Stormwater
The Journal for Surface Water Quality Professionals

FEATURES

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A continuous system of BMPs is helping save New York City's last great freshwater wetlands.

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Big plans are underway on Staten Island's South Shore, as the New York City Department of Environmental Protection (NYCDEP) moves forward with the Storm Water and Sanitary Drainage Management Plan for South Richmond. This suburban area is the site of the Staten Island Bluebelt, a system of streams, ponds, and wetlands managed by NYCDEP for stormwater management purposes. Bluebelt land acquisitions total more than 250 ac. of natural waterways, with a total watershed area in excess of 12,000 ac. South Richmond has the last major stand of freshwater wetlands in New York City. It is also one of the last remaining sections of the city that lacks adequate stormwater and sanitary drainage infrastructure, thus adversely affecting the natural resources of the area and greatly compromising the quality of life for its residents. Under current conditions, the area consistently experiences localized flooding, degraded water quality, and erosion, which impact the wetland resources.

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The residents of South Richmond have long awaited sanitary sewers and stormwater infrastructure in their neighborhoods. Their concerns have not gone unnoticed. To alleviate these conditions and provide improved drainage facilities, the NYCDEP implemented the Storm Water and Sanitary Drainage Management Plan for South Richmond. This comprehensive drainage management plan uses and preserves the South Shore's natural drainage system of streams, ponds, marshes, and wetlands to the greatest extent possible. The two main components of the plan are the nontraditional stormwater management system and the sanitary sewer system. The stormwater component consists of a series of storm sewers, which will collect and convey street runoff to the existing streams. These streams, along with the contiguous wetlands, provide natural drainage corridors for stormwater conveyance. Planned as a gravity flow system, the sanitary sewer component will avoid damage to sensitive natural areas. Successfully implementing the stormwater component of the drainage plan relies on the effective use of drainage corridors with the application of best management practices (BMPs).

BMPs buffer the interface between the piped runoff and the natural drainage corridor. BMPs mitigate the effect of peak discharges, improve water quality, and preserve the area's natural features by storing and channeling stormwater before it is discharged into a receiving water body. In South Richmond, a variety of BMPs are applied to the pipe/stream interface to effectively manage stormwater runoff. The Staten Island Bluebelt program features one of the largest applications of a continuous and comprehensive system of BMPs in the nation, and it is the first time they have been employed on a large scale in New York City.

The effective integration of BMPs into an overall stormwater drainage plan for South Richmond requires combining the existing natural surroundings with the proper adaptation of the urban BMPs. Minimizing environmental disturbance is a primary consideration in planning and designing the system. The intention is to reduce the impact of the stormwater runoff discharge on the streams. By using BMPs to attenuate peak flow and reduce pollutant load to the streams, streambank erosion and flooding can be minimized and water quality in the ponds and streams can be improved. Although individual BMPs, such as shallow marshes, engineered wetlands, and combination pond/wetland systems, are effective stormwater drainage tools, they can be even more effective when used in combination, as they are in this project.

Community Participation

Top and Below: Existing conditions prior to BMP construction

BMP development creates working wetlands that protect against flooding and offer a healthier habitat for wildlife.

One of many important factors integral to the success of the Storm Water and Sanitary Drainage Management Plan is community acceptance and cooperation. The NYCDEP has a strong partnership with the community in order to educate people about the nature of the program and keep them informed of progressive developments. To improve communication between the agency and the community, the NYCDEP implemented a comprehensive public participation program that maintains dialog regarding the project's purpose and objectives and involves citizens in the decision-making process. One of the most important components of the program is the Citizens' Advisory Committee (CAC), a group of approximately 30 citizens representing diverse interests that range from environmental, civic, and homeowners associations to builders' organizations. The CAC's role is to act as a liaison to the broader community and to assist the NYCDEP in developing an effective program.

Planning and Implementation

In the 1970s, New York City's City Planning Commission recognized the need to conduct a study for a comprehensive land-use master plan for the South Richmond area. This study recognized the vast areas that still remained in a natural state and had open-space value in the zoned landscape and that it was important to preserve and protect these natural resources for the long-range land-use and quality-of-life concerns. The study also recognized the need for a zoning component in the overall strategy to accomplish these goals. Since that time, it became apparent that these natural areas, containing water courses and wetlands, could be used for stormwater conveyance as well.

