Gambles Mill Corridor
Water Management Proposal

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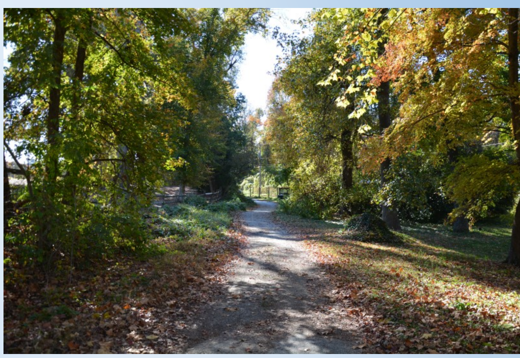
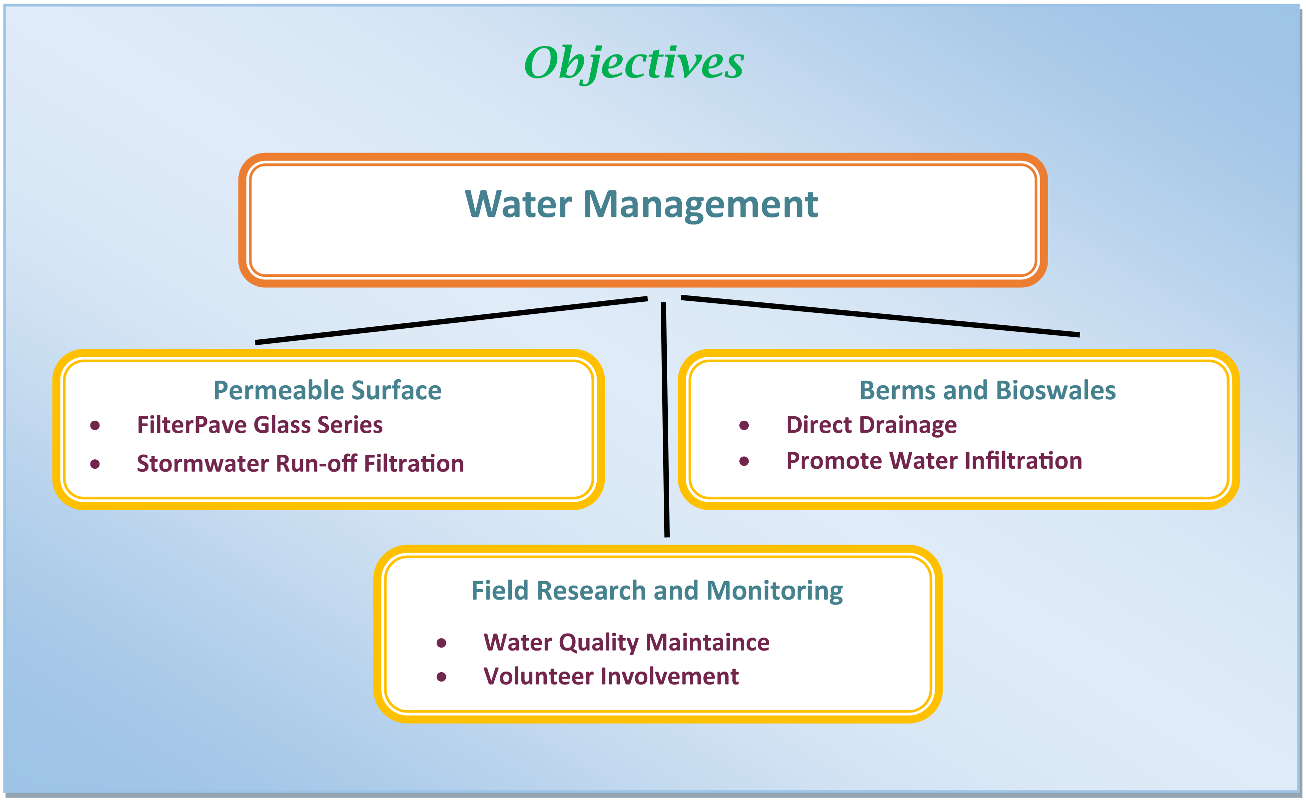
Abstract



