Nine Mile Run Watershed Association

The NMRWA Rain Barrel

In 2005, in Phase I of the NMR Rain Barrel Initiative, NMRWA successfully installed 500 Riversafe rain barrels throughout the watershed. Following the completion of Phase I, local residents continued to inquire about obtaining rain barrels, showing continued interest in the program. The success of Phase I inspired NMRWA to create a more ambitious program that included the goals of designing and manufacturing our own barrel, and installing an additional 3,500 rain barrels within the watershed by June 2010.

Although the primary purpose for embarking on a new program was to dramatically increase the number of rain barrels within the watershed, it could also serve to address concerns or problems experienced by the current rain barrel owners. Thus, before implementing a second phase of the rain barrel initiative, it was important to learn more about how citizens and residents viewed Phase I of the program; therefore, in the summer of 2006, NMRWA conducted a Rain Barrel User Survey (Attachment 1). This survey was designed and administered to determine the viability of implementing a Rain Barrel Initiative Phase II, to uncover issues with the Phase I rain barrel, and to refine NMRWA's maintenance protocols to ensure optimum rain barrel performance. The Rain Barrel User Survey revealed that many rain barrel owners did not maintain or use their barrel properly. Many barrels were clogged with debris, or owners had abandoned use of the barrel because of maintenance issues. The survey results, along with barrel design and shipping costs from Canada, were key factors in NMRWA's decision to design and manufacture its own barrel.

Working with professors from Carnegie Mellon University's Department of Civil and Environmental Engineering, 3 Rivers Wet Weather, water resource professionals, and qualified NMRWA staff, a new design was developed to address the concerns voiced by Phase I rain barrel owners in the user survey. During the design meetings it was decided that the new NMRWA rain barrel should be as large as possible to collect the greatest volume of runoff during a rain event (see Data Analysis section). The new barrel was designed to hold 133 gallons. By adding a siphon overflow to the design, additional roof runoff could be diverted and directed to a permeable area on the property during heavy rain events. Ideally, the barrel would capture the first flush of all rain events.

Rain Barrel before assembly.

Rain Barrel during assembly.

Throughout Phase II, the NMRWA rain barrels were produced by Quick Clamp Rotational Molding, LLC, located in Enon Valley, Pennsylvania. The barrels were made from recycled polyethylene plastic using rotational molding techniques. The barrels were delivered twenty per delivery to the NMRWA location at 702 South Trenton Avenue in Wilkinsburg. NMRWA usually received two deliveries a month, unless there was a special promotion, when that number increased to meet demand. The barrels came with 2 pre-drilled holes, one for the spigot, and one for the overflow adapter. NMRWA completed all other necessary assembly.

Rain barrel construction requires approximately 15 minutes per barrel. PVC pipe for the siphon overflow system is cut to size and all hardware is installed. Most of the hardware is sourced from the local Home Depot in East Liberty, but diverter pieces are supplied from Gutterworks, a company in Barnes City, Iowa; spigots from Riversides, in Ontario, Canada; and nylon overflow pieces are ordered from US Plastics Corp in Lima, Ohio. Supplies are ordered approximately every other month from each of these companies. As with the barrels, the amount and frequency of ordering varies with demand.

From its inception, quality control was viewed as critical to the success of Phase II. NMRWA created a comprehensive methodology for making necessary changes and improvements to the barrel. Using feedback from the homeowner, information gathered from fieldchecks, and research on other rain barrel programs, NMRWA analyzes and tests new ideas in the field. For example:

- **Spigot** - The initial spigot clogged the barrel; a second spigot design was chosen to correct the problem. Unfortunately, while the replacement spigot solved the clogging problem, its plastic material experienced failure due to extremes in temperature during the winter months. This second spigot failure prompted testing a third design. The field tests on this brass spigot have been positive.
- **Overflow adapter** - The first overflow adapter on the side of the barrel eventually caused the overflow tubing to kink, disrupting the overflow system. During heavy rains, the barrel could then overflow over the sides, causing wet basement issues. A new adapter which angles the overflow tubing differently successfully addressed this issue.
- **Downspout diverter** –A downspout diverter is now included in rain barrel installations. An upside down 'Y' piece of downspout, the diverter creates a more user-friendly system. The homeowner simply flips a switch diverting the water either into the barrel, back into the drain stump, or onto a permeable surface. This modification is especially helpful in the winter months, preventing problems that typically occur in low temperatures.

