Burnt Mill Creek:

Using Stormwater Low Impact Development Retrofits and Community Development to Restore the Watershed

QUICK FACTS

Theme	Collaboration
Name	Burnt Mill Creek
Unique LID Components	Many collaborators, residential involvement, urban retrofits, ongoing efforts, cost data, and water quality monitoring
Location	Wilmington, NC
Land Use	Industrial, commercial, and residential (developed)
Watershed Area	4,223 acres of land and 38 acres of creek
Lessons Learned	Involve the public early and provide easy to understand graphics

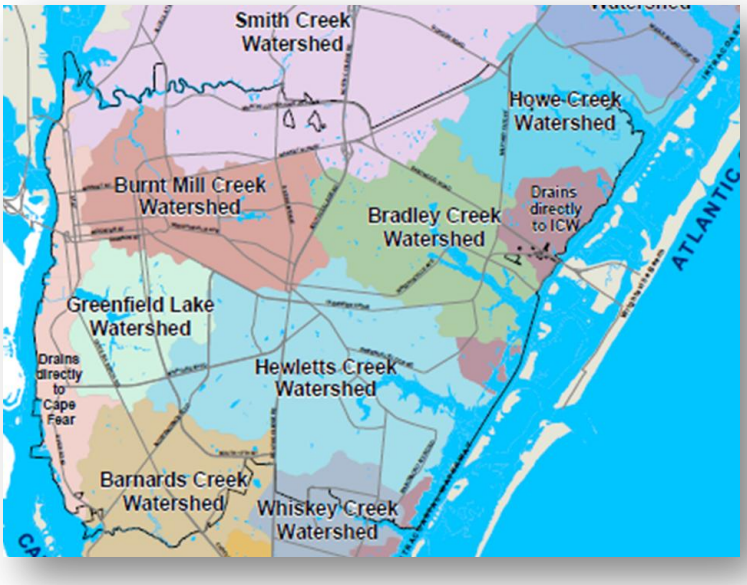


Figure 1. Burnt Mill Creek watershed in coastal NC (City of Wilmington, Retrieved 2009).

Introduction

In North Carolina's coast, the Burnt Mill Creek watershed (Figure 1) contains 38 acres of creek and 4,223 acres of land and the watershed's stormwater runoff drains into the Cape Fear River (City of Wilmington, NC). Burnt Mill Creek is a well developed watershed with almost no agriculture or forest land use, but dominated by industrial, commercial, and residential land uses. Burnt Mill Creek has >20% impervious cover and this level of concrete, roofs, and roads is known to correlate with environmental degradation, poor water quality, and varying degrees of human and wildlife health (Schueler, 1994; Mallin et al, 2000; Holland et al., 2004). The University of North Carolina-Wilmington (UNCW)

sampled six stream sites in the watershed and found the percent impervious cover was strongly correlated to poor water quality (orthophosphate, biological oxygen demand, and surfactants) (Mallin et al., 2009). Burnt Mill Creek has water quality problems including low dissolved oxygen, fecal bacteria contamination, algal blooms, and sediment plumes (Mallin et al., 2009). In addition, the Creek is on the state's impaired water body list (known as the 303d list) for aquatic life and secondary recreation from the impacts of urban stormwater runoff including polyaromatic hydrocarbons (PAHs).

Community stakeholders have worked together since 2001 to plan and implement watershed improvements that will lead to better water quality in the Creek. The NC Ecosystem Enhancement Program (NCEEP) sponsored the first watershed plan that identified the following two action items to improve water quality: 1) low-impact development retrofit techniques (for stormwater management and pollution prevention) and 2) stream restoration. NCEEP and City of Wilmington have been working on stream restoration and stabilization projects. NC State University's (NCSU's) Watershed Education for Communities and Officials (WECO) program, which facilitated the planning process, has coordinated a partnership with the City of Wilmington, the non-profit Cape Fear River Watch, NCSU Department of Biological and Agricultural Engineering (NCSU BAE), UNC-Wilmington, and several other community partners to identify, design, install, and monitor the stormwater retrofits in the watershed. Efforts have been funded by US EPA 319 grants and North Carolina Clean Water Management Trust Funds to collaborate with landowners, design and install retrofits, provide educational outreach to the community, monitor impacts, and address the PAH contamination issue.

