RESILIENT MASSACHUSETTS ACTION TEAM (RMAT)

DRAFT

CLIMATE RESILIENCE DESIGN STANDARDS & GUIDELINES

SECTION 2: DRAFT PROJECT INPUTS AND CLIMATE RISK SCREENING OUTPUT

DRAFT DOCUMENT FOR PUBLIC COMMENT PERIOD

DRAFT DATE: AUGUST 24, 2020

CONTRACT NUMBER: ENV 19 CC 02

OWNER: Massachusetts Executive Office of Energy and Environmental Affairs (EEA)

IN PARTNERSHIP WITH: Massachusetts Emergency Management Agency (MEMA)

RMAT TECHNICAL ASSISTANCE CONSULTANT TEAM:
Weston & Sampson
AECOM
Woods Hole Group
ONE Architecture & Urbanism
Dr. Jennifer Jacobs

RMAT CLIMATE RESILIENCE DESIGN STANDARDS AND GUIDELINES

Section 2 Table of Contents

2. DRAFT PROJECT INPUTS AND CLIMATE RISK SCREENING OUTPUT

This section describes the Project Inputs to the Climate Resilience Design Standards Tool (the Tool) and one of the Outputs of the Tool (Climate Risk Screening Output), which includes a preliminary exposure rating and risk rating.

2.1 PROJECT INPUTS

The Climate Resilience Design Standards Tool (the Tool) requires the user to input details related to the project and physical asset(s) ("Project Inputs"). These Project Inputs are necessary for the user to submit to receive Outputs from the Tool. It is expected that the user will need to spend up to 15 minutes to complete the Project Inputs. The Tool is based on user selection of pre-populated lists of responses for the project and assets, as well as select automated GIS-based spatial queries. The categories and order of Project Inputs are shown in Figure 2.1 and listed in Table 2.1, below.

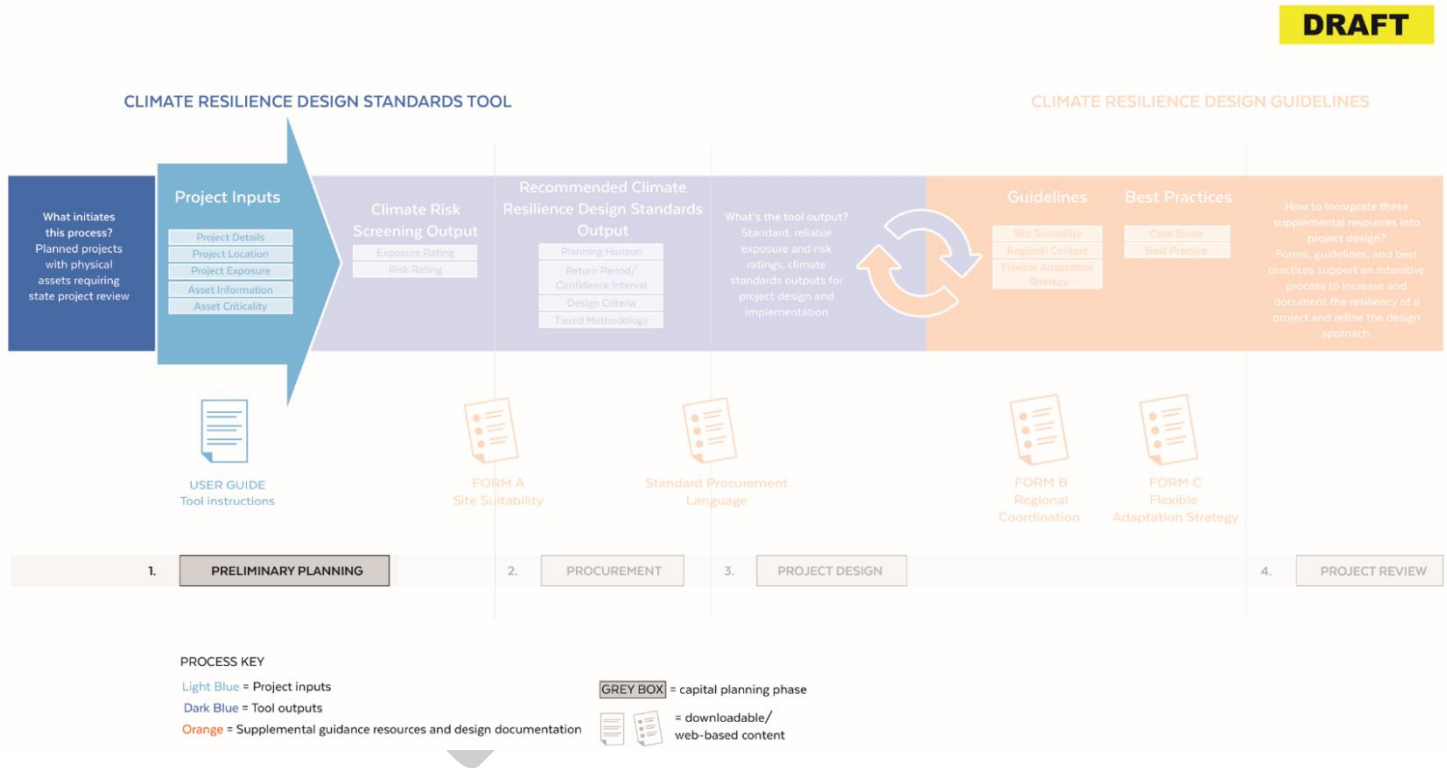

Figure 2.1. *Project Overview Emphasizing the Project Inputs for the Climate Resilience Design Standards Tool*

Table 2.1. Project Inputs for the Climate Resilience Design Standards Tool

PROJECT INPUTS
1. **Project Details and Location**
2. **Project Exposure Questions**
3. **Asset Information**
4. **Asset Criticality Questions**

These Project Inputs assist the GIS-based Tool to determine a preliminary project exposure rating for each climate parameter: sea level rise/ storm surge, extreme precipitation (riverine and urban), and extreme heat. The Project Inputs then inform a preliminary risk rating for each project asset, by climate parameter, by combining its exposure rating and the consequence of impact of that asset failing (derived from the Asset Criticality Questions described in Section 2.1.4).

2.1.1 PROJECT DETAILS AND LOCATION

The project details and location provided as Project Inputs include the following sections, indicated in Table 2.2 below.

Table 2.2. Project Inputs Related to Project Details and Location for the Tool

PROJECT DETAILS AND LOCATION	**PROJECT NAME**
	STATE AGENCY
	PROJECT DESCRIPTION
	ESTIMATED PROJECT CAPITAL COST
	CORE OBJECTIVE
	FUNDING MECHANISMS
	DOES THE PROJECT INVOLVE THE DESIGN OF MORE THAN ONE MAJOR PHYSICAL ASSET?
	PROJECT LOCATION
	MAJOR PHYSICAL ASSETS

The project details help to inform the context of the project. The project location is a key piece of information for the Tool, to apply GIS-based filters to determine project exposure (discussed in Section 2.1.2) provide Climate Risk Screening and Climate Resilience Design Standards Outputs. Users will also input a list of the major physical assets to inform the physical components of the project that will receive a preliminary climate risk rating and appropriate climate resilience design standards.

2.1.2 PROJECT EXPOSURE QUESTIONS

The Project Inputs related to the Project Exposure questions combined with automatic GIS-based analysis through the Tool provide the Project's preliminary exposure ratings for each of three climate parameters (sea level rise/storm surge, precipitation, and heat). The GIS filters and

exposure questions for the user are shown in Table 2.3 below. The GIS queries are based on existing available information, including layers from the Massachusetts Coast Flood Risk Model (MC-FRM), FEMA Flood Map layers, and ResilientMA.org climate data layers.

