AECOM

Coastal Municipalities Impervious Surface Coverage Report

A Resilient Community Partnership Project
Delaware Coastal Programs

This report was prepared by AECOM using Federal funds under award NA17NOS4190151 from the Delaware Coastal Programs and the Office for Coastal Management (OCM), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the OCM NOAA or the U.S. Department of Commerce.

August 2019

AECOM Project No. 60542970

Coastal Delaware BMP Guide

A Resilient Communities Partnership Project

This is a community-based guide designed to summarize strategies for reducing future impervious surface coverage and increasing stormwater infiltration in the coastal Delaware communities. Tools were identified based on their capability to reduce stormwater runoff within this region, as well as cost, feasability, and maintenace. Strategies for incentivizing BMPs are also discussed.

Acknowledgments

Resilient Community Partnership

City of Lewes

Town of Henlopen Acres

City of Rehoboth Beach

Town of Dewey Beach

Town of Bethany Beach

Town of South Bethany

Town of Fenwick Island

Delaware Coastal Programs

Consultants

AECOM

KCI Technologies, Inc.

Contents

Rapid growth compounded with impacts to the groundwater table and growing floodplain are the reasons that costal Delaware communities are seeking out strategies for reducing impervious surface cover.

Introduction

This is a community-based plan designed to summarize strategies for reducing existing and future impervious surface coverage and increasing stormwater infiltration in the coastal Delaware communities. This guide is intended to be used by residents, elected officials, and community members.

Coastal Delaware

Seven unique municipalities make up the coastal Delaware communities: Lewes, Henlopen Acres, Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany, and Fenwick Island.

Based on census data, all of the municipalities are relatively small, ranging in year-round populations of a couple hundred to a couple thousand . However, each summer the area's beaches draw tourists from Pennsylvania, Maryland, New Jersey, Washington, D.C, Virginia, and beyond. While tourism has become an integral part of the local economy, "it is important to consider how seasonal residents and tourists impact the County's housing supply, roads, utilities, and natural environment." Not only are more people visiting the Delaware beaches each year, but Eastern Sussex County is also experiencing rapid residential growth. "Sussex County's lower tax rates, natural environment, quality of life and housing opportunities are attracting retirees, owners of second homes, and other older households in great numbers. Some seasonal visitors buy a second home in Sussex with the intent that it will become their regular retirement home"(Sussex Plan, 2018.) Growth and development has led to an increase in impervious surfaces and reduction in the areas where infiltration to groundwater can occur.

Moreover, based on their proximity to the Atlantic Ocean, each of these communities faces challenges associated with rising sea-level. Rapid growth compounded with impacts to the groundwater table and growing floodplain are the reasons that the coastal Delaware communities are seeking out strategies for reducing impervious surface cover.

Delaware Coastal Programs' Resilient Community Partnership

The Resilient Community Partnership program is administered by the Delaware Department of Natural Resources and Environmental Control's (DNREC) Delaware Coastal Programs Section to provide Delaware communities with technical assistance through federal funding. The program's goal is to help communities undertake the necessary planning to become more resilient to coastal hazards. In early 2018 the City of Rehoboth Beach sought interest from other coastal communities in forming a partnership to apply for assistance in conducting a comprehensive study of impervious surface cover due to development in the coastal communities, and its impacts on stormwater management, flooding, and water quality. As a portion of the deliverable associated with the project, the coastal communities have requested a summary of best management practices (BMPs) that will increase stormwater infiltration and reduce impervious surface coverage.

Regulatory Context

There are three general scenarios upon which BMPs may be placed to manage runoff from:

1) existing developed areas on a voluntary basis

2) small impervious areas being proposed that would not otherwise fall under the third scenario

3) larger (greater than 5,000 sq. ft.) earth disturbance being proposed

Typically, there are no regulatory requirements for projects in the first category, but coastal communities may want to consider inclusion of these types of projects in their building permit processes if for no other reason than to

track installations. Similarly projects in the second category may or may not fall under current requirements depending on the size and type of the proposed activity. Projects in the third category would trigger compliance with the State's Sediment and Stormwater Regulations (DSSR), which would necessitate a permit from the Sussex Conservation District. It is noted that lots in the coastal communities are frequrently less than 5,000 square feet in area and thus, exempt from the DSSR regardless of the activity proposed.

Recognizing that compliance with the DSSR can be burdensome for smaller projects, DNREC has created Standard Plans for numerous situations including single-family house construction. When Standard Plan measures, which generally provide for erosion and sediment control measures, are implemented, the project is considered in compliance with the DSSR.

This document is intended to be used for projects which fall under the first two scenarios. Portions of this document somewhat parallel the DSSR. Coastal communities have the option to enact regulations that are more stringent than the DSSR, but cannot lessen the requirements. For example, any city or town can mandate that projects with earth disturbance of less than 5,000 square feet need to be provided with erosion and sediment control measures above and beyond those specified in Standard Plans and / or permanent stormwater management BMPs as described herein. See the Implementation Section.

As stated previously, this is a community-driven guide and not a regulatory document. When implementing stormwater management strategies in Sussex County, any property owner should consult with the requirements and processes outlined by each governing organization:

• Sussex Conservation District
https://www.sussexconservation.org/services/stormwater.html

• DNREC Sediment and Stormwater
https://dnrec.delaware.gov/swc/Pages/SedimentStormwater.aspx

Coastal Delaware communities have the option to enact regulations more stringent than the DSSR and may want to consider inclusion of the suggested practices in their permitting processes.

Terms Defined

The following terms are used in the document and have been defined for your reference using definitions provided by the United States Environmental Protection Agency (EPA).

Term	Definition
Aggregate	A mass or cluster of rock and/or soil particles, often having a characteristic shape.
Berm	A commonly occurring, low, impermanent, nearly horizontal ledge or narrow terrace on the backshore of a beach, formed of material thrown up and deposited by storm waves.
Channel	A stream or river bed; generally refers to the physical form where water commonly flows.
Discharge	Flow of surface water in a stream or canal or the outflow of groundwater from a flowing artesian well, ditch, or spring. Can also apply to discharge of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.
Forebay	An extra storage space provided near an inlet of a wet pond or constructed wetland to trap incoming sediments before they accumulate in the facility.
Herbicide	A chemical pesticide designed to control or destroy plants, weeds, or grasses.
Infiltration	The movement of water through the ground surface into the unsaturated zone.
Native	A plant or animal that originally occurred in an area.
Percolation	The passage of liquids, powders, or small particles through a porous substance. Water percolates through soil in the water cycle.
Porosity	The ratio of the void volume of a porous rock or soil to the total volume, usually expressed as a percentage.
Public Right-of-Way	Any sidewalk, planting strip, alley, street, or pathway, improved or unimproved, that is dedicated to public use. The term includes any strip of land over which public facilities such as highways, railroads, or power lines are built.
Recharge	The process by which water is added to a zone of saturation, usually by percolation from the soil surface; e.g., the recharge of an aquifer.
Saturation	The percentage of the pore space occupied by a fluid, usually water in hydrologic applications.
Slope	The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating one unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04); degrees (2 degrees 18 minutes), or percent (4 percent).
Snowmelt (Springmelt/ Thaw)	The process by which warm temperatures melt winter snow and ice. Because various forms of acid deposition may have been stored in the frozen water, the melt can result in abnormally large amounts of acidity entering streams and rivers, sometimes causing fish kills.
Swale	Sometimes called a biofilter, if designed accordingly, a grass-lined channel that is designed to convey stormwater in shallow flow. Pollutant removal is accomplished through filtration through the vegetation and swales are frequently designed to allow for infiltration of stormwater.
Trace Elements	An element found in only minor amounts in water, generally less than 1.0 milligram per liter. Includes arsenic, copper, iron, lead, mercury, manganese, selenium, and zinc.
Underdrain (Subsurface Drain)	A shallow drain installed in the bottom of certain BMPs where infiltration may not be sufficient to drain the facility. Can also refer to a shallow drain installed in an irrigated field to intercept the rising groundwater level and maintain the water table at an acceptable depth below the land surface.
Vegetation (Flora)	Plant life.
Weir	A wall or plate placed in an open channel and used to measure the flow of water. The depth of the flow over the weir can be used to calculate the flow rate, or a chart or conversion table may be used.

BMP Selection Guide

What is a BMP?

A Best Management Practice or BMP is a technique or device that captures or treats stormwater runoff. Stormwater refers to the rain water that flows off of different surfaces after it falls to the ground. People commonly see stormwater running out of rooftop gutters and along the sides of streets during a rainstorm.

The surfaces on which rain water falls are classified into two categories:

- Pervious surfaces – surfaces that allow stormwater to seep into the earth like gardens, forests and grass
- Impervious surfaces – surfaces that don't allow stormwater to seep into the earth like driveways, roads, sidewalks, and roof tops.

When land is developed, pervious surfaces are replaced with impervious buildings, sidewalks, and roadways, and less stormwater is able to seep into the ground. A larger amount of stormwater runs off into storm drains and streams, causing more frequent flooding. In developed areas, stormwater is also more likely to pick up pollutants like gasoline residue, animal waste, and trash and wash them into streams, lakes, and the ocean. BMPs typically are designed to capture runoff from impervious areas. When BMPs are constructed, they help reduce flooding in towns and communities and filter pollutants out of stormwater before it reaches important aquatic ecosystems.

Porous Pavement
When pavement is necessary, individuals or towns can install porous pavement that allows stormwater to percolate down. Pictured above is Bay Avenue in Lewes. Conservation landscaping along the edge of the road helps combat erosion.

Excess Impervious Surface Coverage
One of the Coastal Delaware towns submitted this photograph to the project team as an example of excess impervious surface coverage. In heavy rain events, the water has no where to go but their neighbor's property or the street.

BMP Identification and Placement
The diagram to the left shows proposed BMP placement in a suburban neighborhood. Each of these BMPs will be discussed later in this document, with pictures of local examples provided.

To gain a better understanding of local issues and preferences, a survey was was sent to the community leaders in the seven coastal Delaware municipalities. Six of those municipalities participated: Fenwick Island, Bethany Beach, Rehoboth Beach, Henlopen Acres, South Bethany, and Lewes. Questions that pertain to this BMP guide and summaries of the responses from the municipalities are included below.

Does your city code have a definition for "impervious surface"?

Two out of six municipalities had city codes that defined impervious surfaces or materials - Lewes and South Bethany. One additional municipality, Fenwick Island, had a code that mentioned impervious surface but did not define it.

Do you believe this definition is accurate and sufficient?

The two aforementioned municipalities believed that their definitions of impervious surface were accurate or somewhat accurate.

Does your community have ordinances or other regulations which regulates the percentage of impervious coverage on a residential or commercial lot? If so, please list the code reference for review.

One municipality, South Bethany, requires that new developments have a maximum of 45% imperviousness. Fenwick Island and Rehoboth Beach have requirements that define the ratio of the building footprint to the natural area on a lot. Henlopen Acres and Lewes define a maximum allowable building coveargе per zoning district, and Bethany Beach does not regulate this.

Does your community allow for alternative types of pavement, pavers, or surface treatments to be used for parking areas, driveways, etc.? If so, please list the code reference for review.

Rehoboth Beach does not allow the use of alternative pavements, pavers, or surface treatments. Although the survey response did not indicate why permeable pavement is not allowed in this municipality, a common concern with permeable pavement is the high level of maintenance needed on public roadways. This concern can be addressed by installing permeable pavement on sidewalks and private driveways, where maintenance and salting are less frequent. The other five municipalities that took the survey do allow permeable pavement, or their local ordinances do not specify which paving materials must be used.

Does your community have standards and specifications in relation to driveways, curbing, sidewalk, etc.? If so, please list the code reference for review.

All municipalities have separate standards for driveways, sidewalks, and curbs. One municipality, Bethany Beach, pointed out that they typically do not have sidewalks or curbs. This applies to several of the coastal communities.

What challenges do you think are unique to your community?

For the most part, challenges were shared amongst these six municipalities. Some challenges that municipalities cited were large homes built on small lots, large amounts of impervious surface that were previously unregulated, flood hazards, and low infiltration ability.

Is the Community aware of some of the new pervious surface products, if so are there any concerns with specific ones?

