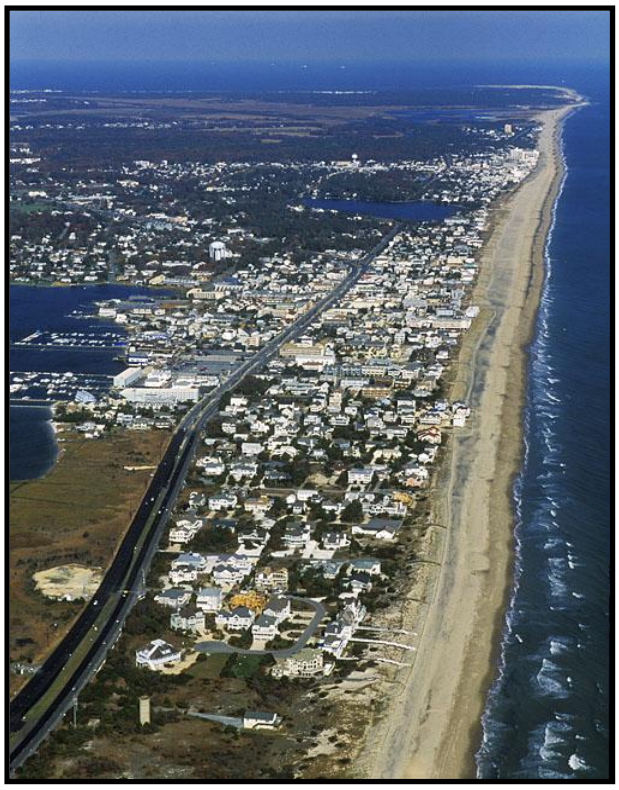
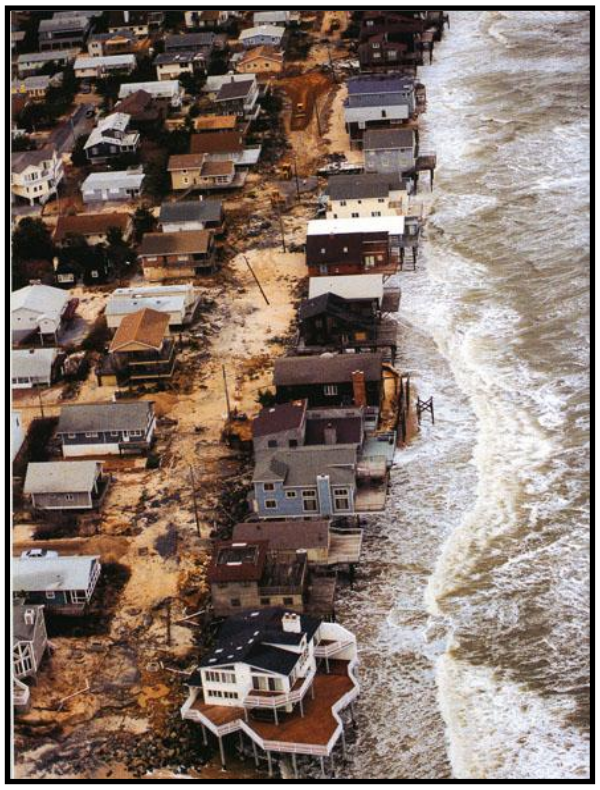
# Coastal Hazards and Community Resiliency in Delaware





This project was compiled by Delaware Sea Grant College Program with funding support from the University of Delaware Coastal Community Enhancement program. The Coastal Community Enhancement Initiative (CCEI) is funded through a grant from the State of Delaware to the University of Delaware to work with coastal communities and jurisdictions on growth and development issues. The Delaware Sea Grant College Program is supported cooperatively by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and the State of Delaware. Additional support and assistance was provided by the staff of the Shoreline and Waterways Management Section, Delaware Department of Natural Resources and Environmental Control.

University of Delaware

Sea Grant Delaware

National Oceanic and Atmospheric Administration · U.S. Department of Commerce · NOAA

Delaware Department of Natural Resources and Environmental Control

# Coastal Hazards and Community Resiliency In Delaware

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## Introduction and Overview

Delaware's coast, like shoreline areas across the nation, is experiencing a tremendous population boom. Rapid development has resulted in an explosion in the number of residents, visitors, homes and infrastructure subject to coastal hazards and floods, especially related to tropical storm systems and northeasters. The storm surge, extreme winds and flooding associated with these extreme events can result in millions of dollars in damage each year.

To help reduce Delaware communities' vulnerability to coastal hazards, the Delaware Sea Grant College Program, UD's Coastal Community Enhancement Initiative, and Delaware's Department of Natural Resources and Environmental Control have cooperated with the Delaware Emergency Management Agency to increase awareness of coastal hazards and provide communities information and resources that will improve societal, economic and personal resiliency to coastal hazards. The information provided in this document is intended to encourage development of projects and programs that will provide an effective means of educating not only the public, but also government official and communities about natural coastal hazards and associated mitigation measures.

Delaware's coastal areas are dynamic environments that are susceptible to a broad range of processes that can create and generate potentially hazardous conditions. Much of Delaware's populated coast is vulnerable to the effects of coastal storms, high winds, wave action, storm surge, flooding, and both episodic and chronic erosion.

*Photo courtesy Kevin Fleming*

Coastal hazards can pose threats to coastal communities – to people, property, infrastructure, society and economies. The same hazards can have significant impacts on natural ecosystems and the environment – beaches, dunes, and marshes.

Storm and flood hazards often extend beyond the coast to inland areas. Essentially all communities in Delaware are vulnerable to many of the same natural hazards – extreme winds, storm surge and/or flooding. Although most natural hazards cannot be avoided or prevented, measures can be taken to reduce community risks and vulnerabilities.

This collaborative project has a number of objectives, but a critical goal is to provide information and resources to communities, elected and appointed officials, residents and property owners. The intent is to increase awareness of coastal hazards and encourage development of mitigation strategies and implementation of incremental steps that communities and individuals can take to become more resilient to hazards. This document and website include the following sections: 1) Introduction and overview; 2) Coastal processes and coastal hazards in Delaware; 3) Concept of community resiliency; 4) Coastal hazard/flood mitigation planning tools and techniques; 5) Technical assistance and training opportunities; and 6) Links to educational resources and materials. Additionally, an overview of coastal hazards in Delaware and examples of hazard/flood impacts on many Delaware communities are provided in PowerPoint format.

It is anticipated that this information will enable communities, city officials, and residents to minimize susceptibility to coastal hazards by creating a level of awareness that will enhance existing coastal hazard mitigation efforts. Additionally, it is hoped that increased education and awareness of the potential impacts of coastal hazards to infrastructure, society and economies will encourage incorporation of natural hazards policies and implementation strategies into community comprehensive planning initiatives.

**Acknowledgments**

Most of the storm damage photographs have been provided by the Shoreline and Waterway Management Section, Delaware Department of Natural Resources and Environmental Control. Significant input and assistance from Shoreline and Waterway Section staff, including Tony Pratt, Jennifer Wheatley, Mike Powell, Maria Sadler, and Greg Williams, are gratefully acknowledged.

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## Section 2: Coastal Processes and Coastal Hazards in Delaware

### Contents



### Introduction

The Delaware shoreline is constantly changing in response to natural forces and human impacts. Coastal sediments (gravel, sand, silt and clay) are constantly moved and reworked by water and wind, creating an inherently unstable and shifting coastal region. The shape and configuration of Delaware's coastline is dependent on many factors, including: the amount of sand available for building beaches; the amount of wave and current energy striking the coast, both on a daily basis and episodically during storms; changes in sea-level; and human activities in the coastal zone that may alter or disrupt natural coastal processes.

It is important to understand and recognize the dynamic forces and complex processes that created, shaped and continue to maintain the shoreline. Everyday coastal processes can quickly become coastal hazards during a coastal storm event. In just a short period, storm-related waves, winds and tides can dramatically alter the beach by moving vast quantities of sand. Elevated water levels and storm surge can threaten and damage homes, businesses, roads and bridges.

Awareness of risks associated with coastal processes and coastal hazards is essential to building safer and more resilient coastal communities. If hazards are not considered in the process of community planning and development, homeowners, property, natural resources and economies may be subject to increased risks and unnecessary impacts.

## Coastal Processes

### *Waves*

Wave action is the main force moving sediment on the beach in Delaware. Waves represent the transfer of energy across the water surface, and in Delaware, waves are primarily generated by wind blowing over water. The size and shape of a wave are determined by the wind speed, duration of time the wind blows, the distance of water over which the wind blows (called the fetch), and as the wave nears the shore, the water depth.

Generally, strong winds blowing for several days over a long fetch produce larger waves. As waves travel away from where they were formed, they move across the ocean in groups. This is why we can see large ocean waves reaching the shoreline during a perfectly calm day.

As ocean waves approach shallower water near the shore, friction with the sea floor slows the wave's speed, and eventually the wave becomes unstable and breaks. Breaking waves in Delaware are generally plunging breakers - the front of the wave develops a curl due to the rather steep slope of the beach face. When the slope of the beach is gentler, spilling breakers occur. These waves spill down their face from top to bottom as they approach the shoreline.

## *Wind*

In coastal areas, winds are important in generating waves and currents. Winds are highly variable and can generate small ripples or large waves. The largest wind-generated waves are caused by storms at sea.

In coastal Delaware, the prevailing (most frequently occurring) winds vary seasonally. Northwesterly winds (blowing from the northwest) are most common during the winter months, whereas southwesterly winds are most common during the summer. There is often a daily variation in wind direction at the beach, with onshore breezes during part of the day and offshore breezes at other times.

During coastal storm events, damage from strong winds can be extensive. High velocity winds can blow shingles off of roofs and knock down trees and power lines. Large objects can be lifted and hurled through the air, causing additional destruction.


## *Tides*

The gravitational attractions of the sun and moon on the ocean's waters cause tides. The Delaware coast experiences two tidal cycles per day of approximately equal heights. Each day's two high tides (and two low tides) are approximately 50 minutes later than those of the previous day. The average vertical distance between a normal low tide and a normal high tide is known as the mean tide range. Mean tide ranges in Delaware are approximately 4 feet along the Atlantic Coast, 4-6 feet along the Delaware Bay, and 2 feet or less in the Inland Bays.

Tides play an important role in beach development and coastal processes because they constantly change the depth of water in which waves approach the coastline and strike the beach. Tides are also important in controlling the horizontal extent of the beach and the types of plants and animals living there.

Tide levels can be affected by wind conditions. Strong offshore winds (blowing from land toward sea) push water away from the land surface, and result in lower-than-normal tides. This is especially noticeable along the Delaware Bay shoreline, and in the Inland Bays. Strong onshore winds (blowing from water to land) tend to cause water to "pile up" along the shoreline, resulting in higher-than-normal tides.

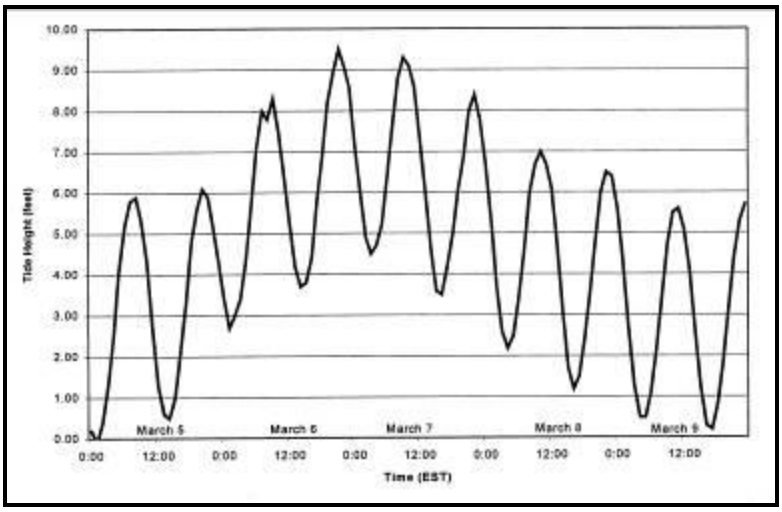



Figure 1. Example of tide levels from Breakwater Harbor tide gage during extreme northeast storm, March 1962. Normal high tide level at Breakwater Harbor is ~4 feet. This storm tide reached a maximum of ~9.5 feet on March 6. *Diagram courtesy Delaware Geological Survey.*

### *Rip Currents*

Rip currents are channelized currents of water flowing away from shore at surf beaches. They typically extend from near the water's edge, through the surf zone, and past the line of breaking waves. The primary driving force generating rip currents is the nearshore circulation pattern resulting from wave forces. As waves transport water towards the shoreline, water returning to sea can form channelized currents which transport water (and sand) offshore.

Rip currents most typically form at low spots or breaks in offshore sandbars when seaward flowing water is confined to these narrow channels. They also may form near structures such as groins, jetties, and piers which may deflect water and currents, forcing the flow in a seaward direction.

The location of rip currents can be recognized by a narrow channel of choppy, churning water; a difference in water color; a break in incoming waves; or a line of foam, seaweed or debris moving offshore.

Rip currents are a major threat to swimmers, and are most dangerous during high surf conditions, when outgoing currents can reach speeds up to 8 feet per second. If caught in a rip current, try to escape the current by swimming parallel to the shoreline. Once you feel the current diminishing, swim toward the shoreline at an angle.

### *Longshore Currents*

Longshore currents move water and sand along (or parallel to) the shoreline. This movement of sand can be compared to a conveyor belt, in that sand is moved from one portion of the beach to another, and is replaced by sand from nearby areas.

When waves strike the beach at an angle, a current is set up along the beach in the direction that the waves are breaking. Swimmers often notice this current when they are in the surf zone and slowly drift down the beach.

Longshore current direction varies with the direction of incoming waves. When waves approach Delaware's Atlantic coast form the southeast (from the right as you are standing on the shore looking out to the ocean), the current will move northward (to your left). Similarly, when waves approach from the northeast (from the left as you are looking out to the ocean), the current will move southward (to your right). Just as the direction of incoming waves can vary from day to day, so does the direction of the longshore current.