Table 2.3. Project Inputs Related to Project Exposure Questions for the Tool

Climate Parameter	GIS Dataset (if applicable)	Question/Filter
Sea Level Rise/Storm Surge	MC-FRM (Filter: tidal benchmarks shapefile, probability maps, planning horizon)	Is any part of the project located within the tidal benchmarks within the asset's useful life?
		Is any part of the project in the 1% annual coastal flood exceedance probability (ACFEP) within the asset's useful life?
	N/A - user question	**Does the project site have a history of coastal flooding?**
	MC-FRM (Filter: probability maps, planning horizon)	Is any part of the project within the 0.1% annual coastal flood exceedance probability (ACFEP) within the asset's useful life?
Extreme Precipitation *Urban Flooding*	**N/A - user question**	**Does the project site have a history of flooding during extreme precipitation events?**
	N/A - user question	**Does the project result in a net increase in impervious area of the site?**
	Days >2 inches rainfall (Filter: RCP 8.5, Basin Scale, Planning Horizon)	How many days per year increase with rainfall greater than 2 inches within the asset's useful life?
Extreme Precipitation *Riverine Flooding*	FEMA flood zones	Is any part of the project within the current 1% annual chance (100-year) FEMA floodplain?
	N/A - user question	**Does the project site have a history of riverine flooding?**
	FEMA flood zones	Is any part of the project within 500 ft. of an existing water body or the current 0.2% annual chance (500-year) FEMA floodplain?
Extreme Heat	Days over 90 degrees (Filter: RCP 8.5, Basin Scale, Planning Horizon)	How many days increase in days over 90 degrees Fahrenheit are there within the asset's useful life?
	GIS Map	Is any part of the project within 100 ft. of an existing water body?
	N/A - user question	**Does the project result in a net increase in impervious area of the site?**

2.1.3 ASSET INFORMATION

The Tool will then prompt users to answer a series of questions for each physical asset in the project. Users must provide the asset information listed in Table 2.4 for each asset.

Table 2.4. Asset Information Provided as Project Inputs for the Tool

ASSET INFORMATION	**ASSET CATEGORY**
	ASSET TYPE
	ASSET SUB-TYPE
	CONSTRUCTION TYPE
	USEFUL LIFE

Asset Category: There are three physical asset categories, indicated in Table 2.5, below. Each Asset Category has a different array of Asset Types, Asset Sub-Types, and Construction Types for Project Input options.

Table 2.5. Project Inputs Related to Asset Category for the Tool

ASSET CATEGORY	**BUILDING/FACILITY**
	INFRASTRUCTURE
	NATURAL RESOURCES

Asset Type: The Asset Types available for each Asset Category are presented in Table 2.6.

Table 2.6. Project Inputs Related to Asset Type for each Asset Category for the Tool

ASSET CATEGORY	BUILDING/FACILITY	INFRASTRUCTURE	NATURAL RESOURCES
ASSET TYPE	Typically Occupied	Transportation	Coastal Resource Area
	Typically Unoccupied	Flood Control	Forested Ecosystems
		Utility Infrastructure	Aquatic Ecosystems
		Solid and Hazardous Waste	Wetland Resource Area - Inland
		Other	Agricultural Resources
			Open Space
			Urban Forest

Asset Sub-Type Inputs: The Asset Sub-Type inputs available for each Asset Category are presented in Tables 2.7, 2.8, and 2.9, respectively for Building/Facility, Infrastructure, and Natural Resources.

Table 2.7. Project Inputs Related to Asset Sub-Type for each Building/Facility Asset Type

ASSET CATEGORY	BUILDING/FACILITY	
ASSET TYPE	Typically Occupied	Typically Unoccupied
ASSET SUB-TYPE	Airport	Food distribution center
	Childcare facility	Fuel storage/station
	Community center	Generator
	Correctional facility	Hazardous waste storage
	Elderly housing	Industrial
	Emergency operations/response building (fire, police, etc.)	Maintenance facility
	Emergency shelter	Material storage
	Government building	Mechanical building/vent stack
	Group home	Morgue
	Higher-education facility	Parking facility
	Hospital and mental health facilities	Power transmission facility, substation, and/or generation station
	House/place of worship	Pump Station - Sanitary
	Laboratory	Pump Station - Stormwater
	Library	Rapid Transit/Rail station
	IT data center	Recreational facility
	Judicial center	Solid waste facility (recycling facilities, transfer stations, etc.)
	Military facility	Telecommunications facility/communication tower
	Mixed-use building	Ventilation building/fan plants
	Non-residential building (office, commercial, retail)	Wastewater treatment plant
	Other	Water storage tank or tower
		Water treatment plant (potable water)
		Other

Table 2.8. Project Inputs Related to Asset Sub-Type for each Infrastructure Asset Type

ASSET CATEGORY	INFRASTRUCTURE			
ASSET TYPE	**Transportation**	**Flood Control**	**Utility Infrastructure**	**Solid and Hazardous Waste**
ASSET SUB-TYPE	Roads (local)	Dams	Energy (electric, gas, petroleum, renewable)	Landfill
	Roads (highway)	Dikes and/or levees	Telecommunications	Solid Waste Facility/Transfer Station
	Pedestrian ways and bikeways	Seawalls	Wastewater	Other Solid and Hazardous Waste
	Railways (rail and rapid transit)	Multi-purpose flood storage	Water	
	Bridge	Other Flood Barrier	Stormwater utility infrastructure	
	Culvert		Other Utility	
	Bus (stops)			
	Ferry/water taxi			
	Ports			
	Other Transportation			

Table 2.9. Project Inputs Related to Asset Sub-Type for each Natural Resources Asset-Type

ASSET CATEGORY	NATURAL RESOURCES						
ASSET TYPE	Coastal Resource Area	Forested Ecosystems	Aquatic Ecosystems	Wetland Resource Area - Inland	Agricultural Resources	Open Space	Urban Forest
ASSET SUB-TYPE	Coastal bank	Upland forest	Large- and mid-size rivers	Banks	Cropland and/or arable land (annual replanting)	Open recreation space	Street trees
	Coastal wetland	Lowland forest	Small streams	Land under Water Bodies or Waterways	Permanent Cropland	Trails	Stormwater detention/retention
	Coastal beach	Woodlands	Connecticut and Merrimack Mainstems	Vernal Pool Habitat	Permanent Pastures (grasslands, shrublands)	Conservation land	Rain gardens
	Coastal dune	Forested swamps	Lakes and Ponds - Non water supply	Lower Floodplains	Riverfront Area	Reserves	Grassland
	Land under the ocean	Riparian forest			Wooded deciduous swamps		Parklands
	Land under an estuary	Shrub swamps			Emergent wetlands		Peatlands
	Land under a salt pond	Young forests and shrublands			Marsh		
	Land subject to tidal action				Wet meadows		
	Land subject to coastal 100-year storm flowage				Bogs		
	Land under streams, rivers, lakes, or creeks within the coastal zone that are anadromous/catadromous fish runs						
	Barrier beach						
	Estuarine open water						
	Salt marsh						
	Rocky intertidal shores						
	Coastal plain ponds						

Construction Type Inputs: The Construction Type inputs available for each Asset Category are presented in the Table 2.10.

