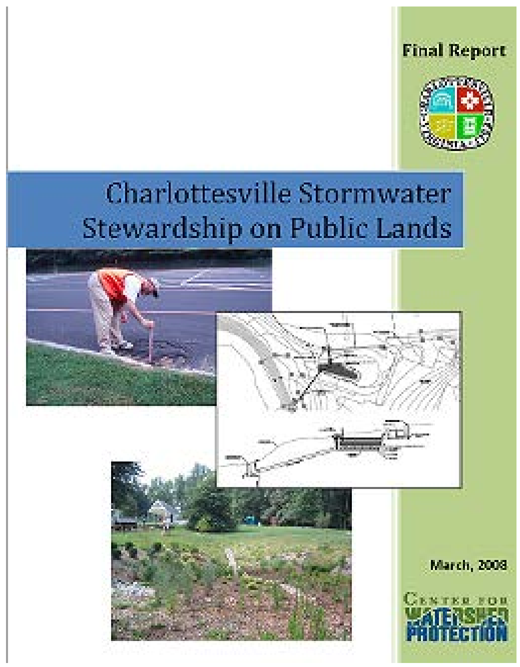
Appendix 7-A

Retrofit Case Study: Charlottesville, Virginia

Stormwater Stewardship on Public Lands



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7-A.1.0. INTRODUCTION Stormwater Stewardship on Public Lands Study

The City of Charlottesville is located in the Central Virginia Piedmont at the foothills of the Blue Ridge Mountains (**Figure 7-A.1**). Charlottesville is the urban center of the Rivanna River watershed (**Figure 7-A.2**), which flows into the James River, a major tributary to the Chesapeake Bay. **Figure 7-A.3** shows the Rivanna River, which flows along the eastern edge of Charlottesville, and is the focal point of local stormwater and watershed management activities.

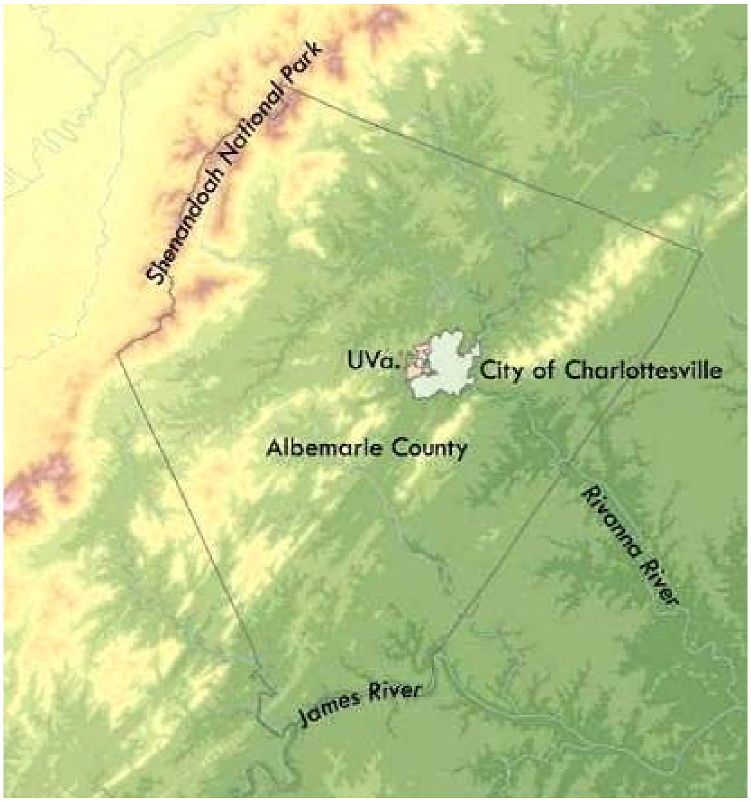

Figure 7-A.1. Location of Charlottesville

Figure 7-A.2. Location of Rivanna River Watershed

Figure 7-A.3. Rivanna River at Charlottesville

At only 10.4 square miles and 40,000 residents, Charlottesville is a fairly dense city. As Charlottesville is home to the University of Virginia, the city becomes even more dense when school is in session and an additional 20,000 students are in residence.