Figure 1. South Richmond Staten Island Bluebelt

Based on the study, the zoned Designated Open Space (DOS) system was established, which captured the network of existing, naturally occurring lakes, ponds, streams, wetlands, important tree stands, and topographic features. The DOS zone also captured a significant amount of publicly owned property and kept it from being sold.

From a land-use point of view, the DOS zone prohibited development in those areas, keeping the natural features protected, but allowed transfer of development rights to the commonly owned abutting properties. From a drainage perspective, the DOS areas were arranged to connect already mapped parks, creating a comprehensive drainage corridor for the natural water-course system. This set a solid framework for the Bluebelt program, which then proceeded to assemble additional lands abutting and within the system.

The entire South Richmond study area divides into 10 watersheds. Each watershed further subdivides into individual sub-basins that drain into streams, lakes, ponds, and wetlands. The suitability of alternative BMPs in these sub-basins was evaluated for their capacities to provide hydrologic/hydraulic benefits. Storm discharge peaks in adjacent BMP facilities were staggered so that excessive flow was not experienced in any one particular site. The incorporation of stormwater BMPs, such as retention basins, provides significant flood attenuation and water-quality benefits on an areawide basis. Flow was stored or retained and released gradually to the downstream areas. Existing wetlands were restored and, in certain cases, preceded by a stormwater treatment system to remove sediments. For example, a long flow path through a constructed wetland can aid in pollutant removal and stormwater attenuation. Drainage corridors were designed for maximum conveyance, detention, and environmental benefit using a series of BMPs to pretreat and control the runoff. Various tools were used, including a comprehensive geographic information system mapping database for the study area. Extensive hydrologic, hydraulic, and water-quality modeling of the streams and tributary watersheds occurred, along with wetland evaluation and analysis, sanitary/storm sewer system layout, and topographic surveys.

PHOTO: ANDREW GORDON PHOTOGRAPHY

A recently constructed BMP in the South Richmond drainage area

A screening process limited the number of BMP designs that were actively pursued, narrowing it down from more than 100 different designs used in other parts of the country. Effective use of the criteria in the BMP selection process allowed for compilation of a more precise listing of BMPs suitable to the watershed. Following the selection of appropriate BMPs, suitable retrofit sites were identified. Scouting for retrofit sites requires a sound understanding of urban streams and hydrology, knowledge of the local area and its potential problem areas, and an ability to envision possibilities for enhancement. The term "retrofit" indicates that the BMP is being constructed to improve existing drainage conditions rather than being constructed as part of a new watershed development plan. These are a few different types of stormwater retrofit techniques:

Retrofit Existing Older Stormwater Management Facilities. This technique involves converting existing detention facilities into multifunctional stormwater BMPs. This is perhaps the easiest retrofit option, because stormwater is already managed in a distinct location in an informal manner and residents already accept and understand stormwater management to some degree. In addition, modifying existing facilities usually involves minimal impacts to secondary environmental resources, such as wetlands and forest cover. Excavation of the pond bottom or modification of the outlet structure results in additional storage for extended detention. The use of baffles, earthen berms, or pond microtopography results in enhanced pollutant removal. The Richmond Creek area at BMP RC-4 exemplifies this type of retrofit technique, which uses a pocket wetland with a high/low marsh and a combination of a forebay and a micropool to enhance pollutant removal from the stormwater flows before these waters enter the creek via the natural wetland. The New York State Department of Environmental Conservation (NYSDEC)—regulated wetland was fed by backwater flooding caused by the undersized culvert at Lighthouse Avenue. Despite the fact that the culvert was enlarged to maximize its conveyance capacity for the stormwater of Richmond Creek, and hence had the potential to drain the adjacent natural wetland, constructing the BMP preserved the wetland. The BMP design uses pocket wetlands to attenuate small storms and provide some pollutant removal; the pocket wetlands then drain into the existing wetland, replacing the loss of water caused by the redesign of the culvert. The most important application of this BMP is a mixture of high and low marsh and upland plantings suitable for varying depths of water.

