Guidance for Using Maryland's 2018 Sea Level Rise Projections

June 2022

PREPARED BY:

KATE MCCLURE, UNIVERSITY OF MARYLAND SEA GRANT EXTENSION
ALLISON BREITENOTHER & SASHA LAND,
MARYLAND DEPARTMENT OF NATURAL RESOURCES

Advisory Group

Development of this guidance included input from an Advisory Group comprised of the following individuals:

NAME	AFFILIATION
Bruna Atilla	City of Baltimore, Office of Sustainability
Christine Conn	MD Department of Natural Resources, Chesapeake & Coastal Service
Alex DeWeese	MD Department of Natural Resources, Critical Area Commission
Tracey Gordy	MD Department of Planning, Local Assistance & Training Unit
Dave Guignet	MD Department of Environment
Jacqueline Guild	City of Annapolis
Sandy Hertz	MD Department of Transportation, Office of Environment
Erik Michelsen	Anne Arundel County, Bureau of Watershed Protection & Restoration
Catherine McCall	MD Department of Natural Resources, Office of Coastal & Ocean Management
Albert McCullough	Sustainable Science, LLC
Amy Moredock	Queen Anne's County, Planning & Zoning
Dave Nemazie	University of Maryland Center for Environmental Sciences
Allison Reilly	University of Maryland College Park, Department of Civil & Environmental Engineering
Mike Scott	Salisbury University, Henson School of Science & Technology and Eastern Shore Regional GIS Cooperative
Virginia Smith	Smith Planning and Design
Jackie Spect	The Nature Conservancy, MD/DC Chapter
Jason Stick	US Army Corps of Engineers, Baltimore District, Technical Assistance Branch
Taryn Sudol	Maryland Sea Grant

Members of the Advisory Group contributed valuable expertise and insights throughout the development of the document. A sincere thank you for their time and expertise.

This document is based in part on the NH Coastal Flood Risk Science and Technical Advisory Panel's 2020 report, *New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections* [1], and Washington Coastal Resilience Project's 2020 report, *How to Choose: A Primer for Selecting Sea Level Rise Projections for Washington State* [2].

Table of Contents

Introduction and Purpose

Rising seas and coastal flooding already impacts communities, infrastructure, and natural and cultural resources in Maryland. The impacts are expected to increase in the future as sea levels continue to rise, putting more Maryland communities, economies, and livelihoods at risk. However, science-based projections of sea level rise can inform decisions and help reduce the impact of future sea level rise. This document is intended to facilitate the use of the 2018 Maryland sea level rise projections in planning, regulatory, and site-specific projects (further defined in Step 1) to increase **resilience** to changing sea levels in the Chesapeake Bay and the Atlantic Coast.

Relative Sea Level Rise

Relative sea level rise (RSLR) is the change in the level of the ocean relative to the land at a particular location. RSLR includes both global and local factors. Globally, sea level is rising due to climate change as warmer temperatures cause the thermal expansion of ocean water and the melting of land ice. Locally, sea level change is also affected by vertical land motion, or the movement of land up or down. In the Mid-Atlantic region, the land is slowly subsiding, or sinking, leading to RSLR rates greater than the average global rate [4]. Because local factors influence RSLR, locally-adjusted projections of RSLR are more appropriate for projects in Maryland than national or global projections [3].

The Maryland Commission on Climate Change Act of 2015 requires the University of Maryland Center for Environmental Science (UMCES) to produce a report every five years with updated sea level rise projections for Maryland in order to facilitate the incorporation of new advances in sea level rise science into local and state decision-making. In 2018, UMCES convened a group of sea level rise experts from the Mid-Atlantic region that resulted in the *Sea-Level Rise Projections for Maryland 2018* [3]. The report provides the most up-to-date sea level rise science and relative sea level rise (RSLR) projections for Maryland that represent the consensus of the expert group. These projections incorporate both global and regional factors (subsidence, distance from melting glaciers and polar ice sheets, and ocean currents) and provide estimates for multiple greenhouse gas emissions pathways beyond 2050. Unlike previous reports, the updated projections include both central estimates and probabilities that RSLR will meet or exceed certain values. These probabilistic RSLR projections are available for several local tide gauges and allow Maryland decision-makers to consider risk tolerance when planning for future sea levels. For the complete methodology and relation to national assessments, refer to the full 2018 report from UMCES.

For the purposes of this guidance, the term "**project**" refers to any private, local, state, and federal planning, regulatory, or site-specific efforts that should consider and incorporate sea level rise projections.

The purpose of this guidance document is to:

- Assist decision-makers in Maryland with incorporating probablistic RSLR projections into planning, regulatory, and site-specific projects at the private, local, state, and federal levels with a step-by-step approach
- Provide guiding principles to consider when planning for sea level rise
- Highlight examples of how RSLR could be applied in projects

This guidance document is based on similar reports produced by other states, including New Hampshire [1], Washington [2], and California [5]. It represents the perspectives of the Advisory Group composed of individuals from local, state, and federal government, NGOs, the private sector, and academic institutions with expertise in using RSLR projections. This approach guides users through a stepwise process to determine an appropriate RSLR estimate that will inform decision-making based on a planning, regulatory or site-specific project's timeframe, **tolerance for flood risk**, and location. This guidance document also includes preliminary guidance on beginning to assess flood impacts due to RSLR, incorporate RSLR estimates into projects, and consider adaptation options to make projects more resilient. However, the guidance does not specifically instruct on adaptation strategies or actions decision-makers could take to mitigate the impact of future sea level rise.

The guidance is advisory and nonmandatory. The guidance document is a working draft that is expected to be revised in 2023 based on user feedback and the next update to the RSLR report from UMCES. If you are using this guidance and have feedback or suggestions for improvement, please complete this form.

Guiding Principles for Incorporating Maryland's Sea Level Rise Projections into Projects

These guiding principles provide an overarching framework that when applied throughout the **decision-making process**, ensures **equity** in project process, design, and implementation while enhancing resilience. They provide users with critical aspects to consider in the decision-making process alongside the science provided in Maryland's 2018 sea level rise report.

1. Use RSLR projections based on the best available science to inform decisions that address future impacts on communities and project sites.
   - RSLR projections for the state are updated every five years by the UMCES as mandated by legislation, and the most recent projections publication should be referenced.

2. Prioritize equity and **justice** principles at each step of the project's planning and decision-making process.
   - Understand and consider the perspectives, experiences, **vulnerability,** and needs of different stakeholders throughout the decision-making process to ensure that decision-making is inclusive.

3. Incorporate stakeholder perspectives into decision-making for the project, such as determining flood risk tolerance and selecting an RSLR estimate.
   - Incorporating stakeholder goals, scope, scale, and other specific perspectives includes understanding who the relevant stakeholders are, creating opportunities for their participation throughout the project's process, and integrating the feedback in a meaningful way to inform decision-making while still accomplishing the goal(s) of the project.

4. Consider the project holistically and build **adaptive capacity** into the project to maximize benefits and ensure the project's longevity.

- Considering a project holistically means viewing the entire project process, beginning with project conception, through implementation, and ongoing maintenance. Be sure to consider any upfront, maintenance or **sunk costs**; the economic, ecological, cultural, and historical characteristics of the project; impacts on the surrounding area (built and natural environment); short- and long-term adaptation options; as well as the ongoing resilience of the community or project over the entire project life cycle. Identifying **incremental action points** and incorporating them into the project allows for increased resilience and adaptive capacity as sea level rises and impacts increase.