Two out of six municipalities stated that they are actively using pervious surface products and are happy with the results. The exact type of impervious surface product used (i.e. pavers, asphalt, or concrete) was not specified. Other municipalities said that their residents were somewhat aware or unaware of the potential uses of pervious surface products.

Survey Results Continued

Concerning the menu of options to address impervious surface coverage, what kind of product would help your municipality most? (Something more visual or more technical?)

Most of the municipalities desired that the BMP Guide be more visual than technical, although some municipalities requested the guide to have a technical aspect as well. In this case, it is assumed that a more visual guide would introduce the concept of BMPs and provide picture examples but would be more general when it comes to specific design constraints. A more technical guide would lay out the detailed design requirements of a BMP.

What kind of audience would you like the "menu of options" to be geared towards?

Municipalities wanted a menu of BMPs to be geared toward town councils and committees, and the community at large.

Interested in learning more about these communities? More survey questions and complete responses are included at the end of this document in Appendix B.

How to Use this Guide

This guide is intended for residents and community leaders to use as an educational and decision-making tool. It defines several BMPs that are used throughout the United States that may be useful in coastal Delaware communities and provides some general specifications related to feasibility, cost, and maintenance. As explained in the Introduction, in some instances, the Delaware Post Construction Stormwater BMP Standards and Specifications manual should be referenced. The BMP chosen for a property will depend on several factors, including the property type, the environmental conditions of the property, and the goals of the BMP construction project.

BMP Benefits

Most of the BMPs included in this guide were chosen for their capability to reduce stormwater runoff since frequent flooding has been an issue in coastal Delaware communities. BMPs can provide other functional benefits as well. The BMP benefits cited in this guide include:

- Runoff Rate Reduction - the BMP slows down stormwater runoff or allows it to percolate into the soil to reduce flooding;
- Water Quality - the BMP filters storm water to remove pollutants;
- Habitat - the BMP creates areas that are beneficial to pollinators, birds, and/or small mammals; and
- Aesthetics - the BMP generally has a high approval rating among property owners and enhances the looks of a landscape.

Property Type

The BMP summaries include a list of appropriate property types where they can be installed. Properties are organized into two categories: residential; and commercial, industrial, and institutional. The BMP summaries include color indicators that correspond to the property type:

Res (Residential) CII (Commercial, Industrial, Institutional)

Feasability and Maintenance

The BMP summaries include tables for feasibility criteria and maintenance needs. A property owner should review these specifications before choosing a BMP, as the location of their property may dictate what kinds of BMPs are feasible. For instance, many regions in coastal Delaware have a groundwater table that is located within 2 feet of the ground surface. Areas that have a shallow depth to the groundwater will not be suitable for BMPs that require at least 2 feet of ground cover between the bottom of the BMP and the top of the groundwater table. See the explanation of the water table below for further details and Appendix A for a map of coastal Delaware's depth to the water table (NRCS, 2018). Additionally, many areas in coastal Delaware are located within the 100-year floodplain. See the explanation of the 100-year floodplain below for further details. In these areas, neither bioretention facilities nor grass-lined channels will be the best choice for stormwater treatment.

Specifications regarding feasibility defined in this guide include:

• Soils Type - The US Department of Agriculture's Natural Resources Conservation Service (NRCS) classifies soils into hydrologic groups based on their ability to transmit water. A Web Soil Survey can be conducted online (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) to determine soil types at specific site locations. Soils are classified into groups A, B, C, or D.

- Group A: Soils have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10% clay and more than 90% sand or gravel.

- Group B: Soils have moderately low runoff potential when thoroughly wet. Water transmission through soil is unimpeded. Group B soils typically have between 10- 20% clay and 50-90% sand.

- Group C: Soils have moderately high runoff potential when thoroughly wet. Water transmission through soil is somewhat restricted. Group C soils typically have between 20-40% clay and less than 50% sand.

- Group D: Soils have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40% clay and less than 50% sand.

• Water Table – The water table refers to the space underground where the soil becomes saturated with water. The elevation of the water table fluctuates and is affected by the amount of rain that falls each season. Specifications related to the water table include the necessary distance between the top of the seasonally high water table and the bottom of a BMP.

• Drainage Area –The drainage area to a BMP includes the land from which stormwater runoff flows into the BMP. One drainage area is separated from another by high elevations such as hills or mountains, but for smaller BMPs, the drainage area might be separated by small elevation changes like a curb on a street or a slope change on a roof. When treating the runoff from a rooftop, the property owner should install a BMP at each downspout so that stormwater is treated from all sides of the roof. On a 1,000-square-foot home, the first inch of rooftop runoff may produce a total of 590 gallons, but if the roof is triangular and drains to two downspouts, each downspout should discharge to a BMP that can treat 295 gallons. Specifications related to BMP drainage areas in this guide include minimum and maximum size constraints.

• Slope Restriction – Slope restrictions may involve a maximum slope of the ground surface in or around a BMP.

• Hot Spot Runoff – Hot spots are areas that produce runoff with a high level of pollutants or have potential for spills or leaks of polluting chemicals. If hot spot runoff is restricted, a BMP cannot treat stormwater with higher concentrations of pollutants than is typically found in urban runoff.

• 100-Year Floodplain – The 100-year floodplain is the area specified by the Federal Emergency Management Agency (FEMA) that has a 1% chance of flooding in any given year. If this category is labeled as restricted, the BMP cannot be located within the 100-year floodplain.

The property owner should consider choosing a BMP for which he or she is willing to perform the proper maintenance tasks. The maintenance tasks and the amount of maintenance needed differ for each BMP. The BMP summaries list the specific maintenance tasks required, the frequency that those tasks should be performed, and a general rating of maintenance difficulty. Maintenance of a BMP is the sole responsibility of the property owner unless otherwise specified by the governing body.

This guide is intended to be used by residents and community leaders of coastal Delaware as a decision-making tool.

---

1. Bioretention

Figure 1: Rehoboth Art League
Soil media, plants, and stones are used to filter stormwater before draining into a ditch system.

Figure 2: Fenwick Island Rain Garden
The Town of Fenwick Island installed rain gardens at Canalfront Park to filter stormwater run-off from nearby parking lots and streets before it runs to the canal.

72h

Bioretention areas are designed to hold water for no more than 72 hours after a storm. If regular maintenance is not conducted, bioretention facilities may hold standing water for more than 3 days and create an environment conducive to mosquito breeding.

Bioretention practices reduce flooding, erosion, and pollution, and enhance groundwater recharge, wildlife habitat, and aesthetics.

Description

Bioretention practices capture and store stormwater runoff and pass it through a bed of engineered soil media known as biosoil (DNREC, 2019). They are typically planted with native plants that have deep roots, which loosen the soil and allow more stormwater to soak into the ground. They reduce flooding, erosion, and pollution and enhance groundwater recharge, wildlife habitat, and aesthetics.

Facilties

Different types of bioretention facilities include:

- Rain Gardens: small to medium-sized facilities planted with native plants and flowers
- Tree Box Filters: small-sized facilities with filter media, trees, and sometimes other plants contained within an engineered box
- Streetscape Bioretention: small-sized facilities with filter media and plants contained within an engineered box, typically located in urban areas
- Large Bioretention: traditional or advanced bioretention facilities that treat larger amounts of stormwater and typically include a clean-out pipe; may include an underdrain or may allow water to percolate into the soil
- Raised Planter Box: a small garden in an elevated box that captures rain water

Feasability

The following table lists the feasability requirements for bioretention facilities.

Soils	Underdrain required if C/D soils
Water Table	If infilitration is used, bottom of facility must be 2 feet above seasonal high water table
Drainage Area	10-acre maximum for large bioretention; 1-acre maximum for rain gardens, tree box filters, streetscape bioretention, and raised planter boxes
Slope Restriction	No Restrictions
Hot Spot Runoff	Restricted if infiltration is used
100-yr Floodplain	Restricted

Bioretention Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Rain Gardens	Res, CII	$	Water Quality, Runoff Rate Reduction, Habitat, Aesthetics	Medium
Tree Box Filters	Res, CII	$$	Water Quality, Runoff Rate Reduction, Habitat, Aesthetics	Medium
Streetscape Bioretention	Res, CII	$$	Water Quality, Runoff Rate Reduction, Habitat, Aesthetics	Medium
Large Bioretention	CII	$$$$	Water Quality, Runoff Rate Reduction, Habitat, Aesthetics	Medium
Raised Planter Box	Res, CII	$$	Water Quality, Runoff Rate Reduction, Aesthetics	Medium

Maintenance

Monthly

- Regularly inspect the site
- Remove debris and blockages
- Remove weeds and invasive plants
- Alert the appropriate governing body if erosion is seen in or around the facility
- Check the facility after a storm to make sure any standing water draws down after 2 days.

As Needed

- Mow the vegetated perimeter of the bioretention facility but not within the facility
- Repair broken components and outlet structure
- Remove sediment in facility
- Water plants every 3 days for the first 18 months after establishment and during droughts (when there has been no rain for more than 10 days)

What to Avoid

- Keep animal waste out of the facility
- Do not remove material from the facility
- Do not shovel snow onto the facility

Bioretention Sizing Chart

Size of Drainage Area (sq. ft.)	Area of Bioretention Facility (sq. ft.)
100	3-6
500	15-30
1,000	30-60
2,000	60-120
3,000	90-180
4,000	150-300

The area of the bioretention facility will depend on the size of the drainage area and the ponding depth inside the facility.

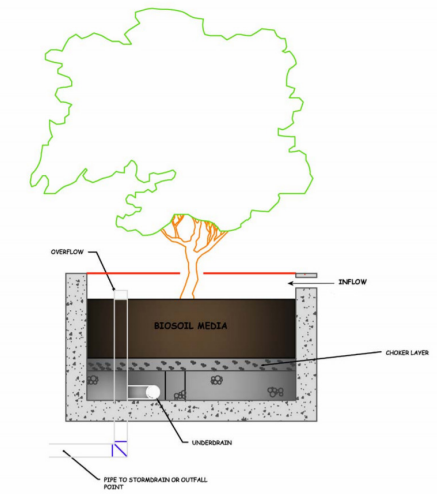


Figure 3: Engineered Tree Box Diagram
The above diagram is provided in DNREC's BMP Standards and Specifications as a typical tree box design.

2. Bioswale

A bioswale is an elongated, linear bioretention facility often found on roadsides within the right-of-way. They can be outfitted with small dams to retain water on steeper slopes.

Figure 4: Route 1 Bioswales
The Center for Inland Bays (CIB) worked with the Town of South Bethany to install bioswales in the medians along Coastal Highway (Route 1.)

Figure 5: Route 1 Bioswales
CIB and South Bethany identified sixteen locations that would assist in assist in filtering stormwater run-off from the highway.

Feasability

The following table lists the feasability requirements for bioswales.

Soils	No restrictions
Water Table	The bottom of the channel should be above the seasonally high water table
Drainage Area	10 acres maximum
Slope Restriction	The longitudinal slope should be less than 4%
Hot Spot Runoff	No restrictions
100-yr Floodplain	Restricted

Maintenance

Monthly

- Regularly inspect the site
- Remove debris and blockages
- Remove weeds and invasive plants
- Alert the appropriate governing body if erosion is seen in or around the facility
- Check the facility after a storm to make sure that any standing water draws down after 2 days.

As Needed

- Mow the vegetated perimeter of the bioretention facility but not within the facility
- Repair broken components and outlet structure
- Remove sediment in facility
- Water plants every 3 days for the first 18 months after establishment and during droughts (when there has been no rain for more than 10 days)

What to Avoid

- Keep animal waste out of the facility
- Do not shovel snow onto the facility

Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Bioswale	CII	$$	Water Quality, Runoff Rate Reduction, Storm Conveyance	Low

Figure 6: Rehoboth Beach City Hall
Outside Rehoboth Beach City Hall, pavers are used instead of concrete for a walkway. Gravel and plantings, which help filter sediment from stormwater before it infiltrates through the pavers, line the walkway.

BMPs improve aesthetics

Figure 9: Residential Backyard in Lewes
Multiple BMPs can be spotted in this resident's backyard. Native species are planted throughout, cisterns hold excess water, pavers and large stones are used instead of concrete.

Figure 7: Delaware Seashore State Park
A streetscaped median lines the entrance to one of Delaware Seashore State Park's public parking lots.

