Healing the **E**cosystem in **N**ewark's **S**tream (HENS)

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Background

Blue Hen Creek is located in a Piedmont sub-watershed within the University of Delaware's experimental watershed. The experimental watershed was created in 2001, by undergraduate students at the University of Delaware, and funded by the Delaware Water Resources Center. It was designed to be used for education and research for the study of water resources on campus.

Blue Hen Creek is responsible for draining 281.6 acres of the experimental watershed. It is a 1st order tributary to the White Clay Creek and is approximately 1.16 miles in length. The creek headwaters at Newark Country Club Golf Course and flows southeast through the University of Delaware's Laird Campus until it reaches White Clay Creek. Further upstream is New London Road. In the 281.6 acres that Blue Hen Creek drains, the primary land uses are residential, commercial, and forested. Approximately 47% of the area surrounding Blue Hen Creek is residential, while 15% is commercial and 33% is considered forested. Combined, this gives the watershed 33% impervious coverage.

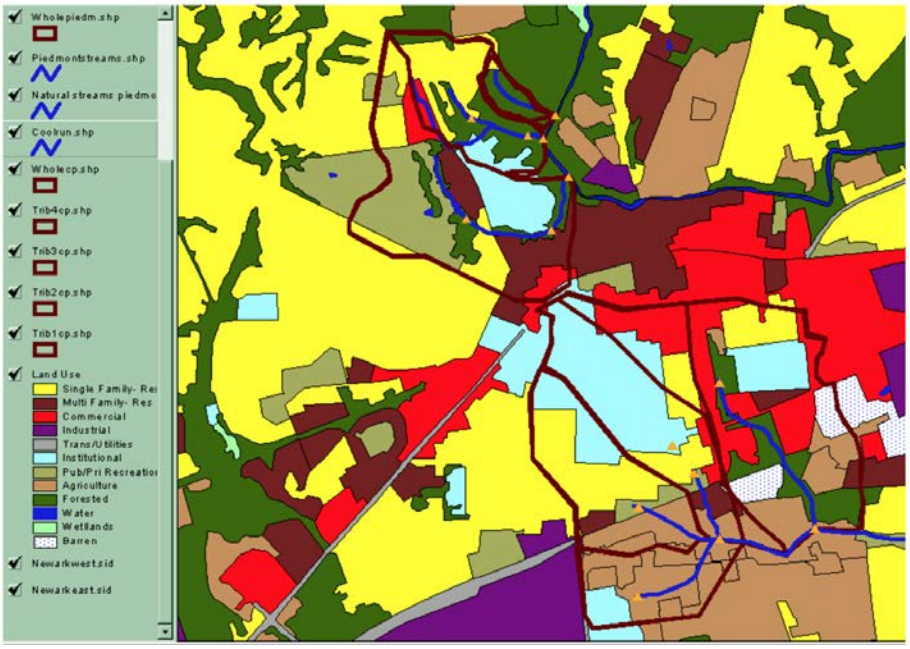

Figure 1. A GIS Layout of Land Uses in Areas Surrounding Blue Hen Creek (Harrell, 2002)

Based on its impact on the water quality in Blue Hen Creek, each land use was assigned a number. A lower number indicates that particular land use has a greater impact on water quality. Agricultural areas were assigned a 2 because of the chemicals within fertilizers and herbicides that are used. Culprits of these chemicals in Blue Hen Creek come from the Newark Country Club Golf Course, and surrounding farm and pasture land. Commercial areas, such as shopping centers, were also assigned a 2 due to the high amount of impervious coverage and increased runoff. Multi-family residential areas were assigned a 2, while single family residential areas

received a 3. This is due to large spaces between houses, and of lawns and wooded areas that tend to be present in neighborhoods of single family homes. Institutional areas are comparable to single family residential areas, as they also tend to contain open spaces. Wooded areas and public or private open spaces were given a 4 because they typically have little to no impact from human activities.