Table 2.10. Project Inputs Related to Construction Type for each Asset Category for the Tool

ASSET CATEGORY	BUILDING/FACILITY	INFRASTRUCTURE	NATURAL RESOURCES
CONSTRUCTION TYPE	New Construction	New Construction	New Construction
	Major Repair/Retrofit	Major Repair/Retrofit	Restoration or enhancement
	Maintenance (critical repair)	Maintenance (critical repair)	Maintenance (environmental)
	Maintenance (environmental)	Maintenance (environmental)	Dam removal
	Renovation		

Useful Life Inputs: The Useful Life inputs available for each Asset Category are presented in the Table 2.11.

Table 2.11. Project Inputs Related to Useful Life for each Asset Category for the Tool

ASSET CATEGORY	BUILDING/FACILITY	INFRASTRUCTURE	NATURAL RESOURCES
USEFUL LIFE	0 to 10 years	0 to 10 years	0 to 10 years
	11 years to 20 years	11 years to 20 years	11 years to 20 years
	21 years to 30 years	21 years to 30 years	21 years to 30 years
	31 years to 40 years	31 years to 40 years	31 years to 40 years
	41 years to 50 years	41 years to 50 years	41 years to 50 years
	51 years to 60 years	51 years to 60 years	Greater than 50 years
	61 years to 75 years	61 years to 75 years	
	Greater than 75 years	Greater than 75 years	

2.1.4 ASSET CRITICALITY QUESTIONS

Criticality is defined as a function of scope, time, and severity for building and infrastructure assets. Scope is defined as the geographic area and population that would be affected by the loss or inoperability of that asset; time is the length of time an asset can be inoperable without consequences; and severity are the consequences that are associated from the loss or inoperability of an asset, such as public health and safety impacts, economic impacts, environmental impacts, and cascading impacts to name a few.

Project Inputs for each asset's criticality will appear as a pre-populated list of question responses for the user to select according to each asset. Criticality is not an output of the Tool and is designed as an internal metric only. The criticality responses received by user selection will inform the preliminary exposure and risk rating outputs, and subsequent Climate Resilience Design Standards. Documents outlining the scoring and methodology informing criticality calculations are

attached at the end of Section 2, Attachments 2.1A, 2.1B, 2.2C. Users will not receive a score related to the asset criticality.

Further details on the scope, time, and severity questions and pre-populated answer choices for each asset category can be found in Tables 2.12 through 2.16.

Table 2.12. Project Inputs Related to Scope and Time Questions for Building/Facility Asset Criticality

BUILDING/FACILITY CRITICALITY		
Criticality Component	**Questions**	**Answer Choices**
SCOPE	1. Identify the geographic area affected	Impacts limited to site only
		Impacts would be limited to local area and/or municipality
		Impacts would be regional (more than one municipality and/or surrounding region)
		State-wide or greater impacts
	2. Identify the population affected	Less than 100 people
		Less than 1,000 people
		Less than 10,000 people
		Greater than 10,000 people
	3. Identify the enhanced impact on vulnerable populations (please refer to the SHMCAP for definition of vulnerable populations: elderly, medical needs, disabled, children, etc.)	The building does not provide services to vulnerable populations
		The building is located in an environmental justice community, and/or provides some services to vulnerable populations (services are not available elsewhere to same population)
TIME	4. Identify the length of time the building can be inoperable without consequences, as described in the severity section	More than a week after event
		One to two days after event
		Immediately after event
		During natural hazard event

Table 2.13. Project Inputs Related to Questions for Building/Facility Asset Criticality

BUILDING/FACILITY CRITICALITY		
Criticality Component	**Questions**	**Answer Choices**
SEVERITY	5. Public health and safety impacts	Loss of building may result in minor injuries
		Loss of building may result in severe injuries, chronic illnesses
		Loss of building may result in severe injuries, possible loss of life
		Loss of life expected as a result of loss of building
	6. Economic impacts (direct replacement and/or repair cost only)	<$100,000
		<$1,000,000
		<$10,000,00
		>$10,000,000
	7. Public and/or social services impacts	Alternative programs and/or services are available to support the community
		Some alternative programs and/or services are available to support the community
		Few alternative programs and/or services are available to support the community
		No alternative programs and/or services are available to support the community
	8. Interdependency impacts	Loss of building may have a minor impact on other facilities, assets, and/or building
		Loss of building may have a moderate impact on other facilities, assets, and/or building
		Loss of building may have a significant impact on other facilities, assets, and/or building
		Loss of building will likely have a debilitating impact on other facilities, assets, and/or building
	9. Environmental impacts Hazardous Materials	No spills and/or releases of hazardous materials are expected
		Spills and/or releases of hazardous materials are expected with relatively easy cleanup
		Spills and/or releases of hazardous materials are expected with moderately difficult cleanup
		Spills and/or releases of hazardous materials are expected with difficult remediation
	10. Environmental impacts Ecological	No impact on surrounding natural resources
		Impact on natural resources can be mitigated naturally
		Impact on natural resources will require remediation/rehabilitation
		Impact on natural resources is irreversible/natural resource lost
	11. Governmental impacts	Loss of building may minimally reduce the ability to maintain state agency services to Commonwealth
		Loss of building may moderately reduce the ability to maintain state agency services to Commonwealth
		Loss of building will significantly reduce the ability to maintain state agency services to Commonwealth
		State agency will no longer able to maintain services to Commonwealth
	12. Psychological impacts (public morale)	Reduced morale and public support
		Demonstrations, protests, and/or lobbying
		Loss of confidence in State Agency
		Loss of confidence in Commonwealth

Table 2.14. Project Inputs Related to Scope and Time Questions for Infrastructure Asset Criticality

INFRASTRUCTURE CRITICALITY		
Criticality Component	**Questions**	**Answer Choices**
SCOPE	1. Identify the geographic area affected	Impacts limited to location of infrastructure only
		Impacts would be limited to local area and/or municipality
		Impacts would be regional (more than one municipality and/or surrounding region)
		State-wide or greater
	2. Identify the population affected	Less than 5,000 people
		Less than 10,000 people
		Less than 100,000 people
		Greater than 100,000 people
	3. Identify the enhanced impact on vulnerable populations (please refer to the SHMCAP for definition of vulnerable populations: elderly, medical needs, disabled, children, etc.)	The infrastructure does not provide services to vulnerable populations
		The infrastructure is located in an environmental justice community, and/or provides some services to vulnerable populations (services are not available elsewhere to same population)
TIME	4. Does the infrastructure serve or is it proposed to function as flood protection?	No
		Yes
	5. Identify the length of time the infrastructure can be inoperable without consequences as described in the severity section	More than a week after event
		One to two days after event
		Immediately after event
		During natural hazard event

Table 2.15. Project Inputs Related to Questions for Infrastructure Asset Criticality

