Southside Sub-region

Hazard Identification

Risk Assessment

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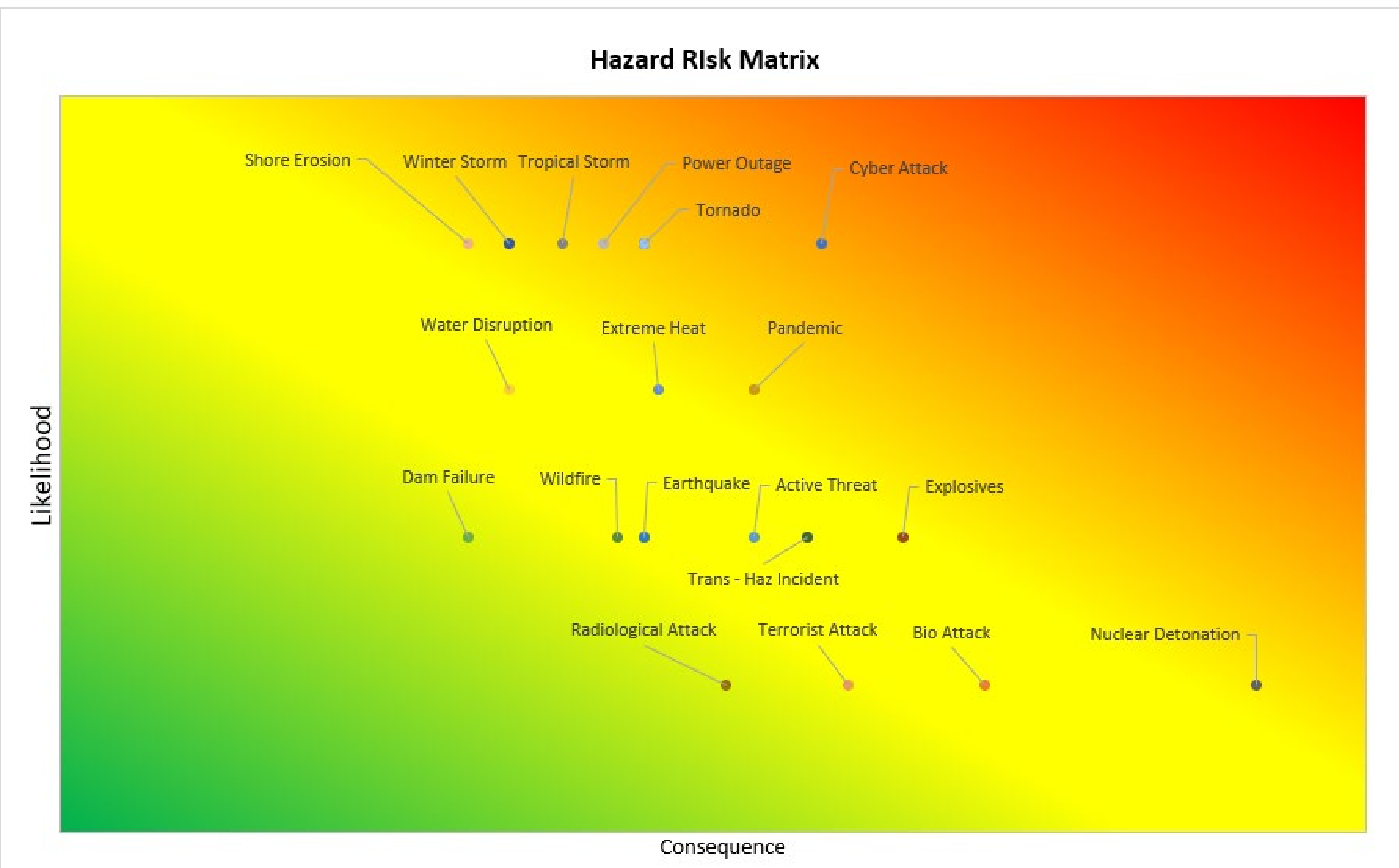
Executive Summary

The City of Virginia Beach contracted with Alliance Solutions Group, Inc. (ASG) in September 2020 to conduct a Hazard Identification Risk Assessment (HIRA) for the Southside sub-region of Virginia Beach, Norfolk, Chesapeake, and Portsmouth. ASG collaborated with 45 representatives from the sub-region over nine months in the development of a risk tool, 52 hazard scenarios, consequence analyses, community survey, workshop, and final report. The purpose of this project was to provide a localized perspective on sub-regional risks to support planning and risk management within each locality across the sub-region and as a resource for state and federal agencies. The HIRA provides a formal justification for which all planning considerations should be based. The sub-regional steering committee requested that ASG model according to the process and products produced by Howard County, MD. The process and product conforms with the Emergency Management Standard (ANSI/EMAP EMS 5-2019).

The benefits of conducting this HIRA include:

- Improved risk communication by establishing a common language
- Setting data-driven planning priorities based on risk
- Justifying planning priorities
- Evaluating and comparing prevention, protection, and mitigation actions
- Anticipating challenges during an incident
- Whole community engagement among the public sector, private sector, and the public

The risk assessment resulted in the following risk matrix of 26 different hazards and threats based on the likely scenario and consequence analysis which included warning time, duration, and impact across six domains.



The assessment also identified that several hazards could influence the risk of other hazards (e.g., prolonged winter storm or flooding could cause water disruptions). Also, sea level rise and land subsidence over time will increase the risk of hazards such as flooding, shoreline erosion, and tropical coastal storms. Finally, during the past year, we have seen an increasing frequency and severity associated with civil unrest, active threats, and cyber-attacks while enduring a pandemic. This highlights the need to plan for multiple simultaneous threats and consider the synergistic and complicating effects on response and recovery operations.

It is expected that this report will be used by the Hampton Roads region, Southside sub-region, Southside cities, and departments to guide preparedness activities (e.g., planning, training, exercises) and decision-making (e.g., resource allocation). The planning process begins with identifying hazards and risks associated with those hazards. This report highlights the relative risk across 26 hazards to aid planners in prioritizing their efforts. Planners and decision-makers should prioritize higher risk hazards over lower risk hazards, rather than focusing on only one dimension of the risk assessment (i.e., likelihood of occurrence or consequences such as severity of impact). A risk-based approach to planning and resourcing ensures capabilities are developed in a manner that optimally reduces overall risk to the community considering limited resources. The report provides a scientifically defensible foundation for preparedness decision making.

1 Introduction and Background

1.1 Introduction

This section discusses the guidance and strategic goals that influenced the planning process.

The Hazard Identification and Risk Assessment (HIRA) is a comprehensive analysis of manmade and natural hazards for the cities of Chesapeake, Norfolk, Portsmouth, and Virginia Beach, Virginia. This area is referred to as the Hampton Roads Southside Sub-Region. The City of Virginia Beach contracted with Alliance Solutions Group, Inc. (ASG) to develop a sub-regional HIRA to serve as a foundational document for emergency preparedness planning efforts. Development of the HIRA was led by the City of Virginia Beach Office of Emergency Management. The HIRA reflects a whole-community approach to risk assessment involving local, state, and federal government stakeholders, private-sector partners, and private citizens.

1.1.1 Overview

This section provides an overview of the sections.

The HIRA is organized into six sections and two appendices

Section 1: Introduction & Background

Provides an overview of the HIRA, key terminology, and the HIRA approach to risk assessment.

Section 2: Risk Management & Planning

A guide for using the HIRA to support preparedness and response efforts.

Section 3: Planning Process

An overview of the HIRA strategic plan, the planning process, and participating partners.

Section 4: Interpreting the Hazard Profiles

A guide to understanding the information contained in the HIRA hazard profiles.

Section 5: Risk Overview

An overview of the HIRA results.

Sections 6 and 7: Hazard Profiles, Manmade & Natural Hazards

Complete risk assessments of each HIRA hazard.

1.1.2 Scope & Organization

This section details the hazards addressed by the HIRA and the organization of information within each hazard profile.

The HIRA provides an in-depth profile, risk assessment, and consequence analysis of 16 manmade threats/technological hazards and 11 natural hazards. The hazards addressed by the HIRA include:

Manmade Threats	Technological Hazards	Natural Hazards
• Active Threat • Biological Attack • Chemical Attack • Civil Unrest • Cyber Infrastructure Attack • Complex Coordinated Terrorist Attack • Explosives • Nuclear Detonation • Radiological Attack	• Dam Failure • Hazardous Material Release • Power Outage • Structure Fire • Transportation Hazard – Bridge/Tunnel Collapse • Transportation Hazard – Incident • Water Utility Disruption	• Flooding • Sea Level Rise • Tropical /Coastal Storm • Shoreline Erosion • Tornado • Winter Storm • Earthquake • Wildfire • Drought • Extreme Heat • Pandemic

Each of the hazard profiles included in the HIRA is organized into the following sections and sub-sections:

I. **OVERVIEW**
   - Definition
   - Risk Profile
   - Risk Matrix
   - Risk Ranking

II. **HAZARD CHARACTERISTICS**
   - Description of the Hazard
   - Local Context

III. **LIKELIHOOD ANALYSIS**
   - Occurrence of the Hazard
   - Likely Scenario
   - Worst-case Scenario
   - Future Likelihood Analysis

IV. **CONSEQUENCE ANALYSIS**
   - Consequence Overview
   - Consequence Analysis: Likely Hazard Scenario
   - Consequence Analysis: Worst-Case Hazard Scenario
   - Public Perception

Additional information on the organization and contents of the hazard profiles can be found in Section 4: Interpreting the Hazard Profiles.

1.2 Key Terminology

This section defines key words and phrases that will be used throughout the HIRA.

Communicating risk-related concepts can be challenging. Many of the terms used in a risk assessment have colloquial meanings that confuse and distract from the intended message. The following definitions are established and many are expanded upon in the U.S. Dept. of Homeland Security Risk Lexicon[1] and will be used throughout the HIRA:

ADVERSARIAL/INTENTIONAL HAZARD: A manmade hazard created by a deliberate action or planned course of action.

ASSET: A person, structure, facility, information, material, or process that has value.

CONSEQUENCE: The effect of an event, incident, or occurrence. Consequence in the HIRA includes impacts to property, health & safety, critical facilities, response capacity, the environment, the economy, and standard of living/quality of life. Analysis of consequence in the HIRA also incorporates the Warning Time and Duration of the hazard.

EMERGENCY-LEVEL HAZARD EVENT: A hazard event that requires a response from at least two agencies or partners.

HAZARD: A potential source or cause of harm or difficulty. A hazard can be natural or manmade.

LIKELIHOOD: The chance of something happening, whether defined, measured, or estimated objectively or subjectively, or in terms of general descriptors (such as rare, unlikely, likely, almost certain) frequencies, or probabilities.

MANMADE HAZARD: A hazard that originates in some way from human activity. Manmade hazards include Manmade Threats and Technological Hazards.

NATURAL HAZARD: A source of harm or difficulty created by a meteorological, environmental, or geological phenomenon or a combination of phenomena.

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[1] *DHS Risk Lexicon: 2010 Edition*, U.S. Dept. of Homeland Security Risk Steering Committee (2010). Available at https://www.dhs.gov/xlibrary/assets/dhs-risk-lexicon-2010.pdf

RISK: The potential for an unwanted outcome resulting from an incident, event, or occurrence as determined by its likelihood and the associated consequences.

TECHNOLOGICAL/ACCIDENTAL HAZARD: A manmade hazard created by negligence, error, or unintended failure.

THREAT: Natural or man-made occurrence, individual, entity, or action that has or indicates the potential to harm life, information, operations, the environment, and/or property.

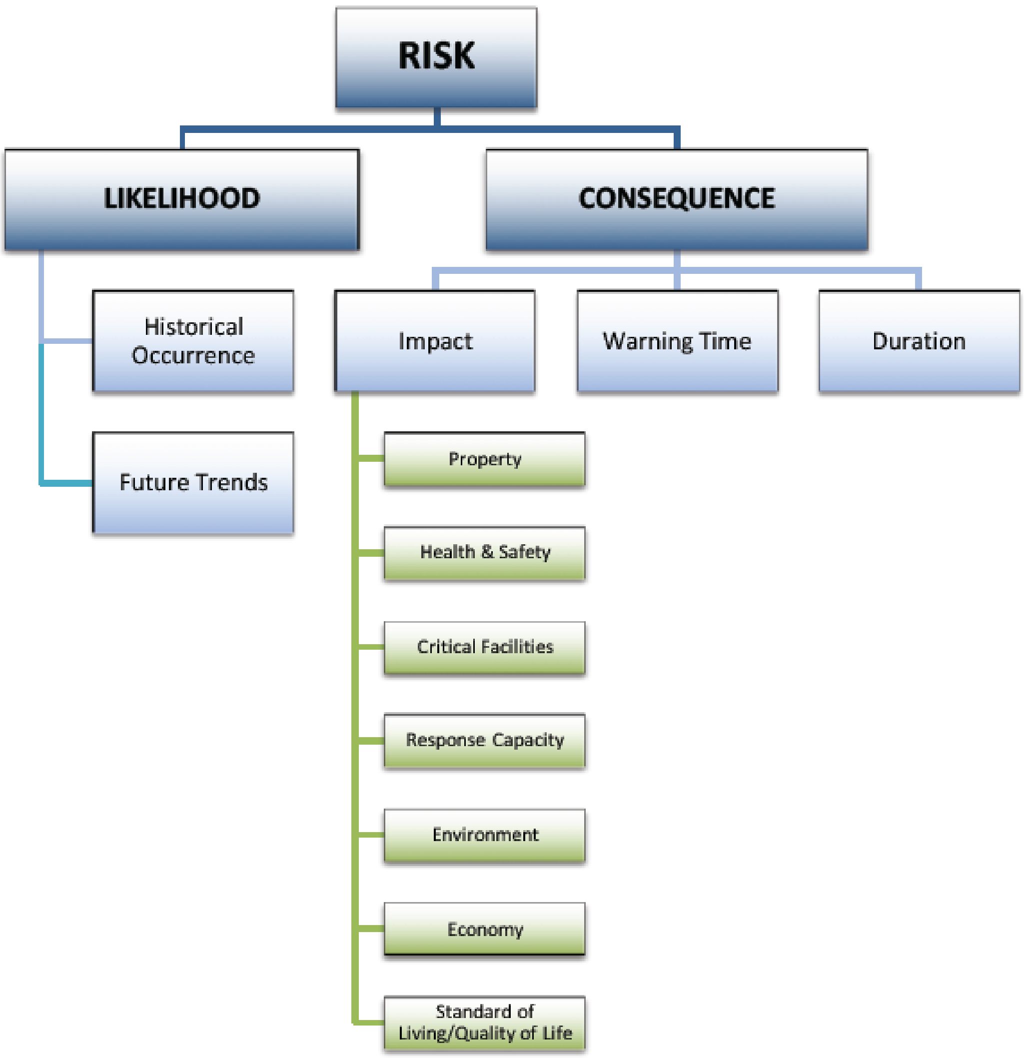
VULNERABILITY: A physical feature or operational attribute that renders an entity, asset, system, network, or geographic area open to exploitation or susceptible to a given hazard. In calculating the risk of an intentional hazard, the common measurement of vulnerability is the likelihood that an attack is successful.

1.3 Assessing the Risk at the Local Level

This section discusses the components of risk as they are evaluated in the HIRA.

There are many ways to assess risk. In its most basic form, a risk assessment is a process that collects information and assigns values to risks. Planners can use risk values for the purpose of informing priorities, developing, or comparing courses of action, and informing decision making.

Risk is most easily understood by analyzing the component parts of risk. The HIRA defines the components of risk in the following manner: Risk is a function of Likelihood and Consequence. Likelihood is defined by historical occurrence and future trends. Consequence is defined by Warning Time, Duration, and Impact. Impact itself is defined by impacts to property, health & safety, critical facilities, response capacity, the environment, the economy, and standard of living/quality of life. The chart below demonstrates this relationship visually:



In the field of risk assessment, there are several approaches to understanding the components of risk. While the HIRA understands risk as a function of likelihood and consequence (commonly written as *RISK = LIKELIHOOD + CONSEQUENCE*), it is also common to see risk demonstrated as a product of Likelihood and Consequence (e.g., *LIKELIHOOD * CONSEQUENCE*) or a function of threats, assets, vulnerabilities, and/or consequences (e.g., *RISK = THREAT * VULNERABILITY * CONSEQUENCE*). Although they appear quite different, there is significant overlap between the variables measured by these approaches. The latter approach is most effective when assessing the risk of targeted threats to specific assets. The likelihood/consequence formula used by the HIRA was chosen for its effectiveness when measuring and comparing all hazards (not just targeted threats) where the asset at stake, i.e., the Hampton Roads Southside Sub-Region.

Planners designed this HIRA approach to be easily adaptable for a wide variety of planning purposes. Guidance for applying the information contained in the HIRA can be found in the Risk Management & Planning section.

1.3.1 The Southside Sub-Region Risk Tool

This section outlines the tool developed by the HIRA to evaluate hazard risk.

The Southside Sub-Region Risk Tool is the key to understanding and interpreting hazard risk. The Risk Tool converts hazard information into a set of numerical scores that allow for comparison across many natural and manmade hazard types. With the appropriate information, any hazard can be processed through the Risk Tool for comparison with HIRA data. Similarly, any existing HIRA risk score can be easily interpreted by referencing the quantitative levels outlined in the Risk Tool. Analysts designed the tool so that the resulting risk score is transparent, replicable, and scientifically defensible. By ensuring a consistent approach to developing the input scores, the resulting relative risk scores are comparable.

The Risk Tool reflects the components of risk outlined earlier in this section. Every hazard is assigned a numerical score in each of the following four risk assessment categories: Likelihood, Impact, Warning Time, and Duration. Numerical scores range from 1 to 4 based on criteria that are defined explicitly in the tool. The scores from each section are multiplied by the assigned weighting factor. Likelihood is weighted at 50% of the Risk Score. Consequence is comprised of Impact (40%), Warning Time (5%), and Duration (5%) for a combined total of 50% of the Risk Score. Once multiplied by the weighting factor, the sum of the scores becomes the total Risk Score for the hazard.

$$Risk = (Likelihood \times 50\%) + (Warning\ time \times 5\%) + (Duration \times 5\%) + (40\% \times \sum_{i=1}^{6} \frac{Impact\ rating_i}{6})$$

SOUTHSIDE SUB-REGION RISK TOOL

LIKELIHOOD FACTORS

LIKELIHOOD

Estimated chance of a single hazard event occurring in a given year based on historical incidence and trend forecasting.

UNLIKELY (1)	INFREQUENT (2)	LIKELY (3)	VERY LIKELY (4)
No documented occurrence. Less than 1% chance of annual occurrence.	1-10% chance of annual occurrence.	11-30% chance of annual occurrence.	30+% chance of occurrence annually.

CONSEQUENCE FACTORS

IMPACT

Estimated effect of a single hazard event on property, health & safety, critical facility functioning, response capacity, the environment, the economy, and standard of living.

LIMITED (1)	SIGNIFICANT (2)	CRITICAL (3)	CATASTROPHIC (4)
▪ Property damage is less than 5% of critical and non-critical infrastructure. ▪ Injuries are manageable with existing resources, no fatalities. ▪ Shutdown of critical facilities for less than 24 hours. ▪ Local resources are adequate to support the response. ▪ Little to no environmental impact. ▪ Little to no economic impact. ▪ Standard of living is only minimally disrupted.	▪ Property damage is 5-25% of critical and non- critical infrastructure. ▪ Injuries are manageable, may include at least one death. ▪ Critical facilities are down for 1-7 days. ▪ Local and mutual aid resources are adequate to perform response, with limited or no state assistance. ▪ Moderate environmental impact. ▪ Moderate economic impact. ▪ Standard of living is moderately affected.	▪ Property damage is between 26-50% of critical and non-critical infrastructure. ▪ Multiple deaths and serious injuries are probable. ▪ Shut down of critical facilities 1-4 weeks. ▪ Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government. ▪ Serious environmental impact. ▪ Serious economic impact. ▪ Standard of living is seriously affected.	▪ Property damage is severe, greater than 50% of critical and non-critical infrastructure affected. ▪ Multiple deaths and serious injuries exceed jurisdiction response capacity. ▪ Shut down of critical facilities will be more than one month. ▪ Response capacity is overwhelmed and requires significant and long lasting state and federal government support. ▪ Severe environmental impact. ▪ Severe economic impact. ▪ Standard of living is extremely impacted and may not be fully recoverable.

WARNING TIME

Estimated time of awareness prior to the onset of the hazard event.

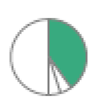
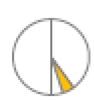
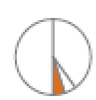
VERY LONG (1)	LONG (2)	MODERATE (3)	SHORT (4)
More than 24 hours	12-24 hours	6-12 hours	Less than six hours

DURATION

Estimated time from onset to conclusion of the hazard event.

SHORT (1)	MODERATE (2)	LONG (3)	VERY LONG (4)
Less than six hours	6-24 hours	Less than one week	More than one week

RISK SCORE WEIGHTING

LIKELIHOOD	IMPACT	WARNING TIME	DURATION
[50%]	[40%]	[5%]	[5%]
			

RISK = LIKELIHOOD + CONSEQUENCE

2 Risk Management and Planning

Contents of this Section include:

I. **Planning with the HIRA**
  - Establishing a Common Language
  - Setting Priorities
  - Justifying Existing Plans
  - Evaluating Prevention, Protection, & Mitigation Actions
  - Responding to an Emergency

2.1 Planning with the HIRA

The Overview section defines the hazard and summarizes the hazard risk profile.

Analysts developed the HIRA to be used for a wide variety of planning and risk management purposes. Data contained in the HIRA can be easily integrated into new and existing plans. Integrating information from the HIRA encourages a data-driven approach to preparedness and decision making.

Benefits of using the HIRA include:

- Improved risk communication by establishing a common language
- Setting data-driven planning priorities based on risk
- Justifying planning priorities
- Evaluating and comparing prevention, protection, and mitigation actions
- Anticipating challenges during an incident
- Whole community engagement among the public sector, private sector, and the public

2.1.1 Establishing Common Language

This section describes how to use the HIRA to add consistency and clarity to planning efforts.

Communicating risk management concepts can be difficult and confusing. Words and ideas are frequently mis-used, and errors in communication can cause serious consequences. The risk terminology used in the HIRA is consistent with existing guidance and has been vetted and approved by a committee of high-level representatives from the Southside Sub-Region's top emergency management stakeholder organizations. Referencing hazards using HIRA-established terminology allows for easy and accurate communication of ideas and helps promote the perception that all Southside Sub-Regional planning documents are working toward the same shared goals.

Example: Integrating consistent HIRA terminology into an existing plan

> *The agency has taken steps to prepare for all ~~emergencies~~ hazards. The agency has taken special steps to prevent ~~attack hazards~~ Manmade Threats. The agency is particularly concerned about ~~gunmen and bombs~~ Active Threat hazards and Explosives hazards. The agency recognizes the risk.*

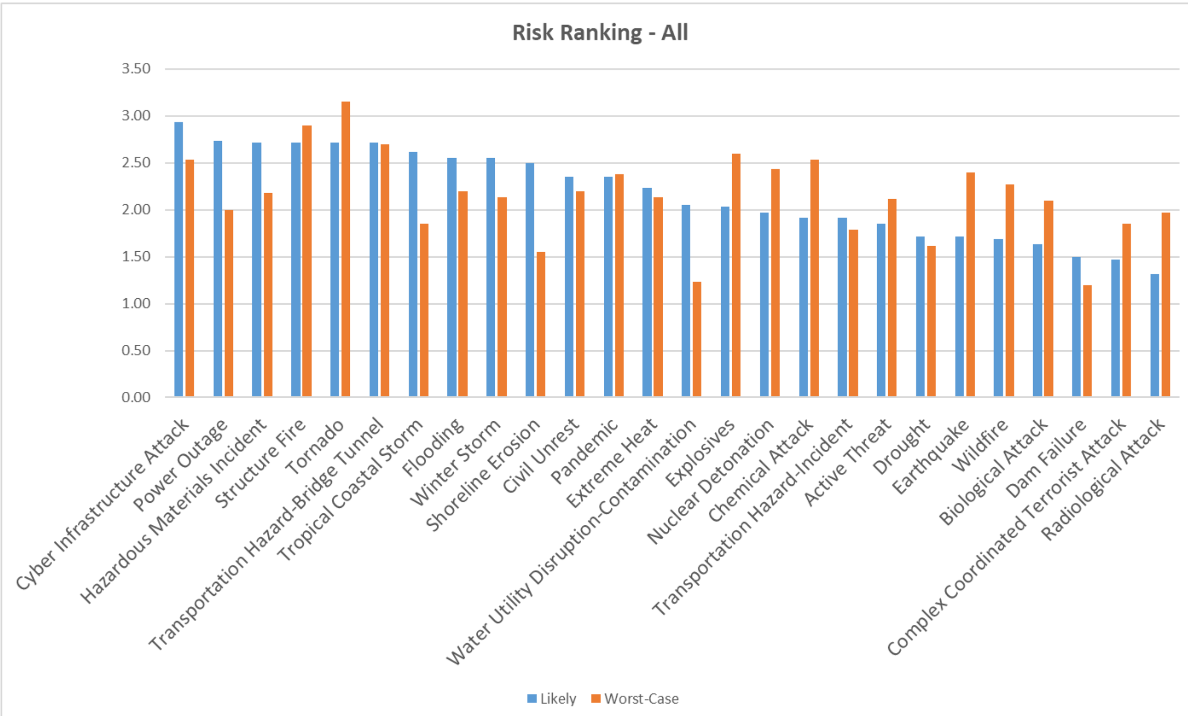
2.1.2 Setting Priorities

This section describes how to use the HIRA to set emergency preparedness priorities.

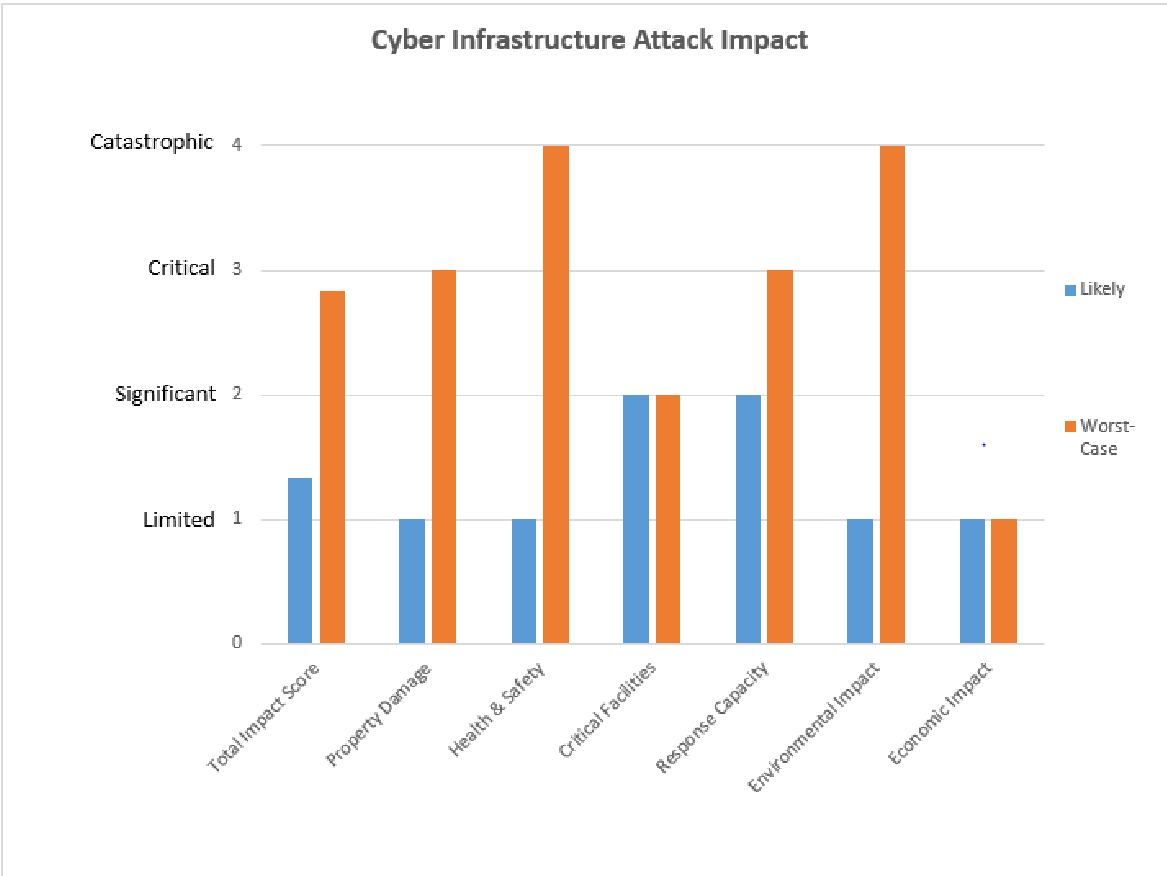
Planners sometimes determine emergency preparedness priorities based a single component (i.e., likelihood, severity of consequences), worst-case possibilities, or biases towards recent incidents. These hazards are not always the hazards that pose the greatest risk to the jurisdiction. It is essential that emergency preparedness decisions are made based on objective data and comparable risks whenever possible. The HIRA provides a scientifically defensible foundation for preparedness decision making.

Example: Using the HIRA to prioritize preparedness activities

The agency has dedicated preparedness efforts to mitigate the risk of Cyber Infrastructure Attacks. Cyber Infrastructure Attacks were identified as the hazard that poses the highest risk to the Southside by the Hazard Identification and Risk Assessment (HIRA).



The HIRA anticipates the property damage and environmental impact from the likely scenario to be limited, so preparedness efforts will concentrate on mitigating risk to critical facilities and response capabilities.



2.1.3 Justifying Planning Priorities

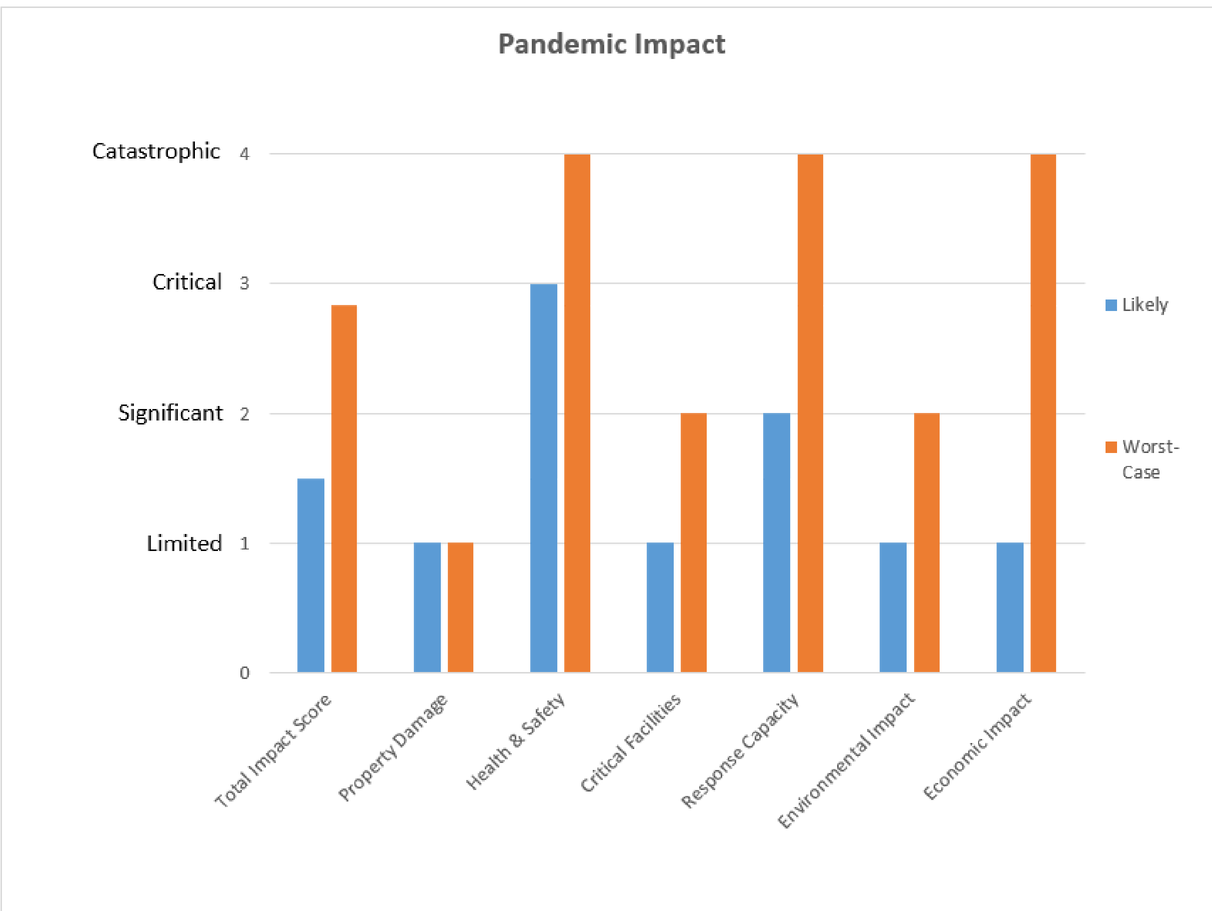
This section describes how to use the HIRA to provide justification for preparedness plans.

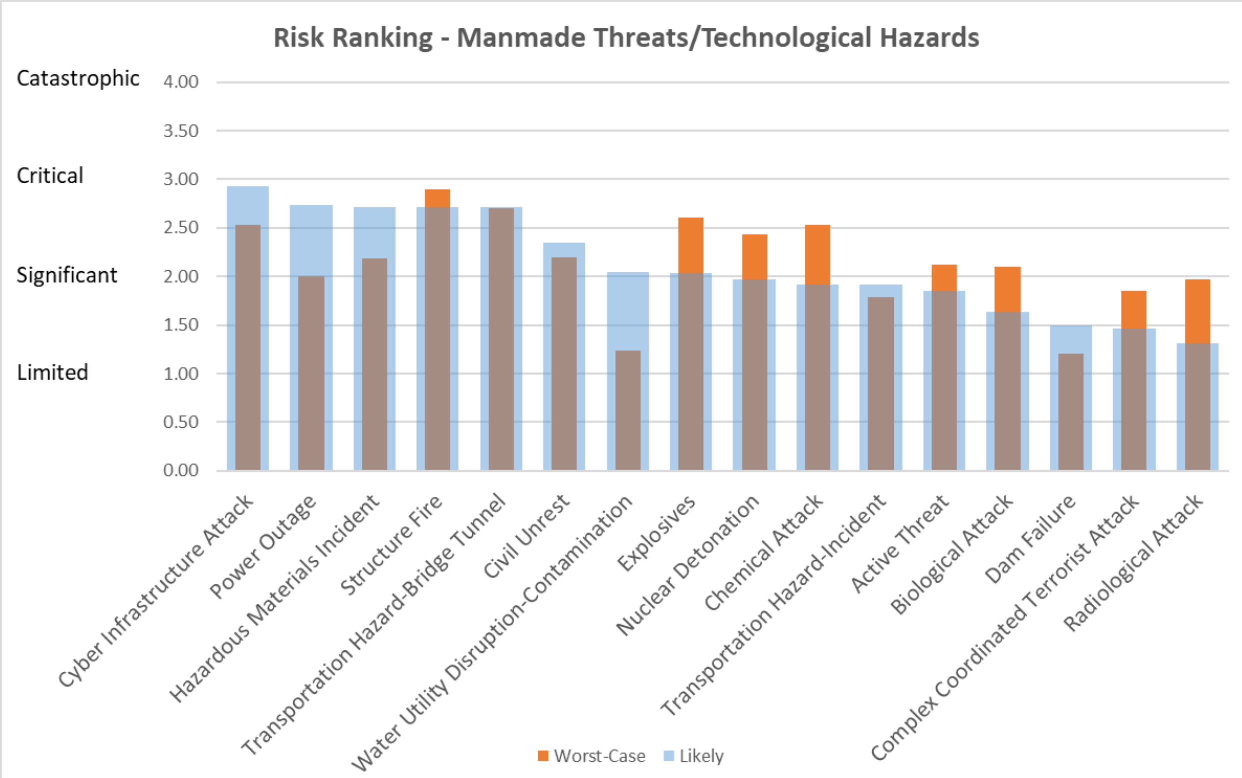
Many preparedness priorities are based on years of experience but lack the hard data to support what decision makers already know to be true. Planners can use the information contained in the HIRA to provide a defensible foundation for planning decisions. This analysis may lend support to previous decisions and justifications, but it may also redirect priorities based on the risk assessment.

Example: Using the HIRA to justify existing plans

The agency has long invested significant resources into pandemic preparedness. Although pandemics are not the highest in overall risk to our community, the Health & Safety impact from a pandemic is expected to be higher than most other hazards addressed in the HIRA. Furthermore, the anticipated impact to Response Capability is considered catastrophic, and the actions we have taken over the past ten years will work to ensure a robust health care response.

The agency has considered investing resources in procuring radiation dosimeters for law enforcement based the threat of a radiological dispersal device. The HIRA rated this threat as the lowest risk. Therefore, agency is redirecting this investment to prevention and mitigation of cyber infrastructure attacks on the city's networks.





2.1.4 Evaluating Prevention, Protection, and Mitigation Actions

This section describes how to use the HIRA to evaluate risk management activities.

Risk management is the process of controlling risk by changing the likelihood or expected consequences from any given hazard. Prevention, protection, and mitigation activities are all approaches to managing risk. The HIRA assigns a risk score to every hazard that incorporates that hazard's likelihood of occurrence and expected consequence. An effective risk management action should reference the likelihood and/or consequence of the hazard as illustrated by the HIRA and demonstrate how the proposed action will reduce the future likelihood and/or the expected consequence of the hazard. A proposed action that does not reduce the likelihood or the consequence of the hazard is not an effective risk management solution.

Example: Using the HIRA to evaluate risk management actions

The agency needs to evaluate three proposals for managing the risk of a radiological attack

- Option A proposes to purchase radiation dosimeters for employees at public facilities.

- Option B proposes to purchase a new system that helps EMS and hospitals manage high-casualty incidents.

- Option C proposes to increase the law enforcement presence in public facilities.

***Option A** does not effectively reduce hazard risk. When describing the consequences of a radiological attack, the HIRA explains that most health & safety impacts result from the traditional explosives used in the attack. The low level of radiation present in most radiological attacks will cause fear but will not significantly impact health & safety. Option A does not reduce likelihood or consequence.*

Option B *effectively reduces hazard risk by reducing the consequence of a radiological attack. Mass casualty systems can reduce two of the key impact areas identified by the HIRA (response capability and health & safety). Option B will also reduce the consequence of other hazard types.*

Option C *effectively reduces hazard risk by reducing the likelihood of a radiological attack. Additionally, police presence may deter the future likelihood of other types of attacks.*

2.1.5 Responding to an Emergency

This section describes how to use the HIRA anticipate challenges during an emergency event.

During an emergency, planning decisions made in seconds have consequences that affect the duration, impact, and cost of recovery. Conducting analysis during an emergency can be time-consuming and may delay the decision making process. The HIRA Consequence Analysis provides an easy-to-understand overview of the expected consequences during an emergency-level hazard event.

Example: Using the HIRA as a planning tool during an emergency event.

Emergency Coordinator

The National Weather Service is predicting a winter storm that will include a prolonged period of sub-freezing temperatures.

Emergency Operations Center Planner

The HIRA shows that sub-freezing temperatures may lead to water line breaks, disruptions in services, and limit the required firefighting capacity in several subdivisions.

Emergency Coordinator

Great catch. Coordinate with ESF#3, Public Works to notify the water purveyor. Perhaps they can engage in flushing, increasing storage capacity, or reversing supply from unaffected areas.

2.1.6 Whole Community Engagement

This section describes how to enhance whole community engagement in planning.

To foster a culture of preparedness throughout the sub-region in concert with FEMA's national strategy, planners are engaging private citizens and businesses which own 85% of the critical infrastructure in the planning processes. The recent cyber-attack on the Colonial Pipeline and the COVID-19 pandemic have demonstrated how hazards affect the local economy and stability for local citizens. The HIRA Consequence Analysis identifies economic impact across all hazards and highlights the need to engage the whole community in ensuring economic resilience.

Example: Using the HIRA to increase public participation in planning and engage the business community.

The agency is updating the continuity of operations plan. In order to adequately account for the hazards identified in the HIRA, the agency is engaging the private sector and the public to determine how these hazards impact citizens' preparedness, their needs during disasters, and reliability of local vendors who support the city and their supply chain resilience.

3 Planning Process

Contents of this Section includes:

I. Planning Overview
II. Planning Process
III. Planning Partners

3.1 Planning Overview

This section discusses the guidance and strategic goals that influenced the planning process.

The HIRA provides a detailed examination of the hazards that may affect the Southside Sub-Region and combines best practice guidance with local stakeholder expertise to create a hazard identification and risk assessment that meets or exceeds industry standards while remaining relevant and specific to the regional context.

Analysts developed the HIRA and accompanying quick-reference sheets to support the emergency preparedness efforts of all regional government agencies, private-sector stakeholders, and the public. The HIRA is a foundational document and was developed to support the needs of many Southside Sub-Regional planning and policy initiatives. Regional initiatives that will build upon this foundation include but are not limited to:

- City Emergency Operation Plans (EOP)
- Hazard-Specific Response Annexes to the EOPs
- The City and Regional Recovery Plans
- The Strategic Plan
- The Multi-Year Training and Exercise Plan
- The Comprehensive Mitigation Plan
- The Public Information and Warning/Communications Plan
- Medical Surge Capacity Plan
- Local Emergency Planning Committee Hazmat Emergency Response Plans
- Continuity of Operations/Government Plans
- Prevention Activities
- Training and Exercise Plan
- Resource Management, Mutual Aid, and Logistics
- Catastrophic Planning
- Public Information and Education
- Economic Development Strategy
- EMAP Accreditation

Guidance from literature, industry accreditation standards, and model programs such as Howard County's HIRA were essential to the development of the HIRA. The federal documents *Understanding Your Risk: Identifying Hazards and Estimating Losses,*[2] *Local Mitigation Planning Handbook (44 CFR 201.6)*[3], and *Integrating Manmade Hazards Into Mitigation Planning*[3] provided federal insight into the risk assessment process.[4]

Analysts and planners developed the HIRA to meet all risk assessment recommendations of the Emergency Management Accreditation Program.[4] EMAP Standard 4.1 provides important guidance on Hazard Identification, Risk Assessment, and Consequence Analysis. This standard states that an "Emergency Management Program identifies the natural and human-caused hazards that potentially impact the jurisdiction using multiple sources." Standard 4.1 also states that the "Emergency Management Program assesses the risk and vulnerability of people, property, the environment and its own

[2] https://mitigation.eeri.org/wp-content/uploads/FEMA_386_2.pdf
[3] https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-planning-handbook_03-2013.pdf
[4] https://www.hsdl.org/?abstract&did=459975

operations from these hazards" and "conducts a consequence analysis for the hazards identified to consider the impact on: public; responders; continuity of operations including delivery of services; property, facilities, and infrastructure; environment; economic condition of the jurisdiction; and public confidence in the jurisdiction's guidance." Because these domains are not mutually exclusive, the table below is provided to show how the impact analysis domains cross-walk with the domains listed in 4.1.2. For example, impact on the public can include health and safety, economic, property damage; impact on responders can include health and safety, responder capabilities, critical facilities; continuity of operations includes shutdown periods for critical facilities, responder capabilities, and economic impact. The impact analysis was organized and conducted according to six primary domains shown in the first column. The public confidence domain cross-sects all of the other domains based on the four survey questions.

Consequence Analysis Impact Domains	Public	Responders	Continuity of Operations	Property, Facilities, Infrastructure	Environment	Economic Condition of Jurisdiction	Public Confidence
Property Damage	X			X		X	
Health & Safety	X	X				X	X
Critical Facilities		X	X	X			
Responder Capabilities		X	X	X			X
Environmental Impact					X	X	
Economic Impact	X		X	X		X	X

3.2 Planning Process

This section discusses the steps that were essential to the completion of the HIRA.

Analysts completed the HIRA project over four phases, comprised of five tasks. Due to limited availability of stakeholders due to COVID-19 response and recovery taskings, analysts streamlined the process of conducting these tasks into the four phases outlined below:

Planning Phase	Key Tasks and Deliverables
Phase I	Formed multidisciplinary, multi-jurisdiction team; identified SMEs; created and validated list of hazards and risk tool with components and weighting factors.
Phase II	Developed hazard profiles in coordination with scenario development experts; researched historical data; estimated future likelihood scores; conducted consequence analysis; surveyed community.
Phase III	Conducted HIRA workshop in two parts: virtual, individual review; hybrid (virtual/in-person) adjudication of comments and feedback to validate hazard profiles.
Phase IV	Developed final report.

3.3 Planning Partners

This section identifies key stakeholders and their roles in the development and completion of the HIRA.

The development of the HIRA involved extensive support from traditional response organizations, government agencies, private-sector partners, and engaged members of the public. Partners in the development of the HIRA can be broken into six groups:

- HIRA Planning Work Group
- HIRA Steering Committee
- Scenario Development Experts
- Subject Matter Experts
- Engaged Public Partners
- Other Supporting Partners

Although several agencies and individuals supported the HIRA project at multiple levels, the organization and function of each group was unique.

HIRA Planning Work Group: The Planning Work Group was responsible for the development and management of the HIRA project from inception to completion. The Planning Work Group drafted all HIRA documents, managed all HIRA data, facilitated meetings, and coordinated the involvement of all HIRA stakeholders. The Planning Work Group was comprised of staff from the city's Offices of Emergency Management.

HIRA Steering Committee: The HIRA Steering Committee provided strategic guidance and support throughout the HIRA project. The Steering Committee reviewed and validated all materials and processes developed by the Planning Work Group. The Steering Committee played an essential role in the identification and selection of Scenario Development Experts and local Subject Matter Experts.

Scenario Development Experts: Scenario Development Experts were selected by the Steering Committee for their expertise in one or more of the hazard categories. Using their expertise and understanding of the local context, the Scenario Development Experts created likely and worst-case scenarios for each of the 26 hazards addressed by the HIRA.

Subject Matter Experts: Subject Matter Experts were selected by the Steering Committee for their expertise in one or more of the subject areas included in the consequence analysis and risk assessment. The multidisciplinary team of Subject Matter Experts was composed of 37 community experts with diverse backgrounds and areas of expertise. Subject Matter Experts used the likely and worst-case hazard scenarios as guides to calculate the anticipated impacts in each of the major consequence areas. At the end of the data collection period, the Subject Matter Expert Workshop brought many experts together to interpret our findings and attempt to build consensus on several of the more subjective components of the risk assessment.

Engaged Public Partners: Public involvement was a key component of the HIRA process. Southside officials invited citizens to participate in the process through the Community Survey on Hazards. In total, 99 members of the public provided information to support the analysis of public confidence and hazard perception.

Other Supporting Partners: Throughout the HIRA project, the Planning Work Group received support from technical experts, industry professionals, and other community stakeholders. The Other Supporting Partners provided essential guidance during the project's development and review.

HIRA Planning Work Group	
Organization	**Representative Name**
Chesapeake Office of Emergency Management	Robb Braidwood
Chesapeake Office of Emergency Management	Bobby Gelormine
Norfolk Office of Emergency Management	Jim Redick
Norfolk Office of Emergency Management	Scott Mahone

Norfolk Office of Emergency Management	Daniel Hudson
Portsmouth Office of Emergency Management	Joe Rubino
Portsmouth Office of Emergency Management	Dave Topczynski
Virginia Beach Office of Emergency Management	Danielle Progen
Virginia Beach Office of Emergency Management	Bradley Killenbeck
HIRA Steering Committee	
Organization	**Representative Name**
Chesapeake Office of Emergency Management	Robb Braidwood
Chesapeake Police Department	Jim Garrett
Chesapeake Public Utilities	David Jurgens
Communications – Portsmouth E911	Paula Garner
Department of Homeland Security CISA	Rob Mooney
Department of Homeland Security CISA	Ben Gilbert
Dominion Energy	Sylvia White
Eastern VA Healthcare Coalition	Mary Morton
Economic Development – Alliance 757	Steve Harrison
FBI/JTTF	Chris Brindisi
FBI/JTTF	Amanda Krugler
Hampton Roads PDC	John Sadler
Hampton Roads PDC	Danielle Spach
Hampton Roads Sanitation District	Anas Malkawi
National Weather Service - Wakefield	Jeff Orrock
National Weather Service - Wakefield	Eric Seymour
Norfolk Communications/Public Information	Lori Crouch
Norfolk Office of Emergency Management	Jim Redick
Old Dominion University	Jared Hoernig
Portsmouth Office of Emergency Management	Dave Topczynski
Portsmouth Information Technology	Daniel Jones
Tidewater EMS Council/HRMMRS	David Long
U.S. Navy	Ruth Reich
Virginia Beach Office of Emergency Management	Danielle Progen
Virginia Beach Fire Department	David Hutcheson
Virginia Beach Public Works	Tonia Alger
Virginia Department of Emergency Management Region V	Harrison Bresee
Virginia Department of Emergency Management Region V	Ray Haring
Virginia Department of Health Tidewater	John Cooke
Virginia Department of Transportation Hampton Roads Harbor Tunnels	Jack Carper
Virginia Department of Transportation Region V	Jim Stanek

Scenario Development Experts and Subject Matter Experts		
Hazard Specialization	**Representative(s)**	**Organization**
Biological	David Hutcheson	Virginia Beach Fire Department
Chemical	Ray Haring	VDEM Region V
Explosives	Chris Brindisi	FBI/JTTF

Hazardous Material Incident Nuclear Detonation Radiological Attack Structure Fire Transportation Incident Wildfire	Jim Garrett	Chesapeake Police Department
	David Long	Tidewater EMS Council
	Jim Stanek	VDOT Region V
	Lori Crouch	Norfolk Public Information
	Paula Garner	Portsmouth E911
	Joe Rubino	Portsmouth OEM
	Dave Topczynski	Portsmouth OEM
Pandemic	John Cooke	Public Health
	Mary Morton	Eastern VA Healthcare Coalition
Drought Earthquake Extreme Heat Tornado Tropical/Coastal Storm Winter Storm	Bobby Gelormine	Chesapeake OEM
	Jeff Orrock	NWS - Wakefield
	Eric Seymour	NWS - Wakefield
	Harrison Breese	VDEM Region V
	Sylvia White	Dominion Energy
	John Sadler	Hampton Roads PDC
	Danielle Spach	Hampton Roads PDC
	Steve Harrison	Economic Development-Alliance 757
	Daniel Hudson	Norfolk OEM
	Dave Topczynski	Portsmouth OEM
Active Threat Civil Unrest Complex Coordinated Terrorist Attack	Chris Brindisi	FBI/JTTF
	Jim Garrett	Chesapeake Police Department
	David Hutcheson	Virginia Beach Fire Department
	Ray Haring	VDEM Region V
	David Long	Tidewater EMS Council
	Lori Crouch	Norfolk Public Information
	Paula Garner	Portsmouth E911
	Jim Redick	Norfolk OEM
Cyber Infrastructure Attack	Daniel Jones	Information Technology
	Rob Mooney	Department of Homeland Security CISA
	Chris Brindisi	FBI/JTTF
	Jim Garrett	Chesapeake Police Department
Water Utility Disruption/ Contamination	John Cooke	Public Health
	David Jurgens	Public Health
	Tonia Alger	Hampton Roads Public Works
Transportation Incident (Bridge/Tunnel Collapse)	Jim Stanek	Virginia Department of Transportation
	Rob Mooney	Department of Homeland Security CISA
	David Long	Tidewater EMS Council
	Ruth Reich	U.S. Navy
	Jack Carper	Hampton Roads Harbor Tunnels
Power Outage Flooding Sea Level Rise and Land Subsidence	Sylvia White	Dominion Energy
	Mary Morton	Eastern VA Healthcare Coalition
	Tonia Alger	Hampton Roads Public Works
	John Sadler	Hampton Roads PDC

Shoreline Erosion	Steve Harrison	Economic Development-Alliance 757
Dam Failure	Ruth Reich	U.S. Navy
Additional Subject Matter Experts		
Area of Expertise	**Representative(s)**	**Organization**
Structure Fire	Jonathan McIvor	Virginia Beach Fire Department
	Evgeniy Ivanov	
Wildland Fire	John Ludford	Virginia Beach Fire Department
	William Skelaney	
	John McMahon	
Other Supporting Partners		
Area of Expertise	**Representative(s)**	**Organization**
Public Information Officer	Lori Crouch	City of Norfolk
	Julie Hill	City of Virginia Beach
	Dana Woodson	City of Portsmouth
	Heath Covey	City of Chesapeake
	Elizabeth Vaughn	City of Chesapeake

3.4 Maintenance Process

This HIRA will be maintained according to the following method and schedule for evaluation and revision:

The Executive Steering Committee will conduct an annual review and update using MS Teams or similar online document sharing platform. Every five years, the Executive Steering Committee will conduct a comprehensive review for the Southside localities (i.e., Virginia Beach, Norfolk, Portsmouth, Chesapeake) aligned with the Hampton Roads regional hazard mitigation plan review.

Each review and update shall consist of verifying the scope of hazards addressed in the HIRA, consideration of emerging hazards from recent incidents and after action reports, determining any substantive changes in the future likelihood of occurrence and consequence analysis ratings that would affect risk, and reviewing any updates to the Emergency Management Standard and other applicable requirements or guidance documents.

Comprehensive reviews and updates shall include a thorough review of the HIRA methodology, input from a larger network of stakeholders such as the SMEs and scenario development experts utilized in this HIRA, a renewed community survey, updates to all elements included in the risk tool, and all of the items included in an annual review. Revisions will be summarized and documented in the revision table located at the beginning of this report. The Executive Steering Committee will disseminate updated reports to stakeholders to ensure preparedness activities such as planning and resource decision-making reflect current risks and priorities.

4 Interpreting the Hazard Profiles

Contents of this Section include:

Guidance for interpreting HIRA hazard profiles:

I. Overview Guide
II. Hazard Characteristics Guide
III. Likelihood Analysis Guide
IV. Consequence Analysis Guide
V. HIRA Planning Assumptions

The information contained within the HIRA hazard profiles is intended to be interpreted and used for a wide variety of emergency preparedness and planning efforts. Profile organization is consistent among all hazard profiles to allow for easy comparison between hazards. The information and analysis contained in the hazard profiles comes from many distinct sources including published literature, unpublished internal documents, subject matter expert consultation, and independent calculation. This section is a detailed guide to the interpretation of the hazard profiles.

There are 16 manmade hazards and 11 natural hazards profiled by the HIRA. Each of the hazard profiles included in the HIRA is organized into the following sections and sub-sections:

I. OVERVIEW
- Definition
- Risk Profile
- Risk Matrix
- Risk Ranking

II. HAZARD CHARACTERISTICS
- Description of the Hazard
- Local Context

III. LIKELIHOOD ANALYSIS
- Occurrence of the Hazard
- Future Likelihood of the Hazard

IV. CONSEQUENCE ANALYSIS
- Consequence Analysis Overview
- Consequence Analysis: Likely Hazard Scenario
- Consequence Analysis: Worst-Case Hazard Scenario
- Consequence Analysis: Public Perception

As the team compiled and reviewed the hazard profiles, analysts recognized that the Seal Level Rise and Land Subsidence profile identified an increasing hazard that has an impact on several other hazard profiles, but that this hazard cannot be analyzed and compared on an annualized basis like the other hazards. Sea Level Rise and Land Subsidence is a changing environmental condition which is estimated to continue worsening over a long-period of time. Nonetheless, it represents a hazard and its associated information is included at Appendix A.

While compiling SME input on flooding, each of the city's representatives provided city-specific information as the impact varies significantly across each of the cities. In order to be consistent with the sub-regional approach to developing the hazard profiles, this information was harmonized. To preserve the comprehensive research and input provided by each city for future planning, these expanded details are preserved in Appendix B.

4.1 Overview Guide

The Overview section defines the hazard and summarizes the hazard risk profile.

4.1.1 Definition

The Definition section contains a concise definition of the hazard. This section establishes the official characterization of the hazard for use in all subsequent Southside Sub-Regional planning and policy efforts. There is a lack of consistent guidance for categorizing and defining hazards, but the hazard definitions contained in the HIRA seek to reflect federal and state guidance whenever possible. The HIRA Steering Committee approved the HIRA definitions.

4.1.2 Risk Profile

The Risk Profile section contains the completed risk table specific to the profiled hazard as established by the Southside Sub-Region Risk Tool. The table characterizes the Likelihood, Consequence, and Risk of the hazard in numerical terms.

Active Threat Risk Profile					
Likelihood	**Risk Assessment Category**	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
	Likelihood	2 Infrequent	2 Infrequent	50%
Consequence	**Impact**	2 Significant	3 Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
	Total Risk Score	1.85	2.12	

The risk assessment for each hazard is based on a Likely and a Worst-Case scenario for that specific hazard category. While different scenarios and details could have been developed, these scenarios reflected the concerns of the HIRA Scenario Development Team and were validated by the HIRA Steering Committee during the workshop. Analysts reviewed, updated, and harmonized these descriptions for consistency and verified data used to support these scenarios with SMEs.

- Likely Hazard Scenario refers to the emergency level hazard scenario that is most likely to occur within the jurisdiction. An emergency level hazard is any hazard that requires a response from at least two agencies.
- Worst-Case Hazard Scenario refers to the worst hazard scenario that could reasonably occur within the jurisdiction.

The Likelihood of hazard occurrence is characterized by the row labeled Likelihood.

- HIRA Subject Matter Expert Teams determined the Likelihood score. Expert teams analyzed historical occurrence data and future trends to assign each hazard an annual probability of future hazard occurrence. Analysts reviewed each input for consistency, supplemented with additional research, interviewed additional SMEs when needed, and translated this probability into a numerical score as outlined by the Risk Tool.
- Likelihood scores were assigned for the Likely and Worst-Case scenarios.

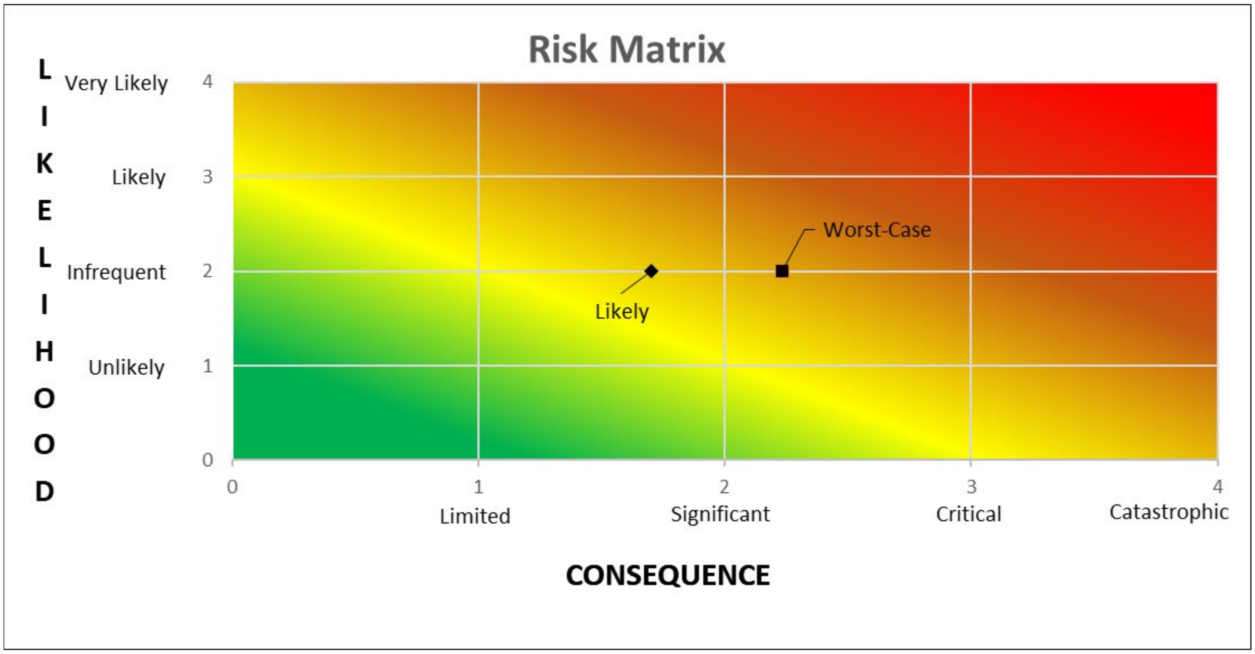
The Hazard Consequence is characterized by the rows labeled Impact, Warning Time, and Duration.

- The Consequence Analysis and Subject Matter Expert Teams determined the Impact score for each scenario and component of Impact. Expert teams considered Consequence Analysis data and Risk Tool specifications to assign each hazard a Total Impact Score based on the average of the Impact components.
- The Warning Time score was assigned by Subject Matter Experts using Risk Tool specifications.
- Subject Matter Experts assigned the Duration score using Risk Tool specifications.
- Analysts reviewed these inputs for consistency across all hazard scenarios based on the criteria in the Risk Tool.

Analysts calculated the Total Risk Score for each hazard as specified in the Risk Tool. Scores for Likelihood, Impact, Warning Time, and Duration were multiplied by their associated weighting factor and summed.

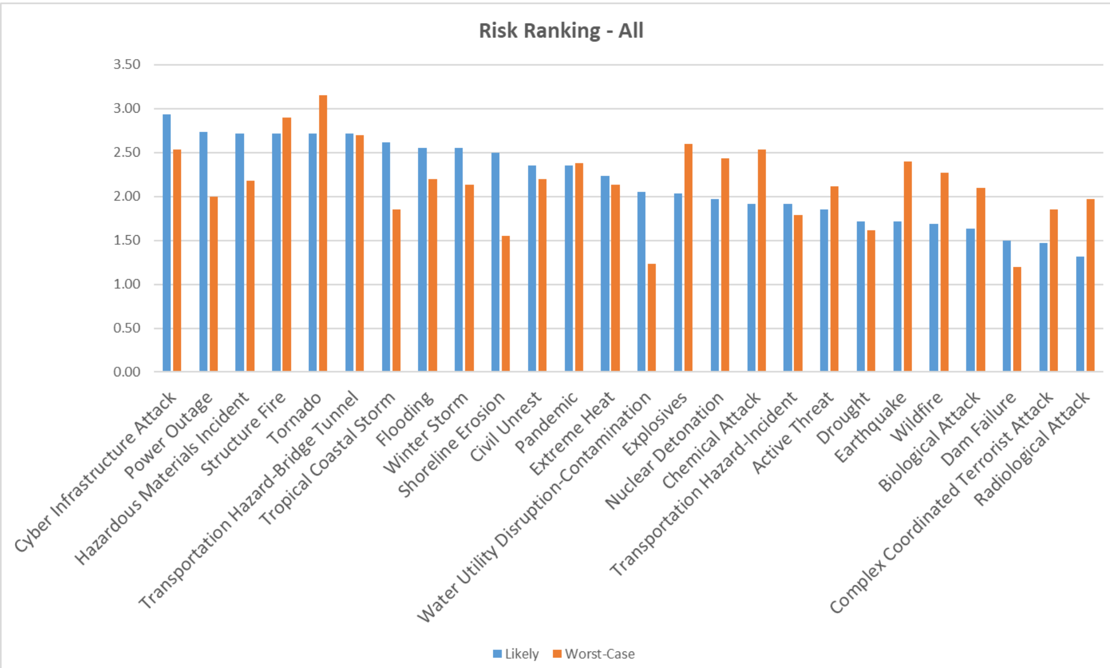
4.1.3 Risk Matrix

The Risk Matrix section contains a graphical illustration of the hazard and its associated Likely and Worst-Case risk. The Risk Matrix illustrates Likelihood on the graph's Y-axis and Consequence on the graph's X-axis. The risk score of the hazard is included below the label of each hazard.

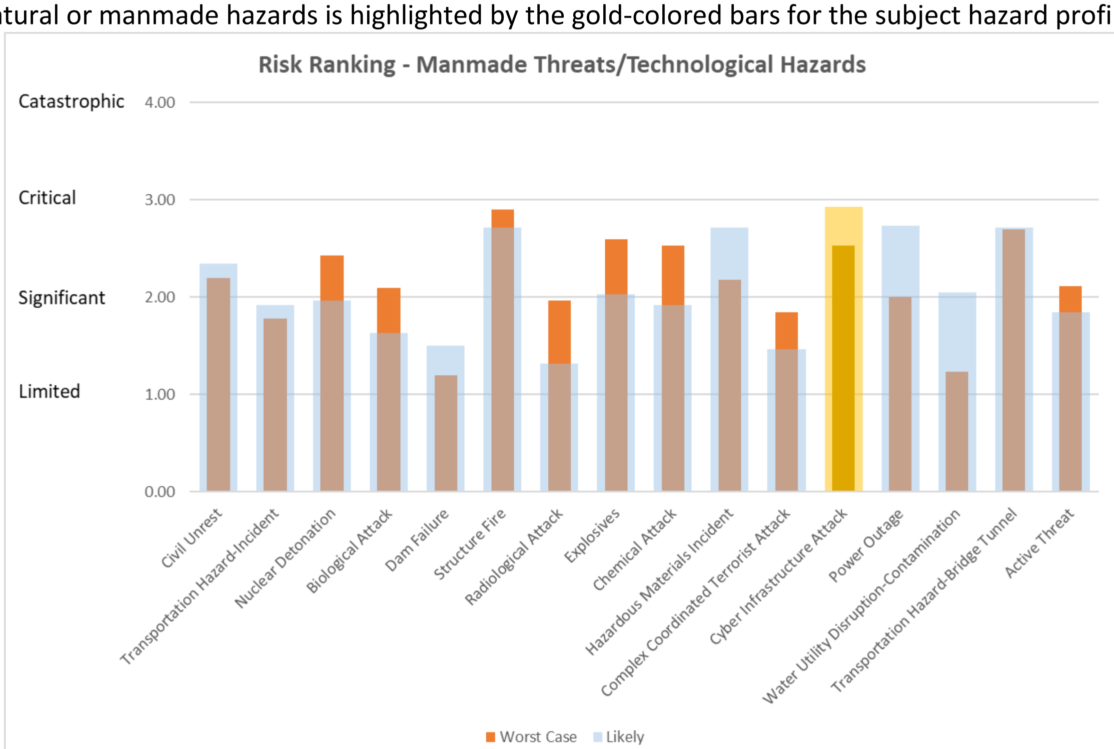


4.1.4 Risk Ranking

The Risk Ranking section contains a graphical representation of the Likely and Worst-Case risk scores for each hazard. The hazards are organized from highest risk to lowest risk based on Likely scenario risk score.



The risk rankings are divided by natural and manmade hazards. Within each hazard profile, the relative risk compared with other natural or manmade hazards is highlighted by the gold-colored bars for the subject hazard profile.



4.2 Hazard Characteristics Guide

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

4.2.1 Description of the Hazard

The Description of the Hazard section further elaborates on the concise hazard characterization provided in the initial Definition. This section derives information from many sources including published literature, federal guidance, and Subject Matter Expert consultation. Information in this section is specific to the hazard and is not specific to the Southside Sub-Region although some local context may be included.

4.2.2 Local Context

The Local Context section factors specific to the Southside Sub-Region that may impact local risk from a specific hazard. This section may include factors specific to the region that affect the likelihood of a hazard's occurrence within the planning area. This section may also include locations, features, critical infrastructure, or population factors that affect region's vulnerability to the hazard.

4.3 Likelihood Analysis Guide

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

4.3.1 Occurrence of the Hazard

The Occurrence of the Hazard section details the documented occurrence of the hazard inside the planning area during the reviewed time period. Historical Occurrence information comes from internal and external records, open-source intelligence, and Subject Matter Expert consultation. The reviewed time period reflects the availability of reliable hazard occurrence data in the jurisdiction. The Notable Incidents sub-section also contains brief profiles of typical or notable occurrences of the hazard in the region.

4.3.2 Future Likelihood of the Hazard for the Southside Region

The Future Likelihood Table outlines the historical and future likelihood of the hazard occurrence inside the planning area.

Future Likelihood of an Active Threat Attack Hazard		
	Likely	**Worst-Case**
Historical Average (time period)	3 events over 20 years (2001-2021)	0.26 events per year in VA (2000-2015)
Historical Annual Probability	15% chance of annual occurence	13% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	1-10% chance of annual occurence	1-10% chance of annual occurrence
Future Likelihood Score	2 - Infrequent: 1-10% chance of annual occurence	2 - Infrequent: 1-10% chance of annual occurrence

- Historical Average is calculated based on the Historical Occurrence profiled in the Occurrence of the Hazard section.
- Historical Annual Probability is calculated based on the Historical Average to annualize the probability.
- Future Likelihood expectations and Future Annual Probability are decided by Subject Matter Experts through analysis of historical occurrence data and trends.
- Future Likelihood Score was derived from the Future Annual Probability as outlined by the Risk Tool.