The Gambles Mill Corridor is an excellent location to implement best water management strategies while also improving the trail experience for visitors to the Corridor. The Gambles Mill Trail would be an ideal place to test a pervious surface trail, improve the water quality through the use of bioswales and berms, and increase student participation in environmental practices through water quality monitoring in the Little Westham Creek. We propose to repave a section of the trail with pervious surface and use bioswales and berms to decrease surface runoff and pollutants in the water. Involving students in testing the water quality throughout the year can provide experience for the students while improving the health of the Little Westham Creek.

Introduction & Background

The University of Richmond has made significant strides towards becoming an environmentally-friendly campus through various projects such as switching from burning coal to natural gas in 2011 in order to reduce greenhouse gasses, implementing a 22,000-square foot array of solar panels in the spring of 2016, and receiving LEED certifications for new buildings. (Sustainability report). To build off of the compounding environmental benefits of past successful projects, we propose a plan that would increase the use of permeable paving surfaces and reduce storm water runoff, all while including students in the process through environmental jobs and monitoring projects. Acting upon this proposal would further demonstrate the University's commitment to sustainable practices by addressing the serious water quality concerns surrounding the Little Westham Creek and the James River Watershed in which the university is located. This is an opportunity to implement an eco-friendly initiative that will showcase the University's commitment to sustainable development.



Permeable Surface

Permeable paving allows rainwater to percolate through the paving and filter through the ground. Alternatively, the impermeable surfaces currently used around campus facilitate the direct transmission of harmful substances found in stormwater runoff into water sources such as streams and rivers (Sholz & Grabowieki, 2006; Metropolitan Area Planning Council). In an effort to reduce the negative effects of stormwater runoff, we propose to repave the trail with a permeable surface called FilterPave Glass Series. The new trail would provide higher filtration rates of 100 gallons of water per hour/per sq.ft and a significantly lower chance of clogging due to its doubled sustainable void space compared to other pervious pavements, while also creating a more attractive surface (Specification Summary; Challenge for Sustainability). This highly porous pavement consists of 40% post-consumer recycled glass, 60% regionally sourced stone, and a proprietary pigmented binder (*Attractive Porous Paving Porous Paving for for Stormwater Management: FilterPave Glass Series, 2017).* FilterPave also holds up better than other types of porous pavements by using a binding material that can expand and contract with freezing and thawing water, which means it does not easily buckle during the winter months (Challenge for Sustainability, 2017; FilterPave FAQ). In a water quality sample study conducted at the Stormwater Management Academy at the University of Central Florida, they found a 33% reduction in phosphorous and nitrogen based on a 25 year design (Stormwater Management Academy). The pervious surface has a strong compressive strength of an average of 1160 psi and flexural strength of 508 psu, which is stronger and more flexible than pervious