Using Stormwater Low Impact Development Retrofits and Community Development to Restore Burnt Mill Creek

Potential retrofit sites were identified as areas with high impervious cover and close proximity to the stream (direct impact). The first step was to approach businesses and neighborhoods to identify common goals and determine their willingness to retrofit the sites. In Burnt Mill Creek, stormwater LID retrofits were completed at two businesses (Port City Java and the Wilmington Family YMCA), a residential community (Stonesthrow Townhomes), a municipal park, and throughout a neighborhood in partnership with a community advocacy group, The Bottom Neighborhood Empowerment Association (BNEA). The BNEA suggested installing stormwater LID retrofits in community spaces to increase awareness. Sites included Anderson Tabernacle Church, Gregory Elementary School of Science and Math, Williston Middle School, and Fannie Norwood Memorial Home. A summary of the watershed's stormwater LID retrofit sites is presented in Table 1 and includes information about the LID type, runoff treatment area, and associated costs, where available (Perrin, et al., 2008a).

Outreach, education, and community involvement were major and necessary major components of this project. The City of Wilmington had already laid a foundation of knowledge about stormwater BMPs by installing them as demonstrations at Ann McCrary Park. Through research they had found that while the community was knowledgeable, they were not installing BMPs. This project sought to provide hands-on assistance getting LID retrofits in the ground. Every potential partner was presented with information about stormwater runoff and benefits of LID retrofits, and asked how an LID retrofit might benefit them. NCSU and the City of Wilmington worked with community members to develop the most suitable LID for each site. In

particular, focused involvement with the BNEA resulted in the installation of 36 rain barrels (e.g., Figure 2) and 12 residential rain gardens. These stakeholder driven sites serve as educational tools for the community. A NCSU College of Design graduate student's survey showed that the Bottom Neighborhood respondents' stormwater management knowledge improved due to the project and the concepts were being shared throughout the neighborhood.

Reaching the general public through the media, public meetings, workshops, websites, newsletters, and educational signage were effective and essential pieces of this project's success. Taking these extra steps to engage the community takes time and effort, but it pays off with local buy in and local site knowledge.

During the site visit, CWP staff went to the Bottom Neighborhood and met homeowners that were extremely proud of their rain garden and/or rain barrel. Pairing small onsite low impact development demonstration sites with education and outreach is exemplary watershed stewardship!

Stormwater management requires a mix of BMPs with specific site designs that are tailored to meet site constraints, community resident needs, and often include additional services not always pre-identified or discussed in project write ups. In the Burnt Mill Creek watershed improvement plan several of these key services and tasks are described in the following:

- Media campaign in Wilmington to educate community before community meetings
  - Local television stations
  - Local newspapers
  - Online stories
- Public meetings
  - Two community meetings for neighbors of Mary Bridgers Park
  - Burnt Mill Creek Watershed Group
  - Coordinate local activities, plan community meetings, and revise watershed plan
  - Gregory Elementary School public celebration and volunteer recognition ceremony
- Low Impact Design retrofit meetings
  - Presentations to Stonesthrow HOA, Port City Java
  - Presentations at BNEA meetings
  - Three workshops in Bottom Neighborhood
  - Thirty-six rain barrels distributed
  - New rain garden locations identified
- Project website
  - Community outreach information available
  - Pictures, presentations, and pamphlets
- Newsletters and meeting summaries were distributed via mail and email
  - Over 100 stakeholders in the database
  - City of Wilmington stormwater newsletter in utility bills
- Educational signs (Figure 3) tell what the BMP is doing at the site and who is responsible
  - Port City Java, Wilmington Family YMCA, Stonesthrow Townhomes, Gregory Elementary, and Mary Bridgers Park
- All landowners provided with *Citizen's Guide to Protecting Wilmington's Waterways*, which contained BMP descriptions and maintenance instructions

These LID stormwater practices worked; NCSU reported high pollutant removal efficiencies for two BMPs (Perrin et al., 2008b). The results suggest that on the smaller scale retrofits remove pollutants from stormwater runoff and as retrofits are added to the landscape they collectively improve watershed stormwater management preventing harmful pollution from entering the Creek. NCSU LID site designs and details are available at WECO's website, in Perrin et al.,

Figure 2. Rain barrel in BNEA (WECO).

