CHAPTER 4: HIGH WIND

INTRODUCTION

The Eastern Shore's location between two coastal bodies, the Chesapeake Bay and the Atlantic Ocean, makes it vulnerable towards high wind events. Hurricanes, coastal spouts, tornadoes, tropical storms, and nor'easters are some of the high wind events that cause the shore to be designated as within the 110 to 120 mph zone.

NATURAL FORCES AND CONDITIONS

CAUSES OF HIGH WIND

High winds on the Eastern Shore of Virginia primarily stem from tropical cyclones like hurricanes, tropical storms, and nor'easters; rotating cells within thunderstorms like tornadoes and waterspouts; and straight-line winds associated with fast-moving thunderstorms. Waterspouts can also occur without thunderstorms. These tend to arise from the water surface and move upward, forming along the base of a developing line of cumulus clouds. Fair weather water spouts tend to move little and dissipate quickly (http://oceanservice.noaa.gov/facts/waterspout.html).

Sources of high wind are tornadoes, waterspouts and various coastal storms. The entire Eastern Shore is located in the 110 to 120 mph design wind zone. This means that structures built should be able to withstand 110 mph (Building Code). This is consistent with a strong Category 1 hurricane whose 3 second gusts could be anywhere from 93 to 119 mph.

HURRICANES, TROPICAL STORMS, AND TROPICAL DEPRESSIONS

Tropical cyclone storms were reviewed in detail in Chapter 6 – Coastal Flooding, but that discussion centered on coastal flooding, not wind speed, which is the key measure of hurricane intensity, as shown in the Saffir-Simpson Wind Scale. However, wind speed is also used to differentiate tropical depressions, tropical storms, and post-tropical depressions.

In tropical depressions, sustained surface wind is 38 mph or less, but these storms are capable of producing high amounts of rainfall. Once surface winds reach 39 mph, the storms are considered trapical storms until they reach the 74 mph hurricane wind threshold.

Hurricanes weaken from being deprived of the conditions that led to their formation: namely by moving over land or into cold water, depriving them of warm, moist air from the sea; or by encounters with strong winds at high levels, which can tear them apart. As they weaken, hurricanes re-trace, in reverse, the steps they made while forming, becoming tropical storms, then tropical or post-tropical depressions, before dissipating entirely (University Corportation for Atmospheric Research, http://www.ucar.edu/news/features/hurricanes/htc_t3.htm).

> *"Tropical cyclone: a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation."*
>
> *-NOAA, National Hurricane Center*

Table 1 Hurricane Category Descriptions

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph 96-112 kt 178-208 km/h	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph 113-136 kt 209-251 km/h	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

NOR'EASTERS

Nor'easters, or Northeasters, usually occur in the mid-latitudes over the winter months from September to April. Because these storms are generally very large and slow moving, they can cause severe and widespread damage at the same level as their stronger summer counterpart, the hurricane (USGS, St. Petersburg Coastal and Marine Science Center).

In the early 1990's the Dolan-Davis Scale was created for the classification of winter storms or Nor'aasters, however, this system is infrequently used by the general public or the media (Zielinski 2002; Schwartz 2005).

Table 2: The Dolan - Davis Scale for Nor'easter Classification. Source: Schwartz, 2005.

Dolan – Davis Scale				
Storm Class	Significant Wave Height (m)	Duration (h)	Power (m^2h)	Effects
1 Weak	2.0	8	32	Minor beach erosion. No property damage.

2 Moderate	2.5	19	107	Moderate beach & dune erosion. No property damage.
3 Significant	3.2	35	384	Significant beach & dune erosion. Moderate property damage.
4 Severe	5	62	1420	Severe beach & dune erosion. Overwash damage. Community-wide structure loss.
5 Extreme	6.8	97	4332	Extreme beach & dune erosion. Massive overwash in sheets & channels. Extensive regional-scale property losses in millions of dollars.