Land Use	Rating	Equation
Multi-family Residential	2	2 x (# multi-family acres/total # acres in sub-watershed)
Agricultural	2	2 x (# agricultural acres/total # acres in sub-watershed)
Commercial	2	2 x (# commercial acres/total # acres in sub-watershed)
Single Family Residential	3	3 x (# Single family acres/total # acres in sub-watershed)
Institutional	3	3 x (# institutional acres/total # acres in sub-watershed)
Wooded	4	4 x (# Wooded acres/total # acres in sub-watershed)
Public/Private Open Space	4	4 x (# open space acres/total # acres in sub-watershed)

Table 1. Land Use Grade Equations (Campagnini, 2001)

The runoff that results from impervious surfaces tends to increase erosion and nutrient runoff, and decrease habitat quality. The risk of erosion is increased with the increase in water flow caused by the inability of runoff to permeate into the ground. When fertilizers, herbicides, garbage, or any other toxic substance gets carried by runoff and enters the stream, it negatively impacts water quality and naturally decreases habitat quality. Based on the rating system created by Anne Kitchell and the Water Resources Agency, ratings of 3 and 4 are good. A rating of 2 indicates that there is between 10 and 25 percent impervious coverage within the watershed and water quality is likely impacted. Impervious coverage that exceeds 25%, a rating of 1, is unable to support aquatic life and needs to be improved. The areas that are most damaging to Blue Hen Creek are commercial, multi-family residential, institutional, and single family residential.

Rating	Watershed Imperviousness	Impact to Stream
4	0%	No Impact
3	0-10%	Sensitive
2	10-25%	Impacted
1	> 25%	Non-Supporting of Aquatic life

Table 2. Impervious Cover Rating Scale (Campagnini, 2001)

Land Use	Impervious Factor (%)
Commercial	85
Multi-Family Residential	65
Institutional	55
Single Family Residential	30
Wooded	0
Agricultural	0
Public/Private Open Space	0

Table 3. Impervious Cover Factors of Land Uses (Campagnini, 2001)

History

The Laird Campus at the University of Delaware is the home of the Blue Hen Creek. This campus houses thousands of students and in 2004 the George Read dorm was constructed to replace the outdated Pencader complex that consisted of twelve residential buildings and three common buildings. This new construction cost the University of Delaware $72 million. In 2005 the Thomas McKean and James Smith Hall were constructed. The current Laird Campus is made up of four residential halls, the Christiana Towers, the Pencadar dining hall, a conference center, and a hotel. The Christiana Towers are no longer in use by the University and scheduled for demolition because of the age and price of maintenance.

Figure 2. Aerial View of Laird Campus Housing

Policies and Mandates in Place

Based upon the EPA's (Environmental Protection Agency) regulations, the University of Delaware worked alongside the City of Newark in establishing the storm management program, fulfilling the conditions of the NPDES (National Pollutant Discharge Elimination System), which targets a wide array of sectors such as pollution preventions, public participation and

education, construction runoff control, and unlawful discharge detection. Furthermore, the University of Delaware introduced University Policy 7-49 Storm Water Management in 2004, with following revisions in 2006 and 2014, that serves in protecting the storm water system by prohibiting University employees, students, and contractors from disposing chemicals into drains leading to it without authorization according to the Environmental Health and Safety.

Mission Statement

Blue Hen Creek is located on Laird Campus at the University of Delaware, considering it part of a Piedmont sub-watershed and the University of Delaware's experimental watershed. The headwater of the stream is located at Newark Country Club Golf Course and it flows until it reaches White Clay Creek. With runoff from the country club at the headwater of the stream, combined with the impervious coverage from surrounding developed land, it raises concern for the health of Blue Hen Creek. Based on previous surveying, Blue Hen Creek received an overall grade of C due to concerns surrounding the overall health of the creek including sediment deposition, channel flow, bank stability, and riparian vegetation in regard to habitats (Harrell, 2002). This provides an opportunity for HENS to improve the overall health of Blue Hen Creek by addressing issues regarding runoff, impervious coverage, and wildlife habitat.

HENS's mission is to target current issues in a stream that runs through the University of Delaware's Laird Campus, Blue Hen Creek, and to raise its current assessment grade of a C to a B- by the year 2035.

