

SEA LEVEL RISE: TECHNICAL GUIDANCE for DORCHESTER COUNTY



Wanda Diane Cole
Maryland Eastern Shore
Resource Conservation & Development Council

for

Maryland Department of Natural Resources
Coastal Zone Management Division
March 2008

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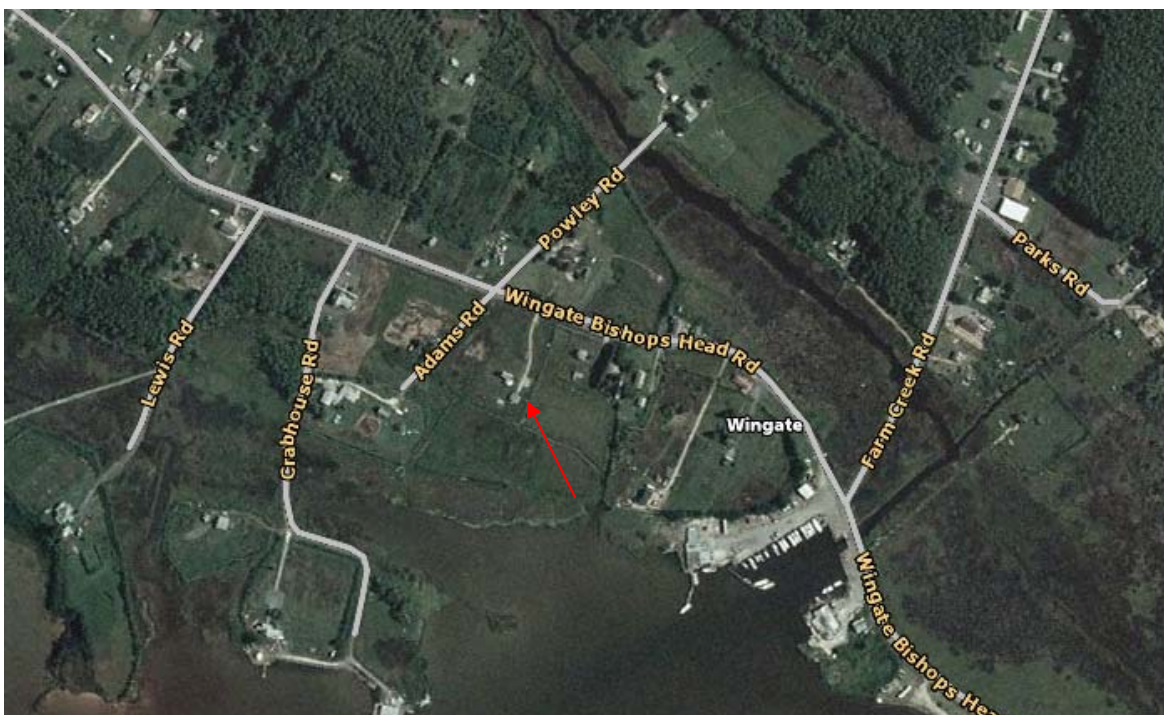
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Aerial view to cover photo: Wingate, Maryland (courtesy 2007 MapQuest, Inc.)

Cover: Spring High Tide, elevation + 3.5 feet
2120 Wingate Bishops Head Road, Wingate, Maryland
Photo: Wanda Diane Cole, RC&D, Inc. October 27, 2007

Acknowledgements

The recommendations described within this document would not be possible without the participation and insight of local and State agency staff, who shared their experiences and observations regarding changes in Dorchester County's landscape that could be attributed to sea level rise. In the absence of long-term, site-specific studies, anecdotal information is paramount to understanding and appreciating the changes- and their related losses- that have occurred in Dorchester County over the last 50 years.

The author wishes to especially thank Zoë Pfahl Johnson, Coastal Planner- Maryland Department of Natural Resources, for her support and guidance during the preparation of this document. Her own work, *A Sea Level Rise Response Strategy for the State of Maryland* documented the statewide needs, and laid out the framework on which this guidance is based.

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Table of Contents

Introduction.....	1
Understanding Dorchester County’s Vulnerability to Sea Level Rise	3
A Sea Level Rise Response Strategy	7
Phase I: Vulnerability and Impact Assessment.....	7
Phase II: Long-Range and Comprehensive Planning	29
Phase III: Codes, Regulations and Development Standards.....	40
Phase IV: Public Education and Outreach.....	43
Planning Timeline.....	46
Financial Assistance.....	49
Conclusion	50
References.....	52

Introduction

Sea level rise is neither a new or recent phenomenon. It has occurred at the end of each ice age, with the last ice age having peaked 18,000 years ago. Mankind's subsequent utilization of the shoreline- for transportation and commerce, hunting and fishing, disposal of wastewater, and recreational and aesthetic uses- has placed the population in areas at risk to the continued encroachment and effects of sea level rise.

Manmade greenhouse gases have been heating the atmosphere and causing global warming in an unprecedented manner. In February 2007, in a report to the Intergovernmental Panel on Climate Change, an international team of scientists conclusively reported that this unnatural form of atmospheric warming has contributed significantly to an accelerated rate of sea level rise on a global scale. What this means for the world is that coastal areas will realize dramatic changes to the landscape, and experience more frequent and more violent storms.

As global atmospheric temperatures rise, the rate of glacial and sea ice melt increases. In 2007, dramatic and unprecedented melting of Arctic sea ice occurred. Earlier in the year, a scientist comparing satellite imagery discovered a large mass of ice had broken off the Antarctic ice shelf. As this ice melts, it enters the ocean and adds to the ocean's water volume. The increased water volume must be accommodated; it either flows horizontally across low-lying shorelines, or rises vertically within waterways bordered by high banks.

Horizontal movement across low-lying landscapes leads to inland encroachments by the tide. Depending on the landscape's profile, the encroachments can range from a few inches to several hundred feet. The flatter the profile, the farther inland the tide will invade. Soils and vegetation may slow this encroachment for a time, but ultimately the landscape will succumb to the effects of inundation, and new shorelines will form farther inland.

Vertical movement of rising waters leads to increased saturation of soils at the base of banks, which weaken and collapse the slopes. Mechanical effects of wave action, which tear away soils at higher points along the slopes, also lead to slope failure. Repeated slope failures result in the landward retreat of the upland/shoreline edge.

As human populations grew, the use of the upland/shoreline edge increased dramatically, placing these people at an increased risk to the effects of sea level encroachment and shoreline retreat. These risks include loss of property, natural resources, livelihoods, and even loss of life.

The scientific data indicates sea level may rise 2-3 feet by the year 2100 (Johnson, 2000). However, if Arctic sea ice, Greenland glacial ice, and Antarctic ice sheets continue to melt at unprecedented rates, sea level could rise as much as 18- 20 feet by year 2200 (Gore, 2006). It is critically important that mankind's future use of shoreline areas be curtailed. Existing uses of shoreline areas must be assessed and managed through timely planning and appropriate response strategies. The National Oceanic and Atmospheric Administration Coastal Zone Management Program (CZM) has provided grant funding to Maryland Department of Natural Resources to

pursue the necessary planning. The statewide Strategy was completed in October 2000. CZM funds were used to produce this guidance document to support planning in Dorchester County.

Understanding Dorchester County's Vulnerability to Sea Level Rise

Despite the lack of detailed, mapped topographic information for the Delmarva Peninsula, recent assessments indicate that, outside the states of Louisiana, Texas, Florida, and North Carolina- which contain 80% of the low-lying areas of the United States, the largest populated region that will be vulnerable to sea level rise is located between Dorchester County, Maryland and Accomac County, Virginia (Johnson, 2000). To appreciate the significant, long-term risks facing Dorchester County's citizens and public officials, one needs to understand what makes Dorchester County so vulnerable to sea level rise effects.

Size

Dorchester County is Maryland's largest county, based on combined land and water acreage. Its land mass- including wetlands- is 350,000 acres, making it Maryland's second largest county in land area. Dorchester County's landscape is characterized by several very long, narrow peninsulas incised by numerous creeks, guts, streams, and ditches. Extensive areas of tidal marsh lie along these peninsulas, and in many places, miles of county roadway must cross through these marshes to reach settlements located at the peninsulas' southern tips.

Road Infrastructure

The southernmost settlements are 35 miles or more from the nearest high school, which is located in Cambridge. With fuel prices currently \$2.95 per gallon, transportation of school children along miles of peninsular roads is an expensive item for taxpayers, as is commuting to work. It is also a considerable distance for providing emergency fire and rescue services when timely response is critical. If and when roads are inundated by high tides, emergency response time is hampered.

Maintenance of these roadways is expensive due to their lengths, the number of culverts and miles of ditches that drain them. Their surfaces experience considerable wear and tear due to freeze-thaw, inundation by tides, and heavy-vehicle traffic. With many of these roads crossing through tidal marsh and nontidal wetlands, there are numerous bridges that also require maintenance. The County's Department of Public Works is responsible for maintaining 20 boat ramps, 21 bridges, 7 major pipe culvert crossings, and 9 minor pipe culvert crossings. Altogether, this water-related infrastructure is expensive to maintain, and the primary source of funding comes from the county's taxpayer-financed general fund. Given the small size of the population, road maintenance is a huge cost per taxpayer. In some areas, the cost to continually maintain road infrastructure most likely outweighs the fair market value of the properties they serve.

Population and Settlement Patterns.

The 2000 census data indicates Dorchester's population was 30,674 people, making it the second smallest county by population in Maryland. Its population density is 0.87 people per acre. For

comparison, the 2000 census for the City of Annapolis lists 35,838 citizens living in an area measuring 4,378 acres, for a density of 8.2 people per acre. The City of Baltimore had 651,154 people in an area measuring 58,931 acres, for a density of 11 people per acre. Hence, Baltimore City has nearly 13 times the number of people as Dorchester County, in one-sixth the land area, to support its infrastructure.

Dorchester County's population is distributed among its incorporated areas of the City of Cambridge, and the Towns of Hurlock, East New Market, Secretary, Vienna, Galestown, El Dorado, Brookview, and Church Creek. The remaining developed areas are classified as villages, and are located in the Neck District, Bishops Head, Crapo, Crocheron, Toddville, Wingate, and on Elliott's, Taylor, Upper and Middle Hooper's Islands. All but one of these villages are located at the southern or westernmost tips of long peninsulas, and surrounded by extensive areas of tidal marsh and open water.

Dorchester County's primary economies are agriculture and forestry-based. Seafood processing- from catching, cleaning, packing, and shipping, to the preparation of seafood- is the primary economy in many of the village areas. The local processing plants are conveniently located here, as they are but a short distance, by boat, from the productive fishing areas of Fishing Bay, Tangier Sound, and lower Chesapeake Bay.

There are boat landings throughout these areas that support the recreational and commercial fisheries that supply the local processing plants. The landings are designed to facilitate the overnight mooring of work boats and the off-loading of daily catches. Despite the threats of storm surge, high winds, salt corrosion, and high transportation costs to bring the catch to market, it is highly likely that settlement of this area will continue until either the resource runs out, or storm damage and road access makes rebuilding cost prohibitive.

With the exception of the Neck District, and some portions of Taylor's Island and Upper Hooper's Island, most properties are assessed at low to medium market values, and the resident work force is primarily blue collar with earnings at the lower end of the pay scale. These are the people most at risk to the effects of inundation by sea level rise, and the ones least able to afford the costs associated with elevating or relocating homes, or repairing flood-related damages to structures and septic systems.

Topography and Flood Elevations

Nearly 60% of the county lies in the 100-year floodplain, with most of that area being tidal floodplain. Over 50% of the county's land area lies below elevation 4.9 feet above sea level (Carlisle, Conn and Fabijanksi, 2006). The average 100-year floodplain elevation in the county is + 6 feet, and most of this area is located south of US 50 and west of Horns Point and the City of Cambridge. A few, small sections of low-lying shoreline occur north and east of Cambridge along the Choptank and Nanticoke Rivers.

With the exception of areas along the Choptank River and Chesapeake Bay, the lowest elevations are buffered by expansive areas of tidal wetlands. All of these areas experienced significant storm surge damage during Tropical Storm Isabel in September 2003, whose surge

elevation reached 8 feet in Dorchester County. Isabel's impact on the Chesapeake Bay area was later determined by NOAA to equal an 80-year storm event (personal comment, John Joyce, 2007), with its storm surge the equivalent of a Category Two storm.