5. Support Maryland's greenhouse gas reduction efforts through project design and implementation.

- Prioritize decision-making that reduces project emissions, for example, by reducing heavy machinery use during construction or increasing the use of locally sourced or recycled materials. Additionally, incorporating green infrastructure or nature based features may support carbon sink efforts that help to reduce overall emissions and support the goals and programs of the Maryland Greenhouse Gas Reduction Act Plan.

6. Protect, enhance, and ensure resilience, operations, and access to critical infrastructure and services including natural, cultural, and historic resources.

- The specifics of the population served and critical service provided will best inform how to incorporate this principle into projects. Natural, cultural, and historic resources serve a critical purpose in Maryland and should be protected as well. Enhance resilient features (natural and built) and maintain public and open spaces wherever possible. In the case of natural, cultural, and historic resources, services may be protected by maintaining public and open space to the greatest extent practical, enhancing existing resilient features, or making decisions to ensure continuity of services. In some cases this may mean adapting in place despite high cost, whereas for other services this could involve a strategic relocation.

7. Coordinate with decision-makers at all relevant levels (private, local, state, NGO, tribal, and federal), and use consistent RSLR estimates for cross- jurisdictional projects.
    - Include all levels of operations in decision-making to ensure decisions are made collectively, reduce redundancies, leverage resources, and ensure consistency in RSLR estimates used for cross-jurisdictional projects.

8. Consider the costs (financial, social, ecological) and legal liability of all possible options to manage flood risk including no action, avoidance, accommodation, resistance, and relocation (see Step 6).
    - Consider the cost of inaction, which may include costs such as the expense of remediating structures after a flood event or the human and social impact of lost livelihoods and cultural resources. Decision-makers should also consider whether they may be held liable for failing to take action to address sea level rise despite being aware of potential future impacts.

Community Involvement & Input

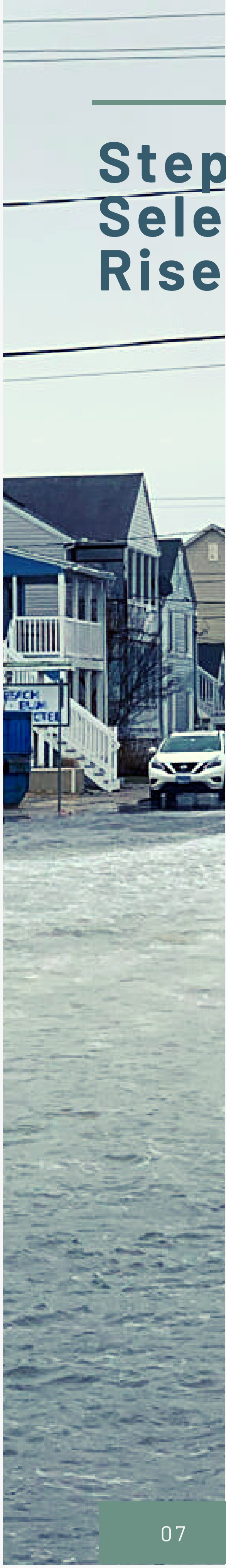
Engaging stakeholders and ensuring equity is essential for project success. Project scoping should include development of a timeline that allows for meaningful community involvement and input that results in outcomes representative of the community. Stakeholders should be identified and involved in each stage of a project (scoping through implementation), with the understanding that stakeholder selection is specific to each project. For example, updating comprehensive plans and zoning ordinances to incorporate sea level rise projections should include input on the timeframe and risk tolerance from residents and businesses in the community (Steps 2 and 3). Thought should be given on the best methods to gain understanding of stakeholder perspectives, gather input, and solicit feedback. Different methods are likely to be appropriate for different subsets of stakeholders. Multiple projects and organizations may share the same stakeholders, so collaboration on engagement activities can help achieve meaningful involvement without over-burdening stakeholders. Looking to other projects and organizations locally and nationally for lessons learned and best practices is a great first step when developing your approach.

Resources:

- Urban Sustainability Directors Network (USDN) Guide to Equitable, Community-Driven Climate Preparedness Planning (May 2017)
- National Oceanic and Atmospheric Administration (NOAA) Introduction to Stakeholder Participation
- National Association for the Advancement of Colored People (NAACP) Equity in Building Resilience in Adaptation Planning

Examples climate adaptation projects engaging diverse stakeholders:

- A Seat at the Table: Integrating the Needs and Challenges of Underrepresented and Socially Vulnerable Populations into Coastal Hazards Planning in New Jersey
- San Francisco Bay Conservation and Development Commission's Adapting to Rising Tides (ART) Program



Step-by-Step Approach for Selecting Relative Sea Level Rise Estimates

This step-by-step approach is intended to guide decision-making in Maryland's 16 coastal counties, Baltimore City, and municipalities within the coastal zone. It provides a framework by which to select a projected RSLR estimate to incorporate into a project to increase resilience over time.

STEP 1: DEFINE THE PROJECT TYPE, GOAL AND AREA

STEP 2: DETERMINE THE PROJECT'S TIMEFRAME

STEP 3: DETERMINE TOLERANCE FOR FLOOD RISK

STEP 4: SELECT A TIDE GAUGE

STEP 5: SELECT AN RSLR ESTIMATE FOR THE PROJECT

STEP 6: ASSESS FLOOD IMPACTS AND CONSIDER ADAPTATION OPTIONS

The remainder of this document provides more detailed information on each step. The worksheet in Appendix A will guide you through the six-step decision-making process of selecting an RSLR estimate for your project.

Step 1: Define the Project Type, Goal, and Area

For the purposes of this guidance, the term "project" refers to any private, local, state, and federal planning, regulatory, or site-specific efforts that should consider and incorporate sea level rise projections.

A **planning project** typically has an impact at a community scale and often has planning horizons and update cycles of five or more years. This guidance can be used to help prioritize action and build resilience into planning projects. A **regulatory project** refers to regulations, ordinances, codes, and designations that are updated and/or adopted by local or state governing bodies. This type of project should consider future RSLR conditions and how those changing conditions may impact what is being regulated in order to inform the development of regulatory standards. A **site-specific project** is one that is done in a specific location or parcel. This guidance can be used to inform where the project is sited, as well as how it is designed and implemented.

Identify the project type (planning, regulatory, or site-specific), define the goal of the project, and consider the project's activities and current vulnerability. Determine the primary planning area, or the regulatory or site location. Consider conducting an inventory of assets in the project area, which will help determine if the area should be separated into smaller sub-areas that may have different flood risk tolerances (see Step 3 for guidance on determining tolerance for flood risk). Project goals and stakeholder preferences of the project team will determine how the project area is defined. Identify who and what will benefit from or be impacted by the project. When identifying who will be impacted, keep in mind that individuals outside the project area may also be affected. For example, all residents in a community may be impacted by decisions about constructing infrastructure even if some individuals do not live near the project site.

Table 1 provides a list of projects that are considered planning, regulatory, and site-specific.

Table 1: Examples of planning, regulatory, and site-specific projects in Maryland that may need to consider RSLR.