Figure 3. Educational sign for coastal stormwater demonstration project (WECO).

2008b, and in Wright et al., 2007. There is a need to continue stormwater retrofits in targeted areas that will likely provide the highest pollutant removals. The team recently received a new EPA 319 grant to implement innovative street retrofits to reduce runoff in the Bottom Neighborhood- the first of their kind in North Carolina.

Table 1. Low impact development stormwater retrofit projects and their treatment area and costs (Wright et al., 2007 and Perrin, et al., 2008a).

Retrofit Site	Stormwater Management Service	Runoff Treatment Area	Cost	Total Cost
Gregory Elementary School of Science and Math	Rain Garden Excavation (1300 ft^2)	9,000 ft^2 parking lot, 800 ft^2 of rooftop	$ 3,800	$ 5,980
	Vegetation, Mulch, Topsoil		$ 680	
	Cistern (500 gallon)		$ 1,500	
	Engineering and student volunteer time		0	
Williston Middle School	Rain Garden Excavation (1200 ft^2)	3000 ft^2	$ 5,200	$ 11,275
	Vegetation		$ 1,075	
	Cistern (2500 gallon)		$ 5,000	
	Student volunteer time		0	
Wilmington Family YMCA	Pervious concrete (6000 ft^2)	Half of the building rooftop, and parking lot	$70,000	$70,000
	Rain gardens (n=2) (1255 ft^2 and 390 ft^2)			
	Vegetation and volunteer time			
Port City Java	Rain garden/bioretention strip construction (n=2) with underdrain (~590 ft^2 each)	15,450 ft^2 (Store and treat 1 in of rainfall)	$ 33,000	$ 33,000
Mary Bridgers Park on Chestnut Street	Stormwater wetland (8605 ft^2) with City of Wilmington Stormwater services staff wetland construction, City of Wilmington equipment	5.5 acres of residential neighborhood collected via stormdrains	$ 22,276	$ 28,946
	Wetland plants and cypress trees		$ 4,670	
	Volunteer time		0	
	Other cost		$ 2,000	
Stonesthrow Townhomes	Stormwater wetland/bioretention (3860 ft^2) construction	5 acre multi-family and parking lot drainage area	$ 17,959	$ 20,348
	Wetland plants		$ 2,389	
	Volunteer time, plant donations		0	
Anderson Tabernacle Church	Rain garden (100 ft^2)	700 ft^2		$ 100
	Excavation, vegetation, and volunteer time		$ 100	
Fannie Norwood Memorial Home	Rain garden (200 ft^2) excavation	850 ft^2	$ 500	$ 700
	Vegetation		$ 200	

Practice flexibility and innovation to address land owner needs and site constraints

Site constraints may not appear until the project is underway, requiring flexibility in design and construction techniques. For example, the parking stops at the Port City Java site impeded parking lot sheet flow water and resulted in flooding, so the stops were raised to allow the water to flow under them into the bioretention area (Figure 4). Learning as much as possible about how the site is used helps in creating a design to meet the landowner's needs. The Port City Java bioretention area vegetation includes shorter trees and shrubs because the owners wanted to keep the view shed from their coffee house to their main headquarters open for coffee shop customers. At Anderson Tabernacle Church, the originally identified rain garden site was relocated after learning the congregation parked in that area for church services.

At the Wilmington Family YMCA site there was an initial meeting with the CEO and substantial follow up to receive the non-profit's board of director's approval. The Wilmington Family YMCA site includes three downspout disconnections to the two rain gardens (size: 1255 ft^2 and 390 ft^2) and permeable pavement (Wright et al., 2007). Retrofitting the Wilmington Family YMCA site increased local knowledge of the process and used local contractors (e.g., cement firm and constructors) to increase LID installation capability. Although there were reservations about losing parking lot spaces the CEO and members were pleased with how the final project looked and functioned. The Wilmington YMCA is proud to house a functional, attractive LID practice on their property.

Communicate through graphics. The Mary Bridgers Park project proposed a new wetland to the community using a concept design that was engineering based (Figure 5).