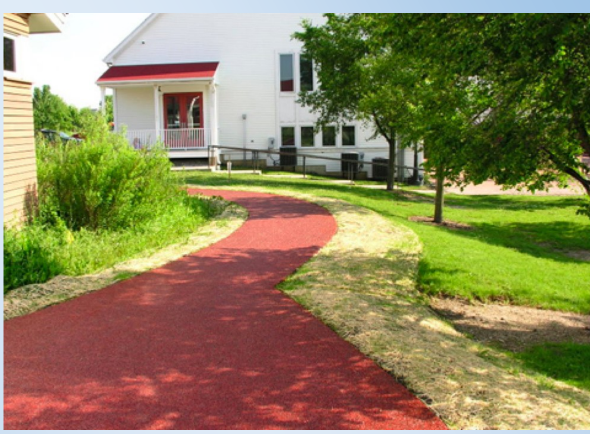


Figure 1: FilterPave Sedona Red

Figure 2: Close up of FilterPave Sedona Red

concrete or porous asphalt (Specification System). We propose to repave 20% of the 0.5 mile trail with FilterPave to demonstrate the benefits of a pervious surface trail. The trail will use approximately 90 glass bottles in every square foot of paving and will use about 237,600 for 20% of the trail (Eco-Friendly Bonded, Recycled Glass, 2017). FilterPave costs approximately $8.50-$18 per square foot, and the approximate total cost for 20% of the 0.5 mile by 5 foot wide trail is $34,320 (Challenge for Sustainability). FilterPave provides a wide variety of colors, but Sedona Red matched the school's theme best as seen in Figures 1 and 2 (Prairie Crossing School - Grayslake, Illinois, 2017). To help maintain the trail in the future, periodic vacuuming will help maintain infiltration rates and will require a poly-surface overcoat every two to three years depending on traffic load to prevent shedding *(Challenge for Sustainability, 2017).*

Field Research and Monitoring for the Little Westham Creek

Every day water crosses watershed boundaries and comes into contact with human beings and their activities, creating situations where water can be polluted. This together with a growing population and a precious supply of fresh water, makes the protection of water for designated and beneficial uses of paramount importance. This therefore calls for continuous water monitoring of our water pathways to ensure these waterways are maintaining the Total Maximum Daily Load (TMDL) in order to meet water quality standards.

Our water monitoring strategy for the Little Westham Creek signifies our vision to fulfill the Clean Water Act responsibilities and is paramount to our objective of improving the overall health of the James River Watershed. It demonstrates our commitment to achieving better water quality through continuous monitoring that is structurally integrated with the key assessment and management requirements as recommended by the United States Environmental Protection Agency (USEPA) and the Water Quality Bureau's Strategic Plan. We hope to use condition information and tools, quantitative performance tracking, enhanced quality assurance and control procedures, and resource condition sharing towards realizing a comprehensive water monitoring and assessment strategy.

Methodology

Monitoring will be done using a Targeted Watershed Approach (TWA).

Average width (m)	Mean depth (m)	Estimated distance for complete mixing (km)
5	1 2 3	0.08-0.7 0.05-0.3 0.03-0.2
10	1 2 3 4 5	0.3-2.7 0.2-1.4 0.1-0.9 0.08-0.7 0.07-0.5
20	1 3 5 7	1.3-11.0 0.4-4.0 0.3-2.0 0.2-1.5
50	1 3 5 10 20	8.0-70.0 3.0-20.0 2.0-14.0 0.8-7.0 0.4-3.0

Table 1: Estimated distances for complete mixing in streams and rivers (*A. Mäkelä and M. Meybeck, 1996).*

1. Site Selection

In this proposal, we shift the emphasis on water quality management efforts from detection of typical stream violations to the assessment of overall trends in water quality. This is because of various complications in compliance monitoring, such as intermittent or random sampling practices and incorrectly selected sampling locations perchance (*A. Mäkelä and M. Meybeck, 1996).*

We are therefore proposing monitoring stations that capture the general condition of the creek, guided by the rule of thumb that sampling stations on rivers should be established at places where the water is sufficiently mixed for only a single sample to be required (*A. Mäkelä and M. Meybeck, 1996).* We have used Table 1 to find zones of complete mixing and therefore possible sampling stations on the Little Westham Creek. However, we advocate for several samples to be taken across the width of the river to allow for the possibility of incomplete mixing. Figure 3 in the appendix shows the proposed sampling location in the Little Westham Creek.

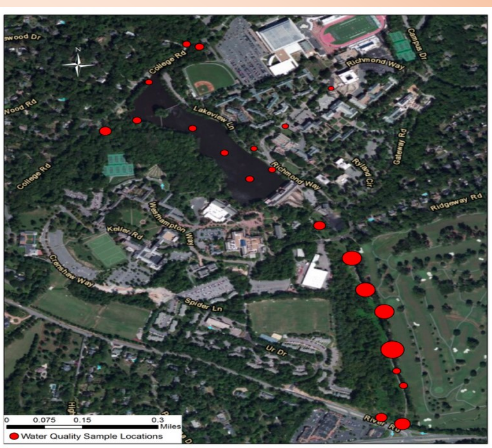


Figure 3: Proposed sampling stations in the Watershed.