PLANNING	REGULATORY	SITE-SPECIFIC
• Vulnerability or risk assessments • Hazard or flood mitigation plans • Comprehensive plans • Nuisance flood plans • Pre-disaster recovery plans • Capital improvement plans • Sustainable Communities Action Plans • Land preservation & recreation plans • Green infrastructure plans • Asset management plans • Transportation plans • Continuity of operation plans • Economic development plans • Historical/cultural resources assessment & plans • Resilience plans	• Zoning ordinances (new development in vulnerable or coastal areas) • Site plans or subdivision • Wetland & shoreline regulations • Critical area regulations • Floodplain ordinances • Freeboard requirements • Coast Smart Climate Ready Action Boundary in the Coast Smart Construction Program Siting & Design Guidelines • Updated building codes • Historic district designations	• New construction • Redevelopment & substantial improvements • Roads, bridges, & culverts • Shoreline stabilization • Wetland restoration • Coastal resilience easements • Land conservation / Program Open Space • Waterway improvement • Natural & nature-based infrastructure • Erosion management / Sediment control • Critical infrastructure • Location of resilience hubs • Land acquisition • Beneficial use of dredge material • State Revitalization Program, Community Legacy Program & Local Government Infrastructure grant projects (DHCD) • Ditch restoration • Nuisance flooding mitigation

Step 2: Determine the Project's Timeframe

Because relative sea level will increase over time, and RSLR estimates should be considered for the project's full duration. Determine the project's timeframe or useful life to the nearest decade. In general, this will be the maximum lifespan of the project. Also, identify any incremental action points or opportunities to adapt the project in the future. Incremental action points are especially important for projects with long timeframes due to increasing uncertainty in sea level rise projections towards the end of the century.

Guidelines for Determining Project Timeframe

PLANNING PROJECT: Consider the time horizon of the plan, the timeframe that is relevant for decisions made under the plan, and how often the plan is updated. Consider a range of timeframes when conducting a vulnerability assessment.

Example: The planning horizon for a comprehensive plan may be 30 years, with required updates every 10 years. Decision-makers may choose to use 30 years as the timeframe for the project but should consider that land use and other decisions made under the plan may extend beyond that timeframe. Incremental action points could occur every 10 years when the plan is updated.

REGULATORY PROJECT: Consider the timeframe relevant to the regulation, the regulatory standard, and incremental updates.

Example: Local floodplain ordinances regulate the construction of residential and commercial buildings. When updating the regulatory standards in the floodplain ordinance, decision-makers may choose to use the average useful life of residential and commercial buildings as the timeframe to account for future risk. An incremental action point could occur every five years as new RSLR projections become available and the floodplain ordinance is updated to account for that projected risk.

SITE-SPECIFIC PROJECT: Consider the useful life of the project and identify any incremental action or adaptation opportunities over the course of the project.

Example: The useful life of a business park may be 60 years. Incremental action points could occur when HVAC or other building systems require maintenance and upgrade.

Step 3: Determine Tolerance for Flood Risk

Determining tolerance for flood risk is necessary in order to select the appropriate RSLR estimate for a project. Stakeholder knowledge, perspectives, and project characteristics all contribute to the determination of flood risk tolerance and the resulting levels of protection and adaptation when planning for future flood impacts in a project area or location. Given different geographies, perspectives, and tolerance to living with water, the determination of flood risk tolerance is subjective and should be undertaken by project decision-makers and stakeholders. Decision-makers should have a working knowledge of current flood risk and impacts in the project area and may consider that information when determining future tolerance for flood risk. For example, if a project area experiences frequent flooding now, this may affect how sensitive stakeholders and assets are to inundation and could influence the willingness of decision-makers and stakeholders to accept the risk of potential future flooding.

Tolerance for Flood Risk

Tolerance for flood risk is the willingness of decision-makers and stakeholders to accept possible consequences of flooding. Flood risk tolerance is different from a project's **sensitivity to inundation**, which refers to the project's capacity to sustain damage or loss of function during a flood event or repeated flood events. A project with high sensitivity to inundation would be easily damaged if flooding were to occur, whereas a project with low sensitivity to inundation would not. When determining tolerance for flood risk, decision-makers and stakeholders should consider current flood risk of the project area, the project's sensitivity to inundation and additional factors such as those described in Table 2.

Determine whether high, medium, or low tolerance for flood risk is appropriate for the project. Project characteristics that should be considered include the project's importance to the community or replacement cost, how easily the project can be adapted to account for future flooding, the implications for public function and safety, consideration of community assets as determined in Step 1, and the sensitivity of the project to inundation (Table 2). When determining how easily the project can be adapted, consider any incremental action points identified in Step 2. Projects that include incremental action points may be easier to adapt to account for future flooding than projects without incremental action points.

Multiple categories of risk tolerance may apply to certain projects or project areas. In such cases, decision-makers and stakeholders may assign flood risk tolerances to each sub-area or structure included in the project. For example, a community updating its comprehensive plan may assign a high flood risk tolerance to recreational, natural, or open space areas but a medium or low flood risk tolerance to residential areas. Alternatively, decision-makers may choose to apply one flood risk tolerance to the entire project area, which should be the lowest tolerance level selected for a sub-area. This should be determined in coordination with the inventory of assets determined in Step 1.

Table 2: Possible project characteristics to consider when determining the level of tolerance for flood risk (Adapted from NH Coastal Flood Risk Science and Technical Advisory Panel's 2020 report, New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections [1])

	HIGH TOLERANCE FOR FLOOD RISK	MEDIUM TOLERANCE FOR FLOOD RISK	LOW TOLERANCE FOR FLOOD RISK
Description	Decision-makers & stakeholders have a High tolerance for flood risk to the project	Decision-makers & stakeholders have a Medium tolerance for flood risk to the project	Decision-makers & stakeholders have a Low tolerance for flood risk to the project
Possible Project Characteristics	Low impact, importance or consequence to the community and/or replacement cost Easy or likely to adapt Little to no implications for public function and/or safety Low sensitivity to frequency and exposure to inundation	Medium impact, importance or consequence to the community and/or replacement cost Moderately easy or somewhat likely to adapt Moderate implications for public function and/or safety Moderate sensitivity to frequency and exposure to inundation	High impact, importance or consequence to the community and/or replacement cost Difficult or unlikely to adapt Substantial implications for public function and/or safety High sensitivity to frequency and exposure to inundation

Examples of high, medium, and low tolerance for flood risk

<u>High tolerance for flood risk:</u> Projects determined to have a high tolerance for flood risk should have low impact, importance or consequence to the community, a low replacement cost, and little to no implications for public safety or the ability of the community to carry on day-to-day functions. The project should have low sensitivity to frequency and exposure to inundation (meaning it is acceptable for this area to flood intermittently) and have the capacity to be easily adapted to account for future flooding. These projects should consider accommodating or taking no action to flood impacts (see Step 6). One potential project example is a coastal resilience easement or other land conservation project that maintains an area as open space or natural areas and can be designed to temporarily accommodate flood waters. These types of projects typically have little or no impact on public safety or function if flooded, allow natural features to stay or expand on the landscape to act as a buffer and lower community flood risk, and, if given sufficient space, can adapt to changing water levels over time.

<u>Medium tolerance for flood risk</u>: Projects determined to have a medium tolerance for flood risk should be able to tolerate some flooding and subsequent impacts. Community day-to-day functions may be affected, but the impacts are likely concentrated to a specific area and critical functions are not compromised. These projects should have a medium importance to the community or medium replacement cost and have the potential to adapt over time somewhat easily. A potential example of a project assigned a medium tolerance for flood risk may be a floodplain ordinance where it is decided that commercial and residential buildings within a certain area can withstand some flooding or be adapted to withstand flooding without compromising critical community functions. In this case, there is an understanding that intermittent inundation may occur, but measures to resist or accommodate flooding (see Step 6) can be taken to reduce the impacts.

