is not revetted with existing erosion control devices. Nothing contained in this subitem makes this island eligible for beach renourishment funds.

(3) Pools, as defined in Section 48-39-270(12):

(a) No new pools may be constructed seaward of the setback line unless the pool is built landward of an erosion control structure or device which was in existence or permitted on the effective date of this act and is built as far landward as practical.

(b) Normal maintenance and repair is allowed without notice to the department.

(c) If a pool, existing on July 1, 1988, is destroyed beyond repair, as determined by the department pursuant to Section 48-39-270(11), it may be replaced if the owner certifies in writing to the department that:

(i) It is moved as far landward as practical. This determination of practicality must include the consideration of local zoning requirements.

(ii) It is rebuilt no larger than the destroyed pool.

(iii) It is constructed according to acceptable standards of pool construction and cannot be reinforced in a manner so as to act as an erosion control structure or device.

(d) If a pool is not destroyed beyond repair as determined by the department pursuant to Section 48-39-270(11) but the owner wishes to replace it, the owner may do so if:

(i) The dimensions of the pool are not enlarged.

(ii) The construction conforms to sub-subitem (iii) of subitem (c).

(4) All other construction or alteration between the baseline and the setback line requires a department permit. However, the department, in its discretion, may issue general permits for construction or alterations where issuance of the general permits would advance the implementation and accomplishment of the goals and purposes of Sections 48-39-250 through 48-39-360.

(C)(1) Notwithstanding the provisions relating to new construction, a person, partnership, or corporation owning real property that is affected by the setback line

as established in Section 48-39-280 may proceed with construction pursuant to a valid building permit issued as of the effective date of this section. The person, partnership, or corporation may proceed with the construction of buildings and other elements of a master plan, planned development, or planned unit development notwithstanding the setback line established in this chapter if the person, partnership, or corporation legally has begun a use as evidenced by at least one of the following:

(a) All building permits have been applied for or issued by a local government before July 1, 1988.

(b) There is a master plan, planned development, or planned unit development:

(i) that has been approved in writing by a local government before July 1, 1988; or

(ii) where work has begun pursuant to approval as evidenced by the completion of the utility and infrastructure installation designed to service the real property that is subject to the setback line and included in the approved master plan, planned development, or planned unit development.

(2) However, repairs performed on a habitable structure built pursuant to this section are subject to the guidelines for repairs as set forth in this section.

(3) Nothing in this section prohibits the construction of fishing piers or structures which enhance beach access seaward of the baseline, if permitted by the department.

(D) Special permits:

(1) If an applicant requests a permit to build or rebuild a structure other than an erosion control structure or device seaward of the baseline that is not allowed otherwise pursuant to Sections 48-39-250 through 48-39-360, the department may issue a special permit to the applicant authorizing the construction or reconstruction if the structure is not constructed or reconstructed on a primary oceanfront sand dune or on the active beach and, if the beach erodes to the extent the permitted structure becomes situated on the active beach, the permittee agrees to remove the structure from the active beach if the department orders the removal. However, the use of the property authorized under this provision, in the determination of the department, must not be detrimental to the public health, safety, or welfare.

(2) The department's Permitting Committee is the committee to consider applications for special permits.

(3) In granting a special permit, the committee may impose reasonable additional conditions and safeguards as, in its judgment, will fulfill the purposes of Sections 48-39-250 through 48-39-360.

(4) A party aggrieved by the decision to grant or deny a special permit application may appeal pursuant to Section 48-39-150(D).

(E) The provisions of this section and Section 48-39-280 do not apply to an area in which the erosion of the beaches located in its jurisdiction is attributed to a federally authorized navigation project as documented by the findings of a Section 111 Study conducted under the authority of the federal Rivers and Harbors Act of 1968, as amended by the federal Water Resources Development Act of 1986, and approved by the United States Army Corps of Engineers. Nothing contained in this subsection makes this area ineligible for beach renourishment funds. The baseline determined by the local governing body and the department is the line of erosion control devices and structures and the department retains its jurisdiction seaward of the baseline. In addition, upon completion of a department approved beach renourishment project, including the completion of a sand transfer system if necessary for long-term stabilization, an area under a Section 111 Study becomes subject to all the provisions of this chapter. For the purposes of this section, a beach nourishment project stabilizing the beach exists if a successful restoration project is completed consisting of at least one hundred fifty cubic yards a foot over a length of five and one-half miles, with a project design capable of withstanding a one-in-ten-year storm, as determined by department, and renourishment is conducted annually at a rate, agreed upon by the department and local governing body, equivalent to that which would occur naturally if the navigation project causing the erosion did not exist. If the two parties cannot agree, then the department must obtain the opinion of an independent third party. Any habitable structure located in an area in which the erosion of the beaches located in its jurisdiction is attributed to a federally authorized navigation project as documented by the findings of a Section 111 Study, which was in existence on September 21, 1989, and was over forty years old on that date and is designated by the local governing body as an historical landmark may be rebuilt seaward of the baseline if it is rebuilt to the exact specifications, dimensions, and exterior appearance of the structure as it existed on that date.