TORNADOS

"We got an emergency message on a cellphone and within 30 seconds, the thing hit and it blew down 40, 50 trees in the park.." That's how one man described the early morning EF1 tornado that struck Cherrystone Campground on July 24, 2014, killing three and injuring 36. The popular summertime destination on the Chesapeake Bay near Cheriton, Virginia, was packed with 1,328 adults and children and 40 staff members at the time. A New Jersey couple was killed instantly when a tree fell on their tent. Their son, who was in a neighboring tent, died days later from a head injury, also from a fallen tree.

The tragedy brought into sharp focus the dangers posed by tornadoes. The July 24 twister was one of Virginia's deadliest, and although the National Weather Service Office issued a tornado warning 20 minutes before it hit, campers were caught off guard, forcing early risers to scramble for cover, and catching others completely unaware.

The catastrophe made national news, and since then the Eastern Shore Disaster Preparedness Coalition has been working cooperatively with campgrounds on preparing materials to be provided to campers at check-in about where to seek shelter during storms and other camper safety information.

Tornadoes have traditionally occurred on the Eastern Shore during the spring and summer months with the largest one reaching F3 status in 1967. This tornado caused 5 injuries and about $25,000 in damage. An F3 tornado has wind speeds ranging from 158 to 206 mph, as you can see in Table 3. Tornados are ranked using the Fujita or F-Scale or some version thus based, the Enhanced Fujita Scale or EF-Scale was implemented in the U.S. in 2007. The most common tornado to strike on the Eastern Shore is the F1 with wind speeds of 73 to 112 mph (Weather Bureau online data).

Table 3: Fujita and Enhanced Fujita Scales

Fujita & Enhanced Fujita Scales				
F Number	EF Number	Description	Wind Range (F)	3 Second Gust (EF)
F0	EF0	Gale	40-73 mph	65-85 mph
F1	EF1	Weak	73-113 mph	86-110 mph
F2	EF2	Strong	113-158 mph	111-135 mph
F3	EF3	Severe	158-207 mph	136-165 mph
F4	EF4	Devastating	207-261 mph	166-200 mph
F5	EF5	Incredible	261-319 mph	Over 200 mph

Source: NOAA Storm Prediction Center

Table 4 High Wind Events Recorded in NOAA Storm Events Database, 1996-2015 Excluding Tropical Cyclones and Nor'Easters

County	Date	Event Category	Property Damage (in 2015 $$)	Crop Damage (in 2015 $$)	Description	Source
NORTHAMPTON CO.	1/19/1996	HIGH WIND			Several power lines down between Cape Charles and Eastville. (No wind speed estimate.)	NOAA, National Climatic Data Center
ACCOMACK CO.	5/11/1996	HIGH WIND	$0	$0	Measured thunderstorm gust of 70 mph.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	5/15/1997	HIGH WIND	$4,430	$2,953	Few trees down between Cedar Grove and Cape Charles. Also hail (.88") caused crop damage.	NOAA, National Climatic Data Center
ACCOMACK CO.	6/26/1997	HIGH WIND	$22,151	$0	Thunderstorm wind blew off back part of a wood frame building	NOAA, National Climatic Data Center
NORTHAMPTON CO.	6/13/1998	HIGH WIND	$7,270	$0	Thunderstorm winds downed trees across both counties. No wind speed estimates given.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	6/16/1998	HIGH WIND	$14,541	$0	Thunderstorm winds blew roof off a gas station; several trees down. (Cape Charles)	NOAA, National Climatic Data Center
ACCOMACK CO.	6/26/1998	HIGH WIND	$7,270	$0	Thunderstorm wind downed trees and light poles; window blown out of car (Wallops Islands)	NOAA, National Climatic Data Center
ACCOMACK CO.	4/9/1999	HIGH WIND	$14,227	$0	Thunderstorm wind: Farm damaged, car moved, dump truck overturned. Debris evident 1/4 MI from damage site. Impact area Onley to Painter.	NOAA, National Climatic Data Center
ACCOMACK CO./ NORTHAMPTON CO.	1/25/2000	HIGH WIND	$0	$0	A significant winter storm affected ESVA with several inches of snow, high winds, and some minor beach erosion. Accomack county had 1 to 2 inches. Precipitation began as rain, which changed to a mixture of snow, sleet, and freezing rain during the afternoon. Winds gusted over 50 mph which created some blowing snow during the late afternoon and evening hours.	NOAA, National Climatic Data Center
ACCOMACK CO.	7/30/2000	HIGH WIND	$0	$0	Three waterspouts reported by on-duty Coast Guard, just off-shore.	NOAA, National Climatic Data Center
ACCOMACK CO.	7/11/2001	HIGH WIND	$0		Thunderstorm wind: 57 mph wind in Melfa; 67 mph recorded in Painter	NOAA, National Climatic Data Center
CO.	5/2/2002	HIGH WIND	$2,635	$0	Thunderstorm wind: Trees down.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	5/18/2002	HIGH WIND	$3,952	$0	Thunderstorm wind: Twelve trees and a power pole down around Cape Charles.	NOAA, National Climatic Data Center
ACCOMACK CO.	7/22/2003	HIGH WIND	$2,576	$0	Thunderstorm wind: trees down. Wind speed 64 mph in Onancock and 57 mph in Accomac.	NOAA, National Climatic Data Center
ACCOMACK CO.	8/16/2003	HIGH WIND	$5,153	$0	Thunderstorm wind: trees down over roads. Wind speeds 57 mph near Sanford, Parksley.	NOAA, National Climatic Data Center
ACCOMACK CO.	8/26/2003	HIGH WIND	$2,576	$0	Thunderstorm wind 57 mph. Numerous trees down near Wallops Island.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	8/16/2005	HIGH WIND	$2,427	$0	Thunderstorm wind 60 mph: Several large tree limbs down on roads. (Cape Charles)	NOAA, National Climatic Data Center
NORTHAMPTON CO.	4/15/2006	HIGH WIND	$9,405	$0	Thunderstorm winds 69 mph: Several large pine trees blown over. Minor structural damage to several cottages with shutters and doors blown off. Dime size hail also fell. (Silver Beach)	NOAA, National Climatic Data Center