<u>Low tolerance for flood risk:</u> Projects determined to have a low tolerance for flood risk should have a high importance to the community and/or replacement cost. These projects are highly sensitive to inundation and public safety, or community day-to-day functions would be substantially impacted if flooding occurs, especially if there is recurrent flooding during a given timeframe. The likelihood or capacity to replace or adapt the project is low. This category often pertains to community assets or facilities such as emergency shelters, hospitals, power stations, water treatment plants, and other critical infrastructure as defined by stakeholders. Projects assigned a low tolerance for flood risk should consider using RSLR estimates that are less likely to occur but would have devastating consequences for the project if they did transpire. These projects should consider avoidance, resistance, or relocation of assets when adapting to future risk (see Step 6).

Step 4: Select a Tide Gauge

RSLR rates and projections vary slightly within Maryland due to variation in vertical land motion (the movement of land up or down). Localized RSLR projections have been calculated based on sea level trends measured by six tide gauges (devices that measure water level) in or near Maryland that have been consistently operating for at least 40 years [6,7]. RSLR projections are available for Annapolis, MD; Baltimore, MD; Cambridge, MD; Lewes, DE; Solomons Island, MD; and Washington, DC (Fig. 1). RSLR estimates differ among these tide gauges by only a few inches a hundred years into the future.

Decision-makers may choose to select the tide gauge that best represents or is the closest to or located within the project area. In most cases, RSLR projections based on the closest tide gauge should be used for the project. However, in some instances, a further tide gauge may be more representative of the project area. For example, Hoopers Island in Dorchester County is closest to the Solomons Island tide gauge but would be better represented by the Cambridge tide gauge because it is on the same side of the Bay. For regional or statewide projects, consider selecting a tide gauge with an intermediate rate of RSLR (Annapolis or Cambridge) to be representative of the whole project area.

Fig. 1: A map indicating the locations of NOAA tide gauges in or near Maryland.

Step 5: Select an RSLR Estimate for the Project

Maryland's 2018 RSLR projections use mean sea level in year 2000 (mean sea level 1991-2009) as the baseline reference and provide probabilities that RSLR will meet or exceed certain values at future timepoints. For example, a 5% probability that RSLR meets or exceeds 2.0 feet in 2050 means that there is a 1-in 20-chance that relative sea level will rise at least 2.0 feet above year 2000 levels by 2050 and a 95% chance that it will rise less than 2.0 feet. The 2018 report provides a "likely" range of RSLR for each timepoint and carbon emissions pathway, which is defined as 67% probability RSLR is between those values.

Projects with low tolerance for flood risk should consider RSLR estimates that are unlikely to be exceeded during the project's lifespan to avoid potentially severe consequences of inundation (i.e., high repair or replacement costs, substantial implications for public safety, etc.). Projects with high or medium tolerance for flood risk may consider less extreme RSLR estimates that are more likely to be realized during the project's lifespan because the consequences of flooding to the project are less severe. Projects with high tolerance for flood risk should plan for the upper end of the "likely" range of RSLR, which corresponds to a 17% chance that RSLR will meet or exceed the value. This recommendation is consistent with planning guidance in Maryland's 2018 sea level rise report and the guidance issued by other states, including California and New Hampshire. Projects with medium or low tolerance for flood risk should consider the 5% and 1% probabilities, respectively. RSLR estimates based on the 1-in-20 or 1-in-100 chance are more protective, but may still be exceeded by extreme sea level rise.

To select the RSLR for your project, find the table of RSLR estimates for the tide gauge identified in Step 4. Table 3 is a representative table based on the Cambridge tide gauge and the stabilized emissions pathway. Tables for all tide gauges (Annapolis, MD; Baltimore, MD; Cambridge, MD; Solomons Island, MD; Lewes, DE; and Washington, DC) based on the stabilized (RCP 4.5) and growing (RCP 8.5) emissions pathways are available in Appendix B.

On the appropriate table, find the row for the year corresponding to the timeframe identified in Step 2 and the column for the risk tolerance level identified in Step 3. The value where that row and column intersect is the projected RSLR estimate that should be used for the project.
For example, a shoreline stabilization project near Cambridge, MD with a 30-year timeframe and high tolerance for flood risk should consider 1.7 feet of RSLR (i.e., the intersection of the row "2050" and the column "High risk tolerance" on the table of RSLR estimates for the Cambridge, MD tide gauge).

Table 3: RSLR estimates above 2000 levels based on the Cambridge, MD tide gauge and the stabilized emissions pathway (RCP 4.5).

RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Cambridge, MD
Emissions Pathway beyond 2050: Stabilized (RCP 4.5)

Year	High tolerance for flood risk	Medium tolerance for flood risk	Low tolerance for flood risk
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.7 ft	2.0 ft	2.4 ft
2060	1.9 ft	2.3 ft	2.9 ft
2070	2.3 ft	2.8 ft	3.5 ft
2080	2.7 ft	3.3 ft	4.2 ft
2090	3.1 ft	3.8 ft	5.0 ft
2100	3.5 ft	4.3 ft	5.7 ft
2110	3.9 ft	4.9 ft	6.7 ft
2120	4.3 ft	5.5 ft	7.7 ft
2130	4.7 ft	6.1 ft	8.7 ft
2140	5.1 ft	6.7 ft	9.7 ft
2150	5.5 ft	7.3 ft	10.9 ft

If a project has multiple timeframes or categories of flood risk tolerance for different aspects of the project, decision-makers may choose a range of RSLR estimates or consider the most protective estimate (i.e., the lowest tolerance for flood risk) for the entire project.

Now that an RSLR estimate has been selected for the project, there needs to be an evaluation of the extent and depth of inundation for the site or project area. This assessment should include the impact on natural, cultural, and historic resources, critical infrastructure, other assets, and residents and businesses, including socially vulnerable populations. Step 6 provides guidance on tools and additional considerations for the assessment.

Greenhouse Gas Emissions Pathways

Beyond 2050, RSLR estimates will depend on the concentration of greenhouse gasses, such as carbon dioxide, in the atmosphere. Maryland's 2018 sea level rise report provides projections for three different International Panel on Climate Change (IPCC) greenhouse gas emissions pathways: Paris Agreement, stabilized emissions, and growing emissions. Under the Paris Agreement pathway (Representative Concentration Pathway (RCP) 2.6), emissions must start to decline now and reach net zero by 2100. The stabilized emissions pathway (RCP 4.5) requires emissions to begin to decline after 2050 and the growing emissions pathway (RCP 8.5) assumes emissions continue to rise throughout the century. The future is undetermined, but most experts believe greenhouse gas concentrations will likely fall between the stabilized emissions pathway (RCP 4.5) and the growing emissions pathway (RCP 8.5).

For the purposes of this planning document, it is recommended that the stabilized emissions pathway (RCP 4.5) and corresponding sea level rise projections be used for most projects. However, RSLR estimates based on the growing emissions pathway (RCP 8.5) are also provided in Appendix B for decision-makers who determine the stabilized emissions pathway (RCP 4.5) is too conservative and would like to consider the higher emissions scenario. Planning for the growing emissions pathway (RCP 8.5) may be appropriate for projects with long timeframes, very low flood risk tolerance, and little or no adaptive capacity.

Refer to Maryland's 2018 sea level rise report for additional information on greenhouse gas emission scenarios. This report is updated every five years to reflect the latest science and information on emissions scenarios and sea level rise projections.

