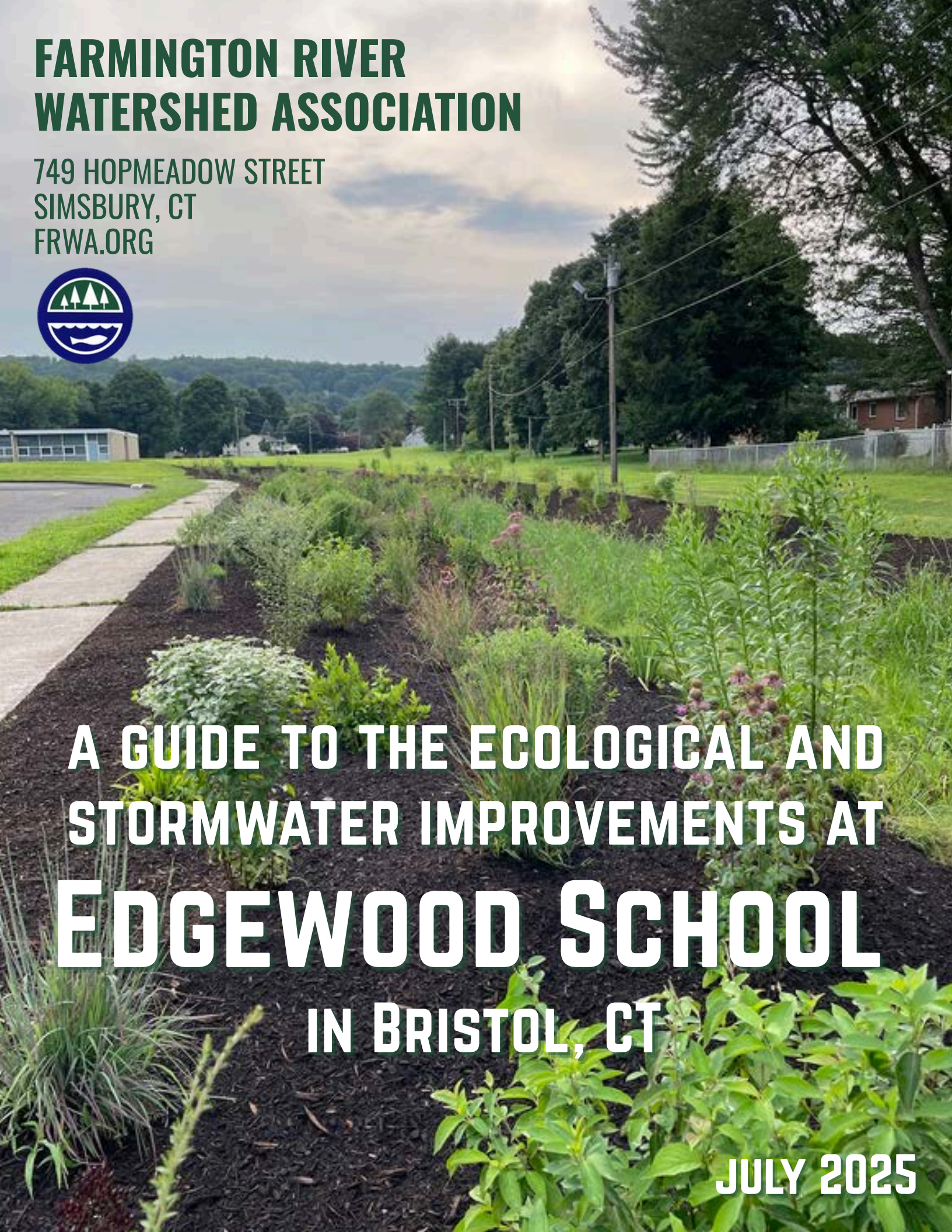
FARMINGTON RIVER
WATERSHED ASSOCIATION

749 HOPMEADOW STREET
SIMSBURY, CT
FRWA.ORG



A GUIDE TO THE ECOLOGICAL AND STORMWATER IMPROVEMENTS AT EDGEWOOD SCHOOL IN BRISTOL, CT

JULY 2025

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About FRWA

The Farmington River Watershed Association (FRWA) is a 501(c)(3) non-profit organization founded in 1953. Our mission is to preserve, protect, and restore the Farmington River and its watershed lands through research, water monitoring, habitat restoration projects, education, and advocacy.

Our water monitoring program informs our work and provides reliable data to the Connecticut Department of Energy and Environmental Protection (CT DEEP) and the Massachusetts Department of Environmental Protection (MassDEP). As opportunities arise, we work to restore streambanks and aquatic habitats for fish and wildlife, for example by removing dams or restoring native plant communities. We also help towns with river management and stormwater pollution reduction education. FRWA has been conducting water monitoring in the Connecticut portion of the watershed since 2004, and in Massachusetts since 2019. More information can be found on our website, frwa.org.

In our education mode, we provide classroom visits, field trips, and student seasonal employment. We host presentations and workshops on river history, water conservation, pollution prevention, and managing stormwater runoff. We organize river cleanups and other outreach events including canoe trips, paddling events, and watershed tours. As advocates, we speak up for watershed protection and river-friendly practices and policies at the local, state, and national level.

The Farmington River is the longest tributary to the Connecticut River, coursing 81 miles from Massachusetts headwaters to its confluence with the Connecticut River. There are 33 towns in the watershed covering 609 square miles of land in Massachusetts and Connecticut. Approximately 100,000 acres of the watershed lies within MA, with the remaining 285,000 acres in Connecticut.

Acknowledgements

FRWA would like to acknowledge and express our gratitude to the City of Bristol Public Works Department, Connecticut Department of Energy and Environmental Protection, the Pequabuck River Watershed Association, Suzanne Sayers of Gardens By Design, Princeton Hydro, and local community volunteers for their efforts related to this project.

This project was funded, in part, by the U.S. Environmental Protection Agency. The funding is administered by the Connecticut Department of Energy and Environmental Protection.

Purpose of this guide

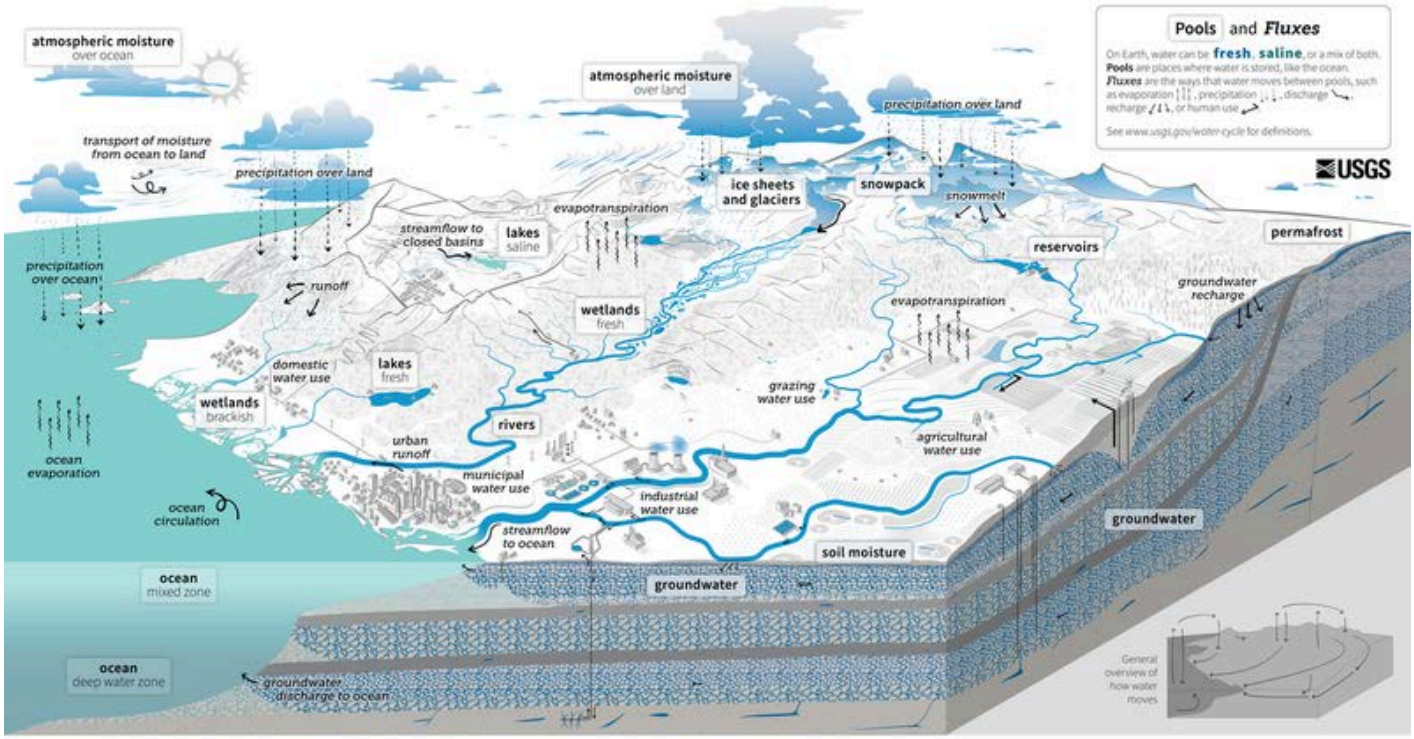
The Farmington River Watershed Association has compiled this comprehensive curriculum guide to educate the community of the Edgewood neighborhood in Bristol, and beyond, about the importance of stormwater remediation projects. While a lot of this information is specific to the bioswale and tree well installation at Edgewood School in Bristol, there is still plenty of general information intended to educate you about stormwater, the importance of the Clean Water Act, the benefits of green infrastructure, and so much more. This guide will lead you through what our surrounding area is comprised of, and demonstrate how every body of water is connected in some manner and that all activity can affect not just our local waterways, but eventually Long Island Sound as well. FRWA hopes to instill the importance of water conservation into you, so that choices you make in the future can have a positive impact on our streams and rivers, allowing you and everyone in the future the opportunity to enjoy what our local environment has to offer.