Modifications such as these were responses to problems uncovered through on-going monitoring of the rain barrels. These emerged from continuous and consistent field monitoring, conversations with rain barrel owners and residents of the watershed, as well as research on different programs/methods. The NMRWA Rain Barrel Initiative is an on-going stormwater management program, one that is constantly changing and evolving. **Over time, the barrel design has evolved and NMRWA is continuously improving on the design.**

NMRWA has nearly 900 rain barrels in the watershed during Phase II of the Initiative, bringing our total for both Phases to 1400. The majority of these were sold at a price of $100 plus tax, with free delivery and installation. This price was below our cost for materials, but was subsidized through our grant from the PADEP's Growing Greener II Program. Approximately 216 of the barrels distributed inside the watershed during Phase II were within our study areas (See Figure 1), and were therefore given at no cost to the homeowner. In addition, 230 barrels have been sold outside of the watershed at a price of $275 plus tax. When the purchaser prefers not to pick up and install the barrel, they can purchase delivery and installation for $50 and $75 respectively. NMRWA has also provided 80 barrels to other nonprofit organizations, including Grow Pittsburgh, Phipps Conservatory, the Stroud Water Research Center, and Friends of the Pittsburgh Urban Forest, at an average price of $120. In many cases these barrels are in prominent locations where they can help to generate interest and attract new inquiries from potential users.

The Rain Barrel Site Specifications and Assessment Process

After an initial rain barrel request is confirmed, a property assessment is scheduled. The property assessment is an onsite meeting with the homeowner and a NMRWA staff member to explain the rain barrel initiative and to determine a suitable location for one or more barrels. This assessment provides a unique opportunity to educate the homeowner about watersheds and stormwater runoff, and is the primary tool for continuous Rain Barrel Initiative evaluation. The staff member instructs the homeowner about the function and purpose of the barrels, barrel maintenance, the Nine Mile Run Watershed, the issues of sewage overflow and non-point source pollution, and stresses that rain barrels are a simple residential approach to stormwater management. NMRWA staff inspects all downspouts, calculates the roof size of the house in relation to drainage, evaluates the slope of the property, and determines proper drainage area and secure locations for the barrel.

The assessment also serves as the initial step in NMRWA's quality control. Property assessments are an effective method of evaluating and avoiding potential problems. The information gathered provides vital details to prevent a problematic rain barrel installation. For example, an installation that drains a roof area larger than the barrel's capacity will cause an overflow malfunction. Water overflowing from the barrel could potentially lead to wet foundations or basements. It is also important that the rain barrel installation is located near a permeable area providing sufficient drainage; otherwise water may run off the property, flowing into the storm drain rather than percolating into the water table, as desired. Barrels must also be located on a flat level surface to prevent possible dislocation of the barrel - on an uneven surface the barrel may pull away from the downspout. Furthermore, if a barrel is not placed on a flat, level surface, the uneven weight distribution could puncture the bottom of the barrel. When conducting a property assessment for a rain barrel NMRWA staff looks for the following site specifications:

- Flat, level surface
- Sufficient permeable drainage area
- Accessibility to downspout
- Greater than a 30 inch diameter footprint
- Sufficient property easement
- Roof area draining to downspout no greater than 250 square feet

A property assessment usually takes a half hour to an hour, not including travel time or pre or post assessment communication with the homeowner. The assessment checklist and a user agreement form are completed at this time. (Attachment 2 & 3) The assessment check list covers all essential information needed to properly install the homeowner's rain barrel. A landowner agreement form covering certain legal provisions is signed, promising that the rain barrels will be maintained properly and effectively. NMRWA also instructs the homeowner to contact the association if they experience problems with the barrel, stressing that the association provides technical support for installed rain

barrels within the Nine Mile Run Watershed. The relatively low number of technical service calls indicates that few homeowners have experienced problems with the barrels.

Following the assessment, NMRWA provides the homeowner with a Rain Barrel Citizen's Guide. (Attachment 4) This guide explains the Nine Mile Run Rain Barrel Initiative, barrel specifications, useful tips for maintaining a rain barrel, and important NMRWA contact information. This simple trifold is NMRWA's key outreach document for increasing watershed awareness. The Rain Barrel Citizen's Guide explains the program and the importance of individual participation in creating change. Furthermore, it clearly explains the primary purpose of the rain barrel program- alleviating the problems associated with stormwater runoff. The guide also lets rain barrel owners share their knowledge with family, friends, and neighbors.

Although the NMR Rain Barrel Initiative seeks to increase the number of rain barrels installed in the watershed, due to the urban nature of the community, homeowners often do not have a suitable location for a rain barrel. The houses might be too close together, there may not be enough space to install a rain barrel or there may be very little permeable area for drainage. In these cases, NMRWA provides the resident with a choice of viable alternatives to reducing stormwater runoff on their property. Alternatives include: downspout disconnects, rain gardens, reducing impervious surface, and tree plantings.

