Stormwater Management

In Our Communities

ECO MEET 2018 Study Packet

City of North Augusta Stormwater Management Department

State Standards Include:

Georgia: S6E3; S6E4, S6E6b; S7Ld; S8P1b

South Carolina: 6.E.2A.3, 6.S.1A.1, 6.S.1A.4, 6.S.1A.7; 7.S.1A.4, 7.S.1A.6, 7.EC.5A.1; 8.S.1A.4, 8.E.5A.1

Pay special attention to the words in bold.

North Augusta
South Carolina's Riverfront

Stormwater Management in Our Communities

Stormwater is the runoff from rain or other forms of precipitation like snow. In an **urban** environment, such as a city, this runoff will not be able to soak into the ground due to impervious surfaces like streets, sidewalks, and buildings. The stormwater will instead flow over surfaces picking up pollution like trash, dirt, and chemicals before entering the storm drain system. The **storm drain system** is made up of drains and pipes that empty stormwater "untreated" into local creeks, streams, wetlands, or other water bodies.

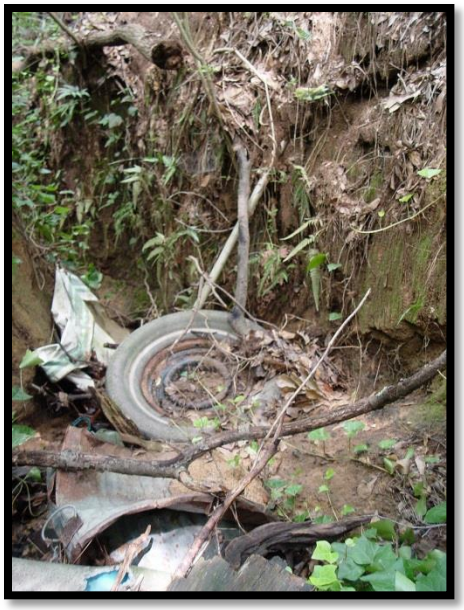
Stormwater Pollution

What is stormwater pollution? The storm drainage system is intended to route rainwater quickly off the streets during a heavy storm, unfortunately, the water is not cleaned before it is dumped into local streams or the Savannah River. Chemicals, trash and debris dropped or spilled on to surfaces (lawns, parking lots, roofs, improperly stored items, streets, walkways, etc.), are washed by rainwater into storm drains. The pollution from stormwater is discharged in every community in the United States. If you consider that, you should understand the importance of preventing stormwater pollution here at home. The ocean is the ultimate destination for every pollutant that rainwater washes out of every community. This is the one of the reasons for the regulations that created small community permits across the United States (small **Municipal Separate Storm Sewer Systems (MS4)** permits) to educate and prevent stormwater pollution at its source, our homes, streets, and businesses.

What Are the Effects of Stormwater Pollution?

- Our **Health**: Stormwater pollution poses a serious health risk to people swimming, consuming fish or using the source for drinking (drinking water wells near the waterbody) in contaminated waters.

- The **Local Environment**: Countless plants and animals can become sick or die from contact with stormwater pollution. They can accumulate toxins over time (through the food web) that can alter their reproductive success or move the pollutants through the food chain at higher and higher levels, ultimately affecting many species including humans. Animals that eat plants can become sick from the plants that have taken the toxins up into their stems and leaves. Other animals or reptiles that eat insects from the streams can become sick as well.



Streams and creeks in your neighborhood can become polluted by trash, making it unsafe for recreation. Trash and debris can clog the stream bed and slowly degrade more toxins into the water over time. These log jams of debris can also create downstream stream bed scour and **erosion** making the stream banks unstable.

- The **Ocean Environment** has already been affected. Trash from the world has become large floating islands of debris in five locations in the oceans. They are called “garbage patches” or “gyres”.

Some of these are as large as the state of Texas. It is estimated that 5 trillion pieces of garbage (mostly plastics) are floating in the patches.

Stormwater pollution and illegal dumping are a root cause of the floating debris fields in our oceans. Stopping the trash from getting into the oceans through stormwater management is one of the most important things we must do.

- Our **Neighborhoods**: Clogged catch basins significantly decrease the quality of life in many neighborhoods. These "nests" of trash and debris can attract rats and cockroaches, create foul odors, and clog the storm drain system. Thus affecting neighborhood appearances and property values, and creating the potential for local flooding during heavy rain events. Clogged drains back water up until it overtops curbs or driveways and that stormwater can wash yards and landscaping away and flood homes. Removing trash from the storm system

Cleaning our Oceans
Meet Boyan Slat

Many people are trying to come up with ways to remove the trash from the ocean, until then, stopping more trash from making it out there is critical. One of those people is a young man.

While diving one day, a 16 year old Dutch student named Boyan Slat saw more trash and plastic below the water than fish. He was so upset that he decided to do a high school project about the issue where he learned that most people believe it is impossible to clean up the oceans, the problem is just too big. Boyan did not believe that to be true and said “let’s clean it up!” At 18 he started a foundation to study the issue and develop the technology to clean up the ocean. He has won many awards and has raised 32 million dollars for his research and the project.

Today Boyan is 22 years old and he says the device is ready. He expects that it will only take a few years to clean up the trash. In 2018, his team of 60 engineers and scientists will launch the first full scale attempt to clean up the pacific patch (number 1 on the graphic). Then they plan to recycle the plastics they gather to earn more money to clean up the other 4 patches.

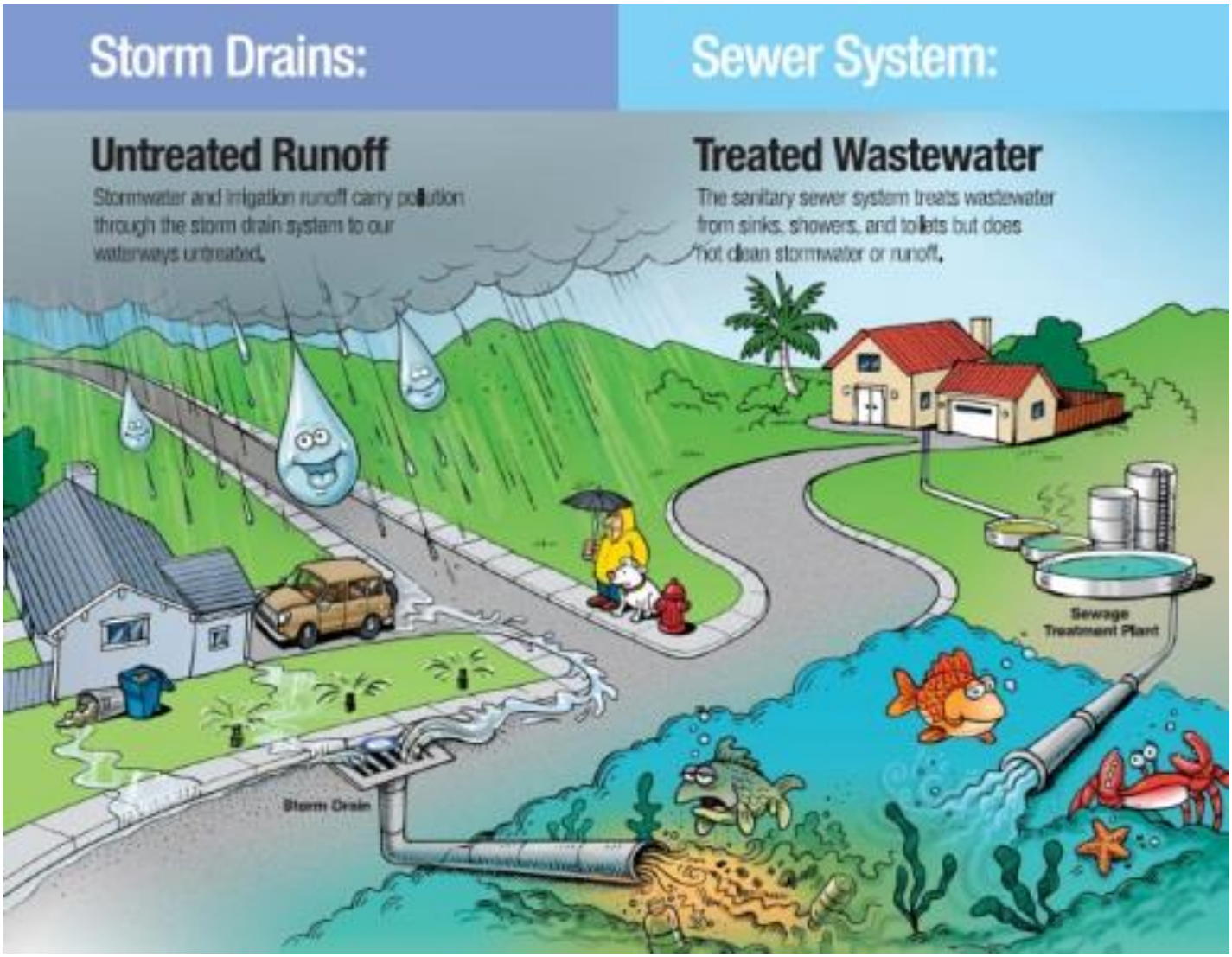
Learn more about Boyan Slat at his website, The Ocean Cleanup, https://www.theoceancleanup.com.