### *Sediment Transport*

The volume of material moved by longshore currents is related to the size and power of incoming waves, and the angle at which they approach the coast. If waves approach straight toward the beach, there is no wave-generated longshore transport. Larger waves can generate a stronger longshore current, and therefore can transport greater amounts of sand. Thus, longshore sediment transport volumes along the Atlantic Ocean coast are much greater than those along Delaware Bay or the Inland Bays.

Along most sections of the coast, waves approach the beach more frequently from one direction than another. Along much of Delaware's Atlantic coast, waves most often approach from the southeast, setting up northward longshore sediment transport. Sand moves northward along the shoreline, and is ultimately deposited at the sand spit, Cape Henlopen, causing it to grow in a northerly direction.

Calculations show that approximately 200,000 cubic yards of sand reach Cape Henlopen every year. This is the equivalent of more than fifty dump truck loads per day, each carrying an average load of 10 cubic yards.

## *Coastal Erosion*

While major storms are extreme events, they are relatively short in duration and occur infrequently. However, they play a major role in shaping how the coast looks and behaves over time. The immediate impact of a single storm is apparent to everyone, but it is the cumulative effects of these storms and the daily movement of sand along the beach that determines how the shoreline moves and changes over time.

The position of the shoreline fluctuates on several time scales. The location where land and water meet can change 50 feet or more over a single 6-hour tidal cycle, due to the rise and fall of the tide on a gently-sloping beach. There can be a 100-foot or greater (up to 200 feet) seasonal change from summer to winter, as sand moves onshore and offshore in response to changes in wave conditions.

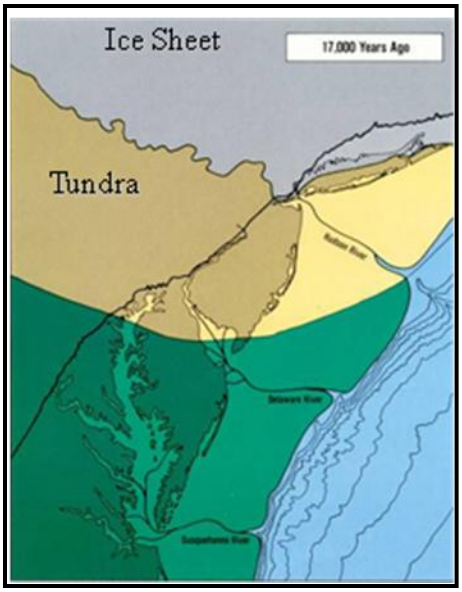
During storms, the location of the coastline and dune line can move dramatically landward in a period of hours to days. Over the long-term (centuries to millennia), sea-level rise also results in encroachment of the sea onto the land.

Technically, coastal erosion occurs when there is a net loss of sand from the beach system – either via alongshore or offshore transport, or through the process of overwash and landward migration of the beach system. The loss may be temporary or permanent, and estimates of shoreline change over the past 100 years or so show that much of the coast has been eroding at average rates of approximately two to three feet per year. However, these rates vary widely along Delaware's beaches, and averaged erosion rates must be used with caution.

## *Sea-Level Rise*

Because Delaware's coastal environments have evolved and responded to increases in sea level over the past 17,000 years, the impact of sea-level rise is considered to be a long-term coastal hazard.

Seventeen thousand years ago, during the peak of the last ice age, sea level was approximately 400 feet lower than it is today, and Delaware's ocean coastline was located 75 miles offshore.




As the climate became warmer and ice in the glaciers melted, sea level rose and the shoreline migrated landward to its present position.


Geological studies indicate that sea level along the Delaware coast has been rising at varying rates over the past 10,000 years.

From 10,000 to 5,000 years before present, sea level rose at a rate of 1.2 feet per century. The rate decreased to 0.8 feet per century from 5,000 to 2,000 years before present, and to 0.5 feet per century during the past 2,000 years. Tide gage records at Breakwater Harbor, Delaware, show that sea level has been rising at a rate of one foot per century since the 1920's. There is considerable agreement among scientists that the rate of sea-level rise will increase in the next 100 years.

Long-term relative sea-level rise is important in that it ultimately controls the position of the shoreline. An increasing sea level means we will be faced with erosion problems for the foreseeable future. Additionally, coastal wetlands may also be affected by long-term sea-level rise, particularly if they do not rise vertically at the same pace as the rising sea.

## Coastal Hazards

### *What are Coastal Hazards?*

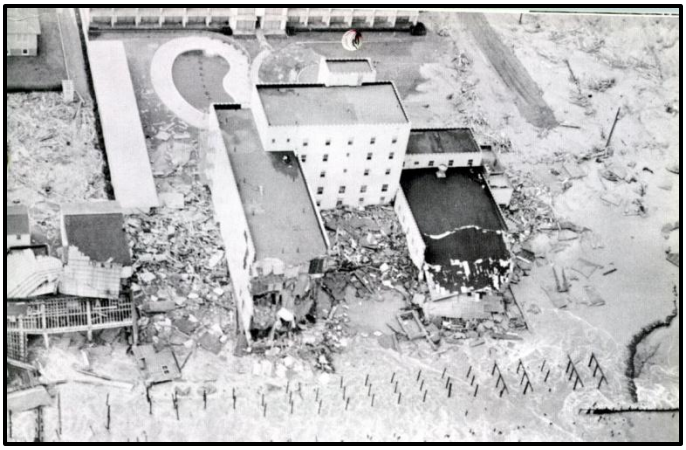
Coastal hazards in Delaware include coastal storms, coastal flooding and storm surge, waves, high winds, short-term and long-term erosion, and accelerated rates of sea-level rise. Each of these natural hazards creates a series of associated risks to life, property and coastal communities. A single severe coastal storm is capable of generating multiple short- and long-term hazards. For example a northeaster or hurricane will generate short duration hazards associated with storm surge, high winds, wave attack, debris impacts and significant shoreline erosion – the effects of these hazards are immediate, severe and readily apparent. Coastal hazards associated with longer term processes such as shoreline erosion and sea-level rise may become apparent only after extension periods of time.

### *Coastal Storms – Tropical Systems and Northeasters*

Coastal storms are primary and significant hazards in Delaware, and they play a major role in shaping the shoreline. Delaware beaches are affected by two types of coastal storms: tropical systems and northeasters. While tropical storm season runs from June 1 through November 30th, northeasters are a year-round threat to coastal Delaware. Since records have been collected, the state has never experienced a direct hurricane hit, but tropical storm systems have passed over and near Delaware annually, usually accompanied by high waves and heavy rainfall.

While not as powerful as hurricanes, northeasters occur more frequently in Delaware. Because they cover a larger area and are typically slow moving storms, northeasters usually affect a large portion of the coast and exert significant impacts on beaches, dunes, buildings,

boardwalks and roads over several successive tides. Northeasters are most damaging when they stall off the coast, as is evidenced by the coastal storm of record in Delaware – the March 1962 storm.



Although the origins of these storms differ, tropical systems and northeasters share many characteristics, and their impacts on the coast can be similar. Both types of storms are characterized by strong winds, high waves and high storm tides. High winds can blow shingles off roofs, and knock down trees and power lines. Large objects can be lifted and blown through the air, hurling projectiles and causing additional destruction. Torrential rainfall accompanying these storms often results in overtopping of creeks, streams and rivers, as well as flooding of roadways and floodplains. High waves, tides and storm surge result in extensive flooding of low-lying coastal areas. Structural debris that ends up in the water can act as battering rams, increase the amount of damage done to buildings, particularly foundations.

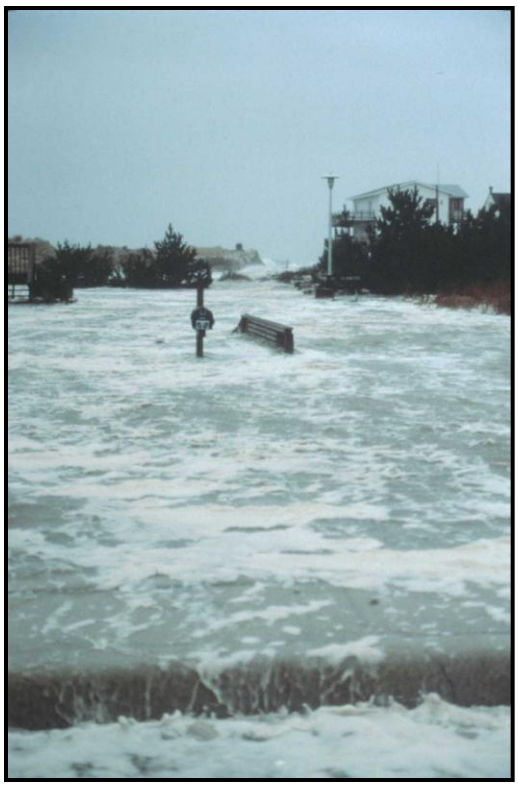
Coastal storms can cause extensive beach and dune erosion, which results in destruction of dunes, narrowing of the beach, or overwash of the beach and dune system. Sand and water may wash over or break through the dunes, and rush over property and streets behind the dune. When overwash occurs, breaking waves and high velocity currents can cause extensive damage to properties located behind the breached dune system.

The worst tropical systems and northeasters move vast quantities of sand, rearranging the beach with long lasting effects on the shoreline. Storm-generated waves and currents move material along the shore to adjacent areas, but some of the sand eroded from the beach and dune may be carried either 1) landward

into overwash fans, or 2) seaward and deposited in water too deep for it to be brought back by the gentler waves during calmer conditions. This sand is lost from the beach system, ultimately resulting in long-term erosion.

### *Inland Flooding and Storm Surge*

Elevated water levels caused by storm surge and inland flooding related to torrential rainfall and excessive run-off are not only threats to human life, but can also cause extensive damage to property. Flooding often results from storm surge generated by high winds and low air pressure, heavy rainfall, or both.



At first glance, the link between inland flooding and coastal hazards may not be obvious. However, torrential rainfall (6 inches or more of precipitation) typically accompanies tropical storm systems and can produce deadly and destructive flooding. This is a major threat to inland areas in Delaware, and all residents should be aware that the impact of coastal storms is not limited to shoreline regions, but can be widespread throughout the region.

Both tropical systems and northeasters can bring rain in large volumes and long duration, which may cause extensive flooding in both coastal and non-coastal areas. Typically, greater rainfall amounts and flooding are associated with tropical systems that have a slow forward speed or stall over an area.

Flooding usually occurs as a result of too much rainfall too fast. Rivers overflow their banks and spill into their natural floodplains. Urban flooding causes problems when storm drains become overwhelmed or clogged by debris, and may be exacerbated in areas where development has impacted or restricted stream flow and increased impermeable surfaces. In

fact, over the past ten to fifteen years, inland flooding caused by tropical storm systems has exerted far greater damage to western Sussex County and New Castle County than to shoreline areas in Delaware.

In general, there are two types of inland flooding associated with tropical storm systems:

**Flash Flooding** occurs in creeks, streams, and urban areas within a few minutes or hours of excessive rainfall. Rapidly rising water can reach heights of 30 feet or more. Streets can become swift moving rivers and underpasses can become death traps.

**River Flooding** occurs from heavy rains associated with decaying hurricanes or tropical storms, and in extreme cases, river floods can last a week or more.

Along the shoreline, storm surge is the principal cause of flooding and inundation during a coastal storm event. Storm surge is caused by the low atmospheric pressure at the center of a storm and the pulling/pushing of water onto the shoreline by accompanying winds. The elevated water levels resulting from storm surge move ashore and flood adjacent land areas.

Storm surge and coastal flooding exposes coastal residents, structures and public infrastructure to significant risks from standing

water, high-velocity flows and waterborne debris.

**Standing water** or slowly moving water can produce increased pressure against structures exposed to floodwaters. If the water level on different sides of a structure is unequal, significant pressure can build in one direction leading to collapse or failure of the building. In cases where floodwaters rise equally along the exterior walls of a structure but the interior space remains dry, catastrophic collapse of the building can occur as the structure collapses inward under exterior water pressure.

**High-velocity flows** can be created by storm surge and wave run-up flowing landward through breaks in dunes or low-lying areas and by wave generated currents flowing along the shoreline. When floodwaters exceed a velocity of 10 feet per second, tremendous force is applied to structures in its path.


**Waterborne debris** carried by floodwater generates short duration impacts when they strike stationary objects. Waterborne debris typically includes any floating object that is not secure: decking, stairs, breakaway wall panels, pilings, fences, propane and oil tanks, boats, portions of buildings and sometimes entire houses. Such objects are capable of destroying other structures on impact.

## *Wave Hazards*


The size and intensity of storm-generated waves depend on the magnitude and duration of the storm as well as the sustained wind speeds. During calm weather, large waves usually break offshore, away from the shoreline. During storm conditions, however, elevated water levels generated by storm surge, allows waves to break much closer to the shoreline, exposing coastal structures directly to wave attack, wave run-up, and wave induced scour and erosion.

**Breaking wave attack** – The most extreme wave hazard to the built environment occurs when a wave breaks on a structure. Peak pressures from a 5-foot high breaking wave can exceed 2,000 pounds per square foot (FEMA, 1999). Post storm damage inspections have shown that breaking waves are capable of destroying all wood-frame or unreinforced masonry walls (FEMA, 2000).

**Non-breaking waves** – A wave can also impact a structure before and after breaking. If a wave strikes a solid structure prior to breaking, the wave energy is reflected back toward the ocean. Associated with wave energy reflection is increased erosion and scour

at the base of the structure, potentially leading to undermining and collapse. If a wave passes under an open foundation, such as the pilings below a fishing pier, the structure may experience vertical uplift forces and associated damage, as decking may be lifted from the pilings and beams.

**Wave run-up** – Wave run-up is the distance a wave will travel up a sloped surface or vertical wall, and is considered a hazard because it can drive large volumes of water and debris against coastal structures. Strong currents associated with run-up can result in localized erosion and scour, and uplift forces can destroy decks, flooring and porches.