Step 6: Assess flood impacts and consider adaptation options

Begin the assessment of RSLR impacts in the project area by visualizing present-day coastal flooding, including nuisance and storm surge flooding, and projected water levels based on the selected RSLR estimate. Tools in Table 4 are a starting point for assessing current and future inundation (there may be others that are not listed that can be used as well). In most cases, more in-depth analysis should be conducted to more accurately visualize flooding. Surveyed site plans can also be used for site-specific projects.

RSLR & Coastal Flooding Impacts

As sea levels rise coastal flooding, including nuisance flooding and storm surge, will occur more frequently and affect areas not currently impacted. **Nuisance flooding**, defined as high tide flooding that causes public inconvenience, was observed in Maryland 1-2 days per year in 2000 but is predicted to occur 40-170 days per year in 2050 [6]. Higher water levels will also cause the impacts of coastal storms to be more severe, with water reaching further inland and increasing coastal erosion. Stormwater management systems may be compromised due to higher water, causing increased flooding during tidal flood and precipitation events. Groundwater levels may rise with sea levels, leading to flooding in low-lying coastal areas with shallow water tables.

Once the current and future flood risk for the project or project area has been visualized, a vulnerability assessment of the project area or sub areas may be necessary depending on how well the vulnerability is understood. In addition to future mean sea levels, the assessment should also consider how RSLR will exacerbate nuisance flooding, storm surge flooding, and other hazards. Trainings, tools, and other resources related to vulnerability assessments are available on NOAA's Digital Coast.

Table 4: Tools for visualizing present-day coastal flooding and projected sea levels

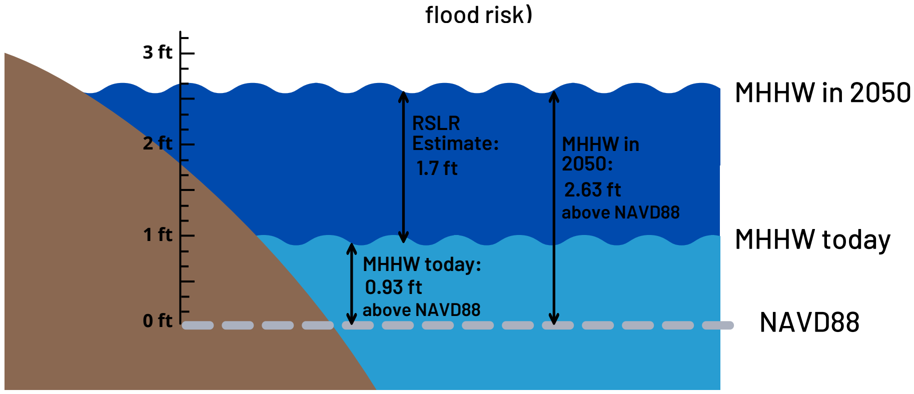
NAME	WEB ADDRESS	DESCRIPTION
NOAA Coastal Flood Exposure Mapper	https://coast.noaa.gov/digitalcoast/tools/flood-exposure.html	• Visualizes sea level rise relative to Mean Higher High Water (MHHW) at one foot increments • Visualizes areas prone to current high tide nuisance flooding and storm surge flooding • Includes FEMA 100-year and 500-year floodplains (1% and 0.2% annual chance of flooding, respectively) • Intended to be used as a screening-level tool
Climate Central Coastal Risk Screening Tool	https://coastal.climatecentral.org	• Visualizes water levels relative to Mean Higher High Water (MHHW) at 0.1 foot increments • Intended to be used as a screening-level tool
MDOT SHA Climate Change Vulnerability Viewer	https://www.arcgis.com/apps/webappviewer/index.html?id=86b5933d2d3e45ee8b9d8a5f03a7030c	• Visualizes water levels relative to Mean Sea Level (MSL) and Mean Higher High Water (MHHW) • Provides flood depth grids for 0 feet of RSLR (referred to as 2015 water levels), 2 feet of RSLR (referred to as 2050 water levels), and 6 feet of RSLR (referred to as 2100 water levels) combined with 10%, 4%, 2%, 1%, 0.2%, and 0% annual chance storms • Intended to be used as a screening tool
MD Climate Ready Action Boundary (CS-CRAB)	https://mdfloodmaps.net/crab/	• Visualizes water levels up to 3 feet (vertical and horizontal) beyond the floodplain and provides flood depth grids • Includes FEMA 100-year and 500-year floodplains (1% and 0.2% annual chance of flooding, respectively) • Indicates area considered by the Maryland Coast Smart Council to be especially vulnerable to current storm surge flooding and future sea level rise. • If state or local capital projects have a cost of over $500,000 and that uses at least 50% state funds is located waterward of the CS-CRAB boundary, then the Coast Smart Construction Program Siting and Design Guidelines apply

RSLR Estimates and Tidal Datums

For some projects, tidal datums other than mean sea level may be relevant (e.g. mean higher high water, mean lower low water, etc.). The RSLR estimate selected in Step 5 can be added to any tidal datum to determine future water levels. For example, mean lower low water (the average height of the lowest low tide) may be relevant for a boat ramp or waterway improvement project. Decision-makers may wish to consider mean higher high water (the average height of the highest high tide) if flooding during high tide is a concern. Tidal datums are available from NOAA Tides & Currents for each tide gauge. Datums can be displayed in relation to mean sea level, the North American Vertical Datum of 1988 (NAVD 88), or other reference points selected by the user. Any vertical reference point can be used, but the same reference point should be used consistently throughout the project.

Example: Estimating water levels in 2050 for a project in Cambridge, MD with high tolerance for flood risk, using mean higher high water (MHHW) relative to NAVD88

MHHW today:		RSLR Estimate:		MHHW in 2050:
0.93 feet	+	**1.7 feet**	=	**2.63 feet.**
above NAVD88		(30-yr timeframe & high tolerance for flood risk)		above NAVD88



Adapting Projects to Account for RSLR

After assessing the RSLR impacts to the project, decision-makers should evaluate adaptation options to address flood risk. Adaptation options typically fall within a framework of five categories: no action, avoid, accommodate, resist, or relocate. Decision-makers should consider ways to allow the project to adapt to future sea level rise and include impacted stakeholders in all decision-making processes. The resources listed in Table 5 can assist with evaluating and implementing adaptation options.

Framework of Options to Adapt to Coastal Flood Risk

- ***No action:** Don't change anything. Consider the potential costs associated with not taking action despite understanding the potential risk.*
- ***Avoid:** Prioritize investment outside of flood-prone areas. Avoid locating priority assets with medium to low tolerance for flood risk in areas likely to be impacted by RSLR during the project's lifespan.*
- ***Accommodate:** Live with the water. Consider options for accommodating flooding in projects with medium to high tolerance for flood risk.*
- ***Resist:** Keep the water out. Consider protecting assets with low tolerance for flood risk.*
- ***Relocate:** Move assets or facilitate migration. Consider relocating assets with low tolerance for flood risk out of areas likely to be impacted by RSLR during the project's lifespan.*

Adapted from NH Coastal Flood Risk Science and Technical Advisory Panel's 2020 report, New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections [1].

Table 5: Online climate adaptation resources.

