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City of Myrtle Beach
Hazard Mitigation Plan Update

September 2015

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SECTION 1

INTRODUCTION

This section provides a general introduction to the City of Myrtle Beach Floodplain Management and Hazard Mitigation Plan. It consists of the following five subsections:

- 1.1 Background
- 1.2 Purpose
- 1.3 Scope
- 1.4 Authority
- 1.5 Summary of Plan Contents

1.1 BACKGROUND

Natural hazards, such as hurricanes, floods, and tornadoes, are a part of the world around us. Their occurrence is natural and inevitable, and there is little we can do to control their force and intensity. We must consider these hazards to be legitimate and significant threats to human life, safety, and property.

The City of Myrtle Beach is vulnerable to a wide range of natural hazards, including hurricanes and tropical storms, flooding, tornadoes, storm surge, and wildfires. The hazard that has gained the most recent awareness is sea level rise. As a coastal community, the City provides a major focus on hazards and events related to flooding. These hazards threaten the life and safety of city residents and have the potential to damage or destroy both public and private property, disrupt the local economy, and impact the overall quality of life of individuals who live, work, and vacation in the community. This vulnerability was most recently highlighted through the winter storm of 2014 which the area is not typically accustomed to as a southern, coastal community.

While the threat from hazardous events may never be fully eliminated, there is much we can do to lessen their potential impact upon our community and our citizens. By minimizing the impact of hazards upon our built environment, we can prevent such events from resulting in disasters. The concept and practice of reducing risks to people and property from known hazards is generally referred to as *hazard mitigation*.

FEMA Definition of Hazard Mitigation:
"Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards."

Hazard mitigation techniques include both structural measures (such as strengthening or protecting buildings and infrastructure from the destructive forces of potential hazards) and non-structural measures (such as the adoption of sound land use policies and the creation of public awareness programs). It is widely accepted that the most effective mitigation measures are implemented at the local government level, where decisions on the regulation and control of development are ultimately made. A comprehensive mitigation approach addresses hazard vulnerabilities that exist today and in the foreseeable future. Therefore it is essential that projected patterns of future development are evaluated and considered in terms of how that growth will increase or decrease a community's overall hazard vulnerability.

As a community formulates a comprehensive approach to hazard mitigation, a key component is to develop, adopt, and update a local hazard mitigation plan as needed. A hazard mitigation plan establishes the broad community vision and guiding principles for reducing hazard risk and, further, proposes specific mitigation actions to eliminate or reduce identified vulnerabilities.

The City of Myrtle Beach has developed a Floodplain Management and Hazard Mitigation Plan that has evolved over the years, as more thoroughly described in Section 2: Planning Process. The Plan documents and represents the City's sustained efforts to incorporate hazard mitigation principles and practices into the routine government activities and functions of the City of Myrtle Beach. At its core, the Plan recommends specific actions to combat hazard vulnerability and protect residents from losses to those hazards that pose the greatest risk. These mitigation actions go beyond simply recommending structural solutions to reduce existing vulnerability, such as elevation, retrofitting, and acquisition projects. Local policies on community growth and development, incentives for natural resource protection, and public awareness and outreach activities are examples of other actions considered to reduce Myrtle Beach's future vulnerability to identified hazards. The Plan remains a living document, with implementation and evaluation procedures included to help achieve meaningful objectives and successful outcomes over time.

1.1.1 Disaster Mitigation Act of 2000 and the Flood Insurance Reform Act of 2004

In an effort to reduce the Nation's mounting natural disaster losses, the U.S. Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) in order to amend the Robert T. Stafford Disaster Relief and Emergency Assistance Act. Section 322 of DMA 2000 emphasizes the need for state and local government entities to closely coordinate on mitigation planning activities and makes the development of a hazard mitigation plan a specific eligibility requirement for any local government applying for federal mitigation grant funds. These funds include the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation (PDM) program, both of which are administered by the Federal Emergency Management Agency (FEMA) under the Department of Homeland Security. Communities with an adopted and federally-approved hazard mitigation plan thereby become pre-positioned and more apt to receive available mitigation funds before and after the next disaster strikes.

Additionally, the Flood Insurance Reform Act of 2004 (P.L. 108-264) created two new grant programs: the Severe Repetitive Loss (SRL) and Repetitive Flood Claim (RFC). The Act also modified the existing Flood Mitigation Assistance (FMA). One of the requirements of this Act is that a FEMA-approved Hazard Mitigation Plan is now required if a community wishes to be eligible for these FEMA mitigation programs.

The Myrtle Beach Floodplain Management and Hazard Mitigation Plan has been prepared in coordination with FEMA Region IV and the South Carolina Emergency Management Division (SCEMD) to ensure that the Plan meets all applicable FEMA and state requirements for hazard mitigation plans. A *Local Mitigation Plan Review Tool*, found in Appendix C, provides a summary of federal and state minimum standards and notes the location where each requirement is met within the Plan.

1.2 PURPOSE

The purpose of the City of Myrtle Beach Floodplain Management and Hazard Mitigation Plan is to:

- Provide a comprehensive update to the *City of Myrtle Beach Floodplain Management and Hazard Mitigation Plan*, as amended in 2010;
- Protect life, safety, and property by reducing the potential for future damages and economic losses that result from hazards;
- Make the community a safer place to live, work, and play;
- Qualify the City of Myrtle Beach for grant funding in both the pre-disaster and post-disaster environments;
- Speed recovery and redevelopment following future disaster events;
- Demonstrate a firm local commitment to hazard mitigation principles;
- Maintain compliance with state and federal legislative requirements for local hazard mitigation plans; and
- Meet the requirements of the Community Rating System (CRS) program.

1.3 SCOPE

The focus of the City of Myrtle Beach Floodplain Management and Hazard Mitigation Plan is on those hazards determined to be “high” or “moderate” risks to the City, as determined through a detailed hazard risk assessment. Other hazards that pose a “low” or “negligible” risk will continue to be evaluated during future updates to the Plan, but they may not be fully addressed until they are determined to be of high or moderate risk. This enables the City to prioritize mitigation actions based on those hazards which are understood to present the greatest risk to lives and property.

The geographic scope (i.e., the planning area) for the Plan includes all areas within the incorporated jurisdiction of Myrtle Beach.

1.4 AUTHORITY

The City of Myrtle Beach Floodplain Management and Hazard Mitigation Plan has been developed in accordance with current state and federal rules and regulations governing local hazard mitigation plans and has been adopted by the City of Myrtle Beach in accordance with standard local procedures. A copy of the City’s adoption resolution is provided in Appendix A. The Plan shall be routinely monitored and revised to maintain compliance with the following provisions, rules, and legislation:

- Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the Disaster Mitigation Act of 2000 (P.L. 106-390);
- FEMA's Interim Final Rule published in the Federal Register on February 26, 2002, at 44 CFR Part 201; and,

- Flood Insurance Reform Act of 2004.

1.5 SUMMARY OF PLAN CONTENTS

The contents of this Plan are designed and organized to be as reader-friendly and functional as possible. While significant background information is included on the processes used and studies completed (i.e., risk assessment, capability assessment), this information is separated from the more meaningful planning outcomes or actions (i.e., mitigation strategy, mitigation action plan).

Section 2: ***Planning Process***, provides a complete narrative description of the process used to prepare the Plan. This includes the identification of who was involved, who participated on the planning team, and how the public and other stakeholders were involved. It also includes a detailed summary for each of the key meetings held, along with any associated outcomes.

The ***Community Profile***, located in Section 3, describes the general makeup of Myrtle Beach, including prevalent geographic, demographic, and economic characteristics. In addition, building characteristics and land use patterns are discussed. This baseline information provides a snapshot of the planning area and helps local officials recognize those social, environmental, and economic factors that ultimately play a role in determining community vulnerability to hazards.

The Risk Assessment is presented in two sections: Section 4: ***Hazard Identification and Analysis*** and Section 5: ***Vulnerability Assessment***. Together, these sections serve to identify, analyze, and assess hazards that pose a threat to the City of Myrtle Beach. The risk assessment also attempts to define any hazard risks that may uniquely or exclusively affect specific areas of Myrtle Beach.

The Risk Assessment builds on available historical data from past hazard occurrences, establishes detailed profiles for each hazard, and culminates in a hazard risk ranking based on conclusions about the frequency of occurrence, spatial extent, and potential impact of each hazard. FEMA's HAZUS®MH loss estimation methodology was also used in evaluating known hazard risks by their relative long-term cost in expected damages. In essence, the information generated through the risk assessment serves a critical function as Myrtle Beach seeks to determine the most appropriate mitigation actions to pursue and implement—enabling it to prioritize and focus its efforts on those hazards of greatest concern and those structures or planning areas facing the greatest risk(s).

The ***Capability Assessment***, found in Section 6, provides a comprehensive examination of the City of Myrtle Beach's capacity to implement meaningful mitigation strategies and identifies opportunities to increase and enhance that capacity. Specific capabilities addressed in this section include planning and regulatory capability, staff and organizational (administrative) capability, technical capability, fiscal capability, and political capability. Information was obtained through the use of detailed survey questionnaires for local officials and an inventory and analysis of existing plans, ordinances, and relevant documents. The purpose of this assessment is to identify any existing gaps, weaknesses, or conflicts in programs or activities that may hinder mitigation efforts and to identify those activities that should be built upon in establishing a successful and sustainable local hazard mitigation program.

The *Community Profile*, *Risk Assessment*, and *Capability Assessment* collectively serve as a basis for determining the goals for the Myrtle Beach Hazard Mitigation Plan, each contributing to the

development, adoption, and implementation of a meaningful and manageable *Mitigation Strategy* that is based on accurate background information.

The ***Mitigation Strategy***, found in Section 7, consists of broad goal statements as well as an analysis of hazard mitigation techniques for Myrtle Beach to consider in reducing hazard vulnerabilities. The strategy provides the foundation for a detailed ***Mitigation Action Plan***, found in Section 8, which links specific mitigation actions for each City department or agency to locally-assigned implementation mechanisms and target completion dates. Together, these sections are designed to make the Plan both strategic, through the identification of long-term goals, and functional, through the identification of immediate and short-term actions that will guide day-to-day decision-making and project implementation.

In addition to the identification and prioritization of possible mitigation projects, emphasis is placed on the use of program and policy alternatives to help make the City of Myrtle Beach less vulnerable to the damaging forces of hazards while improving the economic, social, and environmental health of the community. The concept of multi-objective planning was emphasized throughout the planning process, particularly in identifying ways to link, where possible, hazard mitigation policies and programs with complimentary community goals related to disaster recovery, housing, economic development, recreational opportunities, transportation improvements, environmental quality, land development, and public health and safety.

Plan Maintenance Procedures, found in Section 9, includes the measures that the City of Myrtle Beach will take to ensure the Plan's continuous long-term implementation. The procedures also include the manner in which the Plan will be regularly evaluated and updated to remain a current and meaningful planning document.

SECTION 2

PLANNING PROCESS

44 CFR Requirement

44 CFR Part 201.6(c)(1): The plan shall include documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process and how the public was involved.

This section describes the planning process undertaken by the City of Myrtle Beach in the development of its 2015 Floodplain Management and Hazard Mitigation Plan. It consists of the following six subsections:

- 2.1 Overview of Hazard Mitigation Planning
- 2.2 History of Hazard Mitigation Planning in the City of Myrtle Beach
- 2.3 Preparing the 2015 Plan
- 2.4 The Floodplain Management and Hazard Mitigation Planning Committee (FMHMPC)
- 2.5 Hazard Mitigation Citizen's Advisory Committee
- 2.6 Community Meetings and Workshops
- 2.7 Involving the Public
- 2.8 Involving the Stakeholders

2.1 OVERVIEW OF HAZARD MITIGATION PLANNING

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This process results in a hazard mitigation plan that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term community vision.

To ensure the functionality of a hazard mitigation plan, responsibility is assigned for each proposed mitigation action to a specific individual, department, or agency along with a schedule or target completion date for its implementation (see Section 8). Plan maintenance procedures are established for the routine monitoring of implementation progress, as well as the evaluation and enhancement of the mitigation plan itself. These plan maintenance procedures ensure that the plan remains a current, dynamic, and effective planning document over time that becomes integrated into the routine local decision making process.

Communities that participate in hazard mitigation planning have the potential to accomplish many benefits, including:

- saving lives and property;
- saving money;
- speeding recovery following disasters;
- reducing future vulnerability through wise development and post-disaster recovery and reconstruction;
- expediting the receipt of pre-disaster and post-disaster grant funding; and
- demonstrating a firm commitment to improving community health and safety.

Typically, mitigation planning is described as having the potential to produce long-term and recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that the investments made before a hazard event will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices will enable local residents, businesses, and industries to re-establish themselves in the wake of a disaster, getting the community economy back on track sooner and with less interruption.

The benefits of mitigation planning go beyond solely reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can help achieve multiple community goals, such as preserving open space, maintaining environmental health, and enhancing recreational opportunities. Thus, it is vitally important that any local mitigation planning process be integrated with other concurrent local planning efforts, and any proposed mitigation strategies must take into account other existing community goals or initiatives that will help complement or hinder their future implementation.

2.2 HISTORY OF HAZARD MITIGATION PLANNING IN THE CITY OF MYRTLE BEACH

Myrtle Beach's hazard mitigation planning efforts began as early as 1998 when the City created a committee to write a Floodplain Management and Hazard Mitigation Plan. The committee was comprised of City staff, local and state officials, and members of the public. The planning process was part of the larger visioning process for the City's Comprehensive Plan update. The committee held four working sessions and a public hearing. The process resulted in adoption of the first City of Myrtle Beach Floodplain Management and Hazard Mitigation Plan, which was prepared as a guide to facilitate the implementation of floodplain management as well as provide a guide for reconstruction and redevelopment of floodprone areas to reduce future damages. The guidelines used for the development of the plan were those recommended by the Federal Emergency Management Agency (FEMA) and the South Carolina Emergency Management Division (SCEMD) for natural hazard mitigation and flood mitigation plans. During preparation of the plan, the lead planner also coordinated with representatives from Horry County, the State, South Carolina Sea Grant, and ISO Commercial Risk Services, Inc. The final plan was adopted by Myrtle Beach on April 28, 1998 and adopted by reference in the City's 1999 Comprehensive Plan.

Following completion of the 1998 plan, FEMA published an Interim Final Rule[1] in the Federal Register that specified criteria for the approval of local hazard mitigation plans as required in Section 322 of the Disaster Mitigation Act of 2000 (DMA 2000). This rule required Myrtle Beach to prepare an amendment

[1] FEMA's Interim Final Rule for hazard mitigation planning was published February 26, 2002 at 44 CFR Part 201.

to the 1998 plan in order to remain eligible for specified FEMA mitigation grants including the HMGP, as well as the new Pre-Disaster Mitigation (PDM) program established through DMA 2000.

In 2004, the Floodplain Management and Hazard Mitigation Plan was updated to meet the requirements of DMA 2000. The Floodplain Management and Hazard Mitigation Planning Committee reconvened for several meetings during the preparation of the revised plan and a draft of the Plan was presented to the public on September 23, 2004. The plan was submitted to SCEMD and then to FEMA for review and subsequent approval in accordance with state and federal regulations for hazard mitigation plans. The final Plan was adopted by the City Council on October 26, 2004.

In 2010, the City of Myrtle Beach contracted PBS&J to update the current mitigation plan previously developed by the City staff. The contractor redesigned the format of the plan and honed in on the Community Rating System components of the plan.

A more thorough description and review of the City's earlier hazard mitigation planning and related efforts is provided in Section 6: *Capability Assessment*.

2.3 PREPARING THE 2015 PLAN

Hazard mitigation plans are required to be updated every five years to remain eligible for Federal mitigation and public assistance funding. In preparation of the 2015 Floodplain Management and Hazard Mitigation Plan update, the City of Myrtle Beach hired Atkins as an outside consultant to provide professional mitigation planning services. To meet requirements of the Community Rating System, the City ensured that the planning process was facilitated under the direction of a professional planner. Nathan Slaughter and Ryan Wiedenman both from Atkins served as planners for this project and are member of the American Institute of Certified Planners (AICP).

Per the contractual scope of work[2], the consultant team followed the mitigation planning process recommended by FEMA (Publication Series 386) and recommendations provided by SCEMD mitigation planning staff. The Local Mitigation Plan Review Tool, found in Appendix C, provides a detailed summary of FEMA's current minimum standards of acceptability for compliance with DMA 2000 and notes the location where each requirement or element is met within this Plan. These standards are based upon FEMA's Interim Final Rule as published in the Federal Register on February 26, 2002 in Part 201 of the Code of Federal Regulations. The planning team used FEMA's Local Mitigation Planning Handbook (last revised in March 2013) for reference as they updated the plan.

The City's Floodplain Manager reconvened the Floodplain Management and Hazard Mitigation Planning Committee along with the consultant. It was determined that the entire plan would be updated based on the various changes in the last 5 years and the new FEMA Local Mitigation Planning Handbook. This was discussed at the first meeting of the FMHMPC on March 2, 2015 that is further described later in this section.

The process used to prepare this Plan included twelve (12) major steps that were completed over the course of approximately nine months beginning in March 2010. Each of these planning steps (illustrated

[2] A copy of the negotiated contractual scope of work between Myrtle Beach and Atkins is available through the City of Myrtle Beach upon request.

in **Figure 2.1**) resulted in critical work products and outcomes that collectively make up the Plan. Specific plan sections are further described in Section 1: *Introduction*.

Figure 2.1: City of Myrtle Beach's Mitigation Planning Process

2.4 THE FLOODPLAIN MANAGEMENT AND HAZARD MITIGATION PLANNING COMMITTEE (FMHMPC)

In order to guide the development of this Plan, the City of Myrtle Beach reconvened its Floodplain Management and Hazard Mitigation Planning Committee (FMHMPC) that was created during past planning efforts, including the latest plan approval in December 2010. The FMHMPC represents a community-based planning team made up of representatives from various City departments and other key stakeholders identified to serve as critical partners in the planning process. In November 2009, the City Council passed a resolution that officially recognized the Floodplain Management and Hazard Mitigation Planning Committee. For this plan update, the FMHMPC was reconvened to guide the process of the plan update.

Beginning in March 2010, the City of Myrtle Beach engaged FMHMPC members in regular discussions as well as local meetings and planning workshops to discuss and complete tasks associated with preparing

the Plan. The FMHMPC coordinated on all aspects of plan preparation and provided valuable input to the process. In addition to regular meetings, committee members routinely communicated and were kept informed through email correspondence and phone calls.

Specifically, the tasks assigned to the FMHMPC members included:

- participate in FMHMPC meetings and correspondence;
- provide best available data as required for the risk assessment portion of the Plan;
- assist in updating the local Capability Assessment Survey and provide copies of any mitigation or hazard-related documents for review and incorporation into the Plan;
- support the update of the Mitigation Strategy, including the review and update of community goal statements;
- provide an implementation status update for the existing mitigation actions;
- help design and propose appropriate new mitigation actions for their department/agency for incorporation into the Mitigation Action Plan;
- review and provide timely comments on all study findings, data requests, and draft plan deliverables; and
- support the adoption of the 2015 Myrtle Beach Hazard Mitigation Plan .

Table 2.1 lists the members of the FMHMPC who were responsible for participating in the development of the Plan. Committee members are listed in alphabetical order by last name.

Table 2.1: Members of the Floodplain Management and Hazard Mitigation Planning Committee

NAME	DEPARTMENT / AGENCY
Bruce Arnel	Myrtle Beach Fire Marshal
Bruce Boulineau	Construction Services Director
Emily Hardee	Construction Services, Floodplain Coordinator, CFM
Allison Hardin	Planning, CFM
John Kennedy	Myrtle Beach Police Department, CFM
Mark Kruea	City Manager's Office, Public Information Officer
Tanitra Marshall	SC Department of Health and Environmental Control-OCRM
Steve Moore	Public Works, Director
Diane Moskow-McKenzie	Planning, Senior Planner
Alvin Payne	Myrtle Beach Fire Chief
Val Rosser	Risk Management, Director
Don Shanks	Citizen Representative/Planning Commission
Jackie Vereen	Community Appearance Board
Jenny Thompson	Citizen Representative/American Red Cross
Margaret Walton	Atkins, Project Manager
Ryan Wiedenman	Atkins, Risk Assessment Specialist
Janet Wood	Public Works, Deputy Director

The FMHMPC had two citizen representatives from the City who participated in the meetings and provided valuable information and feedback. Additional participation and input from other identified stakeholders and the general public was sought by the City during the planning process through phone

calls and the distribution of e-mails, advertisements, and public notices aimed at informing people on the status of the Hazard Mitigation Plan (public and stakeholder involvement is further discussed later in this section). The City also posted information on its website (www.cityofmyrtlebeach.com) related to the plan development process.

2.5 HAZARD MITIGATION CITIZEN'S ADVISORY COMMITTEE

With assistance from the City's planning, construction services, and floodplain staff, the Hazard Mitigation Citizen's Advisory Committee was recruited and convened to serve as advisory stakeholders on the mitigation plan. The Advisory Committee represents diverse community interests including business/industry, academia, social services, neighborhood and community groups, and the non-profit sector.

The Hazard Mitigation Citizen's Advisory Committee engaged in two meetings on March 19, 2015 and August 5, 2015 to review the tasks, discuss the overall process, and provide input and comments on the work completed by the FMHMPC and consultant. Citizens provided feedback following these meetings through phone calls and email correspondence.

Table 2.2: Members of the Hazard Mitigation Citizen's Advisory Committee

NAME	DEPARTMENT / AGENCY
Gretchen Abney	Citizen Representative
Emily Hardee	Construction Services, Floodplain Coordinator, CFM
Allison Hardin	Planner and Certified Floodplain Manager
Susan Libes	Coastal Carolina University, Environmental Qualifications Lab
Lisa Swanger	Coastal Carolina University, Environmental Qualifications Lab
Jenny Thompson	Citizen Representative

2.6 COMMUNITY MEETINGS AND WORKSHOPS

The preparation of this Plan required a series of meetings and workshops for facilitating discussion, gaining consensus, and initiating data collection efforts with local government staff, community officials, and other identified stakeholders. More importantly, the meetings and workshops prompted continuous input and feedback from relevant participants throughout the drafting stages of the Plan. The meeting materials including the agendas, sign-in sheets, and minutes are located in Appendix D.

The Kick-off Meeting in March began with an overview of mitigation. A presentation was given that outlined the project tasks, schedule, and mitigation planning process. The next FPHMPC meeting in August had two significant parts. The initial portion reviewed the hazard identification, risk assessment, and vulnerability analysis. The second portion focused on the current capabilities of City and the review of the existing mitigation strategy to include the goals and actions.[3] In many cases, routine discussions and additional meetings were held by local staff to accomplish planning tasks specific to their department or agency, such as the approval of specific mitigation actions for their department of agency to undertake and include in the Mitigation Action Plan.

[3] Copies of the agendas, sign-in sheets, and minutes for all meetings and workshops can be found in Appendix B.

2.7 INVOLVING THE PUBLIC

44 CFR Requirement

44 CFR Part 201.6(b)(1): The planning process shall include an opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.

An important component of the mitigation planning process involved public participation. Individual citizen and community-based input provides the entire planning team with a greater understanding of local concerns and increases the likelihood of successfully implementing mitigation actions by developing community "buy-in" from those directly affected by the decisions of public officials. As citizens become more involved in decisions that affect their safety, they are more likely to gain a greater appreciation of the hazards present in their community and take the steps necessary to reduce their impact. Public awareness is a key component of any community's overall mitigation strategy aimed at making a home, neighborhood, school, business, or entire city safer from the potential effects of hazards.

Public involvement in the development of the City of Myrtle Beach's 2015 Floodplain Management and Hazard Mitigation Plan was sought throughout the planning process with the use of the public participation survey that was made available at various locations throughout the City and on the City's Web site. Public meetings were also held at two distinct periods during the planning process: (1) in beginning of the update process to explain the planning process and project tasks and (2) during the drafting stage of the plan to review the risk assessment and develop the mitigation strategy. A third public meeting was also held upon completion of a final draft Plan but prior to official plan approval and adoption. Public input was sought using three methods: (1) open public meetings; (2) survey instruments; and (3) making copies of draft Plan deliverables available for public review.

The two rounds of open public meetings that were held during the development of this Plan are described below.

March 2, 2010
First Open Public Meeting

The first open public meeting was held concurrently with the first FMHMPC meeting on the afternoon of March 2, 2010. The meeting was advertised through a public hearing notice, a posting on the City's Web site, email list, and on the City's cable access channel.

Figure 2.3 shows the public hearing notice that was disseminated.

Figure 2.3: Notice of First Open Public Meeting

City of Myrtle Beach

Public Hearing

The City of Myrtle Beach Floodplain Management and Hazard Mitigation Committee will hold a

Public Hearing
Monday, March 2, 1015
2:00pm
City Services Building, Large Conference Room
921 North Oak Street
Myrtle Beach, SC 29579

The purpose of the hearing will be to kick-off the Floodplain Management and Hazard Mitigation Plan 5 year update. As part of the planning process, the flood plain hazard mitigation committee holds public meetings and works with hundreds of citizens during the visioning process for the comprehensive plan updates. The plan was prepared as a guide to facilitate the implementation of floodplain management, as well as provide a guide for reconstruction and redevelopment of flood prone areas and as a means to reduce or eliminate future flood damage. We encourage the public to come participate and be part of our planning process.

Second Open Public Meeting

The second open public meetings took place during the Risk Assessment and Mitigation Strategy Meeting on August 5, 2015. There were no public comments received at either of those meetings. However, the Hazard Mitigation Citizen's Advisory Committee provided significant input during their meetings and through correspondence to include mitigation action supporting information.

2.7.1 Public Participation Survey

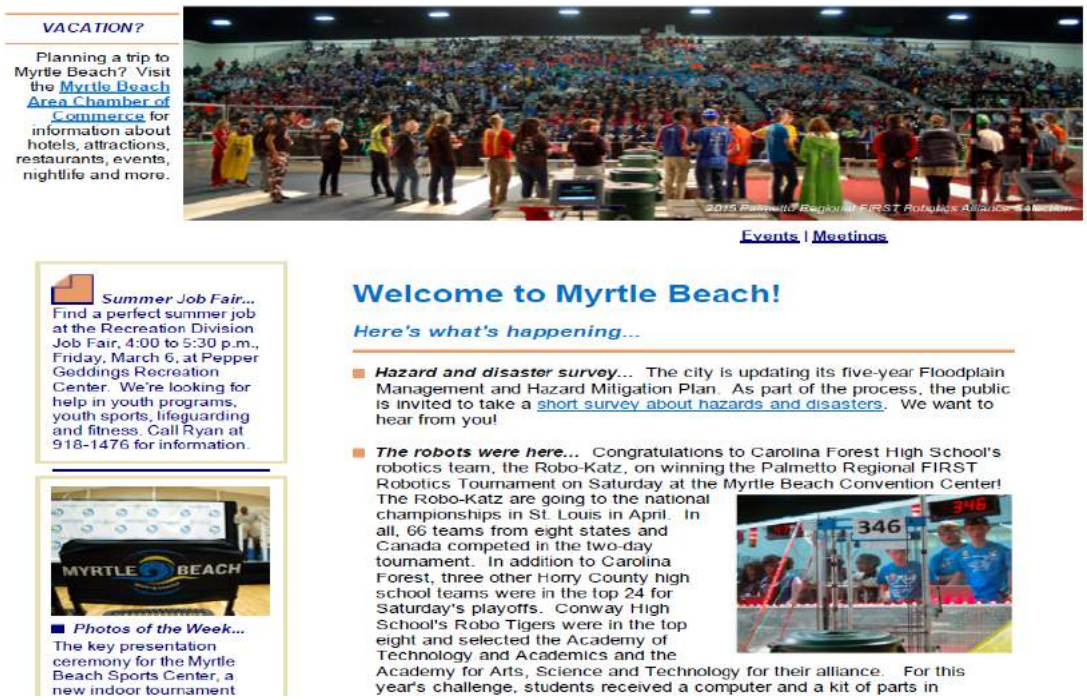
Since the open public meetings only drew a few citizens to attendance, the City of Myrtle Beach utilized the Public Participation Survey to encourage citizens to provide input to the mitigation planning process. The Public Participation Survey was designed to capture data and information from residents of Myrtle Beach that might not be able to attend public meetings or participate through other means in the mitigation planning process.

Copies of the Public Participation Survey were distributed by various City departments and made available for residents to complete at local public offices. The Planning Department's Neighborhoods Division had representatives attend 26 different neighborhood meetings and disseminated copies of the public participation survey with a thank you for providing necessary input for the update of the City's FMHMPC.

An electronic version of the survey was posted on the City's Web site. Numerous survey responses were received, which provided valuable input for the FMHMPC to consider in the development of the plan update. A copy of the survey and a detailed summary of the survey results are provided in Appendix B.

Figure 2.4 shows the posting of the Public Participation Survey on the City's website.

Figure 2.4: Public Participation Survey Posting on City's Website



2.8 INVOLVING THE STAKEHOLDERS

44 CFR Requirement

44 CFR Part 201.6(b)(2): The planning process shall include an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other non-profit interests to be involved in the planning process.

In addition to the FMHMPC meetings, the City of Myrtle Beach encouraged more open and widespread participation in the mitigation planning process through the design and posting of public notices and newspaper advertisements that promoted the open public meetings (described earlier in this Section). The City also went above and beyond in its local outreach efforts through the design and distribution of the Public Participation Survey as well as the creation of the Hazard Mitigation Citizen's Advisory Committee. These media advertisements and survey instruments provided opportunities for local officials, residents, businesses, academia, and other private interests in Myrtle Beach to be involved and offer input throughout the local mitigation planning process.

2.9 DOCUMENTATION OF PLAN PROGRESS

Progress in hazard mitigation planning for the City of Myrtle Beach is documented in this plan update. Since hazard mitigation planning efforts officially began in the city with the development of the initial Hazard Mitigation Plans in the late 1990s and early 2000s, many mitigation actions have been completed and implemented in the city. These actions will help reduce the overall risk to natural hazards for the people and property in the City of Myrtle Beach. The actions that have been completed are documented in the *Mitigation Action Plan* found in Section 8.

In addition, community capability continues to improve with the implementation of new plans, policies, and programs that help to promote hazard mitigation at the local level. The current state of local capabilities for the participating jurisdictions is captured in Section 6: *Capability Assessment*. The City continues to demonstrate its commitment to hazard mitigation and hazard mitigation planning and has proven this by developing the Floodplain Management and Hazard Mitigation Planning Committee to update the Plan and by continuing to involve the public in the hazard mitigation planning process.

SECTION 3

COMMUNITY PROFILE

This section of the Plan provides a general overview of the City of Myrtle Beach. It consists of the following five subsections:

- 3.1 Geography and the Environment
- 3.2 Population and Demographics
- 3.3 Housing and Infrastructure
- 3.4 Employment and Industry
- 3.5 Development Trends

3.1 GEOGRAPHY AND THE ENVIRONMENT

The Grand Strand region of South Carolina extends more than 60 miles from the North Carolina border to Pawleys Island in Georgetown County. The City of Myrtle Beach is located in Horry County at the heart of the Grand Strand area, which is visited by over 17 million tourists annually. The city has a land area of 23.59 square miles. An orientation map is provided as **Figure 3.1.**

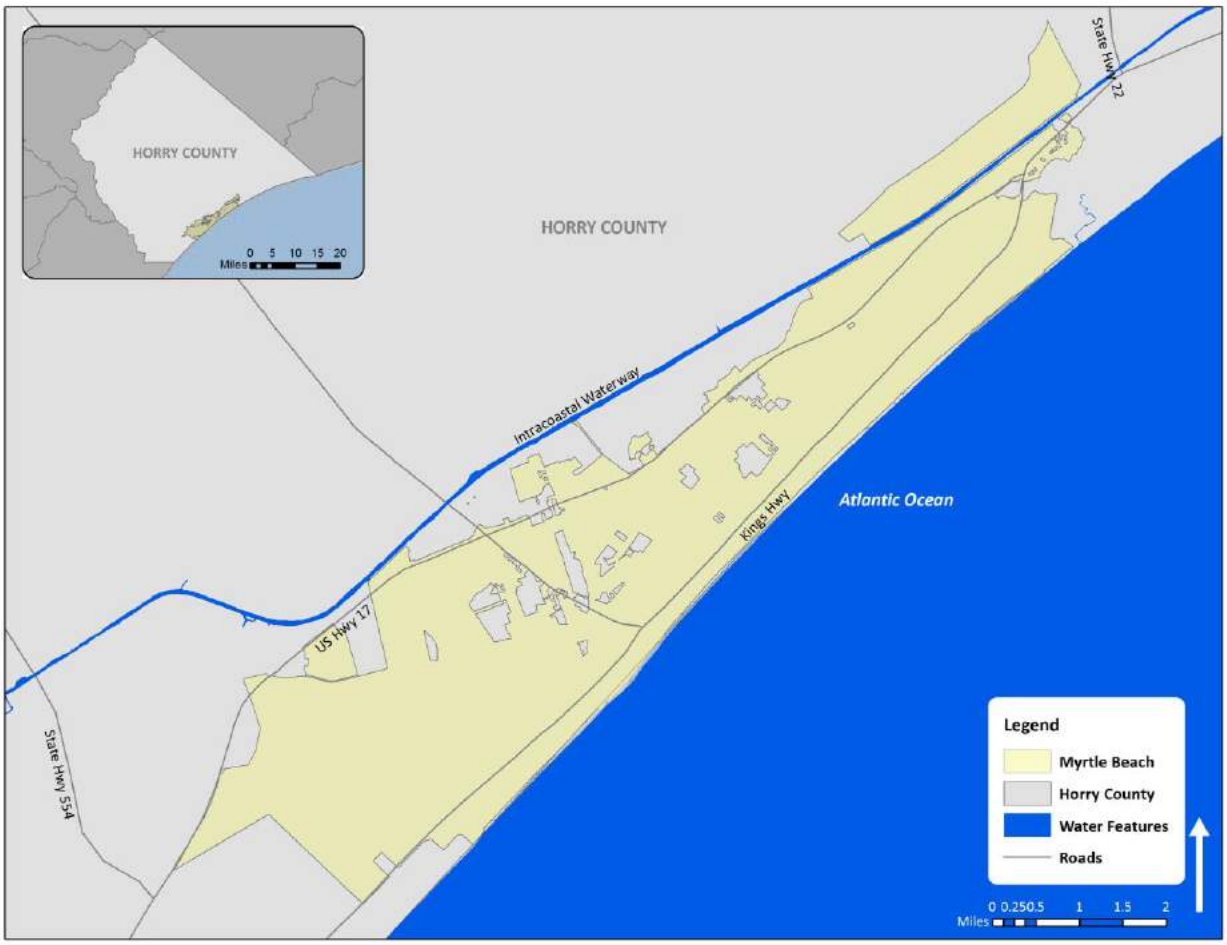
Development of the beach began around 1900. The Conway and Seashore Railroad was constructed from Conway to Myrtle Beach and connected with the Atlantic Coast Line Railroad in Conway. The rail line provided improved access to the beach for tourists and the resort began to grow. Myrtle Beach was incorporated as a town in 1938 and as a city in 1957. Since the 1950's, Myrtle Beach has experienced unprecedented growth and change, fueled by its increasing popularity as a vacation destination. Myrtle Beach is South Carolina's 15th largest municipality and the largest municipality in Horry County. North and South Carolina were home to four of the nation's 20 fastest-growing metro areas between 2013 and 2014 with the Myrtle Beach MSA being second. Development in the area has been strong and continues to attract new residents and visitors especially in the Market Common district and on the extreme northern end of the City. The build-out of these two areas is projected to add approximately 18,200 new residents by 2025.

Myrtle Beach is bordered to the east by the Atlantic Ocean, to the north by the City of North Myrtle Beach, to the west by the Intracoastal Waterway, and to the south by the Town of Surfside Beach. The average elevation of the city is approximately 26 feet.

The climate in Myrtle Beach is considered sub-tropical with generally warm, humid temperatures year-round. The average high temperature is 75°F and the average low temperature is 53°F. The average annual precipitation is 48 inches, with higher rainfall amounts in the summer months.

The dominant surface water resource in Myrtle Beach is the Intracoastal Waterway, which runs north-south near the western boundary of the city. Major rivers near the city include the Pee Dee River and the Waccamaw River, both located south of the city.

Figure 3.1: Myrtle Beach Orientation Map

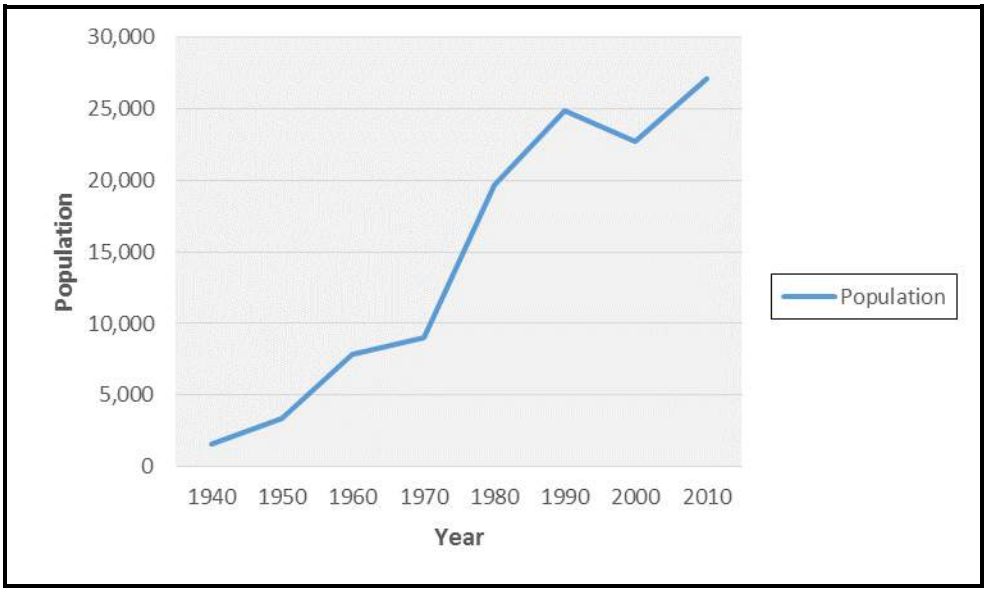


3.2 POPULATION AND DEMOGRAPHICS

Based on data from the US Census Bureau, the resident population of Myrtle Beach increased from 22,759 in 2000 to 27,109 in 2010, resulting in an increase of 19.1 percent. According to the Myrtle Beach Comprehensive Plan, the future population in the city is likely to increase and development in the area has been strong and continues to attract new residents and visitors. While population projections are not available for the City of Myrtle Beach alone, the South Carolina Budget and Control Board has published population projections for Horry County. As of the 2010 Census, Horry County had a population of 269,291. In 2030, the county's population is projected to be 367,680, which represents projected growth of 36.5 percent.

Figure 3.2 charts the population growth in the city from 1940 to 2008 with data provided by the US Census Bureau.

Figure 3.2: Myrtle Beach Population Change



According to the 2010 Census, the median age for city residents is 39.2 years. It is estimated that 15.1 percent of the city's population is made up of persons that are 65 years old and older. The population of Myrtle Beach is 72.3 percent White and 13.9 percent Black or African American. An estimated 13.7 percent of the population (of any race) is Hispanic or Latino.

3.3 HOUSING, INFRASTRUCTURE AND LAND USE

3.3.1 Housing

According to the Census Bureau's 2009-2013 American Community Survey, there are 22,579 housing units in Myrtle Beach. Of these structures, 29.8 percent are single-unit, 65.1 percent are multi-unit, and 5.1 percent are mobile homes. The median value of a home is $167,100 (the median home value for South Carolina is $137,400).

The age distribution of the county's housing stock as reported in the 2009-2013 American Community Survey is as follows:

- Pre-1939 — 1.3 percent
- 1940 to1949 — 1.6 percent
- 1950 to 1959 — 7.3 percent
- 1960 to 1969 — 7.9 percent
- 1970 to 1970 — 18.3 percent
- 1980 to 1989 — 26.8 percent
- 1990 to 1999 — 16.0 percent
- 2000 to 2009 — 20.0 percent
- 2010 or later — 0.7 percent

3.3.2 Infrastructure

Transportation

There are several major highways that provide access to Myrtle Beach. The US 17 Bypass runs north-south along the western edge of the city. Carolina Bays Parkway (Highway 31) is another major north-south route that runs west of the city. US 501 is the major east-west highway through the city and connects to US Highway 17 Business (Kings Highway) in the heart of Myrtle Beach. The Conway Bypass (Highway 22) connects the US 17 Bypass on the north side of Myrtle Beach to US 501 on the west side of Conway, over twenty miles west of Myrtle Beach.

The Coastal Rapid Public Transit Authority provides bus service in the Myrtle Beach area. Shuttle bus services are also offered in the hotel areas during the summer.

Myrtle Beach International Airport is located on the south side of the city and is operated by the Horry County Department of Airports. The airport has a single runway of almost 10,000 feet and a terminal complex for both commercial flights and general aviation.

Utilities

Electric power in Myrtle Beach is provided by Santee Cooper and Horry Electric. The natural gas supplier is South Carolina Electric and Gas. Water, sewer, and solid waste services are provided by the Myrtle Beach Public Works Department. The City gets its potable water from the Intracoastal Waterway where the Waccamaw River provides seven-miles of freshwater. The City also maintains several deep wells in the Black Creek aquifer for emergency use. The City's surface water treatment plant and wastewater plant are located on Mr. Joe White Avenue on the eastern bank of the Intracoastal Waterway.

Community Facilities

There are a number of public buildings and community facilities located throughout Myrtle Beach. There are six fire stations located in the City limits. The Myrtle Beach Police Department is located in the Law Enforcement Center on Oak Street and Mr. Joe White Avenue.

The Chapin Memorial Library is the only municipally-owned library in the state of South Carolina and is located on 14th Avenue North on the east side of Kings Highway (US 17 Business).

The City's Parks and Recreation system consists of 49 active and passive parks and 143 beach access points. Myrtle Beach State Park is located just south of the city limits.

Myrtle Beach is in the Horry County School District, which operates 5 schools within the jurisdiction. Coastal Carolina University, Horry-Georgetown Technical College, and Webster University have satellite campuses in Myrtle Beach.

3.4 EMPLOYMENT AND INDUSTRY

Myrtle Beach thrives on its reputation as a tourist destination. Based on the 2009-2013 American Community Survey, the arts, entertainment, recreation, accommodation, and food services industry employed 28.4 percent of Myrtle Beach's labor force. Educational services, and health care and social

services employed the second highest percentage of the labor force at 14.8 percent with retail trade close behind at 14.1 percent.

According to the Census Bureau's 2009-2013 American Community Survey, the estimated median family income for Myrtle Beach was $50,343, compared to the US average of $64,719 per family and the South Carolina average of $55,058 per family.

3.5 DEVELOPMENT TRENDS

Development in Myrtle Beach has historically been concentrated along the oceanfront. Commercial uses have grown up along major thoroughfares and expansion of the roadway system has resulted in additional locations for new commercial development. In recent years, properties along the oceanfront are being redeveloped at greater intensities to accommodate the growing tourist market. The Downtown Redevelopment Corporation has developed a Pavilion Area Master Plan which outlines a redevelopment strategy for the core area of Myrtle Beach consisting of over 300 acres of land and one-half mile of oceanfront. The current focus is on the South Area Mixed Use Area to create incentives to encourage development. Ordinance and zoning updates have taken place to foster growth and development by a potential investor. A boardwalk was constructed by the City and opened in 2010 and private development was attracted and began in 2011. In addition, other areas of the city are experiencing new commercial and residential development, including the Market Commons District and the extreme northern portion of the city.

SECTION 4

HAZARD IDENTIFICATION AND ANALYSIS

44 CFR Requirement

44 CFR Part 201.6(c)(2)(i): The risk assessment shall include a description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

4.1 OVERVIEW

The City of Myrtle Beach is vulnerable to an array of natural hazards that threaten life and property. FEMA's current regulations and interim guidance under the Disaster Mitigation Act of 2000 (DMA 2000) require, at a minimum, an evaluation of a full range of natural hazards.

Upon a review of the full range of natural hazards suggested under FEMA planning guidance, the City of Myrtle Beach Floodplain Management and Hazard Mitigation Planning Committee (FMHMPC) identified a number of hazards that are to be addressed in the City's Floodplain Management and Hazard Mitigation Plan. The City has also decided to include several human-caused hazards in this analysis as well. All of the hazards included were identified through an extensive process that utilized input from FMHMPC members, research of past disaster declarations for the City, review of the City's previous hazard mitigation plan, and a review of the current South Carolina State Hazard Mitigation Plan. Readily available online information from reputable sources such as federal and state agencies was also evaluated to supplement information from these key sources.

This section of the Plan describes the hazards identified by the FMHMPC to pose a risk to people and property in the city. Further, an assessment of risk for each hazard includes background information, location and extent, notable historical occurrences, and the probability of future occurrences. When possible, hazard profiles also include specific items noted by members of the FMHMPC as they relate to unique historical or anecdotal hazard information for Myrtle Beach.

The following hazards were identified:

- **Atmospheric**
  - Drought
  - Hailstorm
  - Ice Storm
  - Lightning
  - Nor'easter

- Wind Events
- Tornado/Waterspout
- Tropical Storm System/Hurricane

- **Geologic**
  - Earthquake
  - Tidal Wave/Tsunami

- **Hydrologic**
  - Erosion
  - Flood
  - Storm Surge
  - Sea Level Rise

- **Other**
  - Acts of Terror
  - Airplane Crash
  - Hazardous Materials Incident
  - Wildfire

For the 2015 update of this plan, the Floodplain Management and Hazard Mitigation Committee determined that all of the hazards identified in the previous plan were adequate and no additions or subtractions were made to the list of hazards addressed. However, the committee did recommend moving the Sea Level Rise hazard from the "Other" category to the Hydrologic category.

Some of these hazards are considered to be interrelated or cascading (e.g., hurricanes can cause flooding, storm surge, and tornadoes), but for preliminary hazard identification purposes these distinct hazards are broken out separately. It should also be noted that some hazards, such as earthquakes or winter storms, may impact a large area yet cause little damage, while other hazards, such as a tornado, may impact a small area yet cause extensive damage. **Table 4.1** provides a brief description of the aforementioned hazards.

Table 4.1: Descriptions of Identified Hazards

Hazard	Description
ATMOSPHERIC	
Drought	A Drought occurs when a prolonged period of less than normal precipitation results in a serious hydrologic imbalance. Common effects of drought include crop failure, water supply shortages, and fish and wildlife mortality. High temperatures, high winds, and low humidity can worsen drought conditions and also make areas more susceptible to wildfire. Human demands and actions have the ability to hasten or mitigate drought-related impacts on local communities.
Hailstorm	Hail is formed when updrafts in thunderstorms carry raindrops into parts of the atmosphere where the temperatures are below freezing.
Ice Storm	An Ice Storm is a winter storm characterized by significant amounts of freezing rain. It is often associated with severe winter storms which may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Ice storms occur when moisture falls and freezes immediately upon impact on trees, power lines, communication towers, structures, roads, and other hard surfaces. Winter storms and ice storms can cause widespread power outages, damage property, and result in fatalities and injuries.

Lightning	Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a "bolt" when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. (This rapid heating and cooling of the surrounding air causes thunder.) On average, 73 people are killed each year by lightning strikes in the United States.
Nor'easter	The Nor'easter is a particularly devastating type of coastal storm, named for the winds that blow in from the northeast and drive the storm up the U.S. East Coast alongside the Gulf Stream (a band of warm water that lies off the Atlantic coast). They are caused by the interaction of the jet stream with horizontal temperature gradients and generally occur during the fall and winter months when moisture and cold air are plentiful. Coastal storm events are notorious for producing heavy amounts of rain and snow, producing hurricane-force winds, and creating high surf that potentially causes severe beach erosion and coastal flooding.
Wind Events	Thunderstorms are caused by air masses of varying temperatures meeting in the atmosphere. Rapidly rising warm moist air fuels the formation of thunderstorms. Thunderstorms may occur singularly, in lines, or in clusters. They can move through an area very quickly or linger for several hours. Thunderstorms may result in hail, tornadoes, or wind. Windstorms pose a threat to lives, property, and vital utilities primarily due to the effects of flying debris and can down trees and power lines.
Tornado/Waterspout	A Tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud. Its vortex rotates cyclonically with wind speeds ranging from as low as 40 mph to as high as 300 mph. 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 destruction caused by tornadoes ranges from light to catastrophic depending on the intensity, size, and duration of the storm.
Tropical Storm System/Hurricane	Hurricanes and tropical storms are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and with a diameter averaging 10 to 30 miles across. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation, and tornadoes. Coastal areas are also vulnerable to the additional forces of storm surge, wind-driven waves, and tidal flooding which can be more destructive than cyclone wind. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea and Gulf of Mexico during the official Atlantic hurricane season, which extends from June through November.
GEOLOGIC	
Earthquake	A sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the surface characterizes an Earthquake. This movement forces the gradual building and accumulation of energy. Eventually, strain becomes so great that the energy is abruptly released, causing the shaking at the earth's surface which we know as an earthquake. Roughly 90 percent of all earthquakes occur at the boundaries where plates meet, although it is possible for earthquakes to occur entirely within plates. Earthquakes can affect hundreds of thousands of square miles; cause damage to property measured in the tens of billions of dollars; result in loss of life and injury to hundreds of thousands of persons; and disrupt the social and economic functioning of the affected area.

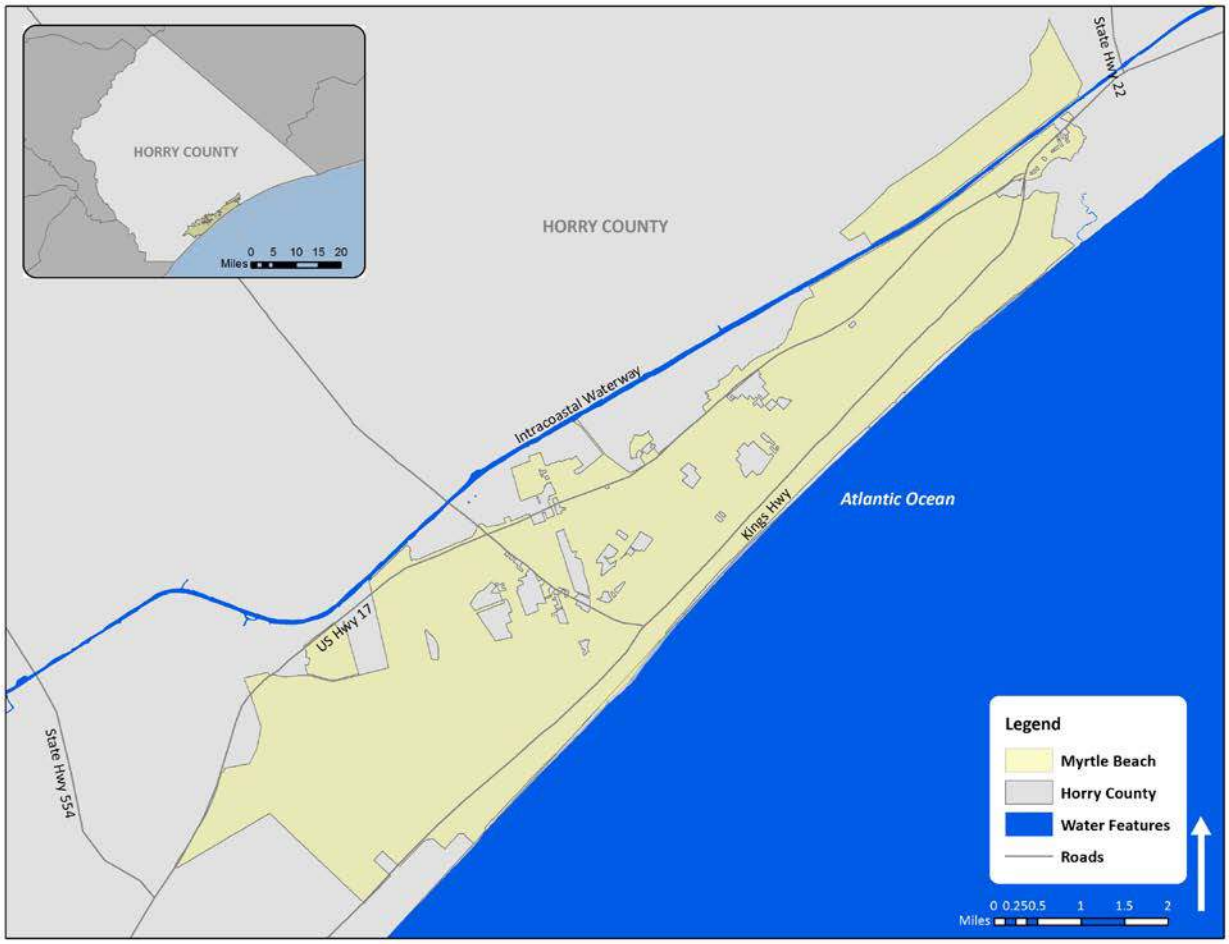
Tidal Wave/Tsunami	A Tsunami is a series of waves generated by an undersea disturbance such as an earthquake or moving plate tectonics. The speed of a tsunami traveling away from its source can range from up to 500 miles per hour in deep water to approximately 20 to 30 miles per hour in shallower areas near coastlines. Tsunamis differ from regular ocean waves in that their currents travel from the water surface all the way down to the sea floor. Wave amplitudes in deep water are typically less than one meter; they are often barely detectable to the human eye. However, as they approach shore, they slow in shallower water, basically causing the waves from behind to effectively "pile up", and wave heights to increase dramatically. As opposed to typical waves which crash at the shoreline, tsunamis bring with them a continuously flowing 'wall of water' with the potential to cause devastating damage in coastal areas located immediately along the shore.
HYDROLOGIC	
Erosion	Erosion is a landward displacement of a shoreline caused by the forces of waves and currents. Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time. It is generally associated with episodic events such as hurricanes and tropical storms, nor'easters, storm surge, and coastal flooding but may also be caused by human activities that alter sediment transport. Construction of shoreline protection structures can mitigate the hazard, but may also exacerbate it under some circumstances.
Flood	The accumulation of water within a water body which results in the overflow of excess water onto adjacent lands, usually floodplains. The floodplain is the land adjoining the channel of a river, stream ocean, lake, or other watercourse or water body that is susceptible to flooding. Most floods fall into the following three categories: riverine flooding, coastal flooding, or shallow flooding (where shallow flooding refers to sheet flow, ponding and urban drainage). Coastal flooding is exacerbated during high tide events.
Storm Surge	Storm surge occurs when the water level of a tidally influenced body of water increases above the normal astronomical high tide, and are most common in conjunction with coastal storms with massive low-pressure systems with cyclonic flows such as hurricanes, tropical storms, and nor'easters. The low barometric pressure associated with these storms cause the water surface to rise, and storms making landfall during peak tides have surge heights and more extensive flood inundation limits. Storm surges will inundate coastal floodplains by dune overwash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. The duration of a storm is the most influential factor affecting the severity and impact of storm surges.
Sea Level Rise	According to NOAA, sea level rise is defined as a mean rise is sea level. As the ocean warms, sea water expands and continental ice sheets melt, thus inundating areas with sea water that were previously above sea level.
OTHER	
Acts of Terror	Terrorism is defined by FEMA as, "the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom." Terrorist acts may include assassinations, kidnappings, hijackings, bomb scares and bombings, cyber-attacks (computer-based), and the use of chemical, biological, nuclear, and radiological weapons.
Airplane Crash	An airplane crash endangers the passengers onboard the craft as well as people and property at the crash site. The extent of an airplane crash risk is based on many factors including the size of the aircraft and location of crash site. For example, a large commuter jet crashing into a heavily populated urban area will likely have far greater damages than a personal aircraft crashing in a rural area.
Hazardous Materials Incident	Hazardous material (HAZMAT) incidents can apply to fixed facilities as well as mobile, transportation-related accidents in the air, by rail, on the nation's highways, and on the water. HAZMAT incidents consist of solid, liquid, and/or gaseous contaminants that are released from fixed or mobile containers, whether by accident or by design as with an intentional terrorist attack. A HAZMAT incident can last hours to days, while some chemicals can be corrosive or otherwise damaging over longer periods of time. In addition to the primary release, explosions and/or fires can result from a release, and contaminants can be extended beyond the initial area by persons, vehicles, water, wind, and possibly wildlife as well.

Wildfire	An uncontrolled fire burning in an area of vegetative fuels such as grasslands, brush, or woodlands defines wildfire. Heavier fuels with high continuity, steep slopes, high temperatures, low humidity, low rainfall, and high winds all work to increase risk for people and property located within wildfire hazard areas or along the urban/wildland interface. Wildfires are part of the natural management of forest ecosystems, but most are caused by human factors. Over 80 percent of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning.

4.2 STUDY AREA

Figure 4.1 provides a base map for the City of Myrtle Beach hazard risk assessment. The map depicts the Myrtle Beach boundary as of 2015.

Figure 4.1: Myrtle Beach Base Map



Atmospheric Hazards

4.3 DROUGHT

4.3.1 Background

Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length. High temperatures, high winds, and low humidity can exacerbate drought conditions. In addition, human actions and demands for water resources can hasten drought-related impacts.

Droughts are typically classified into one of four types: 1) meteorological; 2) hydrologic; 3) agricultural; or 4) socioeconomic. **Table 4.2** presents definitions for these types of drought.

Table 4.2 Drought Classification Definitions

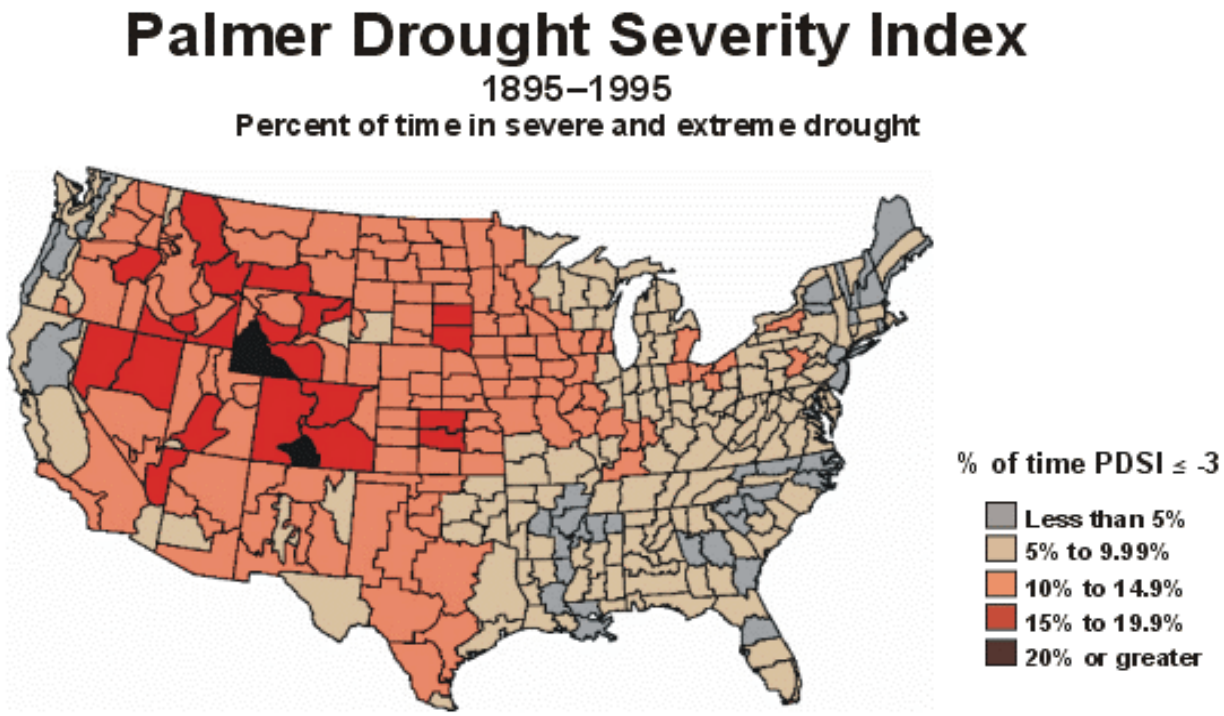
Meteorological Drought	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
Hydrologic Drought	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
Agricultural Drought	Soil moisture deficiencies relative to water demands of plant life, usually crops.
Socioeconomic Drought	The effect of demands for water exceeding the supply as a result of a weather-related supply shortfall.

Source: Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy, FEMA

Droughts are slow-onset hazards, but, over time, can have very damaging affects to crops, municipal water supplies, recreational uses, and wildlife. If drought conditions extend over a number of years, the direct and indirect economic impact can be significant.

The Palmer Drought Severity Index (PDSI) is based on observed drought conditions and range from -0.5 (incipient dry spell) to -4.0 (extreme drought). As evident in **Figure 4.2**, the Palmer Drought Severity Index Summary Map for the United States, drought affects most areas of the United States, but is less severe in the Eastern United States.