(*photos: curtesy of The Ocean Cleanup*)

before it can enter our streams must be a priority to reduce pollution and clogging.

Storm Water Sewers (storm water systems)

Is there a difference between a Sanitary Sewer Drain and a Storm Drain? Yes. The sewer system and the storm drain system are two completely separate drainage systems. The sewer system, or **sanitary wastewater system**, takes all household wastewater from toilets, showers, washers and sinks etc., and routes it through the City plumbing/sewer system to your city's **waste water treatment plant** (North Augusta's sewage goes to the Horse Creek Wastewater Treatment Plant in Aiken County). Once there, the polluted water receives treatment (is cleaned) before being discharged to the Savannah River just below Horse Creek. The treated wastewater is tested repeatedly to ensure that it is safe to discharge to the river. The treatment plant has a **Wastewater Permit** that the government issues to make sure the treatment process works and cleans all pollution from the wastewater.



The storm drain system includes the drains located on streets, parking lots, yards, or other areas that are there to collect stormwater when it rains. These pipes are designed to collect the rainwater only and move it through the community and eventually into a stream, the river and then on to the ocean. The water is not treated (or cleaned) at a treatment plant like sewer wastewater is. Today, the government issues stormwater permits for these stormwater pipes and conveyances for communities. The purpose of this program is to work together to make sure that only stormwater enters these drains.

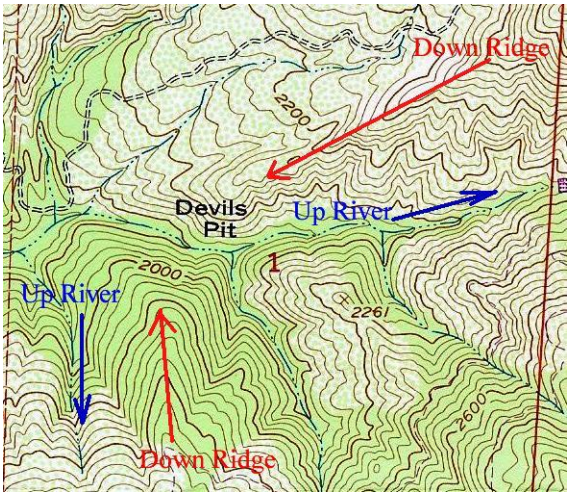
Conveyances to move stormwater: Cities and towns use pipes, grass lined ditches, concrete ditches, and roadside edges or street gutters to route stormwater through the community and into storm ponds or directly to streams or rivers. These conveyances are important to move stormwater away from roadways, houses and businesses so that the water does not flood the community. New methods to let the water filter into the ground are being used today as well.

What is a catch basin? A **catch basin** is a curbside, box-like receptacle that catches rain water from the street gutter to route it into the underground storm drain pipe or to ditches. They are entry points to the storm drain system. Catch basins can be openings only, can also have grates so trash gets kept on the road and not in the drain, or can be in yards or at the end of ditches. In most communities, the new permit programs require we mark them so that people know not to dump waste into the drains. North Augusta uses labels like the one in the picture. The city either attaches marker labels on each catch basins, or for newer streets, the big metal lids have been marked with "No Dumping" imprinted in the metal. The marking program is part of the education of citizens about stormwater pollution.

Impervious surfaces: Any surface that is hard and water cannot drain through it is called an impervious surface. This includes roads, driveways, parking lots, roofs, and sometimes compacted soils. Many impervious surfaces are in cities or towns like all the rooftops, buildings, streets, parking lots, sidewalks, asphalt, concrete, other paving, driveways, and patios. **Pervious surfaces let water drain through them**, these are grassed areas, artificial turf, wooded areas and undeveloped surfaces are all examples of pervious surfaces. Impervious surfaces affect the natural infiltration or runoff patterns of water. If water runs off of it, it is impervious. Runoff is captured and routed to stormwater drain systems to reduce flooding.

Because large, medium and small towns are full of impervious surfaces and people, stormwater pollution is most likely to come from communities. New laws to prevent stormwater pollution have been made to educate and clean up pollution so that stormwater does not wash it into our streams, rivers, and oceans.

Ponds **Stormwater ponds** are required for most development areas to catch water and release it slowly. The rule is generally that the amount and speed of rainwater that would flow off the site before it is developed must be the same or less after it is developed. That rule may vary by town, city or state, but generally that is the standard that must be met. So ponds are designed to capture the runoff from a developed and impervious site and release it at the same rate as if it was never developed. An undeveloped site is usually wooded or grassed with no impervious areas. Water filters into the ground until it is saturated and then will run off in a sheet of water across the landscape. If ditches, downhills, or valleys are already there, the water will flow through them to the nearest stream. These features on the landscape are called **topographic features**. Topo-maps help engineers to see where the water flows by the ridges or slopes in the land (see map to the left). Consider the site like a mini-watershed; to add impervious areas, such as roofs, roads and sidewalks, that rainwater must be captured and slowly released to mimic the original site where water filtered in before it ran off.



Ponds are designed using calculations including the type of soils, the type of ground cover present, the size of impervious areas already there and the amount of rainwater that normally falls in the region. They look at the normal to highest amount of rainfall that usually happens. That information will be used to calculate how much and how fast stormwater runs off the site. Engineers that are designing the new site will then re-calculate the site to show the rate of runoff after the site is developed using the same methods. The ponds are then designed based on the difference. The **outfall** of ponds, (where the

water leaves the pond) is designed to let the water go at an amount and rate to mimic the site just as it was before it was developed. By using this method, you are protecting the streams and rivers and landscape from tremendous flows that come from just the storm pipes without the pond. High flows from pipes can destroy roads, streams and the landscape.

Stormwater Outfalls:

At the end of all the storm sewers where water is emptied into a stream is called the outfall. Outfalls are generally concrete walls with a pipe coming out. At the end of the pipe there should be rock and other materials to slow down the flow of water as it empties the pipe. This protects the outfall from erosion and the stream from being eroded away. Outfalls can be very good at protecting streams or very bad if they fail, are not repaired, or are put in incorrectly. Towns must inspect and maintain outfalls to prevent problems.