If half the county lies between elevations 2.0 and 4.9, then half the county is in peril of experiencing damage during minor storm surges that are not related to tropical disturbances. During the April 15, 2007 Nor'easter, and the October 24 – October 27, 2007 rain event, tide levels reached 3.5 ft, inundating numerous yards and roadways in Toddville, Bishops Head, Crocheron, Crapo, Wingate, and across Elliott Island Road. In many locations, the only land area that was not inundated was the county road, whose side ditches were full and about to spill over onto the roadway.

The Army Corps of Engineers 2006 Draft Storm Surge Map predicts the potential Category Two storm surge for Dorchester County to range from elevations 6.9 to 7.6 feet in the Neck District, and from 7.2 to 10.3 feet in the southern reaches of the County. The 1981 Flood Insurance Rate Maps (FIRM) produced by the Federal Emergency Management Administration (FEMA) show a 100-year flood elevation at 5.0 to 6.0 feet for most of the county. This is at best, a 0.9 foot disparity between actual and mapped flood stages, with the worst being a difference of 5.3 feet. Dorchester County building codes do not have a freeboard requirement for structures other than the first floor being required to be at or above the 100-year flood level depicted on the FIRM.

Mean high water in the southern reaches of the county ranges between 2.0 and 2.5 feet, and the twice-monthly spring high tides range between 2.5 to 3.0 feet. If winds blow from the south and coincide with the incoming spring high tide, water elevations can reach 3.5 to 4.0 feet. This is the elevation that would inundate much of the local landscape when sea level has risen one foot.

Soils and Wetlands

The lower two-thirds of the county is characterized by nearly level lowlands composed of loosely consolidated, windblown materials overlying alluvial and marine deposits. A significant portion of these soils support tidal and nontidal wetlands. Many of the marshes were formed over mineral soils that were once above sea level. However, these mineral soils have since submerged (National Cooperative Soil Survey, 1998).

As one might expect, the level lowland soils have poor surface drainage, resulting in conditions that produce hydric soils that support the growth of wetland vegetation. Over half the county's soils are hydric, with most located in its southern reaches, and most corresponding with the county's 100-year floodplain boundaries.

Soil types play an important role in how flooding affects the landscape, and whether erosion is a significant risk. There are 17 named soils types in Dorchester County whose properties make them subject to the effects of sea level rise. Of these, 11 exhibit hydric (wet) conditions and all are located in the 100-year floodplain. Nine soils experience frequent flooding: Beaches, Bestpitch, Transquaking, Chicone, Fluvaquents, Honga, Nanticoke, Puckum, and Sunken soils. Three have the potential for frost action (freeze-thaw): Chicone, Fluvaquents, and Sunken soils. Four soils have shrink-swell potential: Bestpitch, Transquaking, Elkton, and Keyport, and 11

soils have K factors ≥ 0.35 in the upper two feet of their profiles, meaning they have a high erosion potential: Chicone, Elkton, Hambrook, Keyport, Matapeake, Mattapex, Nanticoke, Othello, Kentuck, Sassafra, and Sunken.

Nearly all of the county's tidal and nontidal wetlands are associated with its 11 hydric soils. The hydrology of these wetlands is supported by surface runoff that is unable to leave a site due to its flatness; from groundwater levels at or within two feet of its surface; from periodic riverine overflow, tidal inundation, and perched impoundments over impermeable soils in depressions.

As sea level rises, so, too, does the groundwater table. Areas that were once upland begin to convert to nontidal wetlands. As the mean high tide encroaches further inland, freshwater wetlands become infiltrated with saline water and the vegetative community changes over to high salt marsh. High salt marshes form in elevations subject to the twice-monthly spring high tides. As these marshes become inundated on a daily basis, the plants can no longer tolerate the increased moisture and salt content, they die, and new plants replace them. This conversion results in the formation of a low salt marsh. As sea level continues to rise, low salt marshes become inundated for prolonged periods, the vegetation drowns and erodes away, and open water appears. Inevitably, Dorchester County will experience a significant loss of wetlands, increased areas of open water, and shifts in the types of wetland habitat. Indeed, aerial photography of Dorchester County confirms that these scenarios have already played out over the last 50 years.

Areas along Lakes and Straits Road and Andrews Road were once productive tomato and truck crop fields (personal comment, Nick Lyons). Most have now converted to tidal marsh. The meandering Blackwater River has lost many of its loblolly pine hummocks, and its high marsh has converted to low salt marsh or open water habitat; so much so that a large lake has formed within the river's oxbows that once looped around the hummocks and through the marshlands.



Boat ramp, pavilion, and parking lot inundated by spring high tide. Transquaking River at Bestpitch Ferry Road. October 27, 2007

A Sea Level Rise Response Strategy

A Sea Level Response Strategy for the State of Maryland identified four distinct planning strategies that need to be addressed when planning for the long-term implications of sea level rise. They are: Vulnerability and Impact Assessment; Long-Range and Comprehensive Planning; Codes, Regulations and Development Standards; and Public Education and Outreach. The guidance provided herein follows that format, and discussion is provided to illustrate specific local implications of sea level rise. The author has purposely written this guidance to focus on necessary changes at the local level. The use of technical descriptions and citing of statistics has been deliberately minimized, and that information may be gleaned from the references cited at the end of this document.

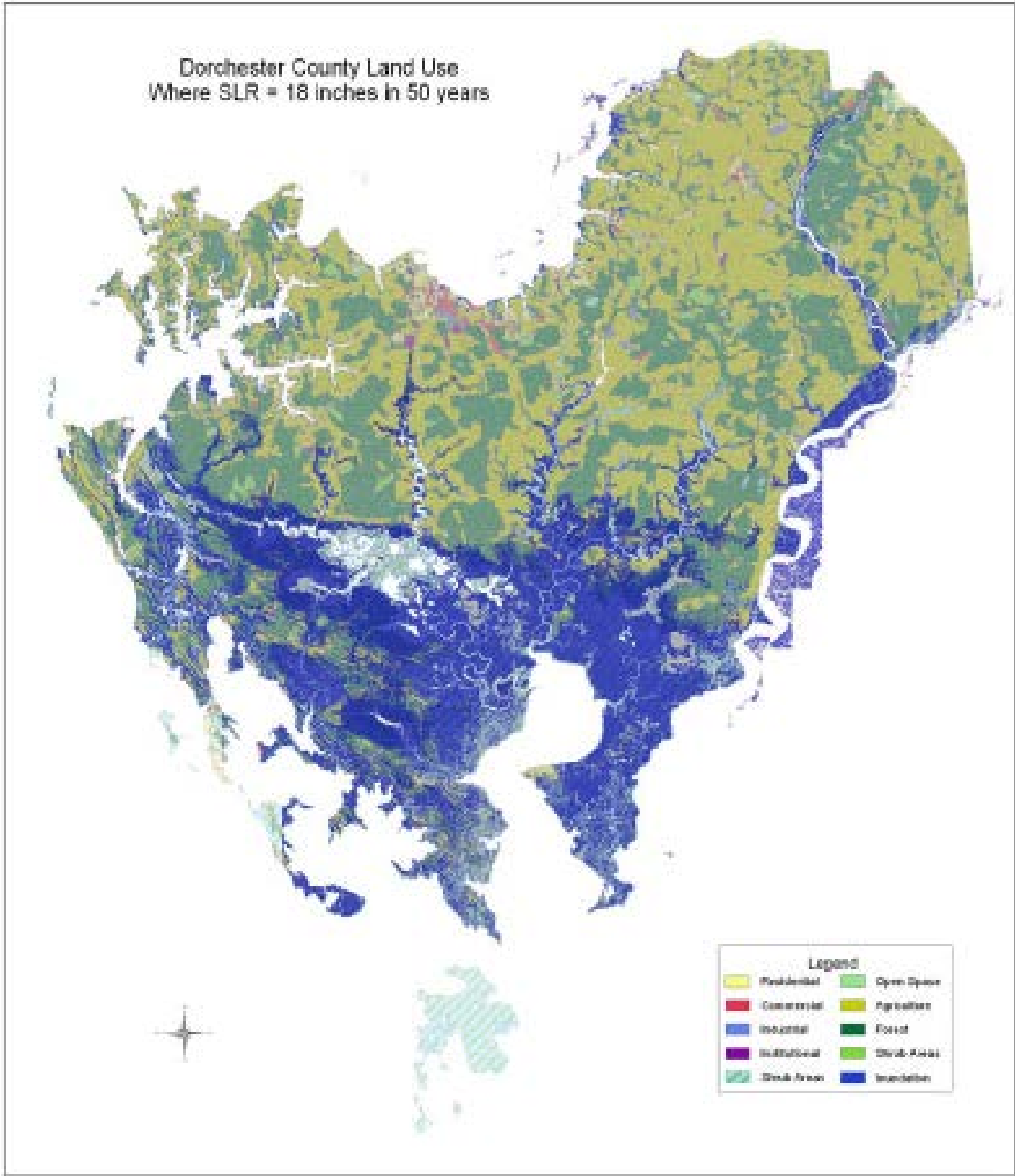
This guidance is presented in a manner intended to allow readers to understand how sea level rise may affect him or her in their daily lives, and to provide educators, planners, engineers, and elected officials a clear picture of the challenges facing them. It is with the sincerest of hopes that the information and guidance provided below will be acknowledged, embraced and incorporated into local policies, codes, protocols and lifestyles. Change is never easy; it takes forward-thinking, courageous individuals to make the tough decisions necessary to lead Dorchester County's citizens out of harm's way and respond properly to the forces of nature.

- Wanda Diane Cole

Phase I: Vulnerability and Impact Assessment

Sea level rise will have a profound effect on Dorchester County. Despite the varying estimates of the rate of sea level rise, Dorchester County's low-lying landscape, miles of shoreline along numerous waterways, and 91,000 wetland acres **guarantee a future with significant impacts related to sea level rise- even at the one foot per century scenario.** The rate of sea level rise in the Chesapeake Bay region over the next century is estimated to be 2-3 feet (Johnson, 2000). With the record melting of Arctic sea ice in 2007, the loss of a large section of the Antarctic ice shelf, and a clearer understanding of the effects of thermal expansion of ocean water **in addition to** atmospheric warming, the global rate of sea level rise has the potential to increase much, much higher (MSNBC, 2007). **Dorchester County as we know it will simply disappear beneath the tide.**

The things that make Dorchester County a beautiful area to visit, and a bountiful area to experience, are what will be at the heart of its undoing. Its 180-degree views are breathtaking because the land is too wet to grow trees. The fishing is good because of the numerous waterways that cut into the landscape. Its scenic beauty is enhanced by both. It is crucial that Dorchester County planners, engineers, emergency response personnel, and elected officials acknowledge and heed the warnings of the past 25 years, and take immediate steps to address the expected impacts of inundation during the next 25 years.



Source: Angie Carlisle, Caleb Conn and Steven Fabijanski. 2006. *Dorchester County Inundation Study: Identifying natural resources vulnerable to sea level rise over the next 50 years.* .

Expected Impacts

Evidence of sea level rise is often subtle, and goes unnoticed by those who are not looking for it. One may notice the needles on a nearby grove of pine trees have turned orange- and think insect damage. In reality, saturation and salt contamination from encroaching tides has signaled the trees' death knell. The tide may have crept across the road- for the first time- during the last n'oreaster. One thinks nothing of this... until it happens again, soon after. The road ditches stay full of water, even though there hasn't been rain for weeks. Fiddler crabs scurry across the centerline of a road that crosses through a loblolly forest. Black needlerush thrives in the understory of that same woods. Agricultural fields become too wet to farm. These are quiet signs that something is changing in the landscape.

