Engineered Stormwater Management for Low-Income Urban Communities

A Design Proposal and Plan for Implementation and Educational Outreach

Proposal #: G4S70481

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Executive Summary

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Engineered Stormwater Management for Low-Income Urban Communities

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Project period
September 15, 2004 through September 14, 2006

Description and Objective of Research

This project focuses on improving the urban landscape through the creation of socially beneficial green spaces, while simultaneously improving environmental quality. The success of this project depends on promoting environmental awareness throughout the community. This pilot project is designed for the Weequahic Park neighborhood of the City of Newark, New Jersey, but its concepts are to act as a reference guide for stormwater management in urban areas throughout the world.

The design team has identified Dayton Street Elementary School and the Seth Boyden Public Housing Complex (Newark Housing Authority) as candidate sites that will benefit greatly from stormwater management. These sites were selected because they possess attributes shared by many urban communities: large areas of impervious surfaces, few green spaces, nonexistent stormwater management, and a lack of funds to ameliorate these problems. These sites are also contributors of non-point source (NPS) pollution; they discharge into a combined sewer system that regularly overflows due to high volumes, spilling effluent into the streets of Newark.

Outcomes of the proposed designs include a better quality of life for the students and employees of Dayton Street School, as well as the local residents of the Seth Boyden Complex and the surrounding community. The students and employees will benefit through the creation of a recreational area that will serve as a biofilter, as well as an educational tool to teach students about hydrologic processes, impacts of stormwater, and potential careers in the field of natural resources and environmental studies. Residents will be able to take greater pride in their community through the beautification of their surroundings and the job training opportunities that will be created for community members through the project implementation process.
Summary of Findings

Several non-point pollution sources have been identified including street, roof, and parking lot runoff, as well as large open areas of compacted soil. Modifying these impervious surfaces will allow for stormwater treatment, infiltration, and groundwater replenishment, while reducing the load stresses of the local combined sewer systems.

Designs for engineered best management practices (BMPs) were developed with the guidance of community members through outreach and meetings. The resulting designs prevent pollutants from entering the existing stormwater system (and ultimately, nearby water bodies), increase groundwater infiltration, and improve local air quality.

In New Jersey, BMPs are designed to control runoff from the water quality storm, which is defined as 1.25 inches of rain over two hours. By designing for the water quality storm, a BMP will treat approximately 90% of New Jersey’s annual storms. Stormwater BMPs that are designed for quantity control are used to reduce the peak stormwater runoff for the 2-, 10- and 100-year design storms, which are defined as 24-hour rainfall events of 3.3 inches, 5.3 inches, and 8.7 inches, respectively. Taking these storm events into consideration, the team decided to use the following BMPs for implementation at the Newark site:

- Bioretention Basin
- Bioswale
- Vegetative Filter Strip
- Cisterns

These are site-appropriate BMPs that will be utilized to improve water quality and water quantity issues, as well as to provide rain-harvested water for landscape maintenance and garden irrigation.

The community is enthusiastically supportive of this project. As a result of contacts through Dayton School, science teacher Jeanette Seabrooks and principal Susan Kandell, the design team received an endorsement from William S. Parrish, Jr., Director, Design & Construction of the Facilities Management Department for the Newark Public Schools. According to Mr. Parrish, a Leadership in Energy and Environmental Design (LEED) 2.0 accredited professional, “Having the Environmental Sciences and Landscape Architecture students of Rutgers developing strategies and best management practices to aid our environment and school district is extremely beneficial, especially when there is a learning opportunity attached for students of our community.”

The Weequahic Park Association (WPA), a principle project partner, is non-governmental community group in Newark. Wilbur McNeil, WPA President, and Kevin Moore, Project Director, readily assisted the P3 design team by providing guidance and allowing the team to speak at a WPA weekly open meeting to reach the community. The project as currently conceived would have been impossible without the WPA’s loyal core group of volunteer/members, who have earned the trust and respect of neighborhood residents and Dayton School educators.
Conclusions

Almost half of the world’s population currently lives in urban areas, and this number is growing. The designs rendered for the City of Newark are easily transferable to other densely populated regions of the world. Understandably, neighborhood residents and leaders wish to ensure the safety, attractiveness, and ecological functions of their community. We have made the Dayton Street School the focus of the design project to demonstrate how BMPs can achieve all of these goals. At present, the children's playground is a paved parking lot that looks out onto another lot containing an abandoned tractor trailer. One way to enhance the day-to-day lives of children in this neighborhood is by engaging them in creating an attractive, stimulating, and fun learning environment. The second portion of the project, which includes designs for the Seth Boyden Public Housing Complex, targets the problems of impacted soils and foreboding public space that are all too characteristic of dwellings in low-income city neighborhoods. In addition to improving ecosystem functions, these designs enhance community safety and attractiveness while providing an educational experience for all.

Project implementation will provide specialized training in stormwater management landscape maintenance for 20 of the local residents. This number will increase as the team continues to raise more funding. The 20 trainees will be paid $20/hour for a total of 17 hours. At the end of their 17 hours, they shall receive a certificate from Rutgers University verifying their participation in the training program.

Proposed Phase II Objectives and Strategies

The Newark design will incorporate BMPs to treat stormwater runoff that will encourage education and community involvement. The design team intends to use innovative BMPs for Dayton Street School with the hope that the children there will become excited about environmental designs for stormwater management. For example, the stormwater harvested from the school roof will initially be directed to a cistern with a holding capacity of 5,000 gallons. The cistern shall be painted to resemble a child’s crayon, and the water that remains within it will be used to supply irrigation to the adjacent raised-bed gardens. The overflow will be treated in the vegetative filter strip and bioretention system.

The rainfall from the lower school roof will be routed over a colorful wall built from rocks and bricks of various sizes. This water will then be directed through the open courtyard, where it will run through textured paving bands that will help the water remain as sheet flow as it continues into the bioretention system. This design meets the school’s needs to retain a portion of the lot for parking during certain times of the school week.

An outdoor classroom shall be built for environmental education and observation and to promote the children’s interaction with nature. Rain draining from the roof adjacent to the outdoor classroom will also be collected in another 5,000-gallon cistern to be used in the irrigation of student-maintained rain gardens. The excess water from the cistern will follow through the drainage rill of the sidewalk area and eventually be collected in the bioretention system.

The overall concept is to demonstrate water falling from the northern-most region of the school and flowing southward via the vegetative filter strip and bioswale to be treated ultimately in the bioretention system. Strategically placed interpretive placards will highlight the historical and environmental reasons for choosing specific site details.

Although BMPs have been designed for both the Dayton Street School and the Seth Boyden Public Housing Complex, $P^3$ competition award funds will be used only for the Dayton Street School portion of
this project. Funding for the Seth Boyden Apartment Complex designs is being solicited from other sources. Team members feel that it is most effective to present designs for both work and home spaces as a model for Newark and other urbanized areas.

**Supplemental Keywords**

Water, groundwater, land, sediments, precipitation, ecological effects, pollution prevention, treatment, effluent, discharge, bioremediation, public policy, public good, sustainable development, socioeconomic, engineering, social science, ecology, monitoring, surveys, ecosystems, environmental engineering, urban and regional planning, watersheds, best management practices, low income urban communities, stormwater drainage, stormwater treatment,

**Relevant Web Sites**

**Dayton Street Elementary School**
http://www.nps.k12.nj.us/dayton_st/index.htm

**Passaic Valley Sewerage Commissioners**
http://www.pvsc.com/

**Rutgers Cooperative Research and Extension Water Resources Program**
www.water.rutgers.edu
P³ PHASE I PROJECT SUMMARY

INTRODUCTION

“Conservation...can be defined as the wise use of our natural environment: it is, in the final analysis, the highest form of national thrift—the prevention of waste and despoilment while preserving, improving and renewing the quality and usefulness of all our resources.”

President John F. Kennedy
(1962 Conservation Message to Congress)

This project focused on improving the urban landscape through the creation of socially beneficial green spaces, while simultaneously improving environmental quality. The success of this project also depended on promoting environmental awareness throughout the community. This pilot project was designed for the Weequahic Park neighborhood of the city of Newark, New Jersey, but its concepts were to act as a reference guide for stormwater management in urban areas throughout the world.