THE WATER CYCLE

The water cycle is the explanation of where water is on Earth and how it moves around. Water is stored in the atmosphere, on Earth's surface, and underground, and can be saline, fresh, or brackish (a mix of saline and freshwater). All water on earth exists either in a pool, or a place of storage, or in flux, a mode of transportation between pools.

A **water cycle pool** is an area in which water is stored, such as lakes, reservoirs, rivers, oceans, groundwater, and snow/ice. **Atmospheric moisture** is the presence of water vapor above land masses and the ocean, typically as clouds. **Groundwater** is liquid water stored underground within pore spaces ands cracks in rocks and sediments. This can be fresh, brackish, or saline. **Surface water** is any water that is stored on the Earth's surface, such as in lakes, rivers, oceans, and reservoirs. This can be fresh, brackish, or saline. A **river** is defined as a natural waterbody that flows from an area of higher elevation to an area of lower elevation. They typically flow into lakes, the ocean, or other rivers but may end due to evaporation, human interaction, or a loss of streamflow to groundwater. A **lake** is an accumulation of water in a low spot on a landscape as a result of surface water runoff or groundwater seepage. **Reservoirs** are manmade lakes which form when a dam is built on a river, allowing the water to pool behind the dam. This may also be referred to as an impoundment.

A **water cycle flux** is a process in which water moves between pools, such as evaporation, precipitation, discharge, and recharge. **Precipitation** is water that is released from clouds in the form of rain, snow, sleet, or hail over a land surface or the ocean. **Evaporation** is the process of liquid water on a surface changing into water vapor and moving up to the atmosphere, driven by an increase in temperature. **Transpiration** is the release of water vapor from plant leaves. **Evapotranspiration** is the process of liquid water converting to water vapor and moving to the atmosphere, including evaporation from water bodies and transpiration by plants.



The Water Cycle

The water cycle describes where water is found on Earth and how it moves. Water can be stored in the atmosphere, on Earth's surface, or below the ground. It can be in a liquid, solid, or gaseous state. Water moves between the places it is stored at large scales and at very small scales. Water moves naturally and because of human interaction, both of which affect where water is stored, how it moves, and how clean it is.

Liquid water can be fresh, saline (salty), or a mix (brackish). Ninety-six percent of all water is saline and stored in **oceans**. Places like the ocean, where water is stored, are called **pools**. On land, saline water is stored in **saline lakes**, whereas fresh water is stored in liquid form in **freshwater lakes**, artificial **reservoirs**, **rivers**, **wetlands**, and in soil as **soil moisture**. Deeper underground, liquid water is stored as **groundwater** in aquifers, within the cracks and pores of rock. The solid, frozen form of water is stored in **ice sheets**, **glaciers**, and **snowpack** at high elevations or near the Earth's poles. Frozen water is also found in the soil as **permafrost**. Water vapor, the gaseous form of water, is stored as **atmospheric moisture** over the ocean and land.

As it moves, water can transform into a liquid, a solid, or a gas. The different ways in which water moves between pools are known as **fluxes**. **Circulation** mixes water in the oceans and transports water vapor in the atmosphere. Water moves between the atmosphere and the Earth's surface through **evaporation**, **evapotranspiration**, and **precipitation**. Water moves across the land surface through **snowmelt**, **runoff**, and **streamflow**. Through infiltration and **groundwater recharge**, water moves into the ground. When underground, groundwater flows within aquifers and can return to the surface through **springs** or from natural **groundwater discharge** into rivers and oceans.

Humans alter the water cycle. We redirect rivers, build dams to store water, and drain water from wetlands for development. We use water from rivers, lakes, reservoirs, and groundwater aquifers. We use that water (1) to supply our **homes** and **communities**; (2) for **agricultural** irrigation and **grazing** livestock; and (3) in **industrial** activities like thermoelectric power generation, mining, and aquaculture. The amount of available water depends on how much water is in each pool (water quantity). Water availability also depends on when and how fast water moves (water timing), how much water is used (water use), and how clean the water is (water quality).

Human activities affect **water quality**. In agricultural and urban areas, irrigation and precipitation wash fertilizers and pesticides into rivers and groundwater. Power plants and factories return heated and contaminated water to rivers. Runoff carries chemicals, sediment, and sewage into rivers and lakes. Downstream from these types of sources, contaminated water can cause harmful algal blooms, spread diseases, and harm habitats. **Climate change** is also affecting the water cycle. It affects water quality, quantity, timing, and use. Climate change is also causing ocean acidification, sea level rise, and extreme weather. Understanding these impacts can allow progress toward sustainable water use.

IMPORTANCE OF WETLANDS & FLOODPLAINS

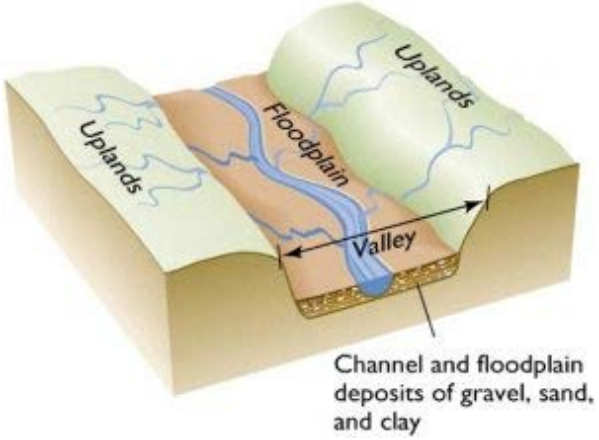
A wetland is an area in which water covers the soil, or is present at or near the soils surface all year, or during varying periods of the year. The hydrology, or water saturation, of an area largely determines the types of plant and animal communities living in and on the soil, allowing wetlands to support both aquatic and terrestrial organisms. Many wetlands are seasonal, and may only be wet for part of the year. Even if they are dry, they still provide critical habitat for wildlife.

WHERE TO FIND WETLANDS:

- **Floodplains along rivers & streams**
- **Margins of ponds & lakes**
- **Depressions surrounded by dry land**
- **Vernal pools & bogs**
- **Marshes dominated by herbaceous plants**
- **Swamps dominated by shrubs**
- **Wooded swamps dominated by trees**

Wetlands act as a natural sponge, trapping and slowly releasing surface water, rain, snowmelt, groundwater, and floodwaters. Trees, root mats, and other vegetation help to slow the speed of floodwaters and distribute them more slowly over a floodplain area. These actions lower flood heights and reduce erosion. Wetlands located within and downstream of urban areas are extremely valuable, working to counteract the high volume and rate of stormwater runoff from impervious surfaces. The holding capacity of wetlands also helps to control flooding and prevent waterlogging of any nearby agriculture.

A floodplain is a relatively flat area of land alongside a river or stream, and stretches from the river bank to the base of the valley. They are prone to flooding when water levels rise due to rainfall or snowmelt. Floodplains provide flood risk reduction benefits from their unique functions. Rivers and streams shape floodplains overtime and will influence riverine ecosystems, which are primarily wetlands. Some of these benefits include; excess water storage, erosion reduction, regulating flow during non-flood periods, and slowing runoff. Floodplains allow for water to spread out and can store excess water temporarily. They can also slow down the rate of runoff, giving more time for that water to infiltrate into the soil. During non-flood periods, they can redirect excess water into the groundwater system if space is available.



BENEFITS OF FLOODPLAINS:

- **Fish and wildlife habitat protection**
- **Natural flood and erosion control**
- **Surface water quality maintenance**
- **Groundwater recharge**
- **Biological productivity**
- **Higher quality recreational opportunities**
  - **Fishing, boating, bird watching, etc.**

NONPOINT SOURCE POLLUTION

Nonpoint source (NPS) pollution is defined as any source of pollution that does not meet the definition of point source pollution under the Clean Water Act. Point source pollution is defined by the EPA as "Any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or smokestack." NPS includes runoff from rain or snowmelt which carries both natural and anthropogenic pollutants to water sources, such as rivers, lakes, wetlands, groundwater, and oceans. NPS pollution is primarily driven by land uses and its name implies that there is no single point from which the pollution comes from; it comes from everywhere.