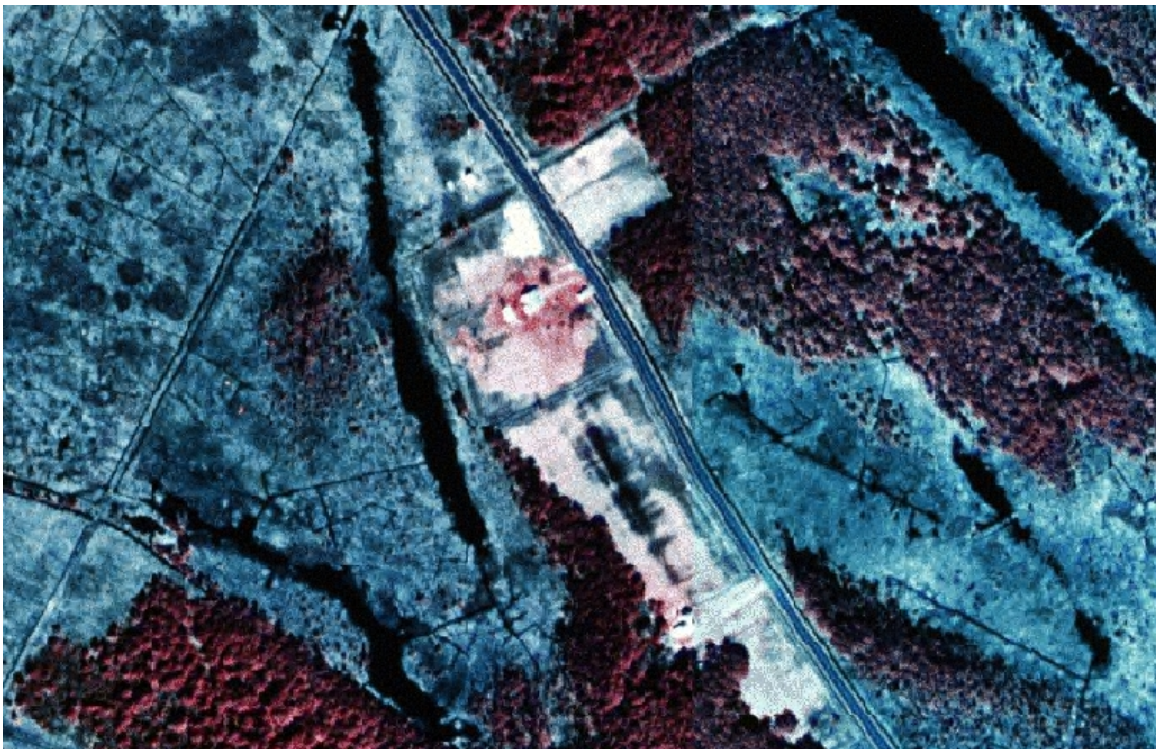
Dorchester County most likely will experience the following impacts as sea level rise continues:

- The daily high tide encroaches further inland on a regular basis. Spring high tides become unusually higher. Higher tides occur more frequently.
- Storm surges occur more often. Surges occur during minor, non-tropical weather disturbances. Storm surge waves become higher as the tide depth increases.
- Unprotected shorelines erode at a faster rate. Shoreline protection structures are eventually overtopped by the tide. Protection of the mainland is lost as barrier islands erode away and are inundated.
- Conventional septic disposal systems begin to fail. High water tables cause underground storage tanks to float.
- Well heads become inundated during storm surges. Poor seals on well caps allow saltwater to enter and contaminate drinking water supplies.
- Salt water intrusion into confined aquifers forces new wells to be drilled deeper, making them costlier. Existing wells will need to be replaced.
- Salt water intrusion into unconfined groundwater contaminates soil, rendering it unsuitable for vegetative growth. Habitats become damaged or disappear. Soils become barren and subject to erosion.
- Agricultural lands become too wet for producing crops, then too saline for silvaculture. Eventually, these fields convert to high marsh.
- Forest lands do not successfully regenerate after a forest harvest, nor do forest plantings thrive.
- A drainage ditch that was once dry between rain events now holds water all the time and appears to have tidal fluctuations.
- Concrete foundations deteriorate from moisture in nearby soils. Crawl spaces become susceptible to mildew and pose health risks. Wood frame construction exhibits rot damage.
- Road pavement cracks more easily and frequently as adjacent and underlying soils become saturated. Mechanical damage by tidewater flowing across them creates potholes. Repeated and costly resurfacing is needed.
- Roads become fully inundated at high tide. Travel on flooded roads at night becomes treacherous. Increasing water depths make driving through flooded areas dangerous at any time of day.
- Salt corrosion damages vehicles, guy wires to utility poles, fence posts, and road signs.

- Culvert pipes sink into the soft soils below them, fill with mud, and are unable to facilitate controlled flow of stormwater.
- Utility poles lean at unsafe angles. Wind-thrown trees fall across roads and onto structures.
- Private lawns become too wet to park cars or use as play areas.
- Houses will require relocation or elevation; however, driveways and yards will remain inundated. Property owners, who try to protect their homes by spreading earth fill to divert tidewater, cause water damage to their neighbors' properties.
- Some property owners create flood control berms around their properties to keep out the tide. These berms are a double-edged sword, as they also hold rainwater in.
- Winds blow stronger; there are no longer any trees to block the winds.
- Vegetative communities change, as do the animal populations that depend on them.
- Economies change or disappear as the landscape changes.
- Many property owners cannot afford the expense to repair, replace, relocate, or otherwise accommodate the impacts of sea level rise. They will be faced with a choice of taking on debt they cannot afford for a property that will still have inundation issues, or abandon the property and start over. In many areas, abandonment has already occurred.



A Toddville Road home damaged by Tropical Storm Isabel in 2003 is elevated using FEMA funds in 2006. From the road, appearances are deceiving; behind and across the street from the house are extensive areas of high marsh and tidal channels. Toddville, Maryland 2006



Toddville Road and surrounding wetlands. This site is depicted in color infra-red and natural color aerial photography below. The color infra-red photography is a 1994-1998 composite courtesy of Maryland Department of Natural Resources web site www.mdmerlin.net. Natural color photography courtesy of the US Department of Agriculture 2005 National Agricultural Imagery Program.



A property owner on Town Point Road constructs a tidewater flood-control berm (above the outbuilding; adjacent to the creek) to protect a historic structure built in 1791. In recent years, high tides have converted former farm fields along the entrance lane (lower right) to a *Spartina patens* marsh.

Cambridge, Maryland. Photo courtesy Dorchester Planning and Zoning

Natural Resources and Resource-based Economies. Natural resources in Maryland are largely managed by various departments within State government: wetlands, water quality and quantity by Maryland Department of the Environment (MDE); forestry, fisheries and wildlife by Maryland Department of Natural Resources (DNR); and agriculture by Maryland Department of Agriculture (MDA). The State may defer the responsibility to implement certain protection measures to local jurisdictions when those protections are best implemented on individual projects reviewed and approved at the local level. The State does not require local governments to catalog, research, monitor, or manage natural resources as integral units. However, if a local government sees a need to provide additional protection of a resource, it may implement additional protection measures so long as they are not less strict than the State's.

Dorchester County implements protection measures by incorporating them into their local zoning and building codes. These protective measures are usually setbacks from a resource. These setbacks establish a buffer around the resource, and a site-specific management plan may be associated with this buffer. Dorchester County addresses water quality and forest habitat issues by requiring minimization of footprints and the use of stormwater technologies. Forest resource losses are managed through planting plans, easements, and similar protection agreements.

According to the June 2006 studies by Carlisle, Conn and Fabijanski, Dorchester County currently contains 126,716 acres of shrub and forest habitat, 91,002 acres of wetlands, and 119,817 acres of agricultural land. Assuming a one foot per century sea level rise, in 25 years

Dorchester County would lose 1,734 acres of shrub and forest habitat, 7,035 acres of wetland habitat, and 243 acres of agricultural land. However, the more likely scenario is the 3 foot per century rate, and resource losses over the next 25 years would total 9,048 acres of shrub and forest habitat (7.36%), 29,314 acres of wetlands (32.2%), and 1,124 acres of agricultural land (0.94%).

The losses under the 3 feet per century scenario will significantly affect the primary economies in Dorchester County: forestry, agriculture, and seafood processing. All of the affected natural resources support these economies. As the resource losses increase, the productivity level of resource-based economies will diminish and/or collapse. Businesses will close and employees will lose their jobs. The lack of jobs in the southern reaches of the county may lead to high unemployment and foreclosures on homes. Unemployment leads to an increased need for social services assistance, and in some cases, leads to an increase in poverty-related crimes.

Loss of Property and Property Values. The single most detrimental impact by rising sea levels on Dorchester County residents and infrastructure will be the physical loss of land mass and their associated property values. Most of the village settlements in south Dorchester County are located at the southern tips of long, narrow peninsulas. These peninsulas are bordered on two sides by open expanses of water and vast areas of wetlands, and incised by numerous ditches and tidal waterways. These water features include 1700 miles of shoreline area, where a slight rise in sea level will allow the tide to seep inland. The presence of vegetation along the shoreline may stabilize the shoreline soils in the short term, but in the long term these shorelines will give way to the mechanical forces of wind and wave action, and the weakened integrity of saturated soils.

There are miles and miles of outlet ditches that were excavated across the county's tidal marshes to drain stormwater away from overflowing roadside ditches. In addition, past mosquito control programs created open water channels in tidal marsh in attempts to minimize the breeding success of saltmarsh mosquitoes. Unfortunately, both of these management practices have led to the long-term degradation of tidal high marsh by allowing the daily high tide access into their interiors.

Indeed, road outlet ditches have proven counter-productive, as they have allowed tidal intrusion deep into areas where flooding was once not a problem. Tidal intrusion through ditchlines has reached inland forested areas, wreaking havoc on both the ecosystem as well as the ability to manage stormwater. This can be observed within the boundaries of the Blackwater National Wildlife Refuge along MD 16 and along MD 335 near Golden Hill.

Tidal action in ditches in the villages has led to the conversion of lawns to high marsh, which in turn, has subjected properties to the setback requirements of the Critical Area 100-foot buffer in areas where a 100-foot buffer formerly did not exist. Aerials of a drainage ditch to Flowers Cove on Upper Hoopers Island at one time had no tidal connection. Today, this ditch not only has a tidal connection, it has grown in width.



This drainage ditch parallels Old House Point Road on Upper Hoopers Island. The down-gradient end makes a 90-degree turn in the vicinity of Cannon Road in order to outlet to Flowers Cove. The head of the ditch begins in the area between the far end of Flowers Road and Old House Point Road. This scene was taken from Flowers Road where it crosses the ditch. This ditch is barely discernible on 1982 aerial photography, and appears to be nothing more than a storm runoff drainage feature. Since then, this ditch is subject to daily tidal fluctuations. Note the *Spartina alterniflora* grasses in the lower right.

Fishing Creek, Maryland 2006

As storm surges occur and sea level rises, the interior high marsh is inundated for prolonged periods, leading to conversion from high to low marsh, and eventually to open water. Once the conversion to open water is achieved, the buffering effects of the high marsh are lost. Human settlement on adjacent uplands is placed at increased risk to flood damage, to loss of property to shoreline erosion, and ultimately to inundation as the shoreline erodes up to and around their structures. Eventually, the land becomes unusable, a damaged structure uninhabitable, and the property owner is faced with abandoning whatever vested interest that may remain in the land.

The assessed value of structures on Upper and Middle Hoopers Islands, which lie at or below elevation 4.5- the area most likely to be inundated within the next 25 years, assuming the 3 feet per century scenario- is estimated to be as much as \$18,750,000 (Michael, 2004). The estimated total assessed value of the structures plus the land is \$34,847,510. On the Hoopers Islands, all of

the properties are located in the FEMA 100-year flood zone. All but 255 are projected to sustain flood damages due to inundation by sea level rise.

The areas of Dorchester County where topography, wet soils, and numerous waterways put them at highest risk of inundation are Aisquith Island, Bishops Head, Crapo, Crocheron, DeCoursey Bridge Road near the Transquaking River bridge, Elliott Island road south of Henry's Crossroads and portions of Elliott Island, Madison, portions of Green Point Road near Secretary, Maple Dam Road between 3800 Maple Dam Road and Shorter's Wharf, Middle and Upper Hoopers Islands, Robbins, Smithville, Swan Harbor, the Bayshore Road and Hooper Neck Road sections of Taylor's Island, Toddville, Wingate, and Woolford.



This property at 2118 Wingate Bishops Head Road appears to have a tidewater flood control berm along its perimeter. If properly maintained, these berms divert the daily and spring high tides away from the structure and yard. The low section along the top of the berm (lower right) indicates this berm has been compromised and will allow tidewater to flow inside the berm. Wingate, Maryland October 27, 2007

On this date, 5 inches of rain had fallen over the area during the previous three days. Rainwater is trapped inside the berm and the unusually high spring tide is over-topping the berm on the road side. Together, the water level is up to the bottom of the vent in the foundation wall. Note that there is very little freeboard between the water level and the top of the foundation wall- and this is not a major storm event. Dorchester County does not have a freeboard requirement in its floodplain regulations.