Figure 4.2: Palmer Drought Severity Index Summary Map for the United States



Source: National Drought Mitigation Center

4.3.2 Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index (**Figure 4.2**), South Carolina has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Further, it is assumed that the City of Myrtle Beach would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

4.3.3 Historical Occurrences

Data from the National Climate Data Center (NCDC) was used to ascertain historical drought events in Myrtle Beach. According to NCDC, five (5) drought events have affected the City of Myrtle Beach between 1993 and 2014, as shown in **Table 4.3**[1]:

[1] These drought events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional drought conditions have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

Table 4.3: Historical Drought Impacts

Location	Date	Deaths/ Injuries	Property Damage (2009 dollars)	Description
Across South Carolina	10/01/1993	0/0	$0	*Not Available*
Darlington, Dillon, Florence, Georgetown, Horry, Marion, Marlboro, and Williamsburg Counties	08/19/1999	0/0	$0	*Not Available*
Darlington, Dillon, Florence, Georgetown, Horry, Marion, Marlboro, and Williamsburg Counties	11/15/2001	0/0	$0	The South Carolina Drought Response Committee declared many parts of the state in a moderate drought. For the year, the state received well below the normal rainfall, averaging 9-12 inches below normal. The below normal rainfall actually began in 1999, and since that time the Pee Dee and the Grand Strand area are about 20 inches below normal.
Darlington, Dillon, Florence, Georgetown, Horry, Marion, Marlboro, and Williamsburg Counties	06/01/2002	0/0	$0	*Not Available*
Darlington, Dillon, Florence, Georgetown, Horry, Marion, Marlboro, and Williamsburg Counties	11/ 2007 - 01/2008	0/0	$0	*Not Available*
Coastal Horry (Zone)	07/01/2011	0/0	$0	*Not Available*

Source: NCDC

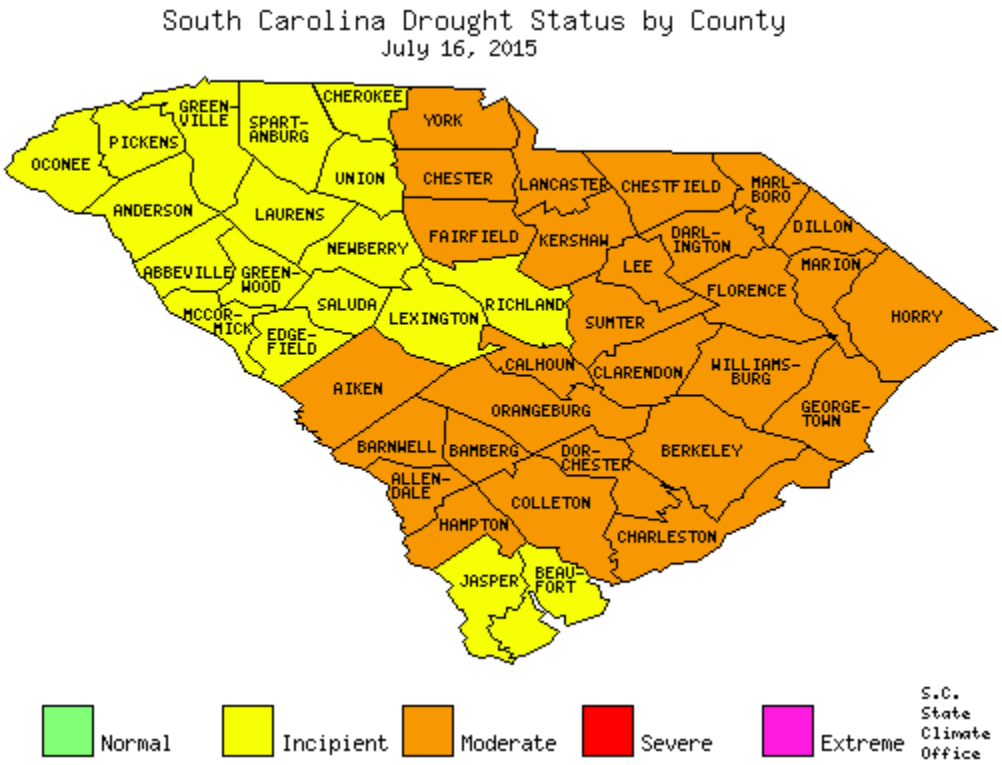
According to S.C. Climatology Office data from 2006-2015, the highest level of drought classification reached in Horry County was Severe in 2007, 2008, and 2011. **Table 4.4** shows the highest level of drought classification reached in each year for Horry County since 2006. **Figure 4.3** is also presented as an example of how the data is captured on a county by county level across the state.

Table 4.4: Highest Drought Levels Reached in Horry County Annually

Year	Horry County
2006	NORMAL
2007	**SEVERE**
2008	**SEVERE**
2009	**INCIPIENT**
2010	NORMAL
2011	**SEVERE**
2012	**MODERATE**
2013	**INCIPIENT**
2014	**INCIPIENT**
2015	**INCIPIENT**

Source: S.C. State Climatology Office

Figure 4.3: County by County Drought Level Example



Source: S.C. State Climatology Office

4.3.4 Probability of Future Occurrences

It is assumed that all of the City of Myrtle Beach has a high probability of a future drought event, so future occurrences are considered likely.

4.4 HAILSTORMS

4.4.1 Background

Hailstorms are a potentially damaging outgrowth of severe thunderstorms. Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until they develop to a sufficient weight and fall as precipitation. Hail typically takes the form of spheres or irregularly-shaped masses greater than 0.75 inches in diameter. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size.

4.4.2 Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. Thunderstorms are considered frequent occurrences throughout Myrtle Beach and coastal South Carolina. It is assumed that all of Myrtle Beach is uniformly exposed to severe thunderstorms; therefore, all areas of the city are equally exposed to hail which may be produced by such storms.

4.4.3 Historical Occurrences

According to the National Climatic Data Center, there have been 295 hail events in Horry County since 1956, 21 of which have affected the City of Myrtle Beach.[2] **Table 4.5** provides detailed information about these recorded events, which caused over $10,000 in reported property damages. Hail ranged in size from 0.75 inches to 1.75 inches in diameter during these events. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment, so it is likely that damages are greater than the reported value. The planning team especially noted that they felt structural damage reported by NCDC seemed very low and that historic dollar damages were much closer to millions of dollars of historic damage.

Table 4.5: Historical Hailstorm Impacts

Location	Date	Magnitude (inches)	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	05/04/1975	1.75 in.	0/0	$0	*Not Available*
Myrtle Beach	6/10/1982	1.75 in.	0/0	$0	*Not Available*
Myrtle Beach	06/03/1988	0.75 in.	0/0	$0	*Not Available*
Myrtle Beach	05/29/1996	0.88 in.	0/0	$0	Nickel-size hail at Springmaid Pier.

[2] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

Location	Date	Magnitude (inches)	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	08/13/2000	0.88 in.	0/0	$0	The agricultural center reported nickel size hail. Severe thunderstorm winds were also suspected as a ham radio operator reported large tree limbs down across Kings Highway.
Myrtle Beach	08/29/2001	1.00 in.	0/0	$0	Public reported quarter size hail.
Myrtle Beach	04/03/2006	0.75 in.	0/0	$0	*Not Available*
Myrtle Beach	04/03/2006	1.00 in.	0/0	$0	*Not Available*
Myrtle Beach	05/14/2006	1.75 in.	0/0	$0	Golf ball size hail was reported.
Myrtle Beach	6/1/2009	0.75 in.	0/0	$0	*Not Available*
Myrtle Beach	6/1/2009	0.88 in.	0/0	$0	*Not Available*
Myrtle Beach	6/26/2009	0.75 in.	0/0	$0	*Not Available*
Myrtle Beach	7/5/2012	1.00 in.	0/0	$1,289	*Not Available*
Myrtle Beach	5/23/2014	0.75 in.	0/0	$200	*Not Available*
Myrtle Beach	5/23/2014	1.75 in.	0/0	$2,000	*Not Available*
Myrtle Beach	5/23/2014	1.75 in.	0/0	$2,000	*Not Available*
Myrtle Beach	5/23/2014	1.75 in.	0/0	$2,000	*Not Available*
Myrtle Beach	5/23/2014	1.00 in.	0/0	$500	*Not Available*
Myrtle Beach	7/28/2014	1.00 in.	0/0	$250	*Not Available*

Source: NCDC

4.4.4 Probability of Future Occurrences

Because severe thunderstorm events will remain a very frequent occurrence for the City of Myrtle Beach, the probability of future occurrences of hail is highly likely. It can be expected that future hail events will continue to cause minor damages to property and vehicles throughout the city.

4.5 ICE STORM

4.5.1 Background

An ice storm is a type of winter storm that is characterized by significant amounts of freezing rain. Ice storms are a result of cold air damming (CAD). CAD is a shallow, surface-based layer of relatively cold, stably-stratified air entrenched against the eastern slopes of the Appalachian Mountains. With warmer air above, falling precipitation in the form of snow melts, then becomes either supercooled (liquid below the melting point of water) or re-freezes. In the former case, supercooled droplets can freeze on impact (freezing rain), while in the latter case, the re-frozen water particles are ice pellets (or sleet). When freezing rain falls onto a surface with a temperature below freezing, it forms a glaze of ice, creating very

hazardous conditions. Sleet pellets usually bounce when hitting a surface and do not stick to objects; however, sleet can accumulate like snow.

Even small accumulations of ice can cause a significant hazard, especially on roadways, power lines, and trees. An ice storm has an immediate impact on power lines, communication towers, roadways, and other hard surfaces. Communications and power can be disrupted for days as a result of an ice storm event.

Winter storms are also discussed in this section because the two hazards are so closely related. A winter storm can range from a moderate snow over a period of a few hours to blizzard conditions with blinding wind-driven snow that lasts for several days. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility and disrupt commerce and transportation. Occasionally heavy snow might also cause significant property damages, such as roof collapses on older buildings.

4.5.2 Location and Spatial Extent

Nearly the entire continental United States is susceptible to ice and winter storms. Some ice storms and winter storms might be large enough to affect several states, while others might affect only limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Myrtle Beach is not accustomed to severe winter weather conditions and rarely receives winter weather. However, the entire city has uniform exposure to the event.

4.5.3 Historical Occurrences

According to the National Climatic Data Center, there have been a total of six (6) recorded winter storm events in Myrtle Beach since 2000 (**Table 4.6**).[3] Over $256,000 in property damages resulted from these winter storm events. Additionally, the planning team noted that the largest winter storm event to impact the city was in 1989 when a storm system dropped more than 15 inches of snow.

Table 4.6: Historical Ice Storm Events

Location	Date	Type of Event	Deaths/ Injuries	Description
Countywide	01/18/2000	Freezing Rain	0/0	Although liquid accumulations were only around 0.10 inch, freezing rain and a bit of snow fell across the area during the early morning hours accumulating mostly on trees and grassy surfaces. Bridges and overpasses were slick and hazardous during the morning commute.

[3] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional winter storm conditions have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

Countywide	01/24/2000	Winter Storm	0/0	As a winter low pressure system intensified along the coast, rain turned to snow inland on the night of the 24th and snow spread to the coast during the early morning of the 25th. Accumulations ranged from around 10 inches in parts of Marlboro County to 5 to 6 inches in the coastal counties. Schools and businesses were closed by this rare snow event.
Countywide	01/02/2002	Winter Storm	0/0	Low pressure formed in the Gulf of Mexico the morning of January 2nd and moved up the eastern seaboard. Moisture moved north, overrunning cold high pressure, setting up a wintery mix for North and South Carolina. The precipitation began as snow over South Carolina that afternoon, and expanded to include North Carolina later that afternoon. The precipitation changed to freezing rain and sleet, then to rain over coastal sections of North and South Carolina that evening and continued through the morning of January 3rd. As the the low pressure center continued to track north, cold air wrapped around the system, changing the precipitation back to all snow by midday on January 3rd, and continued until the snow tapered off by early morning on January 4th. The snowfall totals were heaviest over portions of Darlington, Marlboro, and Robeson counties, where between 6 to 8 inches fell, with some sleet mixed in. Along coastal counties, between 1 and 3 inches of snow occurred, with around a half inch of sleet and freezing rain. There were numerous traffic accidents reported, although there was no information on injuries. There were over 1500 traffic accidents reported in South Carolina alone. The freezing rain from the storm forced many trees and large branches to snap, causing numerous power outages around the area. More than 25,000 customers were without power in Horry, Georgetown, and Brunswick counties. Secondary roads in most areas proved treacherous, but road crews managed to keep highways and primary roads open. Many businesses and schools were closed on January 3rd and 4th, including 64,000 state workers.
Countywide	01/26/2004	Ice Storm	0/0	Another episode of frozen precipitation occurred on the heels of the storm of January 25th, bringing more freezing rain and sleet to areas that already had over a quarter inch of ice still in the trees. The total ice accumulations ranged from a trace near the coast to as much as three quarters of an inch over interior sections. The weight of the ice caused major power outages from falling limbs, as well as significant structural damage to many homes. The state declared a forest disaster for the first time in two years. There was some ice accumulation on the roads, especially on bridges and overpasses, with numerous traffic accidents reported. Many residences were without power for over a week. Monetary damages totaled into the millions per county in some parts of South Carolina, due to cleanup of debris, utility expenses, and home repair.
Countywide	1/28/2014	Winter Storm	0/0	Freezing rain began falling the afternoon of Jan 28th, changed over to mostly sleet in the evening and overnight hours, and tapered off to flurries the morning of the 29th. Total ice accumulations ranged from a tenth to a half inch, and sleet accumulations along the coast

				were also about a half inch. Due to the nature of the precipitation, power outages were isolated, however driving was treacherous. Numerous traffic accidents were reported as well as injuries due to slips and falls.
Countywide	2/11/2014	Winter Storm	0/0	Freezing rain began falling the morning of February 11th. The freezing rain continued intermittently before ending the afternoon of the 12th. Ice accumulations ranged from a tenth to a quarter inch.

Source: NCDC

4.5.4 Probability of Future Occurrences

Winter storm events will remain a possible occurrence in Myrtle Beach, and the probability of future occurrences is certain though not necessarily annually. The impact of snow and ice storms may overwhelm city capabilities and cause major disruptions to transportation, commerce, and electrical power. However, large scale property damages and/or threats to human life and safety are not expected.

4.6 LIGHTNING

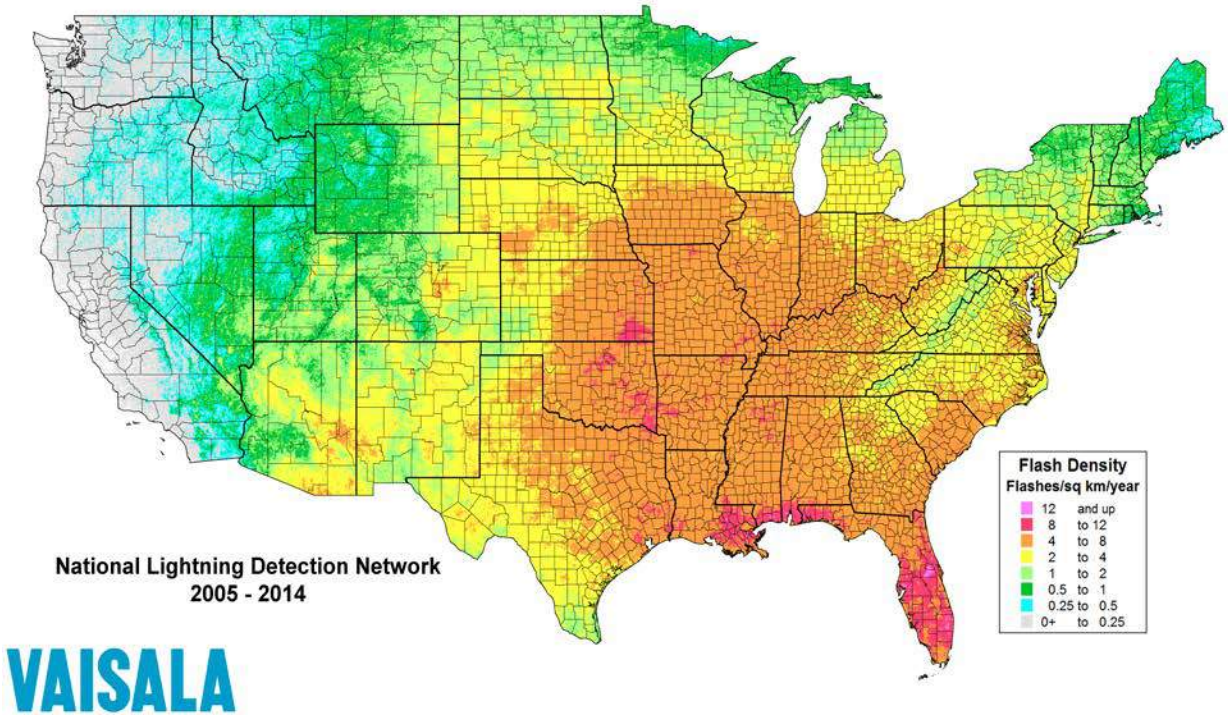
4.6.1 Background

Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a “bolt” when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes the thunder which often accompanies lightning strikes. While most often affiliated with severe thunderstorms, lightning may also strike outside of heavy rain and might occur as far as 10 miles away from any rainfall.

According to FEMA, lightning injures an average of 300 people and kills 80 people each year in the United States. Direct lightning strikes also have the ability to cause significant damage to buildings, critical facilities, and infrastructure largely by igniting a fire. Lightning is also responsible for igniting wildfires that can result in widespread damages to property.

The City of Myrtle Beach is located in a region of the country that is particularly susceptible to lightning strike. **Figure 4.4** shows a lightning flash density map for the years 2005-2014 based upon data provided by Vaisala’s U.S. National Lightning Detection Network (NLDN®). This map demonstrates that Myrtle Beach is located in an area that generally experiences 4 to 8 flashes per square kilometer per year.

Figure 4.4: Lightning Flash Density in the United States



Source: Vaisala U.S. National Lightning Detection Network

4.6.2 Location and Spatial Extent

It is assumed that all of Myrtle Beach is uniformly exposed to lightning. Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Myrtle Beach is uniformly exposed to lightning which strikes in very small, specific geographic areas.

4.6.3 Historical Occurrences

According to the National Climatic Data Center, there have been a total of ten (10) recorded lightning events in the City of Myrtle Beach since 1995.[4] These events resulted in over $390,000 (2014 dollars) in damages, as listed in **Table 4.7**.

Table 4.7: Historical Lightning Impacts

Location	Date	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	06/25/1995	0/1	$0	A lifeguard was injured by lightning.

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional lightning events have occurred in the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

Location	Date	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	06/09/1996	0/0	$0	Lightning caused power outages affecting Santee Cooper Electric customers for up to an hour.
Myrtle Beach	06/03/2001	0/0	$26,729	Official reported that lightning struck a home on North Ocean Blvd, causing moderate fire and water damage.
Myrtle Beach	07/20/2002	0/0	$39,462	Lightning caused a fire at the Chuck Wagon Restaurant on Kings Highway.
Myrtle Beach	07/06/2006	0/0	$5,866	Lightning struck an ambulance, disabling the vehicle.
Myrtle Beach	07/15/2006	0/0	$29,332	A barn was heavily damaged due to fire.

Source: NCDC

4.6.4 Probability of Future Occurrences

According to Vaisala's National Lightning Detection Network, Myrtle Beach is located in an area of the country that experienced an average of 4-8 lightning flashes per square kilometer per year between 2005 and 2014. Given this regular frequency of occurrence, it can be expected that future lightning events will continue to threaten life and cause property damages throughout the city. Therefore, the probability of occurrence for future lightning events in the City of Myrtle Beach is highly likely.

4.7 NOR'EASTER

4.7.1 Background

The Nor'easter is a particularly devastating type of coastal storm, named for the winds that blow in from the northeast and drive the storm up the U.S. East Coast alongside the Gulf Stream (a band of warm water that lies off the Atlantic coast). They are caused by the interaction of the jet stream with horizontal temperature gradients and generally occur during the fall and winter months when moisture and cold air are plentiful. Coastal storm events, such as Nor'easters, are notorious for producing heavy amounts of rain and snow, hurricane-force winds, and high surf that causes severe beach erosion and coastal flooding.

The potential damage of a Nor'easter is similar to a hurricane or tropical storm system with the added risk of hail and snow, thereby threatening property and life with severe winds and flooding.

4.7.2 Location and Spatial Extent

Nor'easters affect the entire east coast of the United States and are thus a threat to the South Carolina coast. Therefore, the City of Myrtle Beach has uniform risk to the Nor'easter hazard.

4.7.3 Historical Occurrences

December 1986:
This Nor'easter reportedly had winds up to 40 miles per hour and waves 10 feet above sea level.

January 1 & 2, 1987
This Nor'easter occurred less than a month after the previous storm, and caused $14.3 million in damages (2014 dollars) in Horry County. The National Weather Service reported it as the worst storm in over a decade.

March 1993:
This Nor'easter occurred during the annual Can-Am fest so it had a definite impact on the local economy. The exact monetary losses were not documented at the time but there has since been a methodology developed that can determine such losses should another event such as this one occur.

It should also be noted that many of the repetitive loss properties that have been identified in the Flood section of this plan are considered repetitive loss properties because of flooding caused by recent nor'easter events.

4.7.4 Probability of Future Occurrences

The probability of a Nor'easter occurring in Myrtle Beach is possible.

4.8 WIND EVENTS

4.8.1 Background

Severe thunderstorms are common throughout South Carolina and occur throughout most of the year. Thunderstorms can produce a variety of accompanying hazards including wind (discussed here), hail, and lightning.[5] Although thunderstorms generally affect a small area, they are very dangerous may cause substantial property damage.

Three conditions need to occur for a thunderstorm to form. First, it needs moisture to form clouds and rain. Second, it needs unstable air, such as warm air that can rise rapidly (this often referred to as the "engine" of the storm). Third, thunderstorms need lift, which comes in the form of cold or warm fronts, sea breezes, mountains, or the sun's heat. When these conditions occur simultaneously, air masses of varying temperatures meet, and a thunderstorm is formed. These storm events can occur singularly, in lines, or in clusters. Further, they can move through an area very quickly or linger for several hours.

According to the National Weather Service, more than 100,000 thunderstorms occur each year, though only about 10 percent of these storms are classified as "severe." A severe thunderstorm occurs when the storm produces one of three elements: 1) Hail of three-quarters of an inch; 2) Tornado; 3) Winds of at least 58 miles per hour.

Thunderstorm events have the capability of producing straight-line winds that can cause severe destruction to communities and threaten the safety of a population.

[5] Lightning and Hail are discussed in detail as separate hazards in this section.

4.8.2 Location and Spatial Extent

A thunderstorm event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Therefore, it is assumed that Myrtle Beach has uniform exposure to an event and the spatial extent of an impact would be potentially large.

4.8.3 Historical Occurrences

There have been seventeen (17) reported thunderstorm wind events in the City of Myrtle Beach since 1994.[6] These events caused over $1.8 million in damages (2014 dollars). In addition to property damage, there were 4 injuries but no reports of fatalities. **Table 4.8** shows the historical occurrences of wind events for Myrtle Beach.

Table 4.8: Historical Thunderstorm Wind Events

Location	Date	Type	Mag (knots)	Deaths/ Injuries	Property Damage (2014 Dollars)	Description
Myrtle Beach	05/14/1995	Thunderstorm Winds	44 kts.	0/0	$0	*Not Available*
South Myrtle Beach	05/19/1995	Thunderstorm Winds	0 kts.	0/0	$8,128	Telephone pole down.
Myrtle Beach	04/26/1996	Thunderstorm Winds	60 kts.	0/0	$0	Vents blown off roof of middle school.
Myrtle Beach	09/12/1997	Thunderstorm Winds	0 kts.	0/2	$737,280	A rain loaded thunderstorm microburst hit the beach berm and hotel area along a 4 block strip (from 26th Ave - 30th Ave). Two people were injured (cuts from flying glass and bruises).
Myrtle Beach	11/02/1997	Thunderstorm Winds	55 kts.	0/0		Strong winds downed power lines on south side of the city.
Myrtle Beach	08/09/2000	Thunderstorm Winds	62 kts.	0/0	$0	A 62 knot wind gust was measured by an anemometer on Springmaid Pier.
Myrtle Beach	08/11/2000	Thunderstorm Winds	55 kts.	0/0	$0	Lifeguard stands were reported to be blown over.
Myrtle Beach	04/17/2006	Thunderstorm Winds	65 kts.	0/0	$1,173	Power lines down on 13th and 14th Street South.
Myrtle Beach	7/26/2010	Thunderstorm Winds	52 kts.	0/0	$16,299	*Not Available*
Myrtle Beach	7/26/2010	Thunderstorm Winds	52 kts.	0/0	$21,732	*Not Available*
Myrtle Beach	7/15/2014	Thunderstorm Winds	56 kts.	0/0	$1,500	*Not Available*

Source: NCDC

[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional thunderstorm events have occurred in the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

4.8.4 Probability of Future Occurrences

Given the high number of previous events and favorable atmospheric conditions of the area, it is certain that wind events, including straight-line winds, will occur in the future. Therefore, the probability of future occurrence is considered highly likely.

4.9 TORNADO/WATERSPOUT

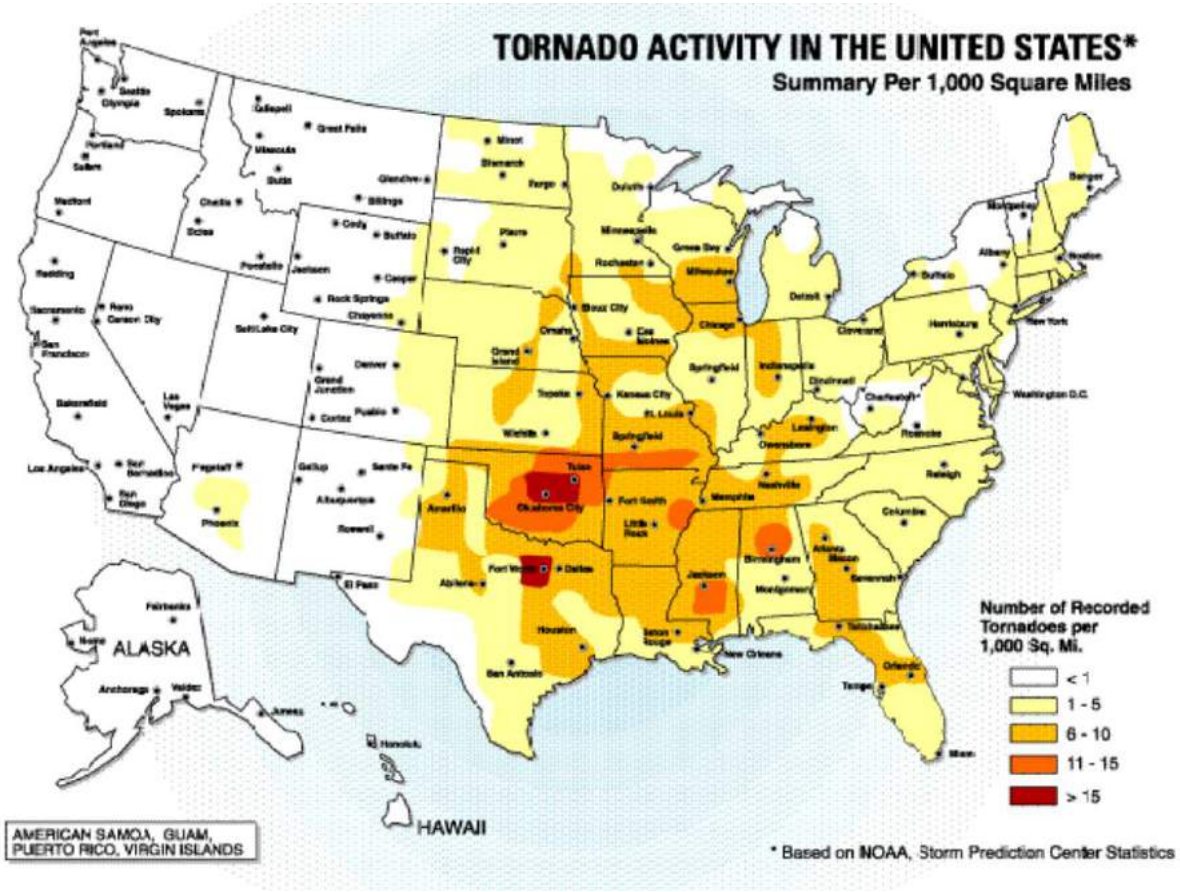
4.9.1 Background

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 (but sometimes result from hurricanes and other tropical storms) 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 National Weather Service, tornado wind speeds normally range from 40 miles per hour to more than 300 miles per hour. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles. Similar to tornadoes, waterspouts have most of the same characteristics of a tornado except that they occur over water instead of land. Indeed land-based tornadoes can turn into waterspouts as they move out over a water body and vice versa.

Each year, an average of over 800 tornadoes are reported nationwide, resulting in an average of 80 deaths and 1,500 injuries.[7] According to the NOAA Storm Prediction Center (SPC), the highest concentration of tornadoes in the United States has been in Oklahoma, Texas, Kansas, and Florida respectively. Although the Great Plains region of the Central United States does favor the development of the largest and most dangerous tornadoes (earning the designation of "tornado alley"), Florida experiences the greatest number of tornadoes per square mile of all U.S. states (SPC, 2002). Comparatively, South Carolina ranks twenty-fourth in the nation for frequency. **Figure 4.5** shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles.

[7] NOAA, 2007.

Figure 4.5: Tornado Activity in the United States



Source: Federal Emergency Management Agency

Tornadoes are more likely to occur during the months of March through May and 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 several miles long.

The destruction caused by tornadoes ranges from light to inconceivable depending on the intensity, size and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, including residential dwellings (particularly mobile homes). Tornadic magnitude is reported according to the Fujita and Enhanced Fujita Scales. Tornado magnitudes prior to 2005 were determined using the traditional version of the Fujita Scale (**Table 4.9**). Tornado magnitudes that were determined in 2005 and later were determined using the Enhanced Fujita Scale (**Table 4.10**).

Table 4.9: The Fujita Scale (Effective Prior to 2005)

F-SCALE NUMBER	INTENSITY	WIND SPEED	TYPE OF DAMAGE DONE
F0	GALE TORNADO	40–72 MPH	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
F1	MODERATE TORNADO	73–112 MPH	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	SIGNIFICANT TORNADO	113–157 MPH	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	SEVERE TORNADO	158–206 MPH	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	DEVASTATING TORNADO	207–260 MPH	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	INCREDIBLE TORNADO	261–318 MPH	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.
F6	INCONCEIVABLE TORNADO	319–379 MPH	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies.

Source: National Weather Service

Table 4.10: The Enhanced Fujita Scale (Effective 2005 and Later)

EF-SCALE NUMBER	INTENSITY PHRASE	3 SECOND GUST (MPH)	TYPE OF DAMAGE DONE
F0	GALE	65–85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
F1	MODERATE	86–110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	SIGNIFICANT	111–135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	SEVERE	136–165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	DEVASTATING	166–200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	INCREDIBLE	Over 200	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.

Source: National Weather Service

4.9.2 Location and Spatial Extent

Tornadoes occur throughout the state of South Carolina and the state as a whole experienced an average of 29 tornadoes per year in the period from 1990 to 2013.[8] Tornadoes typically impact a relatively small area; however, events are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Myrtle Beach is uniformly exposed to this hazard.

Historical evidence shows that all of Myrtle Beach is vulnerable to tornadic activity. This hazard can result from severe thunderstorm activity or may occur during a hurricane or major tropical storm. In fact, historical evidence shows more frequent tornado point locations on the Myrtle Beach coastline. However, it cannot be predicted where a tornado may touch down, so all buildings and facilities are considered to be exposed to this hazard and could potentially be impacted.

[8] South Carolina Department of Natural Resources, https://www.dnr.sc.gov/climate/sco/ClimateData/cli_table_tornado_stats.php

4.9.3 Historical Occurrences

According to the National Climatic Data Center, there have been a total of four (4) recorded tornado/waterspout events in Myrtle Beach since 1979, however it should be noted that two of these events were located far off the coast and did not come ashore or cause major damage (**Table 4.11**).[9] Thirty-nine injuries were reported as a result of a tornado event in 2001, and over $11 million in property damages resulted from all tornado events. The magnitude of these tornadoes ranges from F0 to F2 in intensity, with approximate touchdown locations for each major event where damage occurred shown in **Figure 4.6**. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is possible that a number of occurrences have gone unreported.

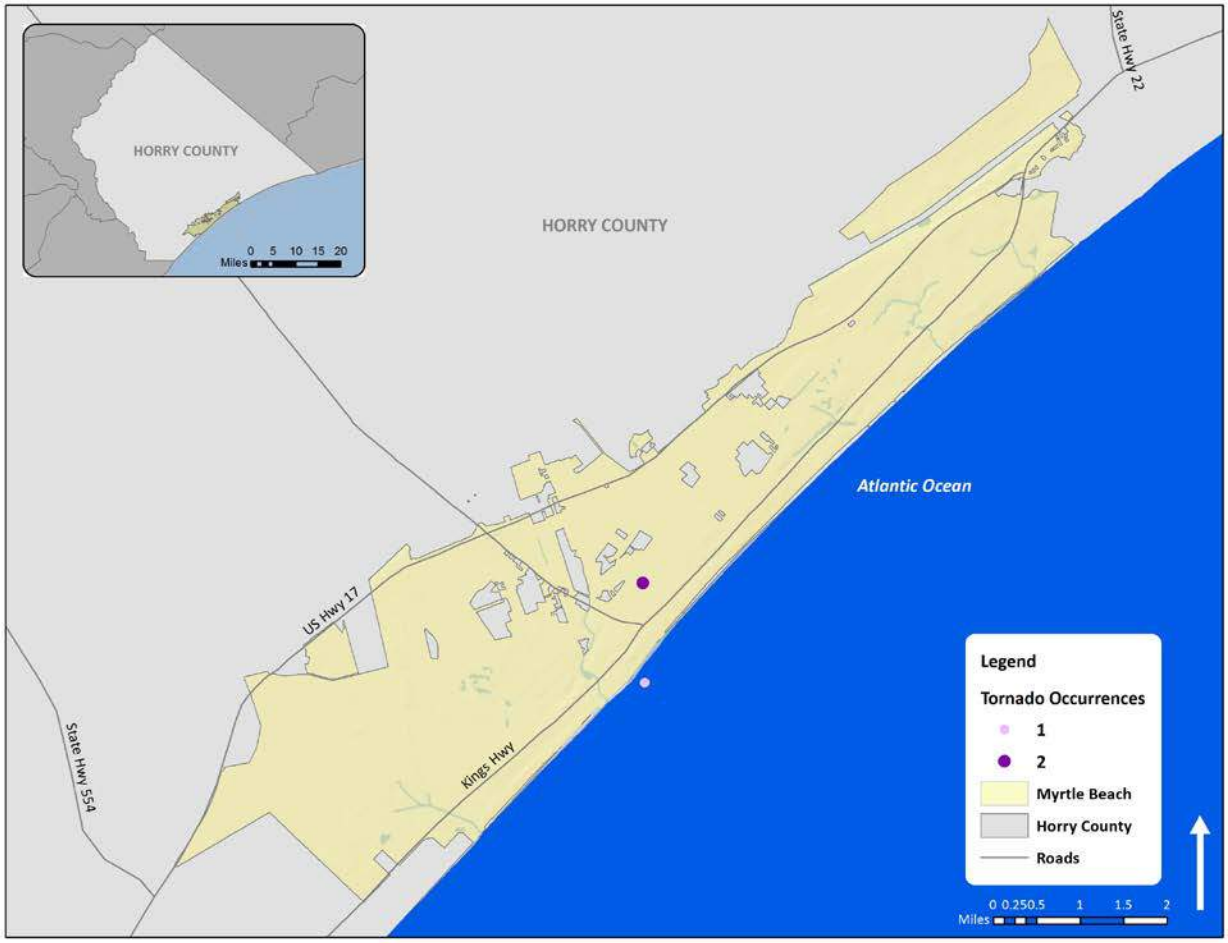
Table 4.11: Historical Tornado/Waterspout Impacts

Location	Date	Magnitude	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	09/04/1979	F1	0/0	$854,070	*Not Available*
Myrtle Beach	07/23/1996	*waterspout*	0/0	$0	Two waterspouts sighted off Myrtle Beach dissipated before coming ashore. No injuries or damage.
Myrtle Beach	07/24/1997	*waterspout*	0/0	$0	Waterspout reported over the ocean just off Myrtle Beach
Myrtle Beach	07/06/2001	F2	0/39	$10,691,502	An F0 tornado briefly touched down at 9th Ave N near the Myrtle Beach Pavilion, and soon after a waterspout formed just off the beach near 3rd Ave N. It slightly damaged the 2nd Ave N pier and then moved over the beach as it developed more strongly, causing F2 damage - overturned buses and extensive damage to vehicles and hotels along the beach to about 4th Ave S. Moving off the beach again, the waterspout continued south about 100 yards from the shore until it came ashore between 28th Ave S and Springmaid Pier, causing a 66 knot gust over water at the Springmaid Pier anemometer. As it moved through the Seagate RV park, it did F1 damage, destroyed 10 RVs and damaged 40 more. Weakening further, the tornado crossed US Hwy Business 17 onto Myrtle Beach International Airport, doing F0 damage to trees and structures.

** This event was reported by the City of Myrtle Beach.*
Source: NCDC

[9] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is possible that additional tornadoes have occurred in the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

Figure 4.6: Locations of Historical Tornado/Waterspout Events in Myrtle Beach



Source: NCDC

4.9.4 Probability of Future Occurrences

The probability of future tornado occurrences affecting Myrtle Beach is possible. According to historical records, Horry County experiences an average of nearly 0.85 confirmed tornado touchdowns every year, while Myrtle Beach experiences a tornadic event roughly every 9 years, on average. While the majority of these events are small in terms of size, intensity and duration, they do pose a significant threat should the City of Myrtle Beach experience a direct tornado strike.

4.10 TROPICAL STORM SYSTEM/HURRICANE

4.10.1 Background

Hurricanes and tropical storms are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. A tropical cyclone refers to any such circulation that develops over tropical waters. Tropical

cyclones act as a "safety-valve," limiting the continued build-up of heat and energy in tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole-ward latitudes. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation, and tornadoes. Coastal areas are also vulnerable to the additional forces of storm surge, wind-driven waves and tidal flooding which can be 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. The majority of 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 in early to mid-September and the average number of storms that reach hurricane intensity per year in this basin is about six (6).

As an incipient hurricane develops, barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. Hurricane intensity is further classified by the Saffir-Simpson Scale (**Table 4.12**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table 4.12: Saffir-Simpson Scale

Category	Maximum Sustained Wind Speed (MPH)	Minimum Surface Pressure (Millibars)	Storm Surge (Feet)
1	74–95	Greater than 980	3–5
2	96–110	979–965	6–8
3	111–130	964–945	9–12
4	131–155	944–920	13–18
5	155 +	Less than 920	19+

Source: National Hurricane Center

The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure and storm surge potential, which are combined to estimate potential damage. Categories 3, 4, and 5 are classified as "major" hurricanes, and while hurricanes within this range comprise only 20 percent of total tropical cyclone landfalls, they account for over 70 percent of the damage in the United States. **Table 4.13** describes the damage that could be expected for each category of hurricane. Damage during hurricanes may also result from spawned tornadoes, storm surge, and inland flooding associated with heavy rainfall that usually accompanies these storms.

Table 4.13: Hurricane Damage Classifications

Storm Category	Damage Level	Description of Damages	Photo Example
1	MINIMAL	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage.	
2	MODERATE	Some roofing material, door, and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected moorings may break their moorings.	
3	EXTENSIVE	Some structural damage to small residences and utility buildings, with a minor amount of curtainwall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures, with larger structures damaged by floating debris. Terrain may be flooded well inland.	
4	EXTREME	More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.	
5	CATASTROPHIC	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.	

Sources: National Hurricane Center; Federal Emergency Management Agency

4.10.2 Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States, and while coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland. The City of Myrtle Beach is located in a region of the country that is susceptible to all of the hazards wrought by hurricanes and tropical storms. All areas throughout the City are susceptible to the accompanying hazard effects of extreme wind, flooding and tornadoes, and coastal areas are also extremely susceptible to the added effects of storm surge, wave action, coastal erosion, and tidal flooding.[10]

4.10.3 Historical Occurrences

According to NOAA historical storm track records, seventy-six (76) hurricane or tropical storm tracks have passed within 75 miles of the City of Myrtle Beach since 1850. This includes: zero (0) Category 5 hurricanes; four (4) Category 4 hurricanes; three (3) Category 3 hurricanes; eight (8) Category 2 hurricanes; twenty-four (24) Category 1 hurricanes; fifty-one (51) tropical storms; and twenty-eight (28) tropical depressions. Of the 118 recorded storm events, 6 had tracks that traversed directly through Myrtle Beach including one Category 2 hurricane and six tropical storms. **Table 4.14** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of the City of Myrtle Beach) and Category of the storm based on the Saffir-Simpson Scale. **Figure 4.7** shows the track of each recorded storm in relation to the City of Myrtle Beach and South Carolina.

[10] Distinct hazard area locations for flooding, storm surge, wave action and coastal erosion are discussed elsewhere in this section.

Table 4.14: Historical Storm Tracks within 75 Miles of Myrtle Beach (1850–2009)

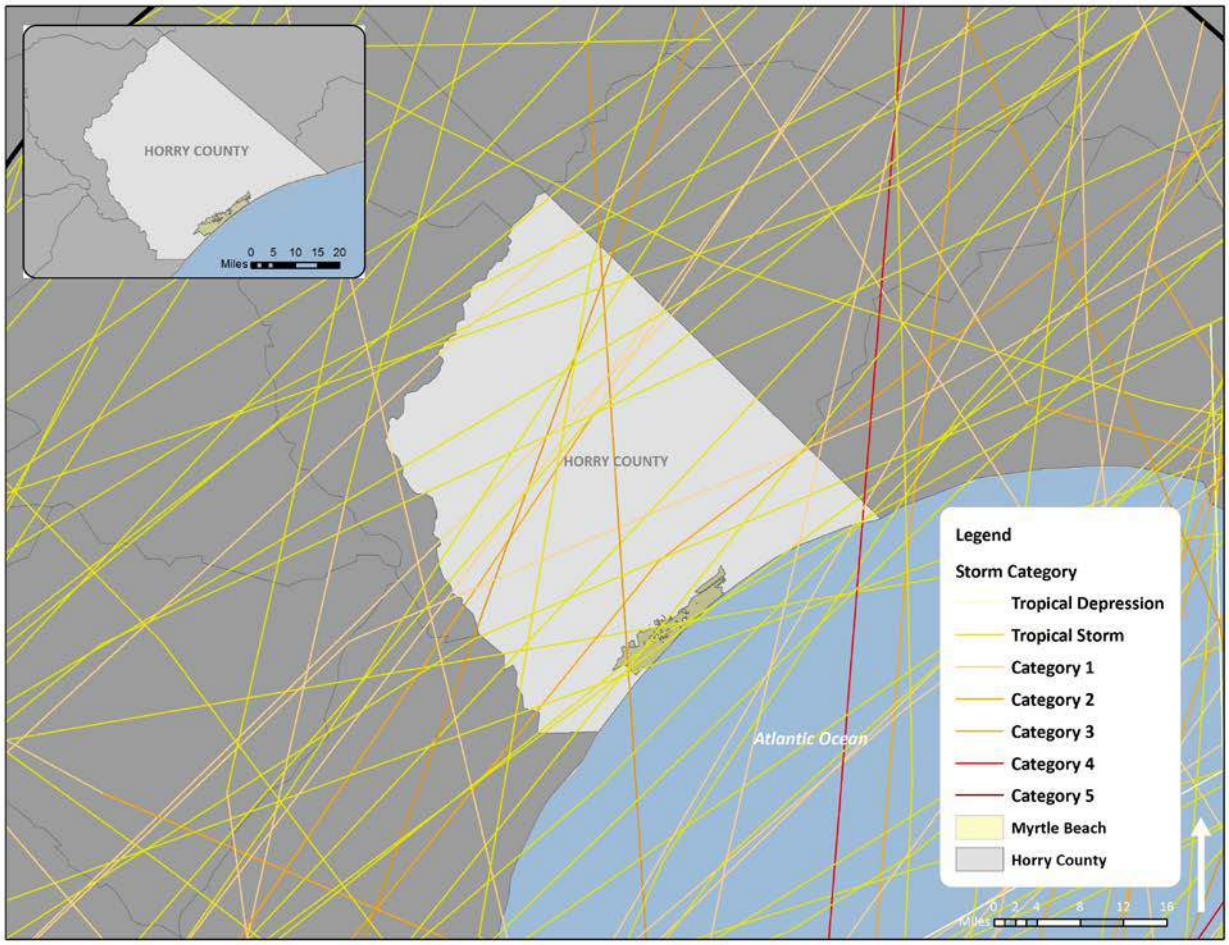
Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
08/24/1851	Not Named	60	Tropical Storm
8/28/1852	Not Named	45	Tropical Storm
10/10/1882	Not Named	60	Tropical Storm
9/1/1856	Not Named	60	Tropical Storm
9/12/1857	Not Named	90	Category 1
9/27/1861	Not Named	80	Category 1
9/18/1863	Not Named	70	Tropical Storm
6/22/1867	Not Named	80	Category 1
10/5/1868	Not Named	45	Tropical Storm
8/29/1871	Not Named	45	Tropical Storm
10/6/1871	Not Named	45	Tropical Storm
10/24/1872	Not Named	80	Category 1
9/20/1873	Not Named	70	Tropical Storm
9/28/1874	Not Named	90	Category 1
9/17/1876	Not Named	90	Category 1
9/12/1878	Not Named	90	Category 1
9/9/1881	Not Named	105	Category 2
10/12/1882	Not Named	80	Category 1
9/11/1883	Not Named	105	Category 2
8/25/1885	Not Named	105	Category 2
7/1/1886	Not Named	50	Tropical Storm
10/20/1887	Not Named	30	Tropical Depression
10/11/1888	Not Named	70	Tropical Storm
06/16/1893	Not Named	60	Tropical Storm
10/4/1893	Not Named	45	Tropical Storm
10/13/1893	Not Named	120	Category 3
9/27/1894	Not Named	80	Category 1
10/9/1894	Not Named	70	Tropical Storm
9/29/1896	Not Named	100	Category 2
9/22/1897	Not Named	65	Tropical Storm
10/31/1899	Not Named	110	Category 2
10/12/1900	Not Named	35	Tropical Depression
7/12/1901	Not Named	40	Tropical Storm
9/18/1901	Not Named	40	Tropical Storm
9/14/1904	Not Named	80	Category 1
11/4/1904	Not Named	35	Tropical Depression
9/17/1906	Not Named	90	Category 1
6/29/1907	Not Named	65	Tropical Storm
9/29/1907	Not Named	40	Tropical Storm
7/31/1908	Not Named	80	Category 1
10/23/1908	Not Named	35	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
8/28/1910	Not Named	40	Tropical Storm
10/20/1910	Not Named	70	Tropical Storm
10/8/1913	Not Named	75	Category 1
5/16/1916	Not Named	35	Tropical Depression
7/14/1916	Not Named	85	Category 1
9/5/1916	Not Named	40	Tropical Storm
9/22/1920	Not Named	80	Category 1
9/16/1924	Not Named	45	Tropical Storm
9/30/1924	Not Named	55	Tropical Storm
9/18/1928	Not Named	70	Tropical Storm
9/15/1932	Not Named	40	Tropical Storm
7/21/1934	Not Named	45	Tropical Storm
10/8/1941	Not Named	60	Tropical Storm
8/1/1944	Not Named	90	Category 1
10/20/1944	Not Named	50	Tropical Storm
6/25/1945	Not Named	70	Tropical Storm
9/17/1945	Not Named	45	Tropical Storm
7/5/1946	Not Named	45	Tropical Storm
11/3/1946	Not Named	20	Tropical Depression
9/24/1947	Not Named	30	Tropical Depression
9/27/1953	Florence	35	Tropical Depression
10/15/1954	Hazel	140	Category 4
8/17/1955	Diane	85	Category 1
9/26/1956	Flossy	35	Tropical Depression
6/9/1957	Not Named	50	Tropical Storm
9/27/1958	Helene	130	Category 4
7/9/1959	Cindy	75	Category 1
7/30/1960	Brenda	60	Tropical Storm
9/12/1960	Donna	110	Category 2
9/14/1961	Not Named	30	Tropical Depression
9/13/1964	Dora	50	Tropical Storm
6/11/1966	Alma	45	Tropical Storm
6/17/1967	Not Named	0	Tropical Depression
6/10/1968	Abby	25	Tropical Depression
10/20/1968	Gladys	85	Category 1
10/19/1968	Gladys	75	Category 1
8/17/1970	Not Named	30	Tropical Depression
9/10/1971	Not Named	25	Tropical Depression
6/21/1972	Agnes	30	Tropical Depression
7/12/1972	Not Named	25	Tropical Depression
9/14/1972	Dawn	30	Tropical Depression
6/28/1975	Amy	25	Tropical Depression
10/26/1975	Hallie	40	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
8/20/1976	Dottie	40	Tropical Storm
9/15/1976	Subtrop:Not Named	35	Tropical Depression
9/6/1977	Clara	25	Tropical Depression
7/3/1981	Not Named	25	Tropical Depression
8/20/1981	Dennis	60	Tropical Storm
6/19/1982	Subtrop:Not Named	60	Tropical Storm
9/12/1984	Diana	130	Category 4
11/22/1985	Kate	60	Tropical Storm
9/7/1987	Not Named	30	Tropical Depression
9/22/1989	Hugo	140	Category 4
7/20/1994	Not Named	30	Tropical Depression
11/21/1994	Gordon	20	Tropical Depression
6/6/1995	Allison	40	Tropical Storm
6/19/1996	Arthur	45	Tropical Storm
7/12/1996	Bertha	105	Category 2
9/5/1996	Fran	115	Category 3
10/8/1996	Josephine	45	Tropical Storm
8/26/1998	Bonnie	115	Category 3
9/4/1998	Earl	50	Tropical Storm
9/16/1999	Floyd	105	Category 2
10/17/1999	Irene	80	Category 1
9/19/2000	Gordon	25	Tropical Depression
9/23/2000	Helene	25	Tropical Depression
6/13/2001	Allison	25	Tropical Depression
10/11/2002	Kyle	40	Tropical Storm
8/13/2004	Bonnie	25	Tropical Depression
8/14/2004	Charley	75	Category 1
8/29/2004	Gaston	75	Category 1
9/14/2005	Ophelia	75	Category 1
9/1/2006	Ernesto	60	Tropical Storm
6/3/2007	Barry	40	Tropical Storm
7/19/2008	Cristobal	45	Tropical Storm
9/6/2008	Hanna	60	Tropical Storm
5/30/2012	Beryl	40	Tropical Storm

Source: National Oceanic and Atmospheric Administration

Figure 4.7: Historical Hurricane Storm Tracks within 75 Miles of the City of Myrtle Beach



Source: National Oceanic and Atmospheric Administration

Some of the more notable historical tropical cyclone events for the City of Myrtle Beach are described below (Information from National Climatic Data Center, National Weather Service, and National Hurricane Center):

Hurricane Hazel, 1954

According to the National Hurricane Center, Hurricane Hazel, a Category 4 storm, was the last hurricane to directly hit the City of Myrtle Beach. Myrtle Beach, South Carolina reported a peak wind gust of 106 mph, and winds were estimated at 130 to 150 mph along the coast between Myrtle Beach and Cape Fear, North Carolina. The storm hit at the highest lunar tide of the year, resulting in increased storm surge and damage. It downed countless trees along the coast. (In fact, so many trees were downed that Hazel is said to have started Myrtle Beach as a tourist destination, clearing the land for golf course and condominium development.) Further, 80 percent of the buildings along the Myrtle Beach coast were destroyed. Hazel was responsible for 95 deaths and $2.3 billion in damages in the United States and $1.1 billion for the Carolinas. In South Carolina, 19 people were killed and over 200 were injured, in addition to the 15,000 homes being destroyed.

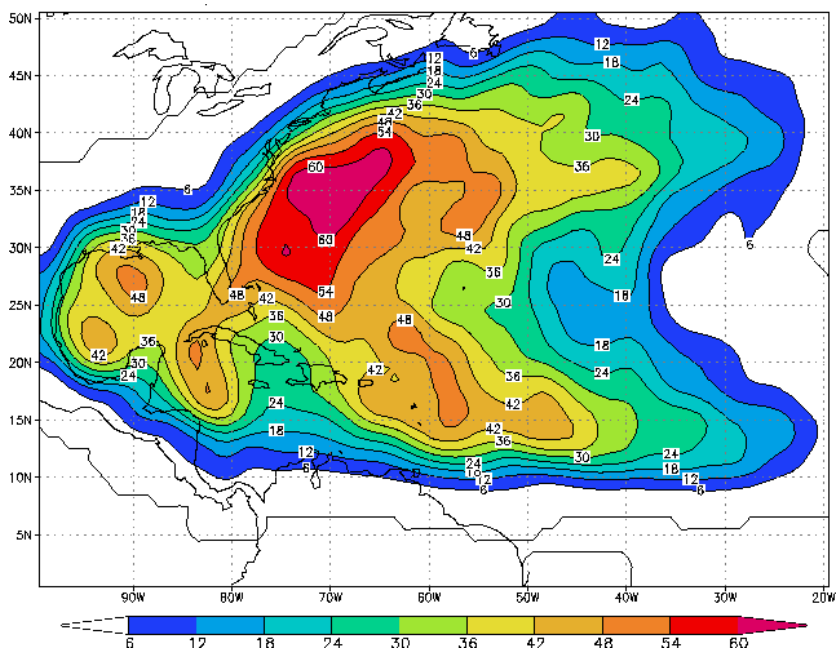
Hurricane Hugo 1989 (indirect hit)

Hurricane Hugo, a Category 4 storm, reached Myrtle Beach on September 22, 1989. It caused 57 deaths in the U.S. and over $7 billion in damages (1989 dollars) - $6 million in Myrtle Beach alone. Up to that time, it was the costliest storm in history (later surpassed by Andrew and Katrina).

4.10.4 Probability of Future Occurrences

The probability of future hurricane and tropical storm events for the City of Myrtle Beach is likely. According to NOAA statistical data, the city is located in an area with an annual probability of a named storm between 48 and 54 percent as presented in **Figure 4.8**. This illustration was created by the National Oceanic and Atmospheric Administration's Hurricane Research Division using data from 1944 to 1999 and counting hits when a storm or hurricane was within approximately 100 miles (165 km) of each location. As a reference point, the tip of Florida's outline can be found near the 25N, 80W intersection, and Myrtle Beach is near the 35N, 85W intersection. This empirical probability is fairly consistent with other scientific studies and observed historical data made available through a variety of federal, state, and local sources.

Figure 4.8: Empirical Probability of a Named Hurricane or Tropical Storm



Source: National Oceanic and Atmospheric Administration

The probability of storm occurrences will vary significantly based on the return interval for different categories of magnitude. The probability of less intense storms (lower return periods) is higher than more intense storms (higher return periods). **Table 4.15** profiles the potential peak gust wind speeds that can be expected in the City of Myrtle Beach during a hurricane event for various return periods according to FEMA's HAZUS-MH®.

Table 4.15: Potential Peak Gust Wind Speeds per Return Period

10-Year	20-Year	50-Year	100-Year	200-Year	500-Year	1,000-Year
65.3 mph	81.1 mph	102.1 mph	114.2 mph	124.7 mph	136.8 mph	145.0

Source: Federal Emergency Management Agency (Hazus-MH 2.2)

GEOLOGIC HAZARDS

4.11 EARTHQUAKE

4.11.1 Background

An earthquake is movement 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 damage to property measured in the tens of billions of dollars, 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, site, and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses the ability to resist shear and flows much like quick sand. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

Most earthquakes are caused by the release of stresses accumulated as a result 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. 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. Magnitude is measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude (**Table 4.16**). 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). A detailed description of the Modified Mercalli Intensity Scale of earthquake intensity and its correspondence to the Richter Scale is given in **Table 4.17**.

Table 4.16: Richter Scale

RICHTER MAGNITUDES	EARTHQUAKE EFFECTS
< 3.5	Generally not felt, but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.4 - 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 - 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 - 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or >	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: Federal Emergency Management Agency

Table 4.17: Modified Mercalli Intensity Scale for Earthquakes

SCALE	INTENSITY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER SCALE MAGNITUDE
I	INSTRUMENTAL	Detected only on seismographs.	
II	FEEBLE	Some people feel it.	< 4.2
III	SLIGHT	Felt by people resting; like a truck rumbling by.	
IV	MODERATE	Felt by people walking.	
V	SLIGHTLY STRONG	Sleepers awake; church bells ring.	< 4.8
VI	STRONG	Trees sway; suspended objects swing, objects fall off shelves.	< 5.4
VII	VERY STRONG	Mild alarm; walls crack; plaster falls.	< 6.1
VIII	DESTRUCTIVE	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged.	
IX	RUINOUS	Some houses collapse; ground cracks; pipes break open.	< 6.9
X	DISASTROUS	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread.	< 7.3
XI	VERY DISASTROUS	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards.	< 8.1
XII	CATASTROPHIC	Total destruction; trees fall; ground rises and falls in waves.	> 8.1

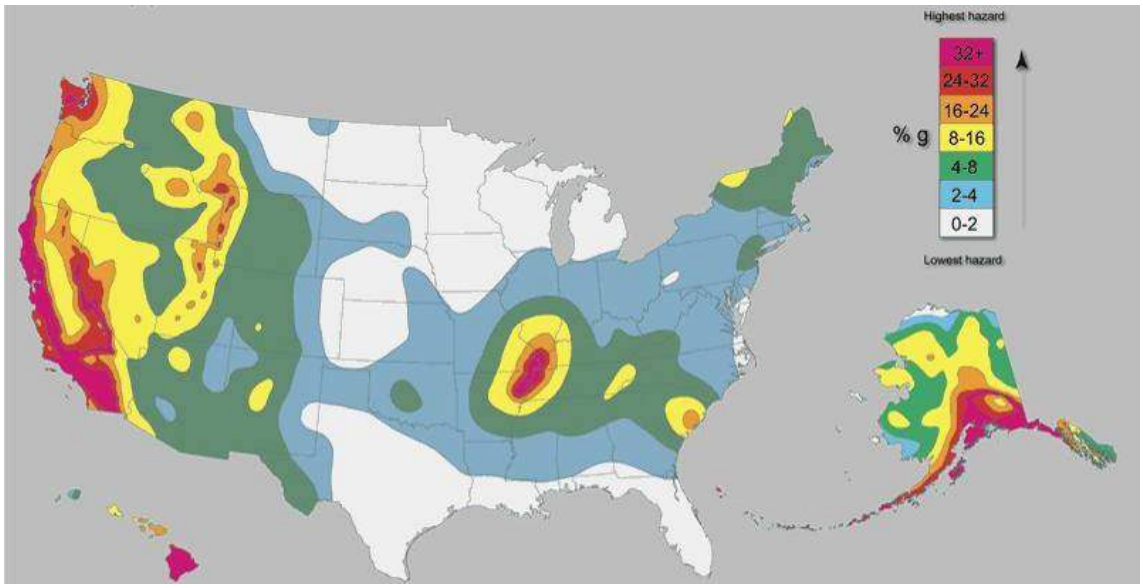
Source: Federal Emergency Management Agency

4.11.2 Location and Spatial Extent

The greatest earthquake threat in the United States is along tectonic plate boundaries and seismic fault lines located in the central and western states; however, the East Coast does face moderate risk to less

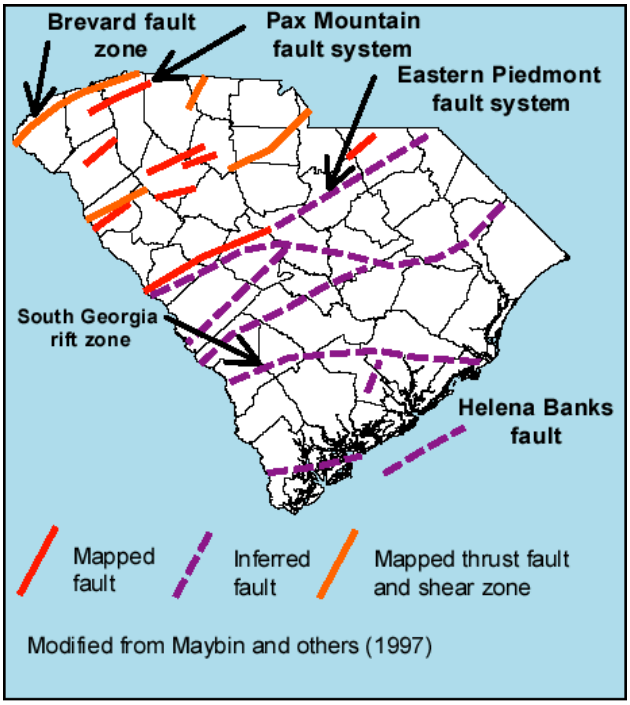
frequent, less intense earthquake events. **Figure 4.9** shows relative seismic risk for the United States and **Figure 4.10** shows the fault lines in South Carolina.