Rain Barrel Installations

Once NMRWA assesses the homeowner's property, finds a suitable location for a rain barrel, obtains a signed copy of the agreement form, and receives payment for the rain barrel (excluding the study areas, where the rain barrels are provided at no charge), an installation appointment is scheduled. Unless requested, the homeowner need not be present during installation. Installation time varies, from a half hour to two hours, depending on the number of barrels and the complexity of the installation. For safety, teams of two NMRWA staff members complete most rain barrel installations. A typical installation requires leveling, sawing, and drilling (Attachment 5) but more complex installations may include raising the barrel on concrete blocks or attaching two or more barrels together, commonly referred to as *railroading*.

Fieldchecks- Quality Control

Regular fieldchecks were determined to be the best method of not only ensuring the success of the program, but also ensuring confidence in our data analysis. Fieldchecks on every rain barrel installed in the watershed are conducted at least once a year, ideally twice. Fieldchecks were instituted primarily to assess the current condition of installed rain barrels. Fieldchecks are also an important element in the

experimental design of the rain barrel program- ensuring consistent rain barrel function. A fieldcheck may take from as little as five minutes to as much as an hour if problems are found. The fieldcheck form (Attachment 6) provides information and data about each barrel for NMRWA's records and analysis.

Fieldchecks are a vital component of the NMRWA Rain Barrel Initiative, documenting the condition of barrels and utilizing that information for modifications, and to fine-tune NMRWA's programming. In most cases, NMRWA completes on-site maintenance immediately. In some cases, NMRWA staff returns later that day or sometime during the week for maintenance. Upon completion of the fieldcheck, the NMRWA staff person leaves a door hanger indicating that the owner's rain barrel has been checked and, if necessary, further maintenance instructions (Attachment 7). Fieldchecks are especially important after the winter months. During the winter, if a barrel is not maintained properly, it may incur damage due to extreme freeze-thaw cycles.

Issues uncovered during routine fieldchecks include:

- Frozen barrels, spigots, overflow hardware, and downspouts
- Clogged spigots
- Kinks in the overflow tubing
- Overflow tubing draining next to foundations
- Spigot malfunctions
- Cracks in the rain barrels
- Owner misuse – not following maintenance instructions
- Disconnected or missing rain barrels
- Change in property ownership

In addition, many barrel owners forget to reconnect the barrel to the downspout in the spring, when rain events are more frequent. It is especially important to conduct fieldchecks before the spring rainy season to ensure that all downspout diverters are redirecting the flow into the barrels and not back into the drain stumps. Otherwise, the barrel is not serving its primary purpose of diverting flow from the storm sewers.

Fieldchecks not only serve as an important procedure to monitor barrels, but they also create a Nine Mile Run presence in the community, providing vital face - to - face time with residents. However, as the number of rain barrels installed in the watershed has increased, and installations are more widely distributed throughout the watershed, this protocol is becoming difficult to maintain. Human resource capacity within NMRWA is limited, and completing 1400 fieldchecks requires additional staff time not considered in the initial planning phase for the program. It is important to note that proper functioning of the barrels remains the homeowner's responsibility to provide the necessary minimal maintenance. Although NMRWA takes a number of steps to ensure that a rain barrel installation is worry-free for the homeowner, and provides as much education as possible, ultimately, the owner is responsible for the proper long-term functioning of the barrel.

Education and Outreach

The NMR Rain Barrel Initiative was designed to not only increase rain barrel use throughout the Nine Mile Run watershed, but also to raise awareness about the issues of stormwater runoff, nonpoint source

pollution and combined sewer overflows. Previous research (MERGE Report and PHASE 1 RB Survey Report) revealed the important role that outreach plays in changing citizen behavior and maintaining interest in environmental programs. In addition, the RB Phase 1 survey clearly indicated the importance of an outreach plan in engaging citizens in stormwater runoff issues and solutions. Thus, funding for citizen engagement and outreach was included in the grant request. Since it was determined an outreach plan was essential for this second phase of the NMRWA Rain Barrel Initiative, the position of Outreach Coordinator was also included in the request for funding.

Outreach began in March 2007, with the announcement of Phase II of the NMRWA Rain Barrel Initiative in the spring issue of the Nine Mile Run News. In addition, press releases and media alerts were sent to all major media outlets in the Pittsburgh area. Additionally, a letter was sent to **519** Phase I rain barrel owners, announcing the new program. Phase II outreach materials were developed in-house and included a postcard (Attachment 8) sent to over **1700** residents in the watershed and **150** posters (Attachment 9) prominently displayed throughout the watershed. With over 9,200 residential structures and over 21,000 housing units in the watershed, a comprehensive mass mailing was considered prohibitively expensive (CDM Report, 2005). Targeted mailings were viewed as the best method to generate resident interest. It was also determined that mailings would be sent to neighborhoods with the greatest likelihood of engagement; homeowners in the four study areas and neighborhoods with the highest percentage of home ownership met this criterion.