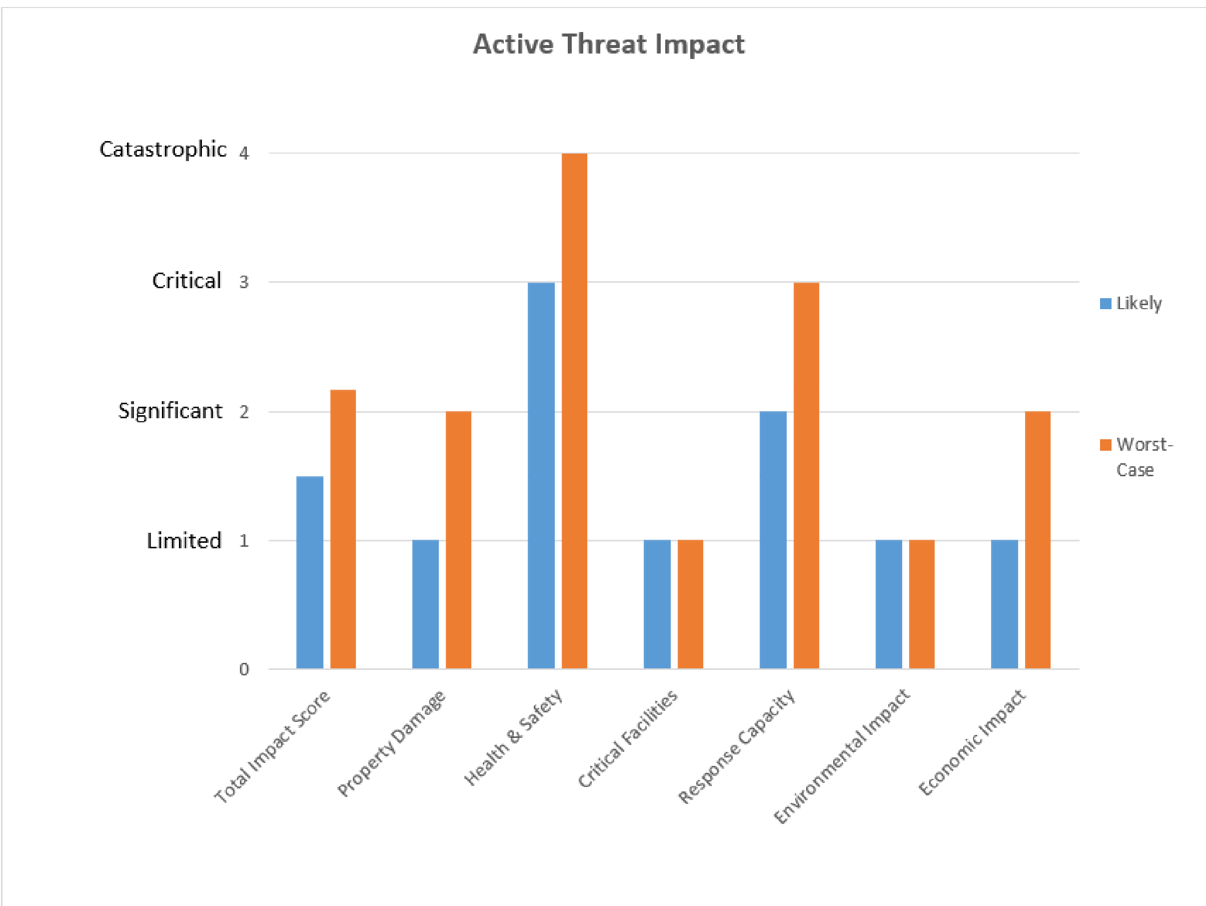
The Considerations sub-section elaborates on the information contained in the Future Likelihood Table. If the future likelihood of hazard occurrence is expected to deviate from historical trends, the factors involved are elaborated in this sub-section. Information in the Considerations sub-section was derived from Subject Matter Expert analysis of historical occurrence and future data trends. This information was reviewed and validated by the HIRA Steering Committee during the workshop.

4.4 Consequence Analysis Guide

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

4.4.1 Consequence Overview

The Consequence Analysis Overview section contains a graphical representation of the hazard's anticipated impact to property, health & safety, critical facilities, response capacity, the environment, and the local economy.



The Total Impact Score was determined by Subject Matter Expert teams based on the description of the likely or worst-case scenario, consequence analysis of that scenarios, considering historical data, and specifications outlined in the Risk Tool.

- The Impact score for each consequence sub-category was derived from the Consequence Analysis using specifications outlined in the Risk Tool.
- Worst-Case impact score is demonstrated by the orange bar as noted on the graph.

The Warning Time and Duration Table provides additional detail on the anticipated duration of the hazard and the expected warning time prior to hazard onset.

Active Threat Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Short - Less than six hours	Short - Less than six hours

- Warning Time refers to the time of awareness prior to the onset of the hazard.
- Duration refers to the time from the onset of the hazard to the point when the hazard ceases to threaten life, property, critical facilities, response capacity, the environment, or the economy.
- Warning Time and Duration are assigned descriptive levels to coincide with the associate score as specified in the Risk Tool.
- Warning Time and Duration were evaluated for both the Likely and Worst-case scenarios.

4.4.2 Consequence Analysis: Likely and Worst-Case Hazard Scenarios

The Consequence Analysis section provides a detailed description of the hazard's anticipated impact to property, health & safety, critical facilities, response capacity, the environment, and the local economy. Each consequence sub-category is assigned a descriptive level to coincide with the associated score as specified in the Risk Tool. The information contained in the Consequence Analysis reflects the data and experience of Subject Matter Experts in each respective field.

Active Threat Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally
Total Impact	Limited-Significant	Total Impact Score: 1.50 on a scale of 1 (Limited) to 4 (Catastrophic)

Active Threat Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Critical	Local resources are expended and require sustained support from
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately
Total Impact	Significant-Critical	Total Impact Score: 2.17 on a scale of 1 (Limited) to 4 (Catastrophic)

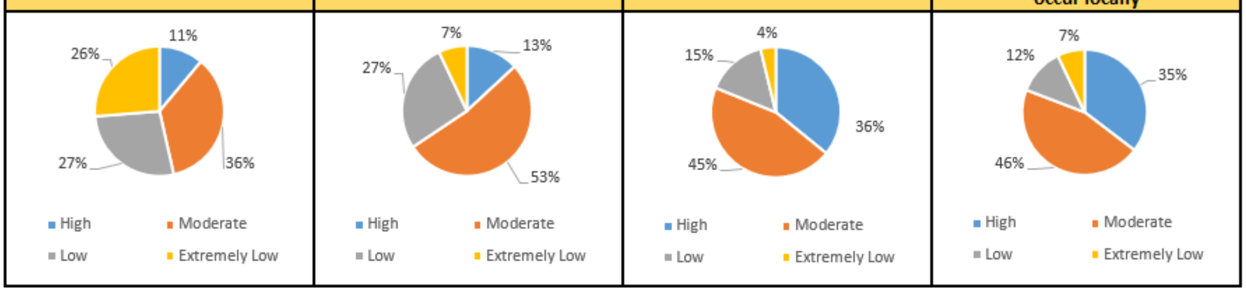
- Property Damage details the anticipated percentage of the region's critical and non-critical infrastructure that will suffer damage from the hazard and the type of damage that is expected.
- Health & Safety details the number of deaths and injuries that are expected to result from the hazard and the types of deaths and injuries that are expected.

- Critical Facilities details the expected shutdown duration of essential functions. Utilities, Information/Communication, and Transportation are each assigned a descriptive level to coincide with the associated score as specified in the Risk Tool.
- Response Capacity details the expected shutdown duration of essential response functions. Police, Fire & Rescue, Health, Hospitals, and Emergency Management are each assigned a descriptive level to coincide with the associated score as specified in the Risk Tool.
- Environmental Impact details the hazard's expected impact to the environment.
- Economic Impact details the hazard's impact to the Southside Region's economy. Loss of economic output and job loss refer only to the hazard's anticipated effect on the gross domestic product of the jurisdiction as determined by Subject Matter Expert analysis. Information in this section does not include the costs associated with cleanup or healthcare for those affected.
- The Total Impact Score was calculated as an average of the sub-category scores on a 1 (Limited) to 4 (Catastrophic) scale by analysts.

4.4.3 Public Perception

The Public Perception section elaborates on the public's confidence and perceptions of consequence as they relate to each of the top eight risks to the Southside Sub-Region. The HIRA Working Group determined that limiting the number of questions on the survey would increase responsiveness from the community. The associated table illustrates the public response to the questions posed by the Community Survey on Hazards.

Cyber Infrastructure Attack Public Perceptions			
Perceived confidence in city's ability to respond and recover from this hazard	Perceived confidence in personal ability to protect self and family from this hazard	Concern over the impact to personal health and safety if this hazard were to occur locally	Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally



The associated table illustrates the public response to the following questions posed by the Community Survey on Hazards:

- Q1: "Please rate your confidence in the city's ability to respond to and recover from this hazard."
- Q2: "Please rate your confidence in your personal ability to protect yourself and your family from this hazard."
- Q3: "Please rate your concern over the impact to personal health and safety if this hazard were to occur locally."
- Q4: "Please rate your concern over the impact to personal standard of living/quality of life is this hazard were to occur locally."

4.5 HIRA Planning Assumptions

This section details the strategic assumptions made during the development of the HIRA.

It is important to understand the assumptions made by the Southside Sub-Region HIRA. Prior to interpreting the information in the HIRA, it is important to review the planning assumptions to assure its continued validity.

- The HIRA assumes that the likelihood and expected consequences of the included hazards have not changed since the data was collected.

  Analysis: The HIRA is updated at strategic intervals. However, if there is reason to believe that there have been significant changes to the likelihood or expected consequence of a hazard since the last update, caution should be taken when interpreting the Risk Score. Periodic updates should be made to reflect changing conditions and environment.

- The HIRA assumes that Scenario Developers and Subject Matter Experts provided accurate insight into their designated area of expertise.

  Analysis: Great effort was put forth to select a team of local Subject Matter Experts with exceedingly high levels of knowledge, experience, and access to information in their designated areas of expertise. Analysts offered and provided consultation to facilitate the analysis and ensure consistency in the method. Nonetheless, opinions and perspectives vary among SMEs regarding the likelihood of hazards that have little or no historical basis, the impact of those hazards, and the future likelihood. This variation risk was mitigated by utilizing a team approach which was independently reviewed and verified by contractor analysts prior to validation by the Steering Committee.

- Future Likelihood ratings above 30% annual probability are equal.

  Analysis: A limitation of the Risk Tool is that it does not differentiate among Likelihood ratings above 30%. Therefore, a hazard with an estimated probability of 90% and 35% are treated as equal in the risk calculation (i.e., Very Likely).

- The Likelihood ratings are represented on an annualized basis.

  Analysis: Some hazards such as natural disasters have over 70 years of historical data upon which to base the Likelihood estimate. Other hazards such as a Nuclear Detonation or a Complex Coordinated Terrorist Attack have not occurred in the Southside sub-region; therefore, an estimated projection was made based on intelligence, analysis, and global trends. Some hazards such as Shoreline Erosion occur both instantaneously and over the long-term. In order to compare relative risks, a standardized Likelihood unit of measure was determined based on annualized probability. This must be updated as environmental and geopolitical change occurs.

- The Likely and Worst-case scenarios and the subsequent likelihood and consequences are realistic representations of the true Likely and Worst-case scenarios.

  Analysis: While the spectrum of possible scenarios may be numerous and vary greatly in severity, our team strived to facilitate the construction of the Likely median scenario and the plausible Worst-case scenario as a comparable end point along a spectrum of severity. These scenarios may not be the actual Likely and Worst-case but are representations of these scenarios for planning and analysis purposes.

- The Impact score assumes hazards with the highest possible Impact score (4=Catastrophic) are equal.
  Analysis: A limitation of the Risk Tool is that it is unable to capture differences in Impact among catastrophic events. A hazard event resulting in 50 deaths will receive the same Impact score as a hazard event resulting in 500 deaths. Similarly, a hazard event resulting in 50 deaths will receive the same Impact score as a hazard event with no deaths resulting in catastrophic consequences to property, the environment, and the economy. Caution should be taken when interpreting the Impact score in absence of the full Consequence Analysis.

- The Public Perception tables assume that the sampled population is representative of the entire population in the Southside Sub-Region.

Analysis: The information on Public Perception is intended to be interpreted with caution. Although effort was made to sample outside of traditional government circles, the sample of 99 respondents was not random and may not be representative of the entire population. Caution should be taken when drawing broad conclusions from Public Perception results. The responses from each city are approximately the same percentage of total respondents.

5 Risk Overview

Contents of this Section Include:

I. Hazard Definitions
II. Risk Overview Charts
III. Trend Analysis

5.1 Hazard Definitions

This section defines the hazard and summarizes the hazard risk profile.

The Southside Region HIRA provides a detailed analysis of 16 manmade hazards and 11 natural hazards. Below is a description of each of the hazards addressed in the HIRA:

ADVERSARIAL/INTENTIONAL HAZARDS	
Active Threat: An Active Assailant hazard refers to an individual actively engaging in killing or attempting to kill people in a confined or populated area. Active Assailant hazards are typically characterized by the assailant's intent to kill with no pattern or method to their selection of victims.	**Cyber Infrastructure Attack**: A Cyber/Communications Infrastructure Attack is an intentional disruption or manipulation of the information and communication systems used to collect, filter, process, create, and distribute data. An attack of this type may seek to impact data or manipulate data to impact physical infrastructure.
Biological Attack: A Biological Attack is an intentional release of viruses, bacteria, or other germs (agents) used to cause illness or death in people, animals, or plants. Biological agents can be introduced and spread through a population by air, through direct contact, through water, or through food.	**Explosives**: An Explosives hazard occurs when an explosive device is intentionally used to cause harm to people, property, operational capacity, or the environment.
Chemical Attack: A Chemical Attack hazard results from the intentional release of potentially harmful chemicals into the environment. Agents used in Chemical Attacks include poisonous vapors, aerosols, liquids, and solids that have toxic effects.	**Nuclear Detonation**: A nuclear blast is the result of a device that uses a nuclear reaction to create an explosion far more powerful than that of conventional explosives. When nuclear weapons or improvised nuclear devices (INDs) explode, the energy is violently released in the form of a blast wave, intense light, heat, and radiation.
Civil Unrest: Civil Unrest is often the result of ideological conflict and may include protests, riots, demonstrations, civil disobedience, and other forms of obstruction. Although many expressions of Civil Unrest are safe and legal, a Civil Unrest hazard occurs when the level of public disorder becomes a threat to health, safety, and property.	**Radiological Attack**: A radiological attack is defined as the spreading of radioactive materials with the intent to cause harm. Radioactive materials are used every day in laboratories, medical centers, food irradiation plants, and for industrial uses.
Complex Coordinated Terrorist Attack: Complex Coordinated Terrorist Attack (CCTA) are acts of terrorism that involve synchronized and independent team(s) at multiple locations, sequentially or in close succession, initiated with little or no warning, and employing one or more weapon systems: firearms,	

explosives, fire as a weapon, and other nontraditional attack methodologies that are intended to result in large numbers of casualties.	
TECHNOLOGICAL/ACCIDENTAL HAZARDS	
Dam Failure: A Dam Failure hazard occurs when part or all of a dam's water-retaining barrier becomes damaged causing the uncontrolled release of water downstream. A Dam Failure hazard can be the result of a design or construction error, insufficient maintenance, human error, or internal erosion. Dam Failures can also occur as the result of an intentional attack or as a cascading effect of natural hazards such as flooding, earthquakes, or geological instability.	**Structural Fire:** A Structure Fire hazard is an uncontrolled fire involving any building or structure. Structure Fires can occur in a residential, commercial, or industrial setting. Fires can easily spread from one structure to another, and the size of a Structure Fire hazard is constantly evolving. Fire can have an intentional or unintentional cause or may be the result of another hazard type.
Hazardous Material Incident: A hazardous material is defined as a matter (solid, liquid, or gas) or energy that when released can cause harm to people, the environment, and property, including weapons of mass destruction, as defined in 18 U.S. Code, Section 2332a, as well as any other criminal use of hazardous materials, such as illicit labs, environmental crimes, or industrial sabotage. A hazardous materials incident involves the uncontrolled release of one or more hazardous materials into an environment in which humans are or could be present or that otherwise holds the potential to put human or environmental safety at risk if not addressed.	**Transportation Hazard-Incident:** Transportation hazards center around highways, waterways, railways, and aircraft routes (especially take-off and landing). Pipelines are also transportation routes for materials that create risk for the region if damaged, blocked, or sabotaged.
Power Outage: The unexpected loss of electrical power. An extended power outage may impact the whole community and the economy.	**Water Utility Disruption:** A sudden disruption or contamination in the potable water service caused by intentional or unintentional events resulting in the water supply to become unsafe or unavailable for use.
Transportation Hazard – Bridge/Tunnel: A Transportation Hazard involving a bridge or tunnel occurs whenever a vehicle accident or collision has the potential to cause harm. Any vehicle is capable of being involved in a Transportation Hazard. The most common types of Transportation incidents involve automobiles, trains, airplanes, or boats.	

NATURAL HAZARDS	
Drought: A drought is a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and humans over a sizeable area. It usually refers to a period of below-normal rainfall, but drought can also be caused by drying bores, lakes, or anything that reduces the amount of liquid water available.	**Shoreland Erosion:** Sea level rise influences the on-going processes that drive erosion, in turn making coastal areas ever more vulnerable to both chronic erosion and episodic storm events (Maryland Commission on Climate Change, 2008). Secondary effects of increased erosion include increased water depths and increased sediment loads which can drown seagrass and reduce habitat and food sources for fish and crabs. Increased wave action contributes to the increased erosion as the wave energy attacks intertidal and upland resources.
Extreme Heat: Extreme heat is defined as temperatures that hover ten degrees or more above the average high temperature for the region and last for several weeks.	**Tornado:** A tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." Tornadoes can co-occur with other weather events such as thunderstorms or hurricanes. While the violently rotating columns of air may only last for a few minutes, affects can be catastrophic, lasting for more than an hour and traveling dozens of miles. Most of the world's tornadoes occur in the United States, usually in April and June.
Earthquake: An earthquake is a sudden release of energy from the earth's crust that creates seismic waves. Tectonic plates become stuck, thus putting a strain on the ground. When the strain becomes so great that rocks give way, fault lines occur. At the earth's surface, earthquakes may manifest themselves by a shaking or displacement of the ground.	**Tropical/Coastal Storm** Hurricanes, tropical storms, and typhoons are collectively known as tropical cyclones. NOAA defines a tropical cyclone as a "warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere".
Flooding: Flooding is defined as the accumulation of water that exceeds a physical barrier or collects in a low-lying area that leads to the inundation of an area. Flooding typically results from large scale weather systems that generate prolonged or highly impactful rainfall. Other conditions such as winter snow thaws, over-saturated soil, ice jams breaking apart, and urbanization can cause flooding as well.	**Wildfire:** Wildfires are uncontrolled forest fires, grassland fires, rangeland, or urban-interface fires which consume natural fuels and spread in response to the environment. Wildfires can be either a natural phenomenon or human-caused. The frequency and severity of wildfires depends on both weather and human activity.

Pandemic: A pandemic is defined as "an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people".	**Winter Storm:** A winter storm is a weather event that produces forms of precipitation caused by cold temperatures, such as snow, sleet, ice, and freezing rain, while ground temperatures are cold enough to cause precipitation to freeze. Windy conditions may also be present during a winter storm.
Sea Level Rise and Land Subsidence: Global sea level is determined by the volume and mass of water in the world's oceans. Sea level rise occurs when the oceans warm or ice melts, bringing more water into the oceans. Sea level rise caused by warming water or thermal expansion is referred to as steric sea level rise, while sea level rise caused by melting snow and ice is called eustatic sea level rise. The combination of steric and eustatic sea level rise is referred to as absolute sea level rise. Absolute sea level rise does not include local land movements. Additionally, while it is often represented as a global average, absolute sea level rise varies from place to place as a result of differences in wind patterns, ocean currents, and gravitational forces.	

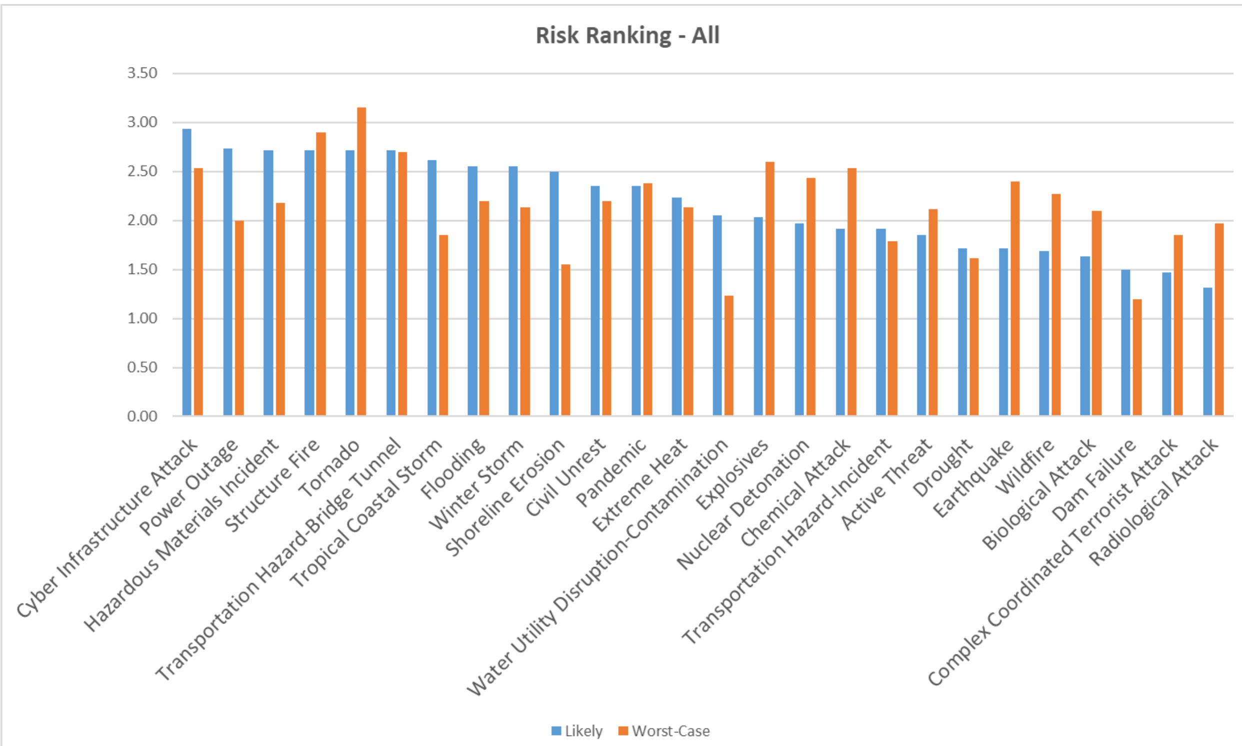
5.2 Risk Overview Charts

The Risk Overview charts compare hazards based on Risk Score, Likelihood, Total Impact, Impact to Property, Impact to Health & Safety, Impact to Critical Facilities, Impact to Response Capacity, Impact to the Environment, and Impact to the Economy. All information is specific to the Southside Sub-Region.

Unless otherwise noted, charts are based on the most likely hazard scenario with the worst-case scenario represented as a shaded overlay or an adjacent bar.

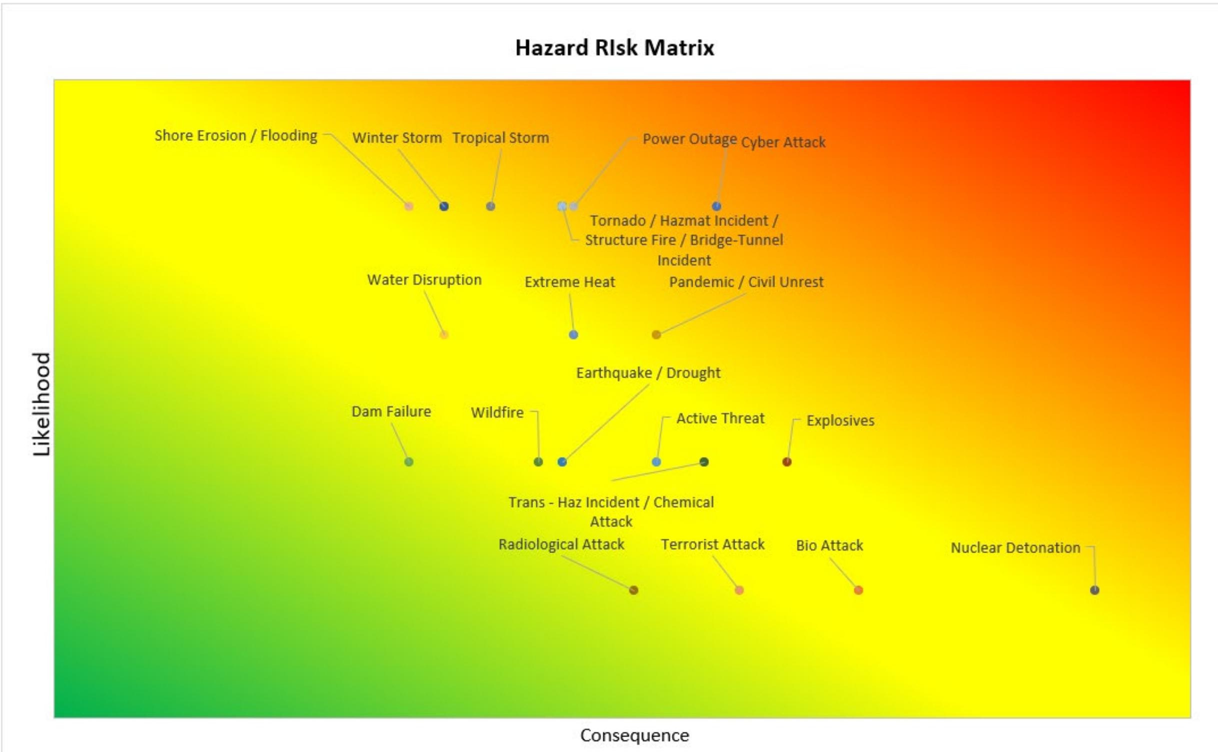
5.2.1 Risk Ranking

The Risk Ranking lists hazards by total Risk Score. Risk is a function of Likelihood and Consequence. Ranking is from highest risk to lowest risk.



5.2.2 Risk Matrix

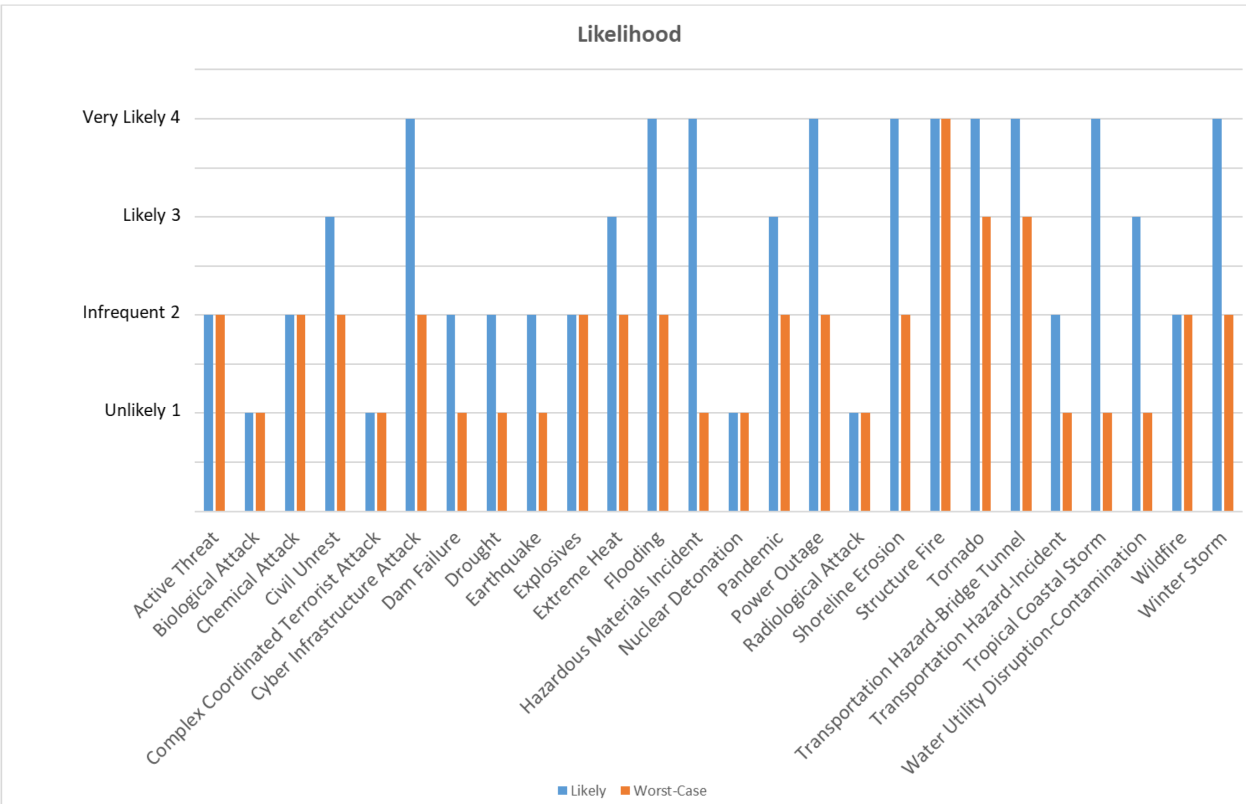
The Risk Matrix illustrates hazard risk graphically by Likelihood and Consequence. Hazards are plotted based on the Likely hazard scenario.



5.2.3 Likelihood

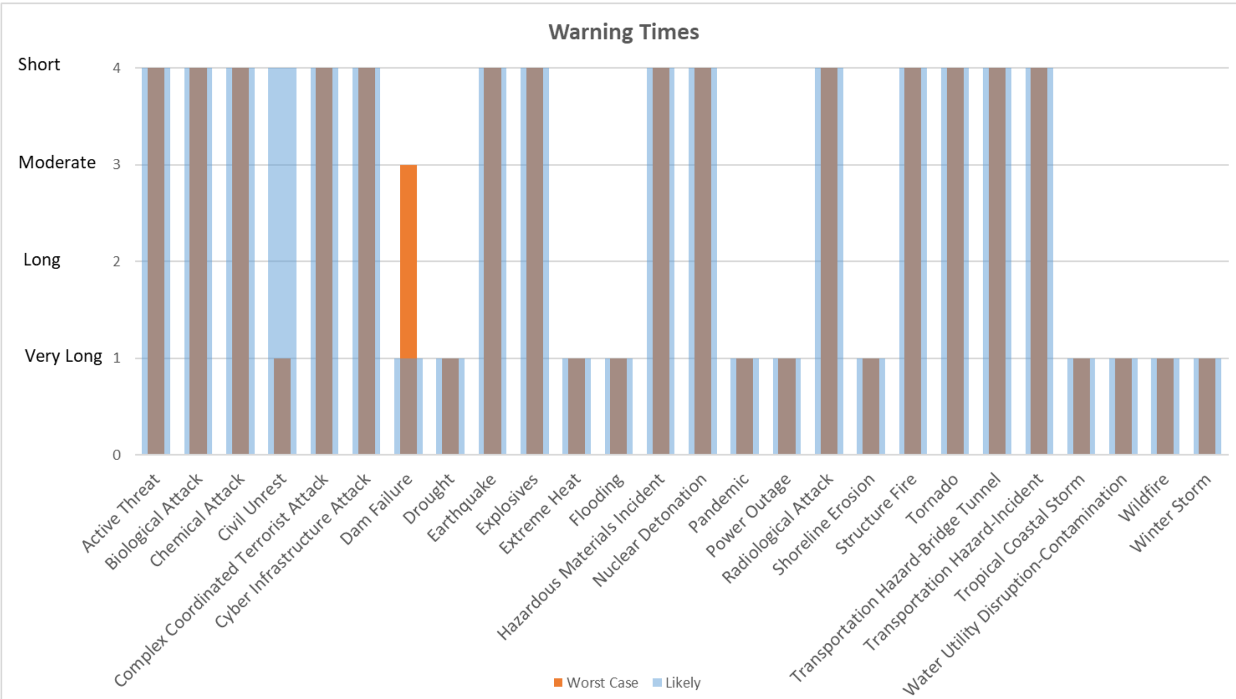
The Likelihood chart lists hazards by the anticipated future annual likelihood of the hazard's occurrence.
Very Likely = 30+ chance of annual occurrence. ***Likely*** = 11-30% chance of annual occurrence.
Infrequent = 1-10% chance of annual occurrence. ***Unlikely*** = Less than 1% chance of annual occurrence.

For risk ranking, the Likely scenario was utilized. Within each hazard profile, the risks are graphed for both Likely and Worst-case scenarios.



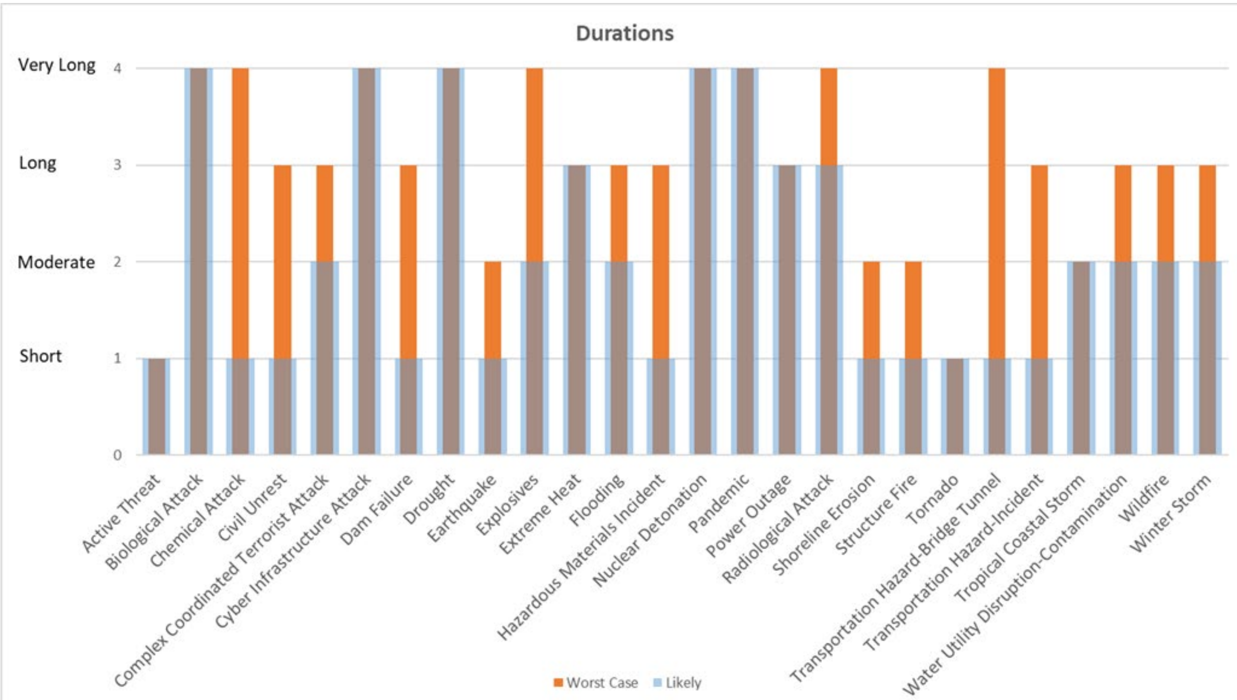
5.2.4 Warning Time

Warning time is based for each scenario is based on the time of awareness prior to the onset of the hazard. (1) Very Long is more than 24 hours; (2) Long is 12-24 hours; (3) Moderate is 6-12 hours; (4) Short is less than 6 hours.



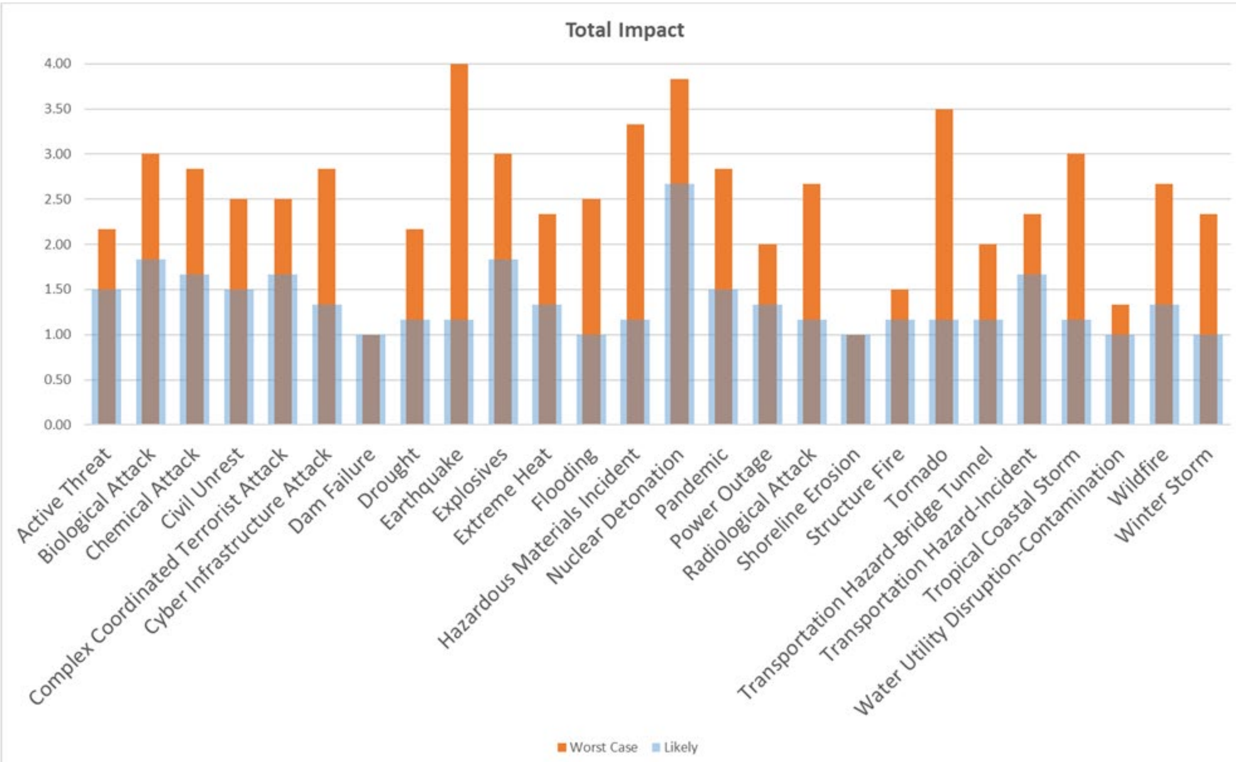
5.2.5 Duration

Duration refers to the time from the onset of the hazard to the point when the hazard ceases to threaten life, property, critical facilities, response capacity, the environment, or the economy. (1) Short is less than 6 hours; (2) Moderate is 6-24 hours; (3) Long is less than a week; (4) Very Long is more than one week.



5.2.6 Total Impact

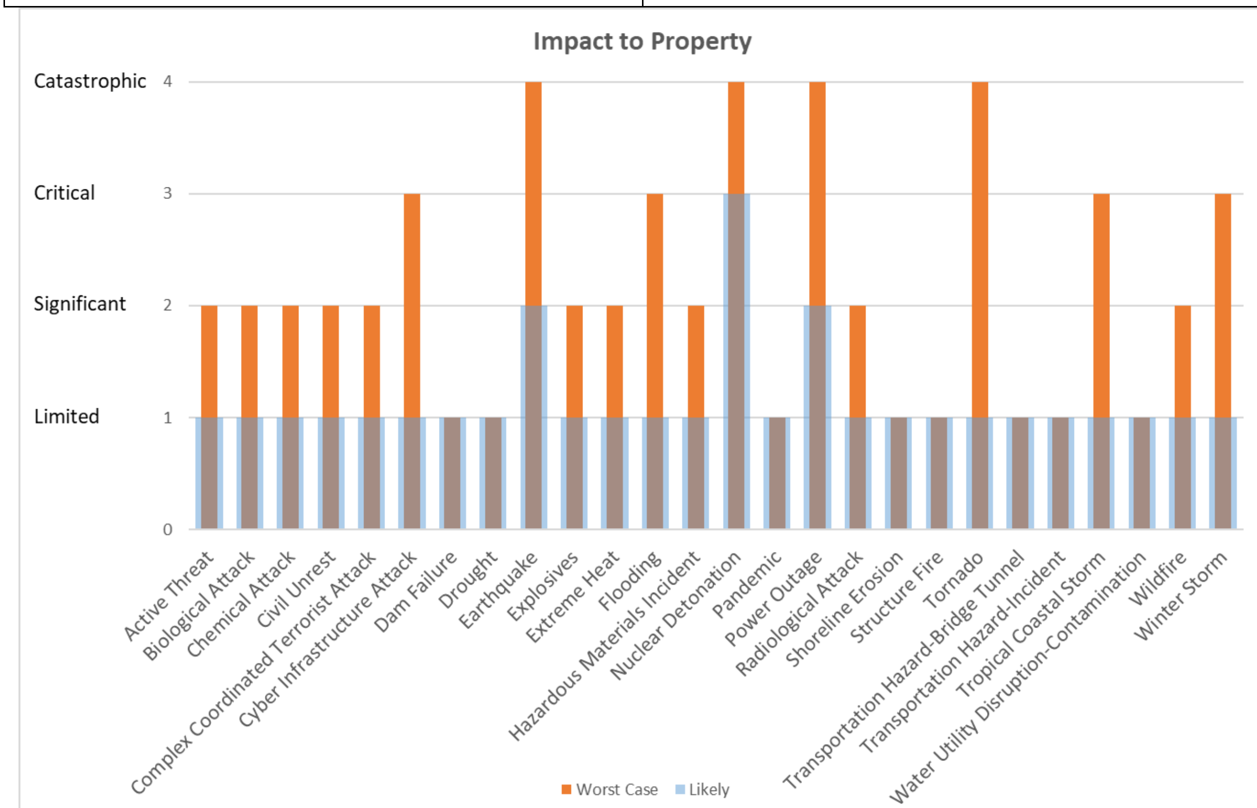
The Total Impact chart lists hazards by Total Impact Score. Total Impact is a combined measure that includes impact to property, health & safety, critical facilities, response capacity, the environment, and the economy.



5.2.6.1 Impact to Property

The Impact to Property chart lists hazards and their associated impact to critical and non-critical infrastructure.

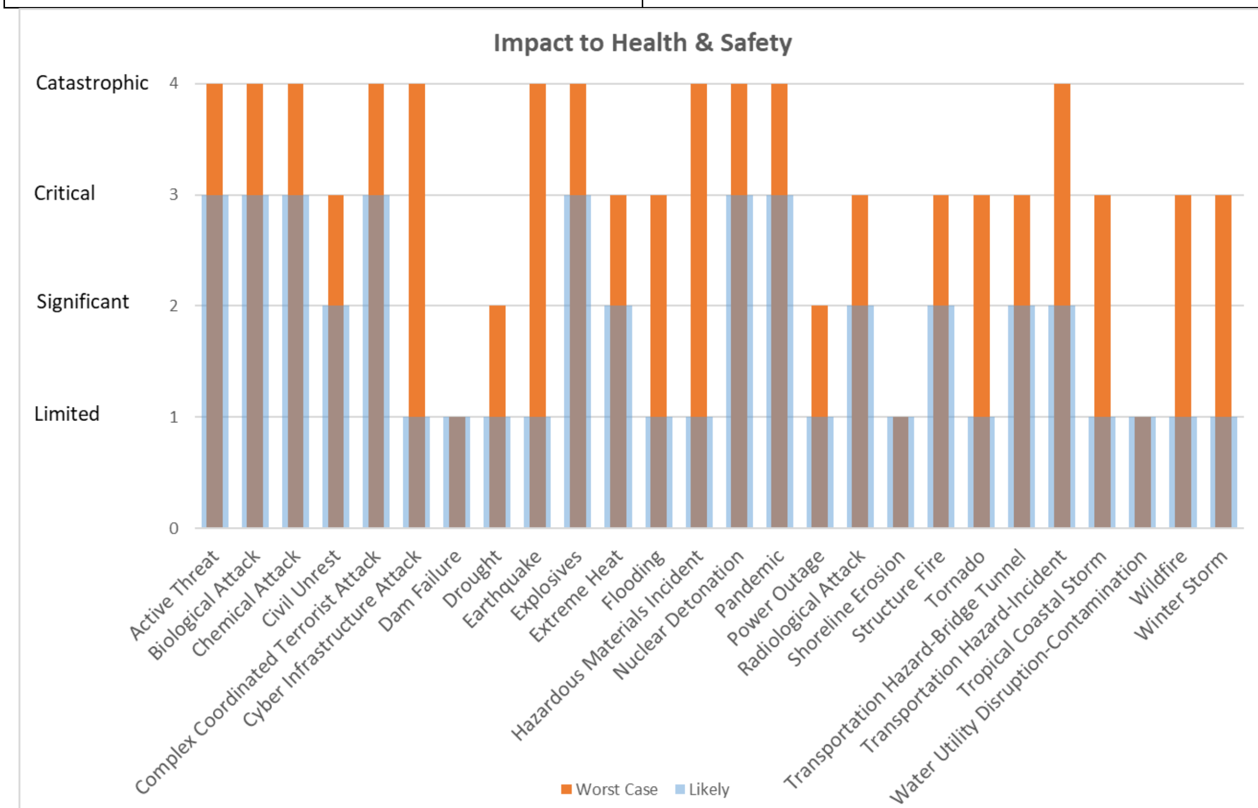
Impact	Property Damage
(1) Limited	Property damage is less than 5% of critical and non-critical infrastructure.
(2) Significant	Property damage is 5-25% of critical and non-critical infrastructure.
(3) Critical	Property damage is between 26-50% of critical and non-critical infrastructure.
(4) Catastrophic	Property damage is severe, greater than 50% of critical and non-critical infrastructure affected.



5.2.6.2 Impact to Health & Safety

The Impact to Health & Safety chart lists hazards and their associated impact to life and health.

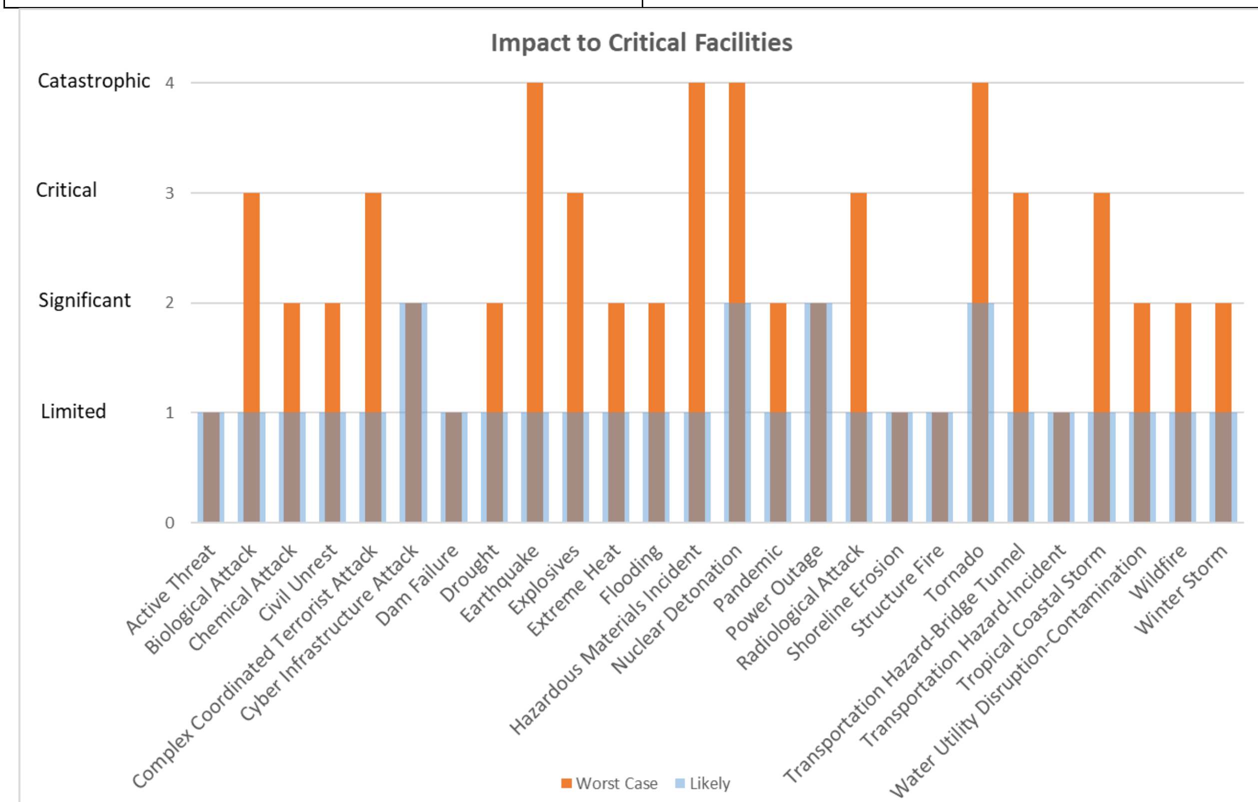
Impact	Health & Safety
(1) Limited	Injuries are manageable with existing resources, no fatalities.
(2) Significant	Injuries are manageable, may include at least one death.
(3) Critical	Multiple deaths and serious injuries are probable.
(4) Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.



5.2.6.3 Impact to Critical Facilities

The Impact to Critical Facilities chart lists hazards and their associated impact to critical functions including utilities, information/communication systems, and transportation.

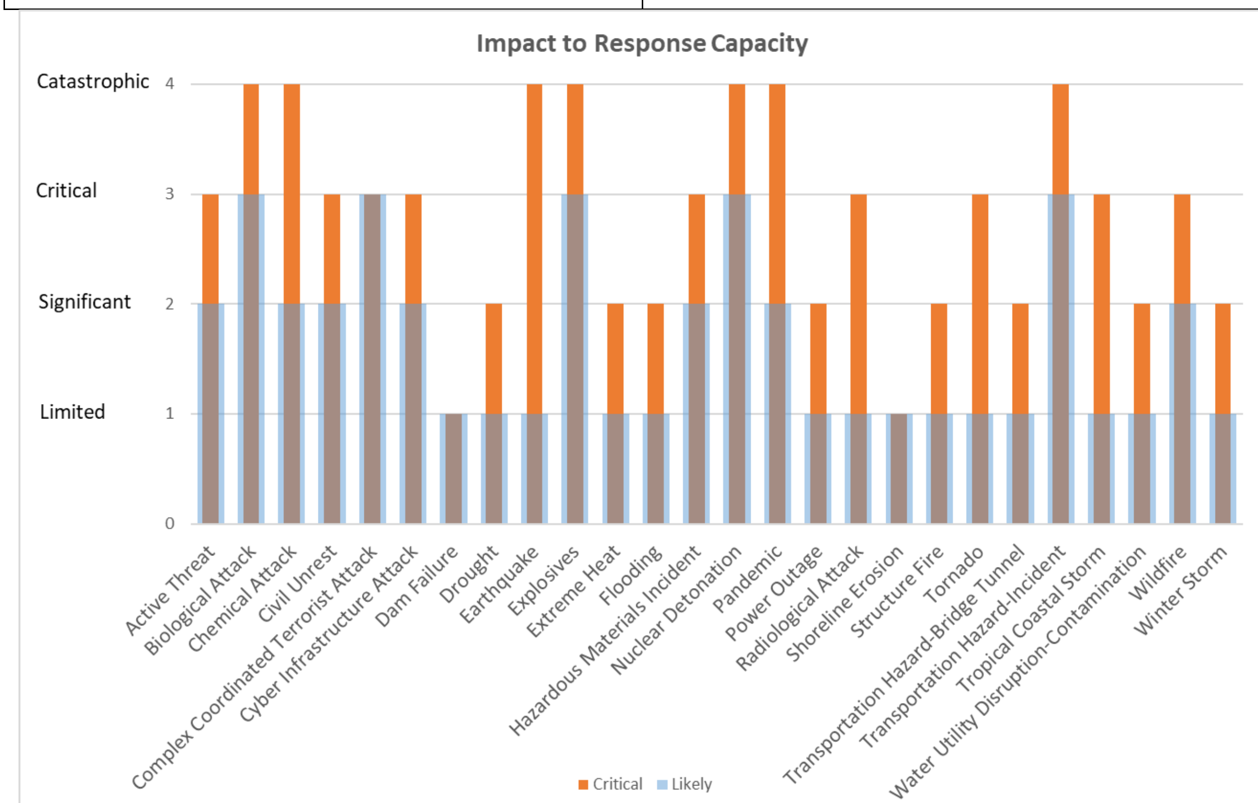
Impact	Critical Facilities
(1) Limited	Shutdown of critical facilities for less than 24 hours.
(2) Significant	Critical facilities are down for 1-7 days.
(3) Critical	Shutdown of critical facilities for 1-4 weeks.
(4) Catastrophic	Shutdown of critical facilities will be more than one month.



5.2.6.4 Impact to Response Capacity

The Impact to Response Capacity chart lists hazards and their associated impact to response systems including police, fire & rescue, health, hospitals, and emergency management.

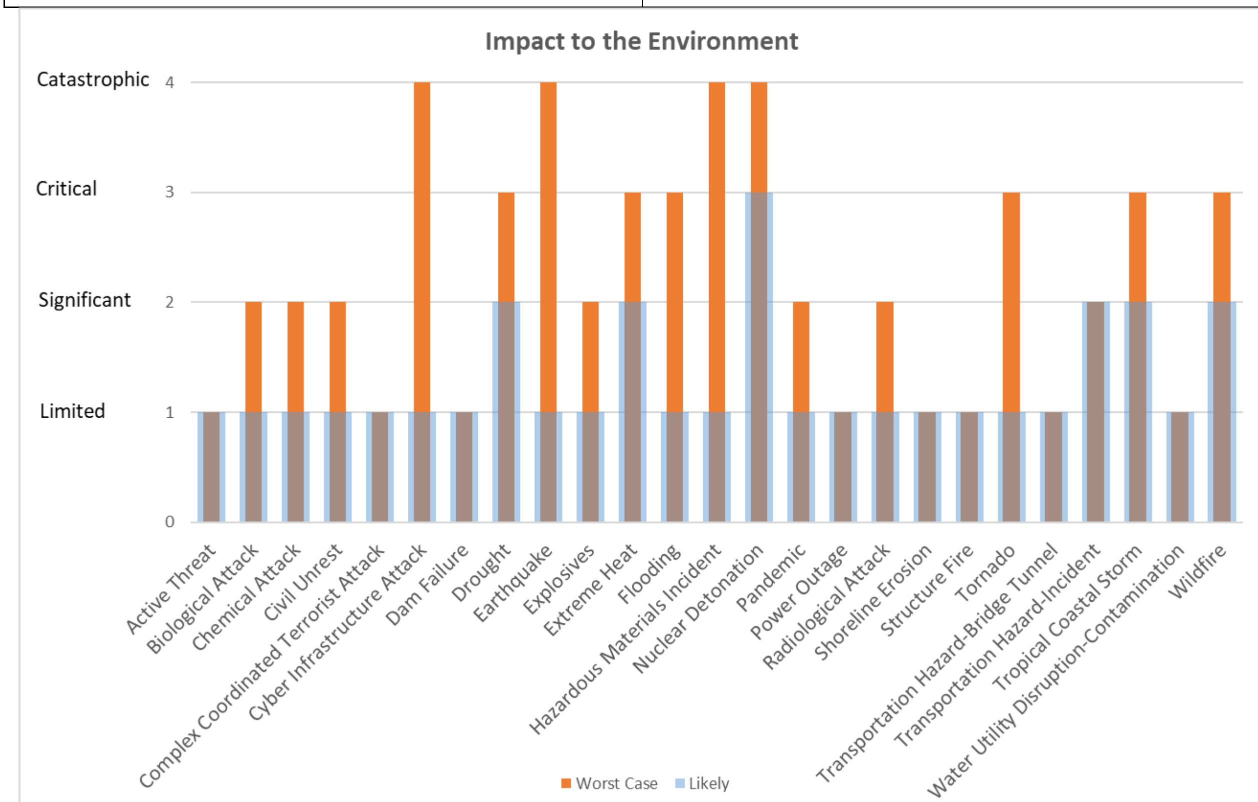
Impact	Response Capabilities
(1) Limited	Local resources are adequate to support the response.
(2) Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
(3) Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
(4) Catastrophic	Response capacity is overwhelmed and requires significant and long-lasting state and federal government support.



5.2.6.5 Impact to the Environment

The Impact to the Environment chart lists hazards and their associated impact to the air, land, water, and wildlife.

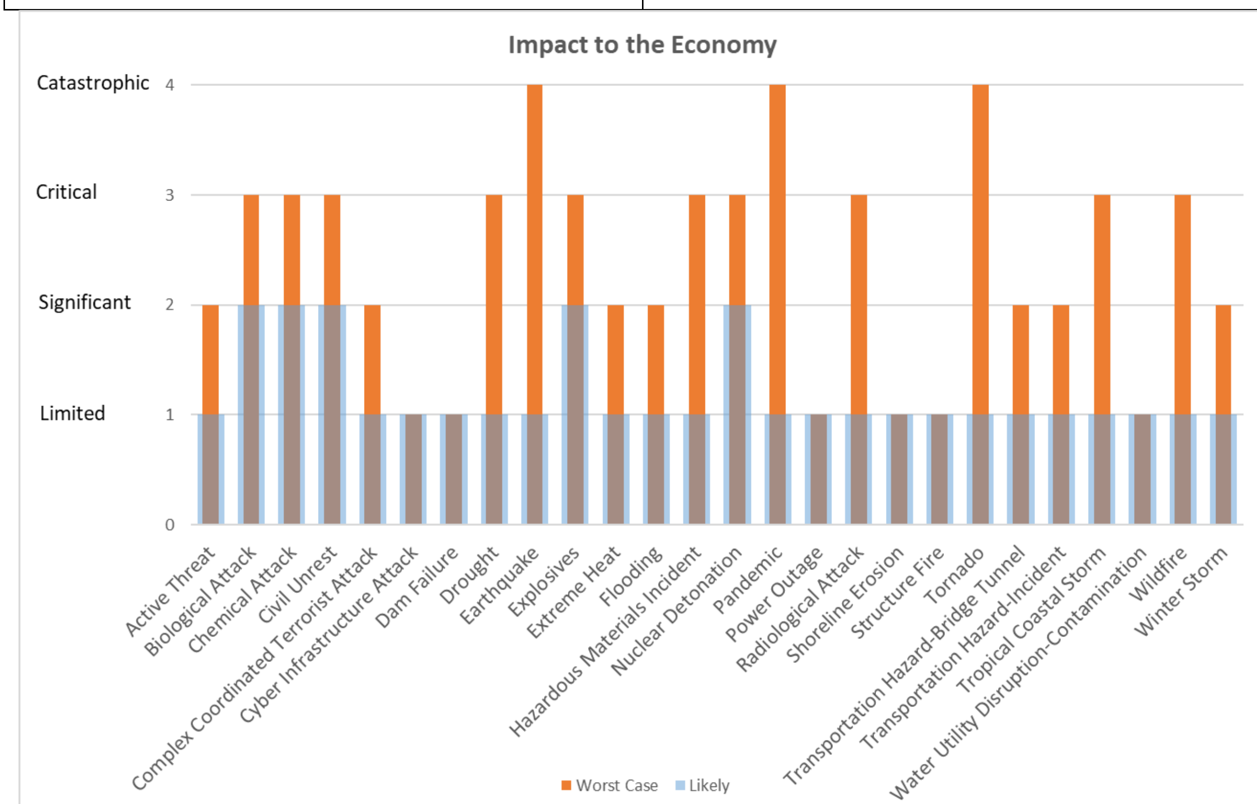
Impact	Environmental Impact
(1) Limited	Little to no environmental impact.
(2) Significant	Moderate environmental impact.
(3) Critical	Serious environmental impact.
(4) Catastrophic	Severe environmental impact.



5.2.6.6 Impact to the Economy

The Impact to the Economy chart lists hazards and their associated impact to the gross domestic product and economic functions in the region.

Impact	Economic Impact
(1) Limited	Little to no economic impact. Standard of living is only minimally disrupted.
(2) Significant	Moderate economic impact. Standard of living is moderately affected.
(3) Critical	Serious economic impact. Standard of living is seriously affected.
(4) Catastrophic	Severe economic impact. Standard of living is extremely impacted and may not be fully recoverable.



5.3 Trend Analysis

During the assessment, SMEs identified hazards where the future likelihood is expected to deviate from the historic likelihood. In all cases, the SMEs identified an increase in likelihood based on observations, global or local trends, or other conditions which are outlined in the Considerations section. The following hazards were identified as increasing in Likelihood.

- Biological Attack
- Chemical Attack
- Civil Unrest (Likely Scenario Only)
- Cyber Infrastructure Attack
- Dam Failure
- Flooding
- Nuclear Detonation
- Pandemic (Likely Scenario Only)
- Radiological Attack (Likely Scenario Only)
- Shoreline Erosion
- Tornado (Likely Scenario Only)
- Wildfire

6 Manmade Hazard Profiles

Active Threat

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

An Active Assailant hazard refers to an individual actively engaging in killing or attempting to kill people in a confined or populated area. Active Assailant hazards are typically characterized by the assailant's intent to kill with no pattern or method to their selection of victims.

Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Active Threat Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	2 infrequent	2 Infrequent	50%
Consequence	**Impact**	1.50 Limited-Significant	2.17 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
	Total Risk Score	1.85	2.12	

Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.

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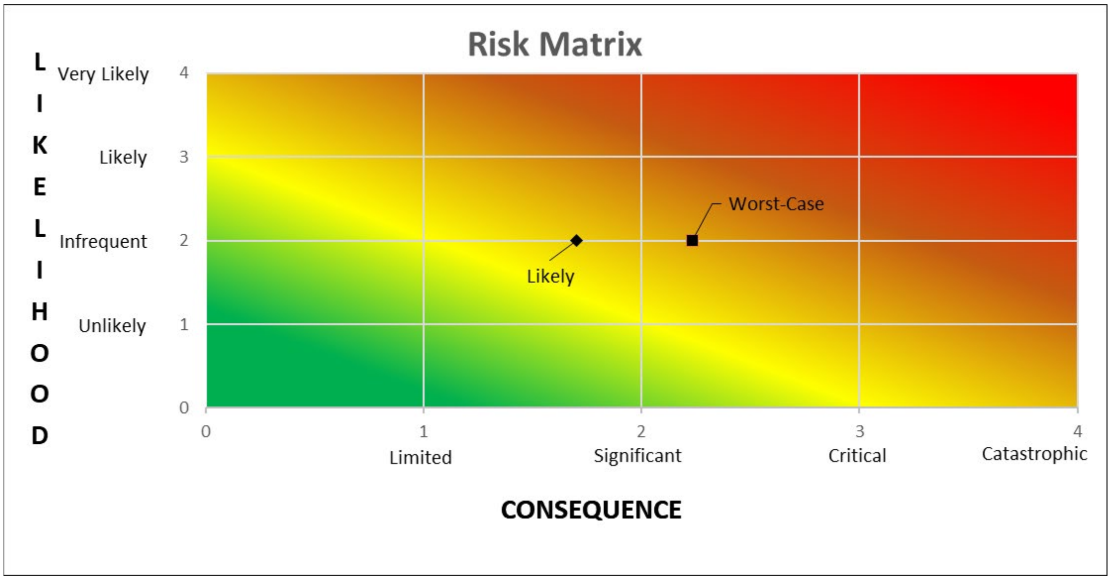

Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.

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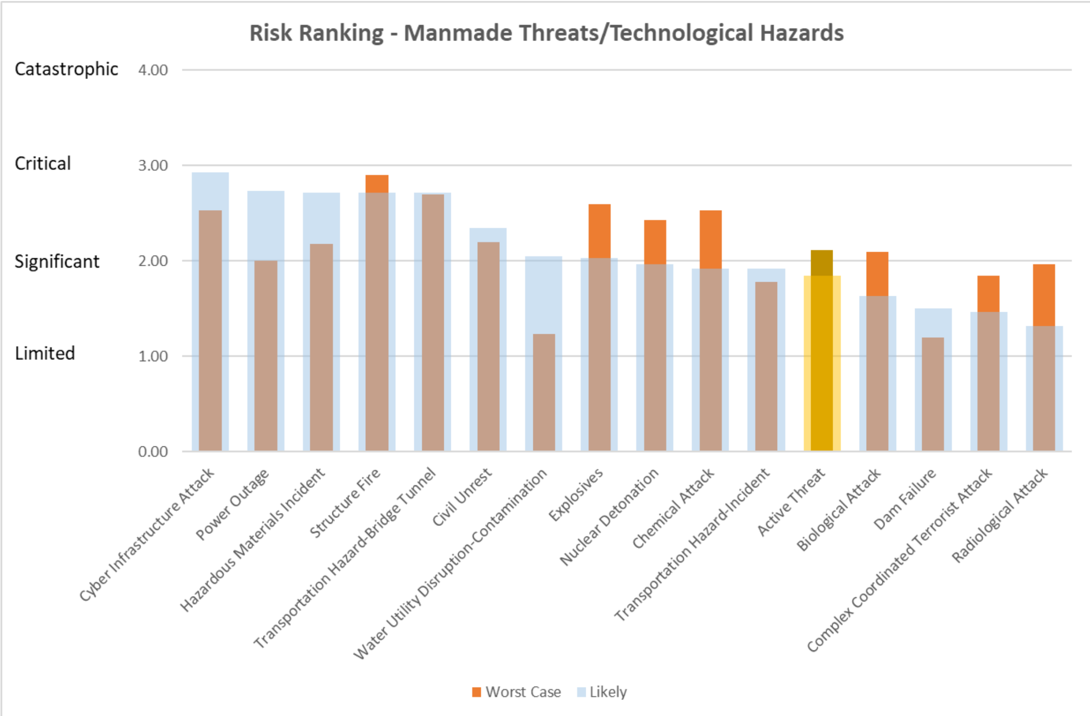

Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

An Active Shooter is an individual actively engaged in killing or attempting to kill people in a confined and populated area; in most cases, active shooters use firearms(s) and there is no pattern or method to their selection of victims. Active shooter situations are unpredictable and evolve quickly. There can also be more than one shooter involved in the same situation. Active shooter situations are often over within 10 to 15 minutes.[5]

The **likely incident** may consist of an individual active shoot that may be disgruntled with anti-government views who plans an attack to shoot officials working at a local government building following an interaction where he felt he had been treated unfairly or believes the government is corrupt. This may involve a trained marksman armed with several weapons who enters a facility and begins shooting each person he encounters and proceeds down the hallway to continue targeting individuals. This may involve shooting dozens of rounds within the first few minutes resulting in multiple injuries and/or deaths.

The **worst-case incident** can be described as an active threat involving one or more highly trained individuals that utilize improvised explosive devices (IEDs) and multiple firearms at a populated venue or facility. The threat may involve placement of multiple IEDs throughout the facility to include points of egress to maximize casualties. The assailant is well-stocked with ammunition to cause extensive casualties.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Hampton Roads Southside Sub-region is home to just over 1.1 million people. It consists of the City of Virginia Beach, City of Chesapeake, City of Norfolk, City of Portsmouth, and City of Suffolk. The area is home to a large US Navy presence and affiliated ship building and repair. Virginia Beach is the most populated city in Virginia at just over 450k permanent residents and roughly 19 million visitors per year. The City of Chesapeake is the second most populated at just under 250k and Norfolk is third with 244k. There are several fortune 500 companies in south Hampton Roads and numerous locations that employ thousands of workers. The south Hampton Roads area is home to the east coast Navy Seal teams, support special operations units, the Marine Corps FAST training unit, and has training venues for contractors that work security overseas for both private companies and non-military government agencies.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of Hazard

An online review revealed that at least three active shooter incidents have occurred in Virginia, to include two in the Southside Region. Due to ongoing political differences and social injustice issues amongst groups, this trend is likely to continue in the future.

A major issue with any instance of active threat is the inability to predict where and how the assailant will strike. Active threats can appear random in nature without any accurate indicators of intent. The motivations for active threat assailants also vary drastically and can be perceived as internal or external. The probable active threat scenario would revolve around the "typical" active threat instance of a single person attacking a group of uninvolved victims over a perceived injustice or threat. The recency of the attack in Virginia Beach demonstrates the proliferation of active assailant attacks in the local

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[5]https:www.fbi.gov/about/partnerships/office-of-partner-engagement/active-shooter-incidents-graphics (date access ed, 6/16/2020)
https://www.dhs.gov/xlibrary/assets/active_shooter_booklet.pdf (date accessed, 6/16/2020)
https://www2.indstate.edu/pubsafety/docs/active-shooter.pdf (date accessed, 6/16/2020)

area. The attacks that occurred in recent history including the following were considered because of similarities between the south Hampton Roads area/population/activities and the area where the attacks occurred:

- On 8/7/2016 a suspect killed 5 police officers and injured nine others during an attack in Dallas, TX
- On 10/7/2017 59 people were killed and more than 500 injured at an attack in Las Vegas, NV
- On 8/3/2019 a suspect opened fire in a Walmart in El Paso, TX killing 20 and injuring 26.
- On 8/4/2019 a suspect opened fire in Dayton, OH where 9 people were killed and 27 wounded.
- On 5/30/2019 10 people were shot at a block party in the Western Branch are of Chesapeake. Multiple assailants.
- On 3/16/2021 a suspect killed 8 people in 3 separate locations in Atlanta. Apparently motivated by sex addiction and internal religious conflict.
- On 3/22/2021 a suspect killed 8 people at a grocery store in Boulder, CO including the first arriving officer.

