

Chapter 5

Milestone 4 The Robinsons Branch Regional Stormwater Management Plan

Part B: Supplemental Provisions

**Completed by the
Rutgers Cooperative Extension
Water Resources Program
Under the guidance of Christopher C. Obropta, Ph.D., P.E.**



Plan B
of the Regional Stormwater Management Plan for the Robinson's Branch Watershed
May 2007
Rutgers Cooperative Extension Water Resources Program

Part B:
The Robinson's Branch Regional Stormwater
Management Plan:
Supplemental Provisions

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4B Recommended Management Measures

4B.1.0 Introduction

A Regional Stormwater Management Plan has been created for the Robinson's Branch Watershed, a twenty-two square mile watershed that takes in parts of Union and Middlesex Counties in NJ. Initial steps of this process included the formation of a committee, a stormwater characterization and assessment, and a compilation of drainage area specific water quality, quantity and recharge objectives. The final steps before the implementation and adoption of a plan is to identify management measures that will achieve the drainage area objectives.

The management measures have been separated into two parts that differ in their implementation. Part A defines the applicable provisions that will be adopted into the Areawide Water Quality Plan to address identified stormwater problems. Part B identifies specific management projects that have been quantified as to their potential in pollutant reduction, stream flow reduction, cost, and other characteristics and are generally voluntary in nature. This document details those projects recommended in Part B.

The management measures that will be implemented as distinct projects are categorized into seven categories and are detailed in Sections 4B.2, Education; 4B.3, Stormwater Utility; 4B.4, Floodplain Management; 4B.5, Arsenic Management; 4B.6, Pathogen Management; 4B.7 Landscaping Professionals; 4B.8 Stressor Analysis and 4B.9, Specific Projects. The specific projects have been ranked after placement in their corresponding municipality.

4B.1.1 Ranking of Management Measures (in Section 4B.7)

4B.1.1.1 Stormwater Rules at 7:8-3.4(e)

The management strategies presented as projects that are recommended in this document have been ranked using the protocol in the Stormwater Rules at 7:8-3.4(e). Priority is given to those projects that "may affect public health, safety and welfare as evidenced by history or of potential for flood damage, risk of loss of or damage to water supplies; and risk of damage to the biological integrity of water bodies". Problems concerning water quantity are generally addressed and prioritized above water quality issues due to these prioritization guidelines. Also, mitigating water quantity problems often alleviates poor water quality by reducing erosion and direct input of stormwater into the stream. Many of these issues were prioritized in the Milestone 2, the Stormwater Characterization and Assessment. Both water quality and water quantity issues were initially prioritized in Section IX and X of that document. Prioritization of subbasins by water quantity characteristics were also determined through the use of aerial loading analysis and detailed at the end of Section IV of the Stormwater Characterization and Assessment for the Robinson's Branch Watershed.

In Sections II.M. and IV of the Robinson's Branch Watershed Characterization and Assessment, it was determined that the water quality within the Robinson's Branch has

several critical issues, among them multiple listings on Sublists 4 and 5 of the New Jersey Integrated Water Quality Monitoring and Assessment Report. Those strategies that mitigate the issues surrounding any of these listings were given the highest priorities.

4B.1.1.2 Planning Committee

The priorities of the Regional Stormwater Management Planning Committee also played a significant role in the prioritization schedule offered in this document. These priorities heavily correlated with those determined through the above methods.

4B.1.1.3 Prioritization of Other Voluntary Measures

The management strategies have not been ranked together with the projects due to their nature of encompassing the entire watershed and the necessity of having these measures completed concurrently with the projects. It is the intention of the committee to not place education, stormwater utilities, pathogen management, landscaping registration, and stressor analysis on a waiting list, but to proceed directly with implementation as circumstances permit. However, they have been noted as a part of each municipality's project tables due to the expected reliance on these tables for choosing mitigation projects.

4B.1.1.4 Priority Storms

During stormwater analysis of the Robinson's Branch Watershed the 2, 10 and 100 year storms were evaluated. Combining results of hydrologic and hydraulic models together with the priorities of the Robinson's Branch Regional Stormwater Planning Committee, the critical storm was determined to be the small "nuisance" storms, falling between the New Jersey Water Quality Storm (1.25"/2 hours) and the 2-yr storm (3.5"/24 hours). It was these storms that were primarily addressed by this plan.

4B.1.1.5 Time schedule

A schedule that details the tasks necessary to bring all projects to fruition should be completed by each town according to priorities of the town. Overall, a goal of completing fifty per cent of the projects within the first decade after adoption is a recommended minimum.

4.B.1.2.0 Cost Estimates

The cost estimates of a management measure were not considered in the prioritization procedure. This must be performed on a case by case basis. The cost estimates are preliminary and require a more detailed assessment.

Cost estimates for the recommended management measures are given in first table in each municipal section that follows. The cost of the disconnection and infiltration of impervious surfaces was determined by determining runoff volumes for the two-year design storm using TR55. This volume was then routed through a bioretention system or rain garden that was two feet deep with an infiltration rate of 0.5 inches per hour. The lower cost of the bioretention basin was taken as \$2 per square foot of basin plus 25% for engineering costs while the higher cost used \$4 per square foot plus 25% for engineering costs. The cost for educational programs includes the cost to construct demonstration

BMPs such as rain gardens and the cost to deliver educational programming at several locations within the subbasin. The costs for the remaining management measures can be found in the first tables within each municipal section. These estimates are based upon best engineering cost estimates and upon similar projects completed in New Jersey. Please note that these are only estimates. Actual costs will be a function of the market prices during the time of construction.

4B.1.3.0 Management Measures Grouped and Named

Section 4B.7 contains tangible projects that can be created to directly mitigate water quantity and water quality issues. These projects are grouped within each municipality and have a unique numerical identifier. This identifier begins with two letter representing the municipality where the project will be primarily contained (ED=Edison; WB=Woodbridge; RW=Rahway; SP=Scotch Plains; CL=Clark; WF=Westfield; FW=Fanwood; PL=Plainfield; CR=Cranford; GW=Garwood). The first two numerical digits are the subbasin number in which the project is primarily contained; and the numbers that follow that represent the number of objectives that the project meets from Milestone 3 (one digit) and the final number attempts to indicate the range in which the cost of the project falls (1=less than 100K; 2=between 100K and 200K, etc.). In the case this method does not present a unique ID, the cost digit is adjusted and may appear in a higher category.

4B.2. Education

Many of the water quality and water quantity objectives must be achieved by addressing the impact of existing development in the Robinson's Branch Watershed. Education plays a key role in reducing the impacts from existing development. Several educational programs already exist in New Jersey that can be used to begin this process. It is important to note that often education is not enough to encourage people to change their behavior. To this end, programs need to be established that provide tools and resources to homeowners, businesses and public entities to help them take the actions that are needed.

The programs that are described below can be used to empower local residents to take action to improve the water quality and the water quantity within the Robinson's Branch Watershed. All but one of these programs have been offered throughout New Jersey and have been very successful at training volunteers and encouraging homeowners and municipalities to implement stormwater management strategies. These programs can be customized to be appropriate for many different situations. They also lend themselves to be adapted into "train the trainer" programs where other organizations can assume ownership of the program in different areas and deliver the program as part of their organization's activities. The adoption of some or all of these programs could have a significant impact on reducing flooding and improving the water quality of Robinson's Branch.

New Jersey Educational Programs

The programs listed below are a sample of educational programs that are available in New Jersey. The NJDEP, the Union and Middlesex County Extension Offices, and the New Jersey 4H are a few other organizations that also offer educational programs. The educational programs that will create true change in the actions of people must provide stakeholders with hands on activities and contain a strong outreach component. It is for this reason that the Rutgers Cooperative Extension programs play an important role and offer programs where the agency is able to come to the municipality and work with the local stakeholders to educate them on specific concerns in their area.

The Environmental Protection Agency (USEPA) and the NJDEP offer newsletters, brochures and other outreach materials and these can be used by the watershed groups in an additional effort to educate stakeholders. However, priority must be given to hands on instruction.

4B.2.1 Rutgers Cooperative Extension Water Resources Program Stormwater Management in Your Backyard Program

This program provides a detailed overview of stormwater management. It introduces the factors that affect stormwater runoff, point and non-point source pollution, the impact of development (particularly impervious cover) on stormwater runoff, and the pollutants found in stormwater runoff. An overview of New Jersey's stormwater regulations is presented including who must comply and what they are required to do. Additionally, the concept of Total Maximum Daily Loads (TMDLs) is introduced along with various other requirements of the Federal Clean Water Act that have serious implications on New Jersey. A thorough discussion of different types of best management practices (BMPs) that can be implemented to control stormwater runoff is presented and how these BMPs can be used to achieve the quality, quantity and groundwater recharge requirements of New Jersey regulations. The BMPs discussed include bioretention systems (rain gardens), sand filters, stormwater wetlands, extended detention basins, infiltration basins, manufactured treatment devices, vegetated filters, and wet ponds. The workshop also discusses the various management practices that the homeowner can install including dry wells, rain gardens, rain barrels, and alternative landscaping. The protocol for designing these systems is reviewed in detail with real world examples provided. A step by step guide is worked through for designing a rain garden so that homeowners can actually construct one on their property. The students have an opportunity to bring in sketches of their property for the class to review and discuss various BMP options for each site. The course also provides a discussion of BMP maintenance focusing on the homeowner BMPs. The course concludes with a discussion of larger watershed restoration projects and how the students can lead these restoration efforts in their community. The course is very interactive and ample time is set aside for question and answer sessions.

The initial target groups for educational programs in the Robinson's Branch Watershed should be areas of dense development around the larger reservoirs of water. Key areas

would include the Pumpkin Patch Subbasin in Woodbridge, Edison and Clark (Unique ID WB4081, ED4081, and CL4081), and the subbasins that surround the Clark Reservoir in Clark (Unique ID CL4082).

For more information, please contact Christopher Obropta at 732-932-4917 or obropta@envsci.rutgers.edu.

4B.2.2 Rutgers Cooperative Extension's Environmental Stewardship Program

Rutgers Cooperative Extension has formed a partnership with Duke Farms to create a statewide Environmental Stewardship certification program. Participants learn land and water stewardship, best management practices, environmental public advocacy, and leadership. Each group meets twenty times for classroom and field study. They are taught by experts from Rutgers and its consortium partners. Students are certified as Rutgers Environmental Stewards when they have completed sixty hours of classroom instruction *and* sixty hours of volunteer internship. Northern classes are held at the Essex County Environmental Center, Duke Farms and the Rutgers EcoComplex. Consortium partners can ask students to provide volunteer assistance in the satisfaction of their internship requirements.

Graduates of this program become knowledgeable about the basic processes of earth, air, water and biological systems. They increase awareness of techniques and tools used to monitor and assess the health of the environment. They gain an understanding of the research and regulatory infrastructure of state and federal agencies operating in New Jersey that relate to environmental issues. Unlike some programs, they are also given an introduction to group dynamics and community leadership. Participants are taught to recognize the elements of sound science and public policy based in science while acquiring a sense of the limits of the current understanding of the environment. The goal of the Rutgers Environmental Stewards program is to give graduates knowledge to expand public awareness of scientifically based information related to environmental issues and facilitate positive change in their community.

For more information please log on to: www.rcrc.rutgers.edu/envirostewards.

4B.2.3 Rutgers Cooperative Extension Water Resources Program Restore-A-Waterway Program

Restore-a-Waterway is a technical service provider program offered by the Rutgers Cooperative Extension Water Resources Program. The Program is funded jointly by the United States Department of Agriculture Cooperative State Research, Education , and Extension Service (USDA CSREES), New Jersey Sea Grant, and the New Jersey Agricultural Experiment Station (NJAES). The goal of the program is to provide technical assistance to citizen groups that want to take action in restoring the condition of

a waterway. Rutgers Cooperative Extension (RCE) provides expertise to these groups to assist them in their efforts. Forms of technical assistance include helping these groups to:

- Perform physical waterway characterizations,
- Develop and implement of chemical and biological quality assurance project plans (i.e. QAPPs),
- interpretat and analyze of data,
- identify problems and sources of those problems within a watershed,
- design solutions to mitigate the identified problems,
- secure funds to implement the designed solutions,
- implement the solutions.

In addition to offering workshops to help educate citizen groups on these technical issues, Restore-a-Waterway can be adapted for municipal officials to address their specific needs. The implementation of solutions after monitoring and analysis is an important focus of this program.

Target communities would be those that are mentioned and prioritized in this document. Selection, design and implementation of BMPs recommended within this document can be optimized through the use of this program.

If you are interested in participating in Restore-a-Waterway, please contact: Gregory Rusciano at (732) 932-2739 or greg.rusciano@rutgers.edu.

4B.2.4 Community-Project-Based Learning Educational Program

The RCE Water Resources Program has joined forces with Research in Education Applied to Learning (R.E.A.L.) Science to create a new method of science instruction called "Community-Project-Based Learning." R.E.A.L. Science is a nonprofit organization that provides a support system for innovative standards-based authentic science projects along with effective teacher in-service training programs in science education. Community-Project-Based Learning incorporates the authentic practice of real scientists into the regular classroom setting. Community-Project-Based Learning identifies a real environmental problem in the community and works with the students to address these driving questions: Is there a real problem with our watershed? What is our contribution to the problem? If there is pollution in our watershed, how can we fix it? The project objectives include the students investigating various aspects of the natural environment on and around the school grounds, students documenting findings, and students communicating these findings to fellow classmates and the community. Working in teams, the students design a solution to a problem and present these solutions to their classmates. The best solutions are selected and built on the school grounds.

These projects expose students to the actual practice of scientists in the fields of ecology and environmental science and cover issues in geology, biology, chemistry, and applied mathematics. Lessons and activities are designed with classroom teachers to instruct

students within the state standards-based curriculum. The students work together to address relevant environmental problems in their community.

Students participate as legitimate members of a scientific community. They work with their teachers, parents, local scientists, and other knowledgeable members of the community to create a solution to a relevant environmental problem in their community. As scientists, the students assemble existing data, collect new data, and work with professionals from the community to fully understand the problem, while honing their skills and learning within the guidelines of the New Jersey State Core Curriculum Content Standards.

Ideal target communities to focus this educational procedure on would be the intermediate schools in the watershed.

For more information, please contact Christopher Obropta at 732-932-4917 or obropta@envsci.rutgers.edu.

4B.2.5 Best Management Practices in Landscaping (under development)

Landscapers contribute to the application of fertilizer, the removal of yard waste, the construction of gardens and the maintenance of the grounds surrounding the streams and lakes within a watershed. For these reasons, a program that will be aimed at teaching the best management practices (BMPs) of landscaping could be required as a part of the licensing processes of landscapers.

As yet undeveloped, this educational program expressly focused on the daily habits of landscape professionals has the potential to be administered through the Environmental Steward or the Restore Our Waterways programs. After initial development of the program, it is possible for the municipality to offer it or have it offered through the box stores that carry lawn maintenance equipment and fertilizers. Key aspects of this educational program will be soil testing and the subsequent application of necessary nutrients; the design, implementation and maintenance of rain gardens; buffer establishment and maintenance and the BMPs of waste disposal.

Registration of Landscaping Professionals

Addressing this significant population can have a strong impact on stormwater management and will best be served by a general registration of landscapers. This is one recommendation that could be undertaken by the individual municipalities. Requirements for using the best management practices can then be more efficiently delivered to the interested parties. See Section 4.B.7.0 of this document for more recommendations on this subject.

4B.3.0 Stormwater Utility

Voluntary programs are excellent methods of addressing water quality and quantity concerns, but sometimes these programs fail to achieve the required goals, and a regulatory approach is needed. With the Robinson's Branch Watershed being composed of many municipalities and two counties, and having a high percentage of densely populated areas, implementing a Stormwater Utility could prove to be a crucial unifying element of addressing the many issues of the watershed.

To address flooding related problems and water quality problems, such as those experienced in the Robinson's Branch Watershed, many communities across the country have considered the option of forming a utility specifically for the purpose of managing stormwater. Although the concept of a "Stormwater Utility" was first proposed in the 1970s, it is within the last ten years that the growth of utilities with a specific mandate to manage stormwater has increased rapidly. These utilities perform various services, which may include overseeing the collection, treatment, and disposal of stormwater, and in some cases assuming the responsibility for maintenance of the stormwater collection systems. These Stormwater Utilities are typically funded through a dedicated revenue stream. As of May 2005 there were over 400 utilities operating throughout the U.S. to manage stormwater flows, but to date, no municipality or county within New Jersey has created such a utility (NJDEP 2005). For a municipality or a county to establish a viable Stormwater Utility, enabling legislation must be enacted.

In a 2005 report prepared for Morris County and the NJDEP entitled *Recommendations for Stormwater Utility Implementation in New Jersey*, several suggestions were put forth to apply modifications to existing laws to facilitate the implementation of stormwater utilities. It is recommended that each law that is modified should support the following functions:

- Authorize creation and operation of stormwater utility systems
- Authorize imposition of user fees to finance operation and maintenance and repayment of bonds
- Require that stormwater system user fees be based on the stormwater runoff contribution of each parcel of land
- Reference a stormwater utility manual that provides guidance regarding stormwater utility implementation and establishment of defensible user fee structures. A manual of this type has been circulated describing a hypothetical stormwater utility implementation process for "Greentown Borough".

As a part of these recommendations that were presented to the State, five specific laws were identified for changes that would allow provisions for stormwater function and services that were listed above. The five laws and recommendation modifications are as follows:

1. NJSA 40

NJSA 40 could have language added that would authorize municipalities to create stormwater utilities by ordinance. Section NJSA 40:62 currently deals with municipal utilities and water districts and would be an ideal area to add language that would impose user fees and require that the fees be based on the stormwater runoff contribution of each parcel of land.

2. Local Bond Law

Under the Local Bond Law, NJSA 40A:2-1 et seq., bond ordinances to finance municipal public utilities may commit the municipality to impose user fees to pay off the bonds and fund the operation of the utility (NJSA 40A:2-15(d)).

3. Municipal and County Sewerage Act

The Municipal and County Sewerage Act, NJSA 40:A26A-1 et seq., currently authorized municipalities and counties. The act currently authorizes imposition of fees on users of "sewerage services", and does not define "sewerage services". NJSA 40A:26A-10 can be amended to specify fees for use of stormwater systems based on the runoff contribution of each parcel of land.

4. Municipal and County Utilities Authority Law

Stormwater-specific provisions should be added to the Municipal and County Utilities Authority Law, NJSA 40:14B-1 et seq. Definitions of stormwater, stormwater system, and service charges should be amended to refer to stormwater systems.

5. County Improvement Authorities Law

The County Improvement Authorities Law, NJSA 40:37A-44 et seq., should be modified to specifically authorize implementation of stormwater management functions and provide for imposition of user fees to finance construction, operation and maintenance of stormwater management facilities.