The design team identified Dayton Street School and the Seth Boyden Public Housing Complex (Newark Housing Authority) as candidate sites that would benefit greatly from stormwater management. These sites were selected because they possessed attributes shared by many urban communities such as large areas of impervious surface, few green spaces, inadequate stormwater management, and a shortage of funds to help alleviate these problems. These sites are contributors of non-point source (NPS) pollution, as they are connected to a combined sewer system that has a tendency to overflow and dump raw sewage into the streets of Newark.

This project targeted several of the observed non-point pollution sources including street, roof, and parking lot runoff, while also dealing with large open areas of compacted soil. The reduction of these impervious surfaces will allow for stormwater treatment and possible groundwater replenishment while reducing the obvious load stresses affecting the local sewer systems.

Other positive outcomes of the proposed designs include a better quality of life for the students and employees of Dayton Street School, as well as the local residents of Seth Boyden Complex and the surrounding area. The students and employees will benefit through the creation of a recreational area that will also serve as a biofilter, as well as through opportunities to learn about the impacts of stormwater and possible careers in the field of natural and environmental resources. The residents will be able to take greater pride in their community through the beautification of their surroundings and job training opportunities that will be created as the project is built.

Although best management practices (BMPs) have been designed for both the Dayton Street School and the Seth Boyden Complex, P³ competition award funds will be used only for the Dayton Street School portion of this project (BMPs are discussed in detail below). Funding for the Seth Boyden Complex designs is being solicited from other sources. Design team members felt that presenting designs for both work and home spaces would be most effective when presenting the project as a model for Newark and other urbanized areas.

About the project area:

Newark is a city faced with serious environmental, social, and economic challenges. Newark is bordered by Newark Liberty International Airport and heavily traveled major highways that link New York to Philadelphia, resulting in air and water pollution levels harmful to human and ecosystem health. Like
other cities, Newark's landscape is dominated by impervious surfaces that create a heat island effect. At the same time, Newark benefits from its location near the New Jersey Meadowlands, a major stop-over site for migratory birds, and the Newark and New York bays and estuaries, areas that have dramatically improved in environmental quality in recent years through public and private efforts. The Weequahic Park neighborhood is an ideal demonstration site, as it drains into these important waterways and includes the full range of landscapes typical of Newark and other major cities. Dayton Street School is across the street from the 300-acre Weequahic Park and borders the Seth Boyden Complex. The area east of Seth Boyden is largely industrial with abandoned sites and is immediately next to the airport.

Crime is another threat. Four people were killed on November 26, 2004 in a vacant lot near the Seth Boyden Complex and the Dayton Street School. Though the mayor insisted it was an isolated incident of vengeance among criminals, neighborhood activists responded with meetings and posters urging “Stop the Violence--Unity Now.” Leaders and members of the key stakeholder organization for this project, the Weequahic Park Association (WPA), emphasize that improving the physical and ecological quality of the neighborhood's landscapes is critical for improving the overall quality of life and the safety of its public spaces.

Understandably, neighborhood residents and leaders especially wish to ensure the safety and attractiveness of Dayton School as a community institution, which is why our project centers on the school. At present, the children's playground is a paved parking lot that looks out onto an empty lot containing an abandoned tractor trailer. One way to enhance the day-to-day lives of children in this neighborhood is by engaging them in creating an attractive, stimulating, and fun learning environment. Science teachers at Dayton Street School are excited about the prospect of improving the local environment while providing students a school-approved reason to get their hands dirty as they help build and maintain the garden portion of the design. The second portion of the project, which includes designs for the Seth Boyden Complex, targets the problems of impacted soil and a forbidding public space all too characteristic of dwellings in poor city neighborhoods.

The project aims are supported by research showing that greening and beautification projects may have profound effects on behavior. According to a study of Chicago Public Housing, “Residents living in 'greener' surroundings report lower levels of fear, fewer incivilities, and less aggressive and violent behavior.” [1] The researchers also gathered objective data measuring and comparing vegetation levels and reported crimes at the housing complex: “Compared to buildings with low levels of vegetation, those with medium levels had 42% fewer total crimes, 40% fewer property crimes, and 44% fewer violent crimes.”

PROJECT TEAM

The student design team consists of three Bioenvironmental Engineering students (Kristine Yates, Karan Bhandari, and David Berry), two Landscape Architecture students (John Donnelly and Mike Avery), and one Environmental Communications student (Medea Villere). All students are seniors and will use the skills and expertise that they gained from course work at Rutgers University and professional internships. The student design team is supervised by Principal Investigator Christopher Obropta, a licensed professional engineer in New Jersey and an Assistant Professor with the Rutgers University Bioenvironmental Engineering Department. Co-Principal Investigators include Karen O’Neill, an Assistant Professor with the Rutgers University Human Ecology Department, and Gregory Rusciano, a graduate student of the Rutgers University Bioenvironmental Engineering program.
IDENTIFYING PROBLEMS - CREATING SOLUTIONS

The design team has addressed three important and interconnected issues in Newark: environmental protection (Planet), environmental justice (Prosperity), and community involvement (People).

Environmental Protection

Environmental protection is important for human and ecological health. To achieve environmental protection, the design team will make use of stormwater BMPs that will help improve water quality, replenish groundwater supplies, and promote direct reuse. According to the U.S. Environmental Protection Agency (2005), “non-point source pollution is the leading remaining cause of water quality problems” [2]. NPS pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources and is often carried to waterways (i.e., lakes, rivers, wetlands, coastal waters, and underground sources of drinking water) by rainfall or snowmelt moving over paved surfaces and through contaminated soil. NPS pollution inputs peak during storm events as a result of the sudden rush of water that flushes pollutants directly into water bodies. The volume of degraded water is increased in many older cities like Newark that rely on combined sewer systems, which combine domestic and industrial wastewater with stormwater runoff [3]. The main problem with combined sewers is their tendency to become overloaded, which results in the release of raw sewage into streets and local waterways (See Figure A-2 in Appendix A.). At the project site, this overloading occurs even on dry days, after the morning showers and lawn watering. Fortunately, there are a wide variety of BMPs that can be implemented to solve these NPS pollution problems.

While very little work has been done to retrofit urban areas with BMPs, it is an increasingly pertinent issue due to the continued growth of dense developments throughout the world. “The world’s cities are exploding, and by the year 2030, the proportion of urban dwellers is expected to be 61% of the world’s population” [4]. Edward Villarreal (2004) found that inner city BMPs can reduce the total rain flow runoff and attenuate peaks in the runoff [5]. Inner city BMPs can also lower the potential for flooding and treat NPS pollution. Villarreal (2004) employed several BMPs, including green roofs, dry ponds, grass swales, and rain barrels, discovering that when BMPs are used in series they are able to control stormwater more effectively. The design team has considered the use of multiple BMPs in series for both the Dayton Street School and the Seth Boyden Complex (See Appendix D). Installation of BMPs to control stormwater runoff is an effective and comparatively inexpensive alternative to building new, separate sewer systems. The design team intends to promote the site designs as examples for other urban communities to follow in an effort to improve regional water quality problems.

Environmental Justice

Environmental justice is an important motivation for this project. The median annual per capita income for the Weequahic Park neighborhood is between $8,151 and $16,522 [6]. This is well below the national poverty line (See Figure A-1 in Appendix A). Historically, low-income and minority-dominated communities have been disproportionately saddled with the environmental burdens of the whole society [7]. This is especially true for aging urban areas, which are normally not considered candidates for BMP implementation due to their lack of available open spaces. These environmental burdens lower the quality of life, creating public nuisances, as well as threats to human health. (See Figure A-2 thru A-6 in Appendix A).
Community Outreach

The project meets the goal of benefiting people, prosperity, and the planet largely because it centers on community outreach and development. Dialogue about the project has enhanced relations among all stakeholders including the local residents, the Weequahic Park Association (WPA), Dayton Street School, and city agencies. It has also yielded project designs that respond to real community needs and dreams.

Standing as the center of this neighborhood is the historic Weequahic Park. Designed by the celebrated Olmstead firm in 1899, Weequahic Park is 311-acres in size and contains an 80-acre lake [8]. The Weequahic Park Association was founded in 1992 to improve conditions of the park and its environs. Association leaders have used scientific assessments and social resources to understand and improve the area's ecosystem functions. One especially fruitful project was the Forestry and Botanical Inventory Project, a collaboration between WPA, Rutgers University-Cook College/New Jersey Agricultural Experiment Station (NJAES), and the Brooklyn Botanical Gardens. Neighborhood high school students helped count, catalogue and create an inventory of Weequahic Park’s biodiversity as a means of demonstrating its ecological value and targeting resources for its preservation. One student reported that, “We learned so much about trees that now I don’t look at trees the same way. It’s so amazing, the things you learn, that I might pick up a career in this. I’m looking seriously into it” [9]. Our project design has further enhanced the relationship between Rutgers University-Cook College/NJAES and the WPA.

