Watershed Education by Circuit Trails

A resource guide to the Greater Philadelphia area for watershed educational activities

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rails·to·trails conservancy

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Acknowledgments

Thank you to the William Penn Foundation for its continued leadership and support for trails over the last three decades.

Our hope is that this document can serve as a tool to promote watershed protection and trail use, and to ignite a sense of wonder regarding urban watersheds and the corridors and initiatives that make them accessible.

Introduction

This resource guide, *Watershed Education by Circuit Trails*, was created to document watershed education through youth engagement via the Circuit Trails. It is hoped that the information in this document about activities and experiences will help other organizations and individuals carry on the work and programming started by Rails-to-Trails Conservancy.

The guide was made possible by a grant from the William Penn Foundation. The program grew with collaboration from several partnerships in the Greater Philadelphia area. The partnerships brought resources and youth together on the Circuit Trails to access waterways and educational platforms.

Along with Circuit Trails exploration and watershed education, partnerships incorporated leadership development, community outreach, continuous youth engagement and planning for a multi-day bike trip known as the Youth Sojourn.

This resource guide contains teachable topics and corresponding lessons that are easily accessible on a Circuit Trail. Topics include watersheds, stormwater runoff, stream ecology, benthic macroinvertebrates, green infrastructure, artificial waterways and stream order.

In addition, this resource guide serves as a route planner. Several tours and routes were created over the summer of 2015. On a weekly basis, Cadence Youth Cycling's Circuit Team navigated

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through Philadelphia and Camden, New Jersey, to access educational platforms. We hope you enjoy replicating these routes and that you will offer feedback and suggestions for additional routes and educational activities.

The guide also reviews struggles and successes with watershed education provided on or near trails. Using analysis of surveys and feedback from youth participants and partners, we were able to synthesize and share their experiences. We conducted our most extensive survey with Cadence Youth Cycling. Our goal was to see if programming increased understanding of watersheds and the Circuit Trails regional network.

For the first time, RTC implemented the Watershed Education by Circuit Trails program. A randomly selected sample of 21 young people took a survey before participating in the program. This established their baseline understanding of watersheds and the trail network. After the program, they were asked to complete the same survey so that RTC could measure change in understanding. Fourteen young people completed both surveys. The results indicated that they had an increased understanding of watersheds and the Circuit Trails.

This is important, because young people in an urban environment often have limited access to trails and outdoor environmental education platforms. We were pleased to obtain positive feedback on our programs from partners and participants.

The Circuit Trails Regional Network

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What Are the Circuit Trails?

Greater Philadelphia is the proud home of the Circuit Trails, a vast regional trail network that connects people to jobs, communities, parks and waterways throughout a nine-county region of Pennsylvania and New Jersey. Already one of the largest trail networks in America, the Circuit Trails currently spans approximately 300 miles and will span an estimated 750 miles when complete. Over 65 nonprofit organizations, foundations and agencies are part of the Circuit Trails Coalition, which is working to advance development of this premier regional amenity.

Talking Points

a. The Circuit Trails is a multiuse trail network connecting people to jobs, communities, parks and waterways in the greater Philadelphia region.

b. Over three hundred miles are open for use, 50 miles are in development, and 400 miles remain to be built.

c. When completed, the Circuit Trails will include 750 miles of trails in the nine- county region. More than 50 percent of the region's population (that is, approximately 3.2 million people) will live within 1 mile of the Circuit Trails.

d. The Circuit Trails network is one of America's largest trail networks.

e. Some of Philadelphia's most iconic trails, including the Schuylkill River Trail, Schuylkill Banks Boardwalk, Pennypack Trail, Chester Valley Trail, Manayunk Bridge and Forbidden Drive are part of the Circuit Trails network.

f. The Circuit Trails Coalition is a collaboration of nearly 65 nonprofit organizations, foundations and agencies working to advance completion of a connected network of multiuse trails.

Chapter 1: Urban Watersheds

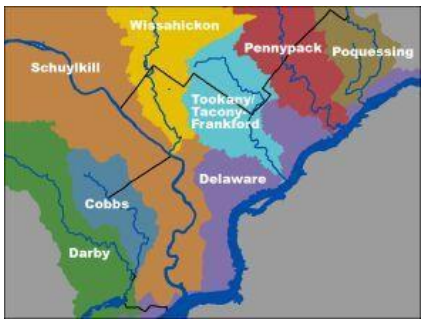
Topic: The Watershed

What is a watershed? Is it a shed full of water? Is it some sort of water filtration system? Simply put, **a watershed is an area of land that drains stormwater into a body of water.** When you are on land, you are always on a watershed. There even are sub-watersheds within larger ones, not unlike political boundaries. Philadelphia is within Pennsylvania, for example, which is within the U.S. Just remember, though, that watersheds follow terrain, not geographic boundaries.

Watershed boundaries extend to areas with higher elevation. When it rains, the stormwater flows downhill along a path of least resistance. All the water flowing down to the same basin is in the same watershed. A drop of rainwater may flow down a stream or other pathway through many different environments—perhaps through a forest, a city and a field. Eventually the water makes its way to a pond, lake or ocean. These bodies of water are the lowest points where water collects.

As stormwater flows down through the watershed, it absorbs natural and artificial compounds. Water is the universal **solvent** and does a great job of absorbing pollutants. Pollutants include road salt, fertilizers and particulates. As it flows, water also does a great job of transporting pollutants that cannot be absorbed, such as trash, oil and other garbage. Whether it is absorbed or not, pollution contaminates waterways and compromises them.

Watersheds also include water found beneath the earth's surface. This water is found in pockets between rocks and in the pores of the soil. Called **groundwater**, it replenishes streams by slowly recharging, or putting water back into, the waterways.



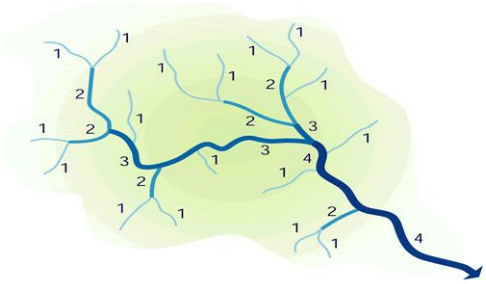
Philadelphia Watersheds (Philadelphia Water Department)

Philadelphia is made up of a large network of creeks and streams. Each flows through its own watershed. People may identify these watersheds differently depending on location, importance and magnitude. This may seem similar to neighborhoods. How do you define neighborhood boundaries in Philadelphia?

The two fundamental watersheds in Philadelphia are the Schuylkill and Delaware rivers. These large watersheds come together to flow into the Delaware Bay and eventually into the Atlantic Ocean. You may ask, "What is the biggest watershed in the world?" Challenge yourself to think about this critically. Don't just say, "the ocean." Think more pacific-ally.

Stream Order

Stream order is a ranking system that measures the relative size of streams. Smaller headwater streams originating from springs are first order. The largest streams, or rivers, are 12th order. When a first-order stream intersects with another first-order stream, the downstream portion becomes a second-order stream. This logic continues for subsequent orders. If a high-order stream intersects with a lower-order stream, the high-order stream maintains its order. For example, if a fourth-order stream intersects with a second-order stream, the downstream section maintains the ranking of fourth order.



Stream Order (SUNY)

The largest order stream in the world is the Amazon River, at 12. This means two 11th-order rivers intersected to form the Amazon. Do you know the stream order of your own local watershed? Take a look at a topography map to determine the answer.

Wetlands

Wetlands are low-lying areas of land that absorb and slowly recharge water like a sponge. A wetland is commonly made up of a diverse group of **facultative** and **obligate** wetland plants that thrive in these habitats. Different types of wetlands include fens, marshes and swamps. Wetlands also can be artificially created through wetlands mitigation projects or use of rain gardens. Wetlands do an excellent job of detoxing polluted waters. Think of them as "nature's kidneys."

Watershed Lessons

Teaching what watersheds are can be done using fun Circuit Trails activities. Taking people outside to sloped land, and especially to the intersection of two streams, offers a great opportunity to show how watersheds work.

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Watershed Hands: Ask everyone to follow your motions. Raise both hands in the air, and wiggle them around. Suddenly clap them together and cup your hands. Ask everyone to visualize the edges of their hands as "mountains," the grooves and ridges as "streams," and the lowest point as a "lake." Choose volunteers who are willing to get their hands wet. Gently pour water on their "mountains," and watch as the water collects at the "lake" in the base of their hands. Tell them that they just witnessed a watershed in action. Joke by saying any breakfast or sweat they had on their hands flowed into their lake.

Watersheds at Your Feet: Ask everyone to imagine which way water would flow if it were to rain on the trail. Use chalk or a stick to draw potential routes on the ground. Drip a few drops of food coloring on the routes. Move some rocks and sticks to create small-scale landscapes in the routes. Once you are ready, gently pour some water directly above the ground, simulating rain. Observe where the water flows. Did it flow where you expected?

