Damage-Resistant Practices for Designing Septic Systems in Coastal High Hazard Areas

Guidance and recommendations for design professionals, permitting officials, and coastal property owners

Septic systems along sections of the Delaware shoreline can leach wastewater into coastal waters if they're not properly located, constructed, and maintained.

Failed septic systems can lead to pollution and public health concerns through the release of untreated waste into adjacent coastal and marine environments, resulting in contaminated bay water, bottom sediments, shellfish beds, and beaches.

Special design criteria must be used to protect septic systems in areas vulnerable to high-velocity flooding, wave action, erosion, and storm damage.

Common Modes of Failure

Septic tanks installed in V zones are often exposed by storm-induced erosion and scour.

Damaged or cracked tanks and broken pipes can be flooded, allowing septic waste to escape into adjacent waterways and properties.

When a tank is exposed, the sewer line from the home is usually severed, making the house uninhabitable.

A damaged septic tank can leave a dwelling uninhabitable and vulnerable to future storms.

Broken tanks, pipes, and distribution boxes become waterborne debris, which can cause damage to pilings and adjacent structures.

Eroded and exposed disposal areas permit wastewater to flow onto properties and into adjacent waterways.

Factors to Consider and Resources for Assessing Risk

Delaware's coast is vulnerable to erosion and sea-level rise. Severe storms erode dunes and beaches, undermine structures, and expose and sometimes destroy on-site wastewater treatment and disposal systems (commonly known as septic systems).

A coastal high hazard area, also known as a high velocity zone or V zone, is the most hazardous of the delineated flood zones because this area is exposed to both floodwaters and wave action. A number of interrelated environmental and engineering factors should be carefully evaluated when planning or designing structures in these high hazard areas.

Waves impact an exposed septic tank.

Waves

Waves can affect coastal structures in a number of ways. The most severe damage is caused by breaking waves and wave run-up, which occurs as waves break and wash up beaches and sloping surfaces. Waves can drive large volumes of water against or around coastal buildings, inducing fluid impact forces, current drag forces, and localized erosion and scour.

Consult the FIRMs for a site to determine its V zone conditions and base flood depths.

Localized scour

Waves and currents are capable of creating turbulence around structures, resulting in localized scour.

Determining potential scour depth is critical in designing coastal septic systems to avoid failure during and after flooding as a result of the loss in either bearing capacity or anchoring resistance around the system. Localized scour determinations will require knowledge of the flood depth, flow conditions, and soil characteristics.

A holding tank is exposed due to localized scour.

Coastal erosion has taken its toll on this dune system.

Velocity zone conditions

V zone conditions and base flood depths may be determined using the effective Flood Insurance Study reports and Flood Insurance Rate Maps (FIRMs) for the site available from the Federal Emergency Management Agency (FEMA).

Definitions

Erosion – Process by which floodwaters lower the ground surface in an area by removing upper layers of soil.

Hydrodynamic forces – The amount of pressure exerted by moving floodwaters on an object. Among these loads are positive frontal pressure against the structure, drag forces along the sides, and suction forces on the downstream side.

Hydrostatic forces – The amount of lateral pressure exerted by standing or slowly moving floodwaters on a horizontal or vertical surface. The water pressure increases with the square of the water depth.

Scour – Erosion by moving water in discrete locations, often as a result of water impacting foundation elements.

V zone – V zones are areas identified on FIRMs as zones VE, V1-30, or V. These areas, also known as coastal high hazard areas, are areas along the coast that have a 1 percent or greater annual chance of flooding from storm surge and waves greater than 3 feet in height, as well as being subject to significant wind forces.

Additional factors and forces to consider

These include expected beach and dune erosion rates and hydrodynamic and hydrostatic loads — not only loads affecting the design structure, but also possible impacts to adjacent structures. A qualified engineer with an understanding of coastal processes and coastal engineering should be used to design a system that will withstand wave, current, flood, and localized scour forces.

Useful resources for assessing risk at your site

- Delaware Department of Natural Resources and Environmental Control's (DNREC's) Ground Water Discharges Section and Shoreline Management Program (www.dnrec.delaware.gov)
- FEMA's Flood Insurance Rate Maps, Flood Insurance Study reports, Coastal Construction Manual, and Technical Bulletin 5 (www.fema.gov)

Recommendations for Minimizing Damage and Failure of Septic Systems

Post-storm assessments in many coastal areas show that l
or displaced. In addition to compromising their subsequer
Therefore, all new and replacement septic systems, includi
They should also be designed to minimize or eliminate inf
adjacent waterways. Contact appropriate local and state

Design to minimize wave and current impacts

- Tanks should be oriented to resist or minimize wave impacts and moving floodwaters.
- The narrowest dimension of the tank should be located perpendicular to the flood flow.

Design to resist scour

- Tank foundations should be embedded to an adequate depth and oriented to resist damage during a base flood event, including anticipated scour depth.
- Tanks should be located such that scour does not undermine the foundation and the openings of fill lines.
- In V zones, fill may not be used for structural support.