Figure 4.9: United States Earthquake Hazard Map



Source: United States Geological Survey

Figure 4.10: Fault Lines in South Carolina



Source: http://www.dnr.sc.gov/geology/earthquake.htm[11]

[11] Maybin, A.H., Clendenin, C.W., Jr., Assisted by Daniels, D.L., 1998, Structural features map of South Carolina: South Carolina Geological Survey General Geologic Map Series, 1p.

4.11.3 Historical Occurrences

According to the National Geophysical Data Center (NGDC), only one significant earthquake has occurred in South Carolina - the Charleston Earthquake of 1886. During this event, Horry County experienced a magnitude of VI (Strong) on the Modified Mercalli Intensity (MMI) Scale. There have also been three notable earthquakes as identified by the NGDC in **Table 4.18.** Although there have been more than two hundred minimal earthquakes reported in South Carolina since 2001, none of these events caused any significant damage and many were not even strong enough to be felt by people.

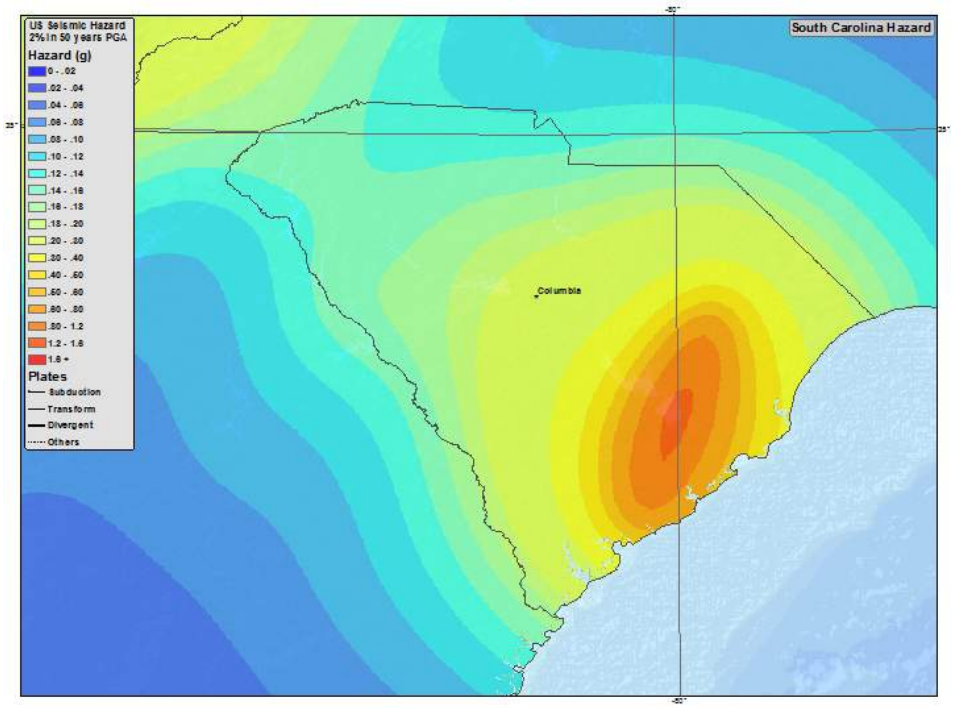
Table 4.18 Historical Earthquakes Experienced in Myrtle Beach

Location	Date	Magnitude (MMI)
Myrtle Beach	3/12/1960	4
Myrtle Beach AFB	2/3/1972	5
Myrtle Beach	11/22/1974	5

4.11.4 Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting the City of Myrtle Beach is unlikely. According to the United States Geological Survey (USGS), Myrtle Beach resides in an area with a moderate seismic risk (**Figure 4.11**). This risk is for earthquakes resulting in light to moderate perceived shaking and damages ranging from very light to moderate. More destructive earthquakes are very rare, low probability events for Myrtle Beach.

Figure 4.11: Seismic Hazard Map for South Carolina



Source: USGS

4.12 TIDAL WAVE/TSUNAMI

4.12.1 Background

A tsunami is a series of great waves that are created by undersea disturbances such as earthquakes or volcanic eruptions. From the area of disturbance, tsunami waves will travel outward in all directions. Tsunamis can originate hundreds or even thousands of miles away from coastal areas.

The time between wave crests may be five to ninety minutes and the open ocean wave speed may average 450 miles per hour. As tsunami waves approach shallow coastal waters, they appear normal in size and the speed decreases until the waves near the shoreline, where it may grow to great height and crash into the shore. Areas at greatest risk are less than 50 feet above sea level and within one mile of the shoreline. Rapid changes in the ocean water level may indicate that a tsunami is approaching. Most deaths during a tsunami are the result of drowning. Associated risks include flooding, polluted water supplies, and damaged gas lines.

4.12.2 Location and Spatial Extent

In the United States, tsunamis have historically affected the West Coast, but the threat of tsunami inundation is also possible on the Atlantic Coast. Pacific Ocean tsunamis are classified as local, regional, or Pacific-wide. Regional tsunamis are most common. While Pacific-wide tsunamis are much less common, with the last one being recorded in 1964, they tend to generate larger waves, which can cause significant destruction.

Two offshore areas are currently under investigation according to a 2002 National Geophysical Data Center report. One area of interest consists of large cracks northeast of Cape Hatteras that could signal the early stages of an underwater landslide that could result in a tsunami. The other area of interest consists of submarine canyons approximately 150 kilometers from Atlantic City, New Jersey. A significant factor for consideration with regard to these areas is recent discoveries along the East Coast that demonstrate the existence of pressurized hydrates and pressurized water layers in the continental shelf. This has produced speculation among the scientific community on possible triggers that could cause sudden and perhaps violent releases of compressed material that may cause landslides and tsunami waves.

Figure 4.12 depicts a scenario presented in the Horry County Emergency Operations Plan that estimates what could happen if an earthquake of 9.0M were to occur in the Puerto Rico Trench. This model was developed by the NOAA Tsunami Warning Center. The areas affected by the tsunami are shown in blue. This includes many highways out to Highway 17/Kings Highway.

Figure 4.12: Tsunami Hazard Map for South Carolina

4.12.3 Historical Occurrences

There is only one historical tsunami event reported to have directly affected the state of South Carolina. This event occurred in Cooper River, as a result of the 1886 Charleston Earthquake. However, as many as 40 tsunamis and tsunami-like waves have been documented in the Eastern United States since 1600. Tsunami events along the East Coast are not the result of traditional sources of tsunami waves (i.e., subduction zones such as the Cascadia Subduction Zone), but rather are typically the result of slumping or landsliding associated with local earthquakes or with wave action associated with strong storms such as hurricanes. Other possible causes of tsunami-like activity along the East Coast could include explosive decompression of underwater methane deposits, the impact of a heavenly body (i.e., an asteroid, comet, or oceanic meteor splashdown) or a large underwater explosion. One significant contributing factor to tsunami-related damage is the massive amount of moving debris possible during a tsunami event—including manmade debris such as boats and on-shore debris as the tsunami strikes land.

To cite one commonly referenced example in terms of Atlantic tsunamis, a severe earthquake registering 7.2 on the Richter Scale on November 18, 1929 in the Grand Banks of Newfoundland

generated a tsunami that caused considerable damage and loss of life at Placentia Bay, Newfoundland and is also known to have impacted the New England and mid-east shoreline.

4.12.4 Probability of Future Occurrences

It is unlikely that a tidal wave or tsunami will occur in Myrtle Beach based on historic occurrences which have been few. However, some recent research into the potential for future tsunamis has shown that there is some chance of one occurring, albeit as a result of possibly different causes than most Pacific-based tsunamis. As noted by the National Geophysical Data Center, possible causes of Atlantic-based tsunamis include methane/pressurized water deposits, and volcanic landslides. Indeed, some recent studies of past tsunamis along the east coast of the United States have revealed that some Atlantic tsunamis may have caused waves of around 3 meters in height.[12] That said, although a tsunami could impact the coastal United States, the relative infrequency of past events seems to indicate that the likelihood of such events is fairly low, especially when compared to other hazards that might impact the jurisdiction.

HYDROLOGIC HAZARDS

4.13 EROSION

4.13.1 Background

Erosion is a hydrologic hazard defined as the wearing away of land; loss of beach, shoreline, or dune material. It is measured as the rate of change in the position or horizontal (landward) displacement of a shoreline over a period of time. Short-term erosion typically results from episodic natural events such as hurricanes and storm surge, windstorms and flooding hazards, but may be exacerbated by human activities such as boat wakes, removal of dune and vegetative buffers, shoreline hardening, and dredging. Long-term erosion is a function of multi-year impacts such as wave action, sea level rise, sediment loss, subsidence, and climate change. Climatic trends can change a beach from naturally accreting to eroding due to increased episodic erosion events caused by waves from an above-average number of storms and high tides, or the long-term effects of fluctuations in sea level.

Natural recovery from erosion can take years to decades. If a beach and dune system does not recover quickly enough naturally, coastal and upland property may be exposed to further damage in subsequent coastal erosion and flooding events. Human actions to supplement natural coastal recovery, such as beach nourishment, dune stabilization, and shoreline protection structures (e.g., sea walls, groins, jetties, etc.) can mitigate the hazard of coastal erosion.

Death and injury are not associated with coastal erosion; however, it can cause the destruction of buildings and infrastructure and represents a major threat to the local economies of coastal communities that rely on the financial benefits of recreational beaches.

4.13.2 Location and Spatial Extent

[12] Tsunamis and Tsunami-Like Waves of the Eastern United States (2002), Science of Tsunami Hazards (Patricia A. Lockridge, Lowell S. Whiteside, and James F. Lander)

All of the coastal areas in Myrtle Beach are susceptible to the coastal erosion hazard. These areas are subject to repeated, episodic coastal erosion events that threaten public and private property. However, the City replenishes the sand lost to coastal erosion through renourishment projects.

4.13.3 Historical Occurrences

According to the National Climatic Data Center, there has been one event with reported coastal erosion impacts in Myrtle Beach since 1995, as shown in **Table 4.19**.[13] In addition, Hurricane Hazel (1954) reportedly caused 990,000 cubic yards of beach erosion. Because the erosion event was part of other hazard events (i.e., a hurricane), the monetary damage for the erosion alone is unknown.

Table 4.19: Historical Coastal Erosion Impacts

Location	Date	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach (surrounding areas presumed)	1989	0/0	$0	Hurricane Hugo caused extensive beach erosion.
Beaufort, Charleston, Georgetown, Horry, Jasper, and Colleton Counties	08/14/1995	0/0	$0	Minor coastal flooding and beach erosion associated with Hurricane Felix as it moved just off the Atlantic Coast.

Source: NCDC

The severity of coastal erosion is typically measured through a quantitative assessment of annual shoreline change for a given beach cross-section of profile (feet or meters per year) over a long period of time. Erosion rates vary as a function of shoreline type and are influenced primarily by episodic events, but can be used in land use and hazard management to define areas of critical concern. According to a study prepared by the Heinz Center, much of the Grand Strand, including Myrtle Beach, experiences an average of two to three feet of erosion per year.[14] However, more recent data from the Department of Health and Environmental Control in 2010 suggests that the erosion rate at all survey monuments in Myrtle Beach (station 5300 to 5505) is -0.59 feet per year.[15]

Shortly after Hurricane Hugo, the City of Myrtle Beach began large scale beach renourishment projects to mitigate erosion.[16] Despite aforementioned rates of erosion, Myrtle Beach has made a commitment to beach renourishment. Sand is mined from offshore to replenish area beaches. It is projected that such projects will be necessary every 8 - 10 years in the city.

4.13.4 Probability of Future Occurrences

[13] The reported erosion event is only inclusive of that reported by the National Climatic Data Center (NCDC). Additional erosion events have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.
[14] "Evaluation of Erosion Hazards" prepared by The H. John Heinz III Center for Science, Economics and the Environment, April 2000. www.heinzctr.org/NEW_WEB/PDF/erosnrpt.pdf#pagemode=bookmarks&view=Fit
[15] South Carolina Department of Health and Environmental Control, 2010.
[16] Schwab, William, *et. al*. "Coastal Change Along the Shore of Northeastern South Carolina – The South Carolina Coastal Erosion Study." United State Geological Survey, Circular 1339: 2009. http://pubs.usgs.gov/circ/circ1339/pdf/circular1339.pdf

Coastal erosion remains a natural, dynamic, and continuous process for the city's coastal areas and its probability of occurrence is highly likely. The damaging impacts of coastal erosion are lessened through continuous beach nourishment and structural shoreline protection measures; however, it is likely that the impacts of coastal erosion will increase in severity due to future episodic storm events as well as the anticipated slow onset, long-term effects of climate change and sea level rise (further discussed in the next section under *Flood*). Given the City's long-term commitment to beach nourishment to mitigate erosion, no further analysis is performed in Section 5: *Vulnerability Assessment.*

4.14 FLOOD

4.14.1 Background

Flooding is the most frequent and costly natural hazard in the United States; a hazard that has caused more than 10,000 deaths since 1900. Nearly 90 percent of presidential disaster declarations result from natural events where flooding was a major component.

Floods generally result from excessive precipitation and can be classified under two categories: general floods, precipitation over a given river basin for a long period of time along with storm-induced wave, or tidal action; and flash floods, the product of heavy localized precipitation in a short time period over a given location. The severity of a flooding event is typically determined by a combination of several major factors, including: stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing and impervious surface.

General floods are usually long-term events that may last for several days. The primary types of general flooding include riverine, coastal and urban flooding. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Coastal flooding is typically a result of storm surge, wind-driven waves and heavy rainfall produced by hurricanes, tropical storms, and other large coastal storms. [17] Urban flooding occurs where manmade development has obstructed the natural flow of water and decreased the ability of natural groundcover to absorb and retain surface water runoff.

Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. However, flash flooding events may also occur from a dam or levee failure within minutes or hours of heavy amounts of rainfall or from a sudden release of water held by a retention basin or other stormwater control facility. Although flash flooding occurs most often along mountain streams, it is also common in urbanized areas where much of the ground is covered by impervious surfaces.

The periodic flooding of lands adjacent to rivers, streams, and shorelines (land known as floodplain) is a natural and inevitable occurrence that can be expected to take place based upon established recurrence intervals. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval.

[17] While briefly mentioned here, coastal flooding is more thoroughly addressed under the "storm surge" hazard.

Floodplains are designated by the frequency of the flood that is large enough to cover them. For example, the 10-year floodplain will be covered by the 10-year flood and the 100-year floodplain by the 100-year flood. Flood frequencies such as the 100-year flood are determined by plotting a graph of the size of all known floods for an area and determining how often floods of a particular size occur. Another way of expressing the flood frequency is the chance of occurrence in a given year, which is the percentage of the probability of flooding each year. For example, the 100-year flood has a 1 percent chance of occurring in any given year, and the 500-year flood has a 0.2 percent chance of occurring in any given year.

4.14.2 Location and Spatial Extent

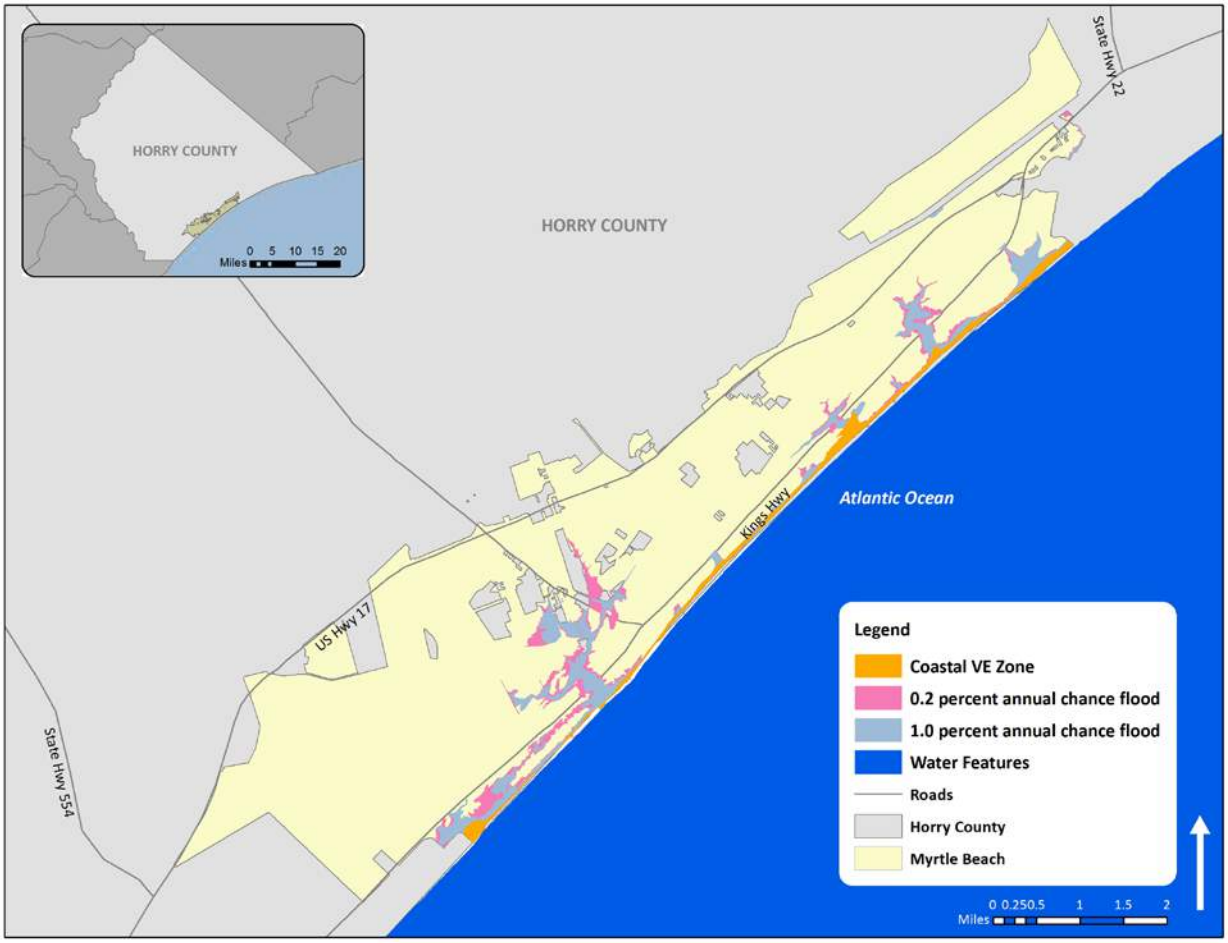
Many areas of the City of Myrtle Beach are susceptible to flooding, and its coastal areas are also very susceptible to tidal and coastal flooding due to coastal storm events including storm surge, hurricanes, tropical storms, and nor'easters.[18] Flooding from rainfall occurs along all six swashes in Myrtle Beach—Midway, Withers, Deep Head, Canepatch, Bear Branch, and Singleton—and in other low-lying areas. Flooding is exacerbated in these areas by high tides. When the discharge points of these drainage systems are blocked by a high tide, then the precipitation that has occurred upstream has nowhere to flow. Instead, the water floods low areas along natural watercourses and within the man-made storm water system. This high tide effect is apparent throughout the city since the discharge points of all drainage systems—the ocean, the swashes, and the Atlantic Intracoastal Waterway—are affected by the tides. Of these discharge points, however, the Intracoastal Waterway near the City is the least affected by the tides.

Several other areas of the City have a history of flooding. The relatively flat topography and inadequately sized drainage facilities have combined to create ponding of storm water. Many of the frequently flooded areas that were identified in the last plan update have been mitigated through various stormwater projects. As a result, there are far fewer areas of concern during this update. The primary area of concern identified during the 2015 update of the plan is around the post office on 5th Avenue N. The city is currently working on a plan to mitigate this area and is hoping to mitigate it in the next few years.

Flood areas can also be mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM). **Figure 4.13** illustrates the location and extent of currently mapped special flood hazard areas for the City of Myrtle Beach based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.[19] This includes Zones A/AE (1-percent annual chance floodplain), Zone VE (coastal floodplain associated with wave action 1.5 feet to 3.5 feet) and Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 23.39 square miles that make up Myrtle Beach, there are 1.01 square miles of land in the 1-percent annual chance floodplain, 0.45 square miles of land in the coastal floodplain, and 0.62 square miles of land in the 0.2-percent annual chance floodplain. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas.

[18] Storm surge is addressed separately within this section.
[19] The DFIRM data used for the City of Myrtle Beach was last updated in 1999.

Figure 4.13: Special Flood Hazard Areas in Myrtle Beach



Source: Federal Emergency Management Agency

4.14.3 Historical Occurrences

Information from the City of Myrtle Beach and the National Climatic Data Center were used to ascertain historical flood occurrence events. According to the city, there have been thirty-seven (37) flood events in the City of Myrtle Beach since 1954.[20, 21] The National Climatic Data Center reported ten (10) additional events in the city for a total of 47. According to the events in **Table 4.20**, there was over $1.9 million (2014 dollars) in property damage due to flood events throughout the City.

[20] The reported flood events are only inclusive of that reported by the National Climatic Data Center (NCDC). It is likely that additional flood events have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

[21] Some of these events are from a single storm or hurricane event that lasted several days.

Table 4.20: Historical Flood Impacts

Location	Date	Type	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	10/15/1954	Flooding	0/0	$0	Hurricane Hazel caused flooding in Myrtle Beach.
Myrtle Beach	10/02/1989	Flooding	0/0	$0	Kings Highway/ US 17 Bypass and Haskel Circle were closed due to 4 inches of rain in 2 hours.
Myrtle Beach	8/10/1990	Flooding	0/0	$0	Kings Highway/ US 17 Bypass was closed due to 3.01 inches of rain in 2 hours.
Myrtle Beach	08/04/1992	Flooding	0/0	$0	Kings Highway/ US 17 Bypass was closed due to 3.1 inches of rain in 2 hours
Myrtle Beach	10/07/1992	Flooding	0/0	$0	Kings Highway/ US 17 Bypass was closed due to 3.3 inches of rain in 2 hours.
Myrtle Beach	10/14/1994	Flooding	0/0	$0	Kings Highway/ US 17 Bypass and Haskel Circle were closed due to 4 inches of rain in 2 hours. In addition, backyards flooded.
Horry County*	12/22/1994	Heavy Rains/ Flooding	2/0	$217,354	Heavy rains caused considerable street flooding in Myrtle Beach. There were many traffic accidents and one apparent hit and run accident in Myrtle Beach caused a fatality. The Forest Acres Apartment Complex right on the beach was evacuated with up to 3 feet of water reported in some coastal homes. Some crop damage reported.
Myrtle Beach	12/23/1994	Flooding	0/0	$0	Rain began in the early evening and continued through the next dumping 3 inches of rain in 6 hours.
Myrtle Beach	12/24/1994	Flooding	0/0	$0	A project area was severely flooded due to 2.5 inches of rain in 6 hours.
Myrtle Beach*	06/05/1995	Flash Flood	0/0	$3,251	
Myrtle Beach*	08/24/1995	Urban Flood	0/0	$0	Heavy rains caused road closures.
Myrtle Beach	10/07/1995	Flooding	0/0	$0	A project area was severely flooded due to 2.5 inches of rain in 6 hours.
Myrtle Beach	07/11/1996	Flooding	0/0	$0	Hurricane Bertha caused 0.5 inches of rain in 24 hours.
Myrtle Beach	07/12/1996	Flooding	0/0	$0	Hurricane Bertha caused 0.1 inches of rain in 24 hours.
Myrtle Beach	09/04/1996	Flooding	0/0	$0	Hurricane Fran caused 0.46 inches of rain in 24 hours.
Myrtle Beach	09/05/1996	Flooding	0/0	$0	Hurricane Fran caused 0.05 inches of rain in 24 hours.
Myrtle Beach	09/06/1996	Flooding	0/0	$0	Hurricane Fran caused 0.2inches of rain in 24 hours.
Myrtle Beach	10/08/1996	Flooding	0/0	$0	2.25 inches of rain in 2 hours caused Kings Highway to close.
Myrtle Beach	07/30/1997	Flooding	0/0	$0	3.75 inches of rain in 2 hours closed Kings Highways and Haskel Circle.

Location	Date	Type	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	02/05/1998	Flooding	0/0	$0	Kings Highway closed as result of 4.5 inches of rain in 2 hours.
Myrtle Beach**	02/17/1998	Flooding	0/0	$0	Nearly 7 inches of rain (including 4.2 inches in two hours) fell on parts of Myrtle Beach resulting in extensive flooding. (this entry was reported from NCDC and the city)
Myrtle Beach	07/31/1998	Flash Flood	0/0	$0	Thunderstorm rains measured 3 to 4 inches, flooding parts of the city. Water approximately 2 feet deep was reported on Kings Hwy between 9th and 11th Avenue.
Myrtle Beach	08/07/1998	Flooding	0/0	$0	Hurricane Bonnie caused 2.5 inches of rain in two hours.
Myrtle Beach	09/22/1998	Flooding	0/0	$0	Hurricane Hugo caused flooding throughout Myrtle Beach.
Myrtle Beach*	6/15/1999	Flash Flood	0/0	$35,514	A slow moving thunderstorm dropped about 4 inches of rain on Myrtle Beach during the afternoon. Drainage pipes were unable to accommodate the runoff at the corner of Ocean Blvd and 55 Ave N, where ponding reached a depth of 5 feet, necessitating the evacuation of 140 people. Between 30 and 40 rain-related car accidents occurred in the Myrtle Beach area.
Myrtle Beach*	09/05/2000	Flash Flood	0/0	$0	Flash flooding prompted Myrtle Beach city crews to barricade sections of Porcher Drive, parts of Oak Street and side streets along 10th Avenue North.
Myrtle Beach	09/06/2000	Flooding	0/0	$0	Hurricane Dennis caused 0.13 inches of rain in 24 hours.
Myrtle Beach	09/07/2000	Flooding	0/0	$0	Hurricane Dennis caused 3.8 inches of rain in Myrtle Beach in 24 hours.
Myrtle Beach	09/15/1999	Flooding	0/0	$0	Hurricane Floyd caused 2 inches of rain in 24 hours. The city was evacuated.
Myrtle Beach	09/16/1999	Flooding	0/0	$575,585	Hurricane Floyd caused 14.8 inches of rain in 24 hours. The city was evacuated.
Myrtle Beach	07/24/2000	Flooding	0/0	$0	3.54 inches of rain in 2 hours caused Kings Highway and Haskel Circle to close. In addition, backyards flooded.
Myrtle Beach	09/06/2000	Flooding	0/0	$0	4.52 inches of rain in 2 hours caused Kings Highway and Haskel Circle to close. In addition, backyards flooded.

Location	Date	Type	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach**	09/18/2000	Flash Flood	0/0	$13,739	Emergency management reported street flooding on 21st Street, with one home sustaining flood damage. In addition, Kings Highway and Haskel Circle closed and backyards flooded due to 3.55 inches of rain in 2 hours. (this was reported in NCDC and the city)
Myrtle Beach	09/19/2000	Flooding	0/0	$0	3.55 inches of rain in 2 hours caused Kings Highways and Haskel Road to close. In addition, backyards flooded.
Myrtle Beach*	07/02/2001	Flood	0/0	$0	Horry Skywarn reported rainwater flooding 1 foot deep at Ocean Blvd and 2nd Ave N, which was closed by police. Radar estimated 4-5 inches fell over a 2.5 hour period.
Myrtle Beach	08/31/2001	Flooding	0/0	$0	3.34 inches of rain in 2 hours caused Kings Highway to close.
Myrtle Beach*	07/18/2004	Flooding	0/0	$0	*Not Available*
Myrtle Beach	08/29/2004	Flooding	0/0	$18,827	0.43 inches of rain fell as a result of Hurricane Gaston.
Myrtle Beach	09/16/2004	Flooding	0/0	$451,954	Flooding throughout Myrtle Beach resulted due to Hurricane Charley.
Myrtle Beach**	09/14/2005	Flooding	0/0	$0	3.55 inches of rain in 2 hours caused Kings Highways and Haskel Circle to close. In addition, backyards flooded. (This event was reported by NCDC and the city.)
Myrtle Beach	10/06/2005	Flooding	0/0	$605,422	7.6 inches of rain in 24 hours caused flooding and Kings Highway to close.
Myrtle Beach	09/01/2006	Flooding	0/0	$0	6.3 inches of rain fell in 24 hours as a result of Hurricane Ernest.
Myrtle Beach	09/03/2006	Flooding	0/0	$0	Hurricane Fran caused 0.53 inches of rain in 24 hours.
Myrtle Beach*	12/2/2009	Heavy Rain	0/0	$0	*Not Available*
Myrtle Beach*	07/29/2010	Heavy Rain	0/0	$0	*Not Available*
Myrtle Beach*	07/1/2013	Heavy Rain	0/0	$0	*Not Available*

**These flood events were reported solely by the National Climatic Data Center.*
***These flood events were reported by both the National Climatic Data Center and the City of Myrtle Beach.*
Source: NCDC

4.14.4 Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of July 2015, there have been 1,229 flood losses reported in the City through the National Flood Insurance Program (NFIP) since 1978, totaling over $33.5 million in claims payments. These losses include both inland (freshwater) and coastal flooding events. It

should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies and for losses in which claims were sought and received. It is likely that many additional instances of flood losses in Myrtle Beach were either uninsured, denied claims payment, or not reported.

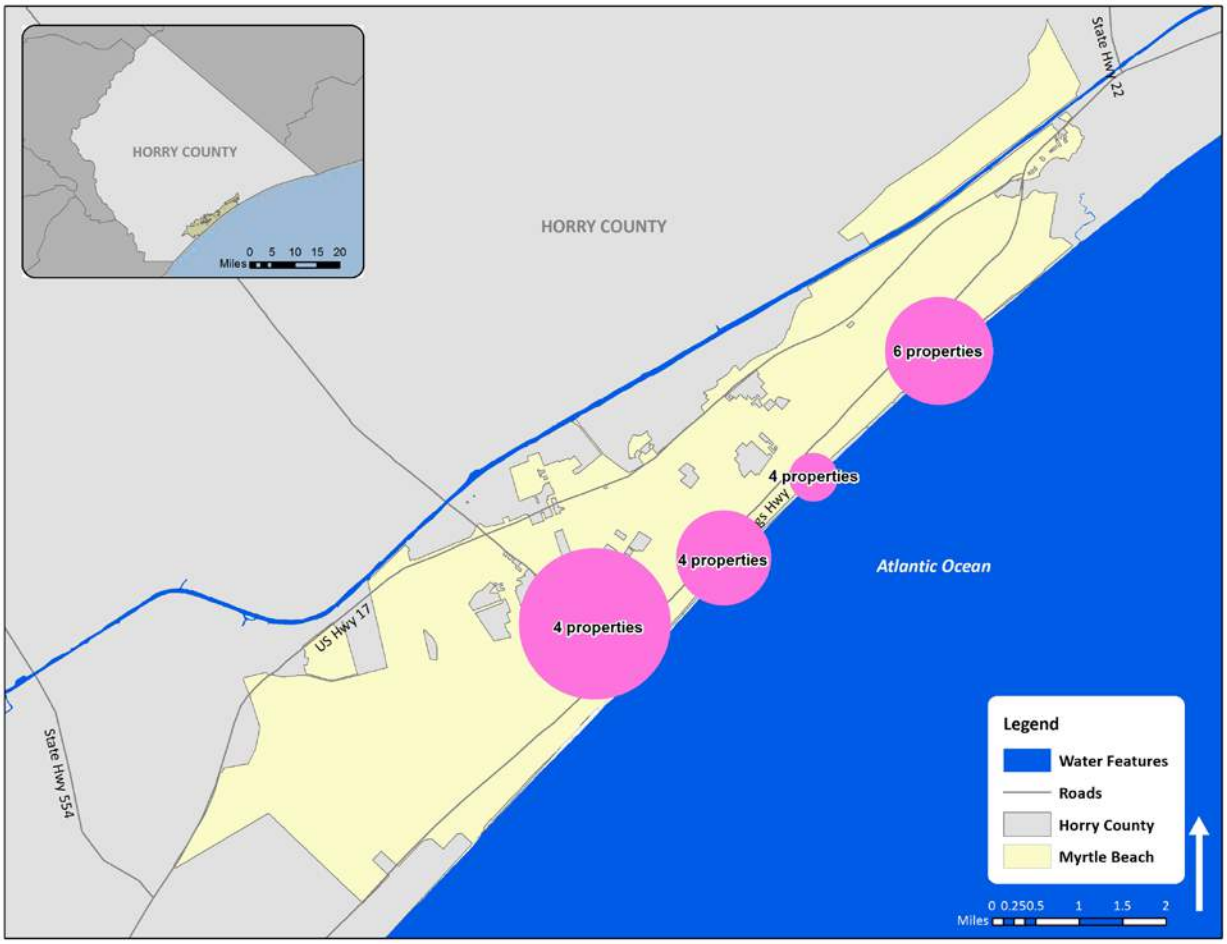
4.14.5 Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 122,000 repetitive loss properties nationwide.

FEMA'S National Flood Insurance Program designated Myrtle Beach as a repetitive loss community in 1996 with 17 properties. In 2004, Myrtle Beach had 64 repetitive loss properties and in May 2009, there were 21 "non-mitigated" repetitive loss properties located in Myrtle Beach. As of July of 2015, there were 18 unmitigated repetitive loss properties including 13 residential properties and 5 non-residential properties (hotels). These properties have accounted for a total of 43 losses and more than $1.3 million in claims payments under the NFIP. The average claim amount for these properties is $35,491.04. Without mitigation, these properties will likely continue to experience flood losses.

As shown on the Repetitive Loss Properties map (**Figure 4.14**), the repetitive loss properties are generally located along the coast, with high concentrations in four primary areas throughout the city. Although exact locations for these properties cannot be identified in the body of this plan due to privacy concerns, local officials have access to address information for each of these properties.

Figure 4.14: Repetitive Loss Areas in Myrtle Beach



Source: City of Myrtle Beach

The oceanfront of Myrtle Beach stretches for the city's entire length, approximately ten miles. This area is exposed to flooding from storms that come in from the ocean, hurricanes, waterspouts, and nor'easters. Most of the repetitive loss properties in this area are east of Ocean Boulevard, which generally corresponds to the VE zones on the FEMA Federal Insurance Rate Maps. The oceanfront in Myrtle Beach has relatively high elevations compared to the barrier islands along the coast to the north and south.

The remaining repetitive loss properties are located further inland. Only three of the repetitive loss properties in Myrtle Beach are located west of Kings Highway (Highway 17). The properties are located in various locations throughout the jurisdiction.

4.14.6 Probability of Future Occurrences

Flood events will remain a frequent occurrence in the City of Myrtle Beach, and the probability of future occurrences is highly likely. The probability of future flood events based on magnitude and according to best available data is illustrated in **Figure 4.13,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain); the coastal flood zone with wave action; and the 0.2-percent

annual chance flood (500-year floodplain). Further, as described in other hazard profiles, it is highly likely that Myrtle Beach will continue to experience inland and coastal flooding associated with large tropical storms, hurricanes, and storm surge events.

It should also be noted that anticipated sea level rise will increase the probability and intensity of future tidal flooding events in years to come. Rising sea level over time will shorten the return period (increasing the frequency) of significant flood events. This hazard is discussed elsewhere in this section. For example; sea level rise of 1 foot over a typical project analysis period (50 years) may cause a flood event currently of annual probability 2-percent (50-year flood) to become an event of 10-percent annual probability (10-year flood).

4.15 STORM SURGE

4.15.1 Background

Storm surge occurs when the water level of a tidally influenced body of water increases above the normal astronomical high tide and are most common in conjunction with coastal storms with massive low-pressure systems with cyclonic flows such as hurricanes, tropical storms, and nor'easters. The low barometric pressure associated with these storms cause the water surface to rise and storms landfalling during peak tides have surge heights and more extensive flood inundation limits. Storm surges will inundate coastal floodplains by dune overwash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. The duration of a storm is the most influential factor affecting the severity and impact of storm surges.

A storm surge is often described as a wave that has outrun its generating source and become a long period swell. It is often recognized as a large dome of water that may be 50 to 100 miles wide and rising anywhere from four to five feet in a Category 1 hurricane up to 20 feet in a Category 5 storm. The storm surge arrives ahead of the storm center's actual landfall and the more intense the storm is, the sooner the surge arrives. Water rise can be very rapid, posing a serious threat to those who have not yet evacuated flood-prone areas. The surge is always highest in the right-front quadrant of the direction in which the storm is moving. As the storm approaches shore, the greatest storm surge will be to the north of the low-pressure system or hurricane eye. Such a surge of high water topped by waves driven by hurricane force winds can be devastating to coastal regions, causing severe beach erosion and property damage along the immediate shoreline.

Storm surge heights and associated waves are dependent on not only the storm's intensity but also upon the shape of the offshore continental shelf (narrow or wide), the depth of the ocean bottom (bathymetry), and astronomical tides. A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but higher and more powerful storm waves. In addition, a storm surge event occurs during high tide will result in increased flooding and inundation of coastal areas. The storms that generate the largest coastal storm surges can develop year-round, but they are most frequent from late summer to early spring.

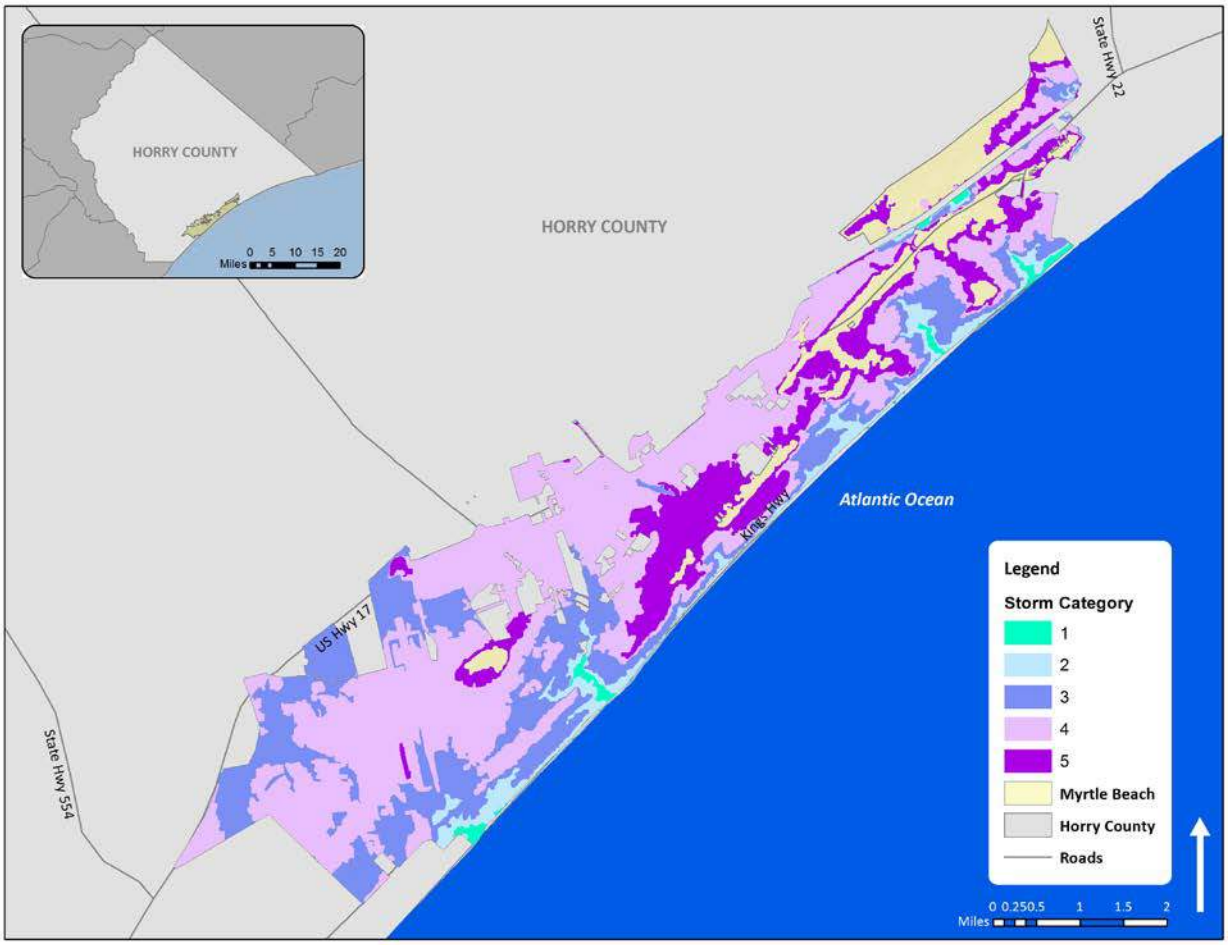
4.15.2 Location and Spatial Extent

There are many areas in the City of Myrtle Beach that are subject to potential storm surge inundation as modeled and mapped by the U.S. Army Corps of Engineers (USACE). **Figure 4.15** illustrates hurricane

storm surge inundation zones with different categories of storms in Myrtle Beach. The illustration is derived from geo-referenced SLOSH (Sea, Lake, and Overland Surge from Hurricanes) data produced by the USACE in coordination with NOAA in 2011. SLOSH is a modeling tool used to estimate storm surge for coastal areas resulting from historical, hypothetical, or predicted hurricanes taking into account maximum expected levels for pressure, size, forward speed, track, and winds. Therefore, the SLOSH data is best used for defining the potential maximum surge associated with various storm intensities for any particular location.

As shown in the figures, the entire coast of the city is at high risk to storm surge inundation. Inland areas will also experience substantial flooding during a storm event. Based on the SLOSH model, 6.6 square miles of Myrtle Beach have been identified as being at risk to a Category 3 storm surge hazard and 21.2 square miles are at risk to a Category 5 event.

Figure 4.15: Storm Surge Risk Areas in Myrtle Beach



Source: United States Army Corp of Engineers, NOAA

4.15.3 Historical Occurrences

According to NCDC, two storm surge events have been reported for Horry County.[22]

October 15, 1954: Hurricane Hazel
Hurricane Hazel struck Myrtle Beach during the highest lunar tide of the year. As a result, storm surge was higher, rising to 15.5 feet during the storm. In addition, the surge downed countless trees along the coast.

September 6, 2008: Tropical Storm Hannah
Tropical Storm Hannah caused several road closures throughout Horry County as a result of flooding and minor storm surge.

While not reported in the NCDC database, **Hurricane Hugo** (September 1989) delivered a storm surge of an estimated 13 feet to Myrtle Beach.

4.15.4 Probability of Future Occurrences

It is likely that the City of Myrtle Beach will continue to experience storm surge associated with large tropical storms, hurricanes and squalls combined with high tides. As noted in the preceding section (under *Flood*), anticipated sea level rise will increase the probability and intensity of future storm surge events in years to come.[23] This rise in sea level will not only increase the probability and intensity of tidal flooding events, but will also contribute to the loss of coastal wetlands and erosion of sand beaches that act as protective buffers against storm surge events.

4.16 SEA LEVEL RISE

4.16.1 Background

Sea Level Rise is defined as the mean rise in sea level. It is caused by two factors: 1) as the ocean warms, sea water expands in volume and 2) continental ice shelves melt, increasing the amount of water in the oceans. This leads to a greater area of land being inundated by sea water.

Rising sea level contributes to the loss of coastal wetlands (which provide protective buffers from flood events), beach erosion, impacts on population and property in low areas, and disruption of coastal habitats and species. Further, flooding and hurricane events are more severe and affect a greater area.

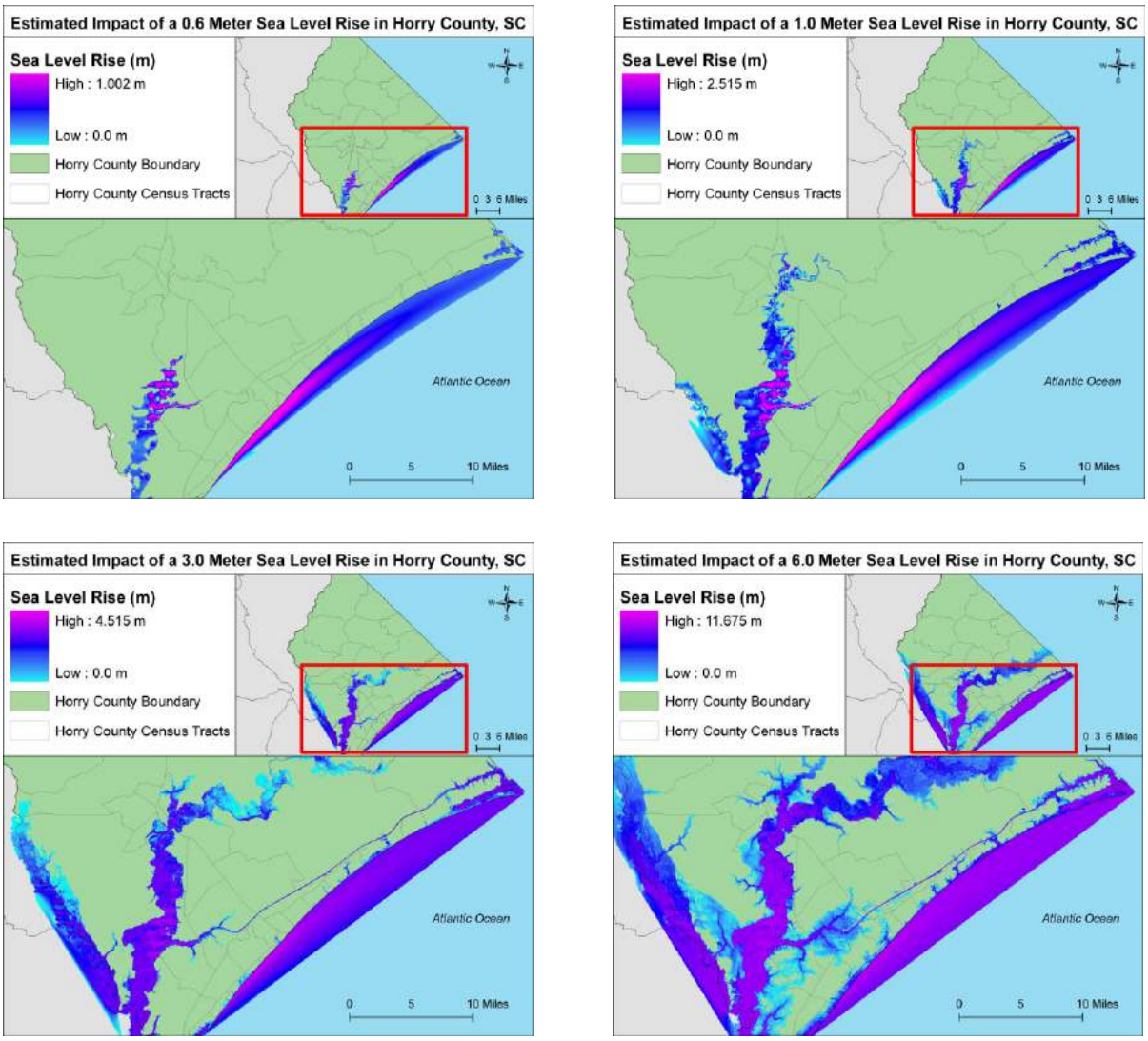
Given that 600 million people live in an area that is less than 10 meters or 33 feet above sea level and the coastal population has doubled in the last 50 years, there is a great vulnerability to sea level rise.

[22] This is only the reported information from NCDC and does not include additional information from the public or local data sources. As more information becomes available, the plan will be amended.
[23] The Sea Level Rise hazard is assessed more extensively under Section 4.19.

4.16.2 Location and Spatial Extent

Sea level rise is occurring at a global scale. However, it does not affect areas uniformly and will be more severe in some places. **Figure 4.16** shows a hypothetical situation of sea level rise where the sea rises at 0.6 meters, 1.0 meters, 3 meters, and 6 meters. This research was conducted by the Hazards and Vulnerability Research Institute at the University of South Carolina and provided by the South Carolina Division of Emergency Management. The analysis used mosaicking LIDAR at a 4 meter grid (converted to match NOAA specifications) to determine elevation. Then ArcView GIS methodologies of bathtub/fill and nearest neighbor functionality were used to determine where flooding would occur at each interval. Myrtle Beach is impacted at each level as indicated in the scenarios.

Figure 4.16: Sea Level Rise in Horry County



Source: Emrich, Christopher. University of South Carolina Hazards and Vulnerability Research Institute; South Carolina Emergency Management Division

Additionally, **Figure 4.17** identifies areas in Myrtle Beach that would be inundated by water as a result of three feet in sea level rise as per projections by NOAA. The highest level of sea level rise projected by

NOAA is shown in **Figure 4.18**. This figure shows the inundation areas in the case of six feet of sea level rise. This demonstrates the additional areas that would be impacted beyond the three feet scenario.

Figure 4.17: Three Feet Sea Level Rise in Horry County

Source: NOAA

Figure 4.18: Six Feet Sea Level Rise in Horry County

Source: NOAA

4.16.3 Historical Occurrences

Sea level rise is a slow-onset hazard and specific events/occurrences are not possible to determine.

4.16.4 Probability of Future Occurrence

There is still much debate regarding the probability of future occurrence of sea level rise. This section will be updated as more information becomes available. Future sea level rise is considered likely.

OTHER HAZARDS

4.17 ACTS OF TERROR

4.17.1 Background

Terrorism is defined by FEMA as, "the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom." Certain facilities are at greater risk than others to a terrorist attack. A high-risk target is defined by FEMA as military and civilian government facilities, international airports, large cities, and high-profile landmarks. Terrorists may also target large public gatherings, water and food supplies, and utilities.

Acts of terror may include assassinations and armed attacks, kidnappings, hijackings, bomb scares and bombings, cyber-attacks (computer-based), and the use of chemical, biological, nuclear, and radiological weapons. Each act of terror is described below[24]:

Assassinations/Armed Attack:
Tactical assault or sniping from a remote location.

Kidnapping:
Capturing a person or persons against their will and holding them in false imprisonment, often for ransom.

Hijacking:
Robbing or seizing control or a vehicle by use of force.

Bomb Scares and Bombing:
A bombing is the result of a detonation of any material that will cause injury, death, or property damage. A bomb scare involves the verbal or written threat to detonate a bomb.

Cyber Attack:
Refers to the electronic attack using one computer system against another.

Chemical Agent:
Liquid/aerosol contaminants can be dispersed using sprayers or other aerosol generators, liquids vaporizing from puddles or containers, or munitions.

Biological Agent:
Liquid or solid toxic contaminants can be dispersed using sprayers/aerosol generators or by point of line sources such as munitions, covert deposits, and moving sprayers.

Nuclear Bomb:
A nuclear device may be detonated underground, at the surface, in the air or at high altitude.

[24] Much of this information comes from the FEMA State and Local Mitigation Planning How-to Guide: Integrating Manmade Hazards.

Radiological Agent:
Radioactive contaminants can be dispersed using sprayers/aerosol generators or by point of line sources such as munitions, covert deposits, and moving sprayers.

The United States Department of Homeland Security posts terror threat levels corresponding to a certain color. This warning system is shown in **Table 4.21.**

Table 4.21: Homeland Security Advisory System

Threat Level	Description	Federal Government Agency Response
SEVERE	Severe Risk of Terrorist Attacks	Under a Severe threat level, personnel will be increased or redirected to address emergency needs, specially trained teams will be pre-positioned as needed, transportations systems are to be monitored, redirected, and/or constrained, and public and government facilities may be closed.
HIGH	High Risk of Terrorist Attacks	A High threat level requires coordinating efforts between Federal, State, and local law enforcement agencies, taking additional precautions at public events (including alternate venues and cancellation), restricting threatened facilities to essential personnel only, and preparing to execute contingency procedures if necessary.
ELEVATED	Significant Risk of Terrorist Attacks	In Elevated threat levels, agencies should increase surveillance of critical places, coordinate emergency plans with neighboring jurisdictions, and implementing emergency response plans, where appropriate.
GUARDED	General Risk of Terrorist Attacks	This Guarded threat level requires that agencies check communications with designated emergency response and command locations, reviewing and updating emergency response plans, and providing the public with information to better manage a terrorist attack situation.
LOW	Low Risk of Terrorist Attacks	This Low threat level requires “proactive measures” such as making sure as personnel is trained to deal with a terrorist attack, identifying vulnerabilities to a terrorist attack, and mitigating any vulnerabilities.

4.17.2 Location and Spatial Extent

While there are few high risk targets in the City of Myrtle Beach, the city is uniformly at risk to a terrorist attack since such events have no geographic boundaries. However, certain acts of terror, such as a bombing, will affect localized areas while others, such as chemical agents, may affect areas for miles if carried by persons, water, or wind. In addition, terrorists may instill fear in people that prevents travel and thus tourism dollars from entering the local economy.

In addition to specific facilities, the planning team also recognized that there are a number of major events that occur in the city throughout the year that draw large crowds and which would be susceptible to a potential act of terror. Most of these events occur between March and October and include the Country Music Festival, Myrtle Beach Marathon, holiday weekends, and Bike Week, among others.

Finally, the planning team noted that a growing concern when it comes to acts of terror is the threat of cyberterrorism which could be perpetrated from a distance and could cause major issues to the city's overall security. City officials noted that this is potentially the biggest threat going forward in terms of acts of terror, even though there have not been any major historic occurrences.

4.17.3 Historical Occurrences

There is no known history of a major act of terror occurring in Myrtle Beach. The planning team did note that there was a fire bomb thrown at City Hall at one point, but it was not considered a large-scale act of terror.

4.17.4 Probability of Future Occurrence

The probability of a future terrorist attack in Myrtle Beach is unlikely. However, a single event could have devastating effects on human lives, the economy, and future way of life.

4.18 AIRPLANE CRASH

4.18.1 Background

An airplane crash endangers the passengers onboard the craft as well as people and property at the crash site. The extent of an airplane crash risk is based on many factors including the size of the aircraft and location of crash site. For example, a large commuter jet crashing into a heavily populated urban area will likely have far greater damages than a personal aircraft crashing in a rural area.

4.18.2 Location and Spatial Extent

The existence of Myrtle Beach International Airport creates increased air traffic over the city. The airport caters to both commercial and cargo flights. However, the location of an airplane crash cannot be predicted. Therefore, the entire city of Myrtle Beach is at risk.

4.18.3 Historical Occurrences

There is no recent history of a major commercial airplane crash occurring in Myrtle Beach. The planning team noted that there have been occasional banner planes that have gone down, but those occur relatively infrequently (maybe every 5 years or so) and do not pose a major threat to safety.

4.18.4 Probability of Future Occurrence

The probability of an airplane crash in Myrtle Beach is unlikely. However, as the airport expands and runs more flights, the risk of a crash increases. Further, a single event could have serious consequences on the affected population and tourism.

4.19 HAZARDOUS MATERIALS INCIDENTS

4.19.1 Background

Hazardous materials can be found in many forms and quantities that can potentially cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property in varying degrees. Such materials are routinely used and stored in many homes and businesses and are also shipped daily on the nation's highways, railroads, waterways, and pipelines. This subsection on the hazardous material hazard is intended to provide a general overview of the hazard and the threshold for identifying fixed and mobile sources of hazardous materials is limited to general information on rail, highway, and FEMA-identified fixed HAZMAT sites determined to be of greatest significance as appropriate for the purposes of this plan.

Hazardous material (HAZMAT) incidents can apply to fixed facilities as well as mobile, transportation-related accidents in the air, by rail, on the nation's highways, and on the water. Approximately 6,774 HAZMAT events occur each year, 5,517 of which are highway incidents, 991 are railroad incidents and 266 are due to other causes.[25] In essence, HAZMAT incidents consist of solid, liquid, and/or gaseous contaminants that are released from fixed or mobile containers, whether by accident or by design as with an intentional terrorist attack. A HAZMAT incident can last hours to days, while some chemicals can be corrosive or otherwise damaging over longer periods of time. In addition to the primary release, explosions, and/or fires can result from a release, and contaminants can be extended beyond the initial area by persons, vehicles, water, wind, and possibly wildlife as well.

HAZMAT incidents can also occur as a result of or in tandem with natural hazard events, such as floods, hurricanes, tornadoes, and earthquakes, which in addition to causing incidents can also hinder response efforts. In the case of Hurricane Floyd in September 1999, communities along the Eastern United States were faced with flooded junkyards, disturbed cemeteries, deceased livestock, floating propane tanks, uncontrolled fertilizer spills, and a variety of other environmental pollutants that caused widespread toxological concern.

Hazardous material incidents can include the spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of a hazardous material, but exclude: (1) any release which results in exposure to poisons solely within the workplace with respect to claims which such persons may assert against the employer of such persons; (2) emissions from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel, or pipeline pumping station engine; (3) release of source, byproduct, or special nuclear material from a nuclear incident; and (4) the normal application of fertilizer.

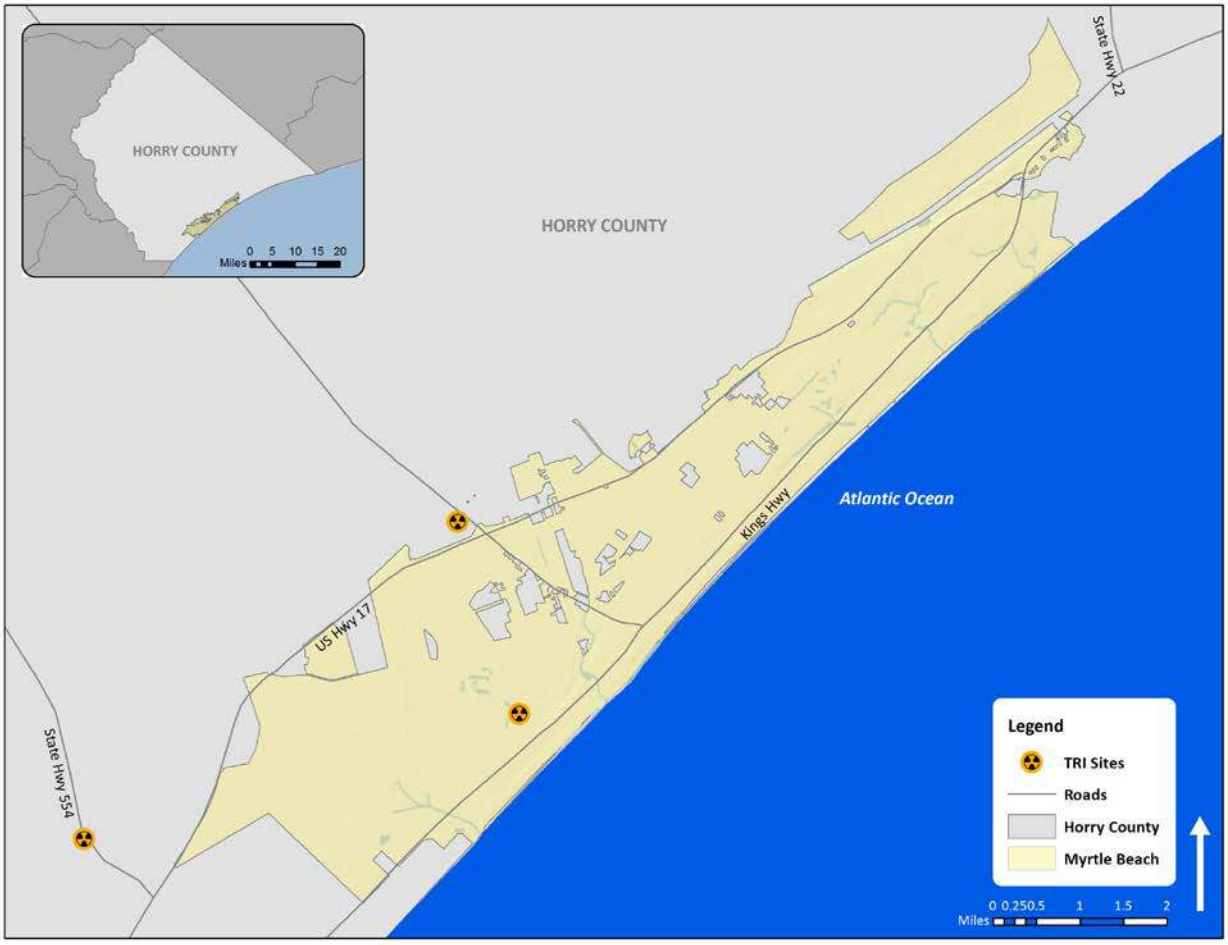
4.19.2 Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Myrtle Beach has three TRI sites that affect it and are shown in **Figure 4.19.**

[25] FEMA, 1997.