Phase II was officially launched with the first installation in May 2007. Throughout the summer of 2007, NMRWA worked to create a series of Citizens Guides (Attachments 10 & 11) introducing citizens to three simple residential stormwater management solutions, rain barrels, rain gardens, and permeable paving. The Citizen's Guide to Rain Barrels is specific to this grant. The series was designed to be complementary, both in the information provided and the visual presentation. These guides not only engaged citizens in the pervasive issue of stormwater runoff but also provided options for homeowners who could not use a rain barrel on their property. Now in their 3rd edition, the citizen guides reflect changes to the program resulting from fieldchecks and current research on the topics.

In January 2008, the NMRWA Outreach Coordinator was hired. Working with local graphic designers, the coordinator immediately began reworking the NMRWA print pieces and developed a suite of outreach tools for the rain barrel initiative. The Nine Mile News (NMRWA's newsletter) was changed to reflect the new focus of the association, with a new front cover, logo, and regular articles about rain barrels and other residential solutions to stormwater runoff (Attachments 12 & 13) The Nine Mile Run newsletter readership increased from **2,463** in the spring of 2007 to over **4,650** in the spring of 2010.

Rain barrel posters and postcards were redesigned for greater visual appeal, efficacy, and brevity, conveying a more effective and concise message. Postcards were neighborhood specific to reflect the differing price points in the watershed (Attachments 14 & 15). New mailings were scheduled for additional targeted neighborhoods, reaching **3650** watershed households. An additional **150** updated posters were placed prominently throughout the watershed and included key areas within Frick Park as

well as in local businesses. The fieldcheck door hanger, used as a follow-up to inform homeowners of current barrel conditions, was also developed at this time.

Banners for tabling events were developed including a banner specific to the NMR Rain Barrel Initiative (Attachment 16). NMRWA rain barrels were taken to regional tabling events as well as all local NMRWA events. A Rain Barrel Fact Sheet, a simple one sheet flyer was created outlining the advantages of rain barrel ownership (Attachment 17). An inexpensive outreach tool, the fact sheets are distributed at tabling events and other public programs. The number of people engaged at tabling events increased from **50** in 2007 to **928** in 2010 with totals of over **2900** folks engaged over the period from spring 2007 through June of 2010.

The addition of an outreach coordinator allowed NMRWA to develop informational presentations on stormwater runoff issues and residential solutions to the problems. Typically these presentations were geared to local environmental groups, gardening clubs, community organizations, libraries and schools. The number of presentation attendees increased from **175** in 2007 to **400** in 2010, with the number of persons engaged reaching **1163** throughout the grant period. Although NMRWA's mission is geographically specific to the Nine Mile Run Watershed, the issues of stormwater runoff and the message to employ simple residential solutions is regional and thus presentations were not restricted to organizations in the watershed but reached many residents throughout Allegheny County.

Recognizing the important role children have in influencing family behaviors, the outreach coordinator developed programming specific to school age children and sought to develop partnerships with local schools and environmental education programs. Partnerships with local schools increased, especially with schools in the watershed, specifically Wilkinsburg High School and Wilkinsburg Middle School, The Western Pennsylvania School for the Deaf, Saint James School, and Word of God School. Key partnerships with environmental education organizations include: Lake Erie Allegheny Earth Force, RiverQuest, ASSET, Boy Scouts of America, and Phipps Conservatory. NMRWA programming for students includes both in class and field components utilizing service learning and project oriented learning methodologies. Since 2008, over **1000** elementary, middle, and high school students have learned about stormwater runoff and nonpoint source pollution through NMRWA's in class presentations and field work in the restoration area.

The outreach coordinator also increased the number of volunteer opportunities for citizens while also adding a greater number of informational tours to the NMR restoration area. Stream clean ups and upper watershed litter pickups helped to engage citizens in the issues of sewage overflows, nonpoint source pollution and their connection to stormwater runoff. Informational tours highlighted the amazing transformation of Nine Mile Run while focusing on the pervasive problems caused by excess stormwater

runoff, including sewage overflows, nonpoint source pollution, stream bank erosion, sedimentation, and the proliferation of invasive plant species.

Outreach was a significant topic during staff and rain barrel meetings and many strategies were explored in efforts to increase resident participation in the rain barrel program and to engage citizens in the issues of stormwater runoff. Canvassing proved to be a successful approach to both outcomes. Canvassing in neighborhoods began in the summer of 2008, with rain barrel program assistants working up to 2 evenings each week during the season. Canvassing not only increased rain barrel installations, weekly installations doubled for the week following each canvassing, but also served as a key method to engage citizens in the issues of stormwater runoff and nonpoint source pollution. In addition, it allowed NMRWA to find out maintenance issues homeowners were having with rain barrels, and to speak with people who may not have responded to a mailing. However, canvassing requires human resource capacity and seasonal staff turnover coupled with other program responsibilities made weekly canvassing difficult. As previously stated, fieldchecks remain a vital component of NMRWA's outreach. The fieldcheck door hanger (Attachment 7) was developed to provide vital information to the rain barrel owner and add an additional layer of citizen engagement beyond the assessment and installation contact points. Face-to-face tactics such as rain barrel assessments, canvassing, and fieldchecks have been found to be the most effective methods for raising citizen awareness about the issues of stormwater runoff.