Notable Incidents in the Southside Region

On April 16, 2007, a mass shooting occurred on the campus of the Virginia Polytechnic Institute and State University, in Blacksburg, VA. The shooter killed 32 and wounded 17 others before taking his own life. It is the deadliest school shooting in U.S. history by a lone gunman.

On May 31, 2019, a Virginia Beach city employee killed 12 people in and around the Virginia Beach municipal complex, public works building. Unknown motivation.

On February 8, 2021, a man shot a security guard at the Norfolk Social Security Office while packing 600 rounds of ammunition, three sandwiches and three beers in a backpack. The suspect was shot by the security guard and taken into custody. Motivated by perceived injustice from the SSA.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

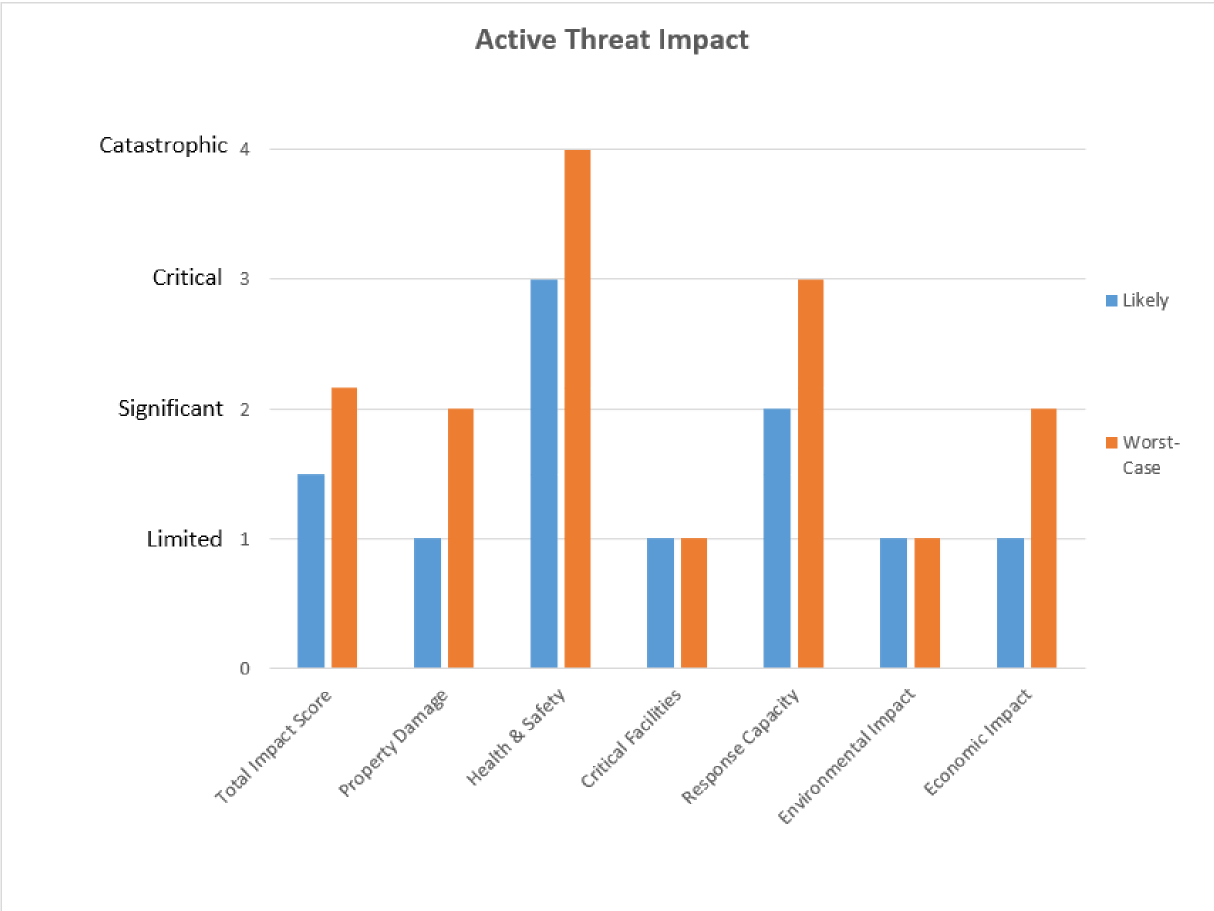
Future Likelihood of an Active Threat Attack Hazard		
	Likely	**Worst-Case**
Historical Average (time period)	3 events over 20 years (2001-2021)	0.26 events per year in VA (2000-2015)
Historical Annual Probability	15% chance of annual occurence	13% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	1-10% chance of annual occurence	1-10% chance of annual occurrence
Future Likelihood Score	2 - Infrequent: 1-10% chance of annual occurence	2 - Infrequent: 1-10% chance of annual occurrence

Considerations: Not likely to deviate from historical likelihood.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living and public confidence in response capability.

Consequence Analysis Overview



Active Threat Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Short - Less than six hours	Short - Less than six hours

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Active Threat Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.50 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Active Threat Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant-Critical	Total Impact Score: 2.17 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Biological Attack

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A Biological Attack is an intentional release of viruses, bacteria, or other germs (agents) used to cause illness or death in people, animals, or plants.[1] Biological agents can be introduced and spread through a population by air, through direct contact, water, or food.

Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

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Biologic Attack Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	1 Unlikely	1 Unlikely	50%
Consequence	**Impact**	1.83 Limited-Significant	3.00 Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	4 Very Long	4 Very Long	5%
	Total Risk Score	1.63	2.10	

Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.

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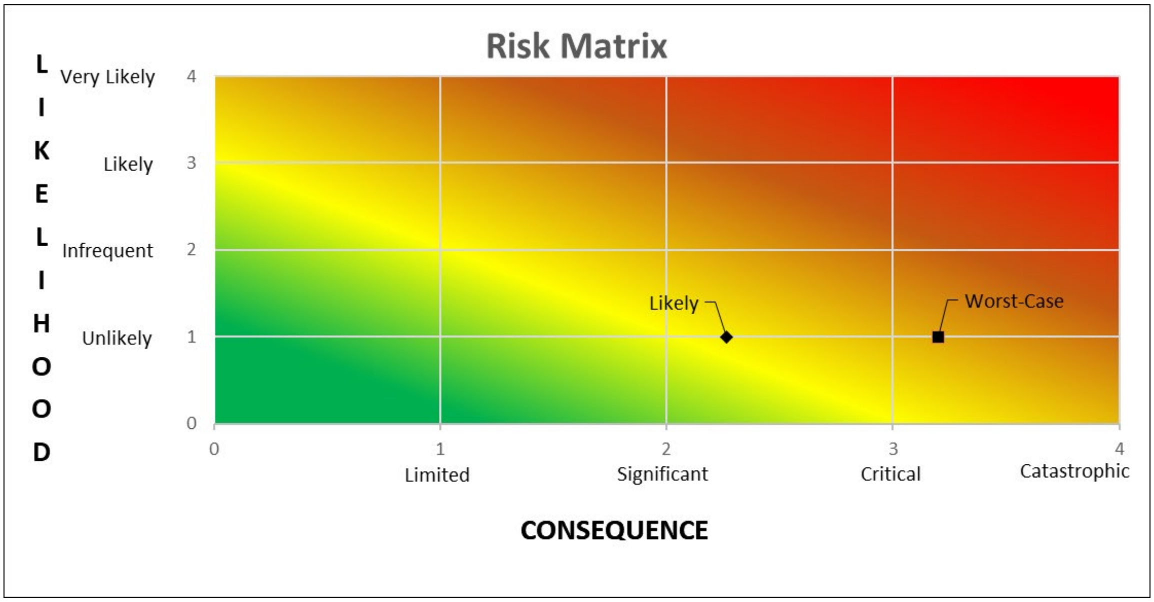

Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.

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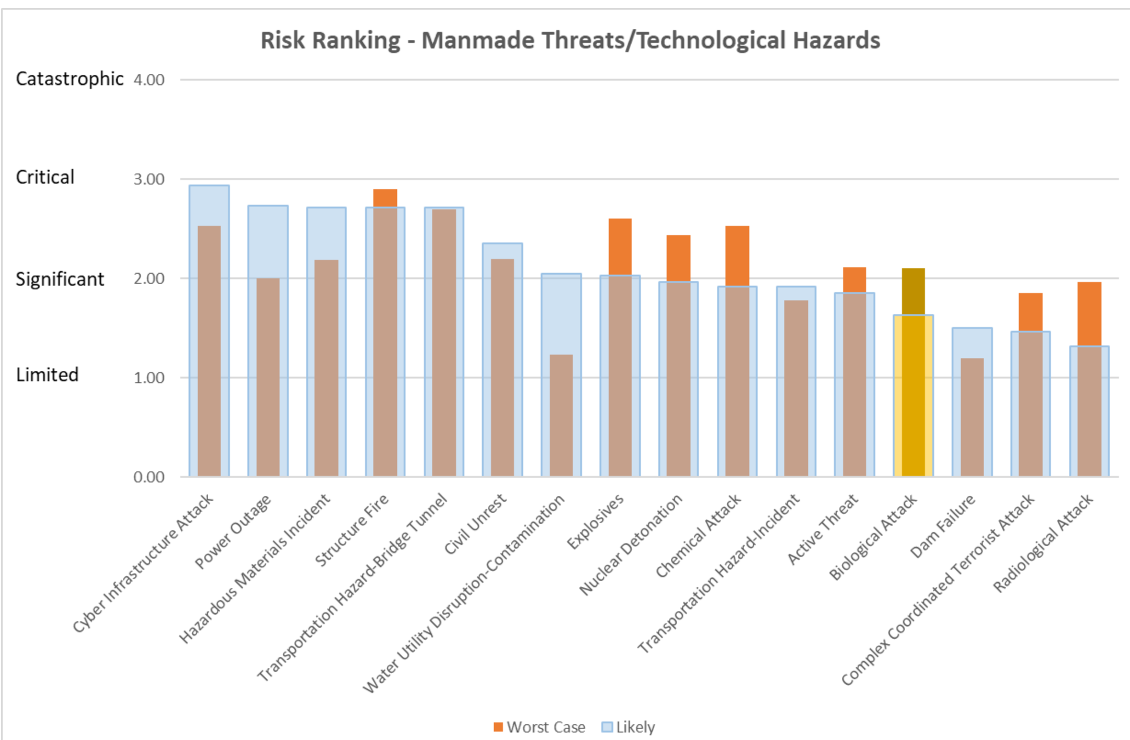


Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A biological attack is the intentional release of a pathogen (disease causing agent) or biotoxin (poisonous substance produced by a living organism) against humans, plants, or animals. An attack against people could be used to cause illness, death, fear, societal disruption, and economic damage. An attack on agricultural plants and animals would primarily cause economic damage, loss of confidence in the food supply, and possible loss of life. It is useful to distinguish between two kinds of biological agents:

- Transmissible agents that spread from person to person (e.g., smallpox, Ebola) or animal to animal (e.g., foot and mouth disease).
- Agents that may cause adverse effects in exposed individuals but that do not make those individuals contagious to others (e.g., anthrax, botulinum toxin).

Unlike a chemical or nuclear attack, a biological attack may go undetected for hours, days, or potentially weeks (depending on the agent) until people, animals, or plants show symptoms of disease. If there are no immediate signs of the attack as with the anthrax letters, a biological attack will probably first be detected by local health care workers observing a pattern of unusual illness or by early warning monitoring systems that detect airborne pathogens. Evidence of an attack may appear in animals before humans.

There may be uncertainties about crucial facts such as the exact location or extent of the initial release, the type of biological agent used, and likelihood of additional releases. Laboratory scientists will work quickly to identify the specific agent. Epidemiologists will attempt to trace the path of infections back toward a single person, vector (insect or animal), vehicle (food or water), or other point of origin. Attribution of a biological attack is typically much more difficult than attribution of a conventional terrorist attack.[6]

The **likely incident** can be described as a biological attack on a mass gathering at the Oceanfront or similar venue. The Virginia Beach Oceanfront is a host to numerous gatherings each year with crowds in excess of 50,000 people. The close proximity of people to each other would make this a vulnerable site for a biological attack. The oceanfront also has limited means of ingress and egress. If the main routes in and out of the oceanfront were blocked, this would increase the efficacy of a biological attack. Historically, biological attacks have not caused a large number of deaths but instead caused mass panic and fear. This panic and fear from a biological attack at the Virginia Beach oceanfront would have devastating effects on the region.

The **worst-case incident** can be described as deployment of a highly infectious, transmissible disease with severe effects and long incubation period such as Ebola virus through an abundance of vectors or infected persons. Containment of infected persons would be very challenging given the long incubation period and would require strict lockdowns until it could be eradicated. The medical resources required to treat infected persons are limited to two locations in the U.S. and would exceed the medical capabilities of these facilities. The recovery period would be long, intensive and require highly specialized resources to collect and contain contaminated articles and decontaminate property. The Dallas Ebola cluster in 2014 illustrated the expansive resources required to contain the spread from one patient infected with Ebola virus who presented at an emergency department.

[6] https://www.dhs.gov/publication/biological-attack-fact-sheet# (date accessed, 6/16/2020)
https://www.dhs.gov/sites/default/files/publications/prep_biological_fact_sheet.pdf (date accessed, 6/16/2020)

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Hampton Roads Southside Sub-region is susceptible to many manmade and natural disasters. The region has a large and diverse population (1.1 million people). Our many waterways, military installations, commercial ports, and numerous soft targets could present themselves as opportunities to anyone wishing harm with the capability of utilizing a "Bioweapon."

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

While not a common occurrence in recent history, the Hampton roads area is a likely and susceptible target to a biological attack as experienced in the past.

Notable Incidents in the Southside Region

Notable events regionally include a Virginia Beach woman who was manufacturing ricin and delivering to her husband through food sources. The man ultimately died from the poisoning and the woman was arrested. The local Hazmat team was deployed in coordination with the police for investigation and evidence collection.

Another notable event would be the numerous "white powder" calls the region received after the 9/11 anthrax attacks. The 2001 anthrax attacks, also known as Amerithrax from its FBI case name, occurred in the United States over the course of several weeks beginning on September 18, 2001, one week after the September 11 terrorist attacks. Most of these calls were negative for Anthrax, but they put a tremendous strain on the local jurisdictions and their Hazmat Teams.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

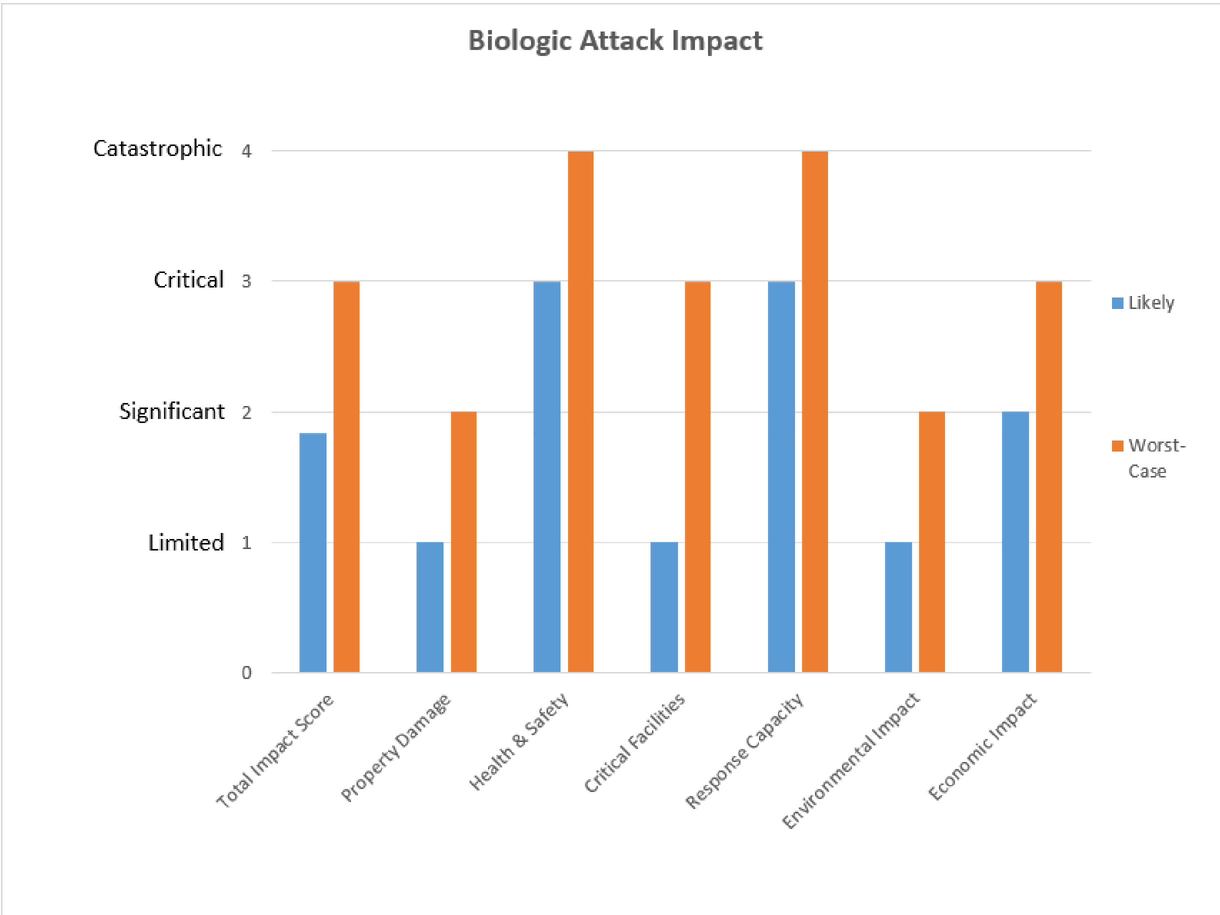
Future Likelihood of an Biologic Attack Hazard		
	Likely	Worst-Case
Historical Average (time period)	Not Calculated	Not Calculated
Historical Annual Probability	Unknown	Unknown
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	Yes
Future Annual Probability	1-10% chance of annual occurance	1-10% chance of annual occurrence
Future Likelihood Score	1 - Unlikely: No documented occurence. Less than 1% chance of annual occurrence	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

Considerations: We estimate that the future likelihood for a biological attack in the region to increase. This is due to the current geo-political climate, the proximity of high-profile naval bases and the large population of DoD and contracting personnel living in the area. The information to successfully plan and execute a biological attack on a hard or soft target is readily available on the internet. Virginia Beach and Norfolk host numerous large gatherings at the ocean front and downtown waterside/arenas drawing crowds of over 50,000 people. This would be a prime target for a biological attack. Virginia Beach and Chesapeake operate several water treatment plants; these may be susceptible to a biological attack.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Biologic Attack Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Very Long - More than one week	Very Long - More than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Biologic Attack Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Limited-Significant	Total Impact Score: 1.83 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Biologic Attack Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Critical	Shut down of critical facilities 1-4 weeks.
Response Capacity	Catastrophic	Response capacity is overwhelmed and requires significant and long lasting state and federal government support.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Critical	Serious economic impact. Standard of living is seriously affected.
Total Impact	Critical	Total Impact Score: 3.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the Southside Region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Chemical Attack

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A Chemical Attack hazard results from the intentional release of potentially harmful chemicals into the environment. Agents used in Chemical Attacks include poisonous vapors, aerosols, liquids, and solids that have toxic effects.

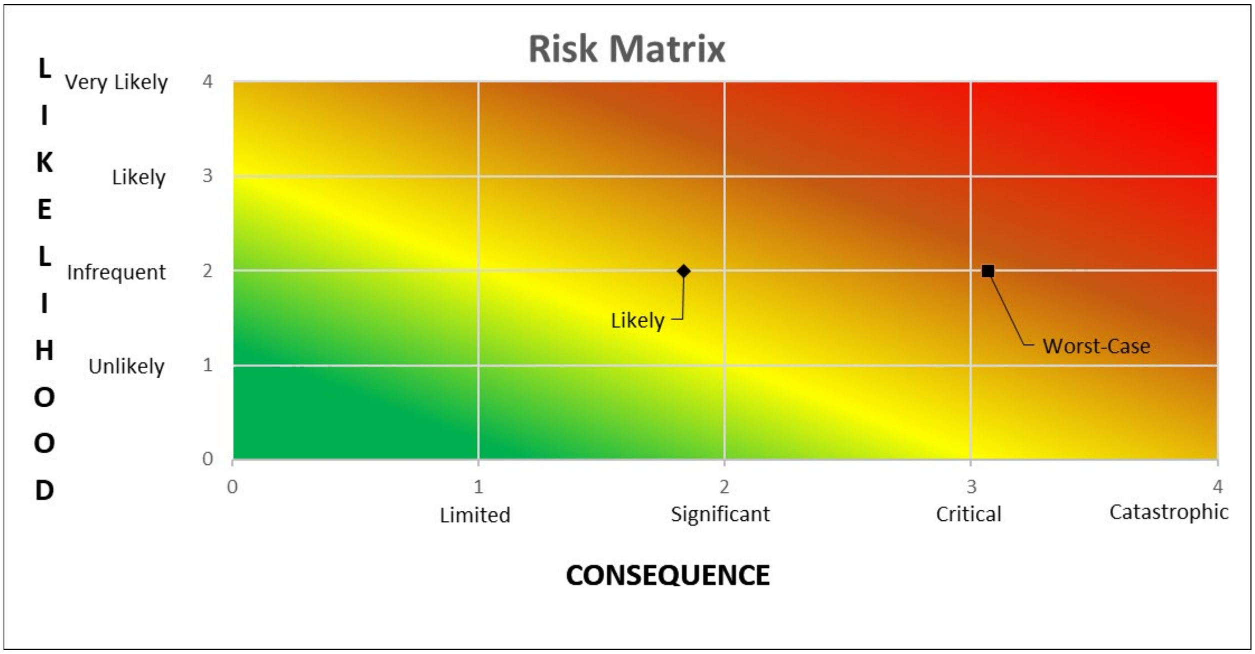
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Chemical Attack Risk Profile					
Likelihood	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
	Likelihood	2 Infrequent	2 Infrequent	50%
Consequence	Impact	1.67 Limited-Significant	2.83 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	4 Very Long	5%
	Total Risk Score	1.92	2.53	

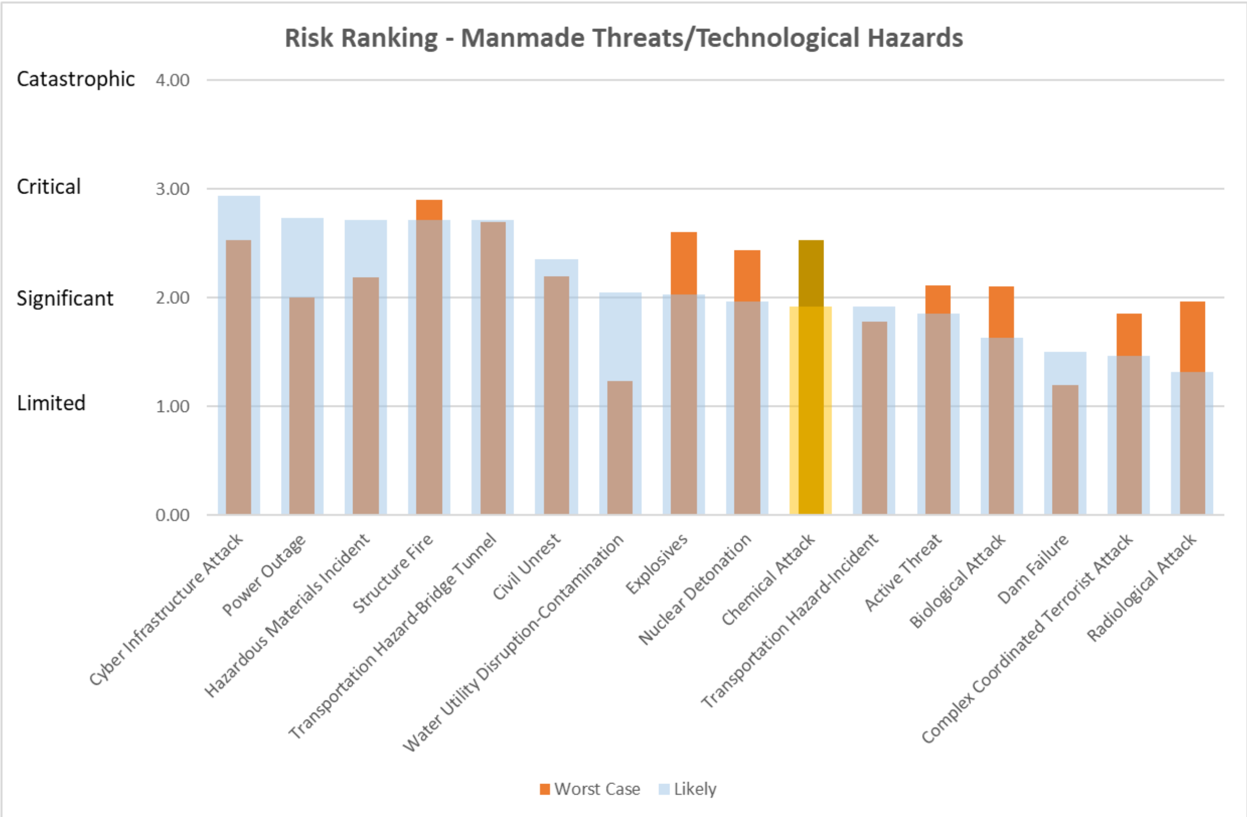
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Chemical agents are poisonous vapors, aerosols, liquids, and solids that have toxic effects on people, animals, or plants. They can be released by missiles, bombs or sprayed from aircraft, boats, and vehicles. Some chemical agents may be odorless and tasteless and can have an immediate effect (a few seconds to a few minutes) or a delayed effect (2 to 48 hours). While potentially lethal, chemical agents are difficult to deliver in lethal concentrations unless targeted to small groups and defined locations. Outdoors, some agents dissipate rapidly. Crude chemical agents can be produced with basic knowledge of chemistry; however, stable, highly toxic chemical agents can be more difficult to produce. A chemical attack could come without warning. Signs of a chemical release include people having difficulty breathing; experiencing eye irritation; losing coordination; becoming nauseated; or having a burning sensation in the nose, throat, and lungs. Also, the presence of many dead insects or birds may indicate a chemical agent release. Recent, targeted assassinations in Russia and the UK with Novichok agents demonstrate the effective employment of highly toxic, difficult to detect agents that could pose a risk to numerous people exposed to the agent.[7]

The **likely incident** would involve a first-generation chemical agent such as chlorine, phosgene, or hydrogen cyanide released at a mass gathering (e.g., at the Oceanfront, or a concert venue). The Virginia Beach Oceanfront is a host to numerous gatherings annually with crowds more than 50,000 people. The close proximity of people to each other would make this an easy location for a chemical attack. The oceanfront also has limited means of ingress and egress. If the main routes in and out of the oceanfront were blocked, this would only increase the efficacy of a chemical attack.

The **worst-case incident** can be described as employment of a Novichok agent on surfaces that receive high-traffic contact such as doors, airport check-in kiosks, and escalator handles at convention centers, hotels, airports, or concert venues. Due to their delayed onset period and oily physical composition, agents can go undetected for several days while it is spread to other surfaces and absorbed through the skin. The decontamination process in the UK after the attack on the Skripals in 2018 lasted over a year and led to the disposal of helicopters, dozens of cars, and other property generating over 540 cubic meters of waste that required incineration.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Hampton Roads Southside Sub-region is susceptible to many manmade and natural disasters. The region has a large and diverse population (1.1 million people). Our many waterways, military installations, commercial ports, and numerous soft targets could present themselves as opportunities to anyone wishing harm with the capability of utilizing a "Chemical Weapon."

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

While not a common occurrence regionally, the Hampton Roads area is a likely and susceptible target for a chemical attack.

[7] https://www.fema.gov/media-library-data/20130726-1621-20490-6631/chemicalfactsheet_final.pdf (date accessed, 6/16/2020)

Notable Incidents in the Southside Region

Notable Events regionally include an individual who made cyanide and injected it into his wife. The wife eventually died from the cyanide exposure. A follow-up investigation of the individual revealed a large amount of homemade explosives in his house.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

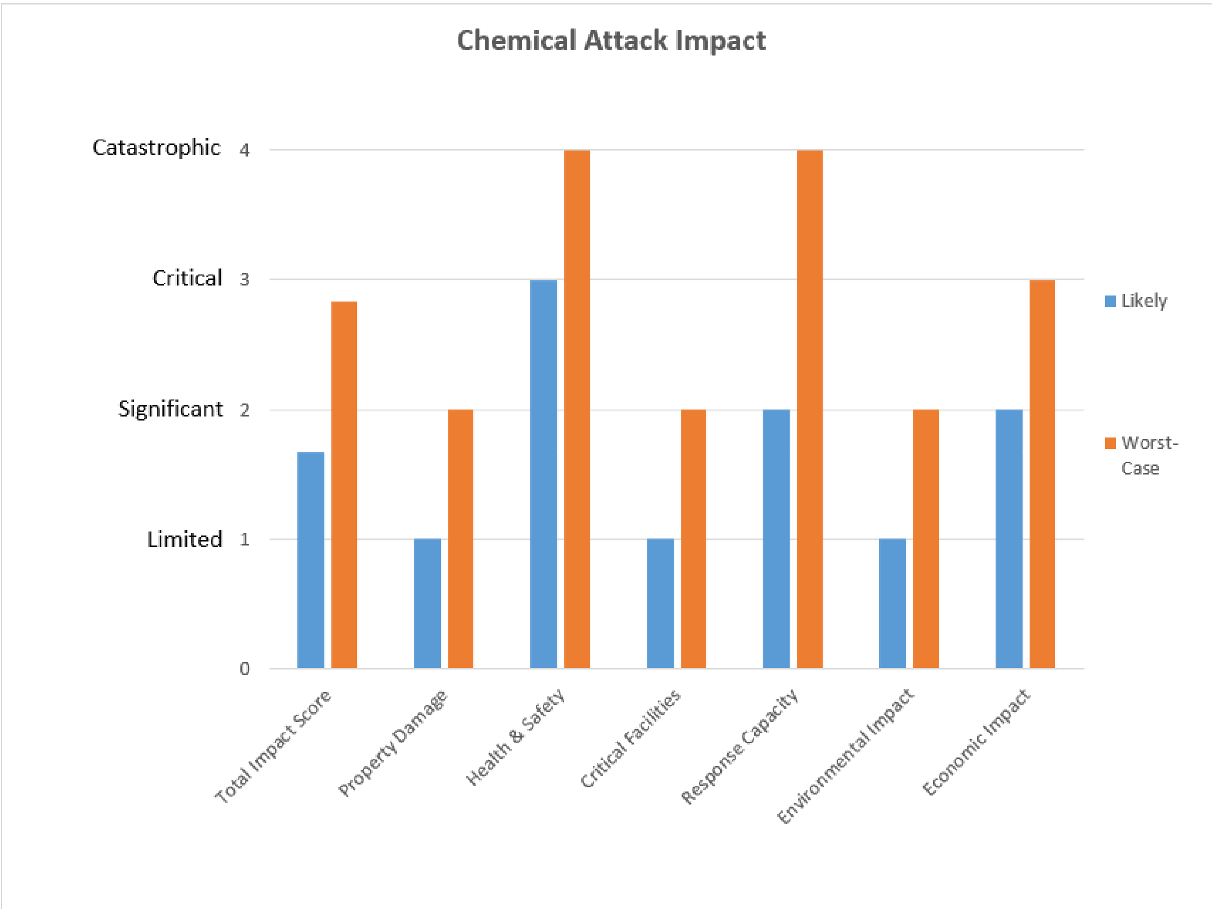
Future Likelihood of an Chemical Attack Hazard		
	Likely	**Worst-Case**
Historical Average (time period)	Few global incidents	Few global incidents
Historical Annual Probability	<1% per year	<1% per year
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	Yes
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	2 - Infrequent: 1-10% chance of annual occurrence	2 - Infrequent: 1-10% chance of annual occurrence

Considerations: Planners forecast the future risk profile for a chemical attack in the region to increase. This is due to the current geo-political climate, the proximity of high-profile naval bases and the large population of DOD and contracting personnel living in the area. The information to successfully plan and execute a chemical attack on a hard or soft target is readily available on the internet and the materials can also be easily obtained online. Virginia Beach is also a host to numerous large gatherings at the ocean front, drawing crowds of over 50,000 people making it a prime target for a chemical attack.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Chemical Attack Warning Time & Duration		
	Likely	Worst-Case
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Short - Less than six hours	Very Long - More than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Chemical Attack Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Limited-Significant	Total Impact Score: 1.67 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Chemical Attack Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response
Critical Facilities	Significant	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Catastrophic	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Significant	Little to no environmental impact.
Economic Impact	Critical	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant-Critical	Total Impact Score: 2.83 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Civil Unrest

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

Civil Unrest is often the result of ideological conflict and may include protests, riots, demonstrations, civil disobedience, and other forms of obstruction. Although many expressions of Civil Unrest are safe and legal, a Civil Unrest hazard occurs when the level of public disorder becomes a threat to health, safety, and property.

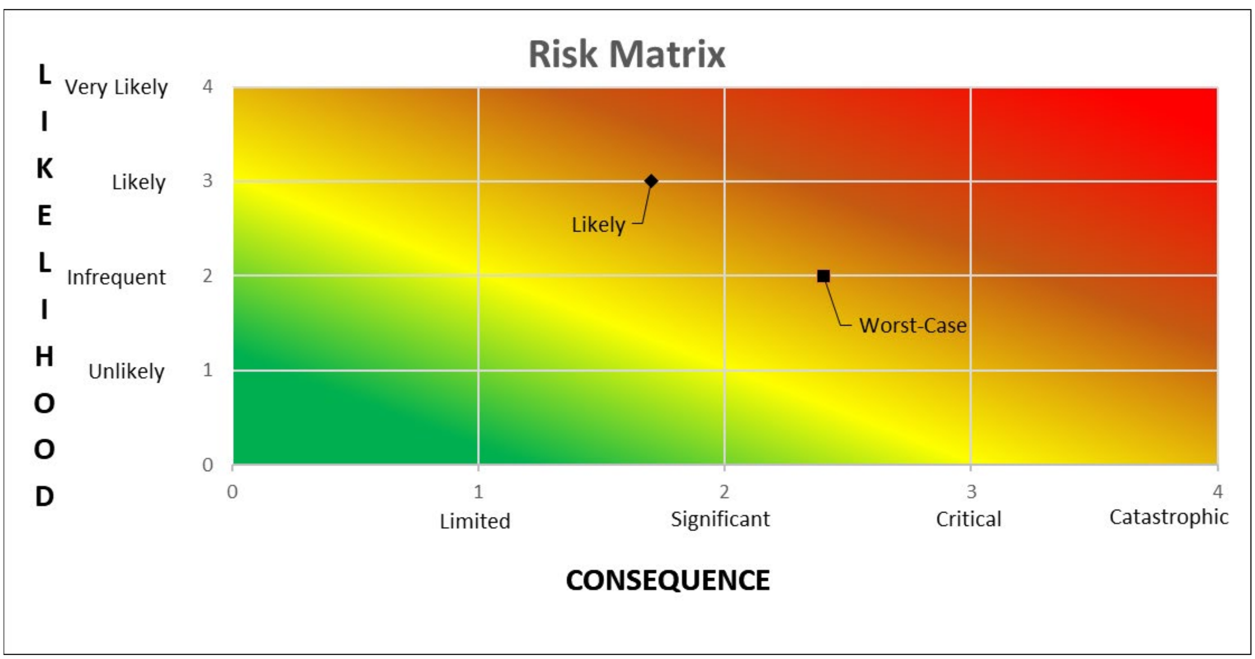
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Civil Unrest Risk Profile				
Likelihood	**Risk Assessment Category**	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
	Likelihood	3 Likely	2 Infrequent	50%
Consequence	**Impact**	1.50 Limited-Significant	2.50 Significant-Critical	40%
	Warning Time	4 Short	1 Very Long	5%
	Duration	1 Short	3 Long	5%
	Total Risk Score	2.35	2.20	

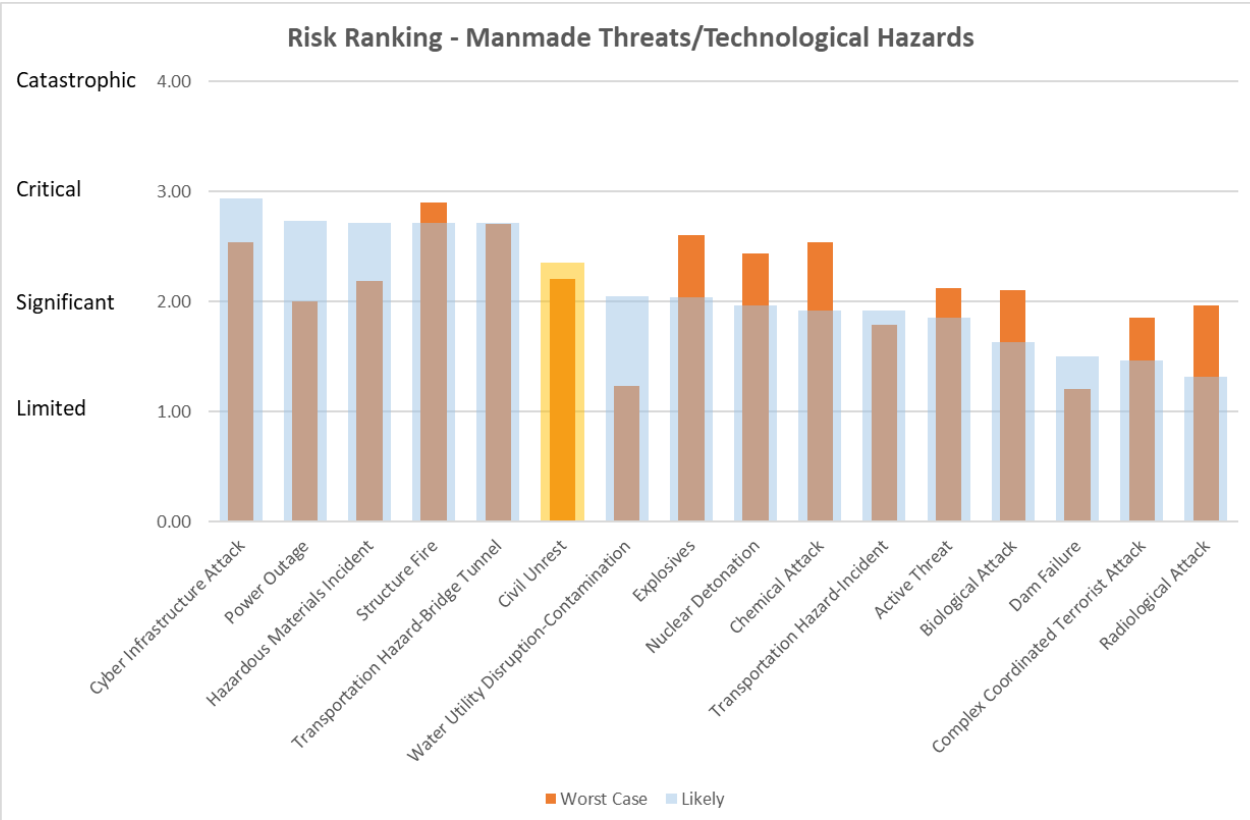
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Civil disturbance means acts of violence and disorder prejudicial to the public law and order. It includes acts such as riots, acts of violence, insurrections, unlawful obstructions or assemblages, or other disorders prejudicial to public law and order. It also includes all domestic conditions requiring or likely to require the use of federal armed forces.

Civil disturbance is a broad term that is typically used by law enforcement to describe one or more forms of disturbance caused by a group of people. Civil disturbance is typically a symptom of, and a form of protest against major socio-political problems. Typically, the severity of the action coincides with the level of public outrage. In addition to a form of protest against major socio-political problems, civil disturbances can also arise out of union protest, institutional population uprising, or from large celebrations that become disorderly. Civil disturbances can take the form of small gatherings or large groups blocking or impeding access to a building or disrupting normal activities by generating noise and intimidating people. Demonstrations can range from a peaceful sit-in to a full-scale riot, in which a mob burns or destroys property and terrorizes individuals. Even in its more passive forms, a group that blocks roadways, sidewalks, or buildings interferes with public order. Often protests meant to be a peaceful demonstration can escalate into general chaos. There are two types of large gatherings typically associated with civil disturbances: a crowd and a mob. A crowd may be defined as a casual, temporary collection of people without a strong, cohesive relationship. Crowds can be classified into the following four categories (Blumer 1946):

• **Casual Crowd:** A casual crowd is a group of people who happen to be in the same place at the same time. Violent conduct does not occur.

• **Cohesive Crowd:** A cohesive crowd consists of members who are involved in some type of unified behavior. Members of this group are involved in some type of common activity, such as worshipping, dancing, or watching a sporting event. Members of these crowds may have intense internal discipline and require substantial provocation to arouse to action.

• **Expressive Crowd:** An expressive crowd is one held together by a common commitment or purpose. They may not be formally organized and are assembled as an expression of common sentiment or frustration. Members wish to be seen as a formidable influence. One of the best examples of this type is a group assembled to protest.

• **Aggressive Crowd:** An aggressive crowd is composed of individuals who have assembled for a specific purpose. This crowd often has leaders who attempt to arouse the members or motivate them to action. Members are noisy and threatening and will taunt authorities. They may be more impulsive, emotional, and require only minimal stimulation to arouse violence. Examples of this type of crowd could include demonstrators and strikers, though not all demonstrators and strikers are aggressive.

Over the last two decades, civil unrest has been driven by the following characteristics: (1) economic and social injustice; (2) sports and event related riots; (3) politically motivated civil unrest; (4) reaction to police actions.[8]

The **likely incident** may unfold as follows: A group of organizers begins to gather support over social media directed at their demographic in the area. They elect to hold a march for their cause starting at a popular tourist attraction in one of the cities on a Saturday evening during the summer. The convenience of the location and availability of local supporters drives thousands of interested supporters to the official social media pages. There is a concert nearby and minor league baseball game scheduled for the same night nearby. The protest begins promptly at 8pm where the protesters march in the middle of a major roadway from the popular downtown tourist attraction towards the baseball stadium. When police begin to confront the crowd, several of the protesters begin to throw items at them. The scores of protesters then flood into outdoor restaurants, tourist sites, the surrounding hotels, and businesses. Some of the protesters begin to vandalize the businesses while hundreds of people are caught in the chaos. The concert is cancelled immediately. Thousands of dollars in damage to the surrounding area is done prior to the unrest being contained. Local Police request assistance from the surrounding jurisdictions which take up to an hour to respond. The streets are cleared and calm by 11pm.

The **worst-case incident** may be described as follows: A police-involved shooting occurred on a Friday night during the summer at a bar in the resort area and immediate controversy hits local social media. The rhetoric revolves around the person shot by police being unarmed at the time. There is a large music festival happening that same weekend in which 250k attendees should be in the south Hampton Roads area. Hotels are booked throughout the area and transportation plans include dedicated remote parking and shuttle areas in Virginia Beach, Norfolk, and Chesapeake. The person shot by the police was there for the concert and protest organizers begin a heavy presence on social media. Smaller issues begin to develop on Friday night after the last concert and continue through the remote parking areas. All three cities see small amounts of vandalism and disorderly persons issues on Friday. There are several protests scheduled for Saturday in the resort area that occur without significant issue. On Saturday night, a national star performing on stage motivates the crowd to demonstrate aggressively for their cause. The concert venue immediately erupts in chaos. The crowd moves from the venue into the hotels and bars nearby. The violence and vandalism spreads quickly and overwhelms the police presence in the area. Due to the issue encountered the night before, localities are hesitant to send a full complement of mutual aid to ensure their cities are protected as well. There are several police vehicles set on fire and numerous businesses are looted. Restaurants and businesses quickly try to close and shelter in place causing small skirmishes throughout the resort area.

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[8] https://definitions.uslegal.com/c/civil-disturbance/ (date accessed, 6/16/2020)
https://training.fema.gov/programs/emischool/el361toolkit/glossary.htm (date accessed, 6/16/2020)
http://www.ready.nj.gov/programs/pdf/mitigation2014b/mit2014_section5-14.pdf (date accessed, 6/16/2020)

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Southside Sub-region of Hampton Roads area is home to just over 1.1 million people. It consists of the City of Virginia Beach, City of Chesapeake, City of Norfolk, City of Portsmouth, and City of Suffolk. The area is home to a large US Navy presence and affiliated ship building and repair. Virginia Beach is the most populated city in Virginia at just over 450k permanent residents and roughly 19 million visitors per year. The City of Chesapeake is the second most populated at just under 250k and Norfolk is third with 244k. There is little distinction between the geographical boundaries for the cities and many events are targeted for the region. The center focus for many events in Virginia Beach is the area adjacent to the Atlantic Ocean known as the Ocean Front. This is predominantly a resort area featuring hotels and businesses that support tourism. Large scale events in Norfolk generally take place near the traditional downtown area that is adjacent to the Elizabeth River which features a large park, hotels, a minor league baseball stadium, and other businesses that support tourism. Chesapeake events are typically centered by the largest city park in the Greenbrier area. Greenbrier is the economic hub for Chesapeake featuring the majority of the hotels, restaurants, and commercial space.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Since civil unrest activity is not significantly associated with the Southside of Hampton Roads Region, but rather influenced by national events, the occurrence of the hazard will be evaluated based on national statistics instead of limited, local statistics for the likelihood of occurrence. Between 2000-2009, there were 15 noteworthy incidents of civil disturbance. Between 2010-2019, there were 33 noteworthy incidents of civil disturbance throughout the U.S. Following the death of George Floyd on May 26, 2020, protests and riots spread to 140 cities including the Southside of Hampton Roads. The Insurance Information Institute rates 2020 as the costliest year for civil disorder in U.S. history with losses topping $1 billion across 20 states with significant losses. The second costliest U.S. civil disorder occurred in 1992 in Los Angeles, CA after a jury acquitted LAPD officers for using excessive force in the arrest and beating of Rodney King.

Notable Incidents in the Southside Region

The Southside region of Hampton Roads experienced some incidences of civil unrest in 2020. On 5/31/2020 the Black Lives Matter-757 group organized a protest at the Virginia Beach Oceanfront in response to the death of George Floyd. Hundreds of people began the march peacefully at the south end of the resort area. Confrontation began with law enforcement and many of the protesters turned to vandalism. The night ended with dozens of businesses damaged and items stolen. The City of Virginia Beach enacted mutual aid in which numerous agencies responded to assist in quelling the unrest including Virginia State Police and Chesapeake Police. Similar protests were held in Portsmouth and Norfolk that same weekend. The Norfolk protest resulted in damage to a confederate monument by an unruly crowd. The Portsmouth protest that occurred on 6/10/2020 became violent. Protesters pulled down a large confederate monument that seriously injured one of the attendees. Another protest in Portsmouth had large crowds shut down the interstate that runs from Portsmouth, through Norfolk, and into Virginia Beach. All the protests during that time began as expressive crowds and ended with aggressive crowds.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of Civil Unrest		
	Likely	**Worst-Case**
Historical Average (time period)	1 event every 5 years (2000-2020)	1 event every 50 years
Historical Annual Probability	20% annual probability	2% annual probability
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	No
Future Annual Probability	21-30% chance of annual occurence	1-10% chance of annual occurrence
Future Likelihood Score	3 - Likely: 11-30% chance of annual occurrence	2 - Infrequent: 1-10% chance of annual occurrence

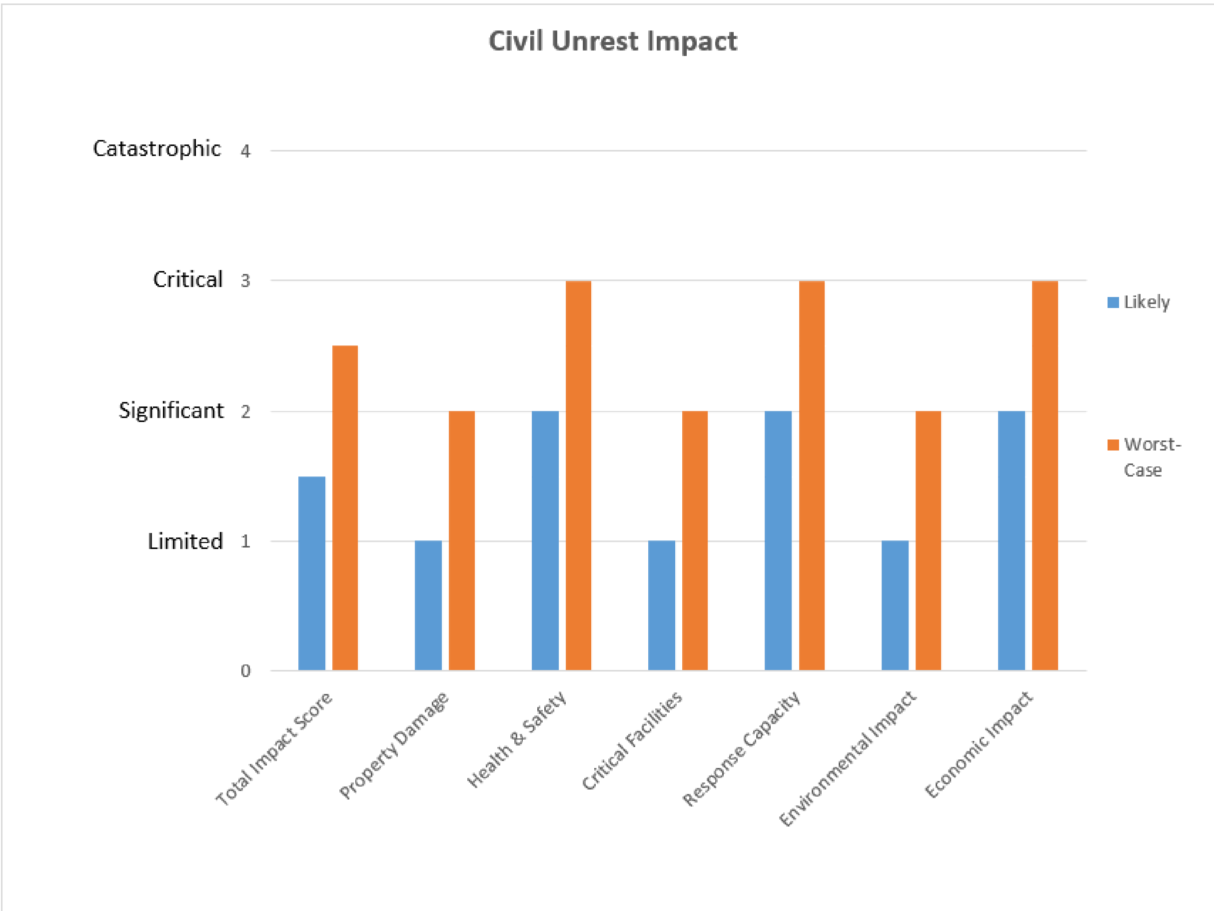
Considerations: Recent history has demonstrated the likelihood of civil unrest, even for events that did not originate in the local area. The protests in May of 2020 that ultimately led to civil unrest were initiated because of police actions in Minnesota. The vast number of public events held in the Ocean Front area in Virginia Beach and the Waterside/Town Point Park area of Norfolk create environments where a protest could easily drift to civil unrest. All local occurrences were planned and organized through social media. Verisk Maplecroft's Civil Unrest Index observed a significant deterioration for the United States' score (i.e., projected decrease of 0.5 or more on the Civil Unrest Index of 0-10) in 2020 and predicts that unrest will remain significantly elevated compared to historic trends over the next two years. The impacts from COVID-19 (i.e., food insecurity, job losses and frustrations over lockdowns), socioeconomic disparities, racial injustice issues, and growing political stressors are factors that will impact the likelihood of future civil unrest.[9]

[9] https://www.verisk.com/insurance/gated-resources/verisk-perspectives/a-dangerous-new-era-of-civil-unrest-is-dawning-in-the-united-states-and-around-the-world/

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Civil Unrest Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Very Long - More than 24 hours
Duration	Short - Less than six hours	Long - Less than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Civil Unrest Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical
Health & Safety	Significant	Injuries are manageable, may include at least one death.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Limited-Significant	Total Impact Score: 1.50 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Civil Unrest Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Critical	Serious economic impact. Standard of living is seriously affected.
Total Impact	Significant-Critical	Total Impact Score: 2.50 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Complex Coordinated Terrorist Attack (CCTA)

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A Complex Coordinated Terrorist Attack (CCTA) are acts of terrorism that involve synchronized and independent team(s) at multiple locations, sequentially or in close succession, initiated with little or no warning, and employing one or more weapon systems: firearms, explosives, fire as a weapon, and other nontraditional attack methodologies that are intended to result in large numbers of casualties.[10]

Risk Profile

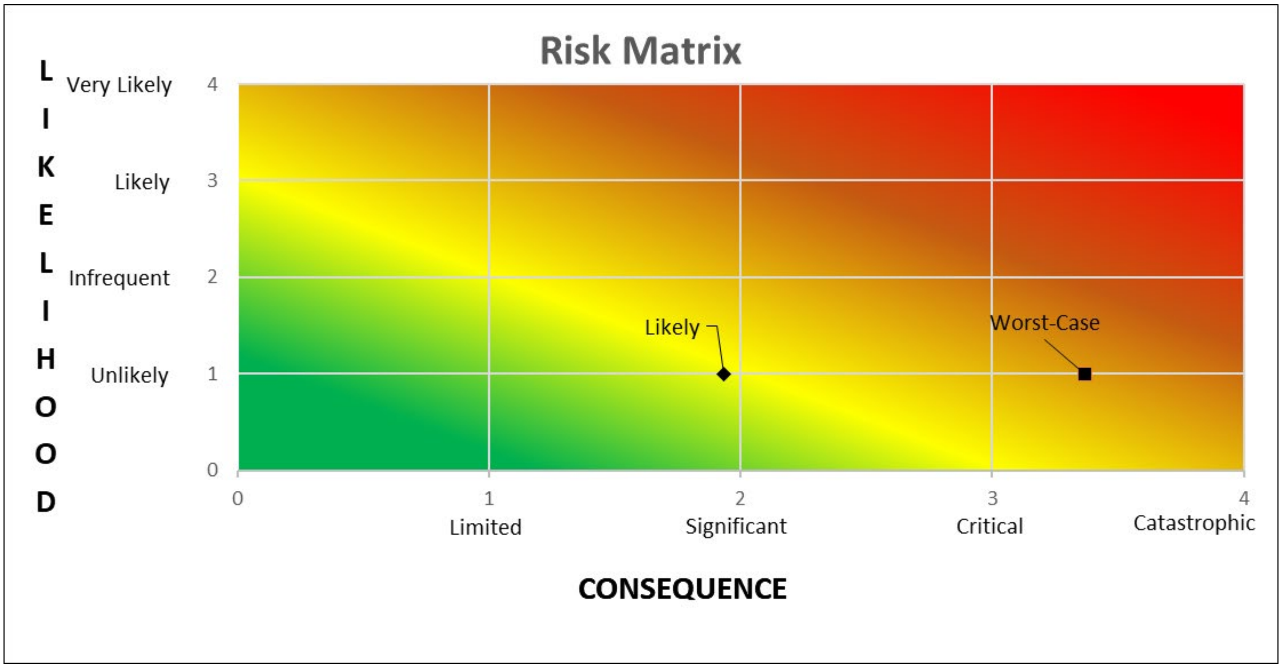
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Complex Coordinated Terrorist Attack Risk Profile				
	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	Likelihood	1 Inlikely	1 Unlikely	50%
Consequence	Impact	1.67 Limited-Significant	2.50 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	2 Moderate	3 Long	5%
	Total Risk Score	1.47	1.85	

[10]https://www.fema.gov/media-library-data/1532550673102-c4846f270150682decbda99b37524ca6/Planning_ Considerations-Complex_Coordinated_Terrorist_Attacks.pdf

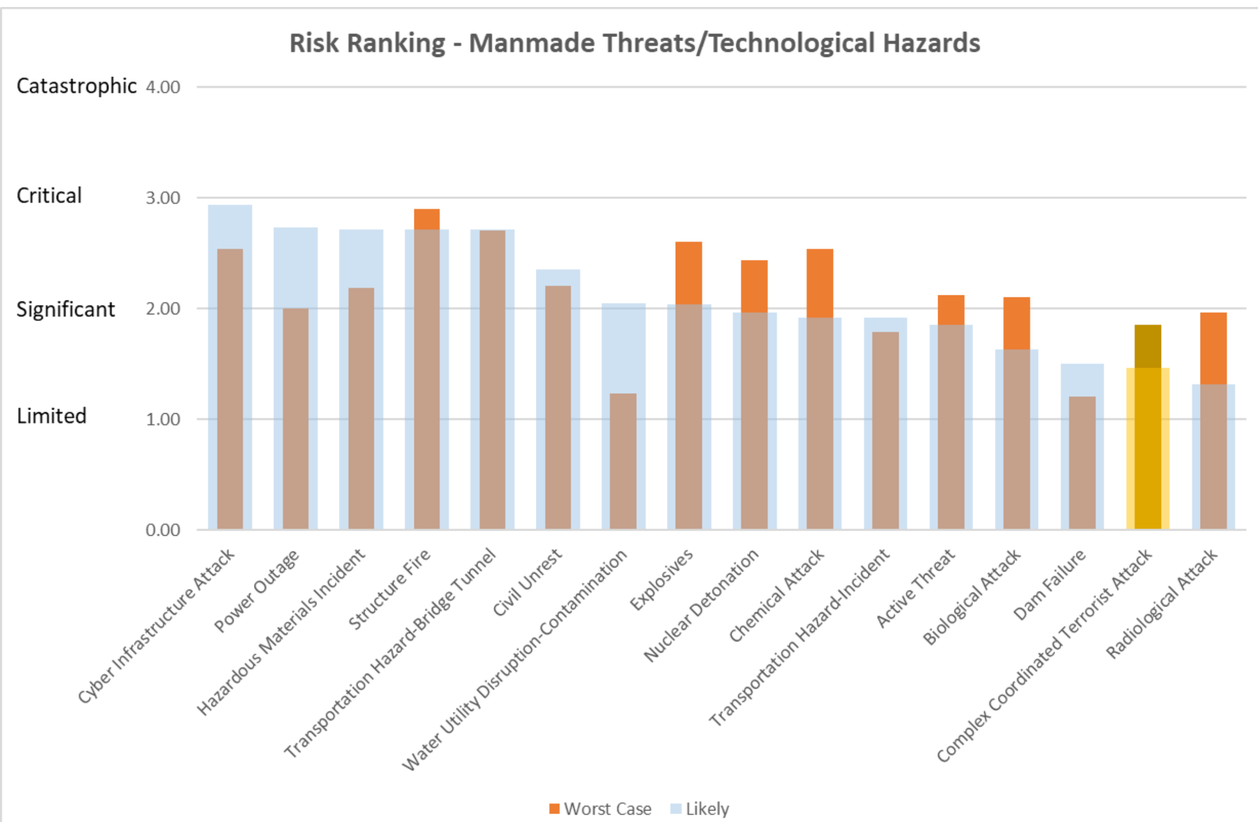
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

CCTAs are an evolving and dynamic terrorist threat, shifting from symbolic, highly planned attacks to attacks that could occur anywhere, at any time, with the potential for mass casualties and infrastructure damage. Although some characteristics of a CCTA are similar to an active shooter incident (e.g., use of firearms, potential for large numbers of fatalities, responding organizations and resources), the complexities of CCTAs (e.g., multiple teams, attack locations, and weapon types) may represent additional challenges to jurisdictions. CCTAs require the delivery of community capabilities and resources across a wide range of Core Capabilities. Based on the assessments of previous CCTAs, attackers may employ the following tactics, techniques, and procedures:

- Use pre-attack surveillance and reconnaissance to gather intelligence for tactical planning and execution;
- Use small teams of well-armed, well-trained individuals employing military or law enforcement style tactics;
- Select soft targets or other vulnerable environments to maximize casualties;
- Strike multiple targets simultaneously or in close succession;
- Strike quickly and move to another location before law enforcement can interdict and disrupt;
- Employ assault weapons, explosives, improvised explosive devices (IEDs), and/or fire as weapons; may use/incorporate other nontraditional methods, such as vehicle ramming, knifing attacks, and dispersing chemical or biological agents;
- Delay or deny exit by victims and entry by public safety by blocking exits and/or chaining/rigging doors with explosives, using tear gas, and/or using fire/smoke to delay law enforcement response efforts and potentially prolong the incident;
- Take hostages to prolong the incident and/or delay law enforcement response efforts;
- Deploy diversions to slow public safety response, consume responder resources, or draw/reorient responders toward or away from specific locations;
- Exploit social media and news coverage to maximize shock value, spread misinformation, instill fear, and promote extreme views;
- Communicate effectively across assault teams, targets, and with outside leadership;
- Coordinate attack timing and methods (e.g., firearms, IEDs, Hazardous Materials [HazMat]) with other attackers and parties providing assistance to assault teams;
- Conduct secondary attacks on first responders, evacuation routes, and/or additional sites, such as medical facilities, that are part of the response;
- Adapt and adjust tactics and/or location quickly based on law enforcement and first responder actions; and
- Learn from past law enforcement and first responder tactics and prior CCTA incidents.[11]

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

To date, CCTAs have not occurred locally. Isolated attacks by individuals have occurred within the region; however, wide-scale multiple attacks carried out by multiple teams or individuals have not transpired. Worldwide, seven CCTA events have occurred since 2004. The local threat of terrorist group operations and activity are difficult to predict and can change quickly. Due to the large military presence in the region, the region could be viewed as a CCTA target.

[11] https://www.fema.gov/media-library-data/1532550673102-c4846f270150682decbda99b37524ca6/Planning_Consi derations-Complex_Coordinated_Terrorist_Attacks.pdf

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Since 2004, the following real-world CCTAs have occurred around the world: Madrid train bombings (2014), London train and bus bombings (2005), Mumbai firearms, bombings, and arson (2008), Paris firearms and bombings (2015), Brussels airport and train bombings (2016), Alexandria/Tanta church bombings (2017), and Barcelona vehicle ramming and knife attack (2017). In each incident, over 100 people were wounded and 16-190 killed. Virginia has not experienced a CCTA.[12]

Notable Incidents in the Southside Region

No notable events have transpired in the Hampton Roads-Southside. Most recently, in 2017, attackers drove vehicles into crowds of pedestrians, and then stabbed escaping bystanders with knives in Barcelona, Spain. The attacks killed 16 people and injured more than 130 others. Authorities believe the assailants resorted to vehicle ramming after explosives planned for use in their attacks accidentally exploded.

In the United States, the September 11th terrorist attacks serve as a reminder of the potential CCTA event impacts as this attack resulted in 2,977 fatalities and more than 25,000 injuries.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of an Complex Coordinated Terrorist Attack		
	Likely	**Worst-Case**
Historical Average (time period)	No events have occurred on the Southside	No events have occurred on the Southside
Historical Annual Probability	<1% chance of annual occurrence	<1% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

Considerations: A major issue with an active CCTA threat is the inability to predict where and how the assailants will strike. A CCTA threat can appear random in nature without any accurate indicators of intent. When an incident occurs, the complexity of the attacks requires responders to engage with a fully integrated and coordinated response. The region could be an attractive target to anti-military and domestic terrorist groups. However, we do not anticipate a change in the future probability of a CCTA in the Southside region.[13]

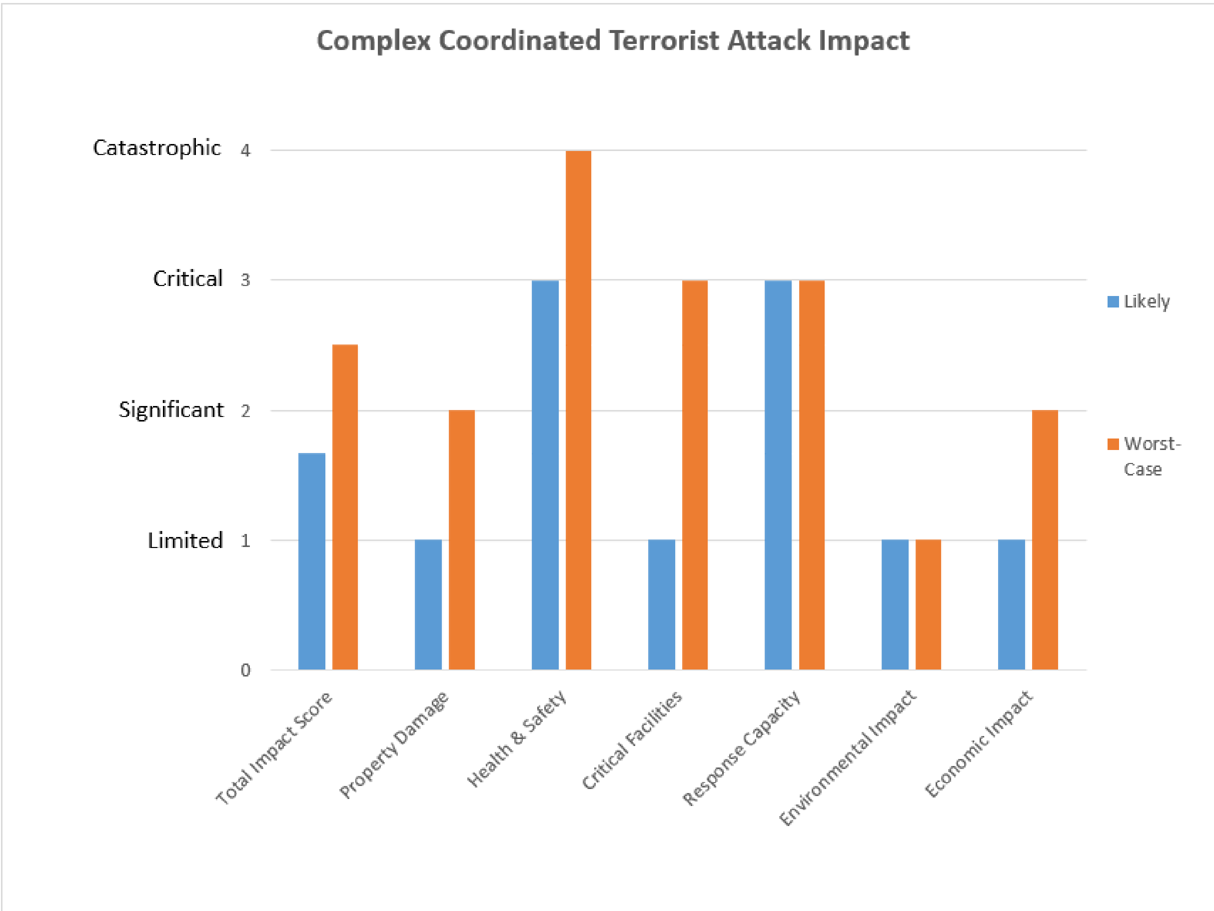
12 https://www.fema.gov/media-library-data/1532550673102-c4846f270150682decbda99b37524ca6/Planning_Consi derations-Complex_Coordinated_Terrorist_Attacks.pdf

13 https://www.fema.gov/media-library-data/1532550673102-c4846f270150682decbda99b37524ca6/Planning_Consi derations-Complex_Coordinated_Terrorist_Attacks.pdf

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Complex Coordinated Terrorist Attack Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Moderate - 6-24 hours	Long - Less than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Complex Coordinated Terrorist Attack Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Critical	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimially disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.67 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Complex Coordinated Terrorist Attack Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Critical	Shut down of critical facilities 1-4 weeks.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant-Critical	Total Impact Score: 2.50 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Cyber Infrastructure Attack

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A Cyber/Communications Infrastructure Attack is an intentional disruption or manipulation of the information and communication systems used to collect, filter, process, create, and distribute data. An attack of this type may seek to impact or manipulate data to influence physical infrastructure.