## *Wind Hazards*

The most significant coastal wind hazards in Delaware originate from coastal storms – northeasters, tropical systems such as hurricanes and tropical storms, and tornadoes that may be generated by these storms. Hurricanes can generate sustained winds ranging from 74 mph to over 155 mph over durations of 12 to 24 hours. Northeasters typically generate lower sustained winds of 35-45 mph, but can last for several days. Tropical systems are characterized by strong on-shore winds as the cyclone approaches the coast, followed by strong offshore winds as the center passes or makes landfall. In a northeaster, winds gradually build out of the

northeast, peak as the storm reaches maximum intensity, and then gradually decrease as the storm moves away from the coast.


Coastal structures can suffer extensive damage when they are not designed or constructed for expected wind velocities, or when wind speeds exceed design levels. Buildings that contain large areas of window space, or with any low-pitched gabled roofs and overhands are particularly susceptible to wind damage (FEMA, 2000). Any structural failure that compromises the building envelope (outer walls and roof) will result in severe structural damage. When the building envelope is breached, interior damage from rainfall and wind is certain, and roof loss and structural failure are possible.

Additionally, high winds can topple trees and break large branches creating the risk of injury and property damage from falling debris. In many communities, storm related power outages are caused by trees falling on elevated power lines.

## *Erosion Hazards*

Erosion hazards can be short-term and dramatic when generated by storm events, or long-term and less recognizable when changes occur over a period of decades.

**Short-term erosion** – Short-term erosion is the rapid recession of the coast in response to coastal storms or flood events. Storm generated erosion ranges over periods of hours to several days. Although the storm events are short-lived, resulting erosion can be equivalent to decades of long-term erosion. The impact of short-term erosion to private and public property can be severe. Dunes and other natural protective features of the coast can be breached and destroyed, exposing structures behind them to further damage from subsequent storms.

**Scour** – Scour refers to localized erosion in addition to that caused by flooding or wave action. Scour is generated by the acceleration of water flow around an object – as water moves past a fixed structure such as a piling, it accelerates, creating turbulence above the bottom. Erodible material such as sand is suspended by the turbulence and transported away, resulting in localized erosion.

**Long-term erosion** – Long-term shoreline erosion along the coast is a result of cumulative impacts of storms, sea-level rise, man-made impacts, sediment supply, and everyday coastal processes such as waves and currents. Regardless of the cause, long-term erosion increases the vulnerability of coastal structures to damage by exposing them to increased risk over the lifespan of the structure.

## *Sea-Level Rise*

From 10,000 to 5,000 years before present, sea level rose at a rate of 1.2 feet per century. The rate decreased to 0.8 feet per century from 5,000 to 2,000 years before present, and to 0.5 feet per century during the past 2,000 years. Tide gage records at Breakwater Harbor, Delaware, show that relative sea level has been rising at a rate of one foot per century since the 1920s when the tide gage was installed.

There is considerable agreement among scientists that the rate of sea-level rise will increase in the next 100 years. The Intergovernmental Panel on Climate Change report (IPCC 2007) recently suggested that rates of sea-level rise are accelerating, and by the year 2100, there may be in an increase in sea level of 2-3 feet along the Delaware coast.

Long-term relative sea-level rise is important in that it ultimately controls the position of the shoreline. An increasing sea level means we will be faced with continued and possibly exacerbated erosion, inundation and flooding problems in the future. Additionally, coastal wetlands may also be affected by long-term sea-level rise, particularly if they do not rise vertically at the same pace as the rising sea.

## *Tsunami Hazards*

While tsunamis are not considered to be a high risk coastal hazard, it is possible that a tsunami could impact the Delaware coast. There are many causes of tsunamis, including earthquakes, landslides, volcanic eruptions, explosions, and meteorite impacts – any disturbance that displaces a large water mass can generate a tsunami.

Tsunamis in the Atlantic Basin are most commonly generated by earthquakes and

landslides. Primary sources of tsunami-producing earthquakes in the Atlantic are located near Puerto Rico, Portugal, and the Canary Islands. Tsunamis in the Atlantic Ocean may also be caused by underwater landslides, usually occurring near the continental shelf and slope.

Wave and tide gauge records have documented the relative magnitude of tsunamis reaching the east coast. In 1918 and 1946, tide gauges recorded waves just a few inches high generated by earthquakes in Puerto Rico and the Dominican Republic, respectively. More recently, Atlantic basin gauges recorded 5-10 inch waves generated by the December 2004 Indian Ocean tsunami.

## *Additional Coastal Hazards*

Coastal communities are exposed to a number of minor hazards that may occur less frequently than flooding or wave attack but that can still cause localized property damage and personal injury. These hazards include:

**Burial by sand**

**Rain, snow and ice**

**Salt spray** frequently leads to corrosion of building materials in the coastal environment, and is a hazard that is commonly overlooked and underestimated. Similarly, moisture effects can lead to decay of building materials such as pilings. Infestation by termites is also common in coastal areas subject to high humidity. Improper preservative treatments, improper design and construction, and even poor landscape practices may contribute to decay and infestation problems.

# Section 3: Community Resiliency

## Contents



## What is a Resilient Community?

Risks from coastal hazards include storms, flooding, erosion and sea-level rise. Infrequent events with limited predictability can pose the greatest risk of disaster, while frequent on on-going hazards can often be monitored and managed to reduce risk. Resiliency represents the ability to "bounce back" after hazardous events. Resiliency is critical to coastal communities because it provides the capacity to absorb shocks while maintaining function. Disaster resilience is "the capacity of a community exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of function and structure."

Another definition of disaster resilience, provided by the 2005 Subcommittee on Disaster Reduction is: "Disaster resilience is the capacity of a community that is exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure. Resilience is determined by the degree to which the community is capable of organizing itself to increase its capacity for learning from past disasters…." Resilient coastal communities take deliberate action to reduce risk from coastal hazards with the goals of avoiding disaster and accelerating recovery in the event of a disaster. This can be achieved in various ways, including:

- Coastal management (policies, construction standards, best management practices, mitigation opportunities and grants);
- Development of community hazard mitigation plans;

- Land use planning (e.g. designation of flood-prone lands for agriculture, conservation, or other uses that suffer minimal damage from floods);
- Protection of natural resources so that the naturally beneficial functions of floodplains and watersheds can be realized.

## How Can Communities Minimize and Mitigate Hazard Impacts?

Delaware communities are susceptible to a variety of natural hazards, and the economic costs of natural hazards, especially inland and coastal flooding, can quickly become staggering. Over the past few decades, major flooding events and coastal storms have damaged infrastructure, residences and businesses throughout Delaware. In addition to these property losses, floods can endanger lives and wreak social and emotional devastation in a community.

Reacting to the severe damage caused by natural hazards is necessary, but merely responding after a flood does nothing to reduce the damage and economic losses incurred by floods. Action can be taken ahead of time to prevent or minimize future damage. A community that develops a hazards mitigation plan works to identify actions that will lessen the impact of a disaster. Associated community benefits from hazard mitigation planning activities include: reduced public and private damage costs; reduced social, emotional, and economic disruption; increased access to funding sources for hazard mitigation projects; and improved ability to implement post-disaster recovery projects.

Hazard mitigation includes any action or initiative that reduces the potential of adverse impacts from hazards to people, property, and both man-made and natural resources. There are many activities that can be taken to mitigate the risks of and damage from floods, coastal storms, and other extreme environmental events.

FEMA has identified six broad categories of general mitigation measures:

| ***Category*** | ***Mitigation Measure*** | ***Examples*** |
|---|---|---|
| Prevention | Government actions or processes that influence the way land and buildings are developed or built. | Planning and Zoning; Building Codes; Open Space Preservation; Stormwater Management Regulations |
| Property Protection | Actions to modify existing buildings or structures to protect them from a hazard or remove them from a hazard. | Acquisition; Relocation; Elevation; Structural Retrofits; Storm Shutters; Flood Insurance |
| Public Education and Awareness | Actions that inform and educate about the hazard and potential ways to mitigate. | Real Estate Disclosures; Outreach Projects; Education/Training Programs |
| Natural Resource Protection | Actions that preserve or restore the functions of natural systems. | Sediment and Erosion Control; Watershed Management; Coastal Wetland Protection/Restoration |
| Emergency Services | Actions to protect people and property during and immediately after a hazard event. | Protection of Critical Facilities; Warning Systems; Emergency Response Services |
| Structural Projects | Construction of structures to reduce the impacts of hazards. | Dams, Levees, Floodwalls; Floodwater Diversions; Beach Nourishment |

## Examples of Hazard Mitigation Actions and Measures

Mitigation can be an effective way of managing hazards and risks that impact both communities and individuals. Mitigation means taking a sustained action to reduce or eliminate long-term risk to people and property from hazards and their effects. An example of a hazard mitigation measure that minimizes risks from natural hazards is establishment of building codes and Federal, state and local regulations that establish minimum requirements for siting, design and construction in coastal communities. When building codes and regulatory requirements are met, they can help reduce the vulnerability of a building or community to natural hazards.

It should be noted, however, that property owners, developers, and builders have the

ability to further manage and minimize risk by providing an increased level of hazard mitigation. For example, as outlined in FEMA's Coastal Construction Manual (FEMA 55CD, 2001):

- A building can be sited further landward than the minimum distance specified by state or local setback requirements.
- A building can be elevated above the level required by NFIP, state, and local requirements.
- Supporting piles can be embedded deeper than required by state or local regulations.
- Structural members or connections can be used that exceed code requirements for gravity, uplift, and/or lateral forces.
- Improved roofing systems can be used that provide greater resistance to wind than required by code.
- Building and roof shapes (e.g. hip roofs) can be selected that reduce wind loads.
- Openings (e.g. windows and doors) can be protected with permanent or temporary shutters or covers, whether or not such protection is required by code.
- Construction of enclosures below an elevated building can be eliminated or minimized.

**Additional hazard mitigation opportunities** include taking the following actions:

- Identify undeveloped land located in high-risk areas to enhance future zoning and land use decisions. The preservation of undeveloped floodplains and wetlands allows these areas to serve as storm and erosion buffers and as temporary storage for floodwaters. After a disaster, a community could assess prior zoning decisions in high-risk areas by calculating damage and losses in those areas. In the absence of a disaster, the community could use zoning information in conjunction with population data to determine the effects of new development (i.e., increased population and vehicles) on a community's disaster resiliency. For example, population growth in high-risk areas will impact evacuation measures and abilities, emergency shelter levels, and other response and recovery activities.
- Prioritize critical facilities in high-risk areas for structural or nonstructural retrofitting,

elevation, or relocation. Water, sewer, electric, fuel, and communications systems may also be buried or elevated.

- Identify populations that need special care and services to target pre-disaster outreach and accelerate post-disaster recovery program services and funding.
- Structural Hazard Mitigation Measures:
- Relocation of facilities from hazardous locations, including roads and bridges, utilities, buildings;
- Slope stabilization and/or installation of soil retention blankets to protect facilities;
- Placement of riprap or retaining walls to prevent erosion of and deter flood waters;
- Protection from high winds - installation of hurricane shutters to protect windows; installation of hurricane clips; strengthening anchoring and connections of roof-mounted equipment;
- Flood-proofing of buildings and/or use of flood-damage-resistant materials;
- Elevation of buildings, mechanical equipment, control panels and utilities to prevent flood damage;
- Anchoring fuel tanks to prevent movement during flood events.

**Nonstructural Hazard Mitigation Measures:**

- Directing development through land-use planning, zoning, and subdivision regulations;
- Limiting risk and increasing the community's capacity to recover through structure and property acquisition;
- Directing development with taxes, incentives, and other techniques;
- Adopting and enforcing building codes;
- Conducting outreach activities to educate the public on hazards, vulnerabilities, and hazard mitigation measures.

## Getting Started - General Tools and Resources for Community Resilience

The information provided in this document and website is intended to assist resource managers, decision-makers, communities, and individuals in making decisions that will minimize damage caused by natural hazards in coastal communities. As described in previous sections, these hazards include not only occasional extreme events such as coastal storms, but also continuous coastal impacts from long-term erosion, shoreline migration, and sea-level rise. The effects of hazards associated with extreme events are immediate and severe, while those associated with longer-term processes are less apparent and more cumulative over time. Therefore, sensible planning and decision-making in communities depends not only on an understanding of the hazards that affect coastal areas, but also an assessment of risks and appropriate risk mitigation and management techniques.

### Community Risk and Vulnerability Assessment

Hazard awareness, risk identification and risk assessment are important elements of coastal community resiliency. Communities must identify their exposure to hazard impacts in order to be able to proactively address emergency planning, response and recover, and implement hazard mitigation measures.

Why conduct a risk and vulnerability assessment? All communities are vulnerable to hazards. A risk and vulnerability assessment is a starting point - a way to begin reducing community vulnerability. Results of the assessment can guide your community towards developing mitigation strategies and prioritizing mitigation projects.

NOAA's Coastal Services Center (CSC) provides a number of training materials that can lead to enhanced community resiliency. These risk and vulnerability assessment tool resources can be found on the CSC website:

- Community Vulnerability Assessment Tool, or CVAT – An informational aid, piloted in coastal North Carolina and widely used by communities, that guides efforts to reduce hazard vulnerability.
- Risk and Vulnerability Assessment Tool – A tool that adds interactive mapping and other

features to the CVAT methodology.

- Vulnerability Assessment Techniques and Applications – A Web site that provides information on assessments and opportunities to network with practitioners and researchers.

NOAA's CSC Community Vulnerability Assessment Tool provides a tutorial, case-study and step-by-step guidelines for assessing community vulnerability. An overview of the 7-step process is included below.

***Step 1. Hazard Identification***

What hazards are you concerned about? How would you prioritize them?

***Step 2. Hazard Analysis***

What are the geographic areas with the highest risk from identified hazards? What areas have the highest potential for being vulnerable to hazards? For example, if coastal flooding or storm surge are identified as potential hazards, then floodplain maps, SLOSH models, etc. can be used to identify the geographic areas with the highest risk from coastal flooding and storm surge.