Rock used to slow water down at outfall

Severe Erosion from unmaintained outfall

Cleaning up our nations waters

Regulatory Background

Prior to the **Clean Water Act** in 1972, there was no regulation on dumping pollution into the navigable waters from point sources. **Point-source pollution** is discharge from a single, discernible source such as a pipe from a textile mill, wastewater plant, or an oil refinery. The Clean Water act *set restrictions* through a permit program called the **National Pollutant Discharge Elimination System (NPDES),** which puts permits on discharges from pipes from **industrial** waste facilities and city wastewater plants to help prevent pollution and keep the waterways throughout the United States fishable and swimmable. The **Environmental Protection Agency (EPA)** helped to enforce these regulations and assist states in creating their own permitting programs. The NPDES permits are re-issued or re-written every 5 years to eliminate pollution over time. So each new permit has more restrictions. This allows companies and towns the time to install controls and build systems to eliminate the waste. The first point-source "**Wastewater permits**" were issued by either the EPA for states that were not issuing their own permits, or by states that chose to meet the regulations through their own permit programs nationwide. Georgia and South Carolina chose to be delegated by the EPA to write their

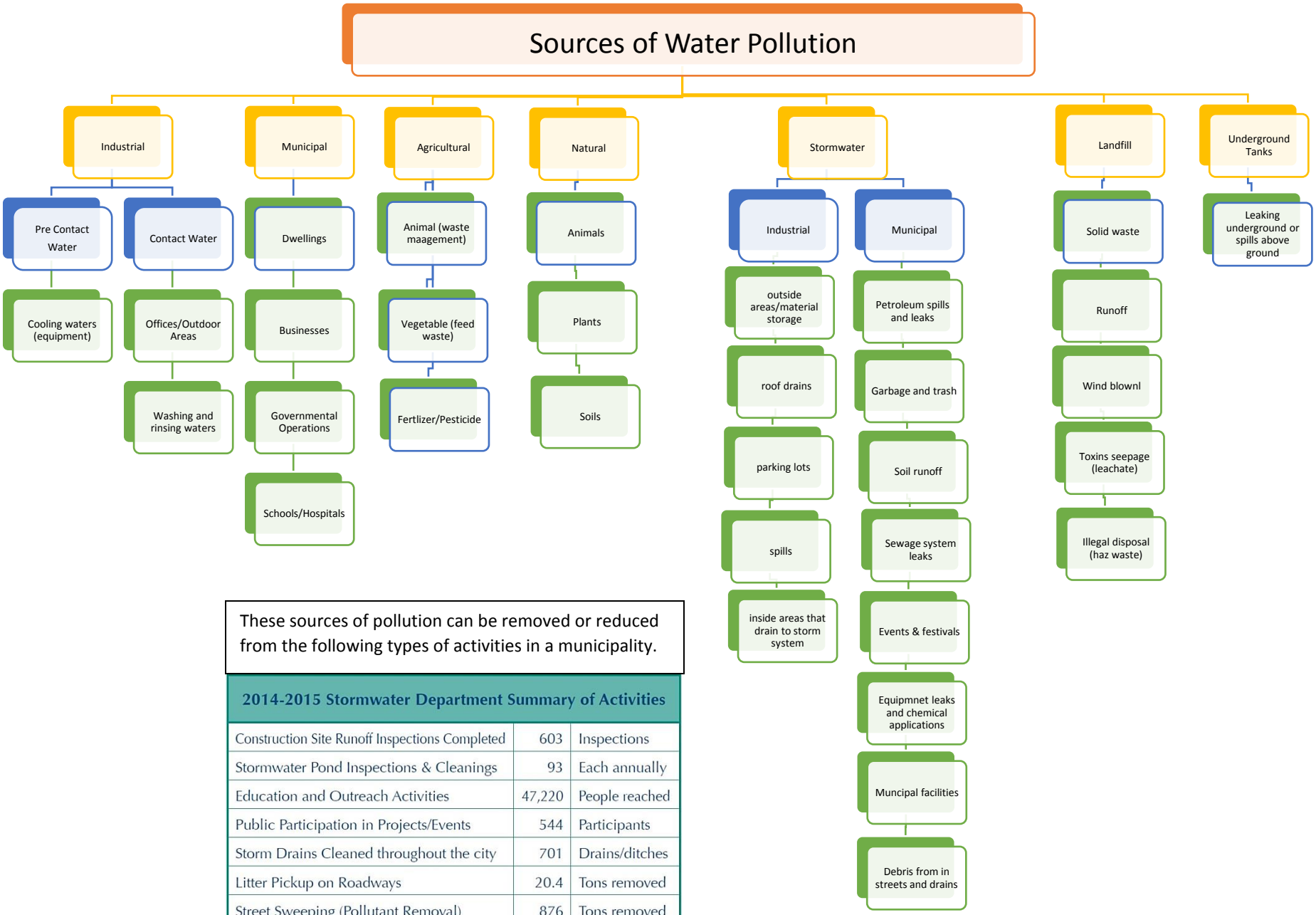
own permits. All state permits must be as strict as the federal permits issued by the EPA. They can be stricter, but not less strict.

Stormwater Permits help reduce the pollution.

It was not until **1987**, however, when the **Water Quality Act** was added by congress to include other pollution sources, like stormwater, into the permitting program to be regulated as nonpoint source pollution. These new regulations were created in two phases, the **NPDES Phase I** and **Phase II** permitting programs. **Nonpoint source pollution** comes from many different sources such as runoff from land, precipitation, deposits from the atmosphere, drainage, or any other water seepage. Stormwater permit programs were developed across the nation to address different sources of these pollutants including industrial facilities, city government's streets and drains, agriculture and construction site stormwater runoff.

The History of Stormwater Permits

1972 **Clean Water Act**	•Stormwater includes storm and rain runoff, snow melt, surface runoff and drainage. •Generally only regulating major manufacturing facilities with known contaminated stormwater runoff that had histories of polluting waterways.
1987 **The Water Quality Act**	•Developing a permit system to require stormwater permits for cities with 100,000 people or more. Large cities only. •New classifications including 2 new types of stormwater permits: municipal and industrial. Industrial for companies, and municipal for cities or towns.
1990 **Phase I Stormwater Rule**	•Phase I- Municipal stormwater discharge permits issued for cities with populations over 100,000. Two types of permits: **Large municipalities** (over 250,000) and **Medium municipalities** (100,000-250,000). •Two new types of Industrial permits: General permits and Individual permits.
1994 **Combined Sewer Overflow Control Policy**	•EPA requires municipalities to create short-term and long-term plans and meet 9 Minimum Controls to reduce combined sewer overflows. When wasteater sewers backup and overflow into streets it gets to stormdrains and streams and creeks. New programs must address and reduce this. •Waste water and sewage should go to treatment plant and stormwater pipes are kept separate.
1999 **Phase II Stormwater Rule**	•Phase II Municipalities, industries, and construction sites now regulated and permit programs began development. • Small municipal stormwater systems added for urban areas *under* 100,000 people. Permits first issued in 2003. •Stormwater Management Plans must be created with 6 minimum control measures and Stormwater Pollution Prevention Plans.