These points represent points of excellent vertical and laminar water mixing.

2. Water Quality Indicators

Monitoring in the watershed will be based on long-term trend water monitoring and studying population of macro invertebrates (*Wisconsin's Water Monitoring Strategy, 2015-2020).*

Study name	Parametrs	Purpose
Long-term Trend Water Quality Monitoring	i) Field Data - Dissolved Oxygen, Temperature, pH, Conductivity and Turbidity ii) Nutrients - Ammonia, Nitrate + Nitrite, Phosphorus	Provide site specific condition assessment and attainment. Provides large scale view of major constituent loading and broad perspective on landscape such as climate change.
Biotic Index Baseline Study	Population of macroinvertebrates	Provide site specific biological assessment and attainment using a macroinvertebrate index of biological integrity (mIBI) over time.

Table 2: Water monitoring strategies, parameters measured and purpose of study.

3. Sampling Frequency

Just like in our sampling station selection, our proposed frequency criterion is based upon the assumption that our primary objectives is determination of ambient water quality conditions and an assessment of yearly trends rather than detection of stream or effluent standards violations. For any stream, the sampling frequency criterion is derived as a function of the random variability of the river flow. The criterion is specifically related to the magnitude of the expected half width of the confidence interval of the mean of the random component of the annual statistic-mean log river flow (*A. Mäkelä and M. Meybeck, 1996).* Therefore, we propose an interval of one month between the collection of individual samples which is the generally acceptable standard for characterizing water quality over a long time period whereas for control purposes weekly sampling may be necessary (*A. Mäkelä and M. Meybeck, 1996).* If significant differences are suspected or detected, samples may have to be collected daily or on a continuous basis.

4. Maintenance

We recognize the importance of maintenance in encouraging a perpetual water monitoring plan in the watershed. We also realize the conflict of interest between monitoring and outreach activities. For outreach, you want to maximize the number of people involved, but for good science, you want to limit the number of people involved to a minimum, in order to ensure consistency (Paul Bukaveckas VCU Water Monitoring).

Therefore it is inevitably helpful to have a written set of protocols, and someone on campus who can provide long-term oversight on data quality and who would help to ensure that our data is comparable over the time frame of the monitoring efforts. We therefore propose, offering the monitoring responsibility as a paid job on campus. This will encourage consistency in data collection and analysis and will provide an excellent opportunity for students in Environmental Sciences an opportunity to engage hands on with monitoring activities. There have also been increased water monitoring efforts by volunteers in the country. Across the country, trained volunteers are monitoring the conditions of their local streams and other water resources. This action called 'volunteer monitoring' is encouraged by the US Environmental Protection Agency (*USEPA Volunteer Stream Monitoring: A Methods Manual, 1997).* USEPA acknowledges that streams and rivers are monitored by volunteer programs more than any other water body type. It will therefore be useful to involve volunteers in water monitoring efforts in the Little Westham Creek. Volunteer monitors have proved to build community awareness of pollution problems, help identify and restore problem sites and are advocates for their watersheds.

This will supplement outreach activities while at the same time fostering monitoring efforts.

Bioswales and Berms

Bioswales are broad, vegetated earthen channels designed to slow and reduce stormwater runoff while filtering pollutants (Department of Conservation & Recreation, 1999: 3.13-1). The drainage path, along with the vegetation, is designed to maximize the amount of time stormwater remains in the bioswale, enabling more pollutants to be filtered out (Gibb, 2015). Berms are a mound of earth with sloping sides between to areas of equal vegetation (Wilkins and Bennett, nd). With the use of bioswales and berms along the trail to control runoff from the golf course and surrounding neighborhoods, the water quality within the Gambles Mill Corridor and Little Westham Creek will be greatly improved. At the same time, the Corridor can be utilized as a center of promotion for environmentally sustainable practices while also improving the aesthetics of the area through the planting of native grasses, wildflowers, and shrubs within the bioswale. This native vegetation can also serve as a habitat for wildlife as birds, bees, and other small animals will be attracted to the mix of grasses and small shrubs.