Engaging citizens in the issues of stormwater management is critical to the mission of the Nine Mile Run Watershed Association. And the NMR Rain Barrel Initiative has proven valuable in increasing both citizen interest and knowledge in the problems associated with stormwater runoff and their effects on Nine Mile Run. The position of outreach coordinator contributed not only to the sustained and continued interest in the rain barrel program, but also to the overall increase in citizen engagement in watershed issues throughout the grant period. Outreach numbers for the period clearly indicate momentum in raising the level of awareness, resulting in increased citizen action to improve conditions in Nine Mile Run. Communities and schools in the upper watershed became more involved with the issues, with increase requests for presentations and rain barrel installations. Furthermore, a dedicated outreach person has allowed NMRWA to develop and implement new strategies designed to solidify NMRWA's reputation as the premier source for simple cost effective solutions to the issues of stormwater runoff in the region.

#s 3&4: Evaluation, and Success in Achieving Outcomes

Program Evaluation

Shortly after launching Phase II of the NMR Rain Barrel Initiative, the Association convened a Rain Barrel Advisory Committee (RBAC). This committee, comprised of key NMRWA staff, as well as representatives from the NMRWA Monitoring Committee, local universities, stormwater professionals, and community representatives, met every two months to evaluate and address any problems that surfaced during the

program's implementation. Some of the problems encountered included: failure of the adhesive used in constructing the barrels, inadequate initial length of the hoses and overflow tubing, securing the rain barrel lid, spigot clogging, spigot failure, winter freezing, issues with suppliers, timely delivery of parts, proper storage of parts and barrels, effective and efficient record keeping, monitoring protocols for barrels and sewers, customer relations, and successful outreach techniques, among others. This committee worked as a proactive and reactive body, anticipating possible problems and addressing issues in a timely manner.

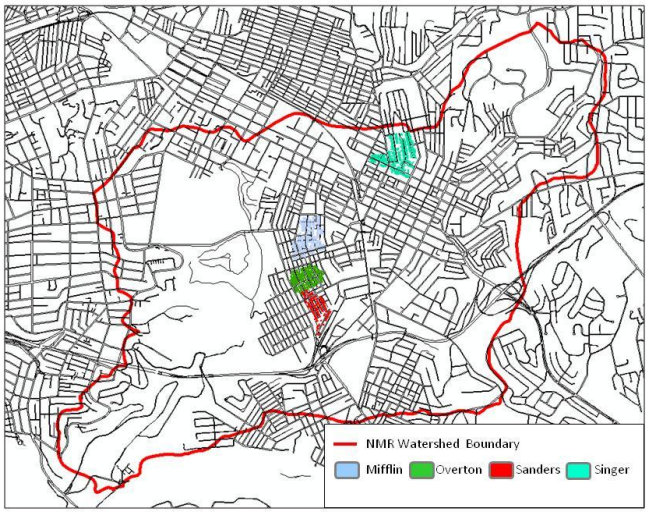
In addition to the RBAC, all Nine Mile Run staff actively working on the rain barrel program met each week to discuss immediate issues and to brainstorm for more efficient and effective programming. These meetings also generated specific actions, addressing issues targeted by the Rain Barrel Advisory Committee, problems uncovered during regular fieldchecks, and administrative related issues. Outcomes from these meetings resulted in changes that included:

- Improved data entry
- Improved efficiency in scheduling
- Searches for new parts suppliers
- Implementation of regular fieldchecks to prevent problems
- Canvassing specific areas to engage a greater number of residents
- Editing and redesigning outreach materials, including the Citizen's Guide
- Testing other rain barrels
- Researching and testing spigot designs
- Implementing a winterizing schedule for owners
- Instituting special pricing for Wilkinsburg Residents- free rain barrel with a $20 membership to NMRWA
- Researching other notable rain barrel programs in the United States

Since 2007, the Nine Mile Run Rain Barrel Initiative has been NMRWA's largest program, engaging most of the staff in some way. The staff continues to meet on a weekly basis to tackle issues that arise about the program and to adjust our protocols, thereby creating a more efficient and effective program.

Meticulous records have been kept throughout the duration of the rain barrel initiative. Each point of contact is recorded, from the initial request to the property assessment to on-going fieldchecks. Microsoft Access is used to record specific information about each homeowner. In addition; Microsoft Excel is used for installation management. Information is recorded to help with assessments/installations/maintenance of rain barrels. To ensure accuracy and redundancy in rain barrel records, all hard-copies associated with assessments and fieldchecks are maintained. This additional layer has proved useful in ground-truthing the data and making any changes in the status of each barrel.