Understanding Stream Order: Using chalk, draw out a network of streams. Ask the students to label them by stream order. This is a good opportunity to lead a discussion on stream restoration. Should restoration projects be focused on smaller ordered streams or larger ordered streams? Hint: Larger ordered streams already feel the impact of pollution from impaired headwater streams. Smaller ordered streams should be thoughtfully maintained before they become tainted by pollution. There is greater benefit for watershed health in assigning high priority to restoration of first-, second- and third-order streams.

Forbidden Drive Bike Tour (11 miles round trip):

RTC partnered with the Bicycle Coalition of Greater Philadelphia's Cadence Youth Cycling program to explore the Forbidden Drive Tour. On this tour, Cadence Youth explored the concept of a watershed by applying the "Watershed Hands" lesson on the green space along the Schuylkill River. In addition, the participants used chalk to learn about stream order at the intersection of Wissahickon Creek and the Schuylkill River. Learn more about this tour in the tour section on page 21.

Topic: Stream Ecology

Ecology is a division of biology that studies the relationship of the environment to the physical, chemical and biological world. Ecology is an engaging field for the statistical and curious-minded. It takes an open lens approach to consider every possible relationship.

Stream habitats or ecological areas are complex and can vary immensely by watershed. In general, streams are either "**muddy bottom**" or "**rocky bottom**." **Stream gradient** has an impact on physical, chemical and biological conditions. A high gradient stream, similar to a steep hill gradient for cyclists, is sloped enough for water to flow faster and maintain a rocky **streambed**. Sediment easily flows downstream and the water usually is more aerated than in a muddy stream. Conversely, a low-gradient stream is flatter and tends to look muddier. Low-gradient streams usually have deeper pools of water and have grassier stream edges.

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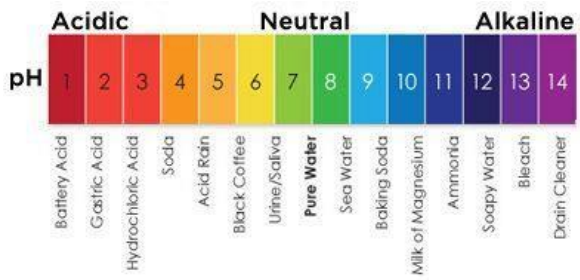
Cobbs Creek-Bartram's Garden Bike Tour (16 miles round trip):

Cobbs Creek is the largest creek system in West Philadelphia. Bartram's Garden is a living outdoor classroom with access to scenic views of the Delaware River. RTC partnered with Neighborhood Bike Works to introduce young people to stream ecology along Cobbs Creek. They learned about stream ecology by sampling for benthic macroinvertebrates and observing the physical state of the creek habitat. Learn more about this tour in the tour section on page 21.

Water chemistry tells a lot about what is going on within a stream. Scientists and amateur adventurers alike can test streams easily with a chemistry kit. Affordable kits can be found at the World Water Monitoring Challenge website. Refer to the appendix to see some of the common chemical parameters that can be examined using chemical sampling.



pH Chart (NJDEP)

Physical Observation

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Knowing what to look for can answer a lot of questions about stream ecology even without conducting any biological or chemical assessment. Are plants growing along the streambanks?

Riparian buffer plants are plants that grow along the edges of waterways. They help filter storm-water runoff and prevent erosion. Eroded banks can indicate that a stream has poor riparian buffers, has experienced flash flooding events, or has been altered by anthropogenic causes.

Philadelphia Water Department

Does the stream have riffles, that is, shallow areas where the water is turbulent? A lack of water riffles in a high gradient stream is undesirable because aquatic life adapted to high gradient streams depend on the increased oxygen levels created by riffles. The fast and turbulent flow splashing against rocks brings oxygen from the air into the water. Macro-invertebrates commonly found in high gradient streams such as water pennies and stoneflies depend on high oxygen levels and need the riffle habitat to survive.

Is the stream straight, non-meandering and low in gradient? That too is undesirable. If high gradient streams have been altered enough by anthropogenic causes they can lose their habitats that are characteristic of high gradient streams. Urban development like culverts or damming can straighten and lower the grade of a stream, eliminating habitats. These are all indicators that stream habitats in high gradient areas have been stressed. Do you notice any odd odors coming from the stream? Sewage odors may indicate a discharge nearby.

Observe the stream surface. Does it appear scummy, foamy or oily? These surface coatings are indicators of stream health. Not all surface coating is bad! Foam may indicate that the water is highly oxygenated—and that is good. Perhaps the foam was created by a riffle upstream. Oil also can be good. Oil can be natural or synthetic. A good way to tell these two oils apart is to disturb the surface with a rock or stick. Natural oil will separate into blocky sections and not come back together easily. Synthetic oil will separate and come back together quickly.

Both natural and synthetic oils appear colorful and shiny. Natural oils found in animals and plants may be secreted into the water. This adds nutrients, which is healthy for the stream. Synthetic motor oil is unnatural and is a pollutant.

Iron Floc (New Hampshire Estuaries Project)

Do you see iron floc in the stream? Iron floc appears as orange, gelatinous goo that settles along slow-moving areas of a waterbody. It is created by harmless bacteria processing iron with oxygen and water. Iron floc is natural, although it may seem "gross" or look like pollution to an untrained eye.

Schuylkill River Youth Walk (1 mile round trip):

RTC partnered with the Academy of Natural Sciences of Drexel University to take young people on a "smelly and slimy" tour. This walk accesses the Schuylkill River Trail between Race Street and the Fairmount Water Works. It is a good walk for young children. There are a lot of green spaces where the children can stop and do arts and crafts projects. Drawing mythical plants and benthic macroinvertebrates was a popular activity on this tour. To learn more about the walk, go to the tour section on page 23.

Pennypack Walking Loop (1.25 miles round trip):

RTC staff hiked with young people on the Pennypack Trail from the Pennypack Environmental Center to Pennypack Creek. This family-friendly hike is a great way to introduce riparian buffer plants to young children. Learn more about this hike in the tours section on page 23.

Biological Observation

Did you know that there are thousands of types of critters living in our watersheds? You may be surprised to learn that [some] flying insects start their lives in streams, in their larvae and nymphal forms. For example, dragonfly nymphs live in streambeds and use jet propulsion to scoot around. They are ferocious predators, equipped with an extendable mouthpiece that quickly shoots out to eat unsuspecting victims.

Black Fly Larva (NJDEP)

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Benthic macroinvertebrates—Macros for short—are spineless (**invertebrate**) creatures that are found on the streambed (**benthic**) and are big enough for you to see with your naked eye (**macro**). Unlike fish, which are much more mobile, Macros stay put. This makes them great biological indicators of stream health. Some are more tolerant of pollution than others, so by a population you can get an idea of how healthy a stream is. The presence, absence, abundance and diversity of Macros tells an observant explorer a lot about what pollutants are present and how serious the pollution may be.

Ecological Lessons

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Sampling streams allows trail users to interact with the stream and practice techniques. It's a very popular activity.

Before entering a stream, it is important to note flow and pollution conditions. The Philadelphia Water website has a Combined Sewer Overflow Public Notification System (CSOcast) that alerts users of sewage conditions in streams. A general rule of thumb is to avoid going into streams the day after rainfall. Also, do not bring children into water that goes above their knees. Always wear closed-toe shoes, and be observant for potentially sharp and harmful objects.

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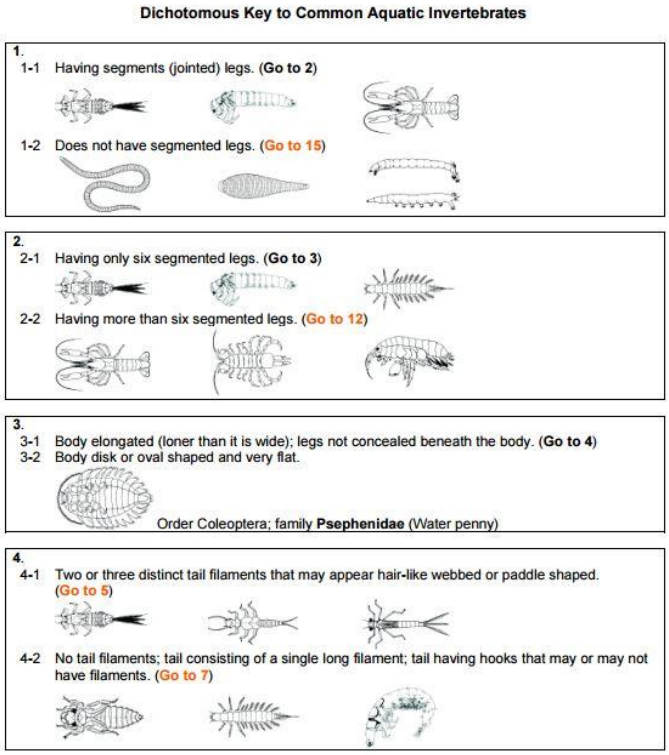
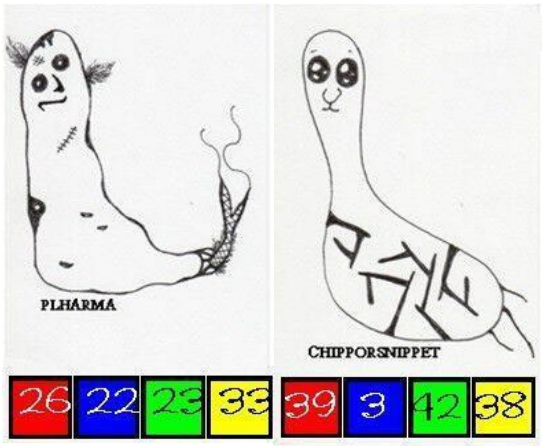
There are two popular ways to sample streams: with a D-net or with a kick net (pictured above). You may be able to borrow a net from a local environmental center. Using a kick seine net is preferable for small groups of young people because the process is more interactive. The kick seine is a one-square-meter net with two wooden poles. The net faces upstream and is angled down to catch the current. Have two volunteers hold the poles and one volunteer shuffle the streambed in a one-square-meter area in front of the net to dislodge macroinvertebrates. The shuffling should be in a grinding motion, turning the water to a chocolate milk color. Rocks can be rubbed too. Carefully lift the net parallel to the water to avoid losing any of the sample.