1. Bioswales:

Bioswales have numerous impacts on the environment. In the short term, a four meter stretch of bioswale can reduce the runoff from a typical small road to about 25 percent of total rainfall (Capital Regional District, nd). In heavy rainfall events, this reduces pollutants in the stream in the short term, and helps to slow stream bank erosion in the long term by mitigating the level of flooding caused by heavy rain. Bioswales also have a positive effect on the environment day to day through water filtration. A 2006 study of grassed bioswales along a highway median showed bioswales to be effective at removing total suspended solids (65-71% removal) and zinc (30-60% removal) (Caflish and Giacalone, 2015). While the Gambles Mill Trail is smaller than a highway and therefore produces less runoff, the proposed bioswale would also be treating the larger amount of runoff from the golf course and therefore have a significant impact on the health of the Little Westham Creek, as well as the James River, of which the Little Westham Creek is a tributary.

Figure 4: Cross section of bioswale proposed for the Gambles Mill Corridor.

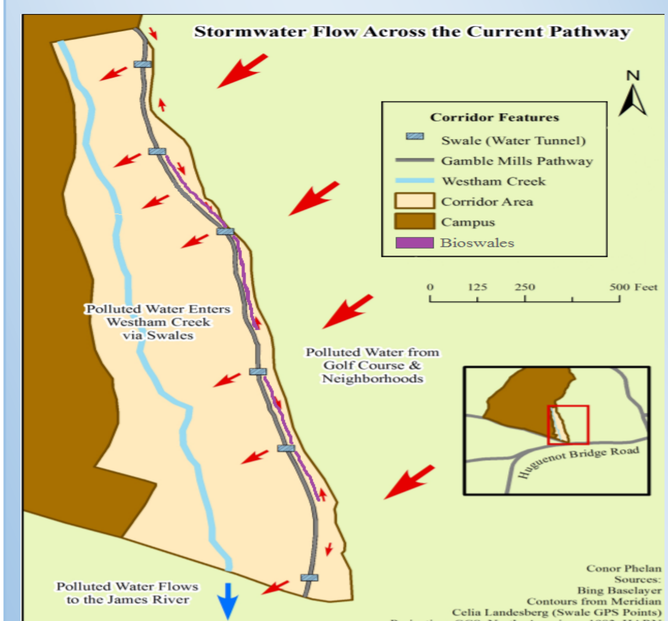


Figure 5: Map of Gambles Mill Corridor with drawn in bioswale locations.

2. Trail Berms:

Berms are another important piece of the green infrastructure which we propose for the corridor. In order to maximize the effectiveness of the bioswales, we propose the implementation of a trail berm along a majority of the trail. The berm would run parallel to the trial and bioswale and directly in between them. The design would be the following: golf course into bioswale, second bank of the bioswale would form one side of the berm, the second slope of the berm would go down towards the trail. In other words, looking down the trail towards river road, the order from left to right would be golf course, bioswale, berm, trail, with the first bank of the bioswale and the trail standing at approximately the same elevation. The effect of the berm would be twofold. First, it would allow stormwater to be effectively guided into the bioswales for maximum infiltration and treatment. Second, it would promote infiltration itself by preventing stormwater runoff from directly crossing over the trail and into the Little Westham Creek. Our proposal estimates that a one foot tall, packed dirt trail berm, with a three to one slope on each side, would be beneficial in preventing direct flow of stormwater into the Little Westham Creek. In order to prevent erosion of the trail berm, it should be vegetated with grass as well. The estimated cost of installing this trail berm is $15,000.