INFRASTRUCTURE CRITICALITY		
Criticality Component	**Questions**	**Answer Choices**
SEVERITY	6. Public health and safety impacts	Loss of infrastructure may result in minor injuries
		Loss of infrastructure may result in severe injuries, chronic illnesses
		Loss of infrastructure may result in severe injuries, possible loss of life
		Loss of life expected as a result of loss of infrastructure
	7. Interdependency impacts	Loss of infrastructure may have a minor impact on other facilities, assets, and/or infrastructure
		Loss of infrastructure may have a moderate impact on other facilities, assets, and/or infrastructure
		Loss of infrastructure may have a significant impact on other facilities, assets, and/or infrastructure
		Loss of infrastructure will likely have a debilitating impact on other facilities, assets, and/or infrastructure
	8. Economic impacts (direct replacement and/or repair cost only)	<$100,000
		<$1,000,000
		<$10,000,00
		>$10,000,000
	9. Environmental impacts – Haz. Mat	No spills and/or releases of hazardous materials are expected
		Spills and/or releases of hazardous materials are expected with relatively easy cleanup
		Spills and/or releases of hazardous materials are expected with moderately difficult cleanup
		Spills and/or releases of hazardous materials are expected with difficult remediation
	10. Environmental impacts – Ecological	No impact on surrounding natural resources
		Impact on natural resources can be mitigated naturally
		Impact on natural resources will require remediation/rehabilitation
		Impact on natural resources is irreversible/natural resource lost
	11. Transportation Only: Evacuation route impacts	Infrastructure is not an evacuation route
		Infrastructure is part of an evacuation route
	12. Governmental impacts	Loss of infrastructure may minimally reduce the ability to maintain state agency services to Commonwealth
		Loss of infrastructure may moderately reduce the ability to maintain state agency services to Commonwealth
		Loss of infrastructure will significantly reduce the ability to maintain state agency services to Commonwealth
		State agency will no longer able to maintain services to Commonwealth
	13. Psychological impacts (public morale)	Reduced morale and public support
		Demonstrations, protests, and/or lobbying
		Loss of confidence in State Agency
		Loss of confidence in Commonwealth

Table 2.16. Project Inputs Related to Types of Ecosystem Services Questions for Natural Resources Asset Criticality

NATURAL RESOURCES CRITICALITY	
Type of Ecosystem Services	Flood protection
	Climate change refuge
	Protection of public and private water supply
	Storm damage prevention
	Improves water quality
	Decarbonization/carbon sequestration
	Pollination
	Infiltration and filtering of stormwater
	Protection of groundwater supply
	Protection of land containing shellfish
	Protection of fisheries
	Protection of wildlife habitat
	Recreation
	Biomass
	Cultural resources/education
	Oxygen production
	Prevention of pollution
	Improves air quality

2.2 CLIMATE RISK SCREENING OUTPUT

2.2.1 GOALS/OBJECTIVES

The Climate Risk Screening Output provided by the Climate Resilience Design Standards Tool includes a preliminary exposure rating for the project and preliminary risk rating for each asset—each by climate parameter: sea-level rise/ storm surge, extreme precipitation, and extreme temperature. The Climate Risk Screening Output aims to aid in project development and capital investment decision-making. This Output from the Tool is shown in reference to the overall project in Figure 2.2 below.

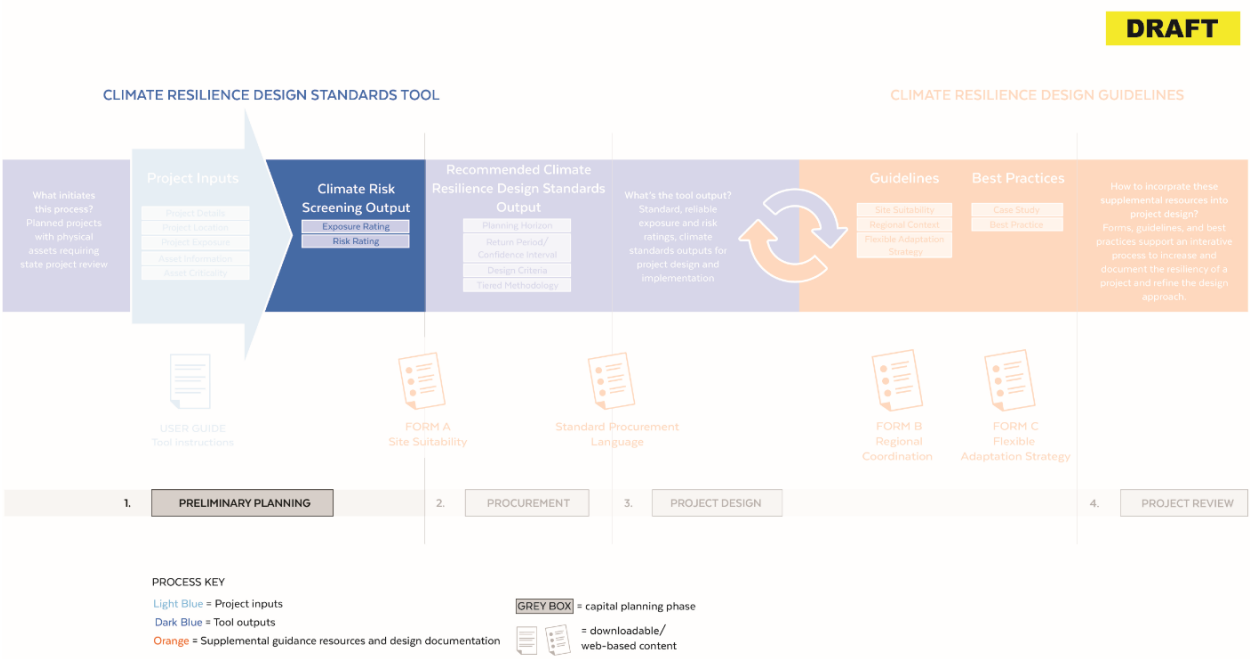

Figure 2.2. *Project Overview Emphasizing the Climate Risk Screening Output from the Climate Resilience Design Standards Tool*

2.2.2 APPROACH

The Climate Risk Screening Output is incorporated into the web-based Climate Resilience Design Standards Tool, which is enabled by spatial analysis through GIS filters. The Project Inputs and screening results also serve as the basis for the Tool's identification of applicable Climate Resilience Design Standards. The Climate Risk Screening Output process is organized as follows:

Initial Project Input: The user will provide the Project Inputs indicated in Section 2.1, above. Through the Tool's spatial analysis and calculation capacity, the following Climate Risk Screening Outputs are provided.

Exposure Rating Output: The purpose of this output is to provide a preliminary assessment of whether the project site and subsequent assets are exposed to impacts of natural hazard events and/or future impacts of climate change. A preliminary exposure rating is calculated, based on the project location and user questions and will be enabled by spatial analysis for each of the following climate parameters: sea level rise and storm surge, extreme precipitation (urban and riverine), and extreme heat. User's will receive a Not Exposed, Low Exposure, Moderate Exposure, or High Exposure calculated output for each climate parameter. Further details on the exposure rating calculation for each climate parameter can be found in Table 2.17. Table 2.18 shows a draft example of a preliminary project exposure rating output the user will receive from the Tool. Indicated in Figure 2.4, below, is a draft example of a high exposure output dashboard a user would receive for the sea-level rise/ storm surge climate parameter.

