

State of Maryland Climate Change and *Coast Smart* Construction Infrastructure Siting and Design Guidelines

January 2014



Martin O'Malley, Governor



MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

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Background

This report is a product of the Climate Change and *Coast Smart* Construction Working Group; a subgroup of the Maryland Commission on Climate Change, Adaptation and Response Working Group. The report was prepared in response to directives outlined in State of Maryland, Gubernatorial Executive Order 01.01.2012.29.

Climate Change and *Coast Smart* Construction Working Group

Numerous State agency staff, as well as other interested parties and individuals, contributed immensely to the preparation of this report. A special thanks is due to the following members of the Climate Change and *Coast Smart* Construction Working Group: Meg Andrews, Don Halligan (Department of Transportation); Chuck Beall (Daft McCune Walker); Barbara Boumboulis (State Treasurer's Office); Terri Garraty, Fiona Burns (Department of Budget and Management); Kate Charbonneau, Kelly Collins, Zoë Johnson, Jordan Loran, Terry Martin, Sandi Olek, Ren Serey, Kate Skaggs, Helen Stewart, Nick Kelly, Alexandra Olaya, Jackie Koehn (Department of Natural Resources); La Verne Gray, Peter Conrad, Chuck Boyd, Jason Dubow (Department of Planning); David Costello, Jeffrey Fretwell, Dave Guignet, Kevin Wagner (Department of the Environment); Dennis Dare (Ocean City); Devon Dodson, Anne Eisele, Kristen Ahearn (Maryland Energy Administration); Cecelia Donovan, Mike Herzberger, Kenna Oseroff (Maryland Environmental Service); William Gluck, Bart Thomas, Mostafa Izadi (Department of General Services); Elizabeth Habic, Gregory Slater (MDOT, State Highway Administration); Richard Higgins, Tim Lavalley (Department of Business and Economic Development); Elizabeth Hughes, Nell Ziehl (Maryland Historical Trust); Mark James (Maryland Emergency Management Agency); Nancy Jones (UMD Center for Environmental Science); Shawn Kiernan (Maryland Port Administration); Les Knapp (Maryland Association of Counties); Lisa Lowe, Ken Miller (Department of Information Technology); Ed Landon, Caroline Varney-Alvarado (Department of Housing and Community Development); Patrick McMahon, John Newton (MDOT, Transit Administration); Ashish Solanki, Wayne Schuster (MDOT, Aviation Administration); and Ashley Valis (Office of the Governor).

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Availability

This report is available in electronic format online at dnr.maryland.gov/climatechange and climatechange.maryland.gov. Print copies are available upon request to the Maryland Department of Natural Resources.

Acronyms

EO: Executive Order

CRS: Community Rating System

DBED: Department of Business and Economic Development

DBM: Department of Budget and Management

DFRIM: Digital Flood Insurance Rate Map

DGS: Department of General Services

DHCD: Department of Housing and Community Development

DNR: Department of Natural Resources

DoIT: Department of Information Technology

FEMA: Federal Emergency Management Agency

HMA: Hazard Mitigation Assistance

IAC: Interagency Committee of Public School Construction

LiMWA: Limit of Moderate Wave Action

MCCC: Maryland Commission on Climate Change

MDE: Maryland Department of the Environment

MEMA: Maryland Emergency Management Agency

MDOT: Maryland Department of Transportation

MDP: Maryland Department of Planning

MTP: Maryland Transportation Plan

NOAA: National Oceanic and Atmospheric Administration

NFIP: National Flood Insurance Program

SHA: State Highway Administration

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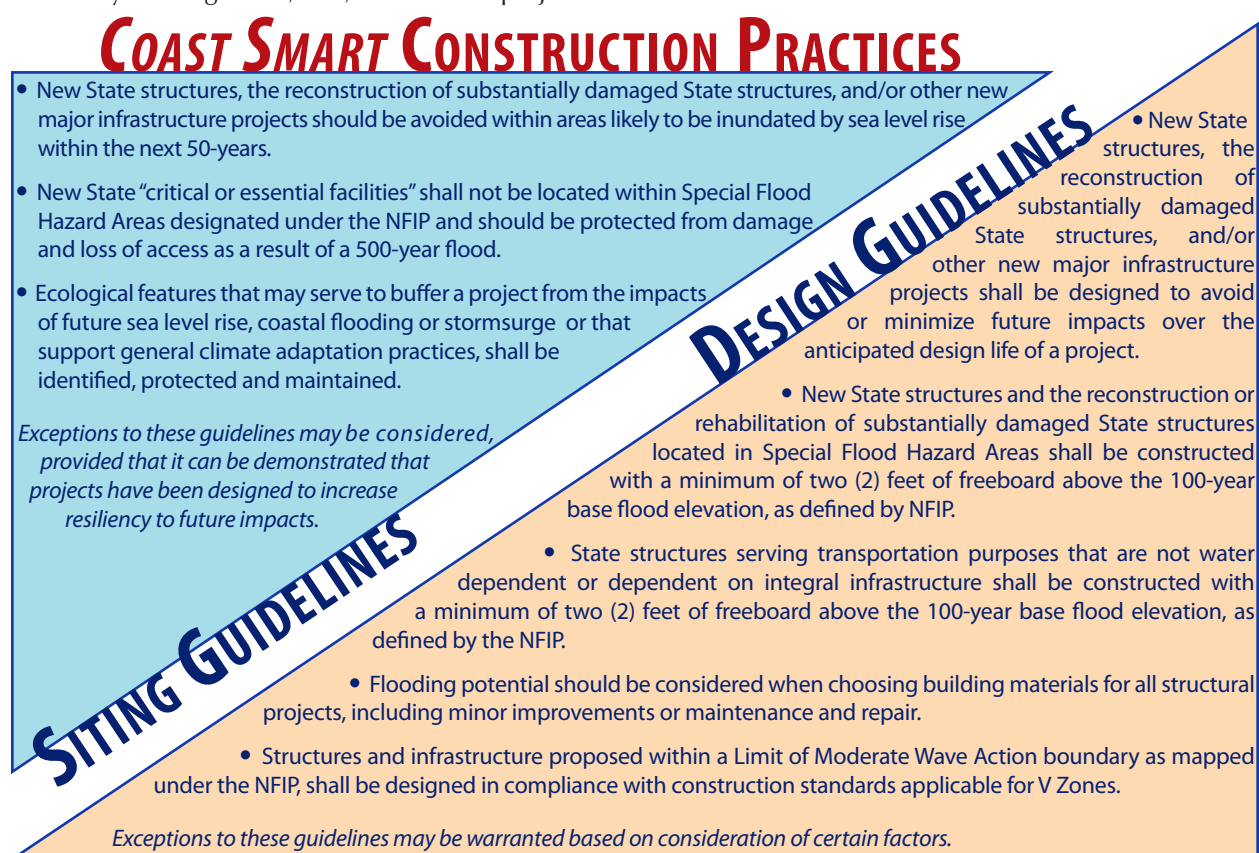
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Executive Summary

INTRODUCTION

To protect Maryland's people, property, natural resources, and public investments in light of changing conditions, Governor Martin O'Malley issued the Climate Change and "Coast Smart" Construction Executive Order (EO) in December 2012. The EO enacts a number of policy directives to increase the resilience of the State's investments to sea level rise and coastal flooding. Section 5 of the EO directed the Maryland Department of Natural Resources (DNR), Chair of the Maryland Commission on Climate Change's Adaptation and Response Working Group, to provide "Coast Smart" construction guidance, including recommendations for the siting and design of State structures, as well as other infrastructure-based projects. Contained in this report are the recommendations of Climate Change and Coast Smart Construction Working Group, convened by DNR to assist with this task.

In short, the State should employ *Coast Smart* practices when constructing all new State structures, reconstructing or rehabilitating substantially damaged State structures, or making other major infrastructure improvements in Maryland's coastal zone, such as roads, bridges, sewer and water systems, drainage systems and essential public utilities. Similar measures should be applied to non-State structure or infrastructure projects if partially or fully funded by State agencies; and, to non-State projects located on State-owned lands.



State agencies should take the necessary steps to incorporate the recommended *Coast Smart* practices into all appropriate architecture, engineering, construction and design manuals, State planning programs, regulatory programs, permitting and review processes, disaster planning and response, capital budgeting, and State grant and loan programs. The following recommendations are intended to guide these actions and more.

State Policy & Practice

State-Agency Oversight. Maryland's Smart Growth Sub Cabinet should provide oversight to individual State agencies as they undertake the process to institutionalize the *Coast Smart* Siting and Design Guidelines.

Implementation Plans. State agencies should develop or amend an agency specific implementation plan. This plan should include the status and next steps toward incorporation of the *Coast Smart* Siting and Design Guidelines into applicable State policy and programs; the identification of appropriate categorical exceptions; and, cost, size and use application thresholds.

Review Authority. The State should appoint a formal body with authority to develop a process to allow a unit of State government or a capital grant or loan recipient to obtain an “exception” from strict application of the recommended *Coast Smart* Siting and Design Guidelines. At a minimum, the exception process should provide for consideration of the siting and design guideline exception criteria, as recommended in the full report; proposed structural and ecosystem-based resiliency measures; cost-benefit analysis; socio-economic considerations; historic preservation considerations; statutory or regulatory conflicts; external grant funding criteria; and mapping error.

State Grant and Loan Programs. The *Coast Smart* Construction Siting and Design Guidelines should be used to guide allocation of State funding, primarily in the form of grants and loans, for non-State structure and infrastructure projects.

Tracking and Reporting. The State should establish an annual reporting and review process to monitor and track individual State agency actions related to implementation of the policy and practices, including siting and design guideline exemption determinations.

Funding Needs. The State should address funding and revenue constraints to ensure adequate support for current and future infrastructure protection needs.

Nature-Based Protection Measures. DNR should take steps to identify and assess key natural features, such as wetlands, vegetated and forested buffers, etc., that protect coastal communities and other built environments and prioritize and target, as appropriate, for conservation and restoration purposes.

Data, Mapping and Modeling

Sea Level Rise Scenarios. All State agencies should utilize the sea level rise scenarios set forth by the Maryland Commission on Climate Change Scientific and Technical Working Group (2013) in the application of the *Coast Smart* planning principles, policy framework, and siting and design guidelines.

Climate Science. The Scientific and Technical Working Group must stay abreast of the latest climate science; and, as warranted, periodically update sea level rise scenarios and planning guidance using the best scientific data available.

Decision-Support Tools. The State should continue to develop State-level data and decision support tools to better understand, prepare for and respond to climate change and sea level rise.

Data and Mapping Products. A number of other specific data products should also be developed, including: an analysis of the 1% annual change stillwater elevation data combined with 50-year and 100-year sea level rise projections; enhanced storm surge risk products that factor in sea level rise; and, refined sea level rise inundation area mapping, derived from 2013-14 LiDAR imagery acquisitions.

Education & Outreach

Cost-Benefit Guidance. The State should develop detailed cost/benefit guidance to better inform State infrastructure investment decisions and implementation of the recommended *Coast Smart* Siting and Design Guidelines.