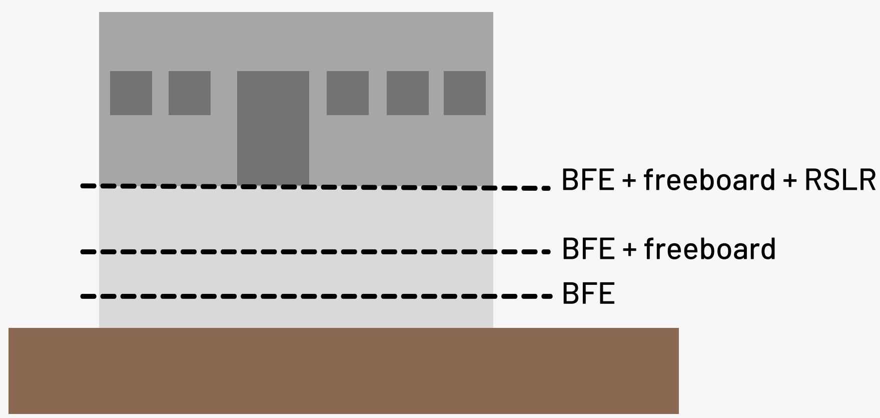
NAME	WEB ADDRESS	DETAILS
U.S. Climate Resilience Toolkit	https://toolkit.climate.gov/	Step-by-step framework for building climate resilience and resources including decision-support tools, case studies, and training courses
NOAA Digital Coast: Adaptation Options	https://coast.noaa.gov/digitalcoast/topics/climate-adaptation.html	Trainings, reference guides, and case studies related to adaptation in coastal communities
Georgetown Climate Center Adaptation Clearinghouse	www.adaptationclearinghouse.org	Searchable database of climate adaptation resources
EcoAdapt Climate Adaptation Knowledge Exchange (CAKE)	https://www.cakex.org/	Case studies, tools, and other resources for all phases of the adaptation process, including assessment, planning, implementation, evaluation, and monitoring

Designing for RSLR and Coastal Storm Impacts

Decision-makers can incorporate RSLR into a project's design to accommodate coastal flood hazards in the future. FEMA floodplain map layers identify a **Base Flood Elevation (BFE)** where water levels are expected to inundate during a 1% annual chance storm. The combined impacts of RSLR and coastal storms may be assessed by adding the RSLR estimate selected for the project to the BFE in the project area. This approach allows decision-makers to account for flooding caused by today's 1% annual chance storm in addition to future RSLR. If a jurisdiction has a **freeboard** requirement, the design flood elevation should be the sum of the RSLR estimate selected in Step 5, the current BFE provided by FEMA, and the freeboard. This is an example of designing to a higher standard to account for the potential impacts of the combination of RSLR and coastal storm surge in the future.

Example: Determining the design flood elevation for a structure in Cambridge, MD with low tolerance for flood risk and a 50-year timeframe.

Base Flood Elevation (BFE):		Required freeboard:		RSLR estimate:		RSLR-adjusted design flood elevation:
2.2 ft	+	**2 ft**	+	**3.5 ft**	=	**7.7 ft**
above ground level		above BFE		(50-yr timeframe and low risk tolerance)		above ground level



Glossary

Adaptive capacity: the ability to adapt a project to reduce the impacts of relative sea level rise or other hazards

Base Flood Elevation (BFE): expected water level during a 1% annual chance storm [7]

Decision-making process: process that includes all steps required to make decisions for projects. This includes project idea inception, consideration of options, stakeholder and community involvement, to decision-making, and implementation of decisions

Equity: Equity is the guarantee of just and fair treatment, advancement, opportunity, inclusion, and access for all individuals. It strives to eliminate barriers and dismantle the systems of oppression that have historically prevented the full participation of some groups. Equity ensures that all community members have access to the environments, resources, and opportunities to reach their full potential and to experience optimal well-being and quality of life [8]

Freeboard: height above the Base Flood Elevation at which a structure's lowest floor must be elevated or floodproofed as a factor of safety

Incremental action point: points throughout the lifespan of a project after the initial phase that allow adaptation actions to be taken if necessary based on updated climate projections

Justice: the realized ability of all individuals to live a full and dignified life. Achieving justice requires directly dismantling barriers to resources and opportunities in society

Nuisance flooding: high tide flooding that causes public inconvenience

Planning project: development of a community-scale plan, such as a comprehensive plan or hazard mitigation plan

Project: any private, local, state, or federal planning, regulatory or site-specific effort that should consider and incorporate RSLR projections [1]

Regulatory project: regulations, ordinances, codes, and designations that are updated and/or adopted by local or state governing bodies

Relative sea level rise (RSLR): the change of the height of the ocean relative to land at a certain location

Resilience: the ability of a system to recover from a disturbance, adapting a complex network of interactions to maintain productivity and fundamental identity

Sensitivity to inundation: capacity to sustain damage or loss of function during a flood event or repeated flooding events

Site-specific project: a project that is done in a specific location or parcel

Sunk cost: costs expended for a project that are not recouped in the future

Tolerance for flood risk: the willingness of decision-makers and stakeholders to accept possible consequences of flooding

Useful life: the number of years a project is likely to remain in use

Vulnerability: the characteristics of exposure, sensitivity, and adaptive capacity that makes a system, asset or the natural environment more or less susceptible to harm or change [9]

References

1. NH Coastal Flood Risk Science and Technical Advisory Panel. 2020. *New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections*. Report published by the University of New Hampshire, Durham, NH. https://scholars.unh.edu/ersc/211/
2. Raymond, C.L., N. Faghin, H. Morgan, and H. Roop. 2020. How to Choose: A Primer for Selecting Sea Level Rise Projections for Washington State. *A collaboration of Washington Sea Grant and University of Washington Climate Impacts Group*. Prepared for the Washington Coastal Resilience Project. https://cig.uw.edu/wp-content/uploads/sites/2/2020/07/SLR-Report-FINAL-July-2020.pdf
3. Boesch, D.F., W.C. Boicourt, R.I. Cullather, T. Ezar, G.E. Galloway, Jr., Z.P. Johnson, K.H. Kilbourne, M.L. Kirwan, R.E. Kopp, S. Land, M. Li, W. Nardin, C.K. Somerfield, and W.V. Sweet. 2018. *Sea-level Rise: Projections for Maryland 2018*, 27 pp. University of Maryland Center for Environmental Science, Cambridge, MD. https://www.umces.edu/sites/default/files/Sea-Level%20Rise%20Projections%20for%20Maryland%202018_0.pdf
4. Dupigny-Giroux, L.A., E.L. Mecray, M.D. Lemcke-Stampone, G.A. Hodgkins, E.E. Lentz, K.E. Mills, E.D. Lane, R. Miller, D.Y. Hollinger, W.D. Solecki, G.A. Wellenius, P.E. Sheffield, A.B. MacDonald, and C. Caldwell. 2018. Northeast. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 669–742. doi: 10.7930/NCA4.2018.CH18
5. California Natural Resources Agency & California Ocean Protection Council. 2018. *State of California Sea-level Rise Guidance: 2018 Update.* http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf
6. Sweet, W., S. Simon, G. Dusek, D. Marcy, W. Brooks, M. Pendleton, and J. Marra. 2021. *2021 State of High Tide Flooding and Annual Outlook*. NOAA Technical Report. https://tidesandcurrents.noaa.gov/publications/2021_State_of_High_Tide_Flooding_and_Annual_Outlook_Final.pdf
7. Federal Emergency Management Agency. *Base Flood Elevation (BFE)*. March 5, 2020.
8. US Climate Action Network. Justice Equity Diversity and Inclusion Glossary. https://www.usclimatenetwork.org/justice_equity_diversity_and_inclusion. Accessed 15 March 2022.
9. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)] IPCC, Annex I: Glossary - Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. 2018; https://www.ipcc.ch/sr15/chapter/glossary/.
10. Deconto R.M. and D. Pollard. 2016. Contribution of Antarctica to past and future sea-level rise. *Nature* 531:591-597.
11. Kopp, R. E., R.M. Horton, C.M. Little, J.X. Mitrovica, M. Oppenheimer, D.J. Rasmussen, B.H. Strauss, and C. Tebaldi. 2014. Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites. *Earth's Future 2:383-406.* doi: 10.1002/2014EF000239.

