

# A Sustainable Chesapeake

BETTER MODELS FOR CONSERVATION

*Edited by David G. Burke and Joel E. Dunn*

THE CONSERVATION FUND



The case study you have downloaded is highlighted below. Other case studies from this Chapter of *A Sustainable Chesapeake: Better Models for Conservation* can be individually downloaded. The editors encourage readers to explore the entire Chapter to understand the context and sustainability principles involved with this and other featured case studies. The full publication contains 6 Chapters in total: Climate Change Solutions, Stream Restoration, Green Infrastructure, Incentive Driven Conservation, Watershed Protection and Stewardship.

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# Sustainable Infrastructure at Navy and Marine Corps Installations

## *An Effective Approach to Controlling Stormwater Entering the Bay*

The United States Department of the Navy has implemented a national policy mandating the use of low impact development techniques as well as a more sweeping Sustainable Infrastructure policy in the Mid-Atlantic region, which have made installations more environmentally and economically efficient to construct, operate, and maintain.

### CASE STUDY SUMMARY

The United States Department of Defense (DoD) is the second largest landholder in the Chesapeake Bay watershed, managing 657 square miles (420,480 acres) spread among 68 installations. The Department of the Navy (Navy), lead agency for the DoD's Chesapeake Bay restoration effort, recently set a goal of no net increase in stormwater volume and sediment or nutrient loading from major renovation and construction projects. They also implemented a monumental, service-wide policy mandating the use of low impact development (LID) techniques on all installation sustainment and modernization projects.<sup>1,2</sup> This policy has already resulted in many LID stormwater retrofit projects that have improved water quality, particularly at installations in the Hampton Roads area of Virginia, which is within the Chesapeake Bay watershed.

The Navy's LID efforts have also led to the development of a broader Sustainable Infrastructure Program, currently being implemented throughout the Naval Facilities

Engineering Command's (NAV-FAC) Mid-Atlantic Region, which uses best available practices at installations to make facilities more environmentally and economically efficient to construct, operate, and maintain. This program integrates environmental stewardship into all capital improvements, public works management and energy management. The installation of LID practices is one main component of the program and a good example of on-the-ground implementation. The Navy's LID policy is applicable to any development entity interested in stormwater practices that provide excellent treatment and discharge volume reduction. The Sustainable Infrastructure Program can be applied at a large company, government agency or organization, or even a small town seeking to improve the life cycle efficiency of its facilities.

### RESOURCE MANAGEMENT CHALLENGE

The Navy manages 40 installations in the Bay watershed and each installation can have hundreds to thousands of buildings, miles of

roads, acres of parking lots, airports, ship docks, power plants, and sewage treatment facilities, which serve hundreds of thousands of