Tidal flooding has almost reached this structure at a property on Wingate-Bishops Head Road. The water has almost reached the sand mound septic system (upper left) and has surrounded a roadside utility pole. The property owner has moved all lawn ornaments up against the house and yet the tide is about to surround them, as well. The foundation of this house appears fairly new, and may have been raised post-Isabel.



In 2006, the out-of-county owner of this property, located at the corner of Crocheron and Wingate Bishop Head Roads, told the author that he had never seen high tides come near the house. The property is now posted For Sale. Toddville, Maryland. October 27, 2007



The driveway to this well-maintained property on Crocheron Road is aptly-named. Despite the owners' meticulous attention to their lovely property, it will not be many more years before sea level rise permanently inundates it. Meanwhile, the owners face health risks from mold growing on saturated building materials, repairing cracked driveway pavement and foundation walls, and the potential to lose everything when the next tropical storm ravages this area. This house should probably be elevated. Given the driveway is almost under water during a spring high tide, elevating the house won't serve any purpose if the property cannot be reached by car. Crocheron, Maryland. October 27, 2007.



The residents in this home on Phillips Gunning Club Road have parked their vehicles on the highest ground in the area- the road. An expansive area of tidal marsh lies to the left, it is a short distance to the Honga River shoreline and the wide-open fetch of Hooper Strait on the right.

Crocheron, Maryland. October 27, 2007

Maintenance of Infrastructure

Roads, bridges and boat ramps in Dorchester County are owned and maintained by either Maryland State Highway Administration (SHA) or Dorchester County Department of Public Works (DPW). Maintenance funds for DPW roads are generated by local income and property taxes. Maintenance funds for boat ramps are often cost shared with DNR. All capital projects are approved by the County Council as part of the annual budget process.

DPW has no long-range Capital Plans regarding maintenance of its facilities. There are no policies or protocol in place to determine when and if a road should be relocated or rehabilitated if damage by chronic inundation has become too expensive to repair. Nor is there a process to determine when a road should be abandoned because it has become unsafe for travel.

DPW's current practice is to continually repair and/or resurface sections of roadway that are damaged by inundation, and this practice is likely to continue until the County Council issues a policy change. This practice includes replacement of culverts that are damaged or undermined

by flanking, freeze-thaw, and subsidence, and the resurfacing of cracked and eroded road surfaces.

The County does not have the tax base to support the rehabilitation of roads to elevations above future tide levels. To do so would require near total replacement of the roadway, as the entire roadbed would need to be removed in order to reach and improve the subgrade to ensure it would bear the weight of the additional pavement and vehicular traffic during wet conditions. Larger culvert pipes would be needed to pass tidal flow, and those pipes would likely need to be made of corrosion-resistant materials. Subgrade drainage would be needed to prevent saturation and subsidence of the road fill. Because raising a road bed includes widening the roadway as well, utility poles, transformer pads, and vault boxes would need to be relocated to accommodate the wider roadway.

It is more expensive to build a bridged road system than a causeway. The estimated cost to repair an existing 10 mile stretch of roadway that runs the length of the Hoopers Islands, ranges from \$385,000 to \$1.5 million per lane mile. With two lanes of travel being necessary, the cost to upgrade this roadway could cost as much as \$30,660,000. This cost is not far below the estimated total assessed value of the land and structures on these islands.

During preparation of this document, the author observed spring high tide inundation along several sections of the following roads: Aisquith Island Road, Andrews Road, Bennett Road, Bishops Head Road, Crocheron Road, East Tedious Creek Road, Elliott Island Road, Goose Creek Road, Harrisville Road, Hooper Neck Road, Hooper Island Road, Hoopersville Road, Lakes and Straits Road in Andrews to Wingate Bishops Head Road and Bishops Head, Liners Road, Maple Dam Road, Parks Neck Road, Pine Top Road- Taylor's Island, Phillips Gunning Club Road, Saint Thomas Road, Shorter's Wharf Road, Smithville Road, Toddville Road, and Wingate Point Road. There has been no planning by DPW or the Dorchester County Planning and Zoning office (PZ) to determine what action to take when any of these roadways has become unsafe for travel due to the risks that regular flooding presents.

It is the author's opinion that the section of roadway between 3800 Maple Dam Road and Shorter's Wharf could be closed to through traffic as there are no residential structures along this stretch, and there is an alternative route available to through traffic via MD 335 between Church Creek and Golden Hill. Maintenance of this roadway could be transferred to the US Fish and Wildlife service for emergency vehicle use in managing the Blackwater National Wildlife Refuge. Tides across this road are sufficiently deep to require vehicles to slow to a near crawl to avoid salt corrosion of the undercarriage, or throwing water up over the hood. During a heavy rain event one night, the author experienced blind driving conditions when the roadway could not be observed due to the presence of deep standing water blending with the ricochet effect of the torrential downpour. These conditions put a driver at risk of steering too far to one side and driving off the edge of pavement and into the marsh.



Aisquith Island Road during a spring high tide and strong south winds. The tide of Charles Creek was one foot above mean high water elevation. Crapo, Maryland October 27, 2007



Wingate Bishops Head Road at its intersection with Adams and Powley Roads. High tide on Hearn's Creek has flooded all three roads. Wingate, Maryland October 27, 2007



The Dead End sign for Adams Road is rather ominous. This scene depicts what the area will look like when sea level has risen exactly one foot. Wingate, Maryland. October 27, 2007

Sections of Smithville Road could also be closed for the same reason as Maple Dam Road, as alternative access to Taylor's Island from Hoopers Island can be achieved by traveling MD 335 via Golden Hill and Church Creek.

Goose Creek Road, Parks Neck Road, Aisquith Island Road, the eastern end of Toddville Road, Saint Thomas Road, Crocheron Road and Bennett Road appear to have very few structures given the length of roadway. It is likely the fair market value of these properties is far outweighed by the cost to repair these roads during the next 25 years. After 25 years, sea level rise will have resulted in daily inundation of all these properties and the roads leading to them.

Many of the existing structures along these roadways are in sufficient disrepair, or access into the properties is cabled off, to suggest these premises do not receive year-round use, and in some cases, very little use. Some of these properties have For Sale signs posted. Consideration should be given to abandoning DPW maintenance of roads where the mile of road per residential structure exceeds a pre-determined cost-benefit ratio. Transferring ownership of road frontage to adjacent property owners would give property owners the option of maintaining access for an additional period, but eventually, permanent inundation of these roads and the properties will prohibit use of this area. If abandonment is pursued, sufficient legal notice would be necessary to allow these property owners sufficient time to examine their options.

Elliott Island is an anomaly. It sits a considerable distance from the mainland but is attached by an expansive area of tidal marsh and tidal guts. Its rapid rise in elevation from the shoreline, and the elevation of most of its interior, would not be affected by a 3-foot rise in sea level. However, to reach Elliott Island, one must travel across nine miles of high salt marsh along a road that has very little freeboard above today's mean high water level.

There are 50 parcels on Elliott Island, with a large percentage of them abandoned, in considerable disrepair, and/or used as weekend recreational retreats by non-county property owners. The population of Elliott Island in 2000 was 86, representing a significant decline since the census taken in 1930, and this trend is expected to continue through the year 2010 (Rodney Banks personal comment, taken from the County's Water and Sewer Master Plan).

The cost to maintain Elliott Island Road for 86 people during the next 25 years must certainly far exceed the fair market value of these properties. Consideration should be given to setting a sunset date for maintenance of this road, and after giving these residents sufficient, legal notice, either turn maintenance over to them or, assuming these residents cannot afford the maintenance, close off and abandon the road.



Property on Elliott Island Road in disrepair and likely little used.

Elliott Island, 2007



Properties on Elliott Island Road that appear to be abandoned. Elliott Island, 2007.



Abandoned property on Elliott Island Road.

Elliott Island, 2007

In the absence of any long-range plans regarding the disposition of these roads, sea level will continue to rise to the point that all of these roads will be permanently inundated, and the decision regarding these roads will be forced upon County officials. Residents in these areas will already have faced additional issues related to sea level rise, and quite likely will have let their elected leaders know their opinions on how to address the matter. It would be less chaotic, less stressful for everyone involved, and financially prudent to plan for this scenario long before it arrives.

The County does not own or operate wastewater treatment plants or public drinking water supplies. These are operated by the incorporated municipalities. It appears all municipal-owned water and sewer treatment facilities in the County are located at elevations that will not be affected by sea level rise within the next century- provided the rate of rise does not exceed 3 feet during that period. Extension of new sewer lines between the City of Cambridge to Church Creek, with potential extension to the Madison and Woolford areas, would involve placement of utility lines and pumping stations within the 100-year tidal floodplain. Pumping stations would need to be elevated above the 100-year floodplain base elevation with additional freeboard provided to accommodate for category two storm surge elevations and wave action. During Tropical Storm Isabel in 2003, much of the damage to structures was a direct result of wind-driven waves slamming floating debris into the walls of structures.

There is one landfill in operation and owned by the County. It is located in Beulah and is situated outside the 100-year tidal floodplain, although the site does contain the 100-year floodplain of Gravel Run and could be subjected to tidally-influenced backwater conditions. As

sea level rises, it could be expected that tidal influences would move upstream, creating a tidal floodplain in this area. This is a situation the County would need to assess in its long-range planning for solid waste disposal.

The County operates one trash transfer station in Golden Hill which would be affected by sea level rise. The transfer station is set up as a drop off point for area residents who do not have commercial trash pick up. This facility has transportable trash containers that would be easy to dismantle and relocate when tidal flooding begins to threaten the continued use of this area. At this time, the trash containers are heavy and watertight, so that any tidal flooding that would occur around them would not pose a contamination risk. However, any spilled substances on the ground would be at risk of becoming suspended and carried away with the tide, as would happen on any other property subject to tidal flooding.

Dorchester County supports twelve schools with an enrollment of 5,000 students. There are two high schools, one school of technology, two middle schools, six elementary schools, and one K-8 school. The South Dorchester School located in Golden Hill is the pre-K to 8 school, and is located in the 100-year tidal floodplain. This structure is old, however, significant renovations were recently completed that will keep this school in operation for likely the next 25 years. In a conversation with the Dorchester Board of Education Facilities Planning office, this school is not on any long-range plan for replacement or other services. The grounds on which this school is sited experienced tidal flooding during Tropical Storm Isabel in 2003. Dorchester County's plans for school expansion and renovations do not include any sites located within the 100-year tidal floodplain.

There are 15 fire companies throughout Dorchester County, in addition to the Central Dispatch and Dorchester Emergency Operation Center in Cambridge. Of these, the companies located in Church Creek, Hoopers Island, Lakes & Straits, Lloyds, Madison, Neck District, and Taylor's Island are located in the 100-year tidal floodplain and Category one and two storm surge zones. Each of these stations is located sufficiently close to tidal water to allow them to respond to water-related emergencies and rescues. These sites are unsuitable as emergency shelters during storm events due to the risk of flooding to the companies' structures. There is not adequate second story area available in these structures to house the area's potential evacuees.

Sea level rise will result in daily or permanent inundation of some of these properties, and long-range planning is needed to address all possible response strategies, such as relocation, replacement, or elevation of existing structures, or first-floor modifications to existing structures. In addition, many fire companies have leased tower space to cellular, wireless internet, and cable TV companies, so that protection of those facilities must also be accommodated. Consolidation of adjacent companies would create a larger service area, but it would allow funding resources to be pooled. A larger facility could then be designed to provide adequate, up to date, emergency shelter for the vicinity's population.

There are 20 county or municipal-owned recreational parks in Dorchester County. Eight of these parks are located in tidal floodplains and subject to future effects of sea level rise: Church Creek, Great Marsh, Long Wharf, Nanticoke Boy Scouts Reservation, Sailwinds, Secretary, Snows Turn/Egypt Road, and Vienna. Some of these parks are developed with pavilions, boat

ramps and parking areas; Sailwinds has a large multi-purpose hall, Church Creek and Snows Turn have athletic fields, and the Nanticoke Boy Scout Reservation is managed for youth group programming. Development of floodplains for recreational uses has been considered a good use of site design, therefore, with the exception of the Sailwinds hall, all of these facilities are inexpensive to replace. Because none of them house people on a live-in or long-term basis, there will be no personal property damage when periodic flooding and permanent inundation affects these parks.