Figure 2. Planning Process Employed for Bluebelt Program

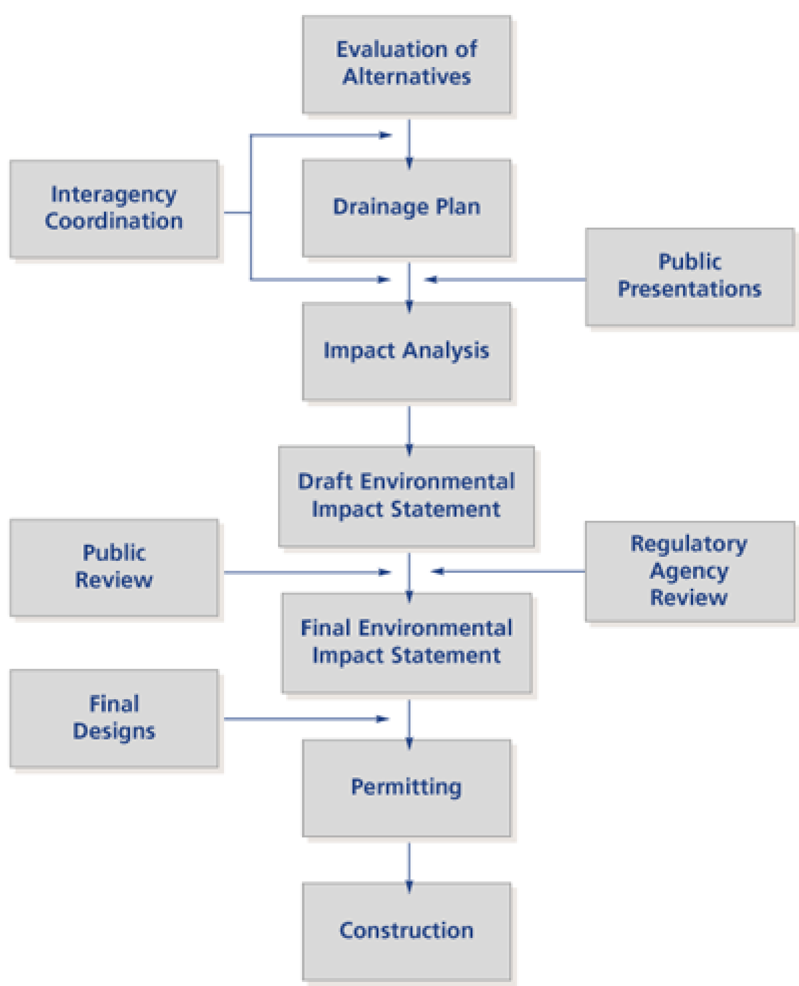
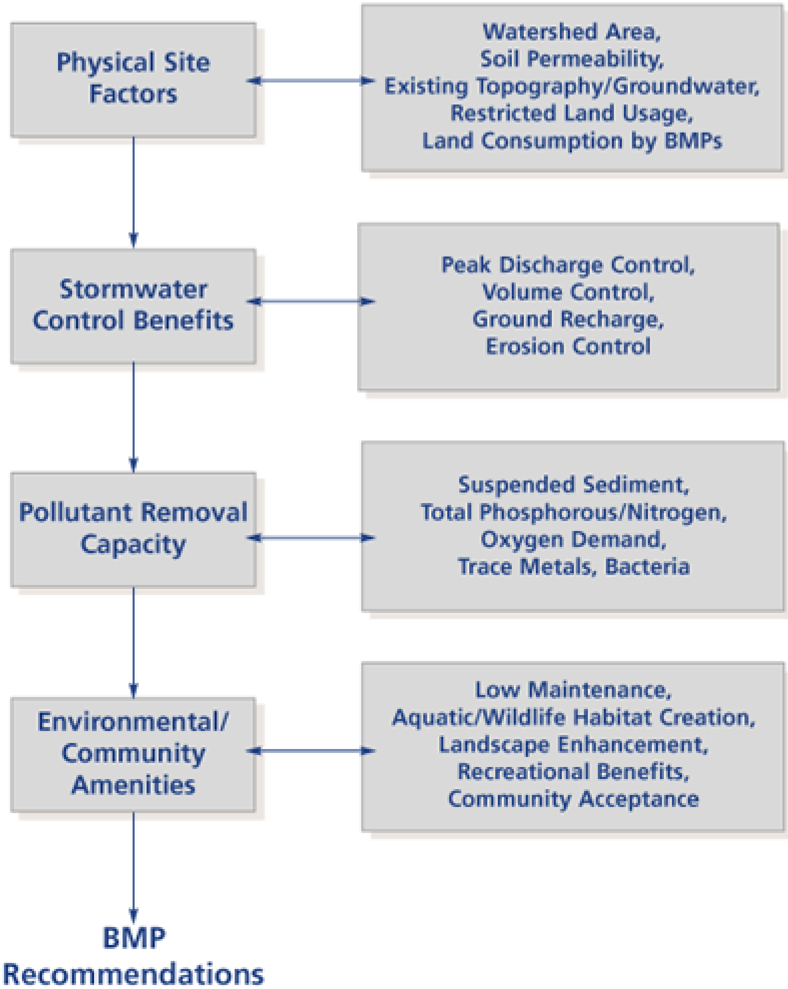


Figure 3. Stormwater BMPs Selection Process



Construction of New BMPs at Storm Drainage Pipe Outfalls.