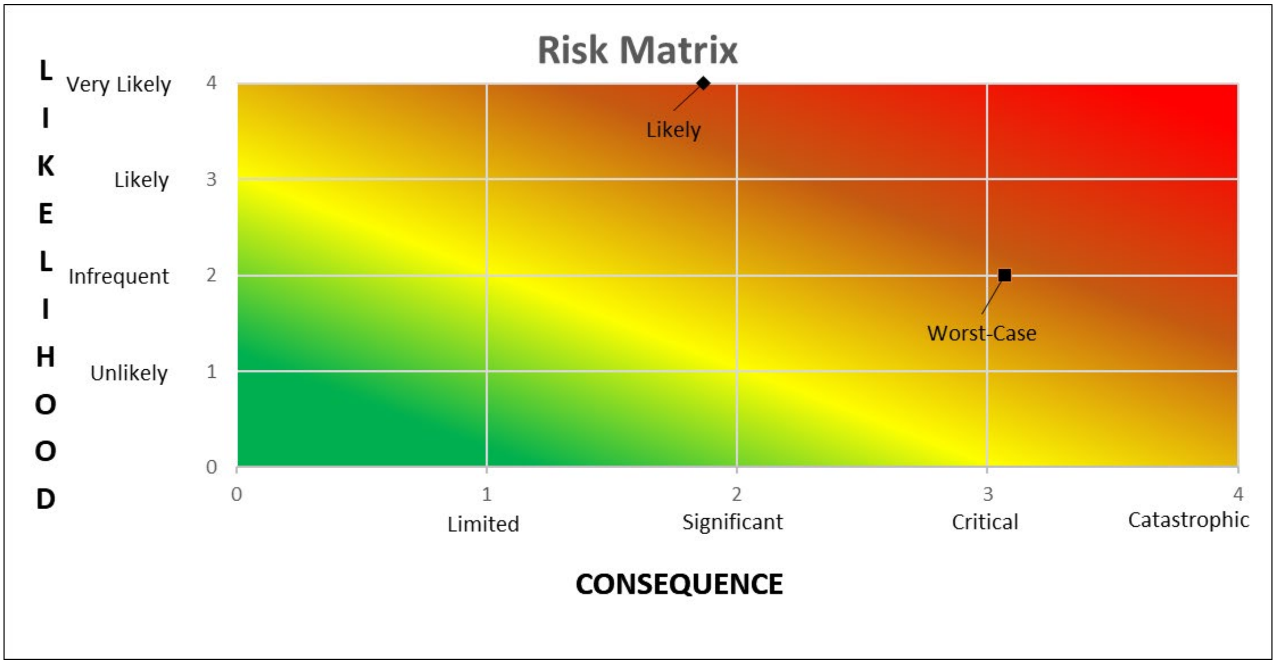
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Cyber Infrastructure Attack Risk Profile				
	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	Likelihood	4 Very Likely	2 Infrequent	50%
Consequence	Impact	1.33 Limited-Significant	2.83 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	4 Very Long	4 Very Long	5%
	Total Risk Score	2.93	2.53	

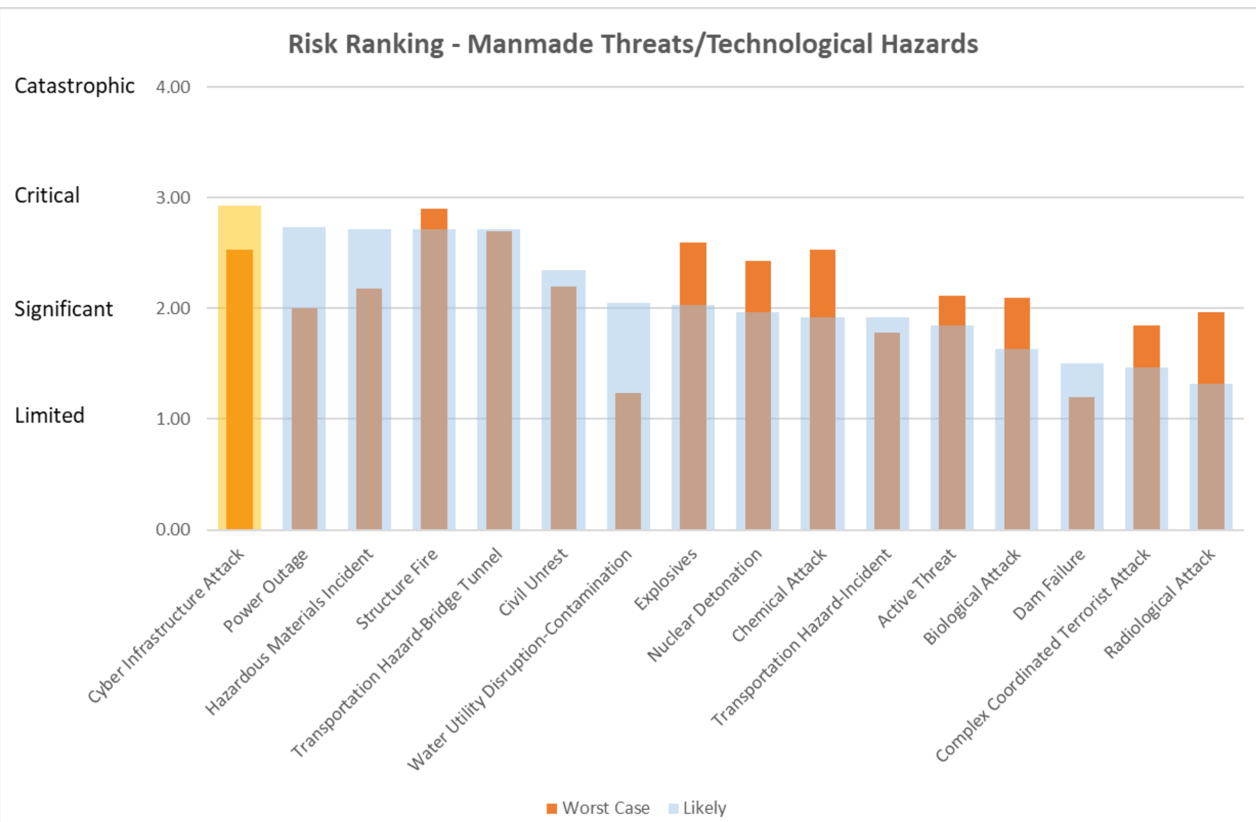
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Critical infrastructure provides the foundation for all aspects of modern life, from power to telecommunications to potable water. Over the past two decades, critical infrastructure entities have increasingly moved toward networked systems to improve their efficiency, accessibility, and reliability. This increased connectivity has created new risks and vulnerabilities. If a legitimate user can remotely access a key component, such as a transformer, to conduct routine maintenance operations, a malicious actor may be able to exploit the same connectivity to inflict harm. These risks are real, significant, and increasingly salient. Our nation's critical infrastructure owners and operators are increasingly aware of these risks and many have invested substantial resources in cybersecurity. A significant cyber incident would likely consist of two distinct but related parts: the actual network penetration (to include data theft, ransom, or manipulation) and the resulting physical effects resulting from that penetration. Initially, a network could be penetrated through a range of mechanisms, such as a phishing attack; the exploitation of vulnerabilities in unpatched systems; or through insider manipulation of systems (e.g., malware implantation) to permit remote access. Once inside, the intruder could steal data, affect operations, disrupt communications, or alter the network. But the second potential impact of a network penetration is the physical effect which can range widely in severity. With the right tools and intent, malicious actors could damage critical infrastructure in ways that replicate the effects of a major natural disaster or man-made attack.[14]

The **likely incident** is an intrusion that results in a data breach from an external party such as a customer or vendor. This type of attack may occur through a phishing tactic as these often target harvesting credentials or personal information stored on the networks but do not affect operations.

A **worst-case incident** consists of an adversary (e.g., a foreign entity) disrupting communications on a wide scale basis such as using a GPS jamming device or a denial of services attack on regional communication systems, networks, radios, servers, or the emergency communications systems (i.e., 911 call centers). An incident of this nature in one city could propagate to other cities resulting in a regional communication and/or GPS outage until authorities eliminate the source of the problems and restore the systems.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Hampton Roads hosts a variety of critical infrastructure such as military installations, transatlantic tables, populated areas, the Port of Virginia, NATO, NSA, and the Portsmouth Naval Shipyard. Local government is becoming more interconnected with each other due to mutual aid and necessary cooperation amongst the jurisdictions. Additionally, utilities serving the region are not limited to assisting individual cities or counties. With more than half of the regional GDP derived from government and military industrial complex operations, planners anticipate this area generating greater attention from attackers than other regions throughout the U.S.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

The cybersecurity threat is ever-present in the region. Attacks against its networks occur daily both internally against the cities and externally from customers, vendors, and suppliers. A lack of cybersecure infrastructure among customers and vendors increases the vulnerability for the cities. As communities become more interconnected, the potential pathways

[14] https://dod.defense.gov/Portals/1/features/2015/0415_cyber-strategy/docs/DOD-DHS-Cyber_Article-2016-09-23-CLEAN.pdf (date accessed, 6/16/2020)

for intrusion increase. As the region generates national headlines, the threat of a cyber-attack increases even more. There have been several cyber threats and attacks against the cities and utilities within the region during recent years.

Notable Incidents in the Southside Region

Phishing attacks which compromise networks through email are common throughout the region.

On Nov 19, 2020, the Hampton Roads Sanitation District was attacked with malware/ransomware (still under investigation) through what is believed to have been a phishing incident. This resulted in shutting down the entire network and a switch to alternate networks.

Other attacks on networks in the region have breached systems and resulted in data loss. Details on these incidents are not publicly available.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

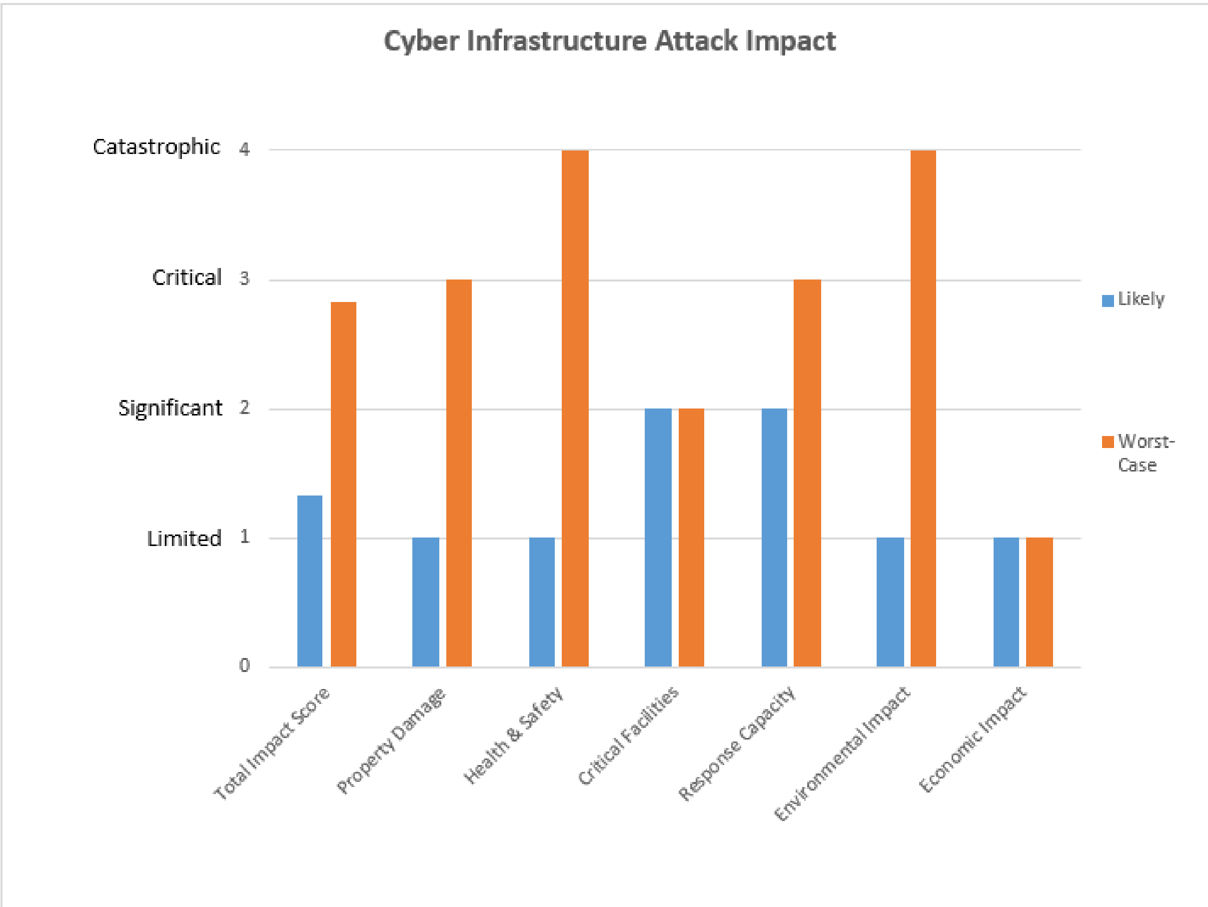
Future Likelihood of Cyber Infrastructure Attack		
	Likely	**Worst-Case**
Historical Average (time period)	Approximately 3 events every 5 years (2015-2020)	No events like this have occurred in our history
Historical Annual Probability	60% chance of annual occurrence	<1% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	Yes
Future Annual Probability	91-100% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of occurrence annually	2 - Infrequent: 1-10% chance of annual occurrence

Considerations: Cyber threats and attacks are likely to increase in the next 5-10 years. Cybersecurity is the new means of warfare. Municipalities store valuable information on citizens which is desired by cyber criminals. State Preparedness Reports consistently rank cybersecurity as the top risk across the nation. While cities are increasing defensive capabilities, significant gaps remain between the threat and defensive capabilities. Mitigation methods will minimize the severity of attacks. Since municipalities are becoming more interconnected, criminals could introduce a weak link vector to cause a more widespread impact on the region. Funding limitations and human capital deficiencies hamper the region's lack of preparedness and ability to close the gap between the threat and defensive capabilities.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Cyber Infrastructure Attack Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Very Long - More than one week	Very Long - More than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Cyber Infrastructure Attack Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Multiple deaths and serious injuries are probable.
Critical Facilities	Significant	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.33 on a scale of 1 (Limited) to 4 (Catastrophic)

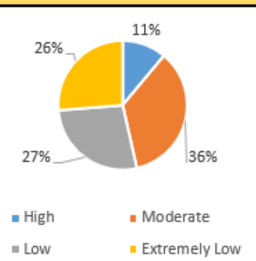
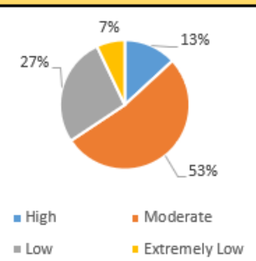
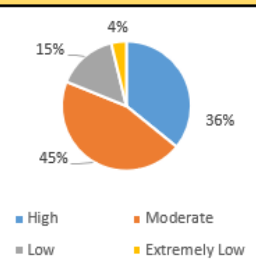
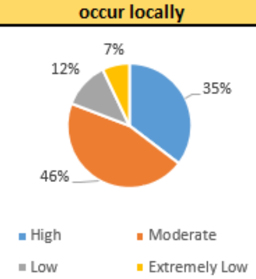
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Cyber Infrastructure Attack Consequence Analysis - Worst-Case		
Property Damage	Critical	Property damage is between 26-50% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Catastrophic	Severe environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Significant-Critical	Total Impact Score: 2.83 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Cyber Infrastructure Attack Public Perceptions			
Perceived confidence in city's ability to respond and recover from this hazard	**Perceived confidence in personal ability to protect self and family from this hazard**	**Concern over the impact to personal health and safety if this hazard were to occur locally**	**Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally**
			

Dam Failure

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A Dam Failure hazard occurs when a portion or the entire dam's water-retaining barrier becomes damaged causing the uncontrolled release of water downstream. A Dam Failure hazard can be the result of a design or construction error, insufficient maintenance, human error, or internal erosion. Dam Failures can also occur as the result of an intentional attack or as a cascading effect of natural hazards such as flooding, earthquakes, or geological instability.

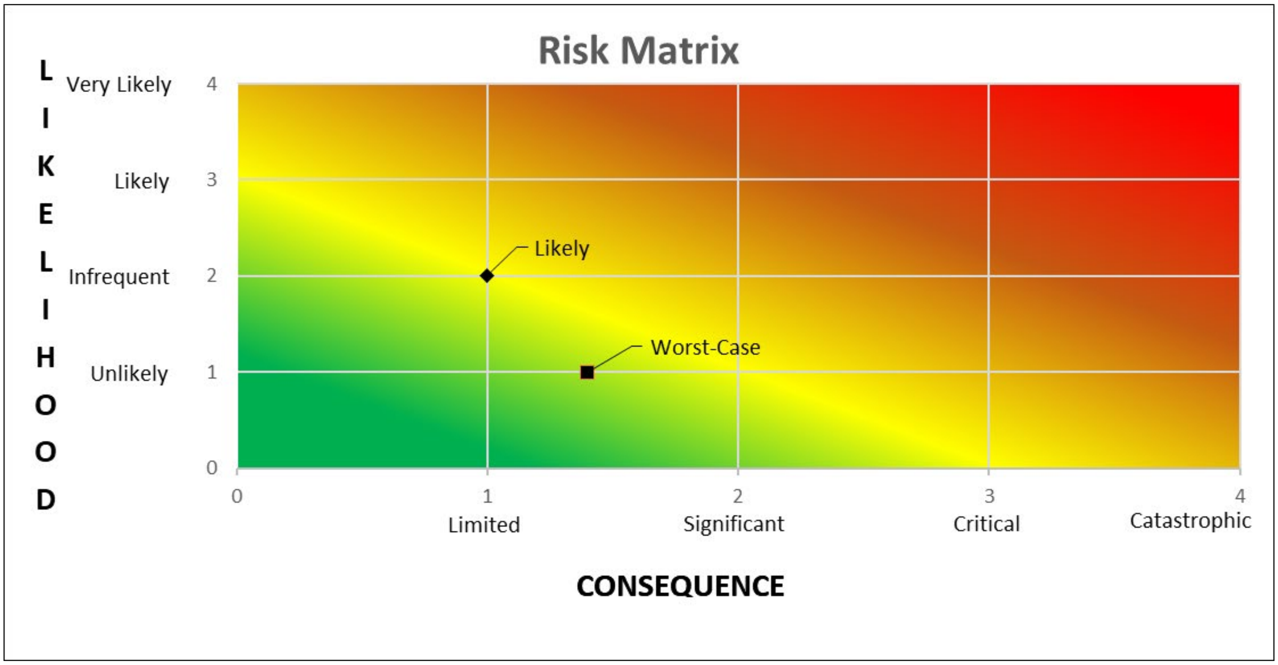
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Dam Failure Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	2 Infrequent	1 Unlikely	50%
Consequence	**Impact**	1.00 Limited	1.00 Limited	40%
	Warning Time	1 Very Long	3 Moderate	5%
	Duration	1 Short	3 Long	5%
	Total Risk Score	1.50	1.20	

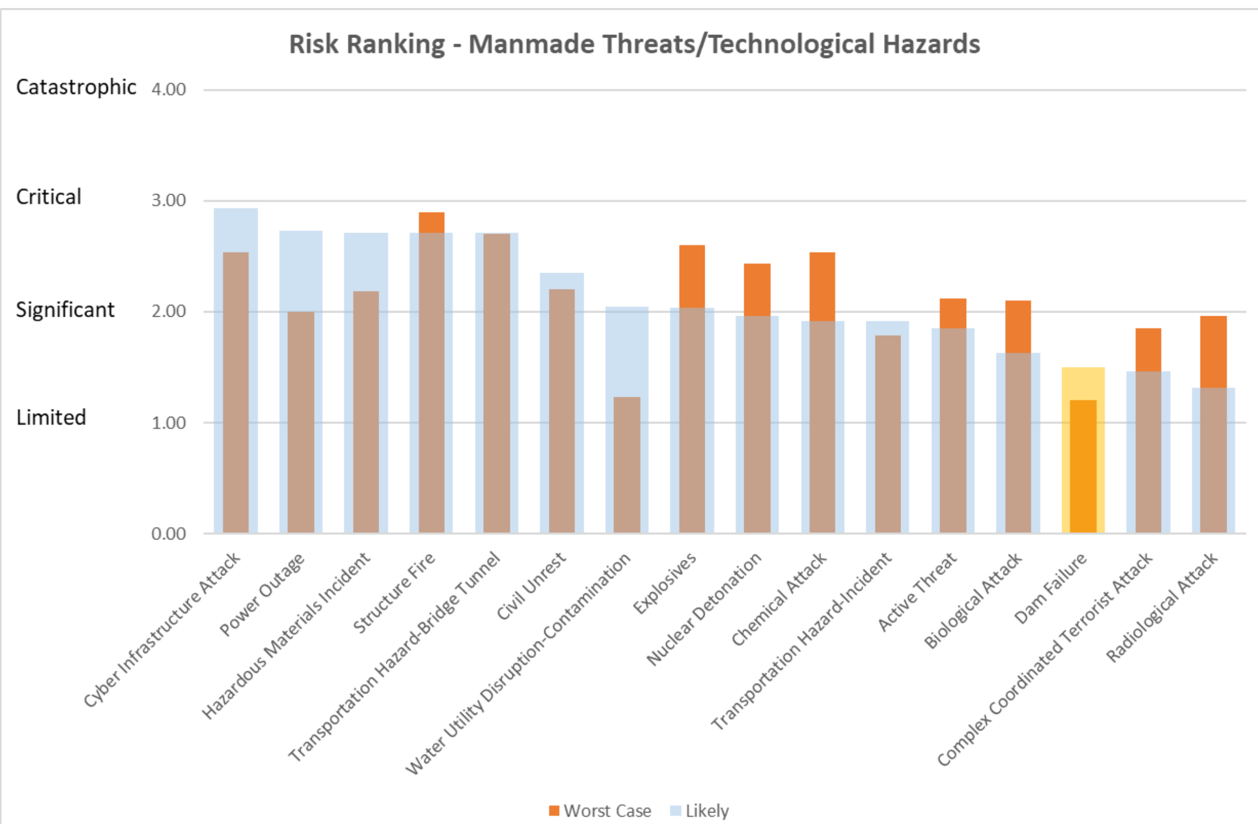
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Approximately 15,000 dams in the United States are classified as high-hazard potential (HHP), meaning that their failure could result in loss of life. Dams can fail for several reasons, including overtopping caused by floods, acts of sabotage, or structural failure of materials used in dam construction. The worst dam failure in the United States occurred in 1889 in Johnstown, Pennsylvania. Over 2,200 died, with many more left homeless. Dams present risks but they also provide many benefits, including irrigation, flood control, and recreation. Dams have been identified as a key resource of our national infrastructure that is vulnerable to terrorist attack. States have the primary responsibility for protecting their populations from dam failure. Of the approximately 94,400 dams in the United States, state governments regulate approximately 70 percent. About 27,000 dams throughout our nation could incur damage or fail, resulting in significant property damage, lifeline disruption (utilities), business disruption, displacement of families from their homes, and environmental damage. The most important step you can take to protect yourself from dam failure are understanding your risk. Contact government offices to learn if an Emergency Action Plan (EAP) is in place and evacuate when directed by emergency response officials. An EAP is a formal document that identifies potential emergency conditions at a dam and specifies pre-planned actions the dam owner implements to reduce property damage and loss of life. The plan may save lives through timely evacuations of those who live, work, or enjoy recreation near a high-hazard potential dam. While dams reduce the risk of flooding., no dam structure can eliminate all flood risk. Large flood events may cause floodwaters to flow over the dam. Alternatively, a dam operator may release excess water downstream to relieve pressure from the dam which may lead to downstream flooding. Understanding hazard areas and the appropriate actions to implement during a dam failure will help save lives.[15]

The **likely incident** involves flooding rains overtopping the dam and causing downstream flooding. If a named storm is forecasted, Portsmouth staff can try to lower the reservoirs with dam outlet valves to mitigate anticipated flooding.

The **worst-case incident** consists of excessive flooding that results in complete failure of the dam and severe downstream flooding as a result.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The City of Norfolk owns and maintains five high-hazard, regulated dams: Lake Whitehurst (located in Norfolk), Little Creek Reservoir (located in Virginia Beach), Western Branch (located in Suffolk), Lake Smith (located in Virginia Beach), and Lake Burnt Mills (located in Suffolk). The City of Norfolk also maintains Lake Prince (located in Suffolk) dam.[16] The City of Virginia Beach owns and maintains two regulated dams: Stumpy Lake Reservoir and Kingston Lake dams. The City of Chesapeake has no dams. The City of Portsmouth owns and maintains four high-hazard, regulated dams: Speights Run Reservoir, Lake Cahoon, Lake Kilby, and Lake Meade. The City of Portsmouth also owns the Lake Kilby Water Treatment Plant Sludge Lagoon dam. All five are located on City of Portsmouth-owned property within the boundaries of the City of Suffolk.[17]

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

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[15]https://www.fema.gov/media-library-data/14858710924047a14db27056f2f5bb7bb75cfcbe017d1/damsafety_factsheet_2016.pdf (date accessed, 6/16/2020)
[16] Commonwealth of Virginia Hazard Mitigation Plan, 2018
[17] Extracted from the Dam Safety Inventory System, provided by DCR, Division of Dam Safety&Floodplain Management (6/29/2021)

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Failure of dams may result in catastrophic localized damages at both the dam location and downstream areas. Vulnerability from dam failure is dependent on dam operations planning and the nature of downstream development. Depending on the elevation and storage volume of the impoundment, the impact of flooding due to dam failure may include loss of human life, economic losses such as property damage and infrastructure disruption, and environmental impacts such as destruction of habitat.[16] Virginia Beach has had no known dam failures. In the City of Portsmouth, following Hurricanes Dennis and Floyd, the Speights Run dam overtopped briefly and the spillway washed out. this caused the Waterworks to flood and remain offline for several days. Portsmouth has since built a floodwall at the plant, re-located the power building, and made some dam improvements. Since then. the City of Portsmouth has experienced storms that have caused minor flooding above Speights Run resulting in marginal damages or utility outages.

Notable Incidents in the Southside Region

Hurricanes Dennis and Floyd impacted the Hampton Roads Region in the fall of 1999. In Virginia Beach, Hurricane Matthew caused runoff from Stumpy Lake to overtop Elbow Road.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

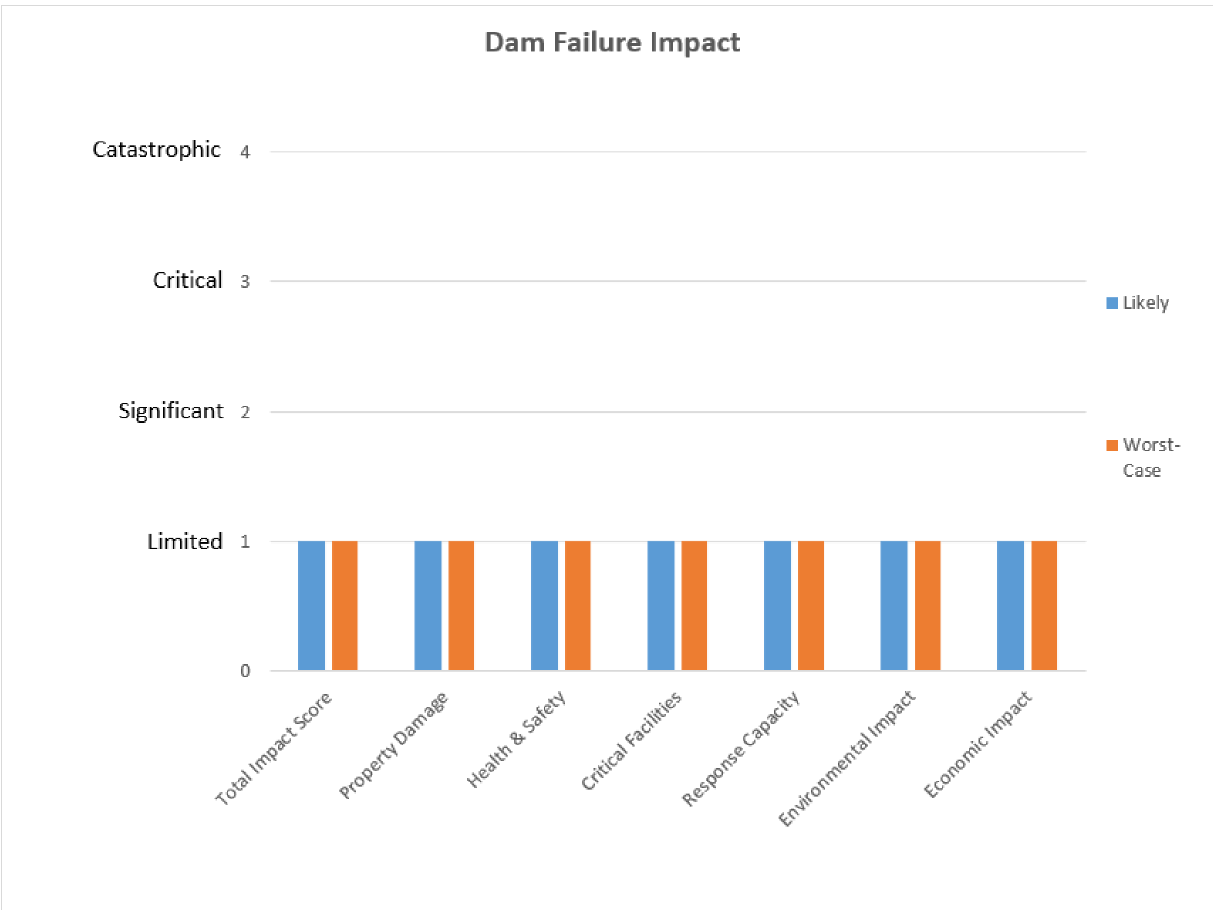
Future Likelihood of a Dam Failure		
	Likely	**Worst-Case**
Historical Average (time period)	3 events every 21 years (1999-2020)	None recorded
Historical Annual Probability	14% chance of annual occurrence	<0.5% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	Yes
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	2 - Infrequent: 1-10% chance of annual occurrence	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

Considerations: For the cities of Virginia Beach and Portsmouth, a 200-year and larger storm event poses the greatest concern statistically a 0.5% or higher chance of occurrence in a single year, for flooding, with a smaller risk for a storm to cause a complete failure. Within Portsmouth, changing weather patterns and continued development while Suffolk is adding more impervious surface in the reservoir watersheds, causing greater impacts following rain events. Portsmouth's dams currently have conditional permits because the existing designs have inadequate spillway design capacities and are expected to overtop during a large storm event. For Virginia Beach, the Department of Public Utilities is currently working with the Department of Conservation and Recreation regarding permitting of the Stumpy Lake dam.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Dam Failure Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Very Long - More than 24 hours	Moderate - 6-12 hours
Duration	Short - Less than six hours	Long - Less than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Dam Failure Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited	Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Dam Failure Consequence Analysis - Worst-Case		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited	Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Explosives

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

An Explosives hazard occurs when an explosive device is intentionally used to cause harm to people, property, operational capacity, or the environment.

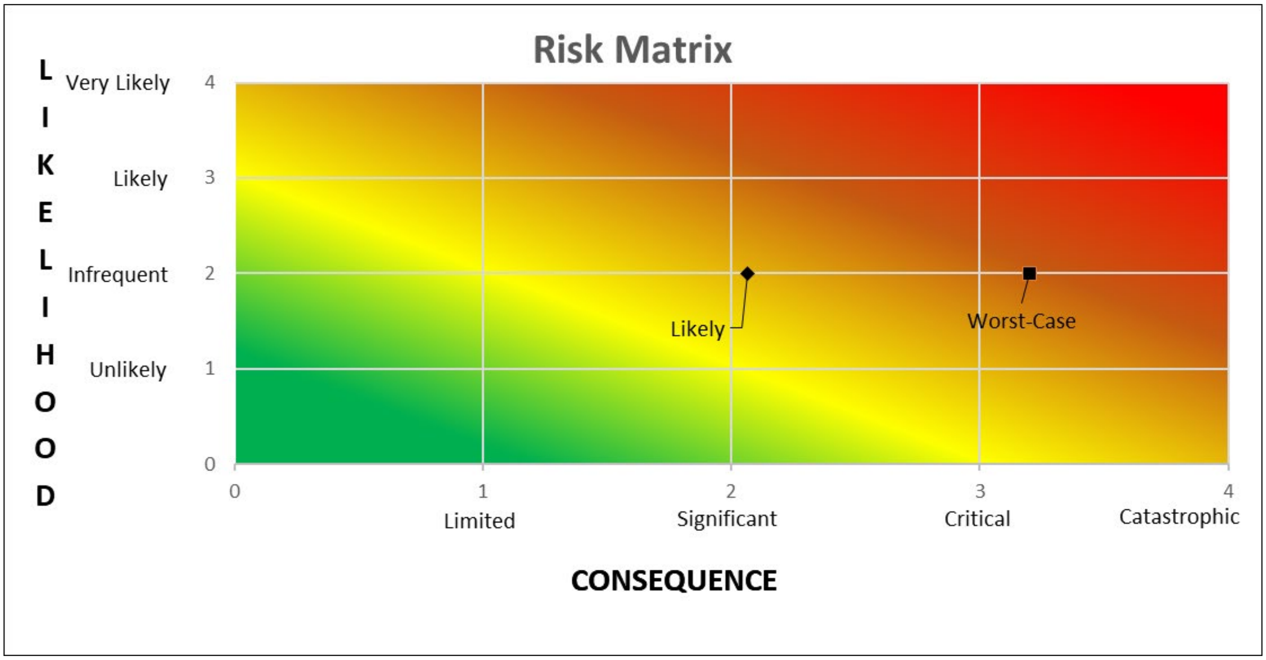
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Explosives Hazard Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	2 Infrequent	2 Infrequent	50%
Consequence	**Impact**	1.83 Limited-Significant	3.00 Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	2 Moderate	4 Very Long	5%
	Total Risk Score	2.03	2.60	

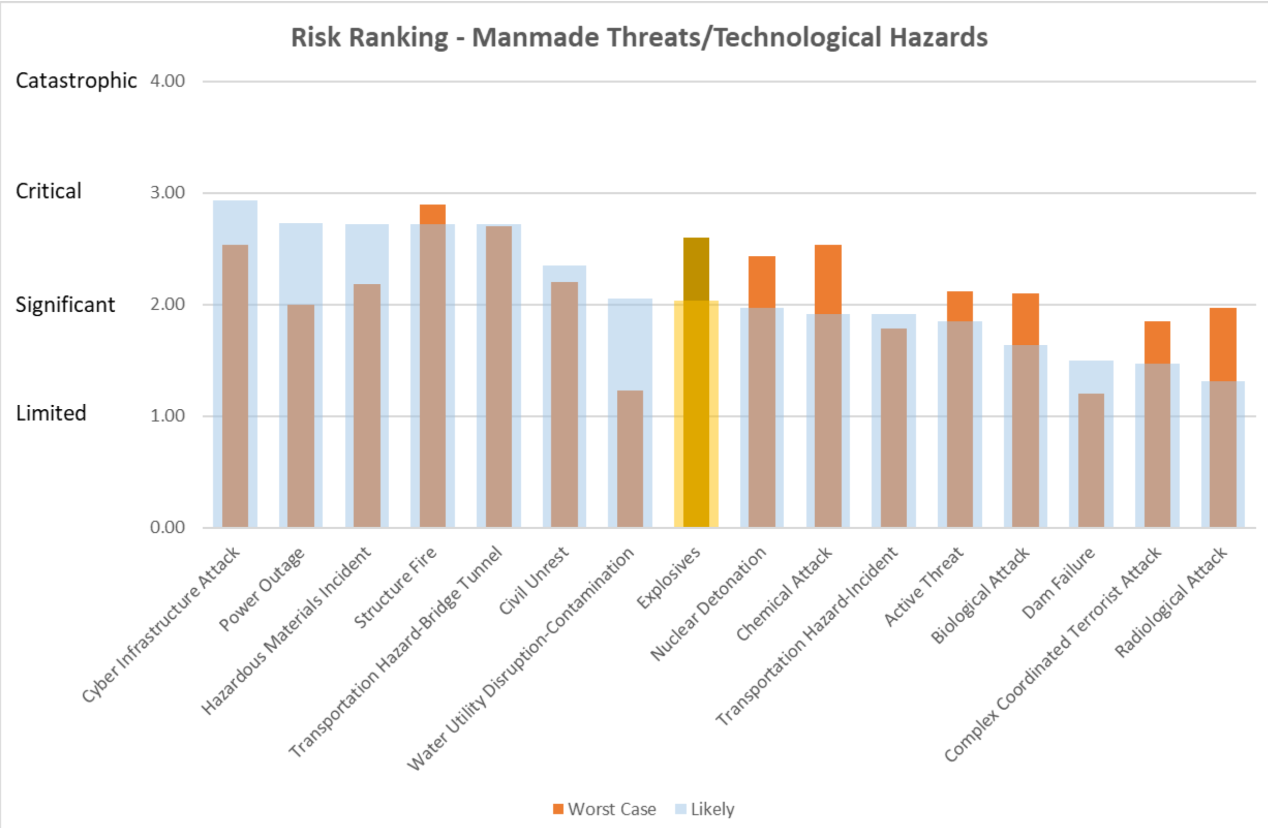
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Explosive devices are one of terrorists' most common weapons. The materials needed for an explosive device can be found in many places including variety, hardware, auto supply and agricultural fertilizer supply stores. Explosive devices are highly portable, using vehicles (e.g., trucks and UAVs) and humans as the means of transport. They are easily detonated from remote locations or by suicide bombers. Detonation of an explosive device causes blast damage, fire, and secondary hazards such as broken glass and other missiles hurtling through the immediate area.[18]

The **likely incident** consists of an adversary placing an improvised explosive device near a crowded area that has the potential to cause a mass casualty incident.

The **worst-case incident** would involve an adversary placing an explosive device in a tunnel or in a cargo shipping container and secondary devices within the area. These incidents would cause extensive damage to critical infrastructure and potentially cause a mass casualty incident.

[18] https://www.fema.gov/media-library-data/20130726-1621-20490-5853/explosionsfactsheet_final.pdf (date accessed, 6/16/2020)

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Hampton Roads Southside Sub-region has a population of 1.1 million people to include a large U.S. military presence, the Port of Virginia, and other essential components that make up the U.S. infrastructure. The Hampton Roads area is home to the Navy Atlantic Fleet with its air wings and support units. The Naval Special Operations Warfare Group, to include the Developmental Group, is located in Virginia Beach. The region's transportation routes are dependent on the use of tunnels and bridges due to the abundant number of waterways in the area. The Hampton Roads area could be considered a target of opportunity for nation states, foreign and domestic terrorist groups.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Explosive incidents have occurred throughout the U.S. and remain one of the more common methods of attack following active shooters. However, accessibility to the quantity of explosives needed has decreased due to the CFATS program, monitoring, tracking, and reporting. Agricultural use products such as ammonium nitrate remain somewhat more accessible but there are systems in place to monitor and interdict suspicious activities. An explosive incident has not occurred in the Southside region.

Notable Incidents in the Southside Region

There have been no notable events reported in the Hampton Roads area. However, explosive incidents have occurred throughout the U.S. (e.g., the Boston bombing, industrial/transportation accidents, Oklahoma City bombing, etc.). Law enforcement has seized large quantities of explosives such as ammonium nitrate. during interdiction activities.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

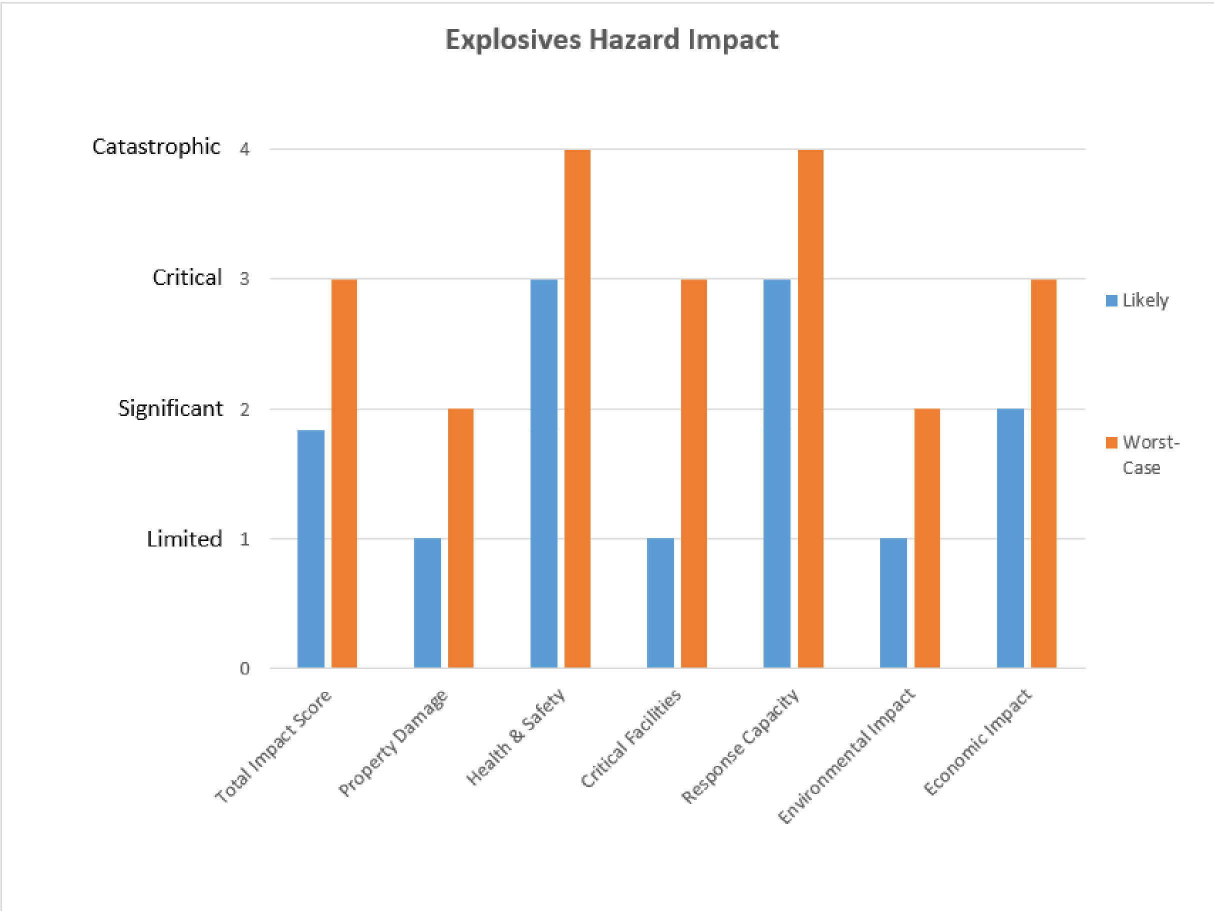
Future Likelihood of an Explosives Hazard		
	Likely	**Worst-Case**
Historical Average (time period)	No events in the Hampton Roads area	No events in the Hampton Roads area
Historical Annual Probability	<1% chance of annual occurrence	<1% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	2 - Infrequent: 1-10% chance of annual occurrence	2 - Infrequent: 1-10% chance of annual occurrence

Considerations: While there is a possibility and existing threat for explosive incidents, the extent of the threat is expected to remain consistent into the future and law enforcement interdiction capabilities have kept pace with this threat. Therefore, we do not anticipate a significant change in the likelihood of this incident in the future.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Explosives Hazard Warning Time & Duration		
	Likely	Worst-Case
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Moderate - 6-24 hours	Very Long - More than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Explosives Hazard Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Limited-Significant	Total Impact Score: 1.83 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Explosives Hazard Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Critical	Shut down of critical facilities 1-4 weeks.
Response Capacity	Catastrophic	Response capacity is overwhelmed and requires significant and long lasting state and federal government support.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Critical	Serious economic impact. Standard of living is seriously affected.
Total Impact	Critical	Total Impact Score: 3.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Hazardous Materials (Hazmat) Incident

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all regional planning documents.

A hazardous material (hazmat) is defined as a matter (solid, liquid, or gas) or energy that when released, is capable of creating harm to people, the environment, and property including weapons of mass destruction, as defined in 18 U.S. Code, Section 2332a, as well as any other criminal use of hazmat, such as illicit labs, environmental crimes, or industrial sabotage.[19] A hazardous materials incident involves the uncontrolled release of one or more hazardous materials into an environment in which humans are or could be present or that otherwise holds the potential to put human or environmental safety at risk if not addressed.

Risk Profile

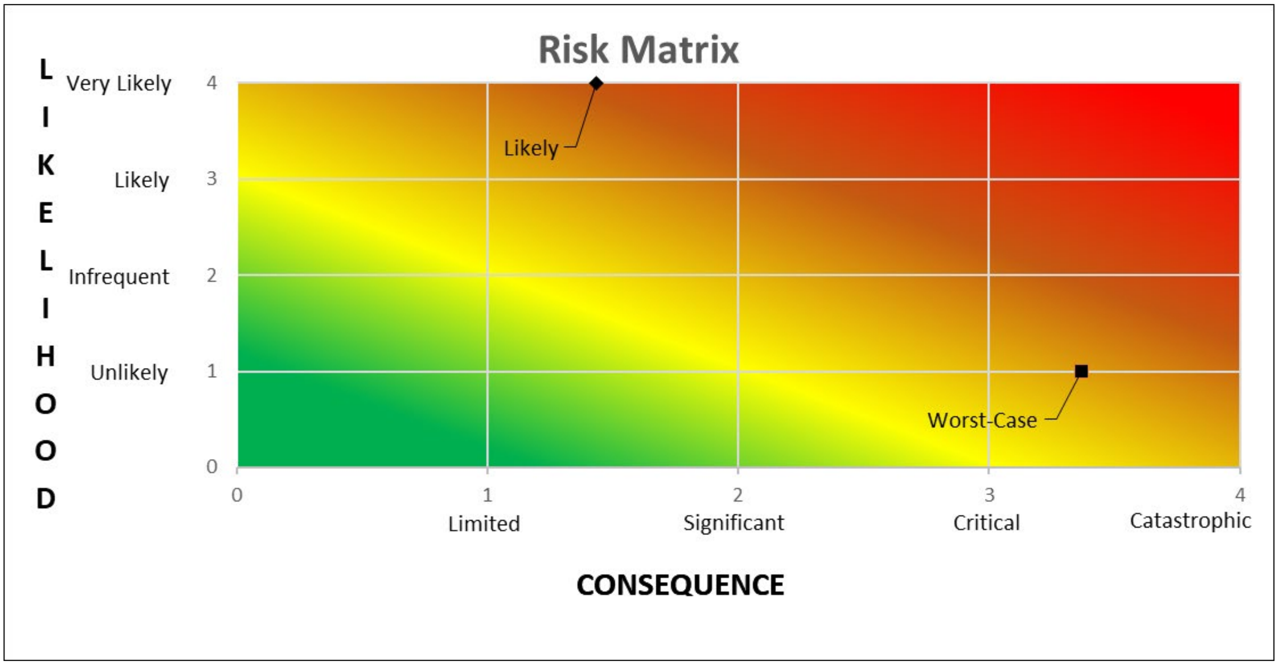
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Hazardous Materials Incident Risk Profile				
Likelihood	**Risk Assessment Category**	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
	Likelihood	4 Very Likely	1 Unlikely	50%
Consequence	**Impact**	1.17 Limited-Significant	3.33 Critical-Catastrophic	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	3 Long	5%
	Total Risk Score	2.72	2.18	

[19] NFPA 472, Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents, 2018

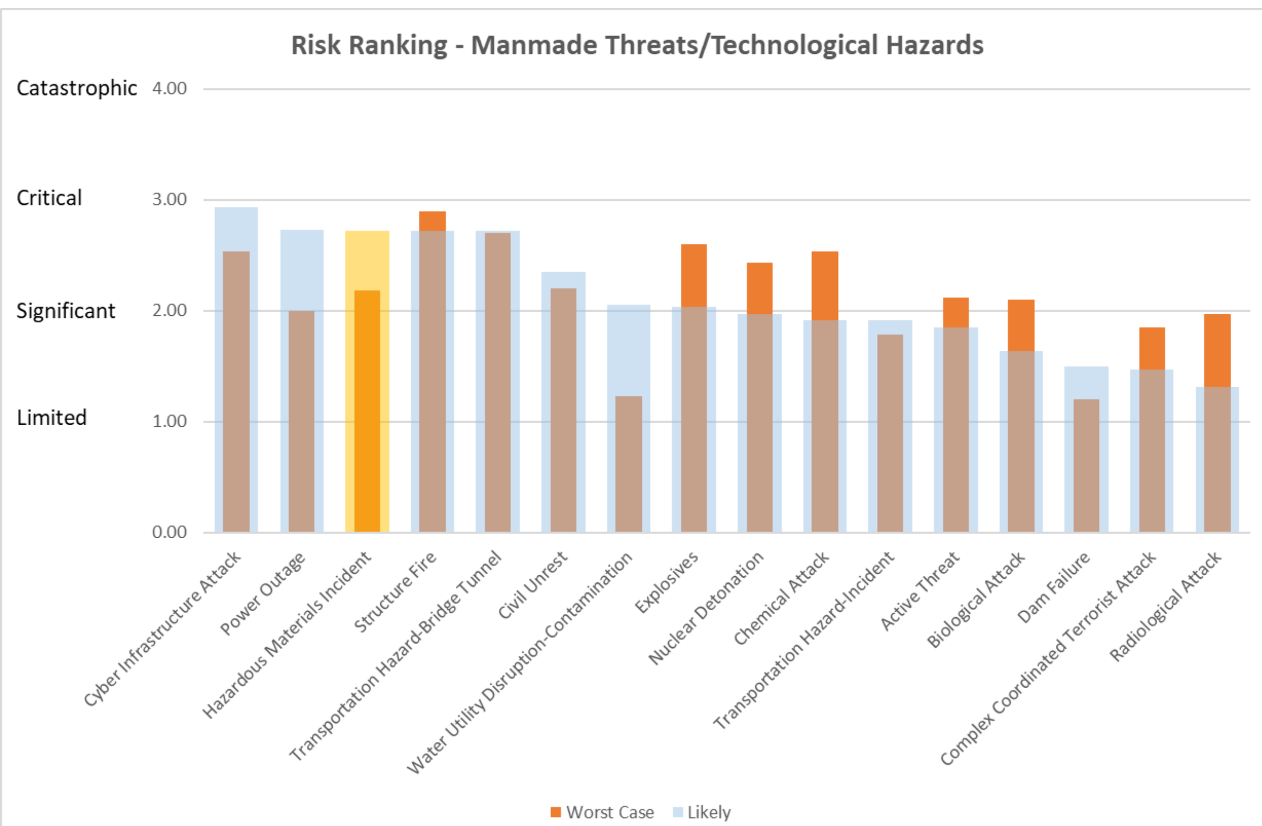
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Hazardous materials include explosives, flammable and combustible substances, oxidizers, poisons, corrosives, and radioactive materials present in a gas, liquid, or solid form. Hazmat is used and/or stored in residential, commercial, or industrial settings and Hazmat exposure routes include skin and eye contact, inhalation, ingestion and skin absorption and can pose a wide range of adverse health risks to those exposed. The NFPA 704 diamond shaped placard is used to visually illustrate hazmat risks by assigning a numerical scale of zero through four (with 0 indicating no hazard and 4 representing extremely hazardous) among three categories to include flammability, health and safety and reactivity of a substance. A fourth category known as “special hazard” identifies additional concerns of a substance such as an oxidizer, acid or radioactive.

The **likely incident** consists of a spill involving a flammable liquid or liquid petroleum gas release.

The **worst-case incident** would involve a catastrophic failure/event that releases over 50,000 pounds of Anhydrous Ammonia from a cold storage facility in a densely populated, urban area. Ammonia is corrosive, flammable, and an irritant. This type of incident would generate high airborne concentrations and pose an Immediately Dangerous to Life and Health (i.e., 300 parts per million (ppm) or greater). Anhydrous ammonia’s flammable range is between 15% and 28%. A release of this magnitude would cause significant health and safety concerns due to the high airborne concentrations and flammability concerns. Additional incidents might include a tank farm fire or tank failure, propane vessel collision in the port, and a high-hazard flammable train derailment involving a large spill and/or fire.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard’s occurrence or vulnerability to the hazard’s consequences.

Incidents can occur anywhere in the region as hazmat is stored, manufactured, used, and transported every day. Hazmat is used in industrial, commercial, and residential environments and are transported by road, rail, barge, and aircraft. Hazmat can include small, household quantities to large-scale quantities found in shipping or industrial/commercial settings. All nine classes of hazmat can be found throughout our region and in all forms. One mistake in handling or containment could result in a hazmat incident in any setting.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Hazmat incidents occur regularly throughout each year. Impacts to the region will depend on the size and scope of the hazmat incident. Hazmat incidents may adversely impact the environment to include air, water, and soil and can cause a range of health effects from mild to severe/death to exposed persons. In addition, these events can have significant economic impacts including the cost of recovery and cleanup, delays in commercial travel, shutdowns to commercial business, and damage to infrastructure. Hazmat incident statistics in the Southside region 2018-2020:

- 2018: 289 Hazmat incidents
- 2019: 263 Hazmat incidents
- 2020: 227 Hazmat incidents[20]

Future Likelihood of the Hazard for the Southside Region

[20] Ref: National Response Center, USCG database (accessed 13 Jan 2021)

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

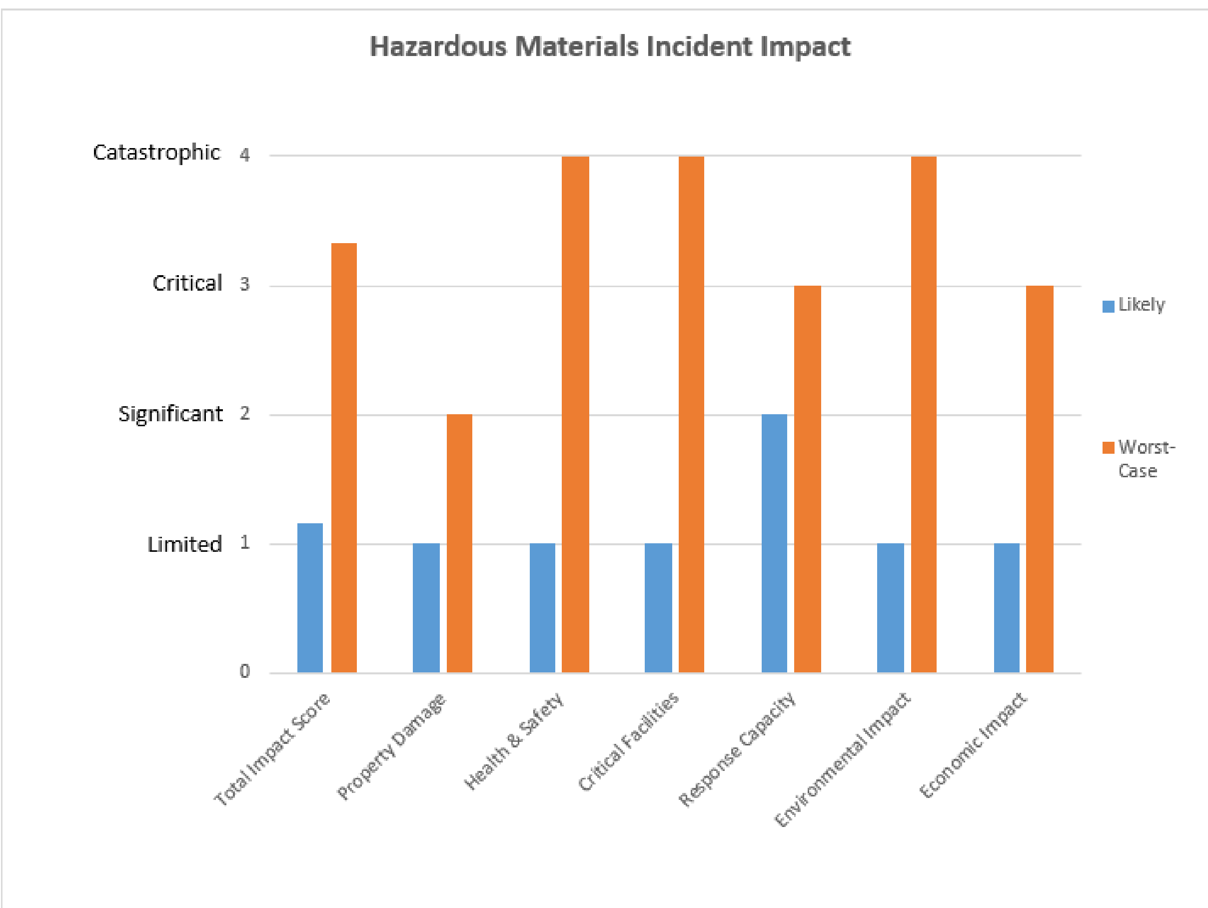
Future Likelihood of a Hazardous Materials Incident		
	Likely	**Worst-Case**
Historical Average (time period)	Monthly	No recorded events in recent history
Historical Annual Probability	100%	<1%
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	91-100% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of annual occurrence	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

Considerations: The future likelihood of hazmat incidents in the region are not expected to be significantly different from the historical occurrence rate. A future annual probability of 100% classifies the likelihood of hazmat incidents as Very Likely with an occurrence rate of one or more events every year.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Hazardous Materials Incident Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Short - Less than six hours	Long - Less than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Hazardous Materials Incident Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.17 on a scale of 1 (Limited) to 4 (Catastrophic)

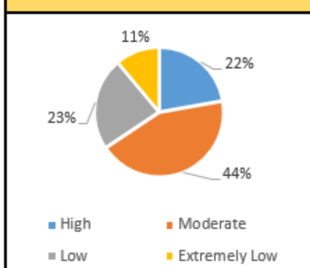
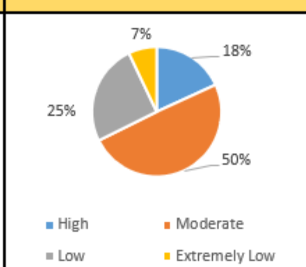
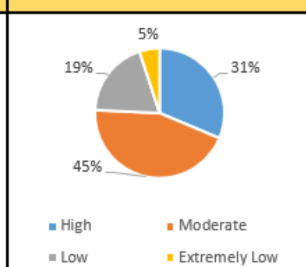
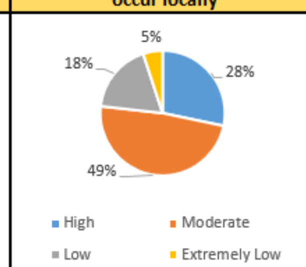
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Hazardous Materials Incident Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Catastrophic	Shut down of critical facilities will be more than one month.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Catastrophic	Severe environmental impact.
Economic Impact	Critical	Serious economic impact. Standard of living is seriously affected.
Total Impact	Critical-Catastrophic	Total Impact Score: 3.33 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Southside Region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Hazardous Materials Incident Public Perceptions			
Perceived confidence in city's ability to respond and recover from this hazard	**Perceived confidence in personal ability to protect self and family from this hazard**	**Concern over the impact to personal health and safety if this hazard were to occur locally**	**Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally**
			

Nuclear Detonation

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A nuclear blast is the result of a device that uses a nuclear reaction to create an explosion far more powerful than that of conventional explosives. When nuclear weapons or improvised nuclear devices (INDs) explode, they produce energy in the form of a blast wave, intense light, heat, and radiation.

Risk Profile

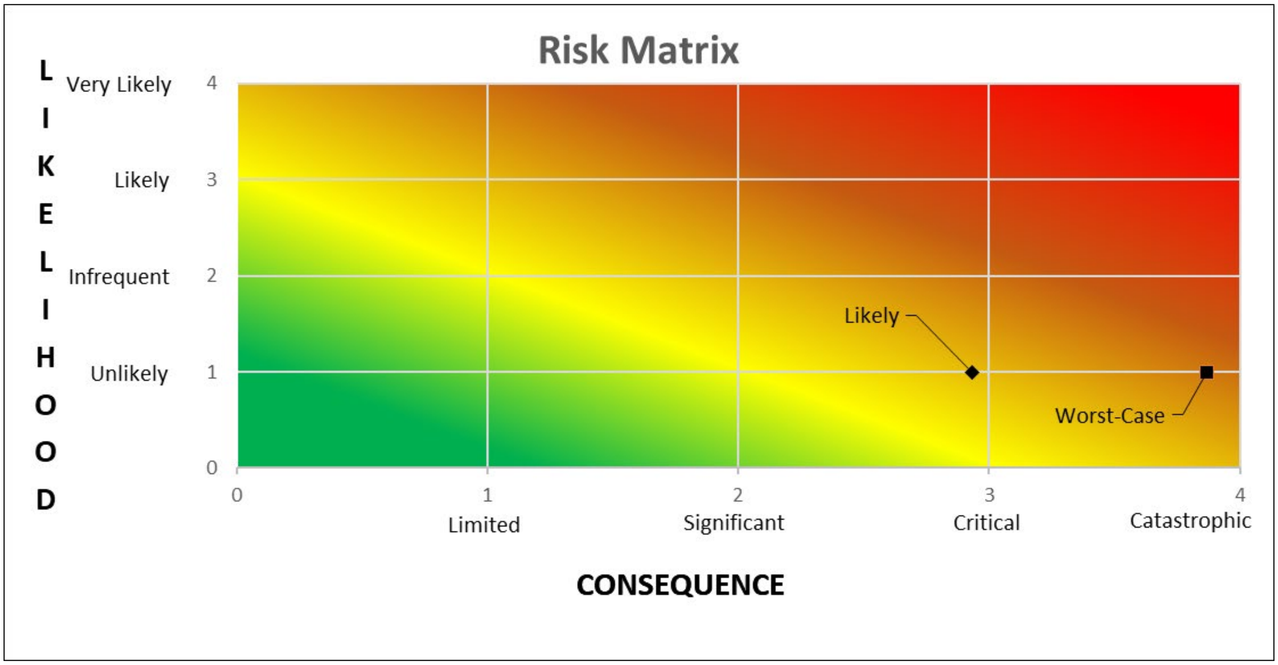
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Nuclear Detonation Hazard Risk Profile

	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	Likelihood	1 Unlikely	1 Unlikely	50%
Consequence	Impact	2.67 Significant-Critical	3.83 Critical-Catastrophic	40%
	Warning Time	4 Short	4 Short	5%
	Duration	4 Very Long	4 Very Long	5%
	Total Risk Score	1.97	2.43	

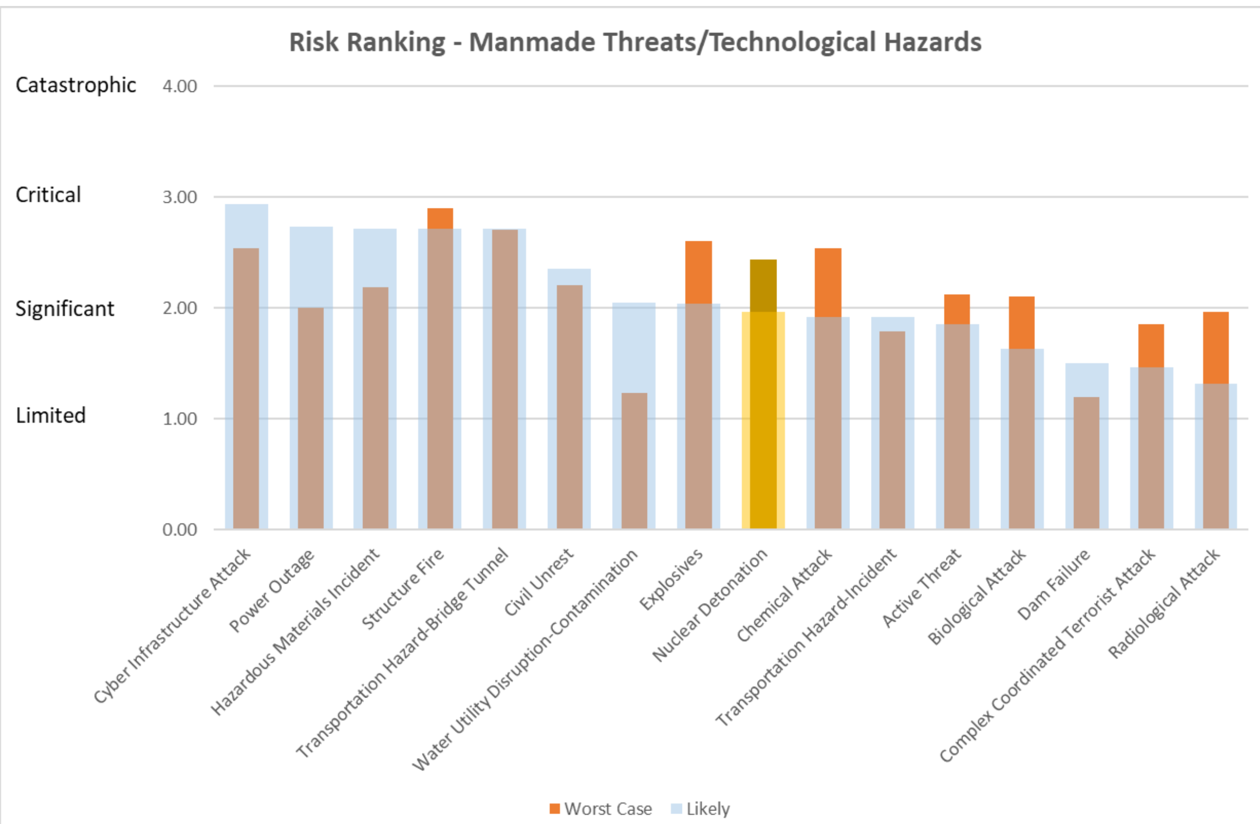
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Nuclear explosions can cause significant damage and casualties from blast, heat, and radiation. A nuclear weapon is a device that uses a nuclear reaction to create an explosion. Nuclear devices range from a small portable device carried by an individual to a weapon carried by a missile. A nuclear explosion may occur without warning. After the immediate blast wave and heat from the explosion, the radioactive byproducts from the nuclear reaction adhere to aerosols and create fallout which is carried through the atmosphere in the immediate area of the blast and farther downwind. Fallout descends back to the ground level within the first 15 minutes and continues for days following the detonation. Over time, the fallout may travel around the world depending on the altitude of the burst, weather patterns and fallout particle sizes. Fallout presents the greatest risk within the first few hours after the detonation when it is emitting the highest levels of radiation. Radioactive contamination may last for years in the effected area. Secondary effects of fallout can result in contaminated water and feed for agriculture as soil becomes contaminated which in turn can contaminate food products such as milk, cattle, and vegetable products. Radioactive isotopes consist of various metals such as cobalt, cesium, and cadmium which can also cause toxicological effects for those that ingest or inhale these metals.[21]

A **likely incident** includes the employment of a 0.1-10 kiloton (KT) improvised nuclear device (IND) by a terrorist organization who wishes to disrupt the U.S. infrastructure. In the event of an incident, the affected area could be isolated or widespread depending on the amount of nuclear material used. A 0.1 KT device can have a severe damage zone of 200 yards, a moderate damage zone of 200 yards to one-half mile, and a light damage zone of one-half mile to two miles. A 1 KT device can create a severe damage zone of one-quarter mile, a moderate damage zone of one-quarter mile to one-half mile, and a light damage zone of one-half mile to two miles. A 10 KT device can have a severe damage zone of one-half mile, a moderate damage zone of one-half mile to one mile, and a light damage zone of one mile to three miles. Victims within the three zones can suffer minor to major injuries, including death due to blast, thermal burn, or radiation injuries. Fallout can occur for up to 24 hours post-detonation and impact an area 10 to 20 miles downwind. Damage to the local infrastructure and casualties could be high depending on the device's size, detonation location and time. With the large military presence in the Hampton Roads area and the fact that most interstate commerce has to travel either over or under a body of water, adversaries could consider the area a target of opportunity.

The **worst-case incident** consists of a detonation of a 10-kt-equivalent IND at or near the center of any Hampton Roads city, at or near ground level, without warning and during a workday. The number of casualties needing immediate medical care would be very significant. An even larger population would be at risk of exposure to radioactive fallout in the hours to days after the explosion. This would result in a mass casualty incident that would overwhelm the region's medical capacity. Additionally, a blast of this magnitude would result in severe to catastrophic damage to all structures within a half-mile radius.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Hampton Roads Southside Sub-region has a population of 1.1 million people with a large U.S. military presence, the Port of Virginia, and other essential components that make up the U.S. infrastructure. The Hampton Roads area is home to the Navy Atlantic Fleet with its air wings and support units. The Naval Special Operations Warfare Group, to include the Developmental Group, is located in Virginia Beach. The region's transportation routes are dependent on the use of tunnels and bridges due to the abundant number of waterways in the area. The Hampton Roads area could be considered a target of opportunity for nation states, foreign and domestic terrorist groups.