On-site Septic Disposal and Drinking Water Facilities

The contamination of drinking water supplies and failure of on-site septic disposal systems is another challenge facing property owners faced with future inundation risks. If these issues cannot be remedied, a home is rendered uninhabitable, and the property dramatically loses its property value. In most cases, the property cannot be sold for other uses due to the level of development that has already altered the land.

The presence of groundwater levels near the surface will affect the integrity of on-site septic disposal systems. Saturated ground conditions impair the soil's ability to infiltrate and filter sewage effluents. Above-ground facilities, such as bermed infiltration ponds (BIP), are potential replacement technology for conventional septic tank and drainfield systems, and sand mound infiltration systems. However, they require large areas of land for construction, and this is often not available on small, grandfathered lots. In some areas, the depth to groundwater is so shallow, that nontidal wetlands are present, and construction of a BIP would require a permit from MDE, and mitigation to offset the wetland losses would be required. If there is no room on a small lot to provide mitigation, the property owner must pay into a mitigation fund. Either way, mitigation is a costly aspect of replacing a septic disposal system.

The problem with BIPS, besides the large consumption of land area, is that they give property owners a false sense of security regarding the long-term survival of their property. The presence of a BIP leads a property owner to think that his or her house must be in a safe location, otherwise the County would not have approved a house for that site. In fact, a property owner may feel reassured to the extent that he or she may build a much larger house than first anticipated, adding extra bedrooms and bathrooms, because the BIP provides considerable capacity.

Such security could not be farther from the truth. BIPs are last-resort options for very wet sites. The wetness of a site should be a red flag to a property owner that groundwater conditions and nearby waterways are somehow connected, and that sea level rise in the waterway will ultimately correspond with a rise in groundwater levels.

Grandfathering provisions in State and local law allow a use to occur on marginal sites if certain parameters can be met. On-site septic disposal systems, irregardless of their impact to nontidal wetlands and proximity to tidal shorelines, are the one item necessary to allow development to proceed in flood-prone areas.

In-ground, sewage holding tanks are a possible replacement technology, provided the ground is not subject to frequent periods of inundation that might cause a holding tank to “float” to the surface. Expensive anchoring devices would rectify that problem. The down side to holding tanks is that they have limited capacity. The more people in a house, and the longer they are there, the quicker a holding tank fills. Holding tanks must be pumped out, requiring the services of companies that specialize in pumping out these tanks. The farther a holding tank is located from the pumping company’s office, and the greater the distance to the effluent disposal site, plus any fees charged by the facility that must treat the effluent, the greater the cost to the homeowner. The pumping of holding tanks is an on-going maintenance need.

These tanks also require safety alarms to alert homeowners when they are nearly full. They require grounding straps to discharge static electricity in the ground and that is generated during storms. Non-resident owners would also need a system that can remotely notify them when a holding tank is full, or a pump has failed.

The County is not in the business of providing public drinking water supplies. Almost all homes located outside an incorporated area are on private, drilled-well, drinking water systems. Assuming a potable water supply is available; wells must be drilled very deep to avoid intercepting aquifers where saltwater intrusion has already occurred. Deep drilling is expensive.

Some aquifers contain high levels of iron, magnesium, and calcium, which require water treatment systems to remove these elements. Failure to remove these elements may result in a shorter lifespan for pipes, valves, and pumps on washing machines and dishwashers. Both the treatment systems or replacement of pipes and pumps are expensive, on-going maintenance items for the homeowner.

Well contamination by saltwater is possible when a property is inundated to a depth that water can seep into a well casing by means of the well cap. Sea level rise will result in higher tides, inland encroachment of high tides, and more frequent storm surges. Wave action on the top of the tide water level, or storm surge level, is capable of pushing saltwater up into the underside of the well cap, allowing the saltwater to enter the well’s protective casing.

Most well caps are not tightly sealed, as electrical wiring and pull-out lines to submersible pumps are usually coiled together and seated just inside the top of the casing. Well heads would need to be raised above the predicted three-foot rise in sea level, plus allowance made for wave height on top the surge. This is not a problem for new well construction, but retrofitting existing wells would be a time-consuming and costly process for local health officials to track and costly to the property owner who is advised to raise the well head.

Shoreline Erosion and Shoreline Retreat

Shoreline erosion and shoreline retreat will affect property values, simply through the physical loss of land. Shoreline erosion is a natural, on-going process, but sea level rise will change the location at which the daily high tide touches the land. As sea level rises within a waterway, it must either spread out sideways across level surfaces, or rise higher within its channel. In Dorchester County, the most prevalent scenario will be the horizontal spreading of the tide

across its level, low-lying landscape. This means that the high tide line will fall at a location farther from the shoreline than it used to do.

Loss of land due to erosion has both damaging and beneficial effects on the environment. Erosion is a natural process that provides sediments necessary to replenish sandy beaches and add material to salt marshes upon which new plants may grow. Beaches and salt marshes help prevent further erosion from occurring, so in essence, some erosion is necessary to prevent further erosion. On the other hand, substantial erosion of a shoreline adds material to the water column at a rate faster than the system can use it to re-establish equilibrium. The excess sediments are carried away and deposited in areas where they do more harm than good, such as covering oyster bars and beds of submerged aquatic vegetation. Therefore, accelerated erosion damages natural resources that are important to the local economy.

To a property owner, accelerated erosion means loss of a financial investment that represents future financial security. A property owner has paid taxes on the land that has since washed into the Chesapeake Bay or its tributaries. The erosion leaves a smaller footprint of land that may restrict where and how an owner uses the land. As the daily tide line moves farther inland, the 100-foot Critical Area buffer moves with it, and the requirements of the Critical Area Law may prevent the owner from building upon portions of the property altogether.

As properties succumb to the tide, a homeowner might consider relocating a home away from the shoreline to a safer point on higher ground. Unfortunately, that option is not available in the nearly level, low-lying areas along much of Dorchester County's waterways.

In Dorchester County, where shorelines occur at the edge of salt marshes, the impacts are not often noticed until aerial photography is examined. The effects of this loss may not be felt until the next n'oreaster or tropical disturbance passes over the area.

Phase II: Long-Range and Comprehensive Planning

Planning for the effects of sea level rise in Dorchester County will require a series of short-term assessments that can then be utilized for developing long-term strategies. Each County agency, whose Program or mandates would be affected by changes in the landscape, will want to identify and quantify the extent to which their Programs must adapt to those changes. Where responsibilities are inter-related or overlap, early coordination between affected County and State agencies is advisable. These agencies would include: Dorchester County Department of Public Works- Roads Division; Dorchester Emergency Management Administration; Dorchester Soil Conservation District; Planning and Zoning; Board of Education, Facilities Planning; Dorchester County Health Department, Environmental Health Division; Maryland Emergency Management Administration; State Highway Administration; Maryland Department of Housing and Community Development; Maryland Department of Economic Development; and, the incorporated towns of Church Creek, East New Market, Secretary, and Vienna.

As described earlier, sea level rise will impact the lives and livelihoods of Dorchester County's citizens in several arenas. Property owners will call upon multiple agencies to address problems involving infrastructure maintenance, public health and public safety issues, and financial or logistical assistance when damages are experienced. Thresholds and timelines will need to be established to determine if, when and how certain services will be provided.

Short-Term Assessments.

Table 1 lists the various planning documents prepared for and used by Dorchester County agencies. These documents guide the County in long-range planning, and are updated on a periodic, multiple-year basis. To address the short-term needs regarding sea level rise, these plans will need to be appended so that they each identify sea level rise as a risk that must be assessed. Discussion will need to focus on the most immediate issues facing each agency. Each plan is discussed below. Recommendations are provided and may be considered for incorporation into each Plan.

Comprehensive Plan. Last adopted in 1996, the Comprehensive Plan is used to guide the County in the direction it would like to grow. It spells out the vision Dorchester County citizens have for how the County should look over the next 15 to 20 years. It examines the County's population trends and economics, identifies land uses and demands on land use, housing and transportation needs, addresses infrastructure, and provides for the protection of sensitive natural resources. The Plan describes the role of each County agency in implementing the strategies it has laid out.

Maryland planning laws require local governments to update their Comprehensive Plans every six-years. While the Plan sets forth a vision over the next 10-15 years, it is not meant to be static. Periodic updates provide the County opportunities to reassess changes in trends, determine what areas of the Plan are not working, and to make changes as appropriate. In preparing for the effects of sea level rise, the Comprehensive Plan is a good tool for identifying impacts and laying out long-term strategies.

Dorchester County recently engaged in a series of exercises to update its Comprehensive Plan, and a draft update was completed in 2006. However, this update will not be circulated for public review and comment until it has incorporated a Water Resources Element chapter. The Water Resources Element was required in 2006 by the Maryland General Assembly, who passed House Bill 1411 requiring local jurisdictions to include a Water Resources Element chapter in their Comprehensive Plans by 2009. Once the Water Resources Element chapter is completed, the updated Comprehensive Plan will be circulated for public comment and subsequent adoption by the County Council.

The 1996 Comprehensive Plan contains “Chapter 7 Environmentally Sensitive Areas”. This section discusses watersheds and watershed planning, 100-year floodplains, and habitat for rare, threatened and endangered species. It does not specifically discuss sea level rise. In 1996, sea level rise was beginning to come to the forefront as a hazard facing coastal and tidewater communities.

The 100-year floodplain section of the Plan calls out the following information:

- Two-thirds of the County drains to the Nanticoke River watershed. The Nanticoke River shorelines are lined with diverse expanses of emergent tidal vegetation, and its shoreline area is not heavily developed.
- Most of the County’s waterways are subject to tidal influences far into their upper reaches. These floodplains experience flooding by high tides and storm surges. They are also susceptible to flooding caused by prolonged, strong, on-shore winds.
- Fifty percent of the County’s land area (177,600 acres) lies within the Critical Area.
- The base flood elevation occurs between five and six feet above sea level.
- In 1990, 15% of the County’s population (4,600) lived in the 100-year floodplain.
- The County has participated in the National Flood Insurance Program since 1981. Its zoning ordinances include a Floodplain District that utilizes base flood elevations as indicated on the Flood Insurance Rate Maps.
- The Plan recommends that potential development density in these areas be reduced. It does not make any recommendations regarding freeboard- the construction of first floors in structures a set height above the base flood elevation. This chapter states that the “existing floodplain protection program is adequate and no changes are envisioned by this comprehensive plan.”

The draft 2006 Comprehensive Plan has provided a detailed discussion on sea level rise. It cites several references regarding erosion rates, State sea level rise strategies, economic impacts associated with property losses, and losses in acreage for various types of land use. The Plan includes a map from *Dorchester County Inundation Study: Identifying natural resources vulnerable to sea level rise over the next 50 years* - by Carlisle, Conn and Fabijanski (2006),

which was developed using LIDAR digital elevation data to show the predicted extent of sea level encroachment in Dorchester County over 25 years using a “high” scenario.

The low scenario uses the established global rate of one foot of sea level rise per century. The high scenario uses the estimated accelerated rate in the Chesapeake Bay of three feet per century. Even this rate may fall short of what the actual long-term sea level rise rate could be: observations in 2007, regarding the amount of ice melt at both polar regions, have shown a far more extensive melting than previously predicted. If this melting trend continues, the global rate of sea level rise could go as high as 10- 20 feet per century, and would be much higher in the Chesapeake Bay as tidewater is funneled up the narrowing channel. For the short-term, or until data shows otherwise, the three foot per century rate is a valid predictor for “worst case scenario” planning purposes.

The draft 2006 Plan directs attention to recommendations by Zoë Pfahl Johnson in *A Sea Level Rise Strategy For the State of Maryland, October 2000* and states that her recommendations be considered, as well as two others. These recommendations are discussed below.

- Adopt standards requiring two or more feet of freeboard in tidally influenced floodplains.

Maryland Department of the Environment has developed a Model Ordinance that addresses at least a two-foot freeboard. Not all counties in Maryland have adopted this ordinance, with Dorchester County being one of them. Adoption of the freeboard requirement would allow Dorchester County eligibility for participation in the National Flood Insurance Program’s buy-out programs. Without it, the only benefit to Dorchester property owners is a reduced flood insurance premium based upon the finished elevation of the first floor above the base flood elevation.

- Update the 1972 tidal wetland maps and the overlying Critical Area boundaries.