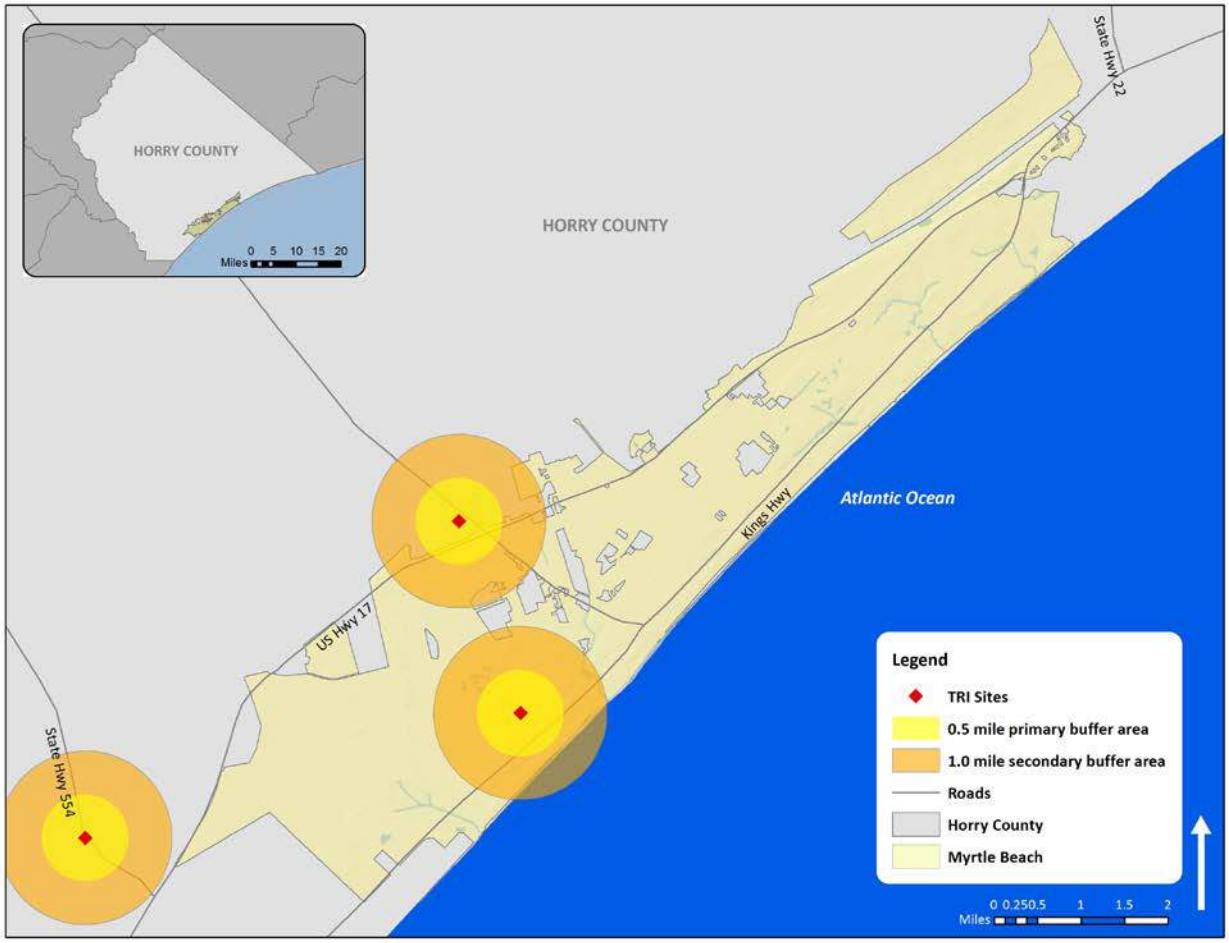
Certain chemicals may travel through the air or water, affecting a much larger area than the point itself. Therefore, analysis is conducted using a 0.5 mile buffer and 1.0 mile buffer around the TRI sites to determine risk of people and property in the area. **Figure 4.20** shows the area affected when the buffers area applied.

Figure 4.19: Toxic Release Inventory (TRI) Sites in the City of Myrtle Beach



Source: EPA

Figure 4.20: Toxic Release Inventory (TRI) Sites with Buffers



Source: EPA

In addition to the identified hazardous materials sites above, the city noted that a hazardous material incident of pertinent concern is a chlorine spill, which is much more likely in Myrtle Beach than in other areas due to the prevalence of swimming pools in the city. A chlorine spill could cause a number of hazards if the chemical is released either into the water supply or natural environment and if it is spilled in the vicinity of large groups of people, it can pose a threat to health and well-being.

4.19.3 Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material;
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire;
- a release or exposure to fire which results in the closure of a major transportation artery;
- the alteration of an aircraft flight plan or operation;

- the release of radioactive materials from Type B packaging;
- the release of over 11.9 gallons or 88.2 pounds of a severe marine pollutant; or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material;
- closure of a major transportation artery or facility or evacuation of six or more persons due to the presence of hazardous material; or
- a vehicle accident or derailment resulting in the release of a hazardous material.

There have been a total of 23 recorded HAZMAT incidents in Myrtle Beach since 1977. These events resulted in about $4,000 (2014 dollars) of property damage as well as 1 injury. **Table 4.22** presents detailed information on historical HAZMAT incidents in Myrtle Beach as reported by the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA).

Report Number	Date	City	Mode	Serious Incident?	Fatalities / Injuries	Damages ($)*	Quantity Released
I-1977070277	6/3/1977	MYRTLE BEACH	Air	No	0/0	$0	0
I-1979040051	3/20/1979	MYRTLE BEACH	Highway	No	0/0	$0	10 LGA
I-1983090581	8/19/1983	MYRTLE BEACH	Highway	No	0/0	$0	0
I-1983090581	8/19/1983	MYRTLE BEACH	Highway	No	0/0	$0	15 LGA
I-1986010043	12/18/1985	MYRTLE BEACH	Highway	No	0/0	$0	40 LGA
I-1986060050	5/31/1986	MYRTLE BEACH	Highway	No	0/0	$0	50 LGA
I-1988080642	8/8/1988	MYRTLE BEACH	Highway	No	0/0	$0	4 SLB
I-1991030668	3/14/1991	MYRTLE BEACH	Highway	No	0/0	$61	35 LGA
I-1994010489	4/2/1993	MYRTLE BEACH	Highway	No	0/0	$41	0.007813 LGA
I-1994050417	4/1/1994	MYRTLE BEACH	Air	No	0/1	$0	1.056688 LGA
I-1997040395	3/17/1997	MYRTLE BEACH	Highway	No	0/0	$0	0
I-1998010362	12/15/1997	MYRTLE BEACH	Highway	No	0/0	$125	0.125 LGA
I-2001030659	2/1/2001	MYRTLE BEACH	Highway	No	0/0	$11	8 LGA
I-2003010706	12/18/2002	MYRTLE BEACH	Air	No	0/0	$0	0.792516 LGA
I-2004010994	7/4/2003	MYRTLE BEACH	Highway	Yes	0/0	$77	125 LGA
I-2003110413	11/2/2003	MYRTLE BEACH	Highway	Yes	0/0	$139,576	5,700 LGA
I-2004081552	8/5/2004	MYRTLE BEACH	Highway	No	0/0	$1,922	20 LGA
I-2004101004	10/16/2004	MYRTLE BEACH	Highway	No	0/0	$3,355	100 LGA
I-2010120284	12/8/2010	MYRTLE BEACH	Highway	No	0/0	$0	1 LGA
I-2014030121	2/28/2014	MYRTLE BEACH	Highway	No	0/0	$0	0.015625 LGA
I-2014090367	8/25/2014	MYRTLE BEACH	Highway	No	0/0	$0	0.023438 LGA
I-2014120158	11/3/2014	MYRTLE BEACH	Highway	No	0/0	$0	0
I-2015030249	2/25/2015	MYRTLE BEACH	Highway	No	0/0	$0	0.03125 LGA

*Property damage is reported in 2014 dollars.

Source: Untied States Department of Transportation Pipeline and Hazardous Materials Safety Administration

4.19.4 Probability of Future Occurrence

Given the location of two toxic release inventory sites in Myrtle Beach and several past incidents, it is likely that a hazardous material incident may occur.

4.20 WILDFIRE

4.20.1 Background

A wildfire is any outdoor fire (i.e. grassland, forest, brush land) that is not under control, supervised, or prescribed.[26] Wildfires are part of the natural management of forest ecosystems, but may also be caused by human factors.

Nationally, over 80 percent of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning. In South Carolina, 98 percent of wildfires are human-caused. The number one cause is woods arson, followed by debris burning.

There are three classes of wildland fires: surface fire, ground fire, and crown fire. A surface fire is the most common of these three classes 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. Wildfires are usually signaled by dense smoke that fills the area for miles around.

Wildfire 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 hazards (such as tornadoes, hurricanes, etc.) increase the probability of wildfires by producing fuel in both urban and rural settings. The South Carolina wildfire season runs from late winter to early spring with March being the most severe.

Many individual homes and cabins, subdivisions, resorts, recreational areas, organizational camps, businesses, and industries are located within high wildfire hazard areas. Further, the increasing demand for outdoor recreation places more people in wildlands during holidays, weekends, and vacation periods. Unfortunately, wildland residents and visitors are rarely educated or prepared for wildfire events that can sweep through the brush and timber and destroy property within minutes.

Wildfires can result in severe economic losses as well. Businesses that depend on timber, such as paper mills and lumber companies, experience losses that are often passed along to consumers through higher prices, and sometimes jobs are lost. The high cost of responding to and recovering from wildfires can deplete state resources and increase insurance rates. The economic impact of wildfires can also be felt in the tourism industry if roads and tourist attractions are closed due to health and safety concerns.

State and local governments can impose fire safety regulations on home sites and developments to help curb wildfire. Land treatment measures such as fire access roads, water storage, helipads, safety zones, buffers, firebreaks, fuel breaks, and fuel management can be designed as part of an overall fire defense system to aid in fire control. Fuel management, prescribed burning, and cooperative land management planning can also be encouraged to reduce fire hazards.

[26] Prescription burning, or "controlled burn," undertaken by land management agencies is the process of igniting fires under selected conditions, in accordance with strict parameters.

4.20.2 Location and Spatial Extent

Myrtle Beach is prone to wildfires. The entire city has uniform risk exposure to a wildfire occurrence. However, drought conditions may make a fire more likely in those locations.

4.20.3 Historical Occurrences

Based on data from the South Carolina Forestry Commission from 2004 to 2013, Horry County experienced an average of 97 wildfires annually which burned a combined average of 2,970 acres per year. The data indicates that some fires in the area can be quite large, averaging over 30 acres per fire. **Table 4.23** lists the number of reported wildfire occurrences in the county between the years 2004 and 2013.

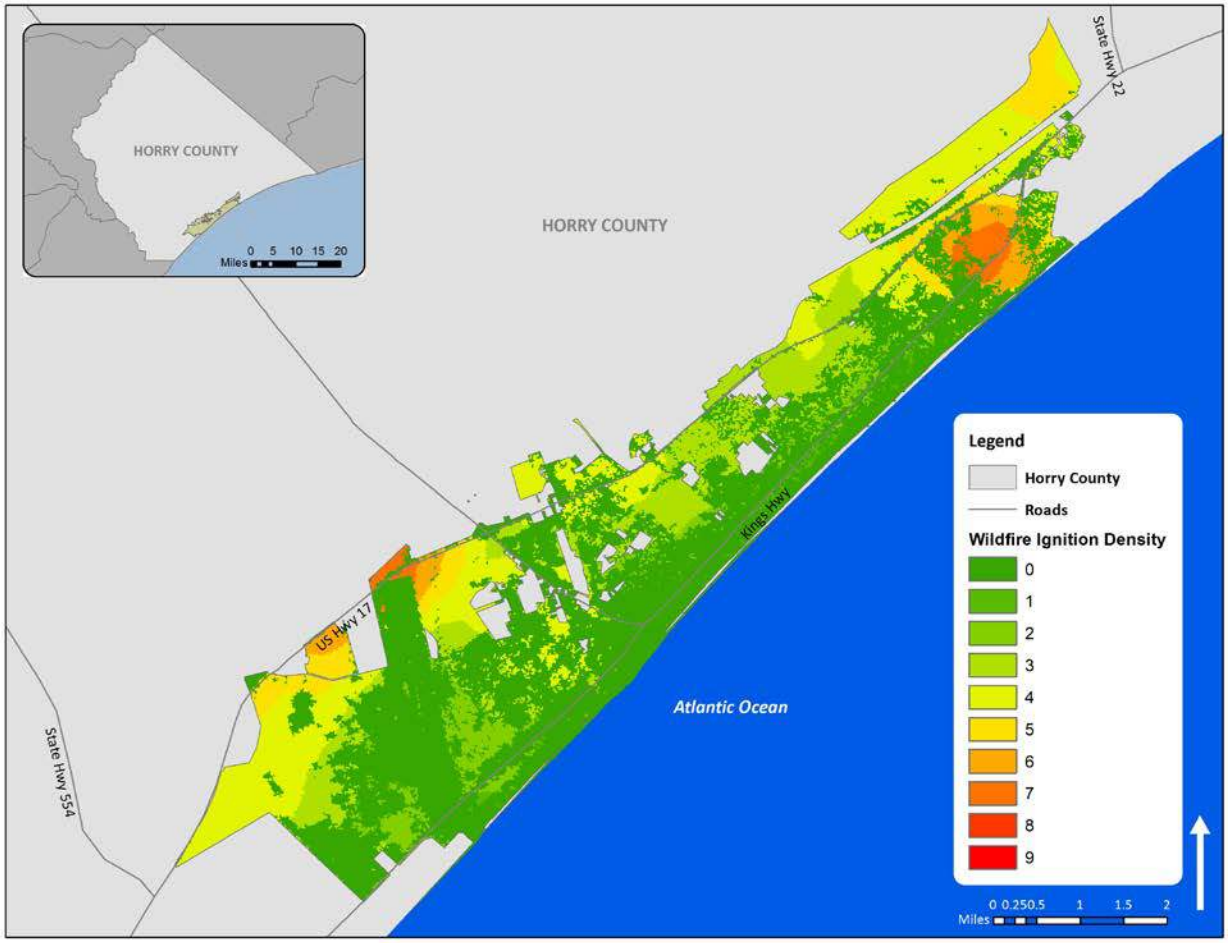
Table 4.22: Historical Wildfire Events in Horry County

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of Fires	147	97	73	131	185	72	46	*Not Available*	90	36
Number of Acres	1,014.5	898.5	321.7	1,631.0	1,126.7	19,357.1	401.5	*Not Available*	1,839.4	139.4

Figure 4.21 shows Wildfire Ignition Density in Myrtle Beach based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and the likelihood of a wildfire igniting in an area. Occurrence is derived by modeling historic wildfire ignition locations to create an average ignition rate map. This is measured in the number of fires per year per 1,000 acres.[27]

[27] Southern Wildfire Risk Assessment, 2014.

Figure 4.21: Historical Wildfire Ignition Density in the City of Myrtle Beach



Source: Southern Wildfire Risk Assessment Data, South Carolina Forestry Commission

4.20.4 Probability of Future Occurrences

There is a highly likely probability of future wildfire events in the City of Myrtle Beach, and it is particularly high during drought cycles and abnormally dry conditions. In addition, certain industrial operations/facilities and transport of flammable materials may also raise the threat of fire.

4.21 CONCLUSIONS ON HAZARD RISK

The hazard profiles presented in this section were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

4.21.1 Hazard Extent

Table 4.24 describes the extent of each natural hazard identified for Myrtle Beach. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

Table 4.23: Extent of Myrtle Beach Hazards

Atmospheric Hazards	
Drought	Drought extent is defined by the South Carolina Climatology Office classifications (Normal, Incipient, Moderate, Severe, Extreme) (pages 4:6-4:9). Horry County and Myrtle Beach have received a Severe rating 3 times over the 10-year reporting period.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Myrtle Beach was 1.75 inches. This size hail has been recorded several times in the history of hail events in Myrtle Beach. It should be noted that future events may exceed this.
Tropical Storm System/Hurricane	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 4.12). The greatest classification of hurricanes to traverse directly through Myrtle Beach was an unnamed storm in 1899 which reached a maximum wind speed of 95 knots in the city. The city is susceptible to many of the coastal impacts of a hurricane or tropical storm including high wind speeds and storm surge (addressed below).
Ice Storm	The extent of winter storms can be measured by the amount of snowfall or ice received (in inches). The greatest 24-hour snowfall reported in the city was around 15 in 1989 inches and ice accumulation has been over 1 inch in many cases. Due to unpredictable variations in snowfall, extent totals will vary and reliable data on snowfall totals is not abundantly available.
Lightning	According to the Vaisala flash density map (Figure 4.4), Myrtle Beach is located in an area that experiences 4 to 8 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Nor'easter	The extent of nor'easters can be measured by the amount of snowfall and ice received (in inches). As mentioned above, the greatest 24-hour snowfall reported in the city was over 15 inches and ice accumulation has been over 1 inch. In addition, extent for nor'easters can be defined by wind speed and wave height. In Myrtle Beach, Nor'easters have caused up to 40 mile per hour winds and waves that are 10 feet above sea level.
Wind Events (Thunderstorm/High Wind)	Wind Event/Thunderstorm extent is defined by the wind speeds reported. The strongest recorded wind event in Myrtle Beach was reported on March 21, 1999 (approximately 75 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 4.5) as well as the Fujita/Enhanced Fujita Scale (Tables 4.9 and 4.10). The greatest magnitude reported in Myrtle Beach was an F2 (reported on July 6, 2001). It should be noted that an F5 tornado is possible.
Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 4.17) and the Modified Mercalli Intensity (MMI) scale (Table 4.18). According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was V (moderate) with a correlating Richter Scale measurement of between 4 and 5 (reported on February 3, 1972 and November 22, 1974).
Tidal Waves/Tsunami	There is no history of tidal waves or tsunami in the Atlantic basin in recent years so an accurate extent measure is difficult to predict. However, it is possible that water depths similar to those experienced by storm surge would occur (in the range of 15-25 feet), with potentially even greater depths depending on the severity of the event that triggered the tidal wave/tsunami.

<table>
<tr><th colspan="2">Hydrologic Hazards</th></tr>
<tr><td>Erosion</td><td>The extent of erosion can be defined by the measurable rate of erosion that occurs or the number of cubic yards eroded. The SC Department of Health and Environmental Control estimates the rate of erosion in Myrtle Beach at around -0.59 feet per year. In addition, during Hurricane Hazel in 1954, almost 1 million cubic yards of sand were eroded in Myrtle Beach.</td></tr>
<tr><td>Flood</td><td>Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 8.94 percent of the total land area in Myrtle Beach.

Flood depth and velocity are recorded via United States Geological Survey stream gages in the city. The greatest peak discharge recorded for the city was reported on April 22, 2003. Water reached a discharge of 7,200 cubic feet per second and the gage height was 18.50 feet. Additional peak discharge readings and gage heights are in the table below.
<table>
<tr><th>Location/Jurisdiction</th><th>Date</th><th>Peak Discharge (cfs)</th><th>Gage Height (ft)</th></tr>
<tr><td colspan="4">Horry County</td></tr>
<tr><td>Midway Swash at Myrtle Beach, SC</td><td>8/31/2001</td><td>413</td><td>7.46</td></tr>
<tr><td>AIW at Myrtlewood Golf Course at Myrtle Beach, SC</td><td>4/22/2003</td><td>7,200</td><td>18.50</td></tr>
</table></td></tr>
<tr><td>Storm Surge</td><td>Storm surge can be defined by the depth of inundation which is defined by the category of hurricane/tropical storm. Since Myrtle Beach could be impacted by a Category 5 storm, depth of inundation could be 23 to 35 feet.</td></tr>
<tr><td>Sea Level Rise</td><td>Sea level rise is defined by the areas impacted, but is more often associated with the amount of sea level rise that is expected to take place. Although it is difficult to predict an exact amount of rise, many projections call for somewhere in the range of 4-6 feet in the next 100 years.</td></tr>
<tr><th colspan="2">Other Hazards</th></tr>
<tr><td>Acts of Terror</td><td>There is no history of terror threats in Myrtle Beach; however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of critical damage with many fatalities and injuries to the population.</td></tr>
<tr><td>Airplane Crash</td><td>An airplane crash might cause death or injury to those involved in the accident as well as to bystanders near the site of the incident. The main effects of an airplane crash might be fire or explosions and a shutdown of transportation corridors.</td></tr>
<tr><td>Hazardous Materials Incident</td><td>According to USDOT PHMSA, the largest hazardous materials incident reported in the city was 5,700 LGA released on the highway on November 2, 2003. It should be noted that larger events are possible.</td></tr>
<tr><td>Wildfire</td><td>Wildfire data was provided by the South Carolina Forestry Commission and is reported annually by county from 2004-2013.

Analyzing the data indicates the following wildfire hazard extent for the county.

• The greatest number of fires to occur in any year was 185 in 2008.
• The greatest number of acres to burn in a single year occurred in 2010 when 19,357.1 acres were burned.

Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the county.</td></tr>
</table>

4.21.2 Priority Risk Index

In order to draw some meaningful planning conclusions on hazard risk for Myrtle Beach, the results of the hazard profiling process were used to generate countywide hazard classifications according to a

"Priority Risk Index" (PRI). The purpose of the PRI, described further below, is to categorize and prioritize all potential hazards for Myrtle Beach as high, moderate, or low risk. Combined with the asset inventory and quantitative vulnerability assessment provided in the next section, the summary hazard classifications generated through the use of the PRI allows for the prioritization of those high hazard risks for mitigation planning purposes and, more specifically, the identification of hazard mitigation opportunities for Myrtle Beach to consider as part of their proposed mitigation strategy.

The prioritization and categorization of identified hazards for Myrtle Beach is based principally on the PRI, a tool used to measure the degree of risk for identified hazards in a particular planning area. The PRI is used to assist the City of Myrtle Beach Floodplain Management and Hazard Mitigation Planning Committee (FMHMPC) in gaining consensus on the determination of those hazards that pose the most significant threat to Myrtle Beach based on a variety of factors. The PRI is not scientifically based, but is rather meant to be utilized as an objective planning tool for classifying and prioritizing hazard risks in Myrtle Beach based on standardized criteria.

The application of the PRI results in numerical values that allow identified hazards to be ranked against one another (the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard (probability, impact, spatial extent, warning time, and duration). Each degree of risk has been assigned a value (1 to 4) and an agreed upon weighting factor[28], as summarized in **Table 4.25**. To calculate the PRI value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final PRI value, as demonstrated in the example equation below:

PRI VALUE = [(PROBABILITY x .30) + (IMPACT x .30) + (SPATIAL EXTENT x .20) + (WARNING TIME x .10) + (DURATION x .10)]

According to the weighting scheme applied for Myrtle Beach, the highest possible PRI value is 3.4 (flood hazard). Prior to being finalized, PRI values for each identified hazard were reviewed and accepted by the members of the FMHMPC.

[28] The FMHMPC, based upon any unique concerns or factors for the planning area, may adjust the PRI weighting scheme during future plan updates.

Table 4.24: Priority Risk Index for Myrtle Beach

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.	1	30%
	Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.	3	
	Catastrophic	High number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	4	
Spatial Extent	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
Warning Time	More than 24 hours	Self explanatory	1	10%
	12 to 24 hours	Self explanatory	2	
	6 to 12 hours	Self explanatory	3	
	Less than 6 hours	Self explanatory	4	
Duration	Less than 6 hours	Self explanatory	1	10%
	Less than 24 hours	Self explanatory	2	
	Less than one week	Self explanatory	3	
	More than one week	Self explanatory	4	

4.21.3 PRI Results

Table 4.26 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles

developed for this section, as well as input from the FMHMPC. The results were then used in calculating PRI values and making final determinations for the risk assessment.

Table 4.25: Summary of PRI Results for Myrtle Beach

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Small	Less than 6 hours	Less than 6 hours	**2.1**
Hailstorm	Highly Likely	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2.6**
Tropical Storm System/Hurricane	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Ice Storm	Possible	Critical	Large	More than 24 hours	Less than 1 week	**2.7**
Lightning	Highly Likely	Minor	Small	Less than 6 hours	Less than 6 hours	**2.4**
Nor'easter	Possible	Critical	Large	More than 24 hours	Less than 1 week	**2.7**
Wind Events (Thunderstorm/High Wind)	Highly Likely	Limited	Large	Less than 6 hours	Less than 6 hours	**3.1**
Tornado	Possible	Critical	Small	6 to 12 hours	Less than 6 hours	**2.3**
Geologic Hazards						
Earthquakes	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2.0**
Tidal Waves/Tsunami	Unlikely	Limited	Small	Less than 6 hours	More than 24 hours	**1.7**
Hydrologic Hazards						
Erosion	Highly Likely	Minor	Small	More than 24 hours	More than 1 week	**2.4**
Flood	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 1 week	**3.3**
Storm Surge	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Sea Level Rise	Likely	Limited	Small	More than 24 hours	More than 1 week	**2.4**
Other Natural Hazards						
Acts of Terror	Unlikely	Critical	Negligible	Less than 6 hours	Less than 6 hours	**1.9**
Airplane Crash	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Highly Likely	Minor	Moderate	Less than 6 hours	Less than 24 hours	**2.7**

4.22 FINAL DETERMINATIONS

The conclusions drawn from the hazard profiling process for Myrtle Beach, including the PRI results and input from the FMHMPC, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table 4.27**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Myrtle Beach. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately and is described in the *Vulnerability Assessment* section. It should be noted that although some hazards are classified below as

posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

Table 4.26: Conclusions on Hazard Risk for Myrtle Beach

HIGH RISK	Flood Wind Events (Thunderstorm/High Wind) Tropical Storm System/Hurricane Storm Surge
MODERATE RISK	Wildfire Ice Storm Nor'easter Hail Storm Hazardous Materials Incident Sea Level Rise Erosion Lightning
LOW RISK	Tornado Drought Tidal Wave/Tsunami Airplane Crash Earthquake Acts of Terror

SECTION 5

VULNERABILITY ASSESSMENT

44 CFR Requirement

44 CFR Part 201.6(c)(2)(ii): The risk assessment shall include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. The description shall include an overall summary of each hazard and its impact on the community. The plan should describe vulnerability in terms of: (A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; (B) An estimate of the potential losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate; (C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

5.1 OVERVIEW

This section builds upon the information provided in Section 4: *Hazard Identification and Analysis* by identifying and characterizing an inventory of assets in Myrtle Beach and then by assessing the potential impact and amount of damages that can be expected to be caused by each identified hazard event. The primary objective of the vulnerability assessment is to quantify exposure and the potential loss estimates for each hazard. In doing so, Myrtle Beach may better understand its unique risks to identified hazards and be better prepared to evaluate and prioritize specific hazard mitigation actions.

This section begins with an explanation of the methodology applied to complete the vulnerability assessment, followed by a summary description of the asset inventory as compiled for Myrtle Beach. The remainder of this section focuses on the results of the assessment conducted and is organized by hazard as listed below:

- **Atmospheric**
  - 5.4 Drought
  - 5.5 Hailstorm
  - 5.6 Ice Storm
  - 5.7 Lightning
  - 5.8 Nor'easter
  - 5.9 Wind Events/Thunderstorm
  - 5.10 Tornado
  - 5.11 Tropical Storm System/Hurricane

- **Geologic**
  - 5.12 Earthquake
  - 5.13 Tidal Wave/Tsunami

- **Hydrologic**
  - 5.14 Erosion
  - 5.15 Flood
  - 5.16 Storm Surge
  - 5.17 Sea Level Rise

- **Other**
  - 5.18 Acts of Terror
  - 5.19 Airplane Crash
  - 5.20 Hazardous Materials Incident
  - 5.21 Wildfire

5.2 METHODOLOGY

This vulnerability assessment was conducted using two distinct methodologies: (1) utilizing a geographic information system (GIS)-based analysis and (2) applying a statistical risk assessment methodology. Each approach provides estimates for the potential impact of hazards by using a common, systematic framework for evaluation, including historical occurrence information provided in the *Hazard Identification and Analysis* section. The results of the vulnerability assessment for the aforementioned hazards are provided following the information on hazard identification and analysis.

A GIS-based analysis was conducted for the following hazards:

- Tropical Storm System/Hurricane
- Earthquake
- Flood
- Storm Surge
- Sea Level Rise
- Hazardous Materials Incidents
- Wildfire

A statistical risk assessment approach was used to analyze the remaining hazards:

- Drought
- Hailstorm
- Ice Storm
- Lightning
- Nor'easter
- Wind Events/Thunderstorm
- Tornado
- Tidal Wave/Tsunami
- Erosion
- Acts of Terror
- Airplane Crash

A brief description of the two different approaches is provided on the following pages.

5.2.1 GIS-Based Analysis

For the GIS-based analysis, digital data was collected from local, regional, state and national sources. ESRI® ArcGIS™ 10.2 was used to assess hazard vulnerability utilizing this digital data, including local tax assessor records for individual parcels and buildings and georeferenced point locations for identified assets (critical facilities and infrastructure, special populations, etc.). Using these data layers, hazard vulnerability can be quantified by estimating the assessed building value for parcels and/or buildings determined to be located in identified hazard areas. FEMA's Hazus-MH software (further described below) was also used to model hurricane winds, coastal flood, storm surge, and earthquake and estimate potential losses for these hazards. To estimate vulnerable populations in hazard areas, digital Census 2010 data by census block was obtained and census blocks intersecting with hazard areas were used to determine exposed population counts.

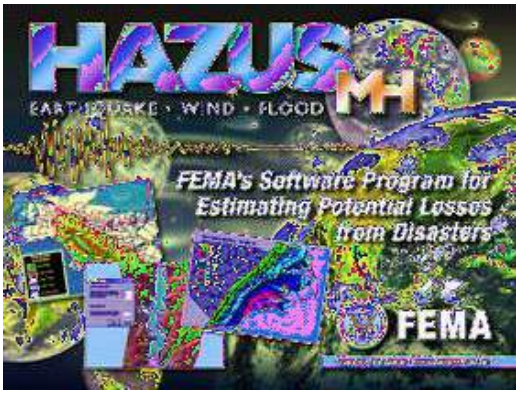
The objective of the GIS-based analysis was to determine the estimated vulnerability of people, buildings, and critical facilities to the identified hazards for Myrtle Beach jurisdictions using best available geospatial data. Local databases were made available through Myrtle Beach including tax assessor records, parcel records, building footprints, and critical facilities data, as well as other regional, state, and federal government data sources were used in combination with digital hazard data as described in the *Hazard Identification and Analysis* section. The results of the analysis provided an estimate of the number of people, buildings, and critical facilities, as well as the value of buildings, determined to be potentially at risk to those hazards with delineable geographic hazard boundaries. A more specific description of the GIS-based analysis conducted for each particular hazard is provided in the individual hazard sections.

5.2.1 Risk Modeling Software Analysis

Hazus-MH

There are several models that exist to model hazards. Hazus-MH was used in this vulnerability assessment to address the aforementioned hazards

Hazus-MH is a standardized loss estimation software program developed by FEMA. It is built upon an integrated GIS platform to conduct analysis at a regional level (i.e., not on a structure-by-structure basis). The Hazus-MH risk assessment methodology is parametric, in that distinct hazard and inventory parameters (e.g., wind speed and building types) can be modeled using the software to determine the impact (i.e., damages and losses) on the built environment.

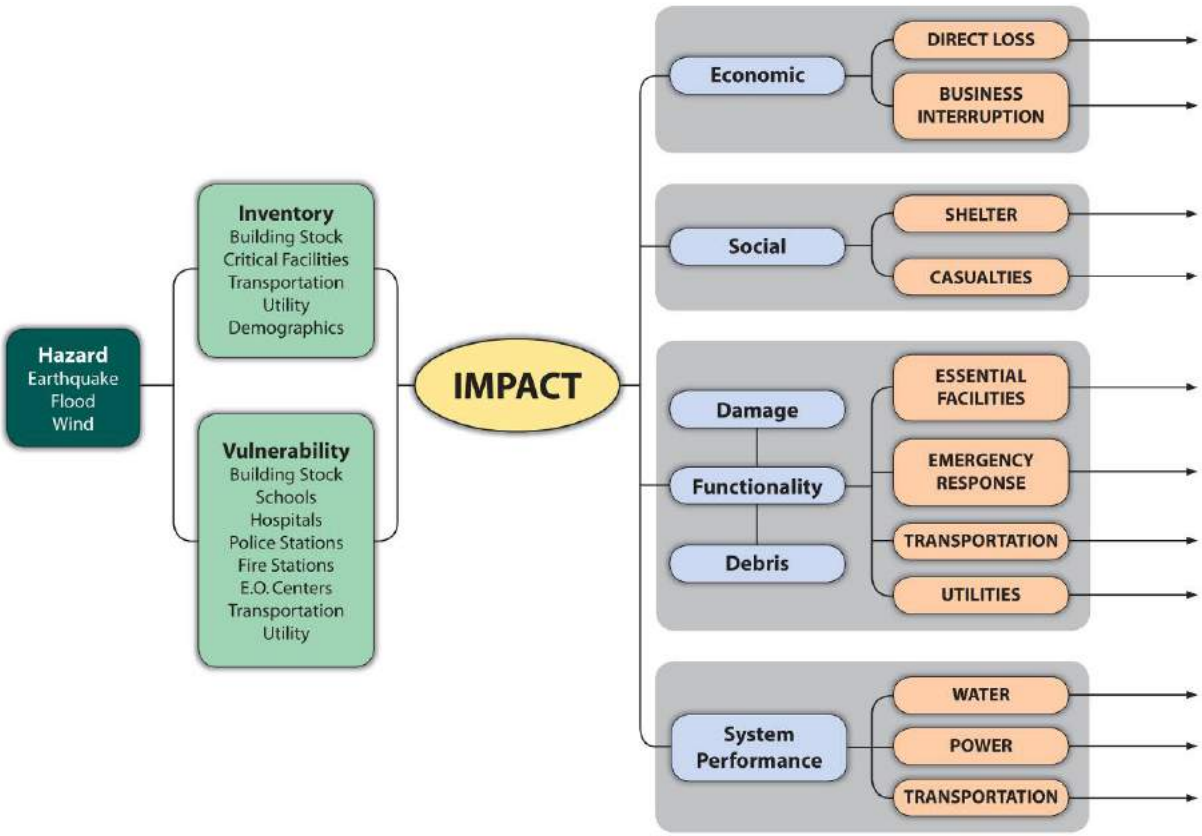


This risk assessment for Myrtle Beach applied Hazus-MH to produce hazard profiles and estimate losses for four hazards for the planning area. At the time this analysis was completed, Hazus-MH 2.2 (2015) was used to estimate potential losses from hurricane winds, coastal flood, storm surge, and earthquake hazards using Hazus-MH methodology. In generating loss estimates through Hazus-MH, some data normalization was necessary to account for recognized differences between actual assessed building values as provided by Myrtle Beach and estimated

replacement building value data as provided within Hazus-MH. In order to account for the difference between modeled and actual values, the ratio of estimated losses produced by Hazus-MH as compared to total Hazus-MH building inventory was used to estimate percent damage. The percent damage ratio was then applied to the local assessed values in order to estimate annualized potential losses and loss ratios in Myrtle Beach for this analysis.

Figure 5.1 illustrates the conceptual model of the HAZUS-MH methodology as applied to Myrtle Beach.

Figure 5.1: Conceptual Model of HAZUS-MH Methodology



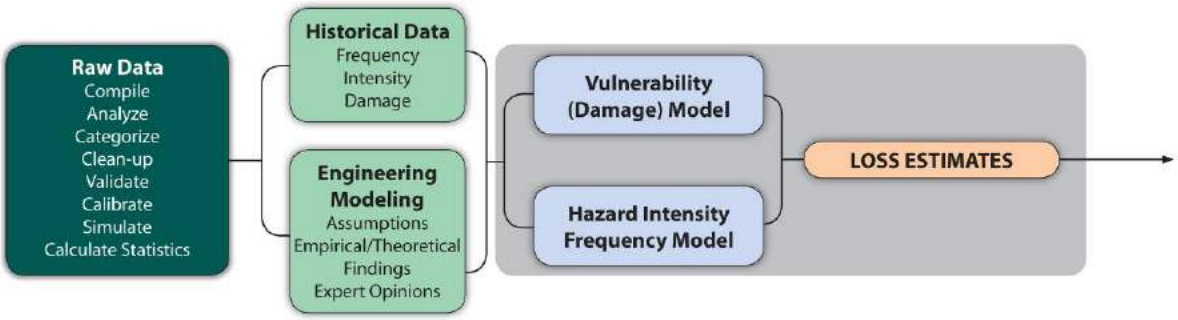
5.2.2 Statistical Risk Assessment Methodology

The statistical risk assessment methodology was applied to analyze hazards of concern that were outside the scope of HAZUS-MH and the GIS-based risk assessment. This includes hazards that do not have geographically-definable boundaries and are therefore excluded from spatial analysis through GIS. Examples include hailstorm, lightning, and tornado. This methodology uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information (presented in the *Hazard Identification and Analysis* section). Historical data for each hazard as described in the *Hazard Identification and Analysis* section was used and statistical evaluations were performed using manual calculations. The general steps used in the statistical risk assessment methodology are summarized below:

1. Compile data from local, state and national sources, as well as literature;
2. Clean up data, including removal of duplicate records and update losses to account for inflation;
3. Identify patterns in frequency, intensity, vulnerability and loss
4. Statistically and probabilistically extrapolate the patterns; and
5. Produce meaningful results, including the development of annualized loss estimates.

Figure 5.2 illustrates a conceptual model of the statistical risk assessment methodology as applied to Myrtle Beach.

Figure 5.2: Conceptual Model of the Statistical Risk Assessment Methodology



The vulnerability assessment findings are presented in terms of potential annualized losses, whenever possible. In general, presenting results in the annualized form is useful in three ways:

1. This approach accounts for the contribution of potential losses from all future disasters;
2. Annualized results for different hazards are readily comparable, thus easier to rank; and
3. The use of annualized losses is the most objective approach for evaluating mitigation alternatives.

The estimated Annualized Loss (AL) addresses the key idea of risk: the probability of the loss occurring in the study area (largely a function of building construction type and quality). By annualizing estimated losses, the AL factors in historic patterns of frequent smaller events with infrequent but larger events to provide a balanced presentation of the risk.

Loss estimates provided in this vulnerability assessment are based on best available data, and the methodologies applied result in an approximation of risk. These estimates should be used to understand relative risk from hazards and potential losses. Uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis (e.g., incomplete inventories, demographics, or economic parameters).

All conclusions are presented in “Conclusions on Hazard Vulnerability” (Section 5.22) at the end of this section. Findings for each hazard are detailed in the hazard-by-hazard vulnerability assessment that follows.

5.3 STUDY AREA DEFINITION

5.3.1 Asset Inventory

An inventory of Myrtle Beach's geo-referenced assets[1] was compiled in order to identify and characterize those properties potentially at risk to the identified hazards. By understanding the type and number of assets that exist and where they are located in relation to known hazard areas, the relative risk and vulnerability for such assets can be assessed. Under this assessment, two categories of assets were created and then further assessed through GIS analysis. The two categories of assets consist of:

1. Improved Property: Includes all improved properties in Myrtle Beach according to local parcel data provided by Myrtle Beach.[2] The information has been expressed in terms of the number of parcels, number of buildings (based upon building footprint data), and total assessed value of improvements (buildings) that may be exposed to the identified hazards.

2. Critical Facilities: Includes airport, fire stations, hospital, police stations, schools, and other critical facilities located within Myrtle Beach.

The following tables provide a detailed listing of the geo-referenced assets that have been identified for inclusion in the vulnerability assessment for Myrtle Beach. While this listing is not all inclusive for assets located in the city, it is anticipated that it will be expanded during future plan updates as more geo-referenced data becomes available for use in GIS analysis.

5.3.2 Improved Property

Table 5.1 lists the number of parcels, the estimated number of buildings and the total assessed value of improvements for participating areas of Myrtle Beach (study area of vulnerability assessment).[3]

Table 5.1: Improved Property in Myrtle Beach

Jurisdiction	Number of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements	Total Market Value of Improvements
Myrtle Beach	32,630	16,537	$241,873,424	$4,472,038,300

Source: Myrtle Beach/Horry County GIS

[1] While potentially not all-inclusive for Myrtle Beach, "georeferenced" assets include those assets for which specific location data is readily available for connecting the asset to a specific geographic location for purposes of GIS analysis. Data for this analysis was obtained from the City of Myrtle Beach and Horry County.
[2] Improved properties in non-participating areas are not included in any way in this vulnerability assessment.
[3] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data as of June 2015. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities.

5.3.3 Critical Facilities

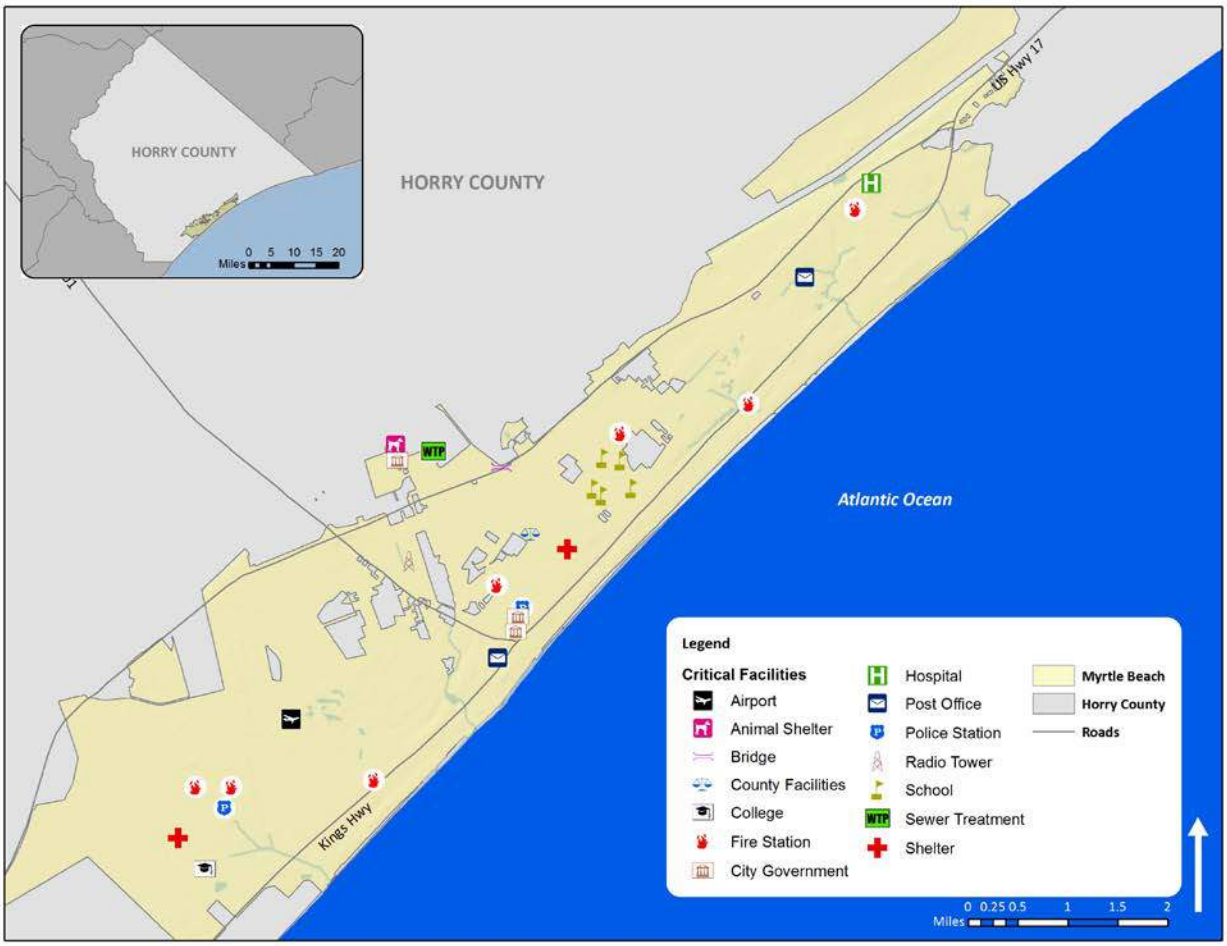
Table 5.2 lists the fire stations, police stations, hospital, airport, and other essential facilities in Myrtle Beach. In addition, **Figure 5.3** shows the locations of essential facilities in Myrtle Beach. **Table 5.49**, near the end of this section, shows a complete list of critical facility names and hazard vulnerability.

Table 5.2: Critical Facilities in Myrtle Beach

Location	Number
Airports	1
Animal Shelters	1
Bridges	3
County Facilities	2
Colleges	3
Fire Stations	7
City Government	6
Hospitals	1
Post Offices	2
Police Stations	2
Radio Towers	1
Schools	5
Sewer Treatment Facilities	1
Shelters	2

Source: City of Myrtle Beach

Figure 5.3: Critical Facility Inventory for the City of Myrtle Beach



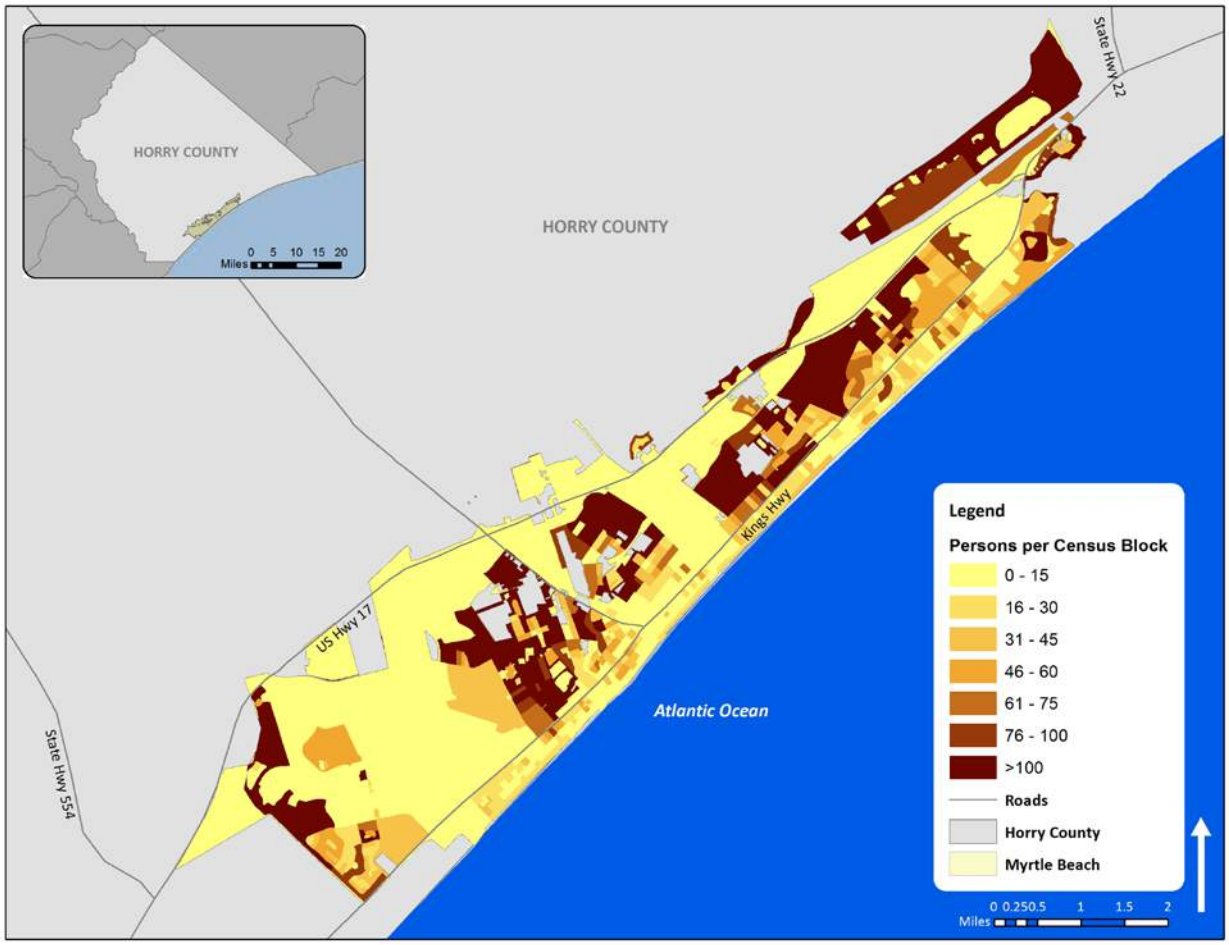
Source: City of Myrtle Beach

5.3.4 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Myrtle Beach that are potentially at risk to these hazards. Although the average daily population is estimated at 105,000 people. During peak tourism season, it's not unusual to have 300,000 or more people that visit the area during the summer months. Further information on population can be found in Section 3, *Community Profile*.

Figure 5.4 illustrates the residential population density across the city as it was reported by the U.S. Census Bureau in 2010 at the census block level. The total population in Myrtle Beach according to Census data was 27,109 persons. However, the population can have large influxes based on visitors and short-term residents. As can be seen in the figure, most of the city's population is located along or near major transportation routes and waterways. More specific information on the estimated number of people living within identified hazard areas is provided for each hazard within this section.

Figure 5.4: Population Density in Myrtle Beach



Source: U.S. Census Bureau, 2010

Finally, since Myrtle Beach is a beach community that attracts a large tourist population each year, it is important to recognize the large seasonal population that is present in the city, especially during the peak season which generally runs from March through October. During this time, the city's population swells and there are many more people at risk to the hazards identified below. Indeed, according to the U.S. Census, in 2010, there were 8,505 housing units that were classified as being for seasonal, recreational, or occasional use out of 23,262 total units. By these counts, that means that just over one third of the housing units in the city are occupied only part of the year, likely by tourists during the peak season.

If these numbers are applied to roughly gauge the change in population in the city from non-peak to peak season, it would indicate that there is at least a 33 percent increase in the number of people present from non-peak to peak season, and the number is likely higher as many tourists come in larger groups than the average household size. This has significant implications for emergency management and planning for the city because there will be significantly more people to account for when it comes to evacuating populations and providing protection/mitigation to people and property.

5.3.4 Development Trends and Changes in Vulnerability

Since the previous hazard mitigation plan was approved in 2010, Myrtle Beach has experienced some growth and development. **Table 5.3** shows the number of building units constructed since 2010 according to the U.S. Census American Community Survey.

Table 5.3: Building Counts for Myrtle Beach

Jurisdiction	Total Housing Units (2013)	Units Built 2010 or later	% Building Stock Built Post-2010
Myrtle Beach	22,579	158	0.7

Source: United States Census Bureau

Table 5.4 shows population growth estimates for the city from 2010 to 2013 based on the U.S. Census Annual Estimates of Resident Population.

Table 5.4: Population Growth for Myrtle Beach

Jurisdiction	Population Estimates (as of July 1)				% Change 2010-2013
	2010	2011	2012	2013	
Myrtle Beach	26,696	27,079	27,433	27,884	4.3%

Note: July 1 population estimates were used in this table to allow comparison of annual population counts (April 1 Census estimates were used for all other population counts throughout the plan which is why the counts may differ).
Source: United States Census Bureau

Based on the data above, there has been a low rate of residential housing development in the county since 2010. However, it should be noted that the city is essentially built out in many areas. Additionally, there has been some significant population growth in the city since 2010. Since the population has increased, there is now a greater number of people exposed to the identified hazards. Therefore, development and population growth have impacted the city's vulnerability since the previous local hazard mitigation plan was approved and there has been some increase in the overall vulnerability.

It is also important to note that as development increases in the future, greater populations and more structures and infrastructure will be exposed to potential hazards if development occurs in the floodplains, storm surge zones, sea level rise inundation areas, primary and secondary hazardous materials buffers, or high wildfire risk areas.

Atmospheric Hazards

5.4 DROUGHT

PRI Value: 2.1
Annualized Loss Estimate: *Negligible*

According to the qualitative assessment performed using the PRI tool, the drought hazard scored a PRI value of 2.1 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.5** summarizes the risk levels assigned to each PRI category.

Table 5.5: Qualitative Assessment for Drought and Heat Wave

Probability	Likely
Impact	Minor
Spatial Extent	Small
Warning Time	Less than 6 hours
Duration	Less than 6 hours

Because it cannot be predicted where drought may occur, all existing and future buildings, facilities, and populations in Myrtle Beach are considered to be equally exposed to this hazard and could potentially be impacted. These results are shown **Tables 5.1-5.3**. It is important to note that only reported drought events have been factored into this vulnerability assessment.[4]

Table 5.6 shows total exposure and potential annualized property losses and percent loss ratios resulting from the drought hazard for Myrtle Beach.

Table 5.6: Total Exposure and Potential Annualized Losses from Drought

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$0

5.4.1 Asset Vulnerability

All of the inventoried assets in Myrtle Beach are equally exposed to the drought hazard, and any anticipated future damages or losses are expected to be minimal.

5.5 HAILSTORM

[4] It is possible that additional drought events may have occurred since 1950 that were not reported to NCDC and are not accounted for in this analysis.

PRI Value: 2.6
Annualized Loss Estimate: *$610*

According to the qualitative assessment performed using the PRI tool, the hail hazard scored a PRI value of 2.6 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.7** summarizes the risk levels assigned to each PRI category.

Table 5.7: Qualitative Assessment for Hail

Probability	Highly Likely
Impact	Minor
Spatial Extent	Moderate
Warning Time	Less than 6 hours
Duration	Less than 6 hours

Because it cannot be predicted where hail may fall, all existing and future buildings, facilities, and populations in Myrtle Beach are considered to be equally exposed to this hazard and could potentially be impacted (**Tables 5.1-5.3**). It is important to note that only reported hail events have been factored into this vulnerability assessment.[5]

To estimate losses due to lightning, NCDC historical hailstorm loss data was used to develop a hailstorm stochastic model. In this model:

- Losses were scaled for inflation;
- Expected annualized losses were calculated through a non-linear regression of historical data.

Table 5.8 shows total exposure and potential annualized property losses and percent loss ratios resulting from the hailstorm hazard for Myrtle Beach.

Table 5.8: Total Exposure and Potential Annualized Losses from Hailstorm

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$610

5.5.1 Asset Vulnerability

While all of the inventoried assets in Myrtle Beach are equally exposed to the hail hazard, any anticipated future damages or losses are expected to be minimal. Specific critical facilities can be found in **Table 5.49** near the end of this section.

5.6 ICE STORM

[5] It is possible that additional hail events may have occurred since 1950 that were not reported to NCDC and are not accounted for in this analysis.

PRI Value: 2.7
Annualized Loss Estimate: *Negligible*

According to the qualitative assessment performed using the PRI tool, the ice storm hazard scored a PRI value of 2.7 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.9** summarizes the risk levels assigned to each PRI category.

Table 5.9: Qualitative Assessment for Ice Storm

Probability	Possible
Impact	Critical
Spatial Extent	Large
Warning Time	More than 24 hours
Duration	Less than one week

Because it cannot be predicted where an ice storm or winter storm (as defined in the *Hazard Identification and Analysis* section) may occur, all existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted. These results are shown in **Tables 5.1-5.3**. It is important to note that only reported ice/winter storm occurrences have been factored into this vulnerability assessment.[6]

Although NCDC does not report any historical damage, local records show at least $256,000 in past damages to property due to ice/winter storms.

Table 5.10 shows total exposure and potential annualized property losses and percent loss ratios resulting from the ice storm hazard for Myrtle Beach.

Table 5.10: Total Exposure and Potential Annualized Losses from Ice Storm

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$12,190

5.6.1 Asset Vulnerability

All of the inventoried assets in Myrtle Beach are exposed to the winter weather hazard (**Table 5.49**). Specific vulnerabilities for these assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates.

5.7 LIGHTNING

[6] It is possible that additional winter storm and freeze events may have occurred since 1950 that were not reported to NCDC and are not accounted for in this analysis.

PRI Value: 2.4
Annualized Loss Estimate: $45,325

According to the qualitative assessment performed using the PRI tool, the lightning hazard scored a PRI value of 2.2 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.11** summarizes the risk levels assigned to each PRI category.

Table 5.11: Qualitative Assessment for Lightning

Probability	Highly Likely
Impact	Minor
Spatial Extent	Negligible
Warning Time	Less than 6 hours
Duration	Less than 6 hours

Because it cannot be predicted where lightning may strike, all existing and future buildings, facilities, and populations in Myrtle Beach are considered to be exposed to this hazard and could potentially be impacted. These results are shown in **Tables 5.1-5.3**. It is important to note that only reported lightning strikes have been factored into this vulnerability assessment.[7]

To estimate losses due to lightning, NCDC historical lightning loss data was used to develop a lightning stochastic model. In this model:

- Losses were scaled for inflation;
- Expected annualized losses were calculated through a non-linear regression of historical data.

Table 5.12 shows total exposure and potential annualized property losses and percent loss ratios resulting from the lightning hazard for Myrtle Beach.

Table 5.12: Total Exposure and Potential Annualized Losses from Lightning

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$45,325

5.7.1 Asset Vulnerability

While all of the inventoried assets in Myrtle Beach are equally exposed to the lightning hazard, any anticipated future damages or losses are expected to be minimal. Inventoried critical facilities in Myrtle Beach can be found in **Table 5.49** near in the end of this section.

5.8 NOR'EASTER

[7] It is possible that additional lightning strikes may have occurred since 1950 that were not reported to NCDC and are not accounted for in this analysis.

PRI Value: 2.7
Annualized Loss Estimate: Negligible

According to the qualitative assessment performed using the PRI tool, the nor'easter hazard scored a PRI value of 2.7 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.13** summarizes the risk levels assigned to each PRI category.

Table 5.13: Qualitative Assessment for a Nor'easter

Probability	Possible
Impact	Critical
Spatial Extent	Large
Warning Time	More than 24 hours
Duration	Less than one week

Because it cannot be predicted what areas a nor'easter may affect, all existing and future buildings, facilities, and populations in Myrtle Beach are considered to be exposed to this hazard and could potentially be impacted. These results are shown in **Tables 5.1-5.3**.

Given the lack of historical loss data on significant nor'easter damage occurrences in Myrtle Beach, it is assumed that while one major event could potentially result in significant losses due to nor'easters, annualizing structural losses over a long period of time would most likely yield a very low annualized loss estimate for the city.

Although NCDC does not report any historical damage, local records show around $14.8 million in damages to property across Horry County from the 1987 Nor'easter.

Table 5.14 shows total exposure and potential annualized property losses and percent loss ratios resulting from the nor'easter hazard for Myrtle Beach.

Table 5.14: Total Exposure and Potential Annualized Losses from Nor'easter

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$0

5.8.1 Asset Vulnerability

While all of the inventoried assets in Myrtle Beach are equally exposed to the Nor'easter hazard, any anticipated future damages or losses are expected to be minimal. Inventoried critical facilities for Myrtle Beach can be found in **Table 5.49** near the end of this section.

5.9 WIND EVENTS (THUNDERSTORM)

PRI Value: 3.1
Annualized Loss Estimate: $93,425

According to the qualitative assessment performed using the PRI tool, the wind event hazard scored a PRI value of 3.1 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.15** summarizes the risk levels assigned to each PRI category.

Table 5.15: Qualitative Assessment for Wind Events

Probability	Highly Likely
Impact	Limited
Spatial Extent	Large
Warning Time	Less than 6 hours
Duration	Less than 6 hours

Historical evidence shows that the city is vulnerable to thunderstorm and severe wind hazards. This is an atmospheric hazard, so all existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted. These results are shown in **Tables 5.1-5.3**. It is important to note that only reported thunderstorm wind events have been factored into this vulnerability assessment.[8]

To estimate losses due to severe thunderstorm wind, NCDC data for occurrences in Myrtle Beach was used to develop a severe thunderstorm stochastic model. In this model:

- Losses were scaled for inflation;
- Expected annualized losses were calculated through a non-linear regression of historical data.

Table 5.16 shows total exposure and potential annualized property losses and percent loss ratios resulting from the severe thunderstorm wind hazard for Myrtle Beach.

Table 5.16: Total Exposure and Potential Annualized Losses from Severe Thunderstorm Wind

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$93,425

5.9.1 Asset Vulnerability

All of the inventoried assets in Myrtle Beach are exposed to the severe thunderstorm wind hazard. Specific vulnerabilities for these assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are

[8] It is possible that additional thunderstorm events may have occurred since 1950 that were not reported to NCDC and are not accounted for in this analysis.

outside the scope of this assessment but will be considered during future plan updates. A complete list of critical facilities at risk can be found in **Table 5.49** near the end of this section.

5.10 TORNADO

PRI Value: 2.3
Annualized Loss Estimate: $593,972

According to the qualitative assessment performed using the PRI tool, the tornado hazard scored a PRI value of 2.4 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.17** summarizes the risk levels assigned to each PRI category.

Table 5.17: Qualitative Assessment for Tornado

Probability	Possible
Impact	Critical
Spatial Extent	Small
Warning Time	Less than 6 hours
Duration	Less than 6 hours

Historical evidence shows that the city is vulnerable to tornadic activity. This hazard can result from severe thunderstorm activity or may occur during a major tropical storm or hurricane. Because it cannot be predicted where a tornado may touch down, all existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted. These results are shown in **Tables 5.1-5.3**. It is important to note that only reported tornadoes have been factored into this vulnerability assessment[9].

To estimate losses due to tornadoes, NCDC historical tornado loss data for occurrences in Myrtle Beach was used to develop a tornado stochastic model. In this model:

- Losses were scaled for inflation;
- Expected annualized losses were calculated through a non-linear regression of historical data.

Table 5.18 shows total exposure and potential annualized property losses and percent loss ratios resulting from the tornado hazard for Myrtle Beach.

Table 5.18: Total Exposure and Potential Annualized Losses from Tornado

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$593,972

[9] It is possible that additional tornado events may have occurred since 1950 that were not reported to NCDC and are not accounted for in this analysis.

5.10.1 Asset Vulnerability

All of the inventoried assets in Myrtle Beach are exposed to the tornado hazard (**Table 5.40**). Specific vulnerabilities for these assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates.