Figure 4. Parking stops were raised post retrofit to avoid flooding (WECO).

Community members were baffled by the engineered designs and were worried that it would be unattractive.

At their request, WECO recruited a Landscape Architect to render a design (Figure 6). The landscaped design concept was easier to understand by project partners, addressed their aesthetic concerns, and was therefore a more effective tool. WECO and partners worked with their clients to convey the stormwater management retrofits proposed in an easy to understand manner while keeping alternative designs and strategies on the table. Community involvement for the Mary Bridgers Park took time but was a necessary step to build community support. Once reluctant home owners became proponents, they offered better solutions for the project, such as a scenic bridge and dog waste station.

Partner with local champions to build trust, make connections, and leverage resources

This project engages a local champion, Hollis Briggs, head of the BNEA. Hollis helps translate information from the researchers and managers to the community

residents. During the CWP staff visit we met with Hollis at the school sites where he explained how he helps smooth the way and open doors for environmental work in the area. In addition, Hollis has a rain garden on his property and so do a few of his neighbors. Successful projects need cooperative and available public partners: WECO and NCSU BAE work closely with Dave Mayes, Head of City of Wilmington's Stormwater Services on all projects, and together built the Mary Bridgers Park wetland. While the City does not have the resources to apply for and manage grants, WECO provides this service and the City provides cost sharing in staff time and equipment. CWP staff met with Dave at the Mary Bridgers Park wetland where he explained the City of Wilmington's need for stormwater LID retrofits to improve water quality and stream channels. He said that working with WECO has been extremely beneficial for residents through improved collaboration and project assistance. He said the reason that he's eager to help WECO efforts, past and present, is that "It's the right thing to do." This positive attitude and good working relationship with local partners are a strong basis for continued collaboration.