The City is mostly built out. The majority of development took place without the benefit of stormwater management requirements and in the absence of the current understanding of stormwater's relationship to water quality and watershed health. This has led to major impacts to the City's urban streams, including severe streambank erosion (**Figure 7-A.4**) and associated sedimentation. Several local streams do not meet water quality standards and have TMDLs established. We also recognize that we are part of the Chesapeake Bay watershed, and that we not only have a responsibility for helping to restore the health of our own local waterways, but that we are also part of larger, significant, and very important restoration efforts to save the Bay.

Figure 7-A.4. Streambank Erosion in Charlottesville

Charlottesville is also a City that has made several formal commitments to environmental stewardship, including adoption of an Environmental Sustainability Policy and Green City Vision statement, and becoming a signatory to the U.S. Mayors Climate Protection Agreement. City policies also pursue protection of riparian buffers, energy and water conservation and efficiency, stream restoration, urban forestry, recycling, greening of the City vehicle fleet, and public transportation initiatives.

On top of all that, Charlottesville is also a MS4 Phase II community. As such, the City has held a stormwater discharge permit from the Virginia Department of Environmental Quality (DEQ) since 2003 and has developed and implemented a stormwater management program that addresses the six minimum control measures required by the permit. City officials have found that stormwater retrofits can be an effective strategy for addressing various components of the overall stormwater management program.

Beyond historical impacts and environmental commitments, current stormwater management regulations in place address impacts from new development in the City. The regulations provide incentives and requirements for the use of low impact development (LID) practices, and other water quality BMPs are being implemented for the remaining development area. Incorporating innovative BMPs into new City owned construction projects is also a priority. However such opportunities are limited, since the City is not undertaking large amounts of new construction.

As a result of all these factors, City officials recognized years ago the importance of installing innovative BMPs as retrofits on existing public lands. They viewed these retrofits as an effective means of addressing historic impacts, providing for environmental stewardship, and meeting MS4 permit commitments and water quality goals. Implementation of retrofit projects on public lands also provides an opportunity to demonstrate and promote the use of the best new practices. The hope is that these practices will become widely used in new development and redevelopment projects and at other existing development sites. Now, as of 2013, with retrofits of existing developed lands becoming a requirement of the City's MS4 permit, they realize that past experience with and proactive engagement on the retrofit front has positioned them well to meet the regulatory requirements related to the restoration of the Chesapeake Bay.

7-A.2.0. GREENLEAF PARK RAIN GARDEN PILOT RETROFIT PROJECT

The retrofit ball got rolling in Charlottesville in 2005. A potential grant opportunity served as the impetus for a rudimentary first look at a subset of public lands with the objective of identifying potential retrofit opportunities. After evaluating seven properties (without the benefit of a distinct methodology, established performance goals or scientific evaluation criteria), the City's Greenleaf Park was selected as the best candidate for a retrofit. City officials decided to install a rain garden.

The City applied for and received a grant from EPA's Chesapeake Bay Program and the DEQ. After contracting out the rain garden design, City Park crews created the landscape plan and constructed the 1,200 square foot rain garden. This project provided the first retrofitting tie-in to the City's MS4 permit, addressing minimum control measures 1 and 2 (public education, outreach, and involvement). Nearly fifty volunteers assisted in this project, accomplishing tasks such as grading, laying filter fabric, mulching, and planting rain garden vegetation. A webpage tracked the construction process, and permanent, high quality educational signage was installed (see **Figure 7-A.5** below).

Figure 7-A.5. Greenleaf Park Rain Garden Retrofit Project

Since its completion, this retrofit has also served as the focus of numerous interpretive tours for the public, an outdoor classroom for a local elementary school, the site of environmental training for City staff, and the backdrop for interviews and environmental news stories by the local media. Hundreds of community members have directly interacted with this retrofit project.

The success of the project inspired City officials to consider additional retrofit opportunities. However, they also realized the need to undertake a methodical, strategic, and scientifically defensible examination of public lands in order to identify the most effective, appropriate, and feasible retrofits that would improve water quality and engage the community in local watershed stewardship.