Table 2.17. Exposure Rating Scoring Derived from Project Inputs for the Tool

Climate Parameter	GIS Dataset (if applicable)	Question/Filter	Response/Score	Total Score (Calculated)	Exposure Rating (Calculated)
Sea Level Rise/Storm Surge	MC-FRM (Filter: tidal benchmarks shapefile, probability maps, planning horizon)	Is any part of the project located within the tidal benchmarks within the asset's useful life?	Yes = 3 No = 0	Total score determined by summing the values of all responses.	**Not Exposed (Total Score 0)** **Low Exposure (1)** **Moderate Exposure (2)** **High Exposure (≥3)**
		Is any part of the project in the 1% annual coastal flood exceedance probability (ACFEP) within the asset's useful life?	Yes = 2 No = 0		
	N/A - user question	Does the project site have a history of coastal flooding ?	Yes = 2 No = 0		
	MC-FRM (Filter: probability maps, planning horizon)	Is any part of the project within the 0.1% annual coastal flood exceedance probability (ACFEP) within the asset's useful life?	Yes = 1 No = 0		
Extreme Precipitation *Urban Flooding*	N/A - user question	Does the project site have a history of flooding during extreme precipitation events?	Yes = 2 No = 0	Total score determined by summing the values of all responses.	**Low Exposure (0 - 1)** **Moderate Exposure (2)** **High Exposure (≥3)**
	N/A - user question	Does the project result in a net increase in impervious area of the site?	Yes = 1 No = 0		
	Days >2 inches rainfall (Filter: RCP 8.5, Basin Scale, Planning Horizon)	How many days per year increase with rainfall greater than 2 inches within the asset's useful life?	< 0.2 days = 0 0.2 to 0.5 days = 1 0.5 days = 2		
Extreme Precipitation *Riverine Flooding*	FEMA flood zones	Is any part of the project within the current 1% annual chance (100-year) FEMA floodplain?	Yes = 2 No = 0	Total score determined by summing the values of all responses.	**Not Exposed (Total Score 0)** **Low Exposure (1)** **Moderate Exposure (2)** **High Exposure (≥3)**
	N/A - user question	Does the project site have a history of riverine flooding ?	Yes = 2 No = 0		
	FEMA flood zones	Is any part of the project within 500 ft. of an existing water body or the current 0.2% annual chance (500-year) FEMA floodplain?	Yes = 1 No = 0		
Extreme Heat	Days over 90 degrees (Filter: RCP 8.5, Basin Scale, Planning Horizon)	How many days increase in days over 90 degrees Fahrenheit are there within the asset's useful life?	< 10 days = 1 10 to 30 days = 2 30+ days = 3	Total score determined by summing the values of all responses.	**Low Exposure (1)** **Moderate Exposure (2)** **High Exposure (≥3)**
	GIS Map	Is any part of the project within 100 ft. of an existing water body?	Yes = 0 No = 1		
	N/A - user question	Does the project result in a net increase in impervious area of the site?	Yes = 1 No = 0		

Table 2.18. Draft Example of Preliminary Project Exposure Rating Output from the Tool

CLIMATE PARAMETER	PRELIMINARY EXPOSURE RATING
SEA LEVEL RISE /STORM SURGE	HIGH EXPOSURE
EXTREME PRECIPITATION - RIVERINE	HIGH EXPOSURE
EXTREME PRECIPITATION - URBAN	MODERATE EXPOSURE
EXTREME HEAT	MODERATE EXPOSURE

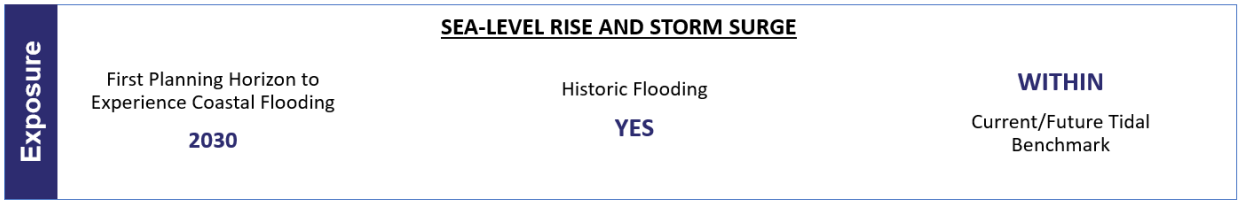

Figure 2.3. *Draft Example of the Climate Risk Screening Output from the Climate Design Standards Tool for High Exposure for the Sea-Level Rise and Storm Surge Climate Parameter*

Risk Rating Output: A preliminary risk rating output is determined for each applicable climate parameter and asset based on the exposure rating (Not Exposed, Low Exposure, Moderate Exposure, High Exposure) and criticality level (Low, Medium, High). This serves as an initial screening to identify projects with assets that receive a "High Risk" designation that may warrant additional review and/or design considerations. Matrix of risk rating output results are shown in Table 2.19, below. Table 2.20 shows a draft example of a preliminary risk rating output, by climate parameter, for multiple assets in a project that the user will receive from the Tool. In addition to receiving this preliminary risk rating output, users can download a PDF version of Form A: Site Suitability, as per the Climate Resilience Design Guidelines and Best Practices Framework. This Form will include a checklist of questions to consider for Site Suitability, which will be further discussed in Section 4, Draft Guidelines and Best Practices Framework.

Table 2.19. Derived Preliminary Risk Rating Outputs from Project Inputs

		Preliminary Exposure Rating			
		Not Exposed	**Low Exposure**	**Moderate Exposure**	**High Exposure**
Criticality	**High**	Low Risk	Moderate Risk	High Risk	High Risk
	Medium	Low Risk	Low Risk	Moderate Risk	High Risk
	Low	Low Risk	Low Risk	Moderate Risk	Moderate Risk

Table 2.20. Draft Example of Preliminary Asset Risk Rating Output from the Tool

ASSET	SEA LEVEL RISE /STORM SURGE	EXTREME PRECIPITATION - RIVERINE	EXTREME PRECIPITATION - URBAN	EXTREME HEAT
Asset 1	HIGH RISK	HIGH RISK	HIGH RISK	HIGH RISK
Asset 2	HIGH RISK	HIGH RISK	MODERATE RISK	MODERATE RISK
Asset 3	HIGH RISK	HIGH RISK	MODERATE RISK	MODERATE RISK

Expanded Detail Output: Within the Tool's Climate Risk Screening Output dashboard, further details will be provided to inform the user about the details behind the exposure and risk rating outputs for the project and each asset. These output details are meant to provide a general overview of important areas for the user to be aware of and evaluate more but does not replace a detailed vulnerability and risk assessment. This dashboard output will highlight factors that are more severe in consequence and are more likely to cause High Risk ratings. A more detailed vulnerability and risk assessment must be completed separate of the Tool's assessment, as applicable. A draft example of a detailed dashboard output users would receive with the preliminary risk rating for one asset is shown in Figure 2.4, below.