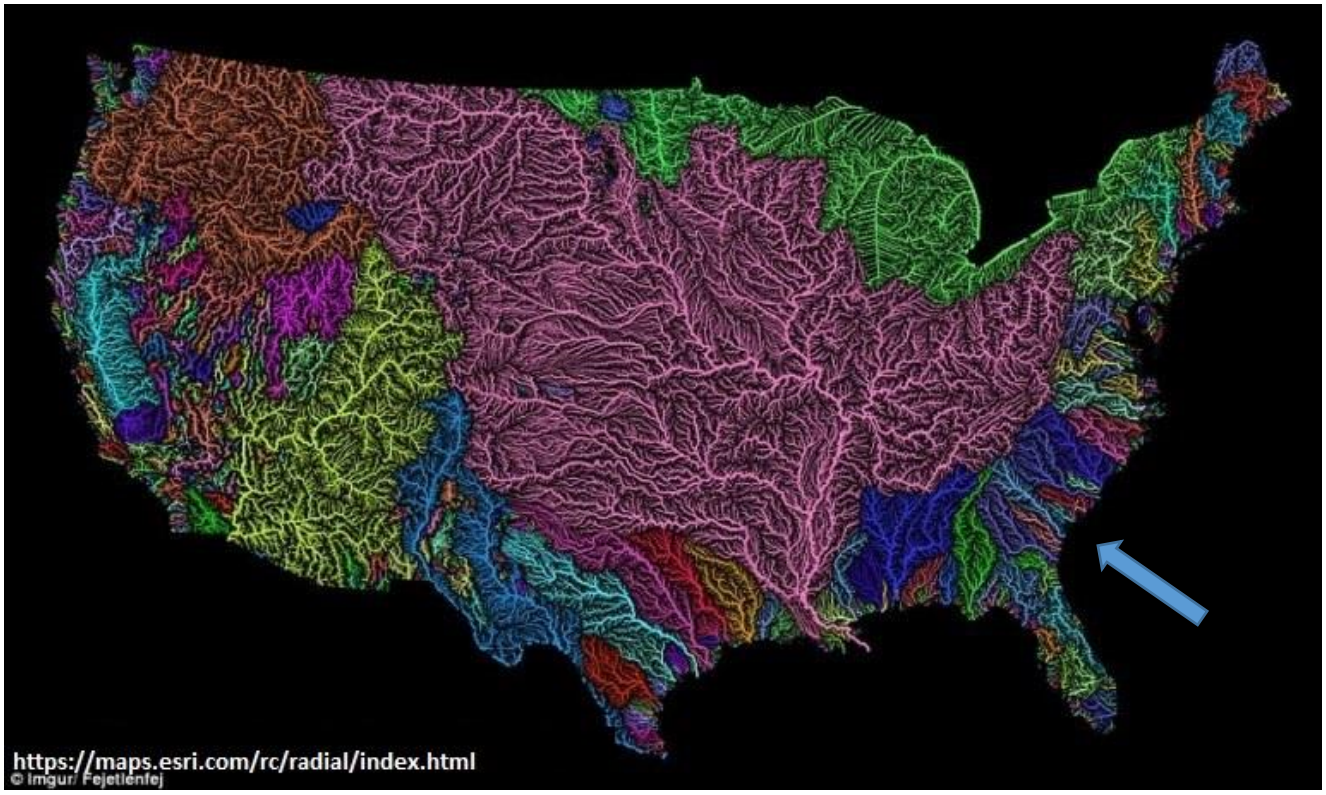


These sources of pollution can be removed or reduced from the following types of activities in a municipality.

2014-2015 Stormwater Department Summary of Activities		
Construction Site Runoff Inspections Completed	603	Inspections
Stormwater Pond Inspections & Cleanings	93	Each annually
Education and Outreach Activities	47,220	People reached
Public Participation in Projects/Events	544	Participants
Storm Drains Cleaned throughout the city	701	Drains/ditches
Litter Pickup on Roadways	20.4	Tons removed
Street Sweeping (Pollutant Removal)	876	Tons removed
Household Hazardous Waste Collection	9.98	Tons collected
Storm Pipe Repairs	1,724	Linear feet

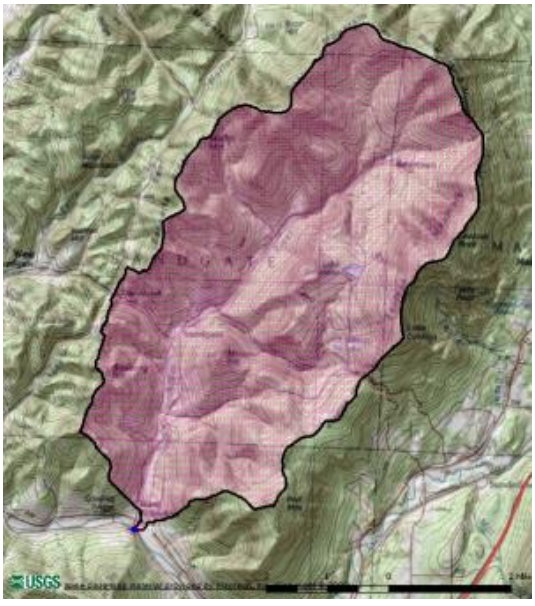
Where is the pollution and how do we measure it?

National Watershed - the United States is made up of a network of watersheds defined by EPA by where the water flows. But there are small towns all along these streams and rivers, and they are the focus to resolve the problem.



Looking at this map, you can clearly see the size of some of the nation's watersheds. ***The light pink watershed that takes up most of the map is the Mississippi River watershed****. Looking at this map, it may make it more clear to see how one plastic bottle can travel through the entire country almost, and end up in our ocean. Everything drains to the oceans, eventually.*

City and towns have small segments of watersheds that they can focus on. By creating laws that each small town must follow, the entire watershed in the nation will become cleaner and water quality across the country and in our oceans will be better. [Note: the ***Savannah River Watershed*** *is also shown (in light blue arrow)]*



What is a watershed?

A **watershed or drainage basin** is an area of land where water drains to a common waterway such as a stream, lake, estuary, wetland, river, or even ocean. Watersheds come in all shapes and sizes. They cross local, state and national boundaries. No matter where you are, you're in a watershed! This small watershed is where the hills in the town force water down to a common stream or smaller streams and then dump into the larger river at the bottom of the photo.

Watersheds are made up of networks of different types of conveyances for water. Watersheds can be looked at from a state wide basis or they can be looked at more closely by county or city. When looking at a watershed on a smaller scale, they can be divided into "drainage basins"

or "sub-watersheds". **Knowing the watershed is critical to tracking down pollution sources.**

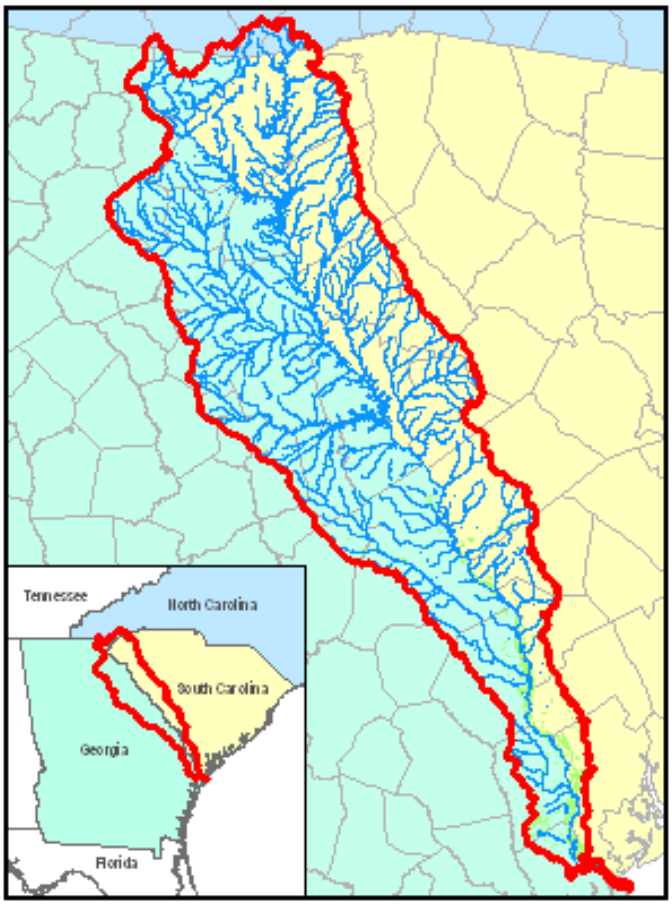
Each watershed is made up of drainage basins that contain different types of streams. Perennial, intermittent or ephemeral streams generally lead to a main branch or receiving water at the lowest point in a watershed or drainage basin. Due to gravity, all rainwater that falls drains to the lowest point in an area (including underground).

Perennial streams are identified by well-defined banks and natural channels that have continuously flowing water year round.

Intermittent streams have well defined banks and natural channels that typically have flowing water from a headwater source for only a portion of the year.

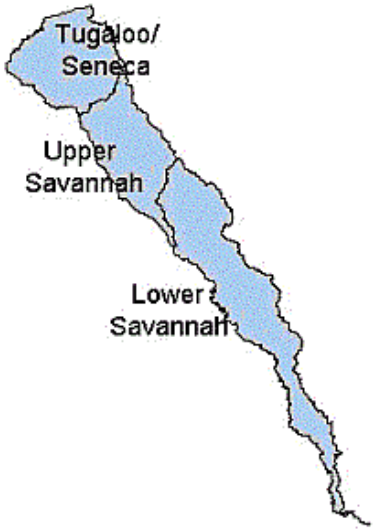
Ephemeral streams do not have well defined channels and flow only in response to rainfall.

Groundwater seeps: groundwater routinely seeps up to the surface throughout the community. The water makes up a lot of the headwater sources of streams. Groundwater will flow much more heavily during wetter periods of time. Other times, during dry conditions, the water will disappear.