SOURCES OF NPS POLLUTION

- **Agriculture**
- **Animal Waste**
- **Poor Septic Systems**
- **Impervious Surface Runoff**
- **Soil Erosion**
- **Atmospheric Deposition**
- **Marinas and Boating**
- **Resource Extraction**

There are a number of different pollutants that NPS will carry into our waterways, each of which having big impacts on human health, water quality, and the health of wildlife. Some of the most common pollutants are described below:

Escherichia coli (E.coli) is a bacteria often found in conjunction with other bacteria that can make humans sick, and is often used as an indicator to understand how polluted a body of water is. *E.coli* can come from a number of sources, such as failed septic systems, livestock manure, wildlife, combined sewer overflows, pet waste, and sanitary lines.

Nutrients refer to phosphorus and nitrogen, which can promote excessive plant and algal growth in higher concentrations. This can lead to an increase in decaying vegetation which depletes the dissolved oxygen in the water and in turn can lead to death of fish and other aquatic organisms. Sources are primarily agricultural fertilizers applied to croplands, golf courses, and manicured lawns.

Sediment refers to loose sand, silt, and clay which settle at the bottom of a waterbody. The EPA has listed sediments as the most common pollutant in freshwater, and that 70% of erosion is a result of human land use. Sources can include tilled farmlands, poorly managed construction sites, and domestic animal activity, all of which have loose soils and a lack of vegetation, promoting erosion much easier than in forested areas.

Chemicals/Oil can have a huge impact on aquatic life, stream health, and human uses like drinking and recreation. Chemical applications like fertilizers and pesticides can run off into a stream. Some chemicals can also "drift" into nearby waterways from wind currents. In urban areas, some people may still dispose of chemicals or oils by pouring them on the ground or into storm drains, which will go straight into waterways with no treatment.

Environmental Protection Agency, Office of Water, Nonpoint Source Program

The big issue with nonpoint source pollution is that there is no direct source to trace pollutants back to. NPS pollution heavily depends on human land use and flow rates, leaving the negative effects to continue to grow. Since pollutants are coming from all different sources, there is no way to regulate the sources. However, the 1987 amendment to the Clean Water Act introduced the Section 319 Nonpoint Source Management Program, which provides grant funding to activities related to reducing NPS pollution and its impacts.

A NOTE ON STORMWATER

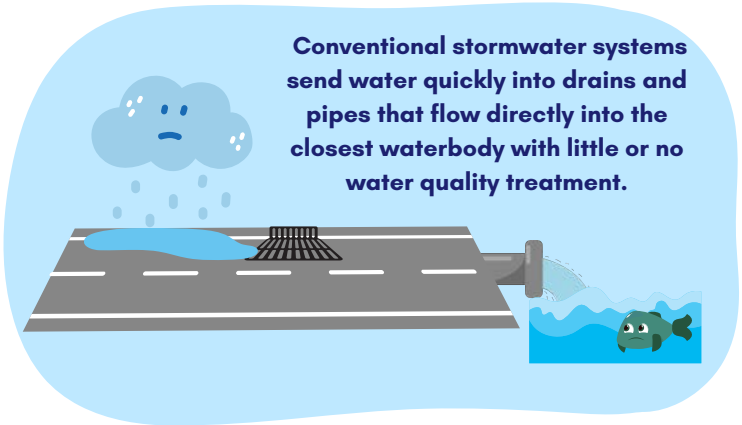
Stormwater runoff is the number one source of water pollution in the nation. It can lead to increased flooding, erosion, pollution, and decreased groundwater recharge during dry periods. Stormwater can contain pollutants such as sediment, nutrients, pathogens such as viruses and bacteria, and chemicals that can threaten aquatic health and contribute to the loss of water dependent recreational activities.

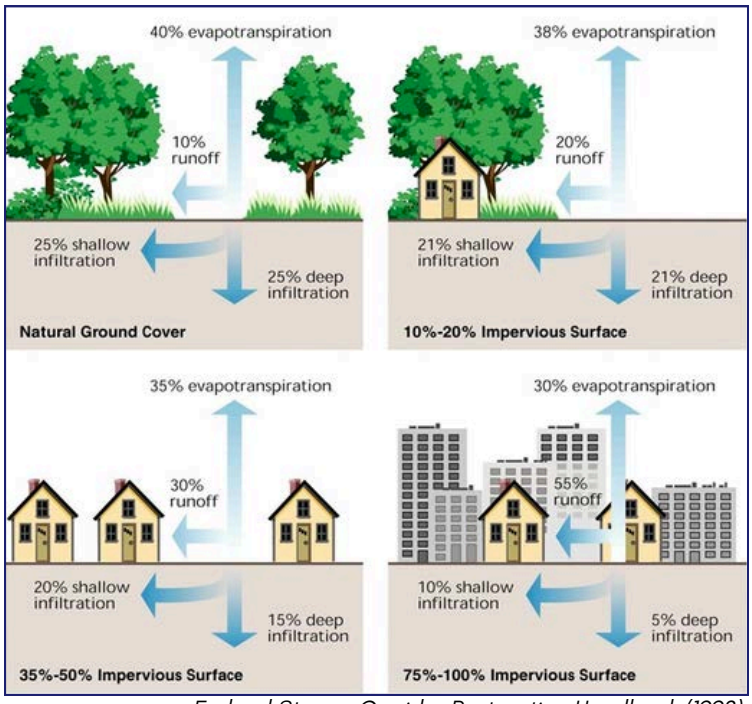
As we develop land and increase the amount of paved surfaces and buildings, also known as **impervious surfaces**, more water flows rapidly into our lakes, rivers, and estuaries. The water picks up heat, sediments, chemicals, and pathogens along its way, and brings them into our streams and rivers.

This type of pollution is referred to as **nonpoint source**, or **NPS**, since it cannot be tracked to a single source like a discharge or effluent pipe. NPS is a challenge to regulate and manage, because its source is the entire landscape. Some of the effects of polluted stormwater runoff include:

- Increased stream temp
- Increased flow volume
- Bacteria and pathogens
- Decrease in dissolved oxygen
- Increase in nutrients (N & P)
- Increase in toxic compounds
- Increase in suspended solids
- Litter and trash

Fortunately, there are ways to help reduce NPS through the use of **Best Management Practices**, or **BMPs.** A variety of BMPs exist that reduce the speed and volume of water entering our streams and rivers, allowing stormwater to slowly infiltrate soil and be treated naturally through physical and biological processes.





Federal Stream Corridor Restoration Handbook (1998)

As the amount of imperious surfaces increases from driveways, roads, and roofs, more stormwater flows into catch basins and stormwater systems. This means that less water is able to infiltrate into the ground, which can intensify flood and drought effects.

There are many different types of stormwater BMP's intended to mimic natural processes, including:

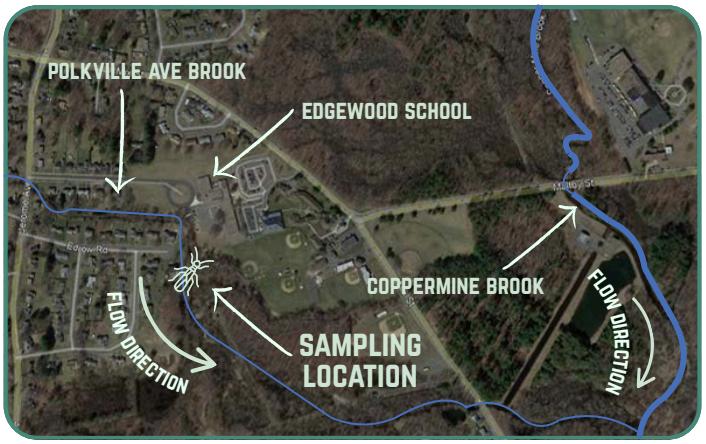
- Tree wells
- Bioswales
- Rain gardens
- Rain barrels/cisterns
- Permeable pavement
- Retention ponds

If you are interesting in learning more about BMP's and how you can reduce stormwater runoff at home with a few simple changes, head to www.riversmartct.org and take the River Smart pledge!

MACROINVERTEBRATES

Macroinvertebrates are the larval or nymph forms of insects that live in aquatic systems until they reach the adult stage of their life cycle. Most species will live at the stream bottom either in the sediments or attached to rocks, logs, and other vegetation. They are frequently used for biological monitoring because of how sensitive some species are to physical and chemical pollutants, and their importance to aquatic habitat. Macroinvertebrates provide better insight into long term water quality conditions compared to a single water sample, because they have to live in that environment over long periods of time. Some species are more sensitive than others, making them great indicators of conditions over time as some species will only be found in very clean, cold waters.