Education Campaign. The State should launch a *Coast Smart* Construction Education Campaign to engage county and municipal officials, determine the needs of local jurisdictions, and convey the need for improved resilience.

NEXT STEPS

The planning principles, policy framework, and siting and design guidelines contained in this report, should be used to guide what, where and how State infrastructure investments decisions are made within vulnerable areas. Following on the heels of the Climate Change and *Coast Smart* Construction EO, implementation of the recommendations laid out in this report are critical steps towards ensuring the protection of Maryland’s people, property, natural resources, and public investments and to certify safe, sound and wise investments over time.



Source: UMCES, IAN

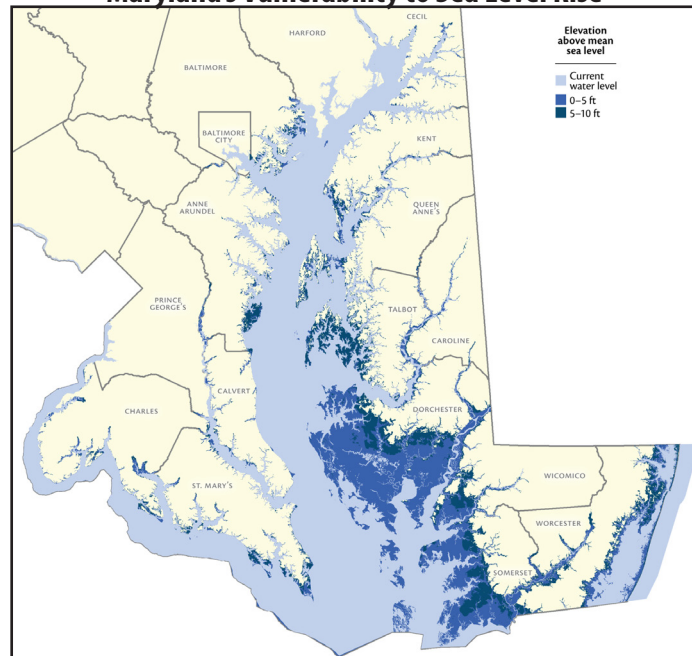
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I. Introduction

Need for Resilience

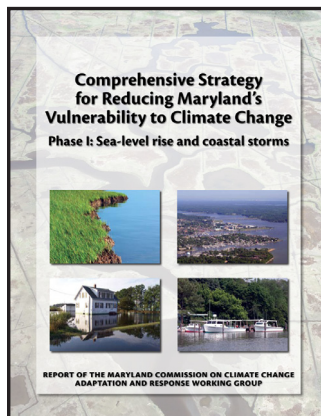
Due to its low-lying topography and proximity along the mid-Atlantic coast, the State of Maryland is one of the most vulnerable States in the country to sea level rise. Tide gauge measurements show that Maryland has experienced approximately one-foot of sea level rise over the last century; and alarmingly, impacts such as increased coastal flooding, inundation of low-lying lands, more shoreline erosion, and salt-water intrusion are already being detected. Over the next century, the rate of sea level rise within Maryland waters is expected to more than double, resulting in a 1.4 foot increase of relative sea level rise by 2050 and 3.7 feet by 2100 (Boesch et al., 2013). The combined forces of regional land subsidence, expansion of the volume of the ocean due to warming, melting glaciers, and changes in ocean currents all play a part. As sea level and other climate change impacts continue to increase in the years to come, Maryland's people, property, natural resources, and public investments will be ever more at risk.

Maryland's Vulnerability to Sea Level Rise



Source: MCCC, 2008

Maryland's Action on Climate Change



In 2007, Governor Martin O'Malley launched the Commission on Climate Change (MCCC), charting Maryland's course as a national leader on climate science, carbon mitigation and climate change adaptation. The notable release of the MCCC's Climate Action Plan in 2008 was the impetus behind many state-level actions, including the passage of Maryland's Greenhouse Gas Reduction Act in 2009. A key component of the Climate Action Plan is its Adaptation Strategy which, details the actions necessary to protect Maryland's environmental heritage, public safety and future economic well-being from the impacts of climate change.

The Strategy is comprised of two components. The first (Phase I) is focused on strategies to reduce Maryland's vulnerability to sea level rise and coastal storms and the second (Phase II), centers on building ecological, societal and environmental resilience to changes in temperature and precipitation within a range of sectors (i.e., agriculture, water resources, etc.). Implementation of both components is well

underway. Recent accomplishments include: passage of the Living Shoreline Protection Act; launch of the *Coast Smart* Communities Initiative; revisions to the State's land acquisition program, *GreenPrint*, to target land to allow for landward migration of wetlands in response to sea level rise; and, the designation of Climate Change Impact Areas in *PlanMaryland*, Maryland's recently adopted State Development Plan.

In July 2013, Maryland released its final Greenhouse Gas Reduction Plan, which lays out a comprehensive framework for reducing greenhouse gases in Maryland by 25% of 2006 levels by the year 2020. Chapter 8 of the Greenhouse Gas Reduction Plan details Maryland's change adaptation strategy and includes in-depth information on Maryland's current and planned progress to implement key actions. The report is available online at climatechange.maryland.gov.

Greenhouse Gas Reduction Plan Chapter 8: Adaptation



State Owned and Critical Facility Exposures to Sea Level Rise

County/City	State Owned Facilities			Critical Facilities			Square mi. (land area)
	High Risk (0-2 ft RSLR)	Moderate Risk (2-5 ft RSLR)	Low Risk (5-10 ft RSLR)	High Risk (0-2 ft RSLR)	Moderate Risk (2-5 ft RSLR)	Low Risk (5-10 ft RSLR)	
Anne Arundel County	7	4	6	151	92	95	415.9
Baltimore County	6	1	4	70	55	122	598.6
Calvert County	1	0	20	24	22	13	215.2
Caroline County	0	0	333	47	8	48	320.1
Cecil County	0	0	2	57	21	22	348.1
Charles County	0	0	0	28	6	6	461.0
Dorchester County	5	14	45	123	56	39	557.5
Harford County*	—	—	—	—	—	—	440.4
Kent County	0	1	1	44	33	24	279.4
Prince George's County*	—	—	—	—	—	—	485.4
Queen Anne's County	0	1	9	75	54	49	372.2
Somerset County	8	55	21	69	66	36	327.2
St. Mary's County	150	76	3	40	27	42	361.3
Talbot County	1	0	23	61	33	40	269.1
Wicomico County	0	19	3	49	42	56	377.2
Worcester County	2	98	1	71	180	148	473.2
City of Baltimore*	—	—	—	—	—	—	80.0
Grand Total	180	269	471	909	695	740	6381.9

*Vulnerability data not available from MDDNR

Source: MEMA, 2011

Infrastructure at Risk

Maryland has thousands of miles and acres of developed property in future sea level rise vulnerable areas. These areas contain billions of dollars worth of public and private investments at risk to future damage from sea level rise, coastal flooding and stronger coastal storms. The need and timeliness of

preparing for such impacts has been heightened after seeing the devastation caused by Hurricanes Isabel in 2003 and Sandy in 2012. The cumulative cost to Maryland taxpayers of severe weather events in 2011 and 2012 was over \$70 million. Twenty-three counties in Maryland required federal assistance in the wake of Sandy. State and local governments need to continue to work hard to plan and prepare for the very likely possibility that the State may see more storms like Sandy in the future.

Recognizing the need to make safe, sound and wise investments in light of changing conditions, Governor O'Malley signed the Climate Change and *Coast Smart* Construction Executive Order (EO) 01.01.2012.29 in December 2012, enacting a number of policy directives to increase the resilience of the State's infrastructure investments to future sea level rise and coastal storms. In particular, the EO directs that all State agencies consider the risk of coastal flooding and sea level rise when they design capital budget projects and charges the Department of General Services with updating its architecture and engineering guidelines to require new and rebuilt State structures are elevated two or more feet above the 100-year base flood elevation.

Working Group Charge

The EO charges the Maryland Department of Natural Resources (DNR) to work with the MCCC, local governments and other parties as appropriate, to develop:

1. Recommendations for additional *Coast Smart* criteria for the siting and design of new, reconstructed, or rehabilitated State structures, as well as other infrastructure improvements such as roads, bridges, sewer and water systems, drainage systems, and essential public utilities;
2. Recommendations concerning the potential application of *Coast Smart* guidelines to non-State infrastructure projects that are partially or fully funded by State agencies; and
3. Other recommendations for executive and/or legislative action.

The Process

In February 2013, DNR convened the Climate Change and *Coast Smart* Construction Working Group to undertake specific tasks as outlined in the EO. Included in the Group were representatives from Maryland Departments of Environment, Housing and Community Development, Transportation, Planning, General Services, Budget and Management, Business and Economic Development, Information Technology and the Maryland Energy Administration, Historical Trust, Emergency Management Agency, as well as the Maryland State Treasurer's Office, University System of Maryland, Maryland Environmental Service, Maryland Municipal League and Maryland Association of Counties. In all, 45 representatives from State and local departments, offices and organizations actively participated in the process to develop the following recommendations.

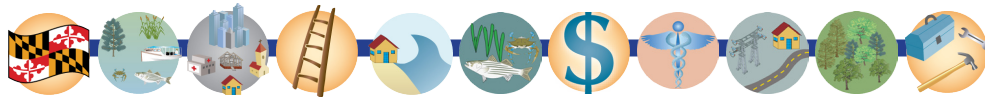
II. Coast Smart Construction — Siting and Design Guidelines

As a guide to how, where and what we build in future sea level rise vulnerable areas, the following planning principles, policy framework, siting and design guidelines are recommended.

Planning Principles

To protect Maryland's environmental heritage, public safety and future economic well-being and to guide the fundamental intent of the Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change (2008), the MCCC's Adaptation and Response Working Group recommended that the Governor and the Maryland General Assembly take legislative and policy actions to:

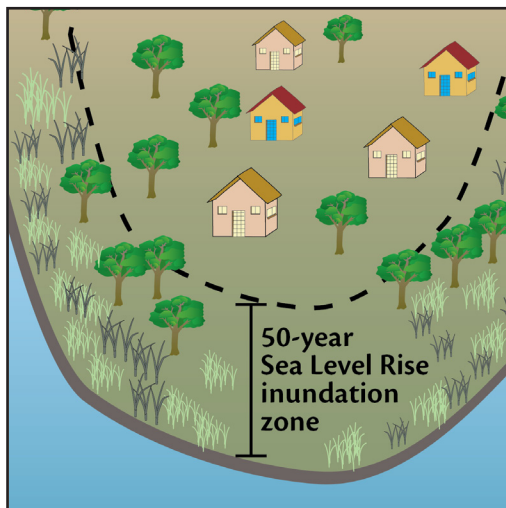
- Avoid and/or reduce impact to the existing built environment, as well as to future growth and development in vulnerable coastal areas;
- Shift to sustainable economies and investments; and, avoid assumption of the financial risk of development and redevelopment in highly hazardous coastal areas;
- Enhance preparedness and planning efforts to protect human health, safety and welfare; and
- Protect and restore Maryland's natural shoreline and its resources, including its tidal wetlands and marshes, vegetated buffers, and Bay Islands, that inherently shield Maryland's shoreline and interior.