***Step 3. Critical Facilities Analysis***

What are your critical facilities and where are they located? How vulnerable are they to physical and operational impacts from hazards? Critical facilities can include shelters, schools, hospitals and nursing homes, Police/Fire and Rescue, government buildings, utilities, communications facilities.

***Step 4. Societal Analysis***

Where are your high-needs neighborhoods? How vulnerable are they to hazard impacts?

High-needs neighborhoods could be most dependent on public resources after a disaster and thus could be good investment areas for hazard mitigation activities.

***Step 5. Economic Analysis***

What are your primary economic sectors, and how vulnerable are they to hazards? Where are your largest employers located, and how vulnerable are they to hazard impacts? These economic centers are areas where hazard risks could have major impacts on your local economy and therefore would be ideal locations for targeting certain hazard mitigation strategies.

***Step 6. Environmental Analysis***

Where are your hazardous or toxic materials located, and how vulnerable are they to natural hazards? How vulnerable are critical natural resources (beaches, dunes, wetlands, bays, etc.) to secondary hazard impacts? Secondary impacts occur when natural hazard events create new hazards such as toxic releases or hazardous spills.

***Step 7. Mitigation Opportunities Analysis***

What are your best opportunities for reducing future hazard vulnerability? For example, are there large tracts of undeveloped land in your community? Are there areas with future plans for significant growth that are in high-risk areas?

## No Adverse Impact and Coastal No Adverse Impact – Planning, Mitigation, and Education

The Association of State Floodplain Managers (ASFPM) developed the No Adverse Impact (NAI) principle to help guide communities in developing floodplain management strategies that go beyond the minimum requirements of federal or state programs. NAI provides tools for communities to prevent increased flood and to provide a higher level of protection for people and property.

In addition, ASFPM and NOAA's Coastal Services Center (CSC) collaborated to develop a Coastal No Adverse Impact Handbook with useful information about the application of mitigation strategies for the management of natural coastal hazards. The handbook introduces local officials and concerned citizens to (NAI) concepts, and suggests how a community can use the NAI approach to minimize the risks and maximize the benefits of their coastal environments. Several examples of NAI concepts and practices are outlined below.

***Planning*** – Communities use planning to direct development and public projects and to ensure their land use regulations (zoning) meet community needs. When done correctly, planning can prevent many hazard-related problems by directing poorly conceived new developments and post-disaster building away from dangerous locations.

Comprehensive land-use plans define how and where a community should be developed, and where development should not occur. Acknowledging floodways and erosion zones as areas that require special attention will result in safer communities. Plans should relate land use to natural hazards by reserving the most hazardous areas such as floodways, V Zones, Coastal A Zones and high erosion zones for parks, greenways, golf courses, wildlife refuges, natural areas, or similar open space. Acknowledging floodways and erosion zones as areas that require special attention will result in safer communities.

While a comprehensive plan usually sets broad goals and objectives, special-

subject plans provide more detailed guidance on certain locations in the community. For example, special-subject plans can include floodplain management plans, stormwater management plans, and hazard mitigation plans. Hazard mitigation plans are developed to coordinate actions to reduce injuries, deaths, property damage, economic losses, and degradation of natural resources. These plans expand on the concept of floodplain management by including all natural hazards facing a community.

DNREC's Flood Mitigation Program website includes a link to a Delaware Floodplain Model Ordinance that can be adopted to specific community needs and incorporated into community plans to reduce flood damage.

***Mitigation*** – Mitigation eliminates or reduces the damage that can be done to existing or proposed development or to the environment. Mitigation measures can be either non-structural or structural. Examples of non-structural measures include elevating buildings, using buffers and vegetation, relocation, acquisition, and avoiding development in hazardous areas. Examples of structural measures include construction of levees, floodwalls, seawalls, rip-rap, groins, jetties, and beach nourishment.

Because of the expense and adverse impacts that often result from structural flood protection projects, many communities have turned to nonstructural approaches to reduce flood losses. Instead of trying to control water, these techniques focus on altering development practices and how people respond to floods.

The first step in altering development practices can be the development of a comprehensive flood hazard plan to address your community's hazards and risks. The plan should provide recommendations to minimize exposure, such as modification to existing zoning maps, building standards and regulations.

FEMA's Mitigation Best Practices is a web site with a collection of illustrated stories about mitigation projects and activities.

***Education*** – The NAI handbook explains that perhaps the most effective means of mitigating coastal hazards and flood hazards is education through outreach. Education

and outreach are required to inform the entire community – decision makers, design professionals, developers, the general public, and property owners.

Property owners, residents and tourists need to be informed of their risk. Community residents need to be provided the opportunity to minimize their personal vulnerability. Current or prospective coastal property owners should be provided with facts and recommendations about siting, design and construction practices that will enhance their ability to build a structure that can withstand the forces of moving water and other hazards.

Local officials should ensure that property owners are periodically informed about coastal hazards and flood hazards, the vulnerability of their homes and property, and mitigation techniques that will minimize vulnerability. Within the National Flood Insurance Program (NFIP), a community can gain Community Rating System (CRS) points by using a newsletter or general mailing to notify community residents about the flood hazard and about flood insurance.

Educational efforts work toward long-term transformation of people's behavior and understanding about where they live, associated hazards, and mitigation measures. Outreach projects provide information to people to make them aware of the hazards and protection alternatives. Education and training can move the process one step further by fostering changes in attitudes and behaviors. NAI recommends that communities should start with their own staff, which then can pass on what they have learned.

Classes offered by Delaware DNREC's Flood Mitigation Program, DEMA, FEMA's Emergency Management Institute and the NOAA Coastal Services Center can help local government staff to better inform elected officials, the public, educators, real estate agents, insurance agents, and surveyors about ways to mitigate the impacts of coastal hazards. ASFPM administers the Certified Floodplain Manager (CFM) program to ensure that floodplain management staff members at local, State and federal levels are knowledgeable about reducing potential flood losses, and stay up-to-date on the NFIP and other flood programs. Information about the certification program, how to apply,

and available training are on the ASFPM website. Delaware's DNREC Flood Mitigation Program is the local contact for administering the CFM examination.

One specific educational tool is FEMA's Coastal Construction Manual, which can assist contractors, designers, and community officials identify and evaluate practices that will improve the quality of construction and reduce economic losses associated with coastal hazards. FEMA has also produced a series of fact sheets to provide technical guidance and recommendations concerning the construction of coastal residential buildings – The Homebuilders Guide to Coastal Construction. The fact sheets present information aimed at improving the performance of buildings subject to flood and wind forces in coastal environments.

Communities interested in education and outreach can get support from FEMA Region III (Delaware's regional FEMA office) and/or Delaware DNREC's State NFIP coordinator. Staff from these offices may be able to assist in planning and conducting workshops, and can provide assistance with other outreach initiatives.

Additional information about tools and techniques for coastal hazard mitigation and floodplain management is included in Chapter 4 (Note: include active link to Chapter 4 of this website).

# Section 4: Coastal Hazard Mitigation and Floodplain Management – Tools and Techniques

## Contents



## Planning

A community can take proactive steps to protect people and property through effective planning initiatives that prevent growth and development in areas prone to any natural hazard, especially floods. Every community should incorporate hazard risk assessment and planning into its comprehensive planning document. A hazard mitigation plan describes what hazards your community faces and what it plans to do about them.

### *Hazard Mitigation Planning*

Hazard mitigation planning and implementation of mitigation plans help coastal communities minimize damage from future storm events. Since communities are at different stages of planning, they should coordinate with and build upon existing efforts on the local, regional, state, and federal level. Hazard mitigation plans should incorporate smart growth measures and address the potential impacts of climate change and related accelerated rates of sea-level rise. Development and implementation of hazard mitigation plans will also help communities participating in the NFIP's Community Rating System (CRS) earn points toward flood insurance premium discounts for residents with NFIP policies. Additionally, participation in the CRS may make communities eligible for grants to fund projects recommended in the

hazard mitigation plans.

The hazard mitigation plan is especially important because if your community does not have an approved multi-hazard mitigation plan, it will not be eligible for federal post-disaster mitigation grants. A multi-hazard mitigation plan identifies potential natural threats to your community through a risk analysis, and determines likely impacts of those hazards. Additionally, the multi-hazard mitigation plan establishes mitigation goals, and outlines strategies and measures that can be taken to minimize the impacts of these hazards on your community.

For more information, contact DEMA's Hazard Mitigation Planning officer at 302-659-3362 (or the designated emergency manager for your community) regarding current status and plans for enhancing or updating the plan, and opportunities to get more involved in the process.

Additional information and resources:

- For instructions on how to conduct a comprehensive risk review, see chapter 4 of the Federal Emergency Management Agency's (FEMA) Understanding Your Risks: Identifying Hazards and Estimating Losses.
- FEMA's Mitigation Planning Guidance website provides a step-by-step approach for creating a multi-hazard mitigation plan.
- If your community has the technical resources, FEMA and the National Institute of Building Sciences have developed a methodology (called HAZUS) to assess a community's hazard exposure. See the HAZUS web site.

***Floodplain Management and Planning Recommendations from ASFPM's No Adverse Impact Program***

Flooding is a threat to most communities in Delaware, and federal, state and local agencies have worked to implement programs and strategies for flood mitigation. The nation's major floodplain management effort is the National Flood Insurance Program (NFIP) which maps floodplains and provides federally backed flood insurance in return for local regulation of development in those mapped floodplains.

The NFIP has had an impact on the problem of development in the floodplain, but while the program has slowed increases in flood damage, it has not stopped or reversed it. Although many local communities participate in the NFIP, they do so by meeting the program's minimum requirements such as construction standards that may not provide sufficient flood protection from all local flood hazards.

ASFPM recognized that by adopting and enforcing only minimum NFIP standards, a community might unintentionally be placing the public and property in harm's way. Therefore, as part of a major flood mitigation program initiative, ASFPM began encouraging local communities to recognize the need to go beyond national and state minimums and take charge of their own flooding issues.

The No Adverse Impact (NAI) floodplain management principle was developed by ASFPM to encourage and enable local officials to assume responsibility for their flood problems and floodplain management programs. As explained in the ASFPM 2003 NAI toolkit publication, "rather than depending on minimum requirements of federal or state programs, NAI provides tools for communities to provide a higher level of protection for their citizens and to prevent increased flooding now and in the future."

***NAI Recommendations for Community Planning and Zoning to Minimize Flood Hazards***

Planning is a key piece of any community flood mitigation effort. The term planning covers a variety of activities that communities pursue to direct future development and publicly funded projects. Good planning avoids unplanned development in the wrong places, and leads to wise use of floodplains and other lands.

The land use planning process should start with identification of hazard areas so that appropriate uses can be pre-planned. Comprehensive land use plans should relate the use of land to the land's hazards, typically by reserving hazardous areas for parks, greenways, golf courses, wildlife refuges, natural areas, or similar open space compatible uses. In some states, a land use plan has regulatory authority, but usually it's the zoning ordinance that provides the teeth to a land use plan.

Land use plans and zoning ordinances have the potential to restrict damage-prone

development in hazardous or sensitive areas. The floodplain should be designated as one or more separate land use or zoning districts that permit only those uses or activities that are not susceptible to damage by flooding or flood-related hazards (such as conservation, recreation, or agriculture).

A benefit of properly prepared land use plans and zoning ordinances is that they usually reduce the amount of at-risk floodplain development. Where floodplain development cannot be avoided, it is important to have regulatory programs and standards that can fully protect it from flood damage.

***Opportunities to Enhance Community Floodplain Management Efforts***

- Understand your community's flood risk.
- Develop a community-specific floodplain management plan.
- Conduct a comprehensive assessment of your community's flood hazards, what is being done now to protect people and property, and what new activities should be undertaken. Floodplain management plans address mapping needs, repetitive loss areas, regulatory standards and procedures, sites that could or should be acquired, possible corrective actions, outreach projects, and other flood protection measures.
- Develop a comprehensive hazard mitigation plan that examines all natural hazards that may impact your community.
- Engage and inform community leaders and citizens to obtain support for recommended best practices.
- Adopt and enforce higher development standards, both inside and outside mapped special flood hazard areas.

## Regulatory Tools

An effective means of achieving hazard mitigation goals is through regulatory oversight of land use practices, locally adopted floodplain management ordinances and laws, as well as adaptation of building codes and standards. These types of regulatory requirements can be established with the intent of reducing the loss of life and damage caused by natural disasters as well as protecting the natural environment.

**Land use regulations** – State and local governments establish regulations for governing the development and use of land within their jurisdictions to promote sound physical, social and economic development. Examples include DNREC regulations - wetlands, subaqueous lands, floodplain management, etc. Also Coastal Zone Management (CZM) regulations that protect coastal resources, manage development in high hazard areas, provide public access, etc. Taken together, the land use regulations oversee all aspects of land development and building in the coastal zone including prohibiting or restricting development in specified area, establishing minimum site requirements, floodplain management, natural resource management, utility easements, etc.

**Building codes and standards** – Building codes set forth the requirements for protecting public health, safety and the welfare of the built environment. There are hundreds of standards related to design and construction practices as well as construction materials.

**National Flood Insurance Program (NFIP)** – Established by Congress in 1968, the National Flood Insurance Program (NFIP) is a voluntary program designed to: 1) reduce the loss of life and damage caused by flooding; 2) to help victims recover from floods; and 3) to promote an equitable distribution of costs among those who are protected by flood insurance and the general public. The NFIP operates through a voluntary partnership between the federal government, the states, and local communities. The Federal Emergency Management Agency (FEMA) administers the NFIP, conducting flood hazard studies, Flood Insurance Studies (FIS) and by developing Flood Insurance

Rate Maps (FIRMs) for individual communities. A FIRM consists of one or more maps delineating the flood hazard by ground elevation. Each FIRM outlines the areas of a community that will be impacted by a 100- and 500-year flood event.