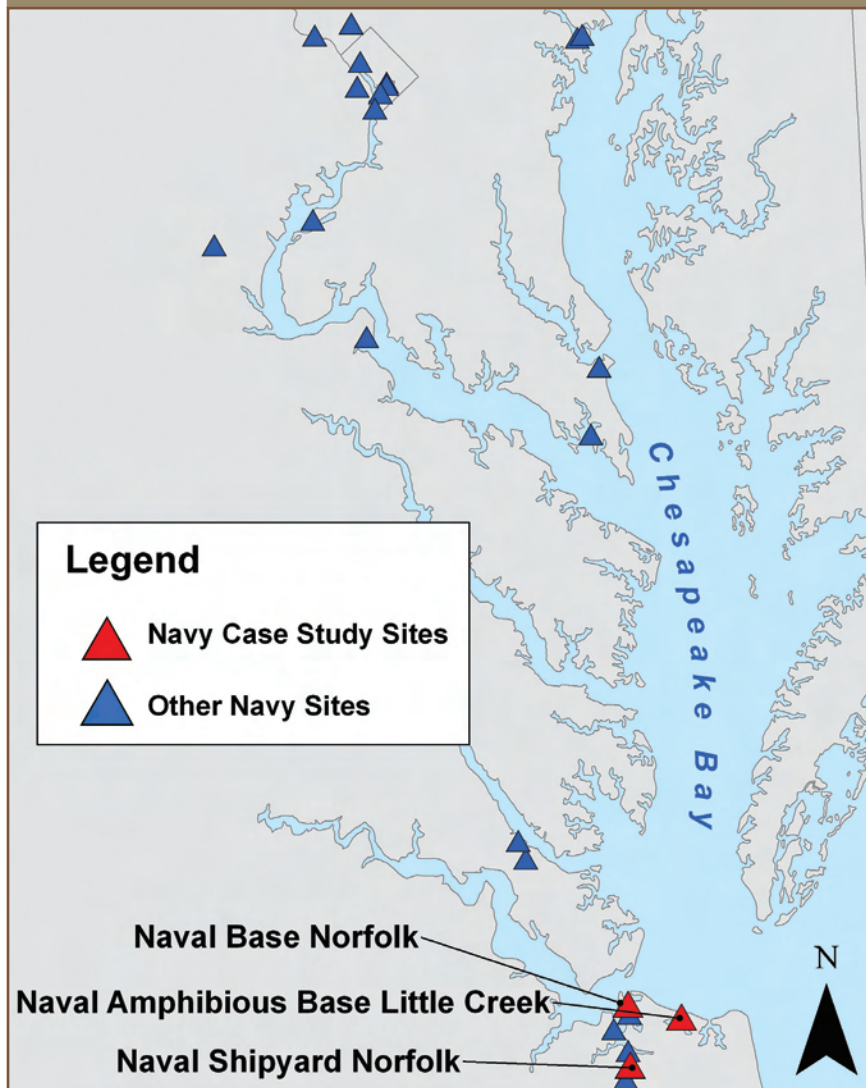
### LOW IMPACT DEVELOPMENT

**L**ow Impact Development (LID) reduces the impacts of land use changes associated with development on hydrology, water quality, and aquatic resources.

LID implements engineered small-scale hydrologic controls to replicate the pre-development hydrologic regime of watersheds through infiltrating, filtering, storing, evaporating, and detaining runoff close to its source.<sup>3</sup>

The main principle behind LID is to use runoff prevention and control options to engineer a site so that it functions hydrologically as though it is naturally vegetated or forested after development.

## Chesapeake Bay Naval Facilities



people. The implementation of Base Realignment and Closure and other installation upgrades and modernization measures have resulted in significant construction activity at Navy installations. This construction activity presents challenges and opportunities for the sustainability of the Chesapeake Bay.

Typically, new construction decreases natural vegetation cover and drainage capacity and increases impervious surfaces (roofs, lawns, driveways, roads, parking lots and other hard surfaces). These changes typically alter an area's hydrology and result in higher peak flows and

greater volumes of stormwater runoff into nearby waterways, as shown in hydrology curves. Bay-wide development in the watershed is increasing impervious surfaces at a rate four times greater than the rate of population growth.<sup>4</sup> From 1990 to 2000, the area of land covered by impervious surfaces in the Bay watershed increased by 40 percent. These factors have made urban and suburban stormwater runoff the fastest growing source of pollution to the Bay and the only type of pollution that continues to increase.<sup>5</sup> In addition, new construction typically adds to the inventory of conventional stormwater collection and convey-

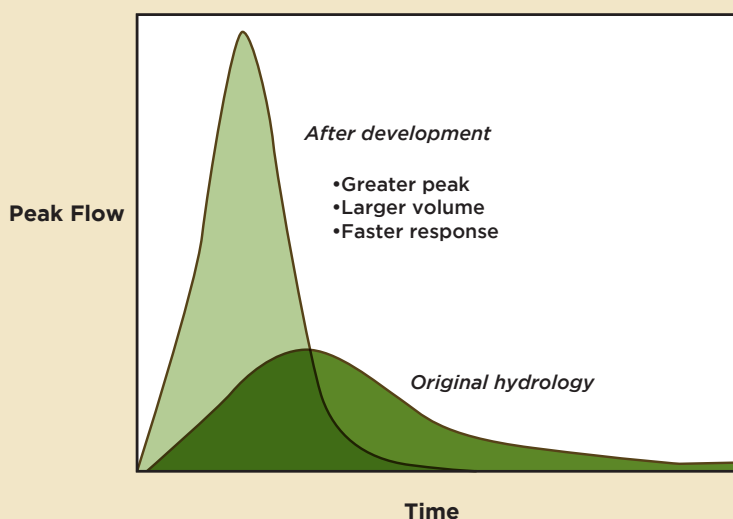
ance infrastructure, which is a major focus of the Bay restoration effort.

Continuing water quality problems have prompted the US Environmental Protection Agency to begin developing mandatory treatment and control of stormwater through the use of Total Maximum Daily Loads (TMDL), which are essentially a clean-up plan for the Bay and its tributary rivers. In a nation-wide effort to reduce impacts to water quality, that will also help the Navy prepare for future stormwater regulations in the Bay, the Navy developed an LID policy that offers a suite of Best Management Practices (BMPs) to maintain or restore predevelopment hydrology. It mitigates the adverse effects of construction projects on water quality by cost effectively reducing the volume and pollutant loadings of stormwater before it reaches the receiving water bodies. LID utilizes strategies that infiltrate, filter, store, evaporate, and/or retain runoff close to its source. LID further reduces installation reliance on aging stormwater management infrastructure. The Navy holds state stormwater discharge permits for most of its facilities in the Bay watershed. In Virginia, the more industrialized parts of the facilities have monitoring requirements and screening values that must be met. The Navy has been exploring the use of LID retrofits to achieve these screening values.

### CONSERVATION VISION

The DoD is an active participant in the Chesapeake Bay Program and in recent years has made a significant commitment to conserving, preserving and restoring the Bay.<sup>6</sup> The origins of the Navy's mandatory LID policy can be traced back to DoD efforts to implement innovative stormwater management practices as set forth in the Chesapeake Bay Executive Directive for managing stormwater on

## ► Before and After Development Hydrology Curves



Graph showing the difference between peak flows given an area's original hydrology and in one where development has altered the hydrology creating intense stormwater runoff.

state and federal lands (see text box). The overall goal of the LID policy is no net increase in stormwater volume and sediment or nutrient loading from major renovation and construction projects. In order to support this goal, as well as reduce reliance on conventional stormwater collection system and treatment options, this policy directs the Navy to consider LID in the design for all projects that have a stormwater management element.