Figure 1: NMRWA Rain Barrel Study Areas



Data Analysis

The NMR Rain Barrel Initiative was designed as an experiment to determine if rain barrel use would result in a measurable reduction in stormwater runoff. The original experimental design was intended to provide data for an analysis of rain barrel efficacy in reducing stormwater runoff in an urban residential application. In addition the experimental protocol would become a model for other rain barrel programs, providing replicable, reliable, valid data. Four study areas were chosen as locations for monitoring stormwater in the system. In order to quantify the effectiveness of rain barrels at alleviating the volume of stormwater and its discharge within the sewer system, four sub-sewershed monitoring locations were selected (Figure 1). Monitoring locations (Table 1) were selected based on the following criteria: (1) the availability of historical flow data, (2) ease of accessibility to monitoring equipment (i.e. the existence of a manhole), (3) high rooftop density, (4) high proportion of residential buildings, (5) large presence of rain barrels from NMRWA Rain Barrel Initiative Phase-I, (6) demonstrated community involvement, and (7) high visibility (Shanahan, 2007). Rain barrels, rain barrel installation, and technical support were offered for free to homeowners within the study areas to encourage participation. Installation goals were set for each study area to achieve a 10% stormwater runoff diversion – the percentage determined to make a measurable difference in sewer flow. Monitoring equipment was installed as goals were approached. Presently, flow monitoring has been completed for the Overton study area, and is underway in the Sanders study area.

Table 1: NMRWA Rain Barrel Monitroing Location Site Characteristics (Shanahan 2007)

Study Area Name	Number of Buildings	Sewershed Area (m²)	Impermeable Area (m²)	Rooftop Area (m²)	Rain Barrel Goal	Rain Barrels Installed
Singer	253	35.2	5.6	6.6	125	41
Overton	205	22.1	3.8	4	78	78
Mifflin	260	31.2	5.9	5.7	111	80
Sanders	173	18.7	3.1	3	66	60

Accurate comparison of historical (2001-2002) to recent data requires evaluating precipitation events of similar size (precipitation depth) and rainfall duration. A one-year monitoring period was proposed (the ***minimal*** amount of time monitoring should be conducted) to ensure the collection of data for comparable storms. American Sigma 910 (2001-2002) and Sigma 920 (2009-2010) flow monitors, donated by 3 Rivers Wet Weather, were used to collect the data. Installation and bi-weekly site assessments were conducted by an ALCOSAN and Edgewood Borough employee. ALCOSAN was also responsible for data retrieval and processing, while NMRWA conducted data analysis. Technical support

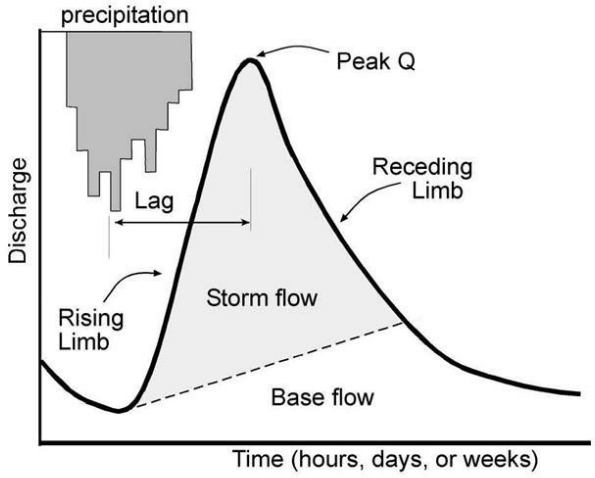
was provided by 3RWW, Joseph Fedor (ALCOSAN), Dr. Daniel Bain (U. Pittsburgh), and Mr. Tom Batroney (Hatch-Mott-MacDonald).

*Rain barrel performance (fill rate and overflow discharge rate) is also being evaluated using a pressure transducer by Dr. Daniel Bain (U. Pittsburgh). Data analysis has yet to be complete*d.

Between 2007 and 2009, over 12 billion-gallons of precipitation fell onto the 6.5 mi^2 Nine Mile Run Watershed. 811 Phase-II Nine Mile Run rain barrels were installed over this same time period, capturing and diverting approximately 3.8 million-gallons of stormwater, or 0.03% of the total precipitation volume. Comparatively, 65.5 million-gallons of precipitation fell onto the Overton sub-sewershed and approximately 487 thousand-gallons, or 0.74% of the total precipitation volume, were diverted from the sewer system. Including the 493 rain barrels installed in the watershed during Phase-I (17 barrels in Overton), the percentage of total stormwater diverted over the NMR watershed and Overton study area increases to 0.089% and 1.12%, respectively. These numbers assume that rain barrels are in prime working condition, precipitation that exceeds rain barrel capacity is directed by the overflow system to permeable surface, and that they are disconnected during the months of December, January, and February.