Design to resist buoyancy

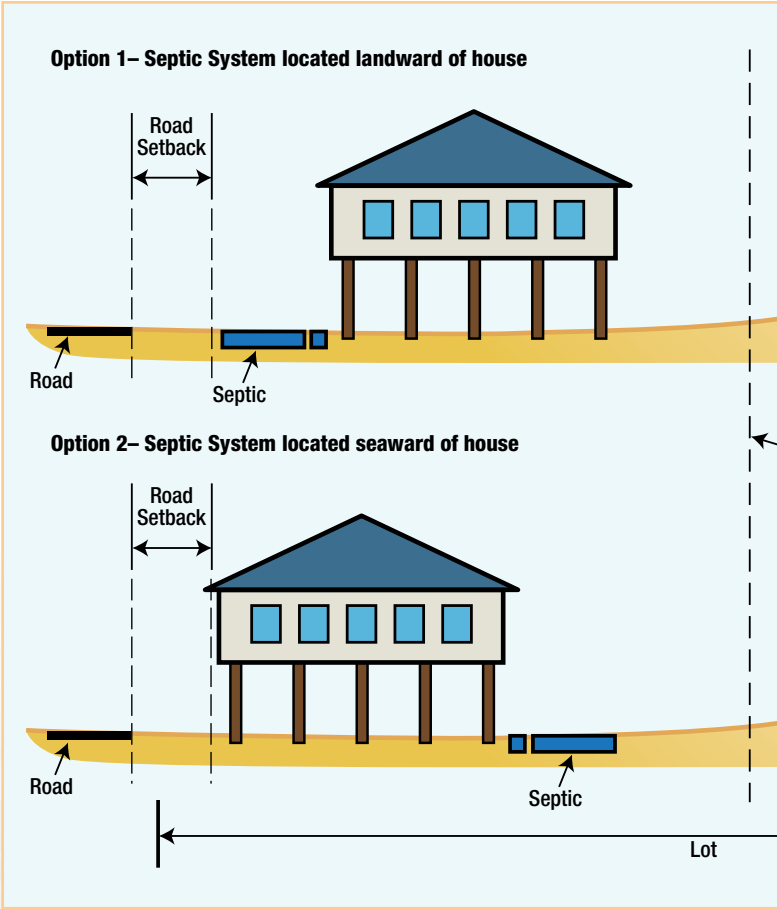
- Tanks should be secured so that buoyancy forces will not lift the tank out of the ground.
- Calculated buoyancy forces should be those associated with water depths anticipated during the base flood event.

Backflow and overflow protection

- Backflow preventers should be installed on all tanks to prevent backing up of sewage into the building and discharge of sewage into floodwaters.
- Overflows must be above the base flood elevation.

Know your risk

- How do you know if your property is located in a flood hazard
  Check your community FIRMs to locate your parcel.
- FIRMs describe high hazard areas (A zones) and coastal high h
  potential for 3-foot or greater waves, high velocity flows, and
- Talk to your local building inspector about whether your struct
  on the FIRM for building permit requirements.

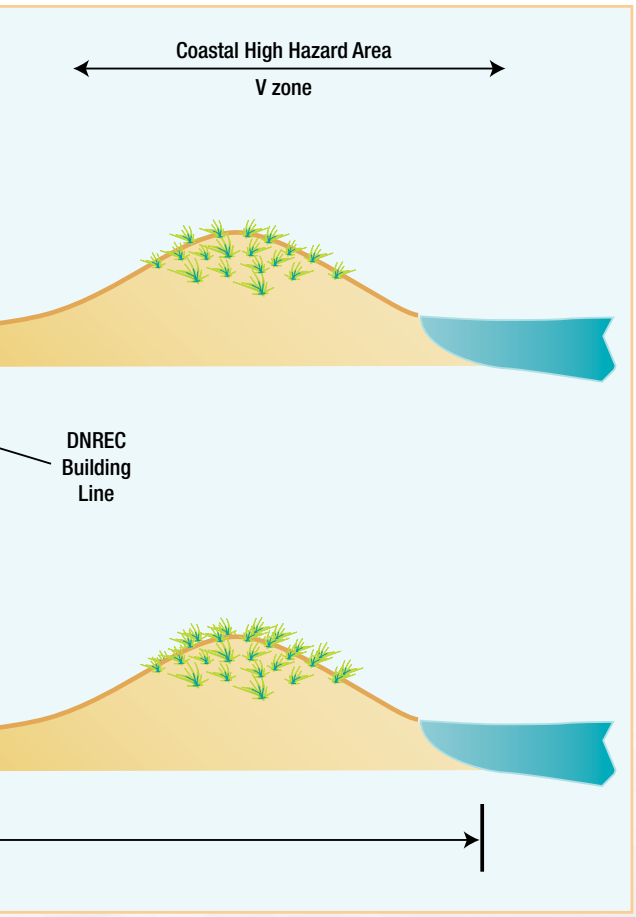


Recommended house and septic placement on a coastal lot:
Hazard Area and the DNREC Building Line

both buried and mounded septic systems are frequently exposed, destroyed,
nt use, damage to these systems can release their contents into adjacent floodwaters.
ing holdings tanks, must be located and designed to minimize or eliminate flood damage.
iltration of floodwaters into the tank, as well as discharges from the system into
officials before beginning work.

or high hazard zone?