Wilbur McNeil, WPA President, and Kevin Moore, Project Director, readily assisted the P³ design team by providing guidance and allowing the team to speak at a WPA weekly open meeting to reach the community. The project, as currently conceived, would have been impossible without the WPA's loyal core group of volunteer/members, who have earned the trust and respect of neighborhood residents and Dayton School educators.

As a result of contacts through Dayton School science teacher Jeanette Seabrooks and principal Susan Kandell, the design team received an endorsement from William S. Parrish, Jr., Director, Design & Construction of the Facilities Management Department for the Newark Public Schools. According to Mr. Parrish, a Leadership in Energy and Environmental Design (LEED) 2.0 accredited professional, “having the Environmental Sciences and Landscape Architecture students of Rutgers developing strategies and best management practices to aid our environment and school district is extremely beneficial, especially when there is a learning opportunity attached for students of our community.” LEED Green Building Rating System® is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings. It provides a complete framework for assessing building performance and meeting sustainability goals. Based on well-founded scientific standards, LEED emphasizes state-of-the-art strategies for sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality [10].

BEST MANAGEMENT PRACTICES

A BMP, as defined by the U.S. Environmental Protection Agency, is “the use of materials, processes or practices that reduce or eliminate the creation of pollutants or wastes at the source. It includes practices that reduce the use of hazardous materials, energy, water, or other resources, and practices that protect natural resources through conservation or more efficient use” [11].
In New Jersey, water quality BMPs are designed to control runoff from the water quality storm, which is defined as 1.25 inches of rain over two hours. By designing for the water quality storm, the BMP will treat approximately 90% of New Jersey’s annual storms, since most of the rainfall comes in storms of less than 1.25 inches. Stormwater BMPs that are designed for quantity control are used to reduce the peak stormwater runoff for the 2-, 10- and 100-year design storms, which are defined as 24-hour rainfall events of 3.3 inches, 5.3 inches, and 8.7 inches, respectively. Taking these storm events into consideration, the team has decided to use the following BMPs for implementation at the Newark sites. These BMPs include:

1). Bioretention Basins
2). Bioswales
3). Vegetative Filter Strips
4). Cisterns

**Bioretention Systems/ Rain Gardens**

As defined by the New Jersey Department of Environmental Protection (NJDEP) a bioretention system, also known as a rain garden, is a landscaped depression that receives stormwater runoff [12]. It consists of a soil bed that is designed to infiltrate stormwater and promote the growth of native vegetation. Stormwater runoff entering the bioretention system or rain garden is filtered first through the vegetation and then through the sand/soil mixture before being conveyed downstream by the underdrain system or discharged directly to the underlying aquifer.

A bioswale is a long and narrow bioretention basin which holds a greater specific volume of water and is used in place of open channels.

NJDEP published the *New Jersey Stormwater Best Management Practices Manual* (2004) in which bioretention systems/rain gardens are described as employing various physical and biological processes in the water quality treatment of runoff [12]. These processes include adsorption, filtration, volatilization, ion exchange, and decomposition. They are used to remove a wide range of pollutants from nutrients to total suspended solids through the utilization of both soil and woody and herbaceous plants to remove pollutants from stormwater runoff. Runoff is conveyed as sheet flow through a grass buffer strip ending in the treatment location, which consists of a ponding area that has a layer of mulch or other organic material, planting soil, and native plants. The grass buffer strip filters sediment from the runoff as it slows the velocity of the runoff and distributes it evenly along the length of the ponding area. The ponding area is graded to have a water depth of 6 to 12 inches. Once the runoff enters the ponding area, it gradually infiltrates through the mulch layer and soil bed or is evapotranspired. The system is designed to infiltrate stored water over a period of one to four days into the underlying soils, thereby eliminating the concerns of providing habitat for mosquito breeding. Although bioretention systems are typically designed to collect, treat, and infiltrate runoff from smaller rainfall events (1.25 inches of rainfall over 2 hours), these systems can also be designed to provide stormwater detention for large storm events to help minimize downstream flooding. See Figure B-1 in Appendix B for pollutant removal rates and detailed engineer renderings of the bioretention system and Appendix C for landscaped renderings.
Applicability of Bioretention Systems

The Newark site presents no important limitations with respect to bioretention systems or rain gardens, such as a low water table (i.e., less than 6 feet), slopes greater than 20%, or a large number of mature trees and other plants. Moreover, the site would benefit from stormwater controls, as it has a significant proportion of impervious areas and compacted soil, resulting in a substantial quantity of stormwater runoff that could otherwise be treated close to the source. The system will be maintained through seasonal landscaping by maintenance crews for the Seth Boyden Complex and Dayton Street School.

Vegetative Filter Strips

Vegetative filter strips are strips of vegetation, either natural or planted, that help to improve the quality of stormwater runoff by trapping sediment and sediment-bound pollutants, providing some groundwater infiltration, and slowing and dispersing stormwater flows over a wide area. Trees and shrubs can be incorporated into portions of the strip to create visual screenings, as well as a physical barrier. They are best suited to treating runoff from roads and highways, roof downspouts, small parking lots and impervious surfaces. Soil particles are able to settle from runoff water as a result of the flow slowing as it moves through the vegetative filter strip. Vegetative filter strips achieve the following broad goals: flood control, groundwater recharge, and pollutant removal. They do not have the capacity to detain flows from relatively large storm events; therefore the team has designed a strip that passes excess water into the bioretention system. See Figure B-2 in Appendix B for more details.

Applicability of Vegetative Filter Strips

Sections of the Newark site are uniformly graded, thereby generating runoff as sheet flow, which is appropriate for treatment by vegetative filter strips.

Establishing a vegetative filter strip requires the same equipment and materials as traditional landscaping. The operation and maintenance costs for a vegetative filter strip will also be comparable to those of typical landscaping requirements. Landscape elements have been designed with aesthetic, public safety, and functional needs in mind.

Cistern

Cisterns are BMPs that result in beneficial reuse of stormwater runoff. They are containers placed to catch roof water and release it slowly or to store it for later use in gardening, filling ponds, or washing cars. Rainwater is oxygenated, free of additives (e.g., chlorine and fluoride) and typically warmer than tap water, qualities that actually make it a better source for plants and safer for the environment. Cisterns operate by retaining a predetermined volume of rooftop runoff and are typically fitted with an overflow pipe. The stored water can be used during dry periods as a supplement to other water sources. A pump is sometimes used for extraction of the collected water from a cistern. See Figure B-3 in Appendix B for more details.

Applicability of Cisterns

Since the Newark Public Schools Facilities Management Department has determined that the Dayton School roof cannot support a green roof, designs for the school will include a cistern that shall collect the roof runoff while supplying water for the maintenance of new landscape elements.
DESIGN PARAMETERS FOR PHASE II

Site 1: Design for Dayton Street School Yard

To accomplish the goals set out by the project design team, the Newark design will incorporate BMPs to treat stormwater runoff that will encourage education and community involvement. As can be seen upon the detail sheet, “Site Plan” (SP) located in Appendix C, the design team intends to use innovative BMPs for Dayton Street School with the hope that children there will become excited about environmental designs for stormwater management. For instance, the stormwater coming off the roof in Section B of Sheet SP will be initially directed to a cistern with a holding capacity of 5,000 gallons. The cistern shall be painted to resemble a crayon, as can be seen in Section B of Sheet “Design Sections and Axonometric View” (DSAV), located in Appendix C. The water that remains within the cistern shall be used to supply the three adjacent raised community gardens with drip irrigation (See Section B of Sheet DSAV and Section B of Sheet SP). The rest shall flow out and be treated in the vegetative filter strip located at Section B of Sheet SP.

The water coming off the roof at Section A of detail Sheet SP shall travel over a colorful wall built from rocks and bricks of various sizes (See Sheet DSAV for more detail). Then this water will be directed through the open courtyard, where it will run into textured paving bands that will help the water maintain its sheet flow as it continues into the bioretention system (See Section C of Sheet SP and Section A and C of Sheet DSAV for more detail). This design meets school needs to retain a portion of the lot for parking during certain times of the school week. Refer to Figure B-1 of Appendix B for detailed engineer renderings of the bioretention system and Appendix C for landscaped renderings. Note: in Appendix C the bioretention system is referenced as “infiltration basin” on Sheet SP and as “vegetative infiltration basin” on Sheet DSAV of Appendix C.