5.11 TROPICAL STORM SYSTEM/HURRICANE

PRI Value: 2.9
Annualized Loss Estimate: $8,488,637

According to the qualitative assessment performed using the PRI tool, the tropical storm system and hurricane hazard scored a PRI value of 2.9 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.19** summarizes the risk levels assigned to each PRI category.

Table 5.19: Qualitative Assessment for Tropical Storm System and Hurricane

Probability	Likely
Impact	Critical
Spatial Extent	Large
Warning Time	More than 24 hours
Duration	Less than 24 hours

Because hurricanes and tropical storms often impact large areas and cross jurisdictional boundaries, all existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted. These results are shown in **Tables 5.1-5.3**. Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, coastal erosion, high winds, and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. However, the current HAZUS-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. Vulnerability to storm surge resulting from hurricanes is addressed individually in a separate section.

It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table 5.20.** In the comparative annualized loss analysis at the end of this section, only losses to buildings are reported in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

Table 5.20: Annualized Loss Estimations for Hurricane Wind Hazard

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Horry County	$70,287,000	$24,784,000	$170,000	$95,241,000

Source: Hazus-MH 2.2

A probabilistic scenario was created using HAZUS-MH to assess the vulnerability of Myrtle Beach to hurricane winds. Default HAZUS-MH wind speed data, damage functions, and methodology were used to determine the potential estimated losses for 50-, 100-, 200-, 500-, and 1000-year frequency events. Since this information on loss estimation was only available at the county level, Myrtle Beach loss was calculated by utilizing the county-level estimate and attributing a proportion of that estimate based on the ratio of building counts in Myrtle Beach to building counts in Horry County, as per American Community Survey 2013 data. It should be noted that since Myrtle Beach is a developed community located directly on the coast, it is likely that this calculation likely underestimates losses from hurricanes. **Table 5.21** shows estimated potential losses to improved properties in incorporated Myrtle Beach for 50-, 100-, 200-, 500-, and 1000-year hurricane wind event scenarios.

Table 5.21: Potential Losses to Improved Property from Tropical Storm Systems and Hurricanes by Return Period

Return Period	Estimated Potential Losses
10-year	$2,167,322
20-year	$17,140,118
50-year	$77,265,507
100-year	$184,964,450
200-year	$391,358,717
500-year	$839,953,421
1000-year	$1,200,273,448

Source: HAZUS-MH, 2.2

Table 5.22 shows total exposure and potential annualized property losses and percent loss ratios resulting from the tropical storm system and hurricane hazard for Myrtle Beach. As explained above, overall annualized loss was calculated by utilizing the county-level estimate and attributing a proportion of that estimate based on the ratio of building counts in Myrtle Beach to building counts in Horry County.

Table 5.22: Total Exposure and Potential Annualized Losses from Tropical Storm Systems and Hurricanes

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$8,488,637

5.11.1 Asset Vulnerability

All of the assets inventoried in Myrtle Beach are exposed to hurricane and coastal storm wind (**Table 5.49**). Specific vulnerabilities for these assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates.

Geologic Hazards

5.12 EARTHQUAKE

PRI Value: 2.0
Annualized Loss Estimate: $24,563

According to the qualitative assessment performed using the PRI tool, the earthquake hazard scored a PRI value of 2.0 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.23** summarizes the risk levels assigned to each PRI category.

Table 5.23: Qualitative Assessment for Earthquake

Probability	Unlikely
Impact	Minor
Spatial Extent	Moderate
Warning Time	Less than 6 hours
Duration	Less than 6 hours

An earthquake has the potential to impact all existing and future buildings, facilities, and populations. These results are shown in **Tables 5.1-5.3**.

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this section only utilize building losses in order to provide consistency with other hazards. **Table 5.24** summarizes the findings.

Table 5.24: Annualized Loss Estimations for Earthquake Hazard

Location	Structural Loss	Non-Structural Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Horry County	$203,000	$686,000	$232,000	4,000	$1,125,000

Source: Hazus-MH 2.2

Table 5.25 shows total exposure and potential annualized property losses and percent loss ratios resulting from the earthquake hazard for Myrtle Beach. Since the best available information on loss estimation was only available at the county level, annualized loss was calculated by utilizing the county-level estimate and attributing a proportion of that estimate based on the ratio of building counts in Myrtle Beach to building counts in Horry County based on American Community Survey 2013 data.

Table 5.25: Total Exposure and Potential Annualized Losses from Earthquake

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$24,563

5.12.1 Asset Vulnerability

All of the inventoried assets in Myrtle Beach are exposed to the earthquake hazard (**Table 5.49**). Specific vulnerabilities for these assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates.

5.13 TIDAL WAVE/TSUNAMI

PRI Value: 1.7
Annualized Loss Estimate: Negligible

According to the qualitative assessment performed using the PRI tool, the tsunami hazard scored a PRI value of 1.7 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.26** summarizes the risk levels assigned to each PRI category.

Table 5.26: Qualitative Assessment for Tidal Wave and Tsunami

Probability	Unlikely
Impact	Limited
Spatial Extent	Small
Warning Time	Less 6 hours
Duration	More than 24 hours

Table 5.27 shows total exposure and potential annualized property losses and percent loss ratios resulting from the tidal wave/tsunami hazard for Myrtle Beach.

Table 5.27: Total Exposure and Potential Annualized Losses from Tidal Wave/Tsunami

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$0

5.13.1 Asset Vulnerability

It is assumed that the City's vulnerability to this hazard would be very similar to results calculated for storm surge.

Hydrologic Hazards

5.14 EROSION

PRI Value: 2.4
Annualized Loss Estimate: Negligible

According to the qualitative assessment performed using the PRI tool, the erosion hazard scored a PRI value of 2.4 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.28** summarizes the risk levels assigned to each PRI category.

Table 5.28: Qualitative Assessment for Erosion

Probability	Highly Likely
Impact	Minor
Spatial Extent	Small
Warning Time	More than 24 hours
Duration	More than 1 week

Table 5.29 shows total exposure and potential annualized property losses and percent loss ratios resulting from the erosion hazard for Myrtle Beach. A distance of 100 yards from the shoreline was utilized to give a rough estimate of the number of people, properties, and facilities at risk to erosion. This distance was chosen because it generally encompasses structures that are along the coastline. It should be noted that the population estimate is likely low because it is calculated using Census data which reflects permanent residents, many of whom do not live along the coastline.

Table 5.29: Total Exposure and Potential Annualized Losses from Erosion

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	304	$73,147,430	$0

5.13.1 Asset Vulnerability

According to the SC Department of Health and Environmental Control, all of Myrtle Beach is classified as a standard erosion zone which means it is a segment of shoreline not directly influenced by an inlet or associated shoals. Because the annual rate of erosion for all survey monuments is also relatively similar across the city at -0.59, all assets are considered to be at some risk to erosion. However, it should be noted that assets located closer to the ocean and directly along the shoreline are at highest risk to erosion. No critical facilities are located directly adjacent to the shoreline.

5.15 FLOOD

PRI Value: 3.3
Annualized Loss Estimate: $257,381

According to the qualitative assessment performed using the PRI tool, the flood hazard scored a PRI value of 3.4 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.30** summarizes the risk levels assigned to each PRI category.

Table 5.30: Qualitative Assessment for Flood

Probability	Highly Likely
Impact	Critical
Spatial Extent	Moderate
Warning Time	6 to 12 hours
Duration	Less than one week

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records (2015). The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified Zone A/AE (1-percent-annual-chance floodplain), Zone VE (1-percent-annual-chance coastal flood zone with associated wave action), Zone X500 (0.2-percent-annual-chance floodplain), and the floodway if/where applicable. **Table 5.31** lists the number of properties determined to be located within each of the special flood hazard areas along with the improved values for structures located on those properties.

Table 5.31: Total Exposure of Improved Properties to Flood[10]

JURISDICTION	Estimated Number of Buildings At Risk	Estimated Assessed Value of Improved Buildings At Risk
AT-RISK (1-PERCENT-ANNUAL-CHANCE FLOOD)		
Myrtle Beach	1.193	$61,763,774
AT-RISK (COASTAL VE ZONE)		
Myrtle Beach	472	$93,670,746
AT-RISK (0.2-PERCENT-ANNUAL-CHANCE FLOOD)		
Myrtle Beach	1,280	$35,451,340

Hazus-MH was used to estimate potential losses in Myrtle Beach resulting from potential coastal flood events. A Digital Elevation Model (DEM) was obtained from the U.S. Geological Survey (USGS) for the study area coordinates for input and flood depth was estimated at the pixel level for affected areas, along with the proportion of the area affected within the census block. Transects and stillwater elevations were input from data provided in the 2003 FEMA Flood Insurance Study for this area. Hazus-MH was utilized to estimate floodplain boundaries, potential exposure for each event frequency, and

[10] Since many structures and parcels are located within more than one flood zone, this exposure analysis likely overestimates the total number and dollar value that are located within all areas of flood risk because some structures/parcels are counted within multiple zones.

loss estimates based on probabilistic scenarios for 10-, 50-, 100-, 200-, and 500-year flood events using a Level 1 analysis and through data normalization using 2007 tax assessed property values. **Table 5.32** shows estimated potential losses for 10-, 50-, 100-, 200-, and 500-year flood event scenarios that resulted from this analysis.

Table 5.32: Potential Losses to Improved Property from Flood by Return Period

Return Period	Estimated Potential Losses
10-year	$17,077,760
50-year	$55,221,771
100-year	$100,924,637
200-year	$114,974,503
500-year	$205,146,073

Source: Hazus-MH

Table 5.33 shows total exposure and potential annualized property losses and percent loss ratios resulting from the flood hazard analysis for Myrtle Beach.

Table 5.33: Total Exposure and Potential Annualized Losses from Flood

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	10,317	$190,885,860	$257,381

Source: Hazus-MH and Horry County Tax Assessor Data

5.15.1 Asset Vulnerability

There are no inventoried assets for Myrtle Beach determined to be vulnerable to the effects of flood. That is to say, none are located specifically in the identified floodplain. However, it is possible that some assets may be vulnerable to flooding from stormwater or from higher magnitude events.

5.16 STORM SURGE

PRI Value: 2.9
Annualized Loss Estimate: $145,591,250

According to the qualitative assessment performed using the PRI tool, the storm surge hazard scored a PRI value of 2.7 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.34** summarizes the risk levels assigned to each PRI category.

Table 5.34: Qualitative Assessment for Storm Surge

Probability	Likely
Impact	Critical
Spatial Extent	Moderate
Warning Time	More than 24 hours
Duration	Less than 24 hours

As discussed in the *Hazard Identification and Analysis* section, storm surge is a flood hazard which is related to hurricanes, but differs from coastal flood events. Only storm surge related to hurricanes is analyzed in this section.

The surge hazard was modeled using SLOSH (Sea, Lake, and Overland Surges from Hurricane). SLOSH was developed by the National Hurricane Center, FEMA, and the Army Corp of Engineers. The SLOSH Maximum of the MEOWs (MOM) data was used to determine SLOSH vulnerability.[11] MOM is a composite of the Maximum Envelope of Water (MEOW), which is generated by running several hypothetical hurricanes and collecting their associated surge heights. The MOM uses the maximum recorded surge height from the MEOW scenarios for each grid block. The data used for Myrtle Beach was updated as of 2010 and was taken from the SC northern conglomerate SLOSH basin. For the vulnerability assessment, critical facilities were overlaid on the surge areas to determine the height of surge (above mean sea level) for each facility.

Table 5.35 lists the number of properties determined to be located within each of the defined storm surge inundation zones in the City along with the improved values for structures located on those properties. It should be noted that this estimation does not take into account whether structures have been elevated or otherwise protected against storm surge impacts. It simply identifies properties and are located within the inundation zones and which could potentially be impacted.

Table 5.35: Total Exposure of Improved Properties to Storm Surge

Storm Surge Inundation Zone	Number of Properties	Total Assessed Value of Improvements (Buildings)	Total Market Value of Improvements (Buildings)
Category 1	145	$19,052,342	$337,376,600
Category 2	1,160	$101,3485,06	$1,774,346,400
Category 3	5,204	$145,591,250	$2,603,937,800
Category 4	12,639	$212,404,416	$3,881,692,200
Category 5	15,392	$231,744,950	$4,266,314,800

Table 5.36 shows total exposure and potential annualized property losses and percent loss ratios resulting from the Category 3 storm surge hazard analysis for Myrtle Beach.

[11] The SLOSH training manual indicates that SLOSH is accurate within +/- 20 percent.

Table 5.36: Total Exposure and Potential Annualized Losses from Category 3 Storm Surge

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	15,629	$145,591,250	$0

5.16.1 Asset Vulnerability

There are a total of 39 inventoried assets in Myrtle Beach determined to be vulnerable to the effects of storm surge. A Category Three storm threatens Myrtle Beach Fire Station 2. A Category Four storm threatens 28 of the 41 critical facilities identified in this analysis. Finally, a Category Five storm threatens every critical facility identified in this analysis with the exception of Fire Station 5 and Grand Strand Medical Center. All of the assets determined to be at risk to storm surge are listed in **Table 5.49** toward the end of this section.

5.17 SEA LEVEL RISE

PRI Value: 2.4
Annualized Loss Estimate: *Undetermined*

According to the qualitative assessment performed using the PRI tool, the sea level rise hazard scored a PRI value of 2.1 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.37** summarizes the risk levels assigned to each PRI category.

Table 5.37: Qualitative Assessment for Sea Level Rise

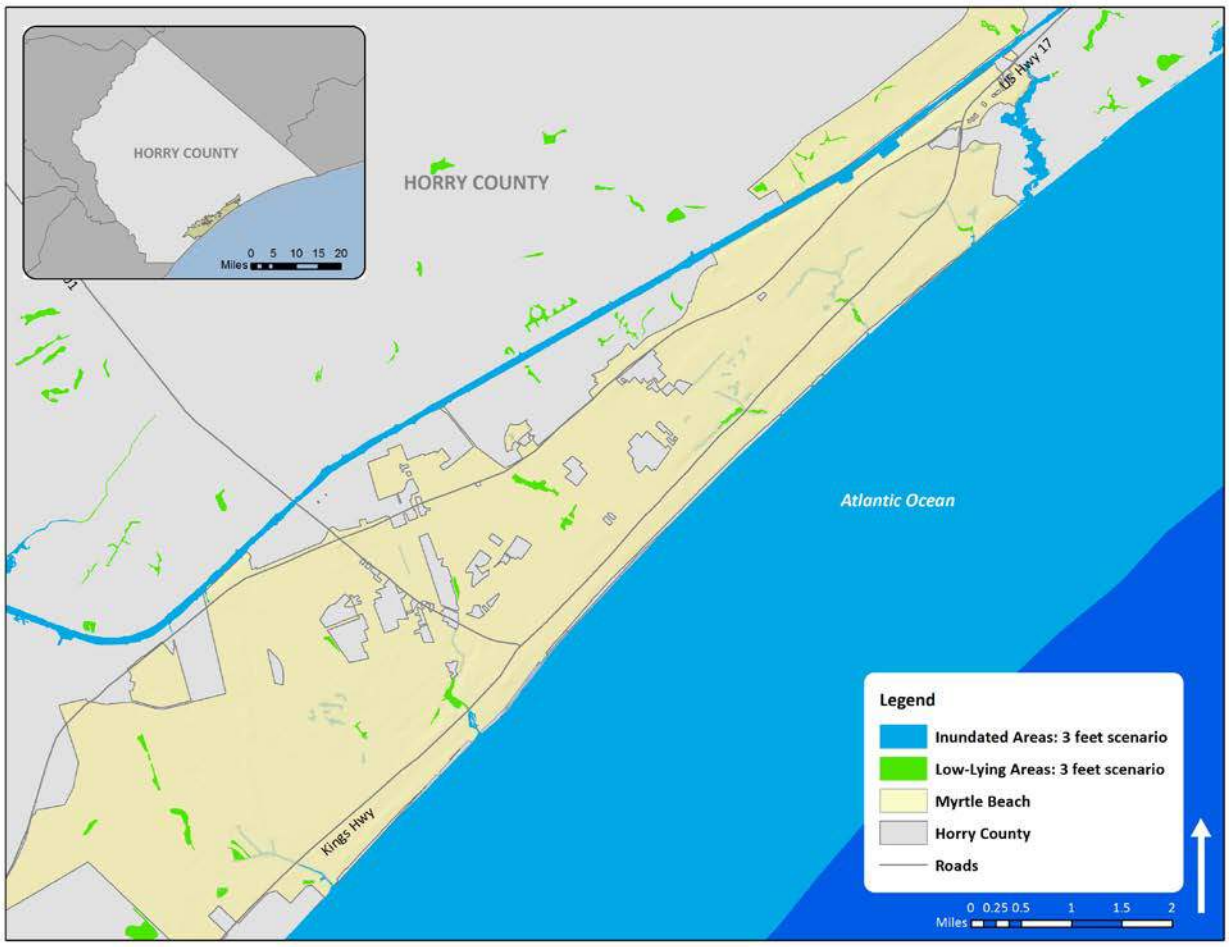
Probability	Likely
Impact	Minor
Spatial Extent	Small
Warning Time	More than 24 hours
Duration	More than one week

Sea Level Rise can cause loss of property, habitat, and valuable tourism dollars. However, measuring its affects can be difficult. For this analysis, data provided by the South Carolina Emergency Management Division was used. This data, highlighted in Section 4: *Hazard Identification and Analysis*, shows sea level rise scenarios at 0.6meter, 1.0 meter, 3.0 meters, and 6 meters.

In order to determine vulnerability, parcel information was overlaid on the sea level affected areas for each “zone” (3 feet and 6 feet of sea level rise) using geographic information system (GIS). Structures located within an affected area are considered to be vulnerable. **Figure 5.5** shows the affected areas in Myrtle Beach for the 3 feet scenario and **Figure 5.6** shows the 6 feet scenario. **Table 5.38** shows the complete results of the analysis, including number of structures in a sea level rise zone and the improved value of the vulnerable structures.

Low-lying areas, displayed in green, are hydrologically "unconnected" areas that may flood. They are determined solely by how well the elevation data captures the area's hydraulics. A more detailed analysis of these areas is required to determine the susceptibility to flooding.[12]

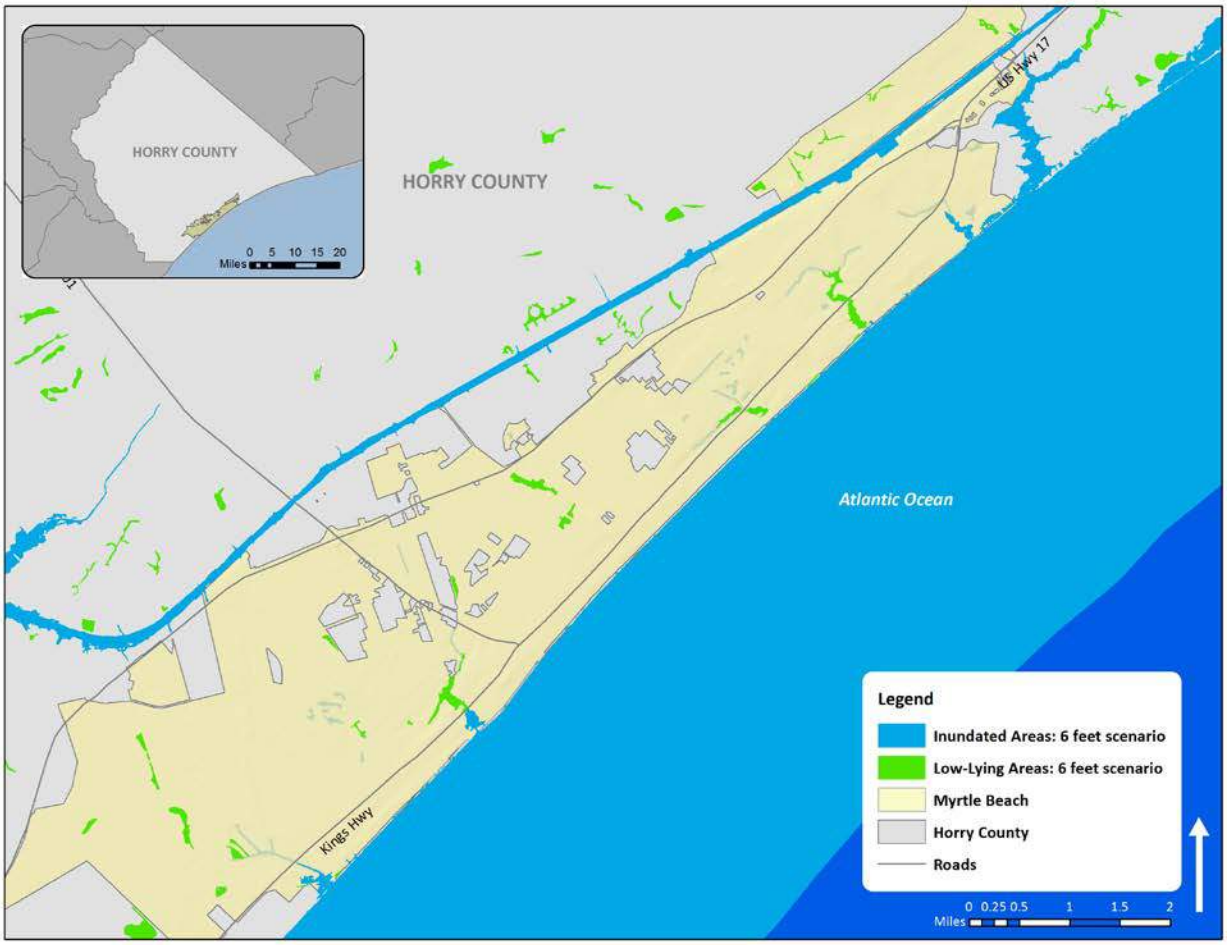
Figure 5.5: Areas Affected by 3 feet of Sea Level Rise



Source: NOAA Office of Coastal Management

[12] NOAA Office of Coastal Management, Sea Level Rise Viewer

Figure 5.6: Areas Affected by 6 feet of Sea Level Rise



Source: NOAA Office of Coastal Management

Table 5.38: Total Exposure and Potential Annualized Losses from Sea Level Rise Hazard

Sea Level Rise Scenario	Estimated Population at Risk	Number of Structures	Total Assessed Value of Improvements (Buildings)
Inundated Areas: 3 feet	581	46	$2,918,484
Low-Lying Areas: 3 feet	1,753	18	$4,251,206
Inundated Areas: 6 feet	740	113	$15,081,716
Low-Lying Areas: 6 feet	3,039	73	$11,037,776

5.20.1 Asset Vulnerability

No critical facilities were found to be vulnerable to Sea Level Rise in either the 3 feet or the 6 feet scenario.

Other Hazards

5.18 ACTS OF TERROR

PRI Value: 1.9
Annualized Loss Estimate: *Negligible*

According to the qualitative assessment performed using the PRI tool, the terror hazard scored a PRI value of 1.9 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.39** summarizes the risk levels assigned to each PRI category.

Table 5.39: Qualitative Assessment for Acts of Terror

Probability	Unlikely
Impact	Critical
Spatial Extent	Negligible
Warning Time	Less than 6 hours
Duration	Less than 6 hours

It cannot be predicted where an act of terror may occur, so all existing and future buildings, facilities, and populations in Myrtle Beach are considered to be equally exposed to this hazard and could potentially be impacted. This cumulative vulnerability is shown in **Tables 5.1-5.3**.

Given the lack of historical loss data on terror events in the Myrtle Beach, while it is assumed that one major event could potentially result in significant losses, annualizing structural losses over a long period of time would most likely yield a very low annualized loss estimate for the city.

Table 5.40 shows total exposure and potential annualized property losses and percent loss ratios resulting from the acts of terror hazard for Myrtle Beach.

Table 5.40: Total Exposure and Potential Annualized Losses from Acts of Terror

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$0

5.17.1 Asset Vulnerability

All of the inventoried assets in Myrtle Beach are exposed to a terrorist attack (**Table 5.49**).

5.19 AIRPLANE CRASH

PRI Value: 2.1
Annualized Loss Estimate: *Negligible*

According to the qualitative assessment performed using the PRI tool, the airplane crash hazard scored a PRI value of 2.1 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.41** summarizes the risk levels assigned to each PRI category.

Table 5.41: Qualitative Assessment for Airplane Crash

Probability	Unlikely
Impact	Critical
Spatial Extent	Small
Warning Time	Less than 6 hours
Duration	Less than 6 hours

An airplane crash could occur anywhere in the city, so all existing and future buildings, facilities, and populations in Myrtle Beach are considered to be equally exposed to this hazard. These results are shown **Tables 5.1-5.3**.

Table 5.42 shows total exposure and potential annualized property losses and percent loss ratios resulting from the airplane crash hazard for Myrtle Beach.

Table 5.42: Total Exposure and Potential Annualized Losses from Lightning

Location	Estimated Population At Risk	Total Assessed Value of Improvements (Buildings)	Annualized Expected Property Losses
Myrtle Beach	27,109	$4,472,038,300	$0

5.18.1 Asset Vulnerability

All of the inventoried assets in Myrtle Beach are potentially at-risk to an airplane crash. These assets are listed in **Table 5.49** near the end of this section.

5.20 HAZARDOUS MATERIALS INCIDENTS

PRI Value: 2.5
Annualized Loss Estimate: *$3,923*

According to the qualitative assessment performed using the PRI tool, the hazardous materials incident hazard scored a PRI value of 2.5 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.43** summarizes the risk levels assigned to each PRI category.

Table 5.43: Qualitative Assessment for Hazardous Materials Incidents

Probability	Likely
Impact	Limited
Spatial Extent	Small
Warning Time	Less than 6 hours
Duration	Less than 24 hours

Hazardous material or toxic releases can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Non-compliance with fire and building codes as well as failure to maintain existing fire and containment features can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

The Toxic Release Inventory (TRI) is a publicly available database from the federal Environmental Protection Agency (EPA) that contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities. This inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990. Each year, facilities that meet certain activity thresholds must report their releases and other waste management activities for listed toxic chemicals to EPA and to their state or tribal entity. A facility must report if it meets the following three criteria:

- The facility falls within one of the following industrial categories: manufacturing; metal mining; coal mining; electric generating facilities that combust coal and/or oil; chemical wholesale distributors; petroleum terminals and bulk storage facilities; RCRA Subtitle C treatment, storage, and disposal (TSD) facilities; and solvent recovery services;
- Has 10 or more full-time employee equivalents; and
- Manufactures or processes more than 25,000 pounds or otherwise uses more than 10,000 pounds of any listed chemical during the calendar year. Persistent, bioaccumulative and toxic (PBT) chemicals are subject to different thresholds of 10 pounds, 100 pounds or 0.1 grams depending on the chemical.

Figure 5.7 shows the locations of TRI listed toxic sites in Myrtle Beach with buffers. Two sizes of buffers—0.5 mile and 1.0 mile—are assumed in respect to the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For mobile analysis, the major roads (Interstate highway and U.S. highway) and railroads are the transportation corridors where hazardous materials are primarily transported that could adversely impact people and buildings. The buffers along the transportation corridors are drawn with the same size as fixed site analysis and are shown in **Figure 5.8**. **Table 5.44** shows estimated toxic release exposure of people and buildings for fixed sites and **Table 5.45** shows the results for mobile site toxic release.

Figure 5.7: TRI Sites with Buffers in Myrtle Beach

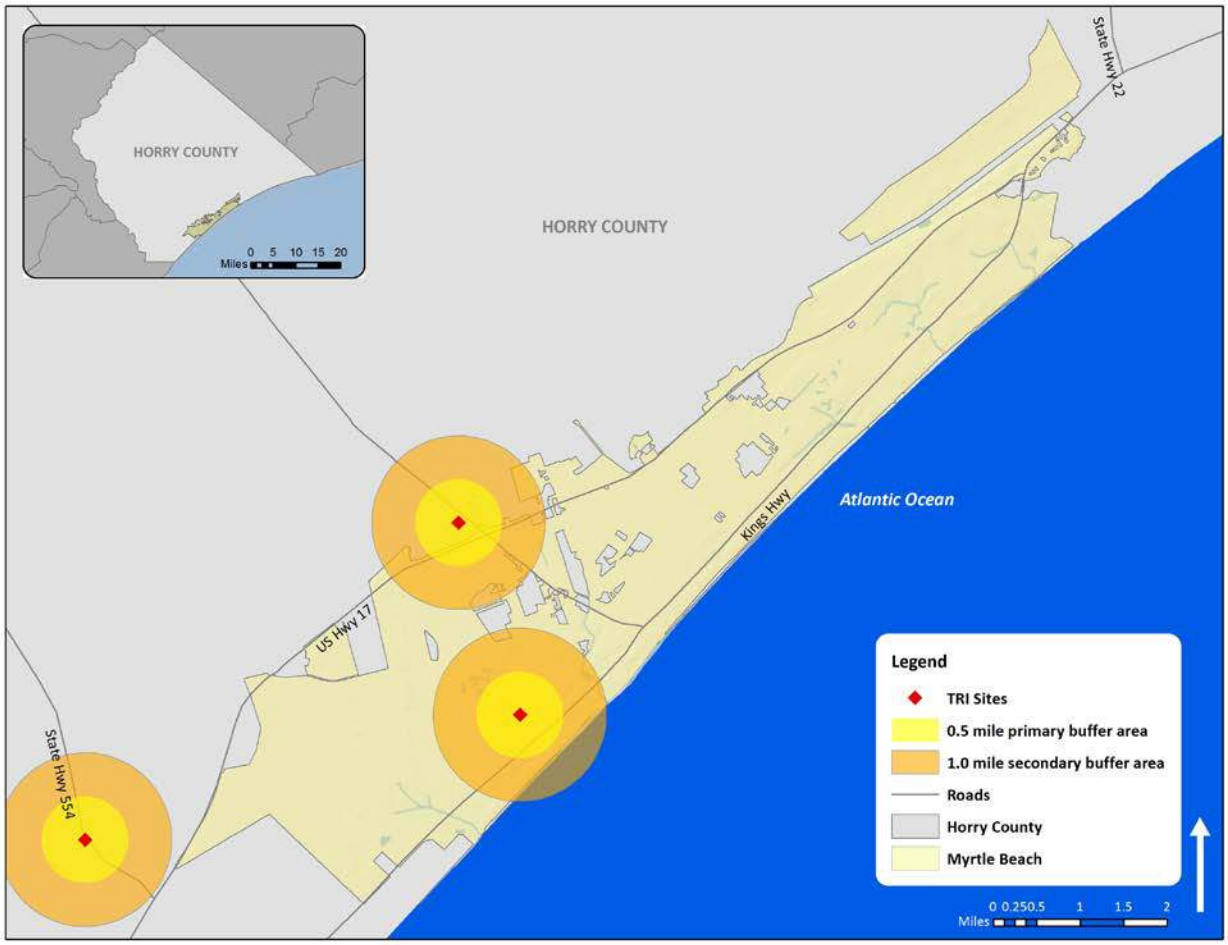


Table 5.44: Exposure of Persons and Improved Property to Hazardous Materials (Fixed Sites)

	Estimated Population At Risk	Estimated Number of Buildings	Total Assessed Value of Improvements (Buildings)	Total Market Value of Improvements (Buildings)
Within 0.5 mile	2,602	810	$10,968,268	$197,349,100
Within 1.0 mile	6,429	3925	$44,615,886	$802,194,600

Source: Horry County GIS

Figure 5.8: Mobile Sites with Buffers in Myrtle Beach

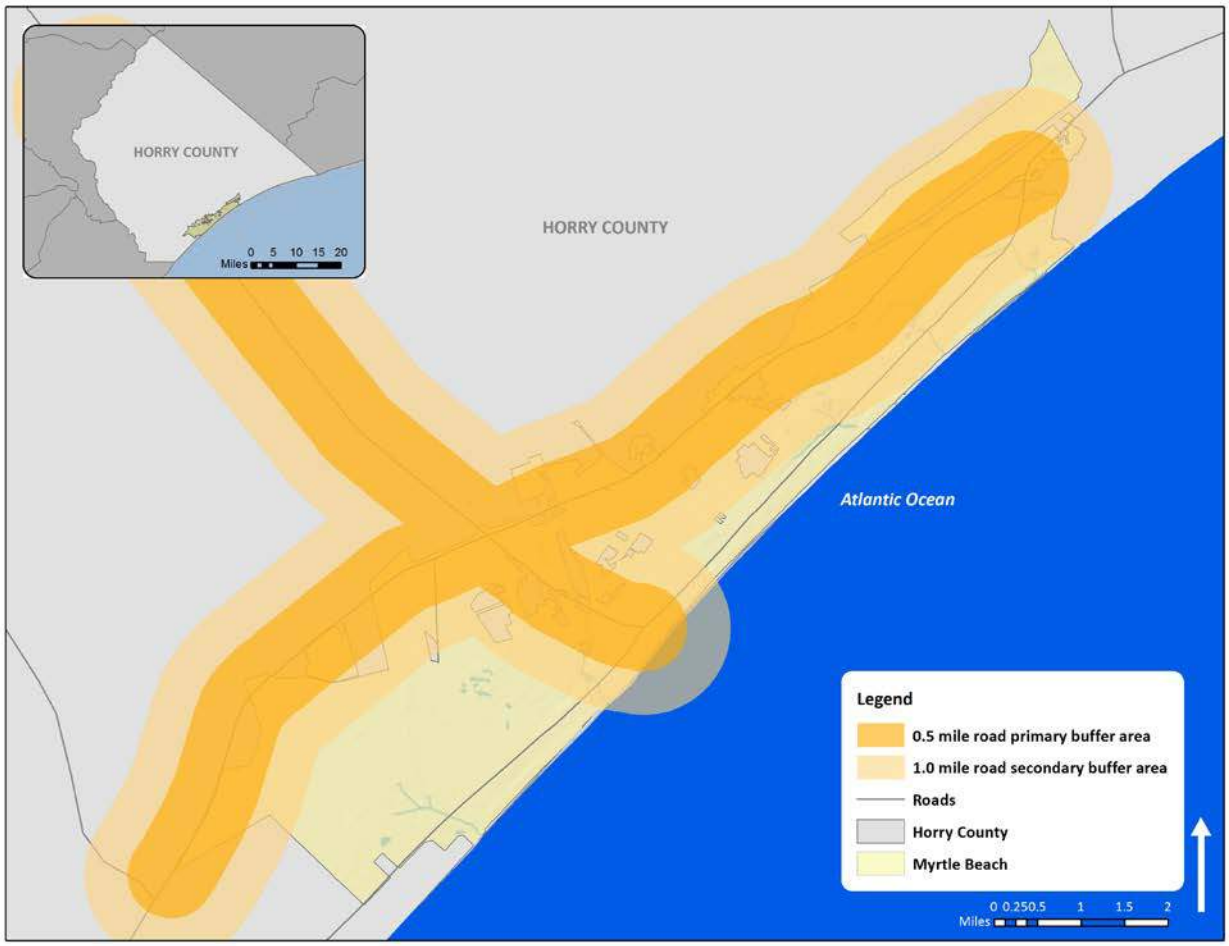


Table 5.45: Exposure of Persons and Improved Property to Hazardous Materials (Mobile Sites)

	Estimated Population At Risk	Estimated Number of Buildings	Total Assessed Value of Improvements (Buildings)	Total Market Value of Improvements (Buildings)
Within 0.5 mile				
Highway	16,746	4,932	$67,921,060	$1,290,016,100
Within 1.0 mile				
Highway	24,760	11,935	$133,124,470	$2,546,312,400

Most hazardous materials incidents that occur in Myrtle Beach are contained and suppressed before destroying any property or threatening lives. Given the lack of historical loss data on significant hazardous materials incidents resulting in structural losses in Myrtle Beach, it is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Myrtle Beach.

5.19.1 Asset Vulnerability

There are a total of four inventoried assets in Myrtle Beach determined to be vulnerable to a fixed-site hazardous materials incident. This includes Myrtle Beach International Airport, Fire Station 3, Rescue 81, and Fire Station S36. Many assets are vulnerable to a mobile hazardous materials incident, including 30 critical facilities in the roads buffer areas and 16 facilities in the rails buffer areas. All of the assets determined to be at risk to hazardous materials incidents are listed in **Table 5.49** toward the end of this section.

5.21 WILDFIRE

PRI Value: 2.7
Annualized Loss Estimate: *Negligible*

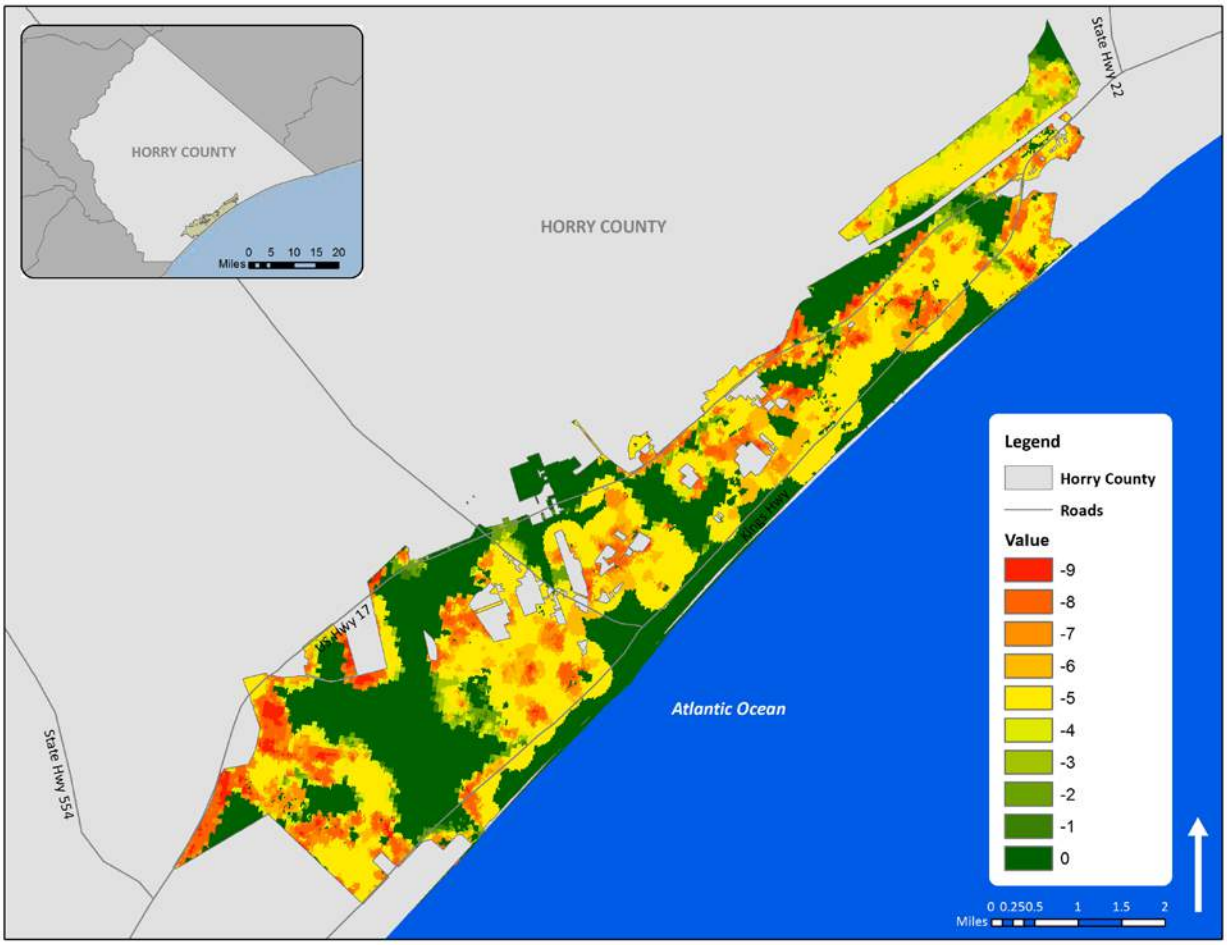
According to the qualitative assessment performed using the PRI tool, the wildfire hazard scored a PRI value of 2.8 (from a scale of 0 to 4, with 4 being the highest risk level). **Table 5.46** summarizes the risk levels assigned to each PRI category.

Table 5.46: Qualitative Assessment for Wildfire

Probability	Highly Likely
Impact	Minor
Spatial Extent	Moderate
Warning Time	Less than 6 hours
Duration	Less than one week

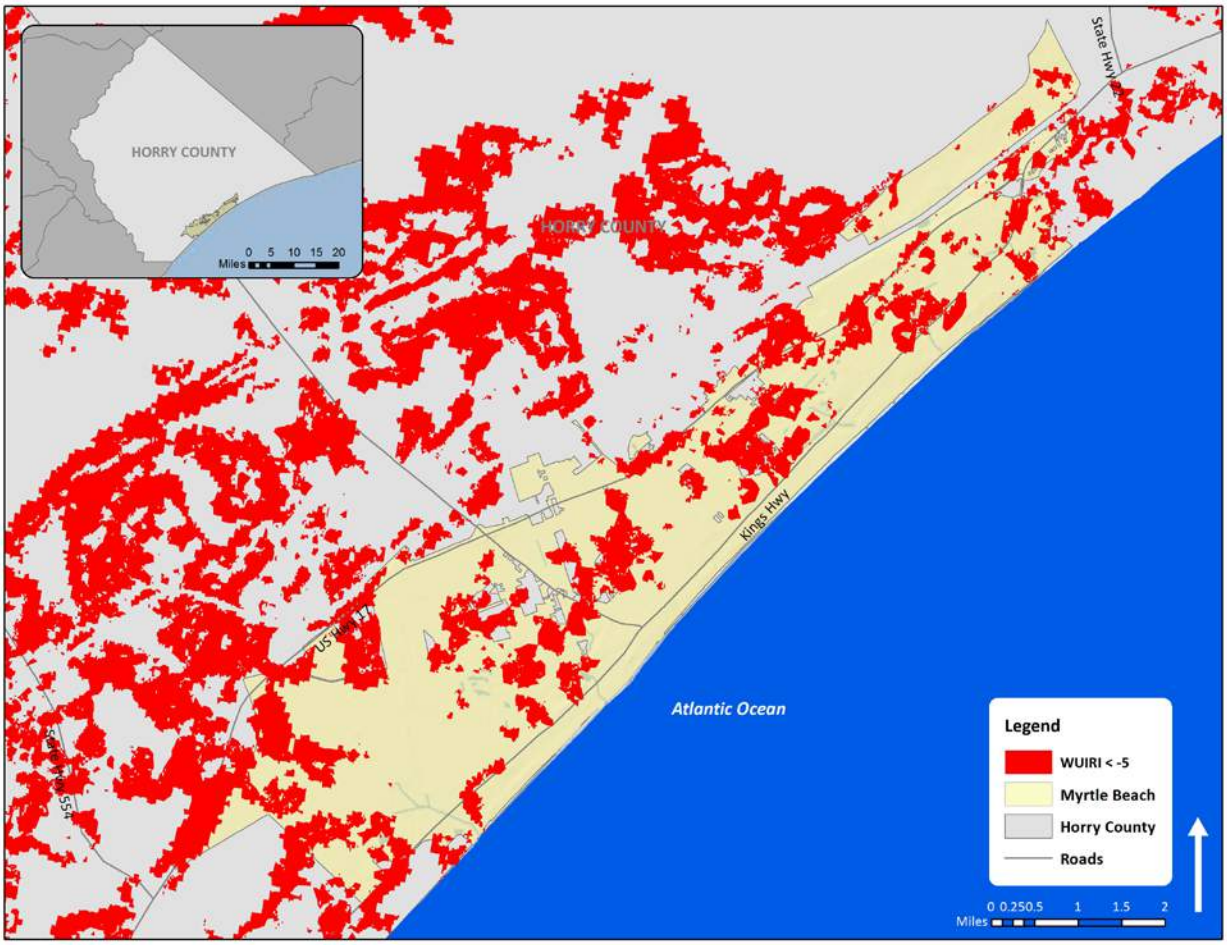
To estimate exposure to wildfire, the approximate number of parcels and their associated improved value was determined using GIS analysis. For the critical facility analysis, areas of risk were intersected with critical facility locations. **Figure 5.9** shows the Wildland Urban Interface Risk Index (WUIRI) data, which is a data layer that shows a rating of the potential impact of a wildfire on people and their homes. The key input, Wildland Urban Interface (WUI), reflects housing density (houses per acre) consistent with Federal Register National standards. The location of people living in the WUI and rural areas is key information for defining potential wildfire impacts to people and homes. Initially provided as raster data, it was converted to a polygon to allow for analysis. The Wildland Urban Interface Risk Index data ranges from 0 to -9 with lower values being most severe (this is only a measure of relative risk). **Figure 5.10** shows the areas of analysis where any grid cell is less than -5. Areas with a value below -5 were chosen to be displayed as areas of risk because this showed the upper echelon of the scale and the areas at highest risk.

Figure 5.9: Wildland Urban Interface Risk Index in Myrtle Beach



Source: Southern Wildfire Risk Assessment

Figure 5.10: Wildland Urban Interface Risk Index Values Less than -5



Source: Southern Wildfire Risk Assessment

To estimate exposure to wildfire, a determination of value for at-risk properties was calculated through GIS analysis by summing the total assessed building values for those improved properties confirmed to be located within areas of high or moderate wildfire risk areas. This information can be found in **Table 5.47**.

Table 5.47: Qualitative Assessment for Wildfire

Location	Estimated Population At Risk	Estimated Number of Buildings	Total Assessed Value of Improvements (Buildings)	Total Market Value of Improvements (Buildings)
Myrtle Beach	22,967	5,049	$61,486,770	$1,180,593,600

5.21.1 Asset Vulnerability

There are five assets vulnerable to wildfire based on the Southern Wildfire Risk Assessment data which are a bridge, two fire stations, a post office, and a radio tower.

5.22 CONCLUSIONS ON HAZARD VULNERABILITY

The results of this vulnerability assessment are useful in at least three ways:

- Improving our understanding of the risk associated with the natural hazards in Myrtle Beach through better understanding of the complexities and dynamics of risk, how levels of risk can be measured and compared, and the myriad of factors that influence risk. An understanding of these relationships is critical in making balanced and informed decisions on managing the risk.

- Providing a baseline for policy development and comparison of mitigation alternatives. The data used for this analysis presents a current picture of risk in Myrtle Beach. Updating this risk "snapshot" with future data will enable comparison of the changes in risk with time. Baselines of this type can support the objective analysis of policy and program options for risk reduction in the region.

- Comparing the risk among the natural hazards addressed. The ability to quantify the risk to all these hazards relative to one another helps in a balanced, multi-hazard approach to risk management at each level of governing authority. This ranking provides a systematic framework to compare and prioritize the very disparate natural hazards that are present in Myrtle Beach. This final step in the risk assessment provides the necessary information for local officials to craft a mitigation strategy to focus resources on only those hazards that pose the most threat to the city.

Exposure to hazards can be an indicator of vulnerability. Economic exposure can be identified through locally assessed values for improvements (buildings), and social exposure can be identified by estimating the population exposed to each hazard. This information is especially important for decision-makers to use in planning for evacuation or other public safety related needs. **Table 5.48** provides a summary of the estimated population counts and improved property values at-risk (exposed) to each hazard.

Table 5.49 provides a summary of results for the vulnerability assessment conducted for each of Myrtle Beach's assets (from the inventory listed earlier in this section). The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**"). It should be noted that in addition to the facilities listed below, the city also has 142 sewer pumping stations and 11 elevated water storage tanks that it maintains both inside and outside of the city limits. These facilities were not mapped and analyzed, but are considered critical.

Table 5.48: Summary of Total Exposure and Potential Annualized Losses to Identified Hazards in Myrtle Beach

Hazard	Estimated Population At Risk	Total Assessed Value of Improvements At-Risk (Buildings)	Annualized Expected Property Losses
Atmospheric			
Drought	27,109	$4,472,038,300	$0
Hailstorm	27,109	$4,472,038,300	$610

Hazard	Estimated Population At Risk	Total Assessed Value of Improvements At-Risk (Buildings)	Annualized Expected Property Losses
Ice Storm	27,109	$4,472,038,300	$12,190
Lightning	27,109	$4,472,038,300	$45,325
Nor'easter	27,109	$4,472,038,300	$0
Wind Events	27,109	$4,472,038,300	$93,425
Tornado	27,109	$4,472,038,300	$593,972
Tropical Storm System/Hurricane	22,759	$4,472,038,300	$8,488,637
Geologic			
Earthquake	27,109	$4,472,038,300	$24,563
Tidal Wave/Tsunami	27,109	$4,472,038,300	$0
Hydrologic			
Erosion	304	$73,147,430	$0
Flood	10,317	$190,885,860	$257,381
Storm Surge	15,392	$145,591,250	$0
Sea Level Rise	6,113	$33,289,182	Undetermined
Other			
Acts of Terror	27,109	$4,472,038,300	$0
Airplane Crash	27,109	$4,472,038,300	$0
Hazardous Materials Incident	24,760	$133,124,470	$3,923
Wildfire	22,967	$61,486,770	$0

Table 5.49: Critical Facilities/Assets in Myrtle Beach

FACILITY NAME	FACILITY TYPE	ATMOSPHERIC								GEOLOGIC		HYDRO					OTHER						
		Drought	Hailstorm	Ice Storm	Lightning	Nor'easter	Wind Events/ Thunderstorm	Tornado	Tropical Storm/Hurricane	Earthquake	Tidal Wave/Tsunami	1.0 percent annual chance flood	0.2 percent annual chance flood	Storm Surge Cat 3	Storm Surge Cat 5	Sea Level Rise	Acts of Terror	Airplane Crash	HAZMAT Fixed (0.5 mile)	HAZMAT Fixed (1.0 mile)	HAZMAT Roads (0.5 mile)	HAZMAT Roads (1.0 mile)	Wildfire
Myrtle Beach International Airport	Airport	X	X	X	X	X	X	X	X	X					X		X	X		X			
Grand Strand Humane Society	Animal Shelter	X	X	X	X	X	X	X	X	X					X		X	X				X	
N Hwy 17 Byp-2	Bridge	X	X	X	X	X	X	X	X	X					X		X	X			X	X	X
N Hwy 17 Byp-2	Bridge	X	X	X	X	X	X	X	X	X					X		X	X			X	X	
HGTC MB 1000 Speir	College	X	X	X	X	X	X	X	X	X					X		X	X					
21st Avenue Complex	County	X	X	X	X	X	X	X	X	X					X		X	X				X	
Horry County Magistrate- Myrtle Beach	County	X	X	X	X	X	X	X	X	X					X		X	X				X	
Myrtle Beach Fire Station 1	Fire Station	X	X	X	X	X	X	X	X	X					X		X	X				X	X
Myrtle Beach Fire Station 2	Fire Station	X	X	X	X	X	X	X	X	X				X	X		X	X					
Myrtle Beach Fire Station 3	Fire Station	X	X	X	X	X	X	X	X	X					X		X	X	X	X			
Myrtle Beach Fire Station 4/EOC/Police Station	EOC/Fire/ Police Station	X	X	X	X	X	X	X	X	X					X		X	X					
Myrtle Beach Fire Station 5	Fire Station	X	X	X	X	X	X	X	X	X							X	X			X	X	
Myrtle Beach Fire Station 6	Fire Station	X	X	X	X	X	X	X	X	X					X		X	X			X	X	X
Myrtle Beach International Airport Fire Station	Fire Station	X	X	X	X	X	X	X	X	X					X		X	X					
City Hall	Government	X	X	X	X	X	X	X	X	X					X		X	X			X	X	
City Services Building	Government	X	X	X	X	X	X	X	X	X					X		X	X			X	X	
Purchasing Department	Government	X	X	X	X	X	X	X	X	X					X		X	X			X	X	

FACILITY NAME	FACILITY TYPE	ATMOSPHERIC								GEOLOGIC		HYDRO					OTHER						
		Drought	Hailstorm	Ice Storm	Lightning	Nor'easter	Wind Events/ Thunderstorm	Tornado	Tropical Storm/Hurricane	Earthquake	Tidal Wave/Tsunami	1.0 percent annual chance flood	0.2 percent annual chance flood	Storm Surge Cat 3	Storm Surge Cat 5	Sea Level Rise	Acts of Terror	Airplane Crash	HAZMAT Fixed (0.5 mile)	HAZMAT Fixed (1.0 mile)	HAZMAT Roads (0.5 mile)	HAZMAT Roads (1.0 mile)	Wildfire
Solid Waste Station	Government	X	X	X	X	X	X	X	X	X					X		X	X			X	X	
Public Works	Government	X	X	X	X	X	X	X	X	X					X		X	X			X	X	
Risk Management Office	Government	X	X	X	X	X	X	X	X	X					X		X	X			X	X	
Grand Strand Medical Center	Hospital	X	X	X	X	X	X	X	X	X							X	X			X	X	
MBPD- Law Enforcement Center	Police Station	X	X	X	X	X	X	X	X	X					X		X	X			X	X	
MBPD- Training Center	Police Station	X	X	X	X	X	X	X	X	X					X		X	X					
Myrtle Beach Post Office (67th Ave N)	Postal	X	X	X	X	X	X	X	X	X					X		X	X			X	X	X
Myrtle Beach Post Office (N Kings Hwy)	Postal	X	X	X	X	X	X	X	X	X					X		X	X			X	X	
MB Radio Tower	Radio Tower	X	X	X	X	X	X	X	X	X					X		X	X			X	X	X
Myrtle Beach Elementary	School	X	X	X	X	X	X	X	X	X					X		X	X				X	
Myrtle Beach High	School	X	X	X	X	X	X	X	X	X					X		X	X				X	
Myrtle Beach Intermediate	School	X	X	X	X	X	X	X	X	X							X	X				X	
Myrtle Beach Middle	School	X	X	X	X	X	X	X	X	X					X		X	X				X	
Myrtle Beach Primary	School	X	X	X	X	X	X	X	X	X					X		X	X				X	
Grand Strand Water and Sewer Authority Plant	Sewer Treatment	X	X	X	X	X	X	X	X	X					X		X	X			X	X	
Convention Center	Shelter	X	X	X	X	X	X	X	X	X					X		X	X					
Crabtree Gymnasium	Shelter	X	X	X	X	X	X	X	X	X					X		X	X					

SECTION 6

CAPABILITY ASSESSMENT

This section of the Plan discusses the capability of the City of Myrtle Beach to implement hazard mitigation activities. It consists of the following five subsections:

- 6.1 What is a Capability Assessment?
- 6.2 Conducting the Capability Assessment
- 6.3 Capability Assessment Findings
- 6.4 Conclusions on Local Capability

6.1 WHAT IS A CAPABILITY ASSESSMENT?

The purpose of conducting a capability assessment is to determine the ability of a local jurisdiction to implement a comprehensive mitigation strategy and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs, or projects[1]. As in any planning process, it is important to try to establish which goals, objectives, and/or actions are feasible, based on an understanding of the organizational capacity of those agencies or departments tasked with their implementation. A capability assessment helps to determine which mitigation actions are practical and likely to be implemented over time given a local government's planning and regulatory framework, level of administrative and technical support, amount of fiscal resources, and current political climate.

A capability assessment has two primary components: 1) an inventory of a local jurisdiction's relevant plans, ordinances, or programs already in place and 2) an analysis of its capacity to carry them out. Careful examination of local capabilities will detect any existing gaps, shortfalls, or weaknesses with ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. A capability assessment also highlights the positive mitigation measures already in place or being implemented at the local government level, which should continue to be supported and enhanced through future mitigation efforts.

The capability assessment completed for the City of Myrtle Beach serves as a critical planning step and an integral part of the foundation for designing an effective hazard mitigation strategy. Coupled with the *Risk Assessment*, the *Capability Assessment* helps identify and target meaningful mitigation actions for incorporation in the *Mitigation Strategy* portion of the Floodplain Management and Hazard Mitigation Plan. It not only helps establish the goals and objectives for the City to pursue under this

[1] While the Interim Final Rule for implementing the Disaster Mitigation Act of 2000 does not require a local capability assessment to be completed for local hazard mitigation plans, it is a critical step in developing a mitigation strategy that meets the needs of the City while taking into account their own unique abilities. The Rule does state that a community's mitigation strategy should be "based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools" (44 CFR, Part 201.6(c)(3)).

Plan, but also ensures that those goals and objectives are realistically achievable under given local conditions.

6.2 CONDUCTING THE CAPABILITY ASSESSMENT

In order to facilitate the inventory and analysis of local government capabilities for the City of Myrtle Beach, a detailed Capability Assessment Survey[2] was distributed to the City Departments. The survey questionnaire requested information on a variety of "capability indicators" such as existing local plans, policies, programs, or ordinances that contribute to and/or hinder the City's ability to implement hazard mitigation actions. Other indicators included information related to the City's fiscal, administrative, and technical capabilities, such as access to local budgetary and personnel resources for mitigation purposes. Survey respondents were also asked to comment on the current political climate with respect to hazard mitigation, an important consideration for any local planning or decision making process.

At a minimum, survey results provide an extensive inventory of existing local plans, ordinances, programs, and resources in place or under development, in addition to their overall effect on hazard loss reduction. In completing the survey, local officials were also required to conduct a self-assessment of the City's specific capabilities. The survey instrument thereby not only helps accurately assess the degree of local capability, but also serves as a good source of introspection for City departments and agencies that want to improve their capabilities as identified gaps, weaknesses, or conflicts can be recast as opportunities for specific actions to be proposed as part of the hazard mitigation strategy.

The information provided in response to the survey questionnaire was incorporated into a database for further analysis. A general scoring methodology[3] was then applied to quantify the City's overall capability. According to the scoring system, each capability indicator was assigned a point value based on its relevance to hazard mitigation. Additional points were added based on the City staff's self-assessment of their own planning and regulatory capability, administrative and technical capability, fiscal capability, and political capability.

Using this scoring methodology, a total score and general capability rating of "High," "Moderate," or "Limited" could be determined according to the total number of points received. These classifications are designed to provide nothing more than a general assessment of local government capability. In combination with the narrative responses provided by local officials, the results of this capability assessment lend critical information for developing an effective and meaningful mitigation strategy.

6.3 CAPABILITY ASSESSMENT FINDINGS

The findings of the capability assessment are summarized in this Plan to provide insight into the relevant capacity of the City of Myrtle Beach to implement hazard mitigation activities. All information is based upon the input provided by local government officials through the Capability Assessment Survey and during meetings of the Floodplain Management and Hazard Mitigation Planning Committee.

[2] The Capability Assessment Survey instrument is available in Appendix B.
[3] The scoring methodology used to quantify and rank the City's capability can be found in Appendix B.

6.3.1 Planning and Regulatory Capability

Planning and regulatory capability is based on the implementation of plans, ordinances, and programs that demonstrate a local jurisdiction's commitment to guiding and managing growth, development, and redevelopment in a responsible manner, while maintaining the general welfare of the community. It includes emergency response and mitigation planning, comprehensive land use planning, and transportation planning, in addition to the enforcement of zoning or subdivision ordinances and building codes that regulate how land is developed and structures are built, as well as protecting environmental, historic, and cultural resources in the community. Although some conflicts can arise, these planning initiatives generally present significant opportunities to integrate hazard mitigation principles and practices into the local decision making process.

This assessment is designed to provide a general overview of the key planning and regulatory tools or programs in place or under development for the City of Myrtle Beach, along with their potential effect on loss reduction. This information will help identify opportunities to address existing gaps, weaknesses, or conflicts with other initiatives in addition to integrating the implementation of this Plan with existing planning mechanisms where appropriate.

Table 6.1 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the City of Myrtle Beach. A checkmark (✓) indicates that the given item is currently in place and being implemented, or that it is currently being developed for future implementation. Each of these other local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Floodplain Management and Hazard Mitigation Plan.

Table 6.1: Relevant Plans, Ordinances, and Programs

PLANNING / REGULATORY TOOL	IN PLACE/UNDER DEVELOPMENT	DEPARTMENT RESPONSIBLE	EFFECT ON LOSS REDUCTION		
			Strongly Supports	Helps Facilitate	Hinders
Hazard Mitigation Plan	✓	Construction Services	✓		
Comprehensive Land Use Plan	✓	Planning / All *City has master Comprehensive Plan			
Floodplain Management Plan	✓	Construction Services			
Open Space Management Plan	✓	Construction Services			
Stormwater Management Plan	✓	Public Works / Code Enforcement			
Flood Response Plan					
Emergency Operations Plan	✓	Fire Department			

PLANNING / REGULATORY TOOL	IN PLACE/UNDER DEVELOPMENT	DEPARTMENT RESPONSIBLE	EFFECT ON LOSS REDUCTION		
			Strongly Supports	Helps Facilitate	Hinders
Continuity of Operations Plan					
Evacuation Plan	✓	Police Department			
Disaster Recovery Plan	✓	Emergency Management, Public Works, Construction Services, Planning/All	✓		
Capital Improvements Plan	✓	Budget, Planning, Public Works	✓		
Economic Development Plan	✓	Myrtle Beach Economic Development Corp.			
Historic Preservation Plan	✓	Horry County			
Flood Damage Prevention Ordinance	✓	Construction Services	✓		
Zoning Ordinance	✓	Construction Services, Planning			
Subdivision Ordinance	✓	Planning	✓		
Unified Development Ordinance					
Post-disaster Red/Rec. Ordinance	✓	*Under Development*			
Building Code	✓	Construction Services			
Fire Code	✓	Fire Department / Construction Services			
National Flood Insurance Program	✓	Construction Services	✓		
NFIP Community Rating System	✓	Construction Services / Public Works	✓		
Other: Beach Management Plan	✓	Planning	✓		

A more detailed discussion on the City's planning and regulatory capability follows, along with the incorporation of additional information based on the narrative comments provided by local officials in response to the survey questionnaire.