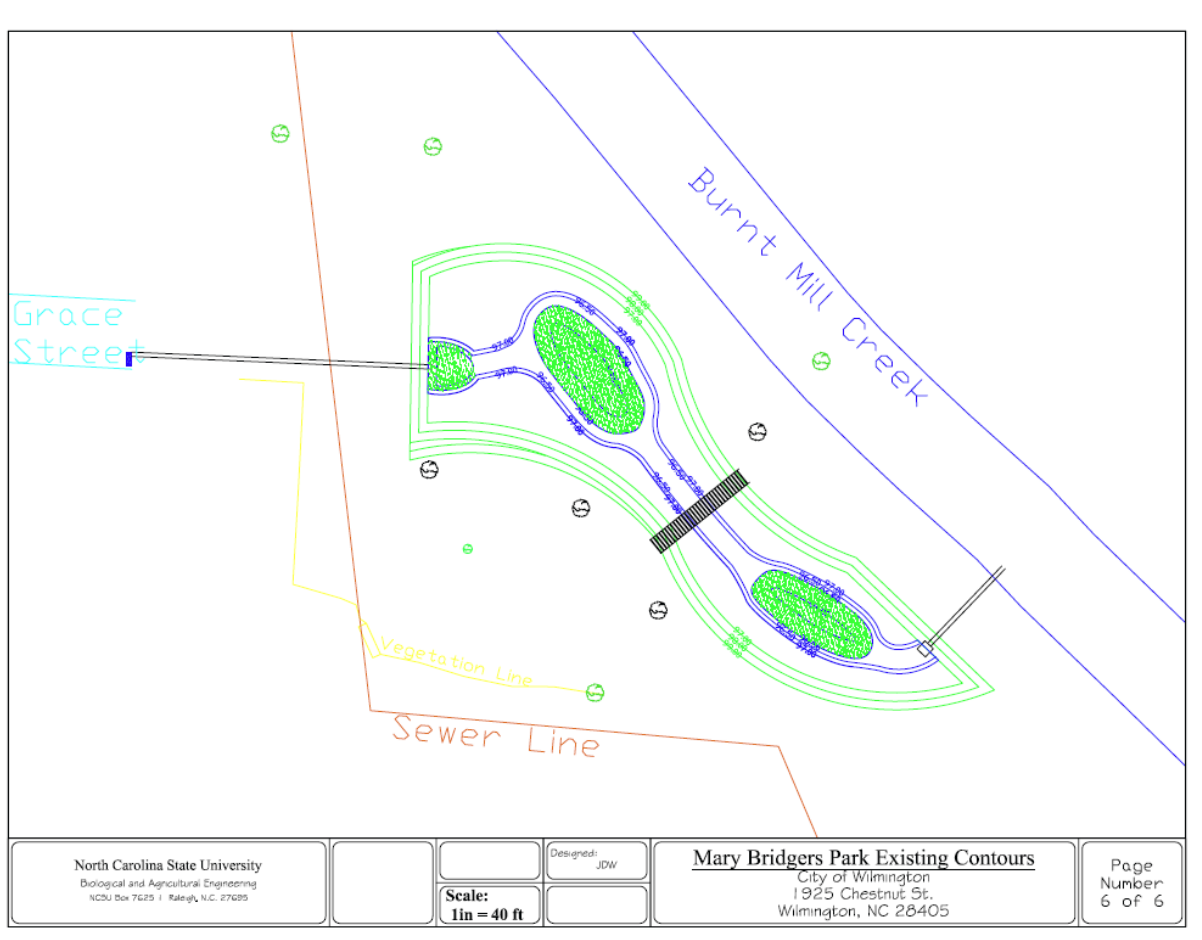


Figure 5. Engineering based concept design for Mary Bridgers Park. This design was done by NCSU Biological and Agricultural Engineering and reflects the bridge that community members requested. More designs are available online from WECO's website at: http://www.ces.ncsu.edu/depts/agecon/WECO/burntmill/index.htm

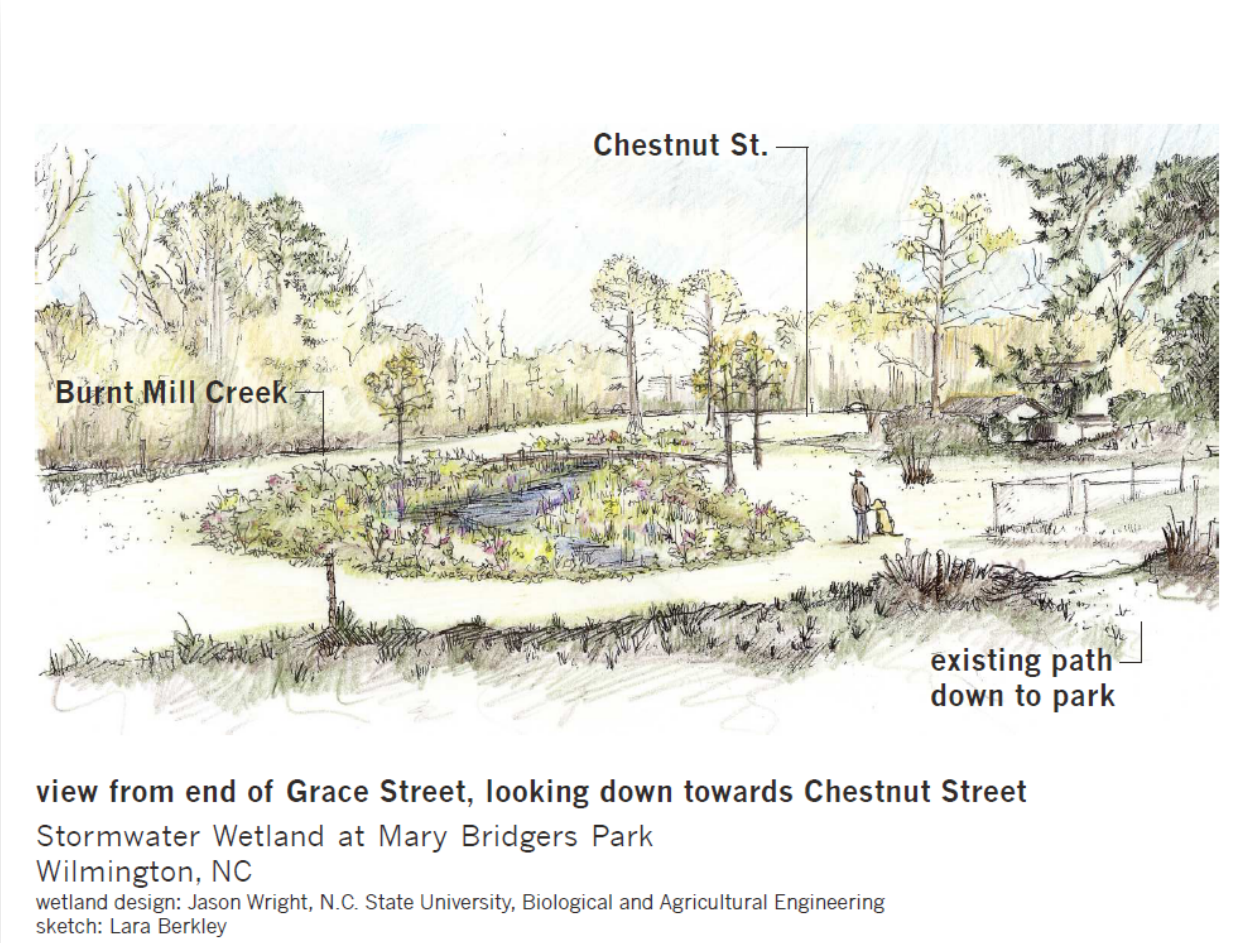
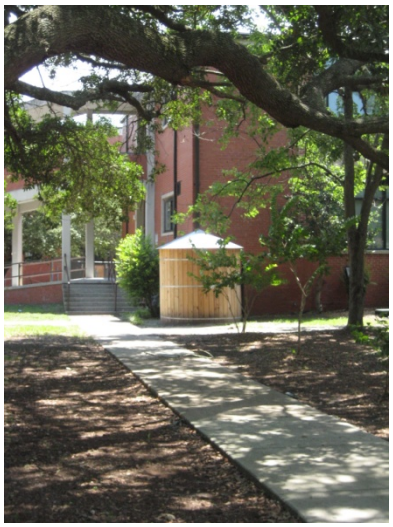