NAVFAC Mid-Atlantic's efforts to improve their environmental performance are now being expanded from stormwater management to include all infrastructure with the intent to conserve natural resources, in the Sustainable Infrastructure Program. Many environmental issues, such as stormwater pollution, climate change, energy independence, and habitat restoration were previously being addressed through disparate processes and budgets. NAVFAC Mid-Atlantic recently set a goal to integrate environmental stewardship, capital improvements (new construc-

tion or renovation), public works management, and energy production and use. They are changing traditional facilities and environmental management to include sustainability as a major objective. This new approach requires the collaboration and integration of designers, planners, facility managers and maintenance personnel. The LID policy and projects have set the stage for the Sustainable Infrastructure Program, and have set

the Navy and the DoD on a course that supports their mission to defend the country as well as protect our natural and cultural resources.

### IMPLEMENTATION RESOURCES

The initial LID retrofit projects at Norfolk Naval Shipyard and Naval Station Norfolk cost \$140,000 and included 9 stormwater planters and three bioretention areas, and were funded by the DoD Legacy Program, which is reserved for projects that demonstrate leadership in environmental protection and restoration. The remaining retrofit projects included two bioretention areas at both Naval Station Norfolk and Navy Amphibious Base Little Creek and were funded with \$250,000 of environmental compliance funding that is used to maintain compliance with stormwater discharge permits. The largest LID project to date has been construction of 13 bioretention areas at a cost of \$400,000. Treatment was required for the stormwater from the impervious area created by capping an old construction debris landfill.

The Navy's LID policy requires implementation of LID techniques on all major construction projects by 2011 with encouragement for implementation in 2008 through 2010. NAVFAC Mid-Atlantic has chosen to implement

### MANAGING STORMWATER ON STATE, FEDERAL AND DISTRICT-OWNED LANDS AND FACILITIES

**T**his Chesapeake Bay Executive Council adopted a commitment to set an example for local governments and private land owners by demonstrating how to develop, fund, and implement innovative stormwater management approaches and technologies on their own lands and facilities in Directive No. 01-1.<sup>7</sup>

This influential Directive was focused on the implementation of management and physical practices that comprehensively address all stormwater related issues, including flow volume and velocity, pollution loads, stream channel integrity, groundwater recharge, and flooding.



LID on all construction projects starting in 2009. Implementation of LID on construction projects is funded with military construction program funding for major projects and with operations and maintenance funding for smaller projects. The Navy has incorporated bioretention areas and tree box filters into most of its recent projects and is currently evaluating the use of permeable pavement and green roofs.

The LID retrofit projects were designed by CH2M Hill, an engineering consulting firm, and constructed by Agviq and Shaw, construction contractors. NAVFAC staff were able to develop the expertise necessary to oversee the projects through attendance at professional development conferences and research on various university (North Carolina State, University of New Hampshire, University of Maryland) and nonprofit organization websites (LID Center, Center for Watershed Protection, U.S. Green Building Council). To gain the expertise needed to implement the LID policy on new construction projects, NAVFAC has contracted with URS consultants and the Low Impact Development Center to provide training for its planning, design, environmental, and maintenance staffs.

### CONSERVATION STRATEGY

Implementation of the Navy's LID policy at NAVFAC Mid-Atlantic is taking place under the larger umbrella of the Sustainable Infrastructure Program, which seeks to deliver sustainable facilities with a lower total life cycle cost than conventional designs through a concept they call total ownership costs. The Sustainable Infrastructure Program includes a process of understanding the baseline of natural and cultural resources on site, recognizing that most ecosystems extend beyond the property boundaries, locating projects

where they minimize impacts to the ecosystem processes and finally maximizing the LID opportunities to maintain the natural hydrology of a site. LID is an important part of this emerging process.

**Low Impact Development (from CH2M Hill 2002)<sup>8</sup>:** LID denotes a wide array of measures intended to limit the cumulative effects of land development and related activities on hydrology, water quality, and aquatic resources. The integration of these measures begins with project conception, through design and construction, and continues after the site is operational. The main principle behind LID is to engineer a site so that it functions hydrologically as though it is naturally vegetated or forested after development. By focusing on the site's hydrology, this natural systems approach to development reduces runoff volume and provides mechanisms for pollutant removal.

LID encompasses numerous runoff prevention and control options. Essentially, these could be any combination of site planning and engineering control measures to minimize, infiltrate, evapotranspire, retain, detain, slow down, and treat stormwater. These measures attempt to protect and/or restore a watershed's natural functions and maintain groundwater recharge, baseflow, storage, and peak flow attenuation.