Figure 8: The Comfort Store, Rehoboth
Outside the Comfort Store, multiple BMPs are implemented in a small area. Pavers are used instead of concrete, landscaping absorbs stormwater, and an extra chamber in the planters stores water temporarily.

3. Infiltration

Figure 10: BayardStreetInfiltrationTrench
The Town of Fenwick Island installed an infiltration trench along Bayard Street to filter and store stormwater before draining to the canal.

Figure 11: BayardStreetInfiltrationTrench
Spray paint is used along the street to indicate where parking is and is not allowed even though there is no curb present.

Figure 12: Infiltration Basin (Plan View)
The diagram pictured to the right is provided in DNREC's BMP Standards and Specifications as a typical infiltration basin design that would be displayed on a stormwater plan.

Infiltration practices temporarily store stormwater before slowly allowing it to drain into soil.

Description

Infiltration practices "capture and temporarily store the design storm volume before allowing it to infiltrate into the soil over a two day period" (DNREC, 2019).

Facilties

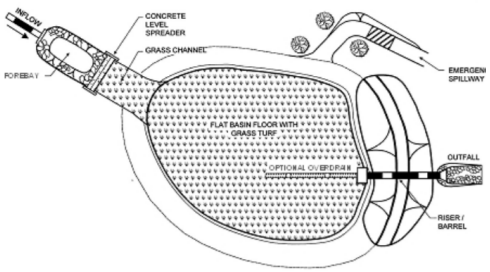
Different types of infiltration facilities include:

- Infiltration Trench: elongated reservoir filled with stone and optionally covered with turf that allows water to percolate into the ground
- Infilltration Basin: engineered facility with a berm, forebay, and overflow weir that stores open water until it percolates into the ground

Feasability

The following table lists the feasability requirements for infiltration facilities.

Soils	A/B
Water Table	Bottom of facility must be 2 feet above seasonal high water table
Drainage Area	Varies with the size of the BMP
Slope Restriction	Slope should be less than 5%
Hot Spot Runoff	Restricted
100-yr Floodplain	No Restrictions
Other Restrictions	Infiltration practices should be set back at a distance that will ensure that water infiltrating into the ground will not interfere with surooundings buildlings and basements. The distance should be determined by a qualified engineer.



Infiltration Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Infiltration Trench	Res, CII	$$	Water Quality, Runoff Rate Reduction	High
Infiltration Basin	CII	$$$	Water Quality, Runoff Rate Reduction	Medium

Infiltration Sizing Chart

Width of Trench (inches)	Rooftop Area Treated (sq ft)	Depth of Trench (inches)					
		36	48	60	72	84	96
		Required Length of Infiltration Trench (feet)					
18	100	4.3	3.2	2.6	2.2	1.9	1.6
24		3.2	2.4	1.9	1.6	1.4	1.2
30		2.6	1.9	1.6	1.3	1.1	1.0
18	1000	42.5	32.1	25.9	21.6	18.6	16.3
24		31.9	24.1	19.4	16.2	13.9	12.2
30		25.5	19.3	15.5	13.0	11.1	9.8
18	5000	21.5	160.7	129.3	108.1	92.9	81.4
24		159.4	120.6	96.9	81.8	69.6	61.1
30		127.5	96.4	77.6	64.8	55.7	48.8

This table (left) assumes that infiltration occurs at the bottom of the infiltration practice and that the porosity of the gravel and the sand aggregate base is 0.4. The assumed infiltration rate of the soils is 0.5 inch per hour and the assumed fill time is 1 hour. If the infiltration rate of the soils is less than 0.5 inch per hour, a larger infiltration device will be needed to treat the first inch of runoff from a roof.

Maintenance

Monthly

- Regularly inspect the site
- Remove debris and blockages
- Alert the appropriate governing body if erosion is seen in or around the facility
- After a storm, make sure standing water draws down after 72 hours

As Needed

- Mow the vegetated perimeter of the facility
- Repair broken components and outlet structure
- Remove any grass, weeds, trees or woody vegetation that grows in the trench
- Fill in animal burrows
- Reseed adjacent bare areas to prevent erosion

What to Avoid

- Keep animal waste out of the facility
- Do not remove material from the facility
- Do not shovel snow onto the facility

Figure 13: Rolling Road Infiltration Trench
The above pictured infiltration trench was installed along Rolling Road in Henlopen Acres to reduce erosion along the street and reduce stormwater run-off.

4. Permeable Pavement

Figure 14: Rehoboth City Hall Parking Lot
Parking spots at the Rehoboth City Hall public parking lot are covered in porous asphalt.

Figure 15: Resident's Stone Driveway
A resident's personal driveway covered in stone.

Figure 16: Porous Asphalt at CIB
The Delaware CIB's main office is located in a vunerable location along the Indian River Bay. Their porous ashpalt parking lot helps disperse water during high rain events.

Permeable pavements allow stormwater runoff to drain while also filtering pollutants.

Description

Permeable pavements allow stormwater runoff and snowmelt to drain through the pavement's surface to the subbase and base layers below. In addition to reducing runoff volume, these layers also help to filter pollutants. Permeable pavements can use either infiltration or an underdrain system depending on the surrounding soils. A stone-filled reservoir underneath the permeable pavements provides structural support.

Facilties

Different types of permeable pavement include:

- Pervious Concrete: Pervious concrete consists of cement-based materials, but with little or no sand, creating substantial voids for infiltration. Pervious concrete can be cast-in place or come in pre-cast sections, depending on the selected design. Popular application of pervious concrete includes sidewalks, alleys, parking lots/lanes, and driveways.
- Permeable Interlocking Concrete Pavers: These pavements include pre-manufactured concrete paver units assembled into an interlocking pattern with permeable areas between the units. The PICP are primarily used in sidewalks, driveways and parking lots/lanes, and alleys without heavy traffic.
- Grid Pavement Systems: Grid pavement systems typically include plastic or concrete sections with openings filled with permeable materials, such as sand or topsoil with grass at the surface. The concrete/plastic units are placed over an aggregate base and are typically used in areas with minimal traffic.
- Porous Asphalt: Porous asphalt includes a permeable asphalt surface with an interconnected void space that allows stormwater to percolate. Porous asphalt can be primarily used in areas with low to moderate traffic, such as parking areas, driveways, and roads with lower volumes of traffic.

Feasability

The following table lists the feasability requirements for permeable pavements.

Soils	Underdrain required if C/D soils
Water Table	Bottom of facility must be 2 feet above the seasonal high water table unless underdrain is provided.

Drainage Area	The ratio of drainage area to surface area of the BMP should be a maximum of 5:1. At least 90% of the runoff draining to these BMPs should drain from impervious surfaces.
Slope Restriction	These BMPs should be installed on slopes less than 5%.
Hot Spot Runoff	Restricted
100-yr Floodplain	No Restrictions
Other	The stone reservoir under permeable pavements must be able to support surface loading and be thick enough for filtration.

Permeable Pavement Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Permeable interlocking concrete pavers	Res, CII	$$$$	Water Quality, Runoff Rate Reduction	Low
Grid Pavement Systems	Res, CII	$$$$	Water Quality, Runoff Rate Reduction	Low
Pervious Concrete	Res, CII	$$$	Water Quality, Runoff Rate Reduction	Low
Porous Asphalt	Res, CII	$$$	Water Quality, Runoff Rate Reduction	Low

Maintenance

As Needed

• For the first 6 months after construction, inspect permeable concrete, asphalt, and pavers twice after storm events, to make sure water has drained within 72 hours
• Mow grass in permeable interlocking pavers
• Remove sediment or soil deposits on permeable pavement
• Pressure wash or vacuum permeable pavement with street sweeper to prevent clogging
• Remove snow with a rubber tipped shovel/plow
• Pull weeds when needed

What to Avoid

• Don't pile mulch, sand, soil, or yard waste on top of the BMP
• Don't pile snow that contains salt or sand on top of the BMP
• Don't replace vehicle fluids or wash vehicles on top of the BMP
• Don't apply sealants or repave the area with materials that don't let water pass through
• Don't let large vehicles regularly drive on or turn around on porous surface
• Don't use herbicides to remove weeds
• Don't apply sand or salt onto areas that may drain to the BMP

Permeable Pavers, Asphalt, Concrete Sizing Chart

Contributing Impervious Drainage Area (square feet)	Depth of Below Surface Gravel Storage (inches)		
	6	9	112
	Area of Pavers (square feet)		
100	32.8	23.2	17.9
500	163.8	115.9	89.6
1000	327.6	231.7	179.2
2000	655.2	463.4	358.5
3000	982.8	695.1	537.7
4000	1310.3	926.8	717.0
5000	1637.9	1158.5	896.2

This table (above) assumes that infiltration occurs along the bottom area of the permeable pavers and that the porosity of the gravel is 0.4. The assumed infiltration rate of the soils is 0.5 inches per hour and the assumed fill time is 1 hour. If the infiltration rate of the soils is less than 0.5 inches per hour, an underdrain may be required. This table reflects the treatment ability of permeable pavers placed on A or B soils.

Figure 17: Non-Porous versus Porous Asphalt
The above picture displays normal concrete on the left installed next to pervious concrete on the right. The porous pavement parking is located at the CIB at the Indian River Inlet.

5. Impervious Surface Removal

When constrained to implement other BMPs, impervious surfaces can simply be removed and replaced with pervious surface to reduce runoff.

Figure 18: Paver Pathway
More and more residents are choosing to use pavers or gravel, which allow infiltration, instead of traditional concrete for driveways and walkways.

Figure 19: Henlopen Acres Walking Trail
Pictured above is another example of traditional asphalt or concrete being replaces by crushed stone for a walking trail.

Description

In some areas of coastal Delaware, impervious surfaces have previously been constructed to accommodate oversized parking requirements or in anticipation of planned development that did not occur. Likewise, some streets have wider paved surfaces than necessary to accommodate transportation and parking. Some of these impervious surfaces are no longer needed and can be removed and replaced with pervious surfaces to reduce stormwater runoff. This approach is best used in locations where other types of BMPs are undesirable or infeasible. Other BMPs provide better stormwater treatment and runoff reduction, but impervious surface removal has fewer environmental constraints.

Feasability

The following table lists the feasability requirements for impervious surface removal.

Soils	No Restrictions
Water Table	No Restrictions
Drainage Area	No Restrictions
Slope Restriction	No Restrictions
Hot Spot Runoff	No Restrictions
100-yr Floodplain	No Restrictions

Bioretention Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Impervious Surface Removal	Res, CII	$$$	Runoff Rate Reduction	Low

Maintenance

As Needed

- Mow grassy areas
- Ensure that no invasive species are present
- Replace any plants that did not survive

What to Avoid

- Don't apply fertilizer or pesticides

6. Dry Well

Dry wells collect and store water that can be treated or filtered.

Figure 20: Gutter system to Dry Well
This gutter system, installed on a resident's home in Lewes, conveys water to two different locations: a dry well and a rain garden.

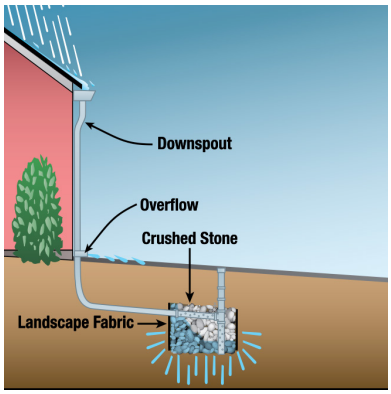


Figure 21: Dry Well Diagram
The diagram above demonstrates how a dry well works.

Maintenance

Monthly

- Regularly inspect the BMP
- Remove debris and blockages
- Alert the appropriate governing body if erosion is seen in or around the facility
- After a storm, make sure any standing water draws down after 3 days

Description

Dry wells are small pits that collect water from the gutters of a house. The pits may be filled with stone or contain a prefabricated detention chamber. Usually multiple devices are required to treat all the stormwater from a single rooftop. They can be located at the ground surface or below ground. Additional water quality benefits can be obtained from dry wells that include treatment features like separators and specialized filters.

Feasability

The following table lists the feasability requirements for dry wells.

Soils	A/B, unless an underdrain is used
Water Table	Bottom of facility must be 2 feet above seasonal high water table
Drainage Area	The amount of rooftop that can drain to a dry well depends on the size and number of dry wells used (see Dry Well Sizing Chart)
Slope Restriction	No restrictions
Hot Spot Runoff	Restricted
100-yr Floodplain	No restrictions
Other Restrictions	Infiltration practices should be set back at a distance that will ensure that water infiltrating into the ground will not interfere with suroounding buildlings and basements. The distance should be determined by a qualified engineer.

Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Dry Well	Res, CII	$$	Water Quality, Runoff Rate Reduction	High

Dry Well Sizing Chart

Depth of Sand Aggregate Base (inches)	Depth of Gravel (inches)	Depth of Trench (inches)				
		24	30	36	42	48
		Contributing Area Captured from Rooftop (sq ft)				
12	24	54	85	122	166	217
	36	70	110	158	215	280
	48	86	134	193	263	344
	60	102	159	229	312	407

7. Rooftop Disconnect

Figure 22: Disconnected Downspout
The downspout featured above is an example provided by the University of Maryland Extension.

Figure 23: Canalfront Hotel Disconnect
The Canalfront Inn in Lewes has a system of drainage pipes that convey water from the roof to planted.beds around the hotel.

Rooftop disconnects can be positioned to flow water into another another BMP.

Rooftop disconnect refers to the act of repositioning downspouts so that stormwater flows onto a permeable surface instead of an impermeable surface. It can be achieved by directing runoff onto grass or landscaping.

Feasability

The following table lists the feasability requirements for rooftop disconnects.

Soils	No Restrictions
Water Table	No Restrictions
Drainage Area	May not exceed 1,000 sq. ft.
Slope Restriction	The maximum slope of the disconnect area should be 25%.
Hot Spot Runoff	No Restrictions
100-yr Floodplain	No Restrictions
Other Restrictions	All locations south of the Chesapeake and Delaware Canal should release rooftop runoff onto a vegetated area that is at least 60 feet long in the direction of flow. Locations north of the canal will require 75 feet of vegetated area.

Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Rooftop Disconnect	Res, CII	$	Runoff Rate Reduction	Low

Maintenance

As Needed

- Weed raised planter boxes
- Regularly mow grassed areas where rooftop runoff flows
- Replace grass and/or plants that have not survived

What to Avoid

- Don't apply fertilizer or pesticides to lawn
- Don't mow too much or mow plants to a height shorter than 3 inches

8. Green Roof

Figure 24: Green Roof
An example of a green roof installed on a commercial building is pictured above.

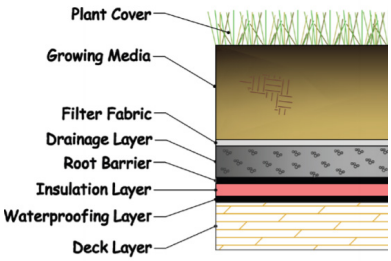


Figure 25: Green Roof
The diagram above is provided in DNREC's BMP Standards and Specifications as the typical layers included in a Green Roof.

Maintenance

As Needed

- Pull weeds as needed
- Water regularly during first year after establishment and during periods of drought

What to Avoid

- Don't apply fertilizer or pesticides

A green roof is a rooftop garden where plants and engineered growing media are used to treat and store rainwater. Green roofs provide building insulation, which often results in decreased costs for heating and cooling.

Feasability

The following table lists the feasability requirements for a green roof.

Soils	No restrictions
Water Table	No restrictions
Drainage Area	Vegetated area should be 66% the size of the drainage area
Slope Restriction	Green roofs are not suitable for roofs with a slope greater than 16% for green roofs that have a shallow growth medium (soil) and 10% for green roofs that have deep growth medium
Hot Spot Runoff	No restrictions
100-yr Floodplain	No restrictions
Other	Rooftop must be analyzed and certified for structural capability by a licensed professional who is experienced in green roof installation. A qualified roofing contractor and landscape architect will be needed to design the structural components and landscape a green roof. Documentation of the structural certification must be provided to Sussex County along with building permit documentation before construction of a green roof. Local building codes must be followed.

Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Green Roof	CII	$$$$	Water Quality, Runoff Rate Reduction	Medium

9. Rainwater Harvesting

Rain barrels and cisterns can be used to store rainwater to be reused for gardening and other non-potable water activities.

Figure 26: Residential Cistern
A resident of Lewes installed a 2,000-gallon cistern on site.

Figure 27: Residential Cisterns
Three catchment drains convey stormwater directly to the aforementioned cistern.

Feasability

The following table lists the feasability requirements for rainwater harvesting.

Soils	No restrictions
Water Table	The bottom of the channel should be above the seasonally high water table
Drainage Area	10 acres maximum
Slope Restriction	The longitudinal slope should be less than 4%
Hot Spot Runoff	No restrictions
100-yr Floodplain	Restricted

Maintenance

As Needed

- Check the water intake and leaf screening devices and remove any build up
- Clean leaf litter from roof top gutters
- Ensure that mosquito screen is in place and tight
- Be sure to drain your rain barrel at regular intervals, and before the winter season to prevent mosquitos
- Inspect and clean out the tank if necessary
- Check for leaks and erosion around the cistern/rain barrel

What to Avoid

- Don't leave water in cisterns or rain barrels for extended periods of time
- Don't use water as a potable water source
- Don't let children play in or around rain barrels
- Don't spray water directly onto edible plants because it may contain bacteria from the roof.

Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Rain Barrel	Res, CII	$	Water Quality, Runoff Rate Reduction	Medium
Cistern	Res, CII	$$	Water Quality, Runoff Rate Reduction	Medium

Rain Garden
One resident of Fenwick Island has installed a rain garden in their front yard to collect, filter, and absorb stormwater.

Infiltration Trench
An infiltration trench runs along Bayard Street in Fenwick Island. One catch basin is covered with stones to capture and filter debris.

Infiltration Trench
Gravel along the right-of-way and in overflow parking areas (low traffic locations) allows water to percolate beneath the surface quickly.

Downspout Disconnection
A drainage system conveys water from the roof of this canal-front hotel, through gutters, to a downspout. A disconnect is added to direct wateraway from the building.

Conservation Landscaping
The Inn is surrounded by planted beds that are filled with native shrubs, flora, and trees. Downspouts are directed to flow towards these landscaped areas.

Permeable Pavement
Pavers are used outside the Canalfront Inn.

Normal Asphalt
There are signs of pooling water that hasn't dried yet, on the normal asphalt.

10. Tree Planting

Figure 28: Trees at Rehoboth Art League
Trees near the Rehoboth Art League's walking path absorb stormwater runoff.

Trees absorb much more water than typical plants; thus they are an effective way to reduce stormwater runoff. Planting large groups of trees together can result in exponentially greater runoff reduction.

Feasability

The following table lists the feasability requirements for tree planting.

Soils	Minimum depth to bedrock must be 4 feet
Water Table	Depth to seasonally high ground water is required to be greater than 1 foot where trees are planted. Choose tree species that are suited to ground water conditions.
Drainage Area	No restrictions
Slope Restriction	No restrictions
Hot Spot Runoff	No restictions
100-yr Floodplain	No restrictions
Other Restrictions	Infiltration practices should be set back at a distance that will ensure that water infiltrating into the ground will not interfere with suroounding buildlings and basements. The distance should be determined by a qualified engineer.

BMP	Propety Type	Relative Cost	Benefit	Level of Maintenance
Tree Planting	Res, CII	$-$$	Runoff Rate Reduction, Habitat	Low

Figure 29: Ohiopyle State Park
Trees are planted in a streetscaped bioretention area between the sidewalk and street at Ohiopyle State Park in southwestern Pennsylvania.

When planting trees and other vegetation, property owners should maximize their use of native species and ensure that no invasive species are planted. Invasive species have few to no native predators or environmental controls and thus can spread more quickly than native species. Invasive plants and trees choke out native ones and make forested areas uninhabitable for birds and mammals. The following tree species are native to Delaware and are organized by the region in Delaware in which they commonly grow (DNREC, 2019). Before planting a tree that is not one of the following species, consult the University of Delaware's Plants for a Livable Delaware guide to ensure that the species is not invasive and choose alternative species that satisfy particular aesthetic functions.

Native Piedmont Tree Species

Sugar Maple: Acer saccharum	Tulip Tree: Liriodendron tulipfera	Hophornbeam: Ostrya virginiana	Sourwood: Oxydendron arboreum
Swamp White Oak: Quercus bicolor	Shingle Oak: Quercus imbricaria	Chestnut Oak: Quercus prinus	American lindern: Tilia americana

Native Coastal Plain Tree Species

Shadblow: Amelanchier Canadensi	Green hawthorn: Crataegus viridis	Loblolly pine: Pinus taeda

Native Piedmont or Coastal Plain Tree Species

Red maple: Acer rubrum	Ironwood: Carpinus caroliniana	Persimmon: Diospyros virginiana	American sweetgum: Liquidambar styraciflua
Downy serviceberry: Amelanchier arborea	Eastern redbud: Cercis canadensis	American beech: Fagus grandfolia	Sweetbay magnolia: Magnolia virginiana
Apple serviceberry: Amelanchier grandflora	Hackberry: Celitis occidentalis	White ash: Fraxinus americana	Black tupelo: Nyssa sylvatica
Allegheny serviceberry: Amelanchier laevis	White fringetree: Chionanthus virginicus	Green ash: Fraxinus pennsylvanica	Virginia pine: Pinus vriginiana
Common pawpaw: Asimina triloba	Pagoda dogwood: Cornus alternifolia	American holly: Ilex opaca	American sycamore: Platanus occidentalis
River birch: Betula nigra	Eastern flowering dogwood: Cornus florida	Eastern red cedar: Juniperus virginiana	London plane: Plantanus x acerifolia
White Oak: Quercus alba	Scarlet Oak: Quercus coccinia	Bur Oak: Quercus macrocarpa	Willow Oak: Quercus phellos
Red Oak: Quercus rubra	Shumard Oak: Quercus shumardii	Common sassafras albidum	Bald cypress: Taxodium distichum

Maintenance

As Needed

- Control invasive plants
- Mow to control weeds and competing undergrowth
- Replant trees that have not survived
- Water trees during the first year of growth

Figure 30: Route 1 Bioswales
Trees are planted along one of the Route 1 Bioswales to help filter stormwater runoff and stabilize the facility.

11. Conservation Landscaping

Conservation landscaping can be done to reduce stormwater runoff in locations where detaining stormwater is not practical. Gardening with native plants increases habitat, reduces runoff rates, and promotes healthy soils.

Figure 31: Resident's Conservation Landscaping
One resident's conservation landscaping along Bayard Street Extension in Fenwick Island.

Feasability

The following table lists the feasability requirements for conservation landscaping.

Soils	Soil may need admendments to give the desired plants the proper nutrients for growth
Water Table	No restrictions
Drainage Area	No restrictions
Slope Restriction	No restrictions
Hot Spot Runoff	No restrictions
100-yr Floodplain	No restrictions

When conservation landscaping, property owners should maximize their use of native species and ensure that no invasive species are planted. The types of plants that should be utilized in a particular area will depend on the existing features of that space like the type of soils that are present and how much sun and water the area typically receives. Delaware's Livable Plants for the Home Landscape guide provides a list of native plants that are appropriate based on the land type of the property owner.

Maintenance

As Needed

- Control invasive plants
- Replant if plants have not survived
- Water regularly during the establishment period and during droughts

BMP	Propety Type	Relative Cost	Benefit	Level of Maintenance
Conservation Landscaping	Res, CII	$-$$	Water Quality, Runoff Rate Reduction, Habitat	Low

Impervious Surface Removal
One resident of Rehoboth Beach chose to remove a portion of concrete typically provided for parking that wasn't necessary.

Landscaping Maintenance
The impervious surface was replaced with native grass. The owner is appropriately maintaining the facility by trimming the grass.

Tree and Landscaping
A tree and other vegetation helps filter stormwater that will drain from the bank's roof and lawn.

Downspout Disconnection
A downspout disconnect conveys water from the roof of the building to the lawn.

Porous Pavement
Porous pavement is used at the Bank of Ocean City's parking lot in Fenwick Island.

12. Filtration

Filtration practices allow stormwater to percolate into the ground. They require that the underlying soils be permeable enough to drain water from the BMP within 72 hours.

Figure 32: Surface Sand Filter
Montgomery County, MD

Figure 33: Underground Sand Filter
The above picture features an underground sand filter in a Newark, Delaware municipal parking lot.