Figure 6. Landscape architect rendering for Mary Bridgers Park that is based on the engineering design done by Jason Wright (NCSU Biological and Agricultural Engineering). This design was done by Lara Berkley.

Table 2. Low impact development stormwater retrofit projects described in Table 1 are pictured here.

Retrofit Site	Site Pictures	
Gregory Elementary School of Science and Math	 Education and outreach sign	 Stormwater is redirected from the drain to the bioretention area
Williston Middle School	 Cistern	 Bioretention area

<table>
<tr>
<td rowspan="2">Wilmington Family YMCA</td>
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Educational sign</td>
<td> 
Downspout disconnection to pervious pavement and bioretention area</td>
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<td> 
Pervious pavement and bioretention area</td>
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<tr>
<td>Port City Java</td>
<td> 
Bridge and educational sign for the bioretention</td>
<td> 
Allowing parking lot water to flow into bioretention area</td>
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Bioretention area before a sampling point

Sampling equipment near the outfall

Parking lot stops raised to prevent flooding

Wright found that the Port City Java bioretention cells had high pollutant reduction efficiency: fecal coliform bacteria (52%), total nitrogen (56%), total phosphorus (59%), total suspended solids (93%), and PAHs (91%) (Perrin et al., 2008b).

<table>
<tr><td rowspan="2">Stonesthrow Townhomes</td><td> 
Constructed wetland</td><td> 
Community involvement in planting (and hopefully maintenance)</td></tr>
<tr><td colspan="2">Photos courtesy of Christy Perrin, WECO.

Stonesthrow Townhomes had high pollutant reduction efficiency: fecal coliform bacteria (97%), total nitrogen (76%), total phosphorus (68%), and total suspended solids (84%) (Perrin et al., 2008b).</td></tr>
<tr><td>Anderson Tabernacle Church</td><td> 

Rain garden</td><td> 
Downspout disconnection</td></tr>
</table>

<table>
<tr><td rowspan="3">Fannie Norwood Memorial Home</td><td> 
Rain garden</td><td>  </td></tr>
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Mary Bridgers Park constructed wetland educational signs</td></tr>
<tr><td> 
Looking from the bridge to the wetland</td><td></td></tr>
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Ann McCrary Stormwater Demonstration Park