Sewer flow data for the Overton study area was collected from March 2009 until March 2010 at 15-minute intervals; historical flow data was collected between 2001 and 2002 at 1-hour intervals. The measured flow rate was plotted against time to create a hydrograph (Figure 2), depicting the drainage network's response to runoff. Important hydrograph features include the rising limb, peak flow (Q is the symbol for discharge), and receding limb of the hydrograph. The area underneath the discharge curve provides the volume of stormwater runoff associated with a particular precipitation event. Baseflow is the component of surface water sourced from a slow seeping of water through the ground. This delay is what keeps water in streams throughout the year, even during a drought. Storm sewers are constructed to be hydraulically disconnected from groundwater, and hence, should not exhibit baseflow.

Figure 2: Generalized Storm Hydrograph[1]

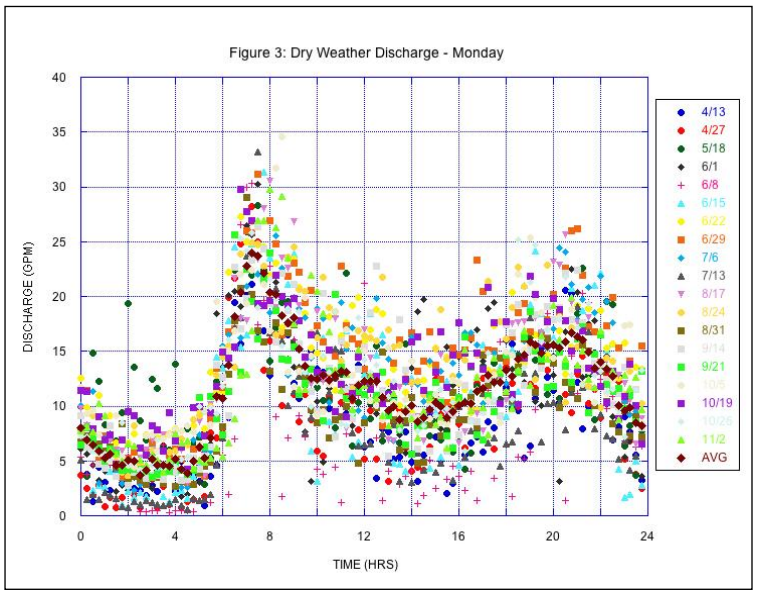


Generalized storm hydrograph showing key features. Base flow within a sewer line is composed of sanitary discharge and groundwater infiltration through leaky pipes.

In theory, rain barrels and stormwater infrastructure in general act as runoff speed bumps. They delay the initial hydrograph response (start of the rising limb), increase lag time (the time between maximum precipitation and maximum discharge), and prolong the duration of storm flow. Capturing and slowly releasing rooftop runoff onto a permeable surface increase the volume of shallow groundwater, and the intensity of the runoff as well as the total runoff volume is reduced. However, the manifestation of these changes is poorly understood.

Comparison of historical to recent data yielded inconclusive results on the effectiveness of rain barrels. This analysis was complicated by a number of factors including: (1) the 1-hr recording interval of the historic flow data is too long, and (2) the Overton

study area sewer line is a combined sewer.



Urban environments have been historically designed to rapidly convey stormwater runoff away from the built environment, resulting in elevated water discharge rates over a shorter period of time. In the Overton study area, maximum sewer flow rates typically occurred within 15-minutes of the maximum precipitation rate, and base flow conditions were reached 15-minutes after precipitation ceased. These time intervals indicate that sewer flow within the Overton study area responds instantaneously to precipitation. Thus, a 1-hr recording interval fails to accurately characterize, and may even completely miss, the sewer response of a precipitation event. In essence, the historical data that was available for comparison is not useful, and therefore the initial conditions are unknown.

Concurrent sanitary sewer flow within the pipe network introduces an additional layer of complexity to the hydrograph. Dry weather, or sanitary, flow ranged from approximately 9,000 to 25,000 gallons per day. Discharge follows a regular daily pattern with maximum discharge occurring at 8:00AM (morning showers), followed by a midday depression, and a secondary peak around 8:00PM, after which flow drops dramatically. Although the pattern of daily flow is predictable, flow intensity varies up to 20 gallons per minute (Figure 3). According to Mr. Tom Batrony, a hydraulic engineer, variations in sanitary flow occur so rapidly that data collection for combined systems should occur at a minimum of 5-minutes intervals, with a 1-minute interval being ideal. The overall effect to the hydrograph is that otherwise smooth short-term (15-minute) changes in discharge are rough, according to residential water consumption, and highly variable background sanitary flow at the daily scale may overshadow storm flow, especially for small precipitation events (less than 0.1”).