Table 4 (Cont.) High Wind Events Recorded in NOAA Storm Events Database, 1996-2015 Excluding Tropical Cyclones and Nor'Easters

County	Date	Event Category	Property Damage (in 2015 $$)	Crop Damage (in 2015 $$)	Description	Source
NORTHAMPTON CO.	6/27/2006	HIGH WIND	$4,703	$0	Thunderstorm wind 57 mph. Several trees blown down (Parksley, Exmore)	NOAA, National Climatic Data Center
ACCOMACK CO./ NORTHAMPTON CO.	7/22/2006	HIGH WIND	$4,703	$0	Thunderstorm wind (57 mph): trees down on power lines. (Wachapreague, Exmore, Eastville).	NOAA, National Climatic Data Center
ACCOMACK CO.	7/28/2006	HIGH WIND	$2,351	$0	Thunderstorm wind: trees down on power lines and blocking roads near Onancock and Accomac (60 mph)	NOAA, National Climatic Data Center
ACCOMACK CO.	4/16/2007	HIGH WIND	$1,143	$0	Low pressure moved off the Delmarva peninsula and intensified rapidly as it moved northeast of the area. Winds on the backside of the departing low produced isolated wind damage. Numerous trees and power lines were downed by winds across Accomack County (58 mph).	NOAA, National Climatic Data Center
ACCOMACK CO.	5/6/2007	HIGH WIND	$2,286	$0	Intense low pressure off the Mid Atlantic Coast produced very strong winds (53 mph).	NOAA, National Climatic Data Center
ACCOMACK CO.	6/8/2007	HIGH WIND	$0	$0	Scattered thunderstorms produced widespread wind damage and large hail near Atlantic. Winds at 57 mph.	NOAA, National Climatic Data Center
NORTHAMPTON	11/3/2007	HIGH WIND	$1,143	$0	Combination of Extratropical Storm Noel tracking up off the Mid Atlantic Coast and High Pressure building into the region from the northwest produced strong northeast winds at 46 mph.	NOAA, National Climatic Data Center
ACCOMACK CO.	3/5/2008	HIGH WIND	$1,101	$0	Scattered sever thunderstorms produced damaging winds and large hail; trees were downed in Hallwood (57 mph)	NOAA, National Climatic Data Center
ACCOMACK CO.	5/11/2008	HIGH WIND	$14,819	$0	Low pressure produced very strong winds (67 mph) and wind damage. Trees and powerlines were downed. Some structural damage and power outages also occurred.	NOAA, National Climatic Data Center
ACCOMACK CO.	5/31/2008	HIGH WIND	$3,318		Scattered severe thunderstorms in advance of a cold front produced damaging winds (57 mph); trees downed on Atlantic Rd. between Atlantic and Assawoman.	NOAA, National Climatic Data Center
ACCOMACK CO.	6/4/2008	HIGH WIND	$1,101	$0	Thunderstorm in advance of cold front; large tree downed in Accomac (57 mph).	NOAA, National Climatic Data Center
ACCOMACK CO.	6/16/2008	HIGH WIND	$1,101	$0	Thunderstorm wind in advance of cold front (57 mph). Power lines downed (Belle Haven)	NOAA, National Climatic Data Center
NORTHAMPTON CO.	6/29/2008	HIGH WIND	$3,303	$0	Scattered severe thunderstorms in advance of a cold front produced damaging winds (57 mph) and large hail. 2 MI NNW Eastville to 1 mi E of Exmore.	NOAA, National Climatic Data Center
ACCOMACK CO.	7/27/2008	HIGH WIND	$1,101	$0	Thunderstorm n advance of cold front. Trees downed near Route 13 near Tasley. (57 mph).	NOAA, National Climatic Data Center