6.3.2 Emergency Management

Hazard mitigation is widely recognized as one of the four primary phases of emergency management. The three other phases include preparedness, response, and recovery. In reality each phase is interconnected with hazard mitigation, as **Figure 6.1** suggests. Opportunities to reduce potential losses through mitigation practices are most often implemented before disaster strikes, such as elevation of flood prone structures or through the continuous enforcement of policies that prevent and regulate development that is vulnerable to hazards because of its location, design, or other characteristics. Mitigation opportunities will also be presented during immediate preparedness or response activities (such as installing storm shutters in advance of a hurricane) and certainly during the long-term recovery and redevelopment process following a hazard event.

Figure 6.1: The Four Phases of Emergency Management

Planning for each phase is a critical part of a comprehensive emergency management program and a key to the successful implementation of hazard mitigation actions. As a result, the Capability Assessment Survey asked several questions across a range of emergency management plans in order to assess Myrtle Beach's willingness to plan and their level of technical planning proficiency.

Hazard Mitigation Plan: A hazard mitigation plan represents a community's blueprint for how it intends to reduce the impact of natural and human-caused hazards on people and the built environment. The essential elements of a hazard mitigation plan include a risk assessment, capability assessment, and mitigation strategy.

- The City of Myrtle Beach council adopted the first version of their local hazard mitigation plan in April 28, 1998 and updated the plan in 2004 and 2010.

Disaster Recovery Plan: A disaster recovery plan serves to guide the physical, social, environmental, and economic recovery and reconstruction process following a disaster. In many instances, hazard mitigation principles and practices are incorporated into local disaster recovery plans with the intent of capitalizing on opportunities to break the cycle of repetitive disaster losses. Disaster recovery plans can also lead to the preparation of disaster redevelopment policies and ordinances to be enacted following a hazard event.

- The City of Myrtle Beach Department of Public Works maintains a Hurricane Manual for response and recovery.
- The City's Tourism Committee has sponsored an Area Business Disaster Recovery Symposium for the past two years, in 2014 and 2015. The third annual symposium to be held January 29, 2016.
- The Tourism Element of the City's Comprehensive Plan addresses the need to continue development of a comprehensive recovery plan for man-made and natural disasters.

Emergency Operations Plan: An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster.

- The Myrtle Beach Fire Department, with assistance from Risk Management, maintains an Emergency Operations Plan to address the City's response to a variety of disasters and emergencies.

SARA Title III Emergency Response Plan: A SARA Title III Emergency Response Plan outlines the procedures to be followed in the event of a chemical emergency such as the accidental release of toxic substances. These plans are required by federal law under Title III of the Superfund Amendments and Re-authorization Act (SARA), also known as the Emergency Planning and Community Right-to-Know Act (EPCRA).

- The Myrtle Beach Fire Department maintains a Hazardous Materials Response Plan.

Continuity of Operation Plan: A continuity of operations plan establishes a chain of command, line of succession and plans for backup or alternate emergency facilities in case of an extreme emergency or disaster event.

- The City has not developed a Continuity of Operation Plan; however, development of a plan is under discussion with the Planning, Risk Management, and Fire Departments.

6.3.3 General Planning

The implementation of hazard mitigation activities often involves agencies and individuals beyond the emergency management profession. Stakeholders may include local planners, public works officials, economic development specialists, and others. In many instances, concurrent local planning efforts will help to achieve or complement hazard mitigation goals, even though they are not designed as such. Therefore, the Capability Assessment Survey also asked questions regarding each of Myrtle Beach's general planning capabilities and the degree to which hazard mitigation is integrated into other on-going planning efforts.

Comprehensive Land Use Plan: A comprehensive land use plan establishes the overall vision for what a community wants to be and serves as a guide to future governmental decision making. Typically a comprehensive plan contains sections on demographic conditions, land use, transportation elements, and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, objectives, and actions.

- The City of Myrtle Beach adopted its first Comprehensive Plan in 1970 to serve as a long range plan for the City's services, facilities, development, and growth. The plan has been updated in 1979, 1985, 1999, 2000, 2006, 2011, and 2015.

- The Natural Resource Element of the Comprehensive Plan emphasizes avoiding environmental hazards and reducing the exposure of people and property to coastal hazards by keeping people and property out of coastal floodplains, high-erosion zones, and inlet hazard areas. Sea level rise, earthquakes, storms, climatic changes, tidal waves, tsunamis, winter storms, drought, and wildfires are also addressed in the element.

- The City of Myrtle Beach has a Comprehensive Plan and land use is only one of 11 elements required in The Local Government Comprehensive Planning Enabling Act of 1994. The areas of population, economic development, tourism, housing, neighborhoods, natural resources, cultural resources, transportation, community facilities, and priority investment are also addressed in the plan.

Capital Improvements Plan: A capital improvements plan guides the scheduling of spending on public improvements. A capital improvements plan can serve as an important mechanism for guiding future development away from identified hazard areas. Limiting public spending in hazardous areas is one of the most effective long-term mitigation actions available to local governments.

- The City maintains a Capital Improvements Plan. Projects in the 10 year Priority Investment Element of the Comprehensive Plan includes stormwater management strategies that will minimize property damage from flooding and various stormwater drainage projects.

- Currently, the City has over 70 planned capital improvement projects to include stormwater and drainage improvements.

Historic Preservation Plan: A historic preservation plan is intended to preserve historic structures or districts within a community. An often overlooked aspect of the historic preservation plan is the assessment of buildings and sites located in areas subject to natural hazards, and the identification of ways to reduce future damages. This may involve retrofitting or relocation techniques that account for the need to protect buildings that do not meet current building standards, or are within a historic district that cannot easily be relocated out of harm's way.

- Myrtle Beach does not currently have a historic preservation plan. However, development of a historic preservation plan is included as an objective in the Historic Resources Subelement of the 2011 Comprehensive Plan Update. Horry County has a Historic Preservation Plan which includes the City.

- Mitigation strategies such as applying for federal grant funds (i.e., PDM, FMA, HMGP) to protect identified at-risk historic structures in Myrtle Beach could be considered in any future historic planning efforts.

Zoning Ordinance: Zoning represents the primary means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the public health, safety, and welfare of those in a given jurisdiction that maintains zoning authority. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, a zoning ordinance can serve as a powerful tool when applied in identified hazard areas.

- Myrtle Beach adopted a new zoning ordinance in 2014, which is included as Appendix A of the City Code of Ordinances, to regulate new development and to guide local decisions for residential, commercial, and industrial growth within the City limits. Unwise development in hazardous areas is prohibited or discouraged through floodplain management regulations and a coastal protection overlay district.

- The City also has a landscaping and tree protection ordinances include prevention measures for soil erosion, surface drainage improvement, and flood minimization.

Subdivision Ordinance: A subdivision ordinance is intended to regulate the development of housing, commercial, industrial, or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Subdivision design that accounts for natural hazards can dramatically reduce the exposure of future development.

- The City's Subdivision Ordinance is included as Chapter 20 of the City Code of Ordinances. The Subdivision Ordinance accounts for natural hazards by prohibiting the platting of land subject to flooding for residential uses and requiring Base Flood Elevations for subdivisions of greater than 50 lots or 5 acres. The Subdivision Ordinance is scheduled for rewrite in 2015.

Building Codes, Permitting and Inspections: Building Codes regulate construction standards. In many communities, permits, and inspections are required for new construction. Decisions regarding the adoption of building codes (that account for hazard risk), the type of permitting process required both before and after a disaster, and the enforcement of inspection protocols all affect the level of hazard risk faced by a community.

- Myrtle Beach has adopted and enforces the 2012 version of the International Building Code.

The adoption and enforcement of building codes by local jurisdictions is routinely assessed through the Building Code Effectiveness Grading Schedule (BCEGS) program, developed by the Insurance Services Office, Inc. (ISO).[4] In South Carolina, the ISO East Region assesses the building codes in effect in a particular community and how the community enforces its building codes, *with special emphasis on mitigation of losses from natural hazards*. The results of BCEGS assessments are routinely provided to ISO's member private insurance companies, which in turn may offer ratings credits for new buildings constructed in communities with strong BCEGS classifications. The concept is that communities with

[4] Participation in BCEGS is voluntary and may be declined by local governments if they do not wish to have their local building codes evaluated.

well-enforced, up-to-date codes should experience fewer disaster-related losses and, as a result, should have lower insurance rates.

In conducting the assessment, ISO collects information related to personnel qualification and continuing education as well as number of inspections performed per day. This type of information combined with local building codes is used to determine a grade for that jurisdiction. The grades range from 1 to 10, with a BCEGS grade of 1 representing exemplary commitment to building code enforcement and a grade of 10 indicating less than minimum recognized protection.

- Myrtle Beach has received a BCEGS rating of grade of 3 for its commercial lines and a rating of 3 for its residential lines.

6.3.4 Floodplain Management

Flooding represents the greatest natural hazard facing the nation. At the same time, the tools available to reduce the impacts associated with flooding are among the most developed when compared to other hazard-specific mitigation techniques. In addition to approaches that cut across hazards such as education, outreach, and the training of local officials, the *National Flood Insurance Program* (NFIP) contains specific regulatory measures that enable government officials to determine where and how growth occurs relative to flood hazards. Participation in the NFIP is voluntary for local governments; however, program participation is strongly encouraged by FEMA as a first step for implementing and sustaining an effective hazard mitigation program. It is therefore used as part of this assessment as a key indicator for measuring local capability.

In order for a county or municipality to participate in the NFIP, they must adopt a local flood damage prevention ordinance that requires jurisdictions to follow established minimum building standards in the floodplain. These standards require that all new buildings and substantial improvements to existing buildings will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties.

A key service provided by the NFIP is the mapping of identified flood hazard areas. Once completed, the Flood Insurance Rate Maps (FIRMs) are used to assess flood hazard risk, regulate construction practices, and set flood insurance rates. FIRMs are an important source of information to educate residents, government officials, and the private sector about the likelihood of flooding in their community.

- The City of Myrtle Beach joined the NFIP in 1977. The current effective map date for the City's FIRMs is August 23, 1999.

- As of June 30, 2015, there were 9,921 NFIP policies in force in Myrtle Beach, providing over $1.8 billion in flood insurance coverage.[5] To date, there has been approximately $33.5 million paid in insurance claims on 1,219 reported losses (478 of these losses were closed without payment).

Community Rating System: An additional indicator of floodplain management capability is the active participation of local jurisdictions in the Community Rating System (CRS). The CRS is an incentive-based program that encourages counties and municipalities to undertake defined flood mitigation activities that go beyond the minimum requirements of the NFIP, adding extra local measures to provide

[5] General NFIP policy data (participation and coverage) is current as of June 30, 2015 as provided by the Federal Emergency Management Agency.

protection from flooding. All of the 18 creditable CRS mitigation activities are assigned a range of point values. As points are accumulated and reach identified thresholds, communities can apply for an improved CRS class. Class ratings, which range from 10 to 1, are tied to flood insurance premium reductions as shown in **Table 6.2.** As class ratings improve (the lower the number the better), the percent reduction in flood insurance premiums for NFIP policyholders in that community increases.

Table 6.2: CRS Premium Discounts, By Class

CRS Class	Premium Reduction
1	45%
2	40%
3	35%
4	30%
5	25%
6	20%
7	15%
8	10%
9	5%
10	0

Source: *FEMA*

Community participation in the CRS is voluntary. Any community that is in full compliance with the rules and regulations of the NFIP may apply to FEMA for a CRS classification better than class 10. The CRS application process has been greatly simplified over the past several years, based on community comments intended to make the CRS more user friendly and extensive technical assistance available for communities who request it.

- The City of Myrtle Beach is currently a CRS Class 5 Community. This means that citizens living in the Special Flood Hazard Area receive a 25% discount on their Flood Insurance premiums.

- As part of their participation in the CRS, the City conducts annual outreach to the public through brochures that are mailed to residents living in or near the local flood hazard area. The brochure, entitled *A Guide to Regulatory Floodplains and Flood Protection*, includes information on the benefits of the floodplain, flood warning systems, required permits in the floodplain, and actions residents can take to reduce their risk of injury from floods. A copy of the most recent brochure is included in Appendix B. Flood information is also available on the City's website and Facebook page.

Floodplain Management Plan: A floodplain management plan (or a flood mitigation plan) provides a framework for action regarding corrective and preventative measures to reduce flood-related impacts.

- The City of Myrtle Beach Floodplain Management and Hazard Mitigation Plan serves as both the hazard mitigation plan and the floodplain management plan for the City. Floodplain management is also achieved through the local zoning, subdivision, and flood damage prevention ordinances.

***Open Space Management Plan**:* An open space management plan is designed to preserve, protect, and restore largely undeveloped lands in their natural state and to expand or connect areas in the public domain such as parks, greenways, and other outdoor recreation areas. In many instances open space management practices are consistent with the goals of reducing hazard losses, such as the preservation of wetlands or other flood-prone areas in their natural state in perpetuity.

- The Recreation Department maintains a Parks and Recreation Master Plan. The consultants of EDAW with Leon Younger and PROS, and DDC engineers prepared the plan.

- The Natural Resources Element of the Comprehensive Plan also contains a Parks and Recreation Subelement. The subelement stresses the magnitude of community and individual benefits. The environmental benefits that come from the increase in trees and other native vegetation helps reduce flooding and erosion.

Stormwater Management Plan: A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding.

- The Public Works Department, with assistance from Code Enforcement implements the City's Stormwater Management Plan.

6.3.5 Fire Safety and Prevention

The City of Myrtle Beach Fire Department (MBFD) provides emergency response and recovery duties for the city's residents and visitors. The following is a summary of some of the recent accomplishments of this department:

- **2011, 2012, 2013, 2014, and 2015 State Homeland Security Program Grants:** Each year, MBFD received grants to enhance the regional capabilities of the Urban Search and Rescue Team (USAR) with equipment and training. The amounts were $39,618, $35,990, $35, 974, $50,550, and $69,500.

- **2011, 2012, 2013, 2014, and 2015 State Homeland Security Program Grants:** The MBFD received grants to enhance the response and capabilities of their HAZMAT-WMD team with equipment and training. The amounts were $99,849, $82,627, $37,142, $39,014, and $59,000.

6.3.6 Administrative and Technical Capability

The ability of a local government to develop and implement mitigation projects, policies, and programs is directly tied to its ability to direct staff time and resources for that purpose. Administrative capability can be evaluated by determining how mitigation-related activities are assigned to local departments and if there are adequate personnel resources to complete these activities. The degree of intergovernmental coordination among departments will also affect administrative capability for the implementation and success of proposed mitigation activities.

Technical capability can generally be evaluated by assessing the level of knowledge and technical expertise of local government employees, such as personnel skilled in using Geographic Information

Systems (GIS) to analyze and assess community hazard vulnerability. The Capability Assessment Survey was used to capture information on administrative and technical capability through the identification of available staff and personnel resources.

Table 6.3 provides a summary of the Capability Assessment Survey results for Myrtle Beach with regard to relevant staff and personnel resources. A checkmark (✓) indicates that the given local staff member(s) is maintained through the City's local government resources.

Table 6.3: Relevant Staff / Personnel Resources

STAFF / PERSONNEL RESOURCES	IN PLACE	DEPARTMENT	COMMENTS
Planners with knowledge of land development and land management practices	✓	Planning	
Engineers or professionals trained in construction practices related to buildings and/or infrastructure	✓	Construction Services / Public Works	
Planners or engineers with an understanding of natural and/or human-caused hazards	✓	Planning, Construction Services, Public Works, Fire Department, Risk Management	
Emergency manager	✓	Fire Department	Fire Department and Risk Manager assist Chief
Floodplain manager	✓	Construction Services	The City has a total of 7 CFMs on staff
Land surveyors	✓	Public Works	No licensed surveyors but Public Works has several staff members who are capable surveyors.
Scientist familiar with the hazards of the community	✓	Public Works	Soil scientist
Staff with education or expertise to assess the community's vulnerability to hazards	✓	Planning, Fire Department , Public Works, Police Department, Construction Services, Risk Manager	
Personnel skilled in Geographic Information Systems (GIS) and/or FEMA's HAZUS program	✓	Planning, Construction Services, Public Works, Finance	
Resource development staff or grant writers	✓	All Departments	

6.3.7 Fiscal Capability

The ability of a local government to take action is often closely associated with the amount of money available to implement policies and projects. This may take the form of outside grant funding awards or locally-based revenue and financing. The costs associated with mitigation policy and project implementation vary widely. In some cases, policies are tied primarily to staff time or administrative costs associated with the creation and monitoring of a given program. In other cases, direct expenses

are linked to an actual project such as the acquisition of flood-prone homes, which can require a substantial commitment from local, state, and federal funding sources.

The Capability Assessment Survey was used to capture information on the City's fiscal capability through the identification of locally available financial resources.

Table 6.4 provides a summary of the results for the City of Myrtle Beach with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds).

Table 6.4: Relevant Fiscal Resources

FISCAL RESOURCES	AVAILABLE	DEPARTMENT	COMMENTS
Capital Improvement Programming	✓	Budget, Public Works, All	1 EMD grant project is currently under construction for flood relief
Community Development Block Grants (CDBG)	✓	Neighborhood Services Division, Horry County	City Manager's Office
Special Purpose Taxes (or taxing districts)	✓	Administration, Budget	SRF Citywide – beach issues
Gas / Electric Utility Fees			
Water / Sewer Fees	✓	Public Works	
Stormwater Utility Fees	✓	Public Works	Fund supports system maintenance. Capital funds are used for projects.
Development Impact Fees	✓	Finance	Water/Sewer services
General Obligation, Revenue and/or Special Tax Bonds	✓	Budget	
Partnering arrangements or intergovernmental agreements	✓		
Other	✓		Underground Utility Fund (Santee Cooper), Street Tree Inventory (USDA, SC Forestry Commission), SAFER Grant, National Arbor Day Foundation, Alliance for Trees

6.3.8 Political Capability

One of the most difficult capabilities to evaluate involves the political will of a jurisdiction to enact meaningful policies and projects designed to reduce the impact of future hazard events. Hazard mitigation may not be a local priority or may conflict with or be seen as an impediment to other goals of the community, such as growth and economic development. Therefore the local political climate must be considered in designing mitigation strategies as it could be the most difficult hurdle to overcome in accomplishing their adoption and implementation.

The Capability Assessment Survey was used to capture information on the City's political capability. Survey respondents were asked to identify some general examples of local political capability, such as

guiding development away from identified hazard areas, restricting public investments or capital improvements within hazard areas, or enforcing local development standards that go beyond minimum state or federal requirements (e.g., building codes, floodplain management, etc.).

- Survey responses indicate that there is a strong local commitment to mitigate the effects of natural hazards in the City of Myrtle Beach. These findings are further confirmed through the City's past mitigation activities as described in the next section under *Previously Implemented Mitigation Measures*.

6.3.9 Local Self-Assessment

In addition to the inventory and analysis of specific local capabilities, the Capability Assessment Survey required City of Myrtle Beach staff to conduct a self-assessment of their perceived capability to implement hazard mitigation activities. As part of this process, city officials were encouraged to consider the barriers to implementing proposed mitigation strategies in addition to the mechanisms that could enhance or further such strategies. In response to the survey questionnaire, city officials classified each of the aforementioned capabilities as either "limited," "moderate," or "high."
Table 6.5 summarizes the results of the self-assessment process for the City of Myrtle Beach.

Table 6.5: Self-Assessment of Capability

Planning and Regulatory Capability	**High**
Administrative and Technical Capability	**High**
Fiscal Capability	**Moderate**
Political Capability	**High**
Overall Capability	**High**

6.4 CONCLUSIONS ON LOCAL CAPABILITY

In order to form meaningful conclusions on the assessment of local capability, a quantitative scoring methodology was designed and applied to results of the Capability Assessment Survey. The methodology used to develop the capability score for the City can be found in Appendix B. The rating attempts to assess the overall level of capability for the City of Myrtle Beach to implement hazard mitigation actions.

6.4.1 Capability Score

According to the capability assessment, the capability score for the City of Myrtle Beach is **71**, which represents **90%** of the total number of points achievable through the Atkins capability scoring methodology. This indicates an overall **"High"** level of local capability.

The capability score is based solely on the information provided by local officials in response to the Capability Assessment Survey. The survey instrument was designed to measure local capability based on those indicators determined to be most relevant for mitigation purposes and referenced in FEMA's "How-to" series planning guidance.

6.4.2 Linking the Capability Assessment with the Risk Assessment and the Mitigation Strategy

The conclusions of the risk assessment and capability assessment serve as the foundation for the development of a meaningful hazard mitigation strategy. During the process of identifying specific mitigation actions to pursue, City staff considered not only the City's level of hazard risk but also the existing capability to minimize or eliminate that risk.

Figure 6.2 shows a *Risk vs. Capability Matrix* that is used to illustrate the City's overall hazard risk in comparison to overall capability.[6] Based on the assessments completed for the City of Myrtle Beach, hazard risk was determined to be HIGH while the overall capability is also HIGH. This means that while the City of Myrtle Beach does face some significant potential hazards, it also has significant capacity to implement mitigation measures to eliminate, reduce, or manage those hazards.

Figure 6.2: Risk vs. Capability Matrix

		HAZARD RISK		
		Limited	Moderate	High
OVERALL CAPABILITY	High			✓
	Moderate			
	Limited			

[6] Overall hazard risk was determined using the results of the risk assessment combined with information on the following factors: total population, population growth rate, land area, historical disaster declarations, unique hazard risks, NFIP participation and the value of existing Pre-FIRM structures.

SECTION 7

MITIGATION STRATEGY

This section of the Plan provides the blueprint for the City of Myrtle Beach to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Floodplain Management and Hazard Mitigation Planning Committee (FMHMPC) and the findings and conclusions of the *Capability Assessment* and *Risk Assessment*. It consists of the following five subsections:

- 7.1 Introduction
- 7.2 Mitigation Goals
- 7.3 Identification and Analysis of Mitigation Techniques
- 7.4 Selection of Mitigation Techniques for Myrtle Beach
- 7.5 Plan Update Requirement

7.1 INTRODUCTION

The intent of the Mitigation Strategy is to provide the City of Myrtle Beach with the goals that will serve as guiding principles for future mitigation policy and project administration, along with an analysis of mitigation techniques deemed available to meet those goals and reduce the impact of identified hazards. It is designed to be comprehensive, strategic, and functional in nature:

- In being *comprehensive*, the development of the strategy includes a thorough review of all hazards and identifies extensive mitigation measures intended to not only reduce the future impacts of high risk hazards, but also to help the City achieve compatible economic, environmental, and social goals.

- In being *strategic*, the development of the strategy ensures that all policies and projects proposed for implementation are consistent with pre-identified, long-term planning goals.

- In being *functional,* each proposed mitigation action is linked to established priorities and assigned to specific departments or individuals responsible for their implementation with target completion deadlines. When necessary, funding sources are identified that can be used to assist in project implementation.

The first step in designing the Mitigation Strategy includes the identification of mitigation goals. Mitigation goals represent broad statements that are achieved through the implementation of more specific mitigation actions. These actions include both hazard mitigation policies (such as the regulation of land in known hazard areas through a local ordinance) and hazard mitigation projects that seek to address specifically targeted hazard risks (such as the acquisition and relocation of a repetitive loss structure).

The second step involves the identification, consideration, and analysis of available mitigation measures to help achieve the identified mitigation goals. This is a long-term, continuous process sustained through the development and maintenance of this Plan. Alternative mitigation measures will continue to be considered as future mitigation opportunities are identified, as data and technology improve, as mitigation funding becomes available, and as this Plan is maintained over time.

The third and last step in designing the Mitigation Strategy is the selection and prioritization of specific mitigation actions for Myrtle Beach (provided separately in Section 8: *Mitigation Action Plan*). The Mitigation Action Plan, or MAP, represents an unambiguous and functional plan for action and is considered to be the most essential outcome of the mitigation planning process.

The MAP includes a prioritized listing of proposed hazard mitigation actions (policies and projects) for the City of Myrtle Beach to carry out with accompanying information, such as those departments or individuals assigned responsibility for their implementation, potential funding sources, and an estimated target date for completion. The MAP provides those departments or individuals responsible for implementing mitigation actions with a clear roadmap that also serves as an important tool for monitoring success or progress over time. The cohesive collection of actions listed in the MAP can also serve as an easily understood menu of mitigation policies and projects for those local decision makers who want to quickly review the recommendations and proposed actions of the Floodplain Management and Hazard Mitigation Plan.

In preparing Mitigation Action Plan for Myrtle Beach, the FMHMPC considered the City's overall hazard risk and its capability to mitigate the effects of hazards as recorded through the risk and capability assessment process, in addition to meeting the adopted mitigation goals and unique needs of the community.

7.1.1 Mitigation Action Prioritization

Prioritization of the proposed mitigation actions was based on the following six (6) factors:

- Effect on overall risk to life and property
- Ease of implementation
- Political and community support
- A general economic cost/benefit review[1]
- Funding availability
- Continued compliance with the NFIP

The City's Floodplain Coordinator helped to coordinate the prioritization process by reviewing each action and working with the lead agency/department responsible to determine a priority for each action using the six factors listed above. Using these criteria, actions were classified as high, moderate, or low priority.

[1] Only a general economic cost/benefit review was considered by the FMHMPC through the process of selecting and prioritizing mitigation actions. Mitigation actions with "high" priority were determined to be the most cost effective and most compatible with Myrtle Beach's unique needs. A more detailed cost/benefit analysis will be applied to particular projects prior to the application for or obligation of funding, as appropriate.

7.2 MITIGATION GOALS

44 CFR Requirement
44 CFR Part 201.6(c)(3)(i): The mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

The primary goal of all local governments is to promote the public health, safety, and welfare of its citizens. In keeping with this standard, the City of Myrtle Beach has developed seven goal statements for local hazard mitigation planning, presented in **Table 7.1**. Each goal, purposefully broad in nature, serves to establish parameters that were used in developing mitigation actions. Consistent implementation of objectives and actions over time will ensure that community goals are achieved.

Table 7.1 Mitigation Goals

GOAL 1
Protect life and property from the hazards of wind, rain, flooding, and ocean surge.
GOAL 2
Preserve the beaches, wetlands, swashes, and waterways.
GOAL 3
Continue to develop and implement storm water drainage plans.
GOAL 4
Create and foster a comprehensive public awareness for all hazards in the community.
GOAL 5
Improve and ensure adequate public safety services and essential municipal services under normal and emergency conditions.
GOAL 6
Preserve the existing land use plan, most especially the residential neighborhoods.
GOAL 7
Reduce economic impact from the effects of a hazard event.

As part of the plan update, the FMHMPC revisited the goals from the existing plan. This was done during the August 5, 2015 meeting to ensure that the previously identified goals remain valid. As a result of this review, the FMHMPC recommended that the existing goals remain the same. Each of the following goal statements represents a broad target for the City of Myrtle Beach to achieve through the implementation of the more detailed Mitigation Action Plan provided in Section 8.

7.3 IDENTIFICATION AND ANALYSIS OF MITIGATION TECHNIQUES

44 CFR Requirement

44 CFR Part 201.6(c)(3)(ii): The mitigation strategy shall include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effect of each hazard, with particular emphasis on new and existing buildings and infrastructure.

In formulating the Mitigation Strategy for the City of Myrtle Beach, a wide range of activities were considered in order to help achieve the established mitigation goals, in addition to addressing any specific hazard concerns. These activities were discussed during FMHMPC meetings. In general, all activities considered by the FMHMPC can be classified under one of the following six (6) broad categories of mitigation techniques: Prevention, Property Protection, Natural Resource Protection, Structural Projects, Emergency Services, and Public Awareness and Education. These are discussed in detail below.

7.3.1 Prevention

Preventative activities are intended to keep hazard problems from getting worse and are typically administered through government programs or regulatory actions that influence the way land is developed and buildings are built. They are particularly effective in reducing a community's future vulnerability, especially in areas where development has not occurred or capital improvements have not been substantial. Examples of preventative activities include:

- Planning and zoning
- Building codes
- Open space preservation
- Floodplain regulations
- Stormwater management regulations
- Drainage system maintenance
- Capital improvements programming
- Riverine / fault zone setbacks

7.3.2 Property Protection

Property protection measures involve the modification of existing buildings and structures to help them better withstand the forces of a hazard or removal of the structures from hazardous locations. Examples include:

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection
- Retrofitting (e.g., windproofing, floodproofing, seismic design techniques, etc.)
- Safe rooms, shutters, shatter-resistant glass
- Insurance

7.3.3 Natural Resource Protection

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, steep slopes, and sand dunes. Parks, recreation, or conservation agencies and organizations often implement these protective measures. Examples include:

- Floodplain protection
- Watershed management
- Riparian buffers
- Forest and vegetation management (e.g., fire resistant landscaping, fuel breaks, etc.)
- Erosion and sediment control
- Wetland preservation and restoration
- Habitat preservation
- Slope stabilization

7.3.4 Structural Projects

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the environmental natural progression of the hazard event through construction. They are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Reservoirs
- Dams / levees / dikes / floodwalls
- Diversions / detention / retention
- Channel modification
- Storm sewers

7.3.5 Emergency Services

Although not typically considered a “mitigation” technique, emergency service measures do minimize the impact of a hazard event on people and property. These commonly are actions taken immediately prior to, during, or in response to a hazard event. Examples include:

- Warning systems
- Evacuation planning and management
- Emergency response and preparedness training and exercises
- Sandbagging for flood protection
- Installing temporary shutters for wind protection

7.3.6 Public Education and Awareness

Public education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Outreach projects
- Symposiums
- Speaker series / demonstration events
- Hazard map information
- Real estate disclosure
- Library materials
- Social media
- Websites
- School children educational programs
- Hazard expositions

7.4 SELECTION OF MITIGATION TECHNIQUES FOR MYRTLE BEACH

In order to determine the most appropriate mitigation techniques for the City of Myrtle Beach, the FMHMPC members thoroughly reviewed and considered the findings of the *Capability Assessment* and *Risk Assessment* to determine the best activities for the community. Other considerations included the effect of each mitigation action on overall risk to life and property, its ease of implementation, its degree of political and community support, its general cost-effectiveness, and funding availability (if necessary).

7.5 PLAN UPDATE REQUIREMENT

In keeping with FEMA requirements for plan updates, the Mitigation Actions identified in the 2010 plan were evaluated to determine their 2015 implementation status. Updates on the implementation status of each action are provided. The mitigation actions provided in Section 8: *Mitigation Action Plan* include the mitigation actions from the 2010 plan as well as any new mitigation actions proposed through the 2015 planning process.

SECTION 8

MITIGATION ACTION PLAN

This section includes the listing of the mitigation actions proposed by the City of Myrtle Beach in the Plan. It consists of the following two subsections:

- 8.1 Overview
- 8.2 Mitigation Action Plan

44 CFR Requirement
44 CFR Part 201.6(c)(3)(iii): The mitigation strategy shall include an action plan describing how the actions identified in paragraph (c)(2)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction.

8.1 OVERVIEW

This section includes the listing of the mitigation actions proposed by the City of Myrtle Beach. It is designed to achieve the mitigation goals established in Section 7: *Mitigation Strategy* and will be maintained on a regular basis according to the plan maintenance procedures established in Section 9: *Plan Maintenance Procedures*.

Each proposed mitigation action has been identified as an effective measure (policy or project) to reduce hazard risk for the City of Myrtle Beach. Each action is listed in the MAP in conjunction with background information such as hazard(s) addressed, plan goal(s), and relative priority. Other information provided in the MAP includes potential funding sources to implement the action should funding be required (not all proposed actions are contingent upon funding). Most importantly, implementation mechanisms are provided for each action, including the designation of a lead agency or department responsible for carrying the action out as well as a timeframe for its completion. These implementation mechanisms ensure that the City of Myrtle Beach Flood Mitigation and Hazard Mitigation Plan remains a functional document that can be monitored for progress over time. The proposed actions are not listed in priority order, though each has been assigned a priority level of "high," "moderate," or "low" as described below and in Section 7 (page 7.2).

The Mitigation Action Plan is organized by mitigation strategy category (Prevention, Property Protection, Natural Resource Protection, Structural Projects, Emergency Services, or Public Education and Awareness). The following are the key elements described in the Mitigation Action Plan:

- Hazard(s) Addressed—Hazard which the action addresses.
- Goal(s) Addressed—Plan goal which the action addresses.

- Relative Priority—High, moderate, or low priority as assigned by the jurisdiction.
- Lead Agency/Department—Department responsible for undertaking the action.
- Potential Funding Sources—Local, State, or Federal sources of funds are noted here, where applicable.
- Implementation Schedule—Date by which the action the action should be completed. More information is provided when possible.
- Implementation Status (2015)—Indication of completion, progress, deferment, or no change since the previous plan. If the action is new, that will be noted here.

8.2 Mitigation Action Plan

The mitigation actions proposed by the City are listed in each mitigation technique on the following pages. **Table 8.1** shows the location of each technique within the MAP as well as the number of mitigation actions proposed for each technique.

Table 8.1: MAP

Mitigation Category	Page	Number of Mitigation Actions
Prevention	8:4	14
Property Protection	8:9	2
Natural Resource Protection	8:10	4
Structural Projects	8:12	2
Emergency Services	8:13	9
Public Education and Awareness	8:15	9

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City of Myrtle Beach Mitigation Actions

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
	Prevention							
P-1	Submit a request to FEMA for mapping the Market Commons District using their Limited Map Maintenance Program, to map the storm surge potential.	Flood, Storm Surge	1, 6	Moderate	Floodplain Coordinator, Public Works Department	FEMA, Local funds	2015	Deferred-This area is now known as the Market Common District - There has been no notable progress in the effort to have the former Air Force base mapped. FEMA has started its Map Modernization program for Horry County, and at the kickoff meeting the former Air Force Base was identified as a priority for study. We received our preliminary maps in September 2015 and this area is shown on the new maps with some flood zones.
P-2	Revise the zoning ordinance to ensure no net loss of fill within the SFHA.	Flood	1	Low	City Council, Planning Commission, Zoning Administrator, Chief Building Official	Operating budget	2016	Deferred-The Construction Services Department is working to revise the zoning ordinance for the SFHA.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
P-3	Create a plan to increase Community Rating System (CRS) points.	Flood	1, 7	Moderate	Floodplain Coordinator, FMHMPC	Local funds	Completed	Completed-The Floodplain Manager implemented a plan to increase the City's potential CRS points. The strategies were to obtain credit for dune protection, to upgrade the web site, amend the public notice brochure, reduce the number of repetitive loss properties, implement a non-conversion agreement for VE properties, provide additional mapping information, implement a repetitive loss notification program, and train inspection staff on flood zone issues. The City's CRS program was reviewed in 2009 and the points increased to 2758. The City's CRS program was reviewed in 2012 and the points increased to 2,849.
P-4	Perform routine maintenance on the City's drainage structures.	Flood	3	High	Public Works Department	Local funds	Completed	Completed-The City's ditches and canal systems are on a constant cutting and cleaning schedule. There is also a schedule for pipe cleaning and catch basin repair. A stormwater management plan was adopted in Fiscal 14-15 for the city.
P-5	Implement a non-conversion agreement as a condition of granting permits in Flood Zones.	Flood	1, 5	High	Construction Services, Floodplain Coordinator	Local funds	Completed	Completed-The Construction Services Department has implemented a policy that requires property owners to sign and agree not to convert areas below the base flood elevation in violation of the floodplain regulations.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
P-6	Work to increase overall staff expertise in floodplain management through training and certification of additional staff.	Flood	1, 5	High	City Manager	Local funds	Completed	Completed-The City has seven certified floodplain managers among its employees. The majority of them attended the SC Association for Hazard Mitigation conference in North Myrtle Beach in 2015, securing continuing education credits necessary to maintain certification. The City added 2 additional staff members as certified floodplain managers in 2013.
P-7	Create and maintain a map of all repetitive loss properties.	Hurricane and Tropical Storm, Flood, Storm Surge	1, 5	High	Floodplain Coordinator	Local funds	Completed	Completed-This action was added during the 2004 annual evaluation process. Since that time, a map was created showing all repetitive loss properties in the City limits. It was submitted under the CRS program for additional credit towards the repetitive loss program. The map was redone when new data came out.
P-8	Create a training program on how to fill out an elevation certificate.	Flood	5	Moderate	Floodplain Coordinator	Local funds	Completed	Completed-This action was added during the 2004 annual evaluation process. Since that time, the Floodplain Coordinator worked with the SC Department of Natural Resources to hold an Elevation Certificate workshop. The City held a training program with SCDNR in 2013.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
P-9	Review the Floodplain Ordinance and other elements of the City's Floodplain Management program to ensure continued compliance with the NFIP.	Flood	1, 5	High	City Council, Zoning Administrator	Local funds	2016	Deferred-The Planning Department and Zoning Administrator have begun work [in 2006] on reviewing Section 909 of the Zoning Ordinance. Changes to the Floodplain Ordinance were approved by the City Council in January 2008. The changes were incorporated into the Zoning Ordinance Rewrite, which was adopted in 2015. Additionally, the City is in the process of amending the Floodplain Ordinance to comply with a FEMA ruling regarding swimming pool enclosures (see Mitigation Action 32). The ordinance for pool enclosures have been revised based on FEMA guidance. The ordinance is reviewed continually.
P-10	Coordinate with Planning and Public Works to draft a stormwater plan.	Flood	3	Moderate	Planning Department, Public Works Department	Local Funds	Completed	Completed-This project was not achieved in 2008; the committee moved it to the 2009 action list, and will re-evaluate the resources needed to begin the process. A stormwater management plan was adopted in Fiscal 14-15 for the city.
P-11	Create a new filing system for elevation certificates in the Floodplain Coordinator's office.	Flood	5	Low	Floodplain Coordinator	Local funds	Completed	Completed-Elevation certificates are now scanned into an electronic folder.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
P-12	Post-construction inspections of private stormwater systems.	Flood	3, 5	Moderate	Public Works Department	Local funds	2017	Deferred-In accordance with NPDES regulations, Public Works staff inspect private stormwater systems for any conditions that may create or exacerbate localized flooding. Through the existing contract, contingent upon annual renewal by the City of Myrtle Beach, with the Coastal Waccamaw Stormwater Education Consortium (CWSEC) Storm Drain Marking Program will assist the City in achieving this goal.
P-13	Encourage more developers to bury their utility lines to prevent damage from wind and flooding.	High Wind, Ice Storm, Northeaster, Flood, Tornado	1	Moderate	Planning Department, Public Works Department, Construction Services	Local funds	Completed	Completed-All new development over the past 3 years has installed underground utilities.
P-14	Become a Firewise Community.	Wildfire	5, 7	Moderate	Fire Marshal	Local funds	2017	The City is currently working on its package to become a Firewise community.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
	Property Protection							
PP-1	Acquire easements or property to correct localized drainage problems.	Flood	3	Moderate	Public Works Department, City Council	Local funds	Completed	The Public Works Department has acquired all easements necessary for ongoing drainage relief projects for the boardwalk/downtown area. Easements have also been acquired for the Pine Lakes drainage projects. Two large road projects brought drainage easements along Oak Forest Lane (2008) and 38th Ave N. The Public Works Department is continually working to acquire easements to correct flooding.
PP-2	Removal of temporary pool enclosures from hotels in the floodplain.	Flood, Storm Surge, Tidal Waves / Tsunami	1, 5	High	Floodplain Coordinator, Zoning Administrator	Local funds	Completed	Completed-FEMA overturned this ruling and now allows pool enclosures. Property owners must apply annually for a permit.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
	Natural Resource Protection							
NRP-1	Continue beach renourishment on a 10-year cycle for the next 50 years, based on the availability of funding for the federal government's share of the cost.	Coastal Erosion, Sea Level Rise, Storm Surge	2	High	City Council, City Manager, Public Works Director	Local funds, Grants	2019	Deferred-Every ten years, the City participates in beach renourishment efforts. The renourishment activity was most recently completed in April 2008. The amount of sand used ranged from 15 cubic yards/foot (in residential areas, where the beach remained healthy) to 40 cubic yards/foot in the area of the 14th Ave N pier (and other areas where beach traffic is heaviest). The City contracts with Coastal Science & Engineering to report on the result of renourishment; this is due each year in the fall. This report will indicate the updated beach profile. The City continues to notify the Army Corps of Engineers after any significant storm event that causes abnormal erosion along the beachfront. Planning has begun with the USACOE to implement another renourishment in 2019.
NRP-2	Conduct study to investigate the cost of constructing a second line of dunes using sand fencing.	Beach Erosion, Coastal Flooding, Storm Surge	1, 2	Moderate	Public Works Director	Beach protection grants	2019	Deferred-Secondary dunes were created along many areas of the beach during the past renourishment. More secondary dunes will be studied as part of the proposed 2019 project.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
NRP-3	Acquire additional swash and wetland areas.	Flood	2	Moderate	Public Works Department, City Council	Local funds, grants	2017	Deferred-No additional swash or jurisdictional wetland areas were gained in the last year. The City has gained almost 100 acres of wetlands on the former Air Force base via conveyance from the developer; these acres are planned for passive recreation trails and open space. An estuary plan is being created for the Withers Swash area that will lead to acquisition of more open space, an extension of Withers Swash park (across 3rd Ave S), and a new neighborhood plan that helps the neighborhood relate to the Swash as a preservation concern.
NRP-4	Coordinate with the Planning Department to include a representative for floodplain issues that may arise during the rewriting of the comprehensive plan.	Flood	1, 5	High	Planning Department, Floodplain Coordinator	Local funds	Completed	Completed-The Floodplain Coordinator and other CFM-certified staff have participated in the Comprehensive Plan revision process, which should be complete by the end of 2011.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
	Structural Projects							
SP-1	Find funding for three currently developed stormwater projects: the 4th Avenue North Plan; the 24th Avenue North Plan; and the Downtown Redevelopment Corporation (DRC) Plan.	Flood	3	Moderate	Public Works Department	TBD	2015	Deferred-The City has expended $2.6 million – including SRF funding – to create a new oceanfront collector system between 1st Ave and 8th Ave N. Twin 84" pipes are being constructed going offshore at 4th Ave. North with a completion date of fall, 2015 at a cost or $13 Million. A total of six pipes will be removed when the ocean outfall is completed. The stormwater project is being done in conjunction with the new boardwalk recreation project. Additionally, a new drainage system was completed in 2008 to end localized flooding on Haskell Circle. Funds from the Pre-Disaster Mitigation (PDM) program were used to accomplish this project.
SP-2	A study for a regional storm water system for the former U.S. Air Force Base has been completed and work on the regional stormwater ponds is progressing.	Flood	3	Moderate	Base Redevelopment Authority, Public Works Department	Local funds, Staff time	Completed	A contract for a sixth lake in the Market Common district was awarded; and the lake was completed in 2007. Bent Oak phases II, II & IV neighborhood project was completed in 2007 to relieve localized flooding in the area. A large regional ditch (the "Mama Ditch") was annexed in 2008 and has been added to the City's stormwater ditch maintenance schedule.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
	Emergency Services							
ES-1	Improvement of Emergency Warning System.	All Hazards	1	Moderate	Emergency Management	TBD	Completed	Completed-We have an agreement with HCEMD to provide emergency warnings for visitors and residents using their code red system.
ES-2	Evacuation Route Improvement.	Hurricane and Tropical Storm	1	Moderate	Emergency Management, SCDOT	Local funds; Federal grants	2016-2020	The SC DOT has installed three overhead message signs on US 17, which can be used to provide information to the public during evacuations and other emergencies. The electronic signs are located on US 17 at SC 544, at Mr. Joe White Avenue North (formerly 10th Avenue North) and at SC 22. The City of Myrtle Beach can request that messages be displayed on these signs as needed during hurricane evacuations or other emergency circumstances. In addition, the SC DOT has installed 16 traffic-monitoring cameras throughout the Grand Strand, on US 17 and US 501. Improvements are made on an annual basis. Educational brochures with the evacuation routes are disseminated to the public.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
ES-3	Maintain the City's Emergency Management Plan. (Each hazard identified in this plan is included in the Emergency Management Plan.)	All Hazards	1, 5	High	Emergency Management	Local funds	2016	The City's Emergency Management Plan has been incorporated into the Floodplain Management and Hazard Mitigation Plan by reference. The Emergency plan is updated each year and was updated in 2015. A copy of the plan is available for viewing on the City's web site.
ES-4	Maintain "Storm-Ready Community" Status.	Hailstorm, Lightning, High Wind, Hurricane, Tornado	1, 5	High	Emergency Management	Local funds	2018	Deferred-The City received its storm-ready approval letter for 2015 but will be able to renew their status in 2018 with all of their eligibility requirements.
ES-5	Apply lessons learned from recent disasters: • Apply for Tsunami-Ready Status • Use the lessons learned from New Orleans' experiences to form evacuation plans • Plan for a Flood Awareness Week	All	1, 5, 7	Moderate	Emergency Management, Floodplain Coordinator	Local funds	2017	Deferred-The City of Myrtle Beach became a Tsunami-Ready Community in 2006. Prior to the 2006 plan evaluation, the Assistant City Manager and Risk Manager collaborated on a plan to assist nursing homes and other critical facilities in evacuating prior to a hurricane. However, the Floodplain Coordinator is still evaluating the options for a Flood Awareness Week for Myrtle Beach.
ES-6	Devise a flood drill to test the flood warning system.	Flood	1	High	Risk Manager, Emergency Manager, Floodplain Coordinator	Local funds	2016	Deferred-We are working with HCEMD to test the flood warning system using the Code Red System.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
ES-7	Train Urban Search and Rescue Team on building collapse rescue.	All	1, 5	Moderate	City Fire Department	Homeland Security Grants	2017	New-Currently, there are 40 trained rescue team members with $300,000 of equipment.
ES-8	Train Water Rescue Team for the floodplain area and other water rescues.	Flood	1, 5	Moderate	City Fire Department	Local funds; Homeland Security Grants	2016	New-Currently, there are 22 trained personnel with strategically placed equipment for a water rescue.
ES-9	Utilize installed cameras throughout the City to monitor emergency situations to include flooding and surge on the beach access points.	All	1, 5	Moderate	Emergency Management/Public Safety	Local Funds	2017	New-Currently new cameras have been installed around the City and they will be utilized for multiple issues.
	Public Education and Awareness							
PEA-1	Create a business task group to establish guidelines for the mitigation of hazard related economic losses to the community.	All	4, 7	Moderate	Planning Director, Planning Commission, City Manager, City Council	Local funds; private sector	2016	Deferred-The City's Tourism Committee with sponsorships from the Chamber of Commerce, Santee Cooper, and Horry County Emergency Mgmt. have sponsored an annual Area Business Disaster Recovery Symposium for the past two years. Approximately 150 businesses have participated in the symposium each year. The third annual symposium will be held in January 2016. The symposium has focused on emergency preparedness and business continuity planning thus far.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
PEA-2	Create a presence on the City's Web site for flood information.	Flood	1, 4	High	Floodplain Coordinator, Public Information Officer	Local funds	2016	This action was added during the 2004 annual evaluation process. Since that time, the Floodplain Coordinator and Public Information Officer collaborated in publishing the City's floodplain pamphlet on the Internet via a link on the front page of the City's web page, www.cityofmyrtlebeach.com/flood.html. This was expanded to include flood insurance information as well. Additional information for floods including mapping information is expected to be added.
PEA-3	Provide training for elected and appointed officials and board members about the benefits of low-impact stormwater design.	Flood	1, 7	Moderate	Planning Department, Public Works Department	Local funds	2017	Deferred-This was a new action identified for the 2010 plan update. The City has plans to provide additional training to officials in the coming year. The Coastal Waccamaw Stormwater Education Consortium (CWSEC) will provide support with the workshops, seminars and good housekeeping training videos.
PEA-4	Develop a public information / safety campaign regarding lightning strikes.	Lightning	1, 4	Moderate	Fire Marshal, Risk Manager, Public Information Officer	Local funds	Completed	Completed – Developed a PSA to better inform our citizens and visitors about lighting safety for our local TV channel.
PEA-5	Place floodplain brochures at City Hall and recreation centers to educate the public on floodplain regulations and preparing for emergencies.	Flood	1, 4, 5	High	Construction Services/Floodplain Manager	Local funds	2016	New

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
PEA-6	Attend community watch meetings and educate the citizens on stormwater and floodplain issues.	Flood	1, 3, 4	High	Construction Services/Floodplain Manager	Local Funds	2017	New-The City would like to maintain these efforts on an annual basis.
PEA-7	Create public service announcements for hurricane or emergency preparedness.	All	1, 4	High	PIO	Local Funds	2017	New- The City would like to maintain these efforts on an annual basis.
PEA-8	Initiate a social media campaign for the City of Myrtle Beach.	All	1, 4	High	PIO	Local Funds	2016	New-The City began a new campaign to communicate information through other formats including Facebook which it is currently using. The City has an Instagram account but plans to utilize it more frequently. The Police Department has a twitter account and uses it regularly.
PEA-9	Plan and hold a disaster awareness day for the City's citizens.	All	1, 4	High	PIO	Local Funds	2017	New-The City feels that there is an interest in citizens learning more. It may be combined with other efforts.
	Previously Completed Mitigation Actions							
	Include the Departmental Disaster Response Plan in the Floodplain Management and Hazard Mitigation Plan by reference.	All Hazards		Moderate	City Council, FMHMPC	N/A		Completed-The City's Departmental Disaster Response Plan (DDRP) was included by reference in the Floodplain Management and Hazard Mitigation Plan last year. The DDRP is a comprehensive collection of the specific responsibilities for each department during a disaster. The City is taking the prescribed steps to update the plan annually.

Action #	Description	Hazard(s) Addressed	Goal Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2015)
	Investigate potential coordination with SC DHEC to create a rainfall alert system.	Flood		Moderate	Public Works Department	Local funds		Completed. The Public Works Department has coordinated with SC DHEC and currently receives rain gauge information online. This data is then used to help design stormwater systems that mitigate problems in particular areas.

SECTION 9

PLAN MAINTENANCE PROCEDURES

44 CFR Requirement
44 CFR Part201.6(c)(4)(i): The plan shall include a plan maintenance process that includes a section describing the method and schedule of monitoring, evaluating and updating the mitigation plan within a five-year cycle. ***44 CFR Part 201.6(c)(4)(ii):*** The plan maintenance process shall include a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

This section discusses how the City of Myrtle Beach's Mitigation Strategy and Mitigation Action Plan will be implemented and how the Floodplain Management and Hazard Mitigation Plan will be evaluated and enhanced over time. This section also discusses how the public will continue to be involved in a sustained hazard mitigation planning process. It consists of the following three subsections:

- 9.1 Monitoring and Evaluating the Previous Plan
- 9.2 Implementation and Integration
- 9.3 Monitoring, Evaluation, and Enhancement
- 9.4 Continued Public Involvement

9.1 MONITORING AND EVALUATING THE PREVIOUS PLAN

Since the previous plan was adopted, the City of Myrtle Beach has worked to ensure that mitigation was integrated into local activities and that the mitigation plan was appropriately implemented. The city outlined a process in the 2010 plan for monitoring and evaluating the plan throughout the interim period between plan updates.

The City of Myrtle Beach was ultimately successful in implementing the monitoring and evaluation process that was outlined in 2010 plan as annual meetings were held by the FMHMPC to discuss the mitigation plan and the priorities that were outlined in it. Any findings and recommendations of the FMHMPC were reported to the City Council.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the FMHMPC generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

9.2 IMPLEMENTATION AND INTEGRATION

Each agency, department or other partner participating under the City of Myrtle Beach Floodplain Management and Hazard Mitigation Plan is responsible for implementing specific mitigation actions as prescribed in the Mitigation Action Plan. Every proposed action listed in the Mitigation Action Plan is assigned to a specific "lead" agency or department in order to assign responsibility and accountability and increase the likelihood of subsequent implementation.

In addition to the assignment of a local lead department or agency, an implementation time period or a specific implementation date has been assigned in order to assess whether actions are being implemented in a timely fashion. The City of Myrtle Beach will seek outside funding sources to implement mitigation projects in both the pre-disaster and post-disaster environments. When applicable, potential funding sources have been identified for proposed actions listed in the Mitigation Action Plan.

Myrtle Beach will integrate this Hazard Mitigation Plan into relevant City government decision-making processes or mechanisms. This includes integrating the requirements of the Hazard Mitigation Plan into other local planning documents, processes or mechanisms, such as comprehensive or capital improvement plans, when appropriate. The members of the Floodplain Management and Hazard Mitigation Planning Committee (FMHMPC) will remain charged with ensuring that the goals and strategies of new and updated local planning documents for their agencies or departments are consistent with, or do not conflict with, the goals and actions of the Hazard Mitigation Plan and will not contribute to increased hazard vulnerability in Myrtle Beach.

The City actively integrates mitigation into the daily operations of conducting City business. This is currently accomplished through the following methods:

- The entire Floodplain Management and Hazard Mitigation Plan is incorporated into the City's Comprehensive Plan by reference.
- The City reviews all of the Mitigation Actions found in this plan as part of the annual reporting requirements of the CRS.
- The City incorporated the goals of the Floodplain Management and Hazard Mitigation Plan into the zoning code as part of a recent rewrite of that code.
- Some of the Mitigation Actions that were identified in previous versions of the plan called for changes/revisions to certain City codes or regulation. Many of these activities have taken place and are documented in the Mitigation Action Plan under the discussion of the implementation status for the action.

Opportunities to integrate the requirements of this Plan into other local planning mechanisms shall continue to be identified through future meetings of the FMHMPC and through the annual review process described herein. Although it is recognized that there are many possible benefits to integrating components of this Plan into other local planning mechanisms, The development and maintenance of this stand-alone Floodplain Management and Hazard Mitigation Plan is deemed by the Myrtle Beach FMHMPC to be the most effective and appropriate method to implement local hazard mitigation actions.

9.3 MONITORING, EVALUATION, AND ENHANCEMENT

Periodic revisions and updates of the Hazard Mitigation Plan are required to ensure that the goals of the Plan are kept current, taking into account potential changes in hazard vulnerability and mitigation priorities. In addition, revisions may be necessary to ensure that the Plan is in full compliance with applicable federal and state regulations. Periodic evaluation of the Plan will also ensure that specific mitigation actions are being reviewed and carried out according to the Mitigation Action Plan.

The Myrtle Beach FMHMPC shall meet in March of every year to evaluate the progress attained and to revise, where needed, the activities set forth in the Plan. The findings and recommendations of the FMHMPC shall be reported to the City Council at their first regularly scheduled meeting in April. The Myrtle Beach FMHMPC will also meet following any disaster events warranting a reexamination of the mitigation actions being implemented or proposed for future implementation. This will ensure that the Plan is continuously updated to reflect changing conditions and needs within Myrtle Beach.

Five (5) Year Plan Review

The Plan will be thoroughly reviewed by the FMHMPC every five years to determine whether there have been any significant changes in Myrtle Beach that may, in turn, necessitate changes in the types of mitigation actions proposed. New development in identified hazard areas, an increased exposure to hazards, an increase or decrease in capability to address hazards, and changes to federal or state legislation are examples of factors that may affect the necessary content of the Plan.

The plan review provides Myrtle Beach officials with an opportunity to evaluate those actions that have been successful and to explore the possibility of documenting potential losses avoided due to the implementation of specific mitigation measures. The plan review also provides the opportunity to address mitigation actions that may not have been successfully implemented as assigned. The Myrtle Beach Floodplain Coordinator will be responsible for reconvening the FMHMPC and conducting the five-year review.

During the five-year plan review process, the following questions will be considered as criteria for assessing the effectiveness and appropriateness of the Plan:

- Do the goals address current and expected conditions?
- Has the nature or magnitude of risks changed?
- Are the current resources appropriate for implementing the Plan?
- Are there implementation problems, such as technical, political, legal, or coordination issues with other agencies?
- Have the outcomes occurred as expected?
- Did City departments participate in the plan implementation process as assigned?

Following the five-year review, any revisions deemed necessary will be summarized and implemented according to the reporting procedures and plan amendment process outlined herein. Upon completion of the review and update/amendment process, the Myrtle Beach Floodplain Management and Hazard Mitigation Plan will be submitted to the State Hazard Mitigation Officer at the South Carolina Emergency Management Division (SCEMD) for final review and approval in coordination with the Federal Emergency Management Agency (FEMA).

Disaster Declaration

Following a disaster declaration, the Myrtle Beach Floodplain Management and Hazard Mitigation Plan will be revised as necessary to reflect lessons learned, or to address specific issues and circumstances arising from the event. It will be the responsibility of the Myrtle Beach Floodplain Coordinator to reconvene the FMHMPC and ensure the appropriate stakeholders are invited to participate in the plan revision and update process following declared disaster events.

Reporting Procedures

The results of the five-year review will be summarized by the FMHMPC in a report that will include an evaluation of the effectiveness of the Plan and any required or recommended changes or amendments. The report will also include an evaluation of implementation progress for each of the proposed mitigation actions, identifying reasons for delays or obstacles to their completion along with recommended strategies to overcome them.

Plan Amendment Process

Upon the initiation of the amendment process, the City of Myrtle Beach will forward information on the proposed change(s) to all interested parties including, but not limited to, all directly affected City departments, residents, and businesses. Information will also be forwarded to the South Carolina Emergency Management Division. This information will be disseminated in order to seek input on the proposed amendment(s) for not less than a 45-day review and comment period.

At the end of the 45-day review and comment period, the proposed amendment(s) and all comments will be forwarded to the FMHMPC for final consideration. The committee will review the proposed amendment along with the comments received from other parties, and if acceptable, the committee will submit a recommendation for the approval and adoption of changes to the Plan to the Myrtle Beach City Council within 60 days.

In determining whether to recommend approval or denial of a Plan amendment request, the following factors will be considered by the FMHMPC:

- There are errors, inaccuracies, or omissions made in the identification of issues or needs in the Plan.
- New issues or needs have been identified which are not adequately addressed in the Plan.
- There has been a change in information, data, or assumptions from those on which the Plan is based.

Upon receiving the recommendation from the FMHMPC and prior to adoption of the Plan, the City will hold a public hearing, if deemed necessary. The Myrtle Beach City Council will review the recommendation from the FMHMPC (including the factors listed above) and any oral or written comments received at the public hearing. Following that review, the City Council will take one of the following actions:

- Adopt the proposed amendments as presented;
- Adopt the proposed amendments with modifications;
- Refer the amendments request back to the FMHMPC for further revision; or
- Defer the amendment request back to the FMHMPC for further consideration and/or additional hearings.

9.4 CONTINUED PUBLIC INVOLVEMENT

44 CFR Requirement
44 CFR Part 201.6(c)(4)(iii): The plan maintenance process shall include a discussion on how the community will continue public participation in the plan maintenance process

Public participation is an integral component to the mitigation planning process and will continue to be essential as this Plan evolves over time. As described above, significant changes or amendments to the Plan shall require a public hearing prior to any adoption procedures.

Other efforts to involve the public in the maintenance, evaluation, and revision process will be made as necessary. These efforts may include:

- Advertising meetings of the FMHMPC in local newspapers, public bulletin boards, and/or City office buildings;
- Designating willing and voluntary citizens and private sector representatives as official members of the FMHMPC;
- Utilizing local media to update the public on any maintenance and/or periodic review activities taking place;
- Utilizing the City Web site to advertise any maintenance and/or periodic review activities taking place; and
- Keeping copies of the Plan in public libraries.

APPENDIX A

PLAN ADOPTION

44 CFR Requirement
44 CFR Part 201.6(c)(5): The plan shall include documentation that the plan has been formally adopted by the local governing body of the jurisdiction requesting approval of the plan.

This section of the Plan includes a copy of the local adoption resolution passed by the City of Myrtle Beach.

APPENDIX B

PLANNING TOOLS

This section of the Plan includes four (4) items:

1. *A Blank Public Participation Survey*
2. *A Blank Capability Assessment Survey*
3. *Scoring Criteria for the Capability Assessment*
4. *Floodplain Brochure distributed by the City of Myrtle Beach*

PUBLIC PARTICIPATION SURVEY
FOR HAZARD MITIGATION PLANNING

We need your help!

The City of Myrtle Beach is currently engaged in a planning process to become less vulnerable to natural disasters, and your participation is important to us!

The city, along with other participating partners, is now working to prepare an update to the *Hazard Mitigation Plan*. The purpose of this Plan is to identify and assess our community's natural hazard risks and determine how to best minimize or manage those risks. Upon completion, the Plan will represent a comprehensive *Hazard Mitigation Plan* for the City.

This survey questionnaire provides an opportunity for you to share your opinions and participate in the mitigation planning process. The information you provide will help us better understand your hazard concerns and can lead to mitigation activities that should help lessen the impact of future hazard events.

Please help us by completing this survey by April 10, 2015 and returning it to:

Sara Seremak, Atkins
1616 E. Millbrook Road, Suite 310
Raleigh, NC 27609

Surveys can also be faxed to: (919) 876-6848 or emailed to sara.seremak@atkinsglobal.com

If you have any questions regarding this survey or would like to learn about more ways you can participate in the development of the *City of Myrtle Beach Hazard Mitigation Plan*, please contact Atkins, planning consultant for the project. You may reach Margaret Walton (Atkins) at 919-357-3299 or by email at margaret.walton@atkinsglobal.com.