Policy Framework

Guided by the principles outlined above, the State should employ *Coast Smart* practices when constructing all new State structures, reconstructing or rehabilitating substantially damaged State structures, or making other major infrastructure improvements in Maryland's coastal zone, such as roads, bridges, sewer and water systems, drainage systems and essential public utilities.

For the purposes of this document, *Coast Smart* means a practice in which, preliminary planning, siting, design, construction, operation, maintenance, and repair of a structure avoids or, in the alternative, minimizes future impacts associated with coastal flooding and sea level rise. *Coast Smart* includes both siting and design guidelines that are applicable throughout the entire life cycle of a project. Similar measures should be applied to non-State structure or infrastructure projects if partially or fully funded by State agencies; and, to non-State projects located on State-owned lands.



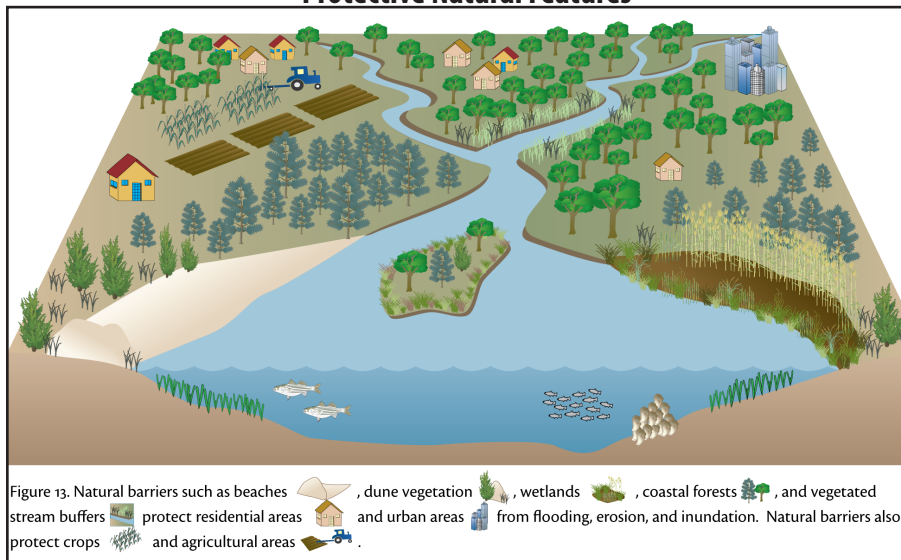
Siting Guideline Depiction

Siting Guidelines

The following specifications related to the location of a structure, infrastructure or use on a lot or parcel or within a larger geographic area are recommended:

1. Construction of new State structures, the reconstruction of substantially damaged State structures, and/or other new major infrastructure projects should be avoided, to the fullest extent practicable, within areas likely to be inundated by sea level rise within the next 50-years.
2. New State "critical or essential facilities" shall not be located within Special Flood Hazard Areas designated under the National Flood Insurance Program (NFIP) and be protected from damage and loss of access as a result of the 500-year flood.
3. Ecological features that may serve to buffer the project from the impacts of future sea level rise, coastal flooding or

Protective Natural Features



Source: MCCC, 2011

or storm surge (e.g., vegetated or forested buffers, dunes, wetland adaptation areas) or that support general climate adaptation practices (e.g., habitat adaptation areas), shall be identified, protected and maintained.

4. Whenever possible, on-site mitigation measures should be directed towards enhancing, restoring or creating ecological features to provide additional protection against future sea level rise and coastal storm impacts.

Siting Guideline Exception Criteria

Exceptions to the Siting Guidelines, outlined above, may be considered for the following project types, provided that it can be demonstrated that projects have been designed to increase resiliency to future impacts:

- a. *Water-dependent uses.* Projects that require continued direct access to the water as an integral part of the use, or facilities that directly support water dependent uses.
- b. *Existing transportation system assets.* Projects that support the continued function of existing transportation system assets.
- c. *Passive public access.* Projects that provide either recreational or scenic access to water bodies or shoreline areas which, need to be within a flood zone for their purpose.
- d. *Temporary structures or uses.* Structures intended to be in place for less than 180 consecutive days in any given calendar year or will be removed at the end of a construction project.
- e. *Stabilization projects.* Actions to secure and maintain assets, structures, infrastructure, and natural and cultural resources to prevent additional damage and to prevent future resource/facility damage; efforts to mitigate a safety or environmental hazard; sand dune and beach restoration; mold remediation; facility weatherization; silt fencing; and minor repairs and restorations.



Boatyard: water-dependant use

CURTIS BRANDT

f. Maintenance, Repair, Renovation and Rehabilitation of Existing Structures. Exceptions for these activities should be based on an analysis of the scope, function and importance of the project, including historic and cultural preservation considerations, and the extent of damage; provided, that it can be demonstrated that measures have been taken to ensure the project is designed to increase resiliency to future impacts.

Design Guidelines

The following structural specifications related to the shape, size, or form of construction practice guidelines are recommended:

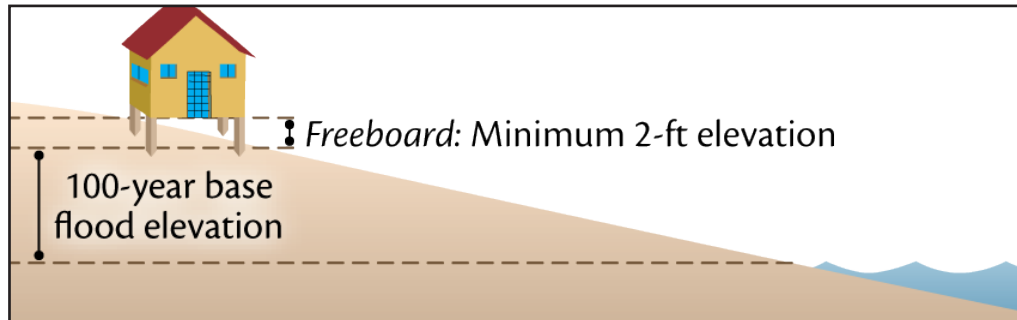
1. To avoid or minimize preventable damages and exposure of State resources to risk, all new State structures, the reconstruction of substantially damaged State structures, and/or other new major infrastructure projects shall be designed to avoid or minimize future impacts associated with future sea level rise, coastal flooding and storm surge over the anticipated design life of a project.

2. All new State structures and the reconstruction or rehabilitation of substantially damaged State structures located in Special Flood Hazard Areas shall be constructed with a minimum of two (2) feet of freeboard above the 100-year base flood elevation, as defined by the NFIP. Users should take note that the Regulatory floodplain maps along the Maryland shoreline are being revised by Federal Emergency Management Agency (FEMA). This revision began in 2011 and should be completed sometime in 2015. For State purposes, the regulatory 100-year floodplain elevation is defined on the Flood Insurance Rate Map (FIRM) or Digital Flood Insurance Rate Map (DFIRM) that will be in effect at the time construction will begin.



Damage from Hurricane Isabel

Freeboard Standard



Design guideline depiction

3. State structures serving transportation purposes that are not water dependent or dependent on integral infrastructure shall be constructed with a minimum of two (2) feet of freeboard above the 100-year base flood elevation, as defined by the NFIP.

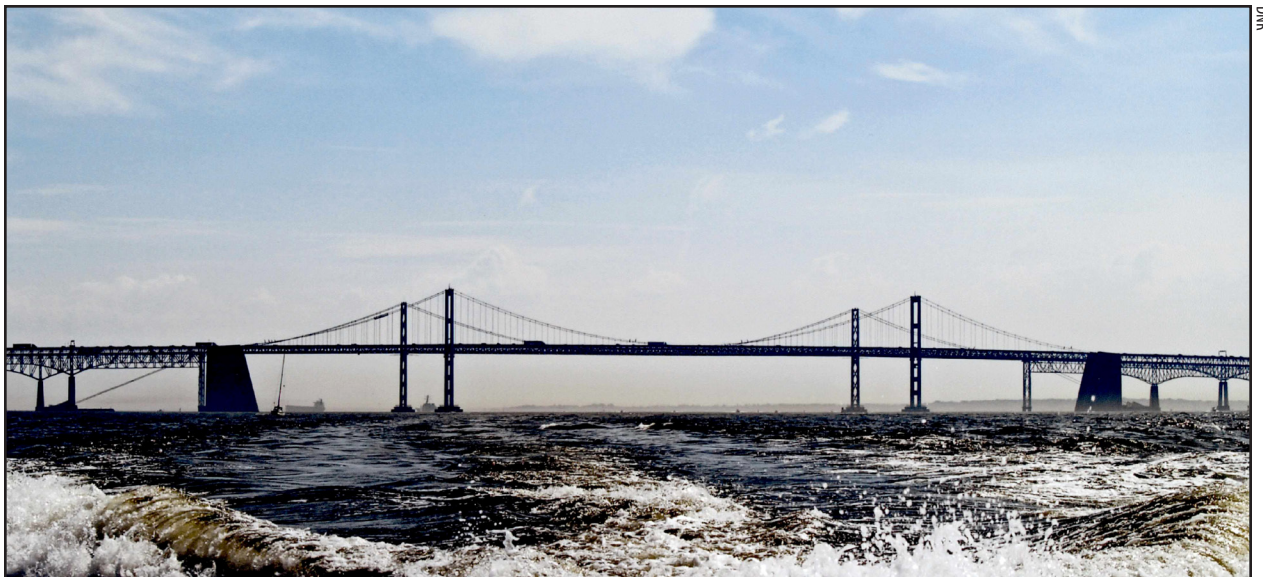
4. Flooding potential should be considered when choosing building materials for all structural projects, including minor improvements or maintenance and repair, as corrosion and other environmental and health consequences can become a concern for materials subjected to flood waters (MDE, 2010). Utilize FEMA standards (44CFR60.3(c)(3)(ii)) for dry-proofing or wet-proofing parts of a structure or portion of infrastructure located below base flood elevation to prevent or minimize the effect of coastal flooding (MDE, 2010).

5. Structures and infrastructure proposed within a Limit of Moderate Wave Action (LiMWA) boundary, also known as the “Coastal A Zone,” when mapped under the NFIP shall be designed in compliance with construction standards applicable for V Zones. The LiMWA is a boundary that identifies the landward location of the 1.5 ft wave height delineating a zone called the “Coastal A Zone” where wave damage is substantial.

Design Guideline Exception Criteria

Exceptions to the Design Guidelines, as outlined above, may be warranted based on consideration of the following factors:

1. Danger that materials may be swept onto other lands to the injury of others;
2. Danger to life and property due to flooding or erosion damage;
3. Susceptibility of the proposed structure or infrastructure and its contents to flood damage and the effect of such damage to the State of Maryland;
4. Importance of the services to the State of Maryland provided by the proposed structure or infrastructure;
5. Availability of suitable alternative locations that are subject to a lower risk of flooding or erosion damage;
6. Necessity or benefits of a waterfront location;
7. Compatibility of the proposed use of the structure or infrastructure with existing and anticipated development;
8. Need to maintain eligibility or designation as a historic structure as defined by the U.S. Department of the Interior and/or the Maryland Historical Trust;
9. Safety of access to and from a site, facility or the structure or infrastructure by passenger and emergency vehicles during a flood;
10. Expected heights, velocity, duration, rate of rise, and sediment transport of the floodwaters and the effects of any wave action expected at the site;
11. Costs of providing government services during and after flood conditions, including maintenance and repair of public utilities and facilities such as sewer, gas, electrical, and water systems, and streets and bridges;
12. Comments provided by the Maryland Department of Transportation (MDOT) regarding the application of freeboard requirements on the transportation function of a given structure;
13. Comments provided by the Maryland Department of the Environment (MDE) and the NFIP State Coordinator.