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[21] https://www.ready.gov/nuclear-explosion (date accessed, 6/16/2020)

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

From the period of 1945 to 1992, there have been 1,032 nuclear detonations on U.S. soil as part of a testing program overseen by the US Government. Not one unprovoked nuclear detonation has been recorded within the United States. While tensions elevated between the U.S. and the U.S.S.R. during the cold war era, various nuclear non-proliferation treaties have helped to quell this threat in recent decades. However, during an interview in February 2021, the U.S. Strategic Command Commander urged policy makers and the U.S. military to shift its principle assumption from "nuclear employment is not possible" to "nuclear employment is a very real possibility" given the changing landscape of regional, conventional conflicts which are escalating with Russia and China. Additionally, foreign adversaries continue to make non-treaty accountable advancements in capabilities with nuclear weapons.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

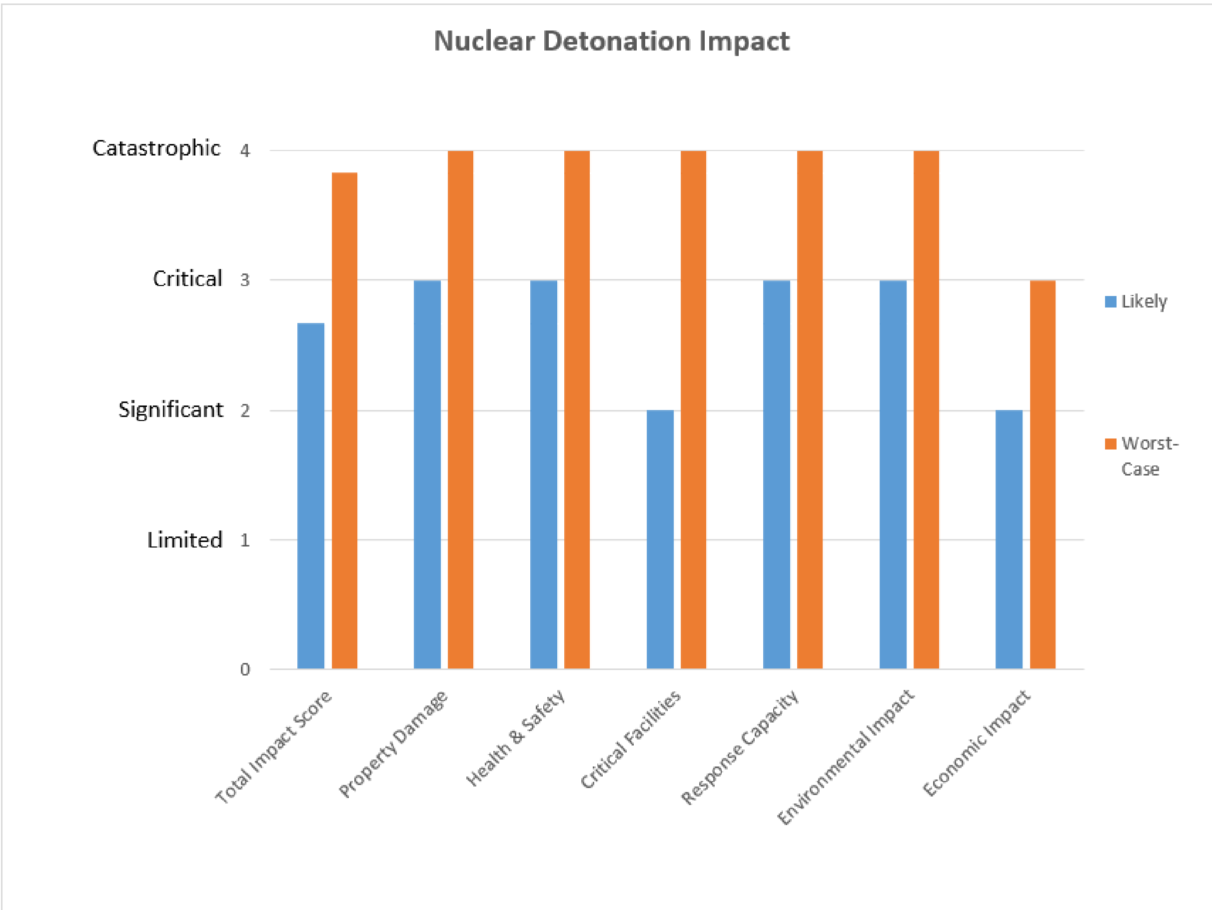
Future Likelihood of a Nuclear Detonation		
	Likely	**Worst-Case**
Historical Average (time period)	No events in our history	No events in our history
Historical Annual Probability	0%	0%
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	Yes
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence.	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

Considerations: Attack with a nuclear weapon is a growing threat according to the U.S. Strategic Command. In February 2021, the USSTRATCOM Commander described the likelihood of nuclear weapon employment as, "a very real possibility." Our adversaries continue to modernize and grow their nuclear arsenal and advance delivery systems which may not be countered with conventional defense systems. Our adversaries also continue to develop technologies and nuclear weapon systems which are not accountable to existing treaties.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Nuclear Detonation Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Very Long - More than one week	Very Long - More than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Nuclear Detonation Consequence Analysis - Likely		
Property Damage	Critical	Property damage is between 26-50% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Critical	Serious environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant-Critical	Total Impact Score: 2.67 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Nuclear Detonation Consequence Analysis - Worst-Case		
Property Damage	Catastrophic	Propert damage is severe, greater than 50% of critical and non-critical infrastructure affected.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Catastrophic	Shut down of critical facilities will be more than one month.
Response Capacity	Catastrophic	Response capacity is overwhelmed and requires significant and long lasting state and federal government support.
Environmental Impact	Catastrophic	Severe environmental impact.
Economic Impact	Critical	Serious economic impact. Standard of living is seriously affected.
Total Impact	Critical-Catastrophic	Total Impact Score: 3.83 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Power Outage

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A Power Outage is defined as the unexpected loss of electrical power. An extended power outage may impact the whole community and the economy.[22]

Risk Profile

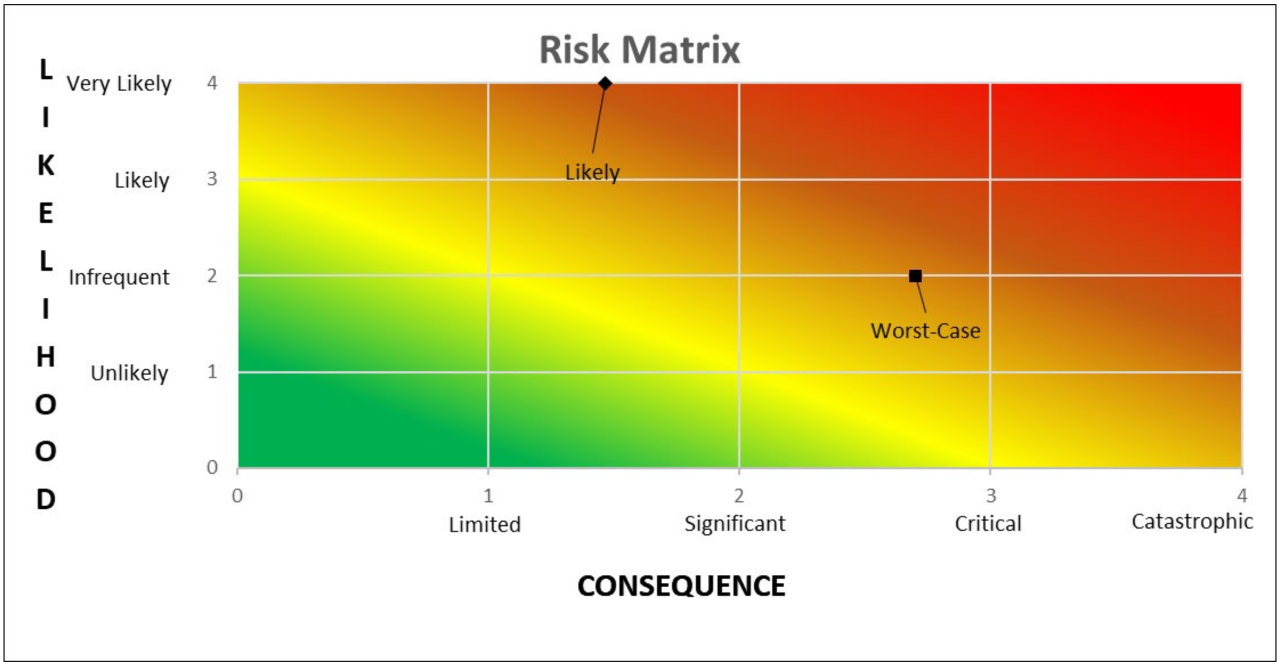
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Power Outage Risk Profile				
	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	Likelihood	4 Very Likely	2 Infrequent	50%
Consequence	Impact	1.33 Limited-Significant	2.00 Significant	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	3 Long	3 Long	5%
	Total Risk Score	2.73	2.00	

[22]https://www.fema.gov/media-library-data/1527865875064-7a5a439a4714d4bb8d553294e0023d2b/PowerOutage_ May2018.pdf

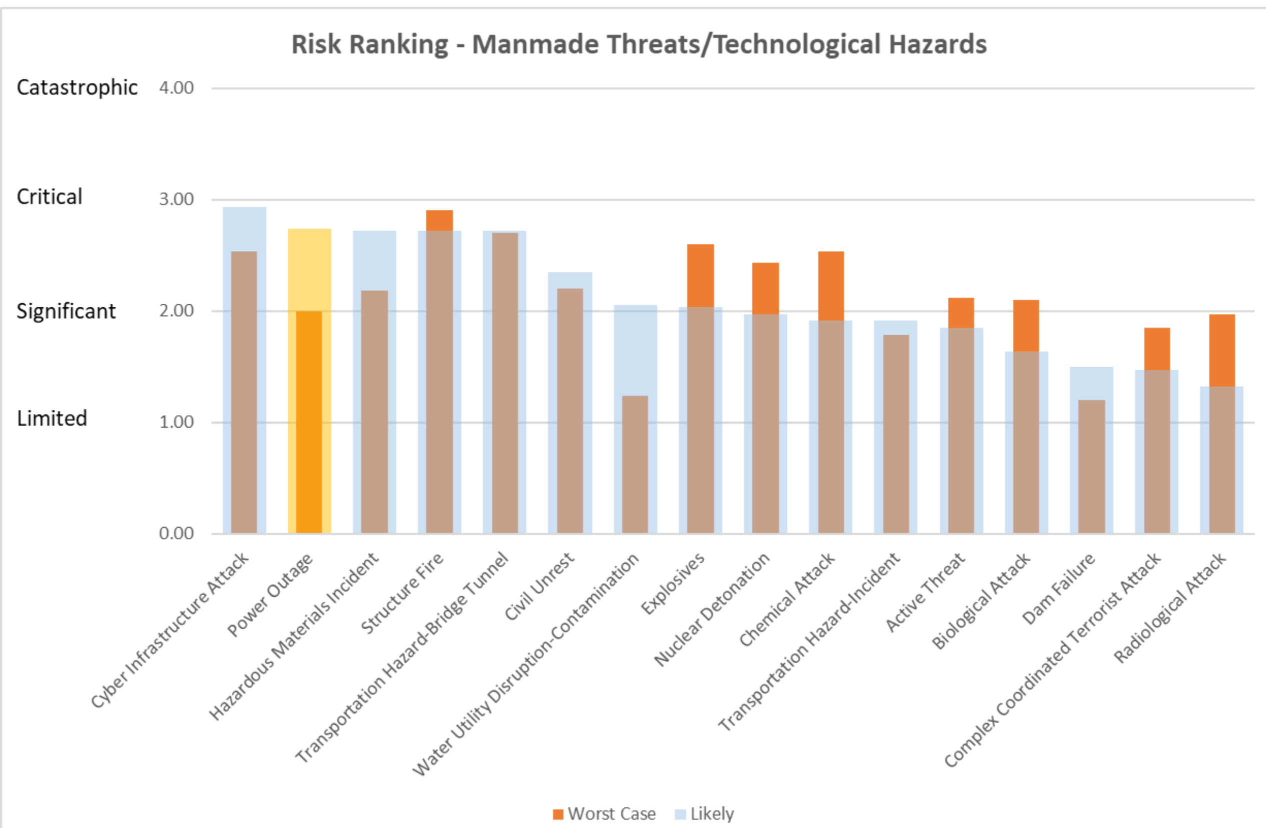
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

According to FEMA, the electric power industry is the backbone of America's economic sectors, generating the energy that powers its people and businesses in global commerce. Critical customers of the 3,200 companies involved in the generation, transmission, and distribution of electricity for U. S. sale represent many industries: Transportation and utility services, emergency and healthcare services, communications infrastructure, and manufacturing are critical grid interdependencies.[23] This reliance creates vulnerability among critical sectors and support infrastructure. As a result, continuity of electric service is not only a national safety and security priority, but communication and coordination between different levels of government and electric services is vital to control hazards and minimize outage impacts. A power outage creating long-term and critical services disruption can result from a natural disaster, space weather, large near-earth object, accident, terrorist act such as an electromagnetic pulse (EMP), or significant cyber incident.

The **likely incident** consists with outages over a large area which may occur following a severe weather event. Damage to infrastructure can include but is not limited to poles, overhead conductors, and transformers. Depending on severity, it may require several days to repair and restore power. Customers without power may require assistance following the event's aftermath.

The **worst-case incident** consists of an area-wide blackout of the bulk power system affecting more than 500,000 customers which may be caused by an unusual event. The bulk power system is controlled by a governing body, PJM, and controls are in place to mitigate such an event.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Power outages can occur in any area and affect multiple customers in our system's territory. Exposure to hazards associated with power outages could be anticipated across Hampton Roads, since access to this utility is topographically uniform. This also means that the potential impact when service is disrupted is large. Power outages affect public safety, communications, and commerce, and strain public and private resources. This is especially true of power outage conditions that persist for an extended time period.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Multiple system-wide outage events occur in Hampton Roads due to extreme weather conditions involving high wind, heavy ice or snow, tornadic activity, and hurricane storm surge. Extreme heat or cold does not necessarily cause large scale outages affecting most end users. Mitigation protocols and contingencies are implemented during these types of events and overseen by PJM, the regional transmission organization. The Department of Energy discloses that 26 Electric Disturbance Events occurred in Virginia from 2010 to 2019 which met reporting criteria.[24]

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[23] https://www.fema.gov/media-library-data/1512398599047-7565406438d0820111177a9a2d4ee3c6/POIA_Final_ 7-2017v2_(Compliant_pda)_508.pdf (date accessed, 6/16/2020)

[24] https://www.oe.netl.doe.gov/OE417_annual_summary.aspx

Notable Incidents in the Southside Region

Several significant weather events caused power outages to Virginia residents within the last ten years as described below:[25]

- In June of 2012, severe storms caused power outages to 880,000 customers.
- During October of 2012, winds from Hurricane Sandy resulted in power outages to an estimated 156,000 customers.
- More recently, storm winds from Tropical Storm Isaias and Hurricane Dorian produced power outages in the Hampton Roads Region.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of an Power Outage		
	Likely	Worst-Case
Historical Average (time period)	2.6 events per year in VA (2010-2019)	0.26 events per year in VA (2000-2015)
Historical Annual Probability	80% chance of annual occurrence	13% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	71-80% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of occurrence annually	2 - Infrequent: 1-10% chance of annual occurrence

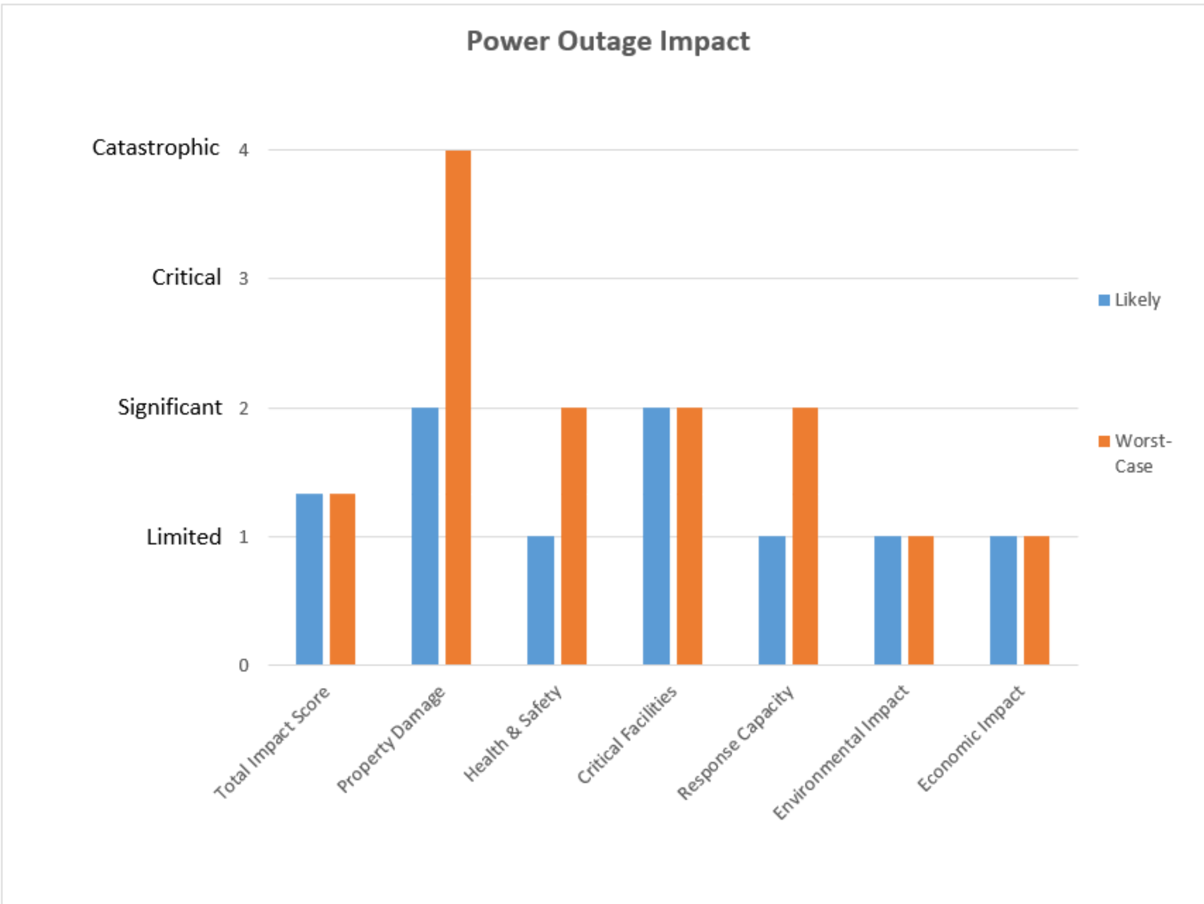
Considerations: Approximately 1.1 million customers are served in the Hampton Roads Southside Sub-region. Outages are primarily caused by severe winter storms, tropical storms, and other weather events. Therefore, future annual probability assumes that the frequency and intensity of these storms will remain consistent with recent historical averages. Additionally, PJM has made investments in infrastructure and modernization that help to mitigate power outages. Given that outages are not expected to exceed one week, the economic impact is estimated at minimal.

[25] http://insideenergy.org/2014/08/18/data-explore-15-years-of-power-outages/
https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=857631

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Power Outage Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Very Long - More than 24 hours	Very Long - More than 24 hours
Duration	Long - Less than one week	Long - Less than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Power Outage Consequence Analysis - Likely		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.33 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

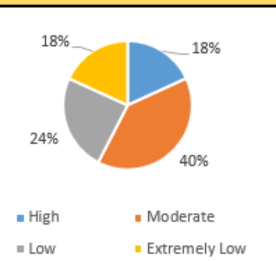
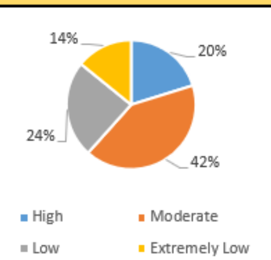
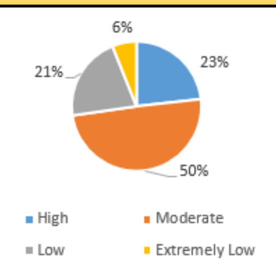
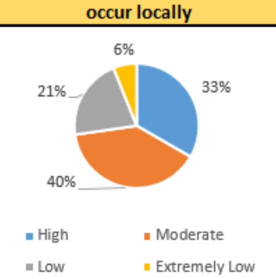
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Power Outage Consequence Analysis - Worst-Case		
Property Damage	Catastrophic	Propert damage is severe, greater than 50% of critical and non-critical infrastructure affected.
Health & Safety	Significant	Injuries are manageable, may include at least one death.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Significant	Total Impact Score: 2.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Power Outage Public Perceptions

Perceived confidence in city's ability to respond and recover from this hazard	Perceived confidence in personal ability to protect self and family from this hazard	Concern over the impact to personal health and safety if this hazard were to occur locally	Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally
			

Radiological Attack

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A radiological attack is defined as the spreading of radioactive materials with the intent to cause harm. Radioactive materials are used every day in laboratories, medical centers, food irradiation plants, and for industrial uses.

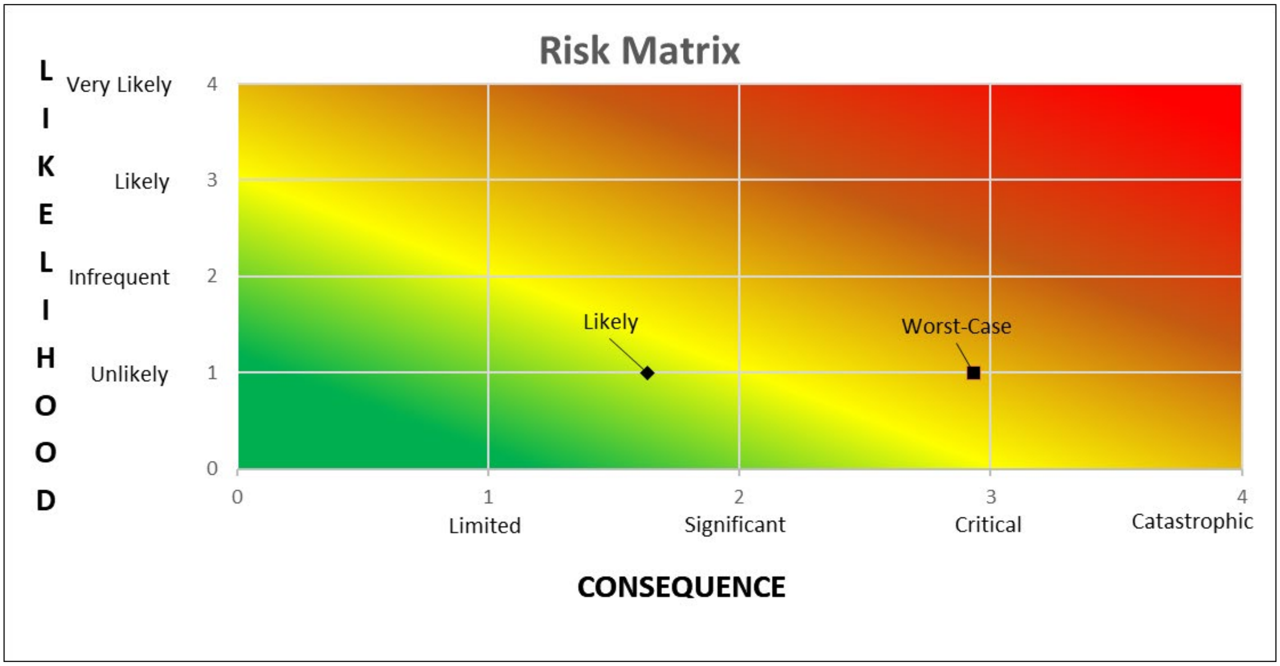
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Radiological Attack Hazard Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	1 Unlikely	1 Unlikely	50%
Consequence	**Impact**	1.17 Limited-Significant	2.67 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	3 Long	4 Very Long	5%
	Total Risk Score	1.32	1.97	

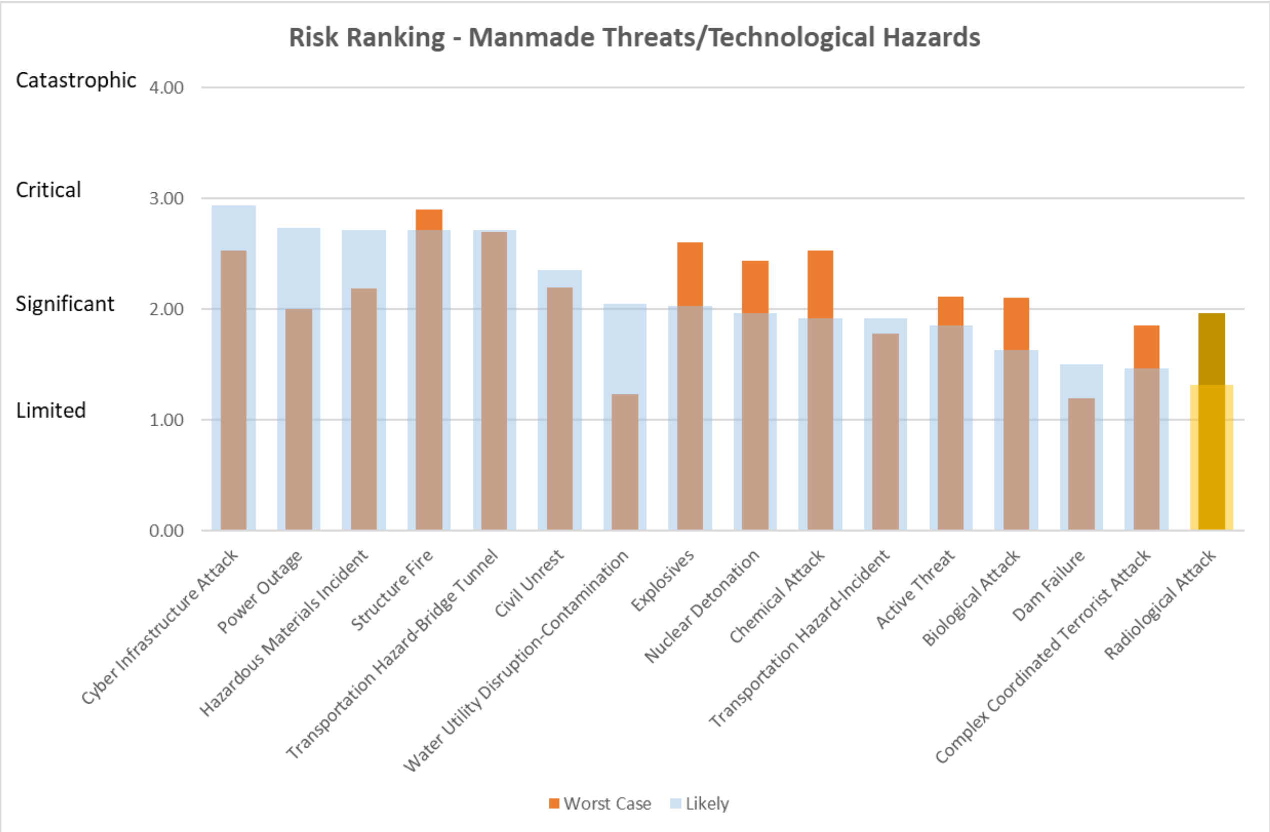
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

If radioactive materials are stolen or acquired, adversaries may use those materials in a "dirty bomb" or "radiological dispersal device" (RDD). A RDD uses conventional explosives or other means to disperse radioactive materials over a targeted area. Radioactive materials emit radiation to include gamma, x-rays, beta , and alpha radiation. Gamma and x-ray radiation can travel long distances in air and can pass through the body, exposing internal organs. Beta radiation can travel a few yards in the air and could cause skin damage. Alpha radiation travels only an inch or two in the air and cannot penetrate skin. Alpha and beta radiation are hazardous if ingested or inhaled. If the method of dispersion is a dirty bomb, most human injuries would take place close to the detonation site.. The likely injuries would result from heat, debris, radiological dust, and the blast waves from the explosion. The health effects of radiation are determined by the amount of radiation, type of radiation, means of exposure (external, internal, ingested, inhaled, absorbed), and the length of time exposed. Long-term health effects are a low concern as the low-dose radiation exposure expected from a RDD would only slightly increase the rate of cancer over naturally existing rates. Acute radiation syndrome is not likely as a result from a dirty bomb. Acute radiation syndrome is a short-term health effect that appears when individuals are exposed to a highly radioactive material over a relatively small amount of time. When exposed to large radiation doses of over 100 REM, 10% of the population would experience signs and symptoms of acute radiation syndrome (nausea, vomiting, diarrhea, and reduced red blood cell counts).

A **likely incident** would involve detonation of radioactive materials intended for industrial or medical use (not x-ray machines) combined with explosives in a backpack-size bomb.

A **worst-case incident** would involve detonation of large-scale explosives with large amounts of radioactive materials in a densely populated area. Another possible scenario could entail a stolen high-energy source placed in a populated location and thereby irradiate a large number of individuals; this is known as a Radiological Exposure Device (RED). An RED is more likely to cause harm compared to an RDD.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Due to the limitations of this means of attack, likely targets will include densely populated areas, areas of important economic importance, military assets, or infrastructure (to include water/food supply). While nuclear-powered warships or powerplants in the region could be a potential source of radiation, the most likely source would originate from a stolen industrial radioactive source material. An increased presence of medical isotopes in the region (from several large medical complexes and treatment centers) could also pose a potential source of radioactive material.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have not been any recent occurrences of radiological attacks in our area, though there is a reasonable concern that an event could occur in the future due to the availability of radioactive materials and the prominence of terrorist activities globally. The risk of an accidental radiological release is most probable.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Radiological Attack		
	Likely	**Worst-Case**
Historical Average (time period)	None	None
Historical Annual Probability	<1% annual probability	<1% annual probability
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	No
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence.	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

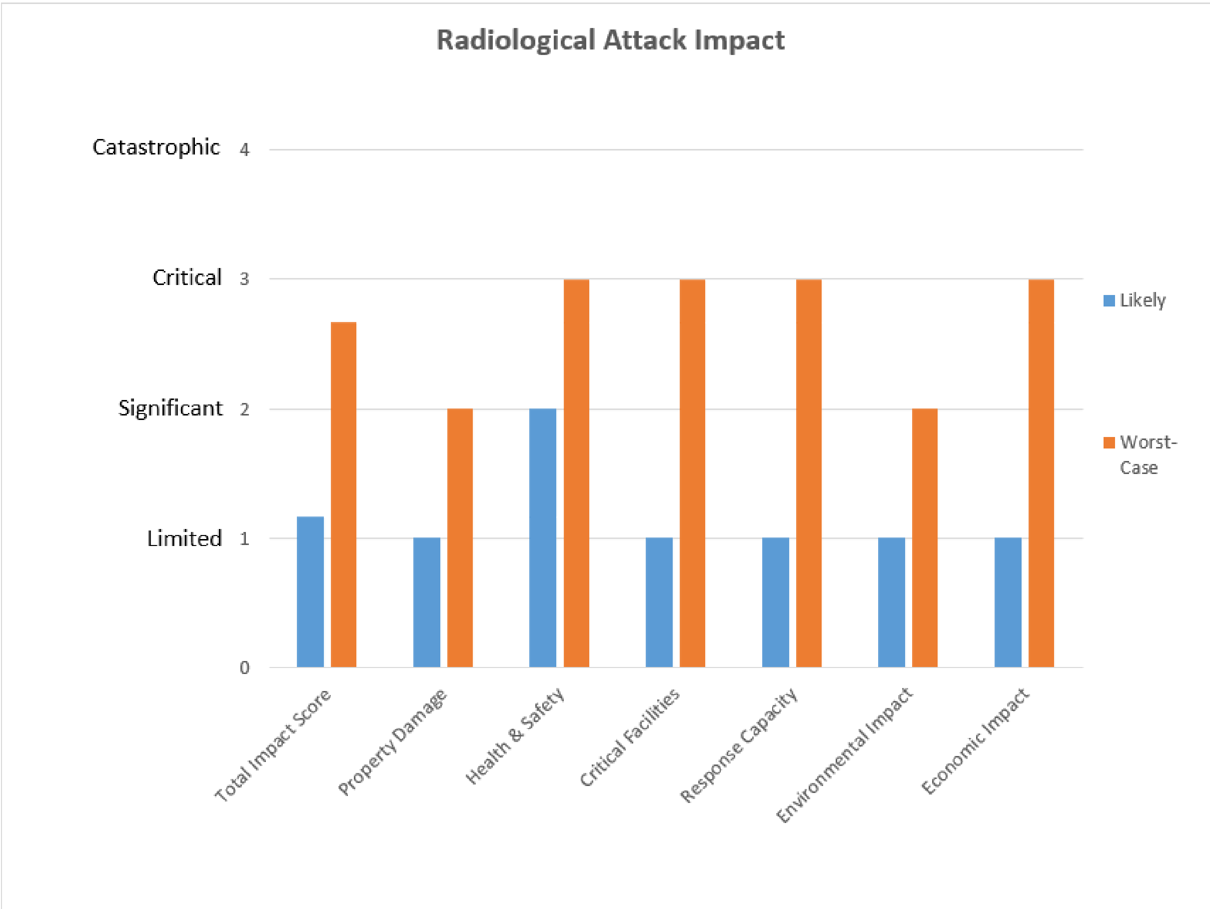
Considerations: A radiological attack is certainly a possibility for local terrorist activities in the future, though the likely impact of such an attack would be limited by their means of dispersion, the amount and type of radiation, the physical and chemical form of the radioactive material, the weather conditions, and the geographical characteristics of the immediate area of the attack. Most explosives would likely limit dispersion of particles to a few city blocks or up to a few miles. Although the materials to carry out such an attack are available, the likelihood of acquiring enough radioactive materials to combine with a large-scale explosive or dispersion device is not a scenario that could be expected to occur with frequency. Because it is difficult to design a radiological dispersion device that would deliver radiation doses significant enough to cause immediate health effects or fatalities in a large number of people, experts generally agree that the most likely use of this device would be to contaminate facilities or places where people live and work or to cause anxiety in those who have been or think they may be exposed.[26]

[26] Radiological Attack Fact Sheet, National Academies, and the U.S. Department of Homeland Security

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Radiological Attack Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Long - Less than one week	Very Long - More than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Radiological Attack Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Significant	Injuries are manageable, may include at least one death.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.17 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Radiological Attack Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Critical	Shut down of critical facilities 1-4 weeks.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Critical	Serious economic impact. Standard of living is seriously affected.
Total Impact	Significant-Critical	Total Impact Score: 2.67 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Structure Fire

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A Structure Fire hazard is an uncontrolled fire involving any building or structure. Structure Fires can occur in a residential, commercial, or industrial setting. Fires can easily spread from one structure to another, and the size of a Structure Fire hazard is constantly evolving. Fire can have an intentional or unintentional cause or may be the result of another hazard type.

Risk Profile

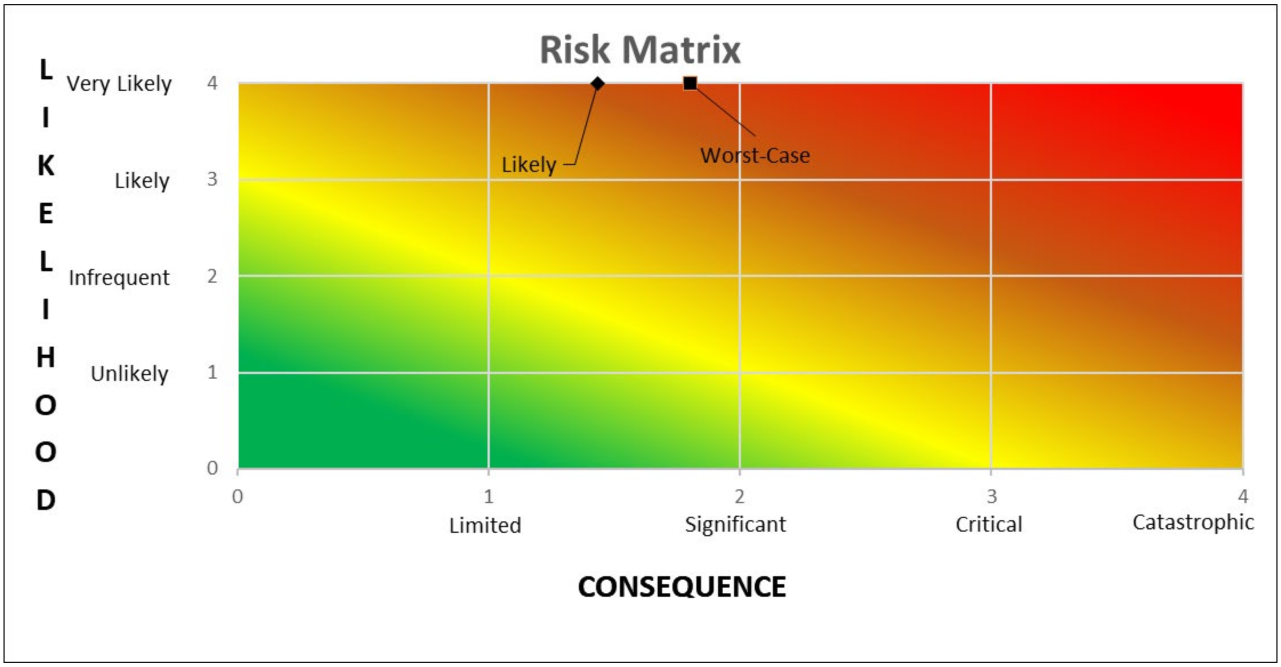
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Structure Fire Hazard Risk Profile

	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	Likelihood	4 Very Likely	4 Very Likely	50%
Consequence	Impact	1.17 Limited-Significant	1.50 Limited-Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	2 Moderate	5%
	Total Risk Score	2.72	2.90	

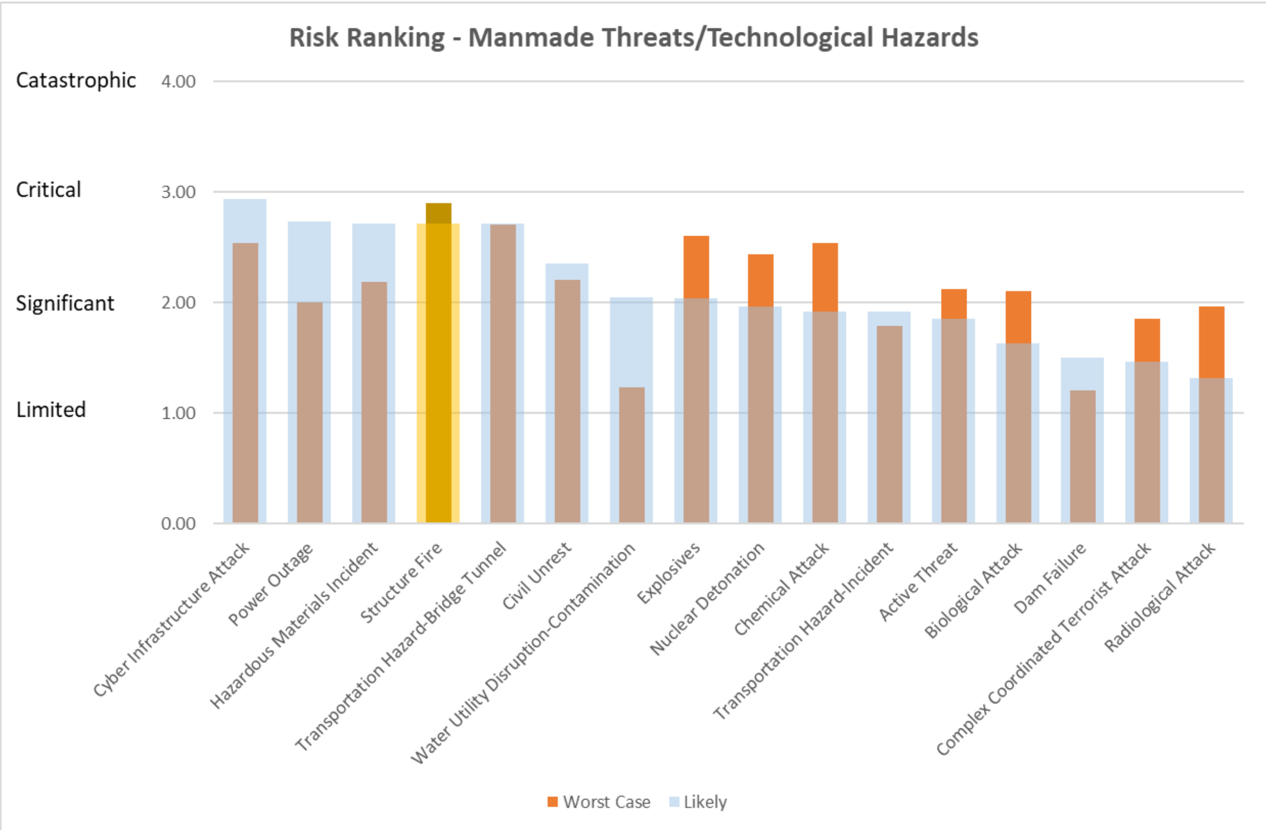
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of Hazard

Any fire in or on a building or other structure is considered a Structure Fire even if the structure itself was not damaged. Mobile property used as a fixed structure, such as manufactured homes and portable buildings, are considered structures. A vehicle that burns inside a structure with the fire limited to the vehicle is considered a vehicle fire.[27]

Structural Fires mainly occur in a residential, commercial, or community-based building. The propagation rates of such fires vary depending on the types of materials used in building construction; in turn, the degree of flame and/or radiant heat generation differs. Building materials can be broadly classified into five categories based on the fire resistivity: (1) concrete and fire-resistive coated steel for high rise residential or commercial buildings, (2) steel (for wall) and steel rafters (for roof) for commercial buildings, (3) brick, mortar (for wall), and wood frame (for floors) for residential buildings, (4) heavy timber for community-based buildings, and (5) wood frame for residential buildings . Categories (1) and (2) comprise the fire-resistant and noncombustible materials. The residential or commercial buildings constructed using such materials do not propagate the fire; therefore, flame behavior remains restricted. However, the materials in categories (3), (4), and (5) are semi-combustible and/or combustible; consequently, their flame generation rate is very high.

In addition to the building materials, the placement of windows (near or far away from the fire source), condition of windows (open or closed), and the methods of building construction play an important role in propagating the structural fires. In this context, an international fire consultant group attempted to graphically model the structural fires' propagation through an improperly sealed wall. They observed that an improperly constructed building allows a significant wind flow inside the building that may considerably expedite the spread of structural fires. Furthermore, many other combustible (e.g., wood furniture, clothes, cooking gas, oil) and noncombustible (e.g., metal furniture, ceramic appliances, water) substances may encounter Structural Fires, and could cause a significant amount of flame, radiant heat, hot surfaces, hot liquids, and vapors. Any metal with a low melting point could easily melt down in structural fires. The presence of flame, radiant heat, hot surfaces, hot liquids, vapors, and molten metal substances in structural fires make it dangerous for any living being.[28]

The **likely incident** is characterized as a residential Structure Fire.

The **worst-case incident** is characterized as a multi-alarm Structure Fire with uncontrolled flame spread to multiple structures.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Structure Fire may occur anywhere where structures exist in the region. Areas that are densely populated and densely developed with unprotected (non-sprinkler) housing are particularly vulnerable to Structure Fires. Structure Fires may spread rapidly in locations with congested infrastructure. Historic areas and special construction permits (military, government, industry) may increase fire risk due to variances allowed in local fire code, ordinances, and regulations.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

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[27] https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Fires-by-occupancy-or-property-type (date accessed, 6/16/2020)

[28]https://www.sciencedirect.com/topics/engineering/structural-fire#:~:text=Any%20metal%20with%20a%20low, dangerous%20for%20any%20living%20being. (date accessed, 6/16/2020)

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

From 2012-2020, there were 3,754 Structure Fires in Virginia Beach. Data for Portsmouth, Chesapeake and Norfolk was not available for this analysis. Structure Fires have a significant economic impact to the property owner and of the surrounding community.

Notable Incidents in the Southside Region

From 2012-2020, Virginia Beach experienced 33 Structure Fires which resulted in a loss greater than $1 million each.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

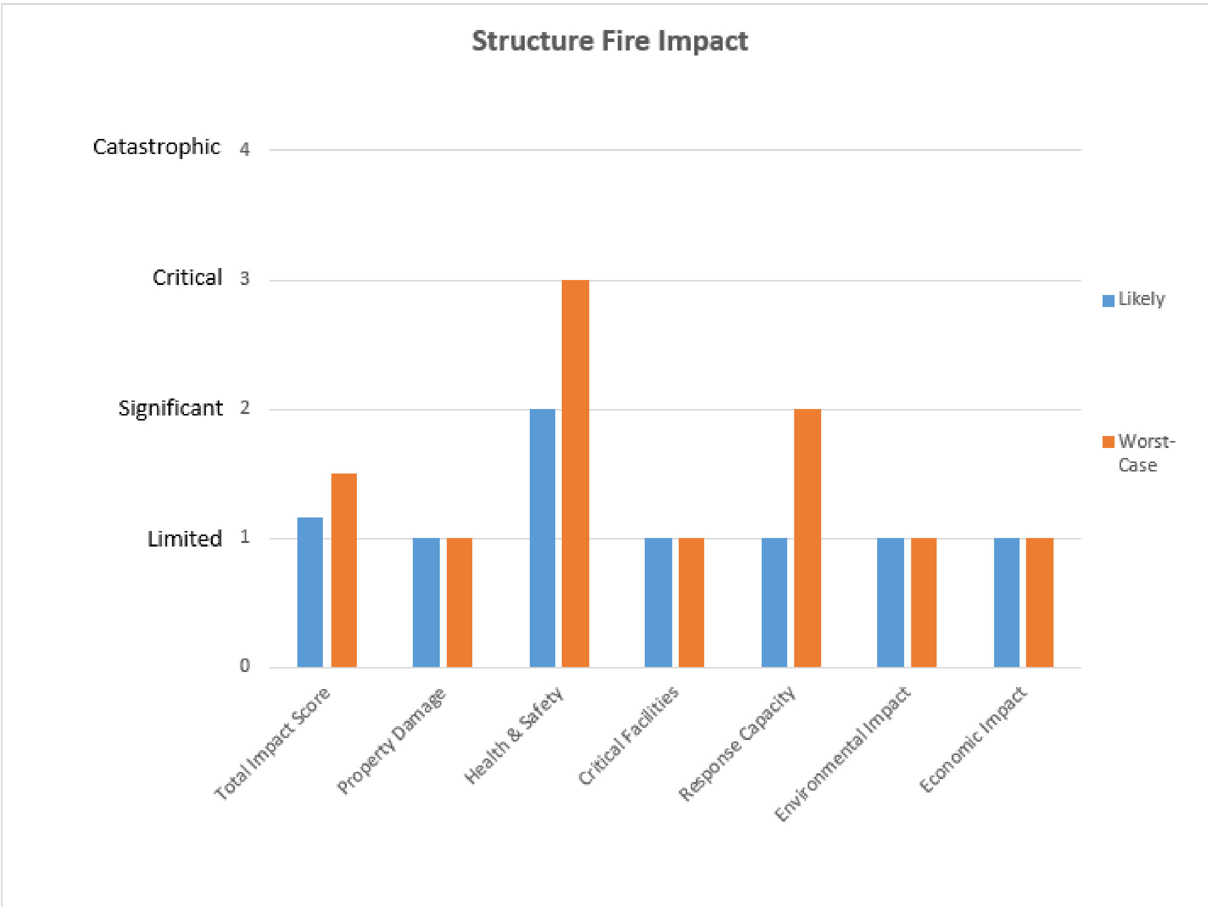
Future Likelihood of a Structure Fire		
	Likely	**Worst-Case**
Historical Average (time period)	1 event every day	90 events every 9 years (2012-2020)
Historical Annual Probability	100%	100% probability of occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	91-100% chance of annual occurrence	91-100% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of occurrence annually	4 - Very Likely: 30+% chance of occurrence annually

Considerations: The future likelihood of Structure Fires in the region is not expected to be significantly different from the historical occurrence rate. A future annual probability of 100% classifies the likelihood of a Structure Fires as Very Likely, or one event every year. Increases in population density and development density will increase the number of structures available to burn. However, fire prevention safeguards built into modern constructions are in place to contribute to a decline in the overall likelihood of Structure Fires in the future.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Structure Fire Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Short - Less than six hours	Moderate - 6-24 hours

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Structure Fire Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Significant	Injuries are manageable, may include at least one death.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.17 on a scale of 1 (Limited) to 4 (Catastrophic)

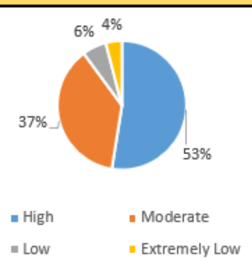
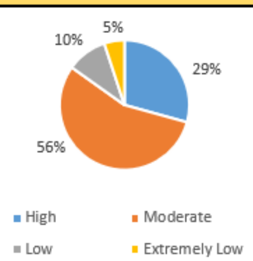
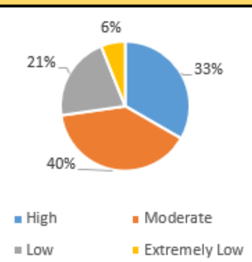
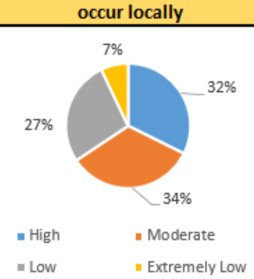
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Structure Fire Consequence Analysis - Worst-Case		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.50 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Structure Fire Public Perceptions			
Perceived confidence in city's ability to respond and recover from this hazard	**Perceived confidence in personal ability to protect self and family from this hazard**	**Concern over the impact to personal health and safety if this hazard were to occur locally**	**Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally**
			

Transportation Hazard – Bridge/Tunnel

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A Transportation Hazard involving a bridge or tunnel occurs whenever a vehicle accident or collision has the potential to cause harm. Any vehicle is capable of being involved in a Transportation Hazard. The most common types of Transportation incidents involve automobiles, trains, airplanes, or boats.

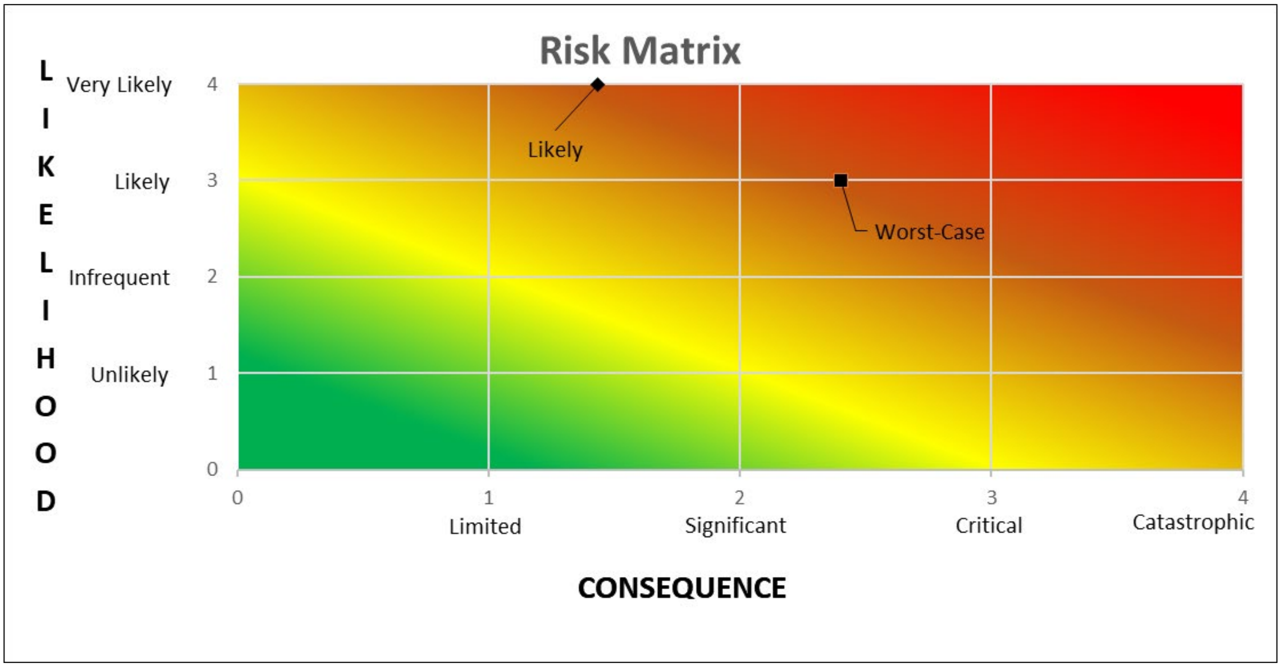
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Transportation Hazard-Bridge Tunnel Risk Profile				
	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	Likelihood	4 Very Likely	3 Likely	50%
Consequence	Impact	1.17 Limited-Significant	2.00 Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	4 Very Long	5%
	Total Risk Score	2.72	2.70	

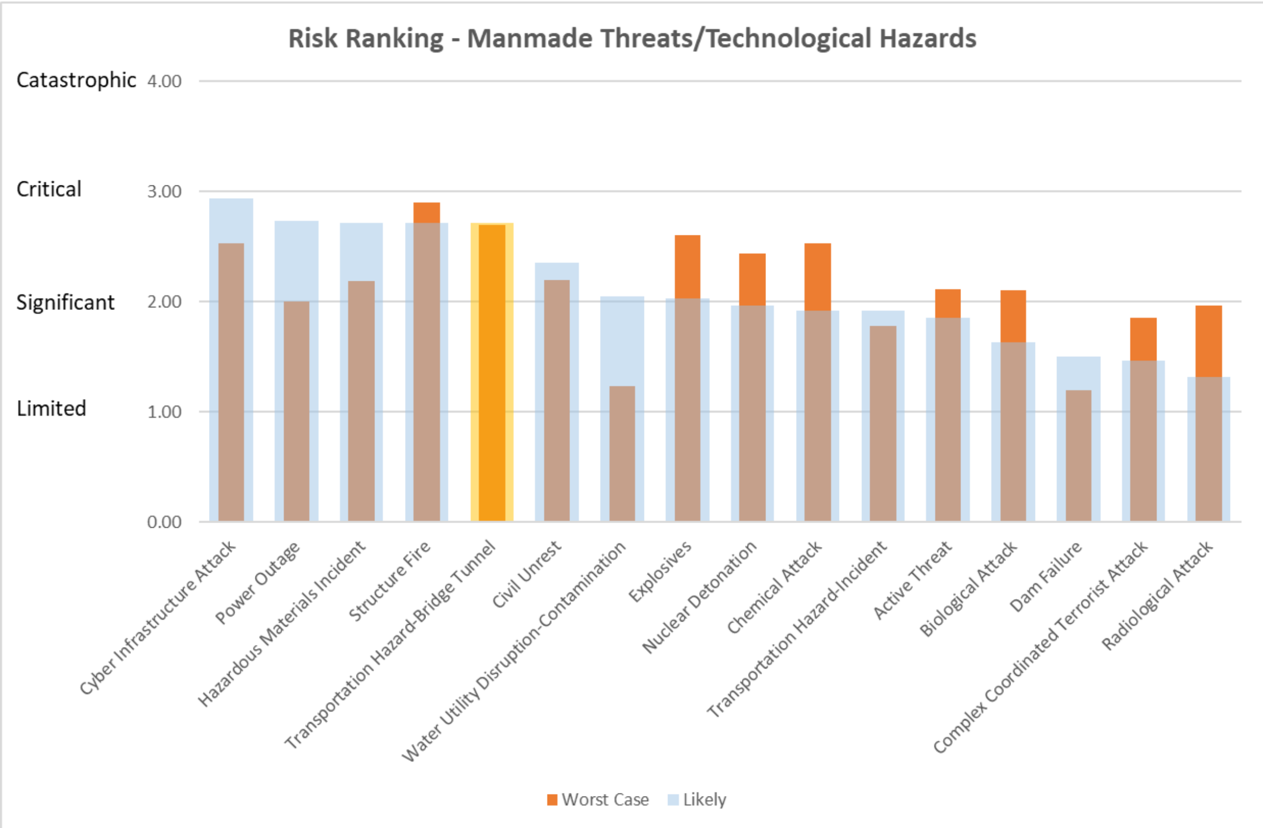
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

These incidents involve land, sea, and air transportation systems that impact a bridge or tunnel such as accidents on or with a bridge or tunnel. An accident is defined as an event that involves any of the following: a loss of life; a report of a serious injury to a person; a collision involving a rail transit vehicle; a runaway train; an evacuation for life safety reasons; or any derailment of a rail transit vehicle, at any location, at any time, whatever the cause.[29]

The Hampton Roads Harbor Tunnels experience approximately 2,000 vehicle incidents each month. Incidents may range from a flat tire or mechanical issues to a multi-vehicle accident or vehicle fire. The average clearance time for incidents occurring inside the tunnel is 13 minutes. The most **likely incident** to occur that would exceed the 13 minutes average clearance time would be a multi-vehicle accident or vehicle fire.

The **worst-case incident** is a large vehicle fire. Numerous incidents have occurred nationally and abroad which have led to the establishment of new tunnel construction standards and development of new tunnel fire suppression technology and techniques although the ages of the Hampton Roads Bridge-Tunnel (HRBT) and Monitor-Merrimac Memorial Bridge-Tunnel (MMMBT) outdate any improved efficiencies resulting from improved construction standards and technology. A large vehicle fire would potentially damage structural members, requiring a significant time period to make repairs. There are contingencies in place, such as long-term detours, to help minimize any long-term traffic delays. However, the shift of 80,000 to 100,000 vehicles daily would significantly impact traffic on interstate, primary, and secondary routes.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Hampton Roads area has a vast potential for transportation accidents and incidents. These incidents can be in the form of automotive, railway, aircraft, or watercraft. The high volume of traffic and congested roadways along with vast and diverse industry and commerce help to increase the likelihood of a transportation incident.

The Hampton Roads Region, located on the south end of the Chesapeake Bay, has many tidal bodies of water. As such, bridges and tunnels are necessary to facilitate travel in and around the region. Combined, these bridges and bridge-tunnels carry hundreds of thousands of vehicles daily. The Virginia Department of Transportation owns five bridge-tunnels in the region: the HRBT, the MMMBT, the I-564 Runway Tunnel, and the Downtown / Mid-town Tunnels, as well as a host of twin-trestle bridges. Each of these tunnels exist buried in earth beneath the harbor floor. Drivers access the tunnels by crossing the twin-trestle bridges. In most instances, interstate roadways transition into tunnel roadways on man-made portal islands. Each of these man-made islands maintain the ventilation buildings for the tunnels. The ventilation buildings house all the critical operating systems such as the ventilation systems, electrical switchgear, drainage, and fire suppression systems. Roadway tunnels in Hampton Roads range from 900 feet (I-564) to 7,500 feet (HRBT) in length.

One of the most likely contributing factors to a transportation incident is the presence of several large shipping ports in the area. These shipping ports provide an opportunity for a water borne transportation incident, but also contribute to land-based transportation incidents due to the increased volume of air, train, and commercial truck traffic required to move goods received at the ports. LNG Tankers travel the Baltimore Channel daily. An accident involving one of these vessels would require response from local and regional assets.

[29] https://www.law.cornell.edu/cfr/text/49/674.7 (date accessed, 6/16/2020)

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There is a bridge/tunnel incident in the region at least annually, involving a motorist or large transport vehicle over the bridge/tunnel.

Notable Incidents in the Southside Region

The Chesapeake Bay Bridge Tunnel is 17.6 miles long and consists of 2 tunnels. Since its opening in 1964, 15 vehicles have fallen from the bridge resulting in 18 fatalities.

- **1967:** A coal barge struck the bridge closing it for two weeks.
- **21 January 1970:** USS Yancey Navy cargo ship was anchored during a storm and pulled loose from the anchor damaging 375 feet and closing the bridge for 42 days.
- **1972:** A barge broke loose closing the Chesapeake Bay Bridge for two weeks.

The HRBT Tunnel conveys 100,000 cars per day. Over the last decade, there have been five major incidents:

- **4 October 2020:** A car fire eastbound in the tunnel led to evacuations.
- **15 May 2019:** An eight-car crash occurred in the eastbound tunnel.
- **16 July 2016:** A crash caused a fire and closed the bridge for four hours.
- **11 Jul 2009:** A pipe burst caused major flooding within the tunnel.
- **2 Jul 2009:** Major flooding from heavy rains closed the tunnel for seven hours.

On 6 March 2003, a Navy Aircraft became stuck on an overpass of the I-564 tunnel.

The downtown tunnel has experienced two major incidents:

- **26 May 2020:** A tractor trailer became lodged in the tunnel due to excess height.
- **17 August 2009:** Major flooding closed the tunnel.

The Midtown Tunnel has experienced three major incidents.

- **2003:** Hurricane Isabel impacts flooded the tunnel due to a tide gate issue requiring the removal of44 million gallons of water. This event caused $70 million in damages and kept the tunnel closed for four weeks.
- **29 October 2012:** closed tide gates due to flooding from rain closed the tunnel for 4 hours).
- **July 10, 2014**: Heavy rainfall resulted in the tunnel’s closure.
- **6 September 2019:** Eastbound closed for 6 hours due to flooding form Hurricane Dorian.

On 13 April 2020, a tractor trailer cab was blown over the side of the High-Rise Bridge due to high wind.

On 12 January 2018, the draw was stuck open on the Gilmerton Bridge.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of an Transportation Hazard-Bridge Tunnel		
	Likely	**Worst-Case**
Historical Average (time period)	5 events over 11 years (2009-2020)	2 events of 11 years (2009-2020)
Historical Annual Probability	45% probability of annual occurrence	18% probability of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	41-50% chance of annual occurrence	11-20% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of occurrence annually	3 - Likely: 11-30% chance of annual occurrence

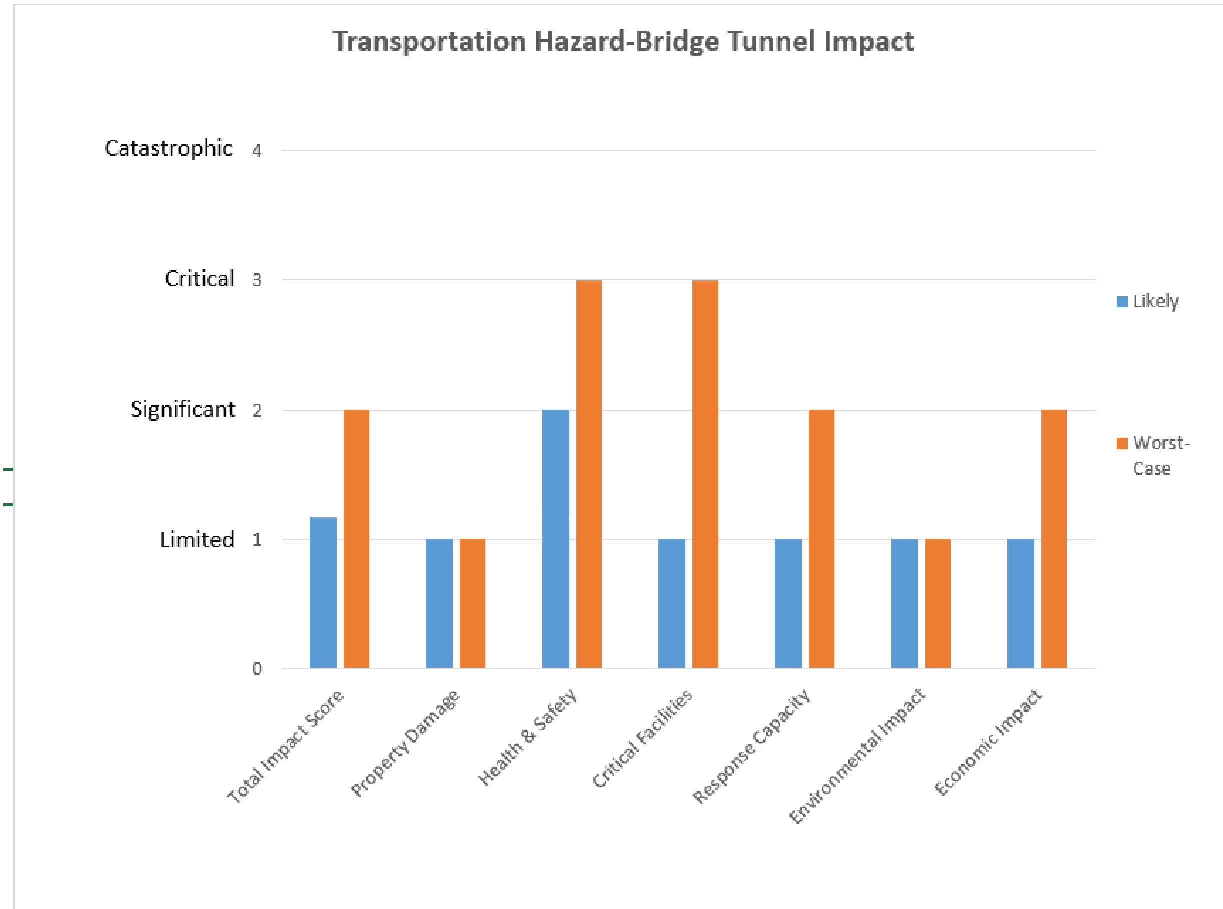
Considerations: Two major considerations for significant incidents involving the regions bridges and tunnels are limited access and construction. Bridges and tunnels in the southeastern Virginia typically include two 12-foot travel lanes and a moderate emergency shoulder. The exception are tunnels which do not have emergency shoulders. As bridges cross bodies of water and are constructed of twin-trestles, emergency egress must be made in the direction of travel since there are no emergency crossovers. Traffic queues often delay emergency response.

Vehicle fires are the biggest concern for the region’s tunnels. Most of the region’s tunnels were built structurally to withstand a 100-Megawatt fire. However, most of the regions' tunnels were constructed prior to development and implementation of new tunnel construction standards which now include emergency exit portals. The future likelihood of a transportation incident involving bridges and tunnels is not expected to be significantly different from historical occurrences. A moderate annual population and increases in motor vehicle traffic due to future expansion of interstate highways and tunnels is expected to result in a slight increase in the likelihood of transportation incidents over time.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Transportation Hazard-Bridge Tunnel Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Short - Less than six hours	Very Long - More than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Transportation Hazard-Bridge Tunnel Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Significant	Injuries are manageable, may include at least one death.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.17 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

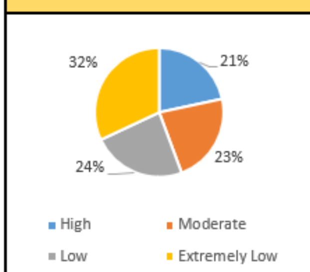
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

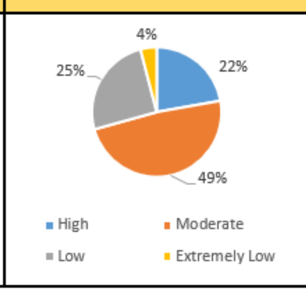
Transportation Hazard-Bridge Tunnel Consequence Analysis - Worst-Case		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Critical	Shut down of critical facilities 1-4 weeks.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant	Total Impact Score: 2.00 on a scale of 1 (Limited) to 4 (Catastrophic)

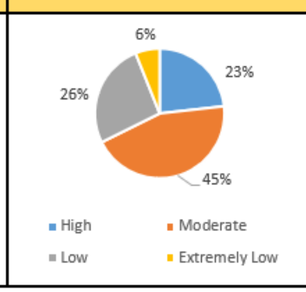
Consequence Analysis: Public Perception

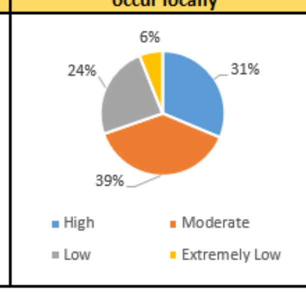
The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Transportation Hazard-Bridge Tunnel Public Perceptions			
Perceived confidence in city's ability to respond and recover from this hazard	**Perceived confidence in personal ability to protect self and family from this hazard**	**Concern over the impact to personal health and safety if this hazard were to occur locally**	**Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally**









Transportation Hazard - Incident

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

Transportation hazards incidents can occur on highways, waterways, railways, and aircraft routes (especially take-off and landing corridors). Pipelines serve as transportation routes for materials that create risk for the region when a pipeline becomes damaged, blocked, or sabotaged.