Another characteristic of the LID approach is management of stormwater at the source through the use of micro-scale controls distributed throughout the site, often as part of landscaping. Conventional stormwater management focuses on fast collection and drainage in closed conduits and end-of-pipe controls such as ponds. In contrast, LID uses reduced imperviousness, open channel sections, flatter grades, artificial storage, disconnection of flowpaths, and

landscaping to slow down runoff and maximize infiltration opportunities.

Most control measures accomplish a primary function but can fulfill one or more additional runoff control features. All of the LID controls remove pollutants from runoff through a variety of mechanisms. A large amount of pollutants are adsorbed onto soil particles and mobilized as part of suspended solids. These pollutants are removed through filtration as the water moves through vegetative covers and percolates in the soil but also by settling in the control devices. Other pollutants are removed through phytoremediation—biological uptake in the root zone of vegetation.

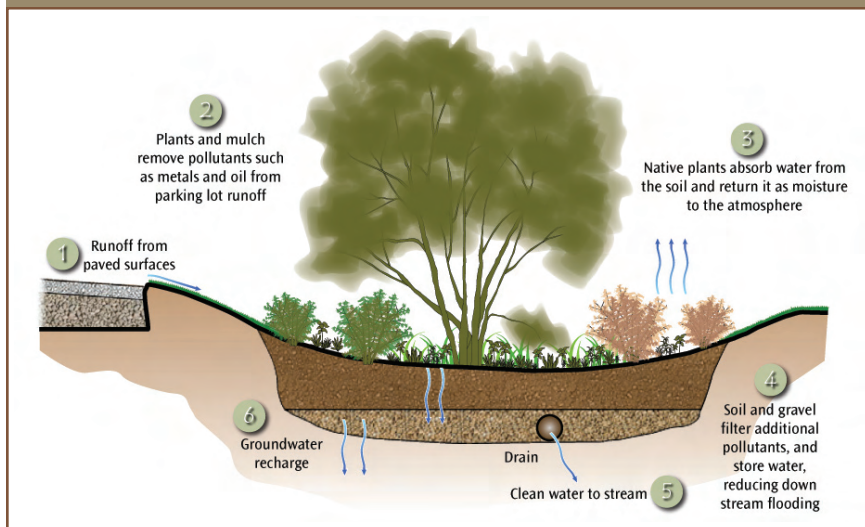
### Summary of LID Stormwater Control Options (From CH2M HILL 2002)<sup>9</sup>:

Five types of LID stormwater control techniques or LID BMPs that are commonly used are described below. They are bioretention, bioswales, foundation planters, permeable pavement, and green roof systems.

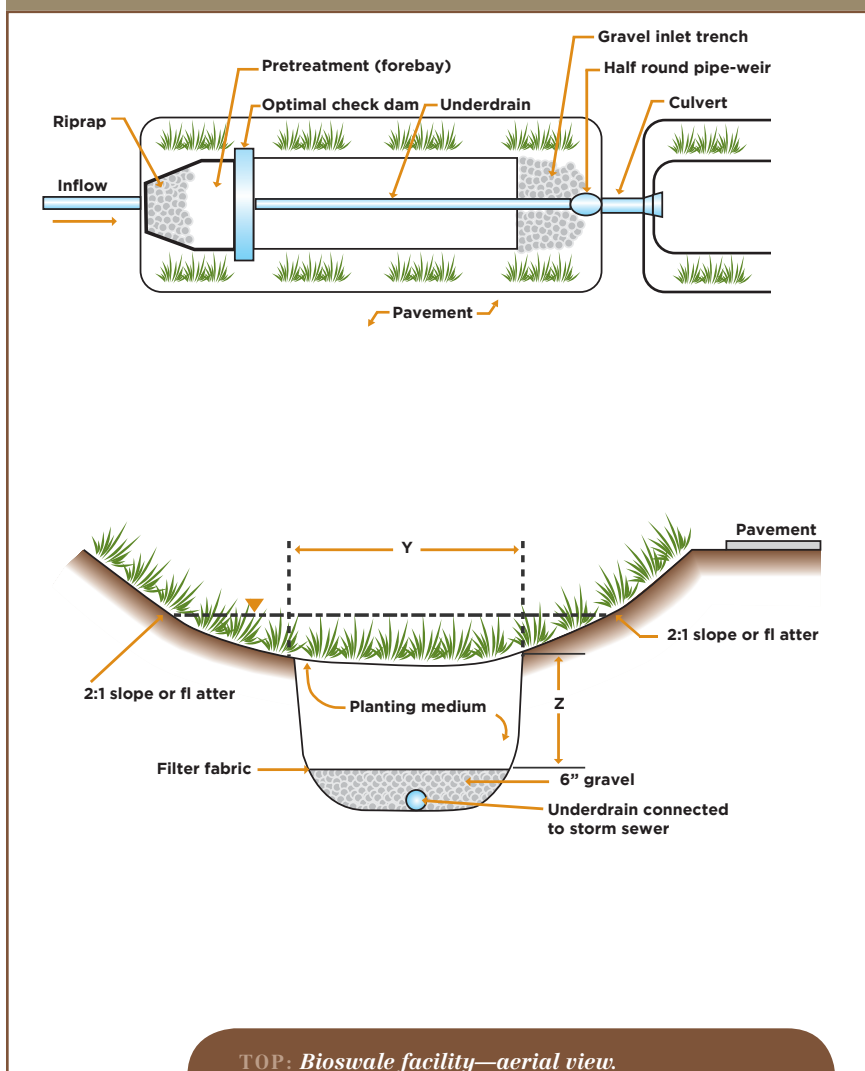
**Bioretention:** This stormwater control technique typically involves the use of a shallow depression that is planted with vegetation, often called a rain garden. The bioretention facilities reduce runoff volume mostly through infiltration and detention. For water quality control, bioretention combines physical filtering and adsorption with biological processes. Bioretention facilities can be located in a parking lot, at the center of each parking row and at the edge of the parking lot. They also can be located in existing green areas, treating runoff from surrounding streets, buildings, and parking lots. Bioretention facilities sometimes do not have a subsurface drain and are not typically designed as a conveyance system.