This endeavor is currently in progress. Maryland Department of the Environment has completed digitizing the 1972 maps, although the location of mean high water has changed over the last 35 years and large areas of marsh land have been lost due to erosion and storm damage. The Critical Area Commission will be updating the location of the 1,000 foot Critical Area boundary based upon the 2003 LIDAR digital elevation information.

- Expand the Critical Area buffer width in areas experiencing greater than 2 feet of erosion per year, using either a fixed distance or the estimated location of the shoreline in 50 years.

The Department of Natural Resources has developed a series of shoreline erosion rate maps which can be found on-line at www.dnr.state.md.us/. Most of Dorchester County’s shorelines are along properties that lie within the coastal floodplain. These properties have little to no relief above sea level. Shoreline erosion rates for this landscape will be a factor of soil type, level of saturation, degree and type of vegetative stabilization, and the wave energy environment. With the exception of some areas along the upper Choptank and the Nanticoke, there will be little need to factor in the landward retreat that occurs with slope failure.

- Amend the Critical Area Law to restrict the use of shoreline erosion control structures that harden the shoreline when non-structural measures would be effective, or to allow natural erosion to occur.

Riparian ownership is guaranteed by Maryland Law, and State law recognizes a property owner's right to protect their shoreline from erosion. Shoreline protection measures prevent property loss due to wave energy tearing apart a shoreline. They also prevent sedimentation caused by saturated soils that loosen and wash away with the tide. However, not all sedimentation is bad, as sediment transported by littoral drift is what replenishes eroding beaches and helps to build the substrate of marshlands.

Shoreline protection structures cannot stop a rising tide, nor prevent it from over-topping the structure and encroaching onto the land that lies behind. This situation is not recognized or regulated by either the Critical Area Law, which encourages shoreline protection measures but does not regulate them, nor the State Tidal Wetland Act, which is the regulatory authority over shoreline structures. The Maryland Department of the Environment (MDE) regulates shoreline protection projects and is the agency best suited for discouraging the use of shoreline hardening measures in areas where shoreline retreat might be the preferred approach to sea level rise.

- Remedy conflicts between §16-20(a) of the Wetlands and Riparian Act and selected sea level rise response strategies.

State and County agencies will need to closely examine the configuration of Dorchester County's wetlands and tidal waterways relative to the location of established residential settlements in order to predict those areas that cannot be realistically protected from the effects of sea level rise using infrastructural support. Policy decisions will need to be made as to which areas will be allowed to retreat naturally, and which areas can be managed as future wetland conversion zones. Once those areas are designated, permits must not be issued that would be counter-productive to these goals.

- Align smart growth strategies to reflect population growth and development patterns in relation to areas vulnerable to sea level rise. Provide a State directive to consider sea level rise issues when establishing new or modified Priority Funding Areas.

Dorchester County currently has remote population centers along narrow peninsulas in the southern reaches of the County. These areas have Village zoning which does permit some new subdivisions if the land can support it. This zoning should be removed to prevent further development beyond what is existing. Fortunately, on Upper and Middle Hoopers Islands and in Toddville, the prevalence of wetlands and hydric soils renders most parcels unfit for subdivision. However, the grandfathering provisions in current State law do not prevent the development of a vacant lot, even if it is constrained by hydric soils and wetland buffers. In most cases, the key factor that renders a lot undevelopable is the failure of its soils to support a septic disposal system.

- Incorporate sea level rise planning principles into the Maryland Rehabilitation Code and the infill and mixed-use zoning models.

Two frustrating things occurred after Tropical Storm Isabel damaged many structures in the coastal floodplain: damaged properties were purchased at “Fire Sale” prices by wealthy persons who lived out of state or out of County in areas that were not at risk to coastal hazards, and thus, these people had no experience with what had occurred and could again occur on these properties; and redevelopment of damaged properties resulted in dwellings intended to maximize the lot’s allowable building potential. In most cases, the new dwellings exceeded the original footprint and the number of stories, thus increasing the vested value of these properties. In many cases, new owners did not rebuild to an elevation that provided freeboard above the base flood elevation: first, it was not required; second, it cost more money and the owners were already spending a considerable amount by building a larger house. New codes should limit or prevent redevelopment in identified sea level rise risk areas, and should require freeboard in all cases.

- Designate tidal wetlands and marshes and significantly eroding areas as sensitive areas; and provide incentive to local governments to develop sea level rise protection guidelines for inclusion in the sensitive area element of their local land use plans.

With the exception of the Villages, almost all of south Dorchester is designated as Natural Resource Area in the 1996 Comprehensive Plan. This is due to the large extent of wetlands in this area.

- Delineate the predicted extent of sea level rise over the next 25 years on County zoning maps as a means of alerting prospective land purchasers and developers of the potential risks.

The predicted extent of sea level rise in 25 years is a good basis for implementing code changes that address freeboard, setbacks from wetlands and drainage ways, and maintenance of roads issues.

- Establish that locations within the potential 25-year sea level rise area is a negative criteria in the consideration of public investment in capital facilities.

Conversely, location within a sea level rise risk area might be considered as a positive criteria when evaluating purchase of conservation easements and siting of habitat restoration projects.

Recommendation. The following Action Strategy should be incorporated into the 2006 Draft Comprehensive Plan:

1. Provide a map with detailed topographical information for south Dorchester County and the Green Point Road area of Choptank River overlaid onto the most recent aerial photography available (2007).
2. Label this map with the projected overland surge elevations for Category One and Two storms and provide colored contour lines for these elevations.
3. Onto this map, overlay the predicted 25-year sea level rise risk line.

4. List all villages, roads, tax map and parcel numbers that fall within this 25-year risk zone.
5. Create a Sea Level Risk District (SLR) and implement codes to address activities associated with those roads and parcels.

Educational Facilities Master Plan. This plan identifies facilities planning information regarding the number and location of facilities, equipment on-site, staffing requirements, community analysis and enrollment, need for expansion or improvements, and transportation guidelines. This document does not call out the fact that the South Dorchester School, which educates K-8 grades, is located in the coastal floodplain. Children attending this school would come from the Hoopers Island area, Crapo, Wingate, Toddville, Crocheron, Bishops Head, and St. Thomas, all areas observed by the author to be inundated during spring high tides of 3.44 feet and higher. It does not mention that the roads in the immediate area of this facility were affected by overland storm surge during Tropical Storm Isabel, nor does it mention whether and how often bus traffic encounters roads flooded by higher than normal tidal flooding when picking up and dropping off students.

Recommendation: In the Transportation Guidelines section, include a list of roads where bus drivers have encountered tidally-flooded roads in the County. Elliotts Island and Maple Dam roads are two roads that flood on a frequent basis.

In the Facilities Needs Analysis, include a discussion that South Dorchester School lies in an area subject to the effects of sea level rise and that no new expansion or major modifications to the structure will be planned. Only minor modifications with a life expectancy of less than 10-15 years should be planned until such time as elevation data and sea level horizontal encroachment is updated.

Land Preservation, Parks and Recreation Plan. This Plan looks at recreational and open space needs in the area, discusses agricultural land preservation, conservation easements, and natural resource areas. While it discusses the extensive number and location of wetlands in the county, and the importance of wetlands to the economy, it does not include a discussion on agricultural, forestry, and wetland losses due to sea level rise. It does not cite a need for conservation easements on lands that might be suitable sites for allowing wetland conversion to occur to offset wetlands lost. The Plan also does not address the impacts to infrastructure by overland surge, or tidal encroachment into drainage ditches.

Recommendation. In Chapter 3: Recreation, Parks and Open Space, discuss those parks located in coastal floodplains and the impacts that can be expected by overland surge and sea level rise encroachment from shorelines and along drainage ditches.

In Chapter 4: Agricultural Land Preservation, discuss the losses of farmland on Taylor's Island to the effects of moisture and salinity as a result of overland surge and sea level encroachment. List those areas where additional agricultural land losses can be expected due to sea level rise.

Discuss the need to avoid purchase of conservation easements using MALPF funds, although outright purchase of these lands may be desirable as future wetland sites.

In Chapter 5: Natural Resource Conservation, discuss the predicted losses of wetlands and forest resources as indicated by Carlisle, et al (2006). Discuss the use of land conservancy purchase and MET easements to buy parcels where new forest resources can be established to replace ones lost, and/or to purchase sites for future wetland replacement areas. This chapter might also be used to predict future shoreline configurations as sea level rise encroaches up outlet ditches or overtops side ditches.

Mutli-Hazard Mitigation Plan. This plan briefly discusses sea level rise and changes in the landscape where inland agricultural areas have now converted to salt marsh. It notes anecdotal observations that the western and southern shorelines have migrated landward, and this information can be corroborated by consulting the original Dorchester Soil Survey and comparing it to the 2006 NAIP photography.

The Plan identifies the number of structures at risk of Category One storm surge. It records areas with repetitive losses: Hoopers Neck Road on Taylor's Island, Seabreeze Drive in Cambridge, and Wingate Point Road in Wingate. It notes that the County participates in the National Flood Insurance Program but not the Community Rating System due to staff constraints. The Community Rating System is the program that would enable buyouts of flood-prone properties in order to avoid future losses. It also estimates the replacement value of at-risk Critical Facilities due to Isabel's storm damage was \$123 million, of which \$95 million went to bridge replacement. Replacement value of damaged residential structures was \$209 million.

Goal 4 of the Plan includes identification of specific issues and needs, and to heighten public awareness of natural hazards. Goal 5 includes acquisition of structures and/or elevating them. It recommends establishing open spaces and recreation areas in flood hazard areas, and limiting housing in high hazard areas.

Mitigation actions include controlling how and where land is developed and structures built, acquisition, elevation and relocation, and providing watershed management and wetland restoration. Potential projects include revising the floodplain ordinance and maps, replacing and adding new bench marks, elevate or acquire repetitive loss properties, and include mitigation projects in the Capital Improvement Plan. Cost of each datum marker is \$1200-1500. Cost to acquire each repetitive risk property is \$75,000.

Recommendations: This Plan has a good discussion on actions and costs. It would benefit to go into greater detail on why sea level rise is a risk to specific areas of the County. This would require the topographical information referenced in the recommendations for the Comp Plan.

Water and Sewer Plan. This Plan discusses facilities and future needs based upon population predictions and/or existing demand. A survey recorded failed septic conditions on Taylor's Island and Smithville. Blackwater, Andrews, Wesley, and Crapo were identified by the Health Department as potential health problem areas. A recommendation was made that if a Facilities Plan is warranted, the Straits Neck area should be studied as a single problem area. All

of this area is surrounded by high salt marsh and nontidal wetlands, and lie within a predicted Category One overland storm surge zone.

Fishing Creek and Hoopersville (Hooper Islands) have known septic tank failure areas. Most of Hoopesville lies at or below elevation 3.0, while elevations in Fishing Creek are mostly at elevation 4.0 and some below elevation 5.0. Storm surges and spring high tides from Back Creek and Flowers Cove back up into road outlet and side ditches here. In 1977, there were 300 developed properties on the two islands.

Galestown, Eldorado and Brookview do not have a central water system, nor is there one planned for the next 10 years. East New Market pumps to the wastewater treatment plant in Secretary. From the maps provided, it appears the treatment facilities are not located in a coastal floodplain, however, a pumping station at the foot of Gordon street may be susceptible to the effects of sea level rise. Vienna moved its wastewater treatment plant out of the floodplain.

The County does not own or operate any water or wastewater facilities. The City of Cambridge owns and operates its own water wells and wastewater treatment plant. The plant was recently upgraded to separate stormwater from wastewater so that the plant now has a significantly increased capacity. The Town of Church Creek pumps its wastewater to the Cambridge plant. The wells and treatment facilities are not located in an area at risk to sea level rise, however, the pumping stations from Church Creek are most likely in the 100-year floodplain.

Recommendation. During the next plan update, determine the elevations surrounding each treatment facility and pumping station, and assess whether any of these facilities are at risk to the effects of Category One and Two overland surge or sea level rise within the next 25 years. If so, equipment buildings and pumping equipment should be raised or made watertight to withstand potential flooding damage.

Table 1 below lists each of these Plans, the agency who coordinates their review, their update schedule, and a contact person.