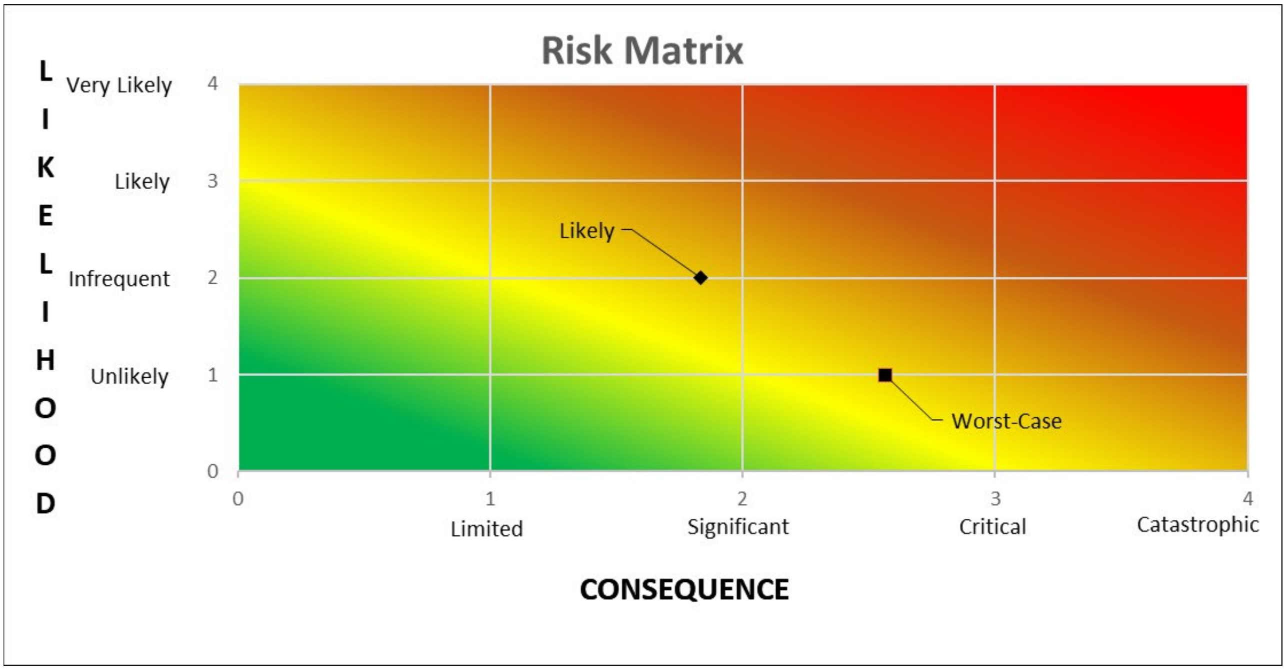
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Transportation Hazard-Incident Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	2 Infrequent	1 Unlikely	50%
Consequence	**Impact**	1.67 Limited-Significant	2.33 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	3 Long	5%
	Total Risk Score	1.92	1.78	

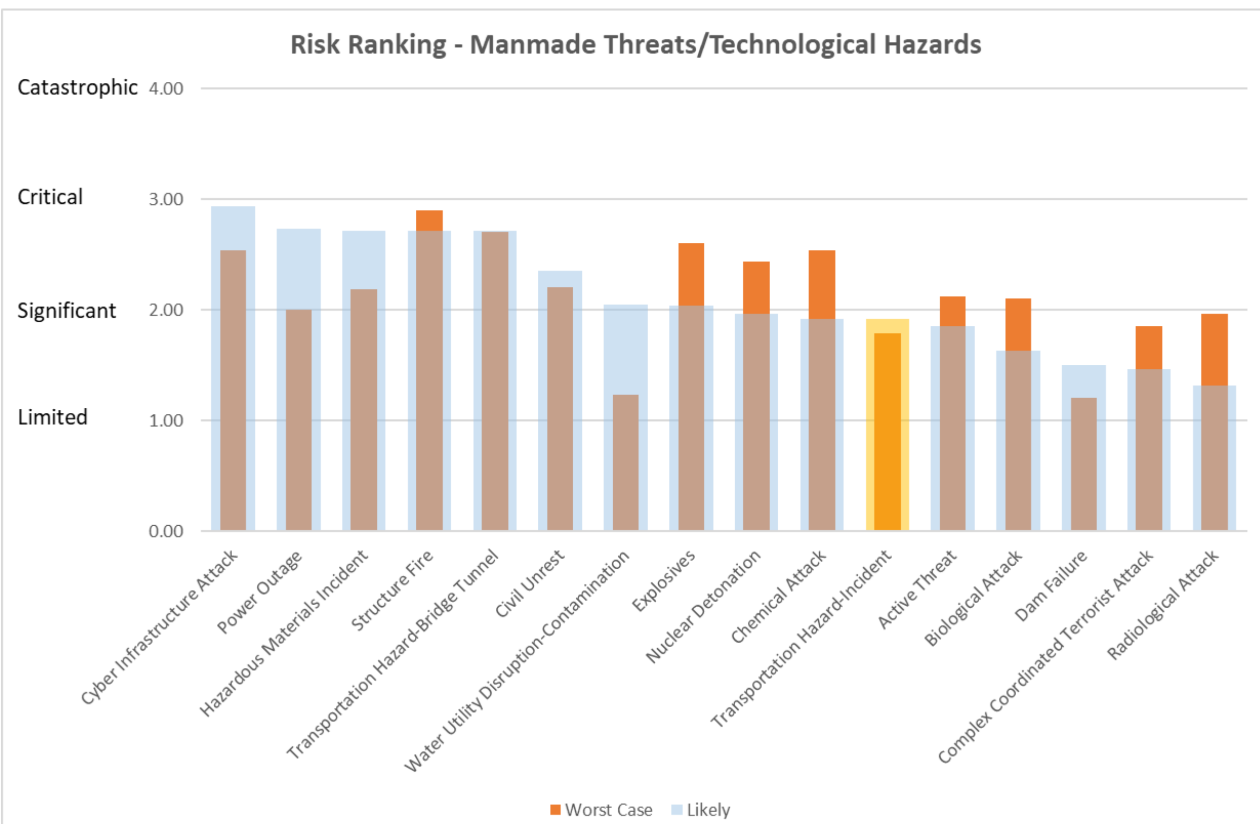
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Transportation hazards involve land, sea, and air transportation systems and include the infrastructure that supports each system. Examples of transportation hazards include:

- Roadway, aviation, nautical, and railway accidents;
- Transportation systems failures or shutdowns, and
- Any impediment to travel/transportation of goods and people.[30]

Accident is defined as an event that involves any of the following: loss of life report of a serious injury; a collision involving a rail transit vehicle; a runaway train; an evacuation for life or safety reasons; or any derailment of a rail transit vehicle, at any location, at any time, whatever the cause.[31]

The most **likely incident** that would be of major significance, consists of a tractor trailer involving a hazardous materials release. This incident could either be in the form of an accident or a faulty containment system and potentially adversely affect both life safety and the environment. The incident could shutdown roadways for an extended period, disrupting commerce and commuters. Roadways could be negatively impacted requiring both time and man hours to render them safe to use.

The **worst-case incident** in the area would involve a jet-fueled aircraft crash in a densely populated area, pipeline rupture, or a railcar derailment (with or without hazardous cargo). These types of incident would overwhelm local responders and would require regional support. An aircraft crash in a densely populated area could result in a significant loss of life. The impact to population, infrastructure, environment, and commerce would be widespread and potentially long enduring. Challenges for first responders would include site access and critical stress management. The mass casualty event would quickly overwhelm the first responders of the immediate jurisdictions as well as the local hospitals. Both equipment and manpower would reach capacity quickly and would require mutual aid from several neighboring jurisdictions as well as some states and federal resources. The impact to the environment would require considerable resources to contain and neutralize.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Hampton Roads area has a vast potential for transportation accidents and incidents. These incidents can be in the form of automotive, railway, aircraft, or watercraft. The high volume of traffic and congested roadways along with vast and diverse industry and commerce help to increase the likelihood of a transportation incident.

One of the most likely contributing factors to a transportation incident is the presence of several large shipping ports in the area. These shipping ports provide ample opportunity for a water born transportation incident, but they also are a major contributor to the increased use of other means of transportation in the area. These shipping ports bring vast quantities of goods in and out of the area and those goods are then transported by air, rail, and road both to and from the ports. LNG Tankers travel the Baltimore Channel daily. A propane/butane hub (NGL Supply Terminal) is located in Chesapeake and serves road, rail, and marine transportation routes. An accident involving one of these vessels would require response from local and regional assets.

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[30]https://www.nationalservice.gov/sites/default/files/olc/moodle/ds_online_orientation/viewef14.html?id=3139&chapterid=896#:~:text=Transportation%20Hazards%20%E2%80%93%20These%20involve%20land,any%20impediment%20to%20travel. (date accessed, 6/16/2020)

[31] https://www.law.cornell.edu/cfr/text/49/674.7 (date accessed, 6/16/2020)

Another local contributor to a transportation incident is the local geography. Most notably the large number of bridges and tunnels in the area. Both of these roadway elements create traffic issues on a routine basis. On many occasions they have provided the backdrop for significant accident scenes often involving heavy vehicles up to and including tractor trailers which, on occasion, have gone off the bridges and into the waterways below. Any issues in, on or around these bridges and tunnels tends to create a significant backup of traffic adding to the likelihood of additional accidents.

Air transportation is another area of local concern. We have an international airport terminal which provides for travel as well as several cargo flights moving goods in and out of the area daily. This volume of arriving and departing aircraft significantly increases the likelihood of a transportation incident involving an aircraft.

Finally, we have several military bases in the area. These bases increase both the population in the area and the need to transport people and equipment. They also create an increased risk of sea and air incident potential.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Incidents on bridges involving a motorist or large transport vehicle over the bridge occur annually. In 2018 and 2019, there were two large commercial motor vehicle accidents in the Southside Sub-region that resulted in fatalities. These did not involve Hazmat. While there have been 18 aviation accidents in the Southside Sub-region over the last decade, all of these cases involved general aviation or military aircraft, not commercial passenger aircraft. Over the last 5 years (2016-2020), there have been 31 rail accidents resulting in one injury.[32]

<u>Notable Incidents in the Southside Region</u>

The Hampton Roads area has witnessed several transportation related events. These have ranged from the numerous passenger vehicle accidents that occur daily, to the hazardous materials release and everything in between.

Some of the more notable events include:
- Airplane crash at the Norfolk Botanical Gardens
- Fighter jet crash into an apartment building
- Tractor Trailer leaking hazardous materials at the Norfolk International Terminal
- Tractor trailer leaking hazardous materials on Hampton Blvd
- Tractor trailer hanging off a bridge on I-64
- Tractor trailer involving a trapped driver on I-64
- Tractor trailer involving a trapped driver on Terminal Blvd
- Tractor trailer going off the Bay Bridge Tunnel into the Chesapeake Bay
- Cargo truck going off the Bay Bridge Tunnel into the Chesapeake Bay
- Various fuel and other chemical leaks from ships
- Natural gas fueled trash trucks involved in vehicle fire situations

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[32] https://www.dmv.virginia.gov/safety/#crash_data/crash_facts/index.asp
https://data.ntsb.gov/carol-main-public/basic-search
https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/AccidentByStateRailroadSQL.aspx

Future Likelihood of the Hazard

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Transportation Hazard-Incident		
	Likely	**Worst-Case**
Historical Average (time period)	One incident involving a Hazmat vehicle over the last three years	No incidents in the last 20 years
Historical Annual Probability	4% annual probability based on national statistics	0%
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	2 - Infrequent: 1-10% chance of annual occurrence	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurence

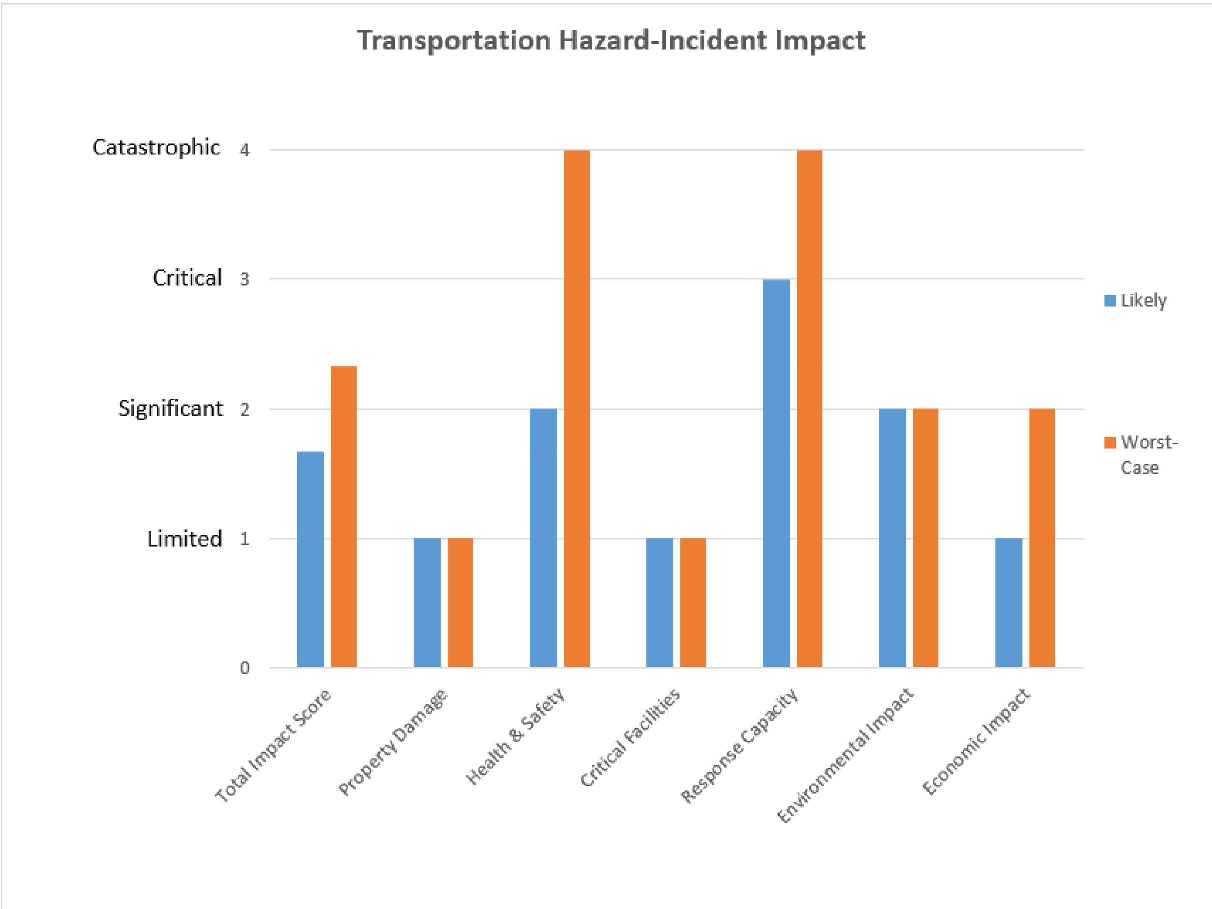
Considerations: These are the most likely to least likely transportation incident to occur in the future:

- A passenger vehicle accident.
- A traffic incident involving a tractor trailer.
- An event occurring while transferring cargo from one form of transport to another.
- An incident involving a train and another vehicle.
- Transportation incidents involving planes both passengers and/or cargo.
- A waterborne incident involving a cargo ship collision.
- Vessel fires on water or in dock/marina.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Transportation Hazard-Incident Warning Time & Duration		
	Likely	Worst-Case
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Short - Less than six hours	Long - Less than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Transportation Hazard-Incident Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Significant	Injuries are manageable, may include at least one death.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.67 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Transportation Hazard-Incident Consequence Analysis - Worst-Case		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Catastrophic	Response capacity is overwhelmed and requires significant and long lasting state and federal government support.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant-Critical	Total Impact Score: 2.33 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Water Utility Disruption/Contamination

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A sudden disruption or contamination in the potable water service caused by intentional or unintentional events resulting in the water supply to become unsafe or unavailable for use.

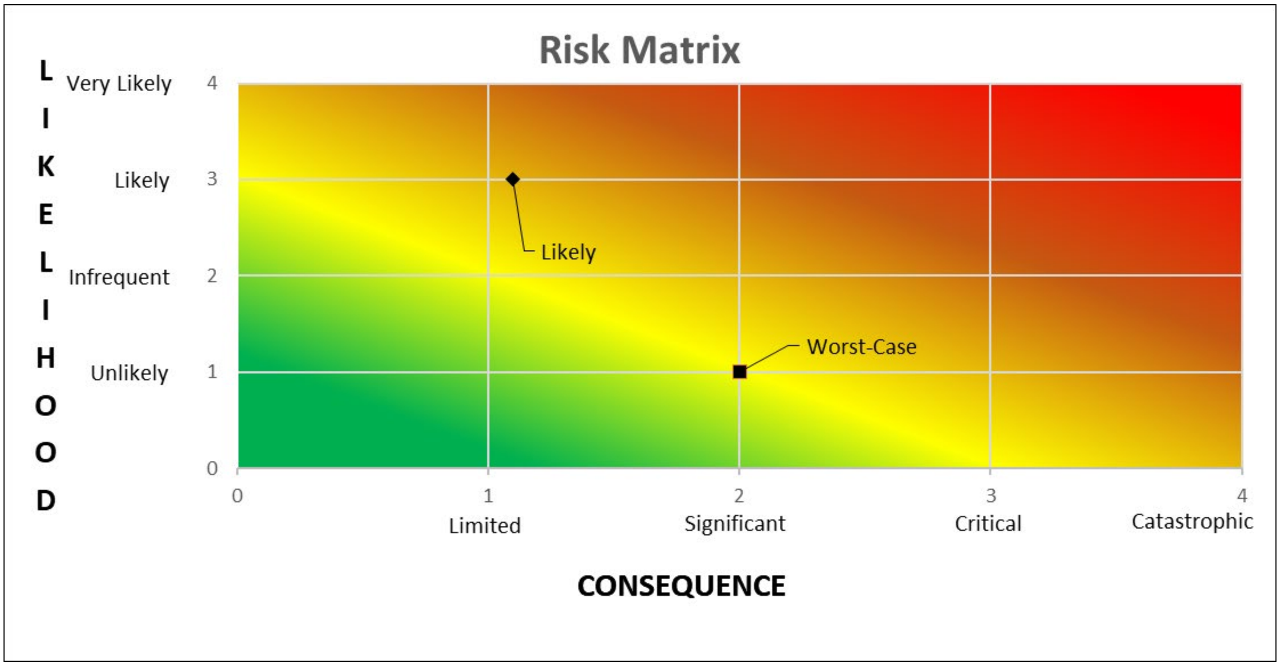
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Water Utility Disruption-Contamination Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	3 Likely	1 Unlikely	50%
Consequence	**Impact**	1.00 Limited	1.33 Limited-Significant	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	2 Moderate	3 Long	5%
	Total Risk Score	2.05	1.23	

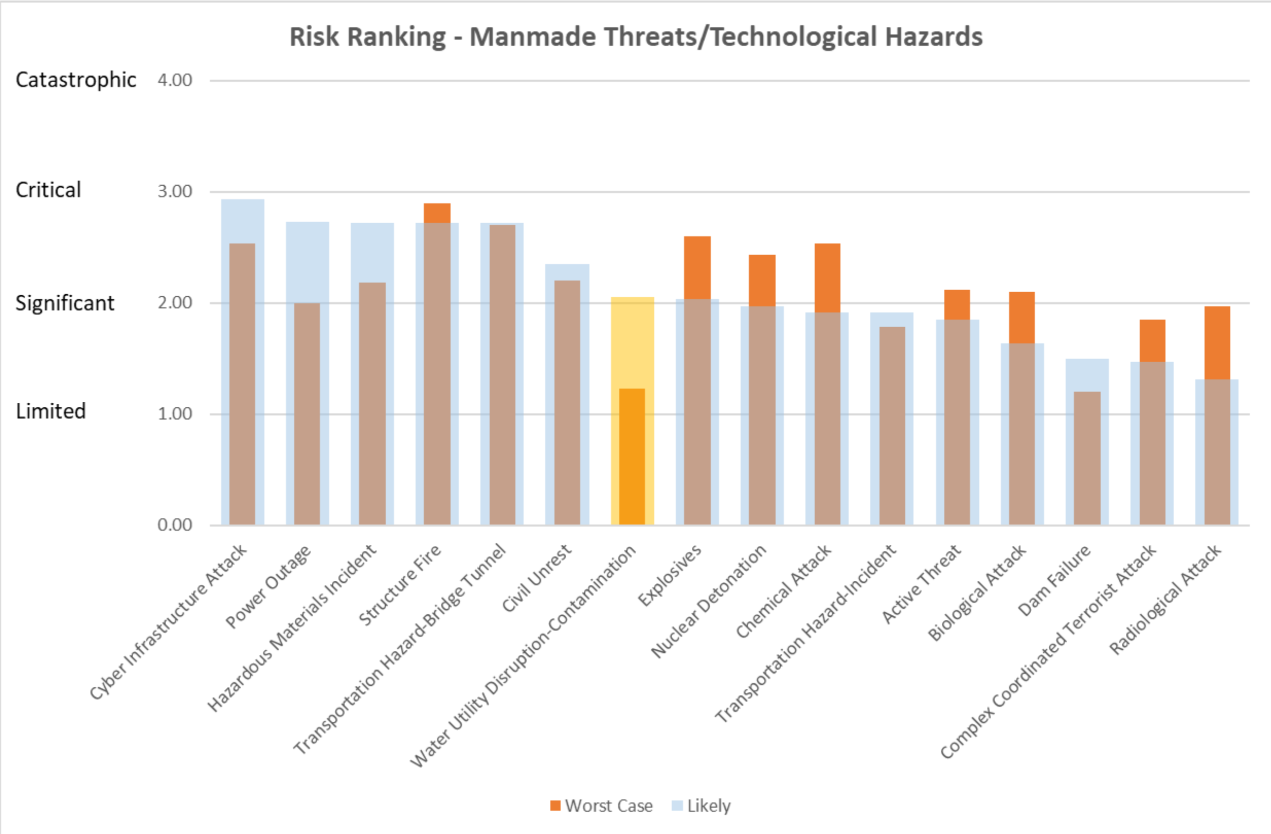
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

The area affected by a Water Utility Disruption can range from a neighborhood block to areas greater than an entire city. The duration of a Water Utility Disruption hazard depends greatly on the cause and scope of the disruption. Short-term disruptions may only last a few hours and are rarely hazardous; however, customers will likely have to boil water before use until test results confirm that water is safe for consumption. Long-term Water Utilities Disruptions can last for several days and may require the distribution of bottled water to selected vulnerable populations. Advanced warning of a Water Utility Disruption is highly unlikely except for planned water infrastructure replacement and system maintenance activities. Most Water Utility Disruptions are unpredictable and can occur anywhere. Several factors contribute to water disruptions to include extreme temperature variances causing ground settling/shifting, frozen distribution lines that result in rupture and loss of pressure, droughts, aging water infrastructure, and pressure changes which may lead to water main breaks. Contamination may occur at the source or could be introduced during the treatment process, storage, or at points throughout the distribution system.

The **likely incident** consists of an area-wide weather event (e.g., ice storm, hurricane, extended winter weather, freezing temperatures) that causes multiple disruptions (e.g., decreased treatment capacity, line breaks, etc.) across several jurisdictions in treatment and distribution.

The **worst-case incident** is one (likely caused by weather such as freezing conditions or hurricane) that disrupts the Norfolk main plant which provides most of the water to Norfolk and all the water to Virginia Beach.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

There are six water treatment plants (WTP) in the Southside region which provides water to 1.3 million customers. The water utilities are comprised of multiple interconnected systems to include various surface and groundwater sources, treatment plants, and distribution systems which provide water to neighboring jurisdictions. The City of Portsmouth treats and provides own water within Portsmouth but the WTP is located in Suffolk. Additionally, Portsmouth provides some water to Chesapeake under contract in the western branch. Chesapeake has two WTPs and receives raw water from Norfolk for one WTP and raw water from other sources in Chesapeake for the other WTP. Chesapeake purchases two million gallons per day of finished water from Norfolk. Norfolk has two WTPs and receives raw water from a variety of reservoirs, mainly the western branch reservoir in Suffolk. Virginia Beach does not have a WTP but purchases 100% of its water from Norfolk's main WTP. Chesapeake, Norfolk, and Portsmouth have emergency ground water capacity in case of surface water drought or contamination. Because of the interconnected systems, flow could be reversed in case of an emergency (e.g., Chesapeake could provide water to Portsmouth if needed). Most of the military installations receive water from these systems.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

The water utilities across the Southside region have multiple redundancies in supply, treatment, storage, and distribution which prevents and mitigates the impact of disruptions or contamination to the system. During the last decade, there have been a few disruptions caused by winter weather and freezing temperatures that affected more than 10,000 customers. Smaller, isolated incidents are quickly managed and resolved with negligible impact. There have been no system-wide problems or disruptions in the last 10 years.

Notable Incidents in the Southside Region

4 January 2018: Winter storm Grayson caused disruptions in Norfolk and Portsmouth (i.e., Norfolk water treatment process; Portsmouth experience significant number of line breaks decreasing volume). The Chesapeake WTP had to operate independently by reconfiguring from normal operations.

Future Likelihood of the Hazard

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

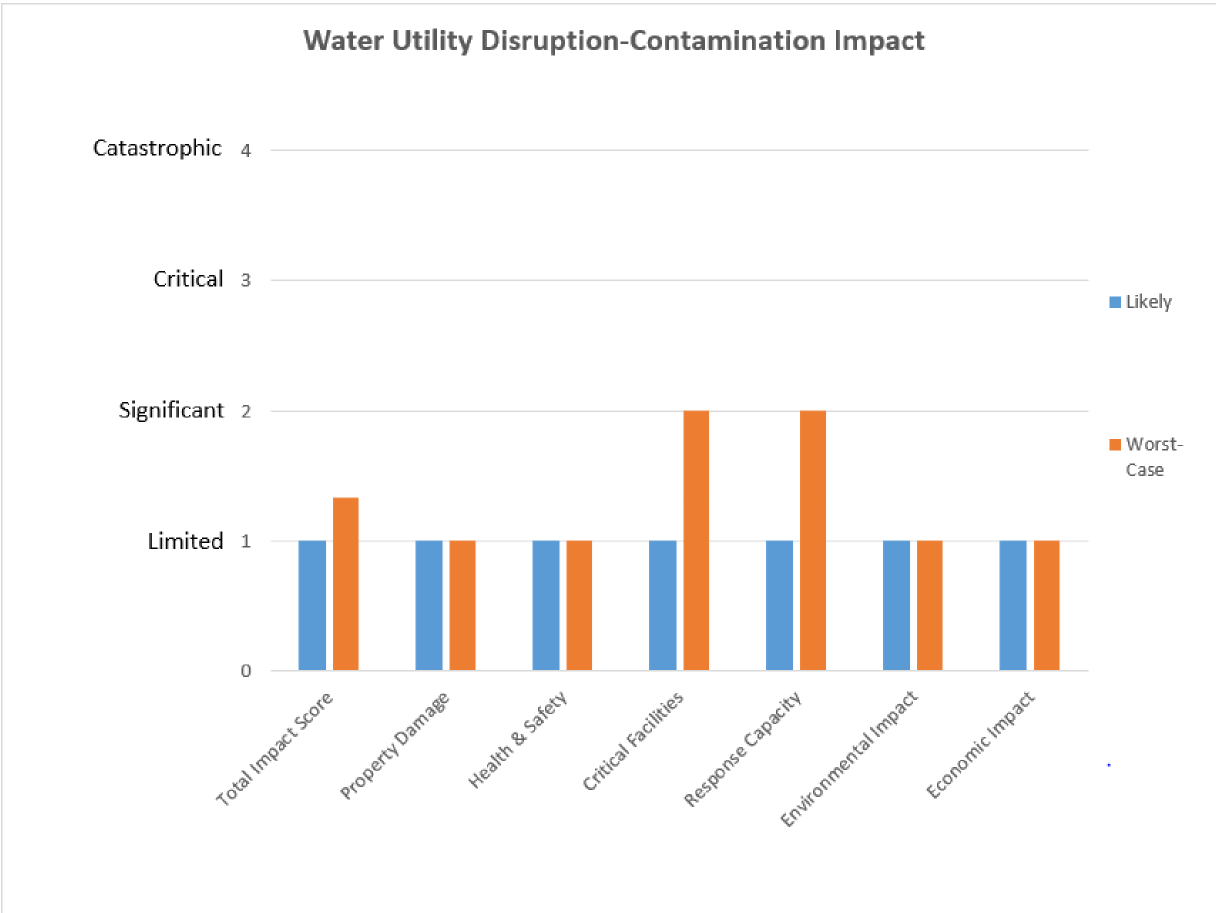
Future Likelihood of an Water Utility Disruption-Contamination		
	Likely	**Worst-Case**
Historical Average (time period)	3 events every 10 years (2011-2020)	<1 event every 50 years
Historical Annual Probability	20-30% chance of annual occurrence	<1% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	21-30% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	3 - Likely: 11-30% chance of annual occurrence	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

Considerations: It is unlikely that the frequency of the causative weather events will change significantly enough in the near future. Additionally, the water utilities have sufficient redundancies built into the system to mitigate most of these incidents and recovery quickly.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Water Utility Disruption-Contamination Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited	Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Water Utility Disruption-Contamination Consequence Analysis - Worst-Case		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.33 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

7 Natural Hazard Profiles

Drought

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A drought is a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and humans over a sizeable area. It usually refers to a period of below-normal rainfall, but drought can also be caused by drying bores, lakes, or anything that reduces the amount of liquid water available.

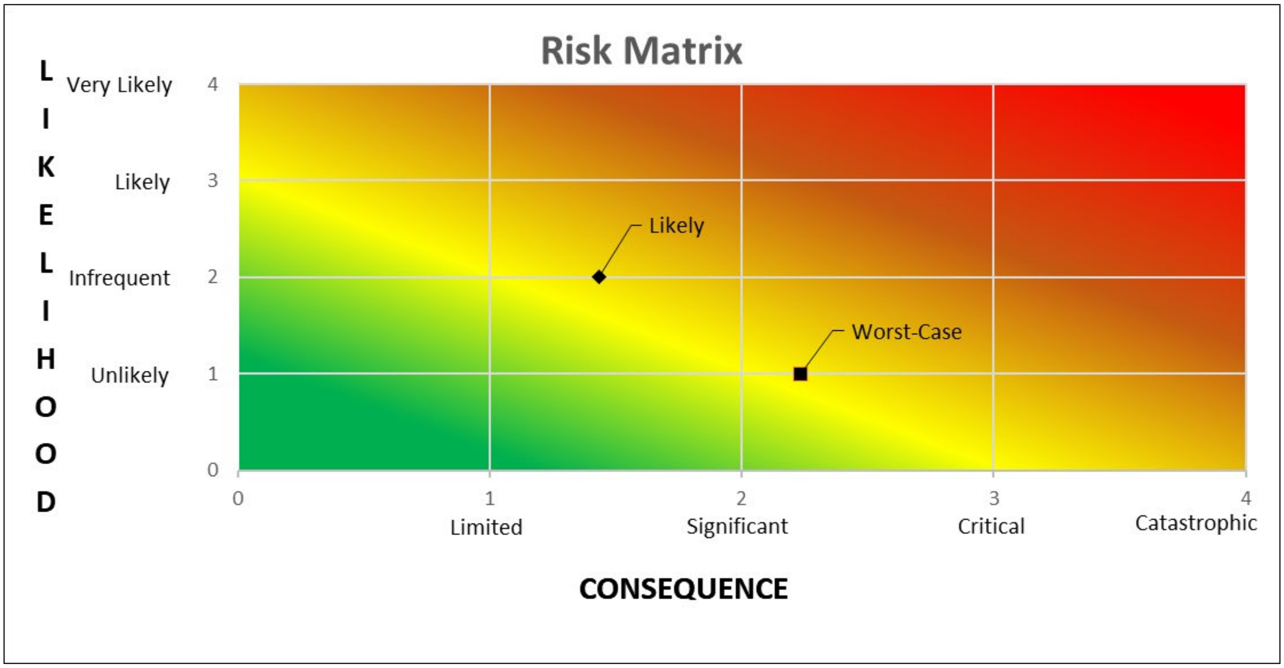
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Drought Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	2 Infrequent	1 Unlikely	50%
Consequence	**Impact**	1.17 Limited-Significant	2.17 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	4 Very Long	4 Very Long	5%
	Total Risk Score	1.72	1.62	

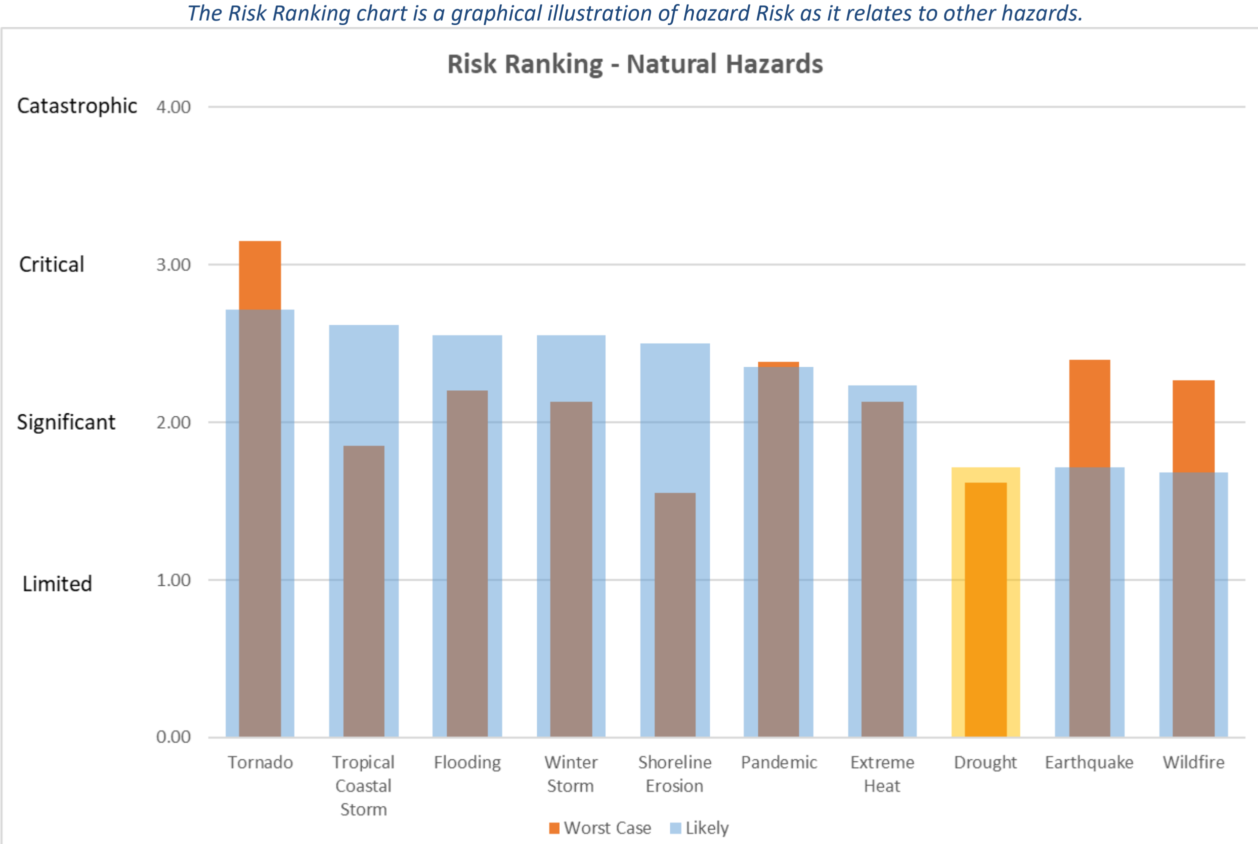
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Drought is a natural climatic condition caused by an extended period of limited rainfall beyond that which occurs naturally in a broad geographic area. High temperatures, high winds and low humidity can worsen drought conditions, making areas more susceptible to wildfire. Human demands and actions can also hasten drought-related impacts. Droughts are frequently classified as one of the following four types: meteorological, agricultural, hydrological, or socio-economic.

Meteorological droughts are typically defined by the level of "dryness" when compared to an average or normal amount of precipitation over a given period. Agricultural droughts relate common characteristics of drought to their specific agricultural-related impacts. Emphasis tends to be placed on factors such as soil water deficits, water needs based on differing stages of crop development, and water reservoir levels. Hydrological drought is directly related to the effect of precipitation shortfalls on surface and groundwater supplies. Human factors, particularly changes in land use, can alter the hydrologic characteristics of a basin. Socio-economic drought is the result of water shortages that limit the ability to supply water-dependent products in the marketplace.[33]

A **likely incident** within the region involves the loss of agricultural crops, and the potential loss of aquatic wildlife. This incident would include water use restrictions issued by officials to reduce unnecessary water consumption.

During a **worst-case event**, the region would suffer a severe loss of agricultural resources, requiring the implementation of water restrictions to reduce water consumption until the region received adequate rainfall.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Drought typically impacts a large area that cannot be confined to geographic boundaries. However, some regions of the United States are more susceptible to drought conditions than others. Drought conditions are of a relatively low to moderate risk for the Hampton Roads Region. The region would be uniformly exposed to this hazard, and the spatial extent of that impact could be potentially large. However, drought conditions do not typically cause significant damage to the built environment. Agricultural areas of Chesapeake and Virginia Beach are more likely to be impacted by drought, especially in the early stages. As water restrictions are implemented because of acute water shortages, impacts on urban consumers increase. These can include use restrictions, drinking water supply effects, and saltwater intrusion.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

According to the National Oceanic Atmospheric Administration (NOAA), three droughts impacted the Southside Region between 1950 and 2020. Based on past events, the Hampton Roads Region could experience recurring drought conditions when the region receives below-normal precipitation for extended periods of time.

[33] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:85

Notable Incidents in the Southside Region

A review of the U.S. Drought Monitor data maintained by the National Weather Service (NWS) Wakefield Office revealed no significant drought periods. However, NOAA's storm events database identifies a drought which occurred in 1997 and caused an estimated $4.75 million in crop damages.

Future Likelihood of the Hazard for the Southside Region

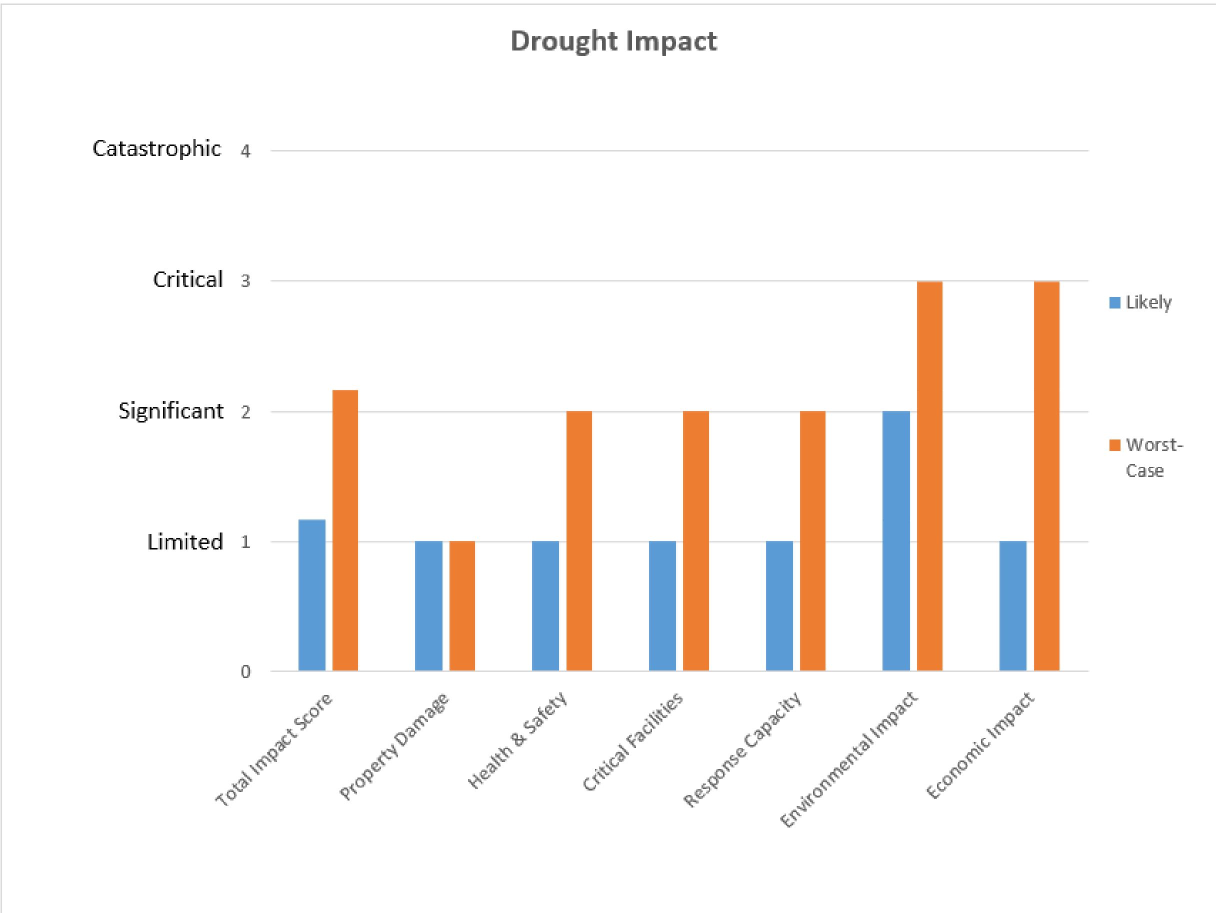
The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Drought		
	Likely	**Worst-Case**
Historical Average (time period)	3 events every 70 years (1950-2020)	No events meeting criteria between 1950-2020
Historical Annual Probability	4% chance of annual occurrence	<1.4% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	2 - Infrequent: 1-10% chance of annual occurrence	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Drought Warning Time & Duration		
	Likely	Worst-Case
Warning Time	Very Long - More than 24 hours	Very Long - More than 24 hours
Duration	Very Long - More than one week	Very Long - More than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Drought Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.17 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Drought Consequence Analysis - Worst-Case		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Significant	Injuries are manageable, may include at least one death.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Critical	Serious environmental impact.
Economic Impact	Critical	Serious economic impact. Standard of living is seriously affected.
Total Impact	Significant-Critical	Total Impact Score: 2.17 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Earthquake

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

An earthquake is a sudden release of energy from the earth’s crust that creates seismic waves. Tectonic plates become stuck, thus putting a strain on the ground. When the strain becomes so great that rocks give way, fault lines occur. At the earth's surface, earthquakes may manifest themselves by a shaking or displacement of the ground.

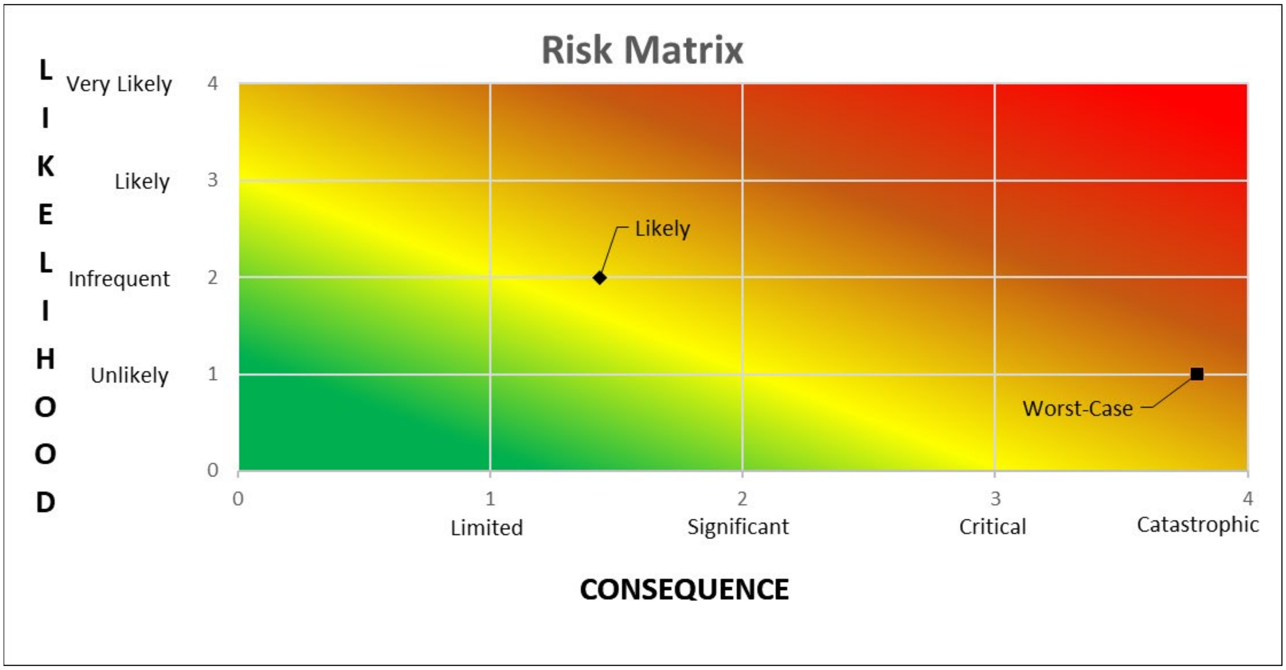
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Earthquake Risk Profile				
Likelihood	**Risk Assessment Category**	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
	Likelihood	2 Infrequent	1 Unlikely	50%
Consequence	**Impact**	1.17 Limited-Significant	4.00 Catastrophic	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	2 Moderate	5%
	Total Risk Score	1.72	2.40	

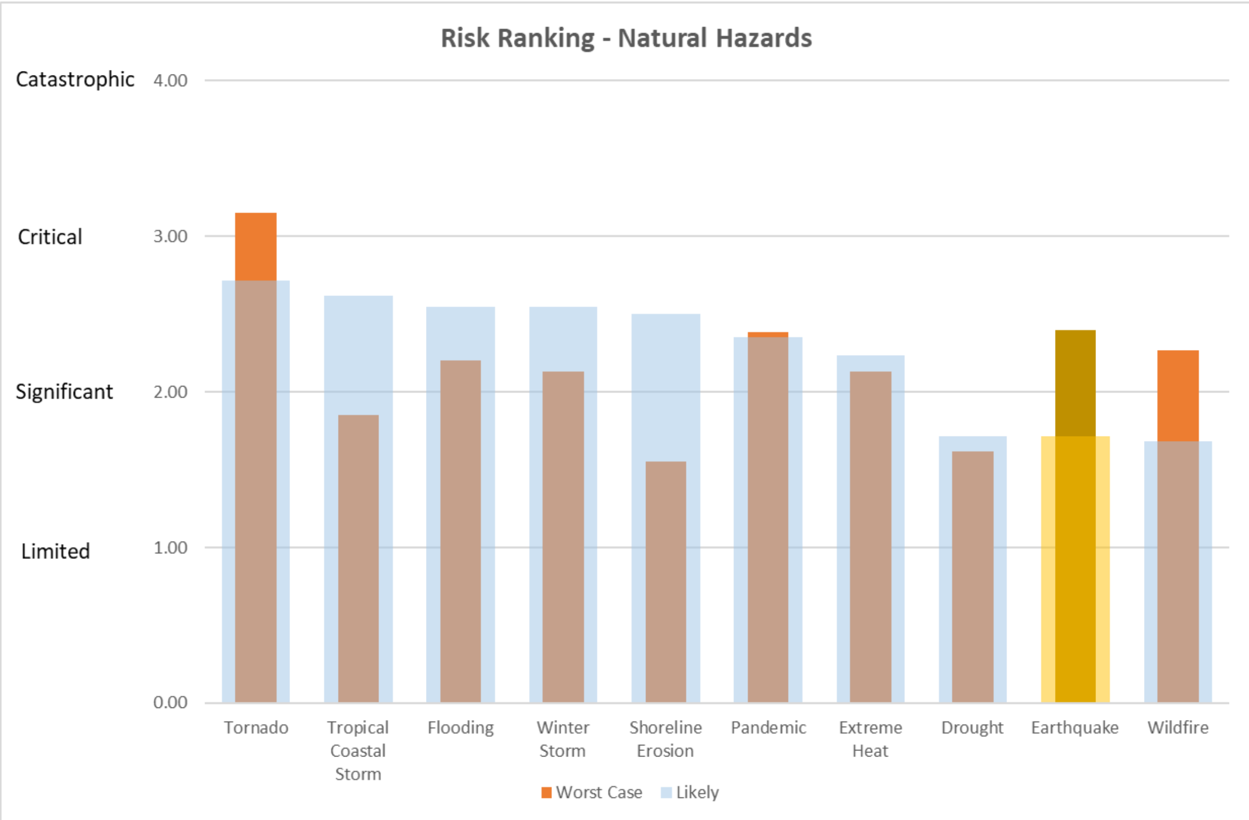
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock in the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of caverns. Earthquakes can affect hundreds of thousands of square miles; cause tens of billions of dollars in property damage; result in loss of life and injury to hundreds of thousands of persons; and disrupt the social and economic functioning of the affected area. Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, and regional geology. Most earthquakes are caused by the release of stresses accumulated because of the rupture of rocks along opposing fault planes in the Earth's outer crust. These fault planes are typically found along borders of the Earth's 10 tectonic plates. These plate borders generally follow the outlines of the continents, with the North American plate following the continental border with the Pacific Ocean in the west but following the mid-Atlantic trench in the east. Earthquakes occurring in the mid-Atlantic trench usually pose little danger to humans. The areas of greatest tectonic instability occur at the perimeters of the slowly moving plates, as these locations are subjected to the greatest strains from plates traveling in opposite directions and at different speeds. Deformation along plate boundaries causes strain in the rock and the consequent buildup of stored energy. When the built-up stress exceeds the rocks strength, a rupture occurs. The rock on both sides of the fracture is snapped, releasing the stored energy, and producing seismic waves, generating an earthquake.

Earthquakes are measured in terms of their magnitude and intensity using the Richter scale; an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude. Each unit increase in magnitude on the Richter scale corresponds to a 10-fold increase in wave amplitude, or a 32-fold increase in energy. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. The scale levels are typically described using Roman numerals, with a I corresponding to imperceptible (instrumental) events, IV corresponding to moderate (felt by people awake), to XII for catastrophic (total destruction).[34]

Most of Virginia's recorded earthquakes have been of magnitude 4.5 or less, and the associated damage has been minor, such as cracks in foundation and tumbling chimneys, etc. However, due to modern development, if Virginia experienced an earthquake of magnitude 6.0 or greater, the consequences could be serious. Since earthquakes in the region are rare event, public messaging, communication, and coordination across Hampton Roads would be critical since most responders and citizens have little to no experience dealing with this type of disaster.

A worst-case scenario would include major damage to critical infrastructure and transportation routes, particularly the bridge and tunnel systems that connect much of Hampton Roads. This would essentially isolate large portions of the region, complicating response and recovery efforts. Damage to buildings has the potential to cause significant search and rescue obstacles. The region would likely require mutual aid support. Flash-flooding from breached reservoirs, widespread electrical fires, and exploding gas pipelines could compound the response and recovery efforts. Releases of hazardous materials from manufacturing, industrial, and military industry in the region would cause adverse impacts to air, water, and soil. Additionally, an earthquake could cause damage to the nuclear reactors at the North Anna Nuclear Power Plant. Infrastructure age and condition varies by locality. However, disruption of water mains for fire protection, communication towers, and roadway damage should be expected throughout the region. The economic, environmental, and social impacts would be devastating.

[34] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:75

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Hampton Roads Southside Subregion is located a short distance from the Central Virginia Seismic Zone. While generally a passive seismic region, recent studies suggest that the southern Appalachian highlands have the potential to produce even larger earthquakes than have occurred in the past.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Historical data is supportive of the low-risk assessment. Since 1774, three earthquake epicenters within 65 miles of Hampton Roads, one on the Delmarva Peninsula and two in the Hampton Roads area. Only minor structural damage resulted from these regional earthquakes. Although unlikely, impacts of a severe earthquake centered in Hampton Roads are unknown based on the historical record, but could be extrapolated from damage experienced in Louisa County during the August 2011 earthquake described below. Damage to local structures would likely be severe because buildings in the region are not typically designed to withstand high magnitude quakes. Underground infrastructure damage is also expected to be severe and could cause long-term power, water, and sewer service interruptions in the region. Likewise, damage to bridges, tunnels and roads could disrupt transportation routes for much of the region.

Notable Incidents in the Southside Region

The Louisa County earthquake occurred in August 2011. While it did not directly impact Hampton Roads, some areas of the region reported tremors and there was concern about the structural stability of older buildings. In Hampton Roads, public messaging and media inquiries were the greatest lessons learned from the event.

Future Likelihood of the Hazard for the Southside Region

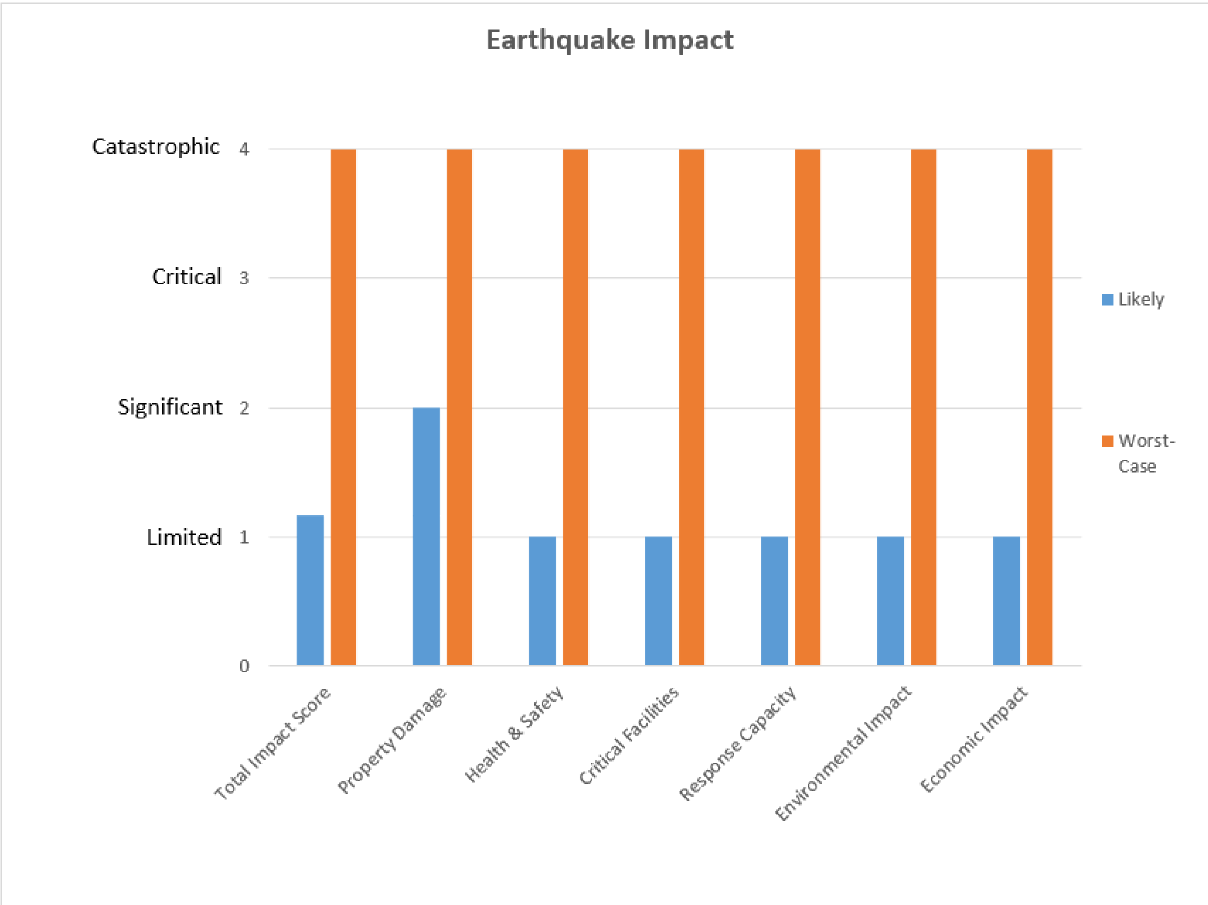
The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of an Earthquake		
	Likely	**Worst-Case**
Historical Average (time period)	1 event every 20 years (1964-2019)	0 events over 245 years (1775-2020)
Historical Annual Probability	5% chance of annual occurrence	0.00789% chance of annual occurrence (USGS, based on 10% gravity, peak ground acceleration)
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	2 - Infrequent: 1-10% chance of annual occurrence	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Earthquake Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Short - Less than six hours	Moderate - 6-24 hours

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Earthquake Consequence Analysis - Likely		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.17 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Earthquake Consequence Analysis - Worst-Case		
Property Damage	Catastrophic	Propert damage is severe, greater than 50% of critical and non-critical infrastructure affected.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Catastrophic	Shut down of critical facilities will be more than one month.
Response Capacity	Catastrophic	Response capacity is overwhelmed and requires significant and long lasting state and federal government support.
Environmental Impact	Catastrophic	Severe environmental impact.
Economic Impact	Catastrophic	Severe economic impact. Standard of living is extremely impacted and may not be fully recoverable.
Total Impact	Catastrophic	Total Impact Score: 4.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Extreme Heat

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

Extreme heat is defined as temperatures that remain ten degrees or more above the average high temperature for the region and last for several weeks.

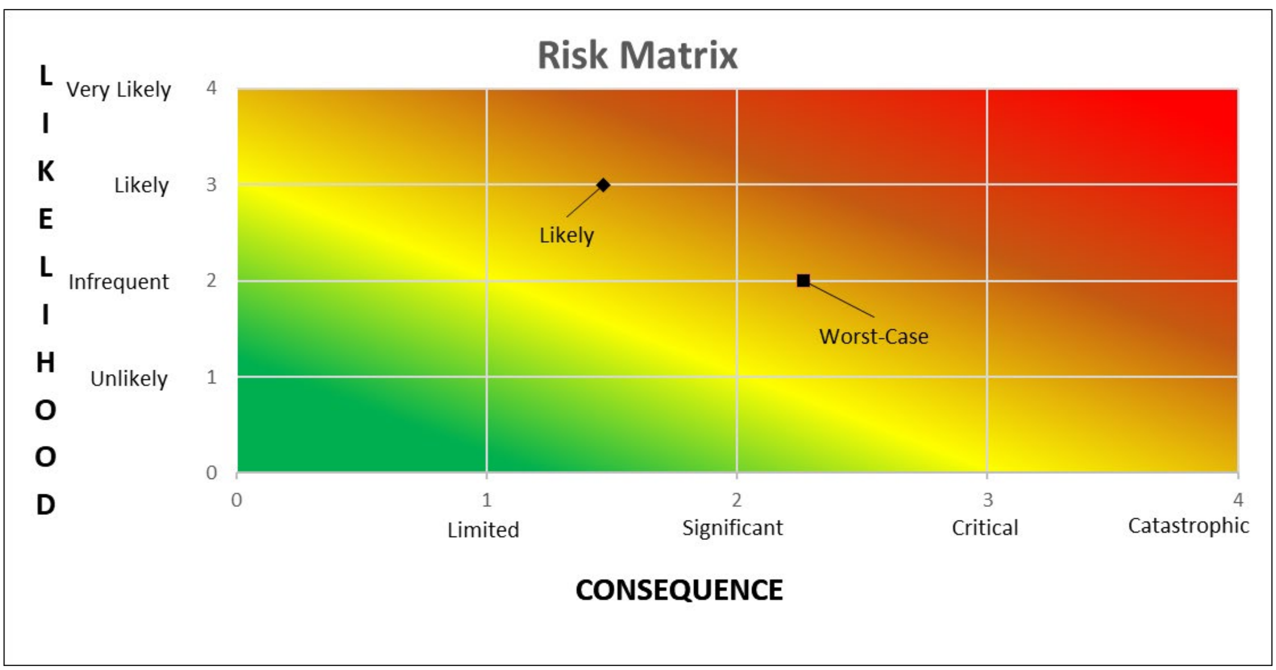
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Extreme Heat Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	3 Likely	2 Infrequent	50%
Consequence	**Impact**	1.33 Limited-Significant	2.33 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	3 Long	3 Long	5%
	Total Risk Score	2.23	2.13	

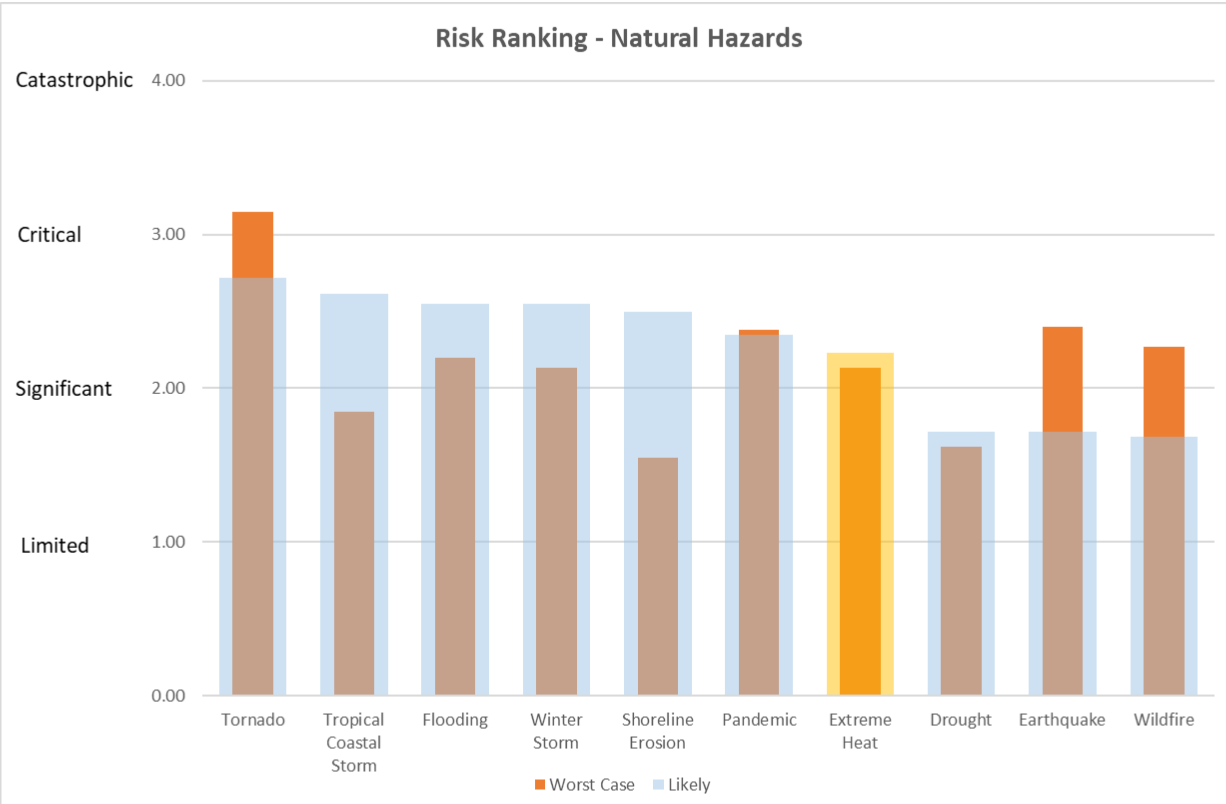
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

During the summer months, humid conditions result from maritime air masses and contribute to elevated heat index values and discomfort. Extreme heat events typically impact a large area and cannot be confined to traditional geographic boundaries. According to the National Weather Service, heat is the leading weather-related killer in the United States and the elderly, people with medical conditions, and outdoor workers are at the highest risk from heat related illnesses.

During a **likely incident**, some residents without air conditioning will require assistance, such as fans and bottled water. Due to high demand and use during heat waves, air conditioning units could fail, and power outages may occur from high electricity demands during peak hours. Extreme heat can cause damage to infrastructure such as roads and bridges and may limit available medical supplies if not properly stored inside a controlled environment.

During a **worst-case event**, the area experiences power outages impacting the homeless and low-income communities across the region. Extended extreme heat events impact roads and infrastructure causing disruption to the transportation sector.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Extreme heat typically impacts a large area and cannot be confined to traditional geographic boundaries. Hampton Roads is uniformly exposed to this hazard and the spatial extent of that impact is potentially large. Extreme heat typically does not cause significant damage to the structures. Summertime temperatures in the Hampton Roads Region can easily climb into the high 90 to low 100-degree Fahrenheit range with high humidity rates. Coastal areas may experience slightly lower temperatures as a result of late day sea breezes or lower water temperatures, depending on the season.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

From 1995 to 2020, five extreme temperature events were recorded for the area. Records prior to 1950 were not reported through the National Weather Service; it is highly likely that the Hampton Roads region will experience periods of extreme heat in the future.

Notable Incidents in the Southside Region

From July 19 - 22, 2019, and July 19-23, 2020 Heat Index values reached 110 – 115.

Future Likelihood for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

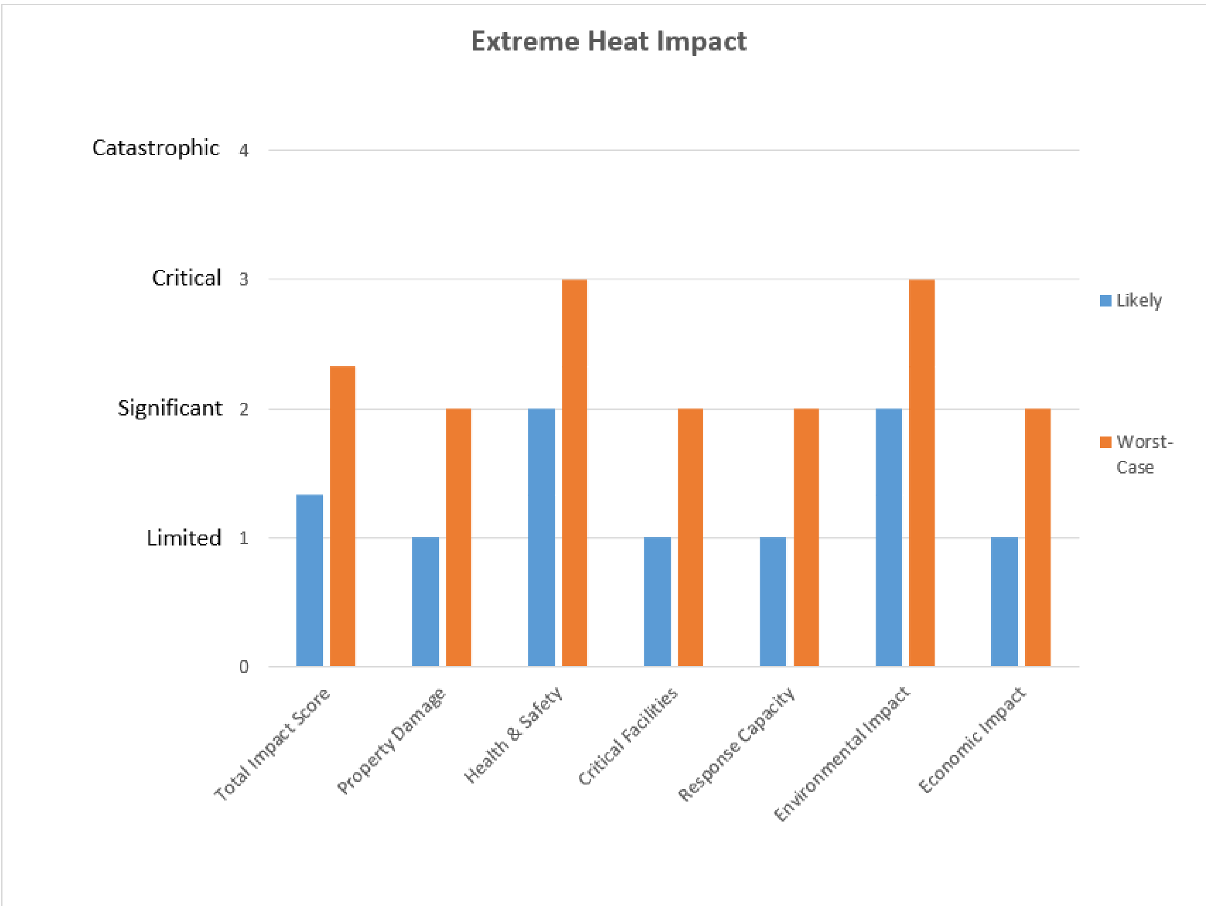
Future Likelihood of an Extreme Heat		
	Likely	**Worst-Case**
Historical Average (time period)	1 event every 20 years (1964-2019)	1 event every 59 years (1950-2019)
Historical Annual Probability	24% chance of annual occurrence	1.7% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	21-30% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	3 - Likely: 11-30% chance of annual occurrence	2 - Infrequent: 1-10% chance of annual occurrence

Considerations: Extreme heat may also be a contributing factor to drought, wildfires, and livestock impact/losses. Additional care for the wellness of seniors and underserved populations (e.g., homeless) may be necessary; these groups include those without air conditioning. Other considerations include damage to infrastructure due to extreme heat, potential water supply shortfalls, and overdemand of electricity during peak hours.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Extreme Heat Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Very Long - More than 24 hours	Very Long - More than 24 hours
Duration	Long - Less than one week	Long - Less than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Extreme Heat Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Significant	Injuries are manageable, may include at least one death.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.33 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Extreme Heat Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Critical	Serious environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant-Critical	Total Impact Score: 2.33 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Flood

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

Flooding is defined as the accumulation of water that exceeds a physical barrier or collects in a low-lying area that leads to the inundation of an area. Flooding typically results from large scale weather systems that generate prolonged or highly impactful rainfall. Other conditions such as winter snow thaws, over-saturated soil, ice jams breaking apart, and urbanization can cause flooding as well.