7-A.3.0. "STORMWATER STEWARDSHIP ON PUBLIC LANDS" STUDY

City officials determined that a formal study was needed, and they gave it the title of *Stormwater Stewardship on Public Lands*. They limited the scope of the study to City Parks and school campuses, because they wanted the retrofits to be publicly accessible in order to best serve as demonstration projects and interactive learning opportunities. Early in the process, they engaged the following key partners:

- Charlottesville City Schools
- The following agencies of City government:
  - Public Works
  - Environmental Sustainability
  - Parks and Recreation
  - Neighborhood Development Services

The partners collaborated on a grant proposal, which was awarded by the National Fish and Wildlife Foundation. The Center for Watershed Protection was selected as the contractor to perform the Study, which was a perfect fit given their recent completion of a manual entitled *Urban Stormwater Retrofit Practices*.

7-A.3.1. Scope and Overall Objectives of the Study

The first step was to develop the overall objectives of the study. The major study objectives included a systematic evaluation of the City's parks and school campuses, in order to identify a prioritized set of retrofits which would improve water quality by removing pollutants, increasing groundwater recharge, and decreasing stormwater volume and velocity. The end result would be a catalogue of retrofit opportunities tailored to the site conditions in and around the public lands. These projects could also serve as stormwater education and outreach opportunities. This study was envisioned as the blueprint and guide for future City retrofit efforts.

7-A.3.2. Development of Retrofit Performance Goals

Early in the process, performance goals for the retrofits that they would be searching for were also established. Care was taken to ensure that the specific retrofit performance goals were complimentary to and would help achieve the overall study objectives.

Primary goals included, but were not limited to:

- ***Pollutant removal***, with the focus on local and regional pollutants of concern. Sedimentation had been identified as one the greatest threats to the health of the Rivanna River watershed, and several local streams were impaired due to contamination by bacteria. Also, nitrogen and phosphorus are the nutrients targeted for reductions in Chesapeake Bay restoration efforts.
- ***Runoff reduction***: the retrofits should achieve overall reductions in stormwater volume.
- ***Relief of drainage problems,*** where possible.
- ***Education and Outreach***: the projects needed to be in accessible locations where school children and staff, the general public, and the development community can interact with and learn from the retrofits.

Secondary Goals included, but were not limited to:

- ***Naturalization and recreation***, ensuring that there was a sensitivity to existing or future active recreational programs on the public lands.
- ***Quick Implementation***: it was important to identify several retrofits that could be implemented right away in order to capitalize on the momentum created by the study.
- ***Create wildlife habitat*** and ***protect/enhance tree canopy coverage*** in the City.

These performance goals were used during the field work portion of the study to evaluate and prioritize potential retrofit projects. This led to identification of 24 properties with high and medium retrofit potential, and some sites with low retrofit potential (**Figure 7-A.6**). The top 24 properties were prioritized for fieldwork. This prioritization was essential in order to focus the subsequent field work on the best opportunities to make meaningful improvements on the public lands themselves and in the subwatersheds in which they are situated.

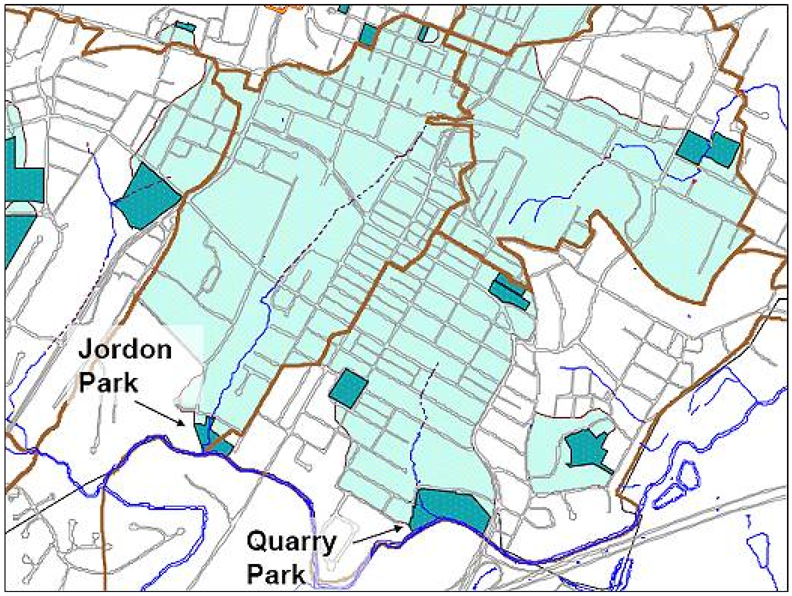

Figure 7-A.6. Map of Portion of Study Area with Potential Project Locations

7-A.3.3. Field Investigations

The 24 sites were evaluated over the course of three days (**Figures 7-A.7 and 7-A.8**). Field teams were led by a CWP staff person experienced with retrofitting. The teams included other Center and City staff as well.