SECTION 48-39-300. Local governments given authority to exempt certain erosion control structures from restrictions.

A local governing body, if it notifies the department before July 1, 1990, may exempt from the provisions of Section 48-39-290, relating to reconstruction and removal of erosion control devices, the shorelines fronting the Atlantic Ocean under its jurisdiction where coastal erosion has been shown to be attributed to a federally authorized navigation project as documented by the findings of a Section 111 Study conducted under the authority of the Rivers and Harbors Act of 1968, as amended by the Water Resources Development Act of 1986 and approved by the United States Army Corps of Engineers. Erosion control devices exempt under this section must not be constructed seaward of their existing location, increased in dimension, or rebuilt out of materials different from that of the original structure.

SECTION 48-39-305. Judicial determination of ownership and whether construction prohibition applies or requires compensation; burden of proof.

(A) A person having a recorded interest or interest by operation of law in or having registered claim to land seaward of the baseline or setback line which is affected by the prohibition of construction or reconstruction may petition the circuit court to determine whether the petitioner is the owner of the land or has an interest in it. If he is adjudged the owner of the land or to have an interest in it, the court shall

determine whether the prohibition so restricts the use of the property as to deprive the owner of the practical uses of it and is an unreasonable exercise of police power and constitutes a taking without compensation. The burden of proof is on the petitioner as to ownership, and the burden of proof is on the State to prove that the prohibition is not an unreasonable exercise of police power.

(B) The method provided in this section for the determination of the issue of whether the prohibition constitutes a taking without compensation is the exclusive judicial determination of the issue, and it must not be determined in another judicial proceeding. The court shall enter a judgment in accordance with the issues. If the judgment is in favor of the petitioner, the order must require the State either to issue the necessary permits for construction or reconstruction of a structure, order that the prohibition does not apply to the property, or provide reasonable compensation for the loss of the use of the land or the payment of costs and reasonable attorney's fees, or both. Either party may appeal the court's decision.

SECTION 48-39-310. Prohibition of destruction of any beach or dune vegetation seaward of setback line.

The destruction of beach or dune vegetation seaward of the setback line is prohibited unless there is no feasible alternative. When there is destruction of vegetation permitted seaward of the setback line, mitigation, in the form of planting of new vegetation where possible, for the destruction is required as part of the permit conditions.

SECTION 48-39-320. Comprehensive beach management plan.

(A) The department's responsibilities include the creation of a long-range and comprehensive beach management plan for the Atlantic Ocean shoreline in South Carolina. The plan must include all of the following:

(1) development of the data base for the state's coastal areas to provide essential information necessary to make informed and scientifically based decisions concerning the maintenance or enhancement of the beach/dune system;

(2) development of guidelines and their coordination with appropriate agencies and local governments for the accomplishment of:

(a) beach/dune restoration and nourishment, including the projected impact on coastal erosion rates, cost/benefit of the project, impact on flora and fauna, and funding alternatives;

(b) development of a beach access program to preserve the existing public access and enhance public access to assure full enjoyment of the beach by all residents of this State;

(c) maintenance of a dry sand and ecologically stable beach;

(d) protection of all sand dunes seaward of the setback line;

(e) protection of endangered species, threatened species, and important habitats such as nesting grounds;

(f) regulation of vehicular traffic upon the beaches and the beach/dune system which includes the prohibition of vehicles upon public beaches for nonessential uses;

(g) development of a mitigation policy for construction allowed seaward of the setback line, which must include public access ways, nourishment, vegetation, and other appropriate means;

(3) formulation of recommendations for funding programs which may achieve the goals set forth in the State Comprehensive Beach Management Plan;

(4) development of a program on public education and awareness of the importance of the beach/dune system, the project to be coordinated with the South Carolina Educational Television Network and Department of Parks, Recreation and Tourism;

(5) assistance to local governments in developing the local comprehensive beach management plans.

(B) The plan provided for in this section is to be used for planning purposes only and must not be used by the department to exercise regulatory authority not otherwise granted in this chapter, unless the plan is created and adopted pursuant to Chapter 23 of Title 1.

SECTION 48-39-330. Disclosure statement.

Thirty days after the initial adoption by the department of setback lines, a contract of sale or transfer of real property located in whole or in part seaward of the setback line or the jurisdictional line must contain a disclosure statement that the property is or may be affected by the setback line, baseline, and the seaward corners of all habitable structures referenced to the South Carolina State Plane Coordinate System (N.A.D.-1983) and include the local erosion rate most recently made available by the department for that particular standard zone or inlet zone as applicable. Language reasonably calculated to call attention to the existence of baselines, setback lines, jurisdiction lines, and the seaward corners of all habitable structures and the erosion rate complies with this section.