Table 4 (Cont.) High Wind Events Recorded in NOAA Storm Events Database, 1996-2015 Excluding Tropical Cyclones and Nor'Easters

County	Date	Event Category	Property Damage (in 2015 $$)	Crop Damage (in 2015 $$)	Description	Source
ACCOMACK CO./ NORTHAMPTON CO.	8/10/2008	HIGH WIND	$4,403	$0	Scattered severe thunderstorms in advance of cold front produced damaging winds (57 mph) and large hail. Several trees and power lines downed just west of Townsend, and between Route 13 and Wallops trees and power lines downed; power outages	NOAA, National Climatic Data Center
ACCOMACK CO./ NORTHAMPTON CO.	12/31/2008	HIGH WIND	$3,303	$0	Intense low pressure departing to the northeast and cold high pressure building in from the west, produced very strong wind gusts of 51 knots (59 mph) was measured at Wallops; 53 mph at Capt Charles; 46 mph at Exmore. Several trees were downed.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	6/9/2009	HIGH WIND	$1,105	$0	Scattered severe thunderstorms in advance of a cold front produced large hail and damaging winds (57 mph). Trees were downed on Plum Street and also Robin Road in Cheriton area.	NOAA, National Climatic Data Center
ACCOMACK CO.	7/26/2009	HIGH WIND	$3,315	$0	Severe thunderstorm winds downed large tree and power lines on Waterfield Road and other locations in Accomack County (57 mph).	NOAA, National Climatic Data Center
NORTHAMPTON CO.	5/12/2010	HIGH WIND	$2,174	$0	Scattered severe thunderstorms in advance of a cold front produced large hail and damaging winds. A large tree and power lines were downed.	NOAA, National Climatic Data Center
ACCOMACK CO.	7/25/2010	HIGH WIND	$1,087	$0	Thunderstorm wind (57 mph): Tree was downed on power lines on Horntown Road.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	7/29/2010	HIGH WIND	$1,087	$0	Scattered severe thunderstorms in advance of a cold front produced large hail and damaging winds (57 mph). A large tree was downed.	NOAA, National Climatic Data Center
ACCOMACK CO.	8/5/2010	HIGH WIND	$2,174	$0	Numerous trees downed in thunderstorm winds (57 mph).	NOAA, National Climatic Data Center
ACCOMACK CO.	2/25/2011	HIGH WIND	$2,107	$0	Very strong gradient winds produced wind gusts to around 60 mph over portions of eastern Virginia.	NOAA, National Climatic Data Center
ACCOMACK CO./ NORTHAMPTON CO.	4/16/2011	HIGH WIND	$6,322	$0	Scattered severe thunderstorms in advance of a cold front produced damaging winds (57 mph). Numerous trees were reported down around Weirwood, Simpkins, Exmore, and Accomac.	NOAA, National Climatic Data Center
ACCOMACK CO.	5/24/2011	HIGH WIND	$4,215	$0	Thunderstorm winds knocked down silos (57 mph) in Assawoman.	NOAA, National Climatic Data Center
ACCOMACK CO.	6/28/2011	HIGH WIND	$2,107	$0	Thunderstorm winds downed several large limbs near Mears and New Church (57 mph).	NOAA, National Climatic Data Center
ACCOMACK CO.	7/20/2011	HIGH WIND	$1,054	$0	Thunderstorm winds downed power lines near Davis Wharf (57 mph).	NOAA, National Climatic Data Center
ACCOMACK CO.	2/24/2012	HIGH WIND	$2,065	$0	Scattered severe thunderstorms in advance of a cold front produced damaging winds (57 mph) and downed trees.	NOAA, National Climatic Data Center
ACCOMACK CO./ NORTHAMPTON CO.	6/29/2012	HIGH WIND	$5,162	$0	A derecho produced a widespread path of damaging winds across much of central and eastern Virginia. Numerous trees and power lines were downed. A gust of 57 MPH was recorded at Kiptopeke.	NOAA, National Climatic Data Center