1. **Where do you live?**
   - ❑ City of Myrtle Beach
   - ❑ Other: _____

2. **Have you ever experienced or been impacted by a disaster?**
   - ❑ Yes
   - ❑ No

   a. **If "Yes," please explain:**

3. **How concerned are you about the possibility of our community being impacted by a disaster?**

- ❑ Extremely concerned
- ❑ Somewhat concerned
- ❑ Not concerned

4. **Please select the <u>one</u> hazard you think is the *highest threat* to your neighborhood:**

- ❑ Airplane Crash
- ❑ Dam / Levee Failure
- ❑ Drought
- ❑ Earthquake
- ❑ Erosion
- ❑ Extreme Heat
- ❑ Flood
- ❑ Hailstorm
- ❑ Hazardous Materials Incident
- ❑ Hurricane / Tropical Storm
- ❑ Land Subsidence / Sink Hole
- ❑ Landslide
- ❑ Lightning
- ❑ Nor'easter
- ❑ Sea Level Rise
- ❑ Severe Winter / Ice Storm
- ❑ Severe Thunderstorm / High Wind
- ❑ Storm Surge
- ❑ Terror Threat
- ❑ Tidal Wave/Tsunami
- ❑ Tornado
- ❑ Wildfire

5. **Please select the <u>one</u> hazard you think is the *second highest threat* to your neighborhood:**

- ❑ Airplane Crash
- ❑ Dam / Levee Failure
- ❑ Drought
- ❑ Earthquake
- ❑ Erosion
- ❑ Extreme Heat
- ❑ Flood
- ❑ Hailstorm
- ❑ Hazardous Materials Incident
- ❑ Hurricane / Tropical Storm
- ❑ Land Subsidence / Sink Hole
- ❑ Landslide
- ❑ Lightning
- ❑ Nor'easter
- ❑ Sea Level Rise
- ❑ Severe Winter / Ice Storm
- ❑ Severe Thunderstorm / High Wind
- ❑ Storm Surge
- ❑ Terror Threat
- ❑ Tidal Wave/Tsunami
- ❑ Tornado
- ❑ Wildfire

6. **Is there another hazard not listed above that you think is a wide-scale threat to your neighborhood?**

- ❑ Yes (please explain): _____
- ❑ No

7. **Is your home located in a floodplain?**

- ❑ Yes
- ❑ No
- ❑ I don't know

8. **Do you have flood insurance?**

- ❑ Yes
- ❑ No
- ❑ I don't know

   a. **If "No," why not?**

   - ❑ Not located in floodplain
   - ❑ Too expensive
   - ❑ Not necessary because it never floods
   - ❑ Not necessary because I'm elevated or otherwise protected
   - ❑ Never really considered it
   - ❑ Other (please explain): _____

9. **Have you taken any actions to make your home or neighborhood more resistant to hazards?**

- ❑ Yes
- ❑ No

   a. **If "Yes," please explain:**

10. **Are you interested in making your home or neighborhood more resistant to hazards?**

- ❑ Yes
- ❑ No

11. **Do you know what office to contact regarding reducing your risks to hazards in your area?**

- ❑ Yes
- ❑ No

12. What is the most effective way for you to receive information about how to make your home and neighborhood more resistant to hazards?

- ❑ Newspaper
- ❑ Television
- ❑ Radio
- ❑ Internet
- ❑ Mail
- ❑ Public workshops/meetings
- ❑ School meetings
- ❑ Other (please explain): _____

13. In your opinion, what are some steps your local government could take to reduce or eliminate the risk of future hazard damages in your neighborhood?

14. Are there any other issues regarding the reduction of risk and loss associated with hazards or disasters in the community that you think are important?

15. **A number of community-wide activities can reduce our risk from hazards. In general, these activities fall into one of the following six broad categories. Please tell us how important you think each one is for your community to consider pursuing.**

Category	Very Important	Somewhat Important	Not Important
1. Prevention Administrative or regulatory actions that influence the way land is developed and buildings are built. Examples include planning and zoning, building codes, open space preservation, and floodplain regulations.	❑	❑	❑
2. Property Protection Actions that involve the modification of existing buildings to protect them from a hazard or removal from the hazard area. Examples include acquisition, relocation, elevation, structural retrofits, and storm shutters.	❑	❑	❑
3. Natural Resource Protection Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems. Examples include: floodplain protection, habitat preservation, slope stabilization, riparian buffers, and forest management.	❑	❑	❑
4. Structural Projects Actions intended to lessen the impact of a hazard by modifying the natural progression of the hazard. Examples include dams, levees, detention/retention basins, channel modification, retaining walls, and storm sewers.	❑	❑	❑
5. Emergency Services Actions that protect people and property during and immediately after a hazard event. Examples include warning systems, evacuation planning, emergency response training, and protection of critical emergency facilities or systems.	❑	❑	❑
6. Public Education and Awareness Actions to inform citizens about hazards and the techniques they can use to protect themselves and their property. Examples include outreach projects, school education programs, library materials, and demonstration events.	❑	❑	❑

THANK YOU FOR YOUR PARTICIPATION!

This survey may be submitted anonymously; however, if you provide us with your name and contact information below we will have the ability to follow up with you to learn more about your ideas or concerns (optional):

Name: _____

Address: _____

_____

Phone: _____ **E-Mail:** _____

Local Capability Assessment Survey

Jurisdiction/Agency: _____ **Phone:** _____

Point of Contact: _____ **E-mail:** _____

1. PLANNING AND REGULATORY CAPABILITY - Please indicate whether the following planning or regulatory tools (plans, ordinances, codes or programs) are currently in place or under development for your jurisdiction by placing an "**X**" in the appropriate box. Then, for each particular item in place, identify the department or agency responsible for its implementation and indicate its estimated or anticipated effect on hazard loss reduction (Strongly Supports, Helps Facilitate or Hinders) with another "**X**". Finally, please provide additional comments or explanations in the space provided or with attachments.

Planning / Regulatory Tool	In Place	Under Development	Department / Agency Responsible	Effect on Loss Reduction			Comments
				Strongly Supports	Helps Facilitate	Hinders	
Hazard Mitigation Plan							
Comprehensive Land Use Plan (or General, Master or Growth Mgt. Plan)							
Floodplain Management Plan							
Open Space Management Plan (or Parks & Rec./ Greenways Plan)							
Stormwater Management Plan / Ordinance							
Natural Resource Protection Plan							
Flood Response Plan							
Emergency Operations Plan							
Continuity of Operations Plan							
Evacuation Plan							
Other Plans (please explain under Comments)							

Local Capability Assessment Survey

Planning / Regulatory Tool	In Place	Under Development	Department / Agency Responsible	Effect on Loss Reduction			Comments
				Strongly Supports	Facilitates	Hinders	
Disaster Recovery Plan							
Capital Improvements Plan							
Economic Development Plan							
Historic Preservation Plan							
Floodplain Ordinance (or Flood Damage Prevention Ordinance)							
Zoning Ordinance							
Subdivision Ordinance							
Unified Development Ordinance							
Post-disaster Redevelopment / Reconstruction Ordinance							
Building Code							
Fire Code							
National Flood Insurance Program (NFIP)							
NFIP Community Rating System (CRS Program)							

Local Capability Assessment Survey

2. ADMINISTRATIVE AND TECHNICAL CAPABILITY - Please indicate whether your jurisdiction maintains the following staff members within its current personnel resources by placing an "**X**" in the appropriate box . Then, if YES, please identify the department or agency they work under and provide any other comments you may have in the space provided or with attachments.

Staff / Personnel Resources	Yes	No	Department / Agency	Comments
Planners with knowledge of land development and land management practices				
Engineers or professionals trained in construction practices related to buildings and/or infrastructure				
Planners or engineers with an understanding of natural and/or human-caused hazards				
Emergency manager				
Floodplain manager				
Land surveyors				
Scientist familiar with the hazards of the community				
Staff with education or expertise to assess the community's vulnerability to hazards				
Personnel skilled in Geographic Information Systems (GIS) and/or FEMA's HAZUS program				
Resource development staff or grant writers				

Local Capability Assessment Survey

3. FISCAL CAPABILITY - Please indicate whether your jurisdiction has access to or is eligible to use the following local financial resources ***for hazard mitigation purposes*** (including as match funds for State of Federal mitigation grant funds). Then, identify the primary department or agency responsible for its administration or allocation and provide any other comments you may have in the space provided or with attachments.

Financial Resources	Yes	No	Department / Agency	Comments
Capital Improvement Programming				
Community Development Block Grants (CDBG)				
Special Purpose Taxes (or taxing districts)				
Gas / Electric Utility Fees				
Water / Sewer Fees				
Stormwater Utility Fees				
Development Impact Fees				
General Obligation, Revenue and/or Special Tax Bonds				
Partnering arrangements or intergovernmental agreements				
Other: _____				

Local Capability Assessment Survey

4. POLITICAL CAPABILITY - Political capability can be generally measured by the degree to which local political leadership is willing to enact policies and programs that reduce hazard vulnerabilities in your community, even if met with some opposition. Examples may include guiding development away from identified hazard areas, restricting public investments or capital improvements within hazard areas, or enforcing local development standards that go beyond minimum State or Federal requirements (e.g., building codes, floodplain management, etc.). Please identify some general examples of these efforts if available and/or reference where more documentation can be found.

Points System for Capability Ranking

0-24 points = Limited overall capability **25-49 points = Moderate overall capability** **50-80 points = High overall capability**

I. Planning and Regulatory Capability
(Up to 43 points)

Yes = 3 points
Under Development = 1 point
No = 0 points

- Hazard Mitigation Plan
- Comprehensive Land Use Plan
- Floodplain Management Plan
- Participate in NFIP
- Participate in CRS Program

Yes = 2 points
Under Development = 1 point
No = 0 points

- Open Space Management / Parks & Rec. Plan
- Stormwater Management Plan
- Natural Resource Protection Plan
- Flood Response Plan
- Emergency Operations Plan
- Continuity of Operations Plan
- Evacuation Plan
- Disaster Recovery Plan
- Flood Damage Prevention Ordinance
- Post-Disaster Redevelopment / Reconstruction Ordinance

Yes = 1 point
No = 0 points

- Capital Improvements Plan
- Economic Development Plan
- Historic Preservation Plan
- Zoning Ordinance
- Subdivision Ordinance
- Unified Development Ordinance
- Building Code
- Fire Code

II. Administrative and Technical Capability
(Up to 15 points)

Yes = 2 points
No = 0 points

- Planners with knowledge of land development and land management practices
- Engineers or professionals trained in construction practices related to buildings and/or infrastructure
- Planners or engineers with an understanding of natural and/or human-caused hazards
- Emergency manager
- Floodplain manager

Yes = 1 point
No = 0 points

- Land surveyors
- Scientist familiar with the hazards of the community
- Staff with education or expertise to assess the community's vulnerability to hazards
- Personnel skilled in Geographic Information Systems (GIS) and/or HAZUS
- Resource development staff or grant writers

III. Fiscal Capability
(Up to 10 points)

Yes = 1 point
No = 0 points

- Capital Improvement Programming
- Community Development Block Grants
- Special Purpose Taxes
- Gas / Electric Utility Fees
- Water / Sewer Fees
- Stormwater Utility Fees
- Development Impact Fees
- General Obligation/ Revenue/ Special Tax Bonds
- Partnering arrangements or intergovernmental agreements
- Other

IV. Self-Assessment of Overall Capability
(Up to 10 points)

High = 2 points
Moderate = 1 points
Low = 0 points

- Technical Capability
- Fiscal Capability
- Administrative Capability
- Political Capability
- Overall Capability

Floodplain Benefits

Floodplains serve many useful purposes, and those that are preserved in their natural or nearly natural state provide a wide range of benefits. For example, floodplains and primary swash areas hold, filter, convey and disperse floodwaters. Without preservation of these natural floodplains, floodwaters would inundate developed areas.

Five main swash areas exist within the City of Myrtle Beach: Midway Swash, Withers Swash, Deephead Swash, Cane Patch Swash and Bear Creek Swash. These serve as natural drainage basins and provide flood storage for stormwater runoff in their immediate area. They also provide a valuable service by filtering impurities from runoff.

The city owns approximately 11 acres of Withers Swash, which it preserves as a passive park area with a nature trail and picnic shelters. This swash provides wildlife habitats, breeding and feeding grounds for fish, and a high rate of plant growth. It's an excellent example of an ecosystem at work.

Maintaining Drainage

Debris in drainage ditches, streams and pipes can cause localized flooding when it rains. City code requires all owners or occupants of property to remove obstructions from the drainage system on their property. Further, it is unlawful for any person to throw or deposit any refuse, trash or debris in any drainage ditch, stream or body of water. For questions, or to report obstructions or violations, call the Public Works Dept. at 918-2000.

Flood Warning System

The city coordinates with the Horry County Emergency Management Office and the National Weather Service in issuing public warnings concerning expected floods and storms. Local television and radio stations may announce weather advisories from the National Weather Service and provide local weather information and advisories.

National Weather Service advisories indicate all warnings which are in effect, including a description of the threat and its potential impact. Watches and warnings are issued for gales (winds of 39 to 54 miles per hour), tropical storms (55 to 73 m.p.h.), and hurricanes (74 m.p.h. or more), as well as for flash floods, coastal flooding and heavy rains.

A hurricane watch indicates that a hurricane poses a possible threat within 48 hours. A hurricane warning means that hurricane conditions are expected within 36 hours. You should prepare to take action. Hurricanes can cause heavy rains, flash flooding, coastal inundation and abnormally high tides. Often, the greatest threat during a hurricane is from flooding. Remember that heavy rains not associated with tropical systems can cause dangerous flooding. Pay close attention to weather advisories.

The governor may issue an evacuation order. An evacuation order means that you should leave. The evacuation routes from the Myrtle Beach area to inland destinations are U.S. 501, Veterans Highway (S.C. 22), S.C. 544, and U.S. 17/S.C. 9. For more information about evacuation routes or flood warnings, call the National Weather Service office in Charleston (843-744-0303) or Horry County Emergency Management (843-915-5150). More information is available on-line at http://www.cityofmyrtlebeach.com/flood.html.

Permits Required for Floodplain Development

The city's zoning ordinance identifies portions of the city as being within the 100-year floodplain. In other words, there is a one percent chance of flooding in a given year. The zoning ordinance and building codes have special provisions regulating construction and other development within those floodplains. Without those provisions, flood insurance through the National Flood Insurance Program would not be available to property owners and renters in Myrtle Beach. Among the requirements are elevation certificates, copies of which are available for viewing in the Construction Services Department.

Before you build, fill or otherwise develop in a floodplain, contact Construction Services (918-1111, 921 Oak Street) to discuss city regulations. Any development in a floodplain without a permit should be reported to the Construction Services Director.

Repairing Flood Damage

A permit issued by Construction Services is required to make any repairs to flood-damaged buildings. Buildings with damage amounting to 50% or more of the building's value must be removed or brought into compliance with floodplain regulations. Buildings existing in a flood plain that do not meet the current regulations may only be improved to less than 50% of the building's value. Additions or alterations that are not a result of storm damage also are limited to less than 50% of the building's value.

The requirements of the zoning ordinance and building codes are minimum standards that all development must meet. To increase the safety of your property and reduce insurance premiums, you should consider building to higher standards. Of course, the safest way to develop your property is to locate improvements outside of the floodplain.

Your property is in or near the local flood hazard area, as mapped by the Federal Emergency Management Agency (FEMA). A map of the 100-year and 500-year floodplains within the City of Myrtle Beach is provided in this brochure for your reference. A larger flood map showing lot-by-lot detail of flood zones and required elevations can be viewed in the city's Construction Services Department, located in the City Services Building at 921 Oak Street.

Certified Floodplain Managers are available in the Construction Services Department to assist you with maps and flood protection information and provide advice on retrofitting techniques for structures in the floodplain.

Also available for review are current and past FEMA Flood Insurance Rate Maps (FIRM) and topographical maps that show elevations of property within the city. FEMA FIRM maps, reference materials, pamphlets and videos are also available at Chapin Library.

Most flooding in Myrtle Beach is caused by ocean water and rain that are driven landward by storms, such as tropical storms and hurricanes. Occasionally, heavy rains will cause localized flooding. Major flooding can occur along the beachfront and inland along the swashes.

Flood waters along the beachfront can rise to heights of 15 to 20 feet above mean sea level, with destructive waves reaching even higher. Most of the land east of Ocean Boulevard/Beach Drive is in this floodplain. Low land near Midway, Withers, Deephead, Cane Patch and Bear Branch Swashes also is prone to flooding.

Major storms affecting the Myrtle Beach area in recent years include Hurricane Hugo (1989), Hurricane Bertha (1996), Hurricane Fran (1996) and Hurricane Floyd (1999). Not only do hurricanes create floods, but they may cause erosion which increases the likelihood of more severe oceanfront flooding during subsequent storms.

WEATHER WARNINGS

In the event of severe weather, please tune to your local television station for emergency information, weather advisories and safety precautions.

Your home and its contents represent your greatest investment, but your homeowner's or renter's insurance policy will not cover losses due to flooding. Myrtle Beach participates in the National Flood Insurance Program, which makes flood insurance available to everyone in the city. Just because your home has not flooded in the recent past does not mean that you are safe. You should carefully consider buying flood insurance to protect yourself from losses due to flooding.

Property owners can insure their buildings and contents, and renters can insure their possessions. You do not have to live in the floodplain to qualify for flood insurance. More information about flood insurance is available from your insurance agent.

Since 1991, the city has participated in the National Flood Insurance Program's Community Rating System, which means premiums for flood insurance in Myrtle Beach are lower than they otherwise would be.

The city's participation in the CRS program includes the availability of staff in the Department of Construction Services to answer questions (on-site or off) about flooding, building requirements that are more stringent than federal minimum standards, regulations for stormwater management in new construction, publications in Chapin Library, and public outreach projects, like this brochure.

For more information, contact the Director of Construction Services (918-1111).

The City of Myrtle Beach requires that all new residential structures be elevated no less than three feet above the base flood elevation. It may be possible to retrofit existing structures by various floodproofing techniques.

Of course, the most effective and permanent means of protecting your structure is to locate it out of the floodplain. If you are unable to relocate your structure, the next most effective means is to elevate your structure above the base flood elevation.

The Department of Construction Services can discuss emergency, temporary and permanent alternatives with you and help you obtain the necessary permits. Chapin Library (918-1275) has reference information available for review regarding temporary and permanent property protection, retrofitting and floodproofing structures. Additional protection measures include:

- Keep materials like sandbags, plywood, plastic sheeting and lumber handy for emergencies.
- Check with a plumber regarding a valve to prevent sewer backups.
- Make sure that drainage ditches are clear of debris and functioning properly.
- If you know that a flood is coming, move valuable contents upstairs or to a safe location.

Residents of hazard areas can take the following actions to decrease the risk of injury due to flooding.

- Do not walk through flowing water. In standing water, use a pole or stick to determine depth.
- Do not drive through flooded areas and do not drive around road barriers. Roads or bridges may be washed out.
- Keep children away from flood waters, ditches, culverts and drains.
- Stay away from power lines and electrical wires. Report downed power lines to the power company.
- Turn off all electrical circuits at the panel or disconnect all electrical appliances.
- Watch for animals, including snakes. Small animals that have been flooded out of their homes may seek shelter in yours.
- Look before you step. After a flood, the ground and floors may be covered with debris, including glass and nails. Floors and stairs that are covered with mud can be very slippery.
- Turn off the gas and be alert for gas leaks. Use a flashlight to inspect for damage. Do not smoke or use candles, lanterns, or open flames unless you know that the gas has been turned off and the area has been ventilated.

A Guide to Regulatory Floodplains and Flood Protection

Provided by

Myrtle Beach Construction Services Department

APPENDIX C

LOCAL MITIGATION PLAN REVIEW TOOL

This appendix of the Plan includes a completed Local Mitigation Plan Review Tool.

LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: City of Myrtle Beach, South Carolina	**Title of Plan:** City of Myrtle Beach Hazard Mitigation Plan Update	**Date of Plan:** September 2015
Local Point of Contact: Emily Hardee	**Address:** 921 Oak Street PO Drawer 2468 Myrtle Beach, SC 29578-2468	
Title: Permits Manager, Floodplain Manager		
Agency: City of Myrtle Beach		
Phone Number: 843.918.1163	**E-Mail:** ehardee@cityofmyrtlebeach.com	

State Reviewer:	**Title:**	**Date:**

FEMA Reviewer:	**Title:**	**Date:**
Date Received in FEMA Region *(insert #)*		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Section 2; App. D		
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Section 2.4-2.8; App. D		
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Section 2.7-2.8; App. B; App. D		
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Section 6.3		
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Section 9.4		
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Section 9.3		
ELEMENT A: REQUIRED REVISIONS			
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Section 4		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Section 4		
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Section 4; Section 5		
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Section 4.14.5		
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Section 6		
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Section 4.14.4; Section 6.3.4		
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Section 7.2		
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Section 7.3-7.4; Section 8.2		
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Section 7.1.1; Section 8.2		
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Section 6.3.1 (Table 6.1); Section 9.1-9.2		
ELEMENT C: REQUIRED REVISIONS			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Section 5.3.4		
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Section 2.9; Section 7.5; Section 8.2		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Section 4.22 (Table 4.26); Section 8.2		
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	App. A		
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	N/A		
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to:

- *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);*
- *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);*
- *Diverse methods of participation (meetings, surveys, online, etc.); and*
- *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of:

1) *A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;*
2) *The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and*
3) *A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.*

How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:

- *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;*
- *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);*
- *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;*
- *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and*
- *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to:

- *Key problems identified in, and linkages to, the vulnerability assessment;*
- *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;*
- *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;*
- *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);*
- *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;*
- *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and*
- *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to:

- *Status of previously recommended mitigation actions;*
- *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;*
- *Documentation of annual reviews and committee involvement;*
- *Identification of a lead person to take ownership of, and champion the Plan;*
- *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;*
- *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);*
- *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and*
- *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

APPENDIX D

PLANNING PROCESS DOCUMENTATION

This appendix of the Plan includes eight (8) items:

1. *FMHMPC Meeting Agendas*
2. *FMHMPC Meeting Minutes*
3. *FMHMPC Sign-in Sheets*
4. *Hazard Mitigation Citizen's Advisory Committee Agendas*
5. *Hazard Mitigation Citizen's Advisory Committee Meeting Minutes*
6. *Hazard Mitigation Citizen's Advisory Committee Sign-in Sheets*
7. *Public Participation Survey Results*
8. *Public Notifications*

City of Myrtle Beach

Hazard Mitigation Plan Update

Kick-off Meeting

Monday, March 2, 2015

2:00 PM

- Introductions
- Overview of Mitigation
  - Ice Breaker Exercise
- Project Overview
  - Key Objectives
  - Project Tasks
  - Project Schedule
  - Project Staffing
- Data Collection
- Roles & Responsibilities
- Next Steps
- Questions, Issues, Concerns

City of Myrtle Beach

Hazard Mitigation Plan Update

Risk Assessment and Mitigation Strategy Meeting

Wednesday, August 5, 2015

10:00 AM

I. Introductions

II. Mitigation Overview

III. Project Schedule

IV. Risk Assessment Findings

V. Capability Assessment Findings

VI. Public Involvement Activities

VII. Mitigation Strategy

VIII. Next Steps

Meeting Minutes
City of Myrtle Beach Hazard Mitigation Plan Update
Project Kickoff Meeting
March 2, 2015

Margaret Walton, the project manager from Atkins, started the meeting by welcoming the representatives from the City, participating municipal jurisdictions, and other stakeholders. Mr. Walton then introduced Nathan Slaughter, Mitigation Planner from the project consulting team.

Ms. Walton led the kickoff meeting and began by providing an overview of the items to be discussed at the meeting and briefly reviewed each of the handouts that were distributed in the meeting packets (agenda, project description, and presentation slides). He then asked each of the meeting attendees to introduce themselves. Following introductions, he provided a brief overview of mitigation and discussed the Disaster Mitigation Act of 2000.

Nathan Slaughter from Atkins then explained the six different categories of mitigation techniques (emergency services; prevention; natural resource protection; structural projects; public education and awareness; and property protection) and gave examples of each. This explanation culminated to an Ice Breaker Exercise for the attendees.

Mr. Slaughter instructed attendees on how to complete the exercise. Attendees were given an equal amount of fictitious FEMA money and asked to spend it in the various mitigation categories. Money could be thought of grant money that communities received towards mitigation. Attendees were asked to target their money towards areas of mitigation that are of greatest concern for their community. Ideally, the exercise helps pinpoint areas of mitigation that the community may want to focus on when developing mitigation grants. The Ice Breaker Exercise results were to be reviewed and presented at the conclusion of the meeting.

Ms. Walton then discussed the key objectives of the planning process and the structure of the hazard mitigation planning committee, which is made up of local governmental departments and other stakeholders. Mr. Slaughter then explained the specific tasks to be accomplished for this project, including the planning process, risk assessment, vulnerability assessment, capability assessment, mitigation strategy and action plan, plan maintenance procedures, and documentation. It was determined that sinkholes/landslides, nuclear hazards, and fracking should all be omitted from the hazard profiles. The project schedule was presented along with the project staffing chart, which demonstrates the number of experienced individuals that will be working on this project.

Mr. Slaughter reviewed the Community Rating System and the specifics as they relate to the City of Myrtle Beach. He explained how the City could obtain more points and increase their rating. The Committee determined that it would be beneficial to have a Citizens' Advisory Group to gain more public involvement and participation.

Ms. Walton discussed the project tasks and reviewed the roles and responsibilities of Atkins, the City, and stakeholders. She stated that we needed the Committee to review the current capability assessment, take the public survey, and assist with data collection.

The results of the icebreaker were also given:

- Prevention—$64

- Structural Projects—$67
- Property Protection—$38
- Natural Resource Protection—$35
- Emergency Services—$28
- Public Education and Awareness—$48

The presentation concluded with a discussion of the next steps to be taken in the project development, which included discussing data collection efforts, continuing public outreach, and the next meeting for the Citizens' Advisory Group.

The meeting was opened for questions and comments and several topics were raised including: public survey availability, public information dissemination to include social media, documentation of CRS points, and plan updates of the Comprehensive Plan and the Beach Management Plan as well as the new Stormwater Management Plan. Atkins asked the Committee what they would like to receive from this plan update and it was agreed that obtaining a CRS Class Rating 4, a more resilient community, and more clarity in the plan.

The meeting was adjourned.

Meeting Minutes
City of Myrtle Beach Hazard Mitigation Plan Update
Risk Assessment and Mitigation Strategy Meeting – Myrtle Beach, SC
August 5, 2015

Ms. Walton initiated the meeting with a review of the meeting handouts, which included an agenda and presentation slides and stating that this would be an interactive meeting. Introductions were made and Ms. Walton began by providing a quick mitigation refresher. The departments of planning, public works, police, construction services, fire, public information, and purchasing were present.

Ryan Wiedenman with Atkins then presented the findings of the risk assessment. He stated that the risk assessment is the base of the mitigation plan and that we now have better data to update the hazard history. Mr. Wiedenman identified the three pieces of the risk assessment and the caveats for the risk assessment. He reviewed the Presidential Disaster Declarations that have impacted the region. He then explained the process for preparing Hazard Profiles and discussed how each hazard falls into one of four basic categories: Atmospheric, Hydrologic, Geologic, and Other. He indicated that each hazard must be evaluated and formally ruled out if it is not applicable to the study area, even where it seems obvious (such as in the case of landslide).

Mr. Wiedenman reviewed the Hazard Profiles and the following bullets summarize the information presented:

- DROUGHT. There have been 4 years since 2006 where drought conditions have been reported as severe, extreme or moderate in the area.

- HAILSTORM. There have been 21 recorded events since 1956. Future occurrences are highly likely.

- LIGHTNING. There have been 10 recorded lightning events since 1995 causing $642,697 in reported property damages. Future occurrences are highly likely.

- NORTHEASTER. No NCDC recorded events. Three previous events recorded from previous plan (1986, 1987, 1993). Future occurrences are possible.

- TORNADOES. There have been 5 recorded tornado events reported in the region since 1979. There was 11 million in property damages. 39 injuries were reported. Future occurrences are likely.

- HURRICANES AND TROPICAL STORMS. NOAA data shows that 76 storm tracks have come within 75 miles of the region since 1850. Future occurrences are likely.

- STORM SURGE. 2 events have been reported by NCDC with a Category 3 and 5 hurricane. Future occurrences are likely.

- SEA LEVEL RISE. Has been measured to some degree but future occurrences are highly likely. Estimated sea level rise could be 5 feet.

- SEVERE THUNDERSTORM WINDS. There have been 17 severe thunderstorm events reported since 1994 with $1.8 million in reported property damages. 4 injuries have been reported. Future occurrences are highly likely.

- WINTER STORM. There have been 6 recorded winter events in the region since 2000 resulting in $256,000 in reported property damages. Future occurrences are possible.

- EARTHQUAKES. There have been 3 recorded earthquake events in the area since 1960. The strongest had a recorded magnitude of V (MMI). Future occurrences are possible.

- TIDAL WAVE/TSUNAMI. There are no recorded events. Future occurrences are unlikely.

- EROSION. Gradual process but several major events were recorded in 1954, 1989, and 1995. Future occurrences are highly likely.

- FLOOD. There have been 47 flood events recorded in the City since 1954, resulting in $654,675 in property damage. There have been 1,229 NFIP losses since 1978 and approximately $33.5 million in claims. Future occurrences are highly likely. There have been 19 repetitive loss properties with approximately $1.3 million in damages.

- WILDFIRE. There is an average of 97 fires per year reported in the County. Future occurrences are highly likely.

- TERROR THREAT. No historic record of major terrorist events in Myrtle Beach. Future occurrences are unlikely.

- AIRPLANE CRASH. No events have been recorded in recent history. Future events are unlikely.

- HAZARDOUS MATERIALS INCIDENTS. 23 reported events in the City. 2 have been reported as serious incidents and only 1 injury. Future occurrences are likely. $145,167 has been reported in property damage.

During the hazard profile discussion, it was suggested that waterspout be added to tornado. There was also a question regarding the drought map that was used as an example. It was also stated that the hazard of hailstorm was under reported. The committee also shared that they had some local erosion data that could supplement the current data shared. Flood areas of concern were also shared and the committee commented on whether the properties had been mitigated. An additional flood property was added to the list for mitigation efforts. A map on the repetitive loss properties was also discussed.

The results of the hazard identification process were used to generate a Priority Risk Index (PRI), which categorizes and prioritizes potential hazards as high, moderate or low risk based on probability, impact, spatial extent, warning time, and duration. The highest PRI was assigned to Flood, followed by Wind Events (Thunderstorm/High Winds), Tropical Storm/Hurricane, and Wildfire. It was decided that Lightning should be elevated to moderate risk and tornado should be moved to low risk. The committee felt that storm surge should be combined with the Tropical Storm/Hurricane hazard so it was best to move it up to a high risk.

Mr. Wiedenman then presented a list of City facilities that needed to be reviewed for addition to the critical facility list. It was determined that 3 of the facilities, MB S30, MBS36, and MB Rescue 81 would be removed as well as the Chamber of Commerce, the Library, and the recreation centers. A duplication of another facility was noted and the name of 2 other facilities were updated. Myrtle Beach Public Works

was added to the critical facility list. The committee also decided that a list of the pump stations and water towers should also be included.

Ms. Walton then began the mitigation strategy discussion. The existing mitigation goals, mitigation action worksheets, current mitigation actions for each jurisdiction, and mitigation action recommendations were distributed. The goals currently address protecting life and property; preserving the beaches, wetlands, swashes, and waterways; developing and implementing stormwater drainage plans; protecting and ensuring quality supply of drinking water; improving and ensuring adequate public safety services and essential municipal services under normal and emergency conditions; preserving the existing land use plan, most especially the residential neighborhoods, and reducing economic impact form the effects of a hazard event. It was agreed that the goals were still appropriate for the City. Prior to the meeting, the existing mitigation actions were disseminated electronically for updates. The existing actions were reviewed in regards to any revision questions. Then the Committee was instructed to develop new actions for each hazard and to ensure that they had an action addressing flood since the City is in the NFIP and CRS by August 19, 2015. Ms. Walton stated that she would be available to assist with mitigation action development. She then thanked the Committee for taking the time to attend and the meeting was adjourned.

ATKINS

Hazard Mitigation Planning Committee Sign-in March 2, 2015

Name	Dept/Org	Phone Number	Email Address
Bruce Arnel	Fire	918-1109	BArnel@cityofmyrtlebeach.com
Diane Moskow-McKenzie	Planning	918-1069	dmckenzie@cityofmyrtlebeach.com
Allison Hardin	Planning	918-1059	ahardin@cityofmyrtlebeach.com
Janet Wood	Public Works	918-2021	jwood@cityofmyrtlebeach.com
Emily Hardee	Const. Services	918-1163	ehardee@cityofmyrtlebeach.com
Tanitra Marshall	SCDHEC - OCRM	238-4528	Tanitra.Marshall@dhec.sc.gov
Valerie R Rossee	Risk Mgmt	918-1007	VRossee@cityofmyrtlebeach.com
Don Shenks	Plan Comm.	497-2570	—
Alvin Payne	MBFD	918-1103	apayne@cityofmyrtlebeach.com
STEVE MOORE	MB PW	918-2000	smoore@cityofmyrtlebeach.com
Bruce Boulineau	CS	918-1176	bboulineau@coms
Jackie Vaughn	CAB	602-4428	JDusenbury@live.com
MARK KRUEA	City of M.B.	918-1014	info@cityofmyrtlebeach.com

City of Myrtle Beach, SC Hazard Mitigation Plan Update

ATKINS

Name	Dept/Org	Phone	Email Address
Jenny Thompson	Red Cross	240.938.1124	beachgrammy223@gmail.com

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Hazard Mitigation Planning Committee Sign-in August 5, 2015

Name	Dept/Org	Phone Number	Email Address
Don Shonks	Plan Comm.	843-497-2576	Don7630@Juno.com
STEVE MOORE	PW / STREET	843-918-2000	smoore@cityofmyrtlebeach.com
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Emily Hardee	Const. Services	843-918-1163	ehardee@cityofmyrtlebeach.com
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AGENDA

City of Myrtle Beach Hazard Mitigation Plan Update
Hazard Mitigation Citizen's Advisory Committee Meeting
March 19, 2015
1:00 PM

1) **Welcome and Introductions**

2) **Mitigation Overview**

3) **Project Overview**

4) **Hazard Identification**

5) **Capability Assessment**

6) **Mitigation Techniques and Strategy**

7) **Next Steps**

8) **Questions, Issues, or Concerns**

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AGENDA

City of Myrtle Beach Hazard Mitigation Plan Update
Hazard Mitigation Citizen's Advisory Committee Meeting
August 15, 2015
2:00 PM

I. Introductions

II. Mitigation Overview

III. Project Schedule

IV. Risk Assessment Findings

V. Capability Assessment Findings

VI. Public Involvement Activities

VII. Mitigation Strategy

VIII. Next Steps

Meeting Minutes
City of Myrtle Beach Hazard Mitigation Plan Update
Hazard Mitigation Citizen's Advisory Committee Meeting #1
March 19, 2015

Margaret Walton, Project Manager from the consultant Atkins, started the meeting by welcoming the attendees and explaining the purpose of the group, which is to provide input on the City of Myrtle Beach Hazard Mitigation Plan Update. She explained that participants for this advisory committee had been identified through the overarching Hazard Mitigation Planning Committee. Mrs. Walton shared that the Advisory Committee would be beneficial to the City and its participation in the Community Rating System.

Mrs. Walton led the meeting and began by providing an overview of the agenda items and briefly reviewed each of the handouts that were distributed in the meeting packets (agenda and presentation slides). He then asked each of the meeting attendees to introduce themselves. Following introductions, he provided a brief overview of the meeting agenda and the stages of the mitigation planning process that would be addressed through this plan.

She emphasized that a mitigation plan is not a response or recovery plan and refers to actions (projects, policies, plans) to reduce the impacts of future hazard events. The hazard mitigation planning process looks at hazards, capability to conduct mitigation, and specific activities to reduce impacts of hazards. He stressed that a mitigation plan is not a response plan.

She explained how Federal legislation requires local governments to have a hazard mitigation plan in place to remain eligible for federal mitigation grants (e.g., HMGP, FMAP, PDM). So, there is funding to implement some of the actions that this plan may identify.

She explained that there is an overarching Hazard Mitigation Planning Committee that is made of up of various departments in the City as well as commissions and the public. This Committee will work through the steps in the planning process for the City:

1. Identify and analyze hazards, risk assessment
2. Capability assessment (of local governments)
3. Mitigation Strategy – specific activities to reduce future impacts
4. Documentation and maintenance

Risk Assessment
Mr. Slaughter explained that FEMA requires that plans address natural hazards, but all-hazards approach is becoming more prevalent. Ms. Walton presented the list of hazards to be addressed in the plan. This was the list that was previously profiled in the last plan which Atkins developed. She stated that the hazard of sea level rise was added to the list from the Hazard Mitigation Planning Committee Meeting.

Capability Assessment
Mrs. Walton explained the community capability assessment and discussed how capability is divided primarily into 3 categories:

- Administrative
- Technical
- Fiscal

She stated that the capability assessment should identify strengths and weaknesses.

Mitigation Strategy
Mrs. Walton discussed the six mitigation techniques and then presented the mitigation goals for the plan. He then explained how the existing plan has mitigation actions, which need to be updated and that the City needs to develop new actions as well.

Public Involvement
Mrs. Walton explained how public comment and participation is a required part of this process. A public survey was developed and extensively disseminated through the public information officer and on the City's website.

A member of the group stated that she could distribute the public participation further through the Coastal Waccamaw Stormwater Education Consortium.

The next steps were discussed to include the next meeting to review a draft of the risk assessment and begin development of the mitigation strategy.

There being no other questions or topics of discussion the meeting was adjourned.

Meeting Minutes
City of Myrtle Beach Hazard Mitigation Plan Update
Citizen's Advisory Committee Meeting
August 5, 2015

Margaret Walton, Project Manager from the project consultant, Atkins, started the meeting by welcoming the attendees and explaining the purpose of the group, which is to provide input on the City of Myrtle Beach Hazard Mitigation Plan Update. She also introduced the project's Risk Assessment Specialist, Ryan Wiedenman. Next, she gave a brief overview of the Community Rating System and the benefits that the program has for the community.

Mrs. Walton led the meeting and began by providing an overview of the agenda items and briefly reviewed each of the handouts that were distributed in the meeting packets (agenda and presentation slides). She then asked each of the meeting attendees to introduce themselves. Following introductions, she provided a brief overview of the meeting agenda and a mitigation overview to include information on the Disaster Mitigation Act of 2000. Mrs. Walton also outlined the rest of the project schedule and the expectations for a draft plan.

Mr. Wiedenman then began the risk assessment portion of the presentation. He explained the three components of the risk assessment: hazard identification, hazard profiles, and the hazard vulnerability assessment. He also provided significant caveats to the risk assessment and shared the historical Presidential Disaster Declarations. Mr. Wiedenman began the risk assessment overview by sharing the identified hazards and the four components of the hazard profile for each hazard. The group mentioned two items that they were concerned about as oil spills and water quality. Mr. Wiedenman suggested that oil spills would be included in hazardous materials. The sample hazard profile that he walked through was storm surge. He also shared the final Priority Risk Index (PRI) and it was suggested that sea level rise be moved up.

Mrs. Walton picked up the next portion of the presentation by reviewing the current capabilities that the City has and stating that the City is very strong in all the areas measured, regulatory, planning, technical, fiscal, and administratively. She then shared the results and information from the public participation survey. A suggestion was made to include a question regarding demographics in future public participation surveys.

Mrs. Walton also led the final portion of the presentation regarding mitigation strategy. She shared the overall idea of a mitigation strategy and the current mitigation goals for the City. The existing mitigation actions were distributed and the group skimmed over them. More emphasis was then placed on the development of new mitigation actions for the City. Examples of various mitigation actions were outlined as well as the elements of each mitigation action. The mitigation action worksheets were distributed and reviewed.

Lastly, she discussed the next steps for the rest of the project and that the expected draft will be sent to the City in the middle of September.

There being no other questions or topics of discussion, the meeting was adjourned.

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Hazard Mitigation Citizen's Advisory Group Meeting Sign-in March 19, 2015

PLEAST PRINT LEGIBLY.

Name	Dept/Org	Phone Number	Email Address
Jenny Thompson	Red Cross	240-938-1124	beachgramma223@gmail.com
Allison Hardin	Planning	918-1059	ahardin@cityofmyrtlebeach.com
Emily Hardee	Const. Services	918-1163	ehardee@cityofmyrtlebeach.com
Susan Libes	CCU - Env. Qual. Lab	843 349 4028	susanl@coastal.edu

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Hazard Mitigation Citizen's Advisory Committee Sign-in August 5, 2015

Name	Dept/Org	Phone Number	Email Address
Lisa Swanger	CCU	843-349-2839	Lswanger@coastal.edu
Gretchen Abney	at large!	843-222-1908	gabney@sc.rr.com
Emily Hardee	Const. Services	843-918-1163	ehardee@cityofmyrtlebeach.com

City of Myrtle Beach
Hazard Mitigation Plan Update

Public Participation Survey Results

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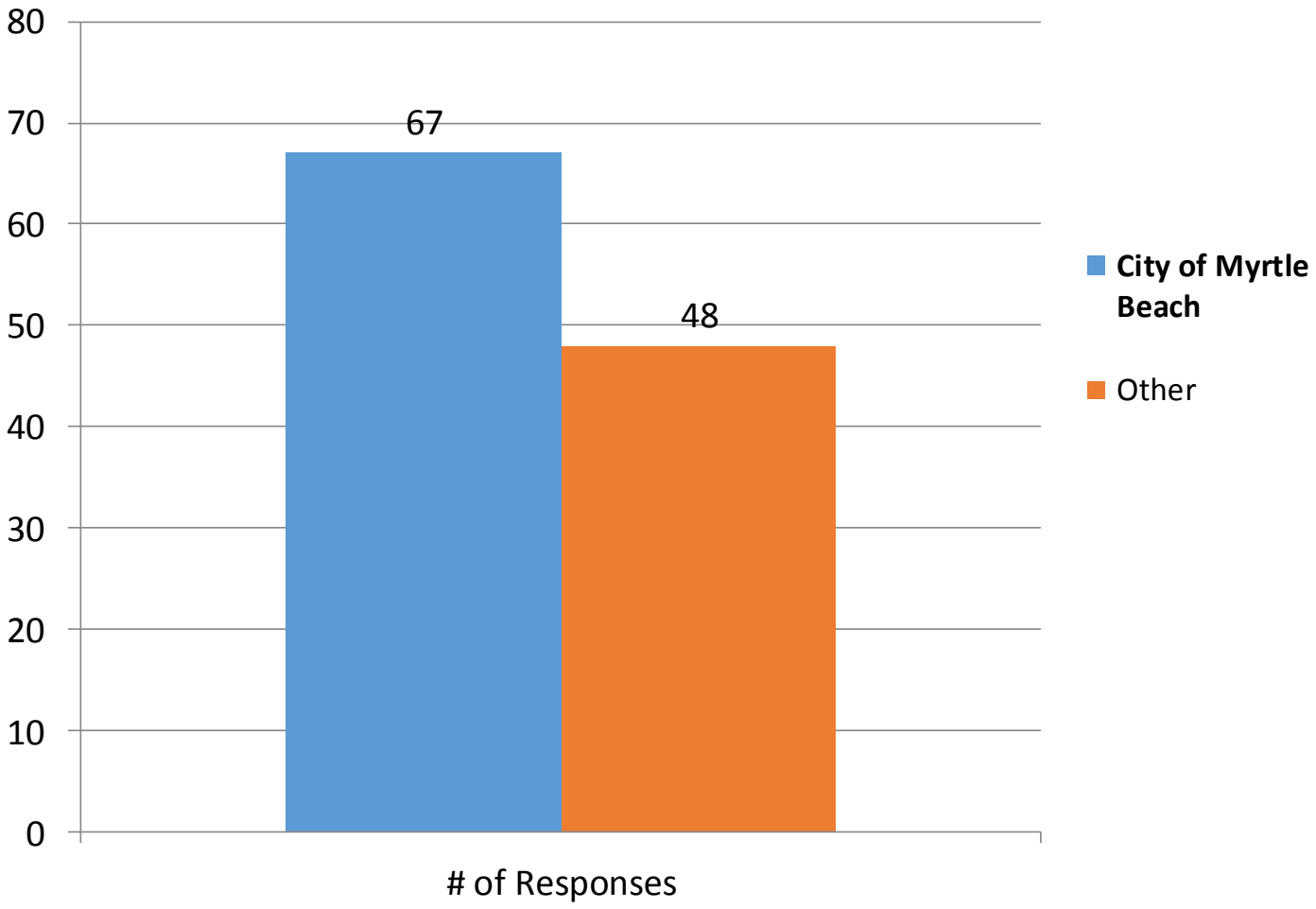
Public Participation Survey

- Provides an opportunity for the public to share opinions and participate in the planning process
- Link to survey posted on City website
- 117 completed surveys received

Public Participation Survey Highlights

- 88% of respondents are interested in making their homes more resistant to hazards
- 52% have already taken action to make their homes more hazard resistant
- 65% do not who to contact regarding risk reduction

1. Where do you live?



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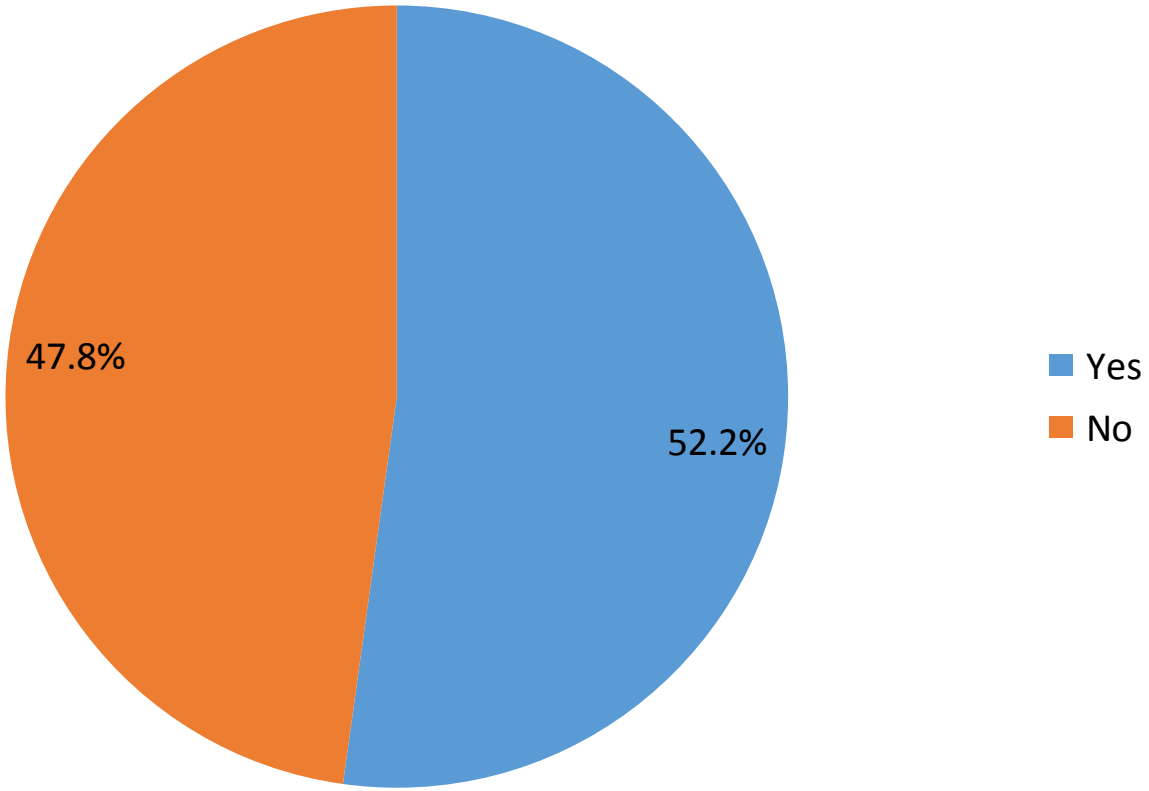
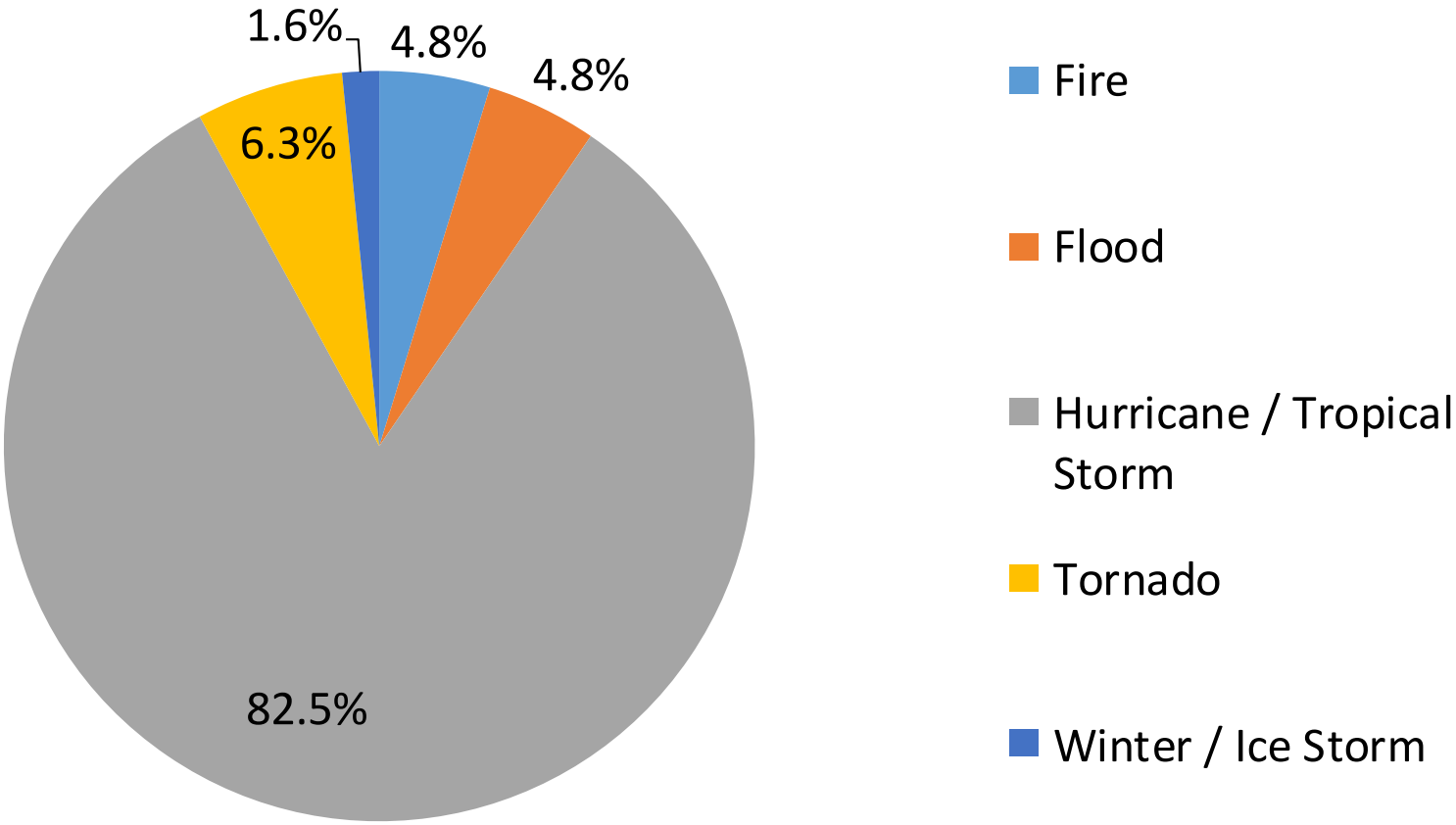
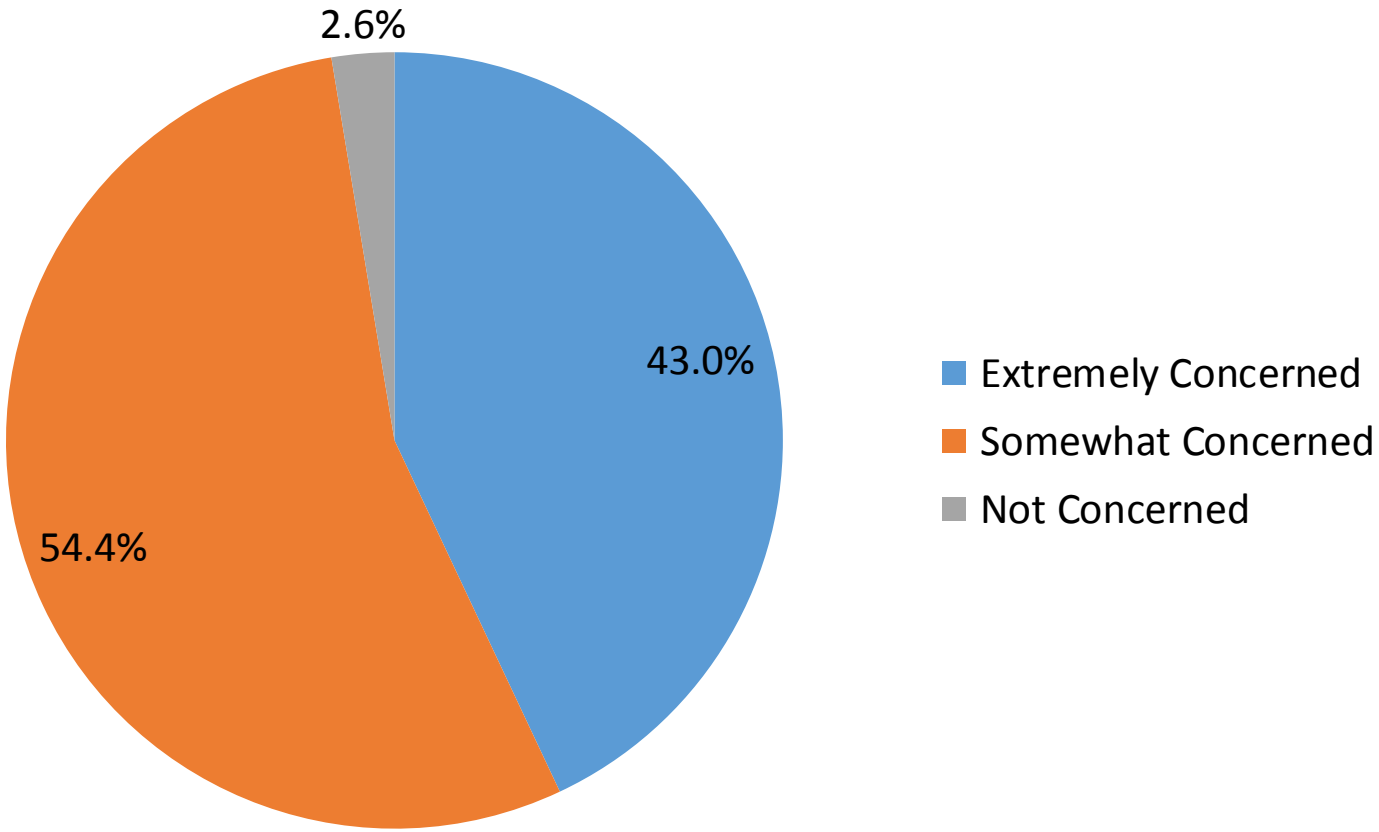
2. Have you experienced a disaster?



2. Examples of disasters experienced



3. How concerned about possibility of disaster?



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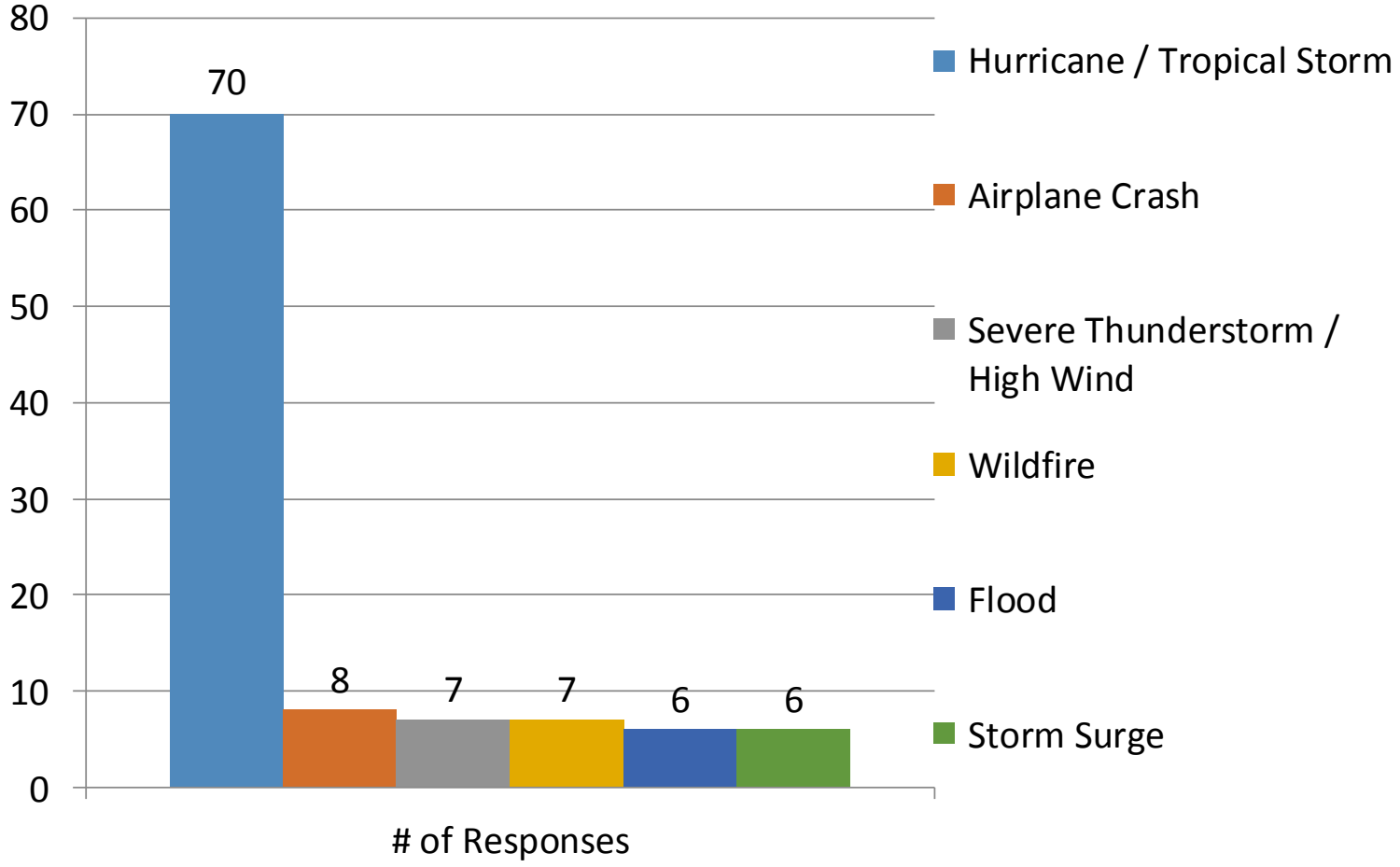
4. Highest hazard threat?