Table 1: Dorchester County Planning Documents

Plan Name	Agency	Last Update	Frequency	Contact Information	Sea Level Rise Addressed?
Dorchester County Comprehensive Plan	Dorchester County Planning & Zoning	1996	Every 6 years	410-228-3234 Steve Dodd Director	No
	Dorchester County Dept of Public Works-Roads Division			410-228-2920 Bob Tenanty Director, DPW	No
Dorchester County Public Schools Educational Facilities Master Plan	Dorchester County Public Schools Facilities Mgmt.	2006	Annual	410-221-1111 Michael Lynch Facilities Planner	No
	Dorchester County Health Department Environmental Health Division			410-228-1167 Bill Forlifer Director	No
Land Preservation and Recreation Plan	Dorchester County Department of Recreation & Parks	2006	Every 6 years	410-228-5578 Scott Eberspacher Director	No
Multi-Hazard Mitigation Plan	Dorchester Emergency Management Administration	2005	Every 5 years	410-228-1818 Wayne Robinson Director	Yes
Water & Sewer	Dorchester County Planning & Zoning	2004	Every 3 years	410-228-3234 Steve Dodd Director	No

Information as of February 20, 2008

Tools and Resources for Long Range Planning

There are several computer models available for predicting the horizontal extent of sea level encroachment by using topographic information and overlaying it onto aerial orthophotos. These models can be set to show one-foot, two-foot, etc. rises in the daily high tide. However, sea level rise will occur gradually and proceed at varying rates over time. Winds and fragile soils will affect the erosion rate and expose inland areas to tidal encroachment in locations that might not now seem a logical progression. The numerous road outlet ditches and tidal guts that cut through Dorchester high marsh must be factored in determining how far inland tidal encroachment could potentially occur. For most of south Dorchester County, even a three-inch change in water level has the potential to encroach inland by several hundred feet. That is because the landscape is already water-worn, a flat, broad, coastal floodplain interrupted by small hummocks of grass and small mammal burrows. It is nearly impossible to accurately predict where water might flow across this flat landscape; therefore, using a computer model is not necessary.

Technology and data are available to look at the gross landscape and then focus in on specific areas to determine potential impacts on infrastructure, property, lives and livelihoods. Listed below are the most readily-available resources that a technician trained in geo-spatial analyses could utilize to make reasonable predictions.

Using digital elevation data overlain onto natural color aerial photography will allow planners to see infrastructure and structures. Overlaying elevation data onto color infra-red photography will allow planners to see small watercourses which would affect the inland reach of tidal flooding.

Using soils and wetland maps, even where the data is old, will enable planners to notice subtleties in the landscape that the digital elevation data might not “see”. These maps might also help predict a trend, such as loss of marsh lands on Honga Peat soils along west-facing shorelines.

A great resource for data and information related to sea level rise and comprehensive planning is *Maryland Shorelines Online*: http://shorelines.dnr.state.md.us/sc_online.asp. *Maryland Shorelines Online* is an Internet portal, created by the Maryland Coastal Program in cooperation with Towson University, which provides information and tools to coastal managers and decision makers, educators, and the public on sea level rise, coastal hazards and shoreline management. The site houses information on Maryland’s legal framework, permitting and regulatory guidance, educational materials, assessments, and spatial decision support tools for shore erosion and sea level rise. The tools provided on the website allow for the identification of potential shoreline protection and restoration options throughout the State to mitigate hazards and enhance natural shoreline habitat.

Shorelines Online also houses much of the Department of Natural Resources sea level rise vulnerability data, including: historic shoreline position maps; a comprehensive inventory of shoreline features and conditions for Maryland’s coast. Recently, *Sea Level Rise Vulnerability* data was uploaded to the site which can now be viewed through the interactive map viewer to depict lands (i.e., 0-2’; 2 – 5’ and 5 – 10’) about mean sea level.

Additional data sources include:

- National Agriculture Imagery Program Photography (NAIP) Natural color, leaf on, August 2005
- Light Detection and Ranging (LIDAR) digital elevation data
- 1972 State Tidal Wetland Maps
- Dorchester County Soil Survey
- State Highway centerline elevation data
- Maps from *Dorchester County Inundation Study: Identifying natural resources vulnerable to sea level rise over the next 50 years*. Angie Carlisle, Caleb Conn and Steven Fabijanski, June 2006. These maps do not indicate scale, don't show major road alignments, and place names are not provided. They would have to be re-scaled for use with other maps.
- DNR shoreline vector maps: <http://www.mgs.md.gov/coastal/maps/shorevect.html>. Depicts locations of shorelines using GIS 8.3 shape files.
- Chesapeake NEMO: www.chesapeakenemo.net. A network of partner agencies who help local governments who request assistance with planning and technical needs. The web site did not list specific areas of expertise that are available. Local governments would contact NEMO regarding their project and discuss what assistance might be made available for that specific effort.

Phase III: Codes, Regulations and Development Standards

The Code of Dorchester County, Maryland contains ordinances which have relevancy to managing for the effects of sea level rise. The specific chapters and paragraphs listed below should be re-examined regarding their effectiveness in implementing long-term strategies necessary for managing the effects of sea level rise. In every instance possible, these codes must be amended to provide language and provisions that grant County agencies a strengthened, flexible ability to manage for the long-term effects of sea level rise. The Dorchester County Planning Commission and County Council must streamline the planning and implementation process by permitting its agencies to implement actions without the need to have every action reviewed and approved as a legislative item by the Council.

Recommendation: Utilizing various sections of the Code, **create a Sea Level Risk (SLR) overlay District** in the zoning chapter. This District should be created using the recommendations found in the draft 2006 Comprehensive Plan, and the 25-year high scenario inundation map created by Towson University in its 2006 inundation study by Carlisle, Conn and Fabijanski. Review, amend and promulgate codes for the SLR District that would take precedent over similar codes in other chapters of the Code. Provide enforcement provisions with strict penalties; provide for a part-time or full-time staff attorney to prosecute violations of these codes; and apply for capacity-building grants that would enable the County to hire additional inspection staff to monitor compliance with construction permits and other activities in the SLR District.

Part I, Code of Public Local Laws

Chapter 40: Roads. §40-2 Control of roads and bridges; levy for repair and construction. The County Commissioners for Dorchester County may control and regulate the public roads and bridges in the County... and may levy such amount annually as may be necessary for the repair of old roads and bridges and for the construction of new roads and bridges.

Part II, Administrative and General Legislation

Chapter 65: Building Code. This section references the International Building Code, with amendments that address local needs. This section can be amended to speak to the need for freeboard above the base flood elevation. One specific section currently references distance above finished grade.

§65-6.O Finished Grade. The grade in the under-floor space shall be as high as the outside finished grade. There shall be a minimum distance of 24 inches from the top of the finished grade under floor to the bottom of the floor joists.

Chapter 80: Economic Development Department. This section creates a department to assist businesses in strategic planning that would lay the groundwork for future economic development; to help companies improve their operations; aid in site searches; and, assist in revitalization: activities that would preserve employment. This department's activities can be expanded to work with companies in sea level risk areas in relocation efforts.

Chapter 96: Forest Conservation Standards. This section contains provisions that speak to the preference for preservation of habitat types, priority for planting site selection, and the establishment of mitigation bank. These codes may be amended to include specific provisions for forest habitat that would manage the level of groundwater, serve as protective buffers to salt marshes and nontidal wetlands, and prohibition of forest harvest on areas with high water tables that lie adjacent to salt marsh.

Chapter 137: Streets, Roads and Driveways. This section discusses subdivision roads and the requirement to meet County standards regarding drainage slope, stormwater easements, specifications on headwall structures, outlet ditches and tidal gates.

Chapter 140: Subdivision Regulations. The purpose of this section is to regulate and control the subdivision of land in order to promote the public health, safety and welfare of county citizens. The ordinances within speak to specific needs that must be met regarding setbacks, environmental protections, accessibility, fire protection, lot size, and elements of shoreline development related to the Critical Area. There are many aspects in these regulations that can be made more restrictive, or prohibited, for subdivisions in the SLR district. Indeed, there are some areas in the SLR district where additional development should be prevented.

Chapter 155: Zoning. This is the foundation on which the Comprehensive Plan is implemented. The character of the land and appropriate land uses are addressed here. Herein, the County strives toward conserving property value and encouraging orderly development. This section identifies zoning districts and the restrictions associated with them. It has in-depth language regarding environmental protection and other development activities that are not necessarily associated with new subdivisions. The Zoning chapter is the one tool the will enable the County to implement a comprehensive, effective, and realistic set of strategies that address the issues associated with sea level rise.

Developing a Sea Level Risk (SLR) District

Once the County has overlaid the 25-year high inundation scenario onto its topographic maps, it will be apparent which areas will be most affected, and which areas are likely to be affected first. Meanwhile, based upon anecdotal observations, it can be assumed that anything on MD 343 west of Horns Point Road, anything west and south of MD 16, and anything south and west of Henry's Crossroads along Elliott Island Road are the areas most at-risk.

At the minimum, the County should provide for the following needs or activities in the SLR District:

- Prohibit new subdivisions
- Prohibit expansion of footprints on existing developed lots
- Restrict major renovations of structures to cosmetic repairs, re-roofing, and replacement of appliances

- Prohibit use of bermed infiltration ponds for development on unimproved lots
- Restrict septic disposal facilities to state of the art facilities whose integrity would not be compromised by storm surge
- Require all new and existing well heads to be raised above the base flood elevation plus a height to accommodate wave action on storm surge
- Require a minimum two-foot freeboard above base flood elevation
- Until federal agencies can update their maps, assume the 100-year flood elevation to be equivalent to the Category Two storm surge elevation, which will vary depending on the waterway
- 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
- Initiate participation in the NFIP Community Rating System; implement provisions for a buy-out program
- Identify properties for potential buy-out. Rank them in order of level of immediate risk.
- Assess losses forest and identify reforestation sites outside the sea level risk zone
- Assess wetland losses and identify suitable areas to accommodate sea level encroachment and conversion to new wetlands
- Strongly participate with Corps of Engineers projects to restore and/or create barrier islands which act as buffers to the wetlands and mainland behind them.
- Prohibit investment on new infrastructure in the SLR District
- Abandon, relocate, raise, or seal any infrastructure that will sustain damage by inundation

Phase IV: Public Education and Outreach

Probably the hardest thing to do will be to officially tell the residences in sea level rise high risk areas what they most likely already believe and have witnessed first-hand: that the day is soon approaching that their homes will be completely surrounded by water with every high tide, and that the roads to those homes will become difficult to navigate.

For the residents of Andrews, Bishops Head, Crapo, Crocheron, Elliott Island, the Hoopers Islands, Shorter's Wharf, Smithville, St. Thomas, Taylor's Island, Toddville and Wingate, when a south or southwest wind blows in the spring high tide, the water elevation reaches 3.4- 3.5 feet above sea level. And when the water reaches that height, Toddville Road, Maple Dam Road, Shorter's Wharf, Bestpitch Ferry Landing, DeCoursey Bridge Road, Hoopers Neck Road, Hoopersville Road, Tedious Creek Roads, Goose Creek Road, Lakes and Straits/Wingate-Bishops Head Road, and Crocheron Road are overrun by tidal water. Normal spring high tides in these areas run between 2.8 to 3.0 feet above sea level, information which can be found by reading the historical datum for NOAA's McCready Creek and Bishops Head tidal stations at http://tidesandcurrents.noaa.gov/station_retrieve.

The area's residents have responded over time to these infrequent, but increasingly more common, floodings by elevating homes, garages and sheds- first onto piers of cinderblocks, finally by having the house jacked and foundation walls built beneath. Dog kennels and motorcycles are observed sitting on top of septic mound treatment systems. After one of these small surges, residents can be seen standing on front porches looking out at their cars parked along the roadway where tidewater did not overrun the ditch. Children's play equipment near Crapo sits surrounded by floodwater, as do the goat pens in Crocheron.

No one likes to hear the inevitable- that their homes and/or businesses will be cut off from the higher and drier world, leaving them with yards of permanently standing water, mildewed foundations, and loss of access in and out of their communities. However, these people deserve to know- and soon- which of them will face the most immediate risk and how soon they might expect this scenario to play itself out.

Education and Outreach Scenarios. Repetition is a good teacher, and the more ways the same information is conveyed, the more widespread the information will become and the greater it will be understood. This outreach should target all generations and all economic classes.

Mailings. Every property owner receives an annual or semi-annual property tax bill. A fact sheet describing the predicted situation in Dorchester County can be enclosed with the tax billings. For one first class stamp, five sheets of 18 lb letter-size paper can be mailed. Most tax statements now include only three sheets of paper, allowing for another two sheets at no extra postage cost.