An outdoor classroom shall be built of concrete with three tiers, two for sitting and one as a barrier at the top to prevent falling. (See Sheet SP for site renderings). Rain draining from the roof adjacent to the outdoor classroom will also be collected in a 5,000-gallon cistern to be used in the irrigation of student-maintained rain gardens. The excess water from the cistern will follow through the drainage rill of the sidewalk area and eventually be incorporated with the runoff entering Section C of Sheet SP to be collected in the bioretention system (Refer to Section 2 of Sheet SP for site renderings and Section 2 of Sheet “Design Details” (DD) for design renderings). When funding has been received for the implementation of the Seth Boyden Complex designs, the excess water from this site will be redirected under the parking lot into an underground dry well (Refer to Section 3 of Sheet SP for site renderings and Section 3 of Sheet DD for design renderings). Section 1 of Sheet SP shall also be implemented at this time for the purpose of connecting the remaining runoff from the school to the BMPs of Seth Boyden. See Detail 1 of Sheet DD for more details on this design.

The overall concept is to highlight and display the flow of water from the northern-most region of the school southward and into the bioretention system. The red asterisks on Sheet SP are the locations of interpretive placards aimed at highlighting the historical and environmental reasons for choosing the details at each of those sites.

Site 2: Seth Boyden Complex

The excess flow from the Dayton Street School will be caught in a grated depression at the corner of the school-yard and carried temporarily underground to be released again in front of the youth center at the Seth Boyden Complex (Refer to Section 1 of Sheet SP and Detail 1 of Sheet DD for more details). The
water leaving the area of the youth center will eventually lead to the first plaza noted as the "Most Urban Water Court" on Concept Sheet of Appendix C. Within this area, the design will take on a hard, urban edge, reflected both in design elements and the amount of infiltration permitted (being the least pervious, most angular site, and possibly flooding at a 5-10 year storm). The water will continue under the road, through a shallow swale passing into the second plaza, which is noted as "Less Urban Water Court" on Concept Sheet. This region will be more pervious and have softer design lines (flooding with a 25 year storm event).

Again the water shall continue its flow through a shallow swale, passing into the last of the three plazas, which is noted as "Park-Like Water Court and Adventure Playground" on Concept Sheet of Appendix C. This space will present a very soft and pervious environment (flooding only during a 75-100 year storm event). Within these spaces the team intends to incorporate the use of vegetated swales, artificial wetlands, and cisterns. By having the three different zones, the design team aims to teach the basic lesson that as building increases, so too does the amount of storm runoff and pollution contributed to the local waterways.

Lengthy and detailed renderings of this site are not attached here but will be available for referencing at the presentation in Washington, D.C. on May 15 and 16.

Hydrologic Modeling

The design team has utilized HydroCAD software to take the elevations surveyed around the sites and the available precipitation data to create a water balance for the sites. HydroCAD is a Windows-based software package that uses TR20 to generate hydrographs and conduct stormwater basin routing. The hydrographs depicting peak flow events before and after BMP implementation for the areas of the outdoor classroom and the bioretention basin can be found in Figure B-5a thru B-7b of Appendix B. These graphs are used to analyze the changes in surface hydrology and are used to quantify the benefits to the community. See Figure B-4 of Appendix B for the hydraulic flow chart. The Hydraulic Flow Chart in Appendix B-4 depicts the land areas, hydraulic routing, and BMPs for modeling the Dayton Street School Yard.

CONTRIBUTIONS FROM THE INDIVIDUALS OF THIS MULTIDISCIPLINARY DESIGN TEAM

The combination of landscape architects, bioenvironmental engineers and communication specialists provided the range of skills needed for this ambitious project. The landscape architects improved the integration and overall aesthetic of the project, kept potential public uses of the site foremost in design considerations, offered innovative concepts for displaying the water runoff before it reached its treatment area, and produced detailed site renderings. The bioenvironmental engineers were responsible for surveying the site, manipulating runoff data through the use of HydroCAD software, and determining BMP size and implementation. The environmental communications specialists coordinated community involvement and ensured that team members focused on ideas and concepts suitable and interesting to various community audiences. Project activities have therefore provided team members an unusually good opportunity to gain skills that will help them to solicit work and produce usable designs for clients and agencies in the future, as well as providing them knowledge about disciplines that can complement their own work.
THE PROJECT’S SUCCESS

The team’s ability to establish working relationships with five organizations that are each known by community members and willing to participate in the execution of proposed designs is indicative of the project’s success (See P³ Phase II Project Description Section Partnerships for more detail on Stakeholders). As a result of the design team and the members of the community, the team has created a template that deals with the community’s concerns over water and air quality, while providing functional and safe green spaces plus opportunities for residents to gain work experience. Most importantly, through its hard work and dedication, the design team has successfully gained the community’s trust that the strategies proposed will benefit the area in which they work, live and play. While we are pleased with having established these relationships, we now understand that it would have been helpful to have contacted key governmental bodies sooner. At present, the team lacks letters of commitment from the Newark City Council and Newark Housing Authority, organizations that need a long lead time for making decisions.

THE QUANTIFIABLE BENEFITS OF PROJECT IMPLEMENTATION

In addition to the qualitative benefits that this project offers to the Weequahic Park community and the world, there are numerous quantitative data available to further justify the implementation of BMPs. For instance, the replacement of impervious surfaces and compacted soils with trees and plants will help to reduce air pollution. Air pollution is an important concern of the local residents as they are located within a half mile of the Newark International Airport and within one mile of the New Jersey Turnpike and the Garden State Parkway. A study published by D.J. Nowak and D.E. Crane (2000) found that trees in New York City removed an estimated 1,821 metric tons of air pollution at an estimated value to society of $9.5 million. Trees were found to remove particulate matter, ozone, sulfur dioxide, nitrogen dioxide, and carbon monoxide [13]. Trees in the Lincoln Park area of Chicago, with a tree canopy of 23 percent, remove 70 pounds of air pollutants per day. Trees throughout Chicago, which currently cover about 13% of the land area, remove approximately 650 tons of air pollutants per year [14]. BMP implementation will create vegetated areas that will be able to remove urban air pollution.

To determine the effects of BMPs on water quantity, the team referenced the data it obtained through the use of HydroCAD. For the New Jersey Water Quality Storm of 1.25 inches over 2 hours, the BMPs in Sections A, B and C of sheet “Site Plan” (SP) in Appendix C are able to reduce the peak flow by 57.46 gallons/second of water, reaching a peak of 5.83 gallons/second from 63.29 gallons/second. The effects of the Outdoor Classroom BMPs in Section 2 of Sheet SP upon the same storm are able to control the entire flow of 12.94 gallons/second of water maintaining a peak of 0 gallons/second.

For New Jersey’s average 2 year storm of 3.3 inches over 24 hours, the BMPs in Sections A, B and C of sheet SP in Appendix C are able to reduce the peak of the flow by 101.96 gallons/second of water, reaching a peak of 58.27 gallons/second from 160.23 gallons/second. The effects of the Outdoor Classroom BMPs in Section 2 of Sheet SP upon the same storm reduce the peak of flow by 27.3 gallons/second from 32.69 gallons/second, obtaining a peak of 5.39 gallons/second.

For New Jersey’s average 10 year storm of 5.3 inches over 24 hours, the BMPs in Sections A, B, and C of sheet SP in Appendix C are able to reduce the peak of the flow by 156.64 gallons/second of water, reaching a peak of 101.21 gallons/second from 257.85 gallons/second. The effects of the Outdoor Classroom BMPs in Section 2 of Sheet SP upon the same storm reduce the peak of flow by 46.38 gallons/second from 52.59 gallons/second, obtaining a peak of 6.21 gallons/second.
The combined sewers in the project area are overloaded and dump raw sewage into the street even during dry weather. The problem is further exacerbated during storm events. The reduction in overall peak flows is important as it reduces the volume of runoff into these combined sewers thereby reducing the occurrence of overflows during/after rainfall events.

The following table illustrates the benefit of BMPs toward improving water quality.