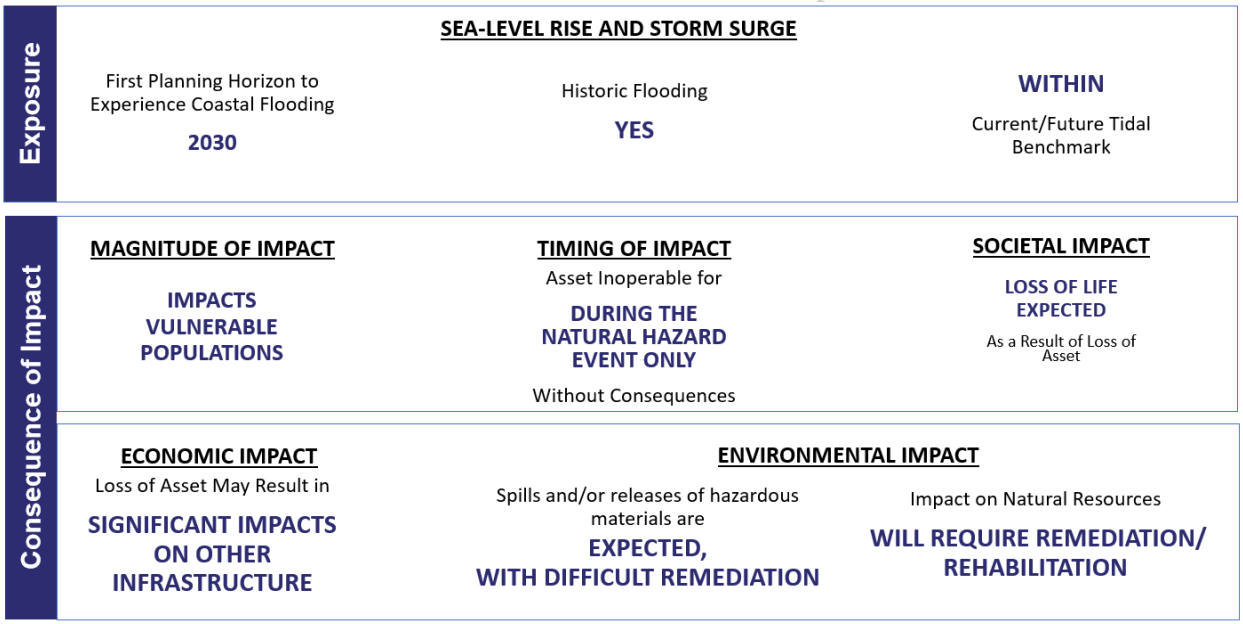

Figure 2.4. *Draft Example of the Climate Risk Screening output from the Climate Design Standards Tool for One Asset by the Sea-Level Rise and Storm Surge Climate Parameter*

2.2.3 INTENDED USER/REVIEWER

The users of the Climate Risk Screening Output from the Tool include State Agency Project Managers, State Agency Program Managers, and Asset Owners, during preliminary project planning. Further details on the timing of review can be found in Figure 2.5.

2.2.4 WHEN TO USE THE CLIMATE RISK SCREENING OUTPUT

Preliminary Planning: Based on Project Inputs, the user will receive an automated Climate Risk Screening Output, which includes preliminary exposure rating for the project and preliminary risk rating for each asset for each climate parameter. Although a project may only be in its early conceptual phase, this is often when projects are submitted for capital planning and the risk ratings should be included with submissions to program managers. Please refer to Figure 2.5 for further details.

Review of the Climate Risk Screening Output may involve further evaluation of assets with high risk ratings. Iterative changes in project planning decisions involving the project and high risk assets should be subsequently modified in the Tool to improve asset risk ratings.

Project Design: In addition to the Climate Risk Screening Output, the Tool will also provide recommended Climate Resilience Design Standards for the project, by asset and climate parameter. Refer to Section 3 for additional information. Once a project has progressed to the project design phase, the user should be able to document if applicable Climate Resilience Design Standards have been met. The process should be conducted iteratively with Project Inputs and Climate Risk Screening Output, if there are changes in design, location, and subsequent output(s).

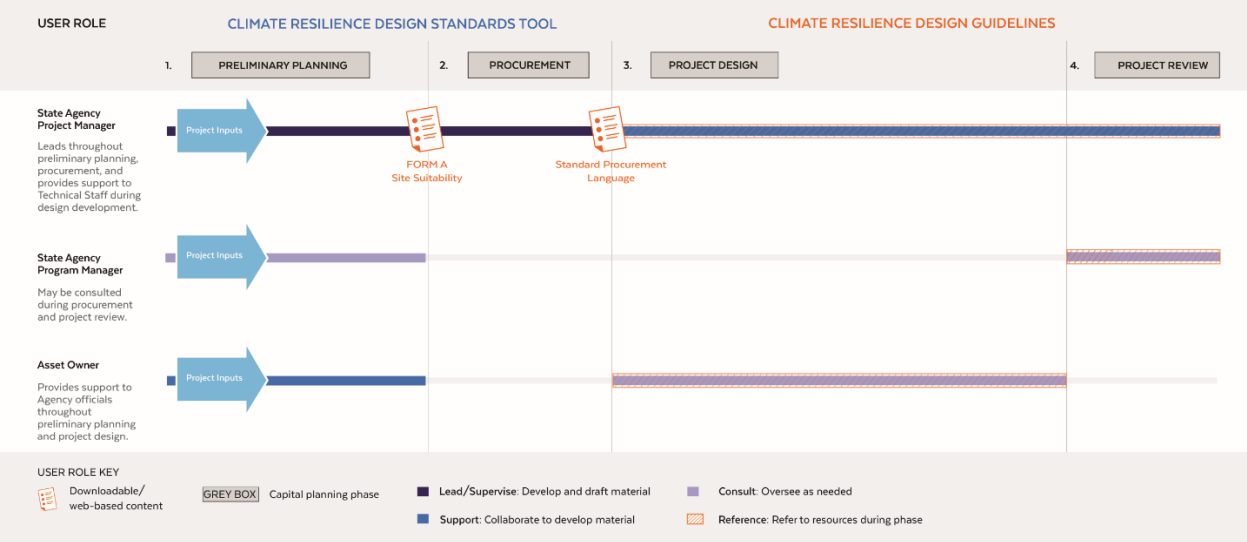

Figure 2.5. *User categories and roles for the Climate Risk Screening output from the Climate Design Standards Tool and supplemental resources part of the Climate Resilience Design Guidelines*

2.2.5 LIMITATIONS

The Climate Risk Screening covers the following climate parameters for physical projects/assets: sea level rise/storm surge, extreme precipitation (urban and riverine), and extreme heat. This is consistent with the scope of the Climate Resilience Design Standards and Guidelines project. The Climate Risk Screening Output (preliminary exposure rating, risk rating, and associated details) is meant to provide a general overview of important areas for the user to be aware of and further evaluate. They are not intended replace a detailed vulnerability and risk assessment for individual projects.

Section 2 Attachments

Attachment 2.1A – Building Criticality Draft Worksheet

Attachment 2.1B – Infrastructure Criticality Draft Worksheet

Attachment 2.1C – Natural Resources Criticality Draft Worksheet

Attachment 2.1A – Building Criticality Draft Worksheet

DRAFT CRITICALITY WORKSHEET FOR BUILDINGS - INTRODUCTION

The primary goal of this worksheet is to illustrate the questions needed to evaluate criticality of Commonwealth-owned buildings for the application of Climate Resilience Design Standards. Separate criticality worksheets are provided for each asset category: Buildings, Infrastructure, and Natural Resources. The separate worksheets recognize that:
• the criticality of one asset category should not be compared to the criticality of another asset category
• the questions and answers should respond to the specific needs of that asset category

The intent of Criticality in the Climate Resilience Design Standards is not to rank one project versus another, rather to inform return periods/ confidence intervals, which tiered methodology to apply to determine design criteria values, and the Climate Risk Screening output.

Criticality is defined as a function of scope, time, and severity for building and infrastructure assets. Scope is defined as the geographic area and population that would be affected by the loss or inoperability of that asset; time is the length of time an asset can be inoperable without consequences; and severity are the consequences that are associated from the loss or inoperability of an asset – such as public health and safety impacts, economic impacts, environmental impacts, and cascading impacts.

SCOPE	TIME	SEVERITY
• The geographic area and population that would be affected by the loss or inoperability of an asset.	• The length of time an asset can be inoperable without consequences.	• The consequences associated from the loss and/or inoperability of an asset.

Criticality Scoring - Internal Metric Only (NOT SHOWN TO USERS)

The scores are determined through a series of questions related to scope, time, and severity with pre-populated responses. Weighting as described below are based on feedback from stakeholders during working groups held in February 2020.