**Bioswales:** This stormwater control technique is typically used in residential and commercial developments

## ► Bioretention Facility Conceptual Drawing



## ► Bioswale Facility Conceptual Drawings



TOP: *Bioswale facility—airial view.*  
 BOTTOM: *Bioswale facility—cross sectional view.*

as well as along highway medians as alternatives to, or enhancements of, conventional storm sewers. Bioswales remove pollutants from urban stormwater by filtration through grasses and other vegetation and infiltration through soil. Bioswales are designed to be part of a conveyance system and have relatively gentle side slopes and shallow flow depths.

**Foundation Planters:** This stormwater control technique uses a planter (concrete box or landscaping block) constructed along a building's exterior to treat rooftop runoff. It involves diversion of stormwater flows from the gutter/downspout system into to the planter, which is then treated by the vegetation and soil in the planter. Typical native landscape plants (shrubs, ornamental grasses, and flowers) are used as an integral part of the system. A foundation planter consists of the container, vegetation, mulch layer, soil layer, and underdrain system. The underdrain system can be connected to an existing stormwater system or allowed to drain onto the sidewalk or street. Other sources of water, such as cooling-system condensate, can also be diverted to the foundation planter.

**Permeable Pavement:** This stormwater control technique uses materials designed primarily to reduce the imperviousness of traffic surfaces, such as patios, walkways, driveways, and parking areas, by increasing infiltration and reducing surface runoff. Permeable paving materials include porous bituminous concrete mixtures, permeable interlocking concrete paving blocks, concrete grid pavers, perforated brick pavers, and gravel or grass engineered to prevent compaction. These porous paving systems are also used as inlets and covers for infiltration trenches. A base course serves as a storage layer. Permeable pavement can be effective at reducing peak surface runoff rates