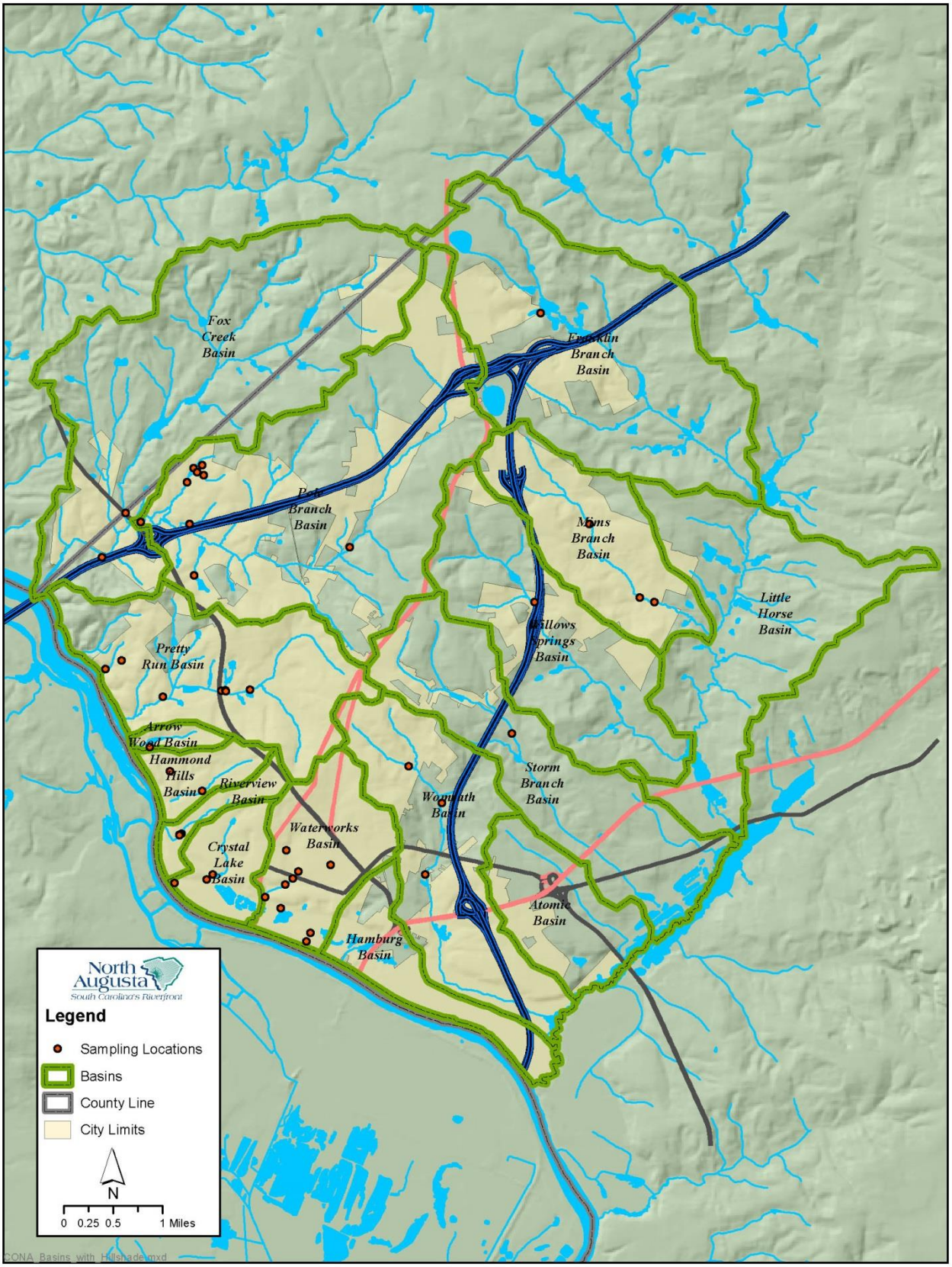


Savannah River Basin

The CSRA falls within the Savannah River Basin which incorporates 35 watersheds and some 2.9 million acres within South Carolina (portions of the basin are located in North Carolina and Georgia). The Savannah River Basin is divided into **three regions**: the **Tugaloo/Seneca**, the **Upper Savannah** and the **Lower Savannah**. Augusta and North Augusta is located mostly within the **Lower Savannah River Basin**.



https://sites.google.com/site/savannahriverbac/what-is-the-savannah-river-basin



Watershed with sub basins of North Augusta, South Carolina with water monitoring sample locations.

Looking for the problem, Stream Water Monitoring

Ambient stream monitoring

Within the lower Savannah River basin, there are multiple sampling locations that the state of South Carolina samples routinely and some randomly. There are also sample stations in Georgia that the state monitors. Each state is required to assess the quality of water in its streams. Local communities may also sample the water. After the assessment, the data and information is provided to the federal government every two years, and every five years a watershed report is prepared for that watershed based on the water samples, the land uses, the population and the industries located in the watershed. These documents are required to make decisions.

For an ambient sample, you pull the sample from the stream during dry weather to see what the normal range of pollutants is for that stream. You may find that a pollutant is present in a high concentration during dry weather. That is a clue for you to go and see if you can find the source of the pollutant. For example, you find a high level of nitrogen in a stream during dry weather. You also find that ammonia and phosphorus are high. These are considered **nutrients** and can come from several sources.

TSS measures the total solids (dirt/debris).

Using the Table 2.2, what would you look for first? The table indicates wastewater as a culprit and where it could be coming from. So checking for leaking sewer lines, leaking septic tanks, illegal pipes, or looking for animals in the creek like cows from a farm would be a good start.

When samples are taken, they are analyzed for many pollutants. Most common pollutants analyzed are nutrients (phosphorus, ammonia, nitrates, and others). Also, since bacteria can make swimmers sick, bacteria are commonly measured in stream segments. Additionally, heavy metals, pesticides, herbicides, total suspended solids (TSS) *see photo*, pH, dissolved oxygen, temperature and sometimes soil samples in the stream bed are taken for analysis. Occasionally, fish tissue samples are collected and tested too. Another measure of the health of the stream is to look at the insects. A **macroinvertebrate** assessment of the stream may be conducted. All of this data can result in the stream being listed as impaired for each that is out of limits or several of the pollutants measured. Generally, only one or two parameters will get a stream listed as impaired.

Stormwater Rain Sampling - First Flush vs 24 hour Composite

Other times you might want to sample a stream during rainfall events. Since the first flush of rainfall, (the first 1 inch of rain) washes off all of the streets, yards and rooftops right away, it is good to take a **"first flush" rain sample**. This will tell you what the highest concentrations of certain stormwater pollutants are that can be washed into the streams from the stormwater pipes in the community. For information about how much the pollution lingered in the water, you can also pull a **24-hour composite sample**. In the composite sample, you take one sample of a certain amount every 30 minutes or one per hour over 24 hours. The composite sample is mixed together to give you the 24 hour load of pollution that entered the stream, if you know the volume of rainfall or flow of the stream. To take these types of samples, a special sampler is placed outside by the stream. It is connected to a rain gage. The gage is used to trigger the machine to start after one-inch of rain is collected. At the same time this sample starts, the machine also starts collecting one sample every 30 minutes (or per hour) for 24


Stormwater sampler for 24 hour and 1st flush.

hours. The machine can also record the amount of flow that passes by (if a gauge is available). The samples are stored in the machine in two bottles, one for the First-Flush sample and the other for the 24 hour composite samples. Once the sample time is up, the samples are collected and individual samples of the two jugs are sent to a lab for testing. Bacteria is one sample that you cannot test with this method.

Impaired streams - The *DREADED* 303D List.

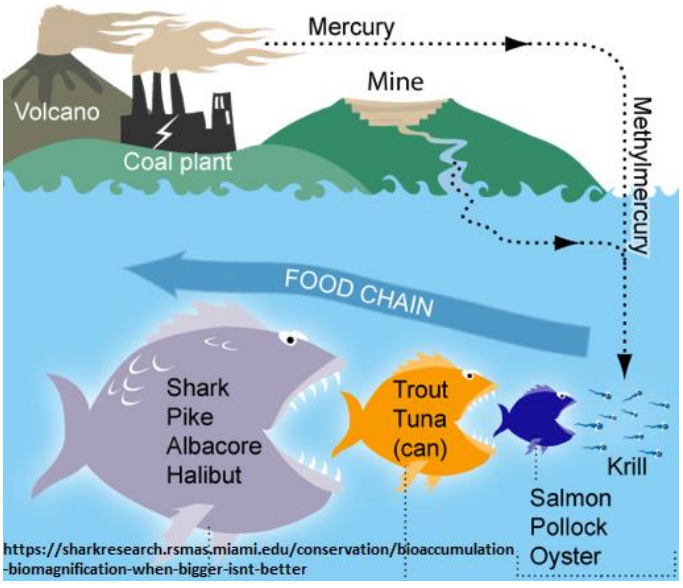
When a stream segment is considered impaired, or polluted, it is because at least 10% of the samples that were measured for a specific pollutant resulted in higher than the state requirement for that pollutant if there is a state standard (or requirement). *For example*, the state requirement for bacteria (E. coli) may be 400 colonies per 100ml of water. If a sample is pulled every month and the results of those samples is over 400 for at least 10% of the samples pulled, then that stream segment is listed on an impaired stream list and sent to the EPA. This list is called the 303D list. The 303D list is updated every two years.