Scope Score is the average score of the scope questions for population and geography affected. However, if the building is located in an environmental justice community, and/or provides some services to vulnerable populations, the scope score is doubled.

Time Score is based on the length of time the building can be inoperable without consequences as described in the severity section.

Severity Score is based on eight (8) consequences that are assigned weights based on relative impact for buildings. Weights are indicated in parentheses in the questions for internal review purposes and will be removed in final tool. The most severe impacts are given the highest weights (3), and lowest impacts are given no weight (1). The composite severity score is a function based on the average of the weighted criteria as follows:
Composite Severity = [3 × ΣTOP+2 × ΣMID+1 × ΣLOW]/8
The weighting is assigned to the consequences as follows:.

TOP: Public health and safety and Economic
MID: Public and/or social services, Interdependency, Environmental (Hazardous materials and Ecological)
LOW: Govermental and Psychological

Final Criticality Score
Composite criticality =AVERAGE [Scope,Time,Composite Severity]
The final score is the normalized value of the Composite Criticality score. The value is normalized on a scale of 10 (low) to 100 (high) due to inherent criticality of all sites.

An asset with final value above 70 is considered High Criticality and value below 40 is considered Low Criticality. Assets with values in between are considered as Medium Criticality. Criticality results are shown for internal review purposes to illustrate the relationships between answers and output. In the web-based tool, users will answer criticality questions but not receive a criticality score.

DRAFT CRITICALITY WORKSHEET FOR BUILDINGS - SCORING

Questions	Answer Choices	Assigned Scores	Weights	Selected Scores	Lowest Score	Highest Score
1. Identify the geographic area affected	Impacts limited to site only	1	None	1	1	4
	Impacts would be limited to local area and/or municipality	2		2		
	Impacts would be regional (more than one municipality and/or surrounding region)	3		3		
	State-wide or greater impacts	4		4		
2. Identify the population affected	Less than 100 people	1	None	1	1	4
	Less than 1,000 people	2		2		
	Less than 10,000 people	3		3		
	Greater than 10,000 people	4		4		
3. Identify the enhanced impact on vulnerable populations (please refer to the SHMCAP for definition of vulnerable populations: elderly, medical needs, disabled, children, etc.)	The building does not provide services to vulnerable populations	1	None	1	1	2
	The building is located in an environmental justice community, and/or provides some services to vulnerable populations (services are not available elsewhere to same population)	2		2		
4. Identify the length of time the building can be inoperable without consequences as described in the severity section	More than a week after event	1	None	1	1	4
	One to two days after event	2		2		
	Immediately after event	3		3		
	During natural hazard event	4		4		
5. Public health and safety impacts (3)	Loss of building may result in minor injuries	1	3	3	3	12
	Loss of building may result in severe injuries, chronic illnesses	2		6		
	Loss of building may result in severe injuries, possible loss of life	3		9		
	Loss of life expected as a result of loss of building	4		12		
6. Economic impacts (direct replacement and/or repair cost only) (3)	<$100,000	1	3	3	3	12
	<$1,000,000	2		6		
	<$10,000,00	3		9		
	>$10,000,000	4		12		
7. Public and/or social services impacts (2)	Alternative programs and/or services are available to support the community	1	2	2	2	8
	Some alternative programs and/or services are available to support the community	2		4		
	Few alternative programs and/or services are available to support the community	3		6		
	No alternative programs and/or services are available to support the community	4		8		
8. Interdependency impacts (2)	Loss of building may have a minor impact on other facilities, assets, and/or building	1	2	2	2	8
	Loss of building may have a moderate impact on other facilities, assets, and/or building	2		4		
	Loss of building may have a significant impact on other facilities, assets, and/or building	3		6		
	Loss of building will likely have a debilitating impact on other facilities, assets, and/or building	4		8		
9. Environmental impacts – Haz. Mat (2)	No spills and/or releases of hazardous materials are expected	1	2	2	2	8
	Spills and/or releases of hazardous materials are expected with relatively easy cleanup	2		4		
	Spills and/or releases of hazardous materials are expected with moderately difficult cleanup	3		6		
	Spills and/or releases of hazardous materials are expected with difficult remediation	4		8		

Questions	Answer Choices	Assigned Scores	Weights	Selected Scores	Lowest Score	Highest Score
10. Environmental impacts – Ecological (2)	No impact on surrounding natural resources	1	2	2	2	8
	Impact on natural resources can be mitigated naturally	2		4		
	Impact on natural resources will require remediation/rehabilitation	3		6		
	Impact on natural resources is irreversible/natural resource lost	4		8		
11. Governmental impacts (1)	Loss of building may minimally reduce the ability to maintain state agency services to Commonwealth	1	1	1	1	4
	Loss of building may moderately reduce the ability to maintain state agency services to Commonwealth	2		2		
	Loss of building will significantly reduce the ability to maintain state agency services to Commonwealth	3		3		
	State agency will no longer able to maintain services to Commonwealth	4		4		
12. Psychological impacts (public morale) (1)	Reduced morale and public support	1	1	1	1	4
	Demonstrations, protests, and/or lobbying	2		2		
	Loss of confidence in State Agency	3		3		
	Loss of confidence in Commonwealth	4		4		

Attachment 2.1B – Infrastructure Criticality Draft Worksheet

DRAFT CRITICALITY WORKSHEET FOR INFRASTRUCTURE - INTRODUCTION

The primary goal of this worksheet is to illustrate the questions needed to evaluate criticality of Commonwealth-owned infrastructure for the application of Climate Resilience Design Standards. Separate criticality worksheets are provided for each asset category: Buildings, Infrastructure, and Natural Resources. The separate worksheets recognize that:
• the criticality of one asset category should not be compared to the criticality of another asset category
• the questions and answers should respond to the specific needs of that asset category

The intent of Criticality in the Climate Resilience Design Standards is not to rank one project versus another, rather to inform return periods/ confidence intervals, which tiered methodology to apply to determine design criteria values, and the Climate Risk Screening output.

Criticality is defined as a function of scope, time, and severity for building and infrastructure assets. Scope is defined as the geographic area and population that would be affected by the loss or inoperability of that asset; time is the length of time an asset can be inoperable without consequences; and severity are the consequences that are associated from the loss or inoperability of an asset – such as public health and safety impacts, economic impacts, environmental impacts, and cascading impacts.

SCOPE	TIME	SEVERITY
• The geographic area and population that would be affected by the loss or inoperability of an asset.	• The length of time an asset can be inoperable without consequences.	• The consequences associated from the loss and/or inoperability of an asset.

Criticality Scoring - Internal Metric Only (NOT SHOWN TO USERS)

The scores are determined through a series of questions related to scope, time, and severity with pre-populated responses. Weighting as described below are based on feedback from stakeholders during working groups held in February 2020.

Scope Score is the average score of the scope questions for population and geography affected. The scope score is doubled if the infrastructure is located in an environmental justice community and/or provides some services to vulnerable populations, AND/OR if the infrastructure serves or is proposed to function as flood protection.

Time Score is based on the length of time the building can be inoperable without consequences as described in the severity section.

Severity Score is based on eight (8) consequences that are assigned weights based on relative impact for infrastructure. Weights are indicated in parentheses in the questions for internal review purposes and will be removed in final tool. The most severe impacts are given the highest weights (3), and lowest impacts are given no weight (1). The composite severity score is a function based on the average of the weighted criteria as follows:
Composite Severity = [3 × ΣTOP+2 × ΣMID+1 × ΣLOW]/8
The weighting is assigned to the consequences as follows:.