Risk Profile

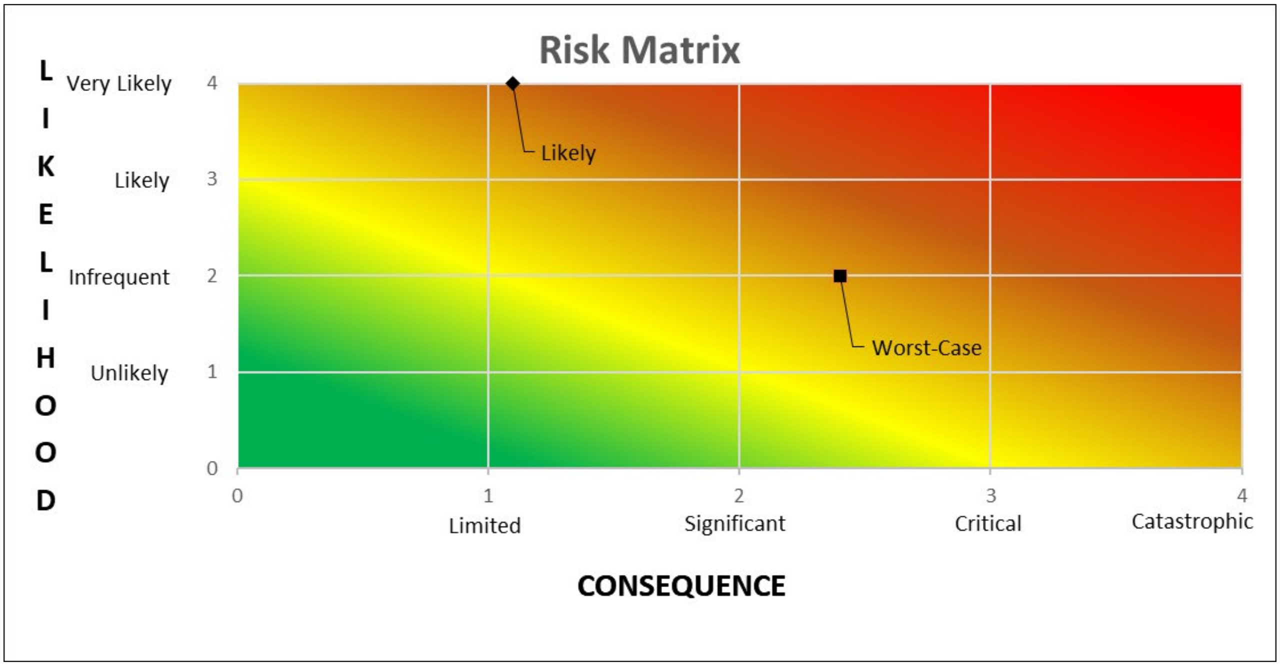
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Flooding Risk Profile

	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	Likelihood	4 Very Likely	2 Infrequent	50%
Consequence	Impact	1.00 Limited	2.50 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	2 Moderate	3 Long	5%
	Total Risk Score	2.55	2.20	

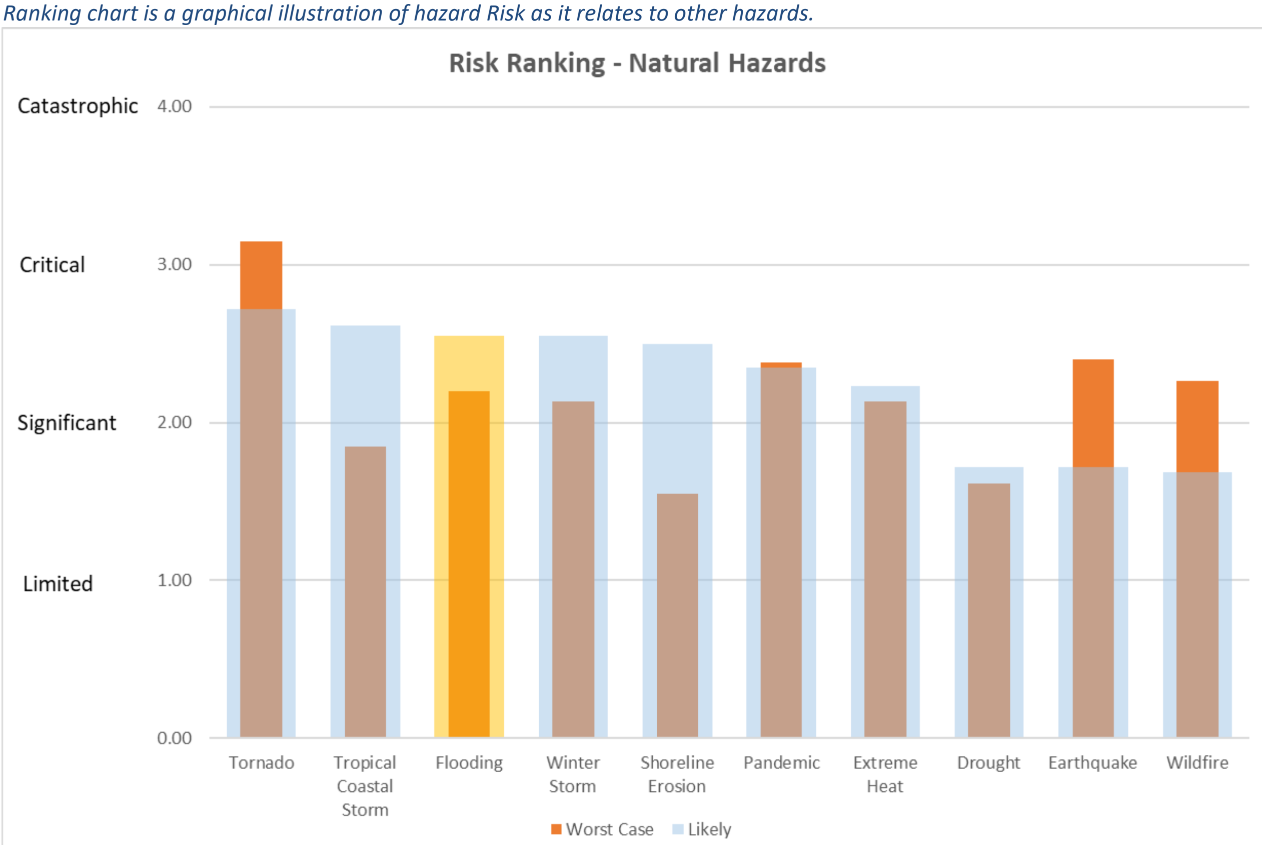
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

The primary types of flooding in the Southside Region include riverine, coastal, and urban flooding. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within a stream or river. Coastal flooding is typically a result of storm surge, wind-driven waves, and heavy rainfall produced by hurricanes, tropical storms, nor'easters, and other large coastal storms. Urban flooding occurs when manmade development obstructs the natural flow of water or when impervious surfaces significantly decrease the ability of natural groundcover to absorb and retain surface water runoff. Approximately 90% of presidentially declared disasters are associated with floods. In addition, most of the stormwater infrastructure in the Southside Region was designed to a lesser standard that current requirements based on increases in precipitation rates and sea level rise.

The most **likely flood events** are caused by summer torrential rainstorms. The intensity of these storms tends to quickly fill up stormwater systems, leading to localized street and sidewalk flooding. As climate change causes these storms to become more frequent and intensive, it is expected that such flood events will become worse. Based on a review of NOAA's Storm Event Database, precipitation from nor'easters, tropical storms and hurricanes cause the most significant flooding.

The **worst-case incident** is based on the 200-year and greater storm event consisting of heavy amounts of prolonged precipitation combined with strong winds from a Category 3 or 4 hurricane which produces significant storm surge and flooding at both coastal and inland areas of the region. Most roads will become impassable due to high water levels and widespread flood damage to homes, businesses and crops occurs. Search and recovery operations teams will have to conduct flood rescue and recovery operations to save those who ignored evacuation orders.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The 2017 Hampton Roads Hazard Mitigation Plan included a HAZUS Level 2 100-year flood vulnerability assessment for the flood hazard within the area of study. The results of the assessment included the estimated flood damage vulnerability in terms of number of buildings moderately damaged, number of buildings substantially damaged, monetary value of building losses, content losses, and inventory losses if a 100-year flood event occurred. More detailed information can be found in Table 5.6 "HAZUS Flood Damage Vulnerability Results" from the 2017 Hampton Roads Hazard Mitigation Plan pg. 5:21. A worst-case 100-year flood event affecting the entire region is estimated to cause moderate damage to 2,500+ buildings totaling losses of $197M, content losses would total $190M and inventory losses of $75M.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Flooding remains a highly likely occurrence throughout the identified flood hazard and storm surge areas within the region. Smaller floods caused by heavy rains and inadequate drainage capacity will be frequent, but not as costly as the large-scale floods caused by hurricanes and coastal storms, which may occur at less frequent intervals.[35]

[35] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:31

Notable Incidents in the Southside Region

Many previous flood events in the region have been a result of coastal storms, tropical storms or hurricanes. Other localized flooding occurs when heavy rains fall during high tide causing waters that would normally drain quickly to back up because of the tides. Based on historical and anecdotal evidence, there is a relatively high frequency of flooding in the region. Some of the notable flood events to impact the area of study are discussed below and are similar to the events within the tropical/coastal storm section.

- **August 4, 2020 (Chesapeake, Norfolk, Portsmouth, Virginia Beach)**: The center of Tropical Storm Isaias tracked north just inland of the Middle Atlantic Coast from late Monday night, August 3rd through Tuesday morning, August 4th. Winds associated with the tropical storm caused moderate (perhaps some locally major) tidal/coastal flooding across portions of Southeast Virginia.
- **November 17, 2019 (Norfolk and Virginia Beach):** The combination of high pressure over northern New England and low pressure just off the Middle Atlantic Coast resulted in very strong northeast to north winds over the southern Chesapeake Bay, which caused minor to moderate coastal flooding. There were tidal anomalies between 2.0 and 3.0 feet over the southern Chesapeake Bay. This caused minor to moderate coastal flooding over portions of Virginia Beach. Water levels in the Chesapeake Bay Bridge Tunnel reached 5.88 feet while levels at Sewell's Point crested at 5.35 feet. Officials reported standing water on Hampton Boulevard in Norfolk and minor flooding at other streets throughout the cities.
- **September 5-6, 2019 (Chesapeake, Norfolk, Portsmouth, Virginia Beach):** Hurricane Dorian tracking northeast along the North Carolina coast and just off the Virginia coast produced tropical storm winds and associated wind damage across portions of southeast Virginia. The strong northeast to north winds produced tidal anomalies between 2.5 and 3.5 feet over the southern Chesapeake Bay causing moderate coastal flooding over portions of Norfolk. Sewells Point reported levels of 5.87 feet. Authorities reported street flooding and stranded vehicles in the Ghent area. The Chesapeake Bay Bridge Tunnel reached 6.63 feet, while Money Point crested at 6.21 feet.
- **October 8-9, 2016 (Chesapeake, Norfolk, Portsmouth, Virginia Beach)**: Post Tropical Cyclone Matthew tracking northeast just off the North Carolina and Virginia coasts, produced very strong northeast or north winds over southeast Virginia and the Virginia Eastern Shore. These winds caused moderate coastal flooding over portions of the area. In Virginia Beach, coastal storm tides of 2 to 3.5 feet above astronomical tide levels were common, with only minor beach erosion reported. The maximum storm tide reached 5.69 feet at the Chesapeake Bay Bridge Tunnel, resulting in moderate coastal flooding from Saturday evening into Sunday morning. In Chesapeake, the maximum storm tide reached 6.64 feet at Money Point, resulting in moderate coastal flooding. The maximum storm tide crested at 5.86 feet at Sewell's Point.
- **January 23, 2016 (Virginia Beach):** A combination of low pressure moving from the southeast United States northeast and just off the Atlantic Coast, and high pressure over southeast Canada produced very strong onshore winds across the Mid-Atlantic. The strength and duration of the onshore winds produced moderate coastal flooding along the Atlantic Coast and Chesapeake Bay. A tidal departure of 2.5 to 3.5 feet resulted in moderate coastal flooding along the Atlantic Ocean and Chesapeake Bay. The peak water level at the Chesapeake Bay Bridge Tunnel was 5.72 feet.
- **October 2-3, 2015 (Chesapeake, Norfolk, Virginia Beach):** Anomalously strong/nearly stationary high pressure over New England produced strong onshore winds over the Mid-Atlantic. The strength and duration of the onshore winds produced a tidal departure of 3 to 4 feet resulting in moderate coastal flooding along the Atlantic Coast and Chesapeake Bay.
- **October 2012 Tropical Cyclone Sandy** moved northward well off the Mid Atlantic Coast producing heavy rain which caused flooding across much of eastern and southeast Virginia. Storm total rainfall ranged from four inches to as much as 10 inches across the area resulting in the closure of numerous roads due to flooding. Storm total rainfall amounts ranged from three to six inches across Chesapeake. Although the storm did not cause the same

destruction locally that it did in the northeast, it remains a significant rain and coastal flood event for parts of the Hampton Roads region.

- **August 2011 Hurricane Irene** moved northward over the Outer Banks of North Carolina and just off the Virginia coast, producing heavy rains which caused widespread flooding across most of south central and southeast Virginia. Storm total rainfall amounts generally ranged from six to 12 inches. Heavy rains associated with Hurricane Irene produced widespread lowland flooding across much of Southside Hampton Roads, to include roadway closures and wash outs. Great Bridge reported 10.75 inches of rain and Deep Creek 9.72 inches of rain.
- **November 2009 Mid-Atlantic nor'easter (or "Nor'Ida")** was a powerful storm that caused widespread flooding throughout the region. Persistent onshore flows brought elevated water levels ashore for four days. At Sewell's Point, observers reported a max storm tide of 7.74 feet, the third highest recorded tide of all time at that location. Widespread coastal damage and major flooding occurred because of seven inches of rainfall and large wind-driven waves impacting beaches. Damage in Virginia exceeded $38.8 million, of which 64% was in Norfolk. According to the NWS, 7.4 inches of rain fell in Norfolk and a peak wind gust of 75 mph was recorded at Oceana. This event is one of the two benchmarks for flooding in Portsmouth.
- **September 2003 Hurricane Isabel** proved to be the costliest disaster in Virginia's history. The storm produced a high storm surge (four to five feet in Southside Hampton Roads) which inundated the tidal portions of the region's creeks and rivers. The storm caused extensive flood damage to structures and infrastructure in the planning area. The NFIP processed more than 24,000 Isabel claims in six states and the District of Columbia, totaling nearly $405 million. As a result of polluted runoff, Virginia Department of Health forbade gathering shellfish in the Virginia portion of the Chesapeake Bay, and rivers flowing into the bay. On September 18, 2003, Hurricane Isabel made landfall off the coast of northeast North Carolina. The hurricane, which had originally been a Category 5 storm, reached Chesapeake as a Category 1 storm. Hurricane Isabel produced historic rainfall amounts, storm surge, and wind severely impacting many areas. Rainfall from Hurricane Isabel averaged four to seven inches over large portions of eastern North Carolina, east-central Virginia, and Maryland. This event is one of the two benchmarks for flooding in Portsmouth.
- **September 1999 Hurricane Floyd** was responsible for wind and flood damage in the Hampton Roads Region. This event produced over 10 inches of rain in Chesapeake and occurred just two weeks after Tropical Storm Dennis had saturated the area with 6.2 inches of rain. Hurricane Floyd caused the Great Dismal Swamp to overflow its banks creating flooding along the Northwest River. The flooding was a 500-year flood of record for parts of the basin. The flooding caused extensive crop losses.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

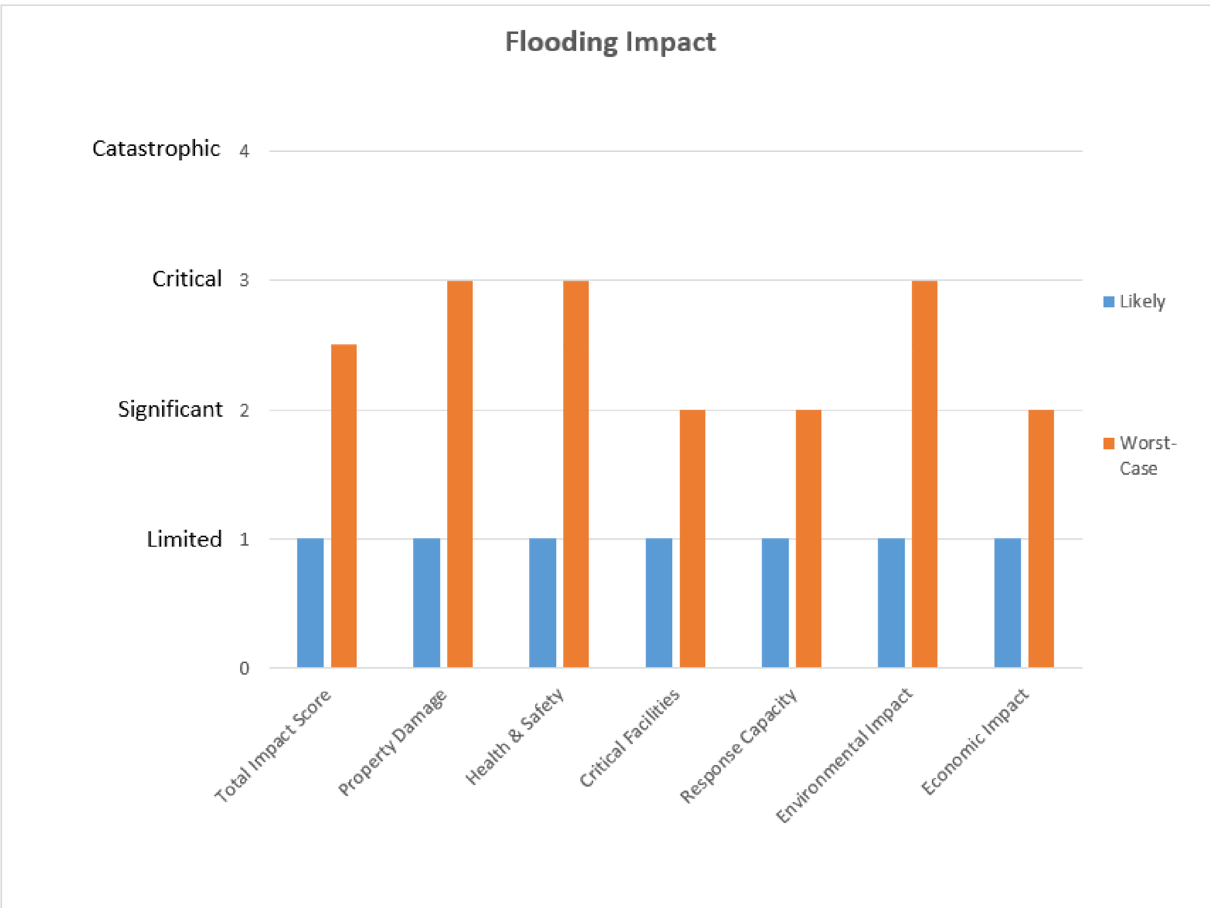
Future Likelihood of Flooding		
	Likely	**Worst-Case**
Historical Average (time period)	18 events every 20 years (2000-2020)	1 event every 200 years
Historical Annual Probability	90% chance of annual occurrence	0.5% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	Yes
Future Annual Probability	91-100% chance of annual occurrence	11-20% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of occurrence annually	2 - infrequent: 1-10% chance of annual occurrence

Considerations: Storm descriptions used for calculating the probability of a storm impacting a certain area have not been updated and are inadequate to describe existing conditions. FEMA categorizations (e.g., 100-year flood) or Virginia stormwater descriptions (e.g., one, five, or 10-year storm) have become outdated as sea levels have risen and storm intensities have increased. Planners will need to reassess the risk to flooding. The likelihood of flooding incidents is expected to increase in the future.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Flooding Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Very Long - More than 24 hours	Very Long - More than 24 hours
Duration	Moderate - 6-24 hours	Long - Less than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Flooding Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited	Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

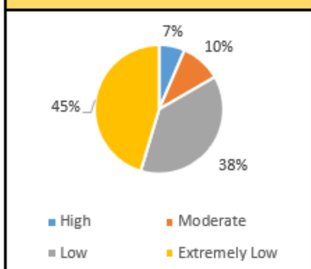
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

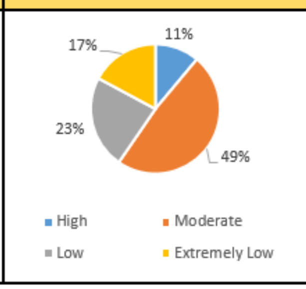
Flooding Consequence Analysis - Worst-Case		
Property Damage	Critical	Property damage is between 26-50% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Critical	Serious environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant-Critical	Total Impact Score: 2.50 on a scale of 1 (Limited) to 4 (Catastrophic)

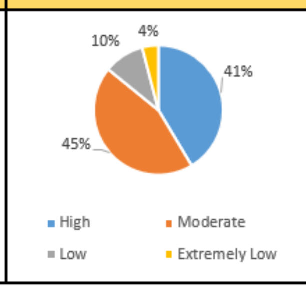
Consequence Analysis: Public Perception

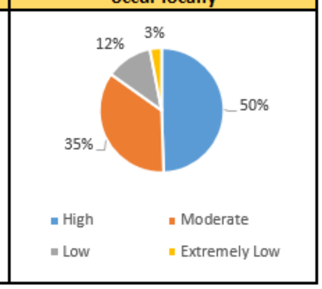
The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Flooding Public Perceptions			
Perceived confidence in city's ability to respond and recover from this hazard	**Perceived confidence in personal ability to protect self and family from this hazard**	**Concern over the impact to personal health and safety if this hazard were to occur locally**	**Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally**









Pandemic

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A pandemic is defined as "an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people".[36]

Risk Profile

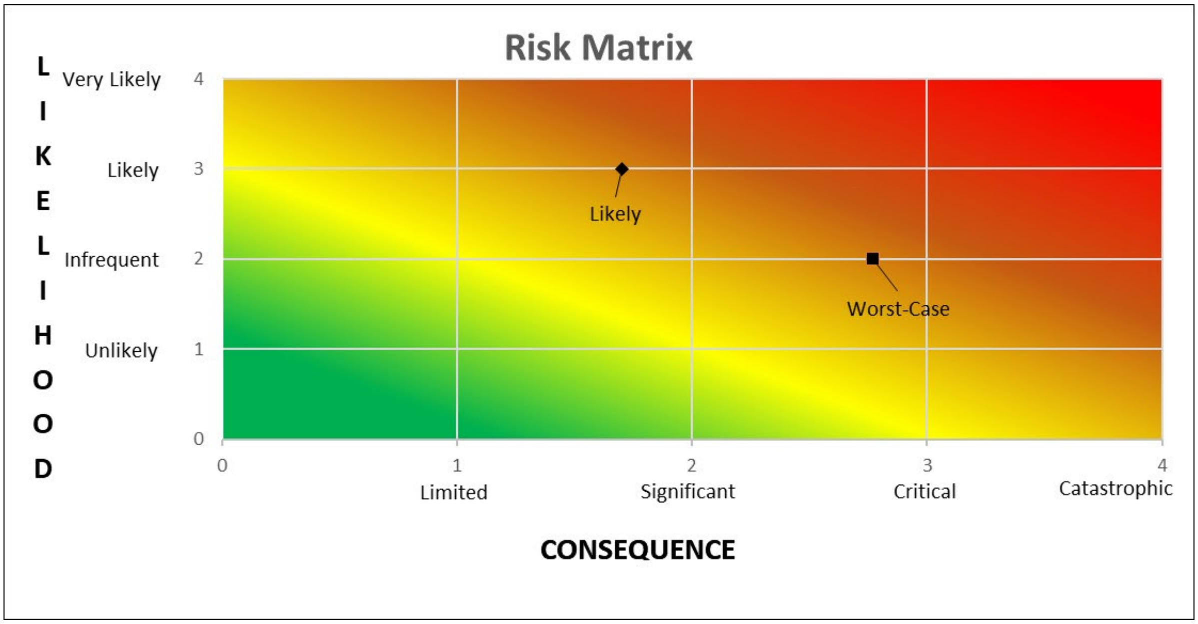
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Pandemic Storm Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	3 Likely	2 Infrequent	50%
Consequence	**Impact**	1.50 Limited-Significant	2.83 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	4 Very Long	4 Very Long	5%
	Total Risk Score	2.35	2.38	

[36] Referenced from WHO website on 17 Dec 2020: Last JM, editor. A dictionary of epidemiology, 4th edition. New York: Oxford University Press; 2001.)

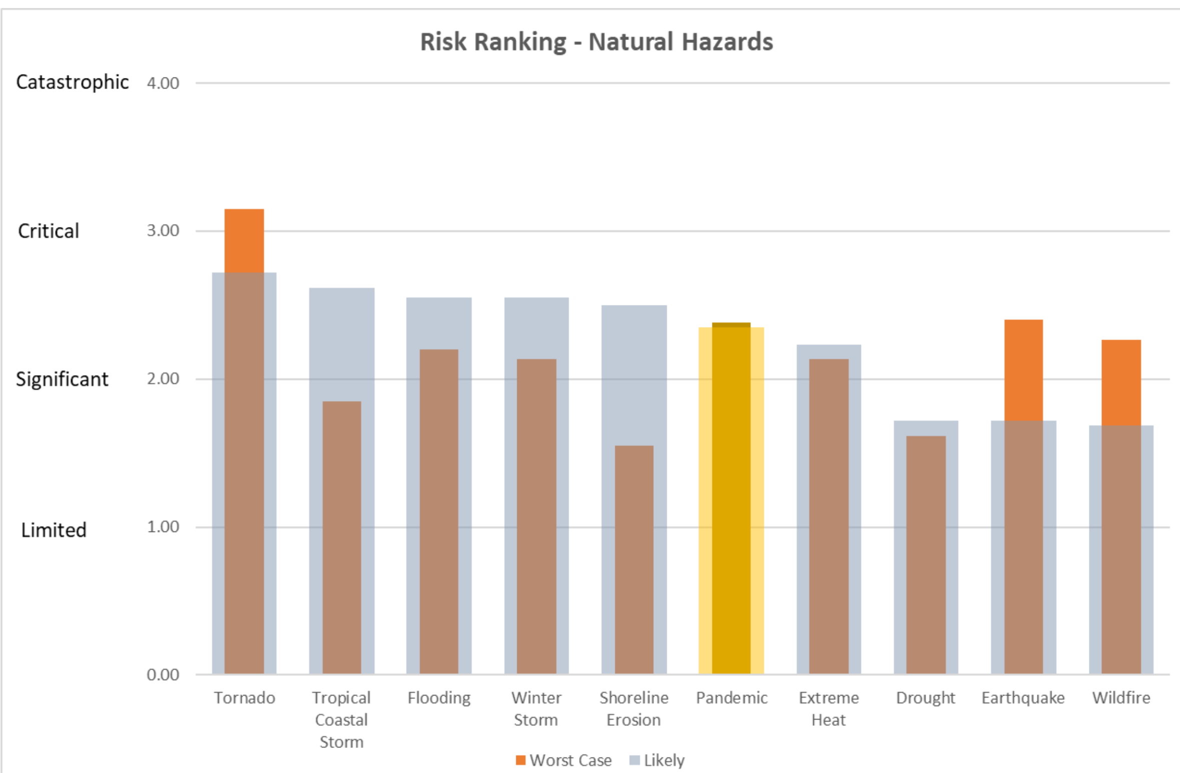
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A pandemic occurs when a widespread occurrence of an infectious disease epidemic spreads internationally, usually affecting a large population. The highest risk for death and permanent disability from the disease is usually encountered by the same groups considered high risk for negative health outcomes. These may include the elderly, those with underlying medical conditions, as well as those with environmental and/or socioeconomic disadvantage. However, there are examples for which these assumptions do not hold true, as some of the worst health outcomes during the H1N1 pandemic occurred among the young.[37] For the Hampton Roads Region, pandemic activity is more likely to align with the regular flu season but could occur at other points in the year and could arise from other infectious diseases.

As we have learned with the "Coronavirus" pandemic (COVID-19), many different types of infectious agents can cause pandemics to occur besides flu viruses. Pandemic severity is influenced by fatality rate, infection rate, transmissibility, and severity. As we experienced with COVID-19, severity can be difficult to characterize and may vary person to person. For example, anthrax has a high fatality rate, is treatable, and is not transmissible, but COVID-19 has a much lower fatality rate, but is highly transmissible, novel and lacking in effective therapeutics. As we experienced with the move to "flatten the curve" in 2020, novel infectious agents can overwhelm medical treatment and care capacity. We must also consider the transmission of the infectious agent and consider that this factor may change over time. For example, newer strains of COVID-19 appear to have an increased level of transmission.

Other novel viruses such as Avian flu (H5N1), Swine flu (H3N2), SARS-CoV, MERS-CoV and SARS-CoV-2 (COVID-19), have also challenged the medical and public health community with detecting, diagnosing, treating, preventing and mitigating the spread. While some disease surveillance provides an early warning, the disease can spread rapidly and go undetected for several weeks. International transportation, densely populated cities, and highly mobile societies contribute to the rapid spread.

The **likely incident** involves a whole government intervention to prevent, mitigate and respond to an infectious disease that is beyond the statistical norms of the seasonal influenza virus. This incident will likely result in a surge in hospitalizations and place a strain on medical resources. A severe influenza season, H1N1 pandemic and recent Ebola Virus incidents are examples of the types of pandemic incidents that we are most likely to encounter.

The **worst-case incident** includes a pandemic that completely alters our existence and overwhelms our healthcare system creating a need to make decisions about who receives care. This entails a widespread disease with high fatality rate, or high infection rate and severity that overwhelms resources. During the COVID-19 pandemic, the sub-region experienced 33,040 cases, 2,136 hospitalizations and 396 deaths as of 17 Dec 2020. This pandemic has several characteristics of a worst-case due to its novel nature, high transmission rate and stress on medical resources (although not exceeding available resources currently). Throughout the pandemic, health officials implemented measures to prevent and mitigate the effects; however, the efficacy of these measures was limited due to the long duration, compliance, and uncertainty of the hazard (e.g., infectious dose).

[37] https:www.who.int/csr/disease/swineflu/frequently_asked_questions/pandemic/en/

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The Hampton Roads Southside subregion hosts several military installations, a regional airport, an active maritime industry, and the Port of Virginia. These ports lead to increased transient populations from international environments, which enhances conditions for the transmission of disease and potential warning time. The Southside Region has several densely populated areas: Norfolk, Virginia Beach, and Portsmouth. The region's Gross Domestic Product (GDP) is greatly influenced by Federal employment and contracts. Approximately 40% of the regional GDP is based on defense spending, which may be a stabilizing factor during a pandemic. Defense-related personnel are engaged in domestic and international travel, which further increases the vulnerability of introducing infectious disease into the region. Congregate facilities (e.g., nursing homes, prisons, etc.) could be more adversely affected by pandemics than the rest of the population.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Six pandemics have been recorded and include the following: the 1918 Spanish Flu pandemic, the flu pandemic of 1930-today, the 1957/58 H2N2 virus, the 1968 H3N2 pandemic, the 2009 H1N1 pandemic, and the current COVID-19 pandemic. The potential exists for other infectious diseases to occur within the Southside Region.[38]

Notable Incidents in the Southside Region

H1N1, COVID-19, and Ebola impacted the region both directly and indirectly. H1N1 and COVID-19 directly resulted in local infections. Ebola did not directly affect the region with infections, but the pandemic required (1) healthcare providers to increase patient screening, (2) the implementation of travel-related quarantine protocols, and (3) additional preparations to prevent the introduction and spread of the disease.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of Pandemic		
	Likely	**Worst-Case**
Historical Average (time period)	1 event every 17 years (1918-2020)	1 event every 100 years (1918-2020)
Historical Annual Probability	6% chance of annual occurrence	1% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	No
Future Annual Probability	11-20% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	3 - Likely: 11-30% chance of annual occurrence	2 - Infrequent: 1-10% chance of annual occurrence

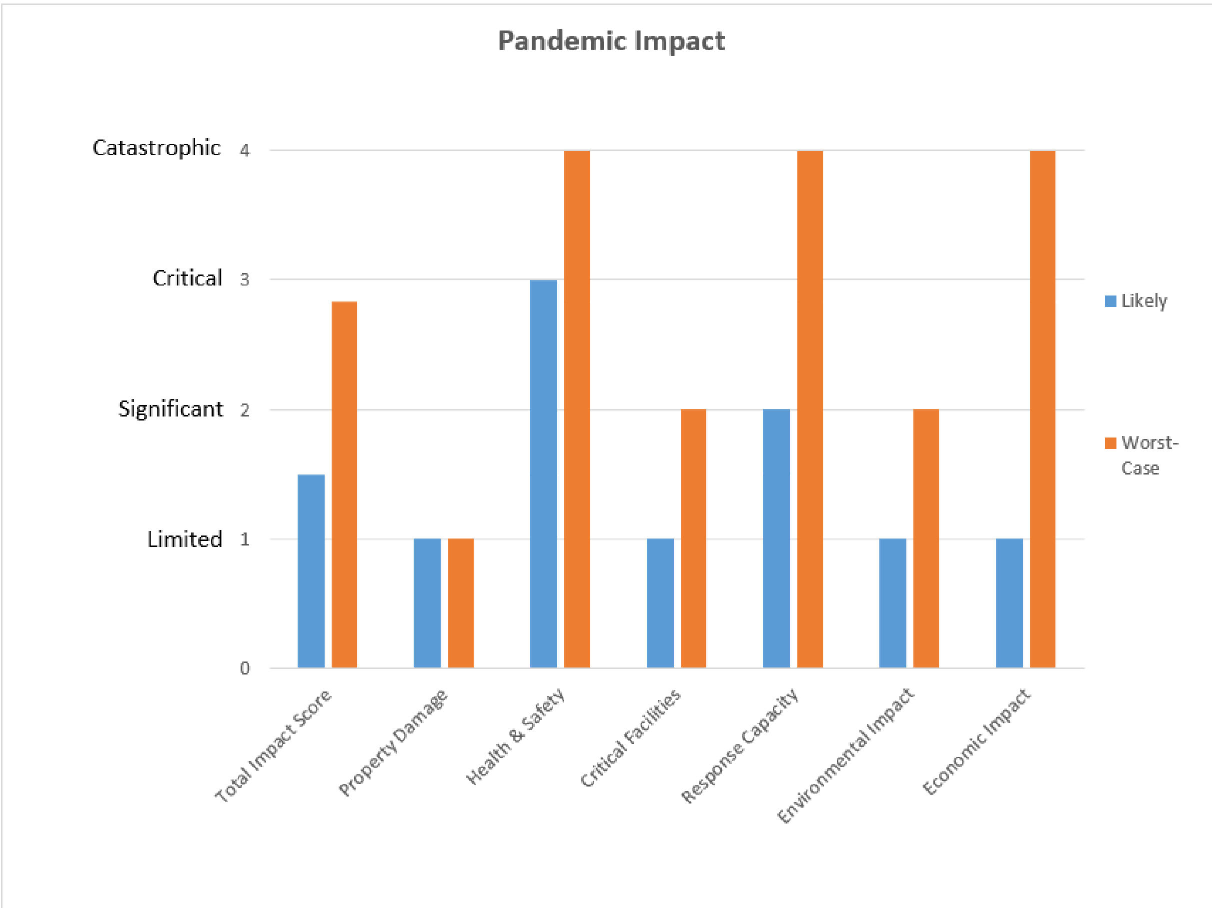
Considerations: The analysis of future likelihood is based on history of pandemics and the increasing frequency and potential for rapid spread in recent decades due to a highly interconnected global transportation system. In the past two decades, we have encountered an increase in novel and highly infectious diseases with increased likelihood of spread.

[38] https://www.cdc.gov/flu/pandemic-resources/basics/past-pandemics.html

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Pandemic Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Very Long - More than 24 hours	Very Long - More than 24 hours
Duration	Very Long - More than one week	Very Long - More than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Pandemic Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.50 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Pandemic Consequence Analysis - Worst-Case		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Catastrophic	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Catastrophic	Response capacity is overwhelmed and requires significant and long lasting state and federal government support.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Catastrophic	Severe economic impact. Standard of living is extremely impacted and may not be fully recoverable.
Total Impact	Significant-Critical	Total Impact Score: 2.83 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Shoreline Erosion

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

Sea level rise influences the on-going processes that drive erosion, in turn making coastal areas ever more vulnerable to both chronic erosion and episodic storm events (Maryland Commission on Climate Change, 2008). Secondary effects of increased erosion include increased water depths and increased sediment loads which can drown seagrass and reduce habitat and food sources for fish and crabs. Increased wave action contributes to the increased erosion as the wave energy impacts intertidal and upland resources.[39]

Risk Profile

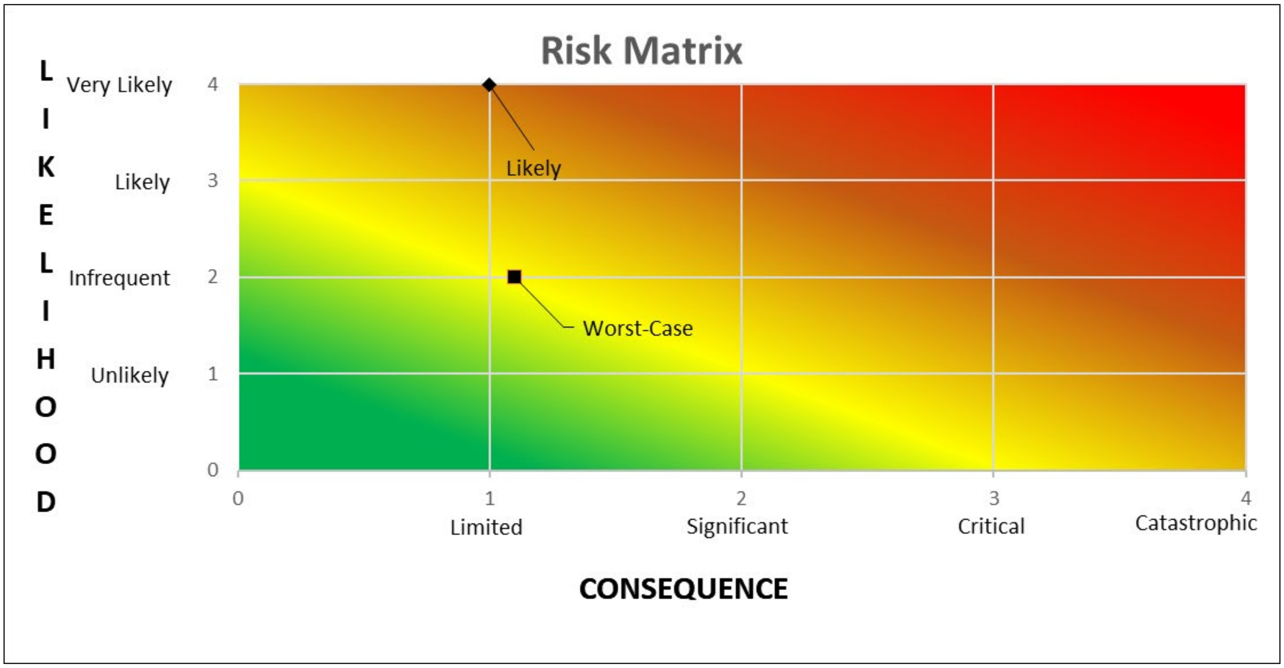
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Shoreline Erosion Storm Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
Likelihood	**Likelihood**	4 Likely	2 Infrequent	50%
Consequence	**Impact**	1.00 Limited	1.00 Limited	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	1 Short	2 Moderate	5%
	Total Risk Score	2.50	1.55	

[39] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:32

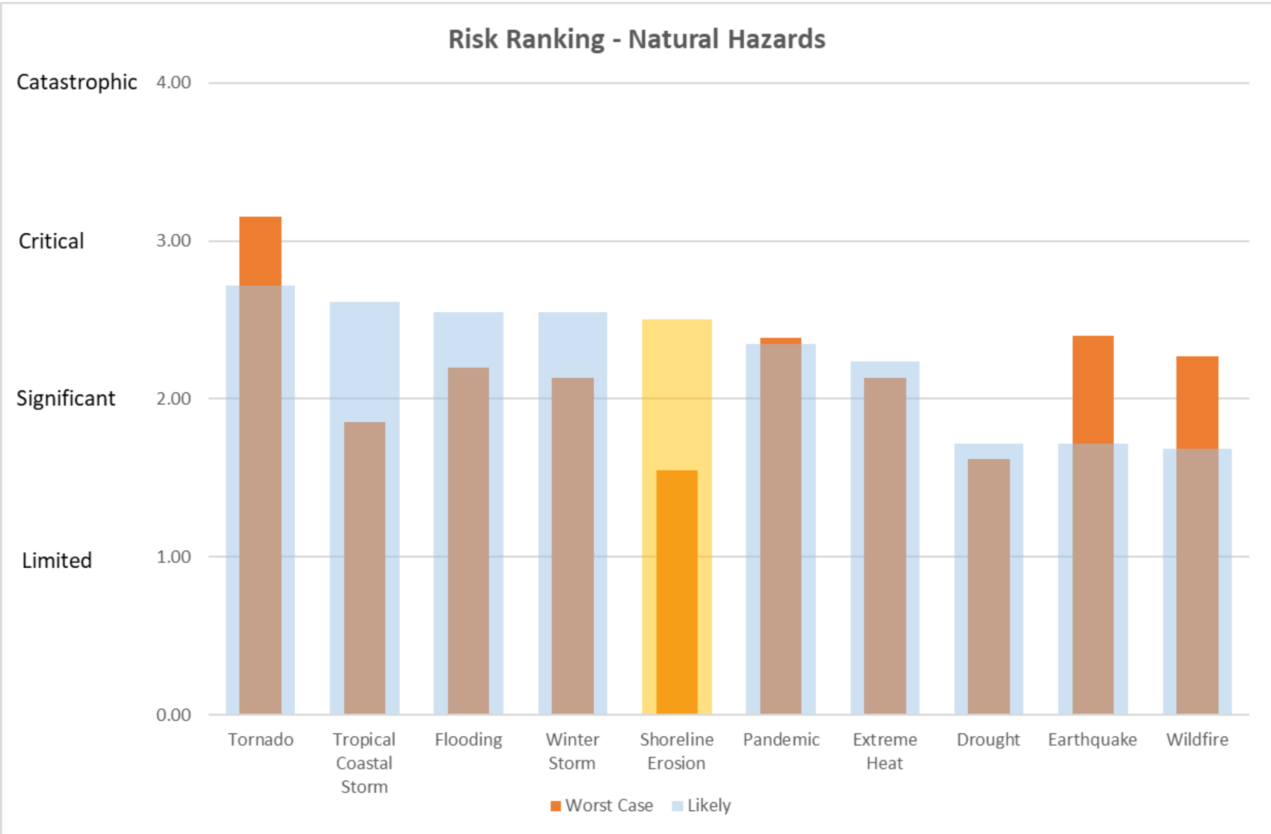
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Erosion is the gradual breakdown and movement of land due to both physical and chemical processes of water, wind, and general meteorological conditions. Natural, or geologic, erosion has occurred since the earth's formation and continues at a very slow and uniform rate each year. Major storms such as hurricanes and tropical storms may cause more sudden, rapid erosion by combining heavy rainfall, high winds, heavy surf, and storm surge to significantly impact riverbanks and the shoreline. As it relates to natural hazards that threaten property damage, there are two types of erosion: riverine erosion and coastal erosion. The primary concern of both riverine and coastal erosion is the gradual removal of rock, vegetation and other sediment materials from riverbanks, stream beds and shorelines that result in soil instability and possible damages to property and infrastructure.

Impacts on the environment are apparent as shoreline erosion from more frequent shoreline inundation contributes to loss of trees, wetland grasses and other valuable habitats of the intertidal zone. Damage to these sensitive features could affect the important local seafood industry which relies on the intertidal zone as a fish and shellfish nursery. Also, eroded shorelines are more vulnerable to damage from severe flood events in the future.[40]

The **likely incident** is caused by a tropical storm or Nor-Easter storm producing high energy waves, minor storm surge and heavy precipitation resulting in flooding of inland areas. Properties that have high, steep slopes and are exposed to the most wave energy will experience a greater risk to erosion. The western shores of the Elizabeth River (River Point) and close to the confluence with the Southern Branch has the greatest combination of bluff-like features and strong wave energy. Weather systems producing periods of sustained winds will generate higher than normal wave energy. This combined with high amounts of precipitation may lead to minimal shoreland erosion over time.

The **worst-case** incident may be caused by a Category 3 or 4 hurricane making landfall just south of the Southside Region causing significant storm surge and heavy rains that lead to flash flooding resulting in minimal to moderate shoreland erosion depending upon the slope of a shoreline, the top of bank elevation, existing vegetation, and the presence of on-site or nearby erosion control structures. Areas with the steepest slope and lacking vegetation will experience the worst shoreland erosion effects (moderate) while most other areas along the coastline will likely experience minor erosion. Direct impacts from a Category 3 or higher intensity hurricane are unlikely, but not impossible.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Shoreline erosion in Hampton Roads occurs as a relatively slow natural process over the long term, with occasional major impacts wrought by coastal storm and flooding hazards. The Atlantic Ocean shorelines in Virginia Beach and Norfolk are the most vulnerable areas regarding coastal shoreline erosion. The fetch for tropical storms and nor'easters is sufficient to create wind-driven wave action that causes significant damage on a regular basis. The Chesapeake Bay shorelines of Norfolk are also susceptible to wind-driven wave action that causes coastal shoreline erosion.[41] Many older shoreline stabilization features in Hampton Roads are vulnerable to the effects of shoreline erosion and their failure can cause subsequent catastrophic failure of parking lots, marinas, parks, garages, roads and other waterfront features.[42]

One factor in accurately determining specific shoreline erosion hazard areas is the continuous implementation of shoreline reinforcement or nourishment projects completed by federal, state and local government agencies. Typically, areas of high concern regarding long term erosion are addressed through shoreline hardening or stabilization projects such as

[40] 2017 Hampton Roads Hazard Mitigation Plan pg. 4:41
[41] 2017 Hampton Roads Hazard Mitigation Plan pg> 5:37
[42] 2017 Hampton Roads Hazard Mitigation Plan pg. 4:52-4:53

seawalls, breakwaters, and beach sand replenishment. The list below displays completed, ongoing, or planned beach replenishment projects within the area of study from the Hampton Roads Resilience Project Dashboard (last updated June 2020).

- Ocean View Beach Nourishment Watershed - Norfolk (Completed)
- Chesapeake Beach Restoration Sub-Watershed - Virginia Beach
- Bay Beaches Restoration (Cape Henry & Ocean Park Sub-Watershed) - Virginia Beach
- Beach Replenishment II Watershed - Virginia Beach
- Croatan Beach Restoration Sub-Watershed - Virginia Beach
- Sandbridge Beach Restoration II and III Sub-Watershed - Virginia Beach

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

The average annual erosion rate on the Atlantic coast is roughly 2 to 3 feet per year; however, erosion rates vary greatly from location to location and year to year. A study by The Heinz Center (2000), Evaluation of Erosion Hazards, states that over the next 60 years, erosion may claim one out of four houses within 500 feet of the U.S. shoreline. It also states that nationwide, erosion may be responsible for approximately $500 million in property loss to coastal property owners per year, including both damage to structures and loss of land. To the homeowners living within areas subject to coastal erosion, the risk posed by erosion is comparable to the risk from flooding and other natural hazard events.[43]

<u>Notable Incidents in the Southside Region</u>

October 28, 2012 (Chesapeake, Norfolk, Virginia Beach): Tropical Cyclone Sandy moving northward well off the Mid Atlantic Coast then northwest into extreme southern New Jersey produced very strong northeast winds followed by very strong west or northwest winds. The strong winds caused moderate to severe coastal flooding across portions of eastern and southeast Virginia. Water levels reached 3.5 feet to around 4.5 feet above normal adjacent to the Chesapeake Bay resulting in moderate to severe coastal flooding. Flooding of streets due to the combination of rain and storm surge was widespread during the height of the storm.

October 2-3, 2015 (Chesapeake, Norfolk, Virginia Beach): Anomalously strong/nearly stationary high pressure over New England produced strong onshore winds over the Mid-Atlantic. The strength and duration of the onshore winds produced moderate coastal flooding along the Atlantic Coast and Chesapeake Bay. A tidal departure of 3 to 4 feet resulted in moderate flooding along the Chesapeake Bay.

January 23, 2016 (Virginia Beach): A combination of low pressure moving from the southeast United States northeast and just off the Atlantic Coast, and high pressure over southeast Canada produced very strong onshore winds across the Mid-Atlantic. The strength and duration of the onshore winds produced moderate coastal flooding along the Atlantic Coast and Chesapeake Bay. A tidal departure of 2.5 to 3.5 feet resulted in moderate coastal flooding along the Atlantic Ocean and Chesapeake Bay. The peak water level at the Chesapeake Bay Bridge Tunnel was 5.72 feet at 6:06 am on January 23.

September 2-3, 2016 (Chesapeake, Norfolk, Portsmouth, Virginia Beach): Tropical Storm Hermine moving northeast along the Southeast Coast then off the Mid Atlantic Coast produced tropical storm force winds, minor to moderate coastal flooding, and locally heavy rainfall across portions of Hampton Roads, the Middle Peninsula, and the Virginia Eastern Shore. Rain bands associated with Tropical Storm Hermine produced generally 2 to 5 inches of rainfall in Chesapeake. Bowers Hill reported 5.28 inches of rain. The Naval Auxiliary Landing Field reported wind gusts of 40 knots. Virginia Beach experienced 3 to 7 inches of rainfall with Sanbridge Beach reporting 6.92 inches of rain and wind gusts of 50 knots at Naval

[43] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:52

Air Station Oceana. Tropical storm wind gusts caused minor tree and structural damage. Norfolk experienced two to four inches of rainfall. The highest sustained wind of 39 knots with a peak wind gust of 48 knots was measured at Norfolk International Airport. Coastal storm tides of 2 to 3.5 feet above astronomical tide levels were common, with only minor beach erosion reported. The maximum storm tide in Sewell's Point, crested at 6.16 feet, which resulted in moderate coastal flooding.

October 8-9, 2016 (Chesapeake, Norfolk, Portsmouth, Virginia Beach): Post Tropical Cyclone Matthew tracking northeast just off the North Carolina and Virginia coasts, produced very strong northeast or north winds over southeast Virginia and the Virginia Eastern Shore. These winds caused moderate coastal flooding over portions of the area. In Virginia Beach, Coastal storm tides of 2 to 3.5 feet above astronomical tide levels were common, with only minor beach erosion reported. The maximum storm tide measured 5.69 feet at the Chesapeake Bay Bridge Tunnel, which resulted in moderate coastal flooding. In Chesapeake, the maximum storm tide reached 6.64 feet at Money Point, which resulted in moderate coastal flooding, while the maximum storm tide reached 5.86 feet at Sewell's Point.

September 5-6, 2019 (Chesapeake, Norfolk, Portsmouth, Virginia Beach): Hurricane Dorian tracking northeast along the North Carolina coast and just off the Virginia coast produced tropical storm winds and associated wind damage across portions of southeast Virginia. Tropical storm winds uprooted several trees and downed power lines, produced minor structural damage, and caused power outages across the area. Observers measured wind gust ranges of 43 knots (49 mph) to 56 knots throughout the region. The northeast to north winds associated with Hurricane Dorian produced tidal anomalies between 2.5 and 3.5 feet over the southern Chesapeake Bay. This caused moderate coastal flooding over portions of Norfolk. Sewell's Point crested at 5.87 feet Authorities reported street flooding and stranded vehicles in the Ghent area. The Chesapeake Bay Bridge Tunnel water levels reached 6.63 feet while Money Point crested at 6.21 feet.

November 17, 2019 (Norfolk and Virginia Beach): The combination of high pressure over northern New England and low pressure just off the Middle Atlantic Coast resulted in very strong northeast to north winds over the southern Chesapeake Bay, which caused minor to moderate coastal flooding. There were tidal anomalies between 2.0 and 3.0 feet over the southern Chesapeake Bay. This caused minor to moderate coastal flooding over portions of Virginia Beach. Water levels in the Chesapeake Bay Bridge Tunnel reached 5.88 feet while levels at Sewell's Point crested at 5.35 feet. Officials reported standing water on Hampton Boulevard in Norfolk and minor flooding at other streets throughout the cities.

August 4, 2020 (Chesapeake, Norfolk, Portsmouth, Virginia Beach): The center of Tropical Storm Isaias tracked north just inland of the Middle Atlantic Coast from late Monday night, August 3rd through Tuesday morning, August 4th. Winds associated with the tropical storm caused moderate (perhaps some locally major) tidal/coastal flooding across portions of Southeast Virginia.

Future Likelihood of the Hazard for Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

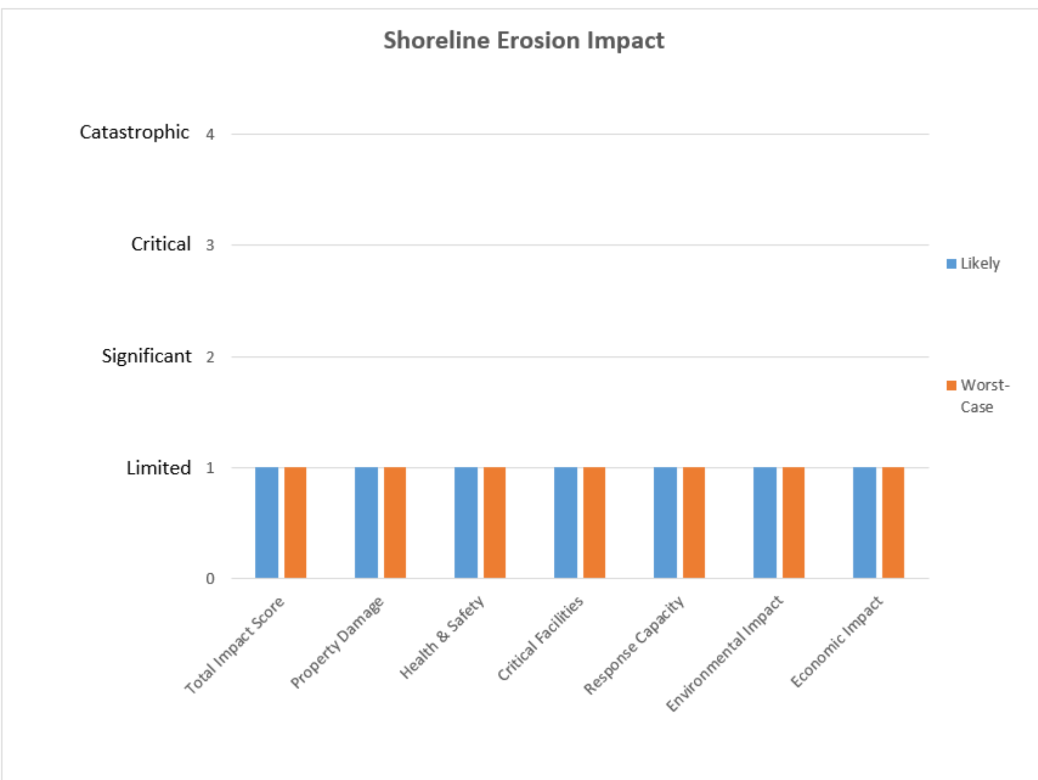
Future Likelihood of Shoreline Erosion		
	Likely	**Worst-Case**
Historical Average (time period)	1 event every 19 months (1.7 years)	1 event every 200 years
Historical Annual Probability	60% chance of annual occurrence	0.5% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	Yes
Future Annual Probability	91-100% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of occurrence annually	2 - infrequent: 1-10% chance of annual occurrence

Considerations: As the extent of flooding increases, the frequency and severity of shoreline erosion will also increase.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Shoreline Erosion Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Very Long - More than 24 hours	Very Long - More than 24 hours
Duration	Short - Less than six hours	Moderate - 6-24 hours

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Shoreline Erosion Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited	Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Shoreline Erosion Consequence Analysis - Worst-Case		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited	Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Tornado

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." Tornadoes can co-occur with other weather events such as thunderstorms or hurricanes. While the violently rotating columns of air may only last for a few minutes, affects can be catastrophic, lasting for more than an hour and traveling dozens of miles. Most of the world's tornadoes occur in the United States, usually in April and June.[44]

Risk Profile

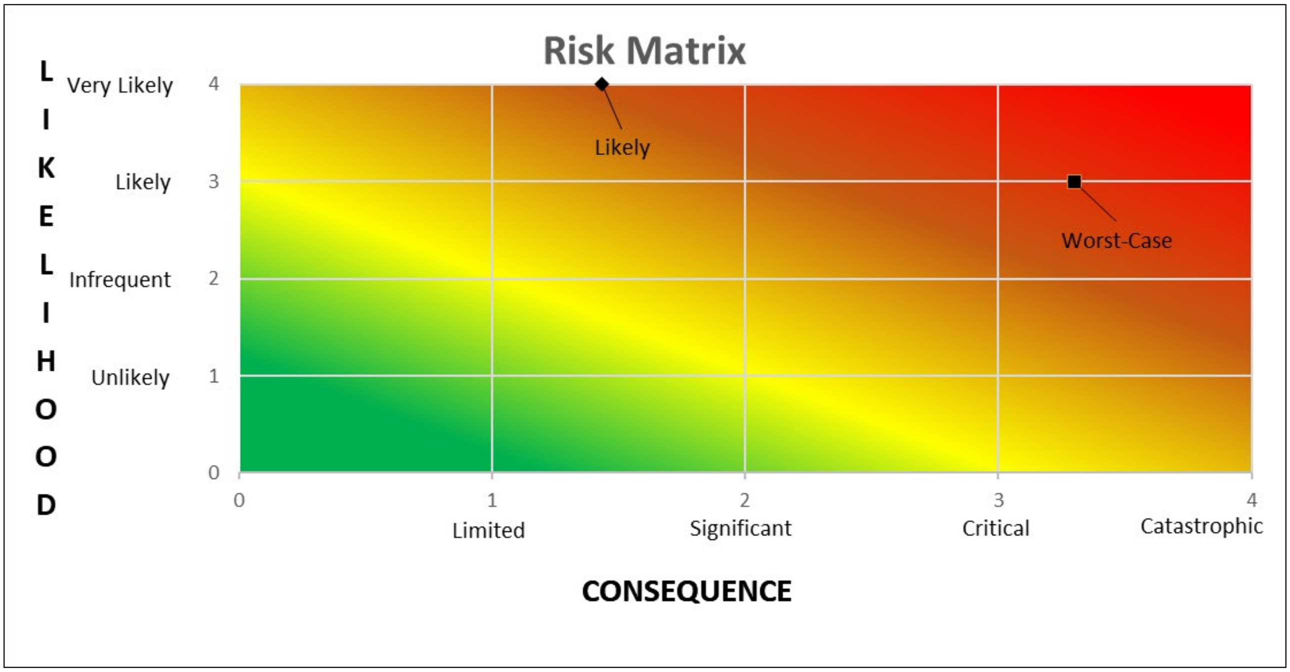
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Tornado Storm Risk Profile				
Likelihood	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
	Likelihood	4 Very Likely	3 Likely	50%
Consequence	Impact	1.17 Limited-Significant	3.50 Critical-Catastrophic	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
	Total Risk Score	2.72	3.15	

[44] https://www.noaa.gov/education/resource-collections/weather-atmosphere/tornadoes

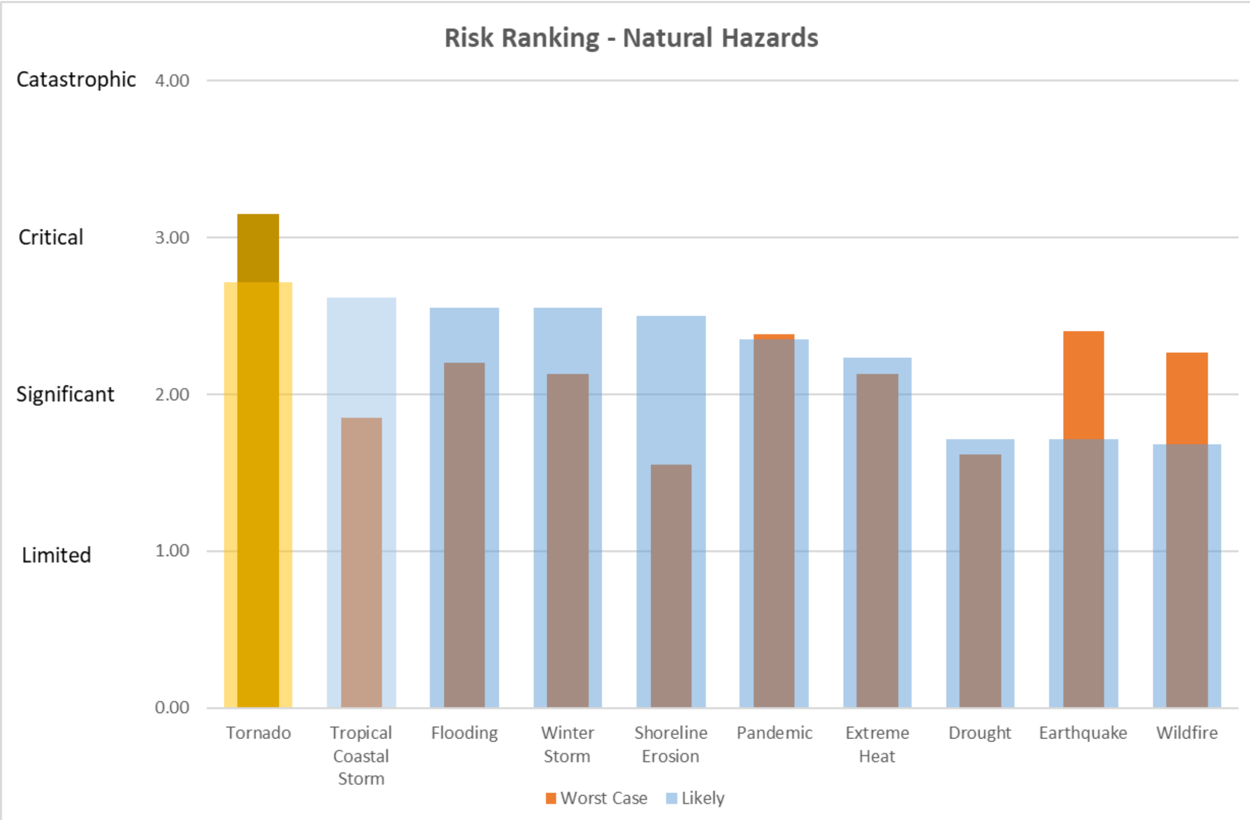
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. According to the NWS, tornado wind speeds normally range from 40 to more than 200 mph. The most violent tornadoes (EF5) have rotating winds of 200 mph or more and cause extreme destruction and turning normally harmless objects into deadly missiles.

They are more likely to occur during the spring and early summer months of March through June and can occur at any time of day but are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small short-lived tornadoes can inflict tremendous damage. Highly destructive tornadoes may carve out a path over a mile wide and tens of miles long. Waterspouts are weak tornadoes that form over warm water and are most common along the Gulf Coast and southeastern states. Waterspouts occasionally move inland, becoming tornadoes that cause damage and injury. However, most waterspouts dissipate over the open water causing threats only to marine and boating interests. Typically, a waterspout is weak and short-lived, and because they are so common, most go unreported unless they cause damage. The destruction caused by tornadoes ranges from light to devastating depending upon the intensity, size, location, and duration of the storm. Typically, tornadoes cause the greatest damages to wood-framed construction such as residential homes (particularly mobile homes) and tend to remain localized in impact.[45]

[45] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:59

Tornado hazards impact individual and community activities. Each year about fifty-six people are killed by tornadoes. The spring of 2011 was the deadliest and costliest tornado season recorded. Between April and June of 2011, tornadoes killed over 580 and caused $21 billion in damage. Most of these occurred in highly populated areas lacking storm shelters.[46]

Injuries from tornado hazards may be direct results of tornado impact or can occur later during recovery and cleanup, when people walk among debris and enter damaged buildings. A study of injuries after a tornado in Marion, Illinois, showed that 50 percent of the tornado-related injuries occurred during rescue attempts, cleanup, and other post-tornado activities. Nearly a third of the injuries resulted from stepping on nails. Other common causes of injury included falling objects and heavy, rolling objects. Because tornadoes often damage power lines, gas lines, or electrical systems, there is a risk of fire, electrocution, or an explosion.[47]

Tornadoes are high-impact, low-probability hazards. The net impact of a tornado depends on the storm intensity and the vulnerability of development in its path. Because the path of each tornado is unique to each event, general descriptions of impacts in Hampton Roads can be drawn from the impacts of previous storms. In Hampton Roads, a high intensity tornado, while unlikely, could be expected to impact almost everything within the storm's path Downed trees can block roadways, impeding traffic and blocking access and egress if any of the region's thoroughfares are impacted. Manufactured homes are particularly vulnerable to damage in the event of tornadoes. placed outside of flood zones and before building codes were in effect requiring foundation tie-downs.

Tornadoes associated with tropical cyclones are somewhat more predictable. These tornadoes occur frequently in September and October when the incidence of tropical storm systems is greatest. They usually form around the perimeter of the storm, and most often to the right and ahead of the storm path or the storm center as it comes ashore. These tornadoes commonly occur as part of large outbreaks and generally move in an easterly direction. Tracking and prior notification by the NWS and local news media helps save lives locally. Most reported tornado in the region have been F0 or F1 causing minor damage.

The worst-case scenario would include significant impacts to life, health, transportation, crops, import/export, and ultimately the economy. The paths remain unpredictable, creating a hazard of unknown possibilities. A tornado of increased strength, span, and time on the ground would increase the chances of loss of life, loss of utilities, and further inhibit emergency services response capabilities. The region is composed of densely populated areas which would increase the potential for death and injury from primary and secondary events. Poorly constructed homes, congregate housing communities, and manufactured homes are at an increased risk for damages. The coast complicates evacuation and access to disaster areas. The possibility of damage to the region's substantial number of healthcare facilities including regional specialty centers (e.g., trauma, cardiac), would create a healthcare challenge. Smaller outlying localities would have access challenges for incoming backup resources due to impassible roads from downed trees and flooding. Many of the region's localities have a "one way in, one way out" means of access. The worst-case scenario would likely include an event during an unexpected timing/season with little or no advanced warning. Significant loss of life and resources could occur, along with the impacts to the local economy.

[46] https://www.noaa.gov/education/resource-collections/weather-atmosphere/tornadoes
[47] https://www.cdc.gov/disasters/tornadoes/after.html

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Tornadoes tend to impact a small area and are difficult to predict where one may occur. Vulnerability of individual structures is based largely on building construction materials and standards, availability of safe rooms, and advanced warning system capabilities. In cases involving intense tornadoes, the best defense against injury or death is a properly engineered safe room or tornado shelter, neither of which is standard practice in the region. Likewise, advanced warning system capabilities are limited to Reverse 911, Emergency Alert System warnings and National Weather Service weather radio broadcasts.

The region's proximity to the coast makes it particularly susceptible to tropical storms, hurricanes, and tornadoes. The potential for impact is high for this densely populated area that houses several military installations.[48]

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Nationally, an average of 1,200 tornadoes are reported annually causing 80 deaths and 1,500 injuries (NOAA, 2002 and 2014). In Virginia, tornadoes primarily occur from April through September, although tornadoes have been observed in every month. Low-intensity tornadoes occur most frequently; tornadoes rated F2 or higher are very rare in Virginia, although F2, F3, and a few F4 storms have been observed.

A research project by Old Dominion University in May of 2020 showed that tornado frequency continues to increase in certain areas since 1950. The research found that the closest to a "Tornado Alley" for Virginia was the lower-lying portions of the state south of Richmond that make up the Piedmont geographic region, and East to Virginia's Fall Line."[49]

Notable Incidents in the Southside Region[50]

- **July 12-13, 1996: Hurricane Bertha** - Spawned tornadoes across Smithfield, Gloucester and Hampton injuring nine people and causing several million dollars in damages.
- **September 6, 1999: Tropical Storm Dennis** - Spawned tornadoes in Hampton with heavy rain, winds, and flooding.
- **April 28, 2008:** An EF 3 tornado spanned 16 miles from WSW of Suffolk, tracking NE crossing portions of Suffolk, Portsmouth, and Norfolk, nearing Naval Station Norfolk causing 200 injuries and $30 million in damages.
- **April 16, 2011:** An EF3 tornado developed just south of the Surry Nuclear Power Plant and continued across the James River into the Kingsmill section of James City county causing $250k of damage.
- **July 24, 2014:** An EF1 tornado developed in the Chesapeake Bay then tracked West crossing a 7.7 mile span reaching almost to the Eastern coast. The tornado killed three people, injured 31 and caused an estimated $1.4 million in damages.
- **February 24, 2016:** An EF3 tornado crossed King and Queens County, Tappahannock, the Rappahannock River, and into Richmond County spanning 10.7 miles. The storm injured 25 and caused $5.2 million in damages.
- **August 4, 2020:** During Hurricane Isaias, multiple tornadoes ranging from EF0 to EF3 spawned across multiple areas of the region and resulted in five injuries and approximately $14 million in damage

48 https://www.adaptationclearinghouse.org/resources/assessing-vulnerability-and-risk-of-climate-change-effects-on-transportation-infrastructure-hampton-roads-virginia-fhwa-pilot.html
49 https://odu.edu/news/2020/5/virginia_s_tornado_a#.X9ew5thKjIU
50 https://hampton.gov/1686/Hurricane-history
https://data.newsleader.com/tornado-archive/virginia
NOAA Databases

Future Likelihood of the Hazard for Southside Region

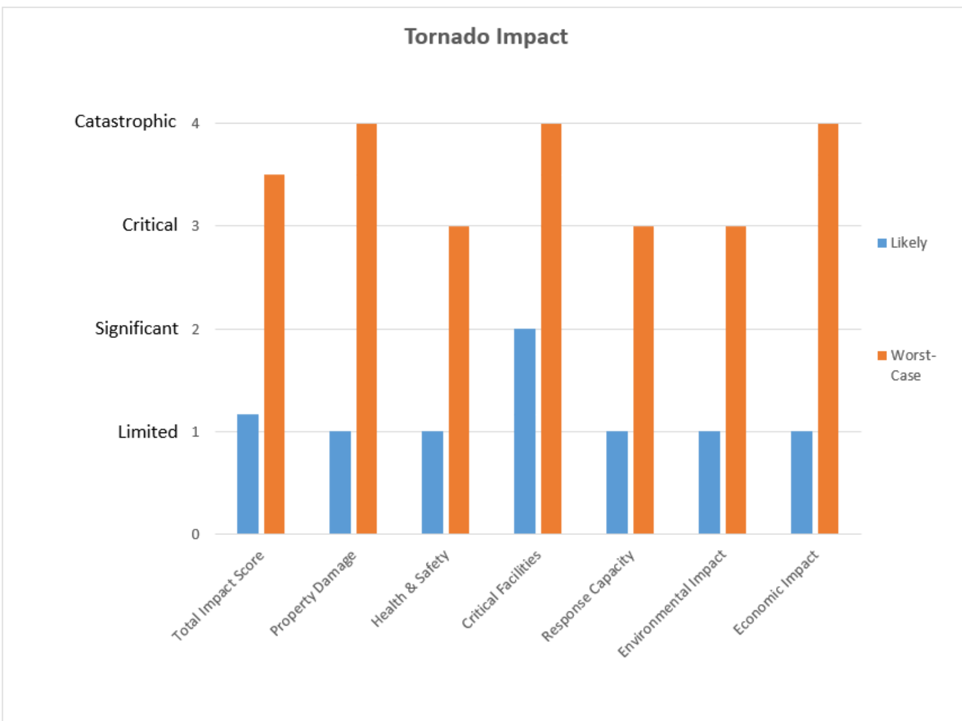
The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of Tornado		
	Likely	**Worst-Case**
Historical Average (time period)	42 events every 50 years (1971-2020)	6 events every 50 years (1971-2020)
Historical Annual Probability	84% chance of annual occurrence	12% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	No
Future Annual Probability	81-90% chance of annual occurrence	11-20% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of occurrence annually	3 - Likely: 11-30% chance of annual occurrence

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Tornado Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Short - Less than six hours	Short - Less than six hours
Duration	Short - Less than six hours	Short - Less than six hours

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Tornado Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.17 on a scale of 1 (Limited) to 4 (Catastrophic)

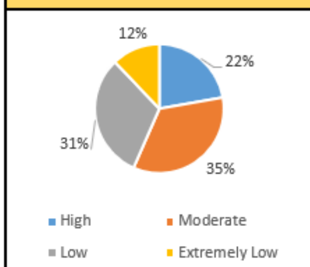
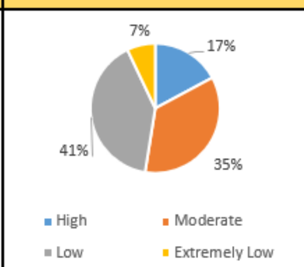
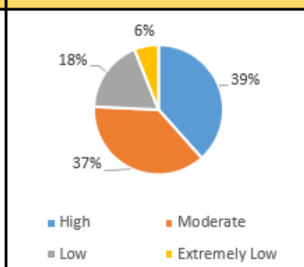
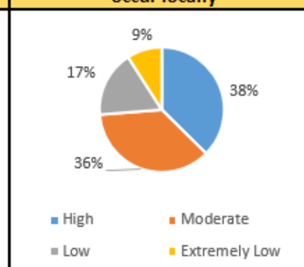
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Tornado Consequence Analysis - Worst-Case		
Property Damage	Catastrophic	Propert damage is severe, greater than 50% of critical and non-critical infrastructure affected.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Catastrophic	Shut down of critical facilities will be more than one month.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Critical	Serious environmental impact.
Economic Impact	Catastrophic	Severe economic impact. Standard of living is extremely impacted and may not be fully recoverable.
Total Impact	Critical-Catastrophic	Total Impact Score: 3.50 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Tornado Public Perceptions			
Perceived confidence in city's ability to respond and recover from this hazard	**Perceived confidence in personal ability to protect self and family from this hazard**	**Concern over the impact to personal health and safety if this hazard were to occur locally**	**Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally**
			

Tropical/Coastal Storms

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

Hurricanes, tropical storms, and typhoons are collectively known as tropical cyclones. NOAA defines a tropical cyclone as a "warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere."