FEMA also provides funding to qualified Delaware communities for flood hazard mitigation and federally-backed flood insurance to property owners and residents living in flood hazard areas. In return, participating communities adopt and enforce floodplain management ordinances that control development and the construction of new buildings, substantial improvements to existing buildings, and the reconstruction of substantially damaged buildings. A participating community's floodplain management ordinance must, at a minimum, meet the requirements of NFIP regulations. However, FEMA encourages communities to establish additional or more stringent requirements through the Community Rating System (CRS). Established in 1990, the CRES awards points to communities for activities that will reduce flood losses, facilitate accurate insurance ratings, and promote awareness of flood insurance. Through the CRS, FEMA recognizes a community's floodplain activities in excess of minimum standards by reducing flood insurance premium rates.

**Higher Regulatory Standards –** Local governments and communities may adopt higher regulatory standards to minimize damage from all flood hazards. Examples of higher regulatory standards as suggested by ASFPM include:

***Add freeboard*** – Freeboard is an additional height requirement above the base flood elevation that provides a margin of safety against flood risks. When constructing a new elevated building, the additional cost of going up another foot or two is usually minimal. Freeboard is the most common higher regulatory standard adopted by states and communities. Not only does freeboard reduce the risk of flood damage, but it also can result in a significantly reduction in flood insurance rates. Example ordinance language: In V-Zones, the lowest horizontal structural member of the lowest floor must be at or above 1 foot above the base flood elevation.

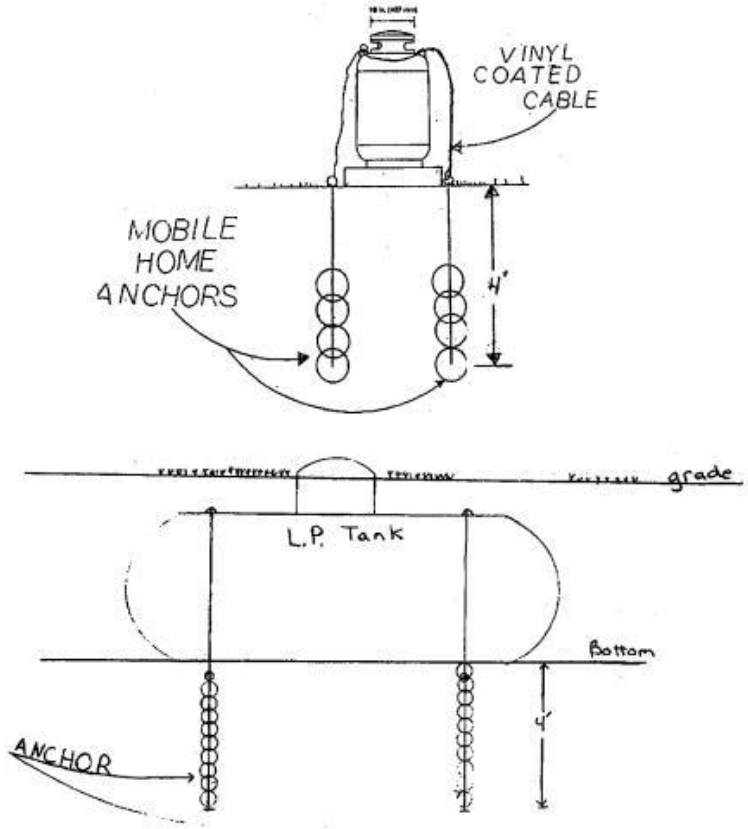
***Limit enclosures*** – Often owners of buildings that are elevated eight feet above grade will enclose the lower area to provide parking, building access or storage. One problem that arises is that this area may later be finished for habitation, greatly increasing the potential for flood damage. Regulations to limit enclosures below the base flood elevation (BFE) discourage finishing these areas, and storing valuable or hazardous items in that area. In coastal V-Zones, this space below BFE should be free of obstructions, limited in size, and/or enclosed only by non-supporting breakaway walls. Additional recommendations include: limit the materials that breakaway enclosures are made of to reduce debris impacts to adjacent structures; and require that non-essential steps beneath elevated structures to be hinged or removable, and elevated during storm events.

***Fuel storage tank protection*** – a) in A-zones – elevate above the design flood elevation and secure; all above ground fuel storage tanks (over 50 pounds) shall be securely anchored to the ground by means of a vinyl-coated metal cable attached to manufactured home screw anchors placed to a level of not less than four feet below grade; b) in V-zones – elevate above the design flood elevation and secured to the dwelling's supporting structure by corrosive-resistant materials in a manner satisfactory to the Building Inspector's reasonable judgment, to insure that fuel storage tank remains securely in place during any severe wind or flood event. Below-ground fuel storage tanks shall be anchored by means of vinyl-coated metal cable attached to manufactured home screw anchors placed to a level of not less than four feet below the lowest elevation of the tank.

An example of the Bethany Beach, Delaware, ordinance regarding the securing of propane tanks is included below:

F. Securing aboveground fuel tanks. Unless elevated above the design flood elevation and secured as provided in Subsection G hereafter, all aboveground fuel storage tanks (over 50 pounds) shall be securely anchored to the ground by means of vinyl-coated metal cable attached to manufactured home screw anchors placed to a level of not less than four feet below grade in the manner shown on the diagram attached hereto. The metal cable shall be corrosive-resistant and of sufficient gauge and strength, and the anchoring assembly completed, so that if the fuel storage tank is detached from its location due to extreme flooding or wind, it shall remain in place and not become a wind- or water-borne missile. This subsection shall be effective as to all aboveground fuel storage tanks installed after the effective date of this subsection (January 18, 2002); all aboveground fuel storage tanks already in place as of the effective date of this subsection shall be brought into compliance with this subsection not later than January 18, 2003. [Added 1-18-2002 by Ord. No. 361]

G. Securing fuel tanks in the special flood hazard area (V Zone). In the special flood hazard area (V Zone), aboveground fuel storage tanks shall be elevated above the design flood elevation and secured to the dwelling's supporting structure by corrosive-resistant materials in a manner satisfactory to the Building Inspector's reasonable judgment, to insure that such fuel storage tank shall remain securely in place during any severe wind or flooding event. Below-ground fuel storage tanks shall be anchored by means of vinyl-coated metal cable attached to manufactured home screw anchors placed to a level of not less than four feet below the lowest elevation of the tank. The metal cable shall be corrosive-resistant and of sufficient gauge and strength, and the anchoring assembly completed, so that if the fuel storage tank is unearthed due to extreme flooding or wind, it shall remain in place and not become a wind- or water-borne missile. This subsection shall be effective as to all fuel storage tanks installed in the special flood area after the effective date of this subsection (January 18, 2002); all fuel storage tanks already in place in the special flood area as of the effective date of this subsection shall be brought into compliance with this subsection not later than January 18, 2003. **[Added 1-18-2002 by Ord. No. 361]**



**Additional examples of higher development standards and regulations**:

***Special Flood Hazard Zoning Ordinance*** – restricts the type of development and the manner in which it is constructed. In any area affected by special flood hazards, the zoning ordinance specifies how new or substantially improved buildings shall be constructed to be flood-resistant.

***Waterway Ordinance*** – Provides a mechanism to assure that canals and waterways are maintained and kept free of debris. This in turn promotes proper drainage during floods. This not only keeps flood losses to a minimum, but reduces soil erosion and sedimentation as well as protects the barrier dunes.

***Flood Damage Protection Ordinance*** – Requires that all new or substantially improved residential construction in special flood hazard areas have the lowest floors no lower than 2 feet above the base flood elevation. All new or substantially improved non-residential construction must have the lowest floor either elevated or flood-proofed 2 feet or more above the base flood elevation. (Basements are not permitted within the flood zone). In addition, the local interpretation of the ordinance requires the bottom of all untreated floor joists, floor insulation, wiring, and mechanical equipment to be above the base flood elevation plus 2 feet of freeboard – a level known as the "design flood elevation."

***Dune Protection Ordinance*** – Protects the dunes from encroachment by development and crossing by pedestrians at other than approved crossing points. The barrier dunes are the single best protection against wind-driven flood waters coming from the ocean during northeasters and hurricanes.

For more information on recommendations for adopting higher regulatory standards and/or the No Adverse Impact program, contact: Delaware DNREC Flood Mitigation Program: 302-739-9921. DNREC's Flood Mitigation Program website includes a link to a Delaware Floodplain Model Ordinance that can be adopted to specific community needs and incorporated into community plans to reduce flood damage.

## Elevation and Siting

In coastal flood zones, elevating structures is an effective way to mitigate potential damage from flooding, wave action and debris. In Delaware communities participating in the NFIP, ordinances and laws require buildings to be sited at an elevation above the Base Flood Elevation (BFE); i.e. the flood elevation that has a 1-percent probability of being equaled or exceeded in any given year. The 100-year storm event is chosen as the standard of protection, and the type of structural elevation required (e.g. open or closed foundation), is determined by the flood hazard potential at the location of the structure. The NFIP designates flood hazards into several broad categories (V-Zone, A-Zone, Coastal A-Zone, and X-Zone).

It should be noted that since the NFIP provides minimum standards, consideration should be given to elevating structures above the Base Flood Elevation to provide an added level of protection.

In all instances, outside utilities (including air conditioning units) should be elevated along with the structure to or above the BFE. Designers and builders should be careful not to elevate the structure too high in regions exposed to exceptionally high winds, as the benefit of reducing the flood hazard may increase the risk associated with other hazards.

The proper siting of buildings and infrastructure is one of the most effective methods of coastal hazard mitigation. Unfortunately, prudent siting has often been overlooked or ignored by property owners, builders and local building/zoning codes. Poorly sited construction exposes structures to increased vulnerability to erosion hazards, flooding, wave attack and wind loads.

The suitability of a coastal development site should be carefully investigated prior to its purchase – otherwise the new owner may be subjected to unwanted constraints in location, design and construction techniques. In addition to conducting an in-depth hazard analysis, the prospective buyer should also investigate the regulatory requirements for the location, including land use regulations, zoning ordinances, setback requirements, floodplain management requirements, building codes, etc. It must be emphasized, however, that compliance with all of the regulatory requirements does not ensure the future safety of a

building or development (FEMA, 2000). Even with proper siting, the vulnerability of a coastal structure may increase over time.

## Coastal/Beach Management Strategies

### Beach Nourishment

The process of adding sand to an eroding beach to restore its width and elevation to specified dimensions is the only beach management tool that directly treats the problem of sand loss on beaches. Used almost exclusively in developed beach areas, nourishment is commonly accomplished by pumping sand onto the breach from an offshore source by suing a dredged. Nourishment may also be accomplished by trucking sand onto the beach.

Beach nourishment does not prevent erosion or stop the movement of sand along a beach. It is actually a strategy that re-sets the erosional clock by adding sediment to the system and re-establishing the buffer of sand between the ocean and structures. Beach nourishment achieves the goal of providing reasonable storm protection to developed areas while providing a recreational beach area as well as biological habitat – most of the amenities the people want their beaches to provide. To be effective over the long term, beach nourishment projects must be periodically maintained by re-nourishment projects.

The design and success of a beach nourishment project depends on many factors including: an evaluation of the causes of erosion and shoreline history of the area; a determination of the level of storm protection that the design beach is expected to provide; calculation of desired beach dimension, including height, width, dune area, and quantity of sand needed for the project; an assessment of environmental impacts of the project; development of benefit/cost analysis, economic analysis, and funding plan for the initial project and maintenance; and establishment of a long term monitoring program to allow a quantitative assessment regarding project performance.

### Shore Protection Structures

The term shoreline hardening refers to construction of all types of structures built to

retain sand or to interfere with waves or currents to reduce their impacts (groins, jetties, breakwaters), or to protect property by reflecting waves and holding back tidal waters (revetments, seawalls, bulkheads).

In the past, installation of hard structures for the purpose of protecting buildings and property had been one of the first actions considered by individual property owners and homeowners association once the threat of storm damage and erosion was perceived. Prior to implementation of regulatory controls, these projects were often implemented without consideration of the effects the structure may have on adjacent properties or the beach itself.

Although installation of hard structures was a common shoreline protection strategy used from the 1920s to the 1970s, they are seldom used now as a sole solution to beach erosion. For the most part, armoring the shore is not considered to be a preferred method of preserving beaches in Delaware.

**Regional Sediment Management**

Survival of structures built along Delaware's barrier beaches depends upon maintenance and management of sediment, especially the beach and dune system. Although storms and sea-level rise are causing the shoreline to move landward, prudent management of beachfront development and wise engineering practices can minimize the adverse effects of these changes to the natural system.

The components of the barrier beach system are all interrelated. Their dimensions, and thus their use for recreation, property protection, and habitat value, are dependent upon the physical forces affecting them. The amount of sand available to the system is limited. Therefore it is important to understand sediment sources, pathways and sinks for regional sediment management purposes. This enables coastal planners and managers to maximize and make the best use of this important resource.

## Natural Resource Restoration

As communities work toward mitigating hazards along the coast, careful consideration should be given to restoring natural features of the coastal environment. Features such as dunes and coastal marshes naturally mitigate coastal erosion and flood hazards.

Dunes provide a buffer between the ocean and buildings and infrastructure along the coast. In addition, dunes store a significant volume of sand that can be released during extreme storm surges and wave events, providing the eroding beach with an additional layer of protection. Although dunes grow and migrate in response to the wind, a properly vegetated dune reduces the amount of sand blown landward of the beach.

Dunes are a unique and valuable coastal resource, providing habitat and protection for a number of species. Dunes are also a component of the natural landscape, adding to the aesthetic beauty and value of the coast. As coastal communities continue work to restore coastal resources lost to development and natural processes, maintenance and establishment of coastal dunes should be considered as a way to enhance the natural environment as well as mitigate the level of flood and wave hazards.

Coastal wetlands provide a buffer between bays, back-barrier lagoons, and coastal uplands. They dissipate wave energy, trap sediments, and via their storage capacity, reduce the velocity and volume of flood waters during storm events. Coastal wetlands are also extremely productive habitats, providing nutrients, shelter and nurseries to the young of many species.

An unintended consequence of increased coastal development has been loss or degradation of coastal wetlands and consequently, a higher susceptibility of bay shore uplands to flood and wave damage. Communities and coastal resource managers should give strong consideration to restoring and conserving wetlands along the coast. Best management practices include planting marsh vegetation, shoreline nourishment and planting, and strategies and/or structures that will minimize wave and erosional impacts to marsh shorelines.