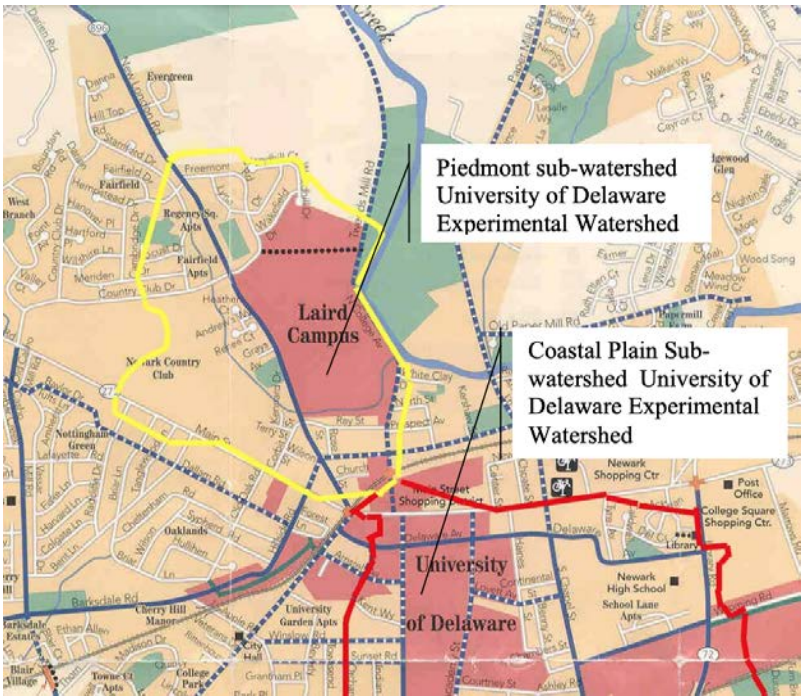

Figure 3. The University of Delaware Experimental Watershed (Campagnini, 2001)

Problems

HENS aims to improve the overall health of Blue Hen Creek by addressing three culprits affecting the watershed's final grade. The three areas of concern include erosion, stream habitat quality, and alkalinity and phosphate content.

Problem	Description	Causes
P1. Erosion	Areas of extreme erosion are present where broken slabs of concrete were placed down one side of the bank to keep it from falling in as well as near New London Road (Rte. 896).	33% impervious cover within the University of Delaware's experimental watershed has increased the amount of runoff. A highly invasive species, multiflora rose, is present along the stream banks and has forced out a majority of the natural vegetation.
P2. In Stream Habitat Quality/Degradation	In one survey, Blue Hen Creek's Habitat received a score of "moderate" in terms of stream habitat. In a later study, the score was "low", which is indicative of an underlying issue affecting the habitat. However, the degradetion is not too extreme, and there is potential to reverse it to a healthier state.	Humans could have impacted the overall ecosystem of the stream as a result of inadequate waste treatment, and thus affected the composition and life cycles of the habitat. Also, multiflora rose is severely hindered other life. The habitat/stream's health is heavily reliant on the chemical quality tests of the water as well as physical objects. Extreme streambank erosion near 896.
P3. Nutrient Runoff	The Blue Hen Creek has abnormally high amounts of algae from the nutrient runoff from the surrounding areas. The nutrient runoff contains phosphorus and nitrogen and when there is an excess of those two things in the water, the algae grows faster	There is increased nutrient runoff from residential areas and Newark Country Club Golf Course (fertilization of the lawns).

	than the ecosystem can handle and causes harm to the stability of the creek.	

Problem 1: Erosion

There are two areas of concern regarding erosion in Blue Hen Creek. One area of concern is where it appears someone put broken slabs of concrete down one side of the bank to keep it from falling in. Another concern is an area of extreme erosion near New London Road. Erosion in Blue Hen Creek may be attributed to the 33% of impervious cover within the watershed. The impervious cover within the watershed can be attributed to surrounding land uses being single- and multi-family residential, commercial, and institutional. With impervious cover exceeding 25%, there is reason for concern regarding the health of the stream. Additionally, an increased amount of runoff is entering Blue Hen Creek from surrounding developed land. As a result, erosion has occurred. Impervious cover within the creek has increased even more so because of the presence of a highly invasive species, multiflora rose. In some areas, multiflora rose crosses the stream channel and connects with multiflora rose on the opposite side of the bank. This highly invasive species has forced the majority of natural vegetation and habitat out.

Goal 1: Reduce impervious cover

Control of the invasive species, multiflora rose, is vital to the improvement of impervious cover surrounding Blue Hen Creek. Because it is present along the streambanks, and even crosses over the stream channel to connect to the opposite bank, the most efficient methods of removal are via cutting and then applying herbicide to the freshly cut stump. Ideally, this should be done in July, August, and up until the middle of September. At the very latest, this process should be before berries start to appear from the plant in August. By removing this invasive species, native species will be able to grow back, promoting diverse riparian vegetation. Once the multiflora rose is removed from Blue Hen Creek, the stream banks will be bare and extremely vulnerable to erosion as well as regrowth of invasive species. To combat this by stabilizing slopes and preventing further erosion from occuring, native trees, shrubs, and grasses should be planted along the banks. To address erosion caused by excess runoff caused by a high percentage of impervious coverage within the watershed, a 20-foot wide forested buffer should be created between the developed land and Blue Hen Creek. To construct this buffer only native trees, such as elm trees, maple trees, and oak trees, should be used. The forested buffer will aid in runoff from impervious surfaces surrounding Blue Hen Creek, reducing erosion caused by runoff. Additionally, it will provide shade to the stream, increasing water and habitat quality; however, it will inhibit the growth of multiflora rose within the stream because it does not grow as well in the shade. Outcomes that are predicted to come from these alterations include native species growing back to create a more healthy ecosystem, a more stable streambank that prevents

invasive species from growing as quickly, and a reduction in the amount of runoff entering the stream.