There are only two ways to get a stream segment off the list. One is to prove through sampling that the stream is no longer impaired. The other is to create a plan for that stream to make sure it is not impacted any further by the pollutant through a **Total Maximum Daily Load (TMDL)** assessment and plan. The TMDL plan requires cities, towns or citizens to look at the stream closely when making development decisions such as where to place a wastewater plant or a farm. Those businesses have wastewater discharges. If a stream is impaired for bacteria, then the new businesses cannot discharge a greater amount of bacteria than the level determined by the TMDL plan. This can also prohibit certain uses of the land so that no further damage occurs to the stream. Most people do not like to be told that they cannot develop the land due to impaired streams and may challenge the city or town in court.

Tracing down the pollution and getting rid of it!

What are pollutants found in stormwater and their cause and effect?

Stormwater picks up a variety of pollutants depending on what the rain and runoff come in contact with. Common pollutants include different types of nutrients and chemicals like nitrogen, phosphorus, ammonia, and chloride. These can come from places like yards, gardens, and golf courses when people use too many pesticides, herbicides, insecticides, fungicides, or fertilizers. All sorts of trash can make its way into stormwater when people litter or their trash cans are knocked over. Cars also contribute increasingly to stormwater pollution in the form of greases, oils, and heavy metals. Many metals like mercury, lead, copper, and zinc can make their way into stormwater from rusty cars, worn out car brakes, or settling from the atmosphere. Accumulation of pollutants in wet habitats leads to unhealthy wildlife. *For example*, coal plant air emissions contain a form of mercury, which settles from air pollution onto the ground to be picked up by runoff. Once this mercury makes its way into creeks and streams it can bioaccumulate in aquatic wildlife resulting in high levels of mercury in some fish. **Bioaccumulation** of a pollutant occurs as smaller organisms are eaten by larger organisms causing the amount of pollution to increase through the food chain.



The Table 2.2 includes more information on potential stormwater pollutants and their sources as well as their impacts on waterbodies. Polluted stormwater results in decreased water quality throughout the watershed. This can mean local concerns (e.g., contaminated drinking water) or issues downstream (e.g., polluted estuaries) as the water

makes its way to the ocean. Polluted estuaries hurt fishing and seafood industries. If you are a stormwater investigator, you need to know where these pollutants come from to trace where they are entering your watershed.

Why sediment is considered a pollutant: Sediments (dirt and debris) are a very serious stormwater pollutant that can wipe out a stream and its entire population by burying the stream. Sediments also carry spilled or historical chemicals to the stream. Sediments can create significant discolorations in the water that is enough to block sunlight, stopping natural processes killing plants and animals over time. Construction sites are disturbing tons of sediment. That is the most likely place to find sediment entering storm drains or being dumped into creeks during heavy rains. For that reason, construction sites must be managed for stormwater. Techniques to prevent offsite impacts of soil are silt fences, vegetated swales, sediment traps, grassing bare areas, working on small parts of the site at a time, and installing filters at all drains.

Table 2-2. Summary of Common Pollutants and Sources

Pollutant	Potential Sources		Impacts on Waterbody Uses
	Point Sources	Nonpoint Sources	
Pathogens	• WWTPs • CSOs/SSOs • Permitted CAFOs • Discharges from meat-processing facilities • Landfills	• Animals (domestic, wildlife, livestock) • Malfunctioning septic systems • Pastures • Boat pumpout facilities • Land application of manure • Land application of wastewater	• Primarily human health risks • Risk of illness from ingestion or from contact with contaminated water through recreation • Increased cost of treatment of drinking water supplies • Shellfish bed closures
Metals	• Urban runoff • WWTPs • CSO/SSOs • Landfills • Industrial facilities • Mine discharges	• Abandoned mine drainage • Hazardous waste sites (unknown or partially treated sources) • Marinas • Atmospheric deposition	• Aquatic life impairments (e.g., reduced fish populations due to acute/chronic concentrations or contaminated sediment) • Drinking water supplies (elevated concentrations in source water) • Fish contamination (e.g., mercury)
Nutrients	• WWTPs • CSOs/SSOs • CAFOs • Discharge from food-processing facilities • Landfills	• Cropland (fertilizer application) • Landscaped spaces in developed areas (e.g., lawns, golf courses) • Animals (domestic, wildlife, livestock) • Malfunctioning septic systems • Pastures • Boat pumpout • Land application of manure or wastewater • Atmospheric deposition	• Aquatic life impairments (e.g., effects from excess plant growth, low DO) • Direct drinking water supply impacts (e.g., dangers to human health from high levels of nitrates) • Indirect drinking water supply impacts (e.g., effects from excess plant growth clogging drinking water facility filters) • Recreational impacts (indirect impacts from excess plant growth on fisheries, boat/swimming access, appearance, and odors) • Human health impacts
Sediment	• WWTPs • Urban stormwater systems	• Agriculture (cropland and pastureland erosion) • Silviculture and timber harvesting • Rangeland erosion • Excessive streambank erosion • Construction • Roads • Urban runoff • Landslides • Abandoned mine drainage • Stream channel modification	• Fills pools used for refuge and rearing • Fills interstitial spaces between gravel (reduces spawning habitat by trapping emerging fish and reducing oxygen exchange) • When suspended, prevents fish from seeing food and can clog gills; high levels of suspended sediment can cause fish to avoid the stream • Taste/odor problems in drinking water • Impairs swimming/boating because of physical alteration of the channel • Indirect impacts on recreational fishing
Temperature	• WWTPs • Cooling water discharges (power plants and other industrial sources) • Urban stormwater systems	• Lack of riparian shading • Shallow or wide channels (due to hydrologic modification) • Hydroelectric dams • Urban runoff (warmer runoff from impervious surfaces) • Sediment (cloudy water absorbs more heat than clear water) • Abandoned mine drainage	• Causes lethal effects when temperature exceeds tolerance limit • Increases metabolism (results in higher oxygen demand for aquatic organisms) • Increases food requirements • Decreases growth rates and DO • Influences timing of migration • Increases sensitivity to disease • Increases rates of photosynthesis (increases algal growth, depletes oxygen through plant decomposition) • Causes excess plant growth

Note: WWTP = wastewater treatment plant; CSO = combined sewer overflow; SSO = sanitary sewer overflow; CAFO = concentrated animal feeding operation; DO = dissolved oxygen.

Small MS4 Permits: These are the requirements of the small MS4 Permit that cities and towns must do. Look over each of these and consider each. What is the most important aspect of the programs? Do you think a permit like this will help remove pollution from communities? Why? Pick one of these 6 things and consider how it works to solve the problem.