There are a number of factors that can influence macroinvertebrate communities, including streamflow, temperature, dissolved oxygen, substrate, and changes to the riparian habitat. While a lot of changes happen naturally, there are also a number of anthropogenic pollutants that can also affect communities, including increased turbidity, excessive nutrients, altered pH, and an increased presence of metals, pesticides, or other toxins.



Two sampling events in Polkville Ave Brook during the Spring of 2025 yielded a diverse composition of species. Several specimens belonged to the orders *Ephemeroptera* (Mayflies), *Plecoptera* (Stoneflies), and *Trichoptera* (Caddisflies), which are known to be sensitive to water pollution.



MACROINVERTEBRATES FOUND IN POLKVILLE AVE BROOK

MAYFLIES *Ephemeroptera*

Small Minnow Mayfly
Family *Baetidae*

3-Tailed Flathead Mayfly
Family *Heptageniidae*

Brush-Legged Mayfly
Family *Isonychiidae*

CADDISFLIES *Trichoptera*

Free-Living Caddisfly
Family *Rhyacophilidae*

Northern Casemaker Caddisfly
Family *Limnephilidae*

Fingernet Caddisfly
Family *Philipotamidae*

STONEFLIES *Plecoptera*

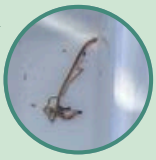
Winter Stonefly
Family *Taeniopterygidae*

Small Stonefly
Order *Plecoptera*

Common Stonefly
Family *Perlidae*

OTHER MACROINVERTEBRATES

Aquatic Worm
Order *Oligochaeta*



Damselfly
Order *Zygoptera*

Aquatic Sow Bug
Order *Isopoda*

Black Fly
Family *Simuliidae*

Crane Fly
Family *Tipulidae*

What is a watershed?

A watershed, or drainage basin, is an area that drains all the waterbodies and rainfall to one stream, lake or river. Watersheds consist of surface water, such as lakes, streams, and reservoirs, and wetlands which encompass all the underlying groundwater.

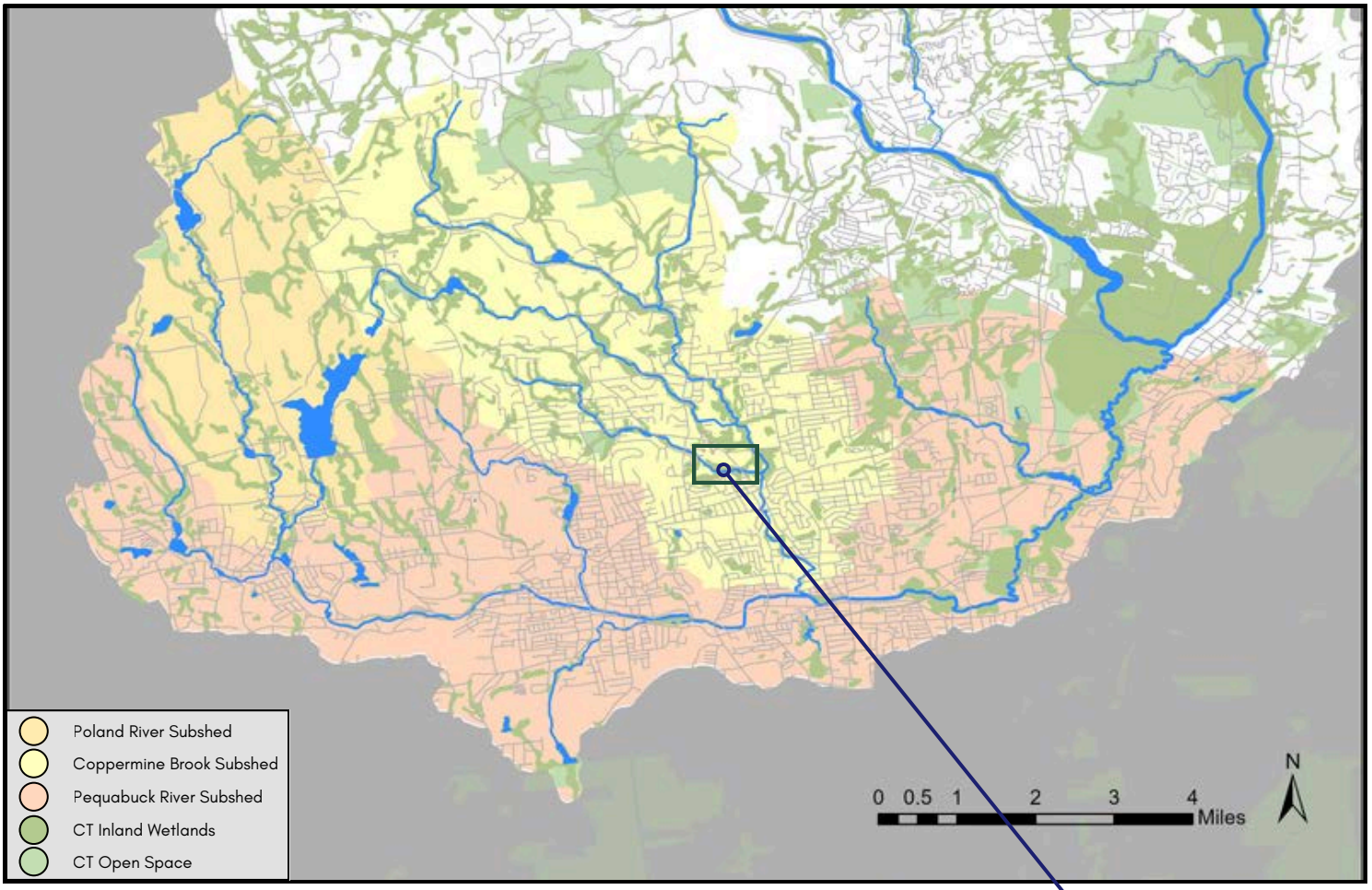
Every single inch of the United States has a watershed, and the largest is the Mississippi River Watershed, which covers 40% of the continental U.S. Watersheds that large will have smaller watersheds within them, often referred to as subsheds or subwatersheds. The Farmington River Watershed is an example of this, as it is a part of the greater Connecticut River Watershed.

Watersheds are precipitation collectors, meaning that all the rain that falls within the watershed area will eventually flow downslope until it reaches the watershed outflow point. Water will move downslope by either entering a stream and flowing down or by soaking into the ground and becomes part of the groundwater supply, which will eventually reach the surface again. If the water soaks into the ground, the soil will filter out any pollutants its picked up along the way, keeping the water nice and clean. But if the water enters a stream at the surface, it will carry in all of these pollutants, such as oil, fertilizers, bacteria, and chemicals, contributing to the largest pollutants issue in the U.S. - polluted stormwater runoff.

Of all the water on earth, less than 3% is freshwater, and only 0.5% is usable at any given time as the rest is frozen, underground, or in the atmosphere. This makes protecting our water resources incredibly important. While legislation has passed to protect our waterways, like the Clean Water Act, there is still a lot more work that needs to be done to ensure that our aquatic habitats and local environments are also being protected.

Watershed and water quality research organizations of all levels are necessary to ensure our waterways are staying clean and healthy by collecting data for a number of parameters and providing it to the state. The Clean Water Act Section 305(b) requires states to monitor and assess the quality of its waters in accordance with set Water Quality Standards. CWA Section 303(d) requires states to list waters that do not meet these standards, also called impaired waters, and begin to develop a Total Maximum Daily Load (TMDL) for the impairment. States are also required to submit a biannual Integrated Water Quality Report to Congress, which encompasses information gathered regarding Sections 305(b) and 303(d).

The Pequabuck River Watershed



The Pequabuck River originates in Litchfield County and flows for approximately 19 miles before draining into the Farmington River in Farmington, Connecticut. It has a 58 square mile watershed, made up of three subregional basins: the 10.2 square mile Poland River subregional basin, the 18.6 square mile Coppermine Brook subregional basin, and the 29.1 square mile Pequabuck River subregional basin.

The Coppermine Brook subregional watershed has a mix of land usage throughout. It has 50% deciduous forest cover and 38% developed areas, which takes up most of the space. Developed open space covers 13%, while low intensity developments contributes 15%. Medium and high intensity development cover 9% and 1% of the total basin area, respectively. Pasture and woody wetland each cover roughly 500 acres, or 4% cover. Open water, barren land, evergreen and mixed forests, scrub, cropland, and emergent herbaceous wetlands account for the remaining 4%, or 492 acres of the watershed.