Coastal property owners should consider using native plants in home landscapes. Not only are native plants uniquely adapted to coastal environments, but proper landscaping also acts to reduce flood hazards by decreasing runoff and high velocity flood waters.

## Construction Techniques

A variety of building techniques, design options, and building materials are available to mitigate potential damage from extreme wind, wave and flood forces that occur during coastal storms. Additionally many best management practices have been derived from analysis of structural failures that have occurred during extreme storm events.

FEMA's Coastal Construction Manual provides design details for those wishing to minimize hazards to buildings. For example, when designing a home, architects and engineers should ensure that all potential wind and water loads have a direct path from each structural member to the foundation. Gable roofs and porch overhangs should be properly designed to resist uplift forces from strong winds. Proper nailing patterns should be applied to sheathing and framing to minimize the chance of uplift.

Additionally, there are many inexpensive building materials and methods that can be used to retrofit existing buildings, including window shutters and hurricane straps placed on roof framing. For flood and wave protection, enclosed areas under the base flood elevation should be constructed with breakaway walls, proper connections between pilings and floor framing should be used, and proper cross-bracing should be installed. All connectors, fixtures and coatings should be constructed of anticorrosive materials and be regularly inspected and maintained over the life of the structure.

Homeowners should be aware of potential risks to external utilities, tanks and furniture. For example, propane, oil, gas and water tanks can be lifted and transported by floodwaters. They should be anchored to concrete pads or held in place with anchoring straps and earth anchors. Outside utilities, including air-conditioning units, heat pumps and electrical boxes should be elevated and secured above base flood elevation. Carports or storage areas under buildings should not have poured concrete pads or grade beams attached to support pilings. Also, outdoor furniture or anything that can be lifted by wind or water should be properly stored and secured prior to a storm to minimize the potential of these items becoming wind or water borne debris.

## Community Maintenance and Preparedness

The proper construction and maintenance of community infrastructure and private property is important to mitigating potential storm damage. There are many ways communities and individuals can plan to minimize risks and minimize damage from coastal hazard events.

**Best Practices Examples**

*Community/individual maintenance initiatives*

- Communities should be diligent in maintaining clear storm drains. In addition, to prevent minor flooding from entering the streets through the storm drain system, flap valves should be placed on the end of all outfall pipes.

- Utility companies serving the community should take preventive measures to reduce the potential for power and service interruption by maintaining utility easements, removing tree limbs around power lines and properly elevating sub-stations, transformers and pump houses in the coastal zone.

- Large signs, old trees and any other lightweight structures upwind of critical infrastructure and buildings should be removed or strengthened to eliminate the potential for damage from wind-borne debris.

- All objects that can be moved by high winds and flood waters should be placed in storage or anchored to ensure they don't become moving debris.

*Community planning and regulatory efforts to minimize hazard risks*

- If possible, evacuation routes should be sited and maintained along roads above the base flood elevation or along the highest roads in the community.

- Communities with property in the floodplain should participate in the National Flood Insurance Program.

- Structures in the floodplain should, at a minimum, be elevated above the base flood elevation and consideration should be given to elevating the structure an additional

amount to provide freeboard for extreme flood conditions.

- If possible, structures should be sited to account for future variations in shoreline position and long-term erosion trends.
- Property owners should abide by all regulations and codes governing the siting and construction of structures in the coastal zone. Variances that increase the vulnerability of private property should not be sought or granted.
- Residents, property owners and communities should strive to be knowledgeable and aware of the dynamic nature of the coastal environment and the associated hazards.

*Resource management*

- Elevated walkways should be constructed across dunes to prevent breaks in the dune line. If unavoidable, breaks in the dune line should be oriented perpendicular to predominant storm winds.
- Dunes should be properly vegetated and maintained to ensure a continuous unbroken line of protection. Fencing should be installed to discourage people from walking across dunes.
- A coastal management plan should be developed to reduce the probability of long-term degradation of coastal protection levels. All coastal management plans should include an understanding of regional coastal processes and limit the impacts to the larger coastal system. For example, beach nourishment project design should give consideration to restoration of the natural environment, including vegetation and geological features.

# Section 5: Technical Assistance and Training Opportunities

## Contents



## Technical Assistance – Agency Resources

The following agencies are the leaders in providing technical assistance on coastal hazards, floodplain management, and mitigation in the State of Delaware:

Delaware Department of Natural Resources and Environmental Control (DNREC)

Delaware Emergency Management Agency (DEMA)

Federal Emergency Management Agency (FEMA)

Additional links and details regarding programs and assistance provided by various state and Federal agencies, along with local government contact information, are listed below.

### State Agencies

The State of Delaware has enacted a number of legislative policies that establish standards and guidelines for activities in floodplains and the coastal zone. Some of the state agencies that administer policies and regulations related to coastal hazard and floodplain management issues are listed below.

Delaware Department of Natural Resources and Environmental Control (DNREC) – The mission of the Delaware Department of Natural Resources and Environmental Control is to protect and manage the state's vital natural resources, protect public health and safety, provide quality outdoor recreation and to serve and educate the citizens of the First State about the wise use, conservation and enhancement of Delaware's Environment.

Division of Soil and Water Conservation - The Division of Soil and Water Conservation is mandated to preserve and protect the state's soil, water and coastal resources. They manage Delaware's shoreline, coastal zone and navigable waterways by regulating coastal and urban land use and construction activities, and by promoting wise agricultural and urban land management practices. The Division also promotes wise water management practices to preserve agricultural interests, protect urban communities and provide for public safety.

Shoreline and Waterway Management Section - The mission of the Shoreline and Waterway Management Section is to maintain and improve Delaware's shoreline and waterways (bays and canals). Overall, the section manages the shoreline through regulation of coastal construction activities and implementation of dune and beach management practices. The program works to protect and enhance eroded beaches to enable continued recreational use of this precious resource. Additionally, the section works to improve the state's ability to endure severe coastal storms with minimal damage to public and private property and infrastructure.

Flood Mitigation Program - Flooding poses a risk to the safety of all communities in Delaware. DNREC's Flood Mitigation Program provides technical assistance to communities with identification of their flooding risks.

Delaware Coastal Programs Section - The mission of the Delaware Coastal Programs Section is to preserve, protect, develop and enhance the resources of our state's coastal zone through effective administration of the Delaware Coastal Management Program and the Delaware National Estuarine Research Reserve.

Delaware Sediment and Stormwater Program - Delaware's Sediment and Stormwater Management program employs a comprehensive approach to sediment control (both during and after construction) and stormwater management that includes monitoring of stormwater quantity and water quality control.

Drainage and Tax Ditches - This program provides technical assistance to landowners, tax ditch organizations, Conservation Districts, and federal, state and local agencies in the areas of drainage, water management, and restoration. It is responsible for assisting

Tax Ditch Organizations with maintaining the state's 2,000 miles of tax ditches that providing drainage and flood control in both agricultural and urban areas.

Division of Water Resources – The Division of Water Resources manages and protects water resources through various regulatory programs by providing technical assistance, laboratory services, and educational services; performing applied research; and helping finance water pollution control measures.

Wetlands and Subaqueous Lands Section -The Wetlands and Subaqueous Lands Section provides permitting services for activities in Delaware's wetlands, bays, rivers, streams, lakes, ponds and other waterways that might require a permit pursuant to Delaware law. These activities include marina construction and operation, as well as the construction of docks and piers, shoreline stabilization projects, dredging, filling, bridge or culvert construction, utility crossings of streams, and a myriad of other projects that could affect Delaware's waters and wetlands.

Delaware Emergency Management Agency (DEMA) - The Delaware Emergency Management Agency is the lead state agency for coordination of comprehensive emergency preparedness, training, response, recovery and mitigation services in order to save lives, protect Delaware's economic base and reduce the impact of emergencies. DEMA is a division within the Department of Safety and Homeland Security and is authorized by Delaware Code, Title 20, Chapter 31§3101-3130.

**Local Governments** (Comprehensive planning, regulations, permitting and inspection)

To obtain information on local regulations/programs that affect activities in floodplains and along the shoreline, contact your local County Planning and Zoning Department or town office:

New Castle County

Kent County

Sussex County

City/County Emergency Management Agencies

New Castle County Office of Emergency Management

Kent County Division of Emergency Planning and Operations

Sussex County Emergency Operations Center

City of Wilmington Emergency Management Office

**Federal Agencies**

Federal Emergency Management Agency (FEMA)

National Oceanic and Atmospheric Administration (NOAA)

NOAA's Coastal Services Center (CSC)

U.S. Army Corps of Engineers (USACE)

USACE Philadelphia District

## Technical Assistance – General Topic Resources

### Shoreline Management and Storm Damage Reduction

DNREC - Shoreline and Waterway Management

The Division of Soil & Water Conservation's Shoreline and Waterway Management Section regulates coastal construction along with dune and beach protection and conservation practices. The section also works to protect and enhance eroded beaches, bolstering the state's capability for enduring coastal storms.

Additional information on shoreline management, construction regulations, and storm damage reduction is available through the Coastal Construction and Beach Preservation website. (http://www.swc.dnrec.delaware.gov/Pages/CoastalConsBeachPres.aspx)

### Flood Hazards

Several agencies in Delaware, including DNREC, FEMA and DEMA, provide technical assistance to communities and property owners on topics related to mitigation of coastal flood hazards in Delaware.

Examples of technical assistance include:

- Determining potential flood risk through flood plain mapping;
- Determining mitigation options, including costs and benefits, for public or private property and infrastructure;
- Understanding regulatory requirements when building in or near a floodplain.

The following are the lead agencies that provide technical assistance on coastal flooding and mitigation in the State of Delaware:

Delaware DNREC Flood Mitigation Program (http://www.swc.dnrec.delaware.gov/Drainage/Pages/Flooding.aspx)

Delaware Emergency Management Agency (http://dema.delaware.gov/)

Federal Emergency Management Agency (http://www.fema.gov/)

**Flood Hazards and Flood Hazard Studies**

Delaware is prone to several types of flooding: non-tidal flooding (river and streams), tidal flooding (tides and storm surges), and coastal high hazard flooding (additional wave action to tidal flooding). The State has a long history of flood hazard mitigation, which is coordinated by Delaware DNREC's Flood Mitigation Program. DNREC's Flood Mitigation Program is responsible for managing and distributing information related to floodplain mapping and studies, Floodplain Management GIS and the Comprehensive Flood Mitigation Grant Program (CFMGP). For more information, contact the

Delaware DNREC's Flood Program
(http://www.swc.dnrec.delaware.gov/Drainage/Pages/Flooding.aspx)

Delaware DNREC's Flood Mitigation Program Information:
http://www.swc.dnrec.delaware.gov/Shoreline/Pages/FloodMitigation.aspx

**Floodplain Maps and Information**

The official sources of floodplain information are the Flood Insurance Rate Maps (FIRMs) published by FEMA. Flood maps are available on-line via FEMA's Map Service Center.

Flooding poses a risk to the safety of all communities in Delaware. DNREC's Flood Mitigation Program provides technical assistance to communities with identification of their flooding risks.

Delaware DNREC's Environmental Navigator mapping program provides web-based statewide flood hazards maps (http://www.nav.dnrec.delaware.gov/dnreceis/).

Additionally, all three counties in Delaware make floodplain information available on their websites which are often more comprehensive than the FIRMs.

Links to the Delaware county web sites:

Kent County

New Castle County

Sussex County

Additional information on flood or other hazard mapping is available through FEMA's Flood Hazard Mapping site (https://hazards.fema.gov/femaportal/wps/portal)

**Flood Insurance**

The National Flood Insurance Program (NFIP) is designed to minimize damage and reduce the costs of repairing damage to buildings and their contents caused by floods. The program establishes building standards and elevation requirements for all structures built in flood zone areas as designated by FEMA's Flood Insurance Rate Maps (FIRMs).

FEMA's Mitigation Division (http://www.fema.gov/about/divisions/mitigation.shtm) manages the NFIP.

The three components of the NFIP include:

Flood Insurance (http://www.fema.gov/business/nfip/)

Floodplain Management (http://www.fema.gov/plan/prevent/floodplain/index.shtm)

Flood Hazard Mapping (http://www.fema.gov/plan/prevent/fhm/)

**Community Participation in the NFIP**

Community participation in the NFIP is voluntary. However, communities that adopt and enforce floodplain management ordinances to reduce future flood damage are provided federally backed flood insurance that is available to homeowners, renters, and business owners in participating communities.

Delaware DNREC is the state agency that assists in implementation of FEMA's NFIP Community Rating System (CRS) (http://training.fema.gov/EMIWeb/CRS/).

The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed minimum NFIP requirements. One benefit of participating in the CRS is that individuals in the community can save on flood insurance premiums.

**Hazard Mitigation Planning**

The Delaware Emergency Management Agency (DEMA) provides technical assistance with the hazard mitigation planning process.

Financial assistance may be available to local governments through DEMA for implementation of mitigation activities identified in local multi-hazard mitigation plans.

Delaware DNREC's flood mitigation program provides technical assistance to reduce and minimize risks to safety and property.

Delaware DNREC's flood mitigation program also provides grants to local governments for flood damage reduction projects.

Delaware DNREC's flood mitigation program also provides grants to local governments for flood damage reduction projects.

FEMA – Understanding Your Risks provides guidance on completing a local risk assessment and provides additional on-line resources.

FEMA's Multi-Hazard Mitigation Planning provides an overview of mitigation planning strategies and activities.

FEMA's Understanding Your Risks: Identifying Hazards and Estimating Losses is a mitigation planning how-to guide.

**Mitigation**

FEMA Mitigation Grant Programs provides an overview of the Pre-Disaster Mitigation (PDM) Program with links to other mitigation resources.

DEMA coordinates several mitigation assistance programs related to minimizing and preventing future damage:

Hazard Mitigation Grant Program (HMGP). The HMGP provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. (Link to .pdf HMGP brochure)

The program's primary objectives are to (1) significantly reduce or permanently eliminate future risk to lives and property from natural hazards; (2) provide funds to implement priority projects identified in hazard mitigation plans; and (3) enable implementation of mitigation measures during disaster recovery.