Municipal stormwater discharges are regulated as point sources under the Clean Water Act (1972). However, control of stormwater is often extremely difficult in urban environments due to both the large volumes of stormwater generated, as well as the space constraints, and so stormwater management is an issue facing urban centers across the country. Uncontrolled stormwater flows pose a danger to both constructed and natural environments, and the collection and rapid routing of water through urban stormwater infrastructure results in problems related to both water quantity and quality. Municipal surface water runoff in urban areas is typically collected in storm sewer systems and conveyed to the nearest receiving water body. The volume of the runoff, the rate of flow, and the water quality are determined by the amount of a watershed's impervious surface, modifications of the landscape, and the natural drainage patterns and topography within a drainage basin. Original storm sewer systems were designed to rapidly route stormwater out of developed areas to the discharge point. As previously undeveloped land is

developed with impervious covers such as blacktop, rooftop, and concrete, the volume of stormwater continues to increase.

While older stormwater conveyance systems were built to efficiently move water downstream, the modern approach now views stormwater as an important component in managing integrated urban water resources. Current strategies are multi-dimensional, and consider water quantity and quality issues, multiple-use facilities, riparian corridors, wetland preservation and creation, and groundwater recharge (NSFMA 2006).

In forward-looking communities stormwater is considered a resource, and the management of stormwater is viewed as an important function of local government on par with the oversight of the drinking water supply and sewage treatment operations. Today stormwater management includes planning, design, construction, operation, and maintenance of specific water control structures and dedicated financial resources required to support these activities. The benefits of successful stormwater management include handling of excess drainage, reduction of the damage caused by flooding, protection of transportation systems, protecting property values, providing long term system maintenance, and environmental enhancement (NSFMA 2006). However, the costs of construction, operation, and maintenance of flood control measures is typically beyond the financial resources available to individual property owners, and in many cases individual municipalities.

Although the creation of a stormwater utility would require fees to be assessed on property owners throughout the watershed, it would provide a steady source of funding that could be used to leverage larger grant or loan funds to implement stormwater control projects.

The recommendation of a stormwater utility for the Robinson's Branch Watershed is believed to be a critical component to addressing the many water quality, water quantity and groundwater recharge issues that the watershed is experiencing. This recommendation is ranked separately under each municipality, but should be addressed on a watershed basis. The Unique ID for this recommendation is the municipal ID + SU4085.

4B.4.0 Floodplain Management

Due to the extent of development in the Robinson's Branch Watershed, flooding from constrictions, and direct connection of impervious areas, the watershed is in need of a group that will work to coordinate all efforts regarding reduction of flooding. This group could be a subcommittee of the Rahway River Watershed Association, the county engineering or planning department, or this may be an ideal use of a stormwater utility.

Proposed new rules found at NJAC 7:13 go a great distance in mitigating the effects of future development, including a rule regarding the implementation of zero net fill. However, the Robinson's Branch is experiencing the effects of not having a well

developed plan in place, and now finds itself in need of reviewing existing development and charting a route for the future.

The Garden State Preservation Trust, also known as Blue Acres, may serve to aid this watershed in its efforts to reduce risk to the health and welfare of its residents, as well as mitigate risk to property.

This watershed must also prioritize working with FEMA to update and digitize floodplain maps. Again, this can be done with a separate committee or as a part of the responsibilities of a stormwater utility.

The Unique ID on the recommendation for this operation in each municipality will be Municipality ID + FM4083.

4B.5.0. Management of the Entrance of Arsenic into the Streams

The Robinson's Branch Watershed contains an area that has been listed on the New Jersey 2004 Integrated List of Impaired Waterways for Arsenic. (See 2M and Section IX of the Robinson's Branch Stormwater Characterization and Assessment). The USGS testing station is located at St. Georges Avenue in Rahway, and is therefore located downstream of a potential drinking water source (the Clark Reservoir). Currently, sources have not been strictly identified, but for the purpose of this report the non-point source contributions will be focal point of the recommendations.

Since this site has been placed on Sublist 5, a TMDL is expected to be produced. This will initiate the management processes that will need to identify sources of arsenic that is leading to the bioavailable levels present in the system. Funding needs to be acquired for the creation of a thorough soil and water sampling program that not only focuses on the original area that the arsenic was found to be above acceptable levels, but to go upstream and evaluate all soils and water that contribute to potential drinking water sources.

After a sampling program has been completed and the fate and transport of the contaminant has been identified, controlling the bioavailable form of arsenic will be essential to the health of the biota and potentially in reducing human consumption. Also, phytoextraction and harvesting of the plants removes arsenic from soils and can be a cost effective management strategy.

Another method of reducing the bioavailability of the arsenic is through the altering of the redox potential of the soil. A higher redox potential has been found to reduce the release of arsenic from the soils. This may be of particular importance when evaluating road salting/sanding practices in the drainage basins. An understanding of road salt and its interaction with soil arsenic should be one aspect of this management strategy.

An overall management strategy that would help to coordinate the participation of all of the involved municipalities in the watershed could be a stormwater utility for the

Robinson's Branch Watershed. To manage resources, this plan should begin in four downstream municipalities, Rahway, Westfield, Clark and Woodbridge. The Unique ID for these projects will be RW-AS4081, WF-AS4081, CL-AS4081 and WB-AS4081.

4B.6.0 Management of Pathogens in Recreational Waters

In Sections II.M. and IV of the Robinson's Branch Watershed Characterization and Assessment, it was determined that the water quality within the Robinson's Branch has several critical issues, among them two listings on Sublist 4 of the 2004 New Jersey Integrated Water Quality Monitoring and Assessment Report. The Robinson's Branch Watershed requires diligence in detecting sources of waste products that could be associated with pathogens. One of the main causal contributing factors in the fecal contamination found in the Robinson's Branch Watershed has been identified as "nonpoint pollution". Parties in the watershed that are responsible for detecting sources have up to this point focused their efforts on waterfowl and other wildlife. Due to the existence of aging infrastructure, the implementation of a Microbial Source Tracking (MST) study is recommended to differentiate the sources of bacteria. Although mitigating this problem will likely be mandated as a part of the TMDL process, two optional projects that will aid this process should be implemented.

Microbial Source Tracking(MST)/Sanitary Sewer Inspection

An MST survey can provide data that can identify if the source of the bacteria is human or non-human. If the results of an MST study indicate human sources, a targeted analysis can be performed on the sanitary sewers that are up gradient of the detection. The results of the MST survey (Unique ID MS4028) could also provide information on the animal sources of bacteria and may help to focus source reduction.

With no known septic systems in operation in this watershed, contamination from human waste would be expected to be due to a breach in the transport system of household waste. In conjunction with MST, or as a completely separate function, inspection and maintenance of the sanitary sewer system will help to ensure that bacteria from human waste are not able to enter the watershed proper.

Aging infrastructure needs maintenance, and one component of maintenance for the sanitary sewer system could be regular cleaning and inspection. The inspection would provide information on the integrity of the system and could be performed with a TV camera intended for this job. Although initially costly, sharing of equipment across the towns in the watershed and capitalization over the years will reduce expenditures. Although the primary reason for these inspections will be to find breaches in the structures that would contribute a source of bacteria to the ecosystem, these inspections will also provide information on stoppages that cause backups, odors, and often result in flooded basements and property damage.

The cost of an encased TV unit that will perform this type of inspection varies greatly. It is recommended that an entity that can represent the three towns within the watershed provide a sharing agreement for the cost and usage of this equipment. Scheduling of inspections to detect sewer defects should be performed according to the age of the system. Typical inspections are performed every two to ten years, depending on the bacteria level found in the watershed.

Goose Management

It is becoming a town mandate to reduce the number of resident Canada geese that reside around waterways with mowed areas surrounding them. Addressing this issue may be due to the unsanitary conditions these animals present at public recreational areas, but the result of reducing pathogen input to the waters is coincident.

Each municipality should have a specific plan, included in the plan for the management of pathogens that details the tasks necessary to keep the resident waterfowl population to a manageable, sustainable number. Key solutions include buffers that are not mowed around waterways. Numerous publications exist on the subject and should be evaluated on a town by town basis. (See U.S. fish & Wildlife Service, Draft Environmental Impact Statement, Resident Canada Goose Management, February 2002; New Jersey Department of environmental Protection Division of Watershed Management, March, 2001; Cornell Cooperative Extension, Managing Canada geese in Urban Environments, 1999)

4B 7.0 Landscaping Professionals

Landscaping professionals should be required to register with the municipality and be notified of proper procedures to comply with MS4 regulations and additional best management practices related stormwater management.

Hiring a professional landscaper for lawn care in residential areas is a growing practice in New Jersey. Landscapers seek to be permitted for pesticide application and irrigation. Although not all landscapers need to be permitted/licensed, beginning an educational program that offers alternatives to traditional management of lawns can have a positive impact on stormwater management.

A program being developed by the Rutgers Cooperative Extension Water Resources Program in cooperation with the Rutgers University Continuing Education will include Best Management Practices and the maintenance that is required. It is expected that this program will increase the use of stream buffers, rain gardens and infiltration in general and become an essential part of the continuing education for professional landscapers. (Unique LP4051)

4B 8.0 Watershed Wide Stressor Analysis

The four Ambient Biomonitoring Network stations located in the Robinson's Branch Watershed tested the waters of the Robinson's Branch Watershed and have consistently found impairments ranging from moderate to severe. Two of these sites have been listed on Sublist 5 of the 2004 New Jersey Integrated Water Quality Monitoring and Assessment Report. Additionally, many committee members and members of the public have expressed concern as to the biological makeup of the stream. For these reasons, it is recommended by this plan that a watershed wide stressor analysis program be implemented. (Unique ID: SA4012). This program should, at a minimum, follow the USEPA Stressor Identification Protocol (USEPA, 2000).

4B.9.0 Specific Projects

Note that recommendations for mitigating water quality issues also provide benefits to water quantity problems and groundwater recharge. All three aspects of the individual BMP will be properly quantified or qualified in the three tables contained in each municipality's section.

4B.9.1. Scotch Plains

The portion of Scotch Plains that falls within the Robinson's Branch Watershed provides the greatest portion of any single municipality within the watershed. In the Township of

Scotch Plains several objectives have been identified as a result of completing Milestones 2 and 3. The subbasin numbers that will be used here can be cross referenced in Figure 1.

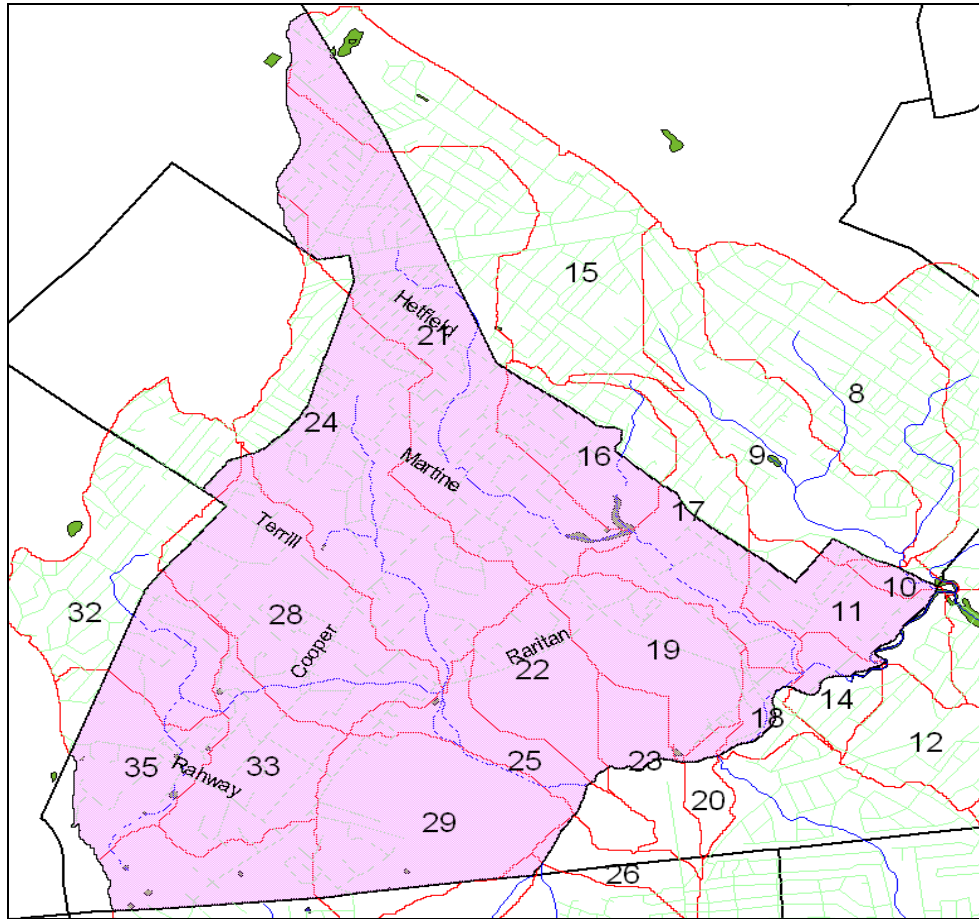


Figure 1: The Subbasins of Scotch Plains

According to the aerial load analysis performed as a part of the Robinson's Branch Characterization and Assessment, three subbasins that have all or a portion of their land area within the Township of Scotch Plains has been identified as some of the top ten worst nonpoint source pollution contributors due to land use. Overall loading was found to be significant in subbasins 24, 21 and a part of subbasin 15. When normalized to land area, subbasins 21 and parts of 15 and 16 were found to be significant. (Normalization to land area provided an even comparison across subbasins, preventing the size of the subbasin from determining the calculated load). Subbasins 21 and 16 consist primarily of high density residential and outlet to the Shackamaxon impoundments.

Several areas have been identified as problems leading to erosion, total suspended solids and sedimentation. Particular concern is noted downstream of Shackamaxon impoundment in Subbasin 17 on the Winding Brook. Erosion, TSS, and sedimentation

are also noted as problems around Inverness, Parkwood, and Broad Street (all subbasin 21). On the Ashbrook tributary, erosion contributes to poor water quality and sedimentation in the area of Terrill Road and Highlander.

Resident waterfowl populations have been found to be a major contributor to poor water quality and high fecal Coliform (see Water Quality section of Characterization and Assessment for information regarding fecal Coliform listing on Sublist 5 of the 2004 NJ Integrated List for Impaired Waterbodies).

Water quantity issues include flooding on the Ashbrook in the areas of Fox Hill Lane and Rahway Road(subbasin 35); Clover Place and Raritan Road by the old Terry Lou Zoo(subbasin 28); and on the Winding Brook Way on West Broad Street from White Oak to Hetfield Avenue (subbasin 21).

Groundwater recharge will help maintain the baseflow of the Robinson's Branch during dry periods and eliminate high peak flows during storms that cause bank erosion and stream bottom scouring.

4 B 9.1.1 Recommendations to Address Water Quality Issues in the Township of Scotch Plains

Shackamaxon

The impoundments by the Shackamaxon Golf Course should be considered a settling basin to capture sediment and maintained as such. This area will receive the runoff from the key contributors of nonpoint source pollution identified in the aerial loading analysis. This will mitigate the effects of land use runoff in the lower subbasins (Cross Reference Unique ID SP2131).

Killam Erosion Study

In 2000, Killiam Associates completed a Stream Erosion Study for the Township of Scotch Plains (Killiam, 2001). The report identifies 44 problems in the Winding Brook and the tributaries to the Robinsons Branch in the Township of Scotch Plains. The problems range from erosion at bridge abutments for private bridges and public street bridges, erosion associated with public footbridges, and erosion associated with stormwater outfalls. The study also identified areas where municipal sanitary sewer manholes are partially exposed in the stream channels. Furthermore, the study identifies areas where severe stream bank erosion was observed, which is threatening improved public and private property. The study provides solutions to each problem identified and an approximate cost for each solution. The cost to address all the identify erosion problems in Scotch Plains within the Robinsons Branch Watershed was in excess of \$1.5 million (please note that these estimates are based upon 2000 dollars and need to be adjusted for inflation).

Addressing the erosion problems identified in the Stream Erosion Study will help address the TSS problem in the watershed as well as improve the aquatic life habitat in the waterways of the Robinson's Branch Watershed. (Cross Reference SP2129)

4 B 9.1.2 Recommendations Address Water Quantity Issues in the Township of Scotch Plains

Disconnection and infiltration of impervious area upstream from these areas is expected to lessen the effects of increased stormwater volume and velocity during storm events (Cross Reference Unique ID SP1652, SP2153 and SP1551, and Maps 1, 2, and 3 in Appendix A)

An additional areas where the disconnection and infiltration of stormwater across an impervious area was identified at the Union County Vocational School, where the parking lot can be routed into a vegetated swale for both water quality and water quantity benefits. Please cross reference SP1951 and Engineering Concept Drawing 2.

The Shackamaxon Golf Course in Scotch Plains has the opportunity to employ detention basins that will serve not only as reservoirs for irrigation water, but will create water hazards for their patrons. In an engineering design concept plan (See Appendix B, Engineering Concept Plan 6) it was estimated that a similar design may be able to infiltrate/store 0.354 ac-ft for every 2 yr storm, while removing 60% of entering phosphorus, 50% of entering nitrogen and 80% of entering total suspended solids. (Cross reference SP1642)

All projects with their estimated costs have been presented in Table 1. These projects may cover water quality issues, water quantity issues and/or groundwater recharge issues. The objectives (cross referenced from Milestone 3) that the project addresses have been noted in Table 3.

Table 1: Scotch Plains Projects and Costs

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
*	SPSU4085	All of SP	Stormwater Utility	Management	Undetermined
*	SPMS4028	All of SP	Pathogen Management	Microbial Source Tracking/Goose Management Plan	Undetermined
*	SPAS4081	All of SP	Arsenic Management	Management and determination of BMPs	Undetermined
*	SPFM4083	All of SP	Floodplain Management	Management	Undetermined
*	SPED4082	All of SP	Education	Education	Undetermined
*	SPSA4012	All of SP	Stressor Analysis	Analysis	Undetermined
*	SPLP4051	All of SP	Registration of Landscaping Professionals	Management and Education	Undetermined
6	SP1652	16	Disconnection and Infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$60,000 to 125,000
7	SP2153	21	Disconnection and Infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$120,000 to 240,000
5	SP1551	15	Disconnection and Infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$22,000 to 45,000
4	SP2131	21 and 16	TSS removal	Settling Basin Maintenance	Unknown, depends on sediments
2	SP2129	All Scotch Plains subbasins	Erosion Control	Varies-See Killam Study (Appendix)	\$1.5 million
3	SP1951	19	Disconnection and Infiltration of impervious area	Vegetated Swale	\$56K to 87K
1	SP1642	16	Water Reuse	Retention Basin with pumps	\$100K-220K

4 B 9.1.3 Estimated Load Reductions and Groundwater Recharge for Scotch Plains Management Measures

Load reductions were estimated for each of the management measures that were recommended for the Township of Scotch Plains. Aerial loading coefficients were used to determine the load reductions for total phosphorus, total nitrogen, and total suspended solids. These loading coefficients were multiplied by the area disconnected for each of the management measures. Since the management measures were designed to infiltrate all the runoff from the two-year rainfall event, each management measure was assumed to reduce the annual load by 90% based upon a volume reduction. These load reductions are presented in Table 2.