This type of retrofit consists of constructing a BMP at the immediate terminus of the storm drainage system. It is often designed as an offline BMP. Flow splitters can be utilized to convey water-quality treatment volumes to a BMP while allowing larger storm frequency events to bypass the BMP. An example of this type of retrofit technique is BMP RC-5 at Richmond Creek watershed. This BMP uses a constructed wetland with a high/low

Verifying tree surveys is part of the comprehensive natural resources inventory

marsh and a combination of a forebay and a micropool to attenuate peak flows, reduce pollutant loading to the creek, and diversify and enhance the impacted wetlands. This system differs from a pocket wetland in its size and ability to handle larger flows. The extended detention provides the ability to control larger flows, while the high/low marshes provide pollutant removal capabilities.

Instream Practices in Channels. In several areas, previously channelized streams can be potential sites for small instream detention structures. These structures consist of small weir walls or check dams placed within the channels. A small ponding area is provided upstream of the structures for establishing wetland areas. This type of retrofit is usually very easy to install and can provide some moderate pollutant removal benefits but can have potentially adverse impacts on the floodplain. Careful analysis of existing floodplain levels compared to those with the BMPs in place must precede any development of the site. These channels have often been designed to convey a certain frequency storm event with a given cross-section. Modification of this geometry can affect adjacent properties and structures.

Before: structurally deteriorating undersized culvert at Aultman Avenue

After: expanded culvert with reconstructed headwall and landscaping

PHOTO: ANDREW GORDON PHOTOGRAPHY

BMP at Lighthouse Avenue

Construction of Facilities

The first completed capital project under the South Richmond Drainage Plan lies within the Richmond Creek Bluebelt. Highlights of the project are extensive landscaping and specialized construction techniques not typically used for sewer projects. The BMPs include shallow marsh wetlands to filter stormwater, outlet stilling basins to reduce water velocity before the water discharges into the stream, and a sand filter to remove pollutants. Constructing the BMPs and related drainage infrastructure involved soil excavation, pipe installation, site work, grading, and implementing planting plans. The use of natural products, native plants, and stone facing to complement the rustic character of the neighborhood enhanced the constructed BMPs. Construction of stone walls and culverts, installation of coconut fiber rolls along the stream's edges to anchor plants, and the planting of at least 25 species of trees, shrubs, and ground cover were a few of the main features adopted to enhance the aesthetic quality of the constructed elements. Carefully planned landscape zones were designed and implemented. All these areas were diversely vegetated to enhance pollutant removal, maintain biodiversity, and promote habitat complexity by supporting a wide variety of wildlife.

Erosion Control During Construction

Reinforced silt fence.

The deputy director of the Bluebelt project (left) inspects proper functioning of the portable sediment tank with sediment trap.

To protect adjacent natural areas, such as streams and wetlands, from the harmful effects of soil erosion and sediment accumulation during construction, a soil erosion and sediment control plan was developed. Concerned regulatory agencies, primarily the NYSDEC, reviewed and approved the plan.

The primary objectives of this plan include minimizing runoff into the wetlands and significantly reducing the amount of sediment accumulation that might occur. Besides degrading the value of these natural features, sediment accumulation reduces the carrying capacity of streams and reduces the stormwater storage capacity of