**Pollutant removal rates of BMPs**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Bioretention Systems Removal Rate</th>
<th>Vegetative Filter Strips Removal Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Suspended Solids</td>
<td>90%</td>
<td>84%</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>70-83%</td>
<td>40%</td>
</tr>
<tr>
<td>Metals (Zn, Pb)</td>
<td>93-98%</td>
<td>50-55%</td>
</tr>
<tr>
<td>TKN</td>
<td>68-80%</td>
<td>20%</td>
</tr>
<tr>
<td>Organics</td>
<td>90%</td>
<td>-</td>
</tr>
<tr>
<td>Bacteria</td>
<td>90%</td>
<td>-</td>
</tr>
</tbody>
</table>

Not only will community members benefit from improved air and water quality, but they shall also reap the benefits of getting paid to receive job training, which will be managed by the Weequahic Park Association. Within the design proposal, the team has suggested the hiring of 20 trainees that will be paid $20/hour for a total of 17 hours. At the end of their 17 hours they shall receive a certificate from Rutgers University verifying their participation within the program. They can use this to help with the acquisition of employment, at a time when new stormwater regulations are raising the demand for specialized landscaping skills.
REFERENCES


P³ PHASE II PROJECT DESCRIPTION

Challenge Definition and Relationship to Phase I

The project will be implemented in the Weequahic section of Newark, New Jersey in the community containing the Seth Boyden Complex and Dayton Street School (see Appendix C). The Seth Boyden Complex is typical of public housing built in large cities during the 1940s and 1950s, featuring high rise apartment complexes and two to four-story apartment buildings situated in “super blocks.” These structures were later discovered to be unfavorable due to their alienation from surrounding neighborhoods and lack of functional public space [1]. The proposed project makes use of the current non-functional public spaces located within the Seth Boyden community by implementing stormwater best management practices (BMPs) that provide source control of stormwater runoff while adding vegetative and recreational value. Conversion of these spaces must be treated as a social, as well as physical, process. The stakeholders for this project are community, educational, and governmental institutions typical of inner-city communities throughout the developed world. The project team has taken its design cues from these stakeholders. The Weequahic Park Association, in particular, was founded on the principles of environmental justice, which hold that the physical conditions of a community have profound influence over the local quality of life. With support from stakeholders, this project can serve as a model case study for other inner-city communities.

Phase I of the project set the groundwork for Phase II. In Phase I, the design team created design plans, developed community partnerships, secured in-kind donations, gained administrative support from the school board, and solicited feedback from the community. Phase II will include the physical implementation of the design plans, development of a grades K-8 educational program relating to the implemented designs, development of a skilled labor training program, and continued collaboration with current project stakeholders. Physical implementation will include heavy and light excavation, installation and grading of select soil material, and the planting of native trees, shrubs, and grasses typically used in stormwater BMPs. The implementation will be conducted in two parts, starting with work on the Dayton Street School designs with funding from the P³ Award. The designs for Seth Boyden will be implemented pending the receipt of additional external funding. Phase II will also involve soliciting authorization and technical assistance from the Newark Housing Authority and the Newark City Council to build the Seth Boyden Complex stormwater management designs. The project team will also pursue a partnership with the Greater Newark Conservancy, a non-governmental community outreach group focusing on urban greening, environmental education, and environmental justice. Leaders of the Conservancy have already expressed interest in aiding the implementation stage by organizing community members to participate in planting the vegetation.

Innovation and Technical Merit

While the stormwater engineering solutions proposed here are based on proven designs, their application in an urban landscape is innovative. Because regulations in most states requiring stormwater controls typically apply only to new construction, which centers in agricultural and suburban regions, commonly used BMPs require large plots of open and unpaved space. As a result, our project designs required careful consideration to address the physical, social, and institutional constraints typical of cities.

The design and installation of stormwater BMPs are interdisciplinary by nature, since they must be engineered to meet the water quantity and quality requirements of a drainage area through the use of vegetation that is carefully selected and placed. The space constraints of an urban project presented
special challenges for engineering as well as landscape architecture. The landscape architecture students’ skills in anticipating the ways people will use public spaces, however, helped the team in designing solutions that integrated ideas gained from our community outreach efforts. Our work with members of the social institutions that support life in Newark has convinced us that creating functional open space in this neighborhood will depend on a range of concerns: education, labor training, environmental justice, water quality, water conservation, urban greening, and air quality.

The stormwater BMPs proposed for implementation were developed in accordance with the specifications of the New Jersey Department of Environmental Protection Agency (NJDEP) BMP Manual [2]. Vegetative filter strips, bioretention systems, and cisterns were designed for the landscape surrounding Dayton Street School and Seth Boyden Complex using the USDA TR-20 [3] hydrologic model to estimate the water quantity management requirements. Planting design plans were then created using native species of grasses, shrubs, and trees that typically thrive under wetlands conditions. The proposed bioretention systems include sloped grass buffer strips, a ponding area with native vegetation (which provides settling of suspended solids), a soil planting layer, and a sand layer. Some systems are equipped with gravel and under-drain piping where soils are not appropriate for groundwater recharge. The soil planting layer: (1) acts as a primary filter with attenuation of pollutants to soil particles, (2) provides rapid infiltration of stormwater runoff (NJDEP BMP specifications require complete infiltration within 72 hours), and (3) sustains healthy vegetation at the surface. The soil planting bed consists of a high sand content to achieve infiltration requirements. The sand layer acts as a secondary filter and a transition between the soil planting bed and the under-drain system or underlying soil. A mulch layer is applied to the top of the soil planting bed to retain moisture and attenuate pollutants. Water collected in the under drain can be retrofitted to a stormwater sewer system, which eventually discharges into surface waters. Systems without an under-drain system are used to recharge groundwater through infiltration. Plants in the bioretention system consist of native grasses, shrubs and trees that are intended to adapt well to the soil and climate of the region. They must also tolerate pollutants and varied depths of water. The plants are intended to uptake water, nutrients, and pollutants. Plant roots may also provide pore spaces, which will provide a habitat for microorganisms, thus promoting biological degradation of some pollutants [4]. Bioretention systems have been shown to remove suspended solids, nutrients, metals, hydrocarbons, and bacteria [2]. A final evaluation of project design plans will be conducted with the Newark Public Schools Office of Design and Construction and Dayton Street School to determine possible practical modifications to the plans to meet concerns such as Leadership in Energy and Environmental Design (LEED) certification requirements.

**Relationship of Challenge to Sustainability**

Phase II of the project will implement a series of stormwater BMPs to provide source protection and beneficial reuse of stormwater. Aesthetics of the community will be enhanced through implementing stormwater BMPs that reduce runoff onto streets and other paved surfaces and that provide new plant and animal habitats, which are scarce in city neighborhoods. Health threats will also be reduced by limiting potential overflow from the combined municipal and stormwater sewer systems.

The physical sustainability of this project depends on its social sustainability. Contributions from the stakeholders within the community shaped the direction of the project, as well as the technical designs. Keeping sustainability in mind, the team designed projects that can be kept up by school custodians and public housing maintenance staff. The Seth Boyden project design provides the option for residents to plant and maintain small garden plots if they desire. The educational units that project members will design with the assistance of Dayton School teachers can be sustained in the school curriculum by
school staff. Interaction with community members was conducted with the interest in promoting good relations between our key contact, the Weequahic Park Association, and community members.

The long-term viability of these projects will also be aided by creating a pilot skilled-labor training program. This will consist of a workshop in which local residents will develop landscaping skills related to implementing and maintaining stormwater BMPs, such as bioretention systems and vegetative filter strips, as well as for wetlands. Often landscapers who are unfamiliar with such structures will mow native grasses and trim shrubs that are intended to enhance water quality. Laborers who earn a certificate from Rutgers Cooperative Research and Extension through this program will be able to work with contractors specializing in stormwater management application. The pilot program will serve as groundwork for a more permanent skilled-labor training program offered by the Weequahic Park Association. The Weequahic Park Association has previously run a similar training program with 100% job placement for their trainees and is eager to revive it. Targeted training that meets the needs of new stormwater regulations will address a key environmental justice concern, the provision of meaningful employment opportunities.

Finally, achieving a Leadership in Energy and Environmental Design (LEED) certification for the Dayton Street School would provide another means of promoting a sustainable community. The LEED Green Building Rating System is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings [5]. Currently, the Newark Public Schools Office of Design and Construction is involved in a campaign to design new LEED certified buildings and to retrofit existing schools to LEED standards. As stormwater management is an important component for LEED certification, implementation of the project designs at the Dayton Street School could result in eight points toward the required 31 points needed to achieve LEED certification.