Figure 7-A.7. Retrofit Reconnaissance

Figure 7-A.8. Finding Retrofit Opportunities

City staff participated to learn the process in order to be able to replicate it in the future, glean as much insight into the potential retrofits as possible, and to offer historic and current knowledge of the properties (such as ongoing master plans or programming conflicts). Detailed field maps, the Center's Retrofit Reconnaissance Investigation (RRI) form, and the methodology from the CWP's Retrofitting Manual were used throughout the field investigations. The City staff was also interested in connecting the field investigations to the MS4 program's minimum control measure 3 (illicit discharge detection and elimination). Staff watched for illicit discharges from the public properties or from surrounding private properties. One active discharge was found and addressed.

A total of 121 potential projects were identified, including 74 retrofits, many of which had concept sketches drawn in the field. These projects involved the following list of:

- 74 retrofit projects (8 storage and 66 on-site practices) that included:
  - Bioretention /rain gardens
  - Stormwater planters
  - Impervious cover removal
  - Swales
  - Vegetated roof
  - Rainwater harvesting
  - Forested stormwater wetland
- 26 landscape management / stewardship projects (e.g., tree planting, use of native landscaping, designation of "no mow" areas, repair of bare soil and eroded areas, etc.)
- 8 pollution prevention projects (e.g., improved dumpster management and materials storage, street sweeping, and clean up of trash and debris)
- 13 outfall repair/stabilization projects
- Identification of important unmapped features (e.g., stormwater infrastructure and live streams, etc.)

7-A.3.4. Ranking Potential Projects

Once the field work was completed and all the potential projects had been identified, it was time to evaluate and rank them. A series of primary and secondary screening factors were derived directly from the initial performance goals and refined through several meetings with City and CWP staff. Each factor was assigned a weight to produce a 100-point scale for ranking, with the primary factors carrying more weight. The ranking process only applied to the stormwater retrofit projects, because these could be directly compared to each other based on pollutant load reductions, cost-effectiveness, and the other screening factors. Other projects (e.g., pollution prevention and landscape stewardship) also reduce pollutant loads, but they are more difficult to quantify and in many cases can be built into existing operation and maintenance activities. Therefore they were not ranked, but the City staff still plan to pursue them over time.

The primary screening goals used in ranking projects were as follows:

- Amount of Total Phosphorus (TP) removed (used as an indicator for other pollutants as well)
- Cost effectiveness (cost per pound of pollution removed)
- Amount of capture of off-site runoff
- Amount of runoff volume reduction
- Relative opportunity for outdoor learning / community outreach

The secondary screening goals included, but were not limited to the following:

- Whether bacteria removal was accomplished by the project
- Degree to which the project promotes LID / innovative practices
- Degree to which the project has a lower maintenance burden and cost

After all the retrofits had been ranked against the screening goals, a meeting was held with CWP and City staff to review the ranked projects and discuss the strongest candidates for design work. Several factors were discussed, including the following:

- Project rank according to the screening factors
- Representation of different types of BMPs
- Representation across parks and school sites
- Sites that provided opportunities for early implementation or already had master plans for development
- Ease of implementation vs. impediments to implementation (e.g., permitting, public safety concerns, utility conflicts, etc.).

Local officials admit that common sense and informed intuition also played a role in prioritizing projects for action. Subsequently, the top candidate sites were evaluated in the field and, through a series of discussions, the final set of candidate sites and retrofit projects were selected.

The evaluation and ranking process put the potential projects in context and produced a prioritized list (see **Figure 7-A.9**).

