INNOVATIVE STORMWATER CONTROLS

CASE STUDY: BETHEL ELEMENTARY SCHOOL

HAYWOOD COUNTY, NORTH CAROLINA

This publication was produced by the Haywood Waterways Association, Inc. with financial support from the North Carolina Clean Water Management Trust Fund.

Its purpose is to (1) highlight the use of innovative best management practices to control stormwater, (2) improve educational opportunities for students and local citizens, and (3) protect water quality, the quality of life, and the aesthetic beauty of the Bethel Community in Haywood County, North Carolina.

HAYWOOD WATERWAYS ASSOCIATION INC

THE BETHEL ELEMENTARY SCHOOL INNOVATIVE STORMWATER BEST MANAGEMENT PRACTICES, or BMPs, collect stormwater flowing off the landscape, remove pollutants picked up by the stormwater, and then slowly release the cleansed stormwater to tributaries of the Upper Pigeon River Watershed in Haywood County, North Carolina. The innovative BMPs function on the school property in attractive, natural systems. Secondary functions include flood control, improving wildlife habitat, and providing environmental education opportunities.

Photo credit - Richard Biggins, USFWS

The 47-acre Bethel Elementary School campus is located on NC Highway 215 approximately five miles south of Canton in the heart of the Upper Pigeon River Watershed. This watershed provides water for drinking, irrigation, recreation, and industry. Many streams are classified as Trout Waters by the NC Department of Environment and Natural Resources, and it is home to several sensitive, threatened, or endangered species, such as the Appalachian elktoe mussel (*Alasmidonta raveneliana*), wavyrayed lampmussel (*Lampsilis fasciola*), and hellbender salamander (*Cryptobranchus alleganiensis*). Many conservation organizations and government agencies consider this watershed to have some of the cleanest water in the southeastern United States.

Stormwater is the number one cause of pollution and is a significant concern to the communities of Haywood County. When it rains, there is increased potential for soil **erosion**; the transport of **pollutants** to waterways, namely sediment, nutrients, and bacteria; and **flooding**. History has shown many times the Pigeon River and its tributaries have breached their banks, taking a significant toll on local economies and human life in the process.

Flooding in Clyde, NC

Many consider this area of western North Carolina to be one of the most beautiful locations in the county. Its plentiful streams, high mountain peaks, extensive forests, historical sites, and friendly people make it a popular tourist destination, as well as a desirable place to live. Unfortunately, as the communities grow, so does the impact to the environment. As more roads, industry, and homes are built, the amount of **impervious surfaces**, or surfaces that don't absorb water, such as driveways, rooftops, and sidewalks, increase. This greatly increases the risk of erosion, pollutant runoff, and flooding when it rains. Instead of forests and farmland absorbing the water, the stormwater rapidly runs off the impervious surface to our waterways. When the ground absorbs water, it not only waters crops and recharges aquifers that so many people rely on for drinking water; it slowly releases the water to streams over an extended time period. **Most people understand that more water in a stream means more water over the banks if it floods, but how many people understand that more impervious surfaces also means floods occur more often and come a lot faster?**

Erosion and Sedimentation

Eroding Streambank

MANY PARTNERS WERE RESPONSIBLE FOR IMPLEMENTING THE PROJECT. To help protect the Upper Pigeon River Watershed and reduce the impacts of stormwater, the Haywood Waterways Association and the Haywood Soil & Water Conservation District approached the Haywood County School Board during the planning stages of the school. The idea was to incorporate an innovative stormwater control system in the plans, which supported the school board's desire to construct an environmentally sensitive campus. The school board agreed if funding could be found. A grant of $442,000 was received from the North Carolina Clean Water Management Trust Fund through the collaborative effort of Haywood Waterways, Haywood Soil & Water Conservation District, Haywood County Schools, and the Southwestern NC Resource Conservation & Development Council. Additional local and regional partners were then brought into the design and construction process. A complete list of these partners is found on the back cover page.

THE INNOVATIVE STORMWATER CONTROLS replace traditional methods such as curb and gutter systems that would have carried water directly to streams. Three tributaries drain the 183-acre watershed surrounding the school. The school building footprint covers 1.8 acres, and 5.3 acres of sidewalks, parking lots, roofs, streets, and athletic fields drain to the stormwater controls. The specific controls include one **constructed wetland**, approximately 6,420 linear feet of **streamside vegetation** (counting both banks of the streams), two **bio-retention basins**, a **bio-swale,** two **filter strips,** and an underground **rain tank** (see the Master Plan map on pages 4 and 5). Together, these controls provide improved wildlife habitat and a natural system that recharges the groundwater and cleans stormwater runoff before it slowly leaves the campus. There is also an education component to this project. An educational kiosk and educational signs posted at each control provide learning opportunities for students as well as the public. The results are improved water quality in the Pigeon River, reduced risk of flooding and a better understanding of the innovative stormwater controls used on the school campus.