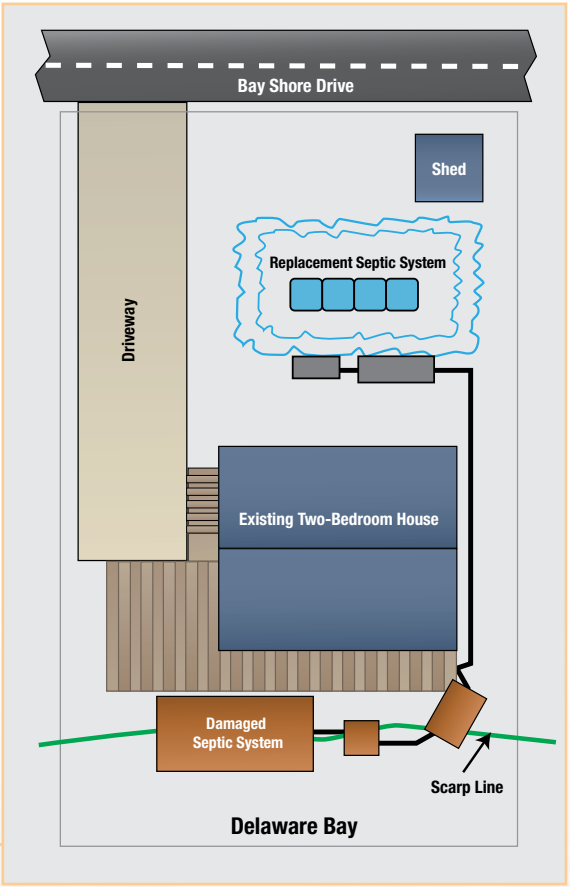
azard areas (V zones). V zones have the
soil scour during coastal storm events.
ure falls within a high risk flood area



landward of the Coastal High

Siting on lower risk portions of property

- New and replacement systems, including holding tanks, should be located outside of V zones and flood hazard areas to ensure they will not release contaminants in a flood and can be used after flood waters recede.
- Locate new and replacement systems landward of the dune. Disturbance of the dune in V zones is prohibited by the National Flood Insurance Program (NFIP) because of potential increase of flooding and damage.
- Placement of vulnerable utilities in dune areas leads to greater exposure to hazards and could minimize flood protection benefits of the dune.



A damaged septic system is replaced with a new system landward of the house.

Highly exposed locations may be subject to extreme wave forces, long-term erosion, scour, debris impact, and large flood depths. In this high-risk location, designing systems that resist damage and the release of contaminants to the environment in a 100-year storm may be technically difficult and may not be economically practical. This replacement holding tank, armored with an engineered bulkhead and concrete slab cap, is shown during a moderate storm.

Rules and Regulations Governing Construction, Reconstruction, and Repair of Septic Systems in Coastal High Hazard Areas

In order to protect public and private waterfront properties from the elements of nature, and in some cases from the actions of neighboring landowners, FEMA, NFIP, DNREC, and local governments have regulations, ordinances, and recommendations that set minimal standards for construction and replacement of septic systems in coastal high hazard areas. A few of the applicable regulations are listed below.

DNREC Division of Watershed Stewardship *(www.dnrec.delaware.gov)*

Regulations Governing Beach Protection and the Use of Beaches

- A permit or letter of approval is required prior to construction and repair of a septic system.
- The septic system must be located landward of the DNREC Building Line when possible and landward of the DNREC easement at all times.
- The system must be designed and certified by a registered professional engineer to withstand damage during coastal storms.

DNREC Division of Water *(www.dnrec.delaware.gov)*

Regulations Governing the Design, Installation, and Operation of Onsite Wastewater Treatment and Disposal Systems

- A permit is required prior to construction and repair of a septic system.
- All systems shall be operated and maintained so as not to create a public health hazard or cause water pollution.

NFIP - administered by New Castle, Kent, and Sussex Counties *(www.floodsmart.gov)*

Ordinances Governing Floodplain Management

- The NFIP requires that septic systems be designed so that floodwaters do not damage any component of the system.
- All new and replacement systems shall be designed to withstand minimal damage from the forces of velocity flow and debris impact.
- The NFIP prohibits man-made alteration of sand dunes, which would increase potential flood damage within V zones.
- All new and replacement systems shall be designed or located so as to minimize alterations to sand dunes, which would increase potential flood damage.

FEMA NFIP 44 CFR 60.3(a)(6)

[The community must] Require within flood-prone areas (i) new and replacement sanitary sewage systems to be designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into flood waters and (ii) onsite waste disposal systems to be located to avoid impairment to them or contamination from them during flooding.

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