Site Name	Description	Project ID	TOTAL
Meadowcreek Park	cistern from hotel parking lot	MW-01	93
Azalea Park	stormwater wetland	AZ-02	89
Schenks Greenway	rain gardens along path	SC-03	84
Buford School	bioswale @ pool building	BU-02	82
Charlottesville High School	rain garden @ MLK PA center	CHS-06	82
Johnson School	bioswale @ amphitheatre	JO-01	77.5
Jordan Park	expanded buffer, divert road runoff	JR-01	75
Pen Park	bioretention at parking lot	PP-03	74
Forest Hills Park	daylight pipe, create swale	FH-01	73
Tonsler Park	forested wetland	TO-01	73
McIntire Park – West	bioretention, small parking lot	MPW-02	69
Pen Park	bioretention at parking lot	PP-06	69
McIntire Park – West	bioretention	MPW-01b	68
Tonsler Park	rain gardens	TO-02a	67
Venable School	disconnect downspouts	VN-02c	67
Venable School	disconnect downspouts	VN-02b	65.5
Johnson School	IC removal	JO-02b	64.5
Burnley-Moran School	swale @ asphalt channel	BM-02b	64
Jackson-Via School	bioretention, swale	JV-02a/b	63
Burnley-Moran School	swale for roadway	BM-01	62
Clark School	rain gardens @ playground	CS-02b	62
Rives Park	rain gardens	RI-01	62

Figure 7-A.9. Ranked List of Potential Retrofit Projects

The prioritized list will serve as a guide for future retrofit implementation, and City staff will be able to quickly ascertain which projects best meet the established performance goals. However, the list is only a guide. Professional judgment, funding opportunities, and broader City needs also will play a role in determining which projects will be implemented at any given time.

7-A.3.5. Formal Project Designs

As one of the final steps in the Study, formal designs were developed for eight selected retrofit projects. In some cases, the City's Parks Department will continue to refine and ultimately implement the landscape plan details, which began only as concept plans.

The design work included the following:
- Preliminary plan view and profile plans
- Landscape concept plans
- Preliminary material specifications and quantities
- Cost estimates
- Concept grading plans

The eight retrofit projects that were designed included the following:
- Two rainwater harvesting projects at City schools
  - One at Venable Elementary School, where roof water will be collected and used by students and staff to irrigate on-site landscaping features.
  - The other project, which was installed in 2009, was a 40,000 gallon underground rainwater harvesting cistern at Charlottesville High School (**Figures 7-A.10 and 7-A.11**) that captures stormwater from approximately 26,000 square feet of the nearby Performing Arts Center roof. The cistern provides water to a pre-existing irrigation system for one of the high school's ball fields.

Figure 7-A.10. High School Athletic Field before Rainwater Harvesting Retrofit

Figure 7-A.11. Construction of the Underground Rainwater Harvesting Cistern at the High School

- Two bioretention / rain garden features
  - One at Burnley-Moran Elementary School, which will convert an existing asphalt drainage channel (**Figure 7-A.12**) that conveys one acre of parking lot and roof runoff into a series of cascading step-pool rain gardens connected by rock spillways. It will be adjacent to a new outdoor classroom, allowing for great educational opportunities.

Figure 7-A.12. Existing Asphalt Swale to be Converted

  - The other was constructed at Charlottesville High School in 2009. It is a 2,600 square foot bioretention filter that treats runoff from four acres of parking lot and adjacent residential parcels at the entrance of the co-located Performing Arts Center (**Figure 7-A.13**). The bioretention filter is used by the high school science classes as an outdoor classroom, and stormwater quality and flow monitoring has been conducted by the University of Virginia and the Rivanna River Basin Commission.