Rain garden and educational sign

Pervious parking lot and educational sign

Dog waste stations

Rain barrel educational sign

Weir slows down stormwater runoff sheetflow

Lessons Learned

- Although consultants who completed the original watershed plan identified a number of potential BMP retrofits using aerial maps, all were determined infeasible after site visits. All subsequent retrofits were identified by speaking with community members and conducting windshield surveys of the watershed.
- The first landowner approached for an LID stormwater retrofit was a large commercial parking lot owner, but he was not interested in the project since he worried it would limit his options for the property. However, with the Wilmington Family YMCA, Mary Bridgers Park, BNEA, and additional partners, it may be easier to engage other commercial landowners in the future. Starting with publicly-owned retrofits gets demonstrations in the ground.
- Planting eye-level shrubs in parking lot island retrofits will help prevent drivers from entering the BMP.
- Allow ample time to coordinate with landowners and community stakeholders before, during, and after BMP installation.
- Include educational signage at every public site to improve local BMP knowledge and explain what the stormwater LID is doing.
- Engineering designs are essential for the job, but more artistic site renderings are better for communicating to the public.
- Community involvement, awareness, and pride are major goals that supplement water quality and water quantity control benefits, but may not necessarily be reflected in quantifiable water quality or water quantity control goals.
- Keeping eyes open at all times to find new opportunities is an essential element (Port City Java burned down, opening the door for discussions about retrofits during reconstruction).
- Flexibility in timelines and project designs are important when working in an urban area with many stakeholders and physical constraints.

Key Findings and Next Steps

The Burnt Mill Creek coastal stormwater LID example highlights a long term investment of time, money, and effort from various stakeholders to educate the community, promote better site design, implement watershed plans, and monitor the LID retrofit benefits. The final project report highlights the extensive collaboration and appreciation for the project stakeholders (Figure 7). Community involvement was achieved through mailings, attending neighborhood meetings, holding workshops, design meetings, media coverage, and high visibility retrofit projects throughout the neighborhoods (e.g., Figure 3 and 4).

This project has numerous educational tools available online at www.ncsu.edu/WECO/burntmill that serve to continue to educate and promote stewardship for this project. Importantly, signs at the retrofit sites draw attention to the BMP and inform the citizen about the function and importance for stormwater management in their neighborhood.

A pollutant of concern identified in the watershed was polycyclic aromatic hydrocarbons (PAHs), many of which are toxic and/or carcinogenic to aquatic animals and humans. PAHs are believed to enter the waterways from the high number of parking lots and roadways draining to the creek. Recent studies indicate that parking lots sealed with coal-tar based sealant are sources of PAH contamination (Stormwater Runoff, 2009). NCSU evaluated existing research on this emerging contaminant and is publishing a NC Cooperative Extension factsheet on preventing PAH contamination in waterways. The new fact sheet will be distributed throughout Wilmington and made available for widespread use via download from WECO's website at www.ncsu.edu/WECO. The LID retrofit at the Port City Java site reduced PAHs entering the bioretention cells from the parking lot by 91% (Perrin et al., 2008b).