Table 2: Scotch Plains and Load Reductions

Rank	Unique Identifier	Drainage Area(acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimate Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
*	SPSU4085	Watershed wide	unknown	unknown	unknown	unknown
*	SPMS4028	Watershed wide	unknown	unknown	unknown	unknown
*	SPAS4081	Watershed wide	unknown	unknown	unknown	unknown
*	SPFM4083	Watershed wide	unknown	unknown	unknown	unknown
*	SPED4082	Watershed wide	unknown	unknown	unknown	unknown
*	SPSA4012	Watershed wide	unknown	unknown	unknown	unknown
*	SPLP4051	Watershed wide	unknown	unknown	unknown	unknown
6	SP1652	7.45	7.45	74.53	894.32	8.08
7	SP2153	50.48	23.78	246.95	2374.79	54.71
5	SP1551	2.59	3.89	41.47	518.43	2.81
4	SP2131	236	386	4142	24320	none
2	SP2129	4100	Unknown, but likely significant	unknown	Unknown, but likely significant	none
3	SP1951	250	30% of input	30% of input	90% of input	0.514 ac-ft of stormwater per 2 yr storm
1	SP1642	1.5	60%	50%	80%	0.354 ac-ft

Note: Preliminary hydrographs for these management measures that are recommended in Milestone 4 are presented in Appendix B.

Also presented in Table 2 are the estimated groundwater recharge volumes. Once again, each management measure was estimated to infiltrate 90% of the annual rainfall or 40 inches per year. These volumes are presented infiltrating at a rate in million of gallons per year.

Table 3: Scotch Plains Funding and Objectives

Rank	Unique Identifier	Management	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	SPSU4085	Stormwater Utility	N/A	N/A	All
*	SPMS4028	Pathogen Management	N/A	All	1
*	SPAS4081	Arsenic Management	N/A	1, 2, 6, and 7	2 and 3

Rank	Unique Identifier	Management	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	SPFM4083	Floodplain Management	N/A	2, 3, 6, and 7	4 and 5
*	SPED4082	Education	N/A	1, 3, 5, 6, and 7	All
*	SPSA4012	Stressor Analysis	N/A	1, 3, 4, 6, and 7	All
*	SPLP4051	Registration of Landscaping Professionals	N/A	N/A	2 and 3
6	SP1652	Disconnection of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
7	SP2153	Disconnection of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
5	SP1551	Disconnection of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
4	SP2131	Settling Basin	Dredging	All	1,2, and 3
2	SP2129	Erosion control	Minor Stream Encroachment Permit	All	
3	SP1951	Disconnection of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
1	SP1642	Capturing and reusing precipitation	Local Construction Permits	All	2, 3, 4, and 5

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. Other

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Total Suspended Solid Loading to the Robinson's Branch
3. Address Nutrient Loading to the Robinson's Branch
4. Address Areas of Flooding
5. Address Recharge to Aquifer and Baseflow Maintenance

4B.9. 2. Edison

The Township of Edison is a section of the Robinson's Branch Watershed that is located in the southwest of the watershed.

The subbasins mentioned in this section can be referenced in Figure 2.

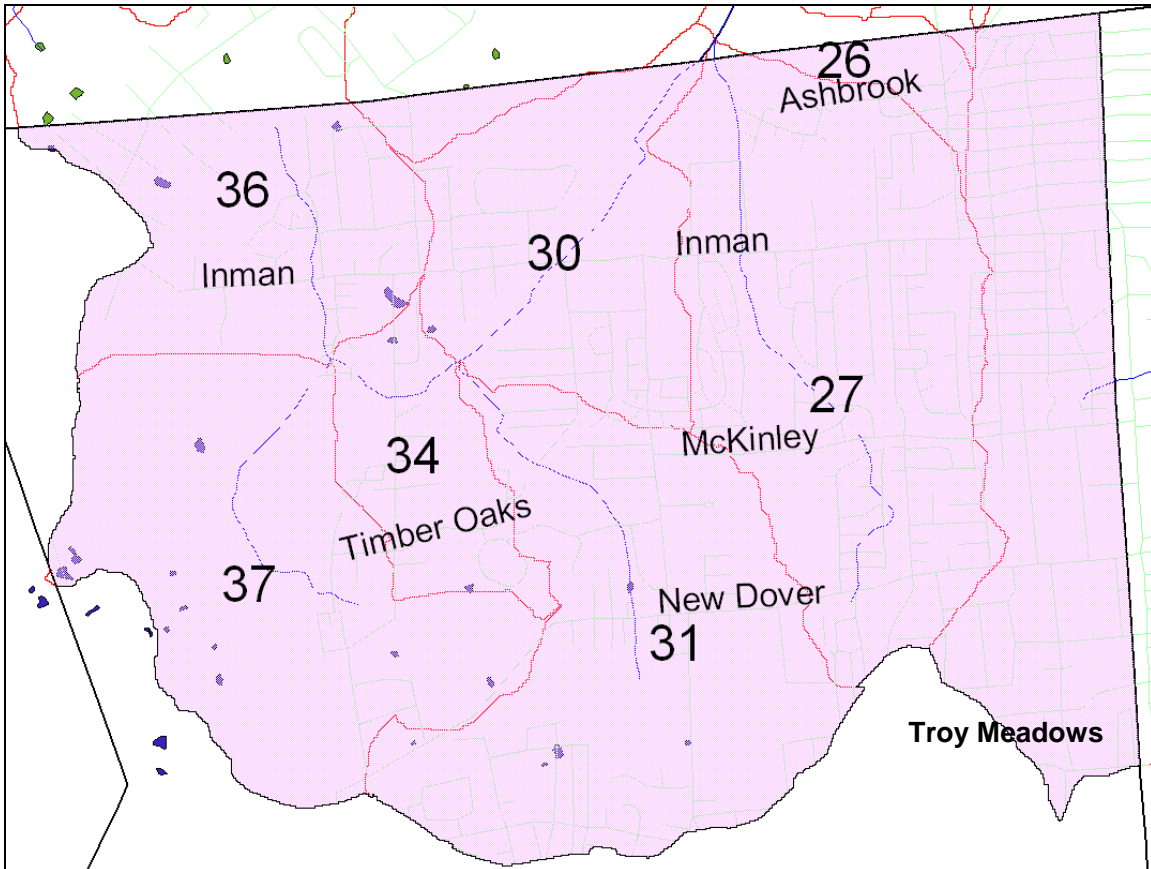


Figure 2: The Subbasins of Edison

The top priority of the concerned residents in this municipality is the preservation of open space and wetlands. Being at the headwaters of the Robinson's Branch Watershed, and currently not a significant nonpoint source of stormwater pollution (according to normalized aerial loading analysis), it is the consensus of this report that this land preservation is a critical component to the water quality, water quantity and the groundwater recharge of the whole of the Robinson's Branch Watershed.

The western portion of Subbasin 13, the Pumpkin Patch subbasin, falls within the municipality of Edison. Land use in this area is more densely developed and contributes to the flooding and poor water quality found in this drainage basin.

An additional priority of the concerned residents is that the integrity of the biota within the stream be maintained or improved upon.

4B. 9. 2.1 Recommendations to Address Water Quantity Issues for the Township of Edison

The wetlands of Edison serve to store stormwater and ultimately mitigate the peak flows that lead to the downstream flooding encountered during storm events. Critical open space should be preserved as a priority in this municipality. (Cross Reference ED3049)

Disconnecting and infiltrating the impervious surfaces will serve to improve water quality, reduce water quantity and increase groundwater recharge. Three areas have been identified as viable projects able to produce benefits to the watershed (Cross Reference ED2759 and Map 4 in Appendix A).

4B. 9.2.2 Recommendations to Address Water Quality Issues for the Township of Edison

The protection and preservation of wetlands and open space in this municipality will serve to address water quality issues, in the subbasins contained in the municipality and downstream. Particular attention should be paid to wetlands bordering the Robinson's Branch in Subbasins 37, 34 and 27. (Cross Reference ED3749)

Stream cleaning should be performed in coordination of habitat protection. Concerned town residents and officials should draft an ordinance to coordinate these efforts within the appropriate agencies (Cross Reference ED4011))

4B 9.2.3 Recommendations to Promote Groundwater Recharge in the Township of Edison

All the BMPs selected to address the water quantity and water quality issues also promote groundwater recharge. The educational programs recommended in Section 4B. 2 will also result in BMPs that promote groundwater recharge and will help encourage residents to take action to infiltrate more stormwater runoff. Table 4 ranks all the projects that were assigned to the Township of Edison.

Table 4: Edison Projects and Costs

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
*	EDSU4085	All of Edison	Stormwater Utility	Management	Undetermined
*	EDMS4028	All of Edison	Pathogen Management	Microbial Source Tracking/Goose Management Plan	Undetermined
*	EDAS4081	All of Edison	Arsenic Management	Management and determination of BMPs	Undetermined
*	EDFM4083	All of Edison	Floodplain Management	Management	Undetermined
*	EDED4082	All of Edison	Education	Education	Undetermined

*	EDSA4012	All of Edison	Stressor Analysis	Analysis	Undetermined
*	EDLP4051	All of Edison	Registration of Landscaping Professionals	Management and Education	Undetermined
3	ED2759	27	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$700,000 to 1,400,000
1	ED3049	All within Edison	Preservation of land	Wetlands, natural	unknown
2	ED4081	All subbasins	Education- "SWM in Your Backyard"	Education and Implementation	\$10,000 for 10 demo gardens and educational programming

The cost estimates were determined using the same procedure as outlined above for the Township of Scotch Plains. Once again, these are only estimates. Actual costs will be a function of the market prices during the time of construction.

4B. 9.2.4 Estimated Load Reductions and Groundwater Recharge for the Township of Edison Management Measures

Load reductions were estimated for each of the management measures that were recommended for the Township of Edison and can be found in Table 5. Aerial loading coefficients were used to determine the load reductions for total phosphorus, total nitrogen, and total suspended solids. These loading coefficients were multiplied by the area disconnected for each of the management measures. Since the management measures were designed to infiltrate all of the runoff from the two-year rainfall event, each management measure was assumed to reduce the annual load by 90% based upon a volume reduction. These load reductions are presented in Table 5. Also presented in

Table 5 are the estimated groundwater recharge volumes. Once again, each management measure was estimated to infiltrate 90% of the annual rainfall or 40 inches per year that will run off of impervious surfaces. These volumes are presented in million of gallons. For all the BMPs in the Township of Edison, the estimated annual groundwater recharge is 86 million gallons a year.

Table 5: Edison Projects and Load Reductions

Rank	Unique Identifier	Drainage Area(acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimate Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
*	EDSU4085	Watershed wide	unknown	unknown	unknown	unknown
*	EDMS4028	Watershed wide	unknown	unknown	unknown	unknown
*	EDAS4081	Watershed wide	unknown	unknown	unknown	unknown
*	EDFM4083	Watershed wide	unknown	unknown	unknown	unknown
*	EDED4082	Watershed wide	unknown	unknown	unknown	unknown
*	EDSA4012	Watershed wide	unknown	unknown	unknown	unknown
*	EDLP4051	Watershed wide	unknown	unknown	unknown	unknown
3	ED2759	78.63	128.98	1335.55	13097.18	85.22
1	ED3049	3060	No additional	No additional	No additional	Base flow preserved
2	ED4081	0.23	0.14	1.2	23	0.25

Note: Preliminary hydrographs for these management measures that are recommended in Milestone 4 are presented in Appendix B.

Table 6 describes the permits that may be required to implement this recommendation. The funding sources that are noted in this table are some choices that may have funding available for these types of projects. The objectives that are met are those that are cross referenced from Milestone 3.

Table 6: Edison Project Funding and Objectives

Rank	Unique Identifier	Management Measure	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	EDSU4085	Stormwater Utility	N/A	N/A	All
*	EDMS4028	Pathogen Management	N/A	All	1
*	EDAS4081	Arsenic Management	N/A	1, 2, 6, and 7	2 and 3
*	EDFM4083	Floodplain Management	N/A	2, 3, 6, and 7	4 and 5
*	EDED4082	Education	N/A	1, 3, 5, 6, and 7	All
*	EDSA4012	Stressor Analysis	N/A	1, 3, 4, 6, and 7	All
*	EDLP4051	Registration of Landscaping Professionals	N/A	N/A	2 and 3
3	ED2759	Disconnection and infiltration of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
1	ED3049	Preservation of Wetlands	None	6, 7, and 8	All Objectives
2	ED4081	Education programming	No permits are required	All	2, 3, 4, and 5

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. Other

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Nutrient Loading to the Robinson's Branch
3. Address Areas of Flooding
4. Address Areas of Increased Stream Volume and Velocity
5. Address Recharge to Aquifer and Baseflow Maintenance

4B.9. 3. Westfield

The Town of Westfield contains 3.5 square miles of the Robinson's Branch 22 square miles. With three unnamed tributaries that discharge upstream of the Middlesex/Clark Reservoir, this municipality remains an extremely important contributor to the water quality of the reservoir and the reaches of the Robinson's Branch downstream of the confluence. However, a significant portion of the streams within this municipality have been routed underground through cement pipes. The land over top of the streams has been developed making daylighting these streams at this point in time a difficult consideration.

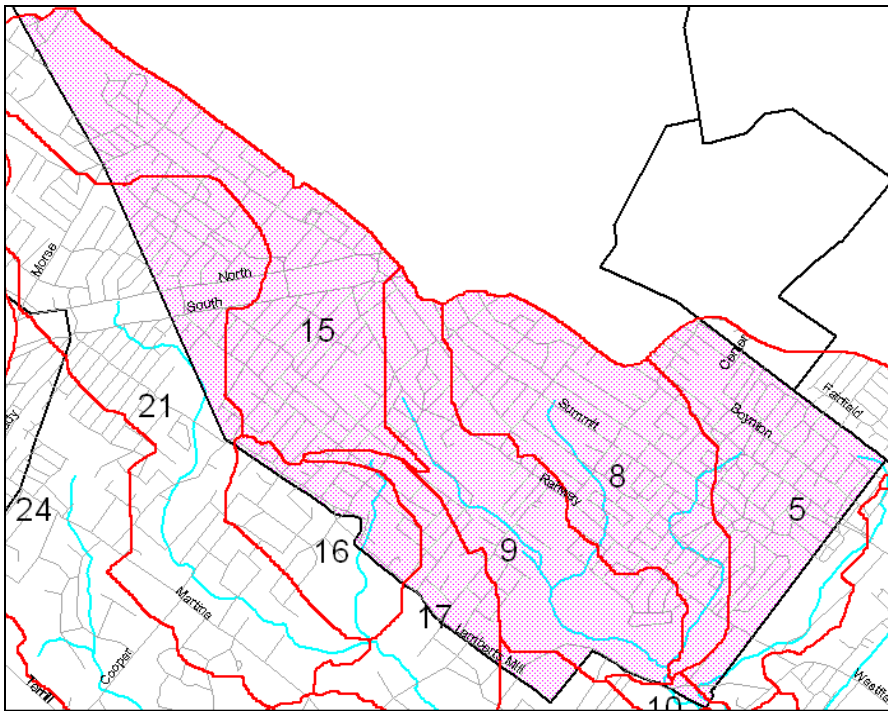


Figure 3: Subbasins of Westfield

This municipality also contains five subbasins that rank in the top ten worst contributing subbasins within the Robinson's Branch Watershed. Overall load is significantly poor in subbasins 21, 15, 8 and 5; and normalized non-point source contribution is poor in subbasins 21, 15, 16, 8 and 5.

The water quality in Tamaques Park, an open space enjoyed by many Westfield residents, has been compromised by nutrients and sediments. Erosion and sedimentation had also presented problems at many other areas where the stream is able to be viewed.

Water quantity problems have been noted in areas such as Lamberts Mill (Subbasin 9) and Knottingham (Subbasin 8) where flooding is an occurrence.

4B. 9. 3.1 Recommendations to Address Water Quality Issues for the Township of Westfield

Until land use has changed where daylighting streams may be an option, the use of manufactured treatment systems should be implemented in critical areas of the subbasins 21, 15, 16, 8 and 5. (Cross Reference WF2136).

If a catch basin is the last in a series (prior to discharge to a waterbody) of catch basins that make up a route of stormwater sewers, it is considered a "terminal catch basin" and can cause a greater impact if improperly maintained. These catch basins will have the greatest impact to the improvement of water quality, and can be considered a "critical area" for the implementation of the manufactured treatment devices.

4B. 9.3.2 Recommendations to Address Water Quantity Issues for the Township of Westfield

Eight locations of industrial sites that can have their impervious area disconnected from the streams have been identified (Cross Reference WF2154, WF0854, WF0553, and WF1559 and see Maps 5 and 6).

4B 9.3.3 Recommendations to Promote Groundwater Recharge in the Township of Westfield

All the BMPs selected to address the water quantity and water quality issues also promote groundwater recharge. The educational programs recommended in Section 4B. 2 will also result in BMPs that promote groundwater recharge and will help encourage residents to take action to infiltrate more stormwater runoff. Table 7 ranks all the projects that were assigned to the Town of Westfield.

Table 7: Westfield Project and Cost

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
*	WFSU4085	All of Westfield	Stormwater Utility	Management	Undetermined
*	WFMS4028	All of Westfield	Pathogen Management	Microbial Source Tracking/Goose Management Plan	Undetermined
*	WFAS4081	All of Westfield	Arsenic Management	Management and determination of BMPs	Undetermined
*	WFFM4083	All of Westfield	Floodplain Management	Management	Undetermined
*	WFED4082	All of Westfield	Education	Education	Undetermined
*	WFS4012	All of Westfield	Stressor Analysis	Analysis	Undetermined
*	WFLP4051	All of Westfield	Registration of Landscaping Professionals	Management and Education	Undetermined
4	WF2154	21	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$180,000 to 360,000
2	WF0854	8	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$180,000 to 360,000
1	WF1559	15	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$800,000 to 1,600,000
3	WF0553	5	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$140,000 to 280,000
5	WF2136	All terminal catch basins	Manufactured Treatment Systems	MS4 Retrofit	\$120,000 and up

4B. 9.3.4 Estimated Load Reductions and Groundwater Recharge for the Township of Westfield Management Measures

Load reductions were estimated for each of the management measures that were recommended for the Township of Edison and can be found in Table 8. Aerial loading coefficients were used to determine the load reductions for total phosphorus, total

nitrogen, and total suspended solids. These loading coefficients were multiplied by the area disconnected for each of the management measures. Since the management measures were designed to infiltrate all of the runoff from the two-year rainfall event, each management measure was assumed to reduce the annual load by 90% based upon a volume reduction. These load reductions are presented in Table 8. Also presented in Table 8 are the estimated groundwater recharge volumes. Once again, each management measure was estimated to infiltrate 90% of the annual rainfall or 40 inches per year that will run off of impervious surfaces. These volumes are presented in million of gallons. For all the BMPs in the Township of Edison, the estimated annual groundwater recharge is estimated to be over 164 million gallons a year.