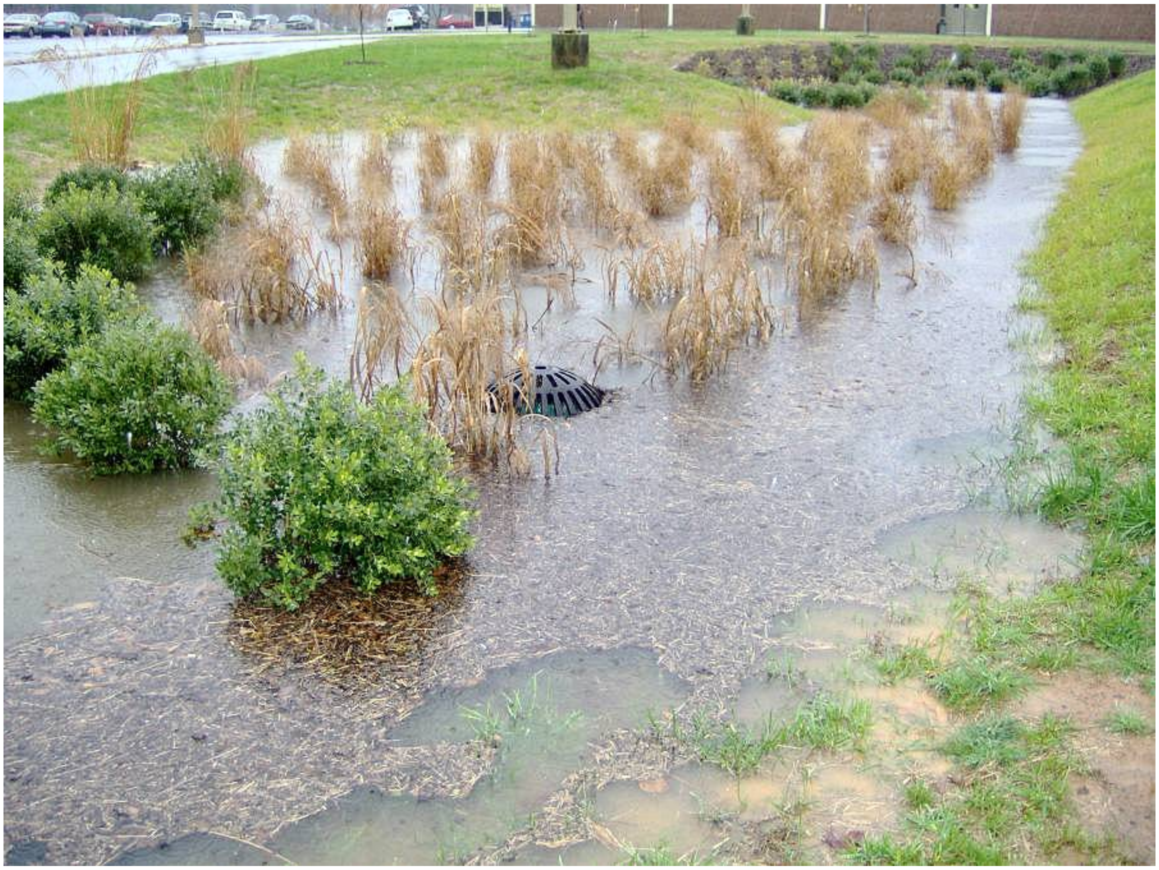

Figure 7-A.13. Charlottesville High School Bioretention Filter

- One bio-swale (Dry Swale), which was constructed in 2009 in Forest Hills Park that daylighted about 300 feet of the existing stormwater piping just prior to where it outfalls into an intermittent stream. The swale treats on-site as well as off-site drainage from nearly 13 acres.
- Constructed Stormwater Wetlands in Azalea Park (**Figures 7-A.14 and 7-A.15**), which were constructed in 2013. The wetlands treat runoff from 40 acres of a residential neighborhood with no pre-existing stormwater treatment, just prior to it entering one of the City's major waterways for which a TMDL has been established.

Figure 7-A.14. Azalea Park Before Constructed Wetland

Figure 7-A.15. Azalea Park After Constructed Wetland

- A piedmont outfall repair – a typical design of step pool treatment cells that provide stable conveyance, stormwater treatment, and volume reduction. The typical design is meant to be customized and applied to various sites where there is an outfall in need of stabilization and repair.
- A runoff diversion – another typical design meant to be customized and applied to various sites where there is an opportunity to divert runoff from an untreated area, such as a roadway, to a riparian buffer or bioretention area.

