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Coastal Areas and Flood Risk: According to the U.S. Army Corps of Engineers and other sources, between 8 and 9 million people live in areas at risk of coastal flooding. In Sussex County, DE, with an estimated population of 224,220, just over 7,000 people (~32%) live in coastal towns that are at high risk of flooding from storms. Flooding results from ocean waters overtopping dunes and beaches; from backwater flooding caused by storm surges in inlets, canals and ponds; from precipitation; and sometimes from all three causes simultaneously.

What Is A Dune? Put simply, a dune is a hill of loose sand built by aeolian processes (wind) or the flow of water (as in Bethany Beach) with an associated deposition of sand, shells, and pebbles. Dunes grow as grains of sand accumulate. Every dune has a windward side and a slip-face. Dunes occur in different shapes and sizes, formed by interaction with the flow of air or water. Generally speaking, there are five types of sand dunes: transverse, linear/longitudinal, star, barchan/crescentic, and parabolic/blowout -- the dunes in Sussex County (which include Bethany Beach) are linear/longitudinal dunes formed on a barrier island.

What Do Sand Dunes Do? Sand dunes protect inland areas from coastal water intrusion by absorbing the impact of waves and storm surges, thus serving as a resilient barrier to the destructive forces of wind and waves. Under natural conditions, the types and density of vegetation are indicators of the age and length and stability of dunes. Grasses may be established within a season, but shrubs take 10 to 20 years to become established, and decades, even centuries, are required to grow a maritime forest.

Dunes Must Be Protected: In addition to being illegal in many coastal towns (i.e., Bethany Beach) to walk/climb on the dunes, there are other reasons why people should stay off the dunes. Dunes: 1) store sand that help diminish potential shoreline erosion; 2) absorb the impacts of storm surges and high waves; 3) prevent water from flooding coastal towns and infrastructure; and, 4) provide crucial habitat and nesting areas for wildlife.

Dunes Are Dynamic: In general, coastal systems are extraordinarily dynamic, characterized by perpetually shifting sands (dunes and beaches), wetlands, backwaters, bays, and of course tributaries that flow to the coast. In their natural, pre-development state, these landscape features were in perpetual motion, shifting and reorganizing in response to seasons, storms, climatic shifts, and depositional and erosional cycles of the ocean. **Beaches are sacrificial in nature, which means that they absorb the wave energy, but the trade-off is that millions of gallons of salt water act to wash beach and dune sands into the ocean.** It takes many years, typically centuries, for dunes to form or to begin to re-establish themselves after they have been damaged.

Bethany Beach Dune System: From the time the first building was erected in Bethany Beach in 1901, the natural, pre-occupation dune system, and its associated beaches, have been manipulated and degraded by human occupation and use. Portions of the dune system were excavated. Homes, commercial buildings, churches, roads, and paths were constructed within the dune system. Dunes and associated wetlands were cleared of vegetation for farming and grazing, and up until several decades ago, dunes suffered impacts caused by trail bikes, dune buggies, 4WD vehicles, and typical recreational activities such as camping, picnicking, and by people walking across the dunes. Patterns of disturbance, for example, people creating paths over and through dunes and foredunes may disturb the vegetation sufficiently to initiate blowouts, pathways for flood waters and storm surges. All of these activities played a role in the degradation of the dune systems all along the Atlantic Coast.

Artificial Dune Implemented in Bethany Beach: Dunes and dune systems are critically important to Bethany Beach and all of the coastal communities in Sussex County. Because the dune system was seriously degraded, and the natural protection function of our dune system lost, the Town turned to the U.S. Army Corps of Engineers (Corps) [do you have the year?] for assistance. After extensive study, the Corps recommended, and the Town agreed, to implement a hurricane and storm damage reduction project consisting of a beach fill -- a 150' wide dune and berm configuration (115' dune base width and 35' berm). The berm was designed to have an elevation of +7 ft-NAVD; the dune was designed to have an elevation of + 16 ft-NA VD. The Bethany Beach Project also included dune grass, dune fencing, and suitable "advance beach fill" and periodic nourishment to ensure the integrity of the artificial beach and dune design. "Advance beach fill" is an amount of sand over and above the design amount placed to protect the integrity of the baseline project, ideally until a subsequent periodic re-nourishment (adding sand) to restore the beach and dune to the project's design width and height.

Resources:

For additional information on dune formation, morphology, functions, and causes of degradation and loss, please refer to "[Coastal Dunes: Geomorphology](#)".

The website [Surging Seas Risk Finder](#) provides information on the estimated number of permanent residents of Bethany Beach that live on exposed land below the 5-foot above sea level elevation, areas where there is a 93% chance of at least one flood over 5 feet occurring between today and 2050. The website also presents a graph showing that coastal flooding in Sussex County has been increasing in terms of both frequency and depths. For example, while coastal areas in Sussex County experienced approximately 50 "coastal flood days" between 1955-1964, the region experienced over 200 "coastal flood days" between 2005-14 (data taken from Lewes gage station 17 miles north of Bethany Beach). The [Surging Seas Risk Finder](#) website also contains links on federal agency (NOAA, FEMA, other) programs and information, the total value of Bethany Beach homes at risk (~\$600 million), maps of high flood risk areas, and actions you can take yourself to reduce flood risk and sea level rise impacts.

Illustrations: The first illustration shows the typical features of a mature dune and beach complex. The second illustration shows how the components of a coastal beach system work together.

Typical Cross Section of a Mature Dune/Beach Complex