Table 8: Westfield Projects and Load Reduction

Rank	Unique Identifier	Drainage Area(acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimate Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
*	WFSU4085	Watershed wide	unknown	unknown	unknown	unknown
*	WFMS4028	Watershed wide	unknown	unknown	unknown	unknown
*	WFAS4081	Watershed wide	unknown	unknown	unknown	unknown
*	WFFM4083	Watershed wide	unknown	unknown	unknown	unknown
*	WFED4082	Watershed wide	unknown	unknown	unknown	unknown
*	WFS4012	Watershed wide	unknown	unknown	unknown	unknown
*	WFLP4051	Watershed wide	unknown	unknown	unknown	unknown
4	WF2154	19.78	36.77	383.67	3654.90	21.44
2	WF0854	24.84	41.52	432.69	4378.21	26.92
1	WF1559	89.36	65.37	676.09	6680.54	96.85
3	WF0553	16.96	123.90	1286.48	12509.80	18.39
5	WF2136	Manufactured Treatment Systems	undetermined	undetermined	undetermined	none

Table 9: Westfield Project Funding and Objectives

Rank	Unique Identifier	Management	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	WFSU4085	Stormwater Utility	N/A	N/A	All
*	WFMS4028	Pathogen Management	N/A	All	1
*	WFAS4081	Arsenic Management	N/A	1, 2, 6, and 7	2 and 3
*	WFFM4083	Floodplain Management	N/A	2, 3, 6, and 7	4 and 5
*	WFED4082	Education	N/A	1, 3, 5, 6, and 7	All
*	WFS4012	Stressor Analysis	N/A	1, 3, 4, 6, and 7	All

*	WFLP4051	Registration of Landscaping Professionals	N/A	N/A	2 and 3
4	WF2154	Disconnection and infiltration of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 4, and 5
2	WF0854	Disconnection and infiltration of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 4, and 5
1	WF1559	Disconnection and infiltration of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
3	WF0553	Disconnection and infiltration of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
5	WF2136	Manufactured Treatment Systems	No permits required	1 and 2	1, 2, and 3

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. Other

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Nutrient Loading to the Robinson's Branch
3. Address Areas of Flooding
4. Address Areas of Increased Stream Volume and Velocity
5. Address Recharge to Aquifer and Baseflow Maintenance

4B.9. 4. Clark

The Township of Clark also has significant issues regarding the contribution of nonpoint source pollution. In the aerial loading analysis conducted as a part of the Robinson's Branch Characterization and Assessment, three subbasins located in Clark fell in the top ten worst contributors, subbasins 13, 1 and 5. When normalized to area, five of the top ten worst nonpoint source subbasins fell within Clark. These basins are 5, 6, 3, 1, and 20. Subbasins 6, 3, and 20 are completely within the boundaries of Clark.

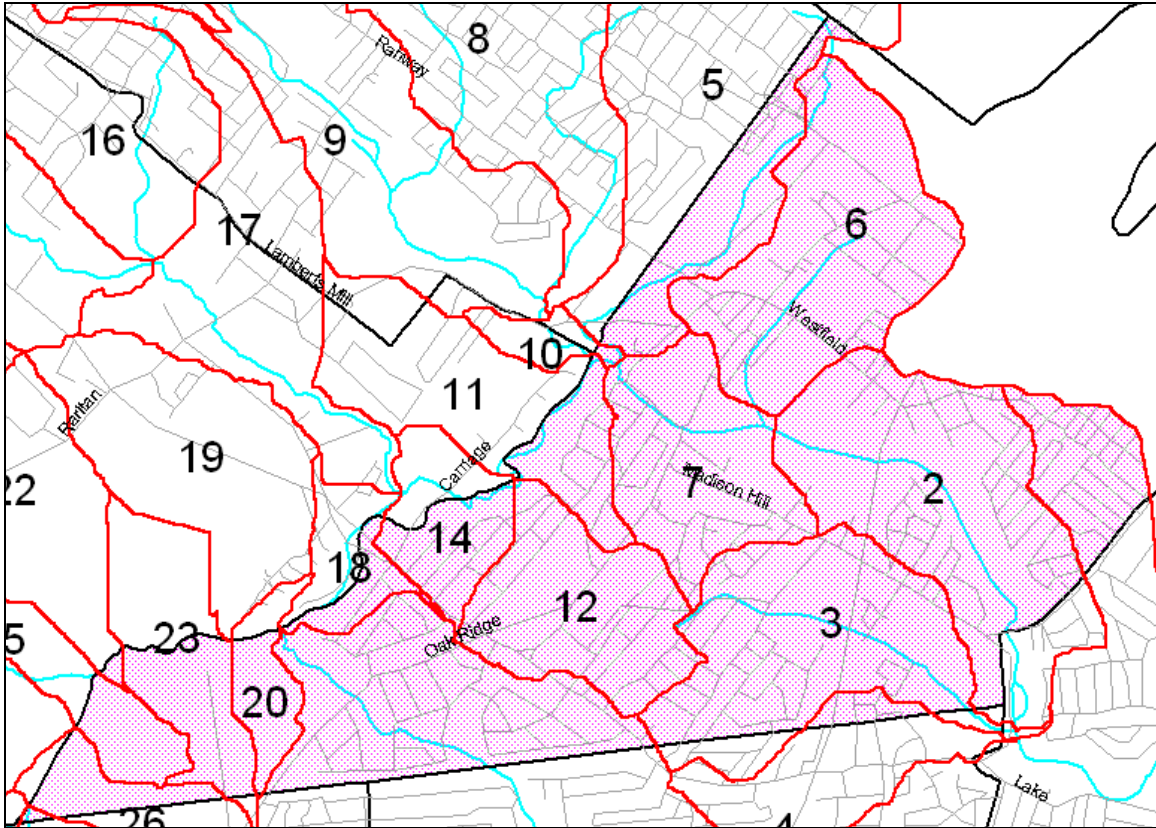


Figure 4: Subbasins of Clark

Water quantity issues in Clark predominate with flooding in the Pumpkin Patch Brook. Partially due to backwater effects upon its confluence with the mainstem Robinson's Branch, and partially due to exceedingly heavy development, the stream has little chance to maintain in its banks during storm events.

A second significant area of flooding is present upstream of a new bridge at Goodman's Crossing. The bridge has been sized for sufficient passage of water, however, the upstream area is extremely constricted with industrial sites and apartments built close to the streambanks, allowing for minimal access to the floodplain.

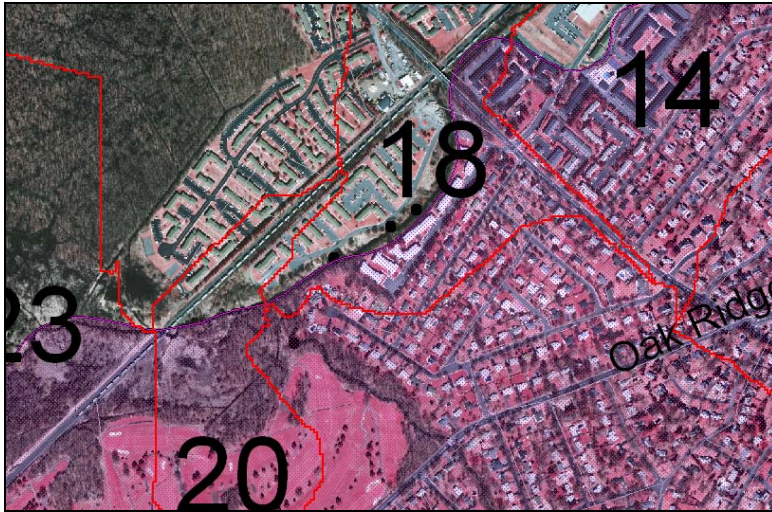


Figure 5: Constriction upstream of Goodman's Crossing. Black dots indicate areas of flooding.

4B. 9. 4.1 Recommendations to Address Water Quality Issues for the Township of Clark

The water quality of the Robinson's Branch in Clark, and in particular, the reservoir, is affected not only by the non-point source contribution of stormwater, but has two identified areas that are thought to be more significant contributors. These areas are the fields of the Clark High School and the runoff from the Clark Public Works on the banks of the reservoir.

The first recommendation is similar to one made for Westfield. Manufactured treatment devices should be implemented in key areas that contribute to the water quality of the streams. If a catch basin is the last in a series (prior to discharge to a waterbody) of catch basins on a run of the stormwater sewer, it is considered a "terminal catch basin" and can cause a greater impact if improperly maintained. Terminal catch basins that feed the reservoir should be a top priority, with terminal catch basins that discharge directly to the Robinson's Branch should be the second priority (Cross Reference CL6731).

A goose management plan that is credibly implemented will serve to reduce fecal contamination downstream of waterfowl gathering areas, such as the fields in back of the high school and the bottom of the reservoir. (Cross Reference GM0421)

4B. 9.4.2 Recommendations to Address Water Quantity Issues for the Township of Clark

The disconnection and infiltration of industrial areas in subbasins 18 and 19 begin to address the over abundance of directly connected impervious area that contributes to the flooding in this area. (Cross Reference Unique ID CL0559, CL1252, and CL0659 and Maps 7 and 8 in Appendix A).

The whole watershed recommendations of stormwater utilities (CLSU4085) and floodplain management (CLFM4083) will also be necessary to plan and fund projects designed to infiltrate and provide access to the floodplain.

Pumpkin Patch

The Pumpkin Patch tributary runs through Woodbridge and then Clark before it merges with the main stem of the Robinson's Branch. At this confluence, flooding is a frequent problem. There are two large concerns that contribute to this water quantity problem. The first issue is that the drainage area that contributes stormwater to this tributary is densely developed and incorporates the traditional direct routing of stormwater during a precipitation event. This causes the worst scenario to the increase in water volume and velocity that gets discharged to the stream. Second, when the merge occurs, a backwater effect happens that does not allow the flow from the Pumpkin Patch to be accepted by the main branch, as it is getting contributions from highly developed areas at a high volume and velocity.

In a study and engineering design performed by Schoor DePalma, the emphasis of the restoration of the Pumpkin Patch was put solely on a design that prevented erosion. The recommendation of this report is that this *is* an important consideration for the integrity of the stream, including preserving streambanks so as not to continue to contribute TSS and phosphorus and this design, or one similar to it (including the entire length of the tributary) must be implemented (WB13).

However, it is critical that the cause of the increase in volume and velocity of the stream be mitigated. This is unlikely to occur with any one project, but will be the result after many stormwater management practices are implemented. Key among these management practices are the disconnection and infiltration of stormwater. Since there is no single area in this drainage basin that this can be recommended, it should be implemented as a part of an education/rain garden program. Since homeowners will be the ones to primarily target, a stormwater utility could be involved, and there may be a concession in fees for the implementation of on site stormwater management.

Tussel Lane

Tussel Lane in Clark is a road that borders an apartment complex and runs parallel to the stream upstream of Goodman's Crossing. This is a new bridge with generous area for the flow to pass. However, the road still experiences frequent flooding events. It is evident that the stream must enter an area that limits access to its floodplains, and therefore is restricted. This restriction is relieved when the stream overtops its banks upstream of the bridge. It does not appear that the bridge is restricting flow, but the constriction just upstream does not allow the passage of the volume of flow that comes into it. Both of the banks around the stream in this area are built very close to the stream. See Figure 5 for an aerial view of this section of stream.

In the hydraulic model performed as a part of the Robinson's Branch Characterization and Assessment, cross sections for this section of stream were obtained only for the five

hundred feet prior to the bridge and do not explain the problem. However, the area before that is the constricted area and then more upstream is the Ashbrook Reservation/wetland which would not be indicated in creating an excess of flow during a storm event. It appears that this area may simply not be well suited for a road, and adjustment of the development may be the only solution.

4B 9.4.3 Recommendations to Promote Groundwater Recharge in the Township of Clark

All the BMPs selected to address the water quantity and water quality issues also promote groundwater recharge. The educational programs recommended in Section 4B. 2 will also result in BMPs that promote groundwater recharge and will help encourage residents to take action to infiltrate more stormwater runoff. Table 10 ranks all the projects that were assigned to the Town of Clark.

Table 10: Clark Projects and Cost

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
*	CLSU4085	All of Clark	Stormwater Utility	Management	Undetermined
*	CLMS4028	All of Clark	Pathogen Management	Microbial Source Tracking/Goose Management Plan	Undetermined
*	CLAS4081	All of Clark	Arsenic Management	Management and determination of BMPs	Undetermined
*	CLFM4083	All of Clark	Floodplain Management	Management	Undetermined
*	CLED4082	All of Clark	Education	Education	Undetermined
*	CLSA4012	All of Clark	Stressor Analysis	Analysis	Undetermined
*	CLLP4051	All of Clark	Registration of Landscaping Professionals	Management and Education	Undetermined
3	CL0559	5	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$600,000 to 1,200,000
2	CL1252	12	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$70,000 to 140,000

1	CL0659	6	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$2,400,000 to 4,800,000
5	CL4081	All	Education and Implementation	Education and Bioretention	
4	CL4082	6, 7, and 2	Education and Implementation	Education and Bioretention	

4B. 9.4.4 Estimated Load Reductions and Groundwater Recharge for the Township of Clark Management Measures

Load reductions were estimated for each of the management measures that were recommended for the Township of Edison and can be found in Table 11. Aerial loading coefficients were used to determine the load reductions for total phosphorus, total nitrogen, and total suspended solids. These loading coefficients were multiplied by the area disconnected for each of the management measures. Since the management measures were designed to infiltrate all of the runoff from the two-year rainfall event, each management measure was assumed to reduce the annual load by 90% based upon a volume reduction. These load reductions are presented in Table 11. Also presented in Table 11 are the estimated groundwater recharge volumes. Once again, each management measure was estimated to infiltrate 90% of the annual rainfall or 40 inches per year that will run off of impervious surfaces. These volumes are presented in million of gallons. For all the BMPs in the Township of Edison, the estimated annual groundwater recharge is estimated to be approximately 380 million gallons of water per year.

Table 11: Clark Projects and Load Reductions

Rank	Unique Identifier	Drainage Area(acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimate Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
*	CLSU4085	Watershed wide	unknown	unknown	unknown	unknown
*	CLMS4028	Watershed wide	unknown	unknown	unknown	unknown
*	CLAS4081	Watershed wide	unknown	unknown	unknown	unknown
*	CLFM4083	Watershed wide	unknown	unknown	unknown	unknown
*	CLED4082	Watershed wide	unknown	unknown	unknown	unknown
*	CLSA4012	Watershed wide	unknown	unknown	unknown	unknown
*	CLLP4051	Watershed wide	unknown	unknown	unknown	unknown
	CL0559	69.10	91.96	967.52	11993.53	74.89
	CL1252	7.57	14.31	149.26	1398.72	8.20
	CL0659	267.41	474.60	4984.46	51169.40	289.83
	CL4081	Entire subbasin	-	-	-	-

Table 12: Clark Project Objectives and Funding

Rank	Unique Identifier	Management	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	CLSU4085	Stormwater Utility	N/A	N/A	All
*	CLMS4028	Pathogen Management	N/A	All	1
*	CLAS4081	Arsenic Management	N/A	1, 2, 6, and 7	2 and 3
*	CLFM4083	Floodplain Management	N/A	2, 3, 6, and 7	4 and 5
*	CLED4082	Education	N/A	1, 3, 5, 6, and 7	All
*	CLSA4012	Stressor Analysis	N/A	1, 3, 4, 6, and 7	All
*	CLLP4051	Registration of Landscaping Professionals	N/A	N/A	2 and 3
3	CL0559	Disconnection of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
2	CL1252	Disconnection of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
1	CL0659	Disconnection of impervious surfaces for two-year storm	Local Construction Permits	All	2, 3, 4, and 5
5	CL4081	Education and Implementation, "SWM in Your Backyard"	No permits are required	All	2, 3, 4, and 5
4	CL4082	Education and Implementation	No permits are required	All	2, 3, 4, and 5

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. Other

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Nutrient Loading to the Robinson's Branch
3. Address Areas of Flooding
4. Address Areas of Increased Stream Volume and Velocity
5. Address Recharge to Aquifer and Baseflow Maintenance

4B.9. 3. Woodbridge

The Township of Woodbridge is composed of densely developed residential and industrial properties. The less densely developed area of Colonia, within Woodbridge, is a part of this watershed, and contains 1.5 miles of the Pumpkin Patch Brook, which has previously been discussed (See 4B. 9.4.2 Clark) regarding the water quantity issue it experiences. Municipal officials in Woodbridge attribute this flooding issue to overdevelopment and inadequate stormwater facilities. Of the approximately 163+ properties along the Pumpkin Patch Brook, it is estimated that 82 lie in the 100 year floodplain and experience some degree of flooding and erosion.

Subbasin 13, the Pumpkin Patch drainage basin, is one of the ten highest contributors to the nonpoint source load in the Robinson's Branch Watershed. Parts of two other subbasins, 4 and 1 are noted as being among the highest for load once normalized to area.

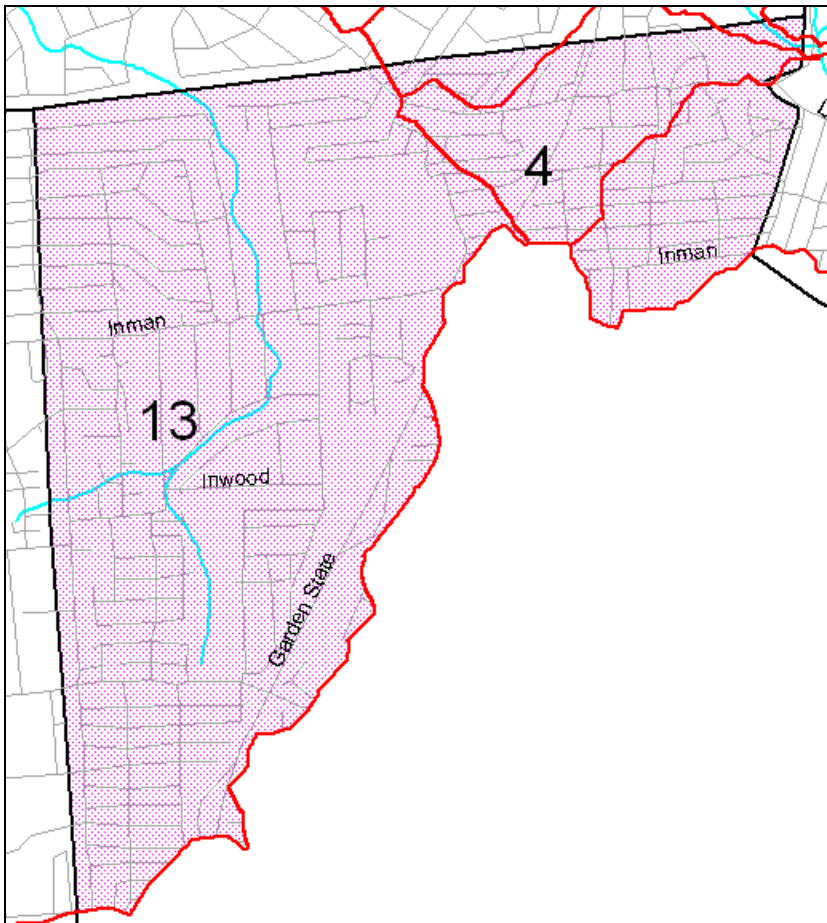


Figure 6: Subbasins of Woodbridge

4B. 9. 5.1 Recommendations to Address Water Quantity Issues for the Township of Woodbridge

The disconnection of impervious area and the infiltration of the precipitation that has been disconnected must be performed across the drainage basin. Since large swath of residential area comprise this drainage basin, this will most likely be able to be performed through an educational component that combines the implementation of rain gardens and other infiltration BMPs.

