



Pennsylvania
Environmental
Council

PEC's Stormwater Management Facility Retrofit Program

Improving Stormwater Detention Basins for Better Stormwater Management

This fact sheet highlights design concepts for stormwater best management practices (BMPs) in urban areas.

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Did You Know?

Traditional stormwater management focuses on rate control while largely ignoring the quantity and quality of stormwater runoff that enters our creeks. Traditional stormwater management methods have resulted in water quality and flooding problems that have degraded our rivers, streams, and lakes. Problems such as water pollution, stream bank erosion, dry streambeds, and reduced aquifer recharge, are some consequences of poorly managed stormwater. Improving how we manage stormwater by employing stormwater best management practices (BMPs) can help reverse these trends and restore our streams. Increasingly, communities across the country are employing BMPs that more closely mimic the water cycle and reduce the volume of stormwater near where it hits the ground. BMPs can be designed maximize stormwater infiltration into the ground and increase evaporation and evapotranspiration opportunities. Many BMPs rely on plants to treat runoff, which also is an aesthetic enhancement in our developed areas. For more information on BMPs, Pennsylvania Environmental Council (www.pecpa.org), PA Department of Environmental Protection (www.dep.state.pa.us).

Pennsylvania Environmental Council's (Council) Stormwater Retrofit Technical Assistance Program developed retrofit concepts to improve stormwater management for participating sites in Neshaminy, Darby, Chester, and Crum, watersheds of southeastern Pennsylvania. During this 18 month project, the Council and its design team (Borton-Lawson Engineering and Cahill & Associates) worked with municipal officials, Environmental Advisory Councils, property owners, and community members to develop conceptual designs that demonstrate how to incorporate stormwater best management practices (BMPs) at developed sites with stormwater basins and parking lots.

The retrofit concepts and opportunities described in this fact sheet focus on improving the function of conventional stormwater detention basins. In addition to basin retrofit concepts described, other BMPs that compliment basin retrofits are highlighted as well. Employing a variety of BMPs offers an opportunity to more comprehensively manage the quality, volume and rate of site runoff. These retrofit design concepts may be applicable or relevant to a site you own or manage, or a development in your community. Prior to retrofitting stormwater facilities and before installing BMPs, contact your municipality for any guidelines and enlist an experienced engineer to develop the design.

Benefits of Retrofitting a Detention Basin:

- Enhance and naturalize the landscape and improve native habitat.
- Prevent stream degradation and restore stream water quality.
- More effectively control runoff from small more frequent storms, which account for up to 90 percent of the annual rainfall events.
- Protect streams from polluted runoff, since basins that manage small storms more effectively capture and treat the "first flush" of non-point source pollutants found in surface runoff.
- Replenish groundwater and recharge aquifers.
- Reduce facility maintenance requirements.

The Retrofit Concept: Convert a conventional detention basin into **Vegetated Water Quality Basin**. A vegetated water quality basin or an extended detention basin is a BMP designed to (1) maximize the flow path through the basin, (2) slow the flow of stormwater through the basin, (3) improve how plants use stormwater to increase absorption and evapotranspiration, (4) filter and trap common runoff pollutants, (5) promote soil saturation/groundwater recharge, and (6) increase evaporation of stormwater. Basin conversions generally involve removing concrete low-flow channels, modifying outlet structures so basins hold water from small storms, re-grading to modify flow path, and re-vegetating with native species. Details of each retrofit are highlighted below.