Table 4 (Cont.) High Wind Events Recorded in NOAA Storm Events Database, 1996-2015 Excluding Tropical Cyclones and Nor'Easters

County	Date	Event Category	Property Damage (in 2015 $$)	Crop Damage (in 2015 $$)	Description	Source
ACCOMACK CO.	8/25/2012	HIGH WIND	$10,323	$0	Scattered thunderstorms associated with low pressure along the Mid Atlantic Coast produced heavy rain which caused flash flooding. Many roads were closed due to flooding. Cars were disabled and filing with water in the Keller-Painter area. Trailer home was damaged by straight line winds (57 MPH). One minor injury was reported.	NOAA, National Climatic Data Center
ACCOMACK CO.	8/3/2013	HIGH WIND	$0	$0	A squall line produced widespread wind damage and embedded large hail across much of central and eastern Virginia. Numerous trees downed across the northern part of the county.	NOAA, National Climatic Data Center
ACCOMACK CO.	1/11/2014	HIGH WIND	$2,002	$0	Thunderstorm winds (57 mph) downed trees.	NOAA, National Climatic Data Center
ACCOMACK CO.	5/27/2014	HIGH WIND	$2,002	$0	Scattered severe thunderstorms knocked down trees, blocking a road between Melfa and Keller (57 mph)	NOAA, National Climatic Data Center
NORTHAMPTON CO.	7/24/2014	HIGH WIND	$951,127	$1,255,819	Tornado and downburst straightline winds (75 mph) struck Cherrystone Campground with little warning to campers. 7.699 MI long; 150 yards wide. Tornado began in the Chesapeake Bay, a few miles west of the campground, then tracked eastward into Cherrystone Campground, continuing eastward across Old Cherrystone Rd. and Route 13 before lifting near Seaside Rd. close to the Northampton Landfill. Straightline wind damage from just S. of Cherrystone to Cape Charles. Many trees were downed or snapped off, some down across homes. Numerous camping trailers were damaged, and several were destroyed. Several trees were downed on cabins. Golf ball size hail, with a few reports of baseball size hail near Cherrystone Campground. Hail fell in a 0.5 to 0.75-MI-wide swath from Cherrystone Campground eastward to Oyster. Considerable leaf debris from trees was associated with the hail. In addition, hail combined with strong winds damaged the siding on a number of homes. Significant crop damage: 2,284 acres damaged.	NOAA, National Climatic Data Center
ACCOMACK CO.	6/15/2015	HIGH WIND	$2,000	$0	Winds of 57 mph struck; several trees were downed.	NOAA, National Climatic Data Center
ACCOMACK CO.	6/18/2015	HIGH WIND	$10,000	$0	Scattered severe thunderstorms associated with a trough of low pressure produced damaging winds (57 mph). Boats were capsized and a roof blown off; a pier was damaged at Deep Creek Marina; trees were snapped in Tasley; and several trees were damaged in Onancock and Accomac.	NOAA, National Climatic Data Center
ACCOMACK CO.	6/20/2015	HIGH WIND	$4,000	$0	Scattered severe thunderstorms in advance of low pressure and a weak cold front produced damaging winds and large hail. Numerous trees were downed and blocking roads. (Winds 57 mph)	NOAA, National Climatic Data Center