A large area of connected impervious has been identified along Inman Avenue in Woodbridge. (Cross Reference WB1359) If disconnected and infiltrated, this area could contribute in a large manner to the water quality, water quantity and the groundwater recharge of this area.

4B. 9.5.2 Recommendations to Address Water Quality Issues for the Township of Woodbridge

The water quality, as well as the water quantity, will be aided by the disconnection and infiltration discussed in the previous section.

The Township of Woodbridge may also decide that manufactured treatment systems will allow them to attain water quality goals if such plans as goose management, microbial source tracking or disconnection is not attaining water quality completely enough, or at the rate that is expected in the MS4 permit mandates (Cross Reference WB1324).

4B 9.5.3 Recommendations to Promote Groundwater Recharge in the Township of Woodbridge

All disconnection and infiltration will ultimately provide an input into the groundwater of this aquifer. When considering disconnection projects, site characteristics must be considered. A site that contains contamination is not considered appropriate for infiltration to groundwater. Water or soil quality testing may need to be performed if contamination is suspect.

Table 13: Woodbridge Projects and Cost

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
*	WBSU4085	All of Woodbridge	Stormwater Utility	Management	Undetermined
*	WBMS4028	All of Woodbridge	Pathogen Management	Microbial Source Tracking/Goose Management Plan	Undetermined
*	WBAS4081	All of Woodbridge	Arsenic Management	Management and determination of BMPs	Undetermined
*	WBFM4083	All of Woodbridge	Floodplain Management	Management	Undetermined

*	WBED4082	All of Woodbridge	Education	Education	Undetermined
*	WBSA4012	All of Woodbridge	Stressor Analysis	Analysis	Undetermined
*	WBLP4051	All of Woodbridge	Registration of Landscaping Professionals	Management and Education	Undetermined
4	WB1351	13	Educational Programming	"SWM in Your Backyard" and Rain Garden Implementation	\$10,000 for 10 demo gardens and educational programming
3	WB1359	13	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$653,400 to 1,306,800
2	WB1324	13	Manufactured Treatment Systems	MS4 Retrofit	\$240,000
1	WB1325	13	Streambank Stabilization	Erosion Control	To be determined

4B. 9.5.4 Estimated Load Reductions and Groundwater Recharge for the Township of Woodbridge Management Measures

Table 14: Woodbridge Projects and Load Reductions

Rank	Unique Identifier	Drainage Area(acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimate Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
*	WBSU4085	Watershed wide	unknown	unknown	unknown	unknown
*	WBMS4028	Watershed wide	unknown	unknown	unknown	unknown
*	WBAS4081	Watershed wide	unknown	unknown	unknown	unknown
*	WBFM4083	Watershed wide	unknown	unknown	unknown	unknown
*	WBED4082	Watershed wide	unknown	unknown	unknown	unknown
*	WBSA4012	Watershed wide	unknown	unknown	unknown	unknown
*	WBLP4051	Watershed wide	unknown	unknown	unknown	unknown
4	WB1351	1652	unknown	unknown	unknown	unknown
3	WB1359	1652	129	1336	13,097	85
2	WB1324	1652	Undetermined	Undetermined	Undetermined	Undetermined
1	WB1325	1652	Unknown/+	Unknown	Unknown/+++	none

Table 15: Woodbridge Project Objectives and Funding

Rank	Unique Identifier	Management	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	WBSU4085	Stormwater Utility	N/A	N/A	All
*	WBMS4028	Pathogen Management	N/A	All	1
*	WBAS4081	Arsenic Management	N/A	1, 2, 6, and 7	2 and 3
*	WBFM4083	Floodplain Management	N/A	2, 3, 6, and 7	4 and 5
*	WBED4082	Education	N/A	1, 3, 5, 6, and 7	All
*	WBSA4012	Stressor Analysis	N/A	1, 3, 4, 6, and 7	All
*	WBLP4051	Registration of Landscaping Professionals	N/A	N/A	2 and 3
4	WB1351	Educational Programming	No permits are required	All	All
3	WB1359	Disconnection and infiltration of impervious surfaces for two-year storm	Local construction permits	All	All
2	WB1324	Manufactured Treatment Systems	No permits are required	1 and 2	1 and 2
1	WB1325	Streambank Stabilization	General Wetlands Permit 16 and minor stream encroachment permit	All	1

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. Other

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Nutrient Loading to the Robinson's Branch
3. Address Areas of Flooding
4. Address Areas of Increased Stream Volume and Velocity
5. Address Recharge to Aquifer and Baseflow Maintenance

4B.9. 6. Rahway

Rahway is the final municipality that the Robinson's Branch courses through before it joins the Rahway. Water quantity and water quality problems are a problem here, and noted through USGS testing, listings on the Integrated List and regular overtopping of banks.

Water quality concerns include arsenic, fecal Coliform, pH, TSS, phosphorus and benthic macroinvertebrates. Subbasin 1 is also noted as one of the top ten highest loading subbasins in the watershed, and is also one of the top ten after being normalized for area. Upstream basins 3 and 4 are also noted as high contributors of nonpoint source pollution after being normalized. These qualities directly reflect the intense land use that this section of the Robinson's Branch Watershed experiences.

Just downstream from the Clark/Middlesex Reservoir, Milton Lake is experiencing severe erosion after the dam outlets back to the stream. Steep banks and erosion jeopardize the integrity of Lake Avenue.

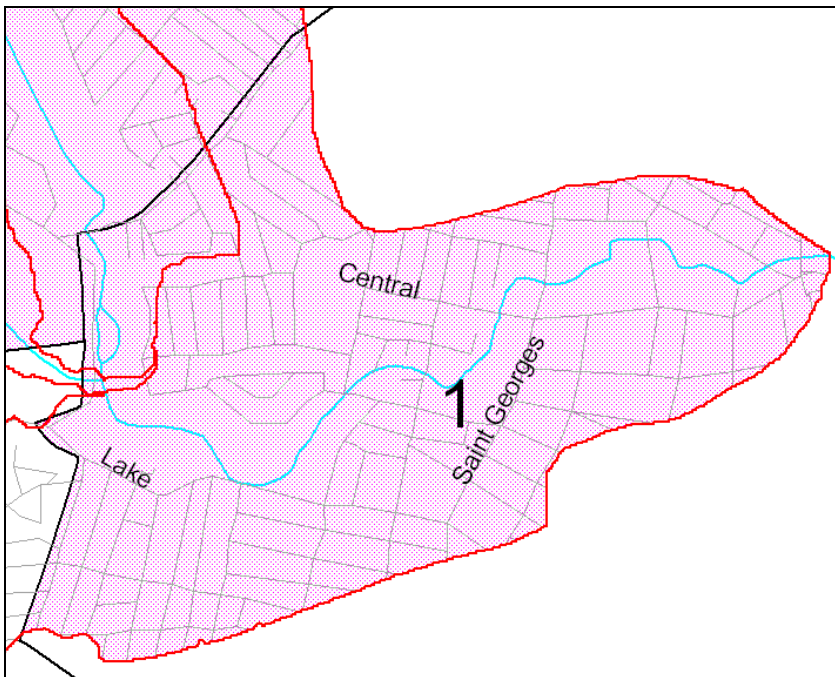


Figure 7: Subbasins of Rahway

4B. 9. 6.1 Recommendations to Address Water Quantity Issues for the City of Rahway

Two areas of disconnection and infiltration have been identified and quantified within the boundaries of Rahway. (Cross Reference RW0119).

Flooding in the City of Rahway has a large contribution from backwater effects experienced when the Robinson's Branch joins the Rahway. Creating the room for the floodplain is the most reasonable plan for this problem, although may be complicated by the city development plan. A stormwater utility (RWSU4085) along with floodplain

management (RWF4083) may provide coordination of the many aspects that come into play in this municipality.

4B. 9.6.2 Recommendations to Address Water Quality Issues for the City of Rahway

Securing solutions to the water quantity problems will aid in the poor water quality experienced by the Robinson's Branch in Rahway. However, we are also seeing the effects of all upstream uses of the stream. When performed on a watershed basis, the water quality in Rahway is expected to improve.

In addition to all recommended BMPs, the use of manufactured treatment devices used within catch basins (preferentially terminal catch basins) is expected to create an improvement in water quality.

4B 9.6.3 Recommendations to Promote Groundwater Recharge in the City of Rahway

All recommendations for disconnection and infiltration will serve to improve the recharge of the aquifer.

Table 16: Rahway Projects and Costs

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
*	RWSU4085	All of Rahway	Stormwater Utility	Management	Undetermined
*	RWMS4028	All of Rahway	Pathogen Management	Microbial Source Tracking/Goose Management Plan	Undetermined
*	RWAS4081	All of Rahway	Arsenic Management	Management and determination of BMPs	Undetermined
*	RWF4083	All of Rahway	Floodplain Management	Management	Undetermined
*	RWED4082	All of Rahway	Education	Education	Undetermined
*	RWSA4012	All of Rahway	Stressor Analysis	Analysis	Undetermined
*	RWLP4051	All of Rahway	Registration of Landscaping Professionals	Management and Education	Undetermined
2	RW0115	1	Streambank Stabilization	Erosion Control	Undetermined
3	RW0119	1	Disconnection and infiltration of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	\$598,950 to 1,197,900
1	RW0124	1	Manufactured Treatment Devices	MS4 Retrofits	\$180,000

4B. 9.6.4 Estimated Load Reductions and Groundwater Recharge for the City of Rahway Management Measures

Table 17: Rahway Projects and Load Reductions

Rank	Unique Identifier	Drainage Area(acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimate Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
*	RWSU4085	Watershed wide	unknown	unknown	unknown	unknown
*	RWMS4028	Watershed wide	unknown	unknown	unknown	unknown
*	RWAS4081	Watershed wide	unknown	unknown	unknown	unknown
*	RWFM4083	Watershed wide	unknown	unknown	unknown	unknown
*	RWED4082	Watershed wide	unknown	unknown	unknown	unknown
*	RWSA4012	Watershed wide	unknown	unknown	unknown	unknown
*	RWLP4051	Watershed wide	unknown	unknown	unknown	unknown
2	RW0115	621	Unknown/+	Unknown	Unknown/+	none
3	RW0119	63.14	127	1328	12,223	68.43
1	RW0124	621	Unknown	Unknown	Unknown	none

Table 18: Rahway Project Objectives and Funding

Rank	Unique Identifier	Management	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	RWSU4085	Stormwater Utility	N/A	N/A	All
*	RWMS4028	Pathogen Management	N/A	All	1
*	RWAS4081	Arsenic Management	N/A	1, 2, 6, and 7	2 and 3
*	RWFM4083	Floodplain Management	N/A	2, 3, 6, and 7	4 and 5
*	RWED4082	Education	N/A	1, 3, 5, 6, and 7	All
*	RWSA4012	Stressor Analysis	N/A	1, 3, 4, 6, and 7	All
*	RWLP4051	Registration of Landscaping Professionals	N/A	N/A	2 and 3
2	RW0115	Streambank Stabilization	General Wetlands Permit 16 and minor stream encroachment permit	All	1
3	RW0119	Disconnection and infiltration of impervious surfaces for two-year storm	Local construction permits	All	All
1	RW0124	Manufactured Treatment Devices	No permits are required	1 and 2	1 and 2

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. Other

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Nutrient Loading to the Robinson's Branch
3. Address Areas of Flooding
4. Address Areas of Increased Stream Volume and Velocity
5. Address Recharge to Aquifer and Baseflow Maintenance

4B.9. 7. Plainfield

The land use in Plainfield has not been shown to be a major contributor to nonpoint source pollution as modeled in the aerial loading analysis discussed in the Characterization and Assessment. The area of Plainfield contained in the Robinson's Branch Watershed lies primarily in subbasin 32 and can be viewed in Figure 8.

Water quality is impacted by areas of erosion and sedimentation, particularly noticeable in an area found along Watchung Avenue and Leland.

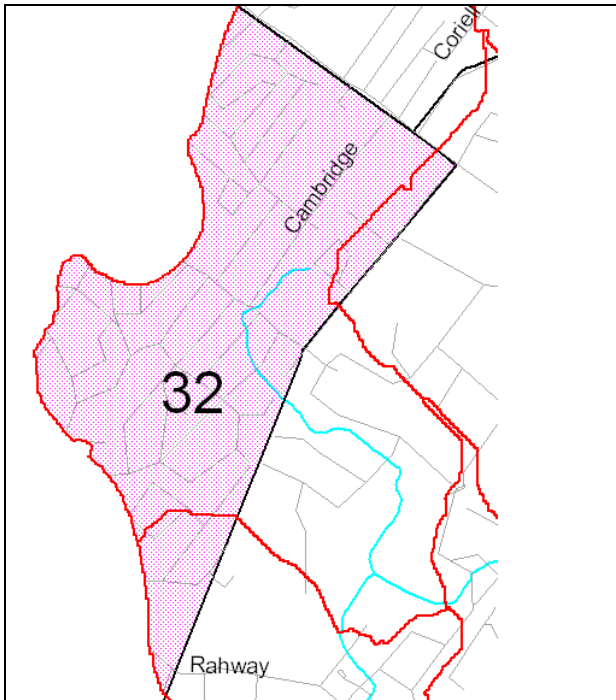


Figure 8: Subbasins of Plainfield

4B. 9. 7.1 Recommendations to Address Water Quantity Issues for the City of Plainfield

The drainage in subbasin 32 is routed into a significant area for detention/retention around Cushing Avenue. This area has good access to its floodplain. When the water flows out of this detention basin, it flows behind the properties of Wald Street. It is after this stretch that the stream appears to become channelized and severely restricted. It is surmised that this restriction has an affect on the flooding on Wald Street. (See Engineering Concept Plan #5). A solution to this restriction may be difficult to obtain due to land use and property rights.

4B. 9.7.2 Recommendations to Address Water Quality Issues for the City of Plainfield

Since Plainfield sits at the headwaters of the Robinson's Branch Watershed, it is a natural place to implement education and disconnection/infiltration.

4B 9.7.3 Recommendations to Promote Groundwater Recharge in the City of Plainfield

Disconnection and infiltration will play a critical role in providing baseflow to the stream in dry periods and provide recharge to the aquifer.

Table 19: Plainfield Projects and Costs

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
*	PFSU4085	All of Plainfield	Stormwater Utility	Management	Undetermined
*	PFMS4028	All of Plainfield	Pathogen Management	Microbial Source Tracking/Goose Management Plan	Undetermined
*	PFAS4081	All of Plainfield	Arsenic Management	Management and determination of BMPs	Undetermined
*	PFFM4083	All of Plainfield	Floodplain Management	Management	Undetermined
*	PFED4082	All of Plainfield	Education	Education	Undetermined
*	PFSA4012	All of Plainfield	Stressor Analysis	Analysis	Undetermined
*	PFLP4051	All of Plainfield	Registration of Landscaping Professionals	Management and Education	Undetermined
1	PF3251	All of Plainfield	Education programming	Restore-A-Waterway	\$10,000 for 10 demo gardens and educational programming

2	PF3235	32	Disconnection of impervious surfaces and infiltration of the two-year storm runoff volume	Rain gardens, bioretention systems, infiltration systems	\$82,000 to 164,000
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4B. 9.7.4 Estimated Load Reductions and Groundwater Recharge for the City of Plainfield Management Measures

Table 20: Plainfield Projects and Load Reductions

Rank	Unique Identifier	Drainage Area(acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimate Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
*	PFSU4085	Watershed wide	unknown	unknown	unknown	unknown
*	PFMS4028	Watershed wide	unknown	unknown	unknown	unknown
*	PFAS4081	Watershed wide	unknown	unknown	unknown	unknown
*	PFFM4083	Watershed wide	unknown	unknown	unknown	unknown
*	PFED4082	Watershed wide	unknown	unknown	unknown	unknown
*	PFSA4012	Watershed wide	unknown	unknown	unknown	unknown
*	PFLP4051	Watershed wide	unknown	unknown	unknown	unknown
1	PF3251	0.34	0.2	1.7	34	0.37
2	PF3235	10.4	16.5	148	1536	12

Table 21: Plainfield Project Objectives and Funding

Unique Identifier	Rank	Management	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	PFSU4085	Stormwater Utility	N/A	N/A	All
*	PFMS4028	Pathogen Management	N/A	All	1
*	PFAS4081	Arsenic Management	N/A	1, 2, 6, and 7	2 and 3
*	PFFM4083	Floodplain Management	N/A	2, 3, 6, and 7	4 and 5
*	PFED4082	Education	N/A	1, 3, 5, 6, and 7	All
*	PFSA4012	Stressor Analysis	N/A	1, 3, 4, 6, and 7	All
*	PFLP4051	Registration of Landscaping Professionals	N/A	N/A	2 and 3

1	PF3251	Education programming and demo rain gardens	N/A	N/A	All
2	PF3235	Disconnection of impervious surfaces and infiltration of the two-year storm runoff volume	Local construction permits	All	All

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. Other

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Nutrient Loading to the Robinson's Branch
3. Address Areas of Flooding
4. Address Areas of Increased Stream Volume and Velocity
5. Address Recharge to Aquifer and Baseflow Maintenance

4B.9. 8. Fanwood

Rain garden at Fanwood Public Library, already used for educational program, we want to build upon that due to the interest in the town, funding, workshops, reimburse for plants, for every 500 dollars spent, you get 25000 gals of water captured, treated and recharged every year(fanwood, clark, woodbridge, Scotch Plains

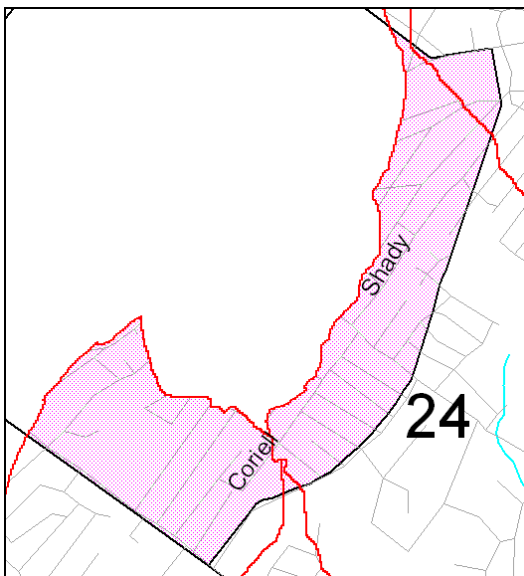


Figure 9: Subbasins of Fanwood

Table 22: Fanwood Projects and Cost

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
*	FWSU4085	All of Plainfield	Stormwater Utility	Management	Undetermined
*	FWMS4028	All of Plainfield	Pathogen Management	Microbial Source Tracking/Goose Management Plan	Undetermined
*	FWAS4081	All of Plainfield	Arsenic Management	Management and determination of BMPs	Undetermined
*	FWFM4083	All of Plainfield	Floodplain Management	Management	Undetermined
*	FWED4082	All of Plainfield	Education	Education	Undetermined
*	FWSA4012	All of Plainfield	Stressor Analysis	Analysis	Undetermined
*	FWLP4051	All of Plainfield	Registration of Landscaping Professionals	Management and Education	Undetermined

4B. 9.8.4 Estimated Load Reductions and Groundwater Recharge for the Borough of Fanwood Management Measures

Table 23: Fanwood Projects and Load Reductions

Rank	Unique Identifier	Drainage Area(acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimate Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
*	FWSU4085	Watershed wide	unknown	unknown	unknown	unknown
*	FWMS4028	Watershed wide	unknown	unknown	unknown	unknown
*	FWAS4081	Watershed wide	unknown	unknown	unknown	unknown
*	FWFM4083	Watershed wide	unknown	unknown	unknown	unknown
*	FWED4082	Watershed wide	unknown	unknown	unknown	unknown
*	FWSA4012	Watershed wide	unknown	unknown	unknown	unknown
*	FWLP4051	Watershed wide	unknown	unknown	unknown	unknown

Table 24: Fanwood Project Objectives and Funding

Rank	Unique Identifier	Management	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	FWSU4085	Stormwater Utility	N/A	N/A	All
*	FWMS4028	Pathogen Management	N/A	All	1
*	FWAS4081	Arsenic Management	N/A	1, 2, 6, and 7	2 and 3
*	FWFM4083	Floodplain Management	N/A	2, 3, 6, and 7	4 and 5
*	FWED4082	Education	N/A	1, 3, 5, 6, and 7	All
*	FWSA4012	Stressor Analysis	N/A	1, 3, 4, 6, and 7	All
*	FWLP4051	Registration of Landscaping Professionals	N/A	N/A	2 and 3

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. Other

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Nutrient Loading to the Robinson's Branch
3. Address Areas of Flooding
4. Address Areas of Increased Stream Volume and Velocity
5. Address Recharge to Aquifer and Baseflow Maintenance

4B.9. 9. Cranford and Garwood

The upper section of subbasin #5 of the Robinson's Branch Watershed is made up of one hundred and twenty nine acres of parts of Garwood and Cranford. Being a relatively small portion of the drainage area, and containing no active stream, it would be best if these two towns assisted the watershed with the general, watershed wide programs.