Facilties

Different types of filtration practices include:

- Surface Sand Filter: a facility exposed to the surface that filters stormwater before allowing it to drain through an underdrain; surface sand filters can treat a larger drainage area than other sand filters
- Underground Sand Filter: filtering facility located underground and connected to a preexisting storm drain system; beneficial to use where space is limited
- Organic, Non-Structural Filter: sand filter covered with peat/sand mixture, topsoil, and plants; best used for maximum nutrient and trace metal removal
- Perimeter Sand Filter: typically used for small parking lots; water flows into inlet grates and is stored in a sedimentation chamber before flowing through a sand filter and into the storm drain

Feasability

The following table lists the feasability requirements for filtration facilities.

Soils	A/B, unless underdrain is used
Water Table	Bottom of facility must be 2 feet above seasonal high water table and bedrock
Drainage Area	2-acre maximum for underground sand filters, perimeter sand filters, and organic, non-structural filters; 5-acre maximum for surface sand filters
Slope Restriction	Filters must be located on slopes <6%
Hot Spot Runoff	No restrictions
100-yr Floodplain	No restrictions

Maintenance

As Needed

• Remove trash and debris
• Clean sediment out of sedimentation chamber when it exceeds 6 inches

What to Avoid

• Keep animal waste out of the facility
• Do not remove material from the facility
• Do not shovel snow onto the facility

Filtration Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Surface Sand Filter	Res, CII	$$$	Water Quality	Medium
Underground Sand Filter	CII	$$$	Water Quality	High
Organic, Non-Structural Filter	Res, CII	$$$	Water Quality	Medium
Perimeter Sand Filter	CII	$$$	Water Quality	High

Bioretention

Bioswales

Infiltration

Permeable Pavement

Impervious Surface Removal

Dry Well

Rooftop Disconnect

Green Roof

Rainwater Harvesting

Tree Planting

Conservation Landscaping

Filtration

Implementation

The communities that requested this document can undertake one or more of several strategies to regulate and/or incentivize BMP implementation and adoption. The previously discussed BMPs could each be integrated into different types of programs. Every program should be accompanied with and based on public involvement, education and outreach.

Regulatory Changes

LID (Low Impact Development) is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product. LID offers great flexibility for developing and re-developing properties. A wide range of LID technology choices are available to match the needs of individual sites and the desires of the parties developing or buying the property.

There are two general regulatory approaches to implementing LID: 1) minimizing impervious surfaces and land disturbance and 2) adopting practices to lessen the impacts when minimization does not occur. The survey responses included in Appendix B were helpful to establish the current regulatory context of each coastal community. Some have already taken actions to minimize impervious surfaces or land disturbance, but all could take further action.

As noted in the Regulatory Context section, municipalities can adopt regulations more rigorous than State regulations, regarding permanent stormwater management measures or erosion and sediment control measures. Communities wishing to do so would need to legally adopt those standards or else developers would be left with uncertainty in the regulatory process. Furthermore, provisions would be needed for plan reviews and construction inspections. These may include an agreement with the Sussex Conservation District, municipal staff increases, or the use of consultants.

Regulatory changes would not be appropriate for scenario 1 as a property owner cannot be required to implement measures after-the-fact. Similarly, regulatory changes would not affect scenario 3 unless a municipality was seeking more stringent measures than the DSSR. However, regulatory changes could be enacted to increase the use of BMPs. As with any regulation, municipalities would need to weigh the advantages and disadvantages before proposing regulations.

The following is a synopsis of each community's current regulations and recommendations for strengthening. The reader is encouraged to review the survey responses in Appendix B for further detail.

Fenwick Island – Needs a definition of "impervious surface," and the prohibition of impervious surface in the setback in commercial zoning districts should be broadened to residential districts. Adjustments could also be made to the floor area regulations in the Zoning Code to lessen developed area and their density.

Bethany Beach – Needs a definition of "impervious surface" and limits of its use. It is recognized that a majority of the town is in the special flood hazard area.

Rehoboth Beach – Needs a definition of "impervious surface" and an allowance for the use of alternative types of pavement. Could make adjustments to street design requirements, floor area ratio, lot coverage requirements, and maximum allowable building areas.

Henlopen Acres – Needs a definition of "impervious surface" and clarity regarding what types of alternative types of pavement can be used.

South Bethany – The Town already defines "impervious materials" and has various restrictions of its use in place. Further restrictions could be considered.

Lewes – The City already has definitions for "impervious cover" and "impervious surface" and various restrictions of its use in place. Further restrictions could be considered.

Each of these programs is adaptable based on community priorities and local decision makers' preferences. Most of the recommended incentive programs are voluntary as opposed to penalty based.

	Incentive	Regulatory
BIORETENTION		
Rain Garden	*	
Tree Box Filters	*	*
Streetscape Bioretention		*
Large Bioretention		*
Raised Planter Box	*	
BIOSWALE		
Bioswale		*
INFILTRATION		
Infiltration Trench		*
Infiltration Basin		*
PERMEABLE PAVEMENT		
Permeable Concrete Pavers	*	*
Grid Pavement Systems	*	*
Pervious Concrete	*	*
Porous Asphalt	*	*
IMPERVIOUS REMOVAL		
Impervious Surface Removal	*	
ROOFTOP DISCONNECT		
Rooftop Disconnect	*	*
GREEN ROOF		
Green Roof		*
RAINWATER HARVESTING		
Rain Barrels	*	
Cisterns	*	
TREE PLANTING		
Tree Planting	*	
CONSEVATION LANDSCAPING		
Conservation Landscaping	*	
FILTRATION		
Surface Sand Filter		*
Underground Sand Filter		*
Organic, Non-Structural Filter		*
Perimeter Sand Filter		*
DRY WELL		
Dry Well	*	*

Some BMPs are more suited to regulations while others can be better incentivized. The table to the left classifies BMPs by their recommended implementation appraoches.

Stormwater Fee Discount

One of the most effective ways that a municipality can incentivize the installation of BMPs and reduce the size of impervious areas is to enact a stormwater fee based on the amount of impervious surface on each property (DVRPC, 2017.) Approximately 2,000 cities and towns across the United States have adopted stormwater fees (commonly called Stormwater Utilities) to provide a revenue stream for stormwater-related expenditures. In Delaware, the City of Wilmington enacted a fee in the mid-2000s with the Lewes Board of Public Works following in 2010, and the City of Newark in 2017.

Unlike water or electric utilities where individual usage can be easily metered, there is no practical way to measure an individual property's contribution to the stormwater system. Therefore, impervious area is often used as a proxy for runoff and the basis for determining use. This approach is generally considered a more equitable method to funding a stormwater program as those with higher amounts of impervious surface pay a larger fee than those with less impervious surface.

Single-family residential properties typically comprise on the order of 75% of the tax parcels in any given jurisdiction but contribute much less than that to the overall impervious cover. Conversely, nonresidential properties typically comprise maybe 25% of the tax parcels in any given jurisdiction but contribute two or three times that amount to the overall imperviousness. Therefore, in order to minimize administrative costs, it is fairly common for Stormwater Utilities to assess fees on a case-by-case basis for nonresidential properties, but to aggregate single family residential property into one or more tiers. Multi-family residential uses like apartments or condominiums are usually grouped with nonresidential properties due to common ownership.

One of the primary benefits of a stormwater fee is it provides a municipality with the opportunity to incentivize BMPs through the awarding of a credit. For example, if a property owner that is assessed a fee based on impervious area installs a BMP that captures and/or manages runoff from a portion of the impervious surface, he or she could be given a credit or fee reduction proportional to the benefits of the BMP. Credits are usually capped (for instance to no more than 25% or 50% of the fee.) The jurisdictional agency needs to establish polices to ensure through either their own inspections or self-reporting that the BMP is being maintained.

Moreover, the decision to levy a fee can often be politically sensitive, but it provides revenue that enables municipalities to invest directly in stormwater BMPs, while also incentivizing private landowners to install BMPs as well. Community outreach and education should be conducted as part of a Stormwater Fee Discount program.

Development Incentives

Contrasting the regulatory approach, a municipality may choose to offer developer incentives during the plan review process.

Incentives may include subtracting the area of a BMP from the total site area when making subsequent area calculations or allowing lot density to be increased if a BMP is provided. Other options could include zoning exceptions, expedited permitting, or fee waivers. Incentives such as these could apply to each coastal community.

An inherent problem with approaches such as these is ensuring the BMP is maintained over time. As with any structure, a BMP's efficiency will diminish if upkeep is not performed. It would be counter-productive to offer an incentive if after a few years the BMP is no longer functioning properly. It would be burdensome for a municipality to inspect each BMP on a recurring basis such as annually. Options like self-reporting could be used instead.

Additionally, municipalities can offer funding, tax credits, or reimbursements to business/property owners that install specific BMPs. Rebates can be based on overlay districts, such as an Environmentally Sensitve District, or practice, such as rainwater harvesting.

Spotlight Example: City of Los Angeles

While the City of Los Angeles may have the capacity to administrate a program beyond the capabilities of the coastal communities, it provides a good example of creating a user-friendly program that goes above and beyond minimum requirements. The City of Los Angeles adopted a Stormwater LID Ordinance in 2011 that required the use of LID standards and practices in future developments and redevelopments to encourage the beneficial use of rainwater and urban runoff. In 2012, the City adopted the NPDES Stormwater Permit that incorporates their LID principals that go above and beyond program requirements. The Stormwater LID Ordinance applies to nearly all development and redevelopment in the City of Los Angeles, exceptions include disturbance less than 500 square feet, emergency construction to address a public health concern, and infrastructure projects within the public right-of way.

The roadmap pictured to the left is a clear and concise approach to guide both homeowners and developers through the LID requirements. LA's Roadmap notes BMP examples that are included in this guide and identifies different requirements based on land use, earth disturbance, and environmental sensitivity.

The City of LA also provides many forms and checklists for residents and developers, as well as a Master Covenant Agreement regarding on-site stormwater mitigation measures and maintenance. Each individual is responsible for maintaining his or her BMPs in good operable condition at all times.

Figure 34: LID Road Map, LA Stormwater

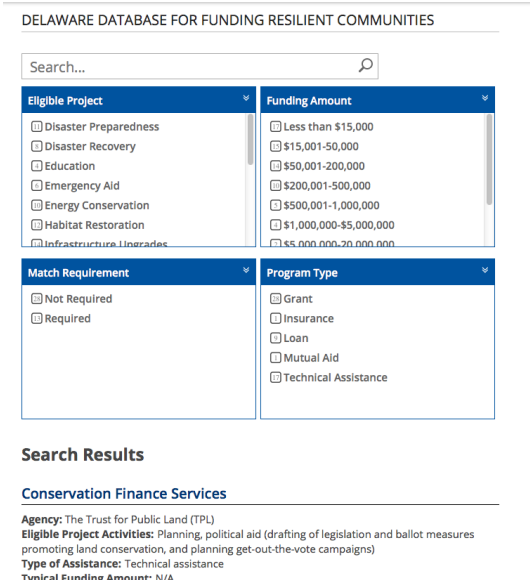


Figure 35: Delaware Database for Funding Resilient Communities, Institute for Public Administration

Grants or Loans

Towns, regional alliances, or non-profit organizations can offer direct funding to property owners/community groups for implementing appropriate BMP projects. At the State level, DNREC's Environmental Finance section offers programs such as Surface Water Matching Planning Grants. Surface Water Matching Planning Grants may be used for planning and design related to stormwater retrofits, water quality improvement projects, stream and wetland restoration, development of master plans, and other green infrastructure practices. Information is available at:

https://dnrec.alpha.delaware.gov/environmental-finance/

The State of Pennsylvania incorporated funding mechanisms into a successful campaign, called Growing Greener, that was backed by a consortium of conservation nonprofits, municipalities, and counties. Funds are distributed among agencies that address program goals such as cleaning up rivers and streams, protecting natural areas, open spaces and working farms, and providing new and upgraded water and sewer sytems.