The Chesapeake Bay Bridge

III. Institutionalization into State Policy and Programs

The process to institutionalize consideration of the planning principles, policy framework and siting and design guidelines into all appropriate planning, design and construction processes should begin immediately. Recognizing that each agency administers State programs differently based on its mission, the incorporation of these guidelines into the following State programs should be accomplished by each respective lead agency, as follows:

Architecture, Engineering, Construction and Design Manuals

Procedural Manual for Professional Services

The Procedural Manual serves as a guide for providing professional services during all phases of design and preparation of contract documents for capital projects involving the construction, alteration or renovation of State buildings with an estimated construction cost greater than \$2 million. It is intended that the procedures also be followed to the fullest extent practicable for other State public improvements such as facilities renewal projects, special structures, roads, utilities, and site improvements.

Chapter II, Section 6 of the Manual outlines Coastal/Flood Plain Design Requirements in two subsections: 6.1 Chesapeake Bay Critical Area Consideration and 6.2 Climate Change and *Coast Smart* Construction. Appendix C of the Manual covers Floodplain Management Criteria for Flood Prone Areas. The Maryland Department of General Services (DGS) should incorporate the recommended *Coast Smart* Construction Siting and Design Guidelines into Chapter II, Section 6 as appropriate.

State School Construction Manuals

The University System of Maryland, St. Mary's College, the Interagency Committee on Public School Construction, and Morgan State College should incorporate the recommended *Coast Smart* Construction Siting and Design Guidelines into all appropriate administrative procedures and policy guidelines as well as their architecture, engineering, construction and design manuals.

Regulatory Programs

Chesapeake and Atlantic Coastal Bays Critical Area Act

In accordance with EO 01.01.2012.29, the Critical Area Commission for the Chesapeake and Atlantic Coastal Bays is currently undertaking the process to evaluate existing regulations and policies for State Agency Actions Resulting in Development on State-Owned Lands and the adoption of new or revised provisions that address climate change and the risk of future sea level rise and other extreme weather-related impacts. During this process, consideration should be given to the recommended *Coast Smart* Construction Siting and Design Guidelines, as outlined in this report.



State Planning, Permitting and Review

PlanMaryland

PlanMaryland, the State Development Plan for the State of Maryland, serves as a guide to the economic and physical development of the State. As provided in EO 01.01.2011.22, PlanMaryland is to make State policies on development transparent so local governments can more efficiently access State resources. State agencies are to also consider PlanMaryland when making decisions about actions that affect development in the State. The Climate Change Impact Area designation process has been incorporated into PlanMaryland. These areas include: 50 and 100-year sea level rise inundation zones; 100-year floodplain; and Category 1-4 storm surge risk zones. Climate Change Impact Areas are currently being used by State agencies and local governments to identify vulnerable areas, as well as areas to target for implementation of climate change and sea level rise resilience measures.

PlanMaryland provides a framework for a collaborative process between State and local governments to address climate change and sea level rise impacts. The process to implement PlanMaryland is being used to facilitate the evaluation of State resource allocation and policies in Climate Change Impact Areas, as well as coordination with local governments. The recommended *Coast Smart* Siting

and Design Guidelines and associated Exception Criteria should be used as the framework to evaluate and guide State investment decisions within these areas.

State Clearinghouse

The Maryland State Clearinghouse for Intergovernmental Assistance (Clearinghouse) manages the review and coordination process for projects and grants in accordance with Presidential EO 12372 and Gubernatorial EO 01.01.1983.17. Designated as the State Single Point of Contact, the Clearinghouse functions as a conduit for enabling communication among federal, State and local governments to direct and sustain growth in Maryland to those areas already supported with the necessary infrastructure and/or identified for future growth. This is achieved by providing a comprehensive review of proposed development projects in Maryland at varying stages.

The process fosters partnerships at the different levels of governments and affords one-stop access to the views of government officials. In addition, citizens, State agency project reviewers and local governments are provided the opportunity to learn about and comment on the proposed projects to ensure they are consistent with agency, State and local plans, programs and objectives. The Clearinghouse is currently evaluating its review and coordination process to identify opportunities to enhance its effectiveness fostering communication among federal, State and local agencies. As a component of this effort, the Clearinghouse is considering revisions and enhancements to its process, as appropriate, regarding projects and grants that are located in or affected by the PlanMaryland Climate Change Impact Areas. As part of this ongoing process, the Clearinghouse should also integrate consideration of the *Coast Smart* Siting and Design Guidelines, as recommended in this report.

Maryland Transportation Plan

In accordance with State and federal statutory requirements, the Maryland Transportation Plan (MTP) serves as a guide and policy framework and establishes a context for transportation investment that supports Statewide goals and objectives. The current MTP contains the following objectives:

- Institutionalize the consideration of future sea levels and storm conditions in prioritizing infrastructure investments in coastal areas; and
- Enhance preparedness and planning efforts to protect human health, safety and welfare in light changing climate conditions.

MDOT's modal agencies have incorporated consideration of climate impacts into their existing project planning processes. The State Highway Administration (SHA) and the Maryland Transportation Authority (MDTA) have developed a climate change adaptation strategy and implementation plan to address severe weather and climate change impacts to the State maintained highway network. This plan was completed in 2012 and will be utilized to address the results of the vulnerability assessment, currently underway by the SHA.

SHA received a grant in April 2013 to pilot a study to further develop the Federal Highway Administration, "Climate Change & Extreme Weather Vulnerability Assessment Framework." The vulnerability assessment is being conducted to evaluate the entire State-maintained network and analyze areas where reoccurring flood events occur. Data collection and mapping applications developed during the pilot will provide the agency with additional information to further the integration of climate change vulnerability assessments into agency practices. Selected sites will be evaluated for potential engineering-design solutions and other sites may be recommended for further study to determine the best solution for resolving the problem. Additionally, MDOT modal administrations are developing plans to include climate impacts into the pre-planning process for compliance with the National Environmental Policy Act. These processes will be finalized to align with forthcoming guidance from the President's Council on Environmental Quality. In undertaking the activities detailed above, the recommended *Coast Smart* Siting and Design Guidelines should be used as the framework to further analyze, evaluate and guide MDOT modal administration climate change and sea level rise planning efforts.

Disaster Planning and Response

Maryland State Hazard Mitigation Plan

Under the planning requirements of the Disaster Mitigation Act of 2000 (44 CFR 201.4), the 2011 Maryland State Hazard Mitigation Plan Update serves as guidance for hazard mitigation for the State of Maryland. Its

State and Critical Facilities within FEMA 100-year flood zone

County/City	Number of Critical Facilities	Critical Facilities Building and Contents Values	Number of State Facilities	State Facilities Building and Contents Values
Anne Arundel County	443	\$1,103,200	16	\$25,137,983
Baltimore County	717	\$9,734,000	63	\$184,312,142
Baltimore City	1,049	\$149,117,733	106	\$1,127,435,779
Calvert County	55	\$2,445,813	5	\$1,935,284
Caroline County	458	\$4,581,227	333	\$106,551,157
Cecil County	265	\$1,308,667	4	\$149,816
Charles County	75	\$0	4	\$496,269
Dorchester County	203	\$7,335,333	19	\$1,990,181
Harford County	319	\$29,786,800	3	\$117,089
Kent County	86	\$2,544,400	1	\$974,500
Prince George's County	749	\$7,488,840	6	\$13,340,297
Queen Anne's County	136	\$5,587,480	1	\$0
Somerset County	184	\$588,267	62	\$15,540,817
St. Mary's County	330	\$10,209,200	227	\$531,629,696
Talbot County	149	\$1,521,653	20	\$6,573,363
Wicomico County	274	\$2,311,067	22	\$86,973,263
Worcester County	398	\$7,045,373	46	\$10,669,632
Grand Total	7,484	\$321,160,506	966	\$2,167,483,376

Source: MEMA, 2010

and each hazard's ranking in local hazard mitigation plans. The plan also includes mitigation strategies to address identified vulnerabilities; provide a thorough capability assessment; and concludes with plan implementation and maintenance procedures.

As a component of the 2011 Update, exposure and risk to coastal flooding and sea level rise was evaluated by intersecting the MDE and DNR hazard layers with the Maryland critical and State-owned facility geospatial database. Risk to State-owned and critical facilities was evaluated for 22 facility categories. The plan identified 3 principle actions that align with the *Coast Smart* planning principles and policy framework:

- Inventory hazard risks to State-owned facilities and identify their risks to hazards including climate change related hazards (e.g., sea level rise, coastal and riverine stream erosion, and increased flooding);
- Incorporate climate change and coastal hazard considerations into building codes for coastal communities (e.g., freeboard, septic siting); and
- Leverage relationships with universities/scientists, through programs such as Cooperative Extension, to educate on hazards and climate change.

As part of the 2014 Plan revision, the Maryland Emergency Management Agency (MEMA) should review and update progress on these actions and additional recommended *Coast Smart* Construction Siting and Design Guidelines, as appropriate.

Hazard Mitigation Assistance (HMA)

The U.S. Department of Homeland Security, FEMA HMA programs present a critical opportunity to reduce the risk to individuals and property from natural hazards while simultaneously reducing reliance on Federal disaster funds. The HMA programs provide funding for eligible activities that are consistent with the Presidential Policy Directive 8: National Preparedness (PPD-8), and the National Mitigation Framework's Long-term Vulnerability Reduction capability. Hazard mitigation projects submitted to MEMA should be reviewed for eligibility by the MEMA staff and the Mitigation Advisory Committee to insure that all State applications are consistent with the recommended *Coast Smart* Siting and Design Guidelines. The HMA program reduces community vulnerability to disasters and their effects, promote individual and community safety and resilience, and promote community vitality.

National Flood Insurance Program (NFIP)

In Maryland tidal and non-tidal programs are regulated differently by various levels of government. MDE regulates

vision is supported by a central goal, objectives and strategies for Maryland State government, local governments and organizations that will reduce or prevent injury from natural hazards to people, property, infrastructure and critical State facilities. The plan features a comprehensive natural hazard identification, risk assessment and vulnerability analysis, that ranks hazard risks across Maryland. The risk analysis uses a comparative formula that includes total population, population density, damages, injury and deaths from past hazard events, geographic extent of the hazard,



all activities in non-tidal waters and their associated floodplains through the State's Waterway Construction Program and oversees community involvement and participation in FEMA's NFIP.