Once on shore, lay the kick seine net in a flat area. Have a few plastic trays available to sort out subsamples. Ice cube trays for additional sorting, tweezers and magnifying glasses also are helpful. Tally up the samples, and go over what was discovered. A dichotomous key may be helpful; this is a scientific flowchart that asks deductive questions about organisms to aid in identification.



West Virginia Department of Environmental Protection

Playing Macro Cards is an opportunity to learn about benthic macroinvertebrates while having fun. More information on the game is at the Discover Oobies website.



Discover Oobies

Camden Aquarium Bike Tour (10 miles round trip): The Cadence Youth Circuit Team learned about ocean watersheds and sharks at the Camden Aquarium during a private classroom workshop. The waterfront provides access to Wiggins Park Marina, which is a great location for discussion of artificial waterways and pollution. Learn more about this tour in the tour section on page 24.

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TOPIC: Stormwater Management

Philadelphia Water Department

Philadelphia Water Department

Urban areas generally have much more pavement than rural or natural areas. Philadelphia has significant urban sprawl, and cement and tar now replace soil and vegetation in many places. An altered landscape changes the stream network, flooding some streams and drying out others. Take a look at the GIS map above. It was created by the Philadelphia Water Department to show the city's remaining streams. Compare it with the historical stream map shown above. What differences do you notice?

Philadelphia's population growth resulted in more space being devoted to residential and commercial construction. You may notice that the GIS stream map above looks a lot less blue than the historical stream map. As you may infer, pavement makes **groundwater infiltration** difficult. Groundwater infiltration is the way earth absorbs water. In a natural environment, rainwater infiltrates the ground, enters aquifers and slowly recharges back into streams. This is important because polluted water gets filtered by vegetated soil before entering waterways. By contrast, flash flood water that flows over paved or **impermeable** surfaces is not infiltrated; it is called **stormwater runoff**.

Unfortunately for low-elevation residents, water still flows downhill. If storm drains are clogged or overburdened, flooding will occur. The watersheds are still active when it rains. Stormwater has to go somewhere and often quickly flows into our streams, creating issues such as flooding, erosion and toxic shock. Universities, government organizations and nonprofits currently are designing and implementing green infrastructure to reduce stormwater runoff. Many examples of restoration projects can be found at the Philadelphia Water Department's website.

A good alternative to traditional pavement is porous pavement. Porous pavement can be designed in multiple ways, but the concept is to allow water to flow through. Where do you think porous pavement would be beneficial? Parking lots, highways and sidewalks? Do you think porous pavement is safer for transportation, because it reduces the risk of hydroplaning?

Engineering Lessons

Best Management Practice Game: Engineers create buffers around storm drains to reduce flooding and excess water. These eco-designs, often referred to as Best Management Practice (BMP) for stormwater runoff, vary depending on budget and the volume of potential inflow. After teaching about stormwater runoff and BMP, ask the students to engineer their own BMP. Using recycled yogurt cups, puncture a small hole at the bottom of each cup to allow water to flow through. Supply the students with a variety of materials such as rice, sponges, soil, coffee and rocks, and ask the students to construct their own BMP to allow water to flow slowly out of the cups without causing clogging. After the students design their BMPs, draw chalk marks on pavement and place the cups on top. Pour an equal amount of water into each cup. Watch as the water filters through and flows out. Observe each design, and note the direction of the chalky water flow.

Petty's Island Bike Tour (14 miles round trip):

RTC took Cadence Youth Cycling on this tour to learn about land use and BMP. Petty's Island was owned by Citgo before the oil company sold it to the state of New Jersey for ecological conservation. This island is a good place for teaching about BMP, because it is an example of land that had been in industrial use and is being restored to a healthier ecological system. To learn more about this tour, go to the tour section on page 24.

Juniata Historical Walking Tour (1 mile round trip):

RTC staff went on this tour with representatives from the Tookany/Tacony-Frankford Watershed Partnership and the Philadelphia Wooden Boat Factory to explore the area's history, benthic macroinvertebrates, stormwater management and riparian buffer plants. Juniata Park maintains several historical artifacts such as stone walls, trails and bridges over bodies of water. The variety of information and scenery makes the Juniata tour fun for all ages. To learn more about it, go to the tour section on page 22.

Tom McKeon

Riparian Blindfold Game: The edges of waterways are home to a unique ecosystem of plants. These wet-loving plants, called riparian buffer plants, keep streams, lakes and ponds healthy and happy. The plant roots hold the soil in position, and leafy vegetation disperses rain impact, preventing soil erosion. The plants themselves also absorb and filter pollutants, keeping the waterway cleaner. It is fun to think of riparian plants as the "eyebrows" of the stream. Much as eyebrows slow sweat from entering eyes, riparian plants slow runoff from entering streams.

A good way to introduce students to plants is to have them interact with plants by using different senses. Organize the students in groups of two. Ask one student to blindfold the other; recycled T-shirts make good blindfolds. Designate a region for the students to explore. It should offer opportunities to feel bark, leaves and branches of woody and herbaceous plants. Once a blindfolded student has felt a plant, the partners walk back to the starting point. Now, without the blindfold, the student tries to find each plant again by recalling how it felt or smelled. The partners then switch places and repeat the activity. Students may keep a discovery journal describing their plants.

The blindfold game requires the educator to have some familiarity with plants to avoid unwanted reactions and pricks from hazardous plants such as poison ivy and brambles.

TOPIC: Artificial Waterways

Reservoirs

Are reservoirs good for the environment? Debate this with your group. Consider the following: Reservoirs provide drinking water, generate clean hydroelectric power, supply water for irrigation and provide recreational opportunities. However, construction alters habitats. Water in deep reservoirs in temperate climates typically stratifies like a lake. Cold, low-oxygen water at the bottom of the reservoir can shock river habitats when it is released to alleviate drought conditions. This sudden change in temperature and water chemistry could have adverse effects. Reservoirs usually are stagnant and serve as a breeding ground for diseases, mosquitoes and snails.

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Rain Barrels

Rain barrels can be installed easily at a home by altering a gutter. For most houses in the Philadelphia area, a 55-gallon rain barrel can fill to capacity during a one-inch storm event. Are rain barrels good for the environment? They help reduce stormwater runoff and, like mini reservoirs, act as a water source during droughts. However, laws regarding rain barrels vary across the U.S. Some municipalities with drier climates have made rain barrels illegal. Research water retention laws with your students, and discuss if rain barrels are good for every ecosystem.

Canals

Canals are manmade "water roads" meant to transport people and supplies by boat. Canals are usually alongside tow paths, which were used for towing the boats. Canals tend to be straight, with slow-moving water. They offer environmental benefits as well as problems. Maintaining and cleaning canals helps keep the water clean. If left unmaintained, canals can act as vectors for diseases. The slow water helps create a habitat for breeding mosquitoes. Canals also alter natural landscapes and redirect water, which alters flow and natural habitats. Have a discussion with your group to determine whether canals are good for the environment.

Sewers

Sewers are important but potentially problematic. They make up an underground network of waterways for draining wastewater and stormwater. Since sewers are artificial and lack the right ingredients to host a natural stream ecosystem, their flowing water is raw and filthy. Without filters, sewer water pollutes as it discharges into a river.

Fairmount Park Bike Loop (9 miles round trip): RTC brought Cadence Youth Cycling on this tour. The loop accesses the Centennial Trail section of the Circuit Trails and touches on a variety of artificial water bodies, including Concourse Lake, Fairmount Dam and East Park Reservoir. To learn more about this tour, go to the tour section on page 21.

TOPIC: Trailside Language Arts

Watershed Haiku: A haiku is a 17-syllable unrhymed poem containing three lines (usually with five, seven and five syllables respectively). Haiku originated in Japan as an expressive way to describe a fleeting moment. Haiku often are about the natural world and are meant to capture a feeling or observation about the environment. They are a fun way to incorporate language arts into your watershed education program.