Table 5: Tornadoes Recorded in NOAA Storm Events Database, 1996-2015

County	Date	Event Category	Property Damage (in 2015 $$)	Crop Damage (in 2015 $$)	Description	Source
ACCOMACK CO.	7/30/2000	**TORNADO**	$2,890	$0	An F0 tornado touched down in a trailer park. The tornado briefly kicked up dust and debris before dissipating, but no damage occurred. .2 MI long and 20 yards wide.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	9/14/2007	**TORNADO**	$34,294	$0	Waterspout came onshore near Whittington Rd. Produced some structural damage and downed numerous trees in about a six mile path from Silver Beach northeast to Wardtown. 50 yards wide. Rated EF0	NOAA, National Climatic Data Center
NORTHAMPTON CO.	9/27/2010	**TORNADO**	$21,739	$0	Blew over a shed, downed trees, and severely damaged a mobile home. There was also one minor injury. .45 MI long; 30 yards wide. Rated EF0	NOAA, National Climatic Data Center
ACCOMACK CO.	8/27/2011	**TORNADO**	$26,342	$0	EF0-rated tornado spawned from Irene downed trees and caused minor roof damage.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	6/1/2012	**TORNADO**	$3,097	$0	EF0 tornado near Savage Neck Dunes. 75 yards wide, .73 MI long.	NOAA, National Climatic Data Center
ACCOMACK CO.	7/14/2012	**TORNADO**	$15,485	$0	Isolated severe thunderstorm along a weak frontal boundary produced a tornado across portions of the Virginia Eastern Shore. A slow moving tornado made a short narrow path through rural portions of Accomack county just east of Onley. The tornado first touched down in a small residential development just southwest of the intersection of Custis Neck Road and Drummondtown Road. Numerous trees were damaged or brought down by the tornado with one tree falling on an unoccupied vehicle. The tornado then continued slowly southwest through a wooded area with the last visible tree damage seen just southwest of Accomack Elementary School.	NOAA, National Climatic Data Center
ACCOMACK CO.	6/18/2013	**FUNNEL CLOUD**	$0	$0	Funnel cloud reported over Tasley.	NOAA, National Climatic Data Center

NORTHAMPTON CO.	7/24/2014	**TORNADO**	$951,127	$1,255,819	Tornado and downburst straightline winds (75 mph) struck Cherrystone Campground with little warning to campers. Began in the Chesapeake Bay, west of the campground, then tracked eas into the campground, continuing east across Old Cherrystone Rd. and Route 13 before lifting near Seaside Rd. close to the Northampton Landfill. Straightline wind damage from just S. of Cherrystone to Cape Charles. Many trees were downed or snapped off, some down across homes. Numerous camping trailers were damaged, and several were destroyed. Several trees were downed on cabins. Golf ball size hail, with a few reports of baseball size hail near Cherrystone Campground. Hail fell in a 0.5 to 0.75-MI-wide swath from Cherrystone Campground eastward to Oyster. Considerable leaf debris from trees was associated with the hail. In addition, hail combined with strong winds damaged the siding on a number of homes. Significant crop damage: 2,284 acres damaged. Three deaths and 36 injuries from event; 5 of the injuries were from the tornado. The rest of the injuries and deaths were determined by the National Weather Service to have been from straightline winds.	NOAA, National Climatic Data Center
ACCOMACK CO.	8/4/2015	**TORNADO**	$2,000	$0	Scattered severe thunderstorms in advance of a cold front produced damaging winds, large hail, and one weak tornado. A weak tornado was reported by several people near and east southeast of Saxis. Large limbs were downed in the road. Other debris was blown around and quarter-size hail was reported near Jenkins Bridge.	NOAA, National Climatic Data Center

TYPE, LOCATION, AND EXTENT

DAMAGES

High wind events cause progressive failure of structures. Once a building's envelope has been breached wind will start to enter the building and either pull or push at other parts of the structure. Partially enclosed buildings experience a 30% higher wind pressure than enclosed buildings. Once a building becomes partially enclosed due to wind damage, higher wind pressures cause further damage (*FEMA Coastal Construction Manual*, 2011).