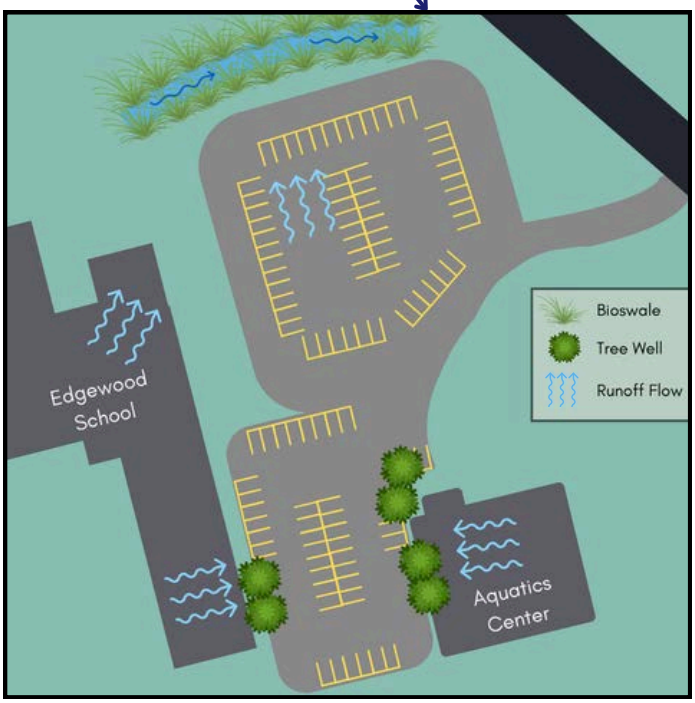


Image not to scale; intended to depict approximate location of bioswale and tree wells.

The Clean Water Act

The Clean Water Act (CWA) is the primary federal law which regulates discharges of pollutants into the waters of the United States along with regulating water quality standards. It was originally enacted in 1948 as the Federal Water Pollution Control Act but was reorganized and amended in 1972, and from then on was known as the CWA. It has put in place a number of regulatory standards to keep the nations' waters clean and useable.

Clean Water Act Protections:

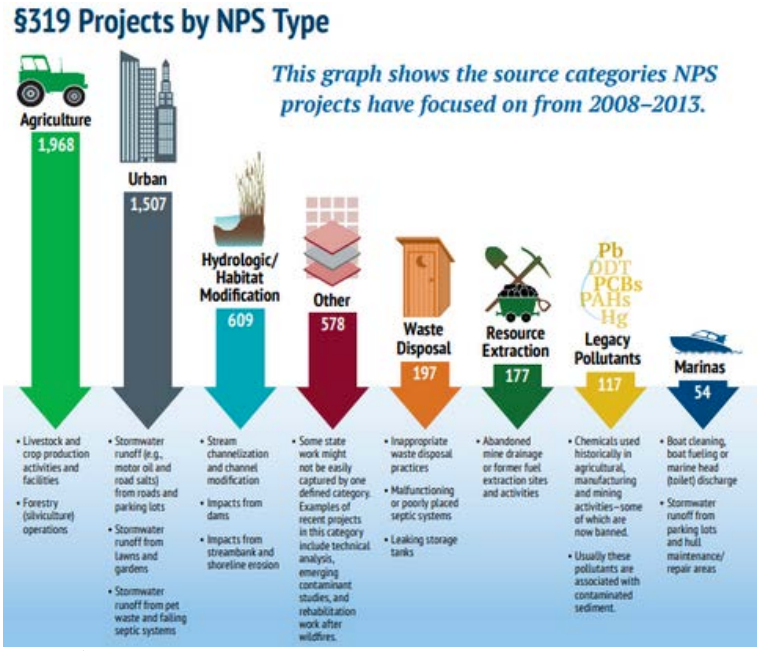
- **Prohibits discharges of avoidable industrial discharges into waters**
- **Requires permits for all point source discharges into waters**
- **Imposes management practices on industries with hazardous substances neat waters**
- **Limits application of sewage sludge when it can pollute waters**
- **Requires states to develop clean up action plans when protected waters become unsafe**

Section 319(h) of the Clean Water Act was enacted by Congress in 1987, establishing a national program aimed at controlling nonpoint sources of water pollution. The Section 319 Nonpoint Source Program is designed to regulate NPS pollution through nonregulatory methods. The EPA has determined that over 70% of Americans live within two miles of a polluted waterbody, and many of these are considered unsafe for swimming and may not be capable of supporting aquatic life. The grants provided by this program are an incredibly important resource in the effort to protect our waterways.

As water bodies are restored, over time others are identified as impaired as a result of our ever developing landscape. The nature of NPS pollution is vast and endless, requiring issues to be addressed through a variety of methods and funding sources. While it doesn't solve all issues, funding from §319 is essential for NPS management programs and watershed projects.

Total Assessed Waters of the United States	Rivers and Streams (Miles)	Lakes, Reservoirs, and Ponds (Acres)
Good Waters	487,299	5,470,004
Threatened Waters	5,550	34,621
Impaired Waters	614,153	13,009,273

Source: USEPA July 2016[4]



USEPA

The §319 program often acts as a catalyst for groups looking to put watershed plans into motion. It allows for a project to start and for staff of all levels to work together to locate additional funding sources needed to pay for the entire project. Of the projects completed nationwide, only 13% of all funding used came from §319. The rest was from state, federal, local, and other funding sources.

Land use is what drives NPS pollution remediation work. The type of NPS pollution affecting local waterways is primarily reliant on that area's land use. Other influences include population, climate, topography, and soil conditions. Most projects are related to agricultural and urban NPS pollution, because it is found all across the country. Other project types are just as important, but may be more location specific, such as marinas, and not as widespread of an issue.

Watershed Based Plans

Development of a Watershed Based Plan is a key step in Watershed Management, leading to restoration of a polluted or otherwise impaired waterbody. Development and implementation of these plans to focus on addressing a specific nonpoint source impairment identified on CT DEEP's Integrated Water Quality Report to Congress qualifies them as Watershed Based Plans, with the ultimate goal of reducing or removing the impairment, so the waterbody can meet Water Quality Standards, and be removed from the list.

Nonpoint source (NPS) pollution is a complex problem. Many of Connecticut's waterbodies are classified as impaired, due to exceedance of a specific water quality parameter, such as indicator bacteria or nutrients. Management Practices can address a wide spectrum of NPS pollutants to maximize their value to water quality and the environment as a whole.

One of the most important goals of the CT DEEP Watershed Management Program is to assist in the development of comprehensive watershed management plans, to protect and restore water quality and conserve and manage water resources, by guiding local land use decision making, and enhancing pollution prevention programs.

There are Nine Elements that must be included in an EPA-approved Watershed Based Plan:

IMPAIRMENT	An identification of the causes and sources of pollution
LOAD REDUCTION	An estimate of the load reductions expected for the management measures described
MANAGEMENT MEASURES	A description of the NPS management measures that will need to be implemented to achieve the estimated load reductions.
MILESTONES	A description of interim, measurable milestones for determining whether NPS management measures or other controls are being implemented
MONITORING	To evaluate the effectiveness of the implementation efforts
PERFORMANCE	To evaluate the effectiveness of the implementation efforts
PUBLIC INFORMATION & EDUCATION	An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation.
SCHEDULE	An expedited schedule for implementing NPS management measures identified
TECHNICAL & FINANCIAL ASSISTANCE	An estimate of the assistance needed, and/or the sources and authorities that will be relied on, to implement this plan

Pequabuck River Watershed based plan

The Pequabuck River Watershed Based Plan (WBP) is primarily intended to provide a path to improve water quality throughout the watershed, including the river itself and the tributary network of various streams and brooks found within its watershed. The Connecticut Integrated Water Quality Report to Congress indicates that water quality in the Pequabuck River and segments of its two major tributaries – the Poland River and Coppermine Brook – are "not supporting" for recreational uses due to indicator bacteria. The Pequabuck River and the lower section of Coppermine Brook are also "not supporting" for aquatic life, primarily due to unknown causes from a variety of potential sources.

Pollutant modeling has shown the majority of bacteria to be coming from stormwater runoff in the Coppermine and Pequabuck subregional basins. Prioritization of local basins was conducted in order to recommend twelve (12) specific best management practices (BMPs) to address areas of concern. These BMPs include the utilization of pervious pavement, stormwater wetlands, bioinfiltration basins, vegetated filters, tree wells, and other secondary BMPs. These recommendations aim to reduce nonpoint source loading of bacteria, nutrients, and sediments.