The Institute for Public Administration (IPA) at the University of Delaware, with support from Delaware Coastal Programs, has developed a searchable online database for resiliency funding opportunities. Users can navigate throught he database to search for programs based on what their goals are; categories include disaster preparedness, disaster recovery, education, emergency aid, energy conservation, habitat restoration, infrastructure upgrades, planning, property acquisition/easements, renewable energy, species protection, storm-proofing retrofits, stormwater management, vulnerability assessment, and wetland protection. More information, as well as the database can be accessed below:

https://www.bidenschool.udel.edu/research-public-service/ddfrc

Awards & Recognition Programs

A town, regional alliance, or non-profit organization may choose to offer annual awards or recognize exemplary BMP projects as a means of marketing, education, and public outreach. This strategy can also help establish partnerships striving towards a common goal. All of the communities involved in the Resilient Communities Partnership Project are also part of the Association of Coastal Towns (ACT). The ACT may want to establish an annual award for either a municipality or homeowner that exemplifies significant effort towards addressing stormwater management through resiliency efforts. Each year, the Governor of Delaware honors Agriculture and Urban Conservation award winners at an annual event. The ACT may want to work with Sussex Conservation and the Governor to also establish a coastal award, since many environmental features of the coastal area are unique.

Intergovernmental Coordination

Through conversation with Sussex Conservation District, it became clear that coordination is a continued challenge with the coastal communities. Each community has a different capacity to administer or delegate their permitting process. Some of the seven communities require both a Sussex County and local municipality permit, some require only a Sussex County permit, and the remainder only a local permit. However, according to Sussex County's website, "all construction in Sussex County, whether new, remodeling or additions, requires a Sussex County issued building permit. County permits are required for all construction activity regardless of whether in a municipality or the unincorporated areas of the county." While, Sussex Conservation District has been working to make sure that all municipalities are following the County's guidelines, the seven communities should work with the County and Sussex Conservation District to identify an approach that will improve coordination and transparency.

Intergovernmental coordination makes tracking BMPs and impervious surface coverage and modelling runoff easier, and will help prepare coastal Delaware for managing stormwater from a regional perspective.

References

Barton, Susan, and Gary Schwetz. *Plants for a Livable Delaware.* National Fish and Wildlife Foundation through the Delaware Estuary Grants Program, https://www.dnlaonline.org/wp-content/uploads/2015/08/plants_livabledelaware.pdf

DNREC. *Delaware Post Construction Stormwater BMP Standards & Specifications.* Feb. 2019, http://www.dnrec.delaware.gov/swc/Drainage/Documents/Sediment%20and%20Stormwater%20Program/2019%20February/Regulatory%20Guidance%20Documents%202019/BMP%20Stds%20and%20Specs%20-%20EFF%20FEB%202019.pdf

EPA. *Managing Wet Weather with Green Infrastructure Municipal Handbook: incentive mechanisms.* June 2009, https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives.pdf

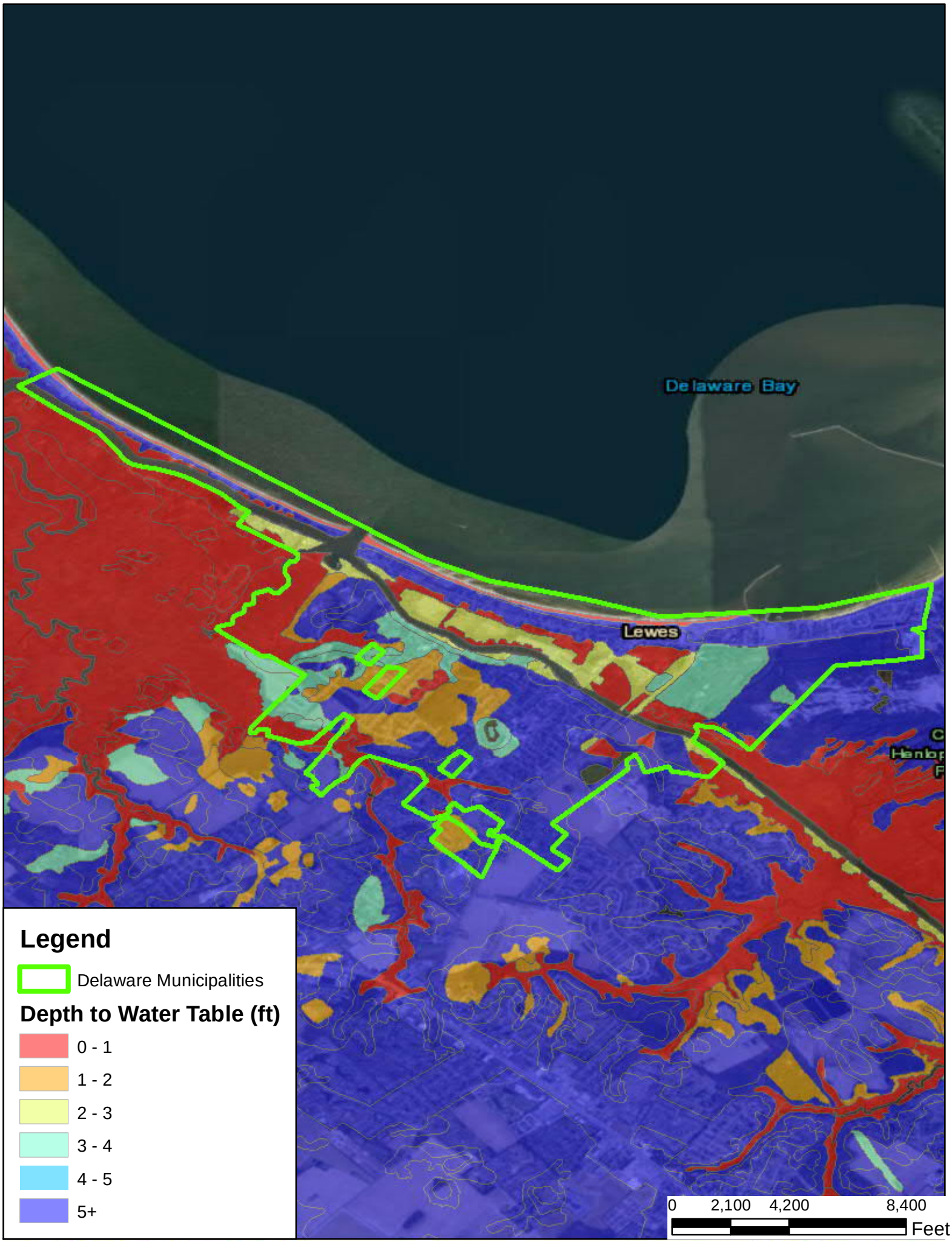
EPA. *Stormwater Discharges from Municipal Sources.* April 2019, https://www.epa.gov/npdes/stormwater-discharges-municipal-sources

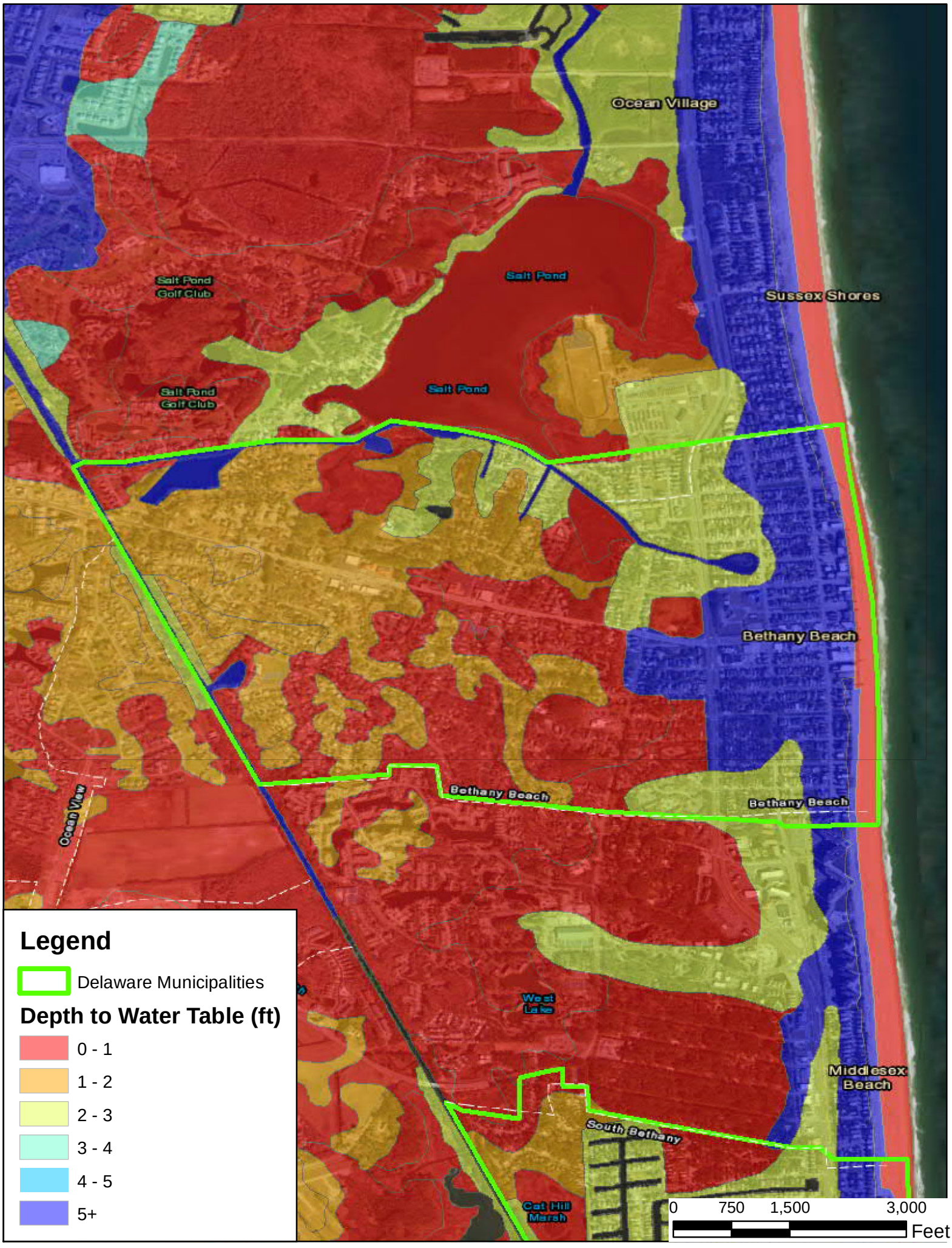
LA Stormwater. P*lanning and Land Development Handbook for Low Impact Development (LID).* May 2016, https://www.lastormwater.org/wp-content/files_mf/lidmanualfinal.pdf

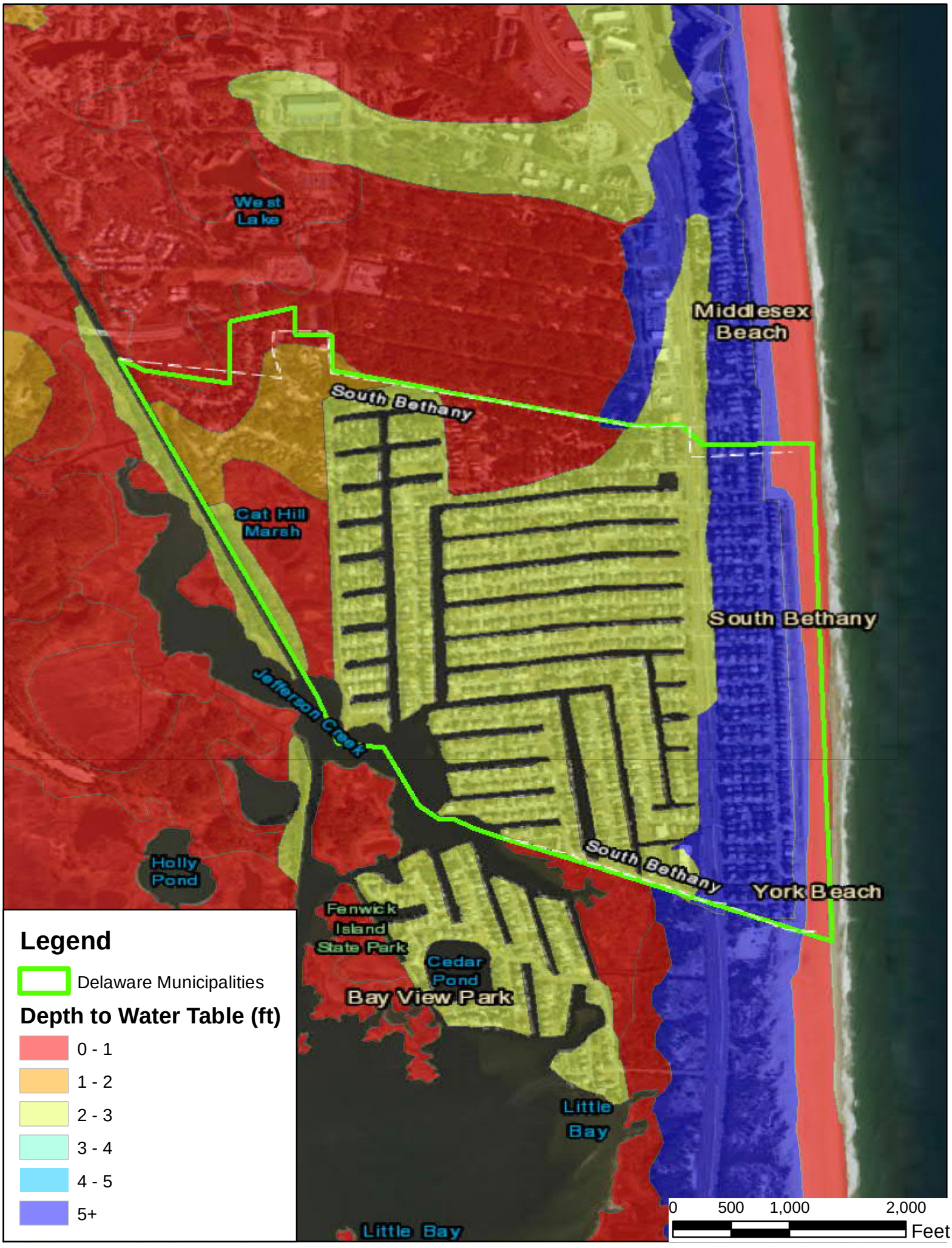
NRCS. *Web Soil Survey.* Sep. 2018, https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