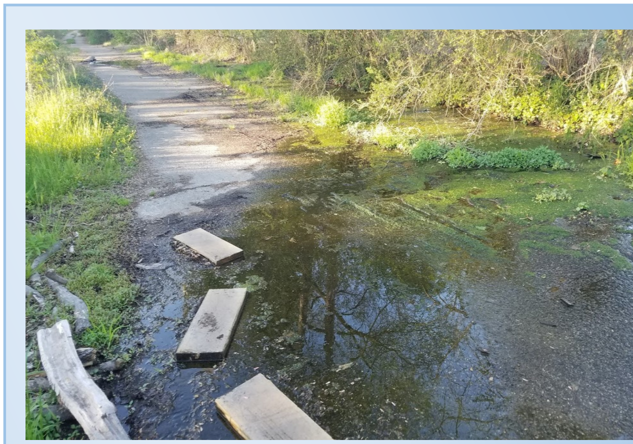


Figure 6: Flooded portion of the Gambles Mill Trail

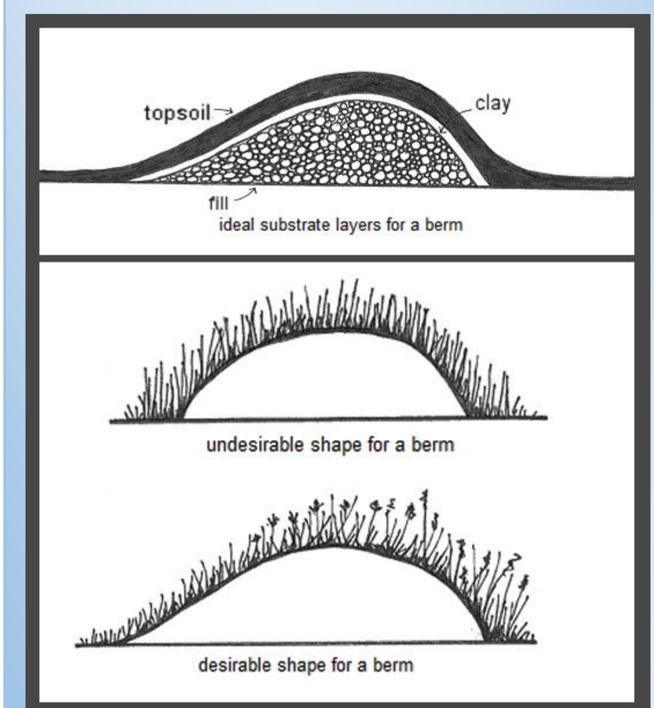


Figure 7: Ideal Berm Design

Outcomes Discussion and Conclusion

While the Gambles Mill Corridor is a relatively small area, it still functions as a tributary to the James River and the Chesapeake Bay. Additionally, the Corridor has the potential to transform the way University of Richmond students view and interact with the natural environment. The installation of berms and bioswales would improve water quality through the natural filtration processes of native plants while also promoting ground infiltration. Furthermore, the vegetation of the bioswales with native species improves the overall aesthetic appeal of the area. Another way to increase ground infiltration is to repave sections of the impermeable asphalt trail with a new permeable surface, FilterPave being a prime example. Water quality monitoring stations are paramount to the development of educational initiatives that drive students to establish a closer relationship with the natural environment and become better stewards of the earth.

The natural landscape that makes up the Gambles Mill Corridor creates the perfect opportunity to showcase the University's commitment to sustainability, as stated in both the 2011 Master Plan and the most recent Sustainability Report. This opportunity to environmentally redesign the corridor is unique for several reasons. The University of Richmond has a tract of land that is severely underutilized, and that not many students know or care about. While the repaving of the trail will help connect students to the James River, it is the actions that we propose that will turn the Gambles Mill Corridor from a simple walking path into a community space that will be a demonstration of how to integrate sustainability and environmental stewardship into our everyday lives.

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