RAIN TANK

As stormwater flows off the impervious surfaces and through the innovative stormwater controls, some of it ends up in the underground rain tank. The rain tank holds that stormwater and slowly releases it to the tributaries, reducing the potential for flooding and stream bank scouring. The innovative stormwater controls will remove many of the pollutants before the stormwater reaches the rain tank, however, some of the stormwater will come directly from impervious surfaces. The rain tank will act as a filter for untreated stormwater, and help remove any remaining pollutants from the treated water. Another important function of the rain tank is to decrease water temperature. On a sunny day, surfaces such as rooftops and asphalt roadways absorb heat. When it clouds up and rains, that heat gets transferred to stormwater. If something isn't done to lower water temperature, heated water gets flushed into our streams. Many of the organisms living in the Upper Pigeon River Watershed, such as trout, darters, and stoneflies, are coldwater organisms that have low tolerances for high water temperatures. Cold water also has more oxygen making it easier for those organisms to breathe. Though underground and out of sight, the rain tank provides many benefits to the aquatic ecosystem.

FILTER STRIPS

Filter strips are simple strips of vegetation, particularly grass, that slow water flow coming from athletic fields and hillsides before it reaches a tributary or a stormwater BMP. The filter strips also help remove pollutants, including sediment, pesticides and fertilizers that are carried by the overland flow of stormwater.


EQUINOX
ENVIRONMENTAL
CONSULTATION & DESIGN
Bethel Element
BASEBALL DIAMOND
BASEBALL DIAMOND
Overflow P
Bio-Retention
Filter Strip
Constructed Wetland
Streamside Vegetation
Educational Kiosk

ary School Stormwater BMP Master Plan

Bio-Swale

Bio-Retention

Bio-Retention

Underground Rain Tank

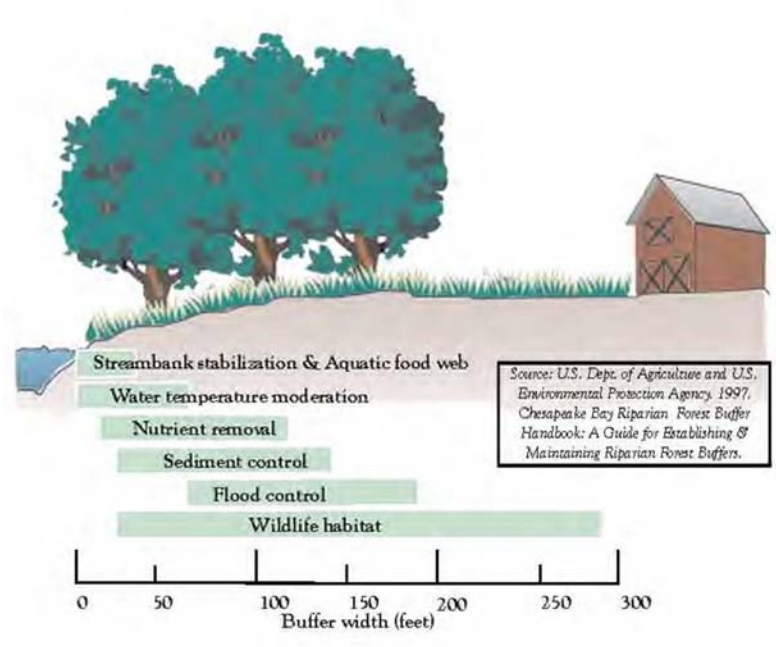
Bio-Retention

CONSTRUCTED WETLANDS

• *Equinox Environmental, Inc.*

A constructed wetland uses natural processes to remove pollutants from stormwater runoff, provides additional flood storage, and supports wildlife habitat. The constructed wetland was designed with three treatment cells. The first cell, called a forebay, allows solids (silt and sediment) carried into the wetland to settle and be periodically cleaned out. The remaining cells are separated with boulder weirs and form pools. The cells allow for particles and pollutants, such as silt and nitrogen, to settle and be absorbed into the wetland soils. Pollutants are also removed by microorganisms in the water and by plants that uptake excess nutrients. When constructed wetlands are part of a series of treatment types, such as filter strips and bio-retention areas, they can be very effective. Constructed wetlands do not have the full ecological range of naturally occurring wetlands, but with careful planning and maintenance, they have a major impact in the treatment of stormwater runoff while also providing an environment that offers food and shelter for wildlife.