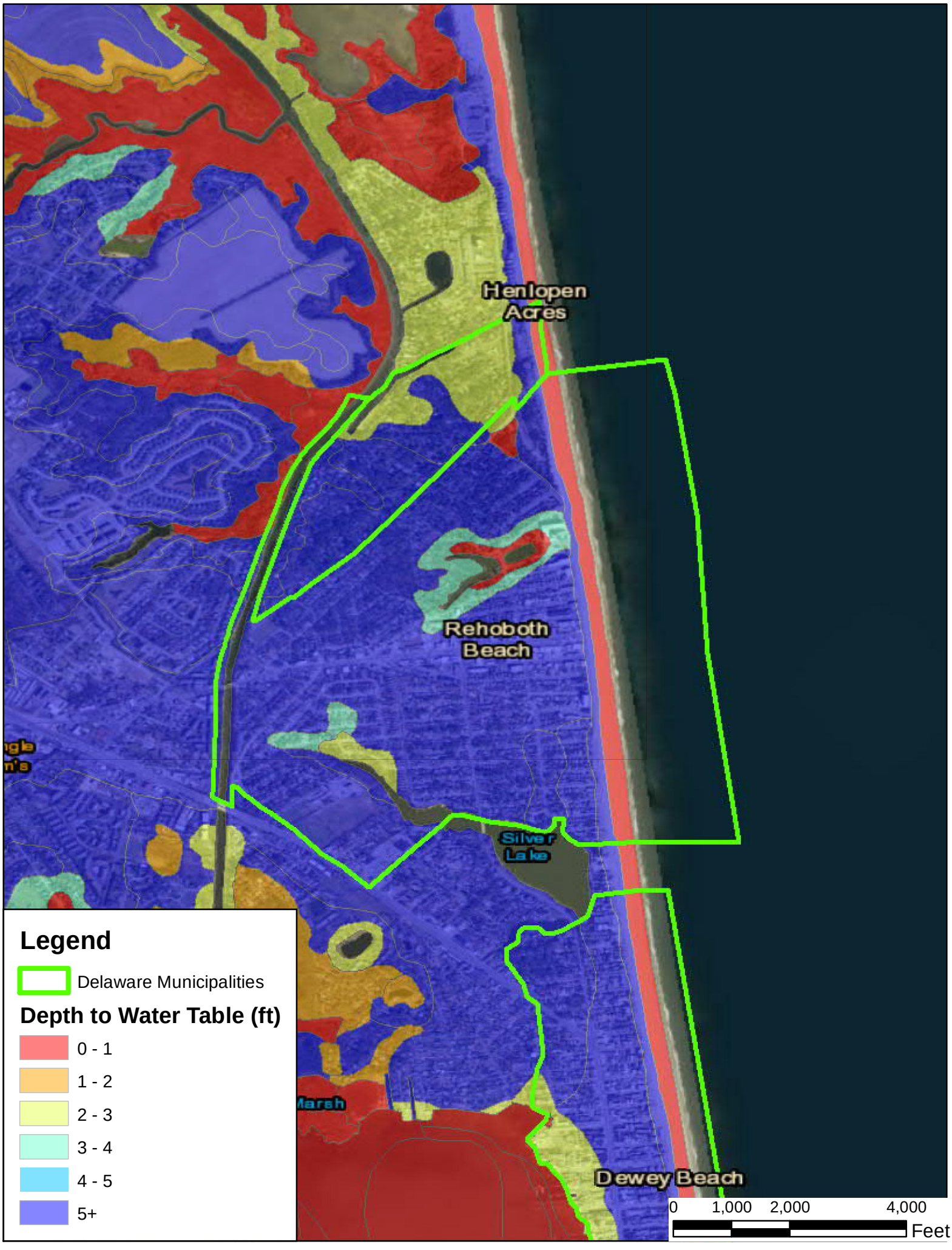
Water Environment Research Foundation. *Using Incentive Programs to Promote Stormwater BMPs.* 2009, https://www.werf.org/liveablecommunities/toolbox/incentives.htm

Appendix A
Maps

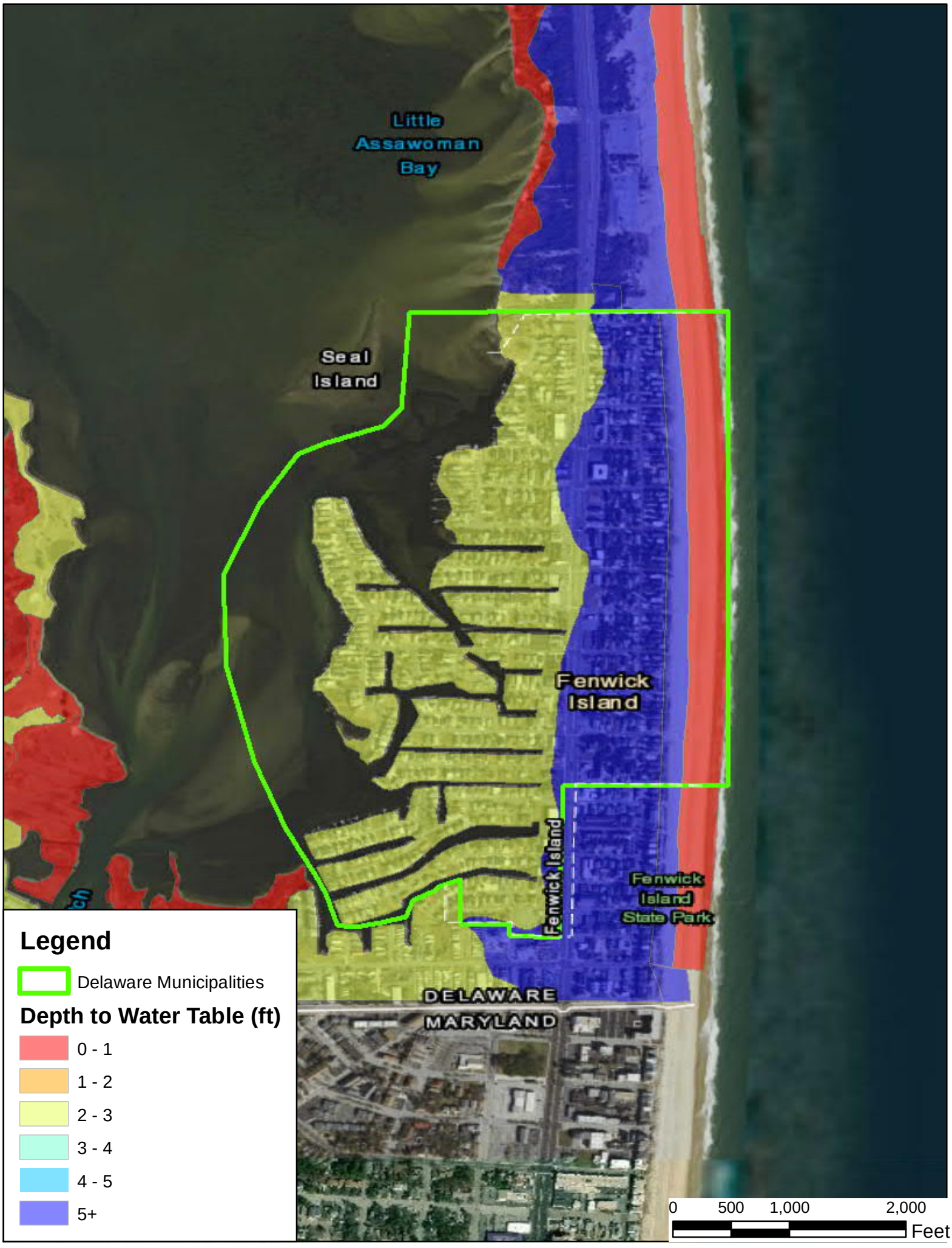

Delaware Bay
Lewes
Legend
Delaware Municipalities
Depth to Water Table (ft)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5+
0
2,100
4,200
8,400
Feet


Ocean Village
Salt Pond
Golf Club
Salt Pond
Salt Pond
Golf Club
Sussex Shores
Bethany Beach
Bethany Beach
Bethany Beach
Ocean View
West
Lake
Middlesex
Beach
South Bethany
Cat Hill
Marsh
Legend
Delaware Municipalities
Depth to Water Table (ft)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5+
0
750
1,500
3,000
Feet


West Lake
Middlesex Beach
South Bethany
Cat Hill Marsh
South Bethany
Jefferson Creek
South Bethany
York Beach
Holly Pond
Fenwick Island State Park
Cedar Pond
Bay View Park
Little Bay
Little Bay
Legend
Delaware Municipalities
Depth to Water Table (ft)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5+
0
500
1,000
2,000
Feet


Henlopen Acres
Rehoboth Beach
Silver Lake
Dewey Beach
Legend
Delaware Municipalities
Depth to Water Table (ft)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5+
0
1,000
2,000
4,000
Feet


Silver Lake
Silver Lake Shores
Dewey Beach
Seabreeze
Dewey Beach
hoboth Bay
Indian Beach
Indian Beach
Indian Beach
Legend
Delaware Municipalities
Depth to Water Table (ft)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5+
0
500
1,000
2,000
Feet


Little Assawoman Bay
Seal Island
Fenwick Island
Fenwick Island
Fenwick Island State Park
DELAWARE
MARYLAND
Legend
Delaware Municipalities
Depth to Water Table (ft)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5+
0
500
1,000
2,000
Feet

Appendix B
Survey Results

Impervious Surface Coverage Survey Responses

The following survey was developed by AECOM and KCI, and then distributed to the seven coastal communities involved in this Resilient Communities Partnership Project in January 2019. Their full responses are included in the order they were received.

1. Does your City Code have a definition for 'impervious surface'? Please list both the definition and code reference for review.

Fenwick Island	We do not. We do prohibit any impervious or semi-impervious pavings in setback areas in Chapter 160-5C(7) of our Zoning code area regulations for Commercial Zone and Chapter 160-8A(11) of our Zoning general regulations; exceptions for Residential Zone.
Bethany Beach	No
Rehoboth Beach	No
Henlopen Acres	No
South Bethany	No, but it does have impervious materials definition. 145-3B{44} IMPERVIOUS MATERIALS Materials that prevent precipitation from contacting the existing soil and do not allow water to penetrate the soil
Lewes	yes - 197-75(B) Impervious Cover - Surfaces providing negligible infiltration such as pavement, buildings, recreation facilities (by example, but not by limitation, tennis courts, swimming pools) and covered driveways. 197-106(15) Surface, Impervious - A surface providing negligible infiltration such as pavement, buildings, recreational facilities (by example, but not by limitation, tennis courts, swimming pools) and covered driveways.