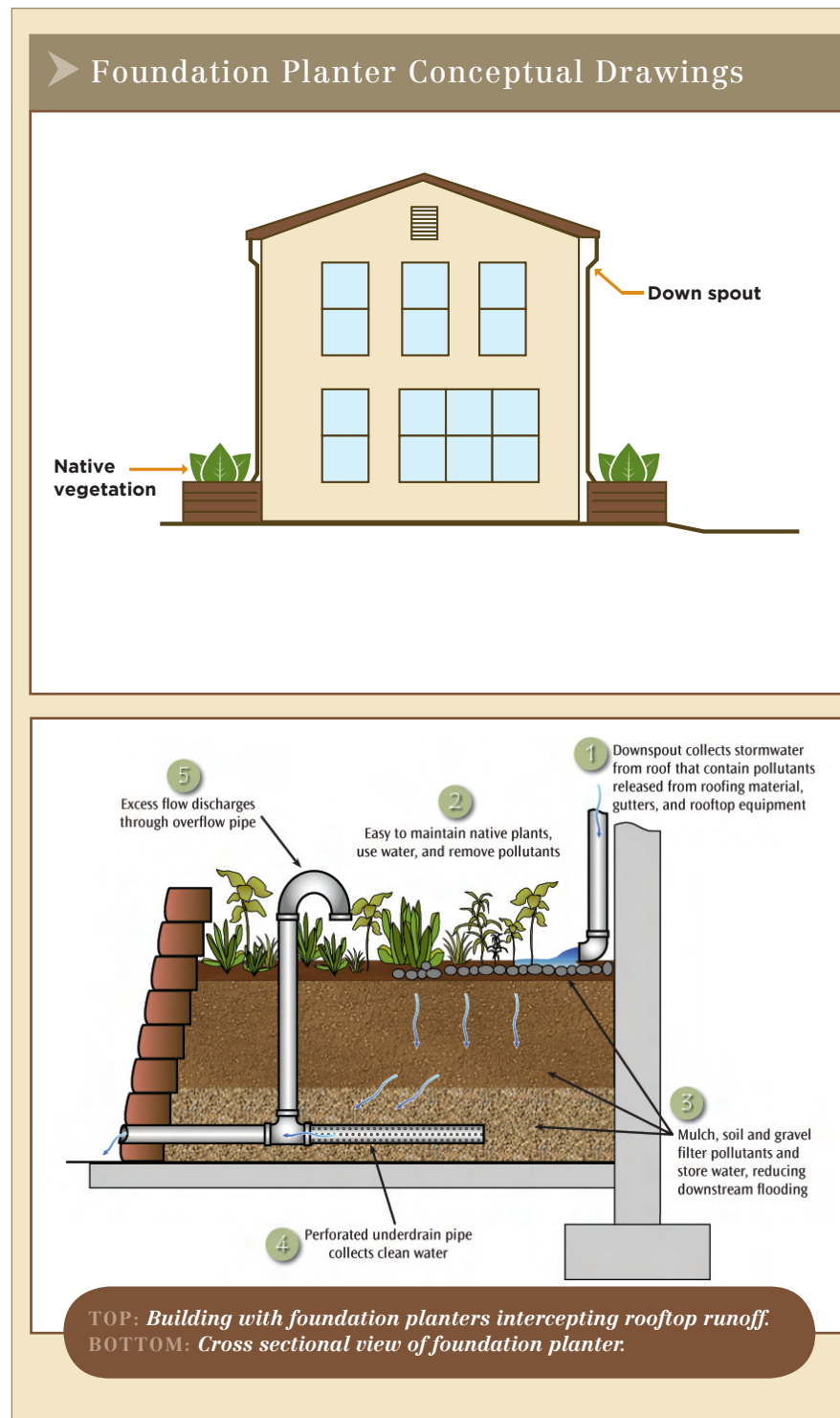


and at improving the groundwater recharge characteristics of developed sites.

**Green Roof Systems:** This stormwater control technique is a form of rooftop runoff management. Rooftop management is the modification of conventional building design—using vegetated roof covers, roof gardens, vegetated building facades, and roof ponding areas—to retard runoff from roofs. Managing rooftop runoff provides substantial benefits in highly urbanized settings where space for other BMPs is limited. In these cases, rooftop measures may be the only practical alternative for relieving pressure on overtaxed storm sewer systems. In addition to achieving specific stormwater runoff management objectives, rooftop runoff management is also aesthetically and socially beneficial. These measures are suitable for flat or gently sloping roofs and the techniques can be retrofitted to many conventionally constructed buildings. Steep roof slopes can be retrofitted with roof gardens, although the cost is higher.

## RESULTS

In 2002, the Navy funded a study by CH2M Hill to assess opportunities to implement LID techniques at the Norfolk Naval Shipyard.<sup>10</sup> The study recommendations were used to select demonstration sites for implementation at the shipyard. The Navy staff also identified some additional demonstration sites at the Naval Station Norfolk and Naval Amphibious Base Little Creek. Initial LID projects were retrofit sites chosen specifically to improve stormwater discharge quality at outfalls where stormwater discharge permit screening values were being exceeded. Projects were completed at Norfolk Naval Shipyard in 2005, at Norfolk Naval Station in 2006 and 2008, and at Naval Amphibious Base Little Creek in



2008. These projects have resulted in the installation of bioretention areas, bioswales, and stormwater planters and are managing stormwater from approximately 17 acres of land/rooftop. NAVFAC is currently evaluating the use of permeable pavements and green roofs.

**Norfolk Naval Shipyard:** With approximately 800 acres of land and 4 miles of waterfront, Norfolk Naval Shipyard is the largest Navy shipyard on the east coast. It is located in the City of Portsmouth, Virginia, on the southern branch of the Elizabeth River which flows into the James River and ultimately the Bay.

The Shipyard demolished an abandoned rail line and replaced it with a rain garden that treats runoff from adjacent parking areas and roadways that drain to an outfall that has historically had elevated heavy metal concentrations. Nine stormwater planters were also installed at the Norfolk Naval Shipyard. These planters are large containers installed at a building's downspout to capture and treat rooftop runoff before discharging it through an under drain system to the underlying pavement and ultimately to nearby storm drains.