Public Service Messages. Most cable companies are required to provide some free cable access for public service purposes. Bay Country Communications is a local provider who often tapes

the County Council meetings. BCC could be requested to broadcast 15 to 30-second messages regarding sea level and sea level risk areas in Dorchester County.

Billboards. They may be an eyesore along the public highways, but they do grab attention. A billboard mural depicting a local scene during a spring high tide or storm surge would certainly grab attention. A catchy slogan, such as “What’s Your Elevation? Sea Level Rise Coming to A Shoreline Near You” would ingrain itself into the subconscious so that people would think about what sea level rise means to them.

In another poster, the left side could show a young child standing in galoshes in tidal water next to a measuring stick. The water measures three inches deep. On the right side, an adult presumably 20 years older, is standing in Wellies in tidal water next to the same, but weathered, measuring stick. The water is now 8 or 10 inches deep.

Town Meetings. Meetings will need to be held to present the aerial and elevation information to local residents as it becomes available. Local residents in the southern part of the County have a long way to drive to get home from work if they work in the Cambridge area or farther. They are not likely to turn around and drive 35 to 45 minutes back to Cambridge for an educational program. Not unless the program is part of a festival with other activities that might detract from the sea level rise program.

To be sure to get the message out to the affected communities, town hall meetings are recommended. These can be held in church halls or fire halls, which are present in every village community. These meetings could be held on weeknight evenings, soon after the dinner hour is over, and should be wrapped up early enough to allow watermen and farmers to keep their normal bedtimes. Meetings could be held early on Saturday mornings, or in the evenings, but not during midday when most people need to go to town to run banking and shopping errands.

Town meetings should provide a brief, but well-illustrated Power Point show that depicts actual site conditions in the area. Fact sheets and maps should be handed out. Questionnaires regarding frequency of flooding and other anecdotal information would help local planners get a feel for areas that are experiencing the most dramatic changes.

People will have questions about what sea level rise will do to them economically and logistically. There will be fears about total economic loss if a home becomes uninhabitable and people cannot afford to move. There will be concerns for access to their homes as roads become more frequently inundated during times when they are away at work or school. Local officials will need to develop meaningful answers about what can or cannot be done, and have suggestions on what people can do to prepare themselves for the inevitable.

Essay Contests. Schools can sponsor essay contests where children write about what they know about sea level rise or how they think it will affect them and their family. Sometimes creative ideas come from such exercises. As often happens, what children learn, they pass along to family.

Technical Assistance. Technical assistance can be provided regarding how to work with or combat the effects of wet soils, developing planting plans to combat erosive conditions, how to sanitize areas with mildew, and other moisture and flooding related issues.

Speaker's Bureaus and Regular Programs. The County agencies could establish a Speaker's Bureau and schedule regular programs that keep repeating the information on expected tidal flooding in the county. There are people who don't read the paper on a daily basis who might miss some of the meetings, but if they knew a meeting was held every other month on the first Wednesday; they could schedule their lives accordingly. Speakers from local agencies as well as scientific experts, insurance agents, and financial institutions, who could speak about how people can cope with the effects of sea level rise.

Planning Timeline

The actions necessary to address sea level rise will be many and will require coordination amongst agencies. Any products that must be created will naturally take time. The following timeline is suggested for focusing on the issues at hand.

Year One

Maps- Using LIDAR, create a map depicting elevations County-wide, starting with the areas south of US 50 and moving next to the Green Point Road area near Secretary.

Using NAIP photography or similar, create a map that overlays elevation data onto orthophoto aerial images of the same areas.

Create a list of tax map and parcel numbers of all properties in the Hoopersville, Fishing Creek, Toddville, Crocheron, Bishops Head, Wingate, Andrews, Crapo, Elliotts Island, Shorter's Wharf, and south Maple Dam Road areas.

Determine how many occupied residential properties lie within the above-listed regions.

Determine how many occupied residential properties lie within elevation 2.0 to 4.0. These are the areas that are periodically inundated by normal spring high tides and wind-drive spring high tide surges.

Apply for grant funding or create a funding source to re-establish bench marks.

Year Two

Meet with National Flood Insurance Program officials regarding requirements to enroll in the Community Rating System so that buyout programs will be a future option. Implement the required strategies to qualify for a CSR rating. Once the rating program is established, advertise to local residents the availability of insurance premium reductions.

Implement code changes to establish a minimum two-foot, preferably a four-foot, freeboard requirement.

Advertise and award bid to re-establish bench marks and re-survey elevations to ground-truth questionable LIDAR data.

Determine which roads lay below elevation 3.5, 4.0, 4.5, and 5.0.

Create a Flooded Road Management Plan to address long-term viability of roads that are continually flooded and expected to be continually flooded by tidal water. Establish which roads are economically feasible for long-term maintenance. Establish a Road Closure strategy for roads where the cost to maintain exceeds the fair market value of occupied properties they serve.

Close roads where a reasonable alternate route exists, such as the southern end of Maple Dam Road to Shorter's Wharf, and Smithfield Road.

Establish Escrow Fund to defer maintenance monies for roads on the Road Closure list with the intention to allow escrowed funds to accumulate to the point where they can be used for a buy-out program. Consider policy to turn over ownership and maintenance responsibility for roads leading to non-occupied residences to the affected property owners (e.g., there is a long length of Goose Creek Road that serves only 2-3 dwellings, none of which appear to be occupied on a permanent basis).

Year Three

Inventory the number of existing septic systems for which there is no replacement technology available, or for where the size of the lot will not permit the installation of improved technology that can withstand periodic inundation. These lots should be first priority for buyout programs.

Inventory the number of wells and well head elevations that are below the Category Two overland surge elevation. This elevation is now believed to be the equivalent to the 100-year flood stage.

Create a Sea Level Risk District (SLR) for inclusion in Comprehensive Plan and promulgate new codes and code changes associated with managing for sea level risk.

With the public hearing process on the SLR District, implement an ambitious public education and outreach program.

Year Four

Implement code changes to require well heads to be adequately sealed and/or raised above Category Two overland surge elevations.

Implement code changes to discontinue the use of Bermed Infiltration Ponds for septic disposal in new communities. Implement code changes to prevent replacement septic systems on lands at immediate risk of sea level rise (a threshold criteria will need to be established).

Implement code changes to prohibit building permits for any footprint expansions or major cost renovations to structures in immediate sea level risk zones.

Implement code changes to prohibit new subdivisions in the SLR District. Implement code changes to prohibit development on unimproved lots that are more than 50% constrained by wetlands. Prohibit the granting of all variances in the SLR District.

Implement code changes to prohibit construction of new homes in the SLR District. At this time a buyout program should have been established.

Every 5- 10 Years, or With Every Comprehensive Plan Update, whichever is sooner.

Update the elevation data against current tidal gage data regarding mean high water and spring high tide elevations.

Financial Assistance

Dorchester County has a small population that is too small to support the infrastructure needs to address sea level risk. The County has 1700 miles of shoreline and 48% of its land mass is wetlands. The costs associated with managing for sea level rise is likely far more expensive than what Maryland's richest metropolitan counties could afford. Therefore, the funding will need to be creative and from varied sources. The highest cost, barring any coastal storm damage, will be the Buyout Program.

Meanwhile, technical assistance will be needed to accomplish survey work, GIS mapping, and developing a Sea Level Risk District and codes. There are grant programs available as well as technical assistance through Chesapeake NEMO. Chesapeake NEMO is a partnership of agencies who can provide planning staff and technical staff to assist in long-range planning efforts.

The following are potential grant sources to help implement some of the action strategies:

Coastal Communities Initiatives. Federal funding through NOAA Coastal Zone Management Program, administered by Maryland Department of Natural Resources Coastal and Watershed Services Division (<http://www.dnr.state.md.us/bay/czm/index.html>). The Coastal Communities Initiative provides financial and technical assistance to local governments to promote the incorporation of natural resource and/or coastal management (e.g. coastal hazards, public access, water-use activities) issues into local planning and permitting activities. Projects that focus on the following areas are given preference during project review:

- Modifying ordinances, codes, plans, and programs to support the goals of local watershed plans.
- Developing local community "greening" strategies (sustainability plans).
- Coordination of natural resource and water resource elements (implementation of HB 1141).
- Revising Critical Area Programs to meet current needs.
- Updating Programs to support local non-point source reduction.
- Developing local coastal hazard plans (shoreline erosion, sea level rise vulnerability) or mapping or modeling to support management options.

Chesapeake Bay Small Watershed Grants. Corporate funding through the National Fish and Wildlife Foundation. These grants can also be utilized for watershed planning purposes.

National Flood Insurance Program Community Rating System. Enrollment in this program enables a local community to become eligible for buyout programs when a damaging storm event occurs. There may also be funding available to buyout properties inventoried as high risk or designated as repetitive risks.

Conclusion

Maryland's most at-risk area for experiencing devastating damages due to sea level rise is Dorchester County. The mean high water elevation there occurs between 2.0 and 2.5 feet; the spring high tide between 3.0 and 3.5 feet. Nearly half the County's flat landscape lies at elevations below 4.9 feet above sea level. When the tide reaches 3.4 feet in south Dorchester, many properties are inundated. When it reaches 3.5 feet, roads are inundated, as well.

Dorchester County is Maryland's second largest county by land mass yet contains its second smallest population. The County is characterized by long, narrow peninsulas that contain large expanses of tidal marsh and nontidal wetlands. In other words, much of the County is already wet and getting wetter. Its landscape is incised by myriads of tidal guts, creeks, ditches, and sloughs, all of which provide avenues for high tides to flow inland and spill over into many adjacent areas.

There are nearly 4,474 residential structures that lie within the County's 100-year coastal floodplain in areas that would be subject to flooding during Hurricane Category One and Two storm surges. Not all these structures are occupied year-round. At the rate of 2.3 persons per household, these structures represent 10,291 citizens- nearly a third of the County's population during the 2000 census. These numbers are significant, but they are more than just numbers. They represent the everyday lives of people and families; people living in homes, not houses; people working to earn a living in order to live their lives. Any change to these numbers results in dramatic changes to families, homes, and a way of life.

Sea level rise does not just change the landscape from high ground to low, wet ground or from salt marsh to open water. Sea level rise destroys economies. It destroys livelihoods and lifestyles. It causes whole communities to disappear from the face of the earth. Like the mythical city of Atlantis, communities in Dorchester County are being buried by the sea.

It does not matter whether one believes global warming is manmade or not. It does not matter whether one believes global warming exists or not. It doesn't matter whether one believes sea level rise is one foot per century or three feet per century. What matters is that the science has documented that sea level is rising and continues to rise. Even if the global population rose to the occasion and took drastic measures to stop global warming, it would be decades before the temperature would drop to a point where sea level rise would stop.

Sea level rise will move shorelines inland. It will flood areas adjacent to shorelines. These are the areas favored by the human race for settlement. These are the areas where coastal populations have congregated. These are the areas where the most monetary damages will occur, and where the greatest number of lives will be altered.

There will come a point in time where waterfront property will no longer be desirable due to its liability and short life expectancy. There will be a time when it will be next to impossible to sell a waterfront parcel due to that liability. Government finances based on property tax assessments

will be faced with making adjustments in tax rates when people stop coveting waterfront properties. Government budgets will experience serious economic declines. It does not matter to the tide if the structure next to the shoreline is a \$2 million mansion or a single-wide trailer. It does not matter whether the structure damaged during the last storm has been raised higher to ride out the next storm, or improved to last another 50 years. It may not be a storm that will end the livability of that home. It could very well be the loss of the yard around the house and the inaccessibility of the road to that house that force its occupants to live elsewhere.

Who is responsible for absorbing the loss when homes become surrounded by the daily tide? The property owner, who may be elderly and not have the income to start over? The property owner whose solvency is tied to his property equity? The employee whose employer must relocate the business many miles away, leaving a workforce behind who cannot sell their flood-damaged properties?

What responsibility does government own, when the science is there to alert officials to the problem that is not only coming their way, but has already arrived? What role does government play in helping these people understand the extent of the disaster awaiting them? What steps must government take in helping its citizens plan for retreat from the encroaching tide, for relocation and dealing with the economic crises that relocation represents?

Today, somewhere in Dorchester County the high tide came into someone's yard just a little bit farther than it has ever done before. The citizens of Dorchester County must ask themselves, "What is MY Elevation?"

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