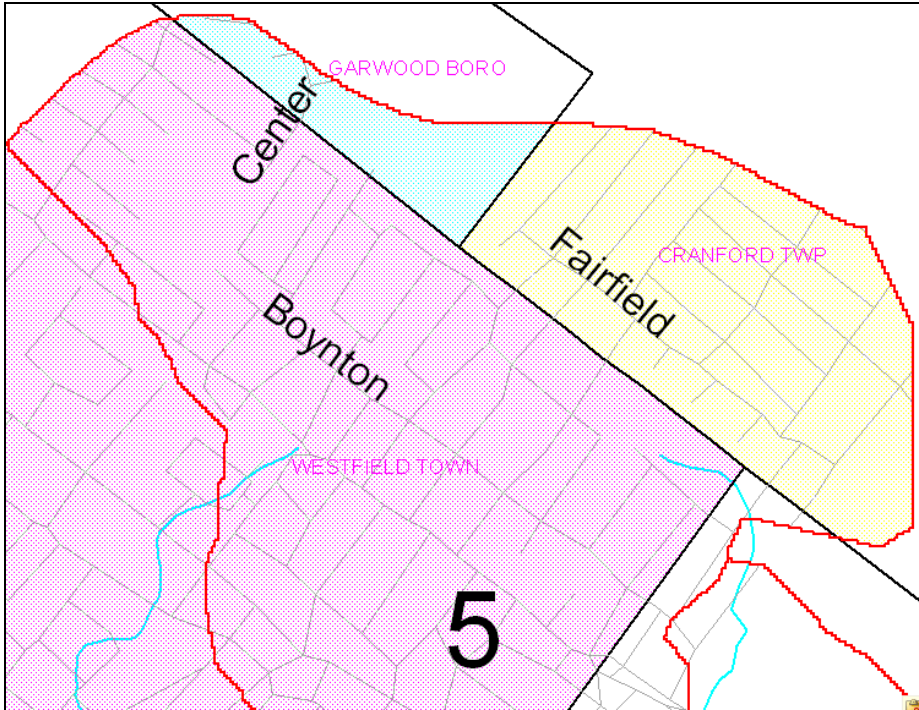


Figure 10: Subbasin of Cranford and Garwood

4B. 9. 9.1 Recommendations to Address Water Quantity Issues for Cranford and Garwood

A persistent theme in current watershed management is attempting to infiltrate the precipitation at the site where it falls. If impervious area makes this unattainable, the next best option is to create an area that will accept the stormwater runoff and infiltrate it, rather than passing it directly to a stream via a storm sewer.

4B. 9.9.2 Recommendations to Address Water Quality Issues for Cranford and Garwood

Water quality of the Robinson's Branch will be aided by attempts at infiltration, as this serves to remove pollutants through a variety of processes. The water quality will also be positively affected by the implementation of the watershed wide programs such as stressor analysis and pathogen management.

4B 9.9.3 Recommendations to Promote Groundwater Recharge in Cranford and Garwood

The infiltration of precipitation will serve to reduce the stress on the aquifers contained in this area.

Table 25: Cranford and Garwood Projects and Costs

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
*	CRSU4085	All of Plainfield	Stormwater Utility	Management	Undetermined
*	CRMS4028	All of Plainfield	Pathogen Management	Microbial Source Tracking/Goose Management Plan	Undetermined
*	CRAS4081	All of Plainfield	Arsenic Management	Management and determination of BMPs	Undetermined
*	CRFM4083	All of Plainfield	Floodplain Management	Management	Undetermined
*	CRED4082	All of Plainfield	Education	Education	Undetermined
*	CRSA4012	All of Plainfield	Stressor Analysis	Analysis	Undetermined
*	CRLP4051	All of Plainfield	Registration of Landscaping Professionals	Management and Education	Undetermined

4B. 9.9.4 Estimated Load Reductions and Groundwater Recharge for the Township of Edison Management Measures

Table 26: Cranford and Garwood Projects and Load Reduction

Rank	Unique Identifier	Drainage Area(acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimate Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
*	CRSU4085	Watershed wide	unknown	unknown	unknown	unknown
*	CRMS4028	Watershed wide	unknown	unknown	unknown	unknown
*	CRAS4081	Watershed wide	unknown	unknown	unknown	unknown
*	CRFM4083	Watershed wide	unknown	unknown	unknown	unknown

*	CRED4082	Watershed wide	unknown	unknown	unknown	unknown
*	CRSA4012	Watershed wide	unknown	unknown	unknown	unknown
*	CRLP4051	Watershed wide	unknown	unknown	unknown	unknown

Table 27: Cranford and Garwood Project Objectives and Funding

Rank	Unique Identifier	Management	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
*	CRSU4085	Stormwater Utility	N/A	N/A	All
*	CRMS4028	Pathogen Management	N/A	All	1
*	CRAS4081	Arsenic Management	N/A	1, 2, 6, and 7	2 and 3
*	CRFM4083	Floodplain Management	N/A	2, 3, 6, and 7	4 and 5
*	CRED4082	Education	N/A	1, 3, 5, 6, and 7	All
*	CRSA4012	Stressor Analysis	N/A	1, 3, 4, 6, and 7	All
*	CRLP4051	Registration of Landscaping Professionals	N/A	N/A	2 and 3

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. Other

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Nutrient Loading to the Robinson's Branch
3. Address Areas of Flooding
4. Address Areas of Increased Stream Volume and Velocity
5. Address Recharge to Aquifer and Baseflow Maintenance

References

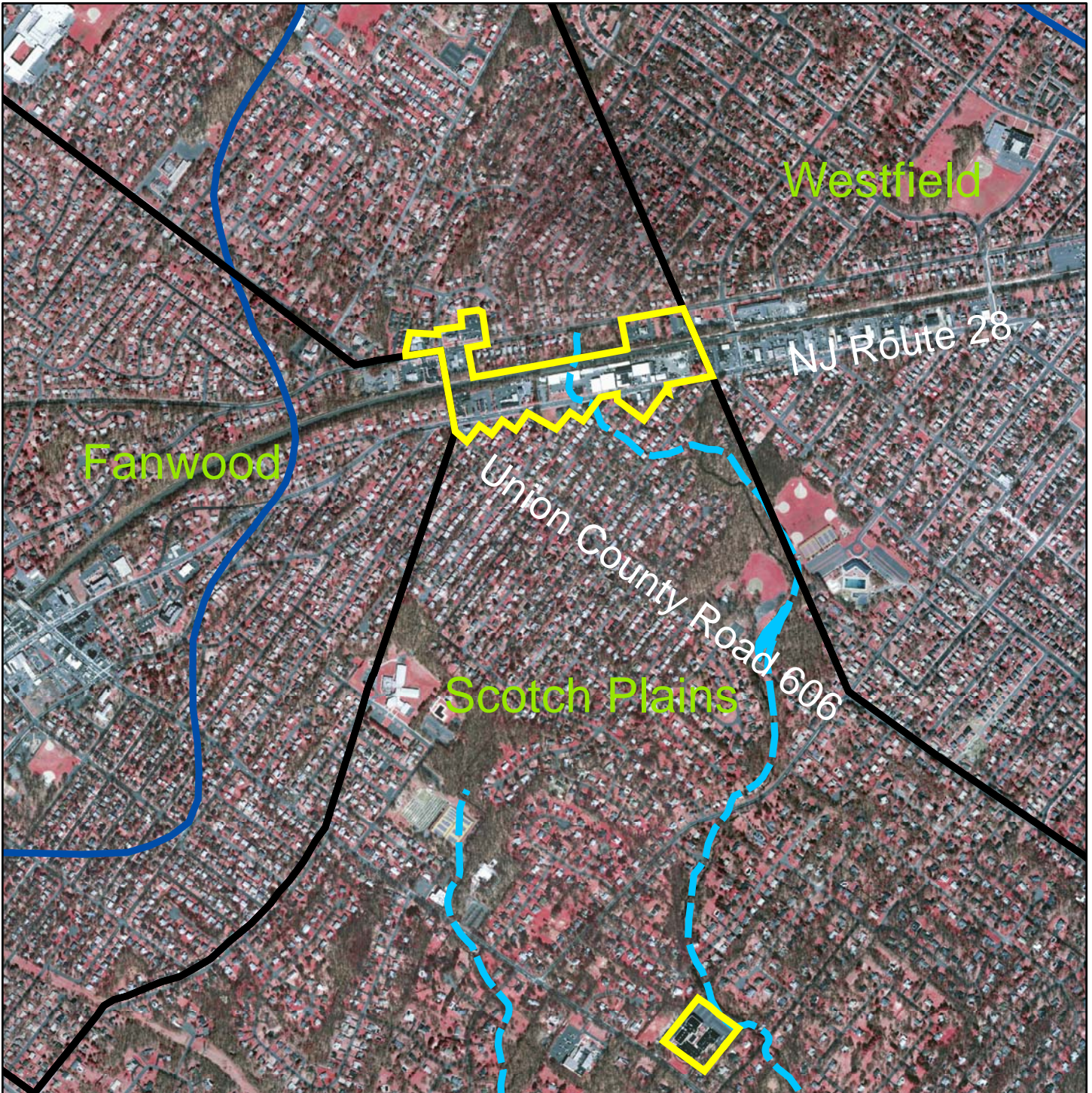
U.S. fish & Wildlife Service, Draft Environmental Impact Statement, Resident Canada Goose Management, February 2002.

New Jersey Department of Environmental Protection Division of Watershed Management and Division of Land Use Management, Best Management Practices Manual, April 2004.

Cornell Cooperative Extension, Managing Canada geese in Urban Environments, 1999.

USEPA Stressor Identification Protocol, USEPA, 2000.

Appendix A: Milestone 4 Reference Maps








MAP 1

Robinson's Branch Regional Stormwater Management Plan

Scotch Plains, Subbasin 21, Unique ID SP2153

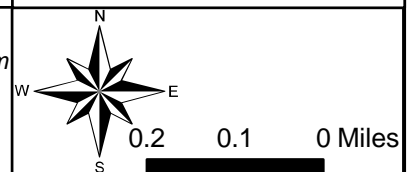
Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

-  Rivers & Streams
-  Municipalities
-  Lakes
-  Watershed Boundary
-  Disconnected Areas for Subbasin 21



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MAP 2

Robinson's Branch Regional Stormwater Management Plan

Scotch Plains, Subbasin 15, Unique ID SP1551

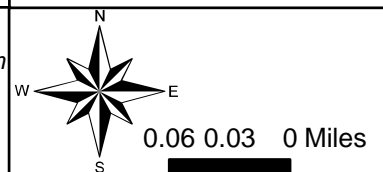
Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

-  Disconnected Areas for Subbasin 15
-  Rivers & Streams
-  Municipalities
-  Lakes
-  Watershed Boundary



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MAP 3

Robinson's Branch Regional Stormwater Management Plan

Scotch Plains, Subbasin 16 and 21 Unique ID SP1652, SP2153

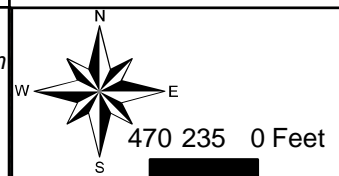
Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

-  Rivers & Streams
-  Municipalities
-  Lakes
-  Watershed Boundary
-  Disconnected Areas for Subbasin 21
-  Disconnected Areas for Subbasin 16



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MAP 4

Robinson's Branch Regional Stormwater Management Plan

Edison, Subbasin 27, Unique ID ED2759

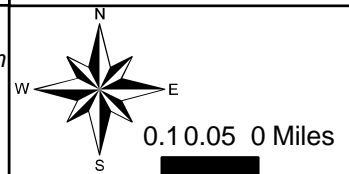
Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

-  Rivers & Streams
-  Municipalities
-  Lakes
-  Watershed Boundary
-  Disconnected Areas in Subbasin 27



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MAP 5

Robinson's Branch Regional Stormwater Management Plan

Westfield, Subbasins 5 and 8, Unique ID WF0553 and WF0854

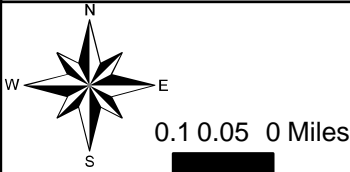
Legend

- Municipalities
- Lakes
- Watershed Boundary
- Rivers & Streams
- Disconnected Areas for Subbasin 5
- Disconnected Areas for Subbasin 8

Data Source: NJDEP 1996 GIS Data CD-ROM



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MAP 6

Robinson's Branch Regional Stormwater Management Plan

Westfield, Subbasins 21 and 15, Unique ID WF2154 and WF1559

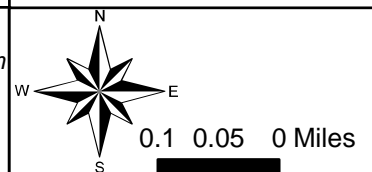
Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

-  Rivers & Streams
-  Municipalities
-  Lakes
-  Watershed Boundary
-  Disconnected Areas for Subbasin 15
-  Disconnected Areas for Subbasin 21



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MAP 7

Robinson's Branch Regional Stormwater Management Plan

Clark, Subbasins 5 and 6, Unique ID CL0559 and CL0659

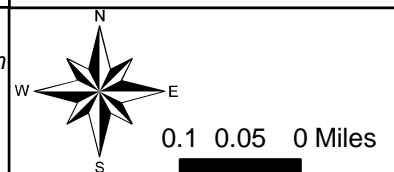
Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

-  Rivers & Streams
-  Municipalities
-  Lakes
-  Watershed Boundary
-  Disconnected Areas in Subbasin 6
-  Disconnected Areas in Subbasin 5



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MAP 8

Robinson's Branch Regional Stormwater Management Plan

Clark, Subbasin 12, Unique ID 1252

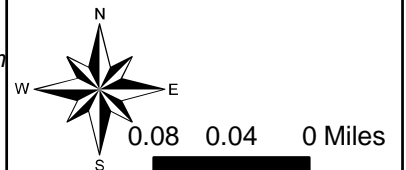
Legend

-  Rivers & Streams
-  Municipalities
-  Lakes
-  Watershed Boundary
-  Disconnected Areas in Subbasin 12

Data Source: NJDEP 1996 GIS Data CD-ROM



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MAP 9

Robinson's Branch Regional Stormwater Management Plan

Woodbridge, Subbasin 13, Unique ID WB1359

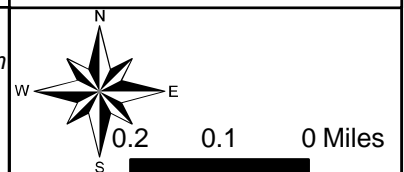
Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

-  Rivers & Streams
-  Municipalities
-  Lakes
-  Watershed Boundary
-  Disconnected Areas in Subbasin 13



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MAP 10

Robinson's Branch Regional Stormwater Management Plan

Rahway, Subbasin 1, Unique ID RW0119

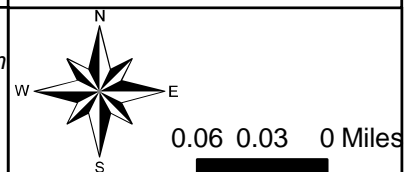
Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

-  Rivers & Streams
-  Municipalities
-  Watershed Boundary
-  Disconnected Areas for Subbasin 1



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MAP 11

Robinson's Branch Regional Stormwater Management Plan

Rahway, Subbasin 1, Unique ID RW0119B

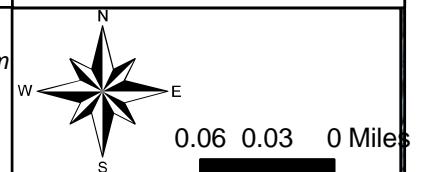
Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

-  Rivers & Streams
-  Municipalities
-  Watershed Boundary
-  Disconnected Areas for Subbasin 1



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MAP 12

Robinson's Branch Regional Stormwater Management Plan

Fanwood, Subbasin 21, Unique ID FW2151

Data Source: NJDEP 1996 GIS Data CD-ROM

Legend

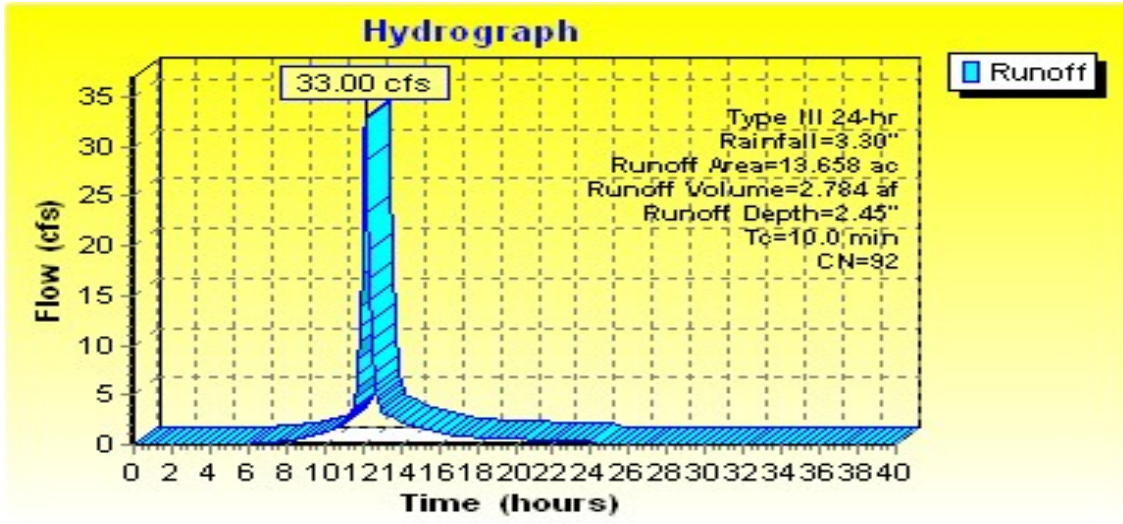
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-  Municipalities
-  Lakes
-  Watershed Boundary
-  Disconnected Areas for Subbasin 21