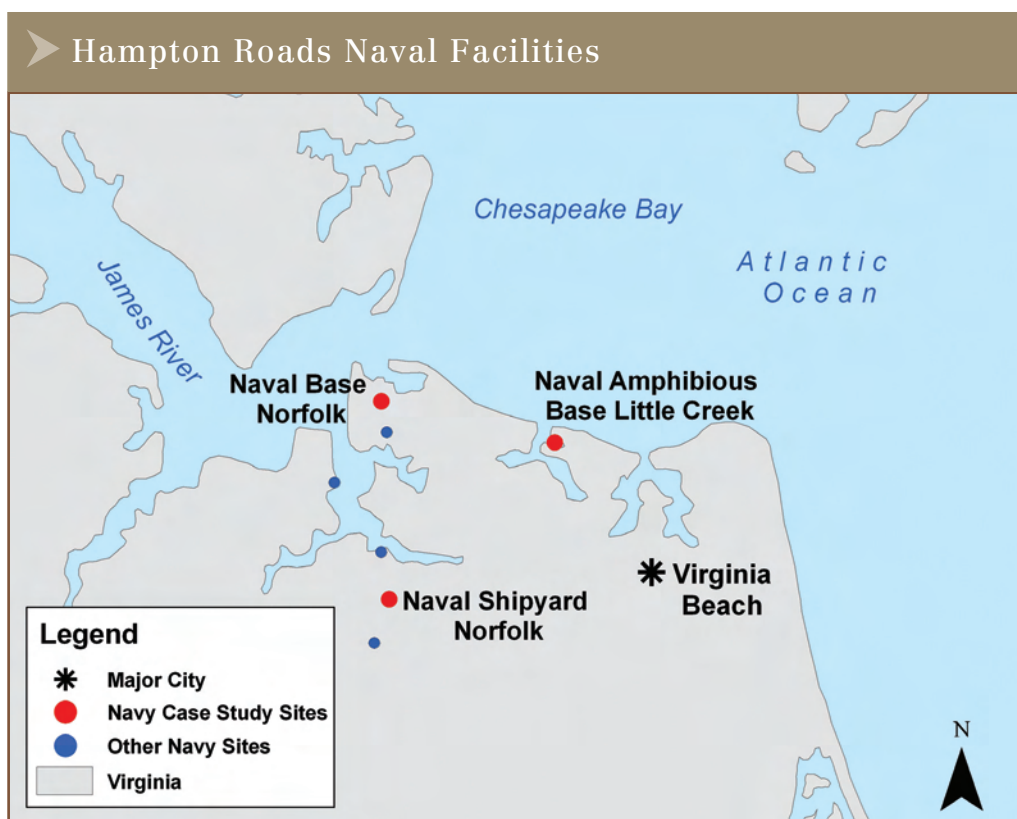
In addition to helping meet the goals of the 2001 Chesapeake Bay Executive Council directive on stormwater, the implementation of LID practices at the Shipyard helps them meet their National Pollutant Discharge Elimination System (NPDES) stormwater permitting requirements and demonstrates the installation's leadership in

the use of environmentally friendly stormwater management practices.

**Naval Station Norfolk:** Naval Station Norfolk is the world's largest naval complex. It is located on 3,400 acres of land in the City of Norfolk, Virginia near the mouth of the Elizabeth and James Rivers which drain into the Chesapeake Bay. It includes a naval seaport, naval air field (Chambers Field), and the Naval Support Activity

(which includes the headquarters of the U.S. Joint Forces Command and Combined Fleet Forces Command) as well as the Navy Staff College.

In 2006, the Station installed a rain garden adjacent to a large parking lot located in front of several aircraft maintenance hangars. The rain garden now treats polluted runoff from a 72,665 square foot parking lot in front of the hangars. The runoff



#### NORFOLK NAVY SHIPYARD

LEFT: A bioretention facility, that was formerly an abandoned railroad line, built for treating street runoff.  
RIGHT: Stormwater planters treat rooftop runoff from a public works vehicle maintenance building.





## NAVAL STATION NORFOLK

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The upper left photograph features the parking lot for aircraft hangars and vegetated drainage swale on adjacent land before construction of a rain garden. The upper right is a photo of the rain garden three years after construction. The middle left features the parking lot next to a fast food court before construction of a rain garden. The middle right is a photo of the rain garden one year after construction. The bottom left photograph features the steam plant before construction of a rain garden. The bottom right is a photo of the rain garden less than two months after construction.

flows through the rain garden and is discharged through an under drain to a monitoring structure before it enters Willoughby Bay. That same year, the Naval Station also installed a rain garden and a stormwater planter at a building site. The rain garden was put in between the installation's steam generation plant and the scrap metal yard and treats runoff from a drainage area of approximately 8,100 square feet. Wax myrtle (*Morella cerifera*), common winterberry (*Ilex verticillata*), ink berry (*Ilex glabra*), and St. John's wort (*Hypericum sp.*) were planted to treat the runoff. A stormwater planter was also installed to treat some of the rooftop runoff by diverting it from the downspout system to the planter.

In 2008, the Station installed a rain garden next to the parking lot of a fast food court. This garden was sized to treat rainfall from 22,468 square feet of parking lot drainage area. Another rain garden was installed in 2008 at another steam plant to treat runoff from approximately 11,500 square feet of the building's roof.

In 2008, the Station also installed 13 separate bioretention areas at a retired 13-acre landfill in the northwest section of the base. The Station partnered with the Virginia Department of Environmental Quality and EPA Region 3 to cap the area

with a 10 acre asphalt cap that can be used as a parking lot. To capture the site's stormwater, the installation constructed several rain gardens instead of building the traditional stormwater management pond. To build the rain gardens, the installation excavated the ground and put in a sand and soil mixture and plants that will work together to capture and filter stormwater runoff. The installation installed under drains in conjunction with eleven of the rain gardens to convey the filtered water to the Bay. The two rain gardens closest to the Bay do not have underdrains since they are located outside the footprint of the former landfill and have sandy soils that are capable of infiltrating the flow.