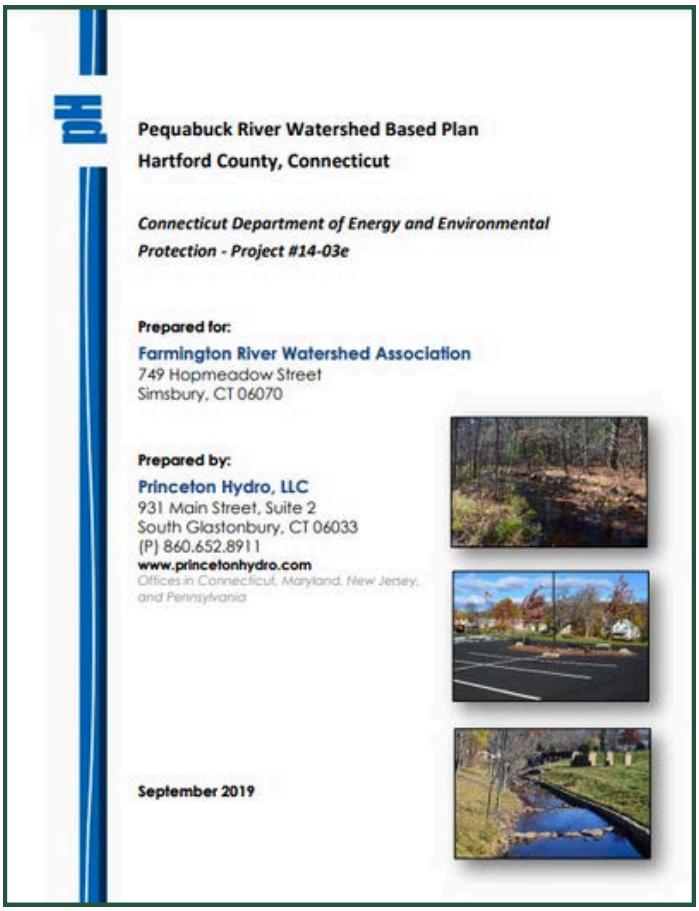
Pequabuck River Watershed Based Plan Project Partners

- **Municipalities of; Bristol, Burlington, Harwinton, Farmington, Plymouth, Plainville, and Wolcott**
- **Farmington River Watershed Association (FRWA)**
- **Pequabuck River Watershed Association (PRWA)**
- **Connecticut Department of Energy and Environmental Protection (CT DEEP)**
- **Connecticut River Conservancy (CRC)**
- **Naugatuck Valley Council of Governments (NVCOG)**
- **Capitol Region Council of Governments (CRCOG)**

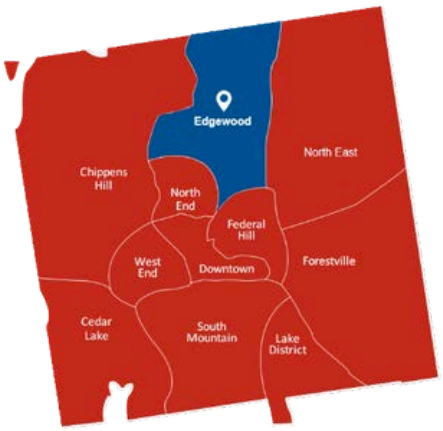
The goals of the Pequabuck River Watershed Based Plan are to:

- Identify and quantify the river's primary source of nutrient, sediment, and bacteria loading
- Incorporate stakeholder involvement, education and identification of funding sources
- Use this data to develop a comprehensive Watershed Based Plan (WBP) that identifies specific actions and pollutant load reduction Best Management Practices (BMP) needed to decrease the water quality impairments of the Pequabuck River and its tributaries

If you are interested in learning more about the WBP, it can be viewed at https://portal.ct.gov/DEEP/Water/Watershed-Management/Watershed-Management-Plans-and-Documents



Bristol's Edgewood neighborhood



The City of Bristol is situated in Hartford County in Central Connecticut, 20 miles southwest of Hartford. It incorporated as a city in 1911, and is known as a manufacturing hub. Bristol has a current population of 61,537.

The Edgewood neighborhood of Bristol is located in the Coppermine Brook subregional drainage basin. It features a strong mixture of residential neighborhoods as well as the Route 6 commercial shopping corridor.

The Bristol Water and Sewer Department has supplied the City of Bristol with high-quality drinking water since the early 1900s. Reservoirs in the towns of Burlington, Harwinton, Plymouth, and Bristol are channeled through the Poland River to the water treatment plant, where the water is treated and sent into the distribution system and storage facilities. Along with the reservoir system, five gravel-packed wells provide water to the distribution system's low-service area and an interconnection with the New Britain Water Department to supplement the Stevens Street area. In 2023 the Bristol Water and Sewer Department produced a total of 2.12 billion gallons of water, or approximately 5.81 million gallons per day.

Why was Edgewood School chosen?

The sites presented in the Pequabuck River WBP were selected as sites where stormwater management could have a high probability of implementation and success. They were first identified through the data collected from field assessments, then they were further selected through the consideration of the pollutant data with effort placed on selecting sites along the most impacted portion of the river. The Pequabuck River WBP outlined Edgewood School in Bristol as BMP-10. The local drainage basin that contains this site is ranked #1 for cumulative pollutant loading in the Pequabuck River WBP.

BIOSWALE POLLUTANT LOAD ESTIMATES

PARAMETER	PRE-INSTALL LOAD	POST-INSTALL LOAD	REDUCTION
Nitrogen (lbs./year)	41	19	55%
Phosphorus (lbs./year)	6.88	2.75	60%
Sediment (tons/year)	0.77	0.19	75%
E.coli (CFU/WQ Storm)	2.57E+10	8.03E+09	68.7%

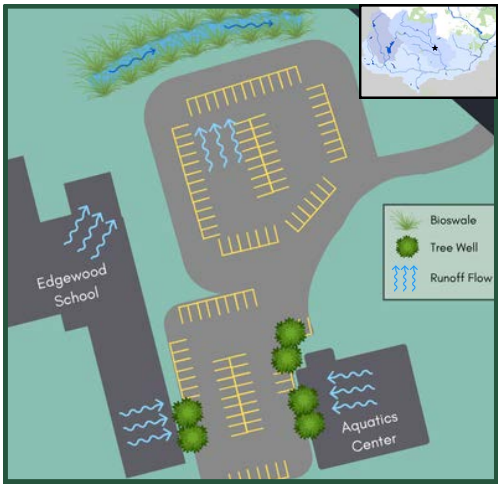
TREE WELL POLLUTANT LOAD ESTIMATES

PARAMETER	PRE-INSTALL LOAD	POST-INSTALL LOAD	REDUCTION
Nitrogen (lbs./year)	33	21.8	34%
Phosphorus (lbs./year)	5.43	1.6	70%
Sediment (tons/year)	0.81	0.1	86%
E.coli (CFU/WQ Storm)	6.17E+09	9.26E+08	85%

This large piece of property has extensive impervious area associated with the buildings and parking infrastructure. Originally, a turf grass basin ran along the west edge of the property, and it was identified that the large size of the area may allow for some significant treatment of runoff prior to entering the Coppermine Brook if converted into a wetland type basin.

EDGEWOOD SCHOOL BIOSWALE

A bioswale is a linear, low-lying trough or depressed channel intended to catch stormwater runoff and filter it to reduce the movement of pollutants downstream. They are designed to receive stormwater runoff from nearby impervious surfaces, such as parking lots and rooftops, and are planted with native vegetation to slow the rate of water soaking into the ground and filter out pollutants such as nitrogen, phosphorus, pathogens, sediments, and other nonpoint source pollutants. They intercept polluted stormwater which would otherwise flow straight into storm drain systems or directly into nearby waterways. Bioswales also provide habitat for birds, pollinators, and local wildlife when planted with native vegetation, effectively improving the biodiversity of an area.



The Edgewood School bioswale was constructed on the north side of Edgewood School, converting an existing 300-foot drainage swale into a bioswale. It is intended to collect stormwater from 2 acres of parking lot and 1 acre from the roof of the school.

CONSTRUCTION

PLANTING

COMPLETE

BENEFITS OF BIOSWALES

- **Improved water quality from natural filtration of nutrients, chemicals, and pathogens**
- **Reduced stormwater runoff and sediment transport during storm events**
- **Reduced temperature pollution from stormwater heated by impervious surfaces**
- **Reduction of oil from paved areas entering waterways**
- **Protection from river and stream erosion**
- **Recharge of local groundwater resources**
- **Year-round habitat for beneficial insects, pollinators, and other wildlife**
- **An attractive addition to the neighborhood**

Edgewood School Treewells

Tree wells and tree filters are designed to intercept stormwater through a curb cut, a curb modified to make a ramp, or surface grate, and to treat the water using a soil or filter media in tandem with a central tree and other plantings. The area around the tree well is typically sloped to allow water to flow into it directly.

These stormwater improvements will collect runoff, usually after heavy rainfall, reducing the volume of runoff entering storm drains, preventing surface flooding, and filtering out pollutants through the soil. Tree wells are found alongside streets, walkways, driveways, and parking lots, installed either as a standalone BMP or integrated into an existing stormwater system.

At Edgewood School, four tree wells have been installed as catch basin retrofits throughout the parking lot. There are two single tree wells located next to catch basins near the north end of the Aquatics Center, a double tree well located along the western side of the Aquatics Center, and a double tree well located along the eastern side of the school. Collectively, they are intended to collect 0.8 acres of water from the southern parking lot.

What is growing in the Edgewood School Treewells?

Serviceberry
Amelanchier arborea

River Birch
Betula nigra

The tree wells at Edgewood School are planted with River Birch and Serviceberry. Both of these plants are native to Connecticut, require little to no maintenance, and have roots that can tolerate wet soils for an extended period of time.

Serviceberry is a pollen source for native pollinators and a host plant for redspotted purple butterfly caterpillars. It also produces berries that are eaten by birds and small mammals.