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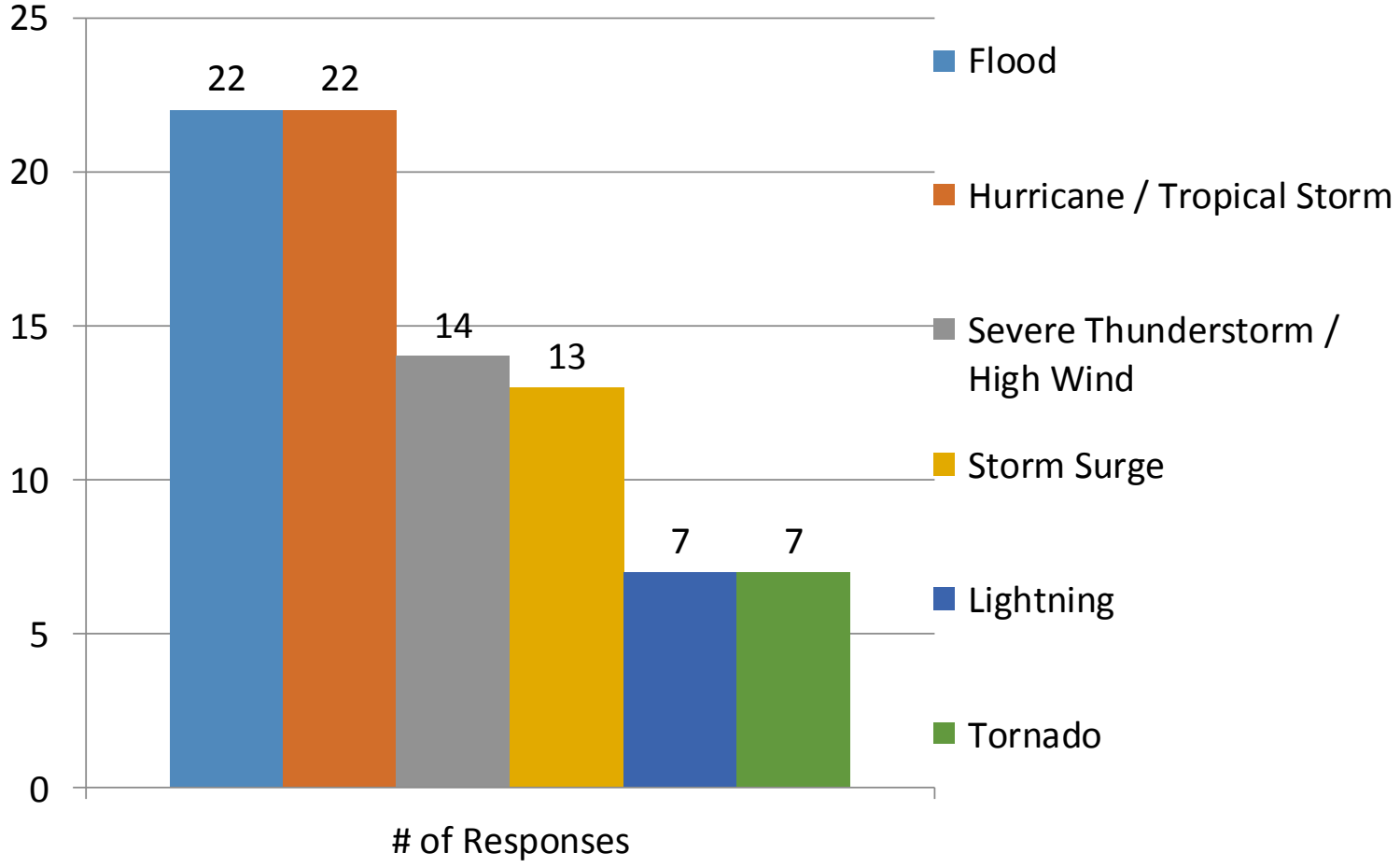
5. Second highest hazard threat?



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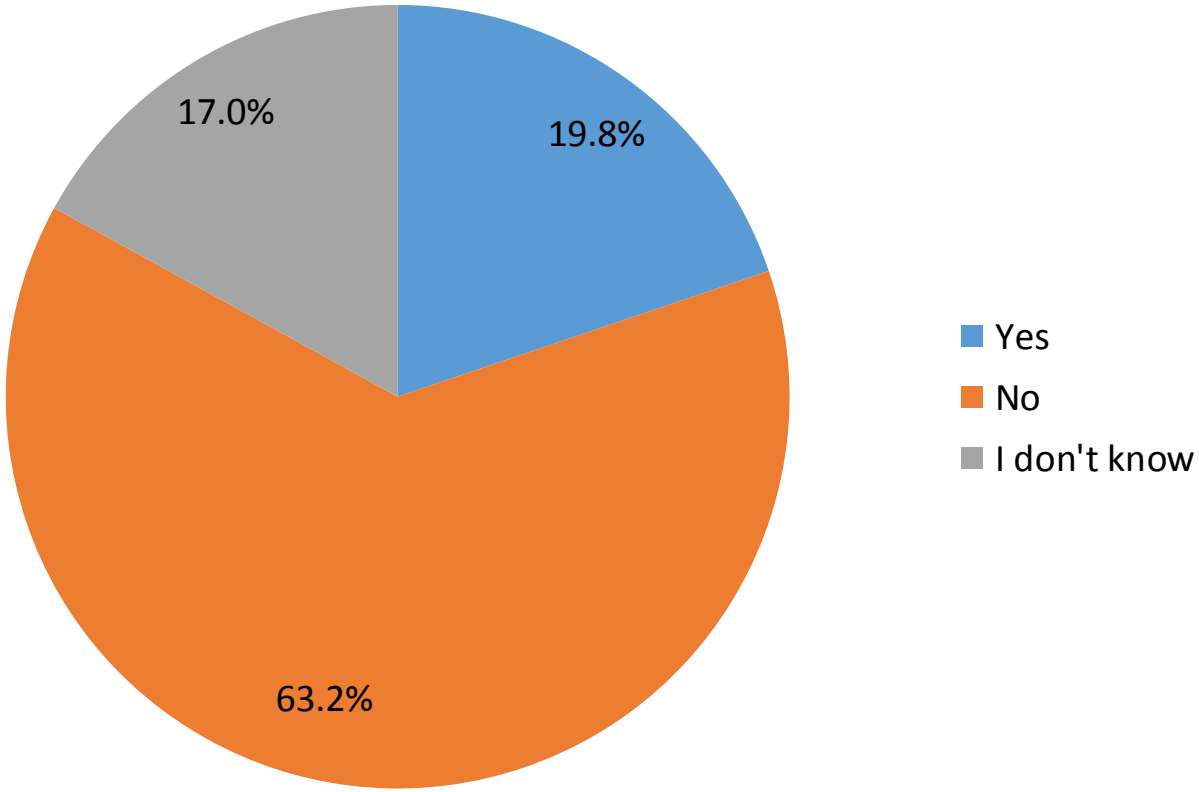
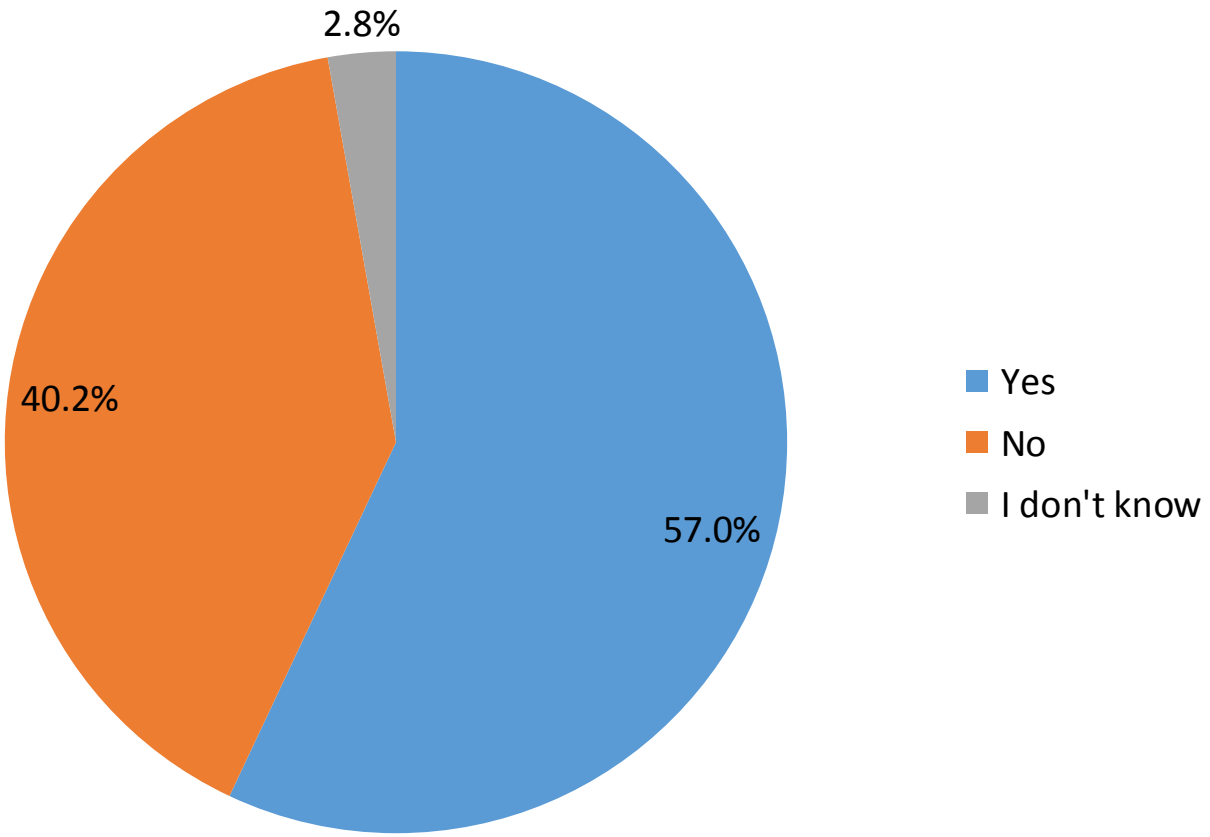
6. Other hazards not listed?

- Sea Level Rise
- Pandemic
- Rioting / Civil unrest
- Violent Crime
- Vehicle accident

7. Is your home in a floodplain?



8. Do you have flood insurance?



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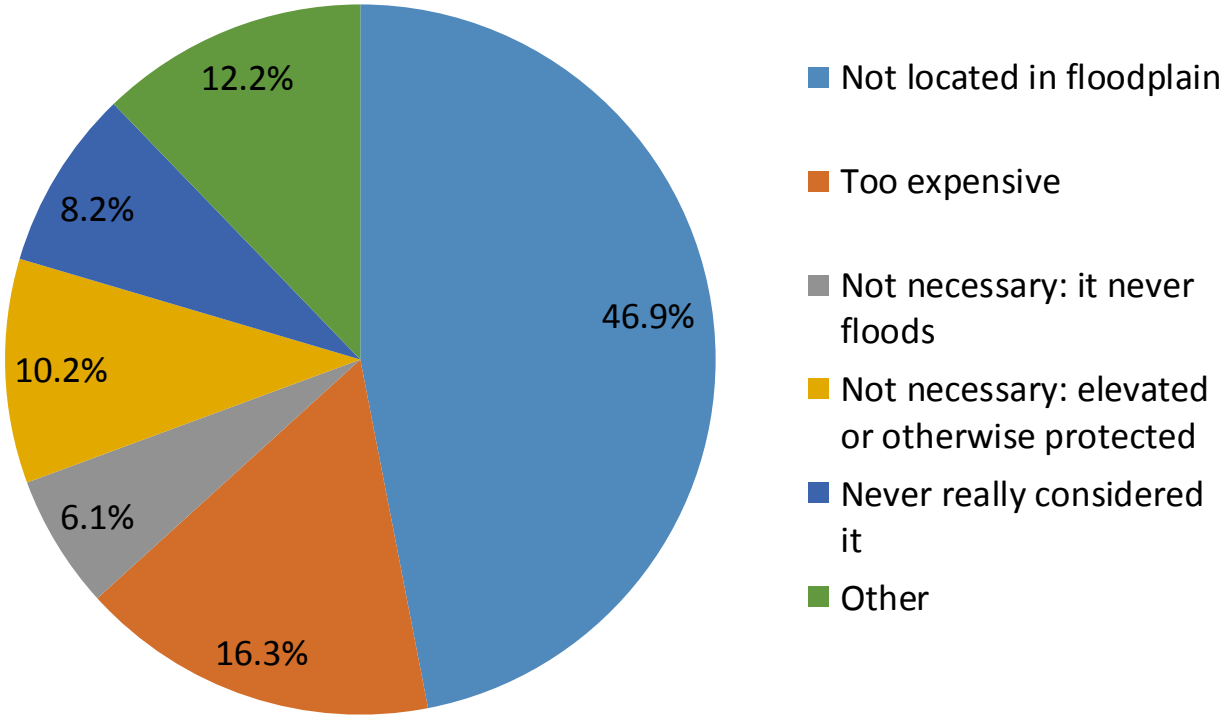
8. Why no flood insurance?



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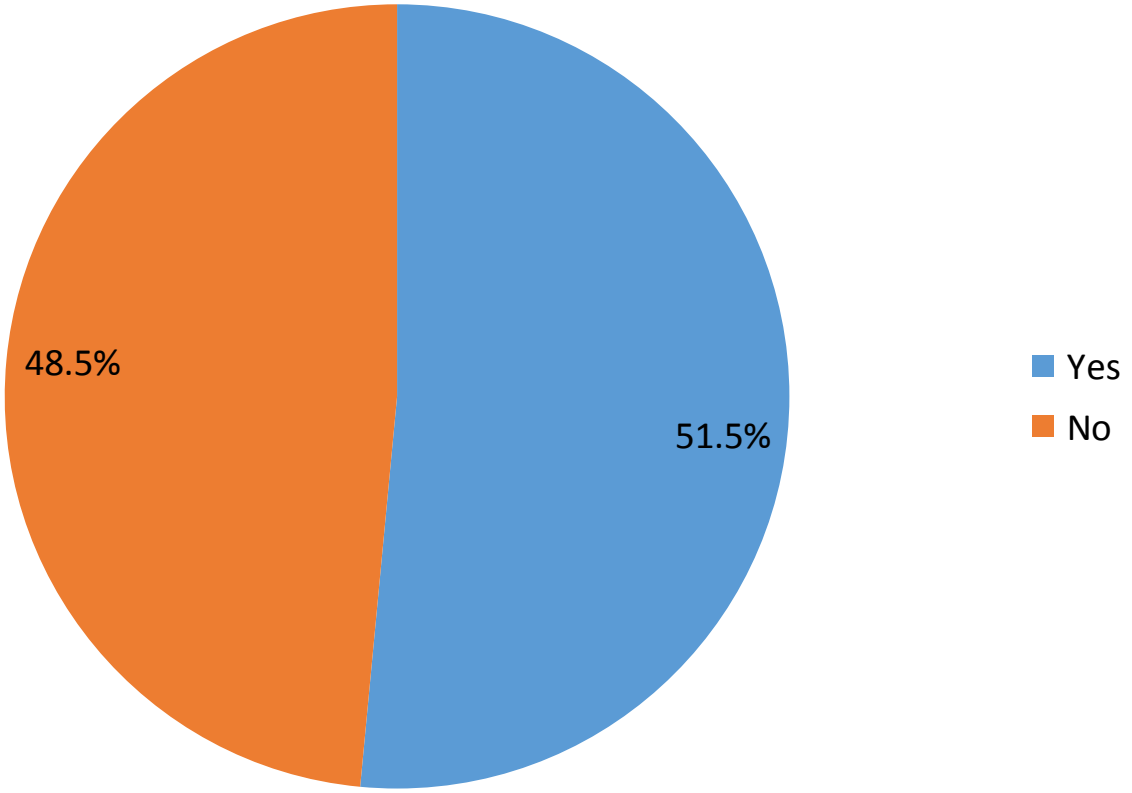
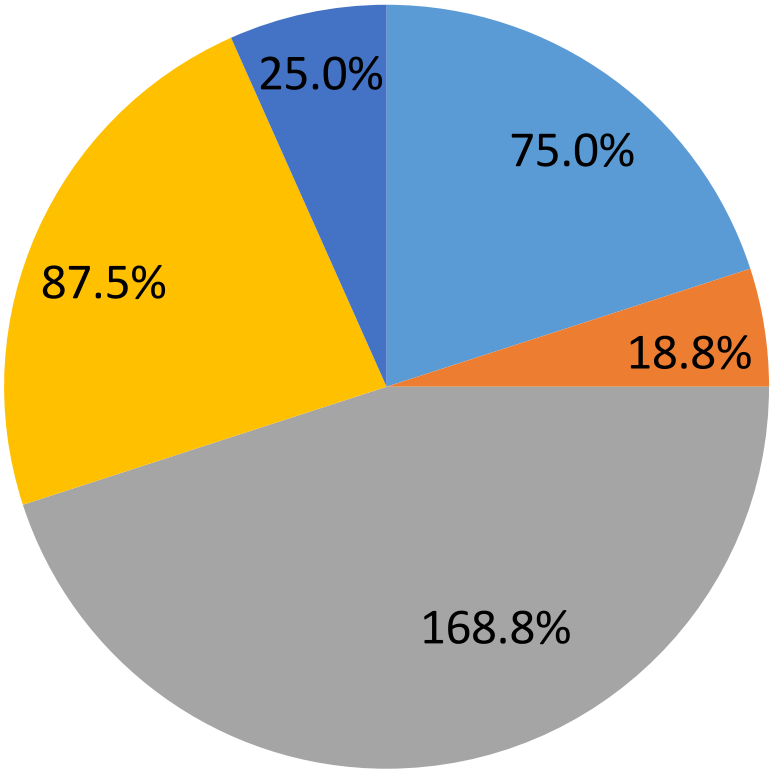
9. Taken action to be more hazard resistant?

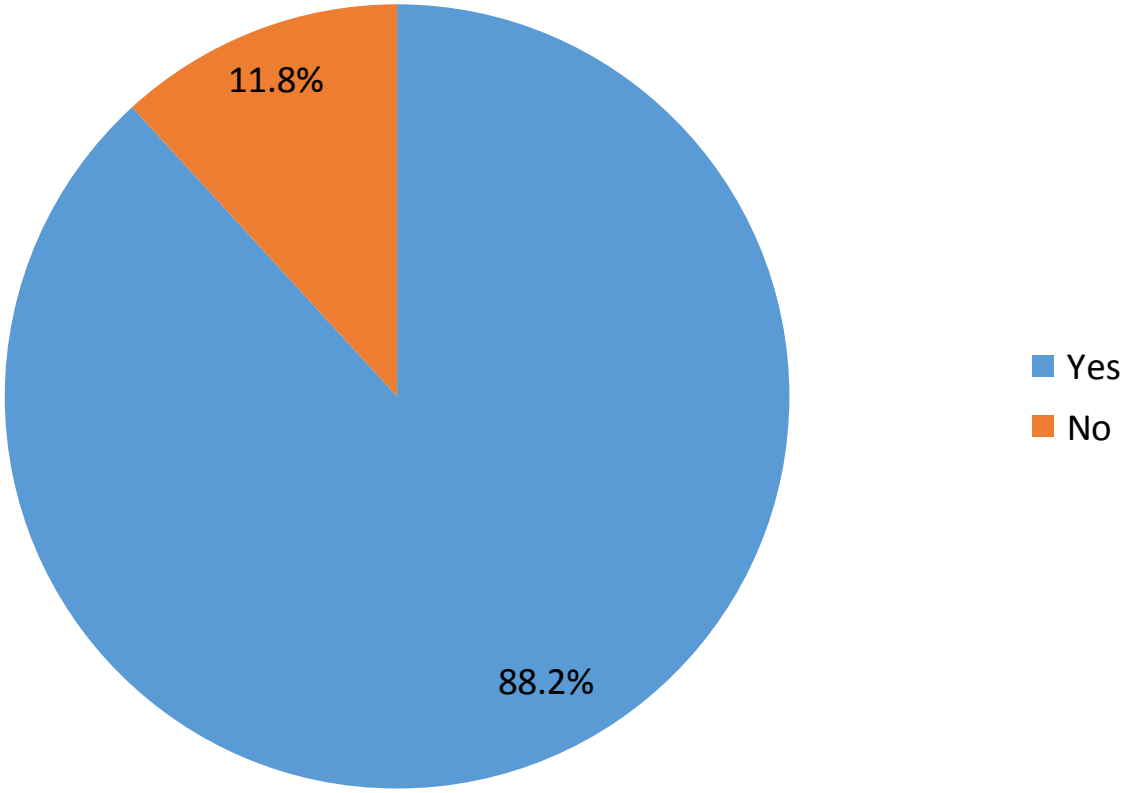


9. Examples of actions taken

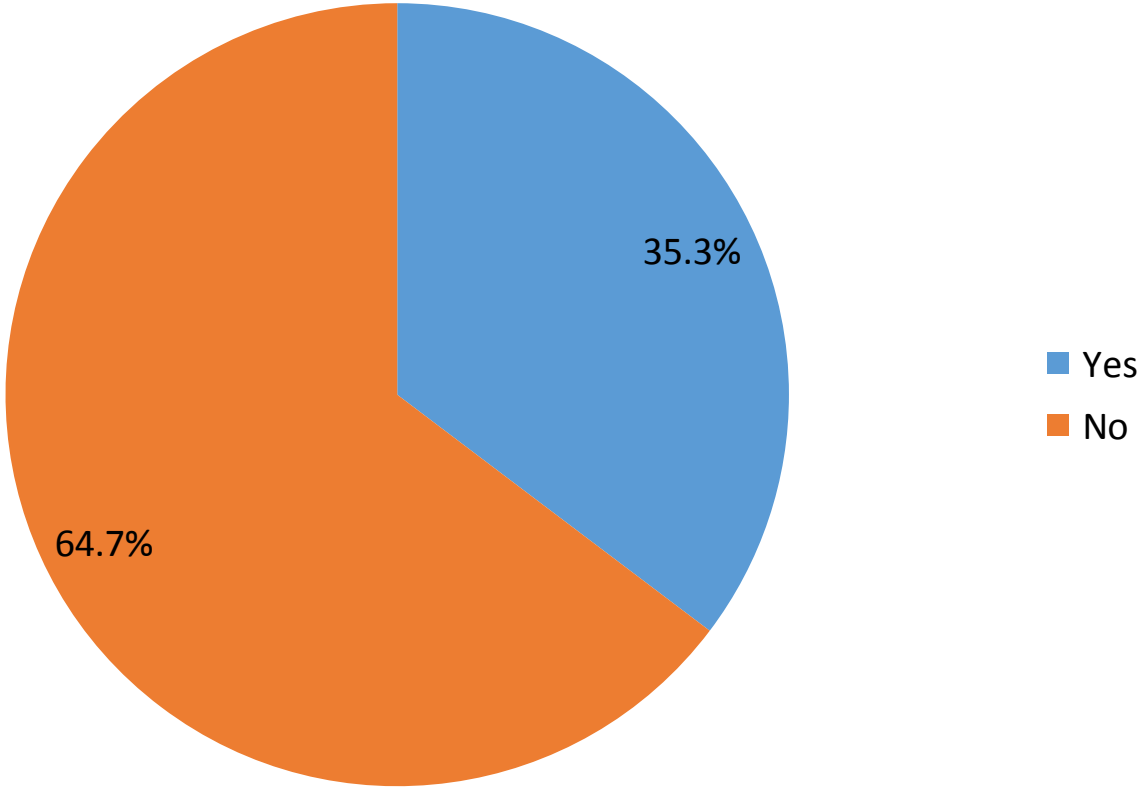


- Debris / Tree Removal
- Drainage
- House Retrofit / Repair / Protection
- Preparedness / Emergency Planning
- Other

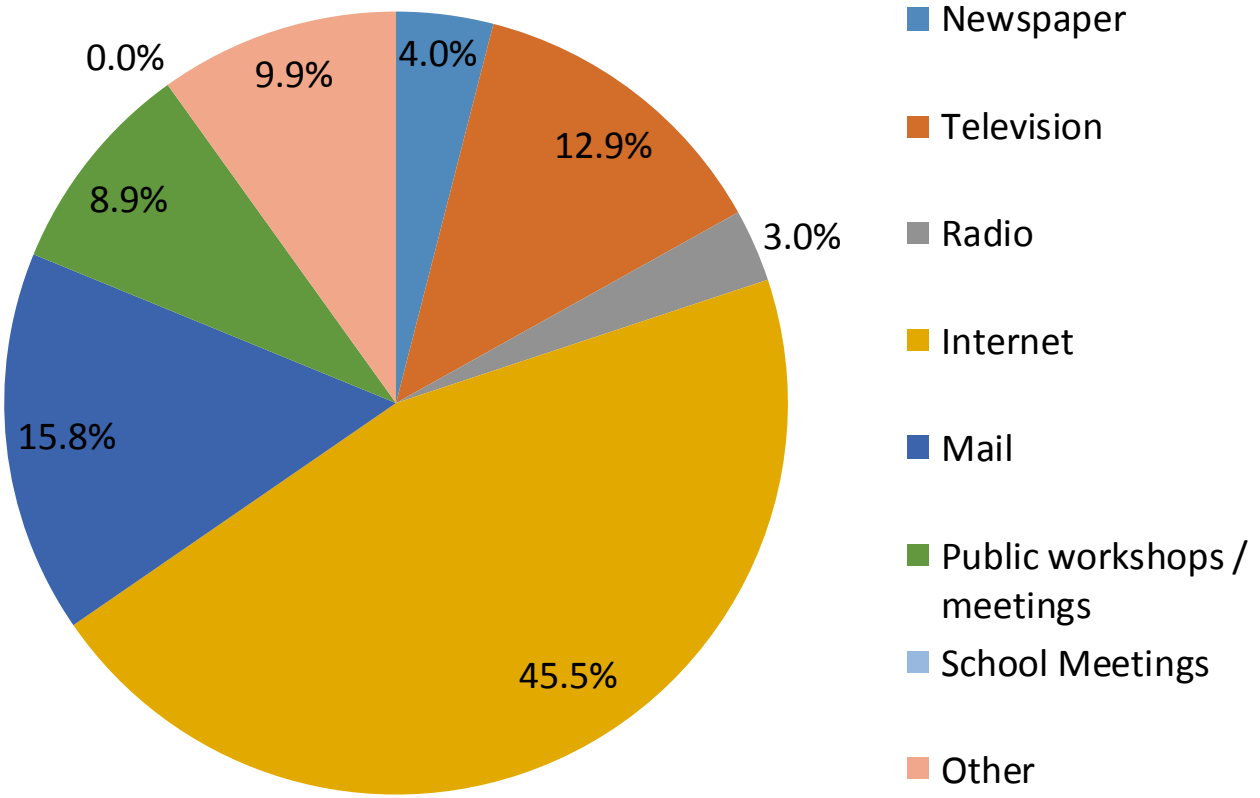
10. Interested in being more hazard resistant?



11. Know who to contact for reducing risks?



12. Most effective way to receive information?



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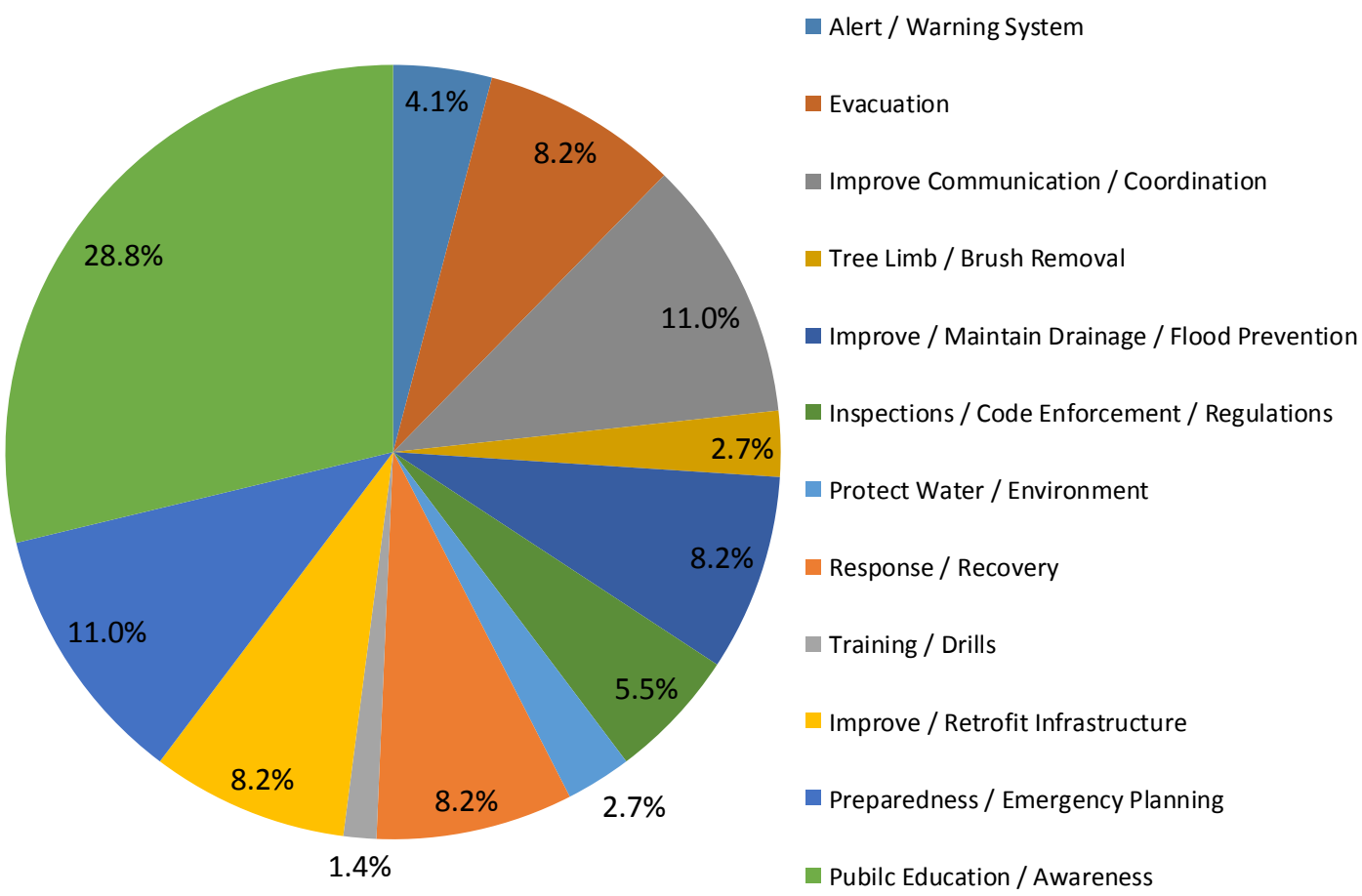
12. Other ways to receive information

- Social media
- Email

13. Steps local gov't could take to reduce risk



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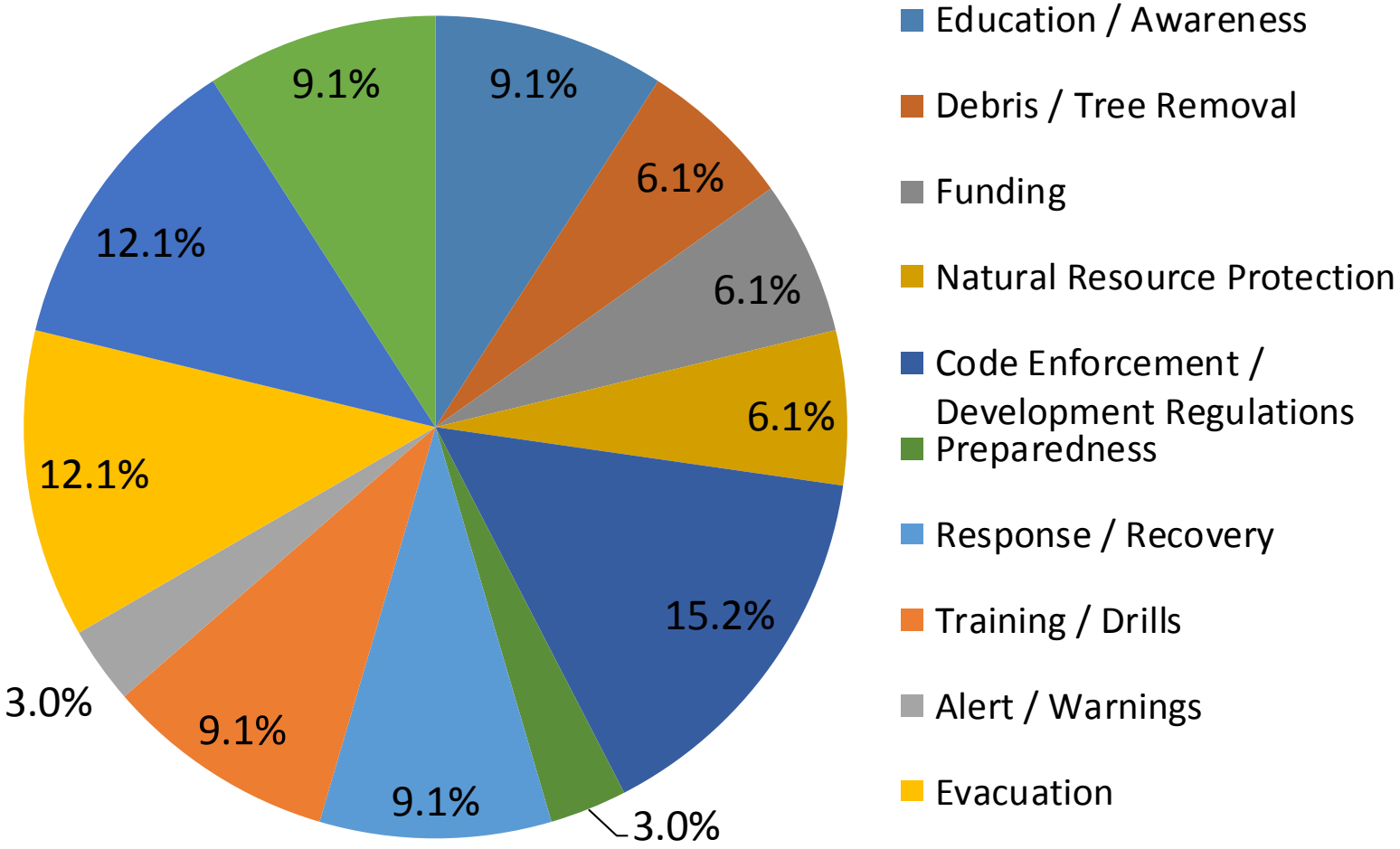
14. Other issues regarding risk and loss



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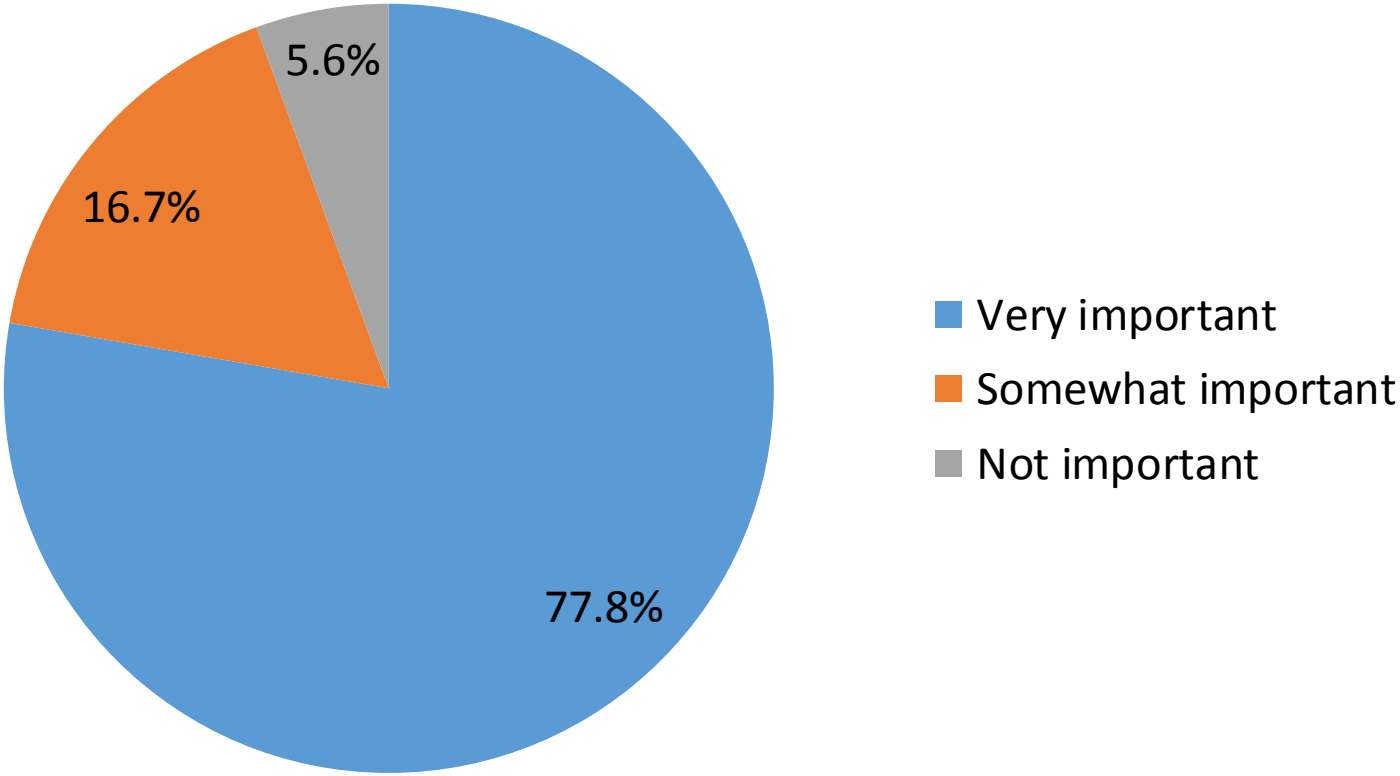
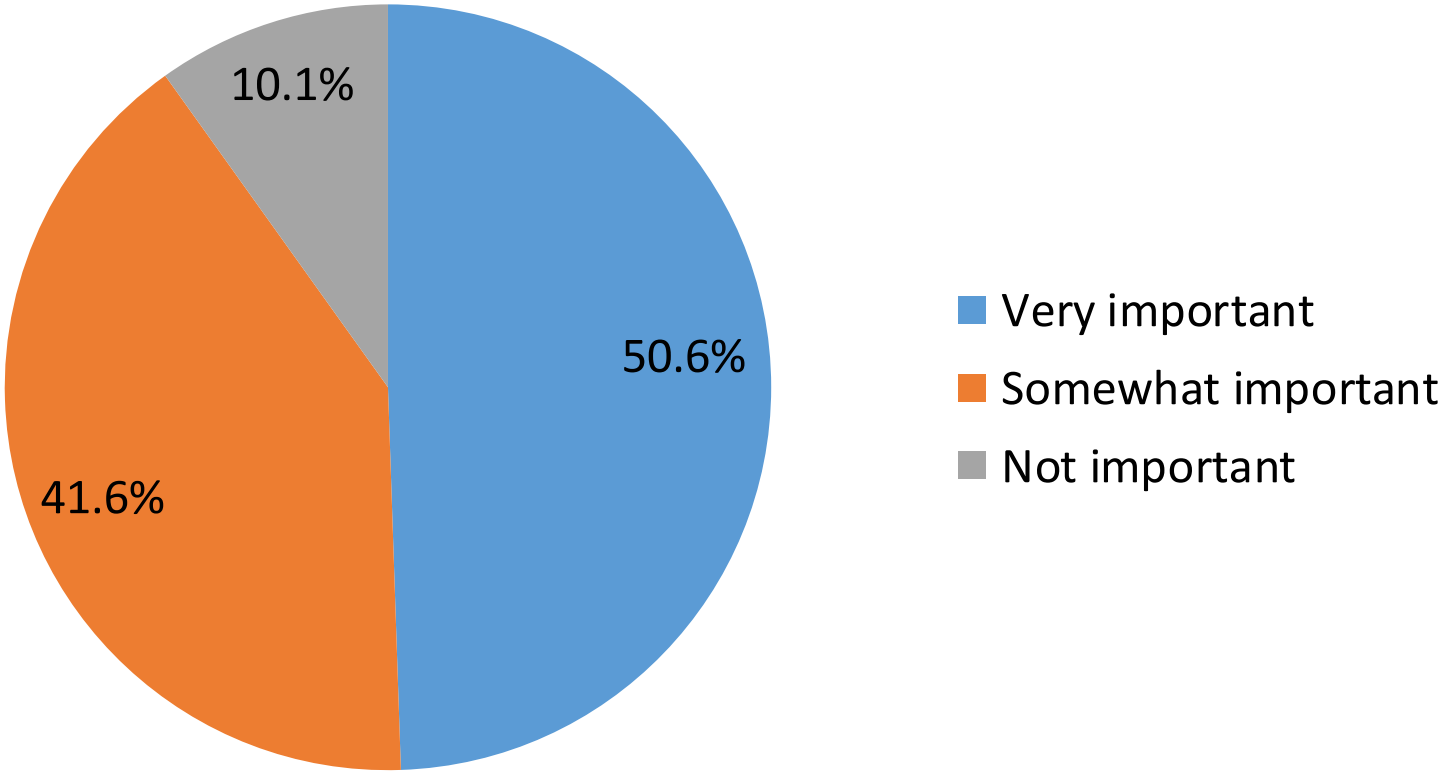
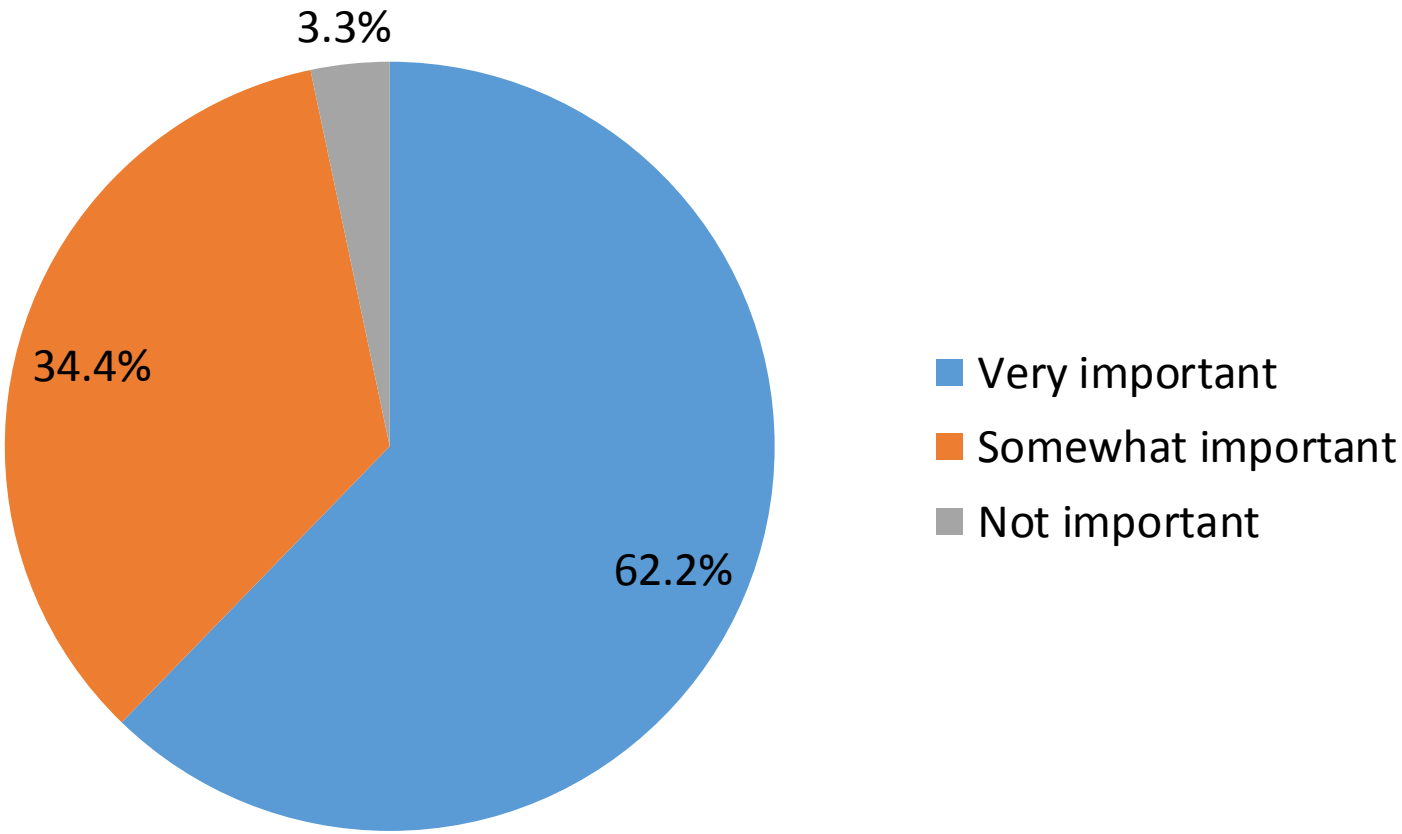
15. Mitigation Actions: Prevention



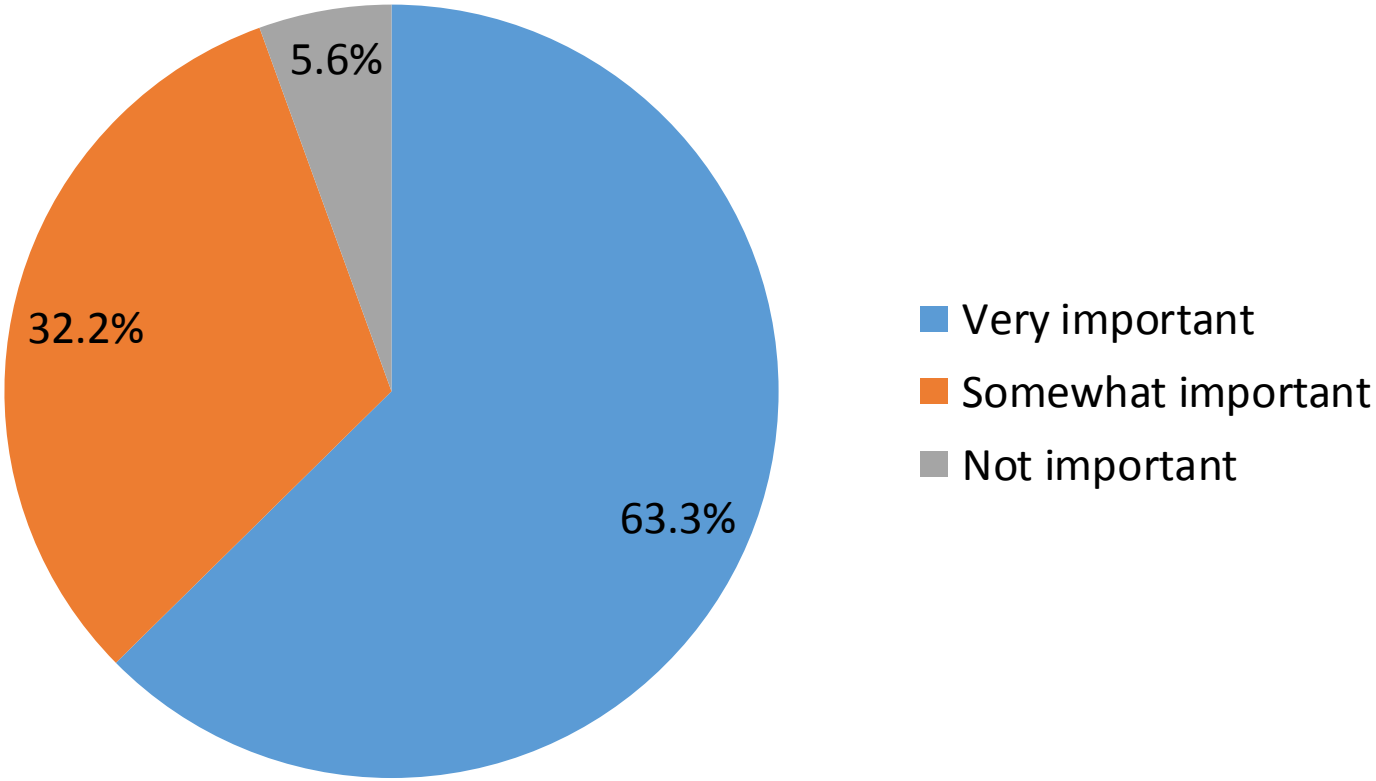
15. Mitigation Actions: Property Protection



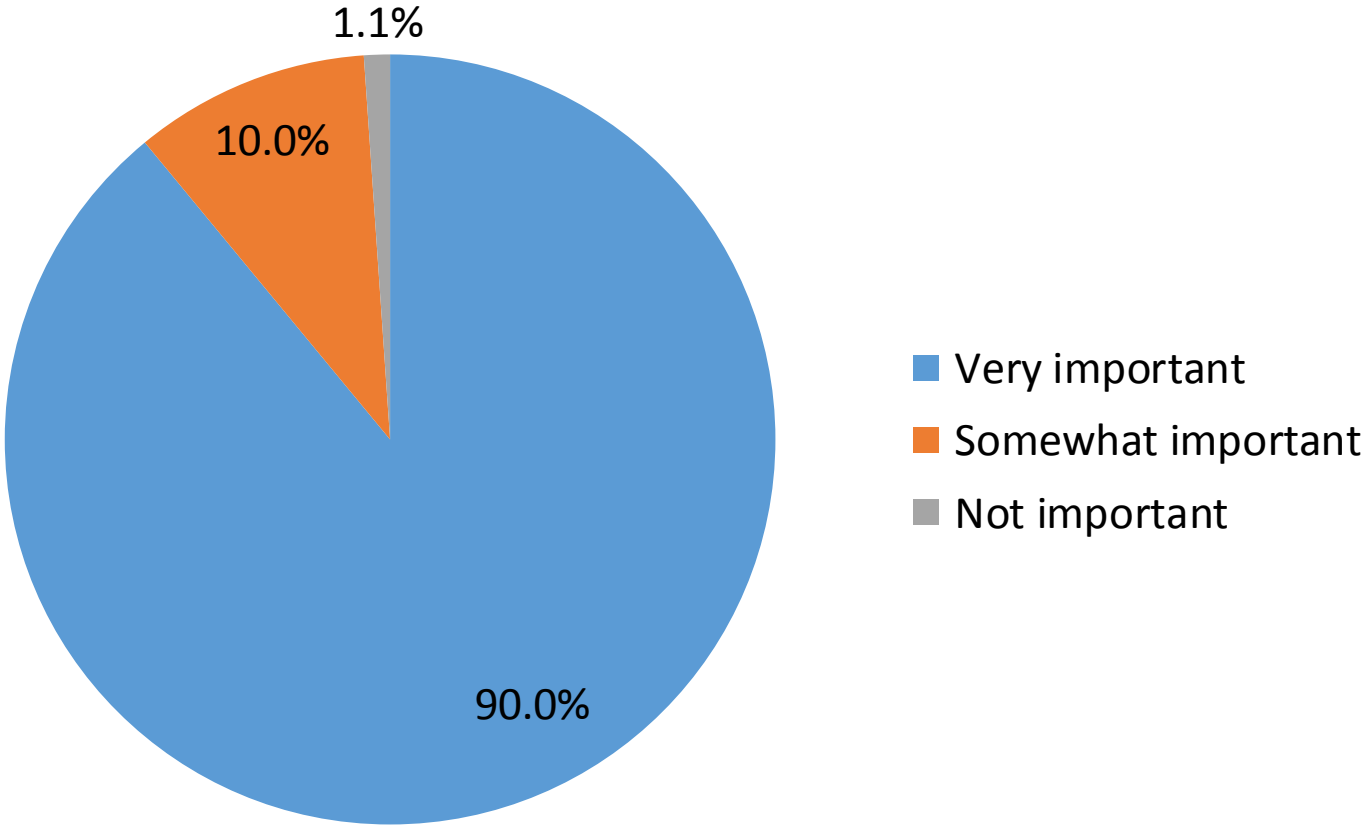
15. Mitigation Actions: Natural Resource Protection



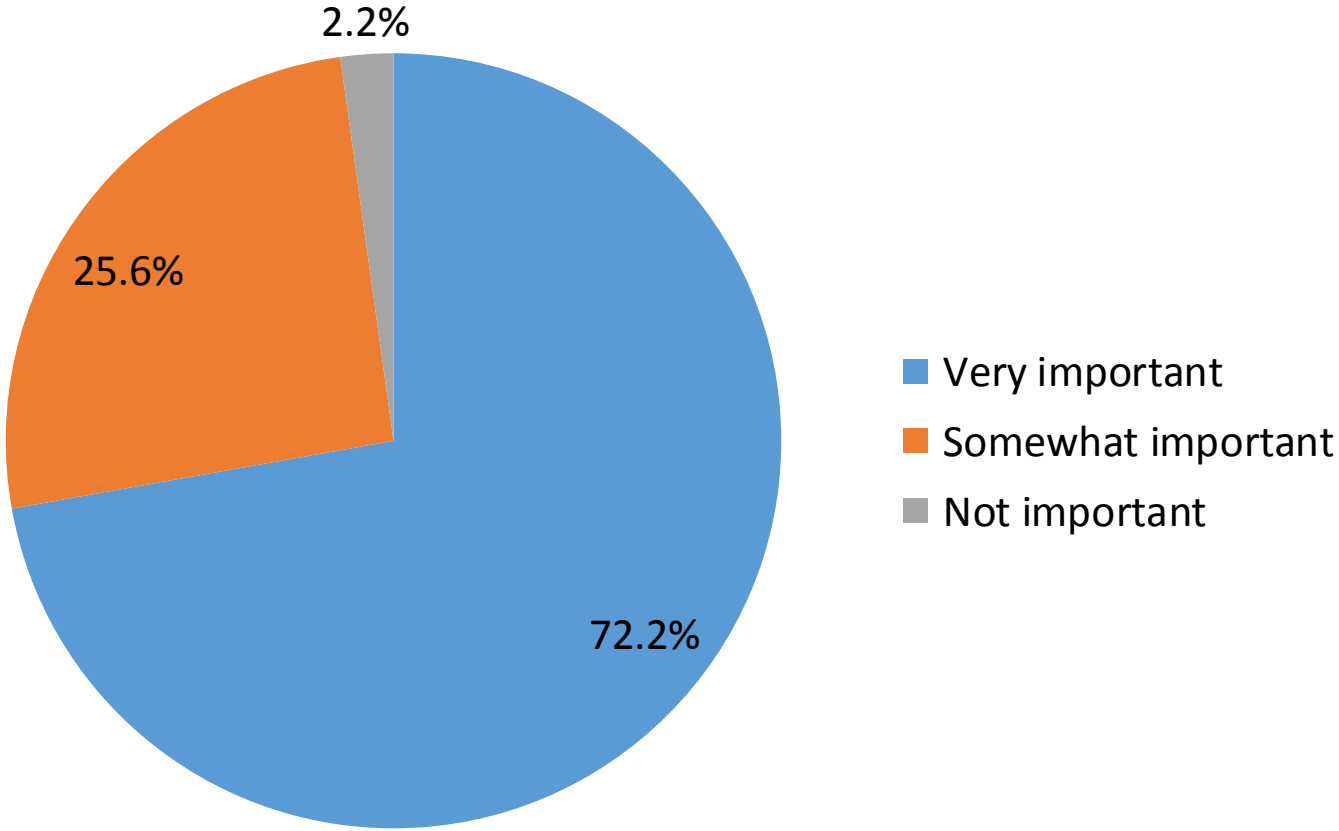
15. Mitigation Actions: Structural Projects



15. Mitigation Actions: Emergency Services



15. Mitigation Actions: Public Education & Awareness



15. Mitigation Actions: Summary

- Highest importance
  - Emergency Services
  - Prevention
  - Public Education & Awareness
- Moderate importance
  - Structural Projects
  - Natural Resource Protection
- Lowest importance
  - Property Protection

City of Myrtle Beach
Hazard Mitigation Plan Update

Public Participation Survey Results

ATKINS

City of Myrtle Beach

Public Hearing

The City of Myrtle Beach Floodplain Management and Hazard Mitigation Committee will hold a

Public Hearing
Monday, March 2, 1015
2:00pm
City Services Building, Large Conference Room
921 North Oak Street
Myrtle Beach, SC 29579

The purpose of the hearing will be to kick-off the Floodplain Management and Hazard Mitigation Plan 5 year update. As part of the planning process, the flood plain hazard mitigation committee holds public meetings and works with hundreds of citizens during the visioning process for the comprehensive plan updates. The plan was prepared as a guide to facilitate the implementation of floodplain management, as well as provide a guide for reconstruction and redevelopment of flood prone areas and as a means to reduce or eliminate future flood damage. We encourage the public to come participate and be part of our planning process.

VACATION?

Planning a trip to Myrtle Beach? Visit the **Myrtle Beach Area Chamber of Commerce** for information about hotels, attractions, restaurants, events, nightlife and more.

Summer Job Fair... Find a perfect summer job at the Recreation Division Job Fair, 4:00 to 5:30 p.m., Friday, March 6, at Pepper Geddings Recreation Center. We're looking for help in youth programs, youth sports, lifeguarding and fitness. Call Ryan at 918-1476 for information.

Photos of the Week... The key presentation ceremony for the Myrtle Beach Sports Center, a new indoor tournament space, is the subject of our Photos of the Week.

New Zoning Code... Developed during more than 100 public meetings, Myrtle Beach's new Zoning Code is in effect. The new Zoning Map is available, too. It's 50 megabytes.

Garage Sale! From castoff to collectible and odd to ordinary, you'll find it at South Carolina's Largest Garage Sale.

The big sale returns to the Myrtle Beach Convention Center from 7:00 a.m. to 2:00 p.m., on **Saturday, August 22, 2015.** Vendor registration will begin at a later date.

Have a request or question about city services? Submit it through our **Customer Service Portal**.

Sign up for weekly e-mails from the city. Send

Welcome to Myrtle Beach!

Here's what's happening...

- ***Hazard and disaster survey...*** The city is updating its five-year Floodplain Management and Hazard Mitigation Plan. As part of the process, the public is invited to take a short survey about hazards and disasters. We want to hear from you!

- ***The robots were here...*** Congratulations to Carolina Forest High School's robotics team, the Robo-Katz, on winning the Palmetto Regional FIRST Robotics Tournament on Saturday at the Myrtle Beach Convention Center! The Robo-Katz are going to the national championships in St. Louis in April. In all, 66 teams from eight states and Canada competed in the two-day tournament. In addition to Carolina Forest, three other Horry County high school teams were in the top 24 for Saturday's playoffs. Conway High School's Robo Tigers were in the top eight and selected the Academy of Technology and Academics and the Academy for Arts, Science and Technology for their alliance. For this year's challenge, students received a computer and a kit of parts in January, then had just six weeks to build a working robot from scratch. More than 3,000 saw the alliance selection and finals at the Convention Center.

- ***Parking meters in effect...*** Parking meters and pay stations are in place from March 1 through October 30 in the commercial areas east of Kings Highway. See our Parking Meter page for more information. If you have a valid handicapped hang tag or license plate, or a Purple Heart or Disabled American Veterans (DAV) license plate, you may park free at any public meter in South Carolina. *(This exemption does not apply to privately operated meters or pay stations.)*

- ***J. R. Martinez is Grand Marshal...*** Myrtle Beach celebrates **Military Appreciation Days** during the month of May with a full schedule of events. Army veteran **J. R. Martinez is Grand Marshal** for our parade on Saturday, May 16, which also is Armed Forces Day. Martinez was severely wounded during a tour of duty in Iraq in 2003. His recovery took 34 months, but today he is a successful actor, author, motivational speaker and winner of *Dancing with the Stars*. You'll have a chance to meet J. R. Martinez at the **Family Picnic**. For more information about activities during May, visit **www.militaryappreciationdays.com**.

J.R. Martinez

- ***Bikefest traffic and safety improvements...*** Myrtle Beach is implementing new safety and traffic management plans for the Atlantic Beach Memorial Day Bikefest, including a traffic loop, from 10:00 p.m. to 2:00 a.m., to keep vehicles flowing. Details and a map of the loop are available, along with the Police Dept.'s Memorial Day Weekend plan as of February.

- ***Fourth Avenue North Deepwater Ocean Outfall...*** Work is underway on a new deepwater ocean outfall at Fourth Avenue North. Completion is scheduled for November 2015 on this $10.4 million project that will carry rainwater more than 1,000 feet off shore. A print-on-demand brochure with details about the project and timeline is available.

- ***Police records and statistics...*** The Police Department's Police-to-Citizen

us your address to receive the **Friday Fax**, Events and Recreation email listings.

Questions? E-mail info@cityofmyrtlebeach.com or call (843) 918-1000.

(P2C) site provides incident reports, arrest records, accident reports, crime statistics and more. Visit the site to learn more about Myrtle Beach police and local law enforcement results.

- ***More city news...*** Visit the Friday Fax for this week's news, agendas and more. Or, add your name to our list by sending us your e-mail address. Check out the Photos of the Week for snapshots of city activities. You'll also find information about flood protection and hurricane preparations.

- ***To learn more*** about Myrtle Beach, contact the Public Information Office at info@cityofmyrtlebeach.com or call 843-918-1014. Our Frequently Asked Questions and Events pages also may be helpful.

ADA Notice: *The City of Myrtle Beach will not discriminate against qualified individuals on the basis of disability in its services, programs or activities. The city will make all reasonable modifications to policies and programs to ensure that people with disabilities have an equal opportunity to enjoy its programs, services, and activities. Call 843-918-1114 for more information.*

City Hall
937 Broadway Street
P.O. Box 2468, Myrtle Beach, SC 29578
(843) 918-1000 Fax: (843) 918-1028
info@cityofmyrtlebeach.com

CITY OF MYRTLE BEACH
MEETING SCHEDULE
August 3 – 7, 2015

MONDAY, AUGUST 3

8:30 a.m.	Staff Meeting/Hosted by City Manager's Office Second Floor Conference Room, City Hall

TUESDAY, AUGUST 4

1:30 p.m.	Planning Commission First Floor Conference Room, City Hall
3:00 – 8:00 p.m.	National Night Out Activities Various Times and Locations

WEDNESDAY, AUGUST 5

9:30 a.m.	Special Events Technical Review First Floor Conference Room, City Hall
10:00 a.m.	Hazard Mitigation Planning Team Conference Room, City Services Building
1:30 p.m.	Community Appearance Board Staff Plan Review Conference Room, City Services Building

THURSDAY, AUGUST 6

1:30 p.m.	Community Appearance Board Conference Room, City Services Building

FRIDAY, AUGUST 7

No Meetings Scheduled

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