The project team (WECO, NCSU, UNCW, the City of

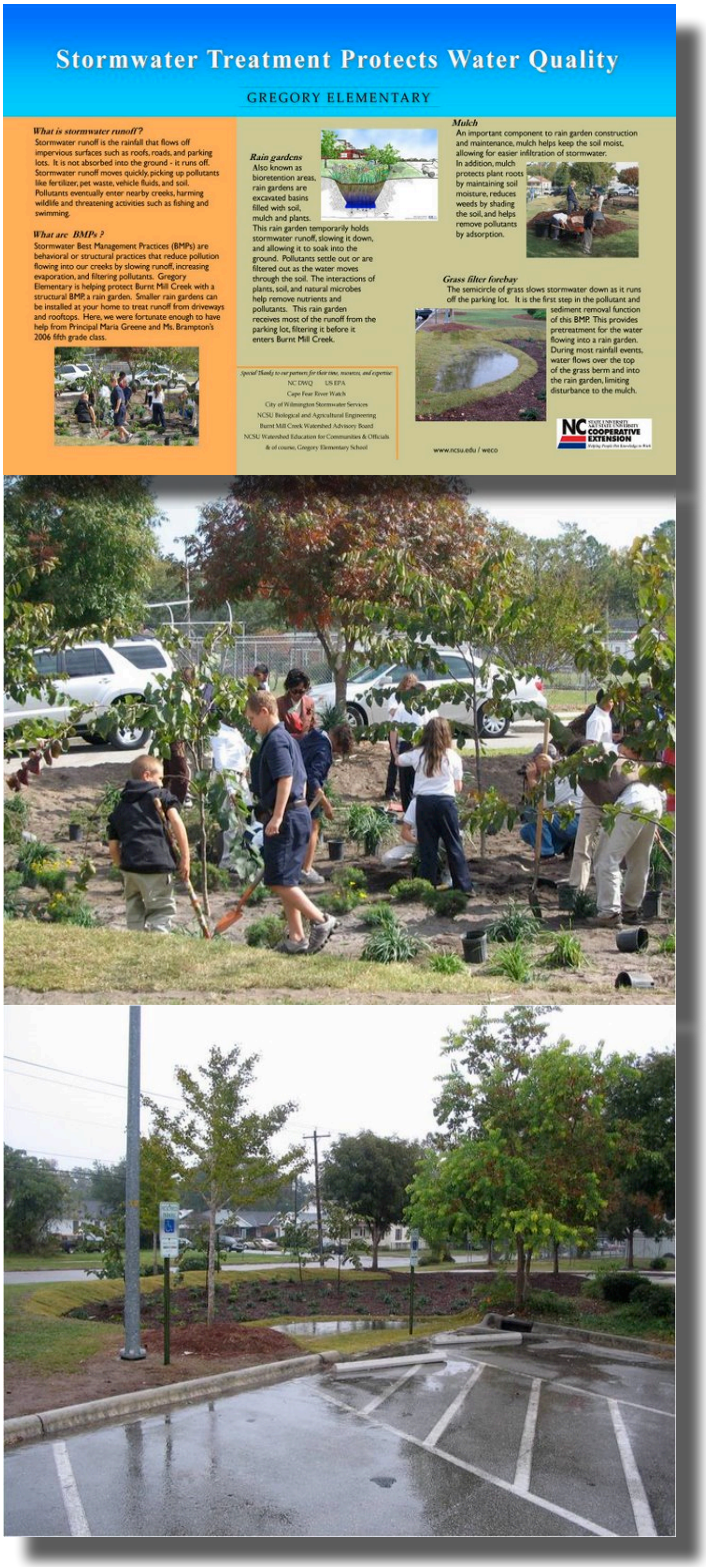

Figure 7. Gregory Elementary School demonstration site (WECO).

Wilmington, and Cape Fear Riverwatch, Inc.) continues to identify areas for improvement and to seek funding sources. They will next use EPA 319 funds to install innovative street retrofits in the Bottom Neighborhood. The project will provide a model for other the City and other NC communities to retrofit their streets.

These efforts used local key resources such as The Citizen's Guide to Protecting Wilmington's Waterways, and Low Impact Development: A Guidebook for NC to enable a productive and sustainable coastal stormwater LID retrofit program. Project partners continue to communicate with LID site landowners and residents to ensure long term LID function and assessment. In addition, project partner's initial success stories in the watershed will ease the path for future stormwater LID projects.

Additional Resources

The Citizen's Guide to Protecting Wilmington's Waterways

www.wilmingtonnc.gov/public_services/stormwater/publications_videos.aspx

Step by step guide for stormwater BMPs that explains what they are, what their purpose is, how to install, and plant selection guidance

Low Impact Development: A Guidebook for NC

http://www.ces.ncsu.edu/depts/agecon/WECO/lid/documents/NC_LID_Guidebook.pdf

Provides technical and policy guidance to local and county government staff, building professionals, and consultants

Thanks to Christy Perrin and Patrick Beggs with WECO for providing a site tour, supporting documents, and product feedback. Also, thanks to Hollis Briggs and Dave Mayes for gathering information and meeting us on site!

For additional information on the Burnt Mill Creek watershed plan and restoration please contact:

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