Tidal floodplains are only regulated at the local level via the requirements on the community to participate in the NFIP. However, all Special Flood Hazard Areas mapped on a community's Flood Insurance Rate Maps (FIRMs) are subject to regulatory requirements at the local level. The State Office of the NFIP, MDE acts as a liaison between these communities and FEMA to ensure all development meets the NFIP requirements. Communities participate in this program so that flood insurance is available in their community and may set higher standards, like freeboard, to receive reductions in premiums and guide development away from the floodplains. It is imperative that State activities match, where possible, the local NFIP regulations to avoid a reduction in premium discounts or suspension from the NFIP Program on the local community. State construction projects should be designed in accordance with the recommended *Coast Smart* Construction Siting and Design Guidelines or NFIP regulations of the local jurisdiction, whichever are more stringent.

Capital Budgeting

Facility Program Manual

Section 3-602(d) of the State Finance and Procurement Article requires that before an appropriation may be authorized for a capital project, the unit of State government requesting the appropriation shall submit a facility program justifying the project (Part I) and describing, in detail, the scope and purpose of the project (Part II).

The Facility Program Manual defines and describes the content of a facility program; provides instruction on the preparation of a facility program; and provides information regarding facility program submission requirements. The Department of Budget and Management (DBM) and DGS should amend the Facility Program Manual to require that in developing a facility program, the recommended *Coast Smart* Siting and Design Guidelines must be used to assess the potential for impacts related to sea level rise and coastal flooding.

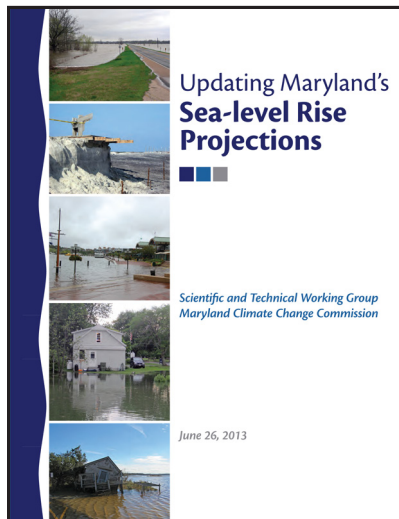
State Grant and Loan Programs

The *Coast Smart* Construction Siting and Design Guidelines should be used to guide allocation of State funding, primarily in the form of grants and loans, for non-State structure and infrastructure projects. State grant and loan programs, including but not limited to the following, should be further analyzed to determine whether additional executive, legislative or administrative requirements will be necessary to accomplish this task:

- Capital Grant Recipients (Local) — DGS/DBM
- Sustainable Communities funding programs — DHCD
- Community Development Block Grants — DHCD
- Program Open Space (Local) — DNR
- Bay Restoration Trust Fund (Local) — DNR
- Waterway Improvement Program — DNR
- MDOT Secretary's Aviation Grant Program — MDOT
- Clean Water and Drinking Water State Revolving Funds — MDE
- Maryland Economic Development Authority & Assistance Fund — DBED
- Maryland Industrial Development Financing Authority — DBED
- Maryland Economic Assistance Fund — DBED
- Public School Construction — IAC
- Community College Construction Grant Program — MHEC/MACC
- Local Jails and Detention Centers — DSPCS
- Community Health Facilities Grant Program — DHMH
- Federally Qualified Health Centers Grant Program — DHMH
- Private Higher Education Facilities Grant Program — Maryland Independent College and University Association

In the interim, the use of State programs and resources for proposed structures and infrastructure projects located within areas vulnerable to future sea level rise and coastal flooding should be subject to additional review and evaluation consistent, with applicable law and policy, to ensure the most appropriate State action and investment of resources. State investments in these areas should be evaluated on a case-by-case basis considering: existing structures and investments; the need for the project; vulnerability of the project; long-term benefits; the extent of resiliency measures incorporated into State or local climate adaptation plans; and, the project siting and design.

IV. Technical Tools and Resources



Sea Level Rise Projections

Section 7 of the Climate Change and *Coast Smart* Construction EO directs the MCCC's Scientific and Technical Working Group to review the sea level rise projections in the Maryland Climate Action Plan (2008) and provide updated projections based on an assessment of the latest climate change science and federal guidance. To fulfill the task, Dr. Donald F. Boesch, President of the University of Maryland Center for Environmental Science, convened a panel of highly qualified scientific experts on sea level rise drawn from Maryland and the Mid-Atlantic region (VA, DE, NJ, PA).

The panel applied the process-based approach used by the National Research Council (National Academy of Sciences) in 2012 to project sea level rise along the U.S. West Coast. "Best" estimates were made of the various contributions to relative sea level rise: thermal expansion of ocean volume, the melting of glaciers and Greenland and Antarctic ice sheets, changing ocean dynamics such as slowing of the Gulf Stream, and vertical land movement. "High" and "Low" estimates for these contributions were

also made, resulting in a range outside of which, the amount of sea level rise expected in 2050 and 2100 would be considered very unlikely.

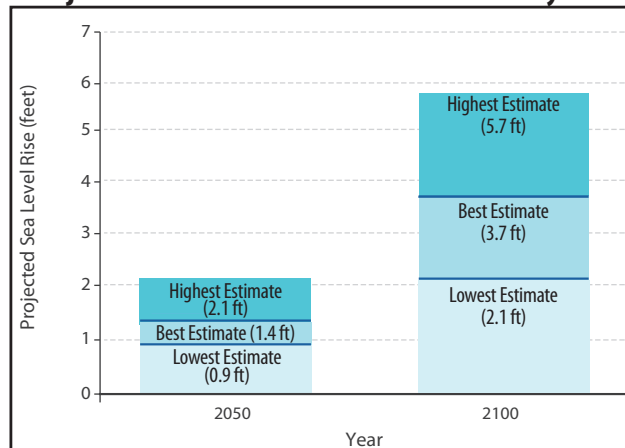
The "Best" estimate of mean sea level rise along Maryland's shorelines by 2050 (over the mean level in the year 2000) is 1.4 feet; based on present scientific understanding. It is unlikely to be less than 0.9 foot or greater than 2.1 feet. The "Best" estimate for mean sea level rise by 2100 is 3.7 feet; it is unlikely to be less than 2.1 feet or greater than 5.7 feet.

As Stated in the report, sea level rise by 2050 will be largely determined by the inertia of Earth's present climate system, including melting of land ice, but over the longer term will be very dependent on the trajectory of human greenhouse gas emissions during the 21st century. Success in global emission reductions over the next 50 years will determine whether generations during the following centuries will have to contend with sea levels more than 10 feet higher than they are today or as little as 3 feet higher.

The Scientific and Technical Working Group recommends that it is prudent to plan for relative sea level rise in Maryland of 2.1 feet by 2050 in order to accommodate the high end of the range of the projections. For a public investment of which, the design life is not expected to extend beyond this century or where infrequent flooding is tolerable, it might be acceptable to use the "Best" estimate of 3.7 feet for adaptation planning. However, where an investment is expected to last longer than this or where there is a very low acceptance of any flooding risk, the "High" estimate of 5.7 feet of relative sea level rise might be more appropriate. Moreover, the report notes that accounting for storm surge on top of sea level will be necessary for specific elevation planning.

The State should use the most up-to-date sea level rise projections for Maryland in order to site and design State investments in a manner that will avoid or minimize future loss or damages. The State should stay abreast of the latest sea level rise science and as it evolves, provide additional guidance on sea level rise projections for Maryland as needed. Until such time as updated sea level rise projections are issued for the State, the sea level rise projections issued by the Scientific and Technical Working Group in June 2013 should be used to guide siting and design of State investments.

Projections of relative sea-level rise for Maryland



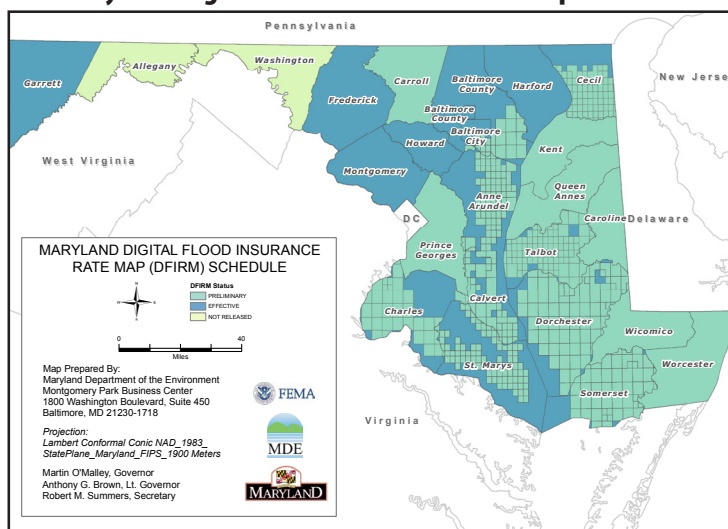
Source: Boesch et al., 2013

Floodplain Mapping

The FEMA Region III office has initiated a coastal analysis and mapping study to produce updated Digital Flood Insurance Rate Maps (DFIRMs) for coastal counties within Region III. The new coastal flood hazard analyses, initiated in the Fall of 2009, is utilizing updated 1% annual chance stillwater elevations obtained from a comprehensive storm surge study being concurrently performed by FEMA Region III. The storm surge study is one of the most extensive coastal storm surge analyses to date, encompassing coastal floodplains in three States and including the largest estuary in the U.S. Ultimately, the study will update the coastal storm surge elevations within the States of Virginia, Maryland, Delaware, and Pennsylvania including the Atlantic Ocean, Chesapeake Bay and its tributaries, and the Delaware Bay. This study differs from the storm surge mapping performed as part of Hurricane Evacuation Studies in that the resulting stillwater elevations are based on probability of occurrence as opposed to Hurricane Category events. However, it is recommended that emergency managers still utilize their hurricane evacuation studies and hurricane category storm surge maps for evacuation planning and decision-making purposes.

An updated coastal flood study was needed to obtain a better estimate of coastal flood hazards and risk for Region III as the current, or effective paper FIRM maps of the 1970's and 80's, are outdated primarily due to the age of the data and mapping methodologies. Additionally, major changes in NFIP policies and methodologies have occurred since the original effective date of many flood insurance studies in the area, creating the need for an update that would reflect a more detailed and complete hazard determination. DFIRMs are being released by MDE in conjunction with FEMA on a community by community basis. Most communities have received Preliminary updates of their maps (Preliminary-DFIRMs) and some have already adopted the newer floodplain maps in the form of a DFIRM. For more information, visit: FEMA's Map Service Center at msc.fema.gov or Maryland's DFIRM Outreach Program at mdfloodmaps.com.

Maryland Digital Flood Insurance Rate Map Schedule



For more information, visit mdfloodmaps.com

It is noted, however, that the existing DFIRM mapping products as well as the updated coastal flood study for Maryland do not take into account future conditions, such as sea level rise. This is one reason why the incorporation of 2 or more feet of "freeboard" above the mapped 100-year base flood elevation for structural projects is so important. It is generally understood that as sea level rises the boundary of the mapped 100-year floodplain will also increase. To inform the State's understanding of risk, it is recommended that the State pursue the development of risk product which analyzes new DFIRM data in conjunction with sea level rise of up to 6 feet (to take in account the "highest" sea level rise scenarios for Maryland). The State should also pursue acquisition of the 1% annual change stillwater elevation data combined with 50-year and 100-year sea level rise projections.