For more information on the HMGP contact DEMA's State Hazard Mitigation Officer: (302) 659-3362.

DEMA and DNREC coordinate several mitigation assistance programs related to minimizing and preventing future damage:

Flood Mitigation Assistance (FMA). FEMA provides FMA funds to assist States and communities implement measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program. Three types of FMA program grants are available: planning, project, and technical assistance grants.

For more information on the FMA program contact DNREC's Flood Mitigation Program Coordinator: (302) 739-9921.

Pre-Disaster Mitigation (PDM) program. This program is intended to provide funding for mitigation measures before a disaster occurs by providing technical and financial assistance to States and local governments. Examples of eligible pre-disaster hazard mitigation activities are those that will complement a comprehensive mitigation plan, and reduce injuries, loss of life, and damage and destruction of property.

For more information on the PDM program contact DEMA's State Hazard Mitigation Officer: (302) 659-2213.

Repetitive Flood Claims (RFC) program. FEMA provides RFC funds to assist States and communities reduce flood damages to insured properties that have had one or more claims to the National Flood Insurance Program (NFIP).

Examples of eligible mitigation activities include: (1) acquisition of properties, and either demolition or relocation of flood-prone structures, where the property is deed restricted for open space uses in perpetuity; (2) elevations; (3) dry floodproofing of non-residential structures; and (4) minor localized flood control projects (funding limited to $1M per project).

For more information on the RFC program contact DEMA's State Hazard Mitigation Officer: (302) 659-2213.

Severe Repetitive Loss (SRL) program. This grant program provides funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP). The program applies only to eligible residential structures, and is intended to reduce or eliminate claims under the NFIP through project activities.

For more information on the SRL program contact DNREC's Flood Mitigation Program Coordinator: (302) 739-9921.

**State Multi-Hazard Vulnerability Assessment**

State hazard mapping and mitigation is coordinated primarily by the Delaware Emergency Management Agency (DEMA). DEMA implements federal mandates of the Federal Emergency Management Agency (FEMA) and facilitates State regulatory and mitigation programs. DEMA Mitigation Program administers the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMAP), and the Pre-Disaster Mitigation Program (PDM) and is the primary coordinating agency for FEMA disaster response, recovery, and relief funding and is the first responder to any disaster in the State.

DEMA also prepares the State Multi-Hazard Mitigation Plan and supports and oversees the completion of local mitigation plans required by FEMA under the Disaster Mitigation Act of 2000.

For more information on the State plan, contact the State Hazard Mitigation Officer at:

Delaware Emergency Management Agency
State Emergency Operations Center
165 Brick Store Landing Road
Smyrna, DE 19977
Phone: (302) 659-3362
Web Page: http://dema.delaware.gov

**Additional Online Technical Resources**

FEMA provides an Online Library that assists with locating reference materials, publications, maps, photographs, audio clips and video clips.

The National Flood Insurance Program www.floodsmart.gov/floodsmart/
This site offers information about the National Flood Insurance Program, your risk to flood, flood insurance policies, preparation and recovery, how to file a claim and more.

Community Rating System www.fema.gov/business/nfip/crs.shtm

The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements.

FEMA Disaster Information www.fema.gov/hazard/index.shtm

This site offers information about different disasters that could affect your area.

FEMA – Are You Ready guide provides links to various hazards and information about dealing with a variety of natural (and other) hazards.

Association of State Floodplain Managers (ASFPM)

Coastal No Adverse Impact Handbook www.floods.org/NoAdverseImpact/coastal.asp

This handbook explains the No Adverse Impact policy, showing specifically how it applies to nation's coastlines, and gives examples of ways to mitigate coastal risk without unintentionally causing negative consequences.

No Adverse Impact Toolkit www.floods.org/NoAdverseImpact/NAI_Toolkit_2003.pdf

No Adverse Impact (NAI) is a forward-thinking, fair, and legally defensible approach to coastal land management. It was first articulated by the Association of State Floodplain Managers. In its broadest sense, it is a set of "do no harm" principles that communities can use when planning, designing, and evaluating public and private projects. By following the NAI approach, communities can protect people, property, and municipal budgets.

NOAA Coastal Services Center (CSC)

Habitat Priority Planner www.csc.noaa.gov/digitalcoast/tools/hpp.html

An ArcGIS toolbar that can aid in resource prioritization. The tool allows users to classify habitats according to their goals, pre-packages ecological metrics and incorporates site-specific datasets, and allows for stakeholder interaction to develop prioritization criteria.

Applying Social Science to Coastal Management http://maps.csc.noaa.gov/socialscience_2/

This site is designed to help coastal managers and staff members learn about different applications of social science in coastal management. Specifically, this site provides links to social science components of ongoing and completed projects at or through the NOAA Coastal Services Center. The site contains a section of tools, methods, and training opportunities as well as general information resources.

Delaware DataMIL

The Delaware Geological Survey (DGS) Delaware Data Mapping and Integration Laboratory (DataMIL) team has recently modified and improved the DataMIL web site in several ways to ensure that the Delaware GIS community and the citizens of Delaware can take full advantage of Delaware's Spatial Data Framework Layers (Aerial Imagery, Boundaries, County Parcels, Elevation, Geographic Names, Surface Cover, Transportation, and Water Features).

These important basemap layers are used regularly by state, county, and local agencies as well as by planners, environmental and engineering consultants, developers, realtors, and the public. DataMIL has served Delaware's framework layers since its release in 2002, and the data are part of the National Spatial Data Infrastructure (NSDI). Instructions for using the website can be found under the "Need Help?" menu in the upper right side of the page banner.

## Training Opportunities

A community can improve its ability to prepare for and respond to storm events by taking advantage of available training for municipal officials. There are many training opportunities available on topics related to coastal hazards, community resiliency, hazard mitigation and preparedness. Training courses may be offered in-state (on-site), at training centers, and on-line.

The following list of courses is not inclusive, but provides an overview of many of the agencies and programs offering training.

### Delaware Training Courses - DEMA

The Delaware Emergency Management Agency Training Program, under an All Hazards umbrella, sponsors a mix of training courses, seminars, workshops, and conferences that are designed to cover Mitigation, Preparedness, Response and Recovery.

The DEMA training program provides coordination and support of course delivery to various governmental agencies involved in emergency functions related to natural hazards, technological hazards, and homeland security. Training is available to approved personnel through the Emergency Management Institute, US Fire Academy, and the Office of Domestic Preparedness. In addition, on-line independent study courses are available to members of the public through the Emergency Management Institute.

DEMA's Professional Development Series.

The Professional Development Series includes seven Emergency Management Institute independent study courses that provide a well-rounded set of fundamentals for those in the emergency management profession. Many students build on this foundation to develop their careers.

To enroll in the on-line courses, go to http://www.training.fema.gov/emiweb/IS/. These courses are available to the public at no cost. The courses are self-paced independent studies

and each takes between 8 and 15 hours to complete. When a student has successfully completed all courses, the Independent Study Program Office (ISPO) automatically sends a Certificate of Completion directly to the student.

**Delaware Training Courses - DNREC**

**Managing Floodplain Development**

Delaware DNREC's Flood Mitigation Program hosts annual training courses for surveyors, engineers, insurance agents and local permitting officials.

Examples of training course topics include: *Using Flood Studies and Flood Maps; Elevation Certificates; Regulating Development in Flood-Prone Areas; National Flood Insurance Program Issues for Insurance Agents; Community Responsibilities and the National Flood Insurance Program; Advanced Training – National Flood Insurance Program*.

Delaware DNREC's Flood Mitigation Program also supports local flood managers in becoming Certified Floodplain Managers (CFM), and proctor CFM exams on an annual basis (http://www.floods.org/certification/certprog.asp).

**Training Programs for Community Officials and Decision Makers**

Delaware DNREC hosts training courses for community officials and decision-makers through the Delaware Coastal Program and the Delaware National Estuarine Research Reserve.

The Coastal Training Program is designed to provide skill-building opportunities and up-to-date scientific information to individuals who are making decisions that affect Delaware's coastal resources. This includes partnering with other agencies and organizations to provide data and information relevant to the current coastal issues.

These decision makers may include local government officials, state legislators, home owners' associations, and many more. For more information about the Coastal Training Program and upcoming workshops, visit their website: http://www.swc.dnrec.delaware.gov/coastal/DNERR/Pages/DNERRCoastalDecisionMakerWork

shops.aspx

**Federal Emergency Management Agency (FEMA)**

FEMA/NFIP website. This website provides information for homeowners, renters, communities, insurance professionals, and state and local officials. The site provides links to computer based training, classroom training and "Ask the Expert" training resources. Visit www.fema.gov/business/nfip. For more information contact a NFIP representative at (856) 489-4003.

Community Hurricane Preparedness. This EMI computer-based course is designed to provide decision-makers with basic information on hurricanes, associated hazards, NWS hurricane forecasting, and community preparation tools and techniques for emergency managers. For more information, visit EMI's website: http://training.fema.gov/EMIWeb/

Emergency Management Institute (EMI). FEMA's Emergency Management Institute offers training for local officials, ranging from free online classes to multi-day classes.
EMI offers several useful floodplain management and hurricane planning courses on-line and at their training facility in Emmitsburg, MD.

Examples of available on-line courses include: *Disaster Basics; A Citizen's Guide to Disaster Assistance; Introduction to Residential Coastal Construction; Introduction to Hazard Mitigation; and Protecting Your Home or Small Business from Disaster.*

Examples of on-site courses in Emmitsburg, MD, include: *Advanced Floodplain Management Concepts; National Flood Insurance Program/Community Rating System (NFIP/CRS); Residential Coastal Construction; Hurricane Planning; HURREVAC/SLOSH Training; Hurricane: Preparedness and Response; and Hurricane: Recovery and Mitigation.*

For more information on courses and to download an admission application: http://training.fema.gov/EMIWeb/. Note that all EMI admission applications must be forwarded and approved by DEMA's state training officer.

**National Oceanic and Atmospheric Administration (NOAA)**

NOAA's Coastal Services Center

NOAA's Coastal Services Center offers several training programs related to coastal hazard management, and community planning and development. Examples are included below. CSC's training center website includes more detailed information.

GIS Tools for Strategic Conservation Planning www.csc.noaa.gov/training/gis_tools.html

This four-day course, co-instructed by staff from the NOAA Coastal Services Center and The Conservation Fund, teaches students how to apply geographic information system (GIS) tools, methodologies, and analyses to strategic conservation planning using a "green infrastructure" approach. Students will use data sets from coastal areas to develop conservation priorities and strategies to address a realistic conservation scenario.

Coastal Inundation Mapping www.csc.noaa.gov/training/coastalin.html

This two-day course, targeted at certified floodplain managers, National Weather Service personnel, and county, state, and municipal officials, teaches participants about coastal inundation issues and spatial techniques for mapping inundation.

Coastal Community Planning and Development www.csc.noaa.gov/training/ccpd.html

Many coastal resource managers involved in planning and development have a general idea of what better coastal growth decision making entails, but they desire a deeper understanding to implement the principles associated with alternative coastal development. This two-day course will actively engage participants in learning about alternatives to how and where growth will occur in their communities. It will provide them with the background, examples, and strategies to support alternative development efforts in coastal communities.

# Section 6: Links to Educational Resources and Materials

## Contents



## Agency/Organization Links and Resources

***State, local and regional resources***

Delaware Department of Natural Resources and Environmental Control (DNREC)

DNREC Shoreline and Waterway Management Section

DNREC Flood Mitigation Program

DNREC Environmental Navigator (on-line mapping program)

DNREC Delaware Coastal Management Program

Delaware Emergency Management Agency

Delaware Sea Grant

UD Center for Applied Coastal Research
Surf And Nearshore Dynamics Camera (SANDCAM) at Rehoboth Beach

DEOS- DE Environmental Observing System
Real-time weather information available on-line – www.deos.udel.edu/

National Weather Service Office, Mt. Holly, New Jersey

USACE Nearshore Wave Gauge – Bethany Beach, DE

Breakwater Harbor, DE - NOAA Tide Predictions (2009)

Rehoboth Beach, DE (outer coast) - NOAA Tide Predictions (2009)

***Federal and national organizations and resources***

Federal Emergency Management Agency (FEMA)

FEMA provides an Online Library that assists with locating reference materials, publications, maps, photographs, audio clips and video clips.

See FEMA's Plan ahead page (http://www.fema.gov/plan/index.shtm).

FloodSmart.gov explains the National Flood Insurance Program.

FEMA has created both a detailed (173-page) guide and a pamphlet outlining various methods for protecting homes from floods. The full-length guide includes sources for additional information and potential sources of funding. Both versions of *A Homeowner's Guide to Retrofitting: Six Ways to Protect Your House from Flooding* are available on the FEMA website.

*Home Builder's Guide to Coastal Construction* includes 31 concise fact sheets with very useful information.

*The Coastal Construction Manual* provides a wealth of information. Possible starting points include Section 2.2.1 (an overview of natural hazards in coastal New England) and Section 2.3 (an overview of lessons learned from past storms). To obtain a free copy of the *Coastal Construction Manual* (in print or on a CD), contact the FEMA Publications Distribution Facility at (800) 480-2520.

FEMA's Online Flood Hazard Mapping program.

FEMA's NFIP Technical Bulletins provide information on many construction requirements for various activities in the floodplain.

FEMA's Flood Map Service Center includes information on viewing and obtaining Flood Insurance Rate Maps online.

Order FEMA Flood Maps online.

NOAA Coastal Services Center

NOAA National Sea Grant

NOAA NWS National Hurricane Center

Association of State Floodplain Managers (ASFPM)
ASFPM is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning and recovery. ASFPM has become a respected voice in floodplain management practice and policy in the United States because it represents the flood hazard specialists of local, state and federal government, the research community, the insurance industry, and the fields of engineering, hydrologic forecasting, emergency response, water resources, and others.