SITE: ORCHARD HILL RESIDENTIAL DEVELOPMENT

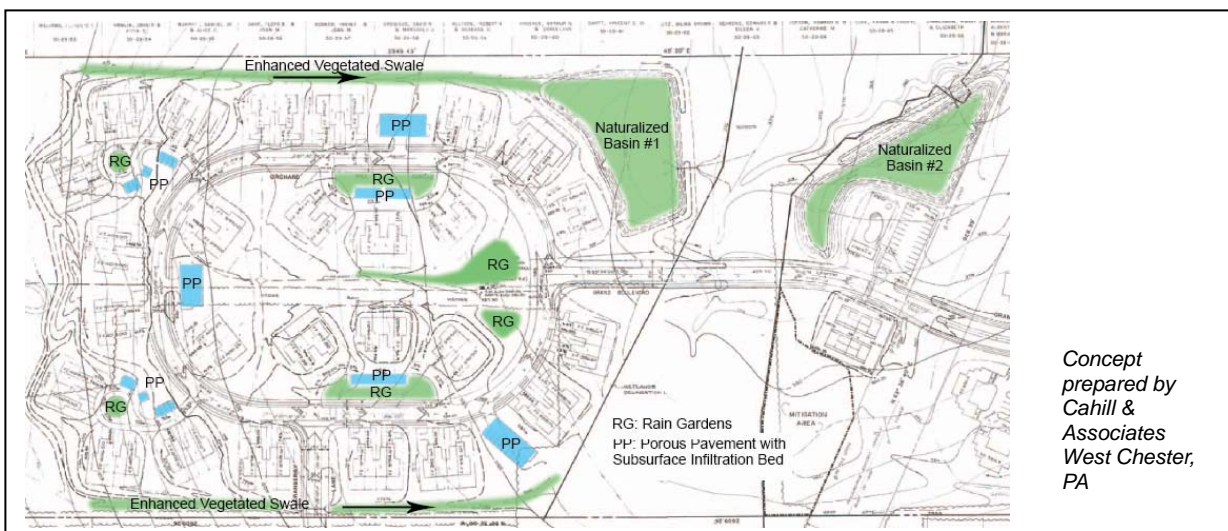
Warrington Township, Bucks County, Neshaminy Creek Watershed
Retrofit concepts developed by Cahill & Associates, West Chester, PA

Site Background: This medium-density 54-acre residential development with conventional stormwater management consists of a single large detention basin discharging to a tributary into Little Neshaminy Creek. The detention basin has been constructed with a concrete low flow channel and is susceptible to high water table conditions and poor drainage. Drainage problems are evident from the saturated and wet conditions within the basin, making it difficult to maintain. The roof leaders and other impervious surfaces in the development, including roads, driveways, and parking areas, are conveyed to the detention basins via a centralized stormwater collection system. Some overland flow is conveyed to the detention basin through grass swales in the development.

STORMWATER BASIN RETROFIT CONCEPT DETAILS

The proposed basin retrofit design concept includes the following modifications.

- **Modify the outlet control structure** by installing a weir plate over the outlet structure to hold a shallow volume (approximately 4-6 inches) of water in the basin to retain water from small storms. (Using a weir plate for this purpose allows for future modification to the outfall if desired.)
- **Replace grass with native species** including trees, shrubs, grasses, and other herbaceous vegetation. The vegetation will reduce stormwater volume through the process of evapotranspiration. Deep root systems help stormwater percolate into the ground and recharge groundwater.
- **Install a sediment forebay**, which is a small basin or cell within the basin separated by a berm or barrier near the inlet to trap and filter sediment and debris first entering the basin. This forebay is designed to permit sediment and pollutants to drop out. The berm can be constructed of earth or riprap. Forebays should be vegetated.



OTHER RETROFIT CONCEPT DETAILS

Other retrofit concepts proposed for this site include:

- **Convert cul-de-sac traffic islands into rain gardens** to capture stormwater runoff from adjacent street. A rain garden is a shallow depression filled with soils and plants that can tolerate periodic flooding by stormwater. This vegetative BMP can control stormwater from impervious surfaces, including rooftops, patios, sidewalks, driveways, and streets. Installing rain gardens in the traffic islands involves: (1) removing sections of curb to allow road runoff to flow into the rain garden; (2) re-grading to ensure the shallow recessed areas are below the street elevation; (3) amending soil with compost or sand to ensure soils soak up rainwater and allow for percolation into the ground (if subsurface soils permit); (4) installing native plants; and (5) educating property owners/occupants about care and maintenance of this BMP.
- **Install Vegetated Bioretention Swales** in backyards and common open spaces to more effectively filter runoff pollutants and to slow the rate and reduce the volume of stormwater flowing to the basin. A vegetated swale is a broad, shallow channel densely planted with a variety of trees, shrubs and/or grasses tolerant of periodic inundation by stormwater flow. Vegetated swales can be installed to convey stormwater over land through a site as an alternative to a concrete channel, a pipe or an eroded earthen channel. A well-designed vegetated swale can effectively control erosion and manage stormwater while enhancing site landscape. If soils permit, swales can be designed with check dams or other features to provide for stormwater infiltration.
- **Disconnect rooftop downspouts** to divert stormwater flows from central storm sewer system. Modify downspouts to redirect roof runoff into new rain gardens or vegetated bioretention swales designed to receive roof runoff. This BMP helps distribute stormwater to vegetative areas helping to filter runoff pollutants and promote uptake and evapotranspiration by plants. This BMP also decentralizes stormwater management, which reduces the volume conveyed to the basin and into the creek during storms.
- **Install Porous Pavement and Infiltration System in common parking areas.** Retrofit on-street parking spaces with porous pavement underlain by stormwater infiltration beds to reduce the volume of stormwater entering the basin and promote groundwater recharge. This retrofit entails replacing the standard asphalt pavement with porous asphalt underlain by a storage bed to capture and infiltrate runoff from parking spaces and the adjacent street. Porous surface material can include a variety of products such as asphalt, concrete or pavers. The subsurface storage and infiltration system consists of a uniformly graded stone bed with a depth of between 12 to 36 inches. It is more economical to undertake this retrofit in conjunction with resurfacing and road improvements.