A building fails in high winds because the wind speed exceeds the capacity of the structure to hold up. This can happen in two ways, wind speed exceeds the design or construction standards used or windborne debris damages the structure and as a result of increased wind pressure the design or construction standards are surpassed. Wind damage commonly assumes a couple of forms. Roofs can fail, lightweight structures can overturn at the foundation, siding and shingles can be pulled off the building and openings can be blown in. Once a structure's envelope has been penetrated by wind, wind-driven rain and debris causes additional damages (*FEMA Coastal Construction Manual*, 2011).

Storms that occur when the trees are in full leaf also cause tremendous tree damage. Hurricane Isabel was such a storm. Thousands of trees were blown over due to the winds from Isabel and saturated soils. Many of these trees and their limbs damaged houses, auxiliary structures, power lines, and vehicles.

EXPOSURE AND POTENTIAL LOSS

The Eastern Shore is in wind Zone II (ASCE7-98). This means that a community shelter in this area would have to be built to withstand 160 mph winds. This shelter could withstand a F2 tornado and a Category 4 hurricane. The building code requires all structures to withstand 110 mph winds, the equivalent of a Category 1 hurricane.

This wind speed is based on the 100-year return frequency. That means that over 70 years a structure would have a 50% chance that the 110 mph wind speed would be met or exceeded. However, wind speed design builds in a 1.5 safety factor. So a structure should withstand a higher wind speed (*FEMA Coastal Construction Manual*, 2011).

Siting decisions affect the types of wind speed seen at a building. Ocean promontories generally receive high wind speed due to the topography of the area. A more exposed condition because of lack of vegetation around the structure will open the building up to greater wind speeds. Those structures near open water are exposed to higher winds than structures located more landward. In addition, the height of a structure above the ground affects the wind speeds. The higher a house is located above ground the higher the wind speed will be around the structure. This can be an issue in flood zones since elevation of the building is the primary means of mitigating flood damage (*FEMA Coastal Construction Manual*, 2011).

In addition, a structure is only as wind resistant as its smallest component. If a window, door, roof covering, siding or chimney fails, the rest of the structure will be subjected to wind pressures that can cause other components to fail even though they perform to their design guidelines (*FEMA Coastal Construction Manual*, 2011).

SECONDARY HAZARDS

Auxiliary hazards of high wind are salt spray and soil erosion. High winds that pick up salt from the ocean blow this over the Eastern Shore causing crops to be destroyed and power lines to fail. Hurricane Isabel caused both types of damage. Additionally, strong winds from the northwest are common during the winter months on the Eastern

Shore. These winds can cause significant soil erosion to fields in the winter stripping critical nutrients from fields and depositing them in local waterways (Local oral accounts).

HUMAN SYSTEMS

There are various ways that property damage and personal injury can be minimized. Preparation is one of the most important of these, and resilient construction is key to this, as discussed previously in the Exposure and Potential Loss section above. Similarly, early warnings are vital to insuring people are able to move to shelter prior to the onset of a high wind event.

WARNING ANNOUNCEMENTS

The National Weather Service provides warnings for high winds through their Land-based Wind Hazard Announcements and Water-based Wind Hazard Announcements.