Create "Watershed Haiku" booklets using recycled paper. Provide some haiku examples to your students, then use the Circuit Trails to take the group to a beautiful location. Ask the students to spend a few minutes in silence, observing their surroundings, and then to write a haiku. If they are having trouble getting started on a poem, they can start off with a sketch.

Washington Avenue Pier (8.5 miles round trip): RTC helped Cadence Youth Cycling learn about restoration practices and create watershed haiku. To learn more about this tour, go to the tour section on page 25.

Tom McKeon

Examples of Youth Haiku

The Circuit connects
People, Cultures, towns by bike
Let's finish this trail!

We're touring
So look around, see
Not racing

Splashing water
Riding road bikes
Watersheds, Circuit, Sojourn

We bike through
Nature is very pretty
I want to go to sleep

The mirror's surface
Broken by two keels kissing
Which one reflected?

Many miles in nature
Positive thoughts of Circuit
Soon no more sore legs

Beautiful waters
Anacondas not near here
Oh no! A squirrel

We're riding more and more
Like a team. Unison
We're family

Riding the Circuit
Three days full of adventure
With these wacky kids

We biked through Philly
To Valley Forge for more fun
We camped out all night

The hills are steep
Cadence Youth pedal pedal
Their Circuit inspires

City this is not
Houses, lake, hills, grass and hills
New Circuit experiences

CHAPTER 2: Bike Tours in Greater Philadelphia

Tom McKeon

Topic: Partnerships

Creating partnerships with other youth-serving organizations is important for achieving shared goals. The Circuit Trails connects young people to new experiences and ideas through outdoor education. RTC collaborated with local partners on events designed to reach young people in different communities. This resource guide would not have been able to incorporate the same quality and variety of lessons on the Circuit Trails without tapping the local knowledge and experience of local organizations. This section highlights the partners with whom RTC collaborated over the summer, the experiences we shared and some submissions from partners describing how they can be reached for future programming. RTC encourages you to reach out to these organizations and others to develop your own partnerships.

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Tookany/Tacony-Frankford Watershed Partnership, Inc.

Tookany/Tacony-Frankford Watershed Partnership, Inc. (TTF): TTF is an exceptional community resource for watershed information. RTC worked closely with TTF to educate young people in the Juniata Park area of Philadelphia. TTF's mission is to improve the health and vitality of the area's local watershed by engaging communities in education, stewardship, restoration and advocacy. The partnership mobilizes watershed stewards through outreach, education and hands-on projects, combining resources to engage different community groups. Here is a snippet of TTF Watershed Partnership's mission for Philadelphia:

> *"In Philadelphia, TTF supports the Philadelphia Water Department's Green City Clean Waters 25-year plan to improve our watersheds by managing stormwater through innovative green infrastructure. TTF has created rain gardens in Germantown and Olney. In its upstream communities, TTF works with many partners to implement stream restoration and green stormwater management projects …."*

For more information, contact:
Doryán DeAngel, Philadelphia Community Watershed Leader
doryan@ttfwatershed.org

Neighborhood Bike Works (NBW): Neighborhood Bike Works has been a consistent partner in RTC's youth programming. In addition to connecting youth through cycling, NBW works on promoting watershed engagement among Philadelphia's young people. RTC joined NBW on the group's biweekly rides to Cobbs Creek via the Cobbs Creek Trail. RTC taught lessons on benthic macroinvertebrates and watersheds. NBW describes its watershed programming as follows:

"Neighborhood Bike Works integrates watershed education into many aspects of youth programming in an effort to expand environmental awareness in Philadelphia, especially among minority groups.

Neighborhood Bike Works (NBW) is a youth-serving nonprofit organization that uses bikes as the hook to engage young people ages 8–18 in life skills development and experiential learning. Through bike repair classes, such as Earn-A-Bike, and bike riding activities, including after school Ride Club and summer Cycling Day Camp, NBW breaks down barriers to bike ownership and trail accessibility that many low income and minority groups experience.

For many years, NBW has visited Philadelphia's green spaces and watersheds with groups of young people, and used the Circuit Trails as a route for group bike rides. In 2015, NBW expanded efforts to get more Philadelphia youth onto bikes, utilizing watershed trails, and increasing awareness of the watershed and its importance to the lives of Philadelphians."

For more information, contact:
Steve Maluk, Executive Director
steve@bikeworks.org

Philadelphia Wooden Boat Factory (PWBF): PWBF engages the community to fulfill the fundamental mission of supporting positive change among Philadelphia youth. RTC partnered with PWBF to conduct a macroinvertebrate training workshop, empowering young people with knowledge about water quality. Here's what PWBF has to say about the organization's work in Philadelphia:

"The Philadelphia Wooden Boat Factory does environmental education and outreach work centered around the Delaware River through their out-of-school-time apprenticeships for Philadelphia youth. Motivated by their own curiosities and driven by their own strengths, the high school apprentices in the Riverguides program train to become both environmental educators as well as advocates for the health of the Delaware River Watershed. Students learn basic environmental science and reconnect themselves with the Delaware River Watershed through hands-on activities and field work as well as participating in the various conservation efforts of other organizations. Facilitated by PWBF science staff, the Riverguides then begin to use the Factory's laboratory and fleet of student-built rowboats to tackle their own projects designed to reconnect and introduce their local communities to the Delaware River."

For more information, contact:
Theophilos Collins, Science Education Director
theo@woodenboatfactory.org

THE ACADEMY OF NATURAL SCIENCES of DREXEL UNIVERSITY

Academy of Natural Sciences of Drexel University: RTC served as a science guest presenter for the summer camp at the Academy of Natural Sciences of Drexel University. The summer 2015 camp theme was Animal Grossology, with programs in which campers examined "gross" natural subjects. RTC joined in to take the youth on a hike on the Schuylkill River Trail to explore gross pools of murky water and algae blooms and smelly riparian buffer plants. The students even had the opportunity to design their own stinky macroinvertebrates! Students learned how to use a **dichotomous key**, which provides a fun way to identify an organism by choosing between alternative characteristics until the organism's description is narrowed down for identification. For this lesson, we used the Stroud Water Research Center's macroinvertebrate identification key.

For more information, contact:
Christine Danowsky, Camp Coordinator
cad364@drexel.edu

Asian Arts Initiative (AAI): This arts-oriented organization partnered with RTC in a program for young people to explore the Circuit Trails by bike. RTC held two events with AAI over the summer. In the first event, young people showcased bicycles they had decorated by taking a ride on the Schuylkill River Trail. They rode from Fairmount Water Works up Kelly Drive to the "Playing Angels" sculpture. Along the way, they stopped to learn about pollution flow. The group participated in an activity called "Artistic Streamfront Properties." Each participant received an imaginary $1 million to design a dream riverfront property. The design could include homes, amusement parks, businesses, water treatment plants, anything. Each person described the riverfront development to the group, and together the participants decided how much pollution each property created. Pollution was represented by paper clips. As the students presented their designs, the pollution traveled downstream. This helped present the concept that we all are affected by upstream sources.

The second partnership event with AAI occurred later in the summer when RTC rented bicycles from Wheel Fun Rentals. Many of the young people would not otherwise have had the opportunity to experience the Circuit in this way because they did not own bikes. Thirty youth rode from Wheel Fun Rentals up Kelly Drive, past the boathouses and beyond to a field by the Schuylkill River, where they participated in the Riparian Blindfold Game described in this report.

For more information, contact:
Gayle Isla, Executive Director
gayle@asianartsinitiative.org

Pennypack Environmental Center: A property of the City of Philadelphia Parks and Recreation Department, the Pennypack Environmental Center has a staff with extensive knowledge about stream ecology, botany, conservation and watersheds. The center hosts programs for young people and educational hikes that include plant identification, stream ecology and science. RTC partnered with Pennypack Environmental Center to lead an afternoon hike on the Pennypack Trail, which meanders alongside Pennypack Creek. The hike enabled participants to learn about macroinvertebrates.

For more information, contact:
Stephanie Hoffer Robinson, Environmental Education Planner
stephanie.hoffer@phila.gov

Lloyd Hall Boathouse: Located directly on the Schuylkill River Trail, Lloyd Hall Boathouse is operated by the City of Philadelphia Parks and Recreation Department. Philadelphia young people attended a summer camp there to learn rowing techniques. RTC taught campers about river life beneath the water's surface. Many of the young people were unaware of **benthic** life. RTC played a game called "Tolerant and Intolerant Species." The group was divided into two teams: red species and blue species. Red species were tolerant of pollution. Blue species were not. Two stream samplers were chosen to call out species. Red congregated on one side of the play area, and blue on the other. The stream samplers yelled out blue, red or both. The species ran across the play area and were chased by the samplers. Once tagged, the "species" sat on the ground and were allowed to tag passersby. The last two remaining species for each color became the next round's stream samplers. After the game, RTC took the group out to the Schuylkill River to learn about eutrophication.