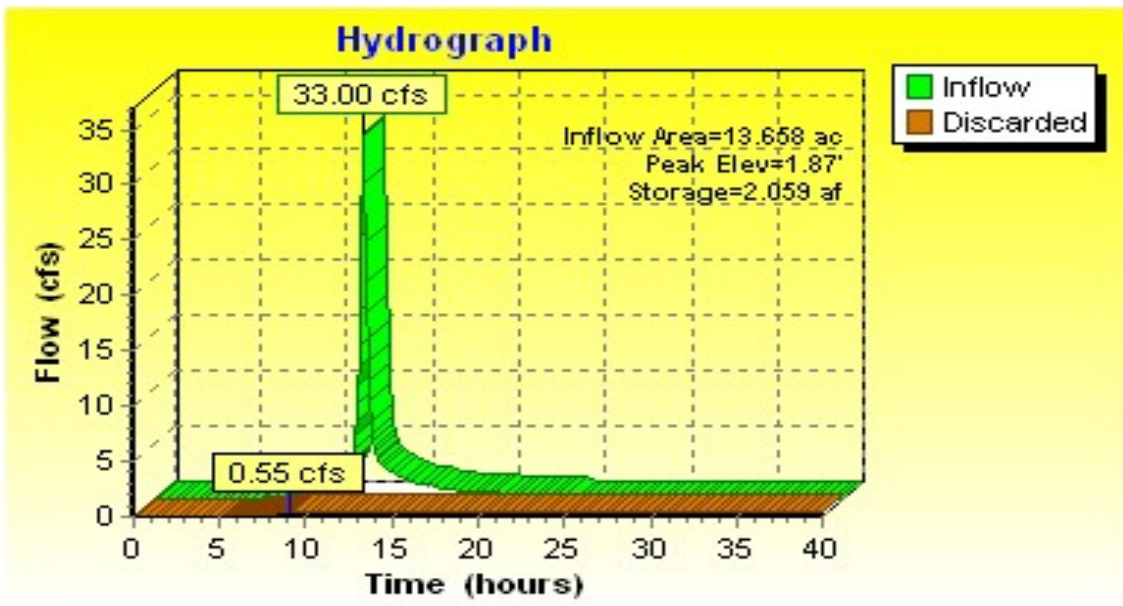
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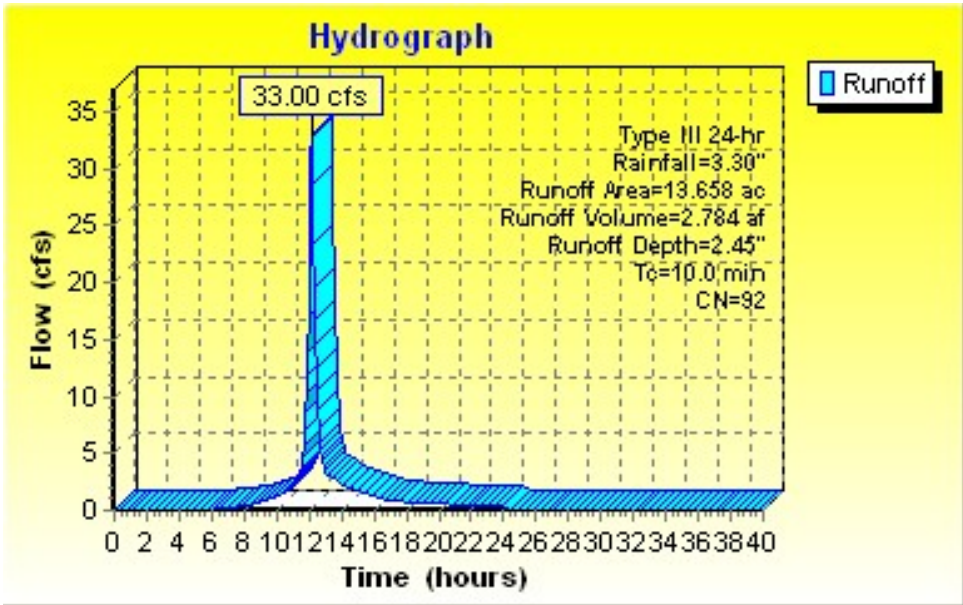
***Appendix B: Hydrographs for Areas of Recommended
Disconnection***



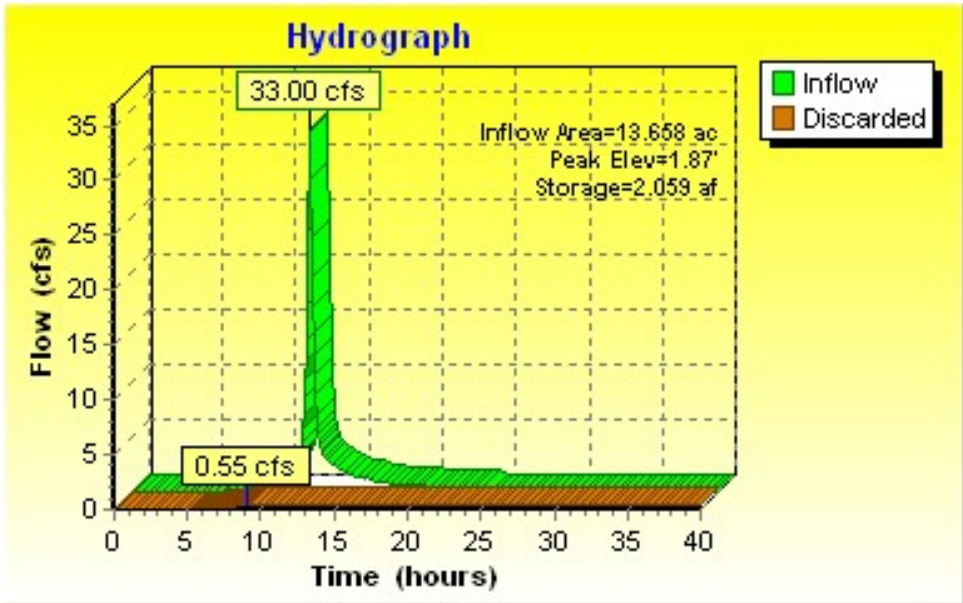
Subbasin 21 Map 1



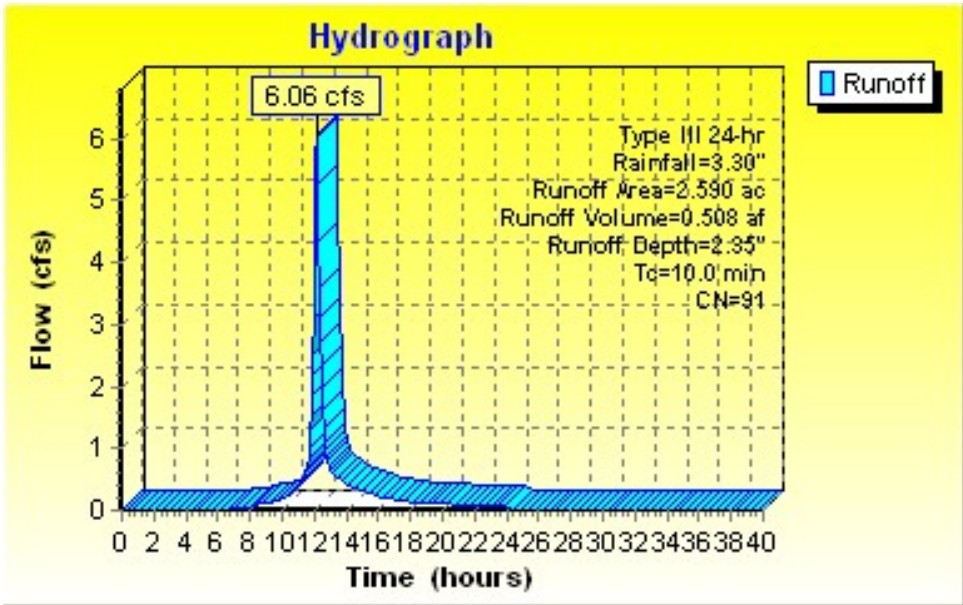
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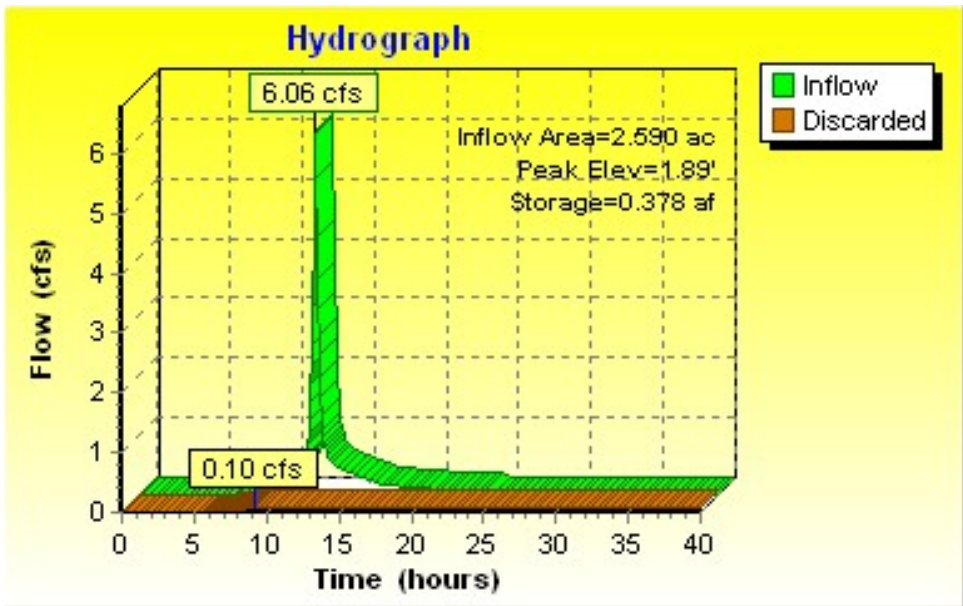
Subbasin 21 Map 3



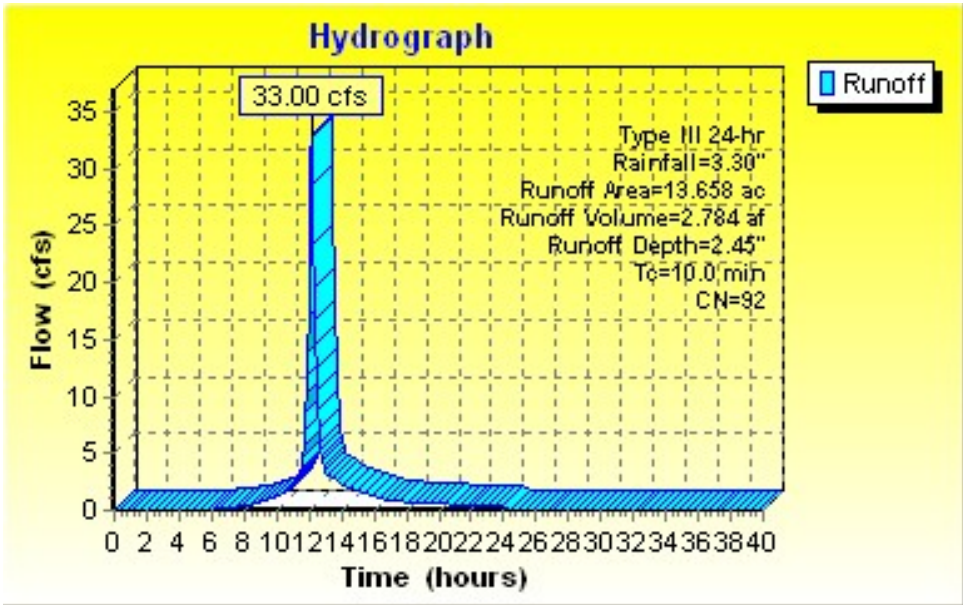
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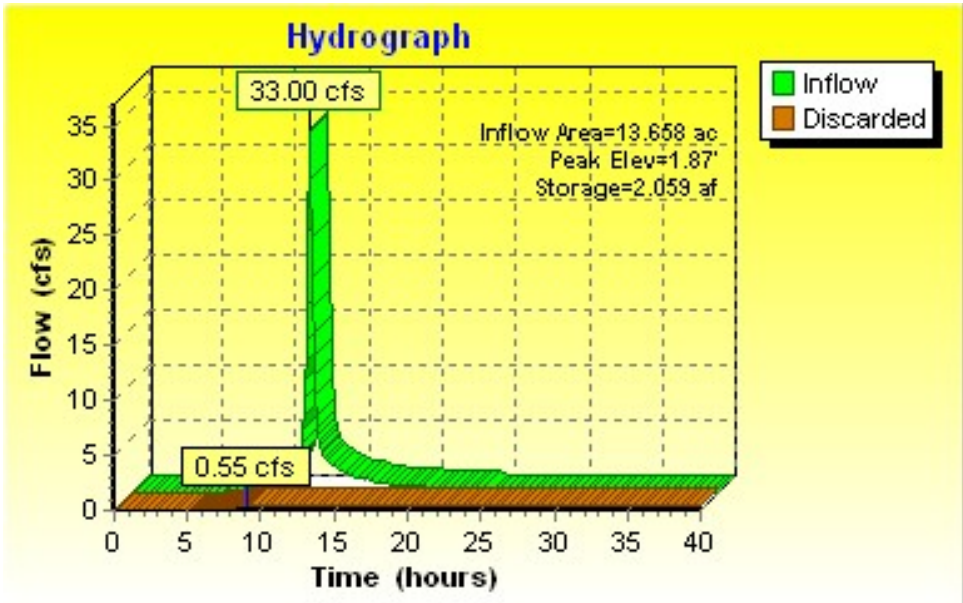
Subbasin 15 Map 3



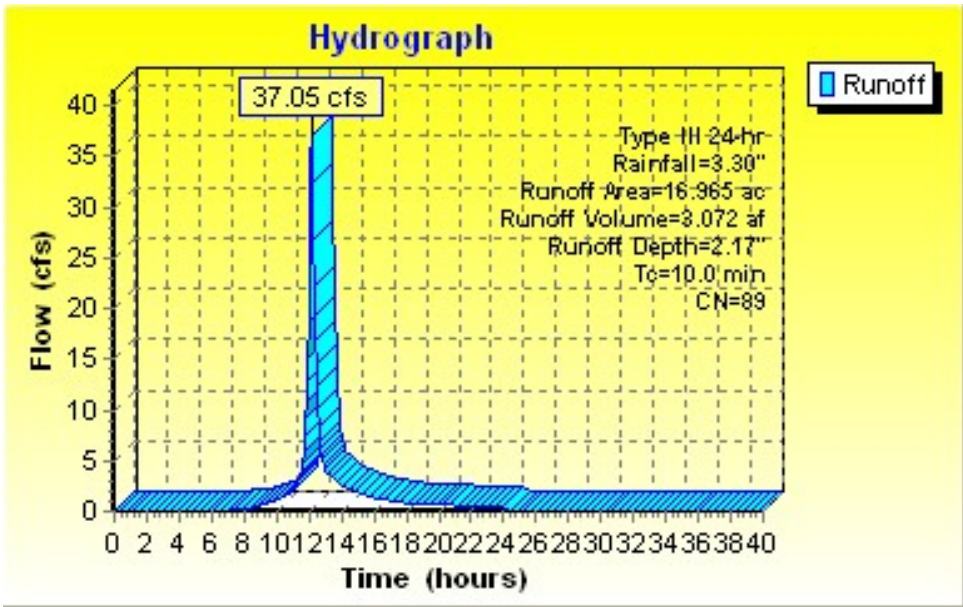
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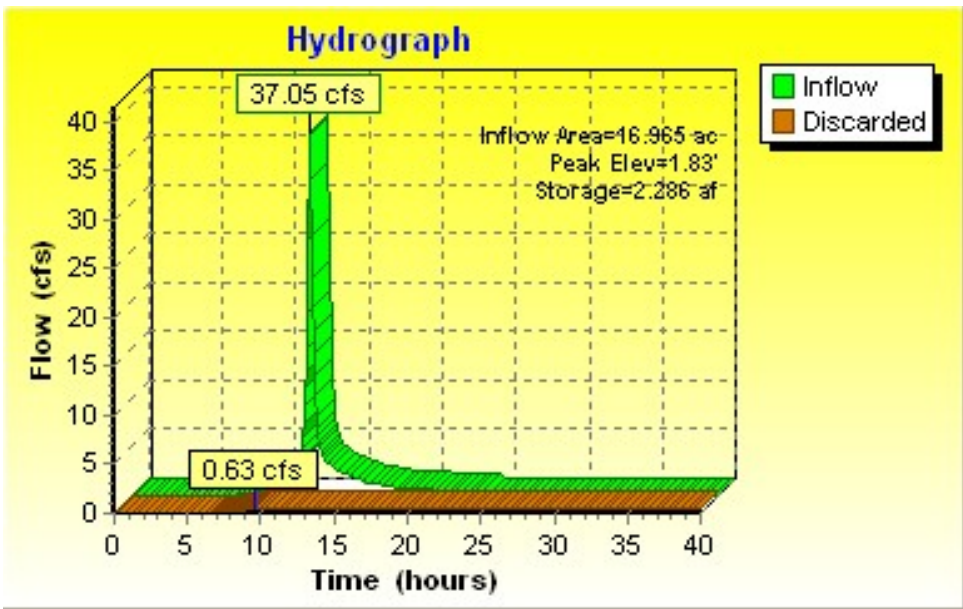
Subbasin 21 Map 3