Land-Based Wind Hazard Announcements
Hurricane Wind Watch: Issued for inland areas that sustained winds of 74 mph or greater associated with a hurricane are anticipated beyond the coastal areas. The actual occurrence, timing and location are still uncertain.
Hurricane Wind Warning: Issued for inland areas that sustained winds of 74 mph or greater associated with a hurricane are anticipated beyond the coastal areas in the next 6 to 24 hours.
Tropical Storm Wind Watch: Issued for inland areas that sustained winds of 39-73 mph or greater associated with a tropical storm are anticipated beyond the coastal areas. The actual occurrence, timing and location are still uncertain.
Tropical Storm Wind Warning: Issued for inland areas that sustained winds of 39-73 mph or greater associated with a tropical storm are anticipated beyond the coastal areas in the next 6 to 24 hours.
Severe Thunderstorm Watch: Issued when severe thunderstorms are possible in and near the watch area. Severe thunderstorms contain winds of 58 mph or higher and/or hail 1 inch in diameter or larger.
Severe Thunderstorm Warning: Issued when severe thunderstorms are occurring or imminent in the warning area. Severe thunderstorms contain winds of 58 mph or higher and/or hail 1 inch in diameter or larger.
Wind Advisory: Issued when the following conditions are expected for 3 hours or longer under the following conditions: sustained winds of 31 to 39 mph and/or wind gusts of 46 to 57 mph.
High Wind Watch: Issued when the following conditions are possible: Sustained winds of 40 mph or higher for one hour or more, or wind gusts of 58 mph or higher for one hour or more.

High Wind Warning: Issued when the following conditions are occurring or imminent: Sustained winds of 40 mph or higher for one hour or more, or wind gusts of 58 mph or higher for one hour or more.
Extreme Wind Warning: Issued for surface winds of 100 knots (115 MPH) or greater associated with non-convective, downslope, derecho (NOT associated with a tornado), or sustained hurricane winds are expected to occur within one hour.
Tornado Watch: Issued when severe thunderstorms and tornadoes are possible in and near the watch area.
Tornado Warning: Issued when a tornado is imminent. When a tornado warning is issued, seek safe shelter immediately.

Water-Based Wind Hazard Announcements
Gale Warning: Issued for the Tidal Potomac River and the Chesapeake Bay when one or both of the following conditions is expected to begin within 36 hours and not directly associated with a tropical cyclone: Sustained winds of 34 knots to 47 knots, or frequent gusts (duration of two or more hours) between 34 knots and 47 knots.
Storm Warning: Storm Warnings are issued for the Tidal Potomac River and the Chesapeake Bay when one or both of the following conditions is expected to begin within 36 hours and not directly associated with a tropical cyclone: Sustained winds of 48 knots to 63 knots, or frequent gusts (duration of two or more hours) of 48 knots to 63 knots.
Hurricane Force Wind Warning: Hurricane Force Wind Warnings are issued for the Tidal Potomac River and the Chesapeake Bay when one or both of the following conditions is expected to begin within 36 hours and not directly associated with a tropical cyclone: Sustained winds of 64 knots or greater, or frequent gusts (duration of two or more hours) of 64 knots or greater.
Special Marine Warning: A warning of potentially hazardous weather conditions of short duration (up to 2 hours) affecting areas included in a forecast area that are not adequately covered by existing marine warnings and producing one or more of the following: Sustained marine convective winds (showers/thunderstorms) or associated gusts of 34 knots or greater; and/or hail three quarters of an inch or more in diameter, and/or waterspouts.

CONSTRUCTION STANDARDS

The 2011 Coastal Construction Manual, Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas (Fourth Edition). V. 1-2 lays out very specific design standards for not only wind, but flooding, fire, and more. Design for wind loads is essentially the same whether the winds are due to hurricanes, thunderstorms, or tornadoes, and both Counties (and subsequently their respective incorporated Towns), go by these standards for building and zoning codes.

The Eastern Shore is in wind Zone II (ASCE7-98). This means that a community shelter in this area would have to be built to withstand 160 mph winds. This shelter could withstand a F2 tornado and a Category 4 hurricane. The building code requires all structures to withstand 110 mph winds, the equivalent of a Category 1 hurricane.

PERSONAL RESPONSIBILITY

Even if structures are built to the proper standard, regular maintenance to ensure their stability and resilience are important. There is a FEMA fact sheet for protected shingled roofs from high winds that could be useful to many Eastern Shore residents.

During high wind events, families and businesses should have a designated ‘safe room’ in which to stay until the event subsides. These rooms should be located outside known flood prone areas, including the 0.2%-annual-chance event, and away from any potential large debris sources.