For more information, contact:
lloydhall.staff@gmail.com

Friends of the Wissahickon (FOW): FOW's mission is to preserve the natural beauty and wilderness of the Wissahickon Valley and stimulate public interest. The organization works closely with the City of Philadelphia Parks and Recreation Department to restore historical structures. FOW maintains natural integrity through invasive species removal and educational programming on the trails.

For more information, contact:
Sarah Marley, Outreach Manager
marley@fow.org

Fairmount Water Works (FWW): Located behind the Philadelphia Museum of Art, Fairmount Water Works is rich in history, having opened its doors in 1815 as the sole water pumping station for the City of Philadelphia at the time—designed and engineered to provide safe and clean drinking water. Today it is a national landmark with a mission to foster stewardship of our shared water resources by encouraging informed decisions about the use of land and water. The facility is open to the public as an information center for all ages. Interactive activities about watersheds make learning fun and easy.

FWW offers watershed programming to school groups. RTC has partnered with FWW by bringing in youth groups for programming on topics including turtles, eutrophication, dams and reservoirs. The information center is air conditioned for hot summer days. FWW has been an exceptional partner.

Here is how Fairmount Water Works describes itself:

> *"Housed in one of Philadelphia's most recognizable landmarks, Fairmount Water Works (FWW) is dedicated to fostering stewardship of shared water resources by encouraging informed decisions about the use of land and water. What makes FWW unique among environmental centers is its location at the river's edge and in the center of the fifth largest city in the nation. FWW has interactive, user-friendly exhibits and programs about water in our world. Out-of-school-time programs for all ages include a speakers' series, architectural walking and bus tours, weekend hands-on science programs for families, and school and summer programs for pre-K to college age students."*

For more information, contact:
Ellen Schultz, Associate Director for Education ellen.schultz@phila.gov

Bicycle Coalition of Greater Philadelphia – Cadence Youth Cycling (CYC):
Hosted by the Bicycle Coalition of Greater Philadelphia, CYC engages young people through the sport of cycling to help them grow into healthy, responsible, confident adults. CYC partnered closely with RTC during the summer of 2015 on three programs: Circuit Team, Cycle Squad and All Star Team.

Circuit Team met at the Philadelphia Museum of Art for bicycle rides every Thursday from 10 a.m. to noon. The objective was to explore the Circuit Trails, using them as a way to access waterways for educational opportunities and to train for the Youth Sojourn.

Cycle Squad met Thursday afternoons at the KIPP DuBois Collegiate Academy. Cadence youth took this opportunity to develop leadership skills through the following team projects: Tour Team, Social Media Team, Community Engagement Team and Fun Team. RTC worked with the young people to develop talking points on watershed issues within Philadelphia. They learned about such issues as combined sewage overflow and stormwater runoff. These topics and other issues, related to biking and outdoor access, provided a platform for the youth to speak with (former) Mayor Michael Nutter and his staff. RTC worked especially close with the Tour Team to develop plans for the Youth Sojourn.

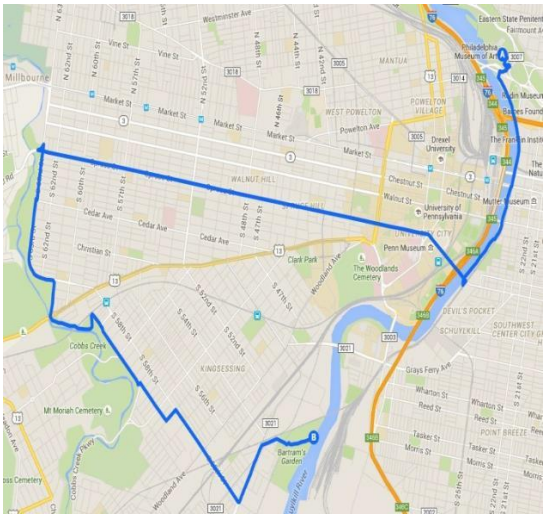
All Star Team met for two hours biweekly for watershed education. This team represents a group of athletes with a high commitment to cycling. The group participated as a sample population to test the effectiveness of watershed education programming. At the start of the summer, a field survey was administered to determine how much they already knew about the Circuit Trails and watersheds. At the end of the season, the same survey was administered to determine how much the group had learned. See the **Watershed and Circuit Regional Trail Network Survey** on page 29.

For more information, contact:
Taylor Kuyk-White, Program Manager
Cadence Youth Cycling
taylor@bicyclecoalition.org

Topic: Tours

The majority of the tours in this guide were tested by Cadence Youth Cycling's Circuit Team (see above). The tours used the Circuit Trails as an educational platform to access waterways. The bike tours are meant to be used by cyclists who are comfortable riding in an urban environment. The walking tours are intended for people of varying abilities and all ages.

Cobbs Creek-Bartram's Garden Bike Tour (16 miles round trip)



This West Philadelphia tour starts at the Philadelphia Museum of Art and heads south on the Schuylkill River Trail (SRT) toward the South Street Bridge. From there, the following route is taken to access educational platforms via the Circuit Trails:

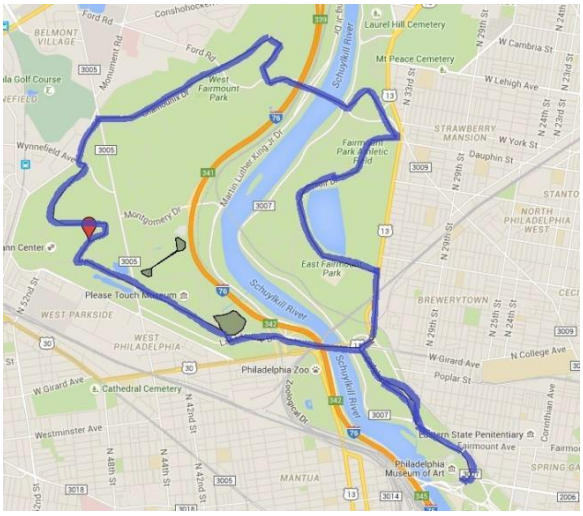
1) Exit the SRT and cross the Schuylkill River on the South Street Bridge.
2) Follow South Street westward to Spruce Street. Continue west on Spruce Street through the historic University of Pennsylvania campus, continuing to 63rd Street.
3) At 63rd Street, the route intersects with the Cobbs Creek Trail section of the Circuit Trails. The Cobbs Creek Trail provides easy access to Cobbs Creek in multiple places. The Cobbs Creek Environmental Center can also be accessed via the Cobbs Creek Trail.
4) The tour continues to the 58th Street portion of the East Coast Greenway to Bartram's Garden. Bartram's Garden is a living outdoor classroom with access to scenic views of the Schuylkill River.

RTC partnered with NBW to introduce youth to stream ecology along Cobbs Creek. Young people learned about stream ecology by sampling for benthic macroinvertebrates and observing the physical state of the creek habitat.

Student quote from NBW:

"The Cobbs Creek Trail allowed me to access a creek for the first time. I didn't realize how polluted creeks within Philadelphia can get."

Fairmount Park Loop (9 miles round trip)



RTC led Cadence Youth Cycling on this bike tour. The loop accesses the Centennial Trail section of the Circuit Trails and touches on a variety of artificial water bodies including Concourse Lake, Fairmount Dam and East Park Reservoir.

1) Start at the Philadelphia Museum of Art, and head north to N. 33rd Street.
2) Take N. 33rd Street to Reservoir Drive.
3) Follow Reservoir Drive to East Park Reservoir. This is a great location to learn about artificial water bodies.
4) This tour passes Concourse Lake, a perfect location to learn about riparian buffer plants.

Student quotes from Cadence Youth Cycling:

"I bike this section of the Circuit Trails frequently and never really thought about artificial waterways until now. I feel more connected to my environment."

"This section of the Circuit Trails is diverse."

Pennypack Walking Loop (1.25 miles round trip)

This short walking tour utilizes the Pennypack Trail section of the Circuit. The hike starts at the Pennypack Environmental Center and follows the posted trail off the property toward the Pennypack Trail. This family-friendly hike is great for young children. The hike cuts through the woods, exposing trail users to a variety of native plants including a patch of pawpaw trees. The hike accesses Pennypack Creek and a shallow water environment that can be used to explore benthic macroinvertebrates.

Student quote from Pennypack Environmental Center:

"There are so many different types of plants! [The] Circuit Trails make me feel safe walking in the woods. I can feel comfortable knowing someone else has explored this area before me."

Juniata Historical Walking Tour (1 mile round trip)

RTC teamed up with Tookany/Tacony-Frankford Watershed Partnership and the Philadelphia Wooden Boat Factory on this tour to provide education about history, benthic macro-invertebrates, stormwater management and riparian buffer plants. The tour starts at the intersection of Whitaker Avenue and Tampa Street at Juniata Park, and passes through a natural area to the Frankford and Tacony creeks via the Tacony Creek Trail. Plenty of parking for school groups is available nearby.

Student quote from The Philadelphia Wooden Boat Factory:

"Juniata Park used to be a dangerous area. The care that goes into constructing trails builds a sense of community. This allows me to appreciate forgotten landmarks."