In addition to the projects designed as part of the study, the City has pursued several other retrofit opportunities. When the Parks Department's maintenance yard was revamped, they took the opportunity to install a bioretention filter to provide stormwater treatment where there had been none previously. A block of City sidewalk has been replaced with permeable pavers and an ADA parking stall was replaced with pervious concrete. Furthermore, the City converted 9,000 square feet of roof area on the City Hall building to a vegetated roof when the building's maintenance cycle called for replacing the roof (see **Figures 7-A.16 and 7-A.17** below).

Figure 7-A.16. Original Roof on City Hall

Figure 7-A.17. Replacement Vegetated Roof Area on City Hall

The City's Public Works Yard has had two retrofits installed. A small 1,500 gallon cistern was installed to collect rainwater off of the fleet maintenance garage, and the water is used in City street sweepers and flusher trucks (see **Figures 7-A.18 and 7-A.19)**. Catch basin filter inserts designed to remove debris, sediment, and hydrocarbons have also been installed in strategic locations throughout the property **(Figure 7-A.20**).

Figure 7-A.18. City Yard Before Retrofit

Figure 7-A.19. City Yard Cistern Retrofit

Figure 7-A.20. City Yard Catch Basin Filter Inserts

Rainwater harvesting systems have also been installed at three Charlottesville City Schools properties to provide irrigation water for schoolyard gardens (**Figure 7-A.21**)

Figure 7-A.21. Rainwater Harvesting at Schoolyard Garden

7-A.4.0. COMMUNITY INVOLVEMENT

The retrofit process and the retrofits in this case study can be seen as an important step in the evolution of a "retrofit culture" (**Figure 7-A.22**) for the City. It is hoped that several high-profile projects on public land will create the spark that leads to ongoing retrofit activities on both public and private land.

Figure 7-A.22. Community Involvement in a Retrofit Culture

The City intends to install many more of the retrofits and practices that have been identified in the Study. This effort ties into a broader Water Resources Protection Program (WRRP), one component of which will provide funding for future retrofit projects. The WRPP will be funded in part through a stormwater utility fee, and includes incentives built into the program for private property owners to construct retrofits on their properties.

As master planning and renovation efforts for park and school properties are undertaken, the Study provides the basis for retrofit opportunities. The Study also affords City officials the potential for private sector involvement (new development and redevelopment projects) through a fee-in-lieu program. Through such a program, new projects that are unable to achieve stormwater management requirements completely on the development site could contribute to a City administered fund that would pay to construct retrofits identified in the Study. In these ways, City officials hope that the retrofit culture can take hold firmly and, over time, result in community benefits as well as real and meaningful improvements in local water quality.

7-A.5.0. CONCLUSION

The following recommendations grew out of the retrofit study experience:

- In order to realize the best results from stormwater retrofits, consider them strategically and methodically, and tailor them to meet the subwatershed's particular needs. Having a reference like the Charlottesville study will enable a community to incorporate retrofits into future planning efforts and broader water resource protection initiatives in the future.
- Retrofits on public lands should be planned for use as demonstration projects to encourage and inspire private property owners to install them on their own property. Doing this increases the local knowledge base regarding innovative stormwater management. The more familiar, understood, and tangible these kinds of projects are, the more likely they are to be replicated elsewhere.
- Involve and educate the public about local retrofit projects. The more involved and invested in a project the community becomes, the greater the chance for achieving long-term success. Using public land, particularly school campuses, allows the greatest access to the retrofits for public interaction and educational opportunities.
- In developed subwatersheds with historical impacts to water resources, such as the watersheds of Charlottesville, installing retrofits is an essential and major component of a successful water resource restoration initiative. In Charlottesville, stormwater retrofits have also become an integral part of the City's overall environmental sustainability efforts.

The Charlottesville *Stormwater Stewardship on Public Lands* Study can be reviewed in more detail at the following web site:

www.charlottesville.org/environmental

7-A.6.0. REFERENCES

Center for Watershed Protection. August 2007. *Urban Stormwater Restoration Manual Series – Manual 3: Urban Stormwater Retrofit Practices, Version 1.1*. Ellicott City, MD.

Frisbee, Dan. March, 2010. "Stormwater Retrofitting as a Program Tool." Presentation at the conference entitled *From the Rooftop to the Bay: Implementing Stormwater Management Strategies in the Chesapeake Bay Watershed.* Staunton, Virginia. Chesapeake Bay Stormwater Training Partnership.