TOP: Public health and safety and Interdependency
MID: Economic, Environmental (Hazardous materials and Ecological), and Evacuation route (if asset type is Transportation)
LOW: Govermental and Psychological

Final Criticality Score
Composite criticality =AVERAGE [Scope,Time,Composite Severity]
The final score is the normalized value of the Composite Criticality score. The value is normalized on a scale of 10 (low) to 100 (high) due to inherent criticality of all sites.

An asset with final value above 70 is considered High Criticality and value below 40 is considered Low Criticality. Assets with values in between are considered as Medium Criticality. Criticality results are shown for internal review purposes to illustrate the relationships between answers and output. In the web-based tool, users will answer criticality questions and not receive a criticality score.

DRAFT CRITICALITY WORKSHEET FOR INFRASTRUCTURE - SCORING

Questions	Answer Choices	Assigned Scores	Weights	Selected Scores	Lowest Score	Highest Score
1. Identify the geographic area affected	Impacts limited to location of infrastructure only	1	None	1	1	4
	Impacts would be limited to local area and/or municipality	2		2		
	Impacts would be regional (more than one municipality and/or surrounding region)	3		3		
	State-wide or greater	4		4		
2. Identify the population affected	Less than 5,000 people	1	None	1	1	4
	Less than 10,000 people	2		2		
	Less than 100,000 people	3		3		
	Greater than 100,000 people	4		4		
3. Identify the enhanced impact on vulnerable populations (please refer to the SHMCAP for definition of vulnerable populations: elderly, medical needs, disabled, children, etc.)	The infrastructure does not provide services to vulnerable populations	1	None	1	1	2
	The infrastructure is located in an environmental justice community, and/or provides some services to vulnerable populations (services are not available elsewhere to same population)	2		2		
4. Does the infrastructure serve or is it proposed to function as flood protection?	No	1	None	1	1	2
	Yes	2		2		
5. Identify the length of time the infrastructure can be inoperable without consequences as described in the severity section	More than a week after event	1	None	1	1	4
	One to two days after event	2		2		
	Immediately after event	3		3		
	During natural hazard event	4		4		
6. Public health and safety impacts (3)	Loss of infrastructure may result in minor injuries	1	3	3	3	12
	Loss of infrastructure may result in severe injuries, chronic illnesses	2		6		
	Loss of infrastructure may result in severe injuries, possible loss of life	3		9		
	Loss of life expected as a result of loss of infrastructure	4		12		
7. Interdependency impacts (3)	Loss of infrastructure may have a minor impact on other facilities, assets, and/or infrastructure	1	3	3	3	12
	Loss of infrastructure may have a moderate impact on other facilities, assets, and/or infrastructure	2		6		
	Loss of infrastructure may have a significant impact on other facilities, assets, and/or infrastructure	3		9		
	Loss of infrastructure will likely have a debilitating impact on other facilities, assets, and/or infrastructure	4		12		

Questions	Answer Choices	Assigned Scores	Weights	Selected Scores	Lowest Score	Highest Score
8. Economic impacts (direct replacement and/or repair cost only) (2)	<$100,000	1	2	2	2	8
	<$1,000,000	2		4		
	<$10,000,00	3		6		
	>$10,000,000	4		8		
9. Environmental impacts – Haz. Mat (2)	No spills and/or releases of hazardous materials are expected	1	2	2	2	8
	Spills and/or releases of hazardous materials are expected with relatively easy cleanup	2		4		
	Spills and/or releases of hazardous materials are expected with moderately difficult cleanup	3		6		
	Spills and/or releases of hazardous materials are expected with difficult remediation	4		8		
10. Environmental impacts – Ecological (2)	No impact on surrounding natural resources	1	2	2	2	8
	Impact on natural resources can be mitigated naturally	2		4		
	Impact on natural resources will require remediation/rehabilitation	3		6		
	Impact on natural resources is irreversible/natural resource lost	4		8		
11. Transportation Only: Evacuation route impacts (2)	Infrastructure is not an evacuation route	1	2	2	2	8
	Infrastructure is part of an evacuation route	4		8		
12. Governmental impacts (1)	Loss of infrastructure may minimally reduce the ability to maintain state agency services to Commonwealth	1	1	1	1	4
	Loss of infrastructure may moderately reduce the ability to maintain state agency services to Commonwealth	2		2		
	Loss of infrastructure will significantly reduce the ability to maintain state agency services to Commonwealth	3		3		
	State agency will no longer able to maintain services to Commonwealth	4		4		
13. Psychological impacts (public morale) (1)	Reduced morale and public support	1	1	1	1	4
	Demonstrations, protests, and/or lobbying	2		2		
	Loss of confidence in State Agency	3		3		
	Loss of confidence in Commonwealth	4		4		

Attachment 2.1C – Natural Resources Criticality Draft Worksheet

DRAFT CRITICALITY WORKSHEET FOR NATURAL RESOURCES

The primary goal of this worksheet is to illustrate the questions needed to evaluate criticality of Commonwealth-owned natural resources for the application of Climate Resilience Design Standards. Separate criticality worksheets are provided for each asset category: Buildings, Infrastructure, and Natural Resources. This worksheet represents the criticality questions for Natural Resources only. The separate worksheets recognize that:
• the criticality of one asset category should not be compared to the criticality of another asset category
• the questions and answers should respond to the specific needs of that asset category

The intent of Criticality in the Climate Resilient Design Standards is not to rank one project versus another, and instead is intended to inform return periods/ confidence intervals, which tiered methodology to apply to determine design criteria values, and the Climate Risk Screening output.

The criticality of Natural Resources is a function of its ecosystem services, such as protection of wildlife habitat, stormwater infiltration, oxygen production, recreation, and flood protection, amongst others. These ecosystem services were provided by State Agency stakeholders during and following February 2020 working groups.

Criticality Scoring - Internal Metric Only - Not Shown to Users
The scores are determined based on how many ecosystem services a natural resource provides. Points are assigned to each ecosystem service based on the impact of the loss of that ecosystem service. The total points are relative based on other ecosystem services so that the a total possible points possible are out of 100. Choice of "Yes" as response to a question automatically assigns full points for the pertinent question, while a "No" selection assigns zero. The final score for ecosystem services is the arithmetic sum of all the points.

An asset with final score above 70 is considered High Criticality and score below 30 is considered Low Criticality. Assets with scores in between are considered as Medium Criticality. Criticality results are shown for internal review purposes to illustrate the relationships between answers and output. Users will not see the points in the final Tool and have the option of selecting Yes/No for ecosystem services affected by the project. In the web-based tool, users will answer criticality questions and not receive a criticality score.

Type of Ecosystem Services	Points	Select "Yes" if the Natural Resource Provides the Following Ecosystem Services
Flood protection	12	NO
Climate change refuge	8	Yes
Protection of public and private water supply	8	NO
Storm damage prevention	8	Yes
Improves water quality	6	NO
Decarbonization/carbon sequestration	6	Yes
Pollination	6	Yes
Infiltration and filtering of stormwater	6	Yes
Protection of groundwater supply	5	NO
Protection of land containing shellfish	5	NO
Protection of fisheries	5	NO
Protection of wildlife habitat	5	NO
Recreation	4	NO
Biomass	4	Yes
Cultural resources/education	3	Yes
Oxygen production	3	Yes
Prevention of pollution	3	NO
Improves air quality	3	Yes
Total Points (Sum of Points)	**100**	**47**
Criticality (High, Medium, Low)	**MEDIUM**	