ASFPM's expansive *Coastal No Adverse Impact Handbook* contains a great deal of useful information

*Summary Report on Building Performance: 2004 Hurricane Season* (PDF, 938KB). Association of State Floodplain Managers (ASFPM)

StormSmart Coasts www.mass.gov/czm/stormsmart/index.htm
The StormSmart Coasts program is designed to help people working in coastal communities address the challenges arising from storms, floods, sea level rise, and climate change, and provides a menu of tools for successful coastal floodplain management.

Institute for Business and Home Safety (IBHS)
The Institute for Business Home Safety is an organization of insurers working to reduce the social and economic effects of natural disasters and other property losses by conducting research and advocating improved construction, maintenance, and preparation practices. Review especially useful information on the IBHS Fortified for Safer Living and Open for Business programs and planning tools.

The Whole Building Design www.wbdg.org/
The goal of 'Whole Building' Design is to create a successful high-performance building. To achieve that goal, we must apply the integrated design approach and the integrated team approach to the project during the planning and programming phases.

Federal Alliance for Safe Homes (FLASH) www.flash.org/
FLASH, Inc. is a non-profit, 501(c)3 organization dedicated to promoting disaster safety and property loss mitigation.

American Planning Association (APA) www.planning.org/
APA provides leadership in the development of vital communities. We measure our success by the successes of our members and the communities they serve.

Extension Disaster Education Network (EDEN) www.eden.lsu.edu
The Extension Disaster Education Network is a collaborative multi-state effort by Extension Services across the country to improve the delivery of services to citizens affected by disasters.

## Floodplain Management and NFIP Resources

Delaware Department of Natural Resources and Environmental Control (DNREC): http://www.dnrec.delaware.gov/Pages/default.aspx
The State of Delaware has enacted a number of legislative policies that establish standards and guidelines for activities in floodplains and the coastal zone. Some of the state agencies that administer policies and regulations related to coastal hazard and floodplain management issues are listed below.

Delaware DNREC Flood Mitigation Program:
http://www.swc.dnrec.delaware.gov/Drainage/Pages/Flooding.aspx
Flooding poses a risk to the safety of all communities in Delaware. DNREC's Flood Mitigation Program provides technical assistance to communities with identification of their flooding risks. Additional information on Delaware DNREC's Flood Mitigation program:
http://www.swc.dnrec.delaware.gov/Shoreline/Pages/FloodMitigation.aspx

Delaware DNREC Environmental Navigator mapping program provides web-based statewide flood hazards maps: http://www.nav.dnrec.delaware.gov/dnreceis/.

Delaware DNREC Division of Soil and Water Conservation:
http://www.swc.dnrec.delaware.gov/Pages/default.aspx. The Division of Soil and Water Conservation is mandated to preserve and protect the state's soil, water and coastal resources. They manage Delaware's shoreline, coastal zone and navigable waterways by regulating coastal and urban land use and construction activities, and by promoting wise agricultural and urban land management practices. The Division also promotes wise water management practices to preserve agricultural interests, protect urban communities and provide for public safety.

FEMA (http://www.fema.gov/) has a wide library of reference materials on line available for downloading as well as hardcopy publications. These provide general background, regulatory explanations, technical guidance, and programs for various aspects of floodplain management.

Many FEMA technical publications are available for distribution by calling 1-800-480-2520 or FEMA's Information Resource Library at http://www.fema.gov/library/index.jsp

FEMA also has a program to provide Key Contacts in the Regional Offices, linked to this same web page. To speak with a map specialist toll-free, call 1-877-336-2627 (FEMAMAP).

FEMA's National Flood Insurance Program (NFIP) website:
http://www.fema.gov/about/programs/nfip/index.shtm

FEMA NFIP Flood Insurance Information: http://www.fema.gov/business/nfip/index.shtm

FEMA NFIP Flood Insurance Library: http://www.fema.gov/business/nfip/library.shtm

FEMA NFIP Publications: http://www.fema.gov/business/nfip/libfacts.shtm

FEMA NFIP Floodplain Management:
http://www.fema.gov/plan/prevent/floodplain/index.shtm

FEMA NFIP Flood Hazard Mapping: http://www.fema.gov/plan/prevent/fhm/index.shtm

Floodsmart Program: http://www.floodsmart.gov/floodsmart/pages/index.jsp

FEMA's Map Assistance Center
(FMAC):http://www.fema.gov/plan/prevent/fhm/fmc_main.shtm

FEMA's Map Service Center:
http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1

FEMA's Map Service Center National Flood Hazard Layer (NFHL) Database link to download DFIRM data - link to Map Service Center (www.msc.fema.gov) and then click on "Order NFHL GIS datasets by state on DVD":
http://www.msc.fema.gov/webapp/wcs/stores/servlet/CategoryDisplay?catalogId=10001&storeId=10001&categoryId=12011&langId=-1&type=12

*Answers to Questions about the National Flood Insurance Program*, Federal Emergency Management Agency. Available for downloading from FEMA's website at
http://www.fema.gov/business/nfip/qanda.shtm

*The Zone-A Manual: Managing Floodplain Development in Approximate Zone A Areas*. Includes the computer program QUICK-2. Federal Emergency Management Agency, FEMA 265, 1995. Available for downloading from FEMA's website at
http://www.fema.gov/plan/prevent/fhm/dl_zonea.shtm

Those who use GIS to assess risk and determine public policy related to risks should be familiar with the multi-hazard assessment software provided by FEMA. FEMA 433- Using HAZUS-MH for Risk Assessment: http://www.fema.gov/plan/prevent/rms/rmsp433.shtm

FEMA offers a number of interactive tutorials on its Flood Hazard Mapping website. Topics include the basics of the NFIP and flood map interpretation; use of GIS in creating digital FIRMs (DFIRMs); processes to amend and revise maps; use of software distributed by FEMA to estimate flood elevations, peak discharges, and develop flood profiles; coastal theory and mapping; reading a Flood Insurance Study. FEMA also offers hydrologic modeling software from this site.
http://www.fema.gov/plan/prevent/fhm/ot_main.shtm

FEMA has posted guidance documents for Cooperating Technical Partners (CTP), including many surveying and mapping aspects:
http://www.fema.gov/plan/prevent/fhm/ctp_main.shtm

FEMA provides a central location for surveyors and engineers to find links to the most frequently needed information, whether forms, legal documents, training, maps and studies, or contact information: http://www.fema.gov/plan/prevent/fhm/en_main.shtm

Other useful technical guidance is available from the Association of State Flood Plain Managers (ASFPM) website: http://www.floods.org

*Code of Federal Regulations: Title 44 - Emergency Management and Assistance. Chapter 1 Federal Emergency Management Agency*. Available for downloading from FEMA's website at: http://www.fema.gov/business/nfip/laws1.shtm or the Government Printing Office website at http://www.gpoaccess.gov/cfr/index.html

*Floodplain Management Bulletin: Elevation Certificate* (FEMA 467-1, May 2004)
http://www.fema.gov/pdf/fima/fema467-6-10-04.pdf

FEMA has posted an on-line tutorial for the LOMA/LOMR-F application forms:
http://www.fema.gov/plan/prevent/fhm/ot_lmreq.shtm

*Guidelines and Specifications for Flood Hazard Mapping Partners*. Available for downloading from FEMA's website http://www.fema.gov/plan/prevent/fhm/gs_main.shtm (information for Study Contractors available at http://www.fema.gov/plan/prevent/fhm/dl_scg.shtm)

*Mandatory Purchase of Flood Insurance Guidelines*. Federal Emergency Management Agency, September 2007. Available for downloading from FEMA's website at
http://www.fema.gov/library/viewRecord.do?id=2954

*How to Read a Flood Insurance Rate Map Tutorial.* FEMA Flood Map Training Course available for downloading from FEMA's website at
http://www.fema.gov/library/viewRecord.do?id=2324

*User's Guide to Technical Bulletins*, Federal Emergency Management Agency (FIA-TB-01). Available for downloading from FEMA's website at
http://www.fema.gov/library/viewRecord.do?id=1484

*Technical Bulletin 1 – Openings in Foundation Walls and Walls of Enclosures (2008)*. Available for downloading from FEMA's website at
http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 2 – Flood Damage-Resistant Materials Requirements (2008)*. Available for downloading from FEMA's website at

http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 3-93 Non-Residential Floodproofing -- Requirements and Certification* (FIA-TB-3). Available for downloading from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 4-93 Elevator Installation* (FIA-TB-4). Available for downloading from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 5 – Free-of-Obstruction Requirements (2008)*. Available for downloading from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 6-93 Below-Grade Parking Requirements* (FIA-TB-6). Available for downloading from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 7-93 Wet Floodproofing Requirements* (FIA-TB-7). Available for downloading from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 8-96 Corrosion Protection for Metal Connectors in Coastal Areas* (FIA-TB-8). Available for downloading from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 9-99 Design and Construction Guidance for Breakaway Walls Below Elevated Coastal Buildings* (2008). Available for downloading from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 10-01 Ensuring that Structures Built on Fill In or Near Special Flood Hazard Areas are Reasonably Safe From Flooding* (FIA-TB-10). Available for downloading from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*Technical Bulletin 11-01 Crawlspace Construction for Buildings Located in Special Flood Hazard Areas* (FIA-TB-11). Available for downloading from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/techbul.shtm

*United States Code Title 42, The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973*. Available for downloading from FEMA's website at http://www.fema.gov/pdf/fhm/frm_acts.pdf

1994 and 2004 Reform Act legislation is available at http://www.fema.gov/business/nfip/laws1.shtm

*Use of Flood Insurance Study (FIS) Data as Available Data*, Federal Emergency Management Agency, Floodplain Management Bulletin 1-98, 1998.
http://www.fema.gov/plan/prevent/floodplain/fis_data.shtm

Dam safety has been a concern for a long time, as dams throughout the country age past their projected life spans with little or no maintenance. Areas relying on these dams to stay dry are at more risk than what may show on the FIRMs. Anyone planning development in the vicinity of dams should be familiar with the Dam Safety and Security Act of 2002 and the 1996 act:
http://www.fema.gov/plan/prevent/damfailure/ndsp.shtm

*Alluvial Fans: Hazards and Management*, Federal Emergency Management Agency/Federal Insurance Administration, Office of Loss Reduction, FEMA-165, February 1989. Available for downloading from FEMA's website at http://www.fema.gov/hazard/flood/pubs/lib165.shtm

Sustainability and sustainable re-development affects what should be put back into an area after a flood, affects how surveyors work with clients in post-disaster development and ties into the Disaster Mitigation Act of 2000 (http://www.fema.gov/library/viewRecord.do?id=1935).

The real objective of mitigation is to prevent problems, but if it is too late to do so, to prevent recurrence of risks. FEMA's Multi-Hazard Mitigation Planning link is:
http://www.fema.gov/plan/mitplanning/

## Coastal Storm Preparedness Information

***Hurricane guides and general information***

NOAA's Hurricane Portal

NOAA's National Hurricane Center

FEMA's Tropical Storm Watch

American Red Cross Hurricane Awareness Page

***Disaster kits and family emergency planning***

DEMA's Disaster Preparedness Site

NOAA's Hurricane Center Supply Kit

American Red Cross Disaster Supplies Kit

FEMA's Disaster Supply Kit for Kids

American Red Cross Family Weather Emergency Plan

***Protecting your pets***

DEMA's Pet Tips

FEMA's Animals and Emergencies

Humane Society's Disaster Preparedness for Pets

FEMA's Pets and Disasters for Kids

***Protecting your home***

Protecting Your Home from Hurricane Wind Damage

Hurricane Retrofit Guide from Florida Division of Emergency Management - describes how homeowners can protect their homes from wind and rain damage.

The Institute for Business & Home Safety's website has useful information on simple steps to protect existing structures from hazards. For example, see their Maintenance Matters program page for ways to reduce water intrusion in basements, or roofing practices that maximize the chances of a building remaining watertight during storms.

FEMA's *Home Builder's Guide to Coastal Construction* includes 31 fact sheets. Page 6 of fact sheet 30, *Repairs, Remodeling, Additions, and Retrofitting,* outlines retrofitting options for homes in coastal areas.

FEMA's *Coastal Construction Manual* - an expansive source on building in the coastal zone. While it is primarily written for building professionals (contractors, architects, building inspectors), it includes information for the general audience as well.

***Protecting your boat***

U.S. Coast Guard's How Do I Prepare My Boat, Trailer or Myself Before a Hurricane?

U.S. Coast Guard Office of Boating Safety's Hurricane Observations and Precautions

Boats.com's Hurricane Prep

Hurricane Preparedness Plan: Marina/Yacht Club/Municipal Anchorage

Major Storm Preparedness: Aware Boater Checklist

## Quick Links – Agencies, Organizations, and Information Resources

***Delaware State and Regional Organizations***

Delaware Department of Natural Resources and Environmental Control (DNREC)

DNREC Shoreline and Waterway Management Section

DNREC Flood Mitigation Program

DNREC Delaware Coastal Management Program

Delaware DNREC Coastal Training Program

Delaware Sea Grant College Program

University of Delaware College of Marine and Earth Studies

University of Delaware Center for Applied Coastal Research

Delaware Geological Survey

Delaware Environmental Observing System

Delaware Emergency Management Agency

Delaware County and Municipal Web Sites

Federal Emergency Management Agency (FEMA) Region III

U.S. Army Corps of Engineers, Philadelphia District

***Federal Organizations***

Federal Emergency Management Agency (FEMA)

National Oceanic and Atmospheric Administration (NOAA)

NOAA Coastal Services Center (CSC)

NOAA National Ocean Service (NOS)

NOAA National Oceanographic Data Center (NODC)

National Sea Grant College Program

U. S. Army Corps of Engineers (USACE)

U. S. Geological Survey (USGS)

***Professional and Trade Organizations***

Association of State Floodplain Managers (ASFPM)

American Shore and Beach Preservation Association (ASBPA)

Institute for Business and Home Safety (IBHS)

Association of Coastal Engineers (ACE)

American Institute of Architects (AIA)

National Association of Home Builders (NAHB)

National Association of Home Builders Research Center

International Code Council (ICC)

International Conference of Building Officials (ICBO)

Building Officials Code Administrators (BOCA)