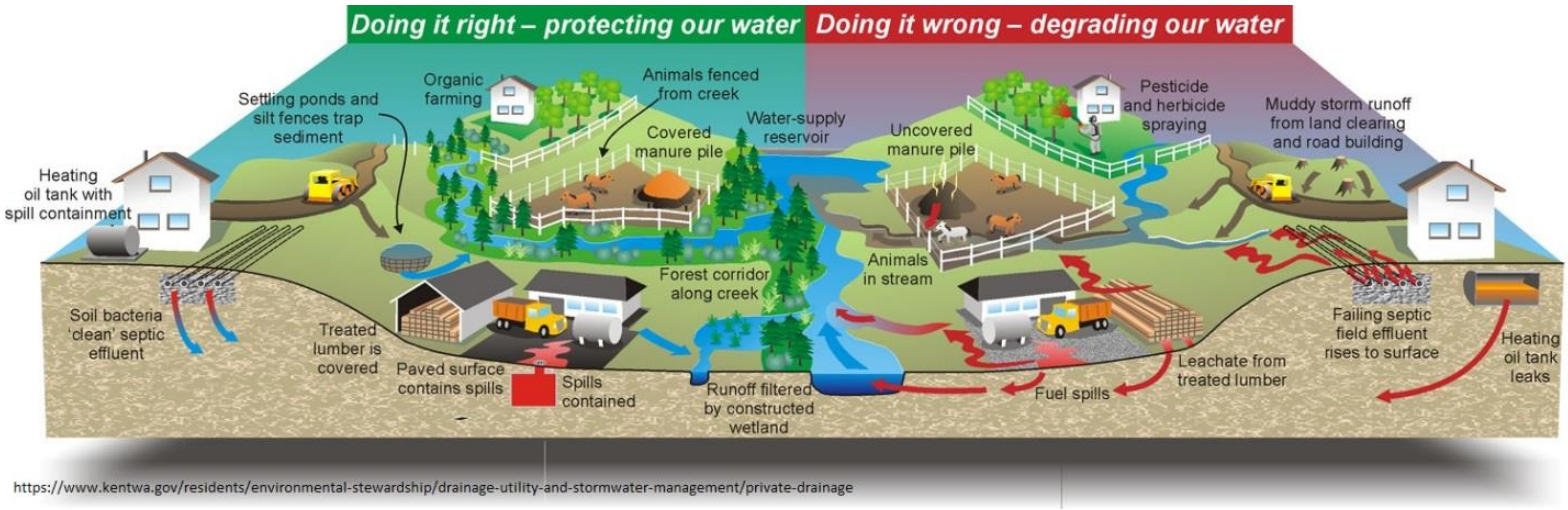
Table 2.3 Stormwater Permits for Cities - Six minimum control measures to prevent pollution from entering our waterways.
1) Illicit Discharge Detection & Elimination
Monitoring streams, rivers, and oceans
Mapping watersheds
Walking streams
Baseline stream sampling - Random
Stream sampling – TMDL, Impaired – Clean-up plans and actions!
Storm drain sampling
Types of sampling: Bacteria, Optical Brighteners, Nutrients, Metals, etc.
Sanitary Sewer Infrastructure Inspection, Maintenance & Inflow & Infiltration (I&I) Testing
Inspect the system of sewage pipes and maintain them so they don't leak.
Inspect all sewer manholes, sewer cleanouts, pump stations, sewer connections and pipes and make sure they are not leaking, broken. Fix problems ASAP.
Visually inspect all citizen reports of leaking sewer, sewer overflows or strange odors to find and fix problems
I&I - smoke testing, dye testing and TV inspection sewers
Drop smoke bombs in sewer lines. Then look for smoke coming from stormwater boxes, if so, there is a leak where one is getting in the other.
Put dye in sewer lines and look in storm drains or nearby streams for color, to verify connections or leaks into each.
Place cameras in sewer lines to visually inspect for leaks or broken areas.
Capacity, Management, Operation, Maintenance (CMOM) Sewer System Program
Used to Maximize Prevention of Sanitary Sewer leaks and Overflows
Assess your system, map it too
Assess all overflow locations and nearby problems that may be causing it
Plan and budget for repairs, prioritize
Assess staff and resources to make sure you have the capacity to maintain your system
Have emergency plans in place to address issues quickly.
Inspection - septic tank owners
Stormwater Infrastructure Inspection, Maintenance & Inflow & Infiltration (I&I) Testing
Stormwater pipes, catch basin, junction box, and outfalls
Stormwater pond inspection & maintenance
Creating Source Control Programs
Preventing stormwater pollution at the source
Treating stormwater where it matters most
TMDL Implementation Plans
GA Impaired Waters Plan
SC TMDL Monitoring and Implementation Plan
2) Public Outreach and Education - Educate young to old about stormwater pollution and its prevention.
3) Public Participation – involve the community in decisions and activities to promote stormwater pollution prevention and awareness
4) Construction Permitting – review plans for the project and issue permits to construction project sites *to prevent stormwater pollution from entering local streams from the construction*.
Do ponds that are being designed treat stormwater and remove pollution?

	Are controls in place to make sure that equipment spills or leaks won't impact streams?
	Are controls in place to make sure that mud and sediment won't impact streams during construction?
	Are controls in place to make sure that long term measures are being built to prevent impacts in the future?
	Are low impact development practices being considered and encouraged?
	Do the developers have an inspector to monitor the project once a week?
5)	Post Construction Retrofitting – investigate older areas of the community to look at the stormwater infrastructure.
	Can stormwater devices be retrofitted to include stormwater treatment or infiltration practices?
	What needs to be done to get this to happen?
	What incentives can a city offer to get owners to upgrade their system?
6)	Community Operations – cities and towns need to review their operations and educate staff to prevent stormwater pollution from maintaining the city and its infrastructure.

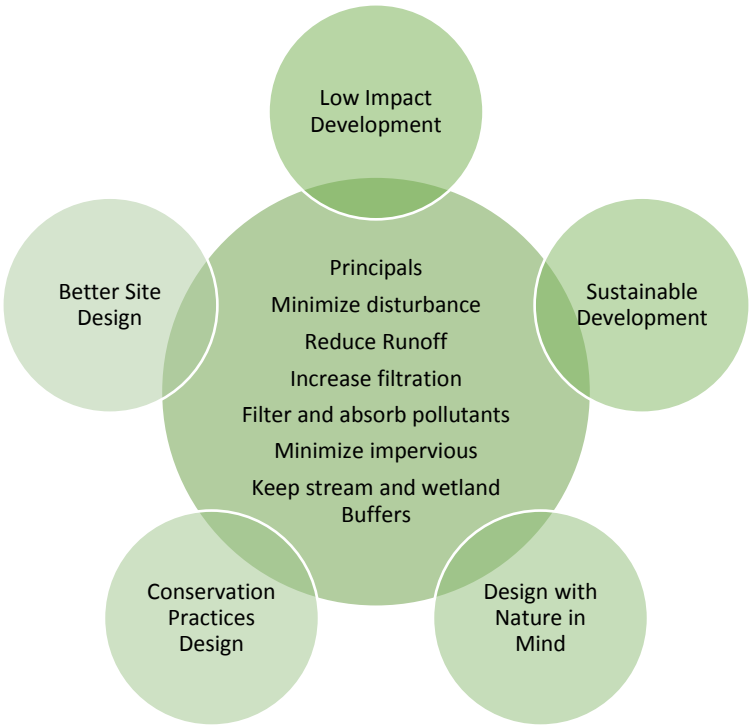
Smarter Ways to Grow – As Cities and Towns Build new neighborhoods, offices and stores.

The following pages are to show you what new things are being done to prevent stormwater pollution in our streams, rivers and oceans. Look around your community and see if you can spot any of these new methods.

Combating Stormwater Pollution - **Best Management Practices <u>BMPs</u>**



NEW DEVELOPMENT KEY CONCEPTS



Ponds built to clean stormwater: In the past ponds were built just to detain or hold water and release it slowly no matter how polluted. Since the stormwater rules were passed, engineers and scientist have learned of ways to use the ponds to clean pollution from stormwater. Now ponds in SC are required to also treat the stormwater before it is released. Each pond has features within them that will allow for pollution to filter out of the water either through falling to the bottom of the pond or for plants and wetland areas to filter the pollution prior to the release of the water.