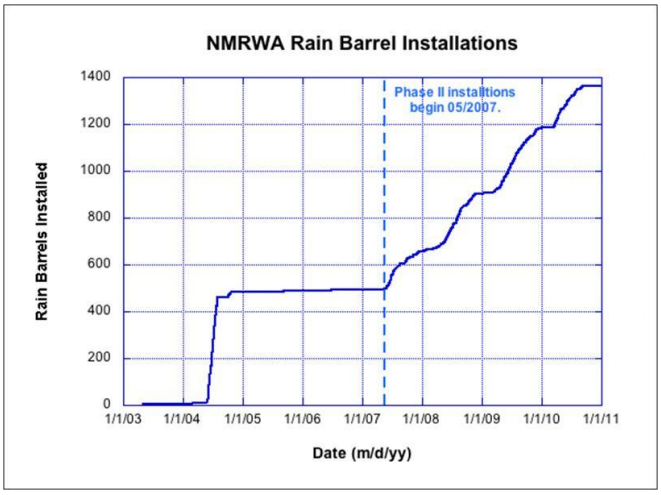
Although initial discharge characteristics are not well defined, 15-minute data from 2009-2010 may be compared to theoretical methods used to estimate effective precipitation (P_e), the amount of precipitation that becomes stormwater runoff. A reduction of effective precipitation by 10% was considered to be the threshold for a measurable difference in storm flow. The Soil Conservation Service (SCS) method for the Overton study area found that the effective precipitation for a 1.0” rain event is 0.17”, equivalent to a volume of approximately 104,400 gallons. It was further determined that the 10% of this volume (10,440 gallons) could be contained in 78 NMRWA rain barrels (Shanahan, 2007). NMRWA succeeded in installing 78 rain barrels within the Overton study area.

Preliminary results indicate that observed values for effective precipitation are lower than theoretical estimations, despite added influence by sanitary flow. Although this suggests that a measurable difference in storm flow was observed, substantially lower effective precipitation

values and equipment malfunctions reduce our confidence in this comparison. For example, the effective precipitation for a 0.774" rain event was calculated to be 0.012", 85% lower than the theoretical value of 0.08". The high population density of large mature trees in the Overton study area makes it unique to other urban environments. Interception by these mature trees may significantly reduce the amount of effective precipitation. Alternatively, the 15-minute collection interval for flow data may be too long to capture maximum flows on a consistent basis.

Comparison to SCS methodology is most significant for storm events greater than 0.4". Equipment malfunction limited the severity and number of precipitation events to analyze; malfunction occurred during the four largest precipitation events during the monitoring period (1.15", 1.25", 1.31" and 3.47"). The small number of events available for comparison does not allow for confident interpretation of data trends or the establishment of trends in general.
From a theoretical standpoint, rain barrels have the potential to significantly reduce stormwater runoff in small watersheds and sewersheds. The high proportion of roof-area (28% of land area in Overton), relative ease of capturing runoff from this source, and its disproportionate retention factor compared to more vast permeable surfaces, suggest that at the very least, rain barrels are important piece of solving stormwater related issues. The density of rain barrels required to have a measurable impact on a larger scale continues to be a major obstacle.

Research on Other Rain Barrel Programs



The Nine Mile Run Rain Barrel Initiative is ongoing and continues to generate interest. Rain barrel installations have remained steady throughout the grant period (Figure 5). However, reaching our goal of 4000 rain barrels in the watershed has been more difficult than expected. Clearly this was an ambitious goal but, considering the lack of a vigorous and costly social marketing campaign, the total numbers are none the less significant. With over 1400 total rain barrels installed within the 6.5 square mile watershed, the NMR Rain Barrel initiative continues to be the largest program of its kind. Research on other major programs revealed that the NMR Rain Barrel Initiative is unique in its larger sized rain barrel, the density of rain barrels installed and in use, installation completed by NMRWA staff, the maintenance program and technical assistance provided, and the extent of scientific monitoring. The rain barrel programs in the NMRWA research included:

- Washington, DC (DC Green, non-profit)
- Philadelphia, Pennsylvania (Philadelphia Water Department, Office of Watersheds, regional government)
- Madison Wisconsin (Sustain Dain, non-profit)

- Lexington, Kentucky and Cincinnati, Ohio (Blue Grass PRIDE, non-profit)
- Milwaukee, Wisconsin. (Milwaukee Metropolitan Sewerage District, water authority)

Each of these regions has instituted a rain barrel program that was well received and considered to be a model program for other organizations. Research included not only looking at available documentation on the programs, but also interviewing key program managers and coordinators. Specific differences between the NMR Rain Barrel Initiative and the programs include, smaller barrel size, lack of technical support, no tracking of rain barrel installations, size of the service area, and little or no scientific monitoring.