Schuylkill River Youth Walk (1 mile round trip)

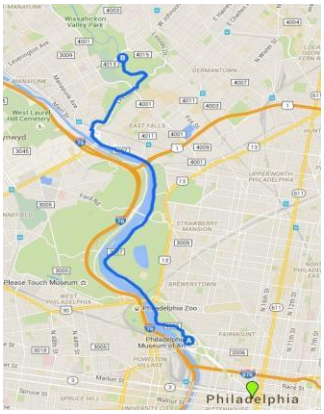
RTC partnered with the Academy of Natural Sciences of Drexel University to take young people on a smelly and slimy tour. This tour accesses the Schuylkill River Trail between Race Street and the Fairmount Water Works. It is a good tour for young children. There are lots of green spaces where the group can stop and take part in arts and crafts activities.

Student quotes from the Academy of Natural Sciences of Drexel University:

"This section of the Circuit Trails has a lot of nice smelling plants!"

"I like taking the opportunity to be as creative as possible. The Schuylkill River Trail makes me feel creative."

Forbidden Drive Bike Tour (11 miles round trip)



This beautiful tour starts on the Schuylkill River Trail (SRT), directly on the north side of the Philadelphia Museum of Art. Named 2015's Best Urban Trail by *USA Today*, the SRT provides some of the most scenic mileage the Circuit Trails have to offer.

The route for this ride can be very crowded on nice days, so be prepared.

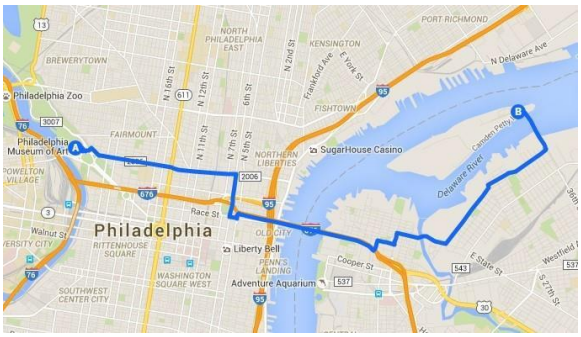
1) As you follow the Schuylkill River northwest along Kelly Drive, you will notice many green spaces by the river that can provide educational platforms.
2) This tour continues to East Falls Bridge near the intersection of Wissahickon Creek and the Schuylkill River.
3) At East Falls, make a right to follow Wissahickon Creek. This section of the Circuit Trails becomes bumpier, so be sure to bring extra inner tubes in case of flat tires.

RTC partnered with the Bicycle Coalition's Cadence Youth Cycling program to explore the Forbidden Drive Bike Tour. On the tour, Cadence Youth synthesized the concept of a watershed by applying the "Watershed Hands" lesson (page 6) on the green space along the Schuylkill River. The group used chalk to learn about stream order at the intersection of Wissahickon Creek and the Schuylkill River.

Student quote from Cadence Youth Cycling:

"The Schuylkill River Trail is great for a bicycling workout! Getting off busy roads makes cycling much more enjoyable."

Petty's Island Bike Tour (14 miles round trip)



This tour crosses the Benjamin Franklin Bridge over the Delaware River into Camden, New Jersey. The 1.8-mile bridge offers a challenging yet scenic ride. The descent into Camden overlooks the Camden Riversharks baseball stadium, the Camden Adventure Aquarium and Rutgers University.

The Circuit Trails route to Petty's Island begins at the Philadelphia Museum of Art.

1) Head east on Spring Garden Street Greenway. This is a good street to teach about best management practices. The storm drains under bridges provide great visuals for how water flows into sewers.
2) Follow signs to the Benjamin Franklin Bridge and cross into Camden. Take a moment to rest at the midpoint of the bridge and observe both the Philadelphia and Camden skylines.
3) Continue onto the North Camden Waterfront Trail to Cooper Waterfront Homes Trail.
5) Take the Cooper Waterfront Homes Trail across State Street Bridge.
6) Follow Cramer Hill Waterfront Park Trail to Petty's Island.

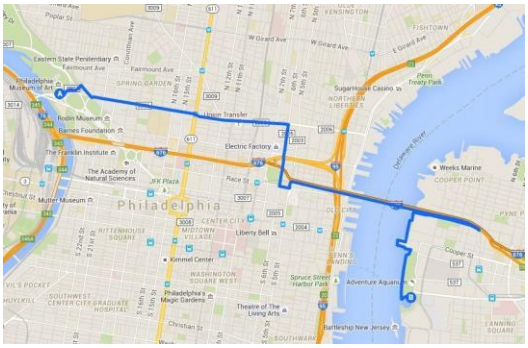
Student quotes from Cadence Youth Cycling:

"This tour helped me appreciate Camden's waterfront beauty. I like how this section of the Circuit Trails took me outside of Philadelphia."

"Petty's Island is a fascinating place to learn about water quality history."

At 635 acres, Petty's Island is the fourth largest island on the Delaware River. It currently is being converted into an environmental reserve. Petty's Island has an interesting history, which includes multiple ownerships and varying land uses. It was a site for dancing and drinking in the 1800s, and a proposed golf course site in the 1900s. The island's Citgo site was owned by Venezuela until it was donated for environmental preservation. Currently Petty's Island is home to a nesting pair of bald eagles. The island is closed to the public unless prior arrangements are made.

Camden Aquarium Bike Tour (10 miles round trip)



This tour starts at the Philadelphia Museum of Art.

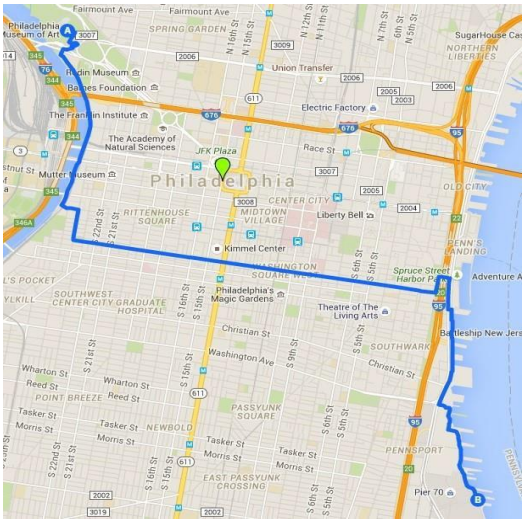
1) Take the Spring Garden Greenway toward the Benjamin Franklin Bridge.
2) Cross the bridge over the Delaware River into Camden, New Jersey, and onto the Ulysses Wiggins Promenade portion of the Camden Greenway.
3) Continue to the Camden Aquarium.

The Cadence Youth Circuit Team learned about ocean watersheds and sharks at the Camden Aquarium during a private classroom workshop. The waterfront provides access to the Wiggins Park Marina, which is a great location for discussions about artificial waterways and pollution.

Student quote from Cadence Youth Cycling:

"The Wiggins Park Marina has a great view of Philadelphia. Not only does the Circuit connect me to new places, but I also learn to appreciate my city in new ways."

Washington Avenue Pier Bike Tour (8.5 miles round trip)



On this trip RTC invited Cadence Youth Cycling to learn about watershed restoration techniques and practice Haiku language arts. The tour heads south toward the South Street Bridge and cuts across the city on Spruce Street, stopping at Spruce Street Harbor Park. This beautiful park showcases hammocks in the summer, and its green space offers a welcoming place to rest.

From the park, continue down the Central Delaware Waterfront Trail to Washington Avenue Pier, a site that is undergoing ecological restoration. The renovated pier is home to native plants and is the starting point of a public hiking trail. At the pier, the Circuit Team took a moment to write a haiku expressing observations about their natural environment and watershed.

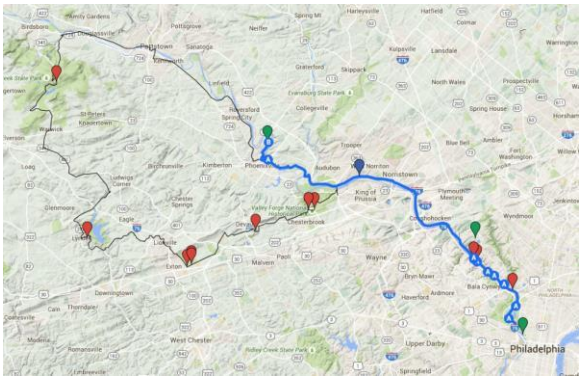
Student quotes from Cadence Youth Cycling:

Tom McKeon

"I was pleasantly surprised to see Philadelphia turn abandoned piers into ecological restorations."

"The Washington Avenue Pier is an inspiring place to write Circuit haikus."

Youth Sojourn (128-mile tour)



RTC hosted Cadence Youth Cycling on our biggest event of the season, the 2015 Youth Sojourn, a three-day overnight bike tour.