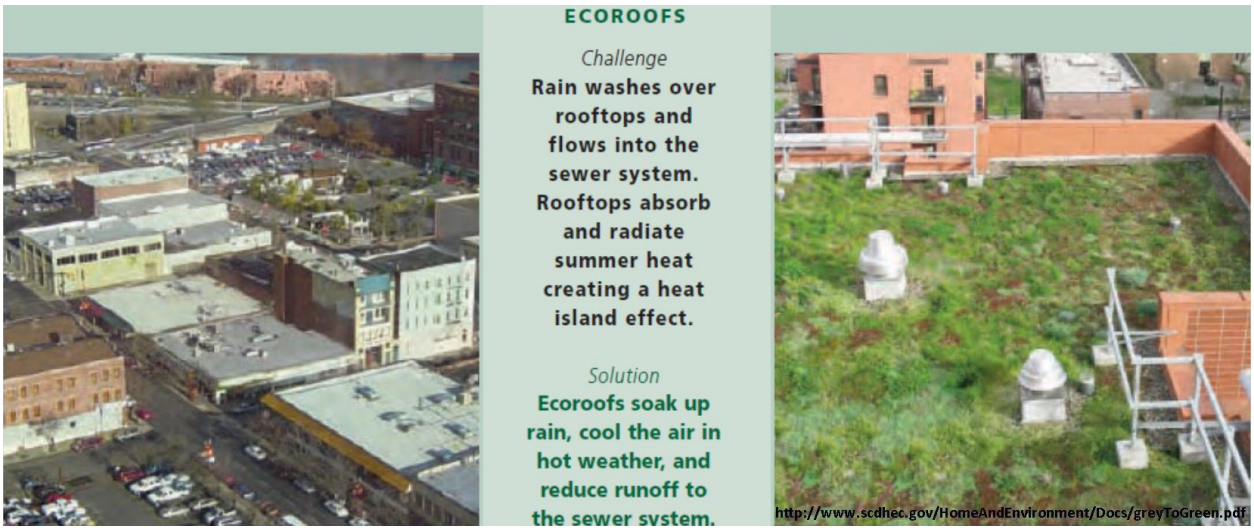
Old pond with no treatment feature, water in and out.

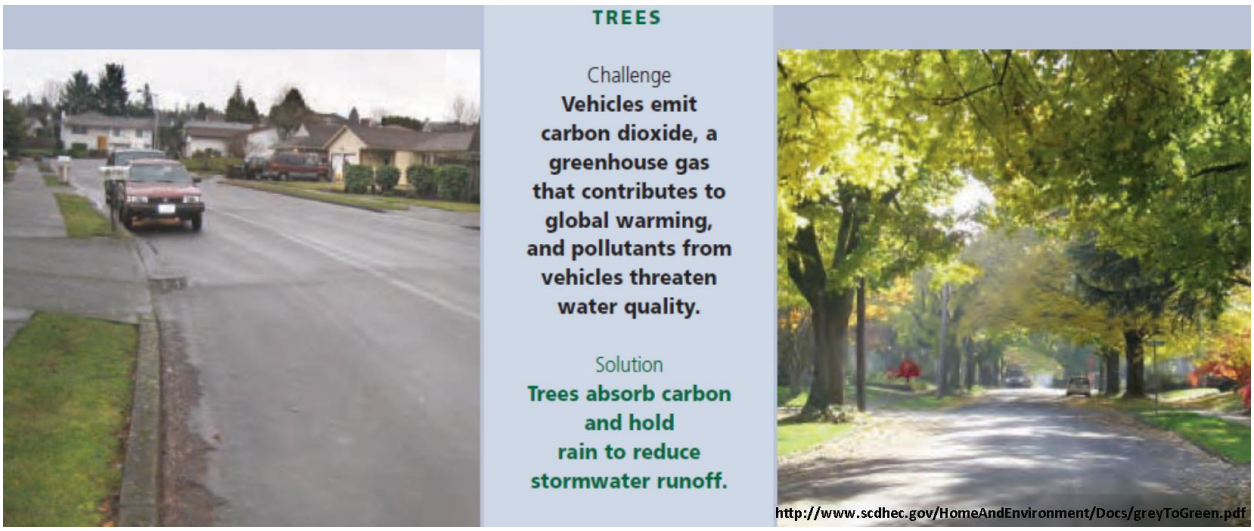
New stormwater treatment ponds filter water first.

The new ponds are not usually perfectly round or oblong; they have meandering features where the water flows around islands of vegetation or over berms that use rock to filter out trash and debris. Sediment is allowed to settle to the bottom before water is discharged out to the streams. These features are proving to work very well in reducing stormwater pollution from new residential subdivisions or large department stores.

Many communities are trying to find ways to encourage owners of older ponds to retrofit them to treat stormwater like the newer ponds do. It is up to the landowner or business owner to make the upgrades. Most are easy to add. In the future, it will be important to upgrade as many as possible to prevent stormwater pollution. Learning new ways to do stormwater pond upgrades will be good for students today. It costs money and the business or owner must get a benefit. Many towns offer reduced stormwater fees for these owners as an incentive to save money for upgrading their ponds. When owners learn they can save hundreds of dollars a month, it makes it easier to spend the money to fix the ponds.

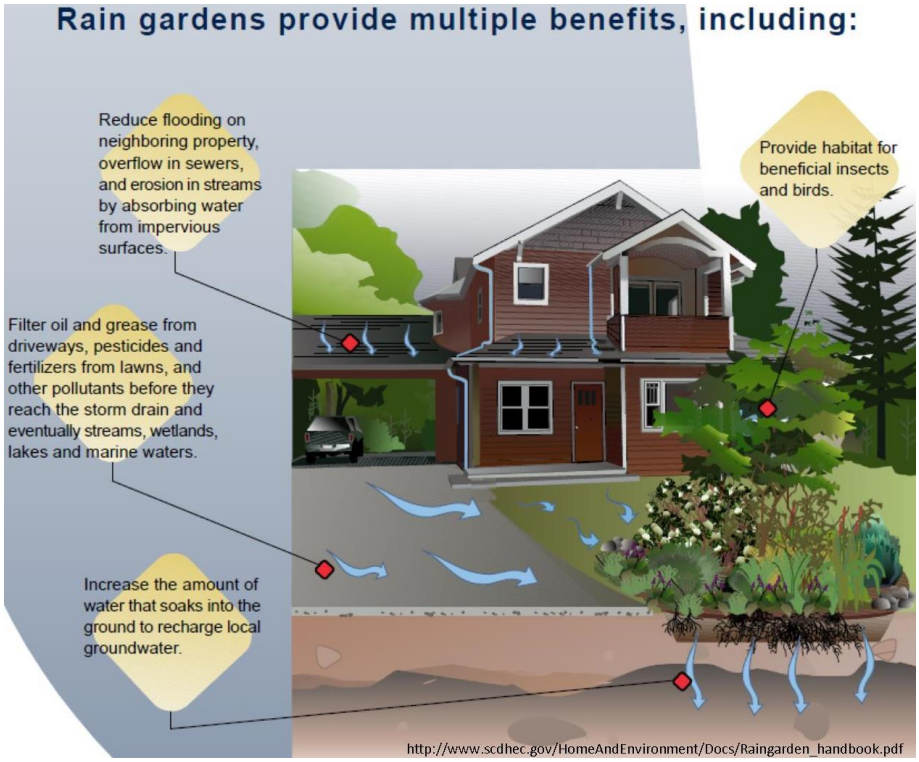
The following practices are being used also:





Water filters through instead of running off of Green Parking Lots - Less Runoff, Less pollution.

New methods in our neighborhoods - Residential practices we can do at home.



Green Stream Corridor Buffers to filter Runoff

Stormwater management is a process and method to reduce stormwater runoff and stormwater pollution. It is new to many people that are used to the old ways of doing things.

As cities and towns grow, we will learn more ways to prevent the problems we see. Use the information you have learned in this packet to consider reducing stormwater runoff, reducing stormwater pollution, and growing our communities so that this problem will become a thing of the past.

Resources:

1. Stormwater: http://www.scdhec.gov/HomeAndEnvironment/Water/Stormwater/
2. http://www.scdhec.gov/HomeAndEnvironment/Water/Stormwater/EducationalResources/
3. Point and Nonpoint Source Pollution: https://www.epa.gov/nps/what-nonpoint-source
4. Drainage services: http://www.blockeddrainsinsleaford.co.uk/wp-content/uploads/2016/07/drainage-services.png
5. Water management strategy: http://www.wbarchitects.com/images/sized/images/uploads/Bayou_St_John_Proposal_3-596x479.jpg
6. National watersheds: http://www.hiddenhydrology.org/category/explorations/
7. Copper graph: http://www.sdcoastkeeper.org/blog/urban-runoff/first-flush-of-urban-runoff