Problem 2: In Stream Habitat Quality/Degradation

Examining Blue Hen Creek's habitat quality is imperative for figuring out the type of stream restoration needed. There are many factors that contribute to the health of the habitat such as the chemical, biological, and physical composition of the water. Also, as a result of the invasive multiflora rose, the neighboring trees have died of choking. In addition, native fauna struggled to grow in these conditions, impacting the habitat and wildlife health. A primirally physical approach to improving aquatic life will be employed.

Goal 2: Improve Habitat Quality

According to research done on water samples for chemical water quality testing, the highest grade awarded was a "B-", so it is undeniable that there is room for improving the habitat. Our primary goal is to obtain an "B+" by the year 2035 via several restoration methods. Removing the multiflora rose should drastically improve the quality of the habitat. In addition, the pollution in the stream is damaging the habitat, so the litter needs to be routinely cleaned and preventive measures be enforced such as fences or additional waste containers. A woody debris will be placed by hand in pools and under boulders, filtering leaf collections and enhancing habitat for fish. Lastly, log, brush and rock structures will be installed by hand tools at the lower ends of stream banks, so shade is provided and the food chain is supported, improving the fish habitat.

Problem 3: Nutrient Runoff

The Blue Hen Creek has been found to have abnormally high levels of algae. Algae can cause great harm to the quality of water. It can also affect the food resources, habitats, and decrease oxygen availability for the fish and other aquatic life. The nutrient runoff coming from the nearby Newark Country Club Golf Course contains phosphorus and nitrogen. It is also coming from the nearby residential areas. When there is increased levels of phosphorus and nitrogen in the waters, algae grows a lot faster. This causes harmful algae blooms, which lead to dangerous toxins that can sicken or kill people and animals, create dead zones in the water, raise treatment costs for drinking water, and hurt industries that depend on clean water. Maintaining the algae levels is important to the success of the Blue Hen Creek.

Goal 3: Decrease the amount of nutrient runoff

The Newark Country Club Golf Course is the main source of nutrient runoff into the Blue Hen Creek. There are many solutions to this problem all dealing with how the Golf Course maintains there fertilization and containing runoff. Some of the ways harmful nutrient runoff can be prevented is buffer strips, controlled releases, construct wetlands or filters, and use turfgrass that

needs less fertilizer. The first option, buffer strips, mean to use native grasses, plants, or turf to reduce the nitrogen and phosphorus going into the creek. It allows time to slow runoff and time for the water to go into the soil. The second option is to have controlled releases. This means to lessen the amount of fertilizer you use and also to not put it out before a rainstorm. Another solution is to construct wetlands and filter beds near the golf course. This prevents the nutrients from getting into the nearby streams. The beds have materials that bind the nutrients. The last solution is to use certain turfgrass at the golf course that needs less fertilizer (less fertilizer means less nutrient runoff).

Summary of Conclusions and Recommendations

Goal	**Recommended Strategy**	**Outcome**
Reduce impervious cover	· Control invasive species · Plant native trees, shrubs, and grasses to stabilize banks · Create a forested buffer between developed land and stream	· Allows for native species to grow back creating a more healthy ecosystem · Creates a more stable bank and prevents invasive species from growing as easily · Reduces the amount of runoff entering the stream
Improve habitat quality	· Limit multiflora rose · Clean and prevent litter from reaching the stream · Place a woody debris in pools and under boulders (low cost) · Place log, brush and rock structures at the end of banks (low cost)	· Other beneficial species to the habitat can grow · Reduces the release of toxic chemicals from litter into the habitat and aquatic life. · Filter leaf collection, improving conditions for fish life. · Supports food cycle and shading.
Decrease the amount of nutrient runoff	· Create buffer strips, wetlands, or filter beds · Have controlled releases, meaning less fertilizer and avoiding using it before rainstorms · Use turfgrass that needs less fertilizer	· Natural ways of avoiding the nutrient runoff into getting into the creek · Less fertilizer means a lot less nutrient runoff into the streams · Reducing runoff means reducing harmful algae

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