Bethel Elementary School
Constructed Wetland



STREAMSIDE VEGETATION

• *Equinox Environmental, Inc.*

Riparian buffers are the area next to the stream that includes the banks of the water, the surrounding land, and the plants that grow on and along the banks. Vegetation along stream banks can greatly benefit the health and quality of the water they embrace. As illustrated in the adjacent figure, distances within the width of the buffer relate to specific functions. The riparian buffer vegetation works to provide stream bank stability, prevent erosion, flood plain protection, shade to keep water temperatures cool, and treatment of stormwater flow from the school campus. Riparian areas are important habitat for wildlife and help to increase biodiversity. They provide food for wildlife, places for wildlife to nest and reproduce, water for wildlife to drink, shelter to protect wildlife from prey, and corridors for animals to move along.

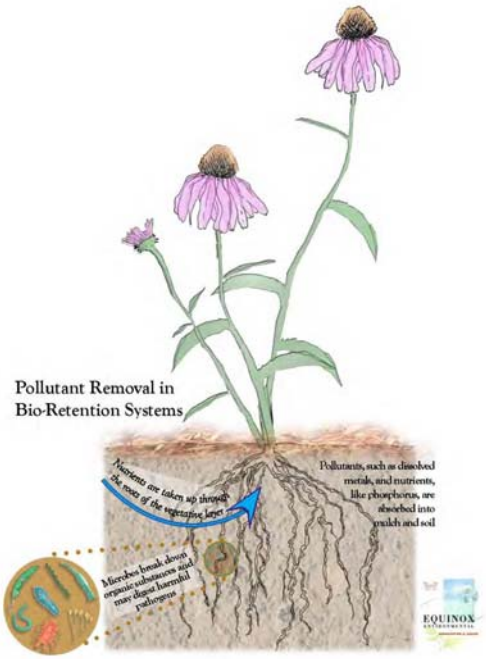
Liatris spicata
Blazing Star

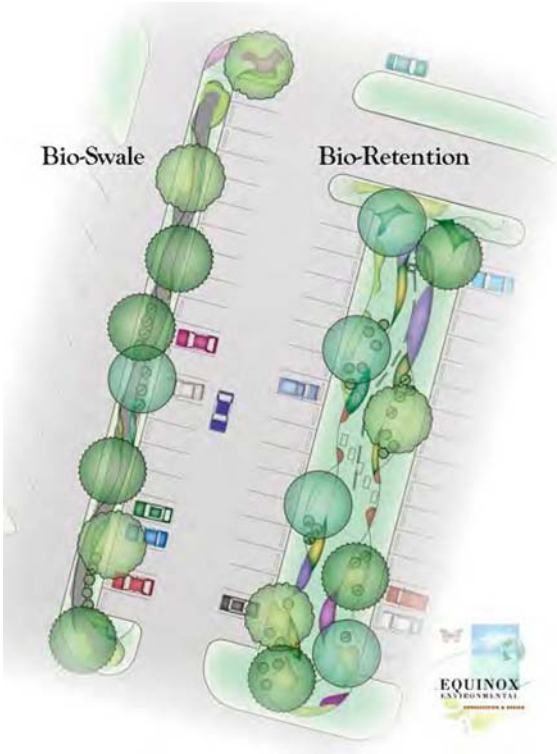
Lobelia cardinalis
Cardinal Flower

Bidens aritosa
Tickseed Sunflower

BIO-RETENTION BASINS • *Equinox Environmental, Inc.*

Bio-retention systems, also called rain gardens, are designed depressions which are landscaped to treat stormwater runoff. The Bethel School bio-retention controls collect water from sidewalks, parking lots, roofs, streets, and athletic fields. Bio-retention systems are made of several layers including a gravel bed at the base, a layer of porous soil, followed by a layer of mulch, and a top layer planted with native vegetation. At the bottom of the system, a perforated drain system (pipes with holes) carries excess water that has been filtered by the bio-retention system to the storm drain system. Bio-retention systems are different from constructed wetlands in that they are designed to drain within 48 hours. They are typically located in dry areas as opposed to wetlands, which are located in areas with wet soils, and they typically require less land. Furthermore, bio-retention areas allow for the use of a greater variety of native plants that are often available in local nurseries. For these reasons, they are very useful in residential and commercial landscapes.