River Birch is a large shade tree that can help cool parking lots during hot months. Birch trees provide shelter as well as nesting and resting spaces for songbirds, and they produce flower clusters called catkins in spring that are a food source for birds.

WHY ARE TREES IMPORTANT?

Trees play a vital role in stormwater retention by holding large amounts of water in their leaves and bark, allowing for evapotranspiration and help promote the slow infiltration of water into the soil. A single tree can store over 100 gallons of water, and in communities, this can lead to a 2-7% reduction in annual runoff, resulting in cost savings on drainage systems. Studies show that combining trees with natural landscaping can reduce storm runoff by up to 65%, with some areas retaining 100% of rainfall on-site.

Without the benefit of trees and vegetated infrastructure, such as tree wells and bioswales, waterways are polluted as oils, heavy metal particles and other harmful substances are washed into our nearby streams and ponds. Fish and wildlife suffer, drinking water becomes expensive or impossible to reclaim, property values are reduced, and our living environment is degraded. Air temperatures increase without shade from trees, and the sound of birdsong disappears when the birds have nowhere to nest.

BENEFITS OF TREES:

- **Promote infiltration and absorption for flood control**
- **Habitat and source of food for wildlife**
- **Shade - thermal regulation**
- **Root systems stabilize soils and help control erosion**
- **Provide aesthetics and privacy on property**
- **Reduces carbon dioxide in the atmosphere**
- **Improves soil quality**

RECOMMENDED LANDSCAPE TREES:

- **Witchhazel***
- **Winterberry***
- **Sweetspire**
- **Highbush Blueberry***
- **American Cranberrybush***
- **Inkberry**
- **Ninebark**
- **Serviceberry***
- **Allegheny Serviceberry**
- **River Birch***
- **Gray Birch**
- **Cockspur Hawthorn**
- **Common Hackberry**
- **Flowering Dogwood***
- **Swamp Oak***
- **Red Osier Dogwood***

** Trees marked with an asterisk have been installed in the Edgewood School Bioswale and Tree Wells*

Trees are increasingly recognized for their importance in managing stormwater runoff. Their leaf canopies help reduce erosion caused by falling rain. Some water evaporates from leaves and some seeps into the soil, while fallen leaves create a spongy layer that retains moisture and supports decomposition, reducing runoff and pollutants. Roots stabilize the soil and absorb water, contributing to groundwater recharge for over half the nation's drinking supply, and they help create conditions in the soil that promote infiltration.

WHO ARE THE POLLINATORS?

Pollinators are insects, birds, or small mammals that assist with plant reproduction by carrying pollen between flowers, and are crucial in supporting biodiversity. About 80% of all flowering plants rely on pollinators for reproduction, and would go extinct without them. They also support many ecosystem services, benefits that people receive from healthy ecosystems, such as pollinating over 1,200 plants that produce fruits, vegetables, and nuts.

There are over 350,000 species of pollinators worldwide, including bees, birds, butterflies, moths, beetles, wasps, bats, and small mammals. Having such a wide variety of pollinators is important because if some pollinators are absent for a period of time, there will always be others to continue the work. In some cases, plants and pollinators have co-evolved, and certain plants will require certain pollinators.

There are a number of threats that pose a risk to pollinators, such as habitat loss, pesticide use, disease, climate change, and the introduction of non-native species. In North America, some butterfly, bat, and hummingbird species are in a decline, while 25% of all bumblebee species are threatened. Habitat restoration and protection are important for supporting pollinator populations. Creating habitat in urban areas can help to increase connectivity between areas of existing habitat, such as planting a bioswale.

Butterflies and moths do not seek out pollen, rather they go to flowers to feed on their nectar and pollen will stick to their legs and bodies and transfer to other flowers as they continue to feed. While they are not the most efficient, they are incredibly effective pollinators and some plant rely exclusively on them to reproduce. Butterflies will pollinate brightly colored flowers during the day, while moths are nocturnal pollinators, and prefer light colored flowers that catch the moonlight.

Bumblebees pollinate wild flowering plants and agricultural crops. They can fly in cooler temperatures and lower light levels than other bees, making them great pollinators. They can perform “buzz pollination”, in which they grab a flower in their mouth and flap their wings to loosen the pollen, and will stick to their fuzzy bodies.

Specialist bees are bees that will only visit one plant species for pollen. About one-third of all bees are specialist bees, and have developed interdependent relationships with some plants - the plants depend on the specialist for pollination. They are solitary and only active for a few weeks of the year, and will follow the bloom schedule of their plant of choice.

NATIVE PLANT CARE GUIDE

Keystone native plants are plant species that are critical to the food web and are necessary in the life cycles of many animals. They have tight relationships with wildlife, having formed over thousands of years, and providing sources of food, cover and places to raise young. Wildlife and pollinators, such as bees, birds and butterflies, would not survive or thrive without the presence of native plants.

This native plant care guide includes the keystone native species planted in the Edgewood School Bioswale, and has information about identification, care, and any value these plants provide to wildlife.

Growth habits

- Can grow 3 - 15 feet tall
- Oval shaped leaves
- Need male and female plants to produce fruit
- Flowers are small, yellow-whitish, bloom between April and July
- Berries grow in summer, last through mid-winter

Care & needs

- Prefers full sun to partial shade
- Likes wet to moist, well-drained acidic soils
  - Will tolerate poorly-drained soils
- Low drought tolerance
- No trimming needed, unless branches are dead

Wildlife value

- Larval host for Henry's Elfin butterfly
- A source of food for butterflies, specialist bees, songbirds, and small mammals

Berries and leaves are toxic to humans if consumed

Winterberry
Ilex verticillata




Trees & Shrubs

Serviceberry
Amelanchier arborea




Growth habits

- Can grow 15-25 feet tall
- Has a rounded growth pattern
- Blooms in March and April
  - Flowers are white with 5 petals and fragrant
- Grows a red/purple berry in late summer to fall

Care & needs

- Grows in a wide variety of conditions
- Likes full sun to partial shade
- Prefers acidic to neutral soil that is moist and well-drained
  - Can tolerate wet or dry soils

Wildlife value

- Pollen source for native bees and other pollinators
- Larval host for redspotted purple butterfly
- Berries eaten by songbirds and mammals

Growth habits

- Grows 50 - 60 feet tall
- Grows wild in low-lying and swampy areas - often moist bottomlands or river banks
  - Can grow in urban/suburban setting
- Flowers in the spring in the form of catkins
- Brown acorns grow in the fall
- Can live up to 300 years

Care & needs

- Prefers full sun
- Prefers moist to wet soils, adaptable to drier soils
- Can tolerate occasional flooding and drought
- Sensitive to salt, compaction, and air pollution
- May need pruning of lower branches

Wildlife value

- Acorns provide food to mammals and some birds
- Larval host for numerous butterflies and moths

Acorns and leaves are toxic to humans if consumed

Swamp Oak
Quercus bicolor




Trees & Shrubs

Red Osier Dogwood
Cornus sericea




Growth habits

- Can grow 6 - 9 feet tall
- Has a rounded shape
- Blooms from June to August
- Grows small white flowers, in 2 -3 inch clusters
- White berries grow from summer into the fall
- Red twigs provide an attractive color in winter

Care & needs

- Prefers full sun to partial shade
- Prefers rich, consistently moist soils
- Prune the plant in early spring to stimulate more growth

Wildlife value

- Larval host for the Spring Azure butterfly
- A source of nectar and pollen for bees and butterflies
- Fruits are a great food source for birds and mammals

Growth habits

- Can grow up to 5 feet tall, 2-3 feet spread
- Flowers are pink/purple, bloom from mid spring to early fall
- Seed pods will split open to disperse

Care & needs

- Likes full sun to partial shade
- Prefers soils with neutral to acidic pH
- Prefers wet soils, can adapt to moist clay/loam soil

Wildlife value

- Important food source for Monarch butterfly larva
- Provides nectar to butterflies and hummingbirds
- Deer resistant

Toxic to humans, dogs, cats, and horses if consumed

Swamp Milkweed
Asclepias incarnata




Herbaceous Perennials

New England Aster
Symphyotricum novae-angliae




Growth habits

- Grows 3 - 6 feet tall
- Blooms from late summer until frost
- Flowers are pink/purple and daisy-like, with yellow centers
- Can self-seed if growing in ideal conditions

Care & needs

- Likes full sun
- Prefer moist and rich soils
  - Can do well with well-drained soils
- Pinch back stems to produce more flowers, promote bushiness, and control the height
- Cutting back after flowing will prevent self-seeding

Wildlife value

- Great source of nectar for butterflies, bumblebees, and honeybees
- Provides food for butterfly and moth caterpillars
- Larval host for Pearl Crescent butterfly
- Seeds feed birds and small mammals

Growth habits

- Grows 2-4 feet tall, 1 - 2 feet wide
- Flowers from midsummer to early fall with bright red blooms
- Can self-seed in ideal conditions

Care & needs

- Likes full sun to partial shade
- Prefers rich, moist to wet soils
- Can tolerate damp soils and poor drainage
- Deadhead for a neater appearance
- Pinch back for more compact, bushier plant