Risk Profile

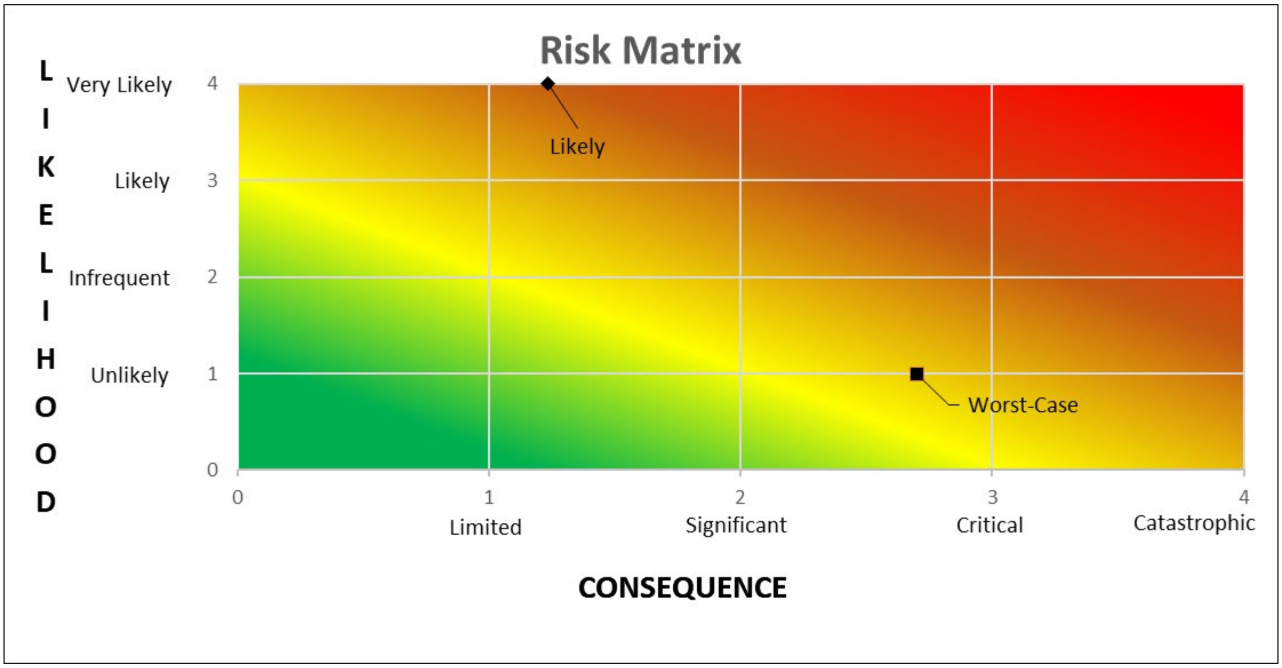
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Tropical Coastal Storm Risk Profile

	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	Likelihood	4 Very Likely	1 Unlikely	50%
Consequence	Impact	1.17 Limited-Significant	3.00 Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	2 Moderate	2 Moderate	5%
	Total Risk Score	2.62	1.85	

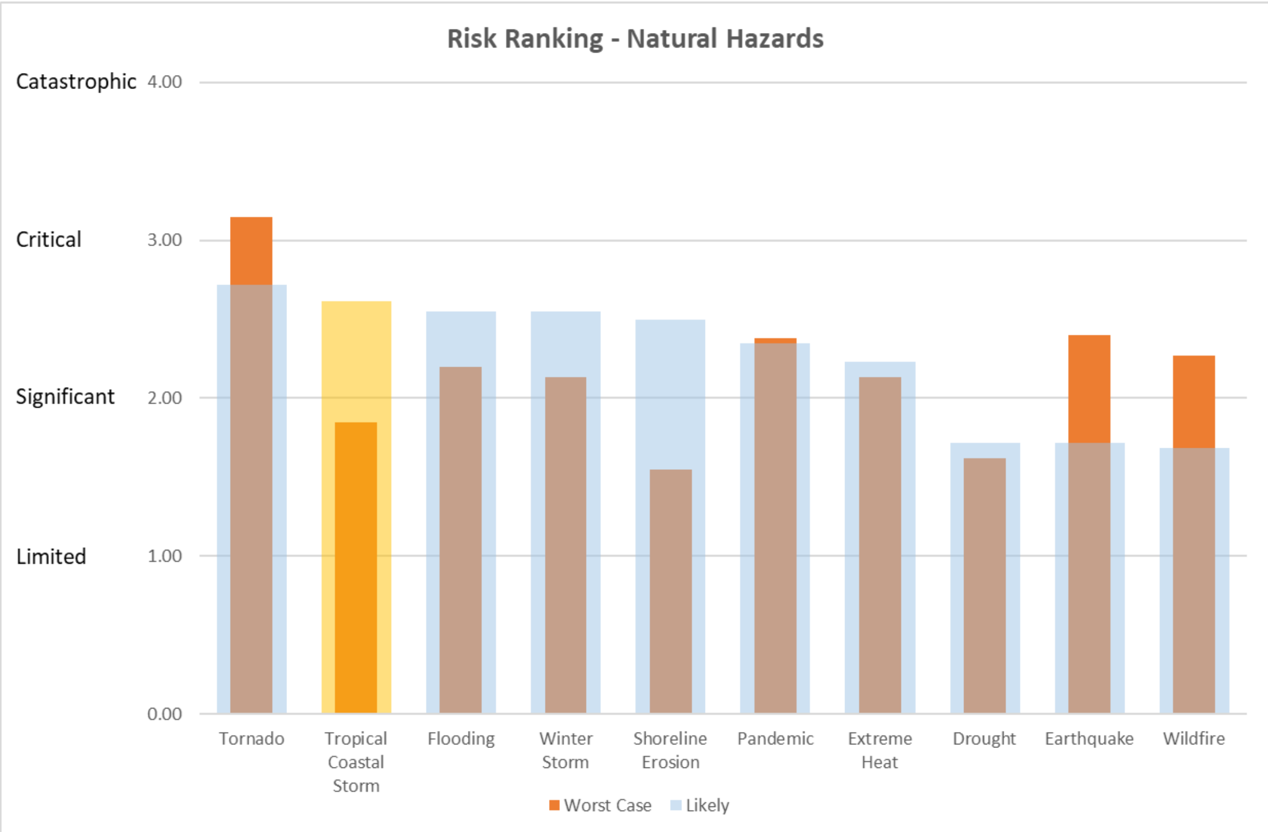
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Hurricanes and tropical storms are characterized by closed circulation developing around a low-pressure center in which the winds rotate counterclockwise in the Northern Hemisphere and with a diameter averaging 10 to 30 miles across.[51] A tropical cyclone refers to any such circulation that develops over tropical waters. Tropical cyclones act as a mechanism to transport built-up heat from the tropics toward the poles. In this way, they are critical to the earth's atmospheric heat and moisture balance. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation, and tornadoes. Coastal areas are particularly vulnerable to storm surge, wind-driven waves, and tidal flooding which can prove more destructive than cyclone wind. The key energy source for a tropical cyclone is the release of latent heat from the condensation of warm water. Their formation requires a low-pressure disturbance, warm sea surface temperature, rotational force from the spinning of the earth, and the absence of wind shear in the lowest 50,000 feet of the atmosphere. Most hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the official Atlantic hurricane season, which encompasses the months of June through November. The peak of the Atlantic hurricane season is September.[52]

It is **likely** that the region will be impacted by hurricanes and tropical storms in the future. Direct impacts from hurricanes of Category 3 and 4 intensities are rare in Hampton Roads due to: (1) historical tracks remaining offshore or impacting land before reaching Hampton Roads; and (2) cooler Atlantic Ocean water temperatures north of Cape Hatteras, which diminish a storm's ability to maintain intensity, or intensify. A Category 5 hurricane is considered implausible in Hampton Roads due to the cooler water temperatures mentioned above. It is likely that Hampton Roads will experience the frequent effects of smaller hurricanes (i.e., Categories 1 and 2 with wind speeds from 74-110 mph), and tropical storms with sustained wind speeds of at least 39 mph and torrential rains, as storms making landfall along the North Carolina and Virginia coastlines could impact the region in any given year.

A **worst-case** or centennial storm occurred August 1933: The Chesapeake-Potomac Hurricane passed just west of the Hampton Roads area. The storm made landfall in NE North Carolina and moved Northwest. This hurricane produced record-high tides for the area: 9.69 feet above Mean Lower Low Water (MLLW). The highest sustained wind measured was 88 mph at the Naval Air Station. Less than a month later, another hurricane struck the area with peak winds at 88 mph and 8.3-foot tides.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Hampton Roads can expect to experience hurricane damage in any given year. Since the mid-1800s, numerous tropical cyclones have affected Virginia, causing the deaths of an estimated 228 people, and costing the Commonwealth more than a billion dollars in damages. Wind damage from events within the region include a large number of downed trees, damage to roofs, siding and signs, and power outages typically lasting less than a week. Downed trees can temporarily block roadways, impeding transportation and rescue/recovery efforts. Business interruptions resulting from power outages are commonplace and many restaurants and cold storage facilities can be negatively impacted, especially during prolonged outages. Commodities such as ice and gas will be in high demand.. Since wind and flood events typically occur simultaneously, the combined impacts are more devastating in flood-prone areas. Roof damage from wind can subsequently result in rain damage to structures, as well. Combined storm surge and wind impacts to both the coast as well as flood-prone areas may make some homes and businesses uninhabitable for days to weeks following an event.

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[51] 2017 Southside Hampton Roads Hazard Mitigation Plan, Pg. 4:44
[52] http://earthobservatory.nasa.gov

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

The Atlantic Ocean averages about 10 storms annually, of which six reach hurricane status according to the NASA Earth Observatory. As a hurricane develops, barometric pressure at its center falls and winds increase and can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour (mph), the system is designated a tropical storm, given a name, and is monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 mph the storm is deemed a hurricane. Meteorologists further classify hurricane intensity by applying the Saffir-Simpson Hurricane Wind Scale which rates hurricane intensity on a scale of one to five, with five being the most intense. Meteorologists recently revised the wind scale to remove storm surge ranges, flooding impact and central pressure statements.[53]

Historical evidence shows that the Southside Hampton Roads Region is vulnerable to damaging hurricane and tropical storm-force winds. Since 1851, there have been over 115 hurricanes and tropical storms that have passed within 75 miles of this region equating to a 69 percent annual chance that a storm will impact the area. The region is less likely to experience the effects of a major (Category 3 or stronger) hurricane; however, it remains a possibility. The effects of smaller hurricanes (Categories 1 and 2 with wind speeds from 74-110 mph) and tropical storms (sustained wind speeds of at least 39 mph and torrential rains) will be more frequent, as storms making landfall along the North Carolina and Virginia coastlines could impact the region in any given year.

Notable Incidents in the Southside Region

- **2004:** Hurricane Ivan produced 40 tornadoes in a single day across the Commonwealth.
- **2018:** Remnants of Hurricane Michael impacted Virginia as a tropical storm with winds of about 50 mph
- **2019:** Hurricane Dorian did not make landfall in Virginia but caused wind gusts in the 64-70 mph range which uprooted numerous trees and causing some minor structural damage. Dorian also caused moderate to major tidal flooding across southeast Virginia. No inland flooding occurred despite 3 to 5 inches of rainfall in coastal section of Virginia Beach.[54]
- **2020:** Hurricane Isaias made landfall in North Carolina as a category 1 hurricane and impacted Hampton Roads with tropical storm winds with gusts between 53-67 mph.[55] Hurricane Isaias produced seven tornadoes in the Commonwealth.

[53] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:44
[54] www.weather.gov/akq/Sep_6_2019_Dorian
[55] www.weather.gov/akq/TSIsaias

Future Likelihood of the Hazard for the Southside Region

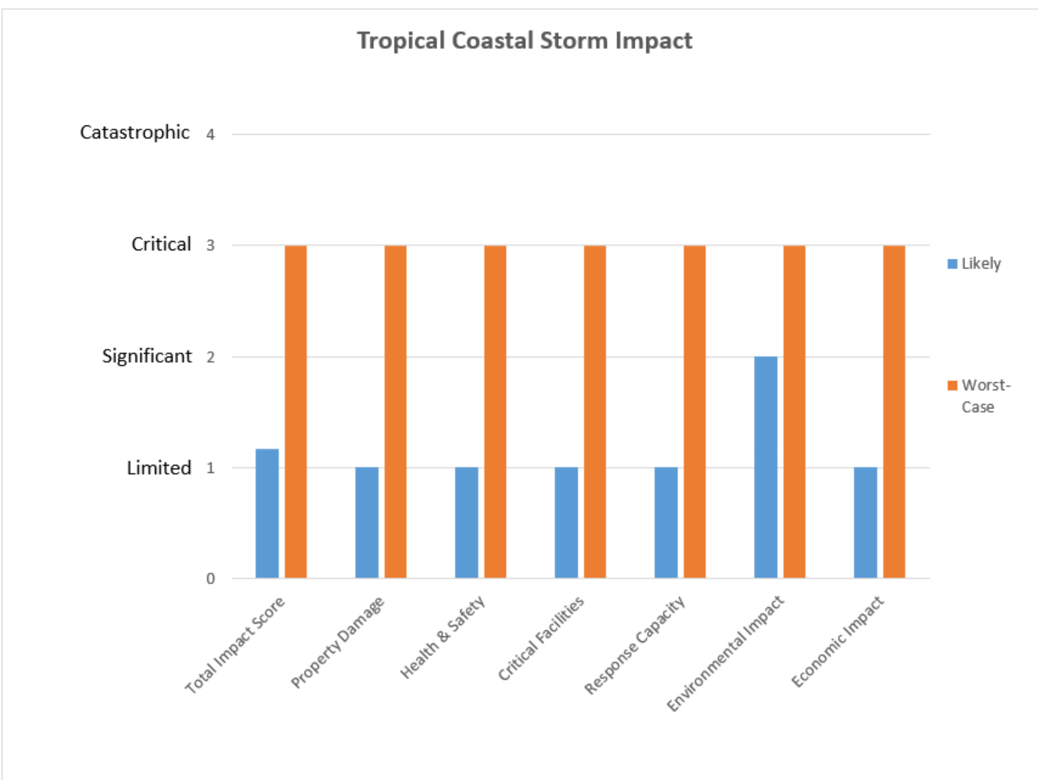
The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of Tropical Coastal Storm		
	Likely	**Worst-Case**
Historical Average (time period)	115 events between 1851-2020	1 event every 40 years (1900-2020)
Historical Annual Probability	69% chance of annual occurrence	2.5% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	61-70% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of occurrence annually	1 - Unlikely: No documented occurrence. Less than 1% chance of annual occurrence

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Tropical Coastal Storm Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Very Long - More than 24 hours	Very Long - More than 24 hours
Duration	Moderate - 6-24 hours	Moderate - 6-24 hours

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Tropical Coastal Storm Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1.17 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

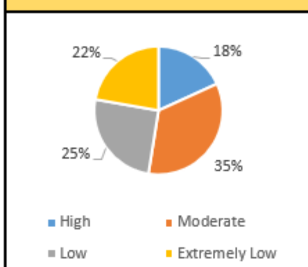
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

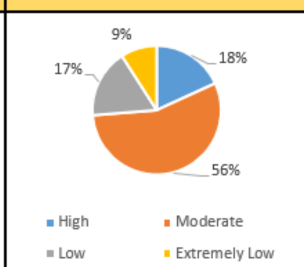
Tropical Coastal Storm Consequence Analysis - Worst-Case		
Property Damage	Critical	Property damage is between 26-50% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Critical	Shut down of critical facilities 1-4 weeks.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Critical	Serious environmental impact.
Economic Impact	Critical	Serious economic impact. Standard of living is seriously affected.
Total Impact	Critical	Total Impact Score: 3.00 on a scale of 1 (Limited) to 4 (Catastrophic)

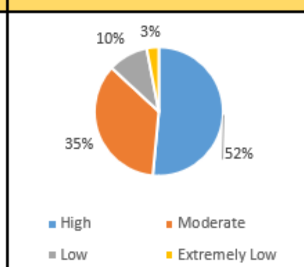
Consequence Analysis: Public Perception

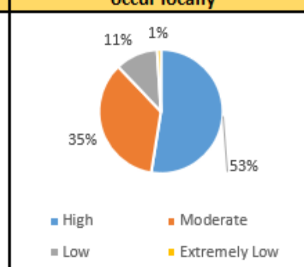
The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Tropical Coastal Storm Public Perceptions			
Perceived confidence in city's ability to respond and recover from this hazard	**Perceived confidence in personal ability to protect self and family from this hazard**	**Concern over the impact to personal health and safety if this hazard were to occur locally**	**Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally**









Wildfire

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

Wildfires are uncontrolled forest fires, grassland fires, rangeland, or urban-interface fires which consume natural fuels and spread in response to the environment. Wildfires can be either a natural phenomenon or human-caused. The frequency and severity of wildfires depends on both weather and human activity.

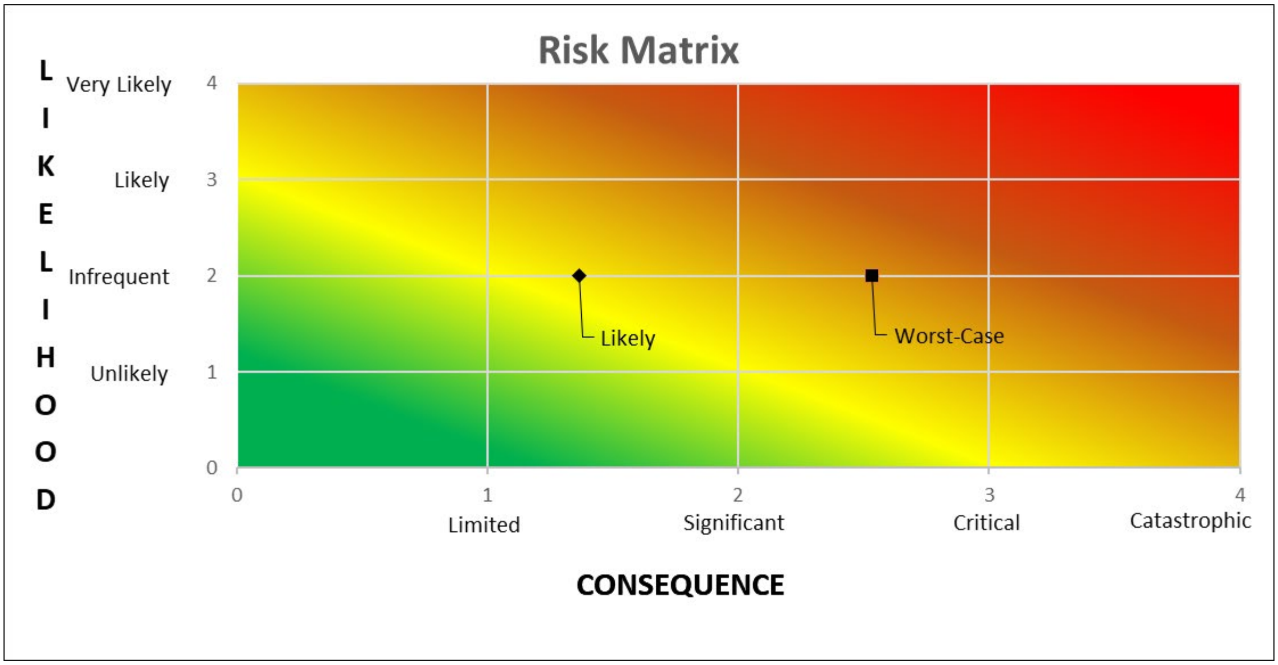
Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Wildfire Storm Risk Profile				
Likelihood	**Risk Assessment Category**	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
	Likelihood	2 Infrequent	2 Infrequent	50%
Consequence	**Impact**	1.33 Limited-Significant	2.67 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	2 Moderate	3 Long	5%
	Total Risk Score	1.68	2.27	

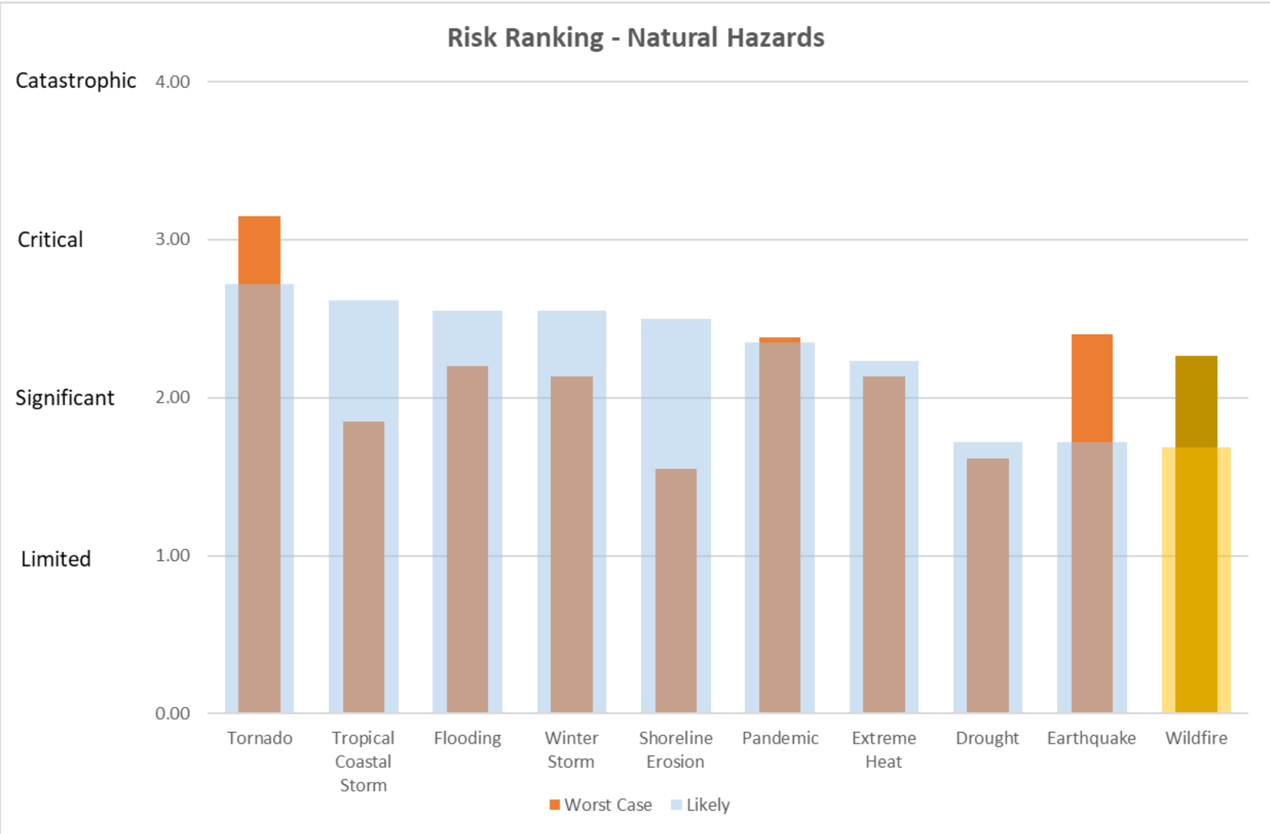
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A wildfire is any fire occurring in a wildland area (i.e., grassland, forest, brush land) except for fire under prescription. Wildfires are part of the natural management of the Earth's ecosystems but may also be caused by natural or human factors. Over 80% of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. Lightning is the second most common cause for wildfire. Wildland fires may also result when a controlled burn (private or public) spreads out of control under favorable environmental conditions. There are three classes of wildland fires: surface fire, ground fire, and crown fire. A surface fire is the most common and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire (muck fire) is usually started by lightning or human carelessness and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildland fires are usually signaled by dense smoke that fills the area for miles around. Fire probability depends on local weather conditions, outdoor activities such as camping, debris burning, and construction, and the degree of public cooperation with fire prevention measures. Drought conditions and other natural disasters (such as hurricanes, tornadoes, and lightning) increase the probability of wildfires by producing fuel in both urban and rural settings. Forest damage from hurricanes and tornadoes may block interior access roads and fire breaks, down overhead power lines, or damage pavement and underground utilities.[56]

The most **likely incident** is based on the following scenario and potential contributing factors: A farmer in the southern part of the city is burning debris at his farm. Below average rainfall, low humidity and breezy conditions enable the fire to spread out of control. The municipal fire department is notified and first arriving fire companies report that the fire is too large for a single resource to handle and request additional resources. The fire has grown beyond one acre in size and is threatening structures. Nearby residents report heavy smoke and sensitive population groups begin experiencing mild smoke inhalation effects that require medical attention. Due to the fire's size, mutual aid from neighboring jurisdictions and the Virginia Department of Forestry may be necessary. An Incident Command System is established to manage the incident and associated resources. The most likely incident may also result from public sector-controlled burns which become uncontrolled and spread.

The **worst-case** incident consists of a large wildfire that impedes on structures and endangers citizens' lives which may result in injuries or deaths to firefighters. Most firefighters are not equipped or adequately trained to fight wildfires. Any large-scale wildfire will require the assistance of multiple jurisdictions and the Virginia Department of Forestry. Due to the wildland urban interface, there is a potential for significant property damage to structures.

[56] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:79

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The southern parts of Virginia Beach and Chesapeake are mostly rural areas consisting of large open and heavily dense forest areas. Part of The Great Dismal Swamp is located in southeastern Chesapeake and is not easily accessible. Wildland fires can occur in urban and rural areas, but historically, the larger fires have occurred in rural areas. Fires can range from a small brush fire to extensive resource depleting wildland fires. Fires can cause damage to farmland, structures, and the large amounts of smoke produced during these fires can cause medical emergencies to those exposed. The flat topography and high moisture in the region mitigate some of the risk for uncontrolled or fast spreading wildland fires. Wildland fires occur predominantly in the months of February through April.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Each year the occurrence of a wildland fire is a high probability especially during periods of drought. The large amount of undeveloped land in the southern parts of Virginia Beach and Chesapeake increases wildland fire chances that would require multiple resources. Prior to the establishment of the Virginia Division of Forestry in 1914, it was not uncommon to experience over a thousand wildfires that burned hundreds of thousands of acres. By 1927, the Division of Forestry implemented programs which resulted in a decrease to only 440 wildfires burning 27,863 acres, an all-time low for Virginia (until recent years). Dry conditions in 1930 spawned a yearlong fire season with 2,554 fires burning 333,023 acres. Over the last 20 years, Virginia has averaged 930 fires impacting of 16,532 acres annually.

Notable Incidents in the Southside Region

When lightning struck in the Great Dismal Swamp National Wildlife Refuge on August 4, 2011, it impacted critical wildlife habitat. A previous fire in 2008 killed trees and brush, leaving dead fuel in its wake. Grass and brush began to re-grow over the old burn scar, but in 2011, drought conditions enhanced the fire risk level quickly igniting a fire following a lightning strike.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

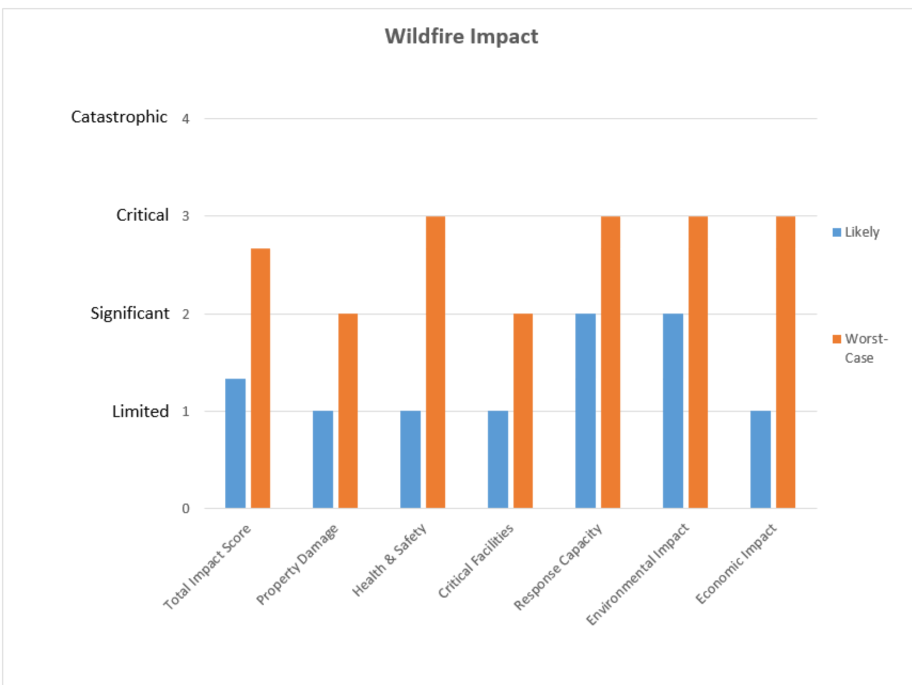
Considerations: As noted above, wildfire incidents are directly related to weather patterns and antecedent conditions, and thus its probability of occurrences are dynamic.[57]

Future Likelihood of Wildfire		
	Likely	**Worst-Case**
Historical Average (time period)	4 events every 5 years (2016-2020)	No events in recent history
Historical Annual Probability	80% chance of annual occurrence	<1% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes	Yes
Future Annual Probability	1-10% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	2 - Infrequent: 1-10% chance of annual occurrence	2 - Infrequent: 1-10% chance of annual occurrence

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Wildfire Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Very Long - More than 24 hours	Very Long - More than 24 hours
Duration	Moderate - 6-24 hours	Long - Less than one week

[57] interview with SMEs, 19 Apr 2021

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Wildfire Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited-Significant	Total Impact Score: 1..33 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Wildfire Consequence Analysis - Worst-Case		
Property Damage	Significant	Property damage is 5-25% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries exceed jurisdiction response capability.
Critical Facilities	Significant	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Critical	Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government.
Environmental Impact	Critical	Little to no environmental impact.
Economic Impact	Critical	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant-Critical	Total Impact Score: 2.67 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

This hazard was not identified as a high-risk hazard; therefore, it was not included in the community survey.

Winter Storm

Overview

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Southside Regional planning documents.

A winter storm is a weather event that produces forms of precipitation caused by cold temperatures, such as snow, sleet, ice, and freezing rain, while ground temperatures are cold enough to cause precipitation to freeze. Windy conditions may also be present during a winter storm.

Risk Profile

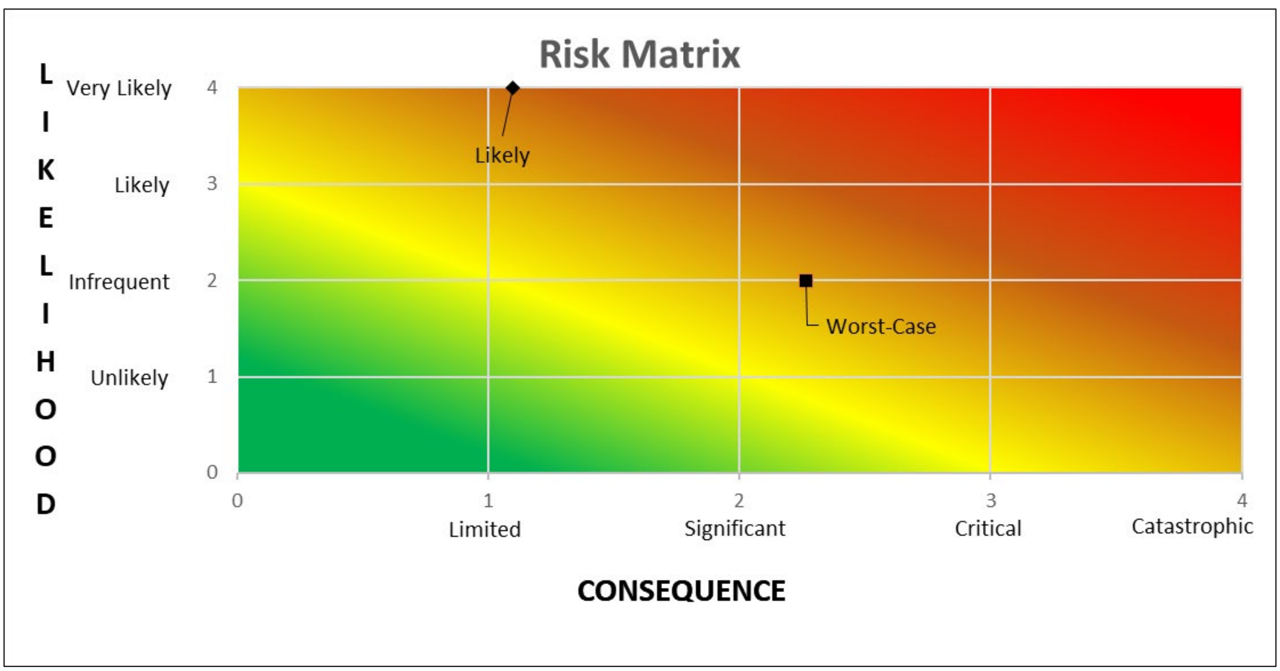
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Winter Storm Storm Risk Profile

	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	Likelihood	4 Very Likely	2 Infrequent	50%
Consequence	Impact	1.00 Limited	2.33 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	2 Moderate	3 Long	5%
	Total Risk Score	2.55	2.13	

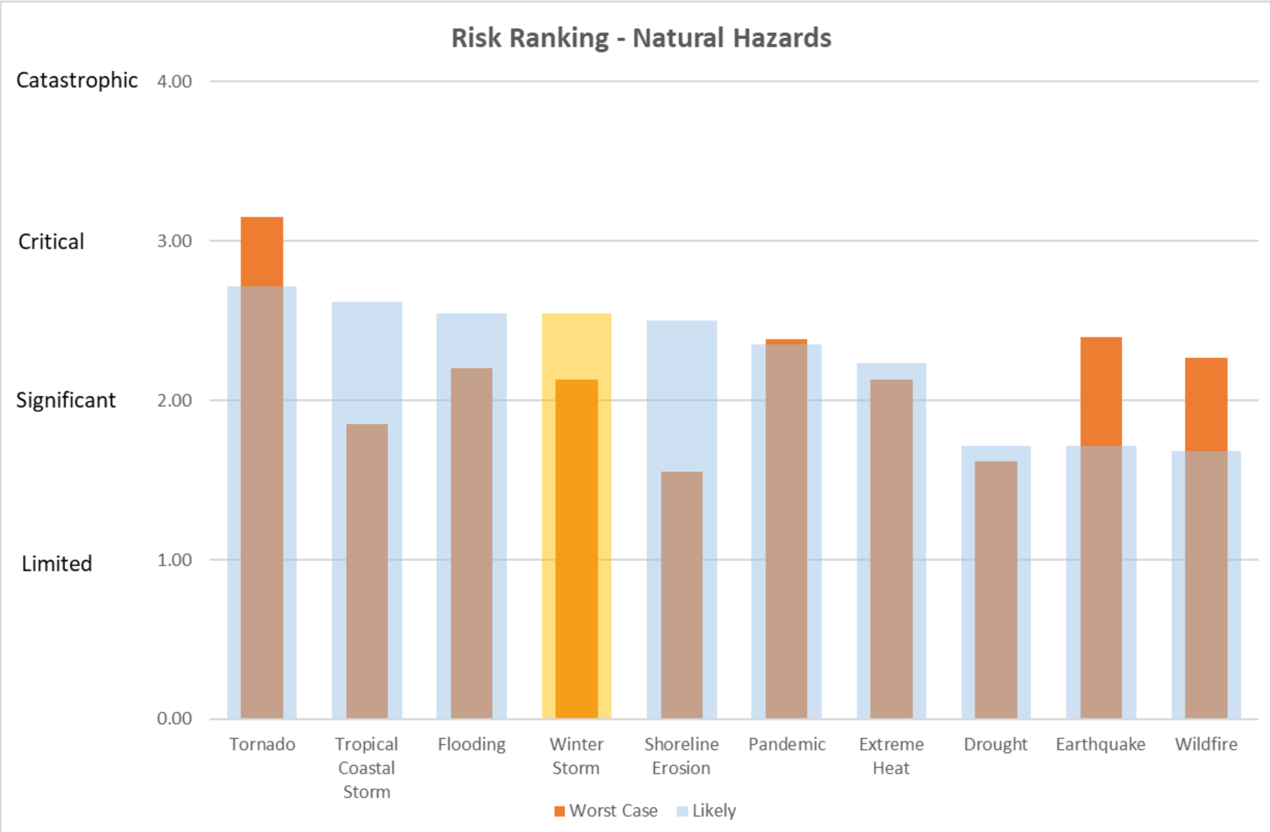
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Hazard Characteristics

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A winter storm can range from a moderate snowfall over a period of a few hours, to blizzard conditions with blinding wind-driven snow that lasts for several day. Some winter storms may be large enough to affect several states, while others may affect only a single community. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility.

The **likely winter storm incident** typically includes snow, sleet, freezing rain, or a mix of these wintery forms of precipitation. Sleet can accumulate like snow and cause a hazard to motorists. Freezing rain, rain that falls onto a surface with a temperature below freezing, can form a glaze of ice. Even small accumulations of ice can cause a significant hazard, especially on roads, power lines and trees. Ice storms have also occurred in the region, when freezing rain falls and freezes immediately upon impact.

During a **worst-case event**, the area would succumb to a heavy amount of snow, totaling anywhere from ten to sixteen inches, accompanied by several days of below-freezing temperatures. Storms that consist of rain and freezing rain, then to snow, further compound the scenario. High accumulations that hamper both plowing and transportation will have a huge impact on the region. Because most cities only plow main roads, transportation on side- or neighborhood roads will be very difficult, causing many to be kept homebound for an extended period. Those that need medical assistance will be impacted, especially those attending dialysis or other routine medical treatments. Low temperatures may freeze pipes leading to a loss of water for some residents. Cities will need to activate snow plowing contract services. Assistance from the VNG will be needed to help public safety crews run calls and respond to emergencies. The storm may produce power outages due to the heavy amount of snow or ice.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Winter storms remain a likely occurrence for the region. While storms will be more likely to produce small amounts of snow, sleet or freezing rain, larger storms, though less frequent in occurrence, could also impact the region.

Likelihood Analysis

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Communications and power in the region can be disrupted for days, and even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Perhaps one of the most common impacts of winter storms in the region is vehicle accidents and stranded, disabled vehicles. Unaccustomed to driving in snow and ice much of the year, drivers attempt to drive at normal speeds despite deteriorated road conditions. Lacking the large fleets of snowplows of some counties and municipalities further north, the region's secondary roads are not cleared as often or as quickly, and roads may remain unplowed or untreated for many days. This impacts special needs populations and others who may become housebound by severe winter storms. Most of the airports in the region also shut down for until the runways are cleared. Recent winter storms in the region have caused severe economic disruption with lengthy school and business closures, damage to vehicles and reduced community services for extended periods. Nor'easters, storms that form along the east coast, often cause winter storms in the region, so the impacts of coastal flooding and shoreline erosion may also be associated with winter storm events.

Notable Incidents in the Southside Region

On Jan 4, 2018, Winter Storm Grayson brought particularly trying weather to the Hampton Roads Region. This storm was memorable in part for its "bomb cyclone" and damaging winds exceeding 70 mph along Virginia's coastline. Later, on Jan 17, 2018, a second winter storm impacted the region while the area was still recovering from Grayson. The "Blizzard of 2018" had extended impacts on the region and underscores the potential for cumulative effects of several weather events to be particularly taxing on resources and economically burdensome if they occur in a single season.

Future Likelihood of the Hazard for the Southside Region

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

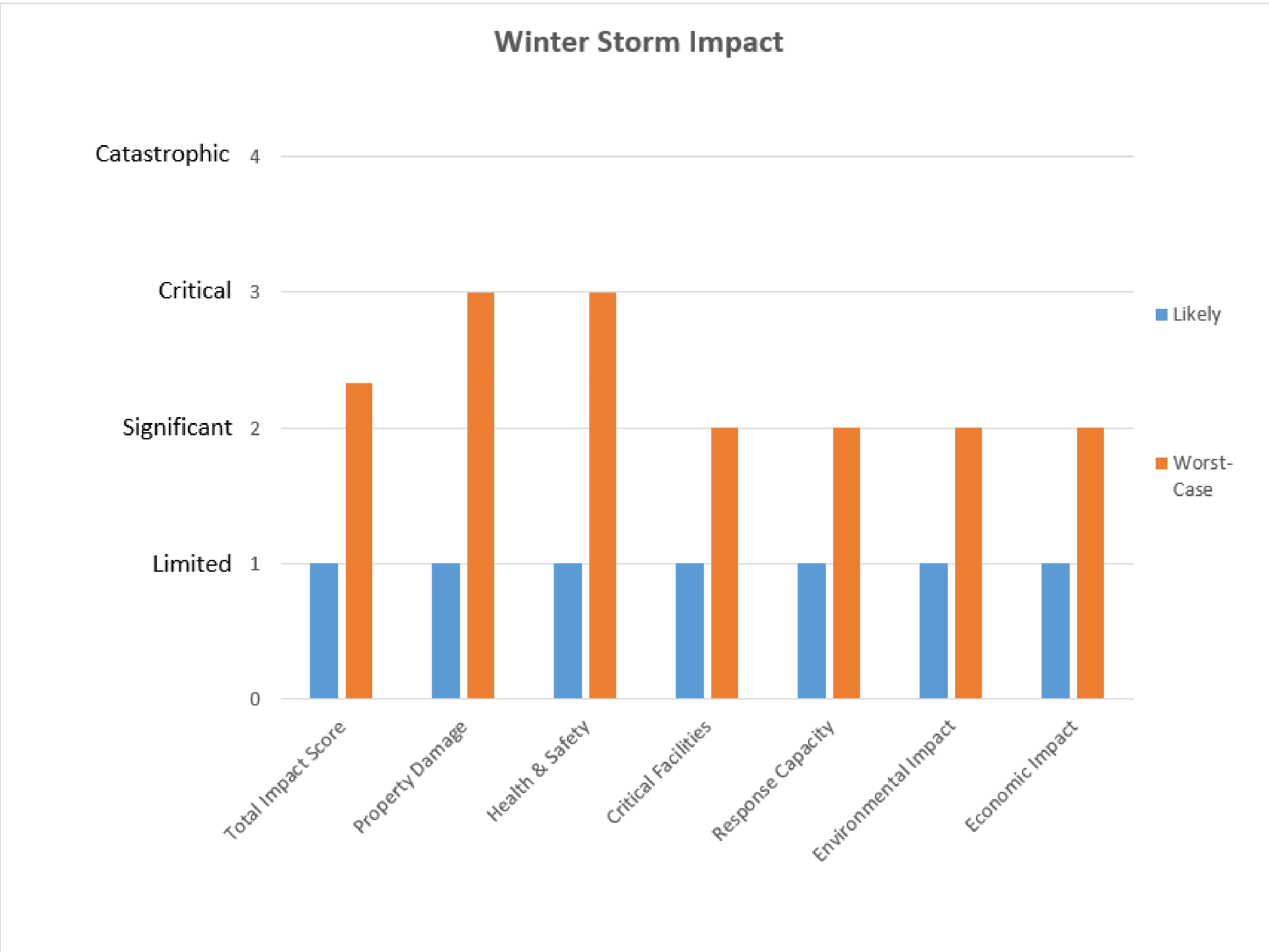
Future Likelihood of Winter Storm		
	Likely	**Worst-Case**
Historical Average (time period)	16 events occurred over the last 25 years (1996-2020)	3 events occurred over the last 25 years (1996-2020)
Historical Annual Probability	64% chance of annual occurrence	12% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No	No
Future Annual Probability	61-70% chance of annual occurrence	1-10% chance of annual occurrence
Future Likelihood Score	4 - Very Likely: 30+% chance of occurrence annually	2 - Infrequent: 1-10% chance of annual occurrence

Considerations: As noted above, wildfire incidents are directly related to weather patterns and antecedent conditions, and thus its probability of occurrences are dynamic.

Consequence Analysis

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Winter Storm Warning Time & Duration		
	Likely	**Worst-Case**
Warning Time	Very Long - More than 24 hours	Very Long - More than 24 hours
Duration	Moderate - 6-24 hours	Long - Less than one week

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Winter Storm Consequence Analysis - Likely		
Property Damage	Limited	Property damage is less than 5% of critical and non-critical infrastructure.
Health & Safety	Limited	Injuries are manageable with existing resources, no fatalities.
Critical Facilities	Limited	Shutdown of critical facilities for less than 24 hours.
Response Capacity	Limited	Local resources are adequate to support the response.
Environmental Impact	Limited	Little to no environmental impact.
Economic Impact	Limited	Little to no economic impact. Standard of living is only minimally disrupted.
Total Impact	Limited	Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic)

Consequence Analysis: Worst-Case Hazard Scenario

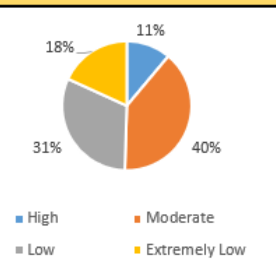
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

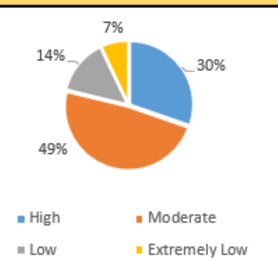
Winter Storm Consequence Analysis - Worst-Case		
Property Damage	Critical	Property damage is between 26-50% of critical and non-critical infrastructure.
Health & Safety	Critical	Multiple deaths and serious injuries are probable.
Critical Facilities	Significant	Critical facilities are down for 1-7 days
Response Capacity	Significant	Local and mutual aid resources are adequate to perform response, with limited or no state assistance.
Environmental Impact	Significant	Moderate environmental impact.
Economic Impact	Significant	Moderate economic impact. Standard of living is moderately affected.
Total Impact	Significant-Critical	Total Impact Score: 2.33 on a scale of 1 (Limited) to 4 (Catastrophic)

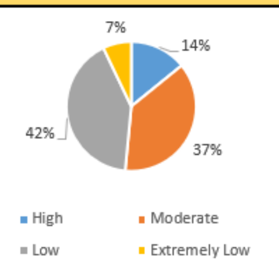
Consequence Analysis: Public Perception

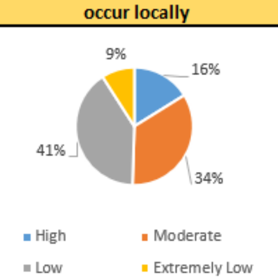
The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in the region's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Winter Storm Public Perceptions			
Perceived confidence in city's ability to respond and recover from this hazard	**Perceived confidence in personal ability to protect self and family from this hazard**	**Concern over the impact to personal health and safety if this hazard were to occur locally**	**Concern over the impact to personal standard of living / quality of life if this hazard were to occur locally**









8 Appendix A: Sea Level Rise and Land Subsidence

Definition:

Global sea level is determined by the volume and mass of water in the world's oceans. Sea level rise occurs when the oceans warm or ice melts, bringing more water into the oceans. Sea level rise caused by warming water or thermal expansion is referred to as steric sea level rise, while sea level rise caused by melting snow and ice is called eustatic sea level rise. The combination of steric and eustatic sea level rise is referred to as absolute sea level rise. Absolute sea level rise does not include local land movements. Additionally, while it is often represented as a global average, absolute sea level rise varies from place to place as a result of differences in wind patterns, ocean currents, and gravitational forces.

Hazard Characteristics:

Increased Coastal Erosion – Sea level rise influences the on-going processes that drive erosion, in turn making coastal areas ever more vulnerable to both chronic erosion and episodic storm events (Maryland Commission on Climate Change, 2008). Secondary effects of increased erosion include increased water depths and increased sediment loads which can drown seagrass and reduce habitat and food sources for fish and crabs. Increased wave action contributes to the increased erosion as the wave energy attacks intertidal and upland resources.[58]

Inundation of Normally Dry Lands – The loss of coastal upland and tidal wetlands through gradual submergence or inundation is likely over time. Wetlands can provide protection from erosion, subdue storm surges, and provide a nursery and spawning habitat for fish and crabs. Without impediments, such as hardened shorelines, and with a slow enough rate of sea level rise, wetlands can normally migrate upland.[53]

Coastal Flooding – An increase in duration, quantity, and severity of coastal storms results in increased flood damages to infrastructure. Increased sea level and/or land subsidence increases the base storm tide, which is the storm surge plus astronomical tide (Boon, Wang, and Shen, undated). Ultimately, sea level rise increases the destructive power of every storm surge. Minor storms that may not have caused damage in the past will begin to affect infrastructure in the future (Boon, et al, undated). Higher wave energy from higher storm tides will translate each storm's destructive forces landward. The damage caused by major storms becomes increasingly costly. Sea level rise will threaten the longevity and effectiveness of stormwater drainage systems and other infrastructure, especially during significant rain events that occur during high tides such as that which may be caused by a nor'easter.[53]

Eight of the top 10 most expensive natural disasters in our Nation were caused by coastal storms. According to the 2010 census population counts, about 39 percent of the U.S. population live in counties bordering the ocean and Great Lakes coast. Because of coastal development and population increases over the past decades, a greater number of structures are at risk for damage from coastal hazards.[59]

Saltwater Intrusion – As sea level rises, the groundwater table may also rise, and saltwater may intrude into freshwater aquifers. This impact may have secondary impacts related to drinking water and agriculture, even for home gardeners.[60]

Local Context:

NOAA has compiled data from regional tide gauges to document the rates of sea level rise. There are three local stations with data pertinent to the area of study, and the rates of sea level rise range from 1.23 feet to 1.98 feet per 100 years. At Sewell's Point, Naval Station Norfolk, the local NOAA tide station with the longest period of record, the mean sea level

[58] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:32

[59] https://www.fema.gov/media-library-data/20130726-1917-25045-4241/risk_map_coastal_factsheet_508.pdf (date accessed, 6/16/2020)

[60] https://www.fema.gov/pdf/floodplain/is_9_complete.pdf (date accessed, 6/16/2020) and 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:32

trend is 4.44 millimeters/year with a 95% confidence interval of +/- 0.27 mm per year, based on monthly mean sea level data from 1927 to 2006. This rate is equivalent to a change of 1.46 feet in 100 years. At Downtown Portsmouth, the mean sea level trend is 3.76 millimeters/year with a 95% confidence interval of +/- 0.45 mm/year based on monthly mean sea level data from 1935 to 1987. This rate is equivalent to a change of 1.23 feet in 100 years. At the First Island, Chesapeake Bay Bridge Tunnel, the mean sea level trend is 6.05 millimeters/year with a 95% confidence interval of +/- 1.14 mm per year based on monthly mean sea level data from 1975 to 2006, which is equivalent to an increase of 1.98 feet in 100 years.[61] A few years ago, VIMS released Sea Level Rise Report Cards for a number of coastal communities in the United States, including Norfolk. These report cards are based on the statistical analysis of observed sea level trends based on established tide gauges. In the case of Norfolk, this analysis has found that there is significant evidence of sea level rise accelerating over the last fifty years. Based on this analysis, VIMS predicts that sea level will rise at Norfolk by 0.49 meters (1.61 feet) between 1992 and 2050, with a 95% chance that mean sea level in 2050 will be between 0.29 and 0.67 meters (0.95 to 2.20 feet) above 1992 mean sea level. This confidence interval accounts for interannual and decadal variations in mean sea level.[62]

In a 2012 report entitled Climate Change in Hampton Roads, Phase III: Sea Level Rise in Hampton Roads, Virginia, HRPDC compiled maps and data to document those areas of the region that are exposed to one meter of sea level rise above spring high tide. Norfolk, Virginia Beach and Chesapeake are the Hampton Roads communities with the highest population exposed to sea level rise. The 2012 report states that about 25,000 people, 9,000 housing units, and 532 businesses in Norfolk will likely be exposed to one meter of sea level rise above high tide. In Chesapeake, 16,000 people, 6,000 housing units, and 380 businesses will likely be exposed to sea level rise. In Virginia Beach, 21,000 people, 10,000 housing units, and 389 businesses will likely be exposed to sea level rise. In Portsmouth, 4,600 people, 2,000 housing units, and 127 businesses will likely be exposed to sea level rise.[63]

Portsmouth: The Hampton Roads Planning District Commission has adopted a sea level rise projection of 1.5 feet by 2050, 3 feet by 2080, and 4.5 feet by 2100. The NOAA Sewell's Point tide gauge has measured a sea level rise trend of 4.47 millimeters per year with data going back to 1927.[64] Land subsidence rates are highly variable in Hampton Roads, and additional studies are being conducted to better measure them.[65]

Chesapeake: Several factors are influencing the rates of sea level rise relative to land in Chesapeake and the Hampton Roads region, including an increased volume of water in the oceans from melting ice. Some scientists believe that thermal expansion of a gradually warming ocean increases ocean volume. The rate of sea level rise is relative to the land adjacent to the sea; land subsidence is the downward movement of the earth's crust. The Southside Hampton Roads Region is experiencing both regional subsidence (along the east coast of the United States) and local subsidence, exacerbating the effects of storms. Local subsidence is believed to be the result of settlement or compaction of subsurface layers into the Chesapeake Bay Impact Crater (CBIC).

NOAA has compiled data from regional tide gauges to document the rates of sea level rise. There are three local stations with data pertinent to the City of Chesapeake, and the rates of sea level rise range from 1.23 feet to 1.98 feet per 100 years.

Virginia Beach: Over the last 6 years, the City of Virginia Beach has undertaken a comprehensive effort to develop strategies to respond to sea level rise and related increases in flooding. This study, known as Sea Level Wise (www.vbgov.com/pwslr), has produced a wealth of information to understand what challenges the City will face and develop diverse strategies to pro-actively reduce the impacts.

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[61] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:35 - 4:37
[62] HRPDC Sea Level Rise Planning Policy and Approach, October 2018
[63] 2017 Hampton Roads Hazard Mitigation Plan, pg. 5:31 - 5:32
[64] https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8638610
[65] https://www.nature.com/articles/s41598-017-15309-5

Virginia Beach and the Hampton Roads Region are experiencing the highest rate of sea level rise on the east coast. Over the last 50 years, sea levels have risen by almost one foot. Higher sea levels and heavier rainfall events are already impacting the City's low-lying lands, buildings, and infrastructure, even on sunny days. Looking forward, sea levels will continue to rise at an even faster rate. Regional planning guidance for Hampton Roads suggest communities plan for sea levels to increase by 1.5 feet by 2050, 3 feet by 2080, and 4.5 feet by 2100. In general, the area of the City exposed to coastal flooding will increase by one-and-a-half times in the 2040's, and by two-times in the 2070's. The southern part of the City is low-lying and will experience the bulk of these increases. In most other areas, the floodplain will be similar, but deeper flooding will be experienced as compared to today's conditions.

Occurrence of the Hazard

In a report to the Virginia General Assembly in 2013 entitled Recurrent Flooding Study for Tidewater Virginia, VIMS presented four scenarios of sea level rise. The lowest, historic scenario is based on observed rates of rise and does not account for any acceleration. The low scenario incorporates some acceleration using assumptions about future greenhouse gas emission. The high scenario is based on the upper end of projections from semiempirical models using statistical relationships in global observations of sea level and air temperature. And the highest scenario is based on consequences of global warming, ice-sheet loss and glacial melting. Each scenario was customized for conditions in southeastern Virginia, including using estimates for subsidence. The report concludes that regional planners should anticipate a 1.5-foot rise in sea level above the 1992 datum within the next 20 to 50 years (2033-2063). According to the VIMS report, “sea level rise will make it easier for the current patterns of weather events to generate damaging flood events in the future. Increases in storm intensity and/or frequency will only aggravate that circumstance.”[66]

Portsmouth: The Sewell's Point tide gauge has been measuring sea level rise since 1927. Newer subsidence monitoring stations are beginning to gather data on subsidence.

Chesapeake: Unlike wildfires, earthquakes or coastal storms, the impacts of sea level rise are not felt or recorded in a matter of hours or days, but instead are slowly observed, recorded, and experienced over decades and centuries. According to VIMS in a report to the U.S. Army Corps of Engineers, Norfolk District, “Land subsidence in Chesapeake Bay is likely to continue at or near present rates.” Future absolute sea level rise measured relative to the center of the earth rather than fixed points on land, “remains uncertain owing to diverse and possibly changing trends world-wide” (Boon, John D., Brubaker, Forrest, Chesapeake Bay Land Subsidence and Sea Level Change: An Evaluation of Past and Present Trends and Future Outlook, November 2010). Therefore, for planning purposes, the rates experienced in the past and documented through tide gauge measurement are expected to continue, and this hazard is considered to have a highly likely probability of occurrence.

Notable Events

Unlike wildfires, earthquakes or coastal storms, the impacts of sea level rise are not felt or recorded in a matter of hours or days, but instead are slowly observed, recorded, and experienced over decades and centuries. However, scientists at the VIMS have gathered data from several historical storms and made careful comparisons in an effort to highlight the historical impact of sea level rise locally.

The Ash Wednesday Storm of 1962 produced a peak storm tide of approximately 7.2 feet MLLW at Sewell's Point. If that same storm were to occur at mean high tide in 2030, using the sea level rise rates estimated by NOAA of 1.46 feet in 100 years, the astronomical tide would be approximately one foot higher. Since the storm tide is obtained by adding the storm surge to the astronomical tide, the same storm could then produce a storm tide of over 8 feet MLLW. By comparison, Hurricane Isabel in 2003 produced a storm tide of 7.887 feet MLLW and caused an immense amount of damage.[67]

[66] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:42
[67] 2017 Hampton Roads Hazard Mitigation Plan, pg. 4:38

Portsmouth: Sea level rise and subsidence are long-term problems that are not influenced by specific events. It is hypothesized that the HRSD SWIFT project, which is pumping up to one million gallons of potable water a day back into the Potomac Aquifer, could help to slow the rate of subsidence by stabilizing the emptying aquifer.

Likely Projection

Sea Level Rise will not present as an incident, but rather a changing condition that exacerbates other hazards. These incidents include named storms, nor'easters, and flash summertime storms. Based on the yearly report from VIMS, the likely scenario follows the NOAA Intermediate Curve which, at this time, aligns with the regional projections.

Worst-case Projection

NOAA has projected 9-11 feet of sea level rise in its worst-case scenarios. This could exceed the current regional projections.

9 Appendix B: Flooding

The Southside team of Scenario Development Experts and SMEs provided the following localized input on the Flooding hazard specific to each city.

Portsmouth

Local Context

Portsmouth regularly experiences flooding, especially the areas in and around Downtown. As one moves from east to west across the city, the source of flooding changes. Areas along the main stem of the Elizabeth River are vulnerable to coastal flooding, especially from wind-driven events like nor'easters. This is because the riverbanks, whether natural or man-made, tend to have lower elevations. Wind events tend to cause the worst flooding due to water being pushed back into the city's stormwater system, which prevents flood waters from being able to drain into the Elizabeth River. Further west, flooding is more likely to occur in low-lying, bowl-shaped topographies during high intensity rain events like summer thunderstorms. Riverbanks tend to be higher in these places, so flood waters topping river banks is rare. Flooding is a threat to major sectors of Portsmouth's economy. The Norfolk Naval Shipyard, located along the main stem of the Elizabeth River, already experiences "overtopping," or the act of flood waters spilling over the top of their dry docks. Also, some of the major gates to enter and exit the shipyard can become impassable due to ponding in front of them during storms. Similarly, major arterial and collector roads serving the Shipyard can become blocked by flood events, preventing employees from getting to and from work. Flooding is also a concern for the Virginia Port Authority, which owns Portsmouth Marine Terminal and operates the Virginia International Gateway. Ships must be able to safely berth at the terminals, while cargo must be free to be offloaded, stored, and transported. Portsmouth has few defenses against flooding. The most prominent is a seawall that extends south and east from the Swimming Point neighborhood just north of Downtown to Ocean Yacht Marina at the southern edge of Downtown. The seawall has been repaired over the last couple of years and has a height of about eight feet, eleven inches above sea level. Portsmouth currently only has a single pump station, although a second one is currently in the design phase. The City has also installed a number of tide gates over its outfall pipes to prevent tidal intrusion. These appear to have been very successful in reducing localized recurrent flooding. In lieu of physical defenses, Portsmouth has been investing in mapping and monitoring activities. First, the City partnered with the Virginia Modeling, Analysis, and Simulation Center, part of Old Dominion University, to conduct a scientific survey of Portsmouth residents to determine experiences and attitudes related to flooding. The result was a 650-page report that contained the quantitative and mapped responses. The City then worked with the Virginia Institute of Marine Sciences to develop a city-wide flood model based on a combination of flood levels from past storms and increases in sea levels. The model shows the extend and depth of flooding based on various scenarios. The City has also partnered with the technology firm Green Stream to install thirteen flood elevation sensors in areas known to flood. These sensors measure the depth of flooding during a storm event and send the information to a publicly accessible dashboard. The City's goal is to integrate the data into app-based mapping programs like Waze and Google Maps so that people can be made aware of flooded streets. Finally, the City has put a lot of work into its CRS program. Portsmouth was given a rating of "7" during its most recent FEMA evaluation.

Occurrence of the Hazard

A review of the flood levels at one of the flood sensors shows that Portsmouth experienced nine events of flooding greater than six inches from July 1, 2020 though the end of the year. Two of those events exceeded a depth of one foot.

Future Likelihood

Likely Scenario: 2-Infrequent: 1-10% chance of annual occurrence

Worst-case Scenario: 1-Unlikely: No documented occurrence. Less than 1% chance of annual occurrence.

Consequence Analysis

Warning Time: Likely - 4-Very Likely: Worst-Case: 4-Very Likely
Duration: Likely- 2-Infrequent: Worst-Case: 3-Likely

Impact	Property Damage		Health & Safety		Critical Facilities		Resp. Capabilities		Environ. Impact		Econ. Impact	
	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case
	1 - Limited	3 - Critical	1 - Limited	4 - Catastrophic	1 - Limited	3 - Critical	1 - Limited	4 - Catastrophic	1 - Limited	3 - Critical	1 - Limited	4 - Catastrophic

Chesapeake

Occurrence of the Hazard

Flooding can occur along all waterways in the City of Chesapeake including the branches of the Elizabeth River, the Indian River, the Northwest River, and the North Landing River. Localized riverine flooding can occur in areas of the City not adjacent to a major body of water. Large sections of the City are low and subject to tidal flooding during hurricanes and severe nor'easters. Flood duration is typically shorter for hurricanes and tropical storms than for nor'easters. Flooding remains a highly likely occurrence throughout the identified flood hazard and storm surge areas of the City. Smaller floods caused by heavy rains and inadequate drainage capacity will be frequent, but not as costly as the large-scale floods which may occur at less frequent intervals, including extended torrential rainfall and storm surge events associated with hurricanes, tropical storms, and nor'easters.

Future Likelihood

Likely Scenario: 3-Likely: 11-30% chance of annual occurrence

Worst-case Scenario: 2-Infrequent: 1-10% chance of annual occurrence

Consequence Analysis

Warning Time: Likely - 4-Very Likely: Worst-Case: 1-Unlikely
Duration: Likely- 1-Unlikely: Worst-Case: 3-Likely

Impact	Property Damage		Health & Safety		Critical Facilities		Resp. Capabilities		Environ. Impact		Econ. Impact	
	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case
	1 - Limited	2 - Significant	1 - Limited	3 - Critical	1 - Limited	3 - Critical	1 - Limited	3 - Critical	1 - Limited	2 - Significant	1 - Limited	3 - Critical

Virginia Beach

Local Context

Virginia Beach sits at the entrance to the Chesapeake Bay, an area where multiple rivers and the Atlantic Ocean meet, exposing our community to several different flood sources. When coastal storm surge, high tides, and heavy rainfall occur at the same time, the potential for flooding in low lying coastal areas becomes much greater than when any of these hazards occur separately. If the ground is already saturated when these conditions occur, flooding can be even more widespread. Interaction of these flood hazards with the built and natural environment determines the extent and depth of flooding. Increased urbanization and deterioration of ecological assets have both contributed to increased flood risks in Virginia Beach. Sea level rise and more frequent and intense heavy rainfall events will only intensify flooding impacts. In order to develop strategies to combat these complex and inter-connected issues, it is imperative to understand the processes driving them and the probability of their occurrence. Coastal flooding occurs when land is flooded from tides, winds, nor'easters, or hurricanes into the City from its surrounding ocean, bays, and rivers. Almost all of Virginia Beach's coastal flood risk is not on the open coast, but inside the City's coastal perimeter. This may be unexpected, especially for those that live along the open coast where water is highly visible. Today, flood pathways are distinct, making it relatively easy to understand and identify sources of flooding. However, as sea levels rise, some of these pathways begin to merge and new pathways open up, resulting in more widespread and complex flood challenges. Although a small amount of overtopping may occur along Virginia Beach's coastline, the majority of flood waters enter the City through key entry points such as tidal rivers, estuaries, bays and inlets. Once inside Virginia Beach, flood water disperses internally to numerous surrounding bays and rivers. Flood waters can be amplified moving upstream as water piles up through these internal water bodies during storm conditions. Some of these flood pathways cross through adjacent municipalities, such as the adjacent cities of Norfolk and Chesapeake, as well as the State of North Carolina to the south.

Occurrence of the Hazard

In 2015, Virginia Beach began updating its Stormwater Master Drainage Plan. The last update was completed in 1990 and only looked at the major drainage systems, canals, and large culvert pipes. The current modeling includes all stormwater pipes larger than 24-inches in diameter, the canals, ditches, swales, stormwater ponds and retention systems. From this information, the City has been able to create maps showing anticipated depth of flooding for each storm event (1-, 2-, 10-, 25-, 50- and 100-year). While the modeling is complete, the Master Plan is still being prepared and has identified numerous areas where flooding can occur as early as a 2-year storm and even on sunny days. The occurrence of flooding is highly anticipated during every rain event.

Future Likelihood

Likely Scenario: 3-Likely: 11-30% chance of annual occurrence

Worst-case Scenario: 2-Infrequent: 1-10% chance of annual occurrence

Consequence Analysis

Virginia Beach: Future Likelihood Expected to Deviate from Historical Likelihood: YES

Warning Time: Likely - 4-Very Likely: Worst-Case: 4-Very Likely

Duration: Likely- 2-Infrequent: Worst-Case: 3-Likely

Impact	Property Damage		Health & Safety		Critical Facilities		Resp. Capabilities		Environ. Impact		Econ. Impact	
	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case	Likely	Worst-Case
	1 - Limited	3 - Critical	1 - Limited	3 - Critical	1 - Limited	2 - Significant	1 - Limited	2 - Significant	1 - Limited	3 - Critical	1 - Limited	2 - Significant