2. Do you believe this definition is accurate and sufficient?

Fenwick Island	We lack a definition of impervious and/or semi-impervious surface.
Bethany Beach	There is no definition
Rehoboth Beach	N/A
Henlopen Acres	N/A
South Bethany	Yes it is accurate.
Lewes	Mostly…accurate but illustrations could help

3. . What section(s) of your City Code regulates impervious surface coverage? Does your community have ordinances or other regulations which regulates the percentage of impervious coverage on a residential or commercial lot? If so, please list the code reference for review.

Fenwick Island	In Chapter 160-2B, we have a definition of "Floor Area" and Floor Area Ratio (FAR)". We regulate allowable floor area regulations in Chapter 160-4(C)(7) of our Zoning Code for the Residential Zone. We prohibit any impervious or semi-impervious pavings in setback areas in Chapter 160-5C(7) of our Zoning code area regulations for Commercial Zone and Chapter 160-8A(11) of our Zoning general regulations; exceptions for Residential Zone.
Bethany Beach	none
Rehoboth Beach	Section 270-21 Natural area, floor area ratio and lot overage
Henlopen Acres	Code does not reference "impervious". Lot and Building Requirements are defined in Chapter 130 Zoning, Sections 19 through 33.
South Bethany	Yes- Pervious minimum requirements 55% and impervious max 45% see below: 145-14.3 Ground covering allowed in setback area. A. In the R-1 Single-Family Dwelling District (§ 145-26) at least 55% of the sum of required building setback area, as defined in Chapter 145, Zoning, Article XI, Setback Requirements, shall be covered with pervious covering materials. The building setback area is the total of the front, rear and side setbacks expressed in square footage (i.e.: 25 feet x 50 feet + 25 feet x 50 feet + 8 feet x 50 feet + 8 feet x 50 feet = 3,300 square feet. 3,300 square feet x 55% = 1,815 square feet minimum pervious coverage). Pervious covering materials, such as, but not limited to, sand, gravel, mulch, grass, shells, natural vegetation, or, when installed per current industry standards or guidelines, permeable pavers, pervious concrete, and porous asphalt. E. Impervious surfaces planned in the setback area require a building permit. The application for a permit shall include a plot or sketch, showing the location and dimensions of all existing and planned impervious surfaces, including a description of the materials to be used.
Lewes	197-75 ater protection overlay & table of dimensional regs

4. Does your community allow for alternative types of pavement, pavers, or surface treatments to be used for parking areas, driveways, etc. If so, please list the code reference for review.

Fenwick Island	We do permit the use of permeable pavers, concrete or asphalt in setback areas.
Bethany Beach	The Code does not specify any particular material and any surface treatment suitable for parking is acceptable
Rehoboth Beach	No
Henlopen Acres	Yes. Acceptable materials not specified.
South Bethany	Yes- C. Only materials, such as, but not limited to, gravel, shells, sand, and grass shall be allowed as a ground covering in any Town right-of-way. Pervious concrete and porous asphalt shall not be used in any Town right-of-way. Permeable pavers may be used within the Town right-of-way along the front of the property, no wider than 50% of the lot width and no closer than five feet to any side boundary line. If the pavers are removed for any reason, it will be the owner's responsibility and cost to replace the pavers. At the time of installing or replacing the pavers a four-inch diameter thick wall conduit (Schedule 40 minimum) shall be installed for any future use for utility purposes.
Lewes	Yes

5. Does your Community have standards and specifications in relation to driveways, curbing, sidewalk, etc.? If so, please list the code reference for review.

Fenwick Island	In Chapter 160-8A(9)(b)[2], sidewalks are required for any new construction and/or substantial improvements in the Commercial Zone
Bethany Beach	Typically, there is no curb or sidewalk. In Chapter 425 Zoning, Article XV specifies the requirements for off street parking and loading
Rehoboth Beach	Yes - See Chapter 232, Streets and Sidewalks
Henlopen Acres	Ch. 130-4.B "Parking Lot"
South Bethany	Yes 145-3B{70} PAVED DRIVEWAY A path or parking area for vehicles, constructed of impervious materials (concrete, asphalt, etc.), leading from the property line abutting the street right-of-way. § 145-42 R-1 and C-1 District parking spaces. For R-1, a parking space shall have a minimum width (parallel to the street) of 10 feet and a minimum length (perpendicular to the street) of 20 feet. Paved driveways shall not encroach into the street right-of-way. For C-1 Commercial, a parking space shall have a minimum width of 10 feet and depth of 20 feet
Lewes	Chapter 167

6. How do Sussex Conservation District and / or DNREC policies and regulations affect your community? Are there gaps or overlaps?

Fenwick Island	We require any disturbance of lot area of more than 5,000 square feet in the Commercial and Residential zones submit plans to Sussex Conservation District per Sussex County regulations. Per DNREC regulations, all construction plans along oceanfront and within 100 feet west of Bunting Avenue submit application to DNREC prior to obtaining Town of Fenwick Island building permit.
Bethany Beach	Sussex Conservation regulations affects very few projects in town due to the small size of most. DNREC policies affect all construction within 3 lots of the beach and a permit from them is required first.
Rehoboth Beach	DNREC - overlap
Henlopen Acres	N/A
South Bethany	Lots are mostly less than 5000 sq ft so Sussex County Conservation rarely applies. DNREC only through floodplain ord.
Lewes	We work with them on major projects

7. What historical choices have led to the current surface coverage issues within your municipality?

Fenwick Island	Prior to the enactment of Chapter 160-8A(11) prohibiting impervious or semi-impervious materials in setbacks areas a trend was becoming evident of larger homes covering all buildable areas of a lot.
Bethany Beach	Historically, the Town has never regulated the amount or type of surface coverage. It is my understanding that the Planning Commission reviewed the issue in the past but had no support for any regulation
Rehoboth Beach	Over building and size
Henlopen Acres	Unknown
South Bethany	Miles of canals dug when developed. Canals are semi-stagnant poorly flushed by tides. So need for pervious spaces to control runoff.
Lewes	A lack of strict planning standards, historically small lots, high water table

8. What challenges do you think are unique to your community?

Fenwick Island	Small lots/large homes.
Bethany Beach	Over 85% of Bethany Beach is in a special flood hazard area and flooding from the Salt Pond, the loop canal and even a heavy rain is an ongoing problem. There is simply nowhere for the water to go. Additionally, the zoning code has historically permitted lots to be completely covered with impervious surfaces. Any regulations enacted now would have little impact.
Rehoboth Beach	Maximum allowable building areas
Henlopen Acres	Unknown
South Bethany	Not unique per se but need for better public engagement for education. It might be possible to advocate for higher percentage of pervious area or take it by zone instead of sum total area as our codes allows.
Lewes	Small, historical lots, low infiltration ability

9. Is the Community more apt to encourage in fill redevelopment, new development or both with new pervious surface regulations?

Fenwick Island	Both although Fenwick Island is nearly built out.
Bethany Beach	Both
Rehoboth Beach	Infill. Smaller scale preferred
Henlopen Acres	Redevelopment
South Bethany	We are fully developed.
Lewes	Not much land left for new development, but they are happening outside of town. Redevelopment with higher coverage in town as well.

10. What is the best local method to promote outreach and education to your Community, such as: workshops, regular Community meetings, etc.?

Fenwick Island	Workshops and scheduled community meetings.
Bethany Beach	The Town uses both workshops and regular meetings to promote and educate the Community on subjects.
Rehoboth Beach	Public hearings
Henlopen Acres	Planning Commission and Board of Commissioners
South Bethany	Community Meetings
Lewes	Cape Gazette, City Council meetings

11. What are the most effective outreach and education days and times for your Community, such as: evenings, weekends, daytime, weekday?

Fenwick Island	Weekends are the best time to scheduled outreach activities.
Bethany Beach	Weekdays and Saturdays
Rehoboth Beach	Late afternoon, evenings and weekends
Henlopen Acres	Daytime, weekends
South Bethany	Evenings
Lewes	Evenings

12. What is your current process to adopt a new regulation and what body would need to be involved (Environmental Committee, Planning and Zoning Commission, Town Council/Commissioners, etc.)? We are looking for the process and timing to consider new regulations?

Fenwick Island	Town Council will forward a proposed code amendment to the Charter & Ordinance Committee for review. If the Charter & Ordinance Committee agrees an amendment to the current code is recommended, a first reading of the proposed amendment is presented to Town Council during regular Town Council meetings. If approved for a first and second reading, the code change is adopted.
Bethany Beach	This would be a zoning issue so the Planning Commission would first study the issue and develop any new regulations (timing unknown). In the past, they have reviewed the issue, held panel discussions with experts in the field and open discussions with Community members. They then send their recommendations to the Town Council for review and possible vote.
Rehoboth Beach	Town Commisioners
Henlopen Acres	Planning Commission and Board of Commissioners
South Bethany	Council- 6 months to adopt.
Lewes	Planning Commission and City Council

13. Do you feel the Community will provide some type of incentive to use alternative environmentally friendly products in place of impervious coverage standards?

Fenwick Island	It's possible although this had already been in place since the year 2000 with no incentives offered.
Bethany Beach	Unknown
Rehoboth Beach	Probably yes
Henlopen Acres	Possibly
South Bethany	No
Lewes	Yes, we are interested in exploring how to make this fair and feasible.

14. Has the Community allowed waivers or variances to the impervious surface regulations? If so, what was the mechanism to approve this option and what is the cost?

Fenwick Island	Although the option of an appeal to the Board of Adjustments is available, there have been none since enactment of this code. An appeal to the Board of Adjustments currently costs between $750 and $2,000.
Bethany Beach	There are currently no impervious regulations
Rehoboth Beach	Not sure
Henlopen Acres	N/A
South Bethany	No
Lewes	Board of adjustments… not too sure historically if this has been waived often or not.

15. Is the Community aware of some of the new pervious surface products, if so are there any concerns with specific ones?

Fenwick Island	We are aware of the various pervious surface products some of which have been used in the Town of Fenwick Island. We have experienced no unfavorable effects so far.
Bethany Beach	The Town recently repaved several streets with a pervious system to improve drainage and is so far happy with the results and expanding the project.
Rehoboth Beach	Some
Henlopen Acres	No
South Bethany	Yes and no.
Lewes	Some residents are aware, most are not.

16. Concerning the menu of options to address impervious surface coverage, what kind of product would help your municipality most? (Something more visual or more technical?)

Fenwick Island	Does your City Code have a definition for 'impervious surface'? Please list both the definition and code reference for review.
Bethany Beach	Visual
Rehoboth Beach	Visula and technical
Henlopen Acres	Visual or technical depending on the audience
South Bethany	Visual
Lewes	More visual, easy for residents to understand.

17. What kind of audience would you like the 'menu of options' to be geared towards?

Fenwick Island	Do you believe this definition is accurate and sufficient?
Bethany Beach	Town Council and Community members
Rehoboth Beach	Homeowners, designers and contractors
Henlopen Acres	Planning Commission - visual
South Bethany	Council-Homeowner
Lewes	Somewhat for officials, more for City Council and Committee/Commission members

About AECOM
AECOM is a premier, fully integrated professional and technical services firm positioned to design, build, finance and operate infrastructure assets around the world for public- and private-sector clients. The firm's global staff — including architects, engineers, designers, planners, scientists and management and construction services professionals — serves clients in over 150 countries around the world. AECOM is ranked as the #1 engineering design firm by revenue in *Engineering News-Record* magazine's annual industry rankings, and has been recognized by *Fortune* magazine as a World's Most Admired Company. The firm is a leader in all of the key markets that it serves, including transportation, facilities, environmental, energy, oil and gas, water, high-rise buildings and government. AECOM provides a blend of global reach, local knowledge, innovation and technical excellence in delivering customized and creative solutions that meet the needs of clients' projects. A *Fortune 500* firm, AECOM companies, including URS Corporation and Hunt Construction Group, have annual revenue of approximately $19 billion.

More information on AECOM and its services can be found at www.aecom.com.

Follow us on Twitter: @aecom

aecom.com

AECOM Project No. 60602380