A Note About Mosquitoes:

An extended detention basin and rain garden planted with a variety of wet meadow plants provides better treatment of stormwater and poses less of a mosquito problem than a basin planted with turf grass because frogs, dragonflies, and birds that will thrive in a wetland meadow ecosystem will act as natural controls.

This naturalized basin in Montgomery County has been planted with grasses and wildflowers



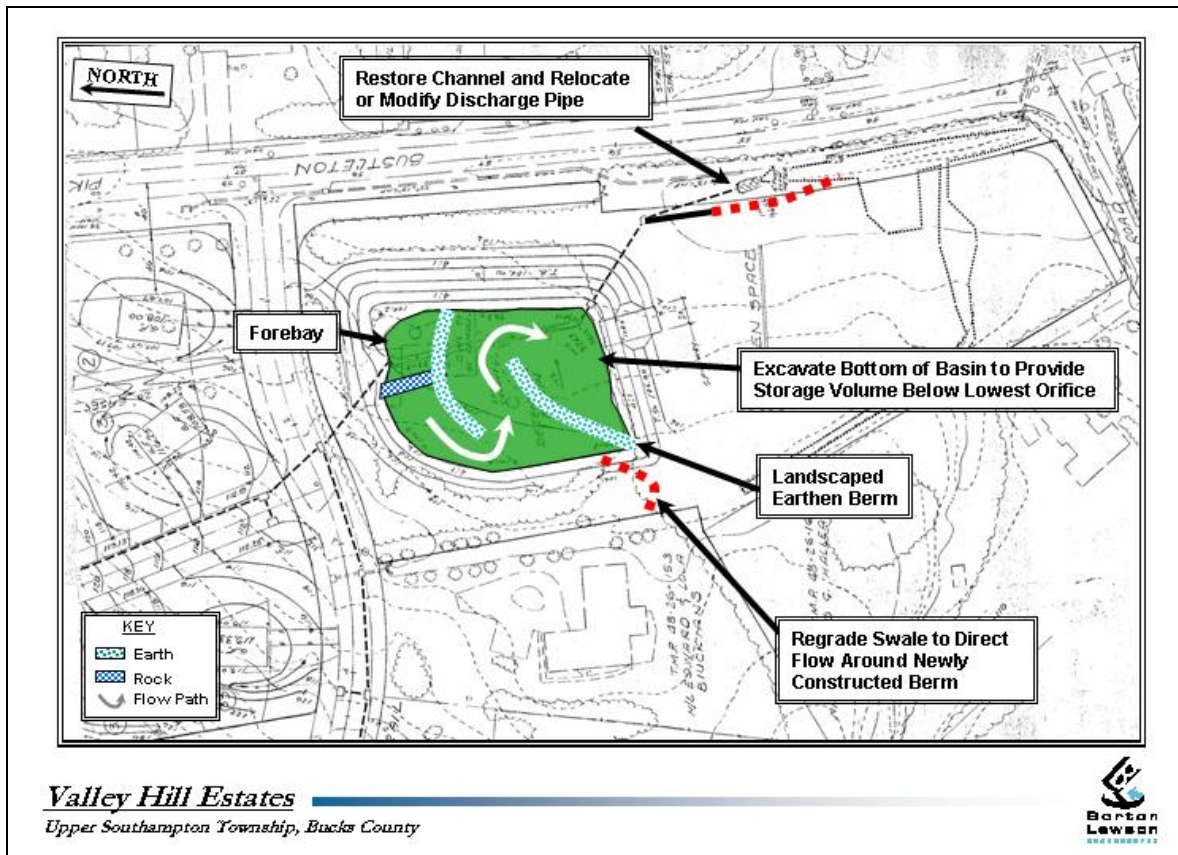
Cost Estimate

Retrofitting this detention basin is estimated to cost \$20,000. (This is an order of magnitude estimate.) The cost to install rain gardens and vegetated bioretention swales can be estimated at \$4.00 a square foot of area. The cost to install porous pavement with subsurface infiltration can be estimated at \$6.00 a square foot.