Integration of P³ Concepts as an Educational Tool

The educational program will be developed in collaboration with educators from the Dayton Street School. The lesson plans will teach students about the science behind water resources issues such as the hydrologic cycle, sources of pollution, stormwater management, and water conservation. The implemented stormwater BMPs will be utilized as a supplement to the lesson plans and serve as a living laboratory for students in the long term. The lesson plans will also incorporate maintenance practices for stormwater BMPs that can be performed by students as a class activity. In the short term, students will participate in the installment of the BMPs through vegetative planting as a supplement to their science course. The project team hopes that the successful implementation of the stormwater BMP designs will leave behind a legacy at Dayton Street School for future students and provide encouragement for students to pursue environmental careers. The Rutgers Cooperative Research and Extension Water Resources Program, led by Christopher Obropta, has developed a successful K-12 environmental education program that focuses on water resources issues. The similar education program proposed here will build upon these past successes.

Measurable Results, Evaluation Method, and Implementation Strategy

The expected results for Phase II include successful implementation of the designed stormwater BMPs, start-up of the training program, and incorporation of the educational program. More specifically, the BMPs are expected to provide source control of stormwater runoff from the Dayton Street School, which helps prevent combined sewer overflows and provides beneficial reuse of water for school
gardens. Monitoring of the BMPs will occur over the first year after installation to evaluate performance. After this time, the Dayton School will be responsible for maintenance while Rutgers’ Cook College will continue to conduct comprehensive research on the effects of the BMPs upon the surrounding environment, as well as the local community. Pollutant removal effectiveness over time will be studied to determine the long-term capabilities of the systems.

Upon completion of the BMPs, the area treated and volume of water treated will be determined. Additionally, the amount of pollutants removed will be calculated based upon water quality testing of the systems and literature on the effectiveness of these types of systems. These results will be provided to the New Jersey Department of Environmental Protection (NJDEP) for input into future watershed restoration plans and TMDLs that will be developed for Newark Bay. This will help the NJDEP to understand the cost benefit of urban retrofitting to address non-point source pollution.

PROJECT SCHEDULE

This project schedule is for the installation of stormwater BMPs for the urban landscape surrounding Dayton Street School. Installation of Seth Boyden Complex BMPs will be deferred pending additional funding.

<table>
<thead>
<tr>
<th>Task</th>
<th>Responsible Parties (see “Project Partners” section)</th>
<th>Timeframe</th>
<th>Anticipated Start Date</th>
<th>Anticipated Completion Date</th>
</tr>
</thead>
</table>
| Design, Engineering & Development of Site Plan | • Rutgers  
• WPA  
• Newark Schools                                      | Completed in Phase I |                       |                             |
| Permitting & Local Approvals                   | • Rutgers  
• Newark Schools                                      | Months 1 -3        | September 2005         | November 2005               |
| Project Organization, Ordering Materials       | • Rutgers  
• Newark Schools                                      | Months 1 – 6       | September 2005         | February 2006               |
| Development and Implementation of Skilled-labor Training Program | • Rutgers  
• WPA                                                | Months 1-2         | September 2005         | October 2005               |
| Development and implementation of Dayton School Water Resources Lesson Plan | • Rutgers  
• Dayton School                                     | Months 1-13        | September 2005         | October 2006               |
| Site Preparation                              | • PVSC                                                | Month 3-4          | November 2005          | December 2005              |
| Construction                                  | • Rutgers  
• PVSC  
• Dayton School  
• Newark Schools  
• Trainees  
• Volunteers  
• GNC                                                  | Month 3-4          | November 2005          | December 2005              |
| Volunteer Organization, Implementation         | • Rutgers  
• WPA  
• GNC                                                  | Months 1 – 4       | September 2005         | December 2005              |
| Maintenance                                   | • Dayton School  
• Rutgers                                              | Months 1 – 13      | September 2005         | October 2006               |
| Monitoring                                    | • Rutgers  
• Dayton School                                        | Months 1 – 13      | September 2005         | October 2006               |
| EPA final report                              | • Rutgers                                              | Month 14           | N/A                    | November 2006              |
PARTNERSHIPS (see Appendix D for documentation)

- **Weequahic Park Association (WPA)**
  - WPA manages an important Olmsted park currently known as the Weequahic Park. This organization has a reputation for community-based leadership and a fierce desire to help the surrounding community.
  - During Phase I, association leaders provided initial design ideas and helped to organize a meeting with members of the local community, as well as representatives from the Dayton Street School and the City Council, which took place on February 19th, 2005. At this meeting the design team discussed design proposals and received further information about community desires, which has been integrated into the final project designs.
  - WPA will remain involved throughout the implementation of Phase II as the key stakeholder organization and community liaison. Their responsibilities shall include overseeing a job training program that will hire local community members to help with design construction. This initiative would revive a job skills program that the WPA managed several years ago that produced both economic and ecological benefits for neighborhood residents.

- **Tenant Association of Seth Boyden Complex**
  - The residents of this public housing facility would benefit from job training.
  - The association’s involvement with Phase I included promoting the community meeting at Weequahic Park.
  - During Phase II they shall be responsible for informing residents of project updates as well as notifying the tenants of any training and job opportunities.

- **Students and Staff of Dayton Street School (DSS)**
  - DSS serves students from pre-K through 8th grade, 99% of whom received a free or reduced price lunch as of the 2002-2003 school year.
  - During Phase I, the school offered insight to their yearly activities and class curriculum that provided the context for the design project’s educational plans.
  - School personnel and students will participate actively in the implementation of Phase II when we will use project designs as a learning tool in the classroom and in the field.

- **Newark Public Schools Department of Design and Construction (NPSDDC)**
  - NPSDDC is currently seeking Leadership in Energy and Environmental Design (LEED) certification for some of their public schools, including Dayton Street School (discussed in detail below). Providing stormwater management plans for DSS will help the school gain points towards this certification.
  - NPSDDC has committed to assist in Phase II implementation with technical support.

- **Passaic Valley Sewerage Commission River Restoration Program (PVSCRRP)**
  - In 1998, the Commissioners created the Passaic River/Newark Bay Restoration Program to promote the recreational and economic uses of Newark Bay, the Passaic River, and its tributaries. Also, the PVSCRRP has a long working relationship with the WPA.
  - The PVSCRRP has offered to provide the Phase II project implementation with labor and machinery in-kind.

- **Greater Newark Conservancy (GNC)**
  - This nongovernmental community group is a potential project partner which promotes environmental justice and community improvement.
  - GNC may contribute in-kind services, in the form of assisting in the organization of volunteer participation, pending development of a partnership in Phase II.
• Rutgers, Cook College/ NJAES
  o Cook College (in New Brunswick) is New Jersey's land grant institution, one of the first in the United States to devote itself to the mission of promoting both agriculture and the environment. Ecologists on the Cook faculty have undertaken many research and extension projects in the Newark area, including work with the WPA.
  o As a land grant institution, the college is partnered with the New Jersey Agricultural Experiment Station (NJAES), which has established educational and outreach ties to New Jersey's cities. As a rapidly urbanizing state, New Jersey's ecological future depends on improving the ecosystem and social functions of its urban areas. This principle is expressed in research and extension projects ranging from county-extension literacy programs to urban wetlands research and restoration projects. The job training program for landscape workers will be administered through the Rutgers Cooperative Research and Extension.
REFERENCES


BUDGET JUSTIFICATION

The budget reflects both direct and indirect costs required to implement the proposed stormwater project at Dayton Street School, Newark, New Jersey. Direct costs include materials and services associated with installing the proposed stormwater BMPs and cisterns in the urban landscape surrounding Dayton Street School. Materials include filter sand, gravel, select-soil material, mulch, a grass seed mix, erosion control mats, and native water-tolerant vegetation (herbaceous grasses, shrubs, and trees) at a cost of $39,020. These materials are specified by the New Jersey Department of Environmental Protection BMP Manual (2004). Other materials include concrete outfall structures and associated piping for the proposed bioretention systems ($10,500). Services required include disposal of excavated asphalt and concrete at a certified demolition and construction recycling center ($3,000).