Here is what the Bicycle Coalition of Greater Philadelphia had to say about the Youth Sojourn in a blog written by Randy Lobasso:

Cadence Youth Cycling Sojourn Ride a Huge Success

Cadence Youth Cycling and Rails-to-Trails Conservancy organized a bicycling and camping trip along the Circuit. Youth athletes, adults and mechanics traveled 128 miles over Labor Day Weekend.

The Sojourn began at Fairmount Water Works on Saturday, September 5th at 8am. 12 youth and 8 adults attended. They had 3 mechanics and 2 SAG support drivers. Rails-To-Trails Conservancy youth engagement coordinator Tom McKeon worked alongside youth athletes to plan out the education programming.

Students and chaperones biked up the Schuylkill River Trail and stopped at East Falls Bridge for the first student-run lesson: What Is a Watershed? They continued to Manayunk Canal for the second lesson, Are Canals Good for the Environment?, before heading up to Phoenixville. Taking a detour off the Schuylkill River Trail, the cyclists traveled north to Black Rock Sanctuary. There, lunch was served and the group had an opportunity to sit down and learn about Black Rock Sanctuary's history from a park ranger.

Afterwards, the group continued to French Creek State Park, travelling a total of 58 miles and even tackling a 2-mile incline at an average grade of 5 percent. At French Creek State Park, the group set up their tents, enjoyed a catered dinner from Valentino's and relaxed with board games and sports.

The next morning, the group enjoyed the park's facilities. Everyone had an opportunity to either rowboat or swim. After lunch they set out towards Marsh Creek State Park to enjoy the scenic view and create haikus about the Sojourn, the Circuit Trails and watersheds.

"One thing that's unique about this trip is that the planning and execution involved our youth leaders," says Cy Maramangalam, Cadence Youth Cycling Program Manager. "The idea started when the CYC Youth Advisory Committee returned from the Youth Bike Summit in February and were inspired to incorporate a bicycle tour in Cadence Programming. A project team called the 'Tour Team' was created, and they worked closely with Tom in planning the route and campsites."

The second day concluded at Saint Peters Church of the Great Valley. The church sits on 16 acres of land, including a cemetery, labyrinth and sheep.

During the evening, everyone enjoyed roasting marshmallows on a campfire, stargazing and sharing stories. Many slept out in the open air. The next morning the group biked towards Valley Forge. At Valley Forge, youth learned about benthic macroinvertebrates and green infrastructure through interactive activities at a stream. They cycled towards the SRT and took it home to conclude with cake at Fairmount Water Works.

"The trip was an incredible success and incredibly fun," continues Maramangalam. "Not only were our CYC youth able to go places they've never gone before, but they were also able to lead discussions in watershed education, experience the true breadth of the Circuit, and its potential once complete."

Anya Saretzky

Tom McKeon

Anya Saretzky

Chapter 3: Results

TOPIC: Lessons Learned From Programming

Since 2015 was the first summer of Watershed Education by Circuit Trails in Philadelphia, there were several lessons learned.

Tom McKeon

Group sizes

For the most part, only one educator attended each program. Large group size—more than 20 young people—made teaching lessons difficult. It was tough to speak loudly and personably enough for large groups to stay focused. Chaperones were very helpful with photography, supervision and handing out materials. In the future, it would be beneficial to have an intern or a staff partner at every program.

Transporting educational supplies

Since the majority of time is spent on off-road trails, transporting personal supplies, first aid, water and educational materials was challenging. It is important to carry only what you need; having an assistant makes this a lot easier. Circuit Trails-branded giveaways such as water bottles, athletic bags and lip balm took up space. Leaders and participants need to bring backpacks and panniers.

Storage

Easy access to educational supplies also is important. Programming takes place all over the city of Philadelphia. Having supplies in the office is ideal. Office space was limited during the summer of 2015 and RTC's main storage facility was located a number of blocks away from the office. This made timing a bit more challenging.

Access and distance

Philadelphia is a big and busy city. Some partnerships were difficult because the organizations were physically far from the RTC office. The partner farthest from the office was the Pennypack Environmental Center. The partner closest to the office was Cadence Youth Cycling.

People love being outside

People enjoy being outside, and exposing young people to the outdoor classroom was generally very well received. This type of program is unique. Fairmount Water Works does a lot of watershed education outside, but not on Circuit Trails. Neighborhood Bike Works was the most similar to RTC in its use of the outdoors. NBW offered youth a watershed educational program on bikes, but not necessarily on Circuit Trails.

Topic: Reportables

- 510 Total number of youth participants
- 121 Total hours of programming
- 42 Hours of watershed programming
- 1,524 Total hours of youth participation
- 544 Total hours of youth participation in watershed programming
- 44 Youth bikes repaired
- 24 Adult bikes repaired

Topic: Surveys

Measuring the effectiveness of each program is important in order to understand what worked and what did not. Field surveys were designed to be quick and to the point. Young people came to events to be outside and observe their natural environments, so shorter surveys helped ensure thoughtful, complete responses. The following two surveys were designed and used over the summer. The first is the shorter, quick survey. The second is the more extensive survey used for Cadence. Since Cadence worked with RTC on a weekly basis, a deeper analysis was important.

Each survey has pre-event and post-event tests that ask the same questions. This is meant to measure changes in response. It allows RTC to understand what survey takers knew going into the program and what they gained, or even lost, after the program.

What Are We Learning Today?

Name:

1) Which of the following are sources of water pollution? (Circle all that apply)

Clouds Bicycles Cars Road Salt
Lawn Fertilizers Trees

2) How well do you understand watersheds?

Not At All Unsure A Little Very Well
I Can Teach It

3) In one sentence, what is a watershed:

4) Can all aquatic insects live in the same amount of pollution?

Yes No Unsure

5) Which direction does pollution flow in a river?

Downstream Upstream Both Directions
No Direction

6) How familiar are you with the Circuit?

Not At All Unsure A Little Very Well
I Can Teach It

Results

Short survey: On average, 80 percent of youth participants in the programs became more familiar with the Circuit Trails and 90 percent gained a better understanding of watersheds.

Long survey: 14 completed surveys were available to measure the impact of the program education. The analysis shows RTC's youth programming increased understanding of both watersheds and the Circuit Trails among Cadence youth.

Understanding of Watersheds
Improved: 12/14 = **85.7%**
No change: 2/14 = **14.3%**
Regressed: 0/14 = **0.0%**

Understanding of Circuit Trails
Improved: 8/14 = **57.1%**
No change: 5/14 = **35.7%**
Regressed: 1/14 = **7.2%**

Here is what the youth participants had to say on the [long survey] post-test about the Circuit Trails network:

"It means I can ride more. I can also meet people."

"It means to be able to go to other places. It also means being able to be connected to the community."

"It gives me a chance to discover more places to go."

"More opportunities to explore new places and meet new people."

"It means a safe way to ride my bike on a path for riders."

"It means I can have fun. It means I can explore the city."

Watershed and Circuit Regional Trail Network Survey

This survey examines the role of Rails-to-Trails education on the awareness and knowledge of watersheds in Philadelphia and the Circuit regional trail network. Participation in this survey is required to complete requirements of your program. Thank you!

What is your name?_____ **Date**_____

Below you will find a list of questions about watersheds and the Circuit. Please answer all questions accordingly					
Please answer the following questions to the best of your ability. For questions that apply, considering how frequently the following questions apply to you, circle the frequency from the following option.					
1. Are you aware of trails in your community?	No		Somewhat	Yes	
2. In 1-2 sentences, describe what the Circuit regional trail network means to you?					
3. Do you talk about water quality with friends, family and coworkers?	Never	Rarely	Often		Always
4. While on a Circuit multi-use trail that runs parallel to a waterway, do you ever think about the quality of the water and its impact on your enjoyment of the trail experience?	Never	Rarely	Often		Always
5. What is a watershed?	Area of land that drains storm water into a body of water.	Water storage building.	An amusement park with water rides.	A wildlife refuge.	City sewage pipes.
6. Do you talk about trails with friends, family and coworkers?	Never	Rarely	Often		Always
7. Circle all the sources of water pollution from the following options:	Bicycles	Clouds	Trash	Wetlands	Cars
	Trees	Geese	Mushrooms	Fertilizers	Road Salt
8. How much of a risk is watershed pollution to you and others? Circle the best fit answer	Don't Know	Little Risk		Some Risk	Big Risk
9. How interested are you in learning more about watersheds and its effect on health? Circle the best answer	Not Interested	Some Interest		Very Interested	
10. Are you familiar with your local stream system?	UNSURE		NO	YES	
11. Do you feel like watershed education is useful to you?	UNSURE		NO	YES	

Thank you for completing the survey

The following image shows how the test was run. The statistics calculations were conducted using an online calculator found at www.socscistatistics.com/tests/ttestdependent.

This online calculator is helpful for anyone with or without a statistics background. The test used for the surveys in this resource guide are paired t- tests.

The value of *t* is 5.204165.

Explanation of results

The output of this calculator is pretty straightforward. The values of *t* and *p* appear at the bottom of the page. If the text is blue, your result is significant; if it's red, it's not. The only thing that might catch you out is the way that we've rounded the data. The data you see in front of you, apart from the *t* and *p* values, has been rounded to 2 significant figures. However, we did not round when actually calculating the values of *t* and *p*. This means that if you try to calculate these values on the basis of the summary data provided here, you're likely going to end up with a slightly different - and less accurate - result.