#### Naval Amphibious Base Little Creek:

Little Creek provides support and services to operating forces and shore commands. It has 2,120 acres of land and 8 miles of waterfront. It is located in the City of Virginia Beach, Virginia, near the mouth of the Bay.

The Base removed an old building and storage tank and built a parking lot that included an infiltration basin in the middle of the lot. This facility detains large influxes of stormwater and includes a sand bottom, which removes up to 35% of pollutants from the runoff. The facility is lined

with crepe myrtle (*Lagerstroemia indica*) and live oaks (*Quercus virginiana*). The Base also created two bioretention facilities adjacent to a maintenance facility that captured pollutants from pressure washing operations and stormwater and filters it before releasing it to the Bay. The Base won a pollution prevention award from the Hampton Roads Sanitation District as a result of their LID projects.

**Educational Signs:** Educational signs were installed at all LID best management practice retrofit sites at the Norfolk Naval Shipyard and at Naval Station Norfolk to teach people about low impact development projects, stormwater management, and the importance of protecting the Bay.

The Navy has found that LID stormwater management practices are more effective than other techniques, easier to maintain, and provide the dual function of landscape aesthetics. As the Sustainable Infrastructure Program is implemented, Navy buildings will be more energy efficient, environmentally sound, and less expensive to operate and maintain.

#### KEYS TO SUCCESS

**Authorization:** Leadership from the Deputy Assistant Secretary of the Navy Environmental Office in devel-



#### NAVAL AMPHIBIOUS BASE LITTLE CREEK

LEFT: An infiltration basin between two parking lots that captures runoff.

RIGHT: A bioretention facility adjacent to a maintenance facility was installed to reduce metals in runoff.



oping and adopting the LID Policy has enabled the program to move beyond the demonstration project phase by requiring that LID be considered on major projects.

**Funding:** The installation of innovative management practices to meet stormwater discharge permit screening values and efforts to comply with the Chesapeake Bay Executive Council Directive on Stormwater Management requires adequate funding for LID projects. Such funding can be direct or the result of savings from the elimination of traditional stormwater management practices.

**Assimilation:** The Navy had to find suitable candidate sites and overcome many institutional barriers to successfully complete the demonstration projects including traditional practices of regulatory agencies and the construction industry. They also had to use innovative design ideas to solve potential utility system conflicts resulting from construction.

**Implementation:** Success in implementing the LID policy and development of the Sustainable Infrastructure Program is attributed to the vision and leadership of the men and women of NAVFAC Mid-Atlantic workforce. Funding of initial LID training of planners, designers, and

maintenance staff by NAVFAC HQ and follow up training funded by NAVFAC Mid-Atlantic have also been instrumental in successful implementation of the policy.

## PHOTOS AND FIGURES

Page 253, 261: Photos, Joel Dunn  
Page 254, 259: Figures, Burke Environmental Associates/The Conservation Fund  
Page 255: Figure, CH2M Hill 2002  
Page 257, 258: Figures, US Navy  
Page 259: Photos, US Navy  
Page 260: Photos, US Navy; except top right and center right, Joel Dunn

## REFERENCES

- <sup>1</sup>Department of the Navy. 2007. Department of the Navy Low Impact Development (LID) Policy for Stormwater Management. Memorandum for Deputy Chief of Naval Operations, Fleet Readiness and Logistics (November 16, 2007), Deputy Commandant of the Marine Corps (Installations and Logistics).
- <sup>2</sup>Lutz, L. 2008. Navy launches policy to stem tide of stormwater: All new construction and major renovations will require low impact development techniques. *Bay Journal* (January 2008). Seven Valleys, PA. Available online at: <http://www.bayjournal.com/article.cfm?article=3235>.

<sup>3</sup>Prince George's County Department of Environmental Resources. 1999. *Low-Impact Development Design Strategies, An Integrated Design Approach*. U.S. Environmental Protection Agency, Washington, D.C. EPA 841-B-00-003.

<sup>4,6</sup>Department of Defense. 2007. *Defending Our National Treasure: A Department of Defense Chesapeake Bay Restoration Partnership 1998-2004*. IAN Press, Cambridge, ME. 176 pp.

<sup>5</sup>Environmental Protection Agency. 2009. Federal Bill Would Improve Stormwater Runoff Management in Chesapeake Bay Region. Environmental Protection Agency, Annapolis, MD. In, [http://www.chesapeakebay.net/news\\_runoffbill09.aspx?menuitem=41576](http://www.chesapeakebay.net/news_runoffbill09.aspx?menuitem=41576).

<sup>7</sup>Chesapeake Executive Council. 2001. Managing Stormwater on State, Federal and District-owned Lands and Facilities. Directive NO. 01-1. Available online at: [http://www.chesapeakebay.net/content/publications/cbp\\_12105.pdf](http://www.chesapeakebay.net/content/publications/cbp_12105.pdf).

<sup>8,9,10</sup>CH2M Hill. 2002. Norfolk Naval Shipyard Low Impact Development Assessment. Prepared for the U.S. Navy by CH2M HILL, Englewood, CO.



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