Data Availability

There are several geospatial databases that can be used to accurately locate existing and future physical structures and assisting in "ground truthing" model predictions. These Statewide databases include high-resolution digital aerial imagery, parcel data, address points, elevations and roadways. Much of this data is available on Maryland iMap (imap.maryland.gov): Maryland's one-stop-shop for geospatial data.

Elevation data. Maryland has a database of accurate elevations, collected over the last 10 years using aerial-based laser surveying instruments (LiDAR). As new data are collected they are added to the database. These data are available to support both engineering and environmental review efforts for site level landscape analysis and to determine the location of a proposed project in relation to 50 and 100-year sea level rise inundation zones. For more information, visit esrgc.org/mapservices.

High-Resolution Digital Aerial Imagery. Since 2007, Maryland has been acquiring high-resolution aerial imagery on a three-year collection cycle. The Eastern Shore was flown in the spring of 2013 and the Western Shore, last flown in 2011, will be flown in 2014. These data have a resolution of six inches, are flown on leaf-off conditions and come in natural color and color infrared products. These images will provide both engineering and environmental review efforts to visually inspect site-level landscapes for features from the office prior to on-site inspections.

Parcel Data. MDP has maintained a Statewide database of parcels since the mid-1990's. Parcel point data is available Statewide. MDP has also developed polygon data for 10 counties (many of which are coastal counties) and has collected and normalized County based parcel polygons for the rest of the State. These parcels are generally located accurately on the map and can be used to assist with both siting and engineering design efforts. For more information, visit planning.maryland.gov/OurProducts/PropertyMapProducts.

Address Points. Local governments have created and maintain an accurate database of addresses. These addresses are represented by a point (dot on the map) that in most instances is located on the primary structure. The Maryland Department of Information Technology has an Address Coordinator and is in the process of collecting these data from each county and creating a seamless address database. Having accurate addresses and building locations will support both engineering and environmental review efforts. For more information, visit imap.maryland.gov.

Roadways. SHA has been collecting and maintaining a geospatial database of State-owned roadways (road centerlines). It is now in the process of forming partnership with local governments to collect local roads data created and maintained by the counties. When compiled in 2014, the data will support both siting and engineering design of roads and other transportation assets within and near areas vulnerable to sea level rise and coastal flooding.

Building Polygons. Building outlines are maintained generally by counties in Maryland via planimetric mapping techniques. Several State agencies (MDP, MDE, DOITT) have collected building polygons to support specific applications. Data distribution agreements limit the sharing of this data for some counties.

Mapping Applications

Maryland's *Coastal Atlas* is an interactive mapping tool that can be used to determine the location of a project in relation to projected sea level rise inundation, historic and projected shore erosion, coastal flooding and storm surge areas. For more information, visit dnr.maryland.gov/ccp/coastalatlas.

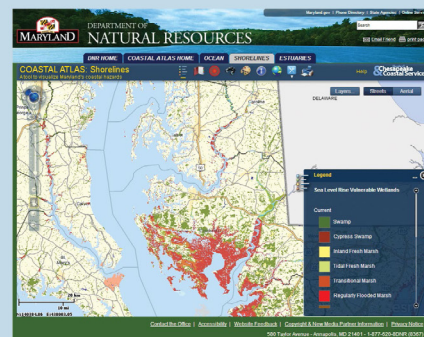
Alternatively, Maryland's *Climate Change Impact Area Mapper* (CCIA) can also be used. The CCIA mapper is an online tool provided by DNR for management decision-making, planning, and education purposes. The mapper brings together multiple data layers from different sources to illustrate land areas in Maryland that are projected to be the most sensitive to anticipated changes in climate. The layers include areas vulnerable to sea level rise, storm surge, coastal flooding, drought and rising temperatures. For more information visit dnr.maryland.gov/climatechange/mapper.asp or mdfloodmaps.com/flood_risk.

Coastal Atlas Online Mapping Tool

The Coastal Atlas is an online mapping tool, developed by Maryland's Chesapeake and Coastal Service. The tool can be used to inform shoreline erosion management decisions, long-range planning, floodplain management, and/or restoration project targeting. Visit the Coastal Atlas to:

- Access coastal hazard data including coastal inundation from storms, areas at risk to sea level rise, and shoreline erosion.
- Identify areas of high erosion to prioritize Best Management Practices siting and design.
- Access Living Shoreline Suitability Index for Worcester, Somerset, and Calvert Counties.
- View areas identified as Wetland Adaptation Areas (areas where wetlands are likely to migrate in response to sea level rise).
- More resources:
 - NOAA Atlas 14 (<http://dipper.nws.noaa.gov/hdsc/pfds/>)
 - NOAA's Restoration Center (<http://www.habitat.noaa.gov/restoration/index.html>)

Access the Coastal Atlas:
<http://www.dnr.state.md.us/ccp/coastalatlas/>



Cost-Benefit Analysis

In some instances, a cost-benefit analysis might help the State decide on the merit of proceeding with a capital investment in an area that might be affected by sea level rise in the future. A cost-benefit analysis, when conducted, can provide a perspective on the life-cycle costs of a capital investment, providing insights for decision-makers into the cost-effectiveness and expected longevity of a capital investment, and whether the project's life span is compatible with the projected incremental sea level rise or inundation potential.

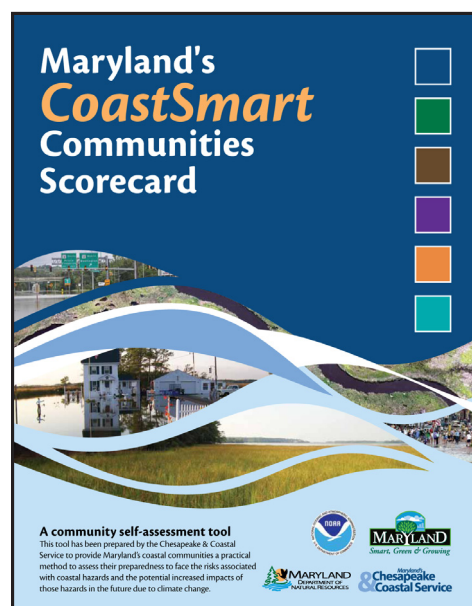
In June 2013, National Oceanic and Atmospheric Administration (NOAA) released "An Economic Framework for Coastal Community Infrastructure" (ERG, 2013) to help planners evaluate options for adapting coastal structures and infrastructure to make it more resilient, reducing the effects of sea level rise and high water level events such as storm surge and astronomical high tides. For more information, visit csc.noaa.gov/digitalcoast/publications/adaptation.

This framework serves as an excellent tool to help inform implementation of the *Coast Smart* Siting and Design Guidelines identified in this report. Moving forward, it is recommended that the State build off this framework, refining and adopting specific elements as necessary, to ensure that the full cost and benefits of climate adaptation measures are identified and considered during structure and infrastructure siting and design processes.

Community Assistance

As Maryland State agencies begin implementing the recommended *Coast Smart* Siting and Design Guidelines, the State should communicate and recommend to local governments and private investors that building resilience to future sea level rise and climate change is now, more than ever, an important consideration.

Along these lines, DNR's *CoastSmart* Communities Program will continue to provide on-the-ground sea level rise planning expertise, training, and technical mapping tools to help local governments in Maryland. The recently developed *CoastSmart* Scorecard is a tool that will help communities in Maryland prepare for sea level



rise and other coastal hazards. The Scorecard provides planning guidance in five major sectors: *Risk and Vulnerability Assessment; People and Property; Infrastructure and Critical Facilities; Natural Resources; and Societal and Economic Impacts*, and can be used to develop a custom made strategic planning and response guide. The Scorecard recognizes the importance of the Federal Emergency Management Agency's Community Rating System (CRS) and suggests areas of overlap where working through the Scorecard may help an application or maintenance to CRS.

Launched by Governor O'Malley in April 2009, Maryland's *CoastSmart* Communities Program has awarded more than a half-million dollars to coastal communities to help prepare for the anticipated impacts of climate change. In partnership with the NOAA, the State provides grants to coastal communities to support the planning and preparation of climate adaptation projects. *CoastSmart* Communities grants favor local government who have gone through a Scorecard exercise and are proposing a project that was identified as the next steps towards becoming "*Coast Smart*." For more information on the *CoastSmart* Communities Program, visit dnr.maryland.gov/coastsmart.

V. Recommendations & Next Steps

The *Coast Smart* Planning Principles, Policy Framework and Siting and Design Guidelines, presented above, were developed for the purposes of increasing the resilience of Maryland's built infrastructure to the impacts of climate change and sea level rise over the long-term. That said, implementation of the recommendations contained in this report will require further state-level action, as follows:

State Policy and Practices

1. *State Agency Oversight.* Maryland's Smart Growth Sub Cabinet should provide oversight to individual State agencies as they undertake the process to institutionalize the *Coast Smart* Siting and Design Guidelines into appropriate architecture engineering, construction and design manuals; regulatory programs; State planning, permitting and review processes; disaster planning and response programs; and capital budgeting programs.

2. *Review Authority.* The State should appoint a formal body with authority, such as the Governor's Smart Growth Subcabinet established under Code State Government Article, §9-1406, to develop a process to allow a unit of State government or a capital grant or loan recipient to obtain an "exception" from strict application of the recommended *Coast Smart* Siting and Design Guidelines. At a minimum, it is recommended that the exception process provide for consideration of the following:

a. *Siting Guideline Exception Criteria* (as more fully described on page 10 of this document.)

b. *Design Guideline Exception Criteria* (as more fully described on page 12 of this document.)

c. *Structural and Ecosystem-Based Resiliency Measures.* Proposed construction practices and site development standards for the protection of structural and ecological features on site, in anticipation of the need to prepare for, respond to, and recover from extreme weather events, sea level rise inundation, coastal flooding, storm surges and shoreline erosion.

d. *Cost-Benefit Analysis.* The full extent of short-term and long-term costs, including those associated with additional shore protection, emergency response during extreme weather events, and the potential necessity of rebuilding or repairing damaged structures.

e. *Socio-Economic Considerations.* The necessity of continued investment of State resources in coastal communities in order to protect and stimulate economic growth and revitalization.

f. *Historic Preservation Considerations.* The necessity of continued investment of state resources in properties individually listed or determined eligible for listing in the National Register of Historic Places or a contributing resource within a historic district listed on or determined eligible for listing in the National Register.

g. *Statutory/Regulatory Conflicts.* Statutory or regulatory requirements (e.g., Americans with Disabilities Act) that may conflict with the strict application of the *Coast Smart* Siting and Design Guidelines.

h. *External Grant Funding Criteria.* Specific grant requirements which may specify alternative construction standards or practices and/or may preclude application of strict interpretation of the Siting and Design Guidelines.

i. *Mapping Error.* Land elevations shown on mapping products or tools are proven to be inaccurate by a licensed surveyor or engineer.

3. *Implementation Plan.* In recognition of the unique nature of infrastructure investment decisions, it is recommended that respective State agencies review internal processes and develop or amend an agency specific implementation plan. This plan should include the status and next steps toward incorporation of the *Coast Smart* Siting and Design Guidelines into applicable State policy and programs; the identification of appropriate categorical exceptions; and, cost, size and use application thresholds. Agency specific implementation plans should be used to inform development of the formalized "exception" review and approval process.

4. *State Grant and Loan Programs.* The *Coast Smart* Construction Siting and Design Guidelines should be used to guide allocation of State funding, primarily in the form of grants and loans, for non-State structure and infrastructure projects. As detailed on page 14 of this report, State grant and loan programs should be further analyzed to determine whether additional executive, legislative or administrative requirements will be necessary to accomplish this recommendation. In the interim, the use of State programs and resources for non-State structure and infrastructure projects located within areas vulnerable to future sea level rise and coastal flooding should be undergo additional review and evaluation, consistent with applicable law and policy, to ensure the most appropriate State action and investment of resources.

5. *Tracking and Reporting.* The State should establish an annual reporting and review process to monitor and track individual State agency actions related to implementation of the policy and practices, including categorical

exemption determinations, as outlined in this report. This process should be used for the purposes of further development or refinement of recommended siting and design guidelines and State policy procedures.

6. Funding Needs. As recommended in Maryland's Phase II Climate Adaptation Strategy (2011), the State should address funding and revenue constraints to ensure adequate support for current and future infrastructure protection needs. Over the long-term, the State will need to review and adjust its existing infrastructure funding priorities to account for critical planning and construction needs in light of climate change and sea level rise.

7. Nature-Based Protection Measures. While the focus of this report is placed on *Coast Smart* principles for built or grey-infrastructure, it should not go unmentioned that the protection and creation of green infrastructure is equally important, particularly in light of climate change and sea level rise. The ecosystem-based services that key natural features, such as wetlands, vegetated and forested buffers, etc. provide in terms of buffering coastal communities and other built environments from the impacts of extreme storms are critically important. DNR should take steps to identify and analyze these features and prioritize and target, as appropriate, for conservation and restoration purposes.

Data, Mapping and Modeling

1. Sea Level Rise Scenarios. All State agencies should utilize the sea level rise scenarios set forth by the MCCC's Scientific and Technical Working Group (2013) in the application of the *Coast Smart* planning principles, policy framework, and siting and design guidelines.

2. Climate Science. The Scientific and Technical Working Group must stay abreast of the latest climate science; and, as warranted, periodically update sea level rise scenarios and planning guidance using the best scientific data available.

3. Decision-Support Tools. The State should continue to develop state-level data and decision support tools to better understand, prepare for and respond to climate change and sea level rise. In particular, more sophisticated mapping applications should be developed to more precisely identify whether the entirety of a proposed project site would be affected by sea level rise and over what time frames, or whether portions of a project site could still proceed without undue risk.

4. Data and Mapping Products. A number of other specific data products should also be developed, including: an analysis of the 1% annual change stillwater elevation data combined with 50-year and 100-year sea level rise projections; enhanced storm surge risk products that factor in sea level rise; and, refined sea level rise inundation area mapping, derived from 2013-14 LiDAR imagery acquisitions.

Education and Outreach

1. Cost-Benefit Guidance. The State should develop detailed cost/benefit guidance to better inform State infrastructure investment decisions. The NOAA framework serves as an excellent tool to help inform implementation of the *Coast Smart* Siting and Design Guidelines identified in this report; however, moving forward, it is recommended that the State build off this framework, refining and adopting specific elements as necessary, to ensure that the full cost and benefits of climate adaptation measures are identified and considered during structure and infrastructure siting and design processes.

2. Outreach Campaign. The State should launch a *Coast Smart* Construction Education Campaign to engage local county and municipal officials; assess the needs of local jurisdictions; and, convey the need for climate change and sea level rise resilience measures.

VI. Conclusion

Climate change and sea level rise are not single issues, but overarching factors that shift the conditions under which Maryland's infrastructure and planning decisions are based. These factors must be addressed during infrastructure planning, design, construction and capital budgeting processes if we are to achieve a sustainable Maryland. The planning principles, policy framework, and siting and design guidelines contained in this report, should be used to guide what, where and how State infrastructure investments decisions are made within vulnerable areas. Following on the heels of the Climate Change and *Coast Smart* Construction EO issued in December 2012, implementation of the recommendations laid out in this report are critical steps towards ensuring the protection of Maryland's people, property, natural resources, and public investments and to certify safe, sound and wise investments over time.

VI. Appendices

Appendix A — Definitions

Base Flood: A flood having a one-percent chance of being equaled or exceeded in any given year; the base flood also is referred to as the 1-percent annual chance (100-year) flood.

Base Flood Elevation: The water surface elevation of the base flood in relation to the datum specified on Flood Insurance Rate Maps. In areas of shallow flooding, the base flood elevation is the highest adjacent natural grade plus the depth number specified in feet on the Flood Insurance Rate Map, or at least four (4) feet if the depth number is not specified.

Climate Change: Any change in climate over time, whether due to natural variability or as a result of human activity. Climate refers to long-term trends in weather that extend multi-decadal periods.

Coast Smart: A construction practice in which, preliminary planning, siting, design, construction, operation, maintenance, and repair of a structure avoids or, in the alternative, minimizes future impacts associated with coastal flooding and sea level rise. “Coast Smart” includes design criteria and siting guidelines that are applicable throughout the entire life cycle of a project.

Critical and Essential Facilities: Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquakes [Note: See Maryland Building Performance Standards, Sec. 1602 and Table 1604.5]. Critical and essential facilities typically include hospitals, fire stations, police stations, storage of critical records, facilities that handle or store hazardous materials, airports, transit and highway access and other essential transportation, and similar facilities.

Design Guidelines: Structural specifications related to the shape, size, or form of a construction practice.

Design Life: The period of time during which, the item is expected by its designers to work within its specified parameters; in other words, the life expectancy of the item. It is the length of time between placement into service of a single item and that item’s onset of wear-out, that is, where additional maintenance is no longer sufficient to prolong its life expectancy.

Erosion Vulnerability: The susceptibility of a given stretch of shoreline to future change in shoreline position due to erosion.

Flood or Flooding: A general and temporary condition of partial or complete inundation of normally dry land areas from: (1) The overflow of inland or tidal waters, and/or (2) The unusual and rapid accumulation or runoff of surface waters from any source.

Freeboard: A factor of safety that compensates for uncertainty in factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, obstructed bridge openings, debris and ice jams, climate change, and the hydrologic effect of urbanization in a watershed.

Habitat Adaptation Areas: Areas that may serve as wildlife habitat, wildlife corridors or support high priority aquatic and terrestrial living resources in the future. These include, but are not limited to areas with hydric soils suitable for future tidal wetland establishment and marsh-dependent breeding bird habitat, as well as species and habitat representation areas, ecosystem and habitat type replication areas, and refugia or relocation areas for climate-sensitive species.

Historic Structure: Eligibility or designation as a historic structure as defined by the U.S. Department of the Interior and/or the Maryland Historical Trust.

Infrastructure: Built infrastructure, including roads, bridges, sewer and water systems, drainage systems, and essential public utilities.

Inundation: The condition of formerly dry areas becoming permanently submerged, such as when the annual average elevation of Mean Lower Low Water (MLLW) rises relative to land (SERDP 2013).

Fullest Extent Practicable: Actions or practices capable of being effected, done, or put into practice.

Limit of Moderate Wave Action (LiMWA): The LiMWA identifies areas that will be affected by waves with a 1.5 foot wave height or greater within the coastal A zone. While FEMA currently does not require special floodplain

management standards or flood insurance purchase requirements based on LiMWA delineations, it is likely that properties and structures within the LiMWA will receive substantial damage from wave action during a one-percent-annual-chance flood event.

Non-State Structure and Infrastructure Projects: Structures and built infrastructure, including roads, bridges, sewer and water systems, drainage systems, and essential public utilities, used primarily for non-State purposes.

Permanent Structure: A structure, as defined herein, installed, used, or erected for a period of greater than 180 days.

Replacement Cost: The current replacement cost of property is the amount it would cost to replace the property today using materials of the same kind and quality, with no deduction for depreciation, and does not include the value of land.

Resilience: Capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well being, the economy, and the environment (NRC 2010).

Risk: Combination of the magnitude of the potential consequence(s) of climate change impact(s) and the likelihood that the consequences(s) will occur (NRC 2010).

Sea Level Rise Vulnerability: The susceptibility of a coastal area to seasonally high-tides or prolonged or permanent inundation or submergence due to a combination of land subsidence and future rise in water level.

Siting Guidelines: Specifications related to the location of a structure or use on a lot or parcel or within a larger geographic area.

Special Flood Hazard Areas: Land in the floodplain subject to a one-percent or greater chance of flooding in any given year and are designated by the Federal Emergency Management Agency in Flood Insurance Studies and on Flood Insurance Rate Maps as Zones A, AE, AH, AO, A1-30, and A99, and Zones VE and V1-30.

Storm Surge: Abnormal and significant rise of water generated by a storm, over and above the predicted astronomical tides.

State-Funded: Partially or fully funded with State of Maryland monies.

Stillwater: The 100-year floodplain elevation on a FIRM or DFIRM before wave heights and wave runups are added. Stillwater elevations should match the 100-year floodplain elevations in all coastal A-zones, but in areas where wave heights are included (LiMWA's and V-zones), stillwater elevations do not include wave heights. For regulatory purposes, the 100-year elevation must include wave heights.

Structure: That which is built or constructed; specifically, a walled or roofed building, including a gas or liquid storage tank that is principally above ground, as well as a manufactured home. A structure, whether permanent or temporary, is not intended to include roads, bridges, rail tracks, dredge material containments facilities or other transportation infrastructure that are not roofed buildings.

State Structure and Infrastructure Projects: Structures and built infrastructure, including but not limited to roads, bridges, sewer and water systems, drainage systems, and essential public utilities, planned and built by Maryland State agencies, used primarily for State purposes.

Substantial Damage: Damage of any origin sustained by a structure whereby the cost of restoring the structure to before damaged condition would equal or exceed 50 percent of the replacement cost of the structure before the damage occurred.

Temporary Structures: Structures or uses intended to be in place for 180 consecutive days or less in any given calendar year or will be removed at the end of a construction project.

Water Dependent Uses: A use which cannot perform its intended purpose unless it is located or carried out in close proximity to water; the term includes docking facilities, port facilities that are necessary for the loading and unloading of cargo or passengers, and ship building and ship repair facilities, but does not include long-term storage or related manufacturing facilities.

Wetland Migration: Long-term inland and upward movement of tidal wetlands, limited by human and geological barriers, in response to changes in sea level.

Vulnerability Assessment: Practice of identifying and evaluating the effects of climate change and climate variability on natural and human systems, so as to understand system sensitivity, exposure, and adaptive capacity (SERDP 1013).

Appendix B — References

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Appendix C — Executive Order No. 01.01.2012.29



The State of Maryland

Executive Department

EXECUTIVE ORDER

01.01.2012.29

Climate Change and “Coast Smart” Construction

- WHEREAS, The State of Maryland has the fourth longest tidal coastline in the continental United States and is one of the States most vulnerable to sea level rise – one of the major consequences of climate change;
- WHEREAS, Climate forecasters have predicted that the extreme weather events experienced in recent years are indicative of the likely impacts of climate change that the State of Maryland will face in the coming decades;
- WHEREAS, The State of Maryland has experienced more than one foot of sea level rise over the last century due to the combined forces of regional land subsidence and global sea level rise;
- WHEREAS, The State of Maryland is currently losing approximately 580 acres every year to shore erosion and, alarmingly, thirteen Chesapeake Bay islands once mapped on nautical charts have been lost;
- WHEREAS, In July 2012, the U.S. Geological Survey published research in the journal *Nature Climate Change* documenting that over the last 20 years, sea levels along the 1,000 kilometer stretch of coast running north from Cape Hatteras to north of Boston, which includes the State of Maryland, have risen at an annual rate three times to four times faster than the global average;
- WHEREAS, Future changes in sea level threaten to increase the State of Maryland’s vulnerability to storm events, causing more shore erosion and severe coastal flooding, inundating low-lying lands, submerging tidal wetlands and marshes, and resulting in additional salt-water intrusion and higher water tables;
- WHEREAS, The State of Maryland has approximately 450 existing State-owned facilities and 400 miles of roadways within areas likely to be impacted by sea level rise over the next 100 years;
- WHEREAS, Billions of dollars of investments in public infrastructure will be threatened if the State of Maryland fails to prepare adequately for climate change;

- WHEREAS, The State of Maryland must lead by example by implementing sound planning strategies to avoid or mitigate against the most damaging and likely effects of climate change; and
- WHEREAS, The State of Maryland must take action now to ensure that State infrastructure investments in vulnerable coastal areas are “Coast Smart” – fiscally wise and structurally sound.
- NOW, THEREFORE, I, MARTIN O’MALLEY, GOVERNOR OF THE STATE OF MARYLAND, BY VIRTUE OF THE AUTHORITY VESTED IN ME BY THE CONSTITUTION AND THE LAWS OF MARYLAND, HEREBY PROCLAIM THE FOLLOWING EXECUTIVE ORDER, EFFECTIVE IMMEDIATELY:
- A. Definitions. In this Executive Order the following words have the meanings indicated:
- (1) “Base flood” is a flood having a one-percent chance of being equaled or exceeded in any given year; the base flood also is referred to as the 1-percent annual chance (100-year) flood.
 - (2) “Base flood elevation” is the water surface elevation of the base flood in relation to the datum specified on Flood Insurance Rate Maps. In areas of shallow flooding, the base flood elevation is the highest adjacent natural grade plus the depth number specified in feet on the Flood Insurance Rate Map, or at least four (4) feet if the depth number is not specified.
 - (3) “Freeboard” is a factor of safety that compensates for uncertainty in factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, obstructed bridge openings, debris and ice jams, climate change, and the hydrologic effect of urbanization in a watershed.
 - (4) “Permanent structure” is a structure installed, used, or erected for a period of greater than 180 days.
 - (5) “Sea Level Rise Vulnerability” is the susceptibility of a coastal area to seasonally high-tides or prolonged or permanent inundation or submergence due to a future rise in water level.
 - (6) “Special Flood Hazard Areas” refers to land in the floodplain subject to a one-percent or greater chance of flooding in any given year and are designated by the Federal Emergency Management Agency in Flood Insurance Studies and on Flood Insurance Rate Maps as Zones A, AE, AH, AO, A1-30, and A99, and Zones VE and V1-30.

(7) “State structures” are structures planned and built by State agencies that are partially or fully funded with State monies.

(8) “Structure” means that which is built or constructed; specifically, a walled or roofed building, including a gas or liquid storage tank that is principally above ground, as well as a manufactured home.

(9) “Substantial damage” means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

B. State agencies that propose capital projects for new State structures or the reconstruction or rehabilitation of substantially damaged State structures for inclusion in the State capital budget on or after July 1, 2013, shall consider the risk of coastal flooding and sea level rise to the project and should site and design State structures to avoid or minimize associated impacts.

C. Consistent with applicable law, the Department of General Services shall update its Policies and Procedures Manual for Architecture and Engineering to include guidelines providing that State agencies shall plan construction of all new permanent State structures and the reconstruction or rehabilitation of substantially damaged State structures located in Special Flood Hazard Areas with a minimum of two (2) feet of freeboard above the 100-year base flood elevation, unless the Department of General Services, after consultation with the Department of Natural Resources and the Department of the Environment, determines that a variance from the guidelines is warranted after consideration of the following factors:

(1) The danger that materials may be swept onto other lands to the injury of others;

(2) The danger to life and property due to flooding or erosion damage;

(3) The susceptibility of the proposed structure and its contents to flood damage and the effect of such damage to the State of Maryland;

(4) The importance of the services to the State of Maryland provided by the proposed structure;

(5) The availability of suitable alternative locations that are subject to a lower risk of flooding or erosion damage;

(6) The necessity or benefits of a waterfront location;

(7) The compatibility of the proposed use of the structure with existing and anticipated development;

(8) The need to maintain eligibility or designation as a historic structure as defined by the U.S. Department of the Interior and/or the Maryland Historic Trust;

(9) The safety of access to the structure by passenger and emergency vehicles during a flood;

(10) The expected heights, velocity, duration, rate of rise, and sediment transport of the floodwaters and the effects of any wave action expected at the site;

(11) The costs of providing government services during and after flood conditions, including maintenance and repair of public utilities and facilities such as sewer, gas, electrical, and water systems, and streets and bridges; and

(12) The comments provided by the Maryland Department of Environment and the National Flood Insurance Plan State Coordinator.

D. The Department of Natural Resources, in consultation with the Maryland Commission on Climate Change and/or other relevant parties as necessary, shall develop additional proposed guidelines concerning Climate Change and “Coast Smart” Construction.

(1) Timing. The Department of Natural Resources shall convene a meeting to discuss implementation and recommendations within 45 days of the effective date of this Executive Order and provide an initial report to the Governor within nine months.

(2) Report. The report shall include:

(a) Recommendations for additional “Coast Smart” criteria for the siting and design of new, reconstructed, or rehabilitated State structures, as well as other infrastructure improvements such as roads, bridges, sewer and water systems, drainage systems, and essential public utilities.

(b) Recommendations concerning the potential application of “Coast Smart” guidelines to non-state infrastructure projects that are partially or fully funded by State agencies.

(c) Other recommendations for executive and/or legislative action.

E. The Critical Area Commission for the Chesapeake and Atlantic Coastal Bays should evaluate existing regulations and policies for State Agency Actions Resulting in Development on State-Owned Lands and consider the adoption of new or revised provisions that address climate change and the risk of sea level rise and other extreme weather-related impacts.

F. The Scientific and Technical Working Group of the Maryland Commission on Climate Change shall review the sea level rise projections established by the Maryland Commission on Climate Change published in the Maryland Climate Action Plan (2008) and shall provide, within 180 days of the effective date of this Executive Order, updated projections based on an assessment of the latest climate change science and federal guidance.

G. This Executive Order shall be implemented in a manner consistent with any review or permitting processes that are required by law. This Executive Order does not apply to any federal or local permits or approval processes.

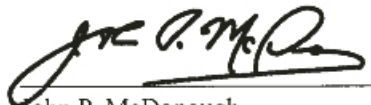
Given Under My Hand and the Great Seal of the State of Maryland
in the City of Annapolis, this 28th day of December, 2012.



Martin O'Malley
Governor



ATTEST:



John P. McDonough
Secretary of State

Appendix D — Project Screening Checklist

Application of the *Coast Smart* Construction Siting and Design Guidelines as detailed above should be administered through the following project screening process:

1. *Project Scope*. Timescale for which project planning, design, construction, maintenance and operational decisions are being made:

- a. Short-term projects (design life < 25 years).
- b. Medium-term projects (design life between 25-50 years).
- c. Long-term projects (design life between 50 – 100 years).
- d. Very long-term projects (design life > 100 years).

2. *Project location*. Proposed project's vulnerability to sea level rise impacts (i.e., future inundation, flooding and storm surge) over the course of the project's design life.

- a. Is the project within a 50- or 100- year sea level rise inundation zone?
 - i. For planning of new State structures or other infrastructure for which the design life is not expected to extend beyond 2100 (short- to medium-term projects) or with a relatively high risk tolerance limit (e.g., rare flooding is tolerable), it is recommended that the sea level rise projection of 2.1 feet by 2050 and 3.7 feet by 2100 be used to assess vulnerability.
 - ii. For structures or public infrastructure projects for which the design life is expected to extend beyond 2100 (long- to very long-term projects) or where there is a very low acceptance of any flooding risk, the relative sea-level rise estimate of 5.7 feet should be utilized.
- b. Is the project within a mapped Special Flood Hazard Area? What is the 100-year flood elevation for the project's location?
 - i. Is the proposed first floor elevation above the 100-year Base Flood Elevation? Is the project within a Limit of Moderate Wave Action (LiMWA) on the FEMA Coastal studies?
- c. Is the project within a storm surge inundation zone (Category 1-4)?
 - i. Assess additional risk of heightened storm surge due to future sea level rise.

3. *Ecosystem Resiliency*. Identify ecological features on site that may serve to buffer the project from the impacts of future sea level rise, coastal flooding or storm surge (e.g., vegetated or forested buffer, dunes, wetland or marsh system). These may include:

- a. Potential wetland migration or habitat adaptation areas on site; or
- b. Natural features that could be enhanced, restored or created to provide additional protection against future sea level rise and coastal storm impacts.

4. *Resiliency Measures*. Identify *Coast Smart* Siting and Design Guidelines incorporated into project siting, design, construction, maintenance and operational planning, or other measures included in State or local climate adaptation plans (e.g., flood gates) that are scientifically workable and with a likelihood of construction within the needed timeframe. These may include:

- a. Siting considerations (e.g., project has been sited outside areas vulnerable to sea level rise within the project's anticipated design life, incorporation of ecosystem resiliency measures);
- b. Design considerations (e.g., height of "freeboard" building materials);
- c. Type of construction (e.g., relocatable, portable, expendable in the event of storm damage); or
- d. Functional use restrictions (e.g., temporary).

5. *Cost/Benefit Analysis*. Assess anticipated benefits and costs of the proposed project, taking into account the following factors:

- a. Risk v. Time. Potential risk associated with sea level rise, coastal flooding and storm surge over the project's anticipated design life.
- b. Risk Tolerance. Determination of risk tolerance (low, medium, high) for the proposed project.
- c. Socio-economic Considerations. Full extent of costs over both short and long terms, including costs associated with the need for additional shore protection, emergency response during extreme events, and the possible need for the repair or rebuilding of damaged structures.
- d. Environmental Impacts. Increased impact of the project to the environment due to the incorporation of resiliency measures (e.g., increasing the height of a bridge may necessitate need for larger bridge abutments with greater impact to waterway and nearby wetland areas).



NATHAN HUBER