BMP specifications require excavation of existing land. Project partner, Passaic Valley Sewerage Commission River Restoration Program (PVSC-RRP), has agreed to provide in-kind services for the excavation of existing asphalt and soil and its transport for disposal. PVSC-RRP possesses a full-time skilled-labor workforce and necessary machinery for completing the service. PVSC-RRP will also assist in the final grading of the site and installation of soil, sand, gravel, and vegetation. By offering to assist the team the PVSC-RRP is fulfilling its New Jersey Pollution Discharge Elimination System (NJPDES) permit requirement to help surrounding communities address non-point source pollution.

The Rutgers project team will be supplying in-kind project organization and supervision and will select and order materials. The team will also be responsible for organizing, supervising, and implementing a volunteer program with the assistance of the Greater Newark Conservancy that will utilize volunteers for the planting of vegetation in the stormwater BMPs. Also, the team will give continued in-kind guidance during the maintenance and monitoring stages of the project.

The final direct costs include $10,000 for the proposed job-training program of local residents. The program will be implemented through Rutgers Cooperative Research & Extension. Project partner, the Weequahic Park Association (WPA), has conducted a similar program and possesses the experience required for such a task. WPA will provide in-kind assistance in the development and implementation of the job training program. The funds will be used to train laborers from the nearby community on the function of stormwater BMPs and related implementation and maintenance practices. The short course will consist of two-training days for twenty trainees paid $20/hour for a total of eight hours. Trainees will also be paid for helping to install the BMPs for $20/hour each for nine hours. This program will yield certification through the Rutgers Cooperative Research & Extension.

Indirect costs are set at a 26.0% rate for Rutgers University facility and administrative costs associated with offsite training initiatives.
CURRICULUM VITAE

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EDUCATION
Ph.D., Civil Engineering, Stevens Institute of Technology, Hoboken, New Jersey, 2002
M.S., Civil Engineering, New Jersey Institute of Technology, Newark, New Jersey, 1989
B.S., Civil Engineering, Magna Cum Laude, New Jersey Institute of Technology, Newark, New Jersey, 1988

PROFESSIONAL LICENSES AND CERTIFICATIONS
Professional Engineer, New Jersey & Pennsylvania

PROFESSIONAL EXPERIENCE
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
• October 2003 – present, Member, Equine Science Center, Rutgers University, Cook College, New Brunswick, NJ
• October 2003 – present, Member, Center for Environmental Prediction, Rutgers University, Cook College, New Brunswick, NJ
• October 2003 – present, Full Member, Graduate Faculty of Bioresource Engineering, Rutgers University, Cook College, New Brunswick, NJ
• October 2003 – present, Full Member, Graduate Faculty of Environmental Sciences, Rutgers University, Cook College, New Brunswick, NJ
• August 2002-present, USDA CSREES Water Quality Coordinator for New Jersey
• July 2002-present, Assistant Extension Specialist in Water Resources with Rutgers Cooperative Extension, Department of Extension Specialists, Rutgers University, New Jersey Agricultural Experiment Station, New Brunswick, NJ
• July 2002-present, Assistant Professor with the Department of Environmental Sciences, Rutgers University, Cook College, New Brunswick, NJ

OMNI ENVIRONMENTAL CORPORATION, (1989-2002), Held positions ranging from Project Engineer to Senior Associate.


AREAS OF EXPERTISE
Dr. Obropta has a background in watershed management, water quality modeling, hydrologic and hydraulic modeling, and coastal engineering. His specific experience includes watershed restoration, wastewater allocation and TMDL studies, storm water management, wetland design, effluent dilution analyses, longshore sediment transport, computer-aided design, and Geographic Information Systems (GIS).

Dr. Obropta has spent the last six years focusing his efforts in the field of watershed management. He has secured numerous grants to implement watershed restoration projects. These projects have included the design of Best Management Practices (BMPs) including storm water treatment wetlands, bioretention systems, in-line treatment systems and riparian buffers. Along with the design and construction of BMPs, many of these projects incorporate soil bioengineering techniques for stabilizing eroding stream banks and restoring natural channels. These projects have required Dr. Obropta to work closely with municipalities, counties, NJDEP and nonprofit grass-roots organizations. During his work in the field of watershed management, Dr. Obropta has had the opportunity to build partnerships, conduct detailed stream corridor analyses, prepare grant applications, design BMPs, secure permits, supervise construction, and conduct long-term monitoring in watersheds throughout the State.

As part of his work in watershed management, Dr. Obropta has prepared a wasteload allocation study for the tidally influenced Pennsauken Creek using the QUAL2E and DEM water quality computer simulation models. For the same watershed, he developed and executed a site-specific nutrient study to establish wastewater treatment plant effluent phosphorus limitations. For this study, Dr. Obropta used a modified version of WASP to model the interaction of nutrient
loadings from point and non-point sources on rooted aquatic vegetation and dissolved oxygen dynamics.

Dr. Obropta has also prepared a Total Maximum Daily Load (TMDL) analysis for Strawbridge Lake. He is currently implementing several studies to further refine this TMDL for phosphorus and begin the implementation of the non-point source pollutant reductions necessary to achieve the TMDL. These studies include preparing water quality sampling programs, conducting riparian corridor/stream channel assessment, and preparing a watershed restoration master plan. Also as part of this project, an extensive GIS has been developed, which incorporates Stream Visual Assessment Protocol data and water quality data collected by volunteers. This GIS allows the stakeholders in the watershed to prioritize potential restoration sites and spatially relate impaired water quality stream sections with riparian corridor conditions, land use, and other physical characteristics of the stream and watershed.

REFEREED PUBLICATIONS


NON-REFEREED PUBLICATIONS


RECENT GRANTS AND CONTRACTS (Principal Investigator, Rutgers University)


9/04-8/05, “Watershed Restoration Plan for the Upper Salem River Watershed: Phase I,” Subcontract to Cumberland County Soil Conservation District on a NJDEP 319(h) Grant, $24,000.


7/04-6/06, “Development of a Regional Stormwater Management Plan for Pompeston Creek, Burlington County, New Jersey,” NJDEP 319(h) Grant Program, $249,570.

1/04-12/04, “Watershed Characterization and Assessment for New Jersey’s Watershed Management Area 5,” Bergen County Planning Department, $22,500.

9/03-9/05, “USDA Regional Water Quality Coordination Project for EPA Region 2,” USDA-CSREES, $140,000.

Biographical Sketch:  KAREN M. O'NEILL

PROFESSIONAL PREPARATION
1998  Ph.D. in Sociology, University of California, Los Angeles.
1989  M.A. in Sociology, University of California, Los Angeles.
1981  B.A. in Anthropology, University of San Francisco.

APPOINTMENTS
Rutgers University, Department of Human Ecology, assistant professor, 1998 - present; graduate program in sociology, associate member, 1999 - present; Center for Environmental Communication, member, 2001 - present.

College of Notre Dame, Department of Sociology, instructor, 1998.

College of DuPage, Liberal Arts Division, instructor, 1995-1997

University of California, Los Angeles, Social Science Cluster Program, instructor, 1991; Political Science Department, research associate, 1990-1991; Center for the Study of the Environment and Society, research associate, 1990; Department of Sociology, research assistant, 1989; teaching assistant, 1989-1992.

RELEVANT PUBLICATIONS

PEER-REVIEWED JOURNAL ARTICLES


PENDING PUBLICATIONS


REPORTS

SYNERGISTIC ACTIVITIES
Raritan Basin Watershed Management Project, New Jersey:
Characterization and Assessment participant, 1999 - 2001
Chair, Legal and Institutional Subcommittee, Lower Raritan Watershed Management Area, 2001 - present
Rural Sociological Society, publications committee, 2000 - 2003 term
Selected Recent Activities: Joint Environmental Policy Symposium, Rural Sociological Society/American Sociological Association (invited speaker); Conference: Who Owns America? Land Tenure Center (speaker); Pacific Coast Branch of the American Historical Association (panel organizer)

COLLABORATIONS WITHIN PAST 48 MONTHS
Adesoji Adelaja, Michigan State University; Jeff Calia, Rutgers University; Caron Chess, Rutgers University; Lee Clarke, Rutgers University; Audrey Cross, Rutgers University; Paul Gottlieb, Rutgers University; Colleen Hatfield; William Hallman, Rutgers University; Robert Kubey, Rutgers University; John Lang, Rutgers University; Rodolfo Nayga, Texas A&M University; Chris Obropta, Rutgers University; Hans Peter Peters, University of Dusseldorf; Diane Phillips, St. Joseph's University; Gregory Rusciano, Rutgers University; Brian Schilling, Rutgers University; Joan Thomson, Penn State University; Jake Woland, Rutgers University.