Wildlife value

- Food source for hummingbirds, butterflies, and bees
- Provides for beneficial insects
- Deer and rabbit resistant

Toxic to humans, dogs, cats, and horses if consumed

Cardinal Flower
Lobelia cardinalis




Herbaceous Perennials

Joe-Pye Weed
Eutrochium purpureum




Growth habits

- Grows 4 - 7 feet tall
- Flowers are small, pinkish/lavender and bloom from mid-summer to early fall
- Seed heads form from flowers and last well into winter

Care & needs

- Prefers full sun to partial shade
- Likes moist to wet, well-drained soils
- Plants should be cut back in late winter
- Divide plants in fall as they go dormant, or in spring as the first shoots appear if needed

Wildlife value

- Attractive to bees and butterflies as a food source
- Supports Pearl Crescent butterfly larvae
- Seeds are eaten by songbirds in the fall
- Moderately deer resistant

Growth habits

- Spreads to form large colonies from rhizomes underground
- Can grow 6 - 12 inches tall
- Flowers bloom from April to May
- Seeds from late spring to early summer
- Semi-evergreen, dies back in very cold temps

Care & needs

- Prefers partial to heavy shade
- Likes wet soils
- Propagate by diving mature plants in the spring

Wildlife value

- Provides nesting, food, and cover for birds, small mammals, and insects
- Attracts songbirds and butterflies
- Deer resistant

Pennsylvania Sedge

Carex pennsylvanica




Grasses

Purple Love Grass

Eragrostis spectabilis




Growth habits

- Can grow 1 - 2 feet tall, spreads up to 2 feet
- Blooms from late summer to mid-fall with small red-purple flowers
- Seeds mature and detach in winter to disperse

Care & needs

- Prefers full sun
- Dry to moist, well-drained soils
- Tolerates poor, infertile soils
  - Intolerant of heavy, wet soils
- Good drought tolerance
- Cut back old stems to the ground in early spring

Wildlife value

- Seeds provide food for birds and small mammals
- Foliage provides cover for ground-nesting birds
- Deer tolerant

Growth habits

- Grows 3-4 feet tall, up to 7 feet with flowers
- Blooms in late summer into fall, with reddish-purple flowers
- Flowers will turn to seed, which last well into winter

Care & needs

- Prefers full sun, can tolerate partial shade but will not grow as strong
- Likes well-drained, moist soils
- Drought and wet soil tolerant
- Cut back in late winter or early spring

Wildlife value

- Seeds provide food for songbirds and game birds
- Provides cover, nesting material, and landing space for birds
- Larval host for Skipper butterflies and the Common Wood-Nymph butterfly
- Deer tolerant

Switchgrass
Panicum virgatum




Grasses

Little Bluestem
Schizachyrium scoparium




Growth habits

- Grows 2-4 feet tall, spreads up to 2 feet
- Blooms from late summer to early autumn, growing delicate purple-bronze flowers
- The flowers turn to fluffy seed heads, which remain into the early winter

Care & needs

- Prefers full sun to partial shade
- Does well in dry to medium-moist, well drained soils
  - Can tolerate a range of soil conditions
- Drought resistant, once established

Wildlife value

- Provides nesting to queen bumblebees until spring emergence
- Larval host to 9 skipper butterfly species, including the Dakota skipper and the Common Wood-Nymph
- Seeds provide food for birds and small mammals
- Deer and rabbit resistant

Invasive Plants

An invasive plant species is one that is not native to an ecosystem, and whose introduction has or will likely cause considerable economic, environmental, or human harm. Many invasives were introduced as ornamentals, while others were introduced accidentally by people or wildlife. Many are aggressive spreaders with no natural predators, allowing them to easily overtake native species in the same area. Invasive species are the second-greatest threat to biodiversity globally. They have contributed to the decline of 42% of U.S. endangered or threatened species, and are the main cause of decline in 18% of U.S. endangered or threatened species.

A plant is considered invasive if it has the following qualities: a high reproduction rate, able to disperse wide distances, can disperse by plant fragment or by seed, lack of control on growth and reproduction, and the ability to grow under a wide variety of conditions and habitats. In Connecticut, there are 9 criteria a plant must meet to be listed on the state's Invasive Plant list. This information and more can be found through the Connecticut Invasive Plant Working Group (CIPWG) at cipwg.uconn.edu.

Invasive plant species can have huge impacts on entire ecosystems, as they can disrupt its functions in many different ways.

- Invasive species will compete with natives for sunlight, moisture, nutrients, and space
- Wildlife habitat can degrade from invasives overtaking their native habitat
- Water quality in nearby streams and ponds will degrade
- Plant diversity will decrease overall
- Increase in soil erosion
- Decrease in recreational access or opportunity
- Eliminate food sources for wildlife
- Increased risk of wildfire spreading
- Increased economic impact

Connecticut Invasive Plant Working Group

There are plenty of resources out there with removal and management recommendations. If you begin to remove any from your property, keep in mind that some species need to be treated with pesticides for effective management, while others can be managed using mechanical methods. Others may need a combination of mechanical and chemical removal methods.


Japanese Barberry


Japanese Knotweed


Winged Euonymus


Multiflora Rose


Mugwort


Garlic Mustard

Invasives Found in Bristol:

- **Garlic Mustard** *Alliaria petiolata*
- **Giant Hogweed** *Heracleum mantagazzianum*
- **Japanese Barberry** *Berberis thunbergii*
- **Mile-a-Minute Vine** *Persicaria perfoliata*
- **Multiflora Rose** *Rosa multiflora*
- **Oriental Bittersweet** *Celastrus orbiculatus*
- **Phragmites** *Phragmites australis*
- **Purple Loosestrife** *Lythrum salicaria*
- **Winged Euonymus** *Euonymus alatus*
- **Mugwort** *Artemisia vulgaris*

Full bioswale plant list

Perennials

Anise Hyssop - *Agastache foeniculum*
Beardtongues - *Penstemon*
Blue Cardinal Flower - *Lobelia siphilitica*
Blue Flag Iris - *Iris versicolor*
Butterfly Weed - *Asclepias tuberosa*
Cardinal Flower - *Lobelia cardinalis*
Coneflower - *Echinacea*
Eastern Bee Balm - *Monarda bradburiana*
Fireworks Goldenrod - *Solidago rugosa*
Green Coneflower - *Rudbeckia laciniata*
Jacob Cline Bee Balm - *Monarda didyma*
Joe Pye Weed - *Eutrochium purpureum*
Marsh Marigold - *Caltha palustris*
Mountain Mint - *Pycnanthemum*
New England Aster - *Symphyotrichum novae-anglicae*
Purple Coneflower - *Echinacea purpurea*
Ragwort - *Jacobaea vulgaris*
Sneezeweed - *Helenium autumnale*
Spotted Bee Balm - *Monarda punctata*
Swamp Milkweed - *asclepias incarnata*
Tickseed - *Coreopsis lanceolata*
White Aster - Symphyotrichum ericoides
False Indigo - *Baptisia australis*
Zig Zag Goldenrod - *Solidago flexicaulis*

Shrubs

High Bush Blueberry - *Vaccinium corymbosum*
Low Bush Blueberry - *Vaccinium angustifolium*
Low Bush Cranberry - *Viburnum trilobum*
Sweetspire - *Itea virginica*
Red Osier Dogwood - *Cornus sericea*
Witch Hazel - *Hamamelis virginiana*
Winterberry - *Ilex verticillata*

Grasses

Big Blue Stem - *Andropogon gerardii*
Little Blue Stem - *Schizachyrium scoparium*
Pennsylvania Sedge - *Carex pensylvanica*
Prairie Dropseed - Sporobolus heterolepis
Purple Lovegrass - *Eragrostis pectinacea*
Rush Grass - *Juncus effusus*
Switch Grass - *Panicum virgatum*

Trees

Dogwood - *Cornus sanguinea*
River Birch - *Betula nigra*
Serviceberry - *Amelanchier arborea*
Swamp Oak - *Quercus bicolor*

RESOURCES

City of Bristol
https://www.bristolct.gov

Connecticut Department of Energy & Environmental Protection
www.ct.gov

Pequabuck River Watershed Based Plan
https://portal.ct.gov/-/media/deep/water/watershed_management/wm_plans/pequabuck/pequabuckwbppdf.pdf

River Smart
https://www.riversmartct.org

Arbor Day Foundation
https://www.arborday.org

The National Gardening Association Plant Database
https://garden.org

UCONN CLEAR Watershed Assessment Tool
https://experience.arcgis.com/template/68b1ebdd244a4f1a800a15af0e600307/page/CCI-Dashboard/

Why Are Wetlands Important?
https://www.epa.gov/wetlands/why-are-wetlands-important

NOAA Nonpoint Source Pollution
https://oceanservice.noaa.gov/education/tutorial_pollution/welcome.html

Farmington River Watershed Association Resources Webpage
https://www.frwa.org/resources

FARMINGTON RIVER WATERSHED ASSOCIATION