The provisions of this section are regulatory in nature and do not affect the legality of an instrument violating the provisions.

SECTION 48-39-340. Distribution of funding.

Funding for local governments to provide for beachfront management must be distributed in a fair and equitable manner. Consideration must be given to the size of the locality, the need for beach management in the area, the cost/benefits of expenditures in that area, and the best interest of the beach/dune system of the State as established by priority by the department.

SECTION 48-39-345. Coastal Division of DHEC to administer funds reimbursed to nonfederal project sponsors under local cooperative agreement with army corps of engineers for cost-shared beach renourishment project.

Any funds reimbursed to nonfederal project sponsors under the terms of a Local Cooperative Agreement (LCA) with the Army Corps of Engineers for a federally cost-shared beach renourishment project, where the reimbursement is for credit to the nonfederal sponsor for federally approved effort and expenditures toward the nonfederal project sponsor obligations detailed in the LCA and where the State has provided funding to the nonfederal sponsor to meet the financial cost-sharing responsibilities under the LCA, must be refunded by the nonfederal sponsor to the State with the State and the nonfederal sponsor sharing in this reimbursement in the same ratio as each contributed to the total nonfederal match specified in the LCA. The Coastal Division of the South Carolina Department of Health and Environmental Control shall administer these funds and make these funds available to other beach renourishment projects.

SECTION 48-39-350. Local comprehensive beach management plan.

(A) The local governments must prepare by July 1, 1991, in coordination with the department, a local comprehensive beach management plan which must be submitted for approval to the department. The local comprehensive beach management plan, at a minimum, must contain all of the following:

(1) an inventory of beach profile data and historic erosion rate data provided by the department for each standard erosion zone and inlet erosion zone under the local jurisdiction;

(2) an inventory of public beach access and attendant parking along with a plan for enhancing public access and parking;

(3) an inventory of all structures located in the area seaward of the setback line;

(4) an inventory of turtle nesting and important habitats of the beach/dune system and a protection and restoration plan if necessary;

(5) a conventional zoning and land use plan consistent with the purposes of this chapter for the area seaward of the setback line;

(6) an analysis of beach erosion control alternatives, including renourishment for the beach under the local government's jurisdiction;

(7) a drainage plan for the area seaward of the setback zone;

(8) a post disaster plan including plans for cleanup, maintaining essential services, protecting public health, emergency building ordinances, and the establishment of priorities, all of which must be consistent with this chapter;

(9) a detailed strategy for achieving the goals of this chapter by the end of the forty-year retreat period. Consideration must be given to relocating buildings, removal of erosion control structures, and relocation of utilities;

(10) a detailed strategy for achieving the goals of preservation of existing public access and the enhancement of public access to assure full enjoyment of the beach by all residents of this State. The plan must be updated at least every five years in coordination with the department following its approval. The local governments and the department must implement the plan by July 1, 1992.

(B) Notwithstanding the provisions of Section 48-39-340, if a local government fails to act in a timely manner to establish and enforce a local coastal beach management plan, the department must impose and implement the plan or the State Comprehensive Beach Management Plan for the local government. If a local government fails to establish and enforce a local coastal beach management plan, the government automatically loses its eligibility to receive available state-generated or shared revenues designated for beach/dune system protection, preservation, restoration, or enhancement, except as directly applied by the department in its administrative capacities.

SECTION 48-39-355. Documentation of authorized activity.

A permit is not required for an activity specifically authorized in this chapter. However, the department may require documentation before the activity begins from a person wishing to undertake an authorized construction or reconstruction activity. The documentation must provide that the construction or reconstruction is in compliance with the terms of the exemptions or exceptions provided in Sections 48-39-280 through 48-39-360.

SECTION 48-39-360. Application of chapter.

The provisions of Sections 48-39-250 through 48-39-355 do not apply to an area which is at least one-half mile inland from the mouth of an inlet.

Appendix E:

Example of Local Opinions

GLOUCESTER-MATHEWS
GAZETTE-JOURNAL

Letter: Simple experiment refutes sea level rise

POSTED ON MAY 02, 2012 - 11:53 AM

PRINTER FRIENDLY VIEW

Editor, Gazette-Journal:

Few of us have escaped seeing glaciers melting followed by the ominous threat that as a result the oceans will rise and we will be washed out to sea unless we give full commitment to the theory that this is a result of man-made global warming.

But that is a false premise easily refuted by a simple scientific experiment anyone could do in their own kitchen. With a few ice cubes, fill a glass with water. Leave it at room temperature and let the ice cubes melt. You will observe that no additional water is produced and the water level does not rise.

Too bad someone didn't figure that out before the spending of billions of dollars in implementing radical green environmentalism, which threatens our way of life.

Sue Long

North, Va.