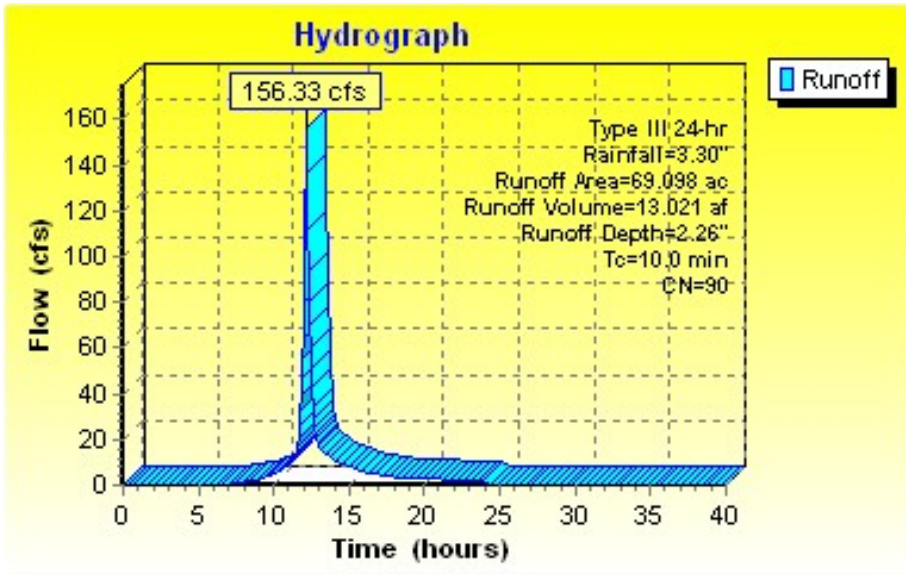
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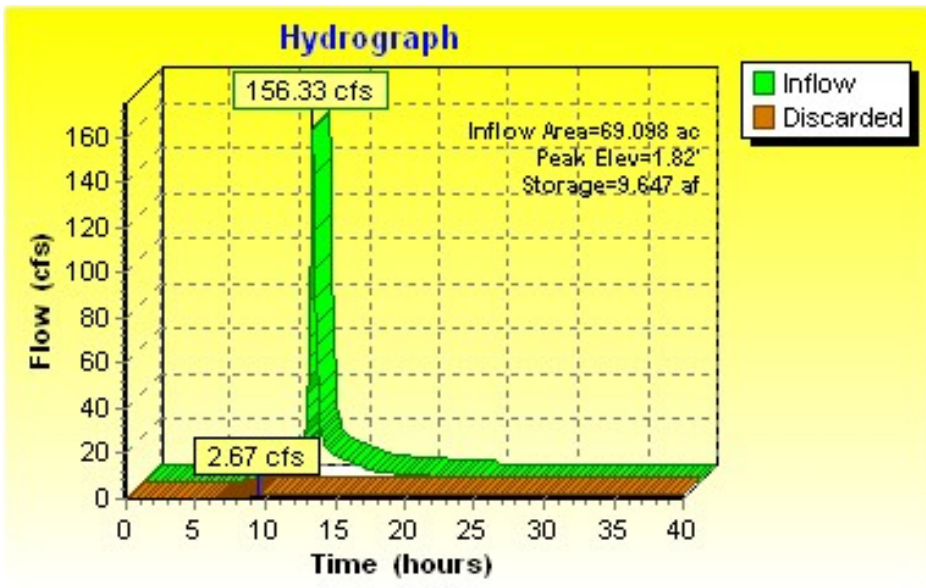
Subbasin 5 Map 5



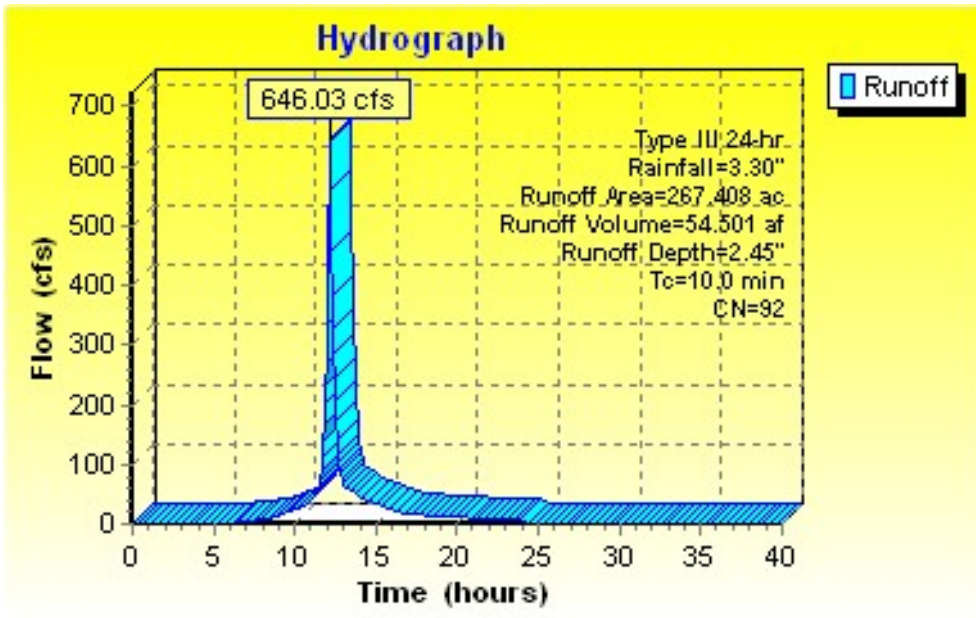
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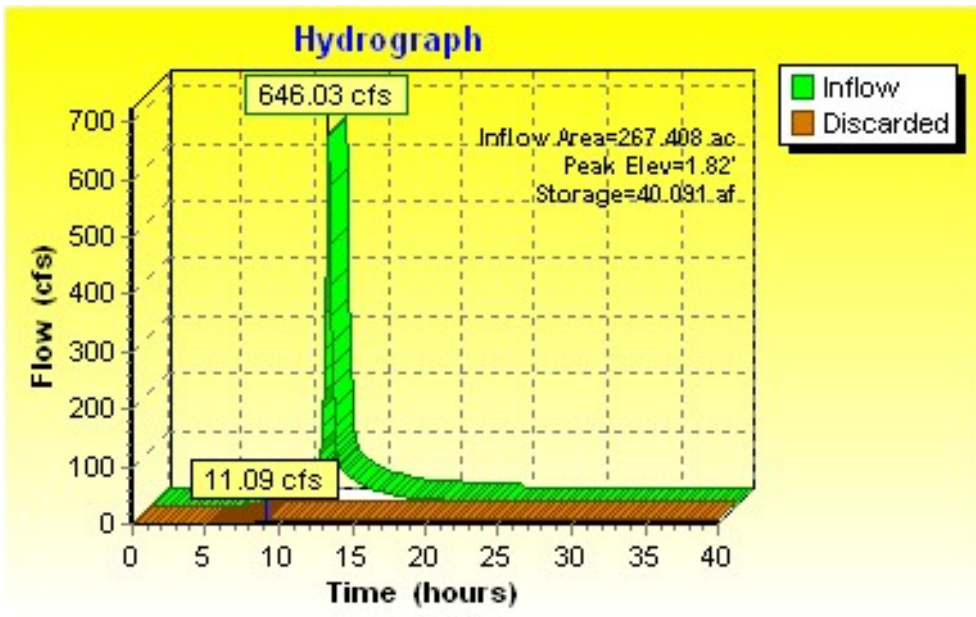
Subbasin 5 Map 7



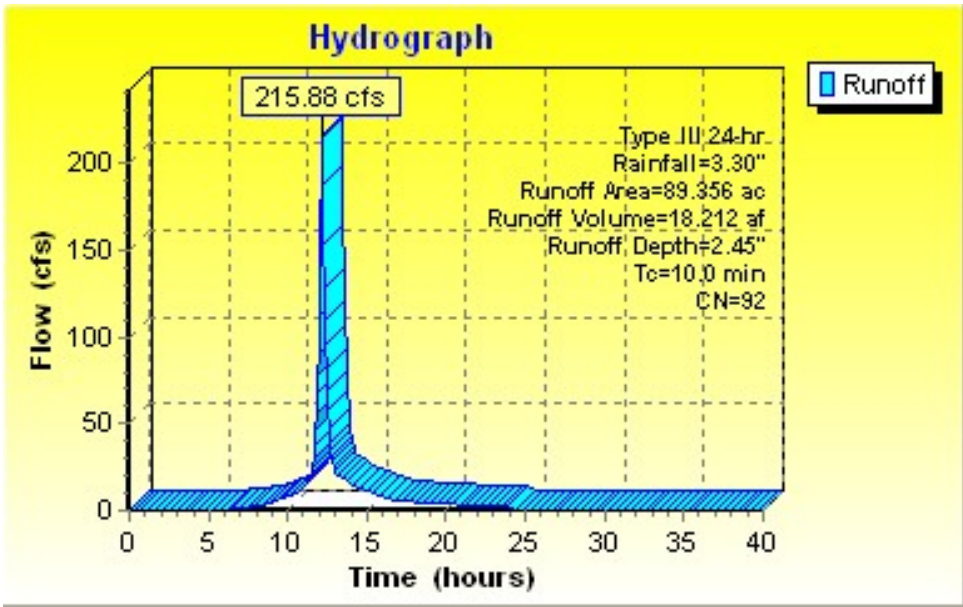
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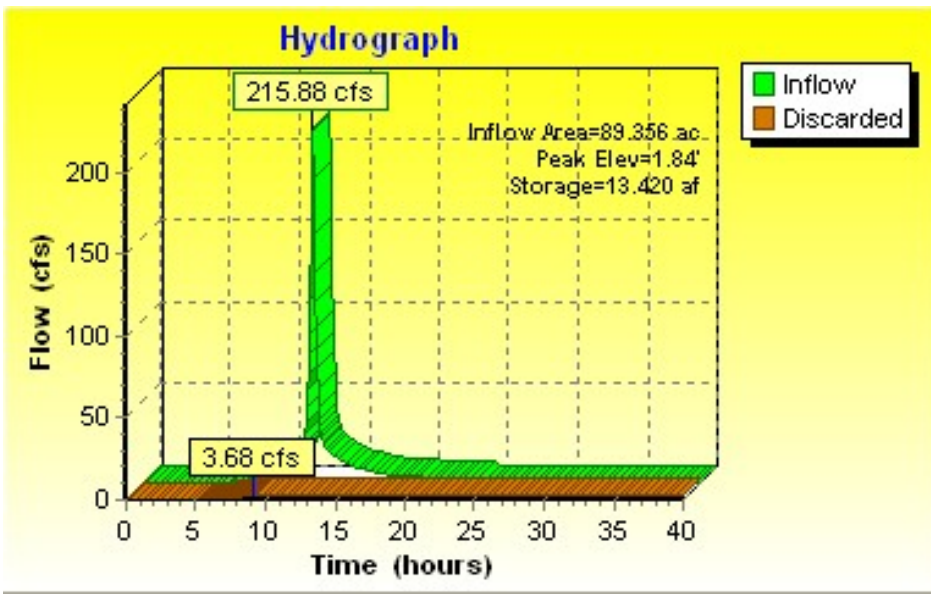
Subbasin 6 Map 7



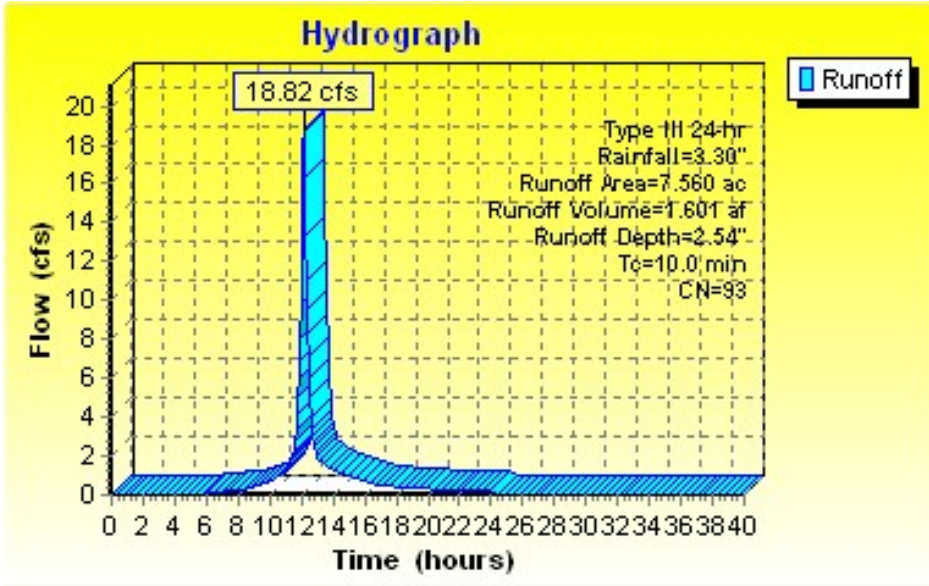
Subbasin 6 Map 7 Storage



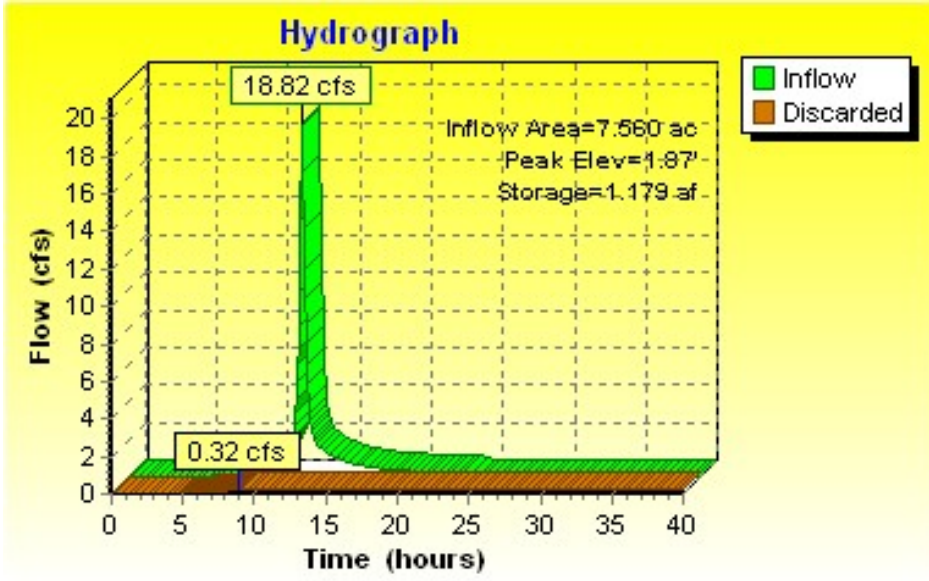
Subbasin 15 Map 6



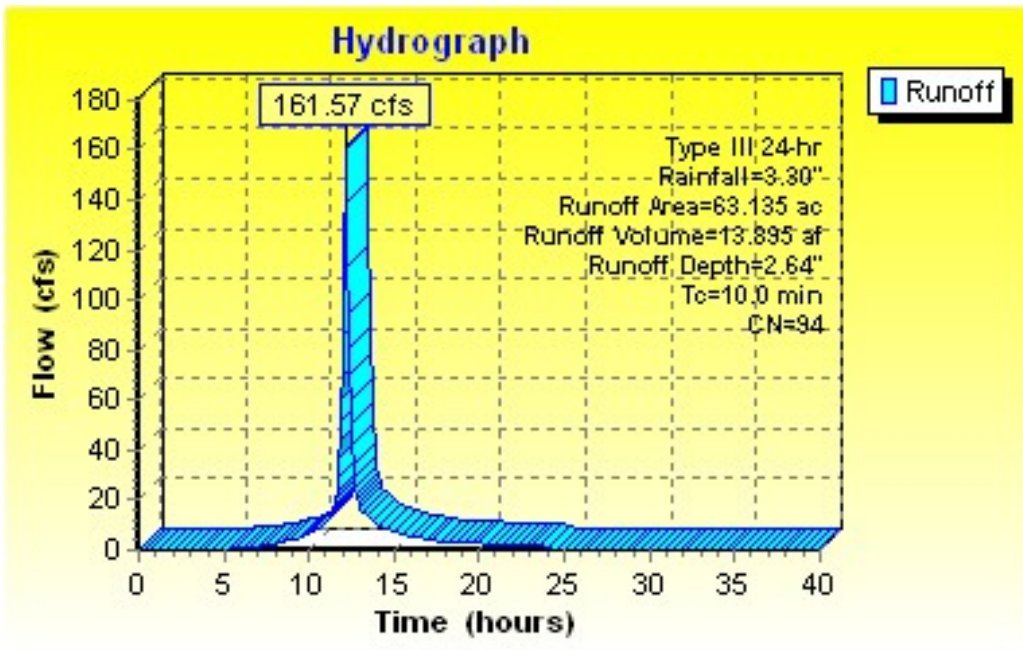
Subbasin 15 Map 6 Storage



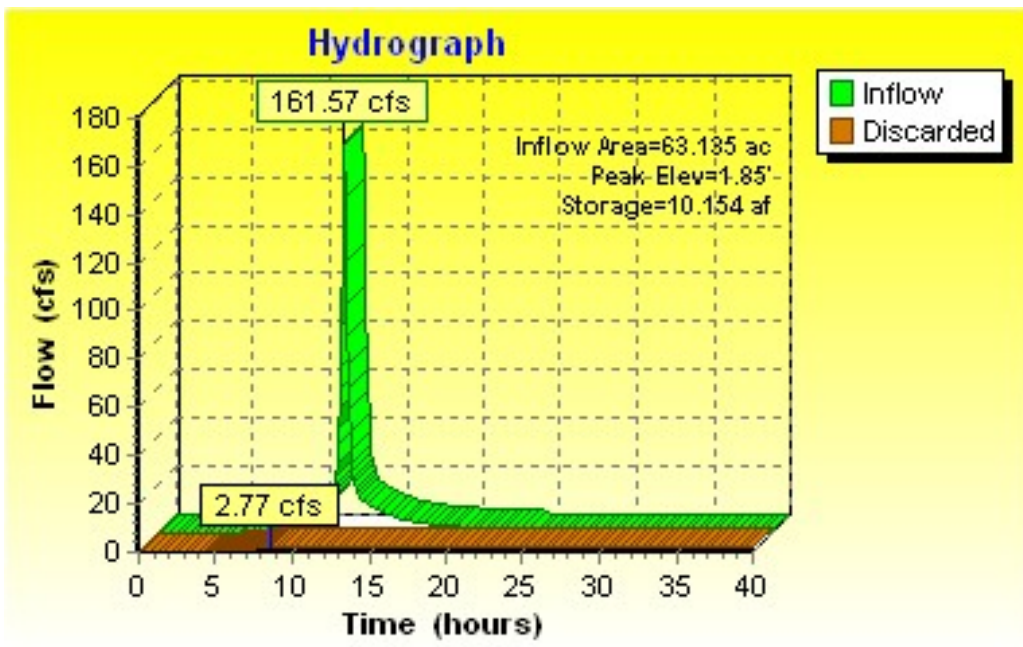
Subbasin 12 Map 8



Subbasin 8 Map 12 Storage



Subbasin 1 Map 11



Subbasin 1 Map 11 Storage

Appendix C: Engineering Concept Plans

Robinson's Branch Engineering Concept Plans Numbered

Eng Concept Plan #1: Disconnection and Infiltration of Commercial Site (Inman and Progress Streets in Edison)

Eng Concept Plan #2: Union County Vocational School Swale

Eng Concept Plan #3: Road Rain Gardens

Eng Concept Plan #4: Tamaques Park, Westfield

Eng Concept Plan #5: Unnatural constriction after Wald and Cushing

Eng Concept Plan #6: Woodbridge by GSP: Roads, schools, and baseball fields infiltrated

Eng Concept Plan #7: Oak Ridge Golf Course

Eng Concept Plan #8: Shackamaxon Golf Course

These engineering concept plans are too large to be printed in this document format. They can be viewed and printed from the Rutgers Cooperative Extension Water Resources webpage found at: www.water.rutgers.edu. Go to "Projects" and then find "Robinson's Branch".

Requests for copies can be made to Sandra Goodrow at (732)932-9800 ext. 6125.