SITE: VALLEY HILL ESTATES RESIDENTIAL DEVELOPMENT

Upper Southampton Township, Bucks County, Neshaminy Creek Watershed
Retrofit concepts developed by Borton-Lawson Engineering, Bethlehem, PA

Site Background: This 12-acre residential subdivision has conventional stormwater management consisting of a single large detention basin discharging to Mill Creek. This development, located west of Bustleton Pike and north of Stump Road, consists of approximately 40 single-family properties and has 1-2 acre of wooded open space. The detention basin was constructed with a concrete low flow channel, and has poor drainage due to the condition of the outfall and poorly draining soils. Rooftops and other impervious surfaces in the development, including roads, driveways and parking areas, are conveyed to the half-acre detention basin via a centralized stormwater system.



STORMWATER BASIN RETROFIT CONCEPT DETAILS

The proposed design concept includes these modifications.

- **Remove concrete low flow channel** and re-vegetate basin with native plants tolerant of variable moisture conditions. This promotes evapotranspiration, reduces the volume of stormwater runoff, filters non-point source pollutants, enhances natural habitat for wildlife, and improves basin aesthetics.
- **Excavate basin bottom** to increase storage capacity below the lowest orifice in the basin's outlet to retain stormwater temporarily from small storms to increase percolation into basin soils and for use by plants.
- **Construct earthen berm** using excavated soils. A newly constructed berm will be configured to extend the flow path and prevent stormwater from taking the shortest route through the basin. (This will prevent "short circuiting" within the basin.) This new extended flow path slows the rate of flow and allows non-point source pollutants to settle and filter out.

- **Install a sediment forebay** within the detention basin near the inlet to capture sediment, debris and provide pretreatment of stormwater runoff before releasing it to the main portion of the basin. The forebay may be constructed with rock and/or earth and should be planted with native plants.
- **Replace grass with native species** including trees, shrubs, grasses, and other herbaceous vegetation. The vegetation will reduce stormwater volume through the process of evapotranspiration. Deep root systems help stormwater percolate into the ground and recharge groundwater.
- **Redirect all overland swales** flowing into the basin away from the outlet structure to extend the flow path and reduce “short circuiting” within the basin.

Cost Estimate

Retrofitting this detention basin at is estimated to cost \$32,000. (This is an order of magnitude estimate.)

NOTES ABOUT PLANTINGS IN BASINS

- ◆ **A LANDSCAPE PLAN.** The landscape plan to be developed should consider soil and moisture conditions. When using vegetative BMPs, select plant species with consideration to their moisture tolerance. Locate native plants well adapted to wet conditions in areas inundated by stormwater and plants tolerant of dry conditions in higher areas less often exposed to stormwater.
- ◆ **MANAGING YOUR VEGETATION.** Plantings in a vegetated extended detention basin and on basin slopes perform a valuable function; however, woody vegetation growing too near basin structures, such as an outlet or inlet pipe, can impact basin function and lead to costly maintenance. Invasive plants, such as *Phragmites* and Japanese Knotweed, should be controlled since they can out-compete desirable native plants. Managing vegetation to protect facility integrity includes performing a periodic inspection and as-needed maintenance to control invasive plants and remove woody debris.
- ◆ **WOODY WASTES.** While grass clippings and small amounts of leafy plant matter can remain in the basin to naturally decompose, it is recommended that large amounts of plant debris, particularly woody stems and branches, be removed to ensure stormwater flow through the basin is unimpeded.
- ◆ **For more information on native plants and a list of recommended plants, please visit the following web sites: Pennsylvania Department of Conservation and Recreation - www.dcnr.state.pa.us/forestry/wildplant/native.aspx and Pennsylvania Native Plant Society - www.pawildflower.org.**

For more information, please contact:

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