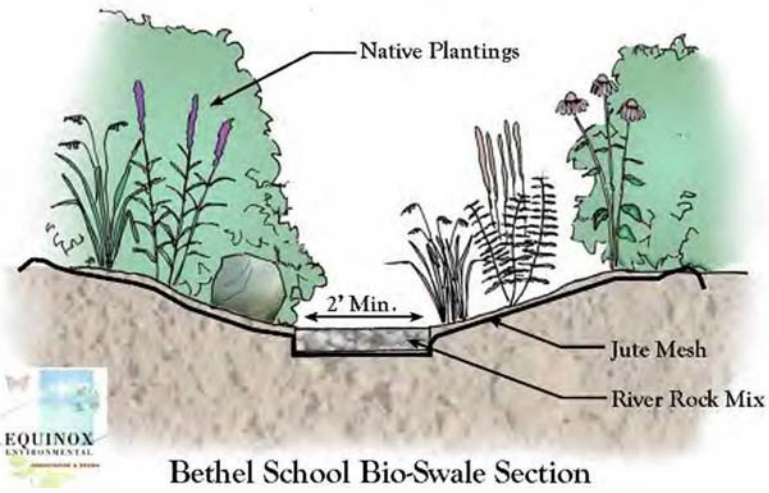




These areas provide a range of dry, moist, and wet conditions for plants to grow. Trees include river birch (*Betula nigra*), black gum (*Nyssa sylvatica*), and red maple (*Acer rubrum*) can adapt to both dry and wet conditions. Shrubs such as Virginia sweetspire (*Itea virginica*), inkberry (*Ilex glabra*) and winterberry (*Ilex verticillata*) not only grow well in bio-retention areas, but they also provide food and shelter for wildlife. Native ferns and grasses such as soft rush (*Juncus effusus*) are also well adapted to the conditions of a bio-retention area. Appropriate plant selection and healthy soils promotes microbial (tiny organisms) activity that breaks down pollutants.

BIO-SWALE • *Equinox Environmental, Inc.*

A bio-swale is a gently sloping channel, or swale, covered in rocks and planted with native vegetation. Similar to other stormwater best management practices, such as bio-retention systems, bio-swales treat and filter sediment, nutrients and other pollutants from stormwater runoff. Unlike bio-retention systems that allow captured surface water to pond and infiltrate through a soil mix into underground drains, bio-swales allow for some infiltration by slowing velocity, but often direct water towards a destination. Controlled transportation of water is particularly important in managing concentrated flows during severe storm events.



Bethel School Bio-Swale Section

Completing this project demonstrated a commitment of the Haywood County School Board to the wise use of our land and water resources. It showed that our local conservation organizations are ready and able to work with landowners and the community to solve problems, protect land resources and improve water quality. Completing the Bethel Elementary School Innovative Stormwater Controls Project increased the community understanding of stormwater and how it impacts our waterways. With proper planning, the damaging effects of stormwater can be lessened and sometimes even eliminated.

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Haywood Waterways Association recognizes the following organizations for their contributions:

American South Contractors: general building contractor.

Bradshaw Engineering: civil engineering, site design, and locating BMPs. Special thank you to **Patrick Bradshaw (owner)** for embracing and supporting the concept.

B. Allen Construction: educational kiosk construction.

Equinox Environmental, Inc.: project design and construction oversight, kiosk and educational sign text and design, and monitoring BMP effectiveness. Special thank you to **David Tuch, Fred Grogan, and Victoria Partridge.**

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Haywood Soil & Water Conservation District: permanent conservation easement holder, monitoring easement compliance, and assisted in presenting the initial concept and project to the school board. Special thank you to **Bill Yarborough,** District Supervisor, for the initial idea and project concept.

Haywood Waterways Association, Inc.: education and outreach: presentations, publications, press releases; educational signs and kiosk design; conservation easement development and baseline report; grant proposal; worked with Haywood Soil & Water Conservation District on presenting the project to the school board. Special thank you to **Eric Romaniszyn**, Haywood Waterways' Project Manager, for writing this report.

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Additional copies of "**Innovative Stormwater Controls, Case Study: Bethel Elementary School**" are available by contacting the **Haywood Waterways Association**.
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