Treatment 1	Treatment 2	*Diff* (T2 - T1)	*Dev* (Diff - M)	*Sq. Dev*
14,22,19,23,16,23,16,19,19,21,17,22,17,20	15,26,23,25,24,21,25,28,30,29,21,26,22,23	1	-4	16
		4	-1	1
		4	-1	1
		2	-3	9
		8	3	9
		-2	-7	49
		9	4	16
		9	4	16
		11	6	36
		8	3	9
		4	-1	1
		4	-1	1
		5	0	0
		3	-2	4
		M: 5		S: 168

Significance Level:

- 0.01
- (•) 0.05
- 0.10

One-tailed or two-tailed hypothesis?:

- One-tailed
- (•) Two-tailed

Difference Scores Calculations

Mean: 5
$\mu = 0$
$S^2 = SS/df = 168/(14-1) = 12.92$
$S^2_M = S^2/N = 12.92/14 = 0.92$
$S_M = \sqrt{S^2_M} = \sqrt{0.92} = 0.96$

T-value Calculation

$t = (M - \mu)/S_M = (5 - 0)/0.96 = 5.20$

The value of *t* is 5.204165. The value of *p* is 0.00017. The result is significant at $p \leq 0.05$.

Calculate Reset

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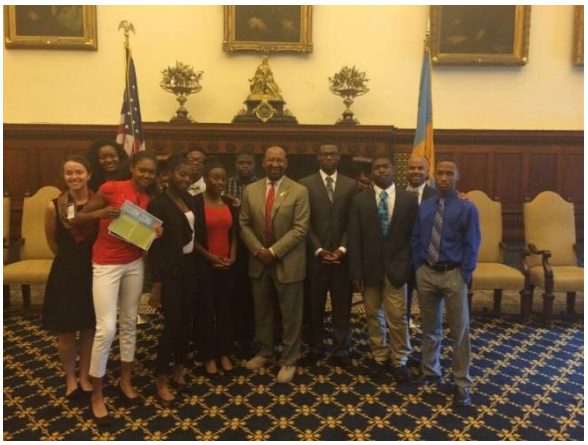
Appendix

Cycle Squad meeting with Michael Anthony Nutter, the 124th Mayor of Philadelphia



Cy Maramangalam

Cadence Youth Cycling Cycle Squad attended Lobby Day at City Hall with three goals in mind: Educate the Mayor and City Council members about the Delaware Watershed, about the Circuit Trails and about the Vision Zero policy for Philadelphia.

Students Coleman Milligan, Tamia Santiago, Sykheem Adams, Marlina Hardy, Joshua Walton, Krystal Philson, Taevon Oliver and Allen Williams were largely successful in their endeavors.
"I wanted them to come back and understand that their voice is important," says Cy Maramangalam, Cadence Program Manager, who accompanied the students to City Hall. "And I wanted them to know what can be done—even as a teenager—and that they can take steps forward to make change on the issues that they care about."

Students met with (then) Mayor Michael Nutter, Councilwoman Jannie Blackwell and the staff of Councilwoman Blondell Reynolds-Brown to speak about issues they wanted the officials to address. Among them: making the roads safer, fixing potholes and cleaning up the roads. (Sometimes broken glass on the pavement forces cyclists into the middle of the road, students said.) They also spoke about Vision Zero, which aims to reduce traffic deaths to zero, and advocated for city's leadership to support that plan.

Chemical and Observational Parameter Measurements

pH: This tells us how acidic or basic something is. The standard scale ranges from 0 to 14, with values lower than 7 being acidic and values higher than 7 being basic. A level of 7 is neutral. In general, pH between 6.5 and 8.0 is comfortable for most organisms. Streams themselves can range in acidity. Streams with unusual pH levels for their environment may indicate that something is wrong. Perhaps acid rain is prevalent in the area or there is a chemical discharge upstream. The pine barrens in New Jersey have especially acidic waters, dipping as low as 3.5 pH. In this case it is a natural occurrence due to the unique ecosystem and substrate.

Dissolved Oxygen (DO): Oxygen in water? Yes, oxygen in water is a good thing. Much as you need to breathe oxygen from the air with your lungs, aquatic creatures with gills filter water to absorb oxygen. Dissolved oxygen is often measured in milligrams per liter (mg/L). Oxygen is introduced into streams by disturbance; think of a bubbling fish tank. A rocky stream with bubbling rapids most likely has a high oxygen level. A slow, stagnant, meandering stream will have low oxygen levels. Different organisms tolerate different oxygen levels. Many algae thrive in waters low in oxygen. Stoneflies, mayflies and water pennies are examples of organisms that thrive in highly oxygenated waters.

Temperature: Do you have an ideal temperature range? Probably so. Constant temperatures far above or below that range, such as a steamy 105 degrees Fahrenheit, or a shivering -40 degrees Fahrenheit (which is also -40 Celsius), would be unhealthy for you. Organisms in waterways have ideal temperature ranges too. Stream temperature can be affected by a depletion of shade plants or habitat alteration due to construction. Water discharged from a reservoir may also alter temperature downstream.

Turbidity: Turbidity measures the level of suspended particles in water, which affects visibility. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU), a metric gauged by lake surveyors using electronic readers. Secchi discs read turbidity by measuring the depth of visibility. These black and white discs are lowered into a body of water until they no longer are visible.

Secchi Disc (NJDEP)

Specific Conductance: This is a measure of how easily electricity can flow through water. High conductivity means electricity can travel farther. Conductivity increases with more free ions. Ions are produced when compounds decay. As a result, negative and positive ions are available to carry a charge. In the winter, road salt contributes to conductivity. High specific conductance is an indicator of solid matter pollution.

Nitrogen: Nitrites and nitrates are found in fertilizers, sewage and industrial waste. These compounds are important nutrients for plant growth. However, excessive amounts of nitrites and nitrates in bodies of water bring eutrophication: The nitrogen compounds foster heavy growth of algae and other aquatic plants, which deprives other life of needed oxygen. How? When the plants die, bacteria use oxygen to decompose the plant material, thereby depleting the dissolved oxygen levels. Nitrogen is the primary cause of eutrophication in saltwater. Nitrite and nitrate quantities usually are measured in parts per million (ppm).

Phosphates: Much like nitrogen, phosphates are used as fertilizers to promote plant growth and will exacerbate eutrophication. Phosphates are the primary source of eutrophication in fresh water. This parameter also is commonly measured in ppm.

Alkalinity: This measures the stream's ability to neutralize acids. Buffering compounds are leeched from substrate that helps protect the stream from large pH fluctuations. Low alkalinity may indicate a strained stream, working hard to neutralize acid rain or other sources of acid.

Vocabulary

Acid rain: Precipitation with low levels of pH. Usually it is harmful to the environment.

Benthic macroinvertebrates: The larvae and nymphal forms of small animals living in the streambed or banks.

Dichotomous key: Scientific flowchart that asks deductive questions about organisms to aid in identification. The dichotomous key asks taxonomic questions about visual characteristics, gradually narrowing possibilities.

Ecology: A division of biology that studies the relationship of the environment to the physical, chemical and biological world.

Eutrophication: Enrichment of nutrients to an ecosystem that results in oxygen depletion and change of habitat.

Groundwater: Water held underground in pores and crevices.

Groundwater infiltration: The process of rainwater to penetrate the ground and enter the pores and crevices of the soil.

Impermeable: Not allowing liquid to pass through; rain cannot infiltrate impermeable soil.

Meandering: The bending sinuosity of a river.

Riparian buffer plants: Plants along waterway edges.

Solvent: A liquid that dissolves solutes to form a solution.

Stream gradient: A ratio of drop in elevation over stream distance. Low gradient "muddy bottom" streams are slower than high gradient "rocky bottom" streams.

Stream order: A ranking system that measures the relative size of streams.

Streambed: The depressed ground underneath a body of water.

Stormwater runoff: Rainwater that does not infiltrate the soil. Water flows along the impermeable surface.

Water chemistries: A wide set of water quality parameters tested to determine water conditions.

Watershed: An area of land that drains stormwater into a body of water.

Wetlands: An area of land with soil that is saturated with water.

Author's Note

Brenae Mitchell

Thank you for a wonderful summer! I enjoyed my time developing partnerships for RTC, making new friends and exploring the Circuit Trails. I hope this resource guide promotes more trailside outdoor education. I would love to hear about ideas and activities that work for you.

Happy Trails!
Tom McKeon

rails-to-trails conservancy

Rails-to-Trails Conservancy, a nonprofit organization with more than 160,000 members and supporters, is the nation's largest trails organization dedicated to connecting people and communities by creating a nationwide network of public trails, many from former rail lines and connecting corridors.

To learn more about Rails-to-Trails Conservancy and its role in making trails, walking and biking a part of the national transportation solution, visit railstotrails.org