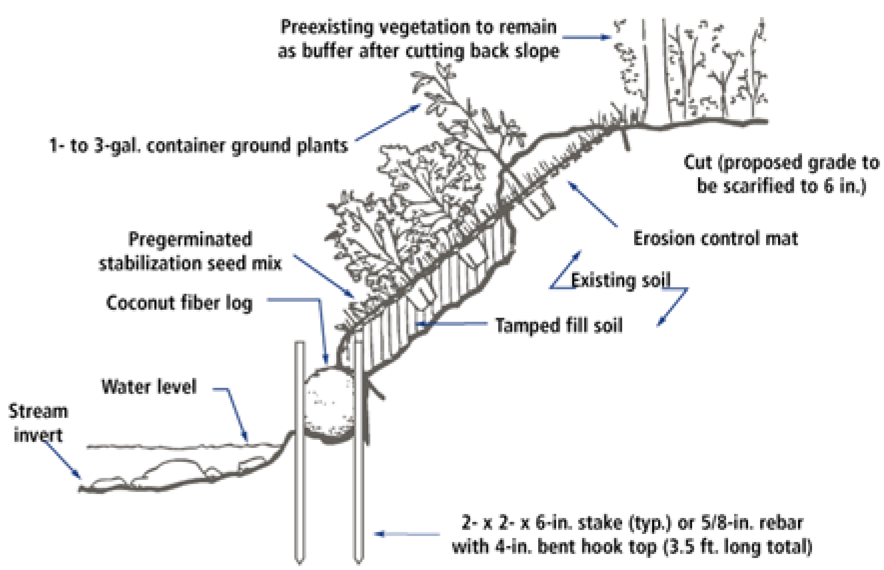
Surface-water collector

wetlands and ponds. Key features of the plan include reinforced silt fencing, surface-water collectors, portable sediment tanks, and crushed-stone—lined sediment traps. Reinforced silt fencing essentially consists of staked hay-bale rows backed with filter fabric and construction-limit fencing. It is installed around all wetland and wooded areas to prevent runoff from entering these sites and to bar access to construction crews and equipment. Surface-water collectors, which are essentially linear trenches filled with crushed stone, are constructed along the roadside at stream crossings for collection and filtration of runoff before discharge into the stream. Portable sediment tanks coupled with crushed-stone—lined sediment traps treat the water pumped from construction trenches. The water passes through sediment-trapping baffles within the sediment tank, then into the adjacent pit lined with crushed stone, where the water infiltrates into the ground. Turbidity levels are determined by onsite measurement. If the turbidity level exceeds the set criteria, the discharge effluent undergoes further treatment or is disposed of off-site. All the soil and sediment control features are temporary and must be removed prior to the end of the construction project.

Streambank Stabilization

Figure 4.
Streambank Stabilization for Moderately Undercut Slopes

(cross-section - not to scale)



Portable sediment tank with sediment trap

Urbanization of watersheds causes flood peaks to be typically quicker, higher, and more frequent, and base flows are generally lower than before urbanization. To control these flows, a variety of streambank stabilization (SBS) techniques have been employed to minimize erosion, sediment transport, and flooding. To minimize erosion, the maximum allowable stream velocity is generally restricted to 3-5 ft./sec. When such velocities are exceeded, there are several techniques to either reduce the maximum velocity or protect the streambank from erosion. The use of riprap bank armor is often used to protect the streambank from erosive velocities. Despite its "engineered" look, this technique is the most effective when velocities cannot be reduced. A less intrusive SBS technique is undercut stabilization. A small amount of riprap is placed at the water line, along the edge of the stream, and a coconut-fiber (coir) roll–a natural, biodegradable fiber used for aquatic planting–is staked above it. Next comes backfilling the area behind the coir roll to meet the existing grade, and planting of the area follows. The riprap and coir roll absorb much of the erosive energy of the storm flows, allowing the streambank vegetation to survive and reducing erosion. Coir roll can be used alone but generally achieves less energy dissipation.

Another SBS technique, rock/toe joint planting, serves the same purpose as riprap bank armor. Providing a single layer of riprap and plantings creates an appearance more complementary to the existing natural surroundings. Effective implementation of the soil erosion and sediment control plan and the streambank stabilization techniques, combined with good housekeeping, successfully protected the natural features of the area and highlights the importance of effective sedimentation and erosion control.

Conclusion

The concept of using special techniques, such as enhanced wetlands for stormwater control, continues to gain national attention because of increasing focus on improving the quality of urban stormwater runoff and, at the same time, protecting the existing natural drainage features. BMP development allows for restoration of formerly degraded wetlands, creating enhanced natural areas that inspire community pride. Volunteers organize cleanup campaigns, and the Bluebelt area is being secured against dumping and vandalism. These promising regraded wetland areas have now become positive and desirable features in the community and enhance local aesthetics. The successful implementation of this plan, which uses natural drainage corridors for stormwater conveyance coupled with new and improved construction methodologies and techniques, makes this a model for future projects.

Project team members working with Hazen and Sawyer include the Center for Watershed Protection, Environmental Concern, and Blumberg & Butter.

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