Appendix A: Worksheet for Selecting a RSLR Estimate

This worksheet provides a template to guide a user through the process of selecting a RSLR estimate for a project. The worksheet follows the steps of the *Guidance for Using Maryland's 2018 Sea Level Rise Projections* and users are encouraged to pay particular attention to the Guiding Principles while answering questions to ensure consideration of all project aspects.

Project name: ____

Project area/location: ____

Step 1: Define the project goal, type and area
Project goal and activities *(Include all intended outcomes (short- and long-term) and identify activities required throughout the entire lifecycle of the project).*
Stakeholders *(Describe the stakeholders who will be impacted by the project and included in the decision-making process. Identify strategies for engagement and consider how the impacts of the project will vary across stakeholder groups).*

Step 2: Determine the project's timeframe	
Project timeframe (years): ___________________	End of project timeframe (year): ________________________
Incremental action point(s): Y | N *Note the year and provide a short description of the incremental action points & opportunity for adaptation below.*	

Year	*Explanation*

Step 3: Determine the project's tolerance for flood risk

Characteristic	*High*	*Medium*	*Low*	*Explanation*
Impact, importance or consequence to the community and/or replacement cost	☐	☐	☐	
Adaptability	☐	☐	☐	
Implications for public function and/or safety	☐	☐	☐	
Sensitivity to frequency and exposure to inundation	☐	☐	☐	
Other: _____________________	☐	☐	☐	
Other: _____________________	☐	☐	☐	

The project's overall flood risk tolerance is:	☐	Low	☐	Medium	☐	High
Explanation:						

Step 4: Select a tide gauge					
☐	Annapolis, MD	☐	Lewes, DE	☐	Washington, DC
☐	Baltimore, MD	☐	Solomons Island, MD	☐	Cambridge, MD

Step 5: Select a RSLR estimate for the project

The project should plan, regulate for, or design for ___________ feet RSLR by year ____________

Incremental action point(s) (year)	*RSLR (feet)*

Step 6: Assess flood impacts and consider adaptation options

Flood impacts *(describe the potential impacts of RSLR and other causes of coastal flooding on the project area during the project's timeframe)*:

Design flood elevation *(if applicable)*:

_______ RSLR (ft) + _______ BFE (ft) + _______ freeboard (ft) = _______ ft

Adaptation options *(if applicable, describe how the project could be adapted to reduce the impacts of RSLR and other causes of coastal flooding. See Guidance document for examples of adaptation options and be sure to consider incremental action points)*:

Appendix B: Sea Level Rise Projections

The report *Sea-Level Rise Projections for Maryland 2018* bases the projections and probabilities for RSLR 2030-2050 on Deconto and Pollard's 2016 (DP16) [10] projection for the stabilized emissions pathway. Beyond 2050, the report bases the projections and probabilities on the Kopp et al. 2014 (K14) [11] methodology. Consistent with the report *Sea-Level Rise Projections for Maryland 2018*, all RSLR estimates included in this document were provided by Dr. Robert Kopp of Rutgers University using the LocalizeSL tool (https://github.com/bobkopp). The following tables provide RSLR estimates above 2000 levels for five tide gauges (Annapolis, MD; Baltimore, MD; Cambridge, MD; Solomons Island, MD; Lewes, DE; and Washington, DC) based on the stabilized (RCP 4.5) and growing (RCP 8.5) emissions pathways.

BASED ON THE STABILIZED EMISSIONS PATHWAY

RSLR estimates above 2000 levels based on the Annapolis, MD tide gauge and the stabilized emissions pathway (RCP 4.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Annapolis, MD
Emissions Pathway beyond 2050: Stabilized (RCP 4.5)

Year	High tolerance for flood risk	Medium tolerance for flood risk	Low tolerance for flood risk
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.6 ft	2.0 ft	2.4 ft
2060	1.9 ft	2.3 ft	2.9 ft
2070	2.3 ft	2.8 ft	3.5 ft
2080	2.7 ft	3.3 ft	4.2 ft
2090	3.1 ft	3.8 ft	4.9 ft
2100	3.4 ft	4.3 ft	5.7 ft
2110	3.9 ft	4.9 ft	6.7 ft
2120	4.3 ft	5.4 ft	7.6 ft
2130	4.7 ft	6.0 ft	8.6 ft
2140	5.1 ft	6.6 ft	9.5 ft
2150	5.4 ft	7.2 ft	10.8 ft

RSLR estimates above 2000 levels based on the Baltimore, MD tide gauge and the stabilized emissions pathway (RCP 4.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Baltimore, MD **Emissions Pathway beyond 2050:** Stabilized (RCP 4.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.6 ft	2 ft	2.3 ft
2060	1.9 ft	2.3 ft	2.8 ft
2070	2.3 ft	2.8 ft	3.5 ft
2080	2.6 ft	3.2 ft	4.1 ft
2090	3.0 ft	3.7 ft	4.8 ft
2100	3.4 ft	4.2 ft	5.6 ft
2110	3.8 ft	4.8 ft	6.6 ft
2120	4.1 ft	5.3 ft	7.5 ft
2130	4.6 ft	5.9 ft	8.5 ft
2140	4.9 ft	6.5 ft	9.4 ft
2150	5.3 ft	7.1 ft	10.6 ft

RSLR estimates above 2000 levels based on the Cambridge, MD tide gauge and the stabilized emissions pathway (RCP 4.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the “likely” range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Cambridge, MD **Emissions Pathway beyond 2050:** Stabilized (RCP 4.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.7 ft	2.0 ft	2.4 ft
2060	1.9 ft	2.3 ft	2.9 ft
2070	2.3 ft	2.8 ft	3.5 ft
2080	2.7 ft	3.3 ft	4.2 ft
2090	3.1 ft	3.8 ft	5.0 ft
2100	3.5 ft	4.3 ft	5.7 ft
2110	3.9 ft	4.9 ft	6.7 ft
2120	4.3 ft	5.5 ft	7.7 ft
2130	4.7 ft	6.1 ft	8.7 ft
2140	5.1 ft	6.7 ft	9.7 ft
2150	5.5 ft	7.3 ft	10.9 ft

RSLR estimates above 2000 levels based on the Lewes, DE tide gauge and the stabilized emissions pathway (RCP 4.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Lewes, DE **Emissions Pathway beyond 2050:** Stabilized (RCP 4.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.7 ft	2.0 ft	2.4 ft
2060	2.0 ft	2.4 ft	2.9 ft
2070	2.4 ft	2.9 ft	3.6 ft
2080	2.7 ft	3.3 ft	4.3 ft
2090	3.1 ft	3.8 ft	5.0 ft
2100	3.5 ft	4.4 ft	5.8 ft
2110	3.9 ft	5.0 ft	6.8 ft
2120	4.3 ft	5.5 ft	7.8 ft
2130	4.8 ft	6.1 ft	8.7 ft
2140	5.2 ft	6.7 ft	9.7 ft
2150	5.5 ft	7.3 ft	10.9 ft