Dissertation advisor: William G. Roy, UCLA
Ph.D. graduates advised, Rutgers University: John Lang; Jamie MacLennan; Marla Perez-Lugo.
Figure A-1. Annual Median Income for Weequahic Section of Newark (2000 U.S. Census Bureau)

Data Classes

- Dollars
  - $8151 - 16522
  - $17575 - 24622
  - $25394 - 31713
  - $33542 - 39181
  - $43851 - 56705

Features

- Major Road
- Street
- Stream/Waterbody

Approx. 1.6 miles across.
Figure A-2. Combined Sewer Overflow

- Picture taken on a Saturday morning in December of a Combined Sewer System overflowing at the edge of the Seth Boyden Complex. There had been no rain event for several days, and yet the combined sewer was still overloaded enough to dump raw sewage into the street.
- This problem is only exacerbated when storm events actually occur.
- The team’s designs will reduce the volume of runoff into the combined sewers thereby reducing the occurrence of such overflows during/after rainfall events.
- These designs can then be replicated in areas throughout the city in a further attempt to remove pollutants when overflows do occur.
Figure A-3. Dayton Elementary School

- Beyond the fence lies the broken asphalt layer of the school yard where the students of grades K-8 are expected to spend their play time.
- The team’s designs will transform this area into an appealing and beneficial recreational space for these school children.
- See Appendix C for more detail on site design.
When the children come outside to play in the space pictured on the right, they are faced with the scene pictured on the left, which is directly across from their Dayton Street School yard.

The team’s designs address this problem and offer a vegetative screen to help obstruct this view.
The team’s designs drastically reduce the large amount of impervious surfaces located throughout this complex, ultimately creating socially beneficial public spaces for the Seth Boyden community and increasing on-site groundwater infiltration.
This picture is a typical sight in and around the Seth Boyden Complex; highly compacted soils with little or no vegetation.

The team’s designs will create vegetated areas which would reduce impervious cover and increase on-site infiltration.
Appendix B
Figure B-1. An Example of A Bioretention Basin/ Bioretention swale

Pollutant removal rates of Bioretention Systems

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Removal Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphorus</td>
<td>70-83%</td>
</tr>
<tr>
<td>Metals (Cu, Zn, Pb)</td>
<td>93-98%</td>
</tr>
<tr>
<td>TKN</td>
<td>68-80%</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>90%</td>
</tr>
<tr>
<td>Organics</td>
<td>90%</td>
</tr>
<tr>
<td>Bacteria</td>
<td>90%</td>
</tr>
</tbody>
</table>

Source: Davis et al, 1998
Figure B-2. Vegetative Filter Strips

Pollutant removal rates of Vegetative Filter Strips

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Removal Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sus. Solids</td>
<td>84%</td>
</tr>
<tr>
<td>Nitrate+ nitrite</td>
<td>20%</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>40%</td>
</tr>
<tr>
<td>Extractable lead</td>
<td>50%</td>
</tr>
<tr>
<td>Extractable zinc</td>
<td>55%</td>
</tr>
</tbody>
</table>

Source: Yu et al., 1993
Figure B-3. An Example of a Cistern Used Outside of A Home

- The team has chosen two 5,000 gallon cisterns to collect the school roof runoff.
- These cisterns are taller and thinner than the one pictured, and will be painted to resemble a child’s crayon.
- The on-site stored water will be used to irrigate garden plots providing an opportunity for water conservation and the possibility of reducing water utility costs.

Source: District of Columbia Water & Sewer Authority
• The flow chart resembles the movement of water through the team’s designs for the Dayton Street School Yard.

• The areas are supplied for each BMP and for all impervious surfaces.

• The volumes of the cisterns are also noted.
Figure B-5a. Hydrographs for New Jersey’s Water Quality Storm

Hydrograph of flow from the school roof traveling through the school yard

- Having a Cistern, Vegetative Filter Strips, a Bioretention swale and a Bioretention Basin reduces the peak volume of flow from 8.46 cfs (63.29 gallons per second) to 0.78 cfs (5.83 gallons per second) reducing the chances of flooding/ponding of rain water downstream.
- The hydrographs show that having the BMPs in place reduces the peak runoff by 90.1% for a New Jersey Water Quality Storm (1.25” over 2 hours).
Figure B-5b. Hydrographs for New Jersey’s Water Quality Storm

Hydrograph of the flow through the Outdoor classroom

- Having a Cistern and a Rain Garden in this area reduces the peak flow volume from 1.73 cfs (12.94 gallons per second) as shown in the first picture to 0 cfs (0 gallons per second) which indicates no flooding/ponding of rain water will occur downstream.

- The hydrographs show that having the BMPs in place reduces the peak runoff by 100% for a New Jersey Water Quality Storm (1.25” over 2 hours).
Figure B-6a. Hydrograph for New Jersey’s Average 2 yr Storm

Hydrograph of flow from the school roof traveling through the school yard

- Having a Cistern, Vegetative Filter Strips, a Bioretention swale and a Bioretention Basin reduces the peak volume of flow from 21.42 cfs (160.23 gallons per second) to 7.79 cfs (58.27 gallons per second) reducing the chances of flooding/ponding of rain water downstream.
- The hydrographs show that having the BMPs in place reduces the peak runoff by 63.6% for a New Jersey 2 year Storm (3.3” over 24 hours).
**Figure B-6b. Hydrograph for New Jersey’s Average 2 yr Storm**

**Hydrograph of the flow through the Outdoor classroom**

- Having a Cistern and a Rain Garden reduces the peak volume of flow from 4.37 cfs (32.69 gallons per second) to 0.72 cfs (5.39 gallons per second) reducing the chances of flooding/ponding of rain water downstream.

- The hydrographs show that having the BMPs in place reduces the peak runoff by 83.5% for a New Jersey 2 year Storm (3.3” over 24 hours).
Figure B-7a. Hydrograph for New Jersey’s Average 10 yr Storm

Hydrograph of flow from the school roof traveling through the school yard

- Having a Cistern, Vegetative Filter Strips, a Bioretention swale and a Bioretention Basin reduces the peak volume of flow from 34.47 cfs (257.85 gallons per second) to 13.53 cfs (101.21 gallons per second) reducing the chances of flooding/ponding of rain water downstream.
- The hydrographs show that having the BMPs in place reduces the peak runoff by 60.7% for a New Jersey 10 year Storm (5.3” over 24 hours).
Figure B-7b. Hydrograph for New Jersey’s Average 10 yr Storm

Hydrograph of the flow through the Outdoor classroom

- Having a Cistern and a Rain Garden reduces the peak volume of flow from 7.03 cfs (52.59 gallons per second) to 0.83 cfs (6.21 gallons per second) greatly reducing the chances of flooding/ponding of rain water downstream.
- The hydrographs show that having the BMPs in place reduces the peak runoff by 88.2 % for a New Jersey 10 year Storm (5.3” in 24 hours).
March 30, 2005

Mr. Christopher Obuqta
Assistant Professor
Rutgers Cooperative Extension
Department of Environmental Sciences
14 College Farm Road
New Brunswick, New Jersey 08901-8551

Re: Letter of Support
U.S. Environmental Protection Agency Design Competition
Proposed Dayton St. School Community

Dear Mr. Obuqta:

Please consider this a letter of encouragement and support of Rutgers Cooperative Extension and students in pursuit of the EPA environmental design competition titled Engineered Stormwater Management for Low Income Urban Communities. Having the Environmental Sciences and Landscape Architecture students of Rutgers developing strategies and best management practices to aid our environment and school district is extremely beneficial, especially when there is a learning opportunity attached for students of our community.

We congratulate you on your Phase 1 acceptance for the project from the EPA involving the Weequahic community, including Seth Boyden Apartments and the Dayton St School. The opportunities to have our students learn about sciences related to water pollution and water conservation is also consistent with the LEED criteria used in designing and building our new schools.

As a LEED 2.0 accredited professional, I also understand the value and am committed to furthering the mission to promote healthy, sustainable building sites and projects. We look forward to supporting your efforts and creating learning opportunities for our students, concurrently.

If you have any further details to share, please contact me at your earliest convenience, advising how this department may be a continued resource.

Sincerely,

William S. Parrish, Jr.
Director, Design & Construction, Facilities Management Department

cc: Marion A. Belden
    Steve Morlins
    Dr. Gayle Griffin
    Sandra Deguineste

File

ALL CHILDREN WILL LEARN