RSLR estimates above 2000 levels based on the Solomons Island, MD tide gauge and the stabilized emissions pathway (RCP 4.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Solomons Island, MD **Emissions Pathway beyond 2050:** Stabilized (RCP 4.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.7 ft	2.0 ft	2.4 ft
2060	2.0 ft	2.4 ft	2.9 ft
2070	2.4 ft	2.9 ft	3.5 ft
2080	2.7 ft	3.3 ft	4.3 ft
2090	3.1 ft	3.8 ft	5.0 ft
2100	3.5 ft	4.4 ft	5.8 ft
2110	3.9 ft	5.0 ft	6.8 ft
2120	4.3 ft	5.5 ft	7.8 ft
2130	4.8 ft	6.1 ft	8.8 ft
2140	5.2 ft	6.7 ft	9.7 ft
2150	5.6 ft	7.3 ft	10.9 ft

RSLR estimates above 2000 levels based on the Washington, DC tide gauge and the stabilized emissions pathway (RCP 4.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Washington, DC **Emissions Pathway beyond 2050:** Stabilized (RCP 4.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.0 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.6 ft	1.9 ft	2.3 ft
2060	1.9 ft	2.2 ft	2.8 ft
2070	2.2 ft	2.7 ft	3.4 ft
2080	2.6 ft	3.2 ft	4.1 ft
2090	3.0 ft	3.7 ft	4.8 ft
2100	3.3 ft	4.2 ft	5.6 ft
2110	3.7 ft	4.8 ft	6.6 ft
2120	4.1 ft	5.3 ft	7.5 ft
2130	4.5 ft	5.9 ft	8.5 ft
2140	4.9 ft	6.4 ft	9.4 ft
2150	5.3 ft	7.1 ft	10.6 ft

BASED ON THE GROWING EMISSIONS PATHWAY

RSLR estimates above 2000 levels based on the Annapolis, MD tide gauge and the growing emissions pathway (RCP 8.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Annapolis, MD **Emissions Pathway beyond 2050:** Growing (RCP 8.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.6 ft	2.0 ft	2.4 ft
2060	2.1 ft	2.5 ft	3.1 ft
2070	2.6 ft	3.1 ft	3.9 ft
2080	3.1 ft	3.8 ft	4.8 ft
2090	3.7 ft	4.6 ft	5.9 ft
2100	4.3 ft	5.3 ft	6.9 ft
2110	4.4 ft	5.4 ft	7.4 ft
2120	5.0 ft	6.1 ft	8.6 ft
2130	5.5 ft	7.0 ft	9.9 ft
2140	6.1 ft	7.8 ft	11.2 ft
2150	6.7 ft	8.6 ft	12.5 ft

RSLR estimates above 2000 levels based on the Baltimore, MD tide gauge and the growing emissions pathway (RCP 8.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Baltimore, MD
Emissions Pathway beyond 2050: Growing (RCP 8.5)

Year	High tolerance for flood risk	Medium tolerance for flood risk	Low tolerance for flood risk
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.6 ft	2.0 ft	2.3 ft
2060	2.1 ft	2.5 ft	3.1 ft
2070	2.6 ft	3.1 ft	3.8 ft
2080	3.1 ft	3.7 ft	4.7 ft
2090	3.6 ft	4.5 ft	5.8 ft
2100	4.2 ft	5.2 ft	6.9 ft
2110	4.3 ft	5.3 ft	7.3 ft
2120	4.8 ft	6.0 ft	8.5 ft
2130	5.4 ft	6.9 ft	9.8 ft
2140	6.0 ft	7.7 ft	11.1 ft
2150	6.6 ft	8.5 ft	12.4 ft

RSLR estimates above 2000 levels based on the Cambridge, MD tide gauge and the growing emissions pathway (RCP 8.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Cambridge, MD **Emissions Pathway beyond 2050:** Growing (RCP 8.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.7 ft	2.0 ft	2.4 ft
2060	2.1 ft	2.5 ft	3.1 ft
2070	2.6 ft	3.1 ft	3.9 ft
2080	3.1 ft	3.8 ft	4.8 ft
2090	3.7 ft	4.6 ft	5.9 ft
2100	4.3 ft	5.3 ft	7.0 ft
2110	4.4 ft	5.4 ft	7.5 ft
2120	5.0 ft	6.2 ft	8.7 ft
2130	5.6 ft	7.0 ft	10.0 ft
2140	6.2 ft	7.9 ft	11.3 ft
2150	6.8 ft	8.7 ft	12.6 ft

RSLR estimates above 2000 levels based on the Lewes, DE tide gauge and the growing emissions pathway (RCP 8.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Lewes, DE **Emissions Pathway beyond 2050:** Growing (RCP 8.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.7 ft	2.0 ft	2.4 ft
2060	2.2 ft	2.6 ft	3.1 ft
2070	2.7 ft	3.2 ft	4.0 ft
2080	3.2 ft	3.9 ft	4.9 ft
2090	3.8 ft	4.7 ft	6.0 ft
2100	4.4 ft	5.4 ft	7.1 ft
2110	4.5 ft	5.6 ft	7.7 ft
2120	5.1 ft	6.4 ft	8.9 ft
2130	5.7 ft	7.2 ft	10.1 ft
2140	6.3 ft	8.0 ft	11.5 ft
2150	6.9 ft	8.9 ft	12.8 ft

RSLR estimates above 2000 levels based on the Solomons Island, MD tide gauge and the growing emissions pathway (RCP 8.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Solomons Island, MD **Emissions Pathway beyond 2050:** Growing (RCP 8.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.1 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.7 ft	2.0 ft	2.4 ft
2060	2.2 ft	2.6 ft	3.1 ft
2070	2.7 ft	3.1 ft	3.9 ft
2080	3.2 ft	3.8 ft	4.9 ft
2090	3.8 ft	4.6 ft	5.9 ft
2100	4.4 ft	5.4 ft	7.0 ft
2110	4.5 ft	5.5 ft	7.5 ft
2120	5.0 ft	6.2 ft	8.7 ft
2130	5.6 ft	7.1 ft	10.0 ft
2140	6.3 ft	8.0 ft	11.4 ft
2150	6.9 ft	8.8 ft	12.7 ft

RSLR estimates above 2000 levels based on the Washington, DC tide gauge and the growing emissions pathway (RCP 8.5) beyond 2050. RSLR estimates for High tolerance for flood risk correspond to the upper end of the "likely" range (17% probability RSLR meets or exceeds value), RSLR estimates for Medium tolerance for flood risk correspond to the 1-in-20 chance (5% probability RSLR meets or exceeds value), and RSLR estimates for Low tolerance for flood risk correspond to the 1-in-100 chance (1% probability RSLR meets or exceeds value).

Tide Gauge: Washington, DC **Emissions Pathway beyond 2050:** Growing (RCP 8.5)			
Year	**High tolerance for flood risk**	**Medium tolerance for flood risk**	**Low tolerance for flood risk**
2030	0.9 ft	1.0 ft	1.3 ft
2040	1.2 ft	1.5 ft	1.8 ft
2050	1.6 ft	1.9 ft	2.3 ft
2060	2.1 ft	2.5 ft	3.0 ft
2070	2.5 ft	3.1 ft	3.8 ft
2080	3.1 ft	3.7 ft	4.7 ft
2090	3.6 ft	4.5 ft	5.7 ft
2100	4.2 ft	5.2 ft	6.8 ft
2110	4.3 ft	5.3 ft	7.3 ft
2120	4.8 ft	6.0 ft	8.4 ft
2130	5.4 ft	6.8 ft	9.7 ft
2140	6.0 ft	7.7 ft	11.1 ft
